Proceedings of the 1st International Conference on Environmental Science and Sustainable Development

22-23 October 2019, Jakarta, Indonesia

ICESSD 2019

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Preface

We are delighted to introduce The Proceedings of the International Conference on Environmental Science and Sustainable Development in 2019, which is the result of several months' collaboration with EUDL (European Union Digital Library) – EAI (European Alliance for Innovation).

Praise our thanks to God Almighty, because for the blessings of His grace, the School of Environmental Science, Universitas Indonesia has successfully held “The 1st International Conference on Environmental Science and Sustainable Development (ICESSD)” with the theme: “The Strengthening of Sustainable Development Goals (SDGs) in Southeast Asia”. The 1st ICESSD 2019 can be held on cooperation between the School of Environmental Science, Universitas Indonesia and Center for Southeast Asian Studies (CSEAS) Kyoto University, and Graduate School of Asian and African Area Studies (ASAFAS) Kyoto University. The 1st ICESSD 2019 which lasted for 2 days precisely on Tuesday-Wednesday, October 22-23, 2019 at the Sari Pacific Hotel Jakarta, Central Jakarta, Indonesia. The conference brought together a number of environmental experts from various disciplines, as well as practitioners, students and lecturers.

This proceeding contained 38 papers which were carefully selected and reviewed by the steering committee and reviewers and through several turnitin and proofreading checks by the editors. Meanwhile, all papers in this proceeding are divided into several sub-topics, i.e.: Ecosystem And Biodiversity Conservation (consists of 2 papers); Environmental Planning And Management (consists of 4 papers); Water And Waste Management (consists of 8 papers); Governance, Culture, and Politics (consists of 2 papers); Sustainable Energy And Renewable Energy (consists of 3 papers); Spatial Planning And Regional Analysis (consists of 6 papers); Community Engagement (consists of 4 papers); Social Movement And Environmental (consists of 3 papers); and Strengthening Of Sustainable Development Goals, with amount of 6 papers.

We hope that the results of this conference can make a profound contribution as well as scientific criticism, especially for environmental problems that we are facing in this century. Hopefully this can be useful, not only for academics, but also for practitioners, the private sector involved in this matter and most importantly the decision makers related to environmental and sustainable development issues.

On behalf of the ICESSD 2019 committee.
Conference Director,
Dr. Hayati Sari Hasibuan, ST., M.Si.
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Mangrove's Vegetation
Structure and Composition
(A Study: Manado City, North Sulawesi Province)

Alve Hadika¹, Mahawan Karuniasa²
{alvehadikaa@gmail.com¹, mahawancac@yahoo.com²}

School of Environmental Science, Universitas Indonesia. Salemba Raya Street, RW.5, Senen Districts, Daerah Khusus Ibukota Jakarta¹,²

Abstract. This study aims to obtain results regarding the structure and composition of mangrove vegetation in the City of Manado, North Sulawesi. The research method used was descriptive and exploratory methods, while to obtain vegetation data was done by purposive sampling and plot sampling methods in each transect. Samples were taken by stratified random sampling. At the study site, no mangrove damage was found. This is thought to be caused by the role of the people of Manado City who care about the mangrove ecosystem and the research location was not located at reclamation location. In general, mangrove vegetation in Manado City was dominated by Sonneratia Alba species. With this structure and composition data, in the next step, the government, the community or other stakeholders can monitor and maintain the condition of this ecosystem so that mangroves can grow and not be damaged.

Keywords: Conservation, Mangrove, Vegetation structure, Vegetation composition.

1. Introduction
Vegetation structure is a structured and stratified live stand, where the vegetation cover is obtained through the results of diameter, height, spatial distribution, diversity, and types of vegetation [7]. Fachrul added that the composition of vegetation is a list of plants found in a location or community. Mangroves are plants that live in the intertidal region (tides). This is in accordance with the statement of Irwanto [10] that mangroves are plant communities that live between sea and land and are affected by tides, currents, fresh water, and sedimentation. Mangroves are often found in estuary areas, the meeting place between river mouths and sea water.

Mangroves have different species distribution in each environmental condition where mangroves grow. Tomlinson [21] said that the distribution of mangrove vegetation in the world can be divided into 2 distribution areas, which shows the differences in the composition of mangrove vegetation from each region based on longitude. The two distribution regions include: The western region (New World Tropics), which is located at 15° West - 120° East, covers Western Africa, South America and the North Pacific. In total only 8 true mangrove species are found in this region. The majority of these species are concentrated in the western part of Colombia. The eastern region (Old World Tropics), located at 15 ° East - 180 ° East, covers Eastern Africa, India, Southeast Asia, Australia, and the Western Pacific Region. Total true mangrove species that can be found in this region number more than 40 species. Mangrove life can be influenced by two things, namely human factors and natural factors. Ministry of Forestry [5] states that human factors are the dominant
factors causing damage to mangrove forests. Human factors also play a positive role, namely with conservation efforts. This conservation can be carried out with rehabilitation and protection of the area [7]. Conservation with rehabilitation is carried out with mangrove planting activities, while efforts to protect the area are carried out by establishing an area such as a national park, protected forest, wildlife reserve and ecotourism development area.

Efforts to protect the area in the form of a National Park in Indonesia are located in North Sulawesi Province, namely Bunaken National Park (TNB). The total area of this National Park is 89,065 ha which consists of two parts, namely the northern part of TNB (covering 5 islands namely Bunaken, Manado Tua, Mantehage, Siladen and Nain plus Tanjung Pisok around the Molas village to Tiwoho village) and the southern part of TNB (TNB) covering territorial waters from Poopoh village to Popareng village. Bunaken National Park is one of the national parks that has a wealth of natural resources, including mangrove ecosystems, seagrass ecosystems, and coral reefs, where these three ecosystems are important coastal ecosystems [16].

Manado City is one of the cities with mangrove area which is smaller than the area in other Cities / Regencies in North Sulawesi Province, namely with an area of 95,346 Ha, which is much smaller than North Minahasa Regency with an area of 4210.71 Ha [15].

There is no damage, however by the finding of reclamation, it causes the needs of inventory in order to start the effort of conservation. Research sites include; Meras Village, Molas Village and Bohowo Village are assumed to have the largest mangrove area and different ecosystem conditions. This study was conducted to determine the structure and composition of mangrove vegetation in the city of Manado, North Sulawesi, because this conservation effort can begin with an inventory of the structure and composition of mangroves. Inventory of structure and composition can be done by analyzing ecosystem vegetation so that changes or damage to the ecosystem can be known, so that conservation efforts can proceed as they should. The results of the study can be used as a basis for policy making, monitoring changes in environmental conditions, and preservation of mangrove ecosystems.

2. Methods

The research material is in the form of mangrove vegetation in Manado City, covering 3 (three) villages, namely Meras Village, Molas Village, and Bohowo Village. The tools used include transect ropes, stationery, calipers, roll meters, fabric meters, plastic ziplock, GPS, litmus paper, digital cameras, and refractometers.

Sampling structure and composition of mangrove vegetation [12], namely by the method of sampling plots (method of sample sampling). Samples were taken by stratified random sampling, namely by dividing populations or samples into specific groups (strata). The determination of plot and sublot positions is carried out randomly where this has been agreed in advance.

Parameters for tree category and sampling include species, trunk diameter and tree height. Seedling categories include species, number and percentage of cover. Other parameters namely; general tree conditions and environmental conditions (pH, salinity, and water temperature). The method used in determining the location of the purposive sampling method, where at each location carried out three repetitions. The stretched transect measures 10 m x 10 m for the tree category, 5 m x 5 m for the sapling or sapling category and a 1 m x 1 m plot for seedlings or seedling [13]. Tree data with dbh (diameter at breast height) ≥ 10 cm, taken from each 10 m x 10 m plot of the number of tree stands, tree diameter, and species
distribution in the plot. Determination of the position of the measurement of the diameter using the recommendations of Cintron and Novelli [4], namely:

a. Branched stems below 1.3 m and each branch has a diameter of ≥ 10 cm, will be measured as two separate trees,

b. Branched stems above dbh then the diameter will be measured at breast height or under the branches,

c. Stems with root forms supporting / air categories, the diameter will be measured 30 cm above the highest protrusion.

d. Stems that are not straight, branched or have an abnormality, the diameter measurements are taken at 30 cm above or below chest height.

Sampling samples are mangrove vegetation with a stem diameter of 2 ≤ dbh <10 cm and a height of >1 m from a subplot of 5 m x 5 m [13]. Data to be taken in the form of vegetation species and stem diameter. The data taken will be analyzed to calculate the index value, namely Density (K), Basal Area (BA), Relative Density (KR), Relative Dominance (DR), and Important Value Index (INP).

Seedling samples are mangrove vegetation with height <1 m in the subplot 1 m x 1 m [13]. The data will be taken in the form of species, the number of individuals and the percentage of cover to the subplot 1 m x 1 m.

The analyzed vegetation data refers to Mueller-Dumbois and Ellenberg (1974), including:

a. **Density (K)**

Density is the number of individuals per unit in one Region / area [12]. The unit of density value is ind/ha, which is obtained using the following formula:

\[
\text{Density} = \frac{\text{Number of ind. of a species in the whole plot}}{\text{Plot Area}}
\]

B. **Basal Area (BA)**

Basal area is the cover of mangrove forest area by a tree trunk obtained from the measurement of the diameter of the trunk. The stem diameter of each species is then converted into a basal area using the following formula:

\[
BA = \frac{\pi D^2}{4} \text{ cm}^2
\]

Information: 

- \( BA = \) Basal Area
- \( \pi = 3.14 \)
- \( D = \) Diameter of trunk

C. **Relative Density (KR)**

Relative density is the percentage of density of each species in the transect [12]. The value of relative density is obtained using the following formula:

\[
\text{Relative Density} = \frac{\text{Species Density}}{\text{Total Density of all species}} \times 100\%
\]

D. **Relative Dominance (DR)**

Relative dominance is the percentage of cover of a species to an mangrove area. The relative dominance is obtained from the basal area values for tree and sapling species, using the following formula:
\[
DR = \frac{\text{Number of basal species}}{\text{Sample snippet area}} \times 100\%
\]

E. Importance Value Index (INP)
Importance value is obtained to find out how much the domination of species value in a mangrove area. This importance is obtained by adding up the values of relative density and relative dominance (Curtis, 1959 in [19]).

\[
\text{INP} = \text{KR} + \text{DR}
\]

Information: 
- \(\text{NP} = \) Importance Value
- \(\text{KR} = \) Relative Density
- \(\text{DR} = \) Relative Dominance

F. Diversity Index (H')
Diversity index is a characteristic of a community that describes the level of diversity of species of organisms contained in the community (Odum, 1993). Diversity index values refer to Shannon-Wiener (Odum, 1993), with the formula:

\[
H' = \log N - \frac{1}{N} \sum ni \log ni
\]

Information: 
- \(H' = \) Shannon-Wiener Diversity Index
- \(n_i = \) Number of individuals per i-th
- \(N = \) Total number of species

For values of \(H' < 2.303\) it means that diversity is low, values of \(H' 2.303-6.908\) means moderate levels of diversity, and values of \(H' > 6.908\) means high levels of diversity.

G. Uniformity Index (J')
Species Uniformity Index is a comparison between the value of diversity with Ln (natural logarithm) of the number of species [2]. The Uniformity Index formula is:

\[
J' = \frac{H'}{\ln S}
\]

Information: 
- \(J = \) Uniformity Index
- \(H' = \) Shannon-Wiener Diversity Index
- \(S = \) Number of species

According to Krebs (1989), the Uniformity Index ranges from 0-1,

- \(0.6 \leq J < 1\) : High species uniformity
- \(0.4 < J \leq 0.6\) : Medium species uniformity
- \(0.4 \leq J\) : Low species uniformity
3. Results and discussions

3.1 Results

The research location is between Longitude 124°48'50.87"E to 124°50'17.64" and Latitude -10°33'-03.33" to -10°31'-03.33". The temperature of the waters found ranged from 28°C - 32°C, salinity values varying between 30 ppt - 38 ppt, and the discovery of pH 7-9. At the study site, no mangrove damage was found. This is thought to be caused by the role of the people of Manado City who care about the mangrove ecosystem and the research location was not located at reclamation location.

![Mangrove Forest of Manado City](image1.jpg)

**Fig. 1.** Mangrove Forest of Manado City

A. Composition of Mangrove Vegetation

The result of research conducted in the city of Manado found 4 species of mangroves and 3 families of mangroves in the transec. The complete data is explained in the following table. Mangrove grouping refers to Tomlinson [21]. Mangroves that are found are major categories of mangroves.
Mangroves found in 3 locations (villages) are divided into 3 categories, namely trees, saplings, and seedlings. The tree and sapling categories were found in 3 families, while in the seedling category were found 2 families.

### Table 2. Distribution of Mangrove Species by Category at Each Location

<table>
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<th>No</th>
<th>Category</th>
<th>Species</th>
<th>Bohowo</th>
<th>Meras</th>
<th>Molas</th>
</tr>
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<tbody>
<tr>
<td>1</td>
<td>Tree</td>
<td><em>Rhizophora apiculata</em></td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Sonneratia alba</em></td>
<td>+</td>
<td>+</td>
<td>+</td>
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<tr>
<td></td>
<td></td>
<td><em>Avicennia marina</em></td>
<td>-</td>
<td>+</td>
<td>+</td>
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<td></td>
<td></td>
<td><em>Avicennia alba</em></td>
<td>-</td>
<td>-</td>
<td>+</td>
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<tr>
<td>2</td>
<td>Sapling</td>
<td><em>Rhizophora apiculata</em></td>
<td>+</td>
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<td></td>
<td></td>
<td><em>Sonneratia alba</em></td>
<td>+</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Avicennia marina</em></td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td>3</td>
<td>Seedling</td>
<td><em>Bruguiiera gymnorrhiza</em></td>
<td>-</td>
<td>+</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Rhizophora apiculata</em></td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
<tr>
<td></td>
<td></td>
<td><em>Sonneratia alba</em></td>
<td>-</td>
<td>+</td>
<td>+</td>
</tr>
</tbody>
</table>

B. Structure of Mangrove Vegetation

### Table 3. Vegetation Structure Results for Each Tree Category Species

<table>
<thead>
<tr>
<th>Location/Species</th>
<th>K (ind/ha)</th>
<th>BA (m²/ha)</th>
<th>KR (%)</th>
<th>DR (%)</th>
<th>INP (%)</th>
</tr>
</thead>
</table>

---

**Fig. 2.** Research map location
Overall the results of research on the structure of mangrove vegetation indicate that this location tends to be dominated by *Sonneratia alba*. This is indicated by the tendency of the high importance value index (INP) of each species in each location and its dominance in all growth categories (trees, saplings and seedlings).

The density value (K) for the tree category obtained produced the highest density found in Meras Village, while the lowest density was located in Bohowo Village.

### Table 4. Diversity Index (H’) and Uniformity Index (J’) in the Tree Category

<table>
<thead>
<tr>
<th>Location</th>
<th>H’</th>
<th>Category</th>
<th>J’</th>
<th>Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manado City</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meras Village</td>
<td>0.48</td>
<td>Low</td>
<td>0.066</td>
<td>Low</td>
</tr>
<tr>
<td>Bohowo Village</td>
<td>0.29</td>
<td>Low</td>
<td>0.042</td>
<td>Low</td>
</tr>
<tr>
<td>Molas Village</td>
<td>0.32</td>
<td>Low</td>
<td>0.046</td>
<td>Low</td>
</tr>
</tbody>
</table>
R. apiculata species dominated in two research locations for the sapling category, while in other villages it was dominated by the only sapling species found, namely A. alba species.

Table 5. Vegetation Structure Results for Each Sapling Category Species

<table>
<thead>
<tr>
<th>Location/Species</th>
<th>K (ind/ha)</th>
<th>BA (m²/ha)</th>
<th>KR (%)</th>
<th>DR (%)</th>
<th>INP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meras Village</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. apiculate</td>
<td>500</td>
<td>0.04</td>
<td>71.4</td>
<td>85.1</td>
<td>156.5</td>
</tr>
<tr>
<td>S. alba</td>
<td>33</td>
<td>0.006</td>
<td>4.8</td>
<td>12.8</td>
<td>17.5</td>
</tr>
<tr>
<td>A. marina</td>
<td>167</td>
<td>0.001</td>
<td>23.8</td>
<td>2.1</td>
<td>25.9</td>
</tr>
<tr>
<td>Total</td>
<td>700</td>
<td>0.047</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td><strong>Bohowo Village</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. apiculate</td>
<td>267</td>
<td>0.03</td>
<td>88.8</td>
<td>96.8</td>
<td>185.7</td>
</tr>
<tr>
<td>S. alba</td>
<td>33</td>
<td>0.001</td>
<td>11.2</td>
<td>3.2</td>
<td>14.3</td>
</tr>
<tr>
<td>Total</td>
<td>300</td>
<td>0.031</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td><strong>Molas Village</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. alba</td>
<td>233</td>
<td>0.01</td>
<td>100</td>
<td>100</td>
<td>200.0</td>
</tr>
<tr>
<td>Total</td>
<td>233</td>
<td>0.01</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

Having the same results as the Tree category, the Density (K) value for the sapling category with the highest density was found in Meras Village, but the lowest density was in Molas Village.

![Fig. 4. Density Value of Each Location of Sapling Categories](image)

The seedling category is dominated by S.alba. In the village of Bohowo no mangrove seedlings were found.

Table 6. Vegetation Structure Results for Each Seedling Category Species

<table>
<thead>
<tr>
<th>Location/Species</th>
<th>K (ind/ha)</th>
<th>KR (%)</th>
<th>DR (%)</th>
<th>INP (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Meras Village</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R. apiculate</td>
<td>3333</td>
<td>20</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>S. alba</td>
<td>3333</td>
<td>20</td>
<td>25</td>
<td>45</td>
</tr>
<tr>
<td>A. marina</td>
<td>10000</td>
<td>60</td>
<td>50</td>
<td>110</td>
</tr>
<tr>
<td>Total</td>
<td>16667</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
<tr>
<td><strong>Bohowo Village</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Molas Village</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>-------</td>
<td>---------------</td>
<td>-------</td>
<td>-------</td>
<td>-------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>A. alba</td>
<td>6667</td>
<td>100</td>
<td>100</td>
<td>200.0</td>
</tr>
<tr>
<td>Total</td>
<td>6667</td>
<td>100</td>
<td>100</td>
<td>200</td>
</tr>
</tbody>
</table>

The following is a comparison of the value of Density (K) between locations:

![Fig. 5. Density Value of Each Location of Seedling Categories](image)

Tree height measurements are carried out to get the height distribution in the study area. Based on the results of measurements, the distribution of mangrove height is divided into 4 (four) classes, namely ≤ 5 m, 5-10 m, 11-15 m and 16-20.
3.2 Discussion

A. Composition of Mangrove Vegetation

The study was conducted in 3 (three) different villages that have their own uniqueness and character. The difference, for example, can be seen from the temperature, salinity, substrate and the distance between the location and community settlement. These different conditions aim to find mangrove species from various conditions where mangroves grow. The village of Bohowo has mangroves that face the sea directly and are influenced by
tourism activities. For the location of Molas Village, this village is close to resorts and community settlements, while Meras Village is still in the form of a forest and is quite far from residential areas.

Meras village has the highest diversity and density due to the natural nature of the area at this location. This is consistent with the statement of Soegiarto and Supriyono [20] which states that human activity also contributes to the condition of mangrove ecosystems in a location. These activities such as development by opening mangrove land for ponds, illegal logging and disposal of waste into the river, either directly or not where this will damage the life of the mangrove ecosystem. In the villages of Bohowo and Molas, the low diversity and density are caused by port activities that have the potential to disrupt environmental conditions and mangrove growth so that they can indirectly damage the ecosystem and have an impact on the death of the mangroves themselves. This is in accordance with the statement of Setyawan [17] which states that mangrove ecosystems are influenced by port activities (boats and humans), large fish, and other facilities.

Overall in the study site is dominated by 4 species namely *Rhizophora apiculata, Avicennia alba, Avicennia marina*, and *Sonneratia alba*. These four species are major components and are species that can easily adapt to mud or muddy sand conditions, where the substrate conditions like this are in accordance with the conditions at the study site. This is consistent with Hardjosentono's [8] statement that dependence on substrate types is clearly demonstrated by the Avicenniaceae family, Rhizophoraceae and other major species which have a common characteristic of living on muddy or sand substrates such as shallow muddy soils, sandy beaches or corals that have layers mud or sand.

The temperature of the substrate found at the study site ranged from 28°C - 32°C, where this condition is a measure of temperature that can be tolerated by various mangrove species. It is in accordance with the statement of Percival and Womersley (1975) in [11] which states that the species *Bruguiera sp.*, *And Rhizophora sp.*, can live at temperatures around 28°C, not significantly different from conditions in the field.

The pH factor, at the study site ranges from 7 - 9, which is also considered tolerable for the growth of productive organisms, including mangroves. Wardoyo (1975) in [9], states that waters with a pH of less than 4 will cause aquatic organisms to die, and pH above 9.5 are unproductive waters.

### B. Structure of Mangrove Vegetation

The distance between locations that are still in one district, is assumed to be the reason why the species found tend to be the same. Existing environmental parameters are aspects that have an important influence on the vegetation yield found. In accordance with the statement of Arief (2003) in [14] that the type of substrate is one of the factors that influence in the regeneration process, if the substrate particles are in the form of mud, then when the fruit falls it can stick directly so that it can increase the density in the environment. If the type of sand substrate or other harder material, the fruit that falls will be difficult to stick and when the tide is carried, the fruit will be carried so that it will reduce the density in the region.

The density value of mangrove species in the tree category is 967-1367 ind / ha, with an average of 1,133 ind / ha. This result is higher when compared to the coastline Balusu District [1] which has an average density of 1027 ind/ha. This is because mangroves found
tend to be dominated by juvenile mangroves that have a large diameter of the trunk. Basal Area Measurement of the mangrove stem is obtained based on the diameter of the stem, which will produce information about the mangrove stem cover in a location. So the higher the diameter of the trunk the greater the Basal Area value and will reduce the density value of the mangrove, so that the dominant species are species that have a large tree diameter and or have a higher density than other species in a location [1].

The value of Diversity Index (H’) and Uniformity Index (J’) included in the low category with H’ ranging from 0.29 to 0.48 and J’ ranging from 0.042 to 0.066. However, the results in Banggai Kepulauan Regency were higher than those obtained in Manado City, namely the diversity index (H’) ranging from 0.48 to 2.80 and the uniformity index (J’) 0.07 to 0.40. This is because the species found in Banggai Kepulauan Regency are more diverse [14].

In the seedling category, there was a decrease in the number of species, but a greater density value was obtained. Decreasing number of species and higher sapling density compared to trees, presumably because the tree category has grown and large first, thus preventing the mangrove category of tillers from getting maximum light, so mangrove-covered saplings cannot grow optimally (disrupting the process photosynthesis) which implies that mangroves remain small in size and have the potential to have high densities. This is in accordance with the opinion of Kusmana [11] that the sapling density will be higher in locations that are protected from various environmental factors that can affect the growth and development of mangrove vegetation.

Based on the results of the study, the height of mangroves in each location is dominated by classes 5-10 m. Mangroves in the city of Manado tend to fall into the category of juvenile mangroves when viewed from their height, this is based on the statement of Chapman [3] that adult mangroves have tree heights ranging from 10 - 30 m or more.

4. Conclusion
It can be concluded that in Manado City, North Sulawesi Province, 5 species of mangroves were found in the transect, all of which were classified as major mangrove categories. In general, mangrove tree vegetation in Manado City is dominated by Sonneratia Alba species. The value of the Diversity Index (H’) and Uniformity (J’) of the tree category in Manado City, is included in the low category. The height of the tree tends to be dominated by class ie 5-10 m.

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Finally, I must express my very profound gratitude to my parents and to all of my friends for providing me with unfailing support and continuous encouragement throughout my years of study and through the process of researching and writing this thesis. This accomplishment would not have been possible without them.
References

A Conceptual Model for Semarang City Sustainability

Ivan Syamsurizal¹, Mufti P. Patria², Raldi H.S. Koestoer³, and Djoko Harmantyo⁴
{ivansyam@yahoo.com¹, mpatria@gmail.com², ralkoest@yahoo.co.uk³, djokoharmantyo@yahoo.com⁴}

School of Environment Science, Universitas Indonesia¹, Department of Biology Faculty of Mathematics and Natural Science, Universitas Indonesia², School of Environment Science, Universitas Indonesia³, Department of Geography Faculty of Mathematics and Natural Science, Universitas Indonesia⁴

Abstract. Coastal site is a very strategic area, proven by the fact that 70% of big cities in the world are located in coastal areas or precisely in coastal areas. Coastal are also has a high level of sensitivity to natural phenomena such as tsunami, tidal floods, strong sea winds, or abrasion. Semarang City is one of the coastal cities with high vulnerability, especially from the tidal flood caused by rising sea levels and land subsidence. Kota Lama/historical area is an area directly adjacent to the coast of Semarang City. This area is the first site affected by the tidal flood that often occurs in Semarang City. This research aims to provide an alternative model for the sustainability of cities in the coastal area through a protection approach to historic areas as a factor of resilience to the city. The method used to produce the model is overlaying technique using ArcGIS software. The variables used in this study are physical and social factors. The physical factors consist of the slope of the coast, the maximum tidal range, average wave height, sea-level rise, beach geomorphology, coastline changes, and land subsidence. Social factors consist of population density, land use, population age, and education level. All variables are given a weight according to their respective criteria by the weighted overlay method. The next step is the process of adding the weights of each variable using simple mathematical operations using the sum tools. The final stage to obtain the vulnerability index distribution zone is carried out reclassification to show its spatial distribution. The results show that the Kota Lama Region is proven to have contributed to the formation of City resilience.

Keywords: Model, Coastal, Kota Lama/historical area, Resilience, Land Subsidence

1 Introduction

Coastal is a very strategic area because of its rich natural resources and the potential value of its spatial functions. Coastal Areas is a transitional area between terrestrial and marine ecosystems which are affected by changes in land and sea [1]. The Coastal environment is an environment very dynamic with various land uses which is very complex [2], [3], [4]. Almost half of the world's major cities have a population density up to 2.6 times denser than the entire island where the city is located [5]. The high density and human activity in the coastal area, in this case, the coastal city, put significant pressure on the existence of the coastal city itself in addition to the pressure from nature because of its position was vulnerable to natural phenomena.

Tidal flood is a phenomenon that often occurs in coastal areas, which is indicated by a rise in sea levels that are local and due to global impacts. Tidal floods inundated coastal areas or places
lower than the high tide level [6]. Tidal floods are a threat that occurs almost every rainy season in the coastal areas. This disaster has an impact on the lives of people living in coastal areas.

Semarang City is one of the coastal cities in Indonesia which has a high vulnerability to tidal flood disasters in addition to certain areas with a high enough slope vulnerable to landslides. The impact of sea-level rise on the coast of Semarang is the existence of tidal flooding which continuously expands its expanse. As research by Suhelmi et al. [7], it was found that the rate of areas inundated on the coast of Semarang by tidal flooding was expected to increase from 3,697.1 ha assuming an increase in sea level optimistic scenario (18 cm) to 5,084.2 ha with a pessimistic scenario (58 cm) in 2100.

Research conducted by Pellikka et al [8] in the Gulf of Finland suggests that, according to the highest sea level scenario, the level of sea-level rise will be even higher than land level in 2100, so that coastal area planning requires detailed knowledge of future flood risks, in addition to long-term changes are also variations in short-term sea level.

Some research has been carried out, namely: Nugroho [9], Miladan [10], Suhelmi [11], Fauziah [12], Yesiana et al. [13], overall, also said that the Coastal of Semarang City has a high vulnerability to disasters especially related to tidal flooding and land subsidence. Looking at the vulnerabilities faced by the City of Semarang, naturally various and appropriate alternatives need to be developed to support efforts to handle and prevent the effects of the vulnerability so that the sustainability of the City of Semarang can be maintained.

Kota Lama/historic area is an area directly adjacent to the coast of Semarang City. This area is the first area affected by the tidal flood that often occurs in Semarang City. Maintaining the sustainability of this region means simultaneously maintaining the sustainability of Semarang City as a whole. This research aims to provide an alternative model of urban sustainability in coastal areas through a protection approach to historic areas as a factor of resilience to the city.

2 Method

2.1 Study Area

Study area in this research is located in The Semarang City where most of it is located in the area around the Kota Lama of Semarang, which is administratively located in 5 sub-districts, namely: Central Semarang, South Semarang, North Semarang, Candisari, and Gajahmungkur subdistrict, as shown in Figure 1.
2.2 Variabel and Data Analysis

The concept of resilience has a very close relationship with the concept of vulnerability, meaning that resilience can be formulated when the vulnerability has been identified and analyzed appropriately. Coastal vulnerability generally consists of economic vulnerability, social vulnerability, and environmental vulnerability. In this research, vulnerability analysis is only done on social vulnerability and environmental vulnerability, while the economic vulnerability is considered as the impact arising from the two vulnerabilities earlier.
According to the **Figure 2**, the KSNT (Specific National Strategic Area)-based development approach is one of the strategic opportunities for the realization of sustainable coastal cities because in its implementation it can encourage the involvement of all components of both the community and institutions even at home and abroad as well as international institutions. The development of KSNT which has great opportunities to be implemented in coastal cities in Indonesia is the KSNT site or world heritage because many coastal cities have been formed for a long time and experienced various times or cultural orders and left various kinds of high-value and world-class urban architecture works. This approach can be an alternative for coastal cities to carry out the development of their cities, and at the same time make efforts to rescue the pressure that can damage the city, so that in turn will encourage its sustainability.

Based on the data distribution of cultural heritage buildings and urban spaces which are considered to have historical value for the city of Semarang, most are located in the area around the Old City of Semarang, which is administratively located in 5 subdistricts, namely: Central Semarang, South Semarang, North Semarang, Candisari, and Gajahmungkur.

Referring to Brenkert et al. [15], the resilience built in this research adopts the Vulnerability Resilience Indicator Prototype (VRIP) model using 3 (three) constituent factors, namely: Exposure, Sensitivity, and Adaptive Capacity. In detail, the data requirements related to research variables will be obtained as explained in Table 1.

<table>
<thead>
<tr>
<th>NO</th>
<th>Types of Data</th>
<th>How to Obtain Data</th>
<th>Data Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Slope of beach</td>
<td>Interpolation</td>
<td>Google</td>
</tr>
<tr>
<td>2.</td>
<td>Average Wave Height</td>
<td>Interpretation</td>
<td>Navy's Hydrological and Oceanographic Service</td>
</tr>
<tr>
<td>3.</td>
<td>Sea level rise</td>
<td>Interpretation</td>
<td>Navy's Hydrological and Oceanographic Service</td>
</tr>
<tr>
<td>4.</td>
<td>Geology</td>
<td>Interpretation</td>
<td>Regional Disaster Management Agency of Semarang City</td>
</tr>
<tr>
<td>5.</td>
<td>Change in Coastline</td>
<td>Historical Sketches</td>
<td>History and Research Books</td>
</tr>
<tr>
<td>6.</td>
<td>Land subsidence</td>
<td>Interpretation and Calculation</td>
<td>Regional Disaster Management Agency of Semarang City and analysis result</td>
</tr>
</tbody>
</table>

(Source: Data Processing, 2019)

Based on Table 1, the type of beach slope data is obtained from DEM data downloaded at https://earthexplorer.usgs.gov/, the data is processed by interpolation techniques which are processed using ArcGIS software. Besides, one way to obtain data is to use interpretation techniques. Interpretation is a way of understanding a phenomenon or phenomenon that occurs by using illustrative media that are not only statements in the form of facts. The interpretation used in this study is in the form of interpretation with a spatial approach (spatial) by understanding the phenomena or phenomena that occur using media in the form of maps. While the calculation technique used in the form of calculations from the tables generated based on the results of processing on the map data.
The interpolation procedure used is interpolation with the finite difference interpolation technique approach. The principle of the method is the assumption that the surface of the specified area obeys some differential equations, both in whole and partially. This equation is then estimated with finite differences and iterative. For example, a problem finding \( z \) functions, such as:

\[
\frac{\delta^2 z}{\delta x^2} + \frac{\delta^2 z}{\delta y^2} = 0
\]  \hspace{1cm} (1)

In a region, and \( z(x_i, y_i) = 0 \) on the boundary line. This equation is the LaPlace equation; and estimates of the limited difference of this equation are:

\[
z_{ij} = \frac{(z_{i-1,j} + z_{i+1,j} + z_{i,j-1} + z_{i,j+1})}{4}
\]  \hspace{1cm} (2)

Whereas, \( z_{ij} \) is the value in cell \( ij \). As an effect, this equation requires a value from a point which is the average of the values of 4 points adjacent to that point, which results in a smooth surface [16]. Thus, the resulting surface has no absolute value, or a maximum and minimum relative value other than the values of the predetermined boundaries [17].

The variables used in this study are social and physical factors. Social factors consist of population density, change in the function of the region, and education level. These social factors were obtained from the Central Bureau of Statistics of Semarang City. While the physical factors used to consist of the slope of the coast, the maximum tidal range, average wave height, sea-level rise, beach geomorphology, coastline changes, and land subsidence. These physical factors were obtained from the Central Bureau of Statistics of Semarang City, Navy's Hydrological and Oceanographic Service, History and Research Books.

**Table 2.** The Reduction Factor for Land Requirements for Environmental Facilities Based on Population Density

<table>
<thead>
<tr>
<th>Area Classification</th>
<th>Low人口密度</th>
<th>Medium人口密度</th>
<th>High人口密度</th>
<th>Very High人口密度</th>
</tr>
</thead>
<tbody>
<tr>
<td>Population density</td>
<td>&lt;150人/ha</td>
<td>151-200人/ha</td>
<td>201-400人/ha</td>
<td>&gt; 400人/ha</td>
</tr>
<tr>
<td>Reduction of land requirements</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>15% (maximum)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>30% (maximum)</td>
</tr>
</tbody>
</table>

Source: Syamsurizal [14]

All variables are given a weight according to their respective criteria by the weighted overlay method. The next step is the process of adding the weights of each variable using simple mathematical operations using the sum tools. The next stage is the filtering process using the query method to group regions that have high, medium, and low weights.

The final stage to obtain the vulnerability index distribution zone is carried out reclassification to show its spatial distribution. The classifications used are high, medium and low grade. Tidal flood areas were obtained from the overlay between elevation data obtained from DEM data (2018) and the ground level elevation data (2018) obtained from the Regional Disaster Management Agency of Semarang City.
3 Result And Discussions

Government policy in the development of coastal areas mandated in Law no. 1 of 2014 and Government Regulation No. 26 of 2008 [18] Concerning National Spatial Planning as well as several other regulations, directing the development of coastal cities to be more optimal in utilizing sea space can also utilize various city potentials, one of which is the development of a Specific National Strategic Area (KSNT) approach. The KSNT definition is an area related to state sovereignty, environmental control, and/or world heritage sites, whose development is prioritized for national interests.

The KSNT concept is applied to the coastal sustainability of the City of Semarang in particular, and the City of Semarang as a whole. This research will produce a model called the Area Resilience Index Model (ARIM). This research is expected to be a renewal in the field of spatial planning and can be a reference in disaster mitigation for future tidal floods. Research on the vulnerability of coastal areas has been done by many researchers before, but from some of these researchers conducted a study of vulnerability of coastal areas to tidal flooding with GIS analysis with overlay analysis, height analysis using DEM and comparing it to sea-level rise sea-level values, and valuation analysis to vulnerability by applying the VRIP (Vulnerability Resilience Indicator Prototype) model.

One of the studies conducted by Miladan [10] to analyze the vulnerability of the coastal area of Semarang City to climate change, especially the problem of rising sea levels that aggravate floods and tides in the region. Then there is also research conducted by Suhelmi [7], regarding dynamic models of flood vulnerability and tidal inundation in low-lying areas. While the research conducted by Brenkert and Malone [19], created a model that could assess the vulnerability of states in India and made a VRIP model based on several indicators, namely physical, social, and ecological conditions.

According to Figure 3, tidal flood data fluctuation occurred in Semarang City over the period 2006 to 2011 taken around Semarang Port on 18 measuring stations. Overall, the tidal flood that
occurred in Semarang City had increased by about 0.4 cm/year while the depreciation by about 0.4 cm/year as well, so the average difference was around 0.1 cm/year. The increase and decrease are almost the same so it can be said that the tides that occur in the city of Semarang are insignificant, so other methods are needed to determine the incidence of tidal floods that occur in Semarang city.

According to some previous studies, the tidal flood phenomenon that occurred in Semarang City was caused by climate change or sea-level rise and also land subsidence. This research will prove that the flood phenomenon occurred is not caused by the tidal flood. Digital Elevation Model (DEM) data processing and study of shoreline changes and loading around the Semarang coast to see tidal flood development so that tidal flood data is generated which will then be assessed with changes in coastline to land subsidence.

This research using GIS analysis is carried out to obtain the elevation change that is processed based on DEM data and data on the rate of change in land subsidence. Before carrying out further processing, it is necessary to pay attention to each scale on each spatial data used. Every spatial data used must have the same scale to overcome errors in its processing. The scale of the map and the spatial resolution are very important. To choose an equivalent image for mapping there is a mathematical formula that was invented by Wado R. Tobler in 1987. He stated, "For the denominator of the map scale with 1000, the equivalent image resolution is half of the result of the division".

In the initial stage, DEM classification is performed to determine the class of altitude region in the study area. Furthermore, the extraction of coordinate information and area altitude information is carried out by distributing points sampling evenly in the Research Area and Semarang City. This following map of elevation points and altitude areas (Figure 4a) and maps of land subsidence rates (Figure 4b) in the study area and Semarang City.

![Fig. 4. (a) elevation points and altitude areas; (b) land subsidence rates](Source: Syamsurizal, 2019)

After the elevation is in accordance with the decline in a certain year, interpolation of these points is carried out to obtain the area affected by tidal flood. Tidal flood prediction is generated from the result of an overlay between elevation data (DEM) and Land Surface Depth Rate Data. These following maps showing the results of the precision in the Tidal flood areas in 2018,
2028, 2038 and 2048 (Figure 5a) and the predicted expanse of the position of historic buildings or historical areas of the Semarang City (Figure 5b).

![Fig. 5. (a) Tidal Flood Regional Prediction in Research Areas 2018, 2028, 2038, and 2048; (b) Tidal flood Regional Prediction of the City Historical Area (Source: Syamsurizal, 2019)](image)

Based on the modelling in Figure 5a and Figure 5b, it can be seen that from a total of 7 research subdistricts areas, tidal flood is predicted to occur in 40 years in 4 sub-districts, in the northern part of the coastal area of the city of Semarang which was affected by tidal floods, it is directly facing the coastline. In the south and central part of the coast of Semarang City, the part affected by tidal flood is the historical area of the Old City while in the western part of the coast of Semarang City, the area affected by tidal flood is the area of cultivation areas such as ponds, then in the east part of it is a settlement area.

The phenomenon of tidal flooding is caused by a shift in the coastline as a result of anthropogenic pressure as if pushing the return of the coastline or disappearance of the existing land (reclaiming the area by the sea). Changes in the coastline around the city of Semarang are influenced by natural factors and the impact of development in the coastal area by human activities. Loading the shoreline shift is found in 5 sub-districts based on the study area. After calculated using the GIS application, Table 3 shows the prediction of the extent of the tidal flood that will occur in the study area in 2018, 2028, 2038, and 2048.

<table>
<thead>
<tr>
<th>Year</th>
<th>North Semarang (Ha)</th>
<th>East Semarang (Ha)</th>
<th>Gayamsari (Ha)</th>
<th>Central Semarang (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2018</td>
<td>1.042.81</td>
<td>50,04</td>
<td>53,85</td>
<td>0</td>
</tr>
<tr>
<td>2028</td>
<td>1.134,63</td>
<td>101,45</td>
<td>118,06</td>
<td>0</td>
</tr>
<tr>
<td>2038</td>
<td>1.163,75</td>
<td>153,88</td>
<td>192,83</td>
<td>0</td>
</tr>
<tr>
<td>2048</td>
<td>1.271,76</td>
<td>247,93</td>
<td>310,62</td>
<td>4.13</td>
</tr>
</tbody>
</table>

**Table 3. Prediction of The Extent of The Tidal Flood in Research Areas 2018, 2028, 2038, and 2048**

(Source: Syamsurizal, 2019)
Based on Table 3, from 2018 to 2048 the total area affected by tidal floods in each affected subdistrict experienced an increase in the area each year. North Semarang is the most widespread sub-district affected by tidal floods with the speed of change in the area of the second-fastest tidal flood area of 7.6 hectares/year with the largest area of tidal floods. Meanwhile, Central Semarang District has the lowest rate of change, only 0.13 hectares/year and with the smallest tidal area among 4 areas affected by the tidal flood in the study area.

4 Conclusion

Semarang Vulnerability to disasters of the tidal flood is not significantly caused by the phenomenon of water level rise the sea that occurs due to the phenomenon of climate change or global warming. The Historic area which is the identity in the formation of Semarang City is not only located in the Kota Lama area as determined by Government but is a delineation of the area formed by buildings that have historical value. The results showed that the historical area of Semarang City is in 7 sub-districts. After modeling, Historical areas are proven to have contributed to the formation of City resilience. North Semarang is the most widespread district affected by tidal floods with the speed of change in the area of the second-fastest tidal flood area of 7.6 hectares/year with the largest area of tidal floods. Meanwhile, Central Semarang District has the lowest rate of change, only 0.13 Hectares/Year and with the smallest tidal area among 4 areas affected by tidal floods in the study area.

Referring to the conclusions obtained from the results of the research, the advice is given is the development of a city, as far as possible consider the carrying capacity of its environment, where one of them is to see and study the history of the formation of the city itself. Utilization of the space created by sedimentation should not be used to accommodate dense human activities but should be limited and it would be better to use it for green open areas or conservation areas. The Old City Region of Semarang, as a historical area of the city, needs to be developed further so that all buildings that have historical value in the formation of Semarang City can be saved. This is believed to contribute to the overall sustainability of the City of Semarang. For this reason, the development of the concept of Specific National Strategic Areas (KSNT) in the historical area of Semarang City is one of the right choices in the effort to maintain the sustainability of Semarang City which has potential as one of World Heritage. The Development of the Conceptual Model of Regional Interest for Urban Sustainability in Semarang City needs to be further developed using the participation and community perception variables related to the use of historical values to build city resilience.

References

Increasing Local Farmers Sustainability Index Status to Preserve Agricultural Sustainability

Hanipah¹, Hayati Sari Hasibuan*², Rudy P. Tambunan³
hanipahtanjung@gmail.com¹, hayati.hasibuan@ui.ac.id*², rudyptamb@yahoo.com³

School of Environmental Science, University of Indonesia, Jakarta, 10430¹, Department of Geography, University of Indonesia, Depok³

Abstract. In recent years, there has been land-use changes from the paddy field to the industrial and housing in Karawang. The proportion of paddy fields changed from 55.35% (2009) to 54.49% (2017). Industries also attracted people to switch professions from farming to the industrial. Indicated by the decreasing number of workers in the farming, from 4,628 people (2009) to 3,744 people (2010) and increasing in the industrial, from 89,163 people (2009) to 242,896 people (2016). The purpose of study is to measure the index of farmers' sustainability status. The study uses the Multi-Dimensional Scaling method with 3 dimensions: social, economic, and environmental. The results found that the economic dimension has the lowest index. The most problem in the economic dimension is the high capital for production. The social dimension showed that farmers have no regeneration. Moreover, the environment dimension showed that almost 40% of the farmers have no land, and the most critical issue to deal with are access to the irrigation to increase the rice-production.

Keywords: Farmer; Index status; Karawang’s farmers; Profession transition; Sustainability

1 Introduction

Karawang regency as one of the rice barns in West Java and in national scale is a agricultural area that need to be protected for sustainability. However, massive urbanization contribute to the decrease of land supply and as a result, more than 25% of agricultural land use have been converted to industrial use, commercial, or residential to meet the increasing of land demand [1]. That phenomenon occurred in Jakarta, which led to the development of suburban areas, as reflected by the expansion of the built up area on the outskirts of Jakarta [18] including Karawang Regency. Karawang Regency has strategic location near the capital Jakarta and crossed by the national road lead Karawang as one of the investors targets in developing industrial and urban built up area such as shopping centers and housing. As a result of the urban expansion, Karawang Regency was planned as one of the target cities to be industrial expansion. It mentioned in some legislation, such as in National Industrial Development Master Plan 2015 – 2035 as Industrial Growth Center Area (WPPI) [15] and mentioned in the Peraturan Daerah Kabupaten Karawang No. 2 Tahun 2013 tentang Rencana Tata Ruang Wilayah tahun 2011-2031.

Urbanization and industrialization require land in the process that led to conversion of productive agricultural land. From the period 2009 to 2017, agricultural land, especially paddy
fields in Karawang reduced 1501 ha [2][4]. The total lose of paddy field area equivalent to 25% of the average area of the one district in Karawang.

The consequence of land use change that originally agricultural areas to industrial development areas, both industrial areas and large industrial and other manufacturing perceived by local people, directly or indirectly, positively or negatively. Farmers as the main actors and directly manage the paddy field feel the effects of agricultural land use change. Although, generally in economic aspects the industries provide more employment opportunities that can help to gain more incomes and welfare of the community. It showed from the number of workers in the industrial sector in Karawang Regency in 2009 were 89,163 people increase to 242,896 people in 2016 [2][3].

However, on the other side the industries existence have negative impact that perceived by people's around the industrial area. Industrial activities on environmental aspects could pollute the environment, such as river water pollution. Polluted river water is used as a source of irrigation. In addition, the growing number of industries make water demand in the industrial sector increased and caused the proportion of irrigation water reduced. This lead to insufficiency of irrigation water demand. The loss of water for agriculture will affect the productivity of paddy fields due to drought. Then, the impact is also felt on the social and economic aspects of farmers. Because of the changing in agricultural environment, caused unproductive land and lead farmers lose income. Loss of income caused by the drought of land can lead to eliminate the profession of farmers in managing wetland and loss of interest of the community especially the young generation to involve in wetland management. It showed from reduced number of farmers in 1 year period (2009 to 2010) from 4,628 people to 3,744 people [5][6] in one location, West Telukjambe District. Most of the effects which previously mentioned shows that the existence and sustainability of farmers in managing their paddy field threatened. Therefore, this research aimed to measure the sustainability index of farmers, especially rice paddy fields farmers. The farmers sustainability is determined from the environment and their welfare. Welfare is a situation where the person's needs are met, freedom, and achieve a better quality of life [11]. There are five indicators of well-being [9]. Those indicators are income, education, employment, housing, and health. In addition, there are three-dimensional measuring well-being that is material, social and human [24]. Dimensions and indicators are organized into several dimensions and attributes to gauge the sustainability of farmers in this study.

There are a number of studies concerning farmer’s sustainability such measured the sustainability of soybean farming from economic aspect in Central Java [20], study about sustainability of agricultural landscape in West Java using spatial analysis [22], and researched about farmers capability to achieved sustainable agriculture [21]. Thus the purpose of this study is to measure and analyze the index of farmers' sustainability status. In this study, the degree of farmers sustainability measured by creating and scoring some dimensions and attributes based on literatures and current practices.

2 Methods

The research was conducted in the West Telukjambe District, Karawang Regency, West Java Province (Figure 1). West Telukjambe is located in the southwest of Karawang Regency located between 6°29'44" - 6°39'275" East Longitude and 107°22'364" - 107°26'659" Southern
Latitude [6], Northern and western of West Telukjambe borders Bekasi Regency. West Telukjambe District consist of 73.36 km² area and located at an average altitude of 57 meters. This research was conducted in August - September 2019.

The population in this study is farmers. Farmers included in this population is someone whose work in the field of management of rice paddy fields and each person represents one household. The number of samples is determined using Slovin formula and total population of 2,494 farmers then obtained sample 96 farmers. The number of samples per village determined proportionally. Data used in the study are primary data obtained from the questionnaires.

Fig. 1. Location of research West Telukjambe District of Karawang Regency

After primary data obtained and collected from the questionnaire then processing the data from questionnaire. Data from the questionnaire is processed using Multi-Dimensional Scalling with Rapfish tools which in this study modified as Rapfarmers to get the index value of sustainability. The MDS approach was chosen because quite stable compared to the method other multivariate [16]. Rapfish chosen as a tools for this study because of it main function as a tools to evaluate sustainability [13]. Before the secondary data is processed, determined the 3 dimensions and attribute that is environment, economic and social. The attributes used in each dimension derived from some literature related to farmer sustainability [7][8][19][12][14][23]. In this study is set at 34 attributes. The number of attributes of each dimension is 11 environment attributes, 10 economy attributes, and 13 social attributes. Each attribute is given a scoring as showed in Table 1.
Next is the analysis of leverage to obtain the sensitivity of each attribute and that have a significant impact on the sustainability index in each dimension. Sensitive attributes known by changing the RMS value if the value higher if an attribute is removed, these attributes have a significant role in sustainability. Then Monte Carlo analysis, to estimate the effect of the error with a confidence level of 95%. The next step is to determine whether the model has been simulated in good category or not by looking at the value of the S-stress and $R^2$ of simulation. The simulation results in good category if the value of the S-stress $<0.25$ and $R^2$ close to 1 [17].

Table 1. Dimensions, attributes, and scoring MDS of Rapfish

<table>
<thead>
<tr>
<th>No.</th>
<th>Dimensions/attributes</th>
<th>Scoring Good</th>
<th>Scoring Bad</th>
<th>Remarks questions and score</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Environment</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Type of land ownership</td>
<td>2</td>
<td>0</td>
<td>What kind of land ownership are processed? (0) claim; (1) leases; (2) personal (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>2</td>
<td>Area of land ownership</td>
<td>5</td>
<td>0</td>
<td>How much land owned? (0) 0 ha; (1) 0.1-0.5 ha; (2) 0.51 to 1 ha; (3) 1.1-1.5 ha; (4) 1.51 to 2 ha; (5) &gt;2 ha (BPS, 2017)</td>
</tr>
<tr>
<td>3</td>
<td>Fertilizer subsidies</td>
<td>2</td>
<td>0</td>
<td>What type of fertilizer are easily available and used? (0) not subsidized; (1) partially subsidized; (2) full subsidized (Ministry of Agriculture, 2018)</td>
</tr>
<tr>
<td>4</td>
<td>Pesticide intensity</td>
<td>3</td>
<td>0</td>
<td>How often is the use of pesticides? (0) 2 times a week; (1) every 1 week; (2) every 2 weeks; (3) every 3 weeks (Reig-Martínez, et al., 2011)</td>
</tr>
<tr>
<td>5</td>
<td>Productivity</td>
<td>4</td>
<td>0</td>
<td>What is the average productivity of the land? (0) 3-4ton / ha; (1) 4-5ton / ha; (2) 5-6ton / ha; (3) 6-7ton / ha; (4) &gt;7ton / ha (BPS, 2017)</td>
</tr>
<tr>
<td>6</td>
<td>Irrigation type</td>
<td>2</td>
<td>0</td>
<td>What type of irrigation? (0) rainfed; (1) semi-technical irrigation; (2) technical irrigation (BPS, 2004)</td>
</tr>
<tr>
<td>7</td>
<td>Irrigation water source</td>
<td>2</td>
<td>0</td>
<td>What is the source of water for irrigation? (0) springs; (1) water wells; (2) surface water (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>8</td>
<td>Irrigation Physical condition</td>
<td>3</td>
<td>0</td>
<td>How is the physical condition of the existing irrigation channels? (0) damaged (damage &gt;40%); (1) moderate damage (damage 21-40%); (2) with minor damage (damage 10-20%); (3) either (damage to &lt;10%)</td>
</tr>
<tr>
<td>9</td>
<td>The adequacy of irrigation discharge</td>
<td>3</td>
<td>0</td>
<td>Is irrigation water discharge from the primary channel meets the required discharge? (0) Adequate but not up to the land; (2) Adequate to the land by a pump; (3) sufficient and to the land without the pump (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>10</td>
<td>Irrigation quality</td>
<td>3</td>
<td>0</td>
<td>What is the quality of irrigation water obtained? (0) heavily polluted; (1) polluted; (2) medium; (3) not polluted (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>11</td>
<td>Seed certification</td>
<td>3</td>
<td>0</td>
<td>What kind of quality seeds are easily available and often used? (0) Poor, not certified; (1) Good, not certified; (2) Good and mix; (3) good certified</td>
</tr>
<tr>
<td>No.</td>
<td>Dimensions/attributes</td>
<td>Scoring</td>
<td>Good</td>
<td>Bad</td>
</tr>
<tr>
<td>-----</td>
<td>-----------------------</td>
<td>---------</td>
<td>------</td>
<td>-----</td>
</tr>
<tr>
<td>1</td>
<td>Source of capital</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Farm income</td>
<td>5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Ownership of farming tools</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>The number of dependents</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Primary expenses</td>
<td>5</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>adequacy of income</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Selling price of grain</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>Total capital</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>Use of income</td>
<td>2</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>Educational ability</td>
<td>3</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>
Table 1. Dimensions, attributes, and scoring MDS of Rapfish

<table>
<thead>
<tr>
<th>No.</th>
<th>Dimensions/ attributes</th>
<th>Scoring</th>
<th>Remarks questions and score</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Good</td>
<td>Good: 0; Bad: 0; Remarks questions and score</td>
</tr>
<tr>
<td>1</td>
<td>Social</td>
<td>2</td>
<td>Is there anyone in family intends to continue its efforts to be a farmer?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) No; (1) hesitated; (2) Yes (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>2</td>
<td>Distance of education facilities</td>
<td>3</td>
<td>What is the distance that must be traveled to achieve educational facilities?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) &gt; 5 km; (1) 3-5 km; (2) 1.5-3 km; (3) &lt;1.5 km (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>3</td>
<td>Type of health facility</td>
<td>3</td>
<td>What kind of health facility closest to where you live?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) Nothing; (1) clinics; (2) health centers; (3) hospitals (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>4</td>
<td>Distance of health facilities</td>
<td>3</td>
<td>What is the distance that must be traveled to reach the nearest health facility?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) &lt;1 km; (1) 1-3 km; (2) 3-5 km; (3) &gt; 5 km (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>5</td>
<td>Farmers liveliness</td>
<td>2</td>
<td>Is the farmer groups still active?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) No; (1) sometimes; (2) active (Ministry of Agriculture, 2018)</td>
</tr>
<tr>
<td>6</td>
<td>Farmers Participation</td>
<td>2</td>
<td>Are farmers actively participating in the planning process of government program?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) Never; (1) sometimes; (2) often (Hayati, et al., 2018)</td>
</tr>
<tr>
<td>7</td>
<td>Source of information</td>
<td>2</td>
<td>Where the source of information about the agricultural program of the government obtained?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) no; (1) The farmers group; (2) The weekly activities village office (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>8</td>
<td>The availability of complaints platforms</td>
<td>2</td>
<td>Is there a government platforms to accommodate complaints about agricultural problems?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) No; (1) There is, but the response is slow; (2) There and rapid response (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>9</td>
<td>Government responsiveness</td>
<td>2</td>
<td>How the government's response to the complaints / reports from farmers about drought damage and irrigation?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) did not respond and was not followed up; (1) responded but were not followed; (2) responded to and acted on (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>10</td>
<td>Counseling program</td>
<td>3</td>
<td>Is counseling and training program of the government still active?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) never; (1) sometimes; (2) active and scheduled (Hayati, et al., 2010)</td>
</tr>
<tr>
<td>11</td>
<td>Industrial presence</td>
<td>2</td>
<td>Is there industries / industrial area around?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) There are and many; (1) There is, but not many; (2) No</td>
</tr>
<tr>
<td>12</td>
<td>Industrial influence</td>
<td>2</td>
<td>Is the existence of the industry can help local community</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>well-being? (0) No; (1) A little help; (2) very helpful</td>
</tr>
<tr>
<td>13</td>
<td>Culture of cooperation</td>
<td>2</td>
<td>What is culture farming in mutual cooperation still active?</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0</td>
<td>(0) never; (1) sometimes; (2) routine (Hayati, et al., 2010)</td>
</tr>
</tbody>
</table>
3 Results and Discussion

Current condition obtained from observations and surveys at the study location found in the West Telukjambe District has entered the third season at the stage of soil treatment and prevention of pests. However, at some point there is land drought and there is no activity in land management (Figure 2).

![Fig. 2](a) drought paddy fields (b) of wetland that is processed in a period of treatment (Observations, 25 September 2019)

Respondents in this research 96 people who work as farmers. Characteristics of respondents from the questionnaire in this study is 98% of male, with age range from 45 years - 80 years and included in the category of productive into elderly. The education level of 69 % respondents are primary school graduated and 100% native inhabitants of West Telukjambe.

Diagram of Farmers Sustainability Index

![Fig. 3](Diagram of farmers sustainability index in the West Telukjambe)

The results of the primary analysis were generated from simulations is Rapfish ordination (ordinated in each dimension) which is processed by entering attribute scoring
number. The result of simulation ordination diagram describes the position of the sustainability of each attribute or dimension to the scale of assessment. Sustainability index values generated from each ordination is presented in Figure 3. The results of multidimensional scaling analysis using the Rapfish presented in Figure 3. The index value of each dimension classified as less sustainable were economic and social dimensions, while for the environmental dimension categorized as quite sustainable.

Index value of each dimension based on the diagram in Figure 3 is in the range 40 - 65. Environmental dimension that has the highest index value of 63.89. Dimensions with the lowest index value is the economic dimension with the value of 46.02 and was followed by the index of the social dimension with the index value of 47.19. Results Rapfish analysis for the environmental dimension is shown in Figure 4.

**RAPFISH Ordination Environment Dimension**

![RAPFISH Ordination Environment Dimension](image)

**Fisheries Status**

Fig. 4 Diagram of Rapfish Sustainability Index for Environment Dimension

**Figure 4** shows the majority of farmers are represented by real fisheries in the diagram is the status value range 60-70 are included in the category of quite sustainable. The status indicates wetland management practices by the farmers in the district of West Telukjambe still supported by the adequacy of natural resources that support agricultural environment farmers. This is supported by the productivity of paddy fields are still high with average productivity reached 6-7 tons / ha.
Then, for each attribute analysis results leverage environmental dimensions shown in Figure 5. Figure 5 illustrates the sensitivity of each of the attributes if the RMS value of an attribute the higher, the more effect on the change in value of the dimension of sustainability indexes. Attributes that have a high sensitivity to the environmental dimension is that has a RMS value above 2.5 or above scale 50.

**Diagram of Sensitivity Attribute Environment Dimension**

In Figure 5 there are nine attributes that have high sensitivity values. The first and second sensitive attribute is the type of irrigation to the RMS value of 4.45 and a source of irrigation to the RMS value of 4.41. Type of irrigation used in paddy fields all respondents are technical irrigation comes from surface water. The type and source of irrigation is suitable for the District of West Telukjambe with relatively flat topography. If both attributes are omitted, would have a significant effect of both of these attributes RMS value against the value of the environmental dimension of sustainability indexes. The third attribute is a sensitive area of land ownership. Amounting to 68.75% of the total respondents have land to private ownership by as much as 33.33% distribution has a land area from 0.1 to 0.5 ha, 18.75% have a land area of 0.51 to 1 ha, 18.75% farmers owned 0.51 – 1 ha, and 16.67% owned 1.1 – 1.5 ha.

Next analysis is the economic dimension of sustainability indexes. The economic dimension of sustainability has the lowest index value compared to the other two dimensions. Results ordinated economic dimensions shown in Figure 6.
**RAPFISH Ordination Economic Dimension**

![Diagram of Rapfish Sustainability Index for Economic Dimension](image)

**Fig. 6** Diagram of Rapfish Sustainability Index for Economic Dimension

**Figure 6** shows the respondents were represented by real fisheries in the diagram at scale 20-50 with less sustainable categories. The status indicates activity land management by the farmers not produce sufficient economic value of life of farmers. This is supported by the incomes from farming less than the cost of basic needs that must be covered. Revenues earned from 55.21% of respondents earned 2-3 million / month, 29% earned 1-2 million / month, 8.33% earned 3-4 million / month, 4.17% earned < 1 million / month, and 3.13% earned 4-5 million / month. The average income of respondents in the District of West Telukjambe between 1-3 million / month. The revenue is lower than expenditure per month to be paid by respondents. Average expenditure per month of the respondents are more than 3 million / month. This value is only for necessities, exclude education needs, transportation and others. The attributes that most influence on the value of the economic dimension farmer sustainability index presented in **Figure 7**.
Fig. 7 Diagram of Sensitivity Attribute Economic Dimension

Figure 7 shows that there are four attributes with values of sensitivity over a scale of 50 or 3.5. The first attribute is the primary expenses attribute with the RMS value of 5.74. The second is the use of income attributes with the RMS value of 4.88. The average income of farming can only be used by the respondent for the basic needs. The third sensitive attribute is the source of capital. As many as 99% of respondents use capital from their own pocket without loans, and 1% were relying on private sources and loans. If the attribute is omitted capital resources, the sustainability index farmers from the economic side will be affected significantly because farming capital became one of the main factors of agricultural production. The fourth sensitive attribute is the adequacy of income. Among the 10 attributes, there are 6 other attributes that are not sensitive. The first non-sensitive attribute is the total capital with the RMS value of 2.83. The number of dependents with RMS values of 2.34, educational ability with RMS value 2.17, farmers’ income with RMS value 1.5, ownership of farming tools with RMS value 1.16, and selling price of grain with RMS value 0.85.
Next up is the result of analysis of the sustainability of the social dimension. The value of the social dimension of sustainability indices including less sustainable categories shown in Figure 8.

**Figure 8** Diagram of Rapfish Sustainability Index for Social Dimension

Figure 8 shows the position of the respondents were represented by real fisheries in the diagram is in the range of less sustainable categories. The index value indicates farmers land management activities in the District of West Telukjambe unsustainable from social dimension. It is caused by several things including regeneration. Amounting to 88% of the total respondents expressed no wish to become the next generation as a farmer in the family. In addition, other attributes that affect the sustainability of the farmers in the district of West Telukjambe of the economic dimension is illustrated in Figure 9 along with the level of sensitivity.
Figure 9 shows that there are seven attributes sensitive to the RMS value above 3 or above scale 50. The first sensitive attribute is the source of information with the RMS value of 5.09. If this attribute is eliminated, it would significantly affect the value of sustainability index of economic dimension. It was because of the presence of resources that are 100% derived from weekly activities; villages reflect their activities aimed at informing and in order to help farmers know the developments surrounding agricultural activities conducted by the local government. The second sensitive attribute is the industrial presence with the RMS value 4.41. The existence of the industry in the District of West Telukjambe increasing by the amount but did not provide a positive influence for the improvement of living standards, especially farmers. The third sensitive attribute is the farmers participation with the RMS value 3.79. Participation of farmers should be increased in order to improve the integration between the needs of farmers and agricultural programs organized by the government to be more effective and efficient.

After analysis of leverage is the Monte Carlo analysis. Monte Carlo analysis was done to calculate the uncertainty value and will be compared with the value of the Rapfish MDS analysis result. The results of Monte Carlo analysis are shown in Table 2.
### Table 2 Value of Monte Carlo Analysis

<table>
<thead>
<tr>
<th>Dimension</th>
<th>Value of Rapfish</th>
<th>Value of Monte Carlo</th>
<th>Difference between rapfish and monte carlo</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environment</td>
<td>63,89</td>
<td>63,57</td>
<td>0,32</td>
</tr>
<tr>
<td>Economic</td>
<td>46,02</td>
<td>46,14</td>
<td>0,12</td>
</tr>
<tr>
<td>Social</td>
<td>47,19</td>
<td>47,2</td>
<td>0,01</td>
</tr>
</tbody>
</table>

Table 2 shows the results of Monte Carlo analysis and Rapfish difference is not more than 5% for all dimensions. The difference in value Rapfish and Monte Carlo analysis for the environmental dimension of 0,32, on the economic dimension of 0,12 and 0,01 for the social dimension. The difference value <5%, which means the value of the analysis result Rapfish has a confidence level exceeds 95%. Values that exceed the confidence level of 95% indicates that the MDS models built in this study was adequate to estimate the sustainability of farmers in the district of West Telukjambe. Next is the analysis of the accuracy (Goodness of fit) to determine the outcome of MDS analysis in this study is adequate. Goodness of fit analysis results are shown in Table 3.

### Table 3 Goodness of fit of S-stress and RMS

<table>
<thead>
<tr>
<th>Value/Dimension</th>
<th>Environment</th>
<th>Economic</th>
<th>Social</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stress</td>
<td>0,16</td>
<td>0,17</td>
<td>0,16</td>
</tr>
<tr>
<td>RSQ</td>
<td>0,94</td>
<td>0,96</td>
<td>0,93</td>
</tr>
</tbody>
</table>

Table 3 shows the value of stress and RSQ for each dimension. The Stress value of the three dimensions in the range 0,16-0,17, while the value of the RSQ is in the range 0,93 to 0,96. Stress value less than 0,25 and the value of RSQ more than 90% even close to 100% indicates MDS analysis model in this study have high precision pick and preparation in accordance with the attributes of each dimension.

### 4 Conclusion

Sustainability status of farmers in the district of West Telukjambe currently for 3-dimensional and overall is in less sustainable category. From the third dimension, the economic dimension has the lowest index value, followed by social dimensions, and then the environmental dimension. Some attribute identified sensitive to the sustainability of farmers in West Telukjambe. These attributes include the status and ownership of land, capital costs, and regeneration. Government commitment is required not only to protect sustainable agriculture, but also a commitment to ensure sustainable farmers to improve land ownership attributes, irrigation discharge, and efficiency of capital costs incurred farmers to be balanced with revenue generated from land management practices.
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References


Community Participation, Sustainable Development and Slum Settlements in Jakarta

Yoka Pramadi¹, Praditya Mer Hananto², Rusydan Fathy³, Dicky Rachmawan⁴, Hidayatullah Rabbani⁵
{yoka.pramadi@lipi.go.id¹, battle_signal@yahoo.com², ruarydanfathy@gmail.com³, dicky.rachmawan1992@gmail.com⁴, hidayatullahrabbani@gmail.com⁵}

Indonesian Institute of Science, Jakarta¹,²,³,⁴,⁵

Abstract. One of the SDG (Sustainable Development Goals) programs being implemented by the Indonesia government is "Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable". Why it matters? The United Nations (UN) explicate that the cost of poorly planned urbanization can be seen in some of the huge slums, tangled traffic, greenhouse gas emissions and sprawling suburbs all over the world. Slums are a drag on GDP, and lower life expectancy. By choosing to act sustainably we choose to build cities where all citizens live a decent quality of life, and form a part of the city’s productive dynamic, creating shared prosperity and social stability without harming the environment. Jakarta as Indonesia's capital city currently has many slums. But not all settlements are always in a slum condition. In our findings, basically there are 3 kinds of transformation of the slum settlements, namely: (1) Zero to Hero: settlements that used to be slum and then transformed into good settlement, being tough and staying sustainable even becoming an "instagramable"; (2) Zero to Ash: settlements that are slum and end remain up displaced and disappear; (3) Hero to Zero: settlements that are not slum then become slums. This transition condition perfectly reverses the resident's ability, government policy, as well as the combination in handling it. This study uses the point of view of criminogenic behavior and crisis communication in dissecting existing phenomena.

Keywords: community participation; sustainable development; slum settlement; inclusive; empowerment.

1 Introduction

One of the SDG (Sustainable Development Goals) programs being implemented by the Indonesia government is "Sustainable Cities and Communities: Make cities and human settlements inclusive, safe, resilient and sustainable". Why it matters? The United Nations (UN) explicate that the cost of poorly planned urbanization can be seen in some of the huge slums, tangled traffic, greenhouse gas emissions and sprawling suburbs all over the world. Slums are a drag on GDP, and lower life expectancy. By choosing to act sustainably we choose to build cities where all citizens live a decent quality of life, and form a part of the city’s productive dynamic, creating shared prosperity and social stability without harming the environment. Jakarta as Indonesia's capital city currently has many slums.

The Community Action Plan (CAP) is a program of the Governor of DKI Jakarta, Anies Baswedan, to organize slums in Jakarta. CAP is the first stage of structuring planning.
Innovation of government development programs, both central and regional, always alternates from one leader to another. The existing bureaucracy is conventional and unable to anticipate changes. Forms of communication patterns of government institutions that occur at this time are top-down.

Individual communication patterns in socializing, interacting well between individuals, organizations and between communities and government are greatly influenced by cultural characteristics. This becomes increasingly apparent when we communicate with individuals from different cultures or groups of society. We can say bureaucrat with its dominant class culture and society with various obligations to submit to the power of the state. The internal obstacle in our current government bureaucracy is paternalistic communication patterns. External barriers are static, pessimistic and skeptical attitudes towards development efforts. The communication pattern that must be developed in the CAP program is participatory communication. This pattern can be used as an innovation in development with a bottom-up approach. Participatory communication provides a space for people to exchange information and knowledge. The application of participatory communication is carried out through dialogical principles.

This research was conducted in several sample locations that indicated slums and had evicted. From several slum areas, we collected data from Kampung Pulo, Jatinegara, East Jakarta and Kampung Akuarium, Penjaringan, North Jakarta. Kampung Akuarium in North Jakarta is one example of turning a slum (zero) into a good area (hero). During the era of governor Basuki Tjahaja Purnama, the village was evicted, which would later be rebuilt by the next governor, Anies Baswedan, in the Community Action Plan (CAP) program. Slum settlements are densely populated residential areas in an urban area, with poor housing conditions and the residents are lower class citizens.

While Kampung Pulo, Jatinegara District, East Jakarta is a densely populated area on the banks of the Ciliwung River. These problems are social problems, such as criminogenic problems. One effort that can be done is the Prevention of Crime Through Environmental Design (CPTED). Kampung Akuarium has a master plan for development in the CAP program and Pulo village is expected to have the CPTED element.

The terms slum settlements and slums housing are set out in Law Number 1 of 2011 (Undang-undang No.1/2011), Article 1 Number 13, concerning Housing and Settlement Areas. Slum settlements are settlements that are not suitable for habitation because of building irregularities, high levels of building density, and the quality of buildings and facilities and infrastructure that do not meet the requirements. Meanwhile, slum housing is housing that has decreased the quality of its function as a residence. Slums are often seen as an area that is synonymous with apathetic, overpopulated, inadequate, poor, dilapidated, dangerous, insecure, dirty, below standard, unhealthy and many other negative stigma [1].

The United Nations Human Settlements Programme (UN-HABITAT) defines a slum area as a household that unable to provide one of basic living such as: 1) Durable house that able to protect against extreme climate condition. 2) Sufficient living space, which means no more than three people sharing the same room. Of course, the room refer to building code. 3) Easy access to water in sufficient amounts at an affordable price. 4) Access to adequate sanitation in the form of a private or public toilet shared by a reasonable number of people. 4) Security of tenure that prevents forced evictions.

Of course, since it said “area” means that there are many households in that condition together and dense in the same urban area. The “slum” term tend to pejorative both in social and physical connotations which is applied by outsiders, often to justify public intervention such as
slum clearance. A slum area usually habitated by marginalized people: those who have very low income, underdeveloped and low educated.

There is a kind of problem which tends to generate in slum area: an unmet standard human basic living. If we go by Maslow’s Hierarchy of Needs, there will be “basic needs” that every human had to get: psychology needs (food, water, warmth, rest) and safety needs (security, safety). As the UN-HABITAT state earlier, its called slum area because of its inability to provide some basic living which is it’s same that Maslow’s theory. Condition that unable to fulfill basic need not only make them vulnerable to multi-impact of inhabitant area such as disease and malnutrition, but also emerge conflict and justification to get its basic need. Hence encourage them to do anything to obtain it, such as resort to crime action.

**Condition to Emerge Criminal Behaviour**

Sutherland & Cressey (1960) argue about what condition causing criminal behavior. For example, negroes, urban-dwellers, and young adults tend to have comparatives high crime rates [25]. Research studies have shown that criminal behavior is related to social and personal pathologies, such as poverty, bad housing, slums area, inadequate and demoralized families, emotional, and other traits nor condition. Yet research studies also have shown that any person with that kind pathologies didn’t commit crime, and those who in upper social economy class tend to violate the law although they didn’t have bad housing nor live in slums area. Of course, there is a different crime, which means violating the law, that doable by the poor and the not poor. It’s mean that just because someone has that kind of social and pathological trait, it will not make them a criminal because there is still another factor to make crime occur.

Let us illustrate a story. Several years ago, in some slum area two boys engaged in a minor theft, they flee when they were discovered by the owner. The first boy, thanks to his athletic ability able to escape by jump across the fence, and later became a priest. The second boy who has a bigger body yet slower get caught, send to penitentiary, and later become a drug dealer.

So, what’s make the second boy became criminal? That’s not because he commits crime by “stealing” (since he is still a boy) nor because run slower hence get caught and spend time in penitentiary, but because he associated with some drug dealer in penitentiary while the first boy associated some priest in his living area. That’s the experience factor that makes the second boy became a criminal.

What is the connection between association and slum area in this part? Because slum area composed by crowded dense house one to another. That kind of environment tends to make easier for someone to associate with another. So, if by some unfortunate event some kid is associated with an active criminal, that kid will learn how to do criminal activity. And when his basic need is unmet, there is a chance that he will use his criminal knowledge to fulfill it because his condition makes him able to do it: commit a crime. Hence the result, that kid became another criminal.

Thanks to his criminal ability, the “kid”, who now is a full grown-up adult, able to fulfill his basic need. Now he not just a one criminal person, but also a part of some crime syndicate. He still lives in his slum area, somehow never get caught, but have a better life than his honest living neighborhood. His better lifestyle with an “easy” job will attract the younger ones. Those younger generation will see him as someone who doing “easy work”, yet have generous income than others. So, the younger will associated with him and his crew, transfer their “crime culture”, and another person with criminal knowledge is born, waiting for a perfect chance to use his ability. That’s the perspective stigma from outsider about slum area, a place where a criminal “born”.
Another way to prevent the birth of either crime or criminal, is through some design. As the name implied, Crime Prevention Through Environmental Design (CPTED) is a theory that basically focused on crime prevention. Its theory composed by law enforcement, architect and even involving resident in community area to create a safety situation that preventing crime. Basically the theory have four point to highlight: control access, surveillance, territorially and maintenance. The CPTED theory itself also using another theory, such as Felson & Cohen’s Routine Activity theory to Glasl’s Conflict Escalation. The essence of that theory is that crime is occur when there is an encounter between two party, like criminal candidate meet victim candidate, plus a kind of X factor that trigger the crime situation, like the absence of guardian, offender capability, victim vulnerability, even some “history” between them. So to prevent the crime we need to “manipulate” the environment such as add a CCTV at certain point, resident patrolling, even merging or separate to isolate some area.

2 Methods

Qualitative research method is used in this research to understand and examine about factors which relate with the transformation of slum area especially in Jakarta. We use two steps to find the factors and understand about slum transformation as flow in our research. Firstly, we use literature study that tell us about urbanization, social exclusion and stigma of slum settlement. In addition, historical view is used to descript about “Hero to Zero” transformation relate with slum are in Jakarta from 1960’s and policy dynamic which had taken from previous governor in general description. Secondly, field research, consist of field observation and interview, is used for taking out primary data collection about “Zero to Ash” and “Zero to Heroes” transformation. Field observation and interview are used to collect not only physical, but also social aspect. To understand how the process of transformation we interview several residents and community leaders that still exist near the site of the slum areas “revitalization”. As a success story of transformation of slum area which we called “Zero to Hero”, we use Kampung Akuarium as research site. Contradicting with Kampung Akuarium’s Story, we use Kampung Pulo as research site as “Zero to Ash” case. After we explain about transformation categories of slum area in the end of this paper, then we demonstrate five stages activity to empowerment slum area community.

3 Results and Discussions

3.1 Urbanization, Social Exclusion and Stigma of Slum Settlement

Slum areas appear in almost every country in the world which around one billion people live there [13]. In Indonesia context, slum areas had reported exist since the colonial era in the 1910s. There were several publications and literature work which described about areas that had poor amenities from health until sanitation that lived by poor people who came from outer Jakarta region especially from rural areas.

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1 Westerveld in 1914, Hendrik Freek Tillema in 1920, and Ajip Rosidi (Famous Sundanese Writer) in 1950s (Hanggoro, 2019).
Then, Slum areas have continued and growth in Jakarta. Although Jakarta’s Government have tried to reduce slum area with demolition and relocation settlement since 1960s, because in that time 60% Jakarta’s people lived in crowded slum areas stated by Ali Sadikin (as Jakarta’s Governor).

In recent times in Jakarta, around 118 from 267 villages (49%) have slum areas ([12]; [29]). These areas spread out in six districts which consists of 39% in North Jakarta, 28% in West Jakarta, 19% in South Jakarta, 12% in East Jakarta, 11% in Central Jakarta and 1% in Kepulauan Seribu [29].

Poverty and urbanization are the main factors of slum areas growth such big city as Jakarta ([13]; [3]; [16]). From this point of view, so we try to examine the urbanization in Jakarta related to the growth of slum areas. The importance of this study relates with goals No.11 from SDGs’ about build inclusive, safe, strong, and sustainable city and settlement [5], further in goal No.11.1 which stated to ensure fulfilled accessibility of basic need, safety, affordable housing for everyone and improve slum areas [7].

Before we see urbanization in Jakarta, lets we see about Indonesia’s urbanization in general. Prediction about people in Indonesia tends to move live in a city that has been done by Tjiptoherijanto (1999). He predicted 55,19% of people in Indonesia will live in the city than in rural areas in 1995-2020 with annual average urbanization 7,1%/year [28]. Pulling factors urbanization are opportunity for business or better jobs with better wage, good facilities and services in city ([3]; [14]; [13]; [28]).

In 2018, Indonesia is one of several countries with the highest urbanization level in the world that reach 4,1%. This percentage of urbanization has higher than in China (3,8%) and Filipina (3,4%) [21]. Moreover, Jakarta is the greatest magnet urbanization in Indonesia which has predicted urbanization level always reach 100% from 2010-2035 [4]. Similar to prediction, Jakarta has reach 102,89% of newcomer growth from 68.763 in 2016 to 70.752 in 2017 [26].
Lot of newcomer who unskilled and low skilled become difficult to be absorbed in the job market, then they will be absorbed in informal job with low income such as street vendor, parking attendant, construction worker and so on ([6]; [18]; [21]). This is the condition that makes slum areas will growth because many newcomers must survive and find their new house, besides of high cost of transportation that consumes 43% of their income, house rent/purchase and food [16].

The number of newcomers in Jakarta which is increasing every year is difficult to anticipate by the DKI Jakarta Provincial Government in terms of providing basic needs—especially decent housing for all its citizens. Besides, the limited space in urban areas for settlement land due to the current urbanization indirectly causes the emergence of slum pockets in Jakarta. Some slum areas in Jakarta can be found in several places that are close to the community’s economic activities such as in the market. Besides, slum settlements can also be found easily on the edge of a River Basin (DAS) or the edge of a railroad crossing. The process of the emergence of slums is related to newcomers who have low-quality human capital because struggling to survive meets the cost of daily living so that the feasibility of settlements is not a priority for them. In other words, slums are very identical to those who have low-income levels. This is the number of increasing Jakarta’s population from 1948’s-2016’s:

<table>
<thead>
<tr>
<th>Years</th>
<th>Total Number Population</th>
</tr>
</thead>
<tbody>
<tr>
<td>1948</td>
<td>823,356</td>
</tr>
<tr>
<td>1949</td>
<td>1,349,625</td>
</tr>
<tr>
<td>1961</td>
<td>2,973,053</td>
</tr>
<tr>
<td>1971</td>
<td>4,684,000</td>
</tr>
<tr>
<td>1985</td>
<td>6,164,848</td>
</tr>
<tr>
<td>1990</td>
<td>8,200,000</td>
</tr>
<tr>
<td>2000</td>
<td>8,400,000</td>
</tr>
<tr>
<td>2010</td>
<td>9,600,000</td>
</tr>
<tr>
<td>2015</td>
<td>10,280,000</td>
</tr>
<tr>
<td>2016</td>
<td>10,300,000</td>
</tr>
</tbody>
</table>

(Source: Procesed from [9]; Badan Pusat Statistik, 2017)

If we compare between Jakarta’s population in 1948’s and 2016’s, then 2016’s population same as 12 times population from Jakarta in 1948’s or same as increasing population in 139,362,41 people/year for 68 years.

On the other hand, increasing uncontrolled urbanization can trigger conditions of social exclusion—conditions aimed at the weak capacity of the community in various aspects of life. Social exclusion is a process (and also an outcome), individuals or groups separated from broader social relationships—characterized by not participating in community activities such as consumption, saving, production, politics and other social activities [23]. Silver sees social exclusion in three points of view: solidarity; specialization and monopoly. The solidarity paradigm sees the weakening of social ties between individuals in society. The specialization paradigm sees that social exclusion is a consequence of specialization that occurs in society.
The monopoly paradigm sees exclusion as a result of group monopoly - highlighting the dominance of a group over a particular group [22]. However, the cause of social exclusion in the context of poor communities in slums is not infrequently caused by Government policies. In turn, the existence of poor communities in slums vis-à-vis with spatial planning policies (re: forced evictions). Spatial planning, especially regarding the arrangement of slums in Jakarta, often leads to a form of resident resistance because it refuses to be relocated. The difference in perspective in seeing the concept of slums is one of the causes of miss-communication between the community and policymakers.

Two assumptions explain the emergence of the slum area by UN-Habitat [21]: In general, and traditional slum area categorized as settlement area in the origin which many people want to live there. Because the origin owner of the house moves to a new area or get a better location in the city, they started renting their houses or land for newcomers as additional income. As time goes by which houses live by renting people, then occur degradation of settlement condition then become slum area. In the second, slum areas are emerged by poor or low-income people who built their impermanent houses on unclear land like riverbanks or empty spaces such as under highway, even on government land without or minimum facilities.

Slum area is an environment that is lived mostly by outer/immigrant people which does not fulfill the standard of well-being for human life [21]. The feature of slum area are poor facilities for infrastructure, health, electricity, education, sanitation, poor management for waste, poor accessibility for clean water, rickety house which is lived by more than 3 people, and low safety environment ([4]; [27]).

There are several stigmas for slum area in several aspects. In the physical aspect slum area can be recognized by their house, begin with simple tent become semi-permanent/permanent building with poor amenities for fulfill basic needs ([2]; [21]; [27]). Moreover, slum area tends to appear in government land or green zone such as riverbanks without good governance ([2]; [12]). Usually, slum areas emerge near working place, water facility, and transportation network ([2]; [27]).

Then, slum areas frequently seen or categorized as degradation zone from the city development process in society. Many people live in the slum area tend to have a low level of education [27]. Because slum areas are considered as a source of social problem, social deviation as the nest of criminal, prostitution, alcoholism, and so on ([2]; [11]; [21]) from social aspect.

The economic aspect that describes the slum area is that many people in there have low rate income with a high rate of unemployment. This condition makes them holding their hunger because they have a little money for buying food regularly, moreover thinking about their plan. Politicians frequently using their (slum area residents) as a tool against their political enemy.

Finally, in the environment and health aspect, the slum area has been seen as the source of waste that makes environment degradation and causes many diseases such as scarlet fever ([2]; [17]; [27]).

3.2 Three Transformation of Slum Settlement

**Hero to Zero:** settlements that are not slum then become slums.

Hanggoro explain about hero to zero relate with area not slum become slum in Jakarta from a historical perspective. Same as previous explanation about urbanization, Jakarta always excess of population because its economic attractiveness especially for job that causes of massive infrastructure projects. For welcoming Asian Game in Soekarno’s Era around 1960s, Indonesia built a stadium which displace 8,000 house that categorized as “kampong”. Jobs opportunity pulled up many people from rural areas and emerged new settlements that were planned or
unplanned. Several areas as green areas, government land or several placed for public facility changed into crowded settlement like Menteng Atas, Medan Merdeka grass field, Tanah Tinggi, around Gedung Proklamasi, Gajah Mada and Hayam Wuruk Street [11].

In 1960, Jakarta had a deficiency of housing for its people around 1.3 million house that must be provided by the government. Then, Star Weekly Magazine as one of the media which interest in public policy topic saw the “displace” policy as inappropriate action from Jakarta Government. Star Weekly said existing settlement (who is lived by poor people), however, its bad condition to be left standing. Then Soemarno as governor of Jakarta converts the budget for “displace policy” into the budget of infrastructure development [11].

Japanese occupation with scorched earth politics and burning of villages resulted in damaged housing. After World War II, an estimated 2000 homes were damaged. In 1940 1,000 houses were planned, but by the end of 1949, only 20 percent had been realized. To overcome the housing problem, since 1948, a satellite city of Kebayoran Baru has been planned to have an area of 730 hectares. In this area it is projected as a residential area whose edges intersect with the Tanah Abang-Tangerang railroad. Construction began in 1949. Land area of 730 hectares was divided for 152.5 hectares of public housing with a number of 6,730 persil of samadia / moderate housing, 69.8 hectares with 2,198 plots of land, 55.1 hectares of villas with 834 plots of land, 75.2 of special buildings hectares, 6.6 hectares flat, 17 hectares shops, 20.9 hectares industry, 118.4 hectares of city parks, 181.5 hectares of roads and 33 acres of rice fields. All of this is intended to provide a residence for 100,000 residents [9].

The idea of developing the city of Kebayoran originally came from Ir. V.R Vsan Romondt. The idea was on July 19, 1948, discussed at a meeting of the Central Housing Committee. Furthermore, on August 5, 1948, the plan was submitted to the government and on September 21, 1948, the government accepted the plan. To accelerate development, on December 1, 1948 compensation payments to residents had begun. In addition to land, the government also compensated 700,000 trees consisting of 26 kinds of fruit trees, 1,668 houses, stalls, and stables. At this initial stage, on December 1949, the government had issued 15 million guilders [9].

The city development plan was compiled by Practices Ingenieur M. Soesilo from the Central Planologish Bureau. In the plan, the new city to be built is called the Kebayoran Satellite City. The naming of satellite cities is not appropriate because satellite cities are usually located 15 kilometers from the capital, while Kebayoran is only 8 kilometers from the capital. The groundbreaking was carried out on 18 March 1948 [9].

Before being determined as a housing complex ahead of World War II, the Kebayoran area had been researched to become a new international airfield replacing the Kemayoran airfield because it was thought to interfere with the city's expansion to the east, but the plan failed. The implementation of the construction of the new city of Kebayoran was handed over to Central Stiching Wederopbouw (CSW), a foundation established by the government with a notarial deed on June 1, 1948 [9].

Since the transfer of sovereignty in 1950, CSW has changed its name to the Central Rehabilitation Foundation (JPP). Furthermore, based on presidential decree number 65 of 1951, JPP or CSW was declared dissolved. Property rights and accounts receivable payables are the responsibility of the Indonesian government. To continue development, with the decree of the minister of transportation, public works and personnel on September 4, 1950, a special department was formed, namely the public works department of the new city of Kebayoran starting on June 1, 1950, then in 1952 it was changed again to the Special Development of the New City of Kebayoran, as a organizations within the Ministry of Public Works and Labor [9].
The land acquisition for the Kebayoran construction is carried out by the land company, provided that the company pays the state 0.30 guilders per square meter for each persil. Based on these calculations, the government spent Rp. 15 million for land purchases, which included Grogol Udik, Pelapetogokan, North Gandaria, Benajan, Kebayoran Districts, and parts of Jatinegara district. Because it was not enough, in 1951 the funds were added Rp. 2.5 million so the amount was Rp. 17,500,000 [9].

On a land area of 323 hectares, it is planned that 7546 houses will be built, but until 1952 only 4,630 houses have been implemented. The remaining persil that have not been used for public housing 619, samadia / moderate houses 1,344, villa 459, and shops 494, with a total number of uncultivated persil of 2,916 housing developments will be endeavored by providing a broader yard to bring closer relations between residents and nature. According to normal comparisons, the total area of roads, landscaping, and parts is 30 percent of the total city area. In the Kebayoran city plan, this ratio was increased to 50 percent [9].

In early 1951 CSW had completed building 2,058 houses, some of which had been sold, while 1,717 were leased. The cost to build 1,7171 houses is Rp. 19,323,530, and of these there are 788 semi-permanent houses. The house is rented at a between price of Rp. 17.50 and Rp. 100. Besides, in the new city of Kebayoran, 1510 public houses, 183 state class 1 houses, 3 markets, 14 schools, 559 private houses, and 2,015 CSW foundation houses were built. Housing development is not only carried out by the government, but also by government agencies and private companies so that the housing model varies [9].

Based on calculations, the cost incurred for the acquisition of 730 hectares of land is Rp. 16 million-plus Rp. 2.5 million prepare the land to be ready to build Rp. 3.5 million, making primary and secondary roads Rp. 6.25 million, roads Rp. 1.5 million, buildings on the highway Rp. 1.2 million, drinking water Rp. 1.6 million, and waterways Rp. 4.8 million. The total amount is Rp. 38.1 million. This figure does not include investment development costs from electricity and gas companies [9].

Along with the development of the economy in Jakarta which then attracts newcomers to live in the Jakarta area. So, the exception of the Kebayoran Baru Satellite City area is increasingly crowded with residents until the suburbs are gradually becoming slums like in the Kramat Pela village area which is currently included in the Kebayoran Baru Distri. Based on data from www.kotaku.pu.go.id, the area in Kebayoran Baru Subdistrict included in the Neighborhood Upgrading and Shelter Project (NUSP) program or community-based slum eradication alleviation programs based on recorded community participation in the North Gandaria sub-district with an area of 5.13 Km2, Petogogan Village 5.18 Km2, Kramat Pela 3.91 Km2. Broadly speaking, not all of the three villages are in the slum category. For example, in the Kramat Pela sub-district that has slums, there are RW 009 on Jalan Pandan and RW 010 in Gang H. Aom (www.Kompas.com).

Zero to Ash: settlements that are slum and end remain up displaced and disappear.

Kampung Pulo located in Jatinegara district, East Jakarta is an area which is located inside of meander Ciliwung River and one of the worst to flooded area when water gate from Bogor opened at heavy rain. On 20 August 2015 in Basuki Tjahya Purnama (a.k.a. Ahok) reign as governor, there is an eviction against some of the dwellers who live at the side of the river. It is said that by law, there should exist a road at the side of the river as an inspection track.

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2 Persil is a unit of land size at the time.

3 The Kebayoran Baru Satellite City Region currently covers the Kebayoran Baru Now Subdistrict area. The Senayan Area is also included in the Kebayoran Baru Subdistrict Area.
If we refer to Hagan’s Prism of Crime, there are multi ways to see something as crime, or not. In this Kampung Pulo case, it’s a fact that their flooded routine already happened for years without any management from governor. The disaster didn’t occur just because there is “water shipment” from Bogor, but also Kampung Pulo side dweller habit to throw garbage in the river. And there is no way to clear the garbage without inspection track. It is true that when Kampung Pulo is flooded, there is help from NGOs and governor, but that is no solution. So, in this way, the governor already committed a crime (an offender) by neglecting his duty resulted in Kampung Pulo get flooded for years.

Which is we could say that when Ahok evicted those who dwell inside of the river, he actually doing his job hence make an inspection track, keep the river clean hence prevent the flood. Of course, there is a resistance from the dweller who got their home evicted. The reason for their resistance is because they had inhabiting that place since 1927, always pay land tax, and some claimed to have certificate as rightful owner of the land and has to be compensated. At first, a negotiation indeed happened between governor, which is Jokowi at that time continued by other representative, and the dweller representative that there will be compensation for those who got evicted. But in Ahok’s era, the compensation only for those who have a certificate as a rightful owner. In the end, according to the interviewees, there is no compensation at all, which makes the dweller angry and resist eviction. Which indicated that the Kampung Pulo dweller thinks that they got swindled by governor as their justification. And if the governor tells the truth that compensation only for those who had a certificate, then there is a chance that their certificate is fake or not the right one. In that case, we can say that Kampung Pulo dweller is a victim by someone.

But it’s a fact that after eviction there is (almost) no flood at all in the Kampung Pulo, which is according to interviewees kinda make other areas envy them. The Kampung Pulo dweller whose didn’t evicted also able to park their vehicle in the inspection track (figure. 3). They had to park their car far elsewhere before. Although the area that didn’t got evicted is still “slum”, hence encourage as a birthplace for a criminal (figure. 4).

Fig. 2. The Ciliwung River is shallow enough for a person able to stand. (Source: Personal Documentation, 2019)
As it said before, that the boy will commit a crime because the “condition” allows him to do it. The objective situation is also important to provide an opportunity for a criminal act. For example, a thief may steal a cake when the owner not in the sight, but will refrain if the owner is in the sight. In Felson & Cohen’s Routine Activity, the cake is the object, the owner is the guardian and the “boy” is the offender. A crime will occur when there is a suitable object, an absence of a capable guardian, and the capable offender. It also means that there is a way to prevent crime by manipulating the environment.

If before the eviction, brawl is tending to happen between area that involved Kampung Pulo and other areas, now it was reduced. And that’s because those who used to involved in brawl already move to another place. It’s one kind of application of environment manipulation in CPTED.

**Zero to Heroes: settlements that are not slum then become slums.**
Assumptions about wild and slum urban villages (Kampung) often lead to the threat of forced evictions. During Governor Basuki Tjahaya Purnama (Ahok), there were at least many cases of evictions during 2015-2016. The reason was because the evicted areas were not intended for settlement, so the settlements that stood there were illegal. Kampung Akuarium, Penjaringan Sub District, North Jakarta became one of the village that found the forced eviction because it was considered as illegal settlements. Kampung Akuarium, is indeed indicated not only as illegal settlements but also slums. Therefore, efforts the resistance of residents ended in vain.

Fig. 5. Location of Kampung Akuarium, Penjaringan Sub District, North Jakarta (Source: Via Google Earth)

The eviction of Kampung Akuarium in 2016 has drawn a lot of protests from the public. Kampung Akuarium is considered as a historical place. In its history, Kampung Akuarium was a witness for the establishment of a marine science research laboratory—Research Center for Oceanography, Indonesian Institute of Sciences (LIPI) since the 1900s ([24]; [20]). In the 1970s, the Research Center was moved to the Ancol District, North Jakarta and Kampung Akuarium area was officially closed for the planned expansion of the Maritime Museum. Then, many residents began arriving and finally settled there—the existence of Kampung Akuarium itself occurred in the process (Interview with Teddy, September 2019). Since the mid-1970s, residents have been living and supporting themselves and their families in Kampung Akuarium, where the sea is their source of livelihood (Interview with Teddy, September 2019).

Fig. 6. Batavia Fisheries Laboratory (Visscherij Laboratorium te Batavia) in 1922 (Source: oceanografi.lipi.go.id)
It cannot be denied, that residents also claim to have certificates that give them the right to occupancy that they have been occupying (Interview with Teddy and Yani, September 2019). Therefore, residents of Kampung Akuarium do not accept if they are considered to inhabit wild areas. Not only that, for residents, Kampung Akuarium is not a slum settlement as the Government considers it (Interview with Teddy, September 2019). Because of that, the people made a resistance the eviction very hard. Even so, the fact is that the physical condition of Kampung Akuarium falls into the slum category if seen at 7 indicators based on the Circular Letter of Ministry of Public Work and Housing (Kementerian PUPR) in 2016 about General Guidelines for Without Slums Program (Program Kota Tanpa Kumuh/KOTAKU). Even though residents resisted strongly, the eviction was inevitable.

After the eviction, residents of Kampung Akuarium continue to carry out advocacy movements and network with NGOs working on related issues, such as the Urban Poor Consortium (UPC), City Poor People's Network (JRMK), and the Rujak Center for Urban Studies after eviction. The climax, these various efforts arrived at the momentum to succeed – the 2017 Jakarta Local Election. The residents of the Akuarium Village were accompanied by NGOs as mentioned succeeded in agreeing with Anies Baswedan at that time. The agreement resulted in a political contract in the form of a win-win solution for both parties. Residents and NGOs will give victory at several polling stations for Anies. While Anies will reorganize 16 Kampung in Jakarta that were evicted during the previous Governor's term. In the post-eviction consolidation process, although some residents chose to stay in simple rental flat (Rusunawa), most of them chose to stay in the Kampung Akuarium by inhabiting shelters built by the DKI
Provincial Government after Anies-Sandi’s victory the Jakarta Election in 2017 (Interview with Topas, September 2019).

The initiative to rebuild the Kampung that was displaced by the political contract was called the Community Action Plan (CAP). For Levitan, CAP is not only a program but a strategy to fight poverty. CAP is a program that means: (1) Mobilizing and utilizing resources, either public or private, or geographical areas in fighting poverty; (2) Providing services, assistance, and other activities to pledge progress towards poverty alleviation; (3) Developed, carried out and managed with maximum participation from the community and group members served; and (4) Conducted, managed, or coordinated by public or private nonprofit institutions (other than political parties), or a combination thereof [15]. CAP is a process that puts the community as a primary source rather than only as an object of development—carried out through mapping, discussion and workshops (UN-HABITAT). CAP is an action plan that places the community as the subject of development. That is, the approach used in the CAP is a bottom-up approach that seeks to explore the problems and potential of the community. Through this approach, the parties involved hope to find ideas and needs that are following the conditions of the community. The CAP emphasizes community involvement in development schemes. Thus, the CAP has inclusive principles because it puts forward a strategy based on the participation, accessibility, and freedom of the community [8].

Under the decision of the Governor of DKI Jakarta No. 878/2018, Kampung Akuarium (RT 012 RW 04) is designated as one of the priority Kampung for implementing the CAP. The implementation of the CAP is divided into two stages, namely the Pre CAP and CAP. The coordinator of the Kampung Akuarium area, Yani and Tedi explained that the Pre CAP stage was an activity of preparation including the formation and training of community work teams, analysis of problems and potentials, tracing the Kampung’s history and culture and workshops entitled International Field School in 2018 and 2019. International Field School is a series of training activities in the form of seminars, focus group discussions, and “This is Kampung”
exhibitions involving residents of the Kampung Akuarium and the Facilitators (UPC, Rujak, JRMK and Academics) in collaboration with Kyoto University.

“Fig. 10. The “This is Kampung” Exhibition in International Field School at Kampung Akuarium in 2019 (Source: Personal Documentation, 2019)

“This is Kampung” Exhibition, displays the design and concept of the Kampung Akuarium as a result of International Field School activities. Based on its potential and history, the community was accompanied by facilitators to initiate the concept of the Maritime Tourism Kampung which was considered suitable and able to improve the welfare of the community. Through various dialogues and training, the concept of a sustainable Kampung is expected to be ready to start (built) in mid-2020 (Interview with Yani, September 2019). Through CAP, relocation and eviction proved not the only way out for the existence of Kampung which has been negatively imaged by the Government. CAP is thus an attempt to re-arrange according to the needs and expectations of the community—prioritizing to accommodate the rights, ideas and needs of the community rather than depriving the human rights of the poor who inhabit settlements that are considered illegal and slums. The Vertical Kampung Model, initiated by residents and facilitators through the CAP, is considered more humane to guarantee the lives of citizens. The design aims to preserve interaction and culture typical of Kampung and in line with the principles of inclusiveness and sustainability in the development agenda.

“Fig. 11. The Latest Concept of Maritime Tourism Kampung for Kampung Akuarium in September 2019 (Source: Design Andesha Hermintomo and Bardha Gemilang)

Sustainable Inclusive Development: Community Empowerment in Slum Settlements

Community empowerment in improving the quality of the slum settlements means how to improve the community’s understanding so that they want to take part in various activities in improving the quality of the environment. Community empowerment efforts by encouraging communities to be independent and can make their own decisions, own initiatives, and improve their lives quality. Involvement or participation can be in the form of contributions of thoughts,
opinions, and actions, it can also be in the form of costs, materials for improving the environment.

Essentially, empowerment can be seen from its participation in five stages activities, namely activities in taking initiative, planning, implementation, supervision and evaluation, and management and maintenance of the residential environment.

First, the initiative stage. At the retrieval initiatives stage, the community introduced to community empowerment that has a purpose to increase community potential. At this stage, the community is given awareness, encouragement, motivation, opportunities including authority that is following their functions and roles. Furthermore, various problems faced in the settlement environment are introduced, so that from their understanding they can come up with a variety of positive ideas and ideas, because without understanding the problems are usually difficult in bringing up the initiative. What needs to be watched out for in community empowerment are various forms of conflict. This has the potential to occur because in community empowerment it involves various fields such as land, property rights, responsibilities, authority and so on. This potential conflict needs to be avoided.

Second, the planning stage, a community-based approach is very necessary, because basically, not all communities can plan independently. As we know the planning of a residential environment is very complex, including the planning of physical space (spatial) and non-space (a-spatial). Planning physical space in the form of various forms of houses, housing, facilities and infrastructure of the residential environment. Non-space planning in the form of idealism, aspirations, behavioral attitudes from various social, cultural, and economic conditions of the community. Community Action Plan (CAP) is one of the programs in the planning stage.

Third, at the implementation stage of improving the quality of the settlement environment, the community can play a role in various fields, for example in the provision of land, building materials, labor, maintaining order, security and so on. The community can take the opportunity and experience where the community's functions and roles need to be considered, including procedures that must be obeyed to avoid conflicts, because the results are for the community itself.

Fourth, the supervision and evaluation stage. A good supervision system will encourage the acceleration of the implementation of work and the achievement of quality following the plan. At the evaluation stage in the structuring of the environment both at the planning, implementation, and supervision stages there are of course conformity, mismatch, errors and other forms of irregularities. Therefore, all walks of life have an important role.

Fifth, management and maintenance stage. At the stage of management and maintenance of the residential environment is a very urgent thing to do by the members of the community. The success of the management of the residential environment is strongly influenced by the activities of residents who are fostering, building and developing their environment. Various programs that have been implemented well, the community is still expected to carry out management and maintenance of the environment through pure awareness in various forms of participation.

4 Conclusion

The dynamics of the slum transition (hero to zero, zero to ash and hero to zero) in Jakarta correlated with the uncontrolled growth of urbanization. In turn, the majority of settlements in Jakarta are inhabited by lower-middle-class people mostly working in the informal economy.
Some of the slums are identified as illegal areas that are included in the DKI Jakarta Provincial Government's structuring program. The reorganization efforts that led to the relocation immediately increased public dissatisfaction. The stigma attached to slums and squatter settlements and the communication crisis in managing slums are the cause of resistance to enforced evictions. On the other hand, some facts show that there is a tendency of a repetitive process the cycle of change from one condition to another and returns to the original condition. This condition is greatly influenced by the active role of the community and the policies that are put in place.

Therefore, the CAP program implemented in **Kampung Akuarium** is a breakthrough development paradigm that is more bottom-up. Through that, the principles of accessibility, freedom, and participation are prioritized in managing the village while empowering the community. Through the CAP program, the existence of **Kampung Kota** in Jakarta will remain sustainable.

**References**


Infiltration Capacity in Flood Mitigating Jakarta

Elsa Herda Adeline¹, Hayati Sari Hasibuan² and Setyo Sarwanto Moersidik³

{elsaherda@gmail.com¹, hayati.hasibuan@ui.ac.id² and ssarwanto@eng.ui.ac.id³}

Environmental Science Study Program, Postgraduate Program Universitas Indonesia¹,²,³

Abstract. Green Open Space (GOS) with hydrological function is expected to assist minimize Jakarta floods. Rainfall data calculated using Ffolliott equation to get the volume and velocity of water that infiltrates. The determination of the GOS locations are based on minimum 1 ha wide; represent different groundwater vulnerability classifications based on Ground Water Level (GWL) 0-40 meters; represents a different classification of Jakarta Groundwater Availability and Utilities Analysis; not include PAM Jaya service coverage areas; include in the Protected Green Open Zone, City Forest Zone, City Park Zone, Green Lane Zone (Green Lane Sub Zone only) and Recreational Green Zone; existing GOS is not as a road median. The highest infiltration based on GWL 0-40 meters located at the Poor category and based on types of the land ecoregion found in Plain sandbank beach - Intersandbank valley and Fluvio-marin Plain.

Keywords: Green Open Space, Infiltration, Jakarta, Land ecoregion, Groundwater

1 Introduction

Green Open Space (GOS) in urban areas has an ecological function as a place to save water reserves that are influential in reducing the heat island situation [1] and also the sustainability of the city, which have a role to maintain the hydrological cycle and water quality[2]. Ecological, economic and social functions are functions that are occupied by GOS which is a green area with benefits for welfare in life, health and contributes to the sustainability of an area[3].

A growing population of the people living in cities until it is estimated that it reaches two-thirds of the world's inhabitant in 2050[4] results in increased land-use change. The increased impermeable surface will inversely proportional to the ability of infiltration thereby increasing the tendency for flooding[1]. These conditions can be the significance basis of maintaining GOS with high soil permeability to delay runoff water so that it also has an effect on reducing urban flooding[5].

Comparison within zoning plans in the Detail Spatial Planning and Zoning Regulations (RDTR-PZ)[6] shows 48% are Settlement Zones, 14% Commercial and Office Zones, 7% Industrial Zones, 11% Blue Open Spaces (BOS), Government and Social and Public Facilities Zones 7% and 13% GOS (without GOS buffer calculations). The other study[7] asserted that the percentage of stipulated GOS zoning was 11.7% (7,749.36 ha) with realized GOS conditions 473.94 ha which
is equivalent to 5.31% of the total area. However, based on information from the Jakarta Forestry Agency, GOS that already realized was only 4.65% (3,080.89) ha. In more detail, Figure 1 shows the design position of the GOS that contained in RDTR-PZ.

Based on geomorphology that shows in Figure 2[8] there are six types of the land ecoregion in Jakarta:

1. Muddy Tidal Plains, which is formed by the marine process and stretches along the coastline with material as generally fine-textured.
2. Plain sandbank beach - Inter-sandbank valley. These are a pile of sand that extends along the coastline with common material is sand.
3. Swamp Plains, this formed from the results of the fluvial deposition process that leave a plain with small basins that are randomly scattered.
4. Flood Plain, the plain that formed around the river channel and always flooded especially in the rainy season.
5. Fluvio-marlin Plain, this plain is usually a little far from the coastline or behind muddy tidal plains and suitable for the development of aquaculture ponds. It is a plain that occurs as a result of marine activity namely a lagoon and then material alluvium covering it[9].
6. Fluvio-volcanic Plain. This plain is predominantly derived from the Pangrango volcano and the Salak volcano located in the southern part Jakarta with the landform’s character is high accessibility due to flat relief, suitable for the development of agricultural cultivation and other developed areas.

![Figure 1. GOS Planning Map](image1)

![Figure 2. Map of Jakarta's land ecoregion types](image2)
Being in a swamp area which is mostly below sea level[10] and also on low and flat alluvial land is characteristic of the city of Jakarta. Based on that facts if flooding occurs especially in the rainy season it has not become surprisingly. That condition not only has the potential to cause inundation which results in flood events but in the north area of Jakarta land subsidence also results in seawater intrusion[11]. The decreasing groundwater level is one of the things that causes land subsidence. There are four kinds of land subsidence that occurred in Jakarta[12], namely the decrease due to the burden of construction, natural consolidation of alluvial soils, tectonic disasters and groundwater extraction.

Flood and inundation events that hit the city of Jakarta routinely are the main issues that form the basis of spatial planning. The city of Jakarta is downstream from several rivers that flow into Jakarta Bay, so that surface runoff from upstream will overload the drainage system in Jakarta City. Based on this, the presence of GOS with hydrological function is expected to assist minimize Jakarta floods. From data published in 2015[13] in the five regions of Jakarta in 702 affected hamlet, there is still standing water with a height of >150 cm. With the development of urban development, the swamp draining activities further enhance the potential for flooding.

The role of GOS in the hydrological aspect is to increase resistance to the risk of drought and flooding[15]. In terms of drought, especially clean water sources, from 2000 to 2015 Jakarta Water Supply Company (PAM Jaya) can only serve 35%[16] of the total population (the difference between total water sales and total water needs), while PAM Jaya states that the percentage of service coverage has reached 60%[17]. Based on this condition the Government cannot prohibit groundwater extraction especially for areas outside the PAM Jaya service area. An analysis related to the presence of groundwater, classified the Jakarta groundwater crisis area based on physical, social and policy variables become into 3 (three) groups conditions[18] of Vulnerable, Prone and Crisis Groundwater. Beside of that refer to aquifer Ground Water Level (GWL) 0-40 meters, Jakarta classified into 5 categories (see Figure 4)[19]:

1. Very good (decrease GWL: -(5-10) meters Above Sea Level (ASL))
2. Good (GWL contour (-5) – 0 ASL)
3. Moderate (GWL contour 0 -25 ASL)
4. Poor (GWL contour 25 – 50 ASL)
5. Extremely poor (GWL contour > 50 ASL)
The Ground Water Conservation Office (GWCO) under The Ministry Of Energy and Mineral Resources provides data on infiltration level[20] measured at several locations in units of cm/sec. (see Figure 4).

2 Methods

This study was based on the approach of a quantitative method used to measure the amount and velocity of infiltration in GOS. It is expected could be determining the planning of potential GOS locations regarding infiltration based on types of the land ecoregion and aquifer groundwater level. When determining the number of GOS samples, the sampling technique used is the Stratified Random Sampling method. The determination of the GOS locations are based on the following criteria:

1. At least 1 ha wide[21]
2. Represent different groundwater vulnerability classifications based on Ground Water Level (GWL) 0-40 meters[19]
3. Represents a different classification of Jakarta Groundwater Availability and Utilities Analysis[18]
4. Location does not include PAM Jaya service coverage areas[17]
5. The location is in the Protected Green Open Zone, City Forest Zone, City Park Zone, Green Lane Zone (Green Lane Sub Zone only) and Recreational Green Zone[6]
6. The existing GOS is not as a road median.

2.1 Data analysis technique

Techniques in analyzing data in this study consist of spatial analysis with Geographic Information Systems (GIS) and descriptive analysis of hydrology with the Ffolliot method. Various information on the world that is complex and in the form of digital information can be derived by GIS and produce digital maps or attribute data as information produced[7]. To analyze
the frequency of rainfall, which refers to how to analyze rainfall in urban drainage[22], a minimum of 10 years of hydrological data is required. Calculating infiltration, rainfall data is needed so that this study will use rainfall data at Jakarta's Meter III Kemayoran station in a period of 10 years. The data will be used in calculating the volume and velocity of water that infiltrates into the ground through an empirical approach to the scope of free aquifers by calculating groundwater potential using the Ffolliott[23] equation (1980).

\[ R = (P - ET).Ai (1 - Cro) \] ................................................................. (1)

\[ R \quad : \quad \text{Infiltration discharge (m}^3\text{/second)} \]
\[ P \quad : \quad \text{Rainfall (mm/year)} \]
\[ ET \quad : \quad \text{Evapotranspiration (mm/year)} \]
\[ Ai \quad : \quad \text{Area (m}^2\text{)} \]
\[ Cro \quad : \quad \text{Surface runoff coefficient} \]

To find the value of evapotranspiration, the Thornthwaite and Mather (1957) equation is used as follows:

\[ PET = 1.6 \left( \frac{L}{12} \right) \left( \frac{N}{30} \right) \left( \frac{10^\alpha}{t} \right)^{\alpha} \] ................................................................. (2)

\[ \alpha = (6.75 \times 10^{-7})I^3 - (7.71 \times 10^{-5})I^2 - (1.792 \times 10^{-2})I + 0.4923 \]

\[ I = \sum_{i=1}^{12} \left( \frac{T_a}{5} \right)^{1.514} \] ................................................................. (3)

\[ PET \quad : \quad \text{Potential evapotranspiration (mm/month)} \]
\[ T_a \quad : \quad \text{Average air temperature (°C)} \]
\[ N \quad : \quad \text{Number of days in a month (30 days)} \]
\[ L \quad : \quad \text{Actual day length (24 hours)} \]
\[ I \quad : \quad \text{Heat index accumulation in a year} \]

A popular method used in calculating the runoff coefficient is called the "Kenessey Method" in which the number of partial coefficients is based on vegetation, slope and soil permeability[24]. If there are various land uses with different C in one watershed, then C can be obtained by taking into account the three factors with each coefficient listed in Table 1.
Table 1. Runoff coefficient for various types of ground cover

<table>
<thead>
<tr>
<th>Topography, Ct</th>
<th>Soil, Cs</th>
<th>Vegetation, Cv</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flat (&lt;1%)</td>
<td>0.03</td>
<td>0.04</td>
</tr>
<tr>
<td>Bumpy (1-10%)</td>
<td>0.08</td>
<td>0.08</td>
</tr>
<tr>
<td>Hills (10-20%)</td>
<td>0.16</td>
<td>0.16</td>
</tr>
<tr>
<td>Highland (&gt;20%)</td>
<td>0.26</td>
<td>0.26</td>
</tr>
</tbody>
</table>

\[ Cr = \frac{\sum_{i=1}^{n} C_i A_i}{\sum_{i=1}^{n} A_i} \] (4)

\( A_i \) : Land area with type of land cover

\( C_i \) : Surface flow coefficient of various types of ground cover

\( n \) : Number of types of ground cover

2.2 Locations

The locations of research can be seen in Table 2, which is located in 5 subdistricts in Jakarta Province consist of Jagakarsa, Makasar, Joglo, Tegal Alur and Duri Kosambi (see Figure 5). Each location is representing each category aquifer groundwater level.

Table 2. GOS Sampling locations with aquifer GWL 0-40 meter

<table>
<thead>
<tr>
<th>No</th>
<th>Categories</th>
<th>Jakarta GWL 0-40 meter [19]</th>
<th>GOS Location</th>
<th>Area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Very good</td>
<td>Jagakarsa, Jakarta selatan</td>
<td>± 1.1</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Good</td>
<td>Makasar, Jakarta Timur</td>
<td>± 1.3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Moderate</td>
<td>Joglo, Jakarta Barat</td>
<td>± 1.1</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>Poor</td>
<td>Tegal Alur, Jakarta Barat</td>
<td>± 3.1</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>Extremely Poor</td>
<td>Duri Kosambi, Jakarta Barat</td>
<td>± 1.5</td>
<td></td>
</tr>
</tbody>
</table>
3 Result and discussion

When the area affected by the 2007 flood event is overlaid with the aquifer groundwater level map, then it can be seen that the "Prone" locations mostly occur in the "Poor" and "Extremely Poor" aquifer category (see in Figure 6). This phenomenon is due to greater land subsidence than areas around and also supports the study that stated one of the caused of land subsidence is by groundwater takes[12].

Besides the location which is historically already a swampy area, Jakarta's target to fulfill 30%[25] GOS has not yet fulfilled become one of the factors that influence the lack of urban water infiltration so that flood events become increasingly difficult to avoid.
Based on the GOS sampling location, it was found that not all locations exposed to flood events in 2015 and the biggest flood in 2007. GOS in Makasar and Tegal Alur subdistrict were found to be included in the inundated area, 10-70 cm at GOS Makassar and 71-150 cm at GOS Tegal Alur, while the other 3 GOS are in a secure area (see Table 3). Table 3 also shows the location of the GOS sampling point for types of land ecoregion.

Table 3. GOS locations and its relation to flood events in 2002/2007 & 2015

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Flood Plain</td>
<td>Very good</td>
<td>Jagakarsa, Jakarta selatan</td>
<td>± 1.1</td>
<td>Secure</td>
<td>Secure</td>
</tr>
<tr>
<td>2</td>
<td>Flood Plain</td>
<td>Good</td>
<td>Makasar, Jakarta Timur</td>
<td>± 1.3</td>
<td>10-70 cm</td>
<td>Quite flood prone</td>
</tr>
<tr>
<td>3</td>
<td>Fluvio-volcanic Plain</td>
<td>Moderate</td>
<td>Joglo, Jakarta Barat</td>
<td>± 1.1</td>
<td>Secure</td>
<td>Secure</td>
</tr>
<tr>
<td>4</td>
<td>Physical Plain-Inter-Physical Valley</td>
<td>Poor</td>
<td>Tegal Alur, Jakarta Barat</td>
<td>± 3.1</td>
<td>71-150 cm</td>
<td>Quite flood prone</td>
</tr>
<tr>
<td>5</td>
<td>Fluvio-marin Plain</td>
<td>Extremely Poor</td>
<td>Duri Kosambi, Jakarta Barat</td>
<td>± 1.5</td>
<td>Secure</td>
<td>Quite flood prone</td>
</tr>
</tbody>
</table>

Based on calculations using the Ffolliot equation, the amount of infiltration based on total rainfall (see Table 4) during the last 10 years in each of GOS locations is shown in Table 5 and Figure 7. Although GOS located in 5 locations there are only 4 types of land ecoregion. Three out of four land ecoregions as overall have similar material in general, consisting of ash, sand, and gravel. Because of that in this calculation, the runoff coefficient based on Table 1 used is a merging of 1) the Flat for topography type (0.03); 2) In soil permeability, Sandy Loam soil (0.08) for Plain sandbank beach - Inter-sandbank valley and Clay and Silt (0.16) for flood plain, fluvio-marin plain and fluvio-volcanic plain; 3) Pasture as a vegetation type (0.21). Based on this determination, the value of Cro is 0.32 for Physical Plain-Inter-Physical Valley and 0.4 for Flood Plain, Fluvio-marin Plain and Fluvio-volcanic Plain.
Table 4. Total Rainfall in 10 years from Meteorology Station Class III Kemayoran - Jakarta Pusat

<table>
<thead>
<tr>
<th>Year</th>
<th>Total Rainfall (mm / year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2010</td>
<td>2,395.00</td>
</tr>
<tr>
<td>2011</td>
<td>1,274.10</td>
</tr>
<tr>
<td>2012</td>
<td>1,488.20</td>
</tr>
<tr>
<td>2013</td>
<td>2,528.10</td>
</tr>
<tr>
<td>2014</td>
<td>2,837.10</td>
</tr>
<tr>
<td>2015</td>
<td>2,086.70</td>
</tr>
<tr>
<td>2016</td>
<td>2,711.50</td>
</tr>
<tr>
<td>2017</td>
<td>2,152.10</td>
</tr>
<tr>
<td>2018</td>
<td>1,501.60</td>
</tr>
<tr>
<td>2019</td>
<td>1,560.00</td>
</tr>
</tbody>
</table>

Table 5. Infiltration debit at GOS locations in 10 years

<table>
<thead>
<tr>
<th>Year</th>
<th>Infiltration Discharge (m³/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Jagakarsa, Jakarta selatan</td>
</tr>
<tr>
<td>2010</td>
<td>16,401</td>
</tr>
<tr>
<td>2011</td>
<td>8,705</td>
</tr>
<tr>
<td>2012</td>
<td>10,175</td>
</tr>
<tr>
<td>2013</td>
<td>17,315</td>
</tr>
<tr>
<td>2014</td>
<td>19,437</td>
</tr>
<tr>
<td>2015</td>
<td>14,284</td>
</tr>
<tr>
<td>2016</td>
<td>18,574</td>
</tr>
<tr>
<td>2017</td>
<td>14,733</td>
</tr>
<tr>
<td>2018</td>
<td>10,267</td>
</tr>
<tr>
<td>2019</td>
<td>10,668</td>
</tr>
</tbody>
</table>
Obtaining the infiltration velocity at each GOS location, the infiltration discharge that already finds should be divided by area (see Table 6). For types of land ecoregion which has the highest infiltration speed every year occurs in Plain sandbank beach - Inter-sandbank valley. The infiltration rate of GWL 0–40 meters shows that the location of GOS with Poor category has the highest infiltration rate.

**Table 6.** Infiltration velocity at GOS location in 10 years

<table>
<thead>
<tr>
<th>Year</th>
<th>Infiltration Velocity (cm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jagakarsa, Jakarta selatan</td>
<td>Makasar, Jakarta Timur</td>
</tr>
<tr>
<td>2010</td>
<td>4.5e-06</td>
</tr>
<tr>
<td>2011</td>
<td>2.4e-06</td>
</tr>
<tr>
<td>2012</td>
<td>2.8e-06</td>
</tr>
<tr>
<td>2013</td>
<td>4.8e-06</td>
</tr>
<tr>
<td>2014</td>
<td>5.4e-06</td>
</tr>
<tr>
<td>2015</td>
<td>4.0e-06</td>
</tr>
<tr>
<td>2016</td>
<td>5.1e-06</td>
</tr>
<tr>
<td>2017</td>
<td>4.1e-06</td>
</tr>
<tr>
<td>2018</td>
<td>2.8e-06</td>
</tr>
<tr>
<td>2019</td>
<td>3.0e-06</td>
</tr>
</tbody>
</table>
When Table 4 shows the highest total rainfall occurred in 2014, it was in line with the ability of infiltration that also reach a peak in 2014 at each GOS. Based on the relationship between the classification of ecoregions with infiltration that occurs, the highest infiltration occurs in Plain sandbank beach - Inter-sandbank valley. In this case, it cannot be compared because the area GOS in Plain sandbank beach - Inter-sandbank valley ecoregion is approximately two to three times greater than other GOS in the other ecoregion.

Based on the distribution of 25 points of infiltration locations obtained from GWCO in Figure 6, the average infiltration velocity value for each category in GWL 0-40 m can be calculated (see Table 6). It is known that the highest infiltration velocity value occurs in the Poor category, while the lowest in the Extremely Poor category.

**Table 7.** The average infiltration velocity in each GWL 0-40 m category

<table>
<thead>
<tr>
<th>Categories Jakarta GWL 0-40 meters</th>
<th>Quantity of Location</th>
<th>Average Infiltration velocity (cm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Extremely Poor</td>
<td>1</td>
<td>0.001</td>
</tr>
<tr>
<td>Poor</td>
<td>11</td>
<td>0.013</td>
</tr>
<tr>
<td>Moderate</td>
<td>7</td>
<td>0.004</td>
</tr>
<tr>
<td>Good</td>
<td>5</td>
<td>0.003</td>
</tr>
<tr>
<td>Very Good</td>
<td>1</td>
<td>0.003</td>
</tr>
<tr>
<td><strong>Overall Average</strong></td>
<td><strong>25</strong></td>
<td><strong>0.008</strong></td>
</tr>
</tbody>
</table>

When average infiltration velocity value is associated with the types of the land ecoregion (see Table 7), Fluvio-marin Plain ecoregion has the highest infiltration velocity value and conversely Flood Plain has the lowest value for infiltration velocity.

**Table 8.** Average infiltration velocity associated with the types of the land ecoregion

<table>
<thead>
<tr>
<th>Types Land Ecoregion</th>
<th>Quantity of Location</th>
<th>Average Infiltration velocity (cm/s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Muddy Tidal Plains</td>
<td>2</td>
<td>0.009</td>
</tr>
<tr>
<td>Physical Plain and Inter-Physical Valley</td>
<td>3</td>
<td>0.006</td>
</tr>
<tr>
<td>Flood Plain</td>
<td>2</td>
<td>0.003</td>
</tr>
<tr>
<td>Fluvio-marin Plain</td>
<td>6</td>
<td>0.016</td>
</tr>
<tr>
<td>Fluvio-volcanic Plain</td>
<td>12</td>
<td>0.004</td>
</tr>
<tr>
<td><strong>Overall Average</strong></td>
<td><strong>25</strong></td>
<td><strong>0.008</strong></td>
</tr>
</tbody>
</table>
4 Conclusion

Infiltration values obtained in the analysis of this study were obtained in two ways, based on rainfall data calculations and secondary data from GWCO. Based on these sources: first, for the calculation of rainfall data founds that the highest infiltration velocity based on types of the land ecoregion is found in Plain sandbank beach - Inter-sandbank valley while on GWL 0-40 meters located the Poor category. Second, regarding secondary data from GWCO, the highest infiltration velocity value based on types of land ecoregion found in Fluvio-marin Plain, while on GWL 0-40 meters, it is also in the Poor category. The difference in the result of ecoregion types for the highest infiltration velocity values is due to the use of the same soil permeability coefficient for the types of ecoregions of Flood Plain, Fluvio-volcanic Plain, and Fluvio-marin Plain. By obtaining a more detailed worth of the soil permeability coefficient in the next study, it is expected to help the limitations in this study related to the worth of the soil permeability coefficient so a more accurate classification of ecoregion can be determined.

References


Sustainability Index Formulation of Soekarno Hatta Airport Railway Transport System

Firman Hamdani Kusumah 1, Hayati Sari Hasibuan 2, Ahyahudin Sodri 3
firmanhk@gmail.com 1, hayati.hasibuan@ui.ac.id 2, ahya.sodri@gmail.com 3
School of Environmental Science, Universitas Indonesia 1,2,3

Abstract. Soekarno Hatta International Airport increased capacity requires good accessibility. To improve accessibility, the government built airport rail. However, the low level of occupancy threatens the achievement of environmentally friendly advantages railway. This condition also affects the sustainability of the Soekarno Hatta Airport Rail. Therefore, it is necessary to know the level of sustainability of airport rail that suitable for developing country that have a limited capacity. This can be achieved by using sustainability transportation index with comparative study approach. Soekarno Hatta Airport Railway has lower sustainability compared to Hong Kong Airport Express and Narita Express. It is necessary to adjust the operation system based on occupancy level and to reduce travel time to improve its sustainability. Other policies that regulate travel behavior are needed so that the Soekarno Hatta Airport Rail will meet its purpose.

Keywords. Airport Rail, Sustainability Index, Soekarno Hatta Airport Rail.

1. Introduction

The high traffic of land transportation to Soekarno Hatta International Airport is not supported by an adequate transportation system. At major airports, passenger terminals are often problematic bottlenecks. The high traffic of people in airport became a problem of its congestion. This intermodal transportation requires to be treated as a continuous end-to-end process. This implies that problems arising either on the air- or the landside of an airport cannot be handled independently. Intermodal transportation can be a successful way to solve it [1]. Until 2017, the main access to Soekarno Hatta International Airport is only supported by road networks. The modal choice that rely only on road-based land transportation have low certainty of travel time depending on the level of traffic, rail systems offer better performance on speed, reliability, punctuality and comfort compared to other modes [1].

Along 2018 Soekarno Hatta Airport serves 68 million passengers and it targeted to serve 100 million passengers by 2025. The increased capacity of Soekarno Hatta International Airport requires adequate accessibility support. It is estimated that the number of daily passengers is more than 160 thousand people per day. The existing road access only has a capacity of around 150 thousand vehicles and this can certainly be a problem. The airport buses passengers capacity is 38,000 passengers daily. This can be concluded that more than 70% passenger are using private/individual cars. To improve the accessibility of Soekarno Hatta International Airport, the government built airport rail.
When transportation systems develop, integration between modes of transportation becomes a significant challenge for sustainable transportation. The integration between modes in the context of sustainable transport should be able to provide individual trip convenient, fast, efficient, secure and seamlessly, that will reducing the cost of switching modes (Zakowska, 2017). The expected vision for integrated transportation systems is that each mode of transportation plays its role at the best scale and operation (Reis et al., 2013).

One form of intermodal integration is air and rail integration. Integration between air transport and train services is defined as providing complete travel services with fast and smooth intermodal transfers (Givoni & Banister, 2006). Integration between rail and air transportation has various types of benefits such as offering direct assistance to congestion problems, reducing negative environmental impacts, and increasing land-to-airport access (Cokasova, 2003). From the perspective of air transport service providers and airport managers, especially at airports with very dense flight schedules, the integration between trains and air transport will provide benefits in providing additional aircraft and passenger capacity, network benefits with higher service frequencies, and the reach of more and broader service goals [4]. The motivation of airports to integrate with railways comes from the desire for increased catch, enabling growth, reducing congestion, and attracting customer targets (Vespermann & Wald, 2011).

Railway development has been seen as a promising strategy to achieve sustainable transportation especially low carbon emissions [6]. Advantages of carbon emissions from the rail compared to road and air transport can make important railway in sustainable transportation. Contributions train for sustainable transport depends on the share of each mode of transport, which is determined by the relationship between rail and other transport modes, including competition, cooperation, and integration (Li, 2014).

The formulation of this research problem is that the construction of the Soekarno Hatta Airport Railway initially aimed to provide public transportation to the airport that was efficient and environmentally friendly. However, because of the low operational effectiveness, the environmental, economic and social sustainability of these transportations is threatened because the resources that have been spent do not meet their objectives. Therefore, it is necessary to formulate a strategy to improve sustainability performance.

2. Method

This research uses quantitative methods with comparative study approaches. The method used is the Transport Sustainability Index. This method is used to analyze the indicators that are variable-forming sustainability that need to be improved to improve the performance of the Soekarno Hatta airport rail.

Environment
Sustainability of the environmental dimension is based on the principle of limiting emissions and waste, minimizing the consumption of both unrenewable and renewable resources, reuse and recycle components, and minimize land use and sound pollution production. The environment category has four sets of variables: energy use, pollution, and greenhouse gas emissions.
A. Energy consumption

The energy consumption indicators are registered for use, which can be converted into energy values based either on the known fuel average energy content, or forecasts based on fuel standards. All energy indicators are considered negative impacts.

\[ \text{Energy}_x = \frac{\text{Energy consumption rate} \times \text{Weight}_x \times \text{Annual distance trip}_x}{\text{Passenger}_x \times \text{average distance}_x} \]

B. Green House Gas

Green House Gas (GHG) emissions represent the system's impact on global climate change through greenhouse effects. The GHG included in this methodology are: CO\textsubscript{2}, CH\textsubscript{4}, and N\textsubscript{2}O. They are input as a single indicator equivalent to CO\textsubscript{2}. For this study, GHG issued during the construction of transportation systems has not been considered, but this can be included in future revisions through the inclusion of lifecycle methodologies. GHG emissions are calculated based on electricity emission factors for each location. All GRK indicators are considered negative impacts.

\[ \text{GHG}_x = \text{Energy}_x \times \text{Electricity rate GHG} \]

C. Noise pollution

Set of pollution factor is noise indicator used is noise, data source can use data historical data or data model; However, the use of noise is difficult in high-level studies due to the data quality and the complexity of the analysis required. All pollution indicators are considered negative impacts. These noise pollution is obtained based on primary data measurements and secondary data for the comparison corridor.

**Economic**

The sustainability of economic aspect needs to be seen from the two perspectives, from the user side and from the operator side. The economic sustainability of each perspective can be defined as a comparison between the costs and benefits of each perspective. Thus, the category of economics includes a set of variables related to the intensity of use towards system formation costs, the user's cost to the benefits of travel, and the comparison of revenue to the cost of the system. The principle of sustainability performance measurement in economic dimension, especially adhering to the criteria of cost efficiency, which refers to performance indicators comparing the quantity of services produced on resources (cost Effectiveness) criteria that refer to the performance indicators comparing the quantity of services consumed by the user to the resources used.

A. User Cost

User cost are an economic cost incurred for travel that accesses the system. In this study, costs were measured in time and money. Financial costs are represented as the average price a user pays per trip, and the time cost is represented by the average time spent on public transport by each user. All costs are negative inputs.

a. Tariff Costs
User Cost_x = \frac{Tariff_x}{Distance_x}

b. Time Cost

Time Cost_x = \frac{time_x}{distance_x}

B. Operating income

a. Operating income Per operating cost

\text{Operation margin}_x = \frac{\text{Operation Income}_x}{\text{Operation Cost}_x}

b. Operating costs per seating distances available

operation cost per seat distance available_x = \frac{operation cost_x}{\text{Seat distance available}_x}

c. Operating costs per train mileage

operation cost per train milage_x = \frac{operation cost_x}{\text{train milage}_x}

d. Operating income Per passenger mileage

operating income per passenger milage_x = \frac{operating income_x}{\text{passenger milage}_x}

e. Operating income Per train mileage

operating income per train milage_x = \frac{operating income_x}{\text{train milage}_x}

Sustainability performance of airport railroad social dimension

Social dimension sustainability performance is assessed based on usage intensity, affordability and service coverage.

A. Usage intensity

The intensity of use of the services in the analysis of the study consists of two indicators that are the passenger load capacity assessed from the comparison between the mileage of the passenger with the distance of the seat is available, and the second indicator is the mileage Passenger per vehicle mileage.

a. Passenger mileage Per Seat Available Kilometer

\text{passenger milage per seat available kilometer}_x = \frac{\text{Passenger milage}_x}{\text{seat available kilometer}_x}

b. Passenger mileage per train mileage

Passenger milage_x = \frac{\text{passenger milage}_x}{\text{rail milage}_x}

B. Affordability

affordability_x = \frac{\text{tariff per km}_x}{\text{Income per kapita}_x}
C. Service coverage

\[ Coverage_x = \frac{\text{air passenger}_x}{\text{distance seat available}_x} \]

D. Mode Share

\[ Mode\ Share_x = \frac{\text{rail passenger}_x}{\text{air passenger}_x} \]

**Normalization of Data**

For indicators with positive impact

\[ n_i = \frac{x_i}{\text{Max (all } x)} \]

For indicators with negative impact

\[ n_i = \frac{\text{Min (all } x)}{x_i} \]

Where \( n \) is the value of indicator utility for each airport rail. The value of \( n \) will approach the value of 1 to indicate the highest performance route and will approach value 0 for the lowest performance route.

**Strategy Analysis**

To identify indicators who need to be improved, this research using gap analysis. The gap is the difference between Soekarno Hatta Airport rail link and the benchmark location. Every indicator then observed until its data level. Based on the data, possibility to interfere and its weight, the strategy can be estimated at best scenario.

**3. Result and Discussion**

The highest Gap is on an environmental indicator with a difference of 0.59 points and a social indicator with 0.58 points. If viewed in sub-level indicators then the highest gap is in share mode, greenhouse gas emissions, service coverage, energy, and usage intensity. The gap is far between 0.78 and 0.95 points where the biggest number is 1. On the Sub indicator mode share, which causes the low score is inadequate number of passengers. The number of passengers is also the cause of low performance on energy consumption, greenhouse gas emissions, usage intensity.
### Table 1. Airport Rail Sustainability Index

<table>
<thead>
<tr>
<th>DIMENSIONS OF SUSTAINABILITY</th>
<th>AIRPORT RAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Soekarno Hatta</td>
</tr>
<tr>
<td>Environment</td>
<td>0.41</td>
</tr>
<tr>
<td>Energy</td>
<td>0.20</td>
</tr>
<tr>
<td>Greenhouse gas</td>
<td>0.10</td>
</tr>
<tr>
<td>Noise</td>
<td>0.93</td>
</tr>
<tr>
<td><strong>Economic</strong></td>
<td>0.64</td>
</tr>
<tr>
<td>User costs</td>
<td>0.73</td>
</tr>
<tr>
<td>Tariff costs</td>
<td>0.93</td>
</tr>
<tr>
<td>Time cost</td>
<td>0.54</td>
</tr>
<tr>
<td>Operating income</td>
<td>0.55</td>
</tr>
<tr>
<td>Operating income Per operating cost</td>
<td>0.32</td>
</tr>
<tr>
<td>Operating cost Per Seat distance available</td>
<td>1.00</td>
</tr>
<tr>
<td>Operating costs per train mileage</td>
<td>1.00</td>
</tr>
<tr>
<td>Operating income Per passenger mileage</td>
<td>0.35</td>
</tr>
<tr>
<td>Operating Income Per vehicle mileage</td>
<td>0.07</td>
</tr>
<tr>
<td><strong>Social</strong></td>
<td>0.33</td>
</tr>
<tr>
<td>Usage Intensity</td>
<td>0.22</td>
</tr>
<tr>
<td>Intensity of seat spacing available</td>
<td>0.22</td>
</tr>
<tr>
<td>Intensity of the train mileage</td>
<td>0.21</td>
</tr>
<tr>
<td>Affordability</td>
<td>0.93</td>
</tr>
<tr>
<td>Service coverage</td>
<td>0.13</td>
</tr>
<tr>
<td>Mode share</td>
<td>0.05</td>
</tr>
</tbody>
</table>

Source: secondary data output, 2019

Airport Rail link Soekarno Hatta have the lowest indices at all indicators. The indices gap shows that economic indicator is the better indices than environmental and social indicator. Based on all indices the lowest performance is the mode share, it shows that the level of utilization of airport rail is very low compared other two airport rail. It also shows that the airport rail underutilizes than other mode such as airport bus or private cars and taxi.
Narita Express have a better score at all indicators. Narita express have a best performance at all sub indicators. It is clear that both Narita Express and Hong Kong Airport Express have a good balance for each dimension of sustainability indices. In general, the Narita Express excels at all three dimensions followed by the Hong Kong Airport Express. If observed based on the relationship between dimensions of the pillars of sustainability, it can be known that the Soekarno-Hatta Airport rail tends to have environmental degradation and low social equity because it is focus more on economic than to the environment and social aspect. To improved its sustainability, Soekarno Hatta Airport rail should improve its performance on environmental and social dimension.

Indicators that can be improved to increase the level of sustainability are passenger numbers and the average distance of the journey. In short-term and only in response to the current low levels of utilization. Reduction in route distances and the number of trips per day have the highest weight by a total of 1,266. However, for the route distance should also be noted for its influence on other indicators because the change of this indicator will have a double effect on the other indicators, with a ratio of 1.266 to 0.7.

It is necessary to adjust the operating pattern based on the occupancy rate, so airport rail will be more effective and efficient. and improvement of the travel time to increase its sustainability. Need policy governing travel behavior so that the utility of Soekarno Hatta Airport will increase so that the destination of development can be achieved.

Figure 1. Sustainability Index of Soekarno Hatta Airport Rail, Narita Express and Hong Kong Airport Express
Sustainability improvement strategy is done by the Principles of efficiency and effectiveness. Improved sustainability is done by adding to the route that has large passenger potential and reduces travel that has low occupancy. In addition, improvements are made with improved connectivity and travel time so that passenger preferences using airport rail will increase.

To improve environmental dimension we can do it by increase its performance from data level. Energy and greenhouse gas variable are basically comparison between energy usage and passenger milage. To improve its performance it can be done by lower the energy consumption by decrease the trip frequencies and/or to increase passenger number and its milage number. The decreasing of trip frequencies will lower the passenger number too, but in the final result if we delete trips that have passenger under daily average number, the effectivity of energy consumed and greenhouse gas emission still better in underutilize public transport. Delete ten trip on low peak hour can improve environmental indices by 3.75%, economic indices 0.94% and social indices 1.20%. For composite indices this strategy can improve the sustainability index by 1.83%.

Passenger number or ridership were the main purpose of public transport achievement. Improvement of ridership level could increase the environmental indices and also in economic and social indices. If the ridership increase 50%, can improve environmental indices by 12.08%, economic indices 3.02% and social indices 10.14%. For composite indices this strategy can improve the sustainability index by 7.42%. Improving ridership is not something that can be done directly. To obtain this goal it should be done by another strategy. Based on passenger preference two most important aspect are tariff and travel time. Increase travel time performance can be one of good strategy to be done. If we compare to Narita and Hong Kong, Soekarno Hatta

<table>
<thead>
<tr>
<th>Data</th>
<th>Number of indicators influenced</th>
<th>Weight of Increased indicators influenced</th>
<th>Weight of Decreased indicators influenced</th>
</tr>
</thead>
<tbody>
<tr>
<td>Train Weight</td>
<td>2</td>
<td>0</td>
<td>0.666</td>
</tr>
<tr>
<td>Operating Cost</td>
<td>3</td>
<td>0</td>
<td>0.3</td>
</tr>
<tr>
<td>Average passenger milage</td>
<td>5</td>
<td>0.916</td>
<td>0.1</td>
</tr>
<tr>
<td>Route Distance</td>
<td>10</td>
<td>0.7</td>
<td>1.266</td>
</tr>
<tr>
<td>Annual air passenger</td>
<td>2</td>
<td>0.25</td>
<td>0.25</td>
</tr>
<tr>
<td>Trip per day</td>
<td>7</td>
<td>0.1</td>
<td>1.266</td>
</tr>
<tr>
<td>Seat capacity</td>
<td>3</td>
<td>0.1</td>
<td>0.375</td>
</tr>
<tr>
<td>Noise</td>
<td>1</td>
<td>0</td>
<td>0.333</td>
</tr>
<tr>
<td>Operating income</td>
<td>3</td>
<td>0.3</td>
<td>0</td>
</tr>
<tr>
<td>Income per capita</td>
<td>1</td>
<td>0.25</td>
<td>0</td>
</tr>
<tr>
<td>Passenger</td>
<td>6</td>
<td>1.166</td>
<td>0.1</td>
</tr>
<tr>
<td>Tariff</td>
<td>1</td>
<td>0</td>
<td>0.25</td>
</tr>
<tr>
<td>Travel Time</td>
<td>1</td>
<td>0</td>
<td>0.25</td>
</tr>
</tbody>
</table>

Note: The weight of indicators influenced indicates the relative importance of each indicator in the sustainability strategy.
Airport Rail performance are very low which is almost two times slower. To increase ridership it also can be done by increasing the connectivity of the station by built connectivity infrastructure or by using a feeder transportation to enlarge the service coverage.

Lower the train weight can be one option to improve its sustainability. What we can do to lower the train weight are to reduce the car number matched to the passenger number. This strategy already done by Narita Express by split it car number. Half number of it take off from outside of Tokyo and then join with another half in Tokyo Station. This strategy related to future route improvement.

To build an integrated transportation system and strengthen each other, the operating pattern of both transport systems must be synergized. The adjustment between headway and flight schedule configuration needs to be done to make this transportation more reliable. In terms of schedules, travel is mainly focused on peak hours, so the service will be more effective.

4. Conclusion

Sustainable transportation indicators ini this research are used to assess Soekarno Hatta Airport Rail performance. Under utilize environmental friendly public transportation can be have worse impact to environment than the less environmental friendly mode. Soekarno-Hatta Airport rail tends to have environmental degradation and low social equity because it is focus more on economic than to the environment and social aspect. To improve the sustainability in short term can be done by delete the uneffective trips or in another word by implement the demand response scheme. In a long term to increase the sustainability can be done by improve its connectivity by connected infrastructure and feeder transportation. The connectivity should integrate the network, fare and ticketing, information, physical infrastructure, and time schedule.

References

Facing Cilegon 2025 Water Crisis

Adipati Rahmat Gumelar1, Dwita Sutijingsih2, Abimanyu Takdir Alamsyah3, Setyo Sarwanto Moersidik4

School of Environmental Sciences, Universitas Indonesia, Indonesia1, Faculty of Engineering, Universitas Indonesia, Depok, West Java2, Faculty of Engineering, Universitas Indonesia, Indonesia3

Abstract. This paper addresses the challenges in discussing renewal of clean water in the city of Cilegon in 2025. The predictions submitted by the Ministry of National Development Planning and also the Ministry of Public Works and Public Housing, reminded about the possibility of a deficit in water resources in the city of Cilegon, then for the City of Cilegon it will no longer be fulfilled. The water crisis which is expected to have an impact on industrial decline and a decline in the level of society must be avoided as far as possible. This research uses a dynamic system method that is able to model the water movement of the City of Cilegon, to then build a scenario of anticipation of the water crisis in 2025. This study discusses how to arrange the water planning of the City of Cilegon which can be used by using water resources in the City of Cilegon independently and sustainably. These findings are expected to contribute to building an agreed city water resources governance scenario to support the improvement of future crises. This study discusses why removing water in the City of Cilegon, the Government of the City of Cilegon needs to improve its water using new water sources, namely from sea water and rain water, and helps support groundwater that has been changed in price.

Keywords: Water crisis, Cilegon, System Dynamics, Coastal City.

1. Introduction

Water is a limited natural resource (FAO, 2018), so its utilization must be done wisely (UN, 1993). As a tropical country, Indonesia has a fairly high average rainfall (more than 2,000 mm per year) and abundant water resources (BPS, 2018). However, the results of a study by the Ministry of Public Works in 2005 and also BAPPENAS in 1997, precisely predicted that at least in 2025, Indonesia would experience a clean water crisis.

A coastal city is a city that consists of five main functions, namely settlements, cities, industry, tourism and conservation (KKP, 2008). These functions interact with each other as an environmental system that requires a large amount of water resources. In cities located in coastal areas, the clean water crisis will be more severe because the presence of these cities on the seashore will double the need for water and also water resources under pressure from the influence of climate and sea water intrusion (PRPW, 2015).

The city of Cilegon in Banten Province, is a large city on the western tip of Java. Its very strategic position because it is dealing directly with the island of Sumatra and traversed by the Indonesian Archipelago Sea Lane 1, makes it one of the centers of industrial activity in Indonesia with an industry growth rate of 14%. The high rate of growth of the industry not only
has a direct impact on the increasing number of water needs in the City of Cilegon, but also on the need for water for other functions. The function of settlements, urban areas and tourism also increased directly because the increase in the pace of industry also encouraged population growth, increased demand for rapid urban services (trade, education, health, etc.), and required the support of tourist areas as a means of recreation.

The interaction between these functions ultimately leads to the high number of water needs in the city of Cilegon. Whereas, as reported by Suci (2010), water crisis has occurred in most of the Sub-districts in the City of Cilegon and every year shows symptoms that are increasingly widespread (Rakhmawati, 2015).

The city of Cilegon currently relies on the Cidanau River which is the main water source for the Krenceng Reservoir to meet all the water needs of the City of Cilegon (Sugiarto, 2006). However, the Cilegon Mandiri PDAM as the provider of water needs for the City of Cilegon, said that as a result of efforts to expand the activities of a number of industries, the current availability of water is inadequate (Kabar Banten, 2019). This should be a serious concern, because the function of industry is a major supporter of economic activity in the city of Cilegon. A decline in industrial function due to lack of water can directly affect the economy of Cilegon City and the welfare of its people. In addition, as a result of the lack of water availability, the Cilegon Mandiri PDAM has also become unable to meet the demand for cooperation to fulfill the installation of clean water with new housing in the City of Cilegon, because the availability of clean water has indeed been very limited.

The imbalance between water availability and water needs in the city of Cilegon can be illustrated in a water resource balance sheet in the city of Cilegon. However, with the condition of the availability of water resources that are very limited, driven by the necessity to meet the needs of industries that have very high industrial growth rates and also the obligation to serve the water needs of the people of Cilegon City, it is a picture that the condition of the water resources balance in Cilegon City is very likely water crisis conditions as predicted by the Ministry of PUPR and BAPPENAS will occur in 2025. Such conditions are developed as a question in this research, namely how to avoid the water crisis conditions in Cilegon City in 2025, but still able to meet water needs for the community and also the industry.

2. Research Methods

This research is basically an effort to understand ways to be able to meet the water needs of a coastal city in Indonesia to be sustainable. To produce these outcomes, researchers conduct research with a quantitative approach, because this research will be based on field studies, secondary data analyzes, in-depth interviews with stakeholders, and measurable variable analysis; so that researchers are not biased in the implementation of theoretical testing of the situation on the ground, as well as to develop models and develop strategies needed.

In this study, the method used is the system dynamics analysis method to produce output in the form of a simulation of water resource balance in the City of Cilegon. The built water resource balance system will be based on a discount ratio or the next door, with water needs as assets and water availability as liabilities. The water demand sub-system will consist of five sub-system functions of coastal cities, namely settlements, cities, industries, tourism and conservation. Whereas the water availability sub-system will consist of four water sources available in the city of Cilegon, namely Cidanau river water which is accommodated in the Krenceng Reservoir, surface ground water, collected rainwater, and desalinated seawater.
Cilegon City was chosen as a research location because Cilegon City met the consideration of determining the study area requirements, namely: an independent city, a coastal city that has geostrategic advantages, and has all the functions of a coastal city (settlements, urban, industrial, tourism, and conservation).

The data used from this study consists of primary data and secondary data. Primary data were obtained from sources, while secondary data were obtained from statistics released by the Central Statistics Agency of the City of Cilegon, the results of previous studies and other supporting documents.

3. Results and Discussions

3.1. Cilegon City Water Resource Simulation Simulation Model

Causal loop diagram or often called causal loop diagram (CLD) is a structure of thinking in an effort to understand complex problems through simplification steps (Muhammadi, et.al, 2001). The causal loop structure is created so that it can help understand the effect of one variable on another, with each variable identified as a specific component or factor and interacting dynamically based on time and condition.

The model is an imitation of the actual condition (Ford, 1999). The Cilegon City water resource balance model which was built into the SFD, was also built by researchers because researchers have limited thinking capacity to solve very complex problems. So the model is used to help solve the problems encountered in this study. Simply stated, the balance of water resources in the City of Cilegon, is simulated as follows.

![Causal Loop Diagram Cilegon City Water Resources Balance](image)

**Fig. 1.** Causal Loop Diagram Cilegon City Water Resources Balance

The water resource balance sheet as seen in Figure 1, that simulates a balance between the availability of water resources and water resource needs over a period of 20 years (2008-2027), arranged like a discount simulation (next to one side) shows the results of the comparison between availability (assets) and needs (liabilities) as follows.
Table 1. Comparison between Water Needs and Water Availability in 2008-2027

<table>
<thead>
<tr>
<th>Year</th>
<th>Water Needs (Litre)</th>
<th>Water Availability (Litre)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>2009</td>
<td>27,402.057.750</td>
<td>38,425,016.885</td>
</tr>
<tr>
<td>2010</td>
<td>55,769,961.975</td>
<td>46,467,043.939</td>
</tr>
<tr>
<td>2011</td>
<td>85,157,229.220</td>
<td>114,129,923.663</td>
</tr>
<tr>
<td>2012</td>
<td>115,622,405.862</td>
<td>151,417,460.261</td>
</tr>
<tr>
<td>2013</td>
<td>14,522,969.527</td>
<td>188,333,420.020</td>
</tr>
<tr>
<td>2014</td>
<td>180,049,640.534</td>
<td>224,881,531.693</td>
</tr>
<tr>
<td>2015</td>
<td>214,159,973.985</td>
<td>261,065,486.878</td>
</tr>
<tr>
<td>2016</td>
<td>249,646,480.753</td>
<td>296,888,940.385</td>
</tr>
<tr>
<td>2017</td>
<td>286,604,057.461</td>
<td>332,355,510.609</td>
</tr>
<tr>
<td>2018</td>
<td>325,137,883.649</td>
<td>367,468,779.896</td>
</tr>
<tr>
<td>2019</td>
<td>365,364,758.721</td>
<td>402,232,294.903</td>
</tr>
<tr>
<td>2020</td>
<td>407,414,622.022</td>
<td>436,649,566.956</td>
</tr>
<tr>
<td>2021</td>
<td>451,432,281.474</td>
<td>470,724,072.409</td>
</tr>
<tr>
<td>2022</td>
<td>497,579,379.800</td>
<td>504,459,252.986</td>
</tr>
<tr>
<td>2023</td>
<td>546,036,631.362</td>
<td>537,858,516.140</td>
</tr>
<tr>
<td>2024</td>
<td>597,006,367.318</td>
<td>570,925,235.388</td>
</tr>
<tr>
<td>2025</td>
<td>650,715,432.000</td>
<td>603,662,750.656</td>
</tr>
<tr>
<td>2026</td>
<td>707,418,479.477</td>
<td>636,074,368.617</td>
</tr>
<tr>
<td>2027</td>
<td>767,401,726.052</td>
<td>668,163,363.022</td>
</tr>
</tbody>
</table>

To more easily understand the comparison of the two Tables, it can be seen the following Water Resources Balance Simulation Table.

Table 2. Cilegon City Water Resources Balance Year 2008-2027

<table>
<thead>
<tr>
<th>Year</th>
<th>Water Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td></td>
</tr>
<tr>
<td>2009</td>
<td>11,022,959.135</td>
</tr>
<tr>
<td>2010</td>
<td>(9,302,918.036)</td>
</tr>
<tr>
<td>2011</td>
<td>28,972,694.443</td>
</tr>
<tr>
<td>2012</td>
<td>35,795,054.399</td>
</tr>
<tr>
<td>2013</td>
<td>173,810,450.493</td>
</tr>
<tr>
<td>2014</td>
<td>44,831,891.159</td>
</tr>
<tr>
<td>2015</td>
<td>46,905,512.893</td>
</tr>
</tbody>
</table>
By observing Table 2, it can be seen that at the beginning of the simulation year in 2008, the amount of water availability was still higher than the amount of water needed in the city of Cilegon. However, over time the amount of water demand in the City of Cilegon has seen a significant increase at the rate of 14% based on the Office of Investment and Integrated Services of the One Door Cilegon City (2017).

This increase in demand is unfortunately not matched by an increase in water availability in the city of Cilegon, which is actually underdeveloped, given that the flow rate of water from the Cidanau River to the Krenceng Reservoir actually shows a decrease due to changes in land use in the upstream of the River from Tangerang Regency, as well as the use of water for activities industry in several parts of the Cidanau River Basin (Krakatau Tirta Industri, 2012).

Efforts to increase clean water reserves are pursued through rainwater collection and utilization of desalination water from the sea. However, both the rate and amount of clean water generated from the two efforts was calculated by simulation, not yet significant enough to maintain the balance of water resources in the City of Cilegon.

<table>
<thead>
<tr>
<th>Year</th>
<th>Water Balance</th>
</tr>
</thead>
<tbody>
<tr>
<td>2016</td>
<td>47,242,459,632</td>
</tr>
<tr>
<td>2017</td>
<td>45,751,453,148</td>
</tr>
<tr>
<td>2018</td>
<td>42,330,896,247</td>
</tr>
<tr>
<td>2019</td>
<td>36,867,536,182</td>
</tr>
<tr>
<td>2020</td>
<td>29,234,944,934</td>
</tr>
<tr>
<td>2021</td>
<td>19,291,790,935</td>
</tr>
<tr>
<td>2022</td>
<td>6,879,873,186</td>
</tr>
<tr>
<td>2023</td>
<td>(8,178,115,222)</td>
</tr>
<tr>
<td>2024</td>
<td>(26,081,131,930)</td>
</tr>
<tr>
<td>2025</td>
<td>(47,052,681,344)</td>
</tr>
<tr>
<td>2026</td>
<td>(71,344,110,860)</td>
</tr>
<tr>
<td>2027</td>
<td>(99,238,363,030)</td>
</tr>
</tbody>
</table>

Fig. 2. Analysis of Cilegon City Water Resources Balance Year 2008-2027
The simulation results of the Cilegon City water resources balance between 2008 and 2027 show in Figure 2, shows that in 2016 the peak year of water availability in the city of Cilegon, which was 47 billion cubic liters of water, but the following year in 2017, the availability of water began reduced and caused the graph to decline until in the 15th year from the start of the simulation or in the year 2023, the balance of water resources in the city of Cilegon entered a water deficit or crisis.

3.2. Scenario Mitigation of Water Crisis in 2025

Predictions based on the results of existing conditions simulations estimate that the water crisis in Cilegon City is very likely to occur in 2023. As a result of predictions obtained based on dynamic system model simulation, efforts to mitigate clean water crises in Cilegon City should also be carried out based on scenarios to improve water resource balance simulation. So based on the same existing conditions, a future condition can be obtained with Cilegon City no longer in a water crisis condition, which is achieved through the application of scenarios based on the objectives to be achieved.

The water crisis is a phenomenon where there are less water resources available than water needs. Indonesia as a tropical country with an average of 2,000 millimeters of rainfall per year (BPS, 2018) actually has abundant water resources, with springs, rivers and lakes easily found everywhere. But in fact, since 1994, the Ministry of Public Works (now the Ministry of Public Works and Public Housing) has warned that in 2025 there will be a water crisis in Indonesia. Three years later, in 1997, BAPPENAS was reminded of the predictions of the water crisis in 2025.

Cilegon City is one of the most developed coastal cities in Indonesia due to its industry growth rate which reached 14%. Based on the prediction results of the simulation model, the City of Cilegon is also not immune to the threat of the water crisis, which is even predicted to occur sooner than the Ministry of PUPR and BAPPENAS predicted. If the Ministry of PUPR and BAPPENAS predict that Regencies / Cities in Indonesia will experience a water crisis in 2025, the City of Cilegon will experience it two years earlier, namely in 2023.

Comparison of the arrival of the water crisis in 2025 according to the predictions of PUPR and BAPPENAS with the predictions of researchers in 2023, both are predictions based on an analysis of data and facts. So what then becomes important is how to reach a solution to avoid the water crisis.

The solution that is attempted to be built is to develop a theoretical solution to the problem of water crisis in 2023 in accordance with the reality of data and facts. Therefore, based on the Cilegon City water resource balance model that has been built, the researchers formulated a scenario to avoid the water crisis in 2023 by carrying out functional interventions as follows:

1) Water Needs (Passiva):
   a) Pressing the population growth rate which currently reaches 2.42%, exceeding the National average.
   b) Pressing the rate of water use in the Settlement Function by 10%, can be realized through the Water Saving Movement at the Household level.
   c) Reducing water use in the Urban Function by 15%, can be realized through the construction of Rainwater Storage Installations to substitute non-consumption water needs in Cilegon City Government buildings such as Government Buildings, Educational Facilities, Health Facilities, Trade Facilities, and Public Offices. The City Government of Cilegon can strengthen through a Regional Regulation that calls for this purpose.
d) Reducing the use of water in the Industrial Function by 1%, can be realized through the construction of Rainwater Reservoir Installation to substitute non-consumption water needs in Industrial Company office buildings. The City Government of Cilegon can strengthen through a Regional Regulation that calls for this purpose.

2) Water Availability (Aktiva):
   a) Integrated Cidanau watershed management through cooperation between boundaries. This collaboration seeks to improve the Cidanau watershed starting from the upstream region, so that the flow of water that flows from the upstream area of the Cidanau River in Tangerang Regency can be maintained. The Provincial Government of Banten together with the Central Government through the Cidanau River Basin Agency can issue Regional Regulations related to the prohibition of water use in the upstream area that does not have a permit, a prohibition on the conversion of land that is not in accordance with the purpose of conserving water resources, and an appeal for people living along the watershed. Cidanau to maintain the cleanliness of the Cidanau watershed.

   b) Increased utilization of water resulting from seawater desalination by 100% of current capacity. This water utilization is strived to reduce the need for clean water in the Industrial Function, through the substitution of raw water with water resulting from sea desalination. The Regional Government of Cilegon City can issue a Regional Regulation that allows the private sector to carry out seawater desalination efforts to clean water for Industry. The Local Government of Cilegon City can also provide incentives to companies that have succeeded in reducing their need for raw water by substituting desalinated water.

Based on the functional intervention effort, a change in simulation results is obtained to mitigate the water crisis in 2025 which is compared as follows.

Table 3. Comparison of Existing Water Resources Balance Sheet with Water Crisis Mitigation Scenario 2025

<table>
<thead>
<tr>
<th>Year</th>
<th>Water Balance Existing</th>
<th>Year</th>
<th>Water Balance Mitigation</th>
</tr>
</thead>
<tbody>
<tr>
<td>2008</td>
<td>-</td>
<td>2008</td>
<td>-</td>
</tr>
<tr>
<td>2009</td>
<td>11.022.959.135</td>
<td>2009</td>
<td>11.022.959.135,00</td>
</tr>
<tr>
<td>2010</td>
<td>(9.302.918.036)</td>
<td>2010</td>
<td>21.316.360.541,20</td>
</tr>
<tr>
<td>2011</td>
<td>28.972.694.443</td>
<td>2011</td>
<td>30.843.309.061,32</td>
</tr>
<tr>
<td>2012</td>
<td>35.795.054.399</td>
<td>2012</td>
<td>39.563.222.874,87</td>
</tr>
<tr>
<td>2013</td>
<td>173.810.450.493</td>
<td>2013</td>
<td>47.431.383.754,26</td>
</tr>
<tr>
<td>2014</td>
<td>44.831.891.159</td>
<td>2014</td>
<td>54.398.429.876,88</td>
</tr>
<tr>
<td>2015</td>
<td>46.905.512.893</td>
<td>2015</td>
<td>60.409.783.768,73</td>
</tr>
<tr>
<td>2016</td>
<td>47.242.459.632</td>
<td>2016</td>
<td>65.405.006.991,90</td>
</tr>
<tr>
<td>2018</td>
<td>42.330.896.247</td>
<td>2018</td>
<td>72.071.541.155,89</td>
</tr>
<tr>
<td>2019</td>
<td>36.867.536.182</td>
<td>2019</td>
<td>73.585.638.716,95</td>
</tr>
<tr>
<td>2020</td>
<td>29.234.944.934</td>
<td>2020</td>
<td>73.767.205.622,68</td>
</tr>
</tbody>
</table>
By comparing the Existing Condition Table (left) with the 2025 Water Crisis Mitigation Scenario Simulation Results (right), it can be seen that there is a change, in the form of no water crisis in 2023 according to the predicted predictions or in 2025 according to the predictions of PUPR and Bappenas.

<table>
<thead>
<tr>
<th>Year</th>
<th>Existing Water</th>
<th>Simulation Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>2021</td>
<td>19,291,790,935</td>
<td>72,513,518,146,23</td>
</tr>
<tr>
<td>2022</td>
<td>6,879,873,186</td>
<td>69,709,955,066,55</td>
</tr>
<tr>
<td>2023</td>
<td>(8,178,115,222)</td>
<td>65,228,492,953,50</td>
</tr>
<tr>
<td>2024</td>
<td>(26,081,131,930)</td>
<td>58,926,007,398,78</td>
</tr>
<tr>
<td>2025</td>
<td>(47,052,681,344)</td>
<td>50,642,355,034,37</td>
</tr>
<tr>
<td>2026</td>
<td>(71,344,110,860)</td>
<td>40,198,207,912,52</td>
</tr>
<tr>
<td>2027</td>
<td>(99,238,363,030)</td>
<td>27,392,608,129,51</td>
</tr>
</tbody>
</table>

Fig. 3. Comparison of Existing Water Condition Charts with 2025 Water Crisis Mitigation Scenarios

As shown in Figure 3, it is known that the peak of water availability will occur in 2020, and although until the year 2027 there has not been a water crisis, the direction of the graph remains down which means that after 2027 the City of Cilegon can still experience a water crisis.

4. Conclusion

Simulation results based on existing conditions have shown that as predicted by the Ministry of PUPR and also BAPPENAS that the City of Cilegon will experience a water crisis. The simulation results even estimate that the clean water crisis in Cilegon City happened two years faster than expected, namely in 2023. By intervening functionally, it can be proven that the water crisis can be mitigated so that it does not occur until the end of 2027. But basically the level water demand in the City of Cilegon has been very high due to the need for Industrial Functions and Settlement Functions, so that being the Government of the City of Cilegon is faced with difficult challenges due to the impossibility of suppressing industrial growth rates.
that directly affect the economy of the City of Cilegon, so the realistic choice for the Government of the City of Cilegon is reduce the need for water from settlements and encourage increased availability of water sourced from the Cidanau River, Rainwater reservoirs, and utilization of seawater desalination.

Acknowledgement
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References
Study of Clean Water Needs Balikpapan, East Kalimantan, Indonesia

Ulfita Fitriati*, Holdani Kurdi, Aulia Isramaulana and Mutiara Mayang
{ufitriati@ulm.ac.id*}

Department of Civil Engineering, Lambung Mangkurat University, Banjarmasin, Indonesia

Abstract. Clean water in human life has a very important function. The Human need for clean water is directly proportional to the population growth. In Balikpapan, which is the capital city of East Kalimantan Province has population 735,850 people by 2015, which represents 22% of total population of East Kalimantan. The results obtained for needs of clean water have not been sufficient and the water quality data has qualified the water requirements Class I. In the calculation of clean water needs of Balikpapan City above, the percentage of non-domestic with domestic demand is 50.30% its mean Balikpapan City have a lot of facility especially office and international company. Balikpapan City needs to immediately add the capacity of Intake because in 2017, is unable to meet the needs of clean water in Balikpapan City. Tirta Manggar PDAM has almost reached 80% service coverge, but loss of water equal to 36.92%.

Keywords: Balikpapan, clean water need, PDAM.

1 Introduction

Clean water in human life has a very important function. The trend that is happening now is reduced availability of natural water resources that can be used directly from day to day. This is due to influence of increasing development progress, population growth increase so that the capture of water by the soil as a source of ground water is reduced and industrial waste pollution in rivers as one source of clean water on the surface (1–3). In Balikpapan, East Kalimantan, water supply from PDAM is also still unable to fulfilled the needs of clean water in quality and quantity. In fact, Balikpapan has population 735,850 people in 2015, which is 22% of the total population of East Kalimantan. In rainy season, Balikpapan was often flooding. In addition to the overflowing of rivers, the floods are also caused by the narrowing of the river due to the waste accumulation.

Clean water is water that is used for everyday purposes and its quality fulfills the requirements of clean water health, according to applicable legislation and can be drunk after cooked.

Water Supply System Components :
1. Rain Water
   Rain water is sublimation of cloud / vapor into pure water. to make rain water as a source of drinking water should be at the time to accommodate rain water do not start when the rain starts to fall, because it still contains a lot of dirt
2. Surface Water
Surface water is the rain that flows on the surface of the earth, the quality of surface water needs to get close attention if the surface water will be used as a clean water.

3. Ground Water

Groundwater is a very important source of water supply especially in areas experiencing drought or long drought causing the cessation of river water flow. (4,5)

There are several methods that can be used to analysis future population growth, namely: Arithmetic, geometric, linear regression, exponential, logarithmic. Influence factors of projected water needs are:

1. The number of people growing every year
2. Level of service
3. Water need for instalation and organization needs
4. Water lose factor. (6)

Domestic water needs is water used for daily activities. To estimate the current and future amount of domestic water demand can be calculated based on population size, population growth rate, and per capita water requirement. The units used are L / person / day (7,8). The basic need for non-domestic water is the water requirement for residents outside the residential area. The need for non-domestic water is often also called urban water needs or municipal (9).

Clean Water Criteria are Class 1, water used and requires the same water quality as that usefulness. Class 2, water used for facilities / infrastructure of water recreation activities, cultivation of freshwater fish, livestock, water to irrigate agriculture and / or other requirements requiring the same water quality as those uses. Class 3, water that can be used for the cultivation of freshwater fish, to irrigate crops and other things requires the same water quality as those uses. Class 4, water which can be used to irrigate crops and or other designations that require the same water quality as those uses (10,11).

Previous research are:


Therefore the author wants to examine how much water needs and water quality in the city of Balikpapan, East Kalimantan Province.
2 Methods

In this study, starting with literature study that is collecting, reading and studying literature books related to the problem of raw water sources and matters associated with it. Then proceed to the formulation of the problem that is calculated needs clean water required by the city of Balikpapan, East Kalimantan. After that proceed with the data collection phase.

The data obtained in the form of primary data and secondary data.

a. Primary data is data obtained directly from the source, include interviews, water quality, and field reviews.

b. Secondary data are data collected by researchers indirectly or using other sources. This data is in the form of location image, last year's public facilities data, 5 years population data from Balikpapan City Statistic, 5 years water loss data, and last year service data backup.

3 Results and Discussions

After analyzed using Arithmetic method, geometric, linear regression, exponential, and logarithmic then sorted and made graph comparison of existing population growth and population growth according to projection of all method got method that fulfill criteria requirement is Arithmetic method, because it is proportional to straight and almost approaching line existing residents (12). Projection of clean water needs must be in accordance with planning requirements with consideration of the following factors, namely domestic water requirements, non-domestic water demand, average water leakage rates of 20%-50% T and maximum day and peak hour factors.

a. Domestic Water Needs

The average water consumption level to be achieved by 2016 is 150 ltr / people / day for home connections and beyond until 2035 (13,14).

b. Non Domestic Water Requirement

a large domestic need especially when the city is a central government district office whose water needs for offices or government agencies can reach 40% of the total domestic water needs. However, in this plan, water demand for non-domestic needs is 14.70% of the total domestic demand for water, in accordance with the calculation of non-domestic needs in 2016 (8,15).

Balikpapan is the largest port and industrial city on the island of Borneo, so it has many international corporate offices. Facility data available in Balikpapan City can be seen in table 1.

<table>
<thead>
<tr>
<th>No</th>
<th>Data</th>
<th>Total</th>
<th>Unit</th>
<th>Standard</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>School</td>
<td>190637</td>
<td>People</td>
<td>20</td>
<td>Liter/People/Day</td>
</tr>
<tr>
<td>2</td>
<td>Hospital</td>
<td>1030</td>
<td>Bed</td>
<td>400</td>
<td>Liter/Bed/Day</td>
</tr>
<tr>
<td>3</td>
<td><em>Puskesmas</em></td>
<td>27</td>
<td>Unit</td>
<td>1000</td>
<td>Liter/Day</td>
</tr>
<tr>
<td>4</td>
<td><em>Puskesmas</em> Assistant</td>
<td>13</td>
<td>Unit</td>
<td>800</td>
<td>Liter/Day</td>
</tr>
</tbody>
</table>
Data of water loss can be obtained from BPS data of Balikpapan Municipality, for 2016 Balikpapan Municipal PDAM distributes clean water equal to 32,710,965 m$^3$ water and experiencing shrinkage equal to 9,779,738 m$^3$ water, or loss of water equal to 36.92% (16,17).

In the calculation of clean water needs of Balikpapan City above, the percentage of non-domestic demand for domestic is 50.30%. From the projection calculation of population growth, until the year 2036 the city of Balikpapan is still in the middle of the city with a population of 141,114 people, according to the standards of the creative works, the water needs per capita (direct line) is 150, and the general faucet 30. Here is the result of the calculation total water supply planning for Balikpapan in table 2.

PDAM Balikpapan has an existing intake of 1281 L/Sec. According to the figure 1, the need for clean water for Balikpapan City in 2017 has passed the existing line of intake or amounted to 2259.385 L/Sec, it can be said for 2017 the need for clean water has not been met. Therefore, PDAM Kota Balikpapan should immediately plan to increase production capacity / intake as soon as possible so that the need of clean water is always fulfilled.

### Table 2. Projected Water Need

<table>
<thead>
<tr>
<th>No.</th>
<th>Year</th>
<th>Projected Water Need</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L/day</td>
</tr>
<tr>
<td>1</td>
<td>2017</td>
<td>195210862.978</td>
</tr>
<tr>
<td>2</td>
<td>2018</td>
<td>205372459.638</td>
</tr>
<tr>
<td>3</td>
<td>2019</td>
<td>215776308.661</td>
</tr>
<tr>
<td>4</td>
<td>2020</td>
<td>226422410.048</td>
</tr>
<tr>
<td>5</td>
<td>2021</td>
<td>237310763.797</td>
</tr>
<tr>
<td>Year</td>
<td>Volume (L/Sec)</td>
<td>Population Projected (People)</td>
</tr>
<tr>
<td>------</td>
<td>---------------</td>
<td>--------------------------------</td>
</tr>
<tr>
<td>2022</td>
<td>248441369.909</td>
<td>2875.479</td>
</tr>
<tr>
<td>2023</td>
<td>259814228.384</td>
<td>3007.109</td>
</tr>
<tr>
<td>2024</td>
<td>271429339.222</td>
<td>3141.543</td>
</tr>
<tr>
<td>2025</td>
<td>283286702.423</td>
<td>3278.781</td>
</tr>
<tr>
<td>2026</td>
<td>295386317.987</td>
<td>3418.823</td>
</tr>
<tr>
<td>2027</td>
<td>307728185.913</td>
<td>3561.669</td>
</tr>
<tr>
<td>2028</td>
<td>319036161.556</td>
<td>3692.548</td>
</tr>
<tr>
<td>2029</td>
<td>326606547.897</td>
<td>3780.168</td>
</tr>
<tr>
<td>2030</td>
<td>334176934.238</td>
<td>3867.789</td>
</tr>
<tr>
<td>2031</td>
<td>341747320.579</td>
<td>3955.409</td>
</tr>
<tr>
<td>2032</td>
<td>349317706.919</td>
<td>4043.029</td>
</tr>
<tr>
<td>2033</td>
<td>356888093.260</td>
<td>4130.649</td>
</tr>
<tr>
<td>2034</td>
<td>364458479.601</td>
<td>4218.269</td>
</tr>
<tr>
<td>2035</td>
<td>372028865.941</td>
<td>4305.890</td>
</tr>
<tr>
<td>2036</td>
<td>379599252.282</td>
<td>4393.510</td>
</tr>
</tbody>
</table>

**Figure 1.** Clean Water Need Projected 2017-2036
Table 3. Result of Water Sampling Test of PDAM Tirta Manggar

<table>
<thead>
<tr>
<th>No.</th>
<th>Parameter</th>
<th>Unit</th>
<th>Field Test Results</th>
<th>Requirement</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Before Processing</td>
<td>After Processing</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Temperature</td>
<td>ºC</td>
<td>30</td>
<td>30</td>
<td>(±3) ºC</td>
</tr>
<tr>
<td>2.</td>
<td>pH</td>
<td>pH</td>
<td>6.8</td>
<td>6.7</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>3.</td>
<td>Electrical Conductivity</td>
<td>mS/cm</td>
<td>0.03</td>
<td>0.119</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Turbidity</td>
<td>NTU</td>
<td>9</td>
<td>1</td>
<td>5</td>
</tr>
<tr>
<td>5.</td>
<td>Dissolved Oxygen</td>
<td>mg/L DO</td>
<td>4</td>
<td>-</td>
<td></td>
</tr>
<tr>
<td>6.</td>
<td>Amount Of Dissolved Solids</td>
<td>g/L TDS</td>
<td>0.015</td>
<td>0.058</td>
<td>0.5</td>
</tr>
</tbody>
</table>

The water quality data of the distribution in Table 3 obtained from the test results of PDAM Tirta Manggar water sample has qualified for Class I water.

4 Conclusions

The population of Balikpapan City is obtained with the following results as follows: 2017; 2021; 2026; 2031; 2036 of 761,251 people; 859,027 people; 981,247 people; 1,103,467 people; 1,225,687 people. Calculation of clean water needs of Balikpapan City with the following results as follows 2017; 2021; 2026; 2031; 2036 equal to 2259.385 L/Sec, 2746.652 L/Sec, 3418.823 L/Sec, 3955.409 L/Sec, 4393.510 L/Sec. Tirta Manggar PDAM has an Intake capacity of 1281 L/Sec according to the calculation of projected clean water demand for the city of Balikpapan in 2017 amounted to 2259.385 L/Sec, it can be said for 2017 the need for clean water have not been sufficient. The water quality data of the distribution obtained from the test results of PDAM Tirta Manggar water sample has qualified for Class I water.

References


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Analysis of the Impact of Urban Development on River Water Quality Case Study of the Pesanggrahan River

Muslim Aminuddin¹, Chotib¹
{muslim.aminuddin1993@gmail.com¹, Chotib@hotmail.com²}

Urban Development Study Program, Universitas Indonesia, Kampus UI Salemba, Jakarta, Indonesia¹,²

Abstract  The Pesanggrahan River from its width characteristics is an intermediate river. The chemical and biological contents of Pesanggrahan River water show that the Pesanggrahan River has been polluted. Water pollution in the Pesanggrahan River is greater in the downstream area, which is due to the accumulation of chemical compounds from industrial and domestic waste. Most of the Pesanggrahan Watershed are residential areas. City development in the Pesanggrahan Watershed has a major influence on the decline in the water quality of the Pesanggrahan River. The biggest development occurred in the period of 2004-2010. Then, in the 2010-2013 period the development was more on the changes in the structure of the Pesanggrahan River flow, namely on river widening and straightening. The area in the Pesanggrahan Watershed is widely used as an illegal industrial area, thus, violating existing spatial provisions. The role of the Jakarta City Government in maintaining river water quality is in the function of building and supervising buildings that violate the rules. This refers to the granting of permits and finally to prosecution of parties who violate and play a role in decreasing the quality of the Pesanggrahan River water.

Keywords: Pesanggrahan River, Pesanggrahan Watershed, water quality

1. Introduction

The problems caused by pollution that occur in the Pesanggrahan River cannot be separated from the role of buildings built in the area. Therefore, it is necessary to identify water quality which will later be linked to the pattern of urban development in the Pesanggrahan River. The process of identifying water quality is done by using the Water Quality Index (WQI) calculation found in the Pesanggrahan River. The indicators observed in the Water Quality Index are (Kannel, Lee, Lee, Kanel, & Khan, 2007): water temperature, pH, dissolved oxygen (DO), total dissolved solids (TDS), total suspended solids (TSS), water hardness, Nitrate (NO3), Nitrite (NO2-), biochemical oxygen demand (BOD), chemical oxygen demand as O2 (COD), Fecal Coliform Bacteria, and Total Coliform Bacteria.

Water Quality Index is used by many developing countries because it has analytical costs involved, which can be a limiting factor for water quality assessment with a small budget. Water Quality Index in this study is used as a reference to determine the effect of development around the Watershed Pesanggrahan on environmental degradation in water. So that in the future the DKI Jakarta Government can take steps in regulating urban development and returning the
function of the Pesanggrahan River to its original function by considering the quality of water available at the Watershed, especially the Pesanggrahan River.

2. Materials and methods

This research was conducted using qualitative and quantitative approaches using field survey methods. The survey method is an investigation conducted to obtain facts from the symptoms that exist and look for facts. The survey method dissects and skins and recognizes problems as well as obtaining justification for the conditions and practices that are taking place. The survey method also evaluates and compares things that people have done in dealing with similar situations or problems and the results can be used in making plans and making decisions in the future (Nazir, 2009).

Sampling was carried out along the Pesanggrahan River. The distance between one sampling point and another point is about 500-700 meters. The distance was chosen so that data on the chemical and biological compounds that are present in the Pesanggrahan River water can be clearly known. Therefore the total samples obtained in this river study is 37 observation points knowing that the length of the Pesanggrahan River in the urban area of DKI Jakarta is ± 20 km.

Pesanggrahan River water sampling is carried out in the Pesanggrahan River Watershed (DAS) area which covers four districts; Pesanggrahan District, Kebayoran Lama District, Kebon Jeruk District, and Kembangan District. Actually, the urban headwaters of the Pesanggrahan River are in the Cilandak area, but Watershed, which is located in that area, is part of the entry area in the Tangerang Regency, Banten Province.

The location of this study was chosen because the Watershed Pesanggrahan has urban characteristics and the Pesanggrahan River flows through dense residential areas.

3. Result and discussion

3.1 Physical Analysis

Pesanggrahan River has a complex system in the urban water system in DKI Jakarta. Judging from the classification described by Kern (1994), Pesanggrahan River is part of the medium river classification. In the process of field observations, the width of the Pesanggrahan River ranges from 10-20 meters in almost all parts of the Pesanggrahan River, except at points 24 and 37, which are tributary branches which have a width of 20-40m.

A river that is in a branching with a tributary usually has a river width that is relatively larger compared to other watersheds. This is caused by several factors such as erosion caused by the flow of the river that erodes the river border or river banks.

The regularity of the Pesanggrahan River flow, according to the classification described by Rosgen (1996) in Maryono (2017), is a straight - type river, this can be seen with the Pesanggrahan River flow pattern that is described and viewed using the help of the Google Earth application and also a map of the Regional Spatial Plan DKI Jakarta which describes the Pesanggrahan River is in type G with a slope of 0-2%. The slope is usually located in the
Watershed area which is upstream of the river. So it has other characteristics, namely the river flow velocity which tends to be slower compared to the downstream areas of the Pesanggrahan River in the Bogor and Depok regions.

3.2 Water Quality Index of the Pesanggrahan River

Temperature

The highest value of the observation of the water temperature of the Pesanggrahan River is at observation point 27, which is at the observation point area behind the Belmont Residence Apartment with a temperature value of 31°C. The meaning is not clear Consider revising, and the lowest value is at observation point 1 or DKI Jakarta's upstream urban Pesanggrahan River with a temperature of 28°C and the low value can be caused by weather factors where at 1 - 8 observations are observed after rain. The average temperature in the study of the Pesanggrahan River is 29.45°C.

Calculation of the temperature value is very difficult to identify the cause, because many factors affect the temperature value of water. Besides the influence of nature factor such as rain and heat weather can also affect water temperature. However, if the weather conditions are relatively stable, the existing conditions of the Watershed Pesanggrahan can be identified, whether the Watershed Pesanggrahan is an area that has an area with good ecosystem conditions or not. The influence of ecosystems such as trees and plants can cause water shad to be a low water surface temperature value. Conversely, if the condition of the Watershed Pesanggrahan does not exist or a bad ecosystem is found / there are no trees, then the surface temperature value of the Pesanggrahan River water tends to follow the existing air temperature. The influence of basic chemical compounds (usually in the form of detergents) can theoretically cause the condition of the relative temperature of the water to be higher than the average value of the existing air temperature.

pH

The highest value of the observation results of the water pH of the Pesanggrahan River is at observation point 37 which is the observation point area downstream of the Pesanggrahan River with a pH value of 8.70 or having alkaline properties, and the lowest pH value of the water of the Pesanggrahan River is at observation point 1 or urban DKI Jakarta Sungai Pesanggrahan with a pH of 7.2 having normal alkaline properties. The average pH in the study of the Pesanggrahan River is pH 7.84. The increase in acidity (pH), which has a tendency to increase, can be ascertained due to the increasing number of chemical compounds with alkaline content that is discharged into the Pesanggrahan River at each point downstream of the Pesanggrahan River. These basic chemical compounds can all be found in detergents or cleaning agents, both from domestic and industrial waste products. pH is a chemical property that is influenced by the content / mixing of a substance's properties in proportion to volume.

Dissolved Oxygen

Increased diffusion of oxygen or Dissolved Oxygen from the air into the waters is usually caused by wind, falling rain to the surface, temperature, pressure, and the content of various dissolved ions that can affect the level of dissolved oxygen. The following are the results of the measurement of dissolved oxygen in the water of the Pesanggrahan River.
The highest value from the observation of Dissolved Oxygen (DO) in Pesanggrahan River water is at observation points 1, 2, 3, and 5, namely in the upstream urban observation point areas of DKI Jakarta Pesanggrahan River with a DO value of 3.50 mg/L. This point can be said to be the cleanest point and has a Watershed (DAS) tendency with a fairly good ecosystem, and the lowest DO value of Pesanggrahan River water is at observation points 36 and 37, namely the downstream observation points of the Pesanggrahan River with DO value of 2.00 mg/L. Watershed at this point tends not to have a good ecosystem with the existing condition of the Pesanggrahan River floodgate, where the garbage is carried by the Pesanggrahan River, or transported or accommodated (the existing condition at point 36 is a flood gate and a "taman kota" landfill, kembangan). The average value of Dissolve Oxygen in the Pesanggrahan River water study is 2.75 mg/L.

The low value of Dissolved Oxygen in river water is caused by accumulated garbage, a reduction in plant vegetation that is always decreasing in the Watershed Pesanggrahan and waste factor that is discharged directly in the Pesanggrahan River. In addition, the low value of Dissolved Oxygen (DO) proves that the Pesanggrahan River has been polluted and the aquatic organisms that live in it are disturbed or in other words aquatic organisms (for example: fish and bacteria) in the Pesanggrahan River flow decline, which is directly proportional to the declined oxygen content.

Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD)

The highest value of the observation of Biochemical Oxygen Demand (BOD) of Pesanggrahan River water is at observation point 26, which is the observation point of the Permata Srengseng complex with the Biochemical Oxygen Demand value of 5.50 mg/L and the lowest value of the Biochemical Oxygen Demand of Pesanggrahan River water is at the observation point 1 namely the DKI Jakarta upstream urban observation point area Pesanggrahan River with a Biochemical Oxygen Demand value of 2.26 mg/L. The average value of Biochemical Oxygen Demand in this Pesanggrahan River water study was 3.87 mg/L.

The highest value of the observation of Chemical Oxygen Demand (COD) of Pesanggrahan River water is at observation point 36, which is the observation point downstream of the Pesanggrahan River flow with a COD value of 30.10 mg/L. Watershed at this point tends not to have good ecosystems with existing door conditions. Pesanggrahan River water, where rubbish is carried by the Pesanggrahan River, is transported or accommodated (the existing condition at point 36 is a flood gate and a temporary "city park", kembangan) in the landfill and the lowest value of Chemical Oxygen Demand Pesanggrahan River water is at the observation point 1 area of the observation point downstream of the Pesanggrahan River with a Chemical Oxygen Demand value of 3.25 mg/L. This point can be said to be the cleanest point and has a tendency of Pesangerah Watershed with a fairly good ecosystem. The average value of Chemical Oxygen Demand in this Pesanggrahan River water study was 14.23 mg/L. In addition, an increase in Nitrate content in river water will result in an increase in Chemical Oxygen Demand in Pesanggrahan River water. In the analysis of Chemical Oxygen Demand values, the predictor variables of temperature and pH, there is a tendency to have no effect on the value of Chemical Oxygen Demand, which can be seen from the results of the plot that is not spread but relatively scattered at one point.
Table 1. Values for water quality study trends for 37 representative monitoring locations from upstream to downstream of Pesanggrahan River.

<table>
<thead>
<tr>
<th>SAMPLE POINT</th>
<th>TEMPERATURE</th>
<th>PH</th>
<th>TDS</th>
<th>TSS</th>
<th>BOD</th>
<th>COD</th>
<th>TDS (CaCO₃)</th>
<th>DO</th>
<th>NITRATE (NO₃⁻)</th>
<th>NITRITE (NO₂⁻)</th>
<th>Fecal Coliform</th>
<th>Total Coliform</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>°C</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>mg/L</td>
<td>cell / 10mL</td>
<td>cell / 10mL</td>
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</tr>
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**Table 1 continued...**
Total Dissolved Solid (TDS)

Conceptually, the amount of dissolved solids in the water will affect the light entering the water or can be said to test how much light will be inhibited when the dissolved solids are higher. The higher the value of Total Dissolved Solid, the greater the content of solids contained in water and the less light that can enter the water. This can result in decreased photosynthetic activity by chlorophyll organisms that are in the water.

The highest value of Total Dissolved Solid observation is at observation point 37, which is the observation area downstream of the Pesanggrahan River with a Total Dissolved Solid value of 400 mg / L. This observation point area is a branching point with the mookervart cengkareng / dog mogot river flow, so it can be said that Mookervart River water quality level is much lower compared to Pesanggrahan River water quality with the changes in result Total Dissolved Solid which is quite significant and the lowest value is at point 12 or at the observation point of the TPU (another name for a communal landfill) soil with a Total Dissolved Solid value of 80mg / L. The average value of Total Dissolved Solid in this Pesanggrahan River water study was 161.89 mg / L. The high value of dissolved solids is generally caused by river areas that are close to residential areas or are in river branching areas, especially if the river has lower water quality than other river flows, therefore, that domestic waste flows into the river and increases the number of particles dissolved.

Total Suspended Solid (TSS)

The highest value from the observation of Total Suspended Solid (TSS) is at observation point 1, which is the urban upstream observation point area of DKI Jakarta Pesanggrahan River with a total Suspended Solid value of 300 mg / L, and the lowest value is at point 37 or at the observation point downstream of the Pesanggrahan River with a Total Suspended Solid value of 15mg / L. The average value of TSS in this Pesanggrahan River water study was 159.75 mg /L.

Nitrate and Nitrite

The highest value of observations of Nitrate content (as NO3-) is at observation point 33 with a Nitrate value of 60.00 mg / L. The high value of Nitrate at this point can be caused by the amount of Domestic Waste discharges of the apartments and some factory wastes around the area of the observation point, and the lowest value is at point 1 or at the urban upstream observation point in DKI Jakarta Pesanggrahan River with a Nitrate value of 12.00 mg / L. The average value of TSS in this Pesanggrahan River water study was 29.89 mg / L.

The highest value of the observed Nitrite (as NO2-) is at observation point 37, which is the observation area downstream of the Pesanggrahan River with a Nitrit value of 4.00 mg / L, and the lowest value is at point 1 or at the Jakarta urban upstream observation point Sungai Pesanggrahan with a Nitrite value of 0.03mg / L. The average value of Nitrite content in the Pesanggrahan River water study was 1.50 mg / L.

The low content of Nitrates and Nitrites in the surface layer is because in the surface layer of the river the available oxygen is quite abundant in the presence of oxygen diffusion from the atmosphere. With the help of bacteria, the oxygen will oxidize Nitrites into Nitrates, therefore, the Nitrite content in the Nitrite layer becomes Nitrate and the Nitrite content in the surface layer becomes small. Thus, the value of the Nitrite content is inversely proportional to the value
of the oxygen content in the water. This can be proven by reviewing the value of Dissolved Oxygen (DO) and also the value of the fecal content and Total Coliform which are interrelated.

**Hardness**

Hardness is derived from salt chemical compounds in the form of cations and anions, causing the water quality of the Pesanggrahan River to become turbid and have a density when viewed with the naked eye.

The highest value of the observation of the Pesanggrahan River water hardness is at observation point 36 which is the observation point of the downstream floodgate Pesanggrahan River (Kembangan) with a water hardness value of 462.20 mg/L which could be due to the floodgates holding up the flow of the Pesanggrahan River so that sediment occurs at the bottom of the river, which causes the depth of the existing deposits. Deposits that have a lower density than water usually arise to the surface, which causes the physical condition of the water to become turbid and hardness in the water to appear and the lowest value is at point 3 or at a location near the downstream of the Pesanggrahan River with a Hardness Water value of 148.20 mg/L and this condition occurs because this condition is due to the concentration and activity of domestic and industrial waste production which is still minimal, but supported by low water flow relatively swift compared. This part of the sentence does not make sense and the meaning is not clear. Consider revising, the average value of hardness content in the Pesanggrahan River water study was 263.38 mg/L. This shows the Pesanggrahan River water flow factor which has a relatively low speed in the Srengseng area downstream of the Pesanggrahan River located in the city park area Kembangan / kemiri market, which is evidenced by the relatively high hardness level of the Pesanggrahan River and the flow of the Pesanggrahan River does not carry over.

**Fecal Coliform and Total Coliform**

The highest value of Fecal Coliform observations of Escherichia Coli bacteria or often called E-coli is at observation point 9, which is the RPTRA Anggrek Bintaro observation point with a Fecal Coliform value of 12,504 cells/100mL (this area is a densely populated residential / residential area) and the lowest value is located at point 37 or downstream of the Pesanggrahan River with a Fecal Coliform value of 1,500 cells/100mL. The average value of Fecal Coliform in the Pesanggrahan River water study is 7,300 cells/100 mL.

The highest value of bacterial Total Coliform observations was at observation point 5, namely the observation point of Pondok Pinang toll gate area with a Fecal Coliform value of 23,960 cells/100mL (this area has a dense urban forest / green land with a deep cliff wall that is deep enough, so still there are many natural ecosystems in it), and the lowest value is at points 36 and 37 or downstream of the Pesanggrahan River with a Fecal Coliform value of 2,800 cells/100mL. The average value of Fecal Coliform in the Pesanggrahan River water study is 13,290 cells/100 mL. The results of the review of the existing field conditions, the value of bacterial coliform which is above the average value is a residential / residential area. Where in the area of domestic waste comes from organic sewage wastes, which is known if bacteria such as E-Coli can multiply rapidly or sourced from the dung of living things (organic).

Decrease in the value of Fecal Coliform is directly proportional to the decrease in the value of Total Coliform, and inversely proportional to the value of Pesanggrahan River water hardness. Drastic decline in organisms such as bacteria / coliforms is generally caused by the content of salt chemical compounds that are sourced from the production of industrial wastes and also detergent / domestic waste, which are the constituent compounds.
3.3 Factor of Declining Pesanggrahan River Water Quality

The decline in the water quality of the Pesanggrahan River is due to the large number of violations committed by the community, especially many who use residential buildings that have become business locations that produce domestic wastes discharged into the Pesanggrahan River. As an example of the Kebayoran Lama and Pesanggrahan area, houses around the Pesanggrahan Watershed are used as the location of the textile industry where the disposed wastes are directly channeled into the Pesanggrahan River, although in their designation and licensing they are both are the same. Considering the can be considered as industrial land that
is illegal and violates spatial planning. Decreasing water quality in the Pesanggrahan River has accumulated chemical contents so that the value of water quality will get worse in the downstream of the river. The decline in the water quality of the Pesanggrahan River caused in large part by domestic waste which is due to the poor sanitation and drainage system in the Pesanggrahan River Region. Where houses dispose their domestic wastes directly into drainage connected to the Pesanggrahan River without any process of processing waste either independently or communally the water does not meet the applicable quality standards. The wastewater disposal system is in the form of domestic (household) wastewater, which domestic wastewater management is generally carried out by using a local sanitation system (on site sanitation) in the form of latrines, which are managed individually or communally, which are equipped with septic or cubluk tanks. Meanwhile, if using a centralized sanitation system (off site sanitation), the implementation requires a considerable amount of cost also in its maintenance, so that the use of the existing centralized sanitation system is estimated to only be able to serve residents living in the DKI Jakarta city.

4. Conclusion

The water quality of the Pesanggrahan River tends to be low and polluted. This can be seen from the observations of the colors of the Pesanggrahan River water samples compared to Aquadest or distilled water, all of which were found at the point of observation for deposits and discoloration. From the water quality index value, chemical and biological contents in the Pesanggrahan River water show that the Pesanggrahan River water is included in the polluted river category. The level of water pollution in the Pesanggrahan River is greater in the downstream river due to the accumulation which is carried by the river water flow of chemical compounds due to industrial and domestic waste from the upstream of the river. Most of the Watershed Houses are both are the same. Spatial allotment errors occur mostly in industrial activities in residential areas. The development that occurred in the Pesanggrahan Watershed area was more on the increase in the number of house buildings and the condition of vacant land to become vertical housing and commercial buildings. The development occurred almost entirely in the period of 2004 to 2010, while in the period 2010 to 2013 more changes were made in the structure of the Pesanggrahan River flow, namely the widening and straightening of the river.

References


Garbage Pollution In The Cisadane River In The Tangerang Region

Hinijati Widjaja1, Alicia Wellsan2, Gabriella Mistissy3, N.Dhea Madinah Al Qibthia4, Febri Yenny5, Olivia Dais Agustin6
{hinijati@trisakti.ac.id1, aliciawellsan@gmail.com2, gmistissy@gmail.com3, dhea.mdh@gmail.com4, febry.atha@gmail.com5, daisolivia@gmail.com6}

Trisakti University, Jalan. Kyai Tapa No. 1 Jakarta Barat-Indonesia1,2,3,4,5,6

Abstract. The Cisadane River that crosses the Tangerang, Banten Province every year is estimated to hold around 14-17 tons of garbage entering from residential areas along the river flow, and which is carried by the flow of water from its head on the slopes of Mount Pangrango and Mount Salak in Bogor, West Java. The influx of large volumes of garbage has disrupted the function of the river as a source of raw water and flood control. The purpose of this study was to determine the impact of the spread of garbage on the Cisadane River. The volume of waste from 13 sub-districts in the Tangerang Region, in August 2018, usually 14 tons to 17 tons. This condition is made worse by the presence of rubbish carried by the flow of water from Bogor and South Tangerang Regencies. Based on 2015 BPS data, the area of residential areas is 61%, 18% rice fields and 17% airports. So it can be understood if floods always occur in several areas of the City of Tangerang, one of which is due to the river flow is not smooth. This research concludes that garbage has caused siltation on the edges, bodies and river banks, consequently disrupting the flow of water and decreasing the function of the Cisadane River. Areas that are easily affected by flooding such as Karawaci Subdistrict, Priuk Subdistrict, Neglasari Subdistrict, Curug Subdistrict, Kosambi Subdistrict, Mekar Kondang Subdistrict, Paku Haji Subdistrict, Sindang Jaya Subdistrict, Sindang Jaya Subdistrict, Teluk Naga Subdistrict

Keywords: Cisadane River, Tangerang, waste, environment

1 Introduction

1.1 Background

The average area of Kota Tangerang is at an altitude of 10-18 meters above sea level. The North has an average height of 10 meters above sea level, while the South has a height of 18 meters above sea level. Judging from the slope of the land, most of the City of Tangerang has a land slope of 0-3%. Cisadane River which has an average water discharge of 88 m3 per second and flows as far as 15 Km. In the city of Tangerang there are also waterways which include the Mokevart Canal, the Tanah Tinggi Main Irrigation Canal, the West Cisadane Main Canal, the East Cisadane Main Canal, and the North Cisadane Main Canal [7]. Irrigation
channels that cross the city of Tangerang are 16 channels with a total length reaching 62,488.30 Km.

The existence of the Cisadane River divides Tangerang City into two parts, namely the East and West parts of the river. The flow of large and small rivers is very beneficial for the supply of clean water raw materials, for the development of clean water installations of the Tangerang City Water Supply Company (PDAM). The surface water supply can also be used for the water needs of industrial activities and the household needs of people who live in river environments. In the planning of the area and the city including the arrangement of the river which is done always try to be able to integrate the life of the city community with the existence of the river. The relationship between the river and the city is a step that must be studied because the behavior (culture) and the restoration step are often not integrated and cause conflict [11].

Based on the General Characteristics of the Cisadane River Basin, it is a natural ecosystem that has a variety of functions for various populations. There are those who use the river as a source of raw water, irrigation, toilet washing needs (MCK), recreation, as well as green open space (RTH). The river problem discussed in this review is the Cisadane River, which is a River Basin (DAS) in Banten Province which is tipped in the Bogor region, West Java, has a length of 139 km. As for the flow that crosses the city of Tangerang, has a catchment area of 1,411 km2 [8], but with the problem of household waste entering water bodies due to the attitude of the community around the banks of the Cisadane River who do not care and do not understand the importance of a river.

In Article 1 Paragraph (5) Government Regulation No. 38 of 2011: concerning Rivers, it has been described that: "A watershed is a land area which is an integral part of the river and its tributaries, whose function is to collect, store and drain the water originating from rainfall to lakes or to the sea naturally where land boundaries are topographical separators and sea boundaries to waters that are still affected by land activities "[2],[11]. The function of the river ecosystem is very important for the availability of water resources [6],[10]. However, almost all of the river basins in urban areas in Indonesia have been damaged. Industrialization and trade exploit large-scale rivers for waste disposal and unfortunately increasingly damage the value of these ecosystems (Lerner and Holt, 2012) [9]. Most of the damage that occurs to rivers is caused by human activities that dispose of household waste, hotel waste and factory waste in watersheds. All kinds of rubbish and waste are discharged into the watershed without any prior treatment so that the river water is polluted.
1.2 Problems

Regarding the inclusion of garbage on the surface of the river, it can disrupt the function of the Cisadane River as flood control for the entire Tangerang Region. Besides the impact of waste can reduce water capacity and this is detrimental, because the river is one of the surface water sources that are often used by communities around the banks of the Cisadane river.

1.3 Purpose

This research was conducted with the aim to find out the problems that pollute the function of the Cisadane River, so it needs to be investigated to what extent the influence of the entry of garbage into the river

2. Methodology

This research was started directly by means of grounded, using a qualitative descriptive method approach with the type of research used in this study is the Empirical approach method, namely that in analyzing this problem carried out with primary data obtained from the field, taking into account the volume of waste entering the body river water in the Tangerang region from the Cisadane river environment situation.

For the implementation of research carried out in a qualitative naturalistic manner, as is in the field, with conditions occurring naturally and in normal situations, which are not manipulated in their circumstances. In addition, literature studies, field observations and interviews with garbage cleaners and a number of communities that live around the riverbank are conducted.

2.1 Time and Place

The study was conducted from the 1st to the 25th June 2018, along the banks of the Cisadane River in the City of Tangerang (Neglasari District) and Tangerang District (Paku Haji District).

2.2 Data

The source of research data is to use primary data (direct observation, for events, the condition of waste in water bodies), the condition of riverbanks and the attitude of the people living around the river. Secondary data obtained from the Tangerang City Regulation No. 10 of 2014 concerning the Medium-term Regional Development Plan of Tangerang City in 2014-
3. Results and Discussion

The volume of waste in the Tangerang Region amounts to 800 tons, while 12% of the amount of waste, around ± 15 tons is in river bodies in 13 sub-districts in the City of Tangerang, which in August 2018 which is usually 14 tons to 17 tons, is exacerbated by the presence of waste which is brought from the surface water flow of Bogor Regency and South Tangerang can reach 1.5 tons. So that in August the amount of garbage in the river's surface water amounted to 18.5 tons from the original 14 tons in May - July 2018.

In Table 1 below, several sub-districts with a slope of <1% are categorized as sloping, but have problems with drainage, which in turn results in flooding of the area. Subdistricts that frequently flood or surface water overflowed the most in Tangerang City, Karawaci District, Neglasari District and Priuk District.

Whereas in Tangerang Regency, which is the North Tangerang area, the subdistrict that often occurs overflowing Cisadane River's surface water, areas that were previously rice fields, such as Curug Subdistrict, Teluk Naga Subdistrict, Mekar Baru Subdistrict, Paku Haji Subdistrict, Sindang Jaya Subdistrict. For the Districts of Kosambi and the District of Legok due to the change of land function into area of property and factory.

And based on Table 1, all Tangerang areas experienced flooding of surface water, which eventually resulted in flooding. According to Heryani (2008) [6], contamination by organic or inorganic waste causes changes in the physical, chemical, and biological conditions of river ecosystems. Because waste is composed of various components, such as waste that is easily biodegradable and difficult to decompose such as leaves (wet garbage), plastic waste, cans and styrofoam (dry waste).

The existing waste will change the structure and function of the river, so that it can reduce the carrying capacity and carrying capacity, and cause ecological disruption. Since the normalization of the Cisadane River on March 26, 2017, the flow of water has become smoother, less flooding in the flood-affected areas. Compared to previous problems, there were various problems caused by the high volume of garbage entering the Cisadane River body, especially
in areas in Tangerang City so that the flow capacity of the flow decreased. It is feared that the reduced flow capacity will disrupt its original function, which is aimed at flood control and provision of raw water from the PDAM.

Thus the river normalization is held in addition to dealing with flood management, also for the arrangement of the Cisadane River border, situ revitalization, and raw water supply. The impact of normalization has re-functioning the Pasar Baru Dam of the Cisadane river located in Koang Jaya Sub-district, Karawaci sub-district, Tangerang City. Based on the data the dam was built during the Dutch colonial period around 1930 [6] [8] [4]. The initial purpose of the construction of the Cisadane irrigation dam, which was equipped with 10 weirs width 10 m, two intake gates and two doorvoer / drain gates, there were 5 units of propulsion engines, with one unit moving two weirs, the length of the channel 214,978 m consisting of main channel (84,585 m'), secondary channel (103,393 m'), drainage channel (27,000 m'), which are used to irrigate rice fields with an area of 40,663 hectares, irrigating the areas of Tangerang Regency, Tangerang City, Serang Regency and DKI Jakarta.

Almost at the same time as the construction of the Cisadane irrigation dam, approximately one km away was the Scott Sluis Aflat Sluis building or the Sewan Dam, which had the function of pouring water into DKI Jakarta, through the MookerVaart River. With the existence of dams, the working pattern of irrigation should be clear, and landfill is clear in which direction the waste will go with the flow, and gather on the surface of the Cisadane river. But because of the long river there are residential settlements, which are accustomed to using Cisadane surface water for bathing, washing and toileting (MCK), and with the culture of bad habits of the community, namely littering causes garbage pollution, which is the waste disposal from the community can never be completely resolved, and the river can never be clean of rubbish.

The type of waste, which is found on Cisadane's surface water bodies is in the form of paper, plastic, beverage bottles, household utensils, food wrapping mattresses, food scraps and leaves, twigs or stems from plants. It is the biggest contributor to household waste that can never be controlled, the behavior of the surrounding community who live on the banks of the Cisadane River are not proactively ecologically proactive for their environment, moreover the authorities here are also passive in action. This is evident from several interviews with officers in the field, showing that garbage cleaners in the Cisadane River cannot act, when a community violates regulations, such as dumping garbage directly into
water bodies. Likewise, the results of interviews with several people who live on the banks of the river, who behave indulgently with the condition of the waterway.

According to Lerner and Holt (2012), the community is the highest actor (ultimate beneficiary) in terms of river use [9]. In regional and city planning, river planning and structuring is always trying to be able to integrate the lives of urban communities with their rivers. The relationship between the river and the city is a step that must be studied because between behavior (culture) with the restoration step is often not integrated and cause conflict [11].

Table 1. Administrative City / Regency: Tangerang City and Tangerang Regency: Districts and Sub-Districts / Villages through which the river is flooded and its existing conditions.[4],[8]
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<tr>
<td>9</td>
<td>Kelapa Dua</td>
<td>6</td>
<td>South Tangerang</td>
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<tr>
<td>10</td>
<td>Kemiri</td>
<td>7</td>
<td>North Tangerang</td>
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</table>
Based on the specifications of the Cisadane weir that serves to prevent the overflow of the Cisadane River's surface water, Tangerang City should never have flooded. But in reality some of the existing sub-districts such as Karawaci District, Neglasari District and Priuk District are always flooded. This condition is exacerbated during the rainy season, water discharge enters a critical level, because the water level reaches 11.70 meters from the normal limit of 12.50 meters.
[2]. Flood supply areas are usually upstream of the watershed, so changes in upstream land cover can cause a decrease in infiltration capacity and increased surface runoff [5]. Based on this, a lot of water supply must be managed as much as possible flowed into the ground (infiltration), because the pile of garbage in surface water that can cause flooding occurs in the Regency and City of Tangerang, because the area is mostly flat (slope <2%) and by closing paddy fields. The area included in the Cisadane watershed (28,446 ha or 18.78%) is very vulnerable to flooding.

Because there is still a lot of garbage that clogs the drainage flow, it indicates that the drainage system in both districts is still not good. The community must routinely clean gutters in front of their houses because if it is not done it will cause drainage flow not smooth. This condition also contributed to siltation in the Cisadane River due to the abundance of deposition of organic matter (due to poor sanitation) and stagnant rubbish which made it a pile of sediment as high as 1.32 meters. River basin space currently only has an effective depth of 1.41 meters.

<table>
<thead>
<tr>
<th>No.</th>
<th>Facilities</th>
<th>∑ (unit)</th>
<th>Purpose</th>
<th>Specifications</th>
<th>Explanation</th>
</tr>
</thead>
</table>
| 1.  | Weir door  | 10       | • diverting water so that it can flow into the channel and into the fields for irrigation purposes. • to raise the water level so that it can be flowed by gravity to where it is needed | * 10 m wide  
* Long  
* Normal discharge -12.45 (upstream)  
* Flood discharge (downstream peil)  
* Ready Conditions (peil +09.00 to + 10.00)  
* Standby Conditions (peil + 10.00 to + 11.00)  
* Beware condition (peil + 11.00 to + 12.00)  
* Peil Condition> - 12.50 Automatic alarm sounds | * Weir (Bangunan sadap) or Weir (Diversion Structure) is a building (complex of buildings) across the river that serves to increase the elevation of river water.  
* The definition of weir according to the ARS Group, 1982, Analysis of Wages and BOW Materials (Burgerlijke Openbare Werken), Bandung is a water structure (and its accessories) that is built across the river or on a riverbank  
* Current condition: -Still works  
-Still manual how it works  
* The intake or gate functions to regulate the amount of water entering, which will be flowed into the irrigation channel through a mud bag |
| 2.  | Intake door | 2        | 1. For irrigation needs  
2. For drinking water needs  
3. As an energy generator | * The maximum surface water discharge is 2,200 M3 / sec |
<p>| | |</p>
<table>
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<tbody>
<tr>
<td>1.</td>
<td>To reduce sedimentation</td>
</tr>
<tr>
<td>2.</td>
<td>Prevent the entry of sediment into the irrigation canal network</td>
</tr>
<tr>
<td>3. Building mud bags</td>
<td>* This building is located at the beginning of the primary channel / main channel behind the retrieval building. Mud bags deposited sediment fractions that were larger than fine sand fractions (0.06 - 0.07 mm) and were usually placed downstream of the uptake channel</td>
</tr>
<tr>
<td>4. Dividers / flood control</td>
<td>* Current condition:</td>
</tr>
<tr>
<td>5. Rinse at various river discharge conditions</td>
<td>- Still works</td>
</tr>
<tr>
<td></td>
<td>- Still manual how it works</td>
</tr>
</tbody>
</table>

Source: Processed from various sources (2018).

Based on data in BPS Tangerang in 2015, Tangerang Regency has land allotments such as, 56.3% settlements 31.7%, ponds / paddy fields 11% and airports 1%. All four land uses are all vulnerable to flooding, both because the surface of the land becomes impermeable or saturated with water. While the City of Tangerang, with an area of 8504.90 ha, is also very vulnerable to flood hazards, with an area of 61% are settlements, 18% rice fields, 20% ponds and 1% airport. With the designation and development of residential expansion compared to other allotments, there is an imbalance in the ecological balance of the Tangerang Region, so that it can be understood if floods always occur in the City and Regency of Tangerang. With the condition of the community always throwing household garbage into the water body, while there is not enough landfills.

The Final Waste Disposal Site (TPA) in the Tangerang Region.

1. Jatiwaringin Landfill, Mauk District, Tangerang Regency

Waste generated by 3 million inhabitants in Tangerang Regency reaches 580 M3.

Furthermore, the garbage is transported to the Final Disposal Site (TPA) in Jatiwaringin
Village, Mauk District. However, only half of that amount can be transported daily to the landfill. The Jatiwaringin TPA with an area of 20 ha is a final landfill that holds rubbish from all of Tangerang Regency. The Jatiwaringin Final Disposal Site (TPA) still uses a system of piling garbage or open dumpling. In other words, the rubbish is only stored, piled up, arranged, and tidied there. That causes disruption to the comfort of the population in the Jatiwaringin Village.

2. Cipeucang TPA in Setu Subdistrict, South Tangerang

TPST are located in District Tigaraksa, Pasar Thursday, Cikupa, Sepatan, Panongan, Mauk, Pagedangan, and Legok. Every day waste production in the region reaches 130 tons, but only half of it is able to be transported to landfill due to fleet limitations. Because all this time, garbage has only been transported around 50% to the final landfill (TPA) in Cipeucang, Setu District, in a day, garbage entering the Cipeucang TPA is around 600 M3 meters with a weight reaching 130 tons. From the total weight of waste calculated per day, if divided by the total population of South Tangerang, which reaches 1.4 million people, the garbage per household can reach three kilograms per day. Cipeucang TPS has a 15 hectare waste collection area. However, there are currently only around 4.4 hectares that can be used. Of the 130 tons that were raised in half were scattered, because the pattern of moving from the residents' garbage transport carts to the garbage collection is still the traditional way, as a result there are some volumes that are not transported from the garbage cart at the Rawa Kucing landfill, Neglasari District Tangerang Regency.

3. TPA Rawa Kucing uses an open dumping disposal system, and has an area of 8 Ha, which is used only 6 Ha, while the rest is still not used. The Rawa Kucing TPA works well even though it is sometimes overloaded. Estimated 4508 M3, per day the volume entering the river. But the pattern of appointment and distribution by truck to the final shelter is more or less scattered and eventually some will enter the waterway by 20%. The condition of the land is very narrow and open there is a possibility of wind and rain exposure also contributes to the entry of garbage into the water body. Waste management in the landfill also makes the odor odor not pierce the nose. This does not take into account the time of heavy rain which results in a flow that carries garbage from the drainage channel and from the upstream direction of Cisadane.
4. Conclusions and Suggestions

This research can answer in general, that the attitudes of the people who live on the banks of the Cisadane river, are still less concerned with their environment, so that the harmony of attitudes with the sustainability of the river's ecological functions is still very low. Based on the discussion above, it can be concluded that the entry of garbage into the Cisadane River has caused:

1. Siltation on the banks, bodies and banks of the Cisadane River.
2. In certain areas Tangerang City Region which is vulnerable to flooding consists of: Karawaci Subdistrict, Priuk Subdistrict and Neglasari Subdistrict. And in certain areas Tangerang District Region that is vulnerable to flooding consists of: Curug District, Kosambi District, Mekar Kondang District, Paku Haji District, Sindang Jaya District, Teluk Naga District.
3. Disrupting the function of the Cisadane River as flood control, and providing raw water for the entire Tangerang Region.

Suggestion

1. Routine sediment dredging is needed to increase the Cisadane River water flow to prevent siltation.
2. Need to make a means of capturing waste in the Cisadane River, in order to facilitate the transportation of incoming garbage.
3. Invite citizens to participate actively, to help keep the river clean, Grow a sense of belonging and love a clean and healthy environment.

References


Partnership As An Effort To Consolidate Waste Management Initiatives In Tourism Destinations On Small Islands: The Case Of Penyengat Island

Zainul Ikhwan¹, R.Hamdani Harahap², Lita Sri Andayani³, Miswar Budi Mulya⁴

(zainul.ikhwan@gmail.com; r.hamdani@usu.ac.id; lita_andayani@yahoo.com; miswarbm_ikl@yahoo.com)

Postgraduate Doctoral Student, University of Sumatera Utara and Lecture Environmental Health Study Program, Health Polytechnic of Tanjungpinang, Tanjungpinang, Indonesia¹
Faculty of Social and Political Science. Universitas Sumatera Utara²
Faculty of Public Health. Universitas Sumatera Utara³
Faculty of Mathematics and Natural Sciences, Universitas Sumatera Utara⁴

Abstract. Waste management on small islands has challenges, low awareness of the community and culture, limited land, seasonal changes and appropriate waste management technology. Moreover, Penyengat Island is an object of cultural preservation and tourist destination. The purpose of the case study is the small tourist island of Penyengat, Tanjungpinang in waste management through the role of stakeholders and community participation. This type of research is qualitative, and data are obtained by semi-structured interviews and observations. Interviews were conducted with 21 stakeholders in the small island waste management system. (government, private sector, public, universities and professional organizations). Waste management at the location of destination and cultural preservation requires synergy from all stakeholders including the community. There needs to be a form of compensation for environmental services in tourism development so that an eco tourism tourism package is formed. There is a balance between ecological, economic and social aspects.

Keywords: waste management, Penyengat, small island, tourism destinations

1. Introduction

Based on Law Number 32 of 2009 explains Environmental Management which is supported and systematically to preserve environmental functions and prevent environmental damage in planning, utilization, control, maintenance, supervision, and law enforcement. Environment as a place of union with all components of objects, conditions, and living things,
human relationships, which affect nature and live in harmony and balance[1]. A lot of assistance for environmental management, one of which is through waste management. Based on Law 18 of 2008[2] and Government Regulation 81 Year 2012[3] explains waste management system in Indonesia has mandated two programs that state the amount of waste and its handling.

Waste management in small island communities such as Penyengat Island, Tanjungpinang City, which is also a cultural and religious tourism island. Tourism islands really need serious waste management because of climatic conditions, topography, lack of funding, inappropriate planning, consumption patterns complexity, tourism flows and seasonal variations will affect the amount and composition of waste[4], lack of excavation of information as a guide as well as time constraints due to the level of mobilization or laziness, as well as the lack of caring[5]; [6] limited land, land for landfill waste and also requires a high bias in the transportation of waste by sea. Geographically, the location is isolated the need for food and clothing and materials are generally imported with no thought on how to manage the waste generated from these activities. This is exacerbated by the lack of facilities and infrastructure in waste management so that there is no management in the form of a system that manages waste effectively, efficiently and sustainably[7]. Improper waste management can result in deteriorating environmental, economic and social quality that is difficult to recover such as the effects of greenhouse gases, land degradation, exploitation of resources resulting from water and soil, air pollution and loss of biodiversity and positive value and attractiveness tourism location[8, 9], special attention is especially in Penyengat Island because there are many historical sites and cultural reserves that must be guarded and have special rules in their management.

The way waste management operates in a very complex environment and has different handling priorities[10]. For example, tourists do not feel responsible for waste problems because only tourists visit in a short time, do not develop social ties[11] but they should pay for environmental services or environmental compensation. Waste management often only adds costs, especially in the industrial field[12]. Based on data from the Department of Public Housing, Settlements, Cleanliness and Cemeteries in Tanjungpinang City in 2016 waste is dominated by 67% of waste sources originating from households, 10% market, commercial (ports, shops) 15%, industry 5.2%, roads, parks and rivers 2%. Based on the amount of waste that enters the final waste disposal site in Ganet over a period of 5 years (2010-2014) of 363.53 m3 / day means the service is less than 52.94%. This happens because of the limitations of the fleet of waste transporters, especially for the transportation of rubbish on small islands and the lack of community awareness in reducing and handling waste.

Penyengat Island is a testament to the history of the Malay Kingdom and is well preserved. The island has only 2,000 meters long and 850 meters wide and is located 2 KM from Bintan Island (the island where the capital of the Riau Islands is located Tanjungpinang). This island is
known as a tourist destination for religious and cultural tourism. On this island there is the Sultan Riau Mosque, Engku Bilik Palace, Tabik Building, Marhum Palace Office, Putri Well, Ammunition Building, Benteng Bukit Kursi, Indra Perkasa Traditional Hall and several tombs such as the Tomb of Raja Haji Fisabilillah, Tomb of Engku Putri Raja Hamidah, Tomb of Raja Raja Ali Haji etc. Based on the record of the population report of Penyengat Village, the number of inhabitants who inhabited Penyengat Island with an area of 2 km² in 2017 amounted to 2,760 inhabitants (841 households with a density of 690), this number increased from the previous year (2016) which amounted to 2,724 people (821 households with a density of 681). The estimated amount of landfill in 2016 is 7,763 m³/day or 1,435 tons/day, and in 2017 it is 7,763 m³/day or 1,416 tons/day. The amount of waste generation continues to increase considering that there are no waste treatment systems in the sting island.

The development of tourism presents both positive and negative impacts on an area and the community around the tourism activity. The positive impact generated on the economy is opening up employment opportunities, increasing income and increasing infrastructure and public facilities in the tourist destination. But on the other hand, tourism activities can have a negative impact, such as water, soil and air pollution and damage to the natural environment, as well as degradation of moral, social and cultural values and have an impact on public safety and health.

The tourism industry generates additional volumes of waste, especially plastic waste\textsuperscript{[8,13,14]}. Generally, tourism activities can produce waste that is almost double the level of local waste production\textsuperscript{[8]}. The ability of nature and humans in managing waste is limited\textsuperscript{[14,15]} and the character of tourists will influence the local population with culture and lifestyle\textsuperscript{[16]}, so that produces changes in consumption patterns and local waste management according to local potential and conditions.

2. Methods

This type of research is qualitative, and data are obtained by semi-structured interviews and observations. Interviews were conducted with 21 stakeholders in the small island waste management system consisting of government stakeholders, related agencies (the Tourism Office, the Environmental Office, the Sanitation Office and the Health Office and the Public Works Department) and the private sector, social institutions, waste service users, the sector informal as well as universities and professional organizations.

3. Results and Discussion

Waste management on Penyengat Island is only carried out from house to house, and only a portion of the penyengat community collects waste to be taken by officers to the end of the island and there is no waste processing such as open dumping, as a result the waste will also fall into the sea. Based on a 2010 study conducted in 192 coastal countries by\textsuperscript{[17]}, Indonesia became the second largest plastic marine waste disposal in the world after China of around 3.32 million metric tons/year. Marine waste consists of a variety of solid materials both organic and inorganic
People more often burn rubbish in the open which results in increased levels of CO₂ and global warming or throwing trash directly into the sea which has an impact on pollution.

The main problem of waste management on small islands is limited land so it is difficult to carry out waste management such as a large 3R TPS or landfill development. The problem of rubbish on other small islands is during certain seasons such as the north wind season or the holiday season, the waste production will accumulate many times more than usual days, so that the accumulation of waste often occurs. Waste generated on the island as well as coming to the island must be managed with a 3R TPS. The amount of waste often exceeds the capacity that can be handled by the island, due to the limited availability of land for waste disposal, budget funds and human resources. As a result, many solid wastes are burned or discarded by the community and some even dumped directly into the sea. The process of recycling waste often has difficulty in marketing. Waste management that is not managed will produce ecological impacts, for example environmental pollution that results in the loss of natural resources; economic impacts such as decreased productivity; social, for example, the emergence of conflict and health.

The 2012-2013 Ministry of Environment and Forestry survey on Environmental Care Concern Index shows that behavior does not sort waste (76.1%), burn waste (38.2%), household wastewater discharged into rivers, ponds, swamps, sea (15.8%). Low environmental awareness due to education, age, number of people in the household, knowledge and attitudes and marital status. Cultivation of awareness about environmental quality, will have an impact on attitudes and behavior of waste management and limited use of waste recycling and need good cooperation and interaction for achieving optimal goals. Children are prone to illness when they are born and / or developing in a dense, dirty environment and lack of space for recreation and learning.

Based on the report from the janitor, the janitor in the January-March 2019 area of the coastal area, totaling 3.9 bags (0.2 m³ per bag) per day. Based on the results of interviews and field observations, the condition of the waste brought by officers to the TPS location is 1 ton per day, with a rhythm of transportation twice a day which is transported by pick-up (emperor) with a capacity of 1 cubic.

The purpose of synergy is to increase the effectiveness, efficiency and confidence in the sustainability of waste management services on Penyengat Island through increasing understanding and awareness and a sense of need for waste management starting from the reduction and utilization of waste in the household level, so that waste management can be done together and sustainably. The capacity of waste management on Penyengat Island is enhanced through stakeholder involvement, availability and access to facilities and infrastructure. In addition, strong commitment, extensive networks, financial support and transparency and accountability are also needed.

In the operational technical aspects of handling waste on Penyengat Island only takes place collection and removal without the process of transporting and processing or disposing of waste. More open conditions of storage, without sorting out the characteristics and characteristics of waste. The first solid waste management starts from the existing waste source waste. However, in Penyengat Island there is no individual solidification of waste in each household, as well as open, leaky and uncovered storage conditions that make waste mixed with water, and as a vector nesting site and intruders such as cockroaches, rats that can cause diseases such as diarrhea. Besides that, the waste is still mixed up. Whereas according to Regional Regulation number 3 of 2015, article 27 paragraph 2 (two), the waste sorting and storage facilities should be labeled or marked, differentiated in shape, material and color of the
container, and using a closed container. Waste that has not been sorted has the potential to produce leachate that can pollute water, and it is difficult to compile or recycle waste.

Waste collection by the community by utilizing the provided container, and among the people living in the coastal area throw it to the beach. Based on 2 (two) types of collection patterns of the Indonesian National Standard (SNI), the Penyengat Island community uses a communal pattern facilitated by the local government. The communal pattern procedure is implemented through village officials where officials who have been appointed to service cleanliness, collect and carry waste to the Temporary Disposal Site, or containers to be taken to the Final Disposal Site, while the means of collecting on a three-wheeled motor that have waste sorting is effective and effective. efficient [33]. While the waste collection process on Penyengat Island uses the pick-up service (the emperor) because of different road access conditions from the mainland area of Tanjungpinang City. Waste collected and brought to the end of Penyengat Island is stacked and without treatment the waste management produces leachate and has the potential to pollute water, soil and the environment.

Result of qualitative research were implemented by means of Focus Group Discussion.  
1. Increase public knowledge about waste management,  
2. The regional government must provide adequate facilities and infrastructure for waste management.  
3. Declaration of the Waste Management program (focus on reducing and handling waste) on Penyengat Island  
4. Collaboration between the community, government and the tourism sector in creating tourism packages that are environmentalists  
5. There are forms of regulation in the form of fees for environmental services  
6. The existence of an environmental education package system  

Then the process of collecting and transferring also does not occur as a result of sorting waste, so that the conditions of the waste moved by the officials are mixed in one container, so that waste is often wet when moved. As for the removal of waste using pick-up (emperor) services with a growing rhythm of transportation, from 2 emperors with one transport to 2 emperors with two transportation. Waste transportation is only carried out on rubbish which is on the coast to be taken to the Tanjungpinang City Final Processing Site (TPA) by using a sea access (boat) of 2 (two) pieces. However, the condition of waste in the TPS is not carried out in the process of transportation and processing, so that waste accumulates on one land. Transportation of waste from TPS to municipal landfill has not been carried out with consideration of the relatively large transportation costs. The waste processing carried out from time to time is by burning through community initiatives that bring waste to land that is on land. Therefore, it is necessary to manage waste involving the role of the community by optimizing the 3R Waste Management Site, in order to obtain the most relevant waste management for the coastal areas of Penyengat Island.  

Waste management by applying the concept of reduce, reuse, and recycle (3R). First, composting organic waste and collecting inorganic waste to collectors or making crafts. Second, collecting organic waste to the place and collecting inorganic waste. Whereas based on regulation number 3 of 2015 article 36 paragraph 1, waste processing should include activities, compaction, composting, material recycling, and turning waste into energy sources. However, waste processing in the final stages of operational techniques is not carried out so that the waste that is in the Waste Processing Site is not processed. The final solution is to burn the trash,
causing smoke and potentially causing air and water pollution from leachate and residual residue produced.

The institutional aspect does not yet have a waste management body responsible for waste management, both from the authorized RT / RW and the agency, even though the building facilities have been provided. So that the waste that piled up without being managed, and only carried out the processing of waste by burning it, became a pile of waste that began to rise.

Funding aspects, there are no costs involved in waste management on Penyengat Island, which have been spent by the public in the process of transporting, collecting, and disposing of waste. This is because the process is carried out by the Sanitation Department through the officers. Levies have not been applied because the community's awareness is still very lacking, there have been threats that many people are throwing their trash into the sea, especially coastal communities, and in the mainland, community throwing waste into the bushes or burning in open places openly. On Penyengat Island there is no proceeds from the sale of recycled products because the processing building facilities are deactivated so there are no costs allocated for waste management.

In terms of legal regulations, regional regulations already have legal provisions governing waste management, namely regional regulation number 14 of 2009 and regional regulation number 3 of 2015. However, there is a lack of awareness raising and awareness rising so that many people do not know the waste management provisions and consciously do it sustainably and become a shared responsibility. This is evidenced by the ongoing processing of waste by burning.

Based on Regional Regulation number 3 of 2015-chapter VI article 21 paragraph 1, waste management provisions governing waste management, waste reduction should be done with the principle of 3R covering activities, limiting waste generation, waste recycling, and or reuse of waste. However, due to the lack of delivery in the applicable legal provisions, the waste management has not yet been carried out as the applicable provisions.

The aspect of community participation is still said to be intermediate, so the community cannot be involved on their own initiative, it is still needed guidance and appeal from the RT / RW in mutual assistance activities or community service. There is no initiative to provide waste bins at the sources of waste (households) with already in a separate condition between types and characteristics of waste. Cooperation between the government, the community and business owners or packaging waste owners is needed to move together to carry out 3R efforts to protect the environment and nature in a sustainable manner. Penyengat Island is a historical city of struggle against invaders, there are many former cannons and fortifications found on this island. One of the tombs of the national hero Raja Ali Haji with his famous work Gurindam 12 is on this island. In addition, there is the Sultan Mosque which still stands strong and is used daily by the community to worship. history of the mosque stone is glued with egg whites. However, the amount of trash around the homes of residents makes tourists less satisfied during a visit to this island.

The piles of waste that littered Penyengat Island should receive special attention. The piles of waste will damage the image of the island which is one of the tourist destinations in Tanjung Pinang. To overcome this waste problem, the City Government of Tanjungpinang cooperates with BUMNs that have CSR funds, such as PT Pelindo, BI, PT Angkasa Pura and others, as do other regions that become tourist destinations such as Belitung, Pulau Seribu and others. Collaboration must also be stronger with fellow government institutions of the Environmental Agency (upstream) to increase public awareness and and in the context of reducing the amount
and type of waste and the Department of Housing, Settlement, Cleanliness and Gardening of Tanjungpinang City (downstream) for the prevention rubbish.

Community participation in management can take the form of waste planning, construction and action. Based on Regional Regulation number 3 of 2015 regarding waste management article 46 paragraph 2 the role of the community can be done by: (1) giving proposals, considerations and suggestions to local governments, (2) formulating waste management policies, (3) providing suggestions and opinions in settling waste disputes. However, these roles are not yet involved in the stinging Empowerment is a concept that is oriented towards reducing formal and informal barriers, as well as efforts to give strength to the community, institutions and government.

The wrong assumption in terms of community participation that local governments must assume responsibility for waste management and the community is not expected to take part or contribute. The level of community involvement in waste management depends on the initiative of local authorities. Both government agencies and citizens must take an active part in realizing operational efficiency in waste management, and community participation in decision making is mentioned by experts as a socio-cultural aspect in addition, community awareness and social apathy for solutions. Among many stakeholders, community is the largest stakeholder category in the waste management system and has a multi-faceted relationship with waste management activities.

The study also found that when people participated in waste sorting, it would reduce the cost of waste management. Through a partnership approach, Penyengat Island is designed for a major improvement in their waste management system. It is expected to be a success model, because waste management standards on small islands are at the service level, willingness to pay and waste behavior and practices. Partnerships between community members, government and the private sector address the gaps that usually exist between local residents and the tourism industry at their destination. The capacity of waste management has increased due to stakeholder involvement, facilities and access and increased financial transparency and public accountability.

The waste management partnership must continue and grow even better. Synergy is also done with the education sector, in this case schools, especially primary schools, to provide young education for the sake of character building, caring for waste management, caring for the environment and caring for sustainability.

4. Conclusion

Waste management at the location of destisation and cultural preservation requires synergy from all stakeholders including the community. There needs to be a form of compensation for environmental services in tourism development so that an eco tourism tourism package is
formed. There is a balance between ecological, economic and social aspects. Collaboration between the community, government and the tourism sector in creating tourism packages that are environmentalists.

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References


The Blue Water Footprint of Block-printed Batik Coloured by Natural Dye of Myrobalan (*Terminalia bellirica* Roxb.) Mordanted by Alum and Copperas

Widhi Handayani¹, Alberta Rika Pratiwi², Budi Widianarko²

{widhyandayani@gmail.com¹, pratiwi@unika.ac.id², widianarko@unika.ac.id²}

Satya Wacana Christian University, Jl. Diponegoro 52-60 Salatiga, Central Java, Indonesia¹, Soegijapranata Catholic University, Jl. Pawiyatan Luhur IV/1 Semarang, Central Java, Indonesia²

**Abstract.** The batik production by home industries in Central Java, Indonesia, has been creating surface water pollution because of synthetic dyes, and triggers to its replacement by natural dyes. However, the use of natural dye could consumes more water, as the fabric should be immersed into the extract repetitively, which make up to the high of Blue Water Footprint. This study aims to examine the Blue Water Footprint (BWF) of batik production coloured by Myrobalan (*Terminalia bellirica* Roxb.) extract. An experiment was conducted in a large-scaled batik home industry in Jarum village, Klaten. White block-printed cotton fabrics, Myrobalan extract, and alum and copperas were used for the experiment, while water usage were calculated. The BWF of block-printed batik of both treatments were 156.48 – 158.70 L/pc or 68.52 L/m² of fabric, on average, which is mainly contributed by the dewaxing process. Implementing cleaner production, hence, is central to increase water use efficiency.

**Keywords:** Home industry; Block-printed batik; Blue water footprint; Mordant; *Terminalia bellirica* Roxb.

**1 Introduction**

Batik is commonly understood as textile product which is produced by traditional handcraft. In fact, it is a process of drawing where a resist dye technique is involved by applying the wax on the cloth to prevent certain parts of the cloth from being coloured, in order to create patterns [1]. Indonesian batik is a product which is usually produced by home industries. The batik production often releases wastewater without proper treatment [2]. As a consequence, the discharge of the wastewater pose negative impact to aquatic environment [3]. This negative impact is often correlated to the use of synthetic dyes which are reported to contain carcinogenic compounds and difficult to decompose and this has been promoting the revival of natural dyes for global textile colouration, as the latter is considered to be eco-friendly [4]. Unfortunately, our previous study showed that applying natural dyes for batik production does not necessarily changes the production to be more eco-friendly [5].

In natural dyeing, a white cotton cloth should be soaked into natural dyes extracts in turns with drying, and those steps are done repeatedly until an expected colour is formed [6]. Repeated cloth-soaking means absorbing the liquid extract of dyes, and because the water will be evaporated during the drying process, this pattern corresponds to the consumptive water use which is a component of Blue Water Footprint [7]. The consumptive water use probably works for Myrobalan (*Terminalia bellirica* Roxb.) because in order to form an expected
colour from it, the cloth should be soaked into its extract for many times. The more frequent
the cloth is dipped into the extract, the more water that will be absorbed. On the final step of
dyeing, the batik artisans are usually adding mordants such as alum and copperas, because the
mordants play a significant role in forming the final colour.

Studies on water usage for batik have been reported, mainly in regard to cleaner
production [8] and eco-efficiency measurement [9], [10], [11]. Nevertheless, those researches
were conducted using Life Cycle Assessment (LCA), Data Envelopment Analysis (DEA), and
other approaches which measure the use of resources to produce batik in general, instead of
merely water. However, the approach used to measure water usage only based on its direct use
to produce batik, which is commonly different from the water footprint approach. The water
footprint approach consists of three components of Blue Water Footprint, Green Water
Footprint, and Grey Water Footprint [7]. The Blue Water Footprint is an indicator of
consumptive water use of blue water or freshwater, which includes (1) evaporated water; (2)
water that incorporated in the product; (3) water that does not return to the same catchment
area, and (4) water that does not return in the same period after its withdrawal [7]. This is the
difference between the mentioned approaches and the water footprint.

Studies on water footprint of batik production have been reported [12], [13].
Unfortunately, these studies were focused on the general production of batik and did not
attempt to specifically explain the consumptive water use of batik production by application of
a specific dye. Therefore, this study aims to examine the Blue Water Footprint (BWF) of batik
production coloured by natural dye extract of Myrobalan (T. bellirica Roxb.) mordanted by
alum (aluminium sulphate) and copperas (ferrous sulphate).

2 Methods

This research was conducted in a batik home industry which produces block-printed batik
by natural dyeing and one of the natural dye used for dyeing is Myrobalan (T. bellirica Roxb.).
This research is conducted in Jarum village because some areas of this village sometimes
suffer from drought in dry season and batik production during this season could be disturbed
due to the drought, in addition to the reason explained by [5]. By this study, we are seeking an
opportunity to encourage the batik artisans to improve the water usage management.

As explained in the previous section, the BWF includes (1) evaporated water; (2) water
which is incorporated in the product; (3) water which does not return to the same catchment
area, and (4) water that does not return in the same period after its withdrawal [7]. However,
in this research, we consider the three former water uses, i.e. water which is evaporated and
incorporated in the cloth, and the water which is used but is not returned in the same area,
particularly not as clean as when it was withdrawn. We do not include the water which is
saved by the artisan, because they also use the water for domestic purposes and not merely for
batik production.

The experiment on the home industry was conducted by preparing six block-printed white
cotton clothes of 2.0 m x 1.15 m size for each. The Myrobalan extract was prepared by the
batik artisan by their own formulae. The clothes were weighed and treated to pass the whole
batik making-process as usually performed by the batik artisan. All processes were observed
and consumptive water use regarding to the water absorbed by the cloth during dyeing process
were calculated based on Equation 1.
\[ v = \left( \frac{w_1 - w_0}{\rho} \right) \times f_s \]  

(1)

The notation \( v \) represents the volume of water absorbed (ml), \( w \) represents the weight (g) of the cloth after soaking \( (w_1) \) and before soaking \( (w_0) \), \( \rho \) represents the density of Myrobalan extract (g/ml), and \( f_s \) represents total number of soaking the cloth.

The Equation 1, however, is not appropriate to calculate the water evaporates and lost return flow during dewaxing process, therefore the measurement of the water consumed on that process is conducted based on our previous study [5]. The wax, natural dyes, and water attached or absorbed by each clothes were also measured according to our previous research [13]. Colour measurement of the Myrobalan extract and the coloured clothes were conducted using a Minolta CR-200 chromameter resulting the \( L^* \), \( a^* \), and \( b^* \) parameters which were used to calculate the total colour change (\( \Delta E \)) [14], [15].

3 Results and Discussion

3.1 Colours of block-printed batik by the application of different mordants

Our result showed that the behaviour of this artisan was similar to our previous study which found that it is unusual for batik home industry artisan to measure the use of materials, such as water [13]. In addition, the process of making block-printed batik by natural dyeing was similar to that of hand-drawn batik as explained previously [5], except that drawing on the cloth is replaced by block-printing and degumming. The block-printed clothes were usually degummed by soaking them for 30 minutes in a detergent solution, followed by washing and drying. After all, the clothes are then ready for colouration. The white block-printed cotton clothes were then coloured by Myrobalan extract by dipping the clothes in turn with drying them under the sun. Three of the clothes were dipped for twelve times, while the three others were dipped for seven times. After the process was finished, the twelve times dipped clothes were mordanted by alum, while the seven times clothes were mordanted by copperas and the results are presented in Fig 1.

![Fig.1. (a) extract of Myrobalan (T. bellirica); (b) block-printed batik cloth after coloured by Myrobalan and mordanted by alum; and (c) block-printed batik cloth after coloured by Myrobalan and mordanted by copperas](image)

This study finds the difference on the colour of block-printed batik clothes after they were mordanted by alum (Fig.1b) and copperas (Fig. 1c). Copperas tends to form a darker colour on the cloth while alum forms a lighter colour. This indicates that frequency of soaking might not strongly influence the final colour, because the colour of Fig. 1b was resulted by repeatedly
immerse the cloth in Myrobala extract for twelve times, and only seven times immersion in Myrobala extract to form the colour of Fig 1c. Other study also reported that the use of aluminium sulphate and ferrous sulphate to mordant fabrics coloured by *Acacia nilotica* extract forms lighter and darker colours, respectively [16]. Moreover, the reaction between iron ion and tannic acid will results an iron-tannate complex which forms dark shades such as blue-black, green-black, brown, or grey [17]. This correspond to darker colours formed on fabrics coloured by *A. nilotica* and *T. bellirica* which were mordanted by copperas, as those plants contain tannin [16], [18].

Table 1. Colour difference of block-printed batik clothes coloured by Myrobalan and fixed by different mordants

<table>
<thead>
<tr>
<th>Mordants</th>
<th>∆L*</th>
<th>∆a*</th>
<th>∆b*</th>
<th>∆E*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alum (Aluminium sulphate)</td>
<td>25.40</td>
<td>2.59</td>
<td>19.54</td>
<td>32.15</td>
</tr>
<tr>
<td>Copperas (Ferrous sulphate)</td>
<td>15.64</td>
<td>1.06</td>
<td>2.76</td>
<td>15.92</td>
</tr>
</tbody>
</table>

Table 1 shows the colour difference of block-printed batik clothes mordanted by alum and copperas. It is indicated by the ∆E value that the colour difference is higher on alum than that of copperas, and this is influenced mostly by ∆L* and ∆b* values. The L* value refers to lightness of the sample (Magdći et al., 2009). Therefore, higher L* value means higher colour lightness and this is indicated visually as the colour of Myrobalan extract (Fig. 1a) is darker than the clothes mordanted by alum (Fig 1b). The positive b* value indicates tendency to form bright yellowish tone, while the negative refers to blue colour [14], [15]. High value of ∆b* therefore, indicates a yellow colour, and visually this is in line to the result presented in Fig. 1b, while lower value of ∆b* presented by copperas mordanted-cloth (Fig. 1c) tends to indicate a darker yellowish shade. Visually, the colour of Myrobalan extract (Fig.1a) and copperas mordanted-cloth (Fig 1c.) tend to be more similar than that of alum mordanted-cloth.

3.2 Material usage for block-printed batik production

Table 2 presents materials usage to produce a block-printed batik of 2.00 m x 1.50 m size. In general, the water absorbed per m² and the wax attached onto the cloth mordanted by alum and copperas were similar. It is only the natural dye absorbed by the cloth which indicates the difference between alum and copperas treatment. As indicated in Table 2, the copperas mordanted-cloth absorbed 16.20 g/m² Myrobalan dye, and 25.00 g/m² of Myrobalan dye was absorbed by the alum mordanted-cloth, and this difference could be related to the frequency of immersion.

Table 2. The materials used to produce a block-printed batik coloured by Myrobalan

<table>
<thead>
<tr>
<th>Mordants</th>
<th>Wax (g/m²)</th>
<th>Myrobalan dye (g/m²)</th>
<th>Water (L/m²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alum (Aluminium sulphate)</td>
<td>208.33</td>
<td>25.00</td>
<td>0.23</td>
</tr>
<tr>
<td>Copperas (Ferrous sulphate)</td>
<td>211.67</td>
<td>16.20</td>
<td>0.22</td>
</tr>
</tbody>
</table>

In comparison to our previous study, hand-drawn batik which is produced by natural dyeing used 120 g dye, 430 g of wax, and absorb 0.29 L of water per pc of 1.15 m x 2.50 m fabric [13], which are equal to 41.74 g/m², 149.56 g/m², and 0.10 L/m² dye, wax, and water, respectively. This study found that the block-printed batik in this study used less dyes in
comparison to the hand-drawn batik, and this could be understood because this study only focused on a species of plant for dyeing, while the other batik SME used some species of plants in dyeing. In regard to the use of wax, the difference could be influenced by the motifs, i.e. full batik motifs tend to use more wax than the less ones. Finally, the difference in water absorption by the fabric may be influenced by the kind of the cotton fabric used. It is generally known among batik artisans that there is primissima cotton fabric and prima cotton fabric. The latter is thinner and of lower quality than the primissima. Primissima is usually used to make fine hand-drawn batik, while the block-printed batik is usually made on the prima fabric. The difference in the thickness of the fabric, which is corresponded to the yarn count, could affect the water volume absorbed by the fabric. It is reported that some processes of immersion, capillary sorption, adhesion, and spreading influence the wetting phenomenon of textile structures [19]. However, other study reported that yarn count affected the wetting rate of the fabric. When thin and thick fabrics of the same type of material were compared, the thinner wets faster than the thicker ones when equal amounts of water are applied [20]. This could be the reason that the fabric used for this study absorbed more water than that of the previous study.

3.3 Blue Water Footprint of block-printed batik coloured by Myrobalan

Table 3 presents data on the water consumed during the production of block-printed batik. It is indicated by Table 3 that water was consumed in some steps of degumming, dyeing in turns with drying, dewaxing, and final drying. Similar to the previous result, the difference on water usage was found in the dyeing process, in which the water consumed by alum mordanted-cloth was higher than that of copperas mordanted-cloth. Therefore, this might affect the total volume of water consumed during batik production. Nevertheless, it is found that the BWF of block-printed batik of both alum and copperas were mostly similar, i.e. 156.48 – 158.70 L/pc of 2.00 x 1.15 m size or equal to 68.52 L/m² of batik cloth.

<table>
<thead>
<tr>
<th>Block-printed batik making-process</th>
<th>Unit</th>
<th>Water usage in a batik making-process by different mordants</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Alum (Aluminium sulphate)</td>
</tr>
<tr>
<td>Block-printing</td>
<td>L/pc</td>
<td>0.00</td>
</tr>
<tr>
<td>Degumming</td>
<td>L/pc</td>
<td>0.46</td>
</tr>
<tr>
<td>Dyeing</td>
<td>L/pc</td>
<td>4.12</td>
</tr>
<tr>
<td>Dewaxing</td>
<td>L/pc</td>
<td>153.89</td>
</tr>
<tr>
<td>Final drying</td>
<td>L/pc</td>
<td>0.23</td>
</tr>
<tr>
<td>Total Blue Water Footprint</td>
<td></td>
<td>158.70</td>
</tr>
<tr>
<td>Total Blue Water Footprint</td>
<td>L/m²</td>
<td>69.00</td>
</tr>
</tbody>
</table>

In comparison to other study, this result is higher than the water consumed for block-printed batik production in Pekalongan which is reported to be 5 L/m output – 8 L/m output [8]. Another study reported that after introduction of eco-efficiency, the water consumed for block-printed batik production in Pekalongan could reach 1.09 L/pc (dyeing), 22.5 L/pc (dewaxing), and 37.5 L/pc (washing) or 61.09 L/pc in total [9]. The result of this study is much
lower than our results, and this is possible because of the different approach we use for this study. Our result is also much higher than other study which found that in order to produce a block-printed batik of 2.75 x 1.75 m in size, 6.41 L/pc water is required [12]. In comparison to the benchmark of batik cloth, which is reported as 25 – 50 L/m of cloth [8], this result indicates that the home industry is inefficiently uses water.

This study also found that the highest component in Blue Water Footprint calculation falls to dewaxing process, which includes the water evaporates during boiling and the effluent derived from the dewaxing and washing which were usually discharged without treatment. It should be noted that the artisan was usually used two cubical tanks of (1) 58 cm in diameter and 30 cm height and (2) 56 cm in diameter and 40 cm height, respectively. The artisan will use these tanks for boiling the clothes whenever he needs to do this task, regardless the number of the clothes. Therefore, in this study, we do not divide the volume of water of the tanks to the number of clothes as doing so will resulting inaccurate calculation. Furthermore, the result of this study is in line to the finding of other study which indicates that 62.85% of water footprint of textile production in Bangladesh was derived from washing, dyeing, and finishing stage [21]. Nevertheless, it is also reported that Blue Water Footprint makes a 13.85% up of total Water Footprint in textile production, while the rest is made up by the Grey Water Footprint [21]. Another study in China showed that the GWF of China’s textile production could reach 62 Gm³/year, while the highest BWF was only 1.09 Gm³/year [22]. Therefore, in textile production, generally the Blue Water Footprint has a lower portion than the Grey Water Footprint.

Finally, this study indicates that the block-printed batik clothes were unsustainably produced. Efforts to promote awareness of batik artisans in order to increase the efficiency of water usage are central to reduce the water footprint. As systemic environmental problems are related to human behaviour, clean technology is necessary for sustainability while lifestyle changes and human values is the key to protect and preserve the resource [23]. Moreover, treating water effluent and cleaner production are two options which could be implemented in order to reduce the water footprint [24].

4 Conclusion

The Blue Water Footprint of block-printed batik coloured by Myrobalan (T. bellirica Roxb.) extract of both treatments were nearly similar, i.e. 156.48 – 158.70 L/pc of 2.00 m x 1.15 m, or equal to 68.52 L/m², on average. The dewaxing process makes the biggest portion of the Blue Water Footprint. Nevertheless, this study has a limitation as it is not intended for generalization purpose. Future works highlights the need to increase the efficiency of water use by transforming the behaviour of batik artisan, as well as water effluent treatment and implementation of cleaner production.

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References


People Acceptance of Rainwater Harvesting In Fisheries Settlement Coastal Area, North Jakarta

A Hargianintya1, H S Hasibuan2, S S Moersidik3
{nirahargi@gmail.com1, hayati.hasibuan@ui.ac.id2, ssarwanto@eng.ui.ac.id3}

School of Environmental Science, Universitas Indonesia, Indonesia
Department of Environmental Engineering, Faculty of Engineering, Universitas Indonesia, Indonesia

Abstract. Muara Angke Fisheries Settlement Area, North Jakarta is a region that potential to experience water scarcity caused by limited water piped network and accompanied by poor groundwater quality due to seawater intrusion. In this situation, rainwater can be an alternative water source to meet household water needs. However, the implementation of Rainwater Harvesting (RWH) in hamlets 22, Muara Angke has not been a priority. Hence, this study aims to assess the acceptance of residents on RWH, their willingness to participate in implementing RWH, and the challenges of installing and maintaining RWH. The study uses the Multi-Dimensional Scaling (MDS) method with social, economic, and environmental aspects. The social aspect consists of 3 indicators: social capital, education, and government support. The economic aspect consists of 3 indicators: income, maintenance cost, and saving. The environmental aspect consists of 3 indicators: the quality, the quantity, and the continuity of rainwater. Data collection in this study involved 93 questionnaires which distributed after socialization of the RWH program and its benefit to the residents. This study analyzes the local people acceptance after socialization the RWH program and benefit to the residents. Results showed that education, social capital, government support, income, maintenance costs, saving, and 3 aspects of rainwater were statistically significant in explaining local resident acceptance of RWH in the study area. The people acceptance of RWH after socialization was change compared to before the socialization.

Keywords: Rainwater Harvesting, people acceptance, Coastal Area, Community Access

1. Introduction

The coastal area is one of the areas in Indonesia that has a high potential to experience water scarcity. Limitation of water supply, salinity, poor groundwater quality, drought, and groundwater depletion are major difficulties for people to get safe water source. Areas near coastlines with large populations can experience saltwater intrusion due to over groundwater exploitation [1]. Also, tidal waves can flood wells, ponds, and pollute natural sources of freshwater [2]. As a result, this condition will lead to a series of consequences, including the
emergence of waterborne diseases, loss of livelihood security, and large-scale migration within and across borders [3].

Rainwater Harvesting (RWH) is considered to be a solution to overcome water scarcity in coastal areas. Akter and Ahmed [4] studied the potential of RWH in the urban community of Agrabad Chittagong, Bangladesh. Their study revealed that the RWH allows rainwater to increase clean water by 20 liters/person/day throughout the year. A similar study by Campisano et al. [5] shows that the application of RWH has high annual water savings of 30%-50%. If people use the Rainwater Harvesting (RWH) widely, it will have several benefits, such as: overcoming drought, reducing soil erosion, reducing the risk of flooding, increasing groundwater supply, and economical water supply alternatives [6].

Despite abundant benefits to collect rainfall, utilization of rainwater itself is still not optimal even though Indonesia has high rainfall instead [7]. According to Oweis in Shalamzari [8], the main reasons people do not want to use RWH are the role of local government, cost, and system incompatibility with user needs. To achieve the sustainability of RWH, the local people should involve in the planning and development process. For this reason, people perception and acceptance are the critical basis for sustainability of RWH.

This study provides an overview of people acceptance of Rainwater Harvesting (RWH) in fisheries settlement, Muara Angke, North Jakarta. Currently, the local people of Muara Angke have to buy clean water from a local mobile vendor and pay for groundwater usage. People expenditure to purchase clean water is IDR 200.000 – IDR 1.600.000 every month. According to actual conditions, RWH seems to be a beneficial method for meeting the water needs of the resident in fisheries settlement, Muara Angke. However, the application of RWH in this region has not been a priority. This study aims to assess the acceptance of resident on RWH, their willingness to participate in implementing RWH, and the challenges on installing and maintaining RWH.

2. Research Methods

2.1 Study Area

The study conducted in a small fisheries settlement area (Rukun Warga (RW) or Hamlet 22) in Muara Angke, North Jakarta. The description of the location and administrative boundaries of Muara Angke is presented in Figure 1. This area can be used to represent the condition in many coastal areas that have the potential to experience water scarcity.
2.2 Methodology

The following methodology was followed to conduct the study:

a. Preparing an initial survey
b. Conducting Forum Group Discussion (FGD) and interviews with community representatives and local government (head of Pluit area, head of RW/hamlets 22 and all neighborhood leader)
c. Conducting socialization and distributing questionnaires that have been developed regarding the initial survey and FGD
d. Processing data and analysis

In this study, respondents are the inhabitants in RW/hamlet 22, Muara Angke, North Jakarta. A total of 93 respondents interviewed. This study used primary data obtained from the questionnaire. The distribution of the questionnaires was carried out after socialization on August 30, 2019. Data processing was used Multidimensional Scaling (MDS) method with SPSS 20. The data consists of 3 aspects: Social, Environment, and Economic aspects. Social aspects consist of 3 indicators: participation, social capital, and government support. Environmental aspects consist of 3 indicators: the quality, the quantity, and the continuity of rainwater. Economic aspects consist of 3 indicators: ability to pay, maintenance cost, and saving. In this study, questionnaires analysis using Likert scoring technique that provides five alternative answers: strongly agree (score:5), agree (score:4), undecided (score:3), disagree (score:2), and strongly disagree (score:1).

3. Result and Discussion

3.1 General Profile of Respondent

The average age of the respondents was in the age group 36-45 years (38%), and 32% of the respondents were in the group 26-35 years (32%) (Figure 2.a). The range of age population
shows that the community was productive, potential, and active. Overall there were more females (82%) than there were males (18%) (Figure 2.b).

According to data from Fisheries Integrated Service Unit 2019, the population density in Muara Angke reaches 474,03 people per square kilometre (very densely populated). The house and neighborhood condition is very tight (Figure 3).

Fig. 2. Proportion Age and Sex
(a) Age, (b) Sex

Fig. 3. The House Conditions
It was observed from the field survey that about 57% of people can only complete education up to elementary school, 29% of respondent can complete up to junior high school, and only 1% of respondent can complete up to diploma (Figure 4.a). This data shows that the majority of the respondent in Muara Angke has a final education in elementary school. The distribution of occupation of the household is presented in Figure 4.b. The occupation of the majority of the respondent is housewife (74%).

![Fig. 4. Proportion of Education and Occupation](image)

It has been found from the survey that most of the respondents (43%) earned between IDR 1,100,000 to IDR 2,000,000 per month and 24% respondents earned between IDR 2,100,000 to IDR 3,000,000 per month (Figure 5.a). Income groups of IDR 3,100,000 – IDR 4,000,000 (8%) and IDR 4,100,000 – IDR 6,000,000 (1%) represent the lowest percentage of income level groups. Figure 5.b shows that most of the respondents’ annual expenditure to buy water is around IDR 200,000 – IDR 500,000 (70%) every month.

![Fig. 5. Proportion of income and Water Cost](image)

Overall, the average expenditure to buy water in a month is IDR 482,183 or 23% of the respondents’ average income (IDR 2,056,989). This shows that the population does not have good access to clean water. Good access to clean water can be realized if at least the expenditure of water can be reached less than 10% of total household income [9]. Most people in the study area pay well water to the owners, buy a tank and or gallon water from a local vendor to fulfill their water needs (Figure 6).
3.2 Acceptance of Rainwater Harvesting (RWH)

Based on the result of initial survey (July 12, 2019) and the distribution of questionnaires to 19 residents, 15 residents of Muara Angke claimed to have known about RWH, while four residents did not know anything about RWH. However, residents who already know about rainwater harvesting did not have the willingness to adopt and use it. Due to economic reason (expensive initial investment) and due to perception of the quality of rainwater that is not good when it’s compared with the other water sources.

The result from Forum Group Discussion (FGD) (July 26, 2019) and Socialization (August 30, 2019) were representative of Muara Angke residents, majority of residents and the local government strongly supporting the adoption of RWH in Muara Angke area (Figure 7). Rainwater Harvesting can be an alternative of water source for residents.
Rainwater Harvesting is the technique through which rainwater is captured from roof catchment and stored in tanks/reservoirs/groundwater aquifers [10]. According to Worm dan Hattum [11], there are three basic components in rainwater harvesting: catchment/rainwater collection facilities (roof); delivery system, and storage (Figure 8). The obstacle to adoption RWH in this area are residents need to prepare a substantial initial investment fund and residents need to provide land for water storage tanks in their area.

Based on the results of processing MDS analysis, stimulus coordinates are obtained from each indicator shown in Table 1.
Table 1. Stimulus Coordinates on each indicator

<table>
<thead>
<tr>
<th>Stimulus Number</th>
<th>Stimulus Name</th>
<th>Dimension 1</th>
<th>Dimension 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Participation</td>
<td>0.8024</td>
<td>-0.7641</td>
</tr>
<tr>
<td>2</td>
<td>Social Capital</td>
<td>0.7813</td>
<td>0.4233</td>
</tr>
<tr>
<td>3</td>
<td>Government Support</td>
<td>1.6292</td>
<td>0.0292</td>
</tr>
<tr>
<td>4</td>
<td>Quality of Rainwater</td>
<td>0.3526</td>
<td>-1.0508</td>
</tr>
<tr>
<td>5</td>
<td>Quantity of Rainwater</td>
<td>-2.2704</td>
<td>-0.4593</td>
</tr>
<tr>
<td>6</td>
<td>Continuity of Rainwater</td>
<td>0.7395</td>
<td>0.4907</td>
</tr>
<tr>
<td>7</td>
<td>Ability to Pay</td>
<td>-1.7725</td>
<td>1.1029</td>
</tr>
<tr>
<td>8</td>
<td>Maintenance Costs</td>
<td>-0.9998</td>
<td>0.0202</td>
</tr>
<tr>
<td>9</td>
<td>Saving</td>
<td>0.7377</td>
<td>0.2078</td>
</tr>
</tbody>
</table>

Based on the coordinates of the table above, a position map of each indicator can be generated with the configuration shown in Figure 9.

Fig. 9. Perceptual Map each Indicator

It can be seen that perception of people acceptance on continuity of rainwater, social capital, saving, and government support has similarities because located close together and in the same quadrant I. Perception of people acceptance on participation and quality of rainwater also have similarities because located close together and in the same quadrant IV. While the ability to pay, maintenance cost, and quantity of rainwater were located far apart from one another, in other words, the perception of people acceptance of these three indicators is different and dissimilar with other indicators.

In order to see the perception of people acceptance of RWH after socialization, questionnaires were distributed, and 93 respondents had answered the questionnaires. The average scoring results are shown in Figure 10.
In the Social Aspect, Indicators of participation (average score: 4.2), social capital (4.3) and government support (average score; 4.3) have almost the same average value (above 4.0). From the environmental aspect, continuity of rainwater has the highest average score (4.1), the followed by quality of rainwater (average score: 3.8) and quantity of rainwater (average score: 3.8). The economic aspect shows that only the saving indicator has an average score above 4.0. Indicators of Maintenance cost (average score: 3.9) and ability to pay (average score: 3.9).

**Table 2. Perception Level Range**

<table>
<thead>
<tr>
<th>Perception</th>
<th>Range Average Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>Very good</td>
<td>4.2-5.0</td>
</tr>
<tr>
<td>good</td>
<td>3.4-4.2</td>
</tr>
<tr>
<td>Average</td>
<td>2.6-3.4</td>
</tr>
<tr>
<td>Fair</td>
<td>1.8-2.6</td>
</tr>
<tr>
<td>Poor</td>
<td>1.0-1.8</td>
</tr>
</tbody>
</table>

Based on the average value of scoring results, 7 from 9 indicators (participation, quality of rainwater, quantity of rainwater, continuity of rainwater, ability to pay, maintenance cost, and saving) belong to the level “good” perception and 2 other indicators (social capital and government support) belong to the level “very good” perception (Table 2.). However, some respondents have “average” level of perception on the indicators: quantity of rainwater (30%), ability to pay (26%), and maintenance costs (23%).

### 3.3 Discussion

The impacts of the phenomenon of climate change greatly affect people’s livelihoods as a fisherman in the coastal area [12]. The water demand in the coastal settlement will higher every time. This is because population growth is rise rapidly every year, so the need for settlement is intensifying [12]. The coastal area has its carrying capacity, including for water supply resources. Prevention of physical, ecological, economic, and socio-cultural degradation in coastal areas requires the concept of coastal carrying capacity, so that later it can determine how
well the quality of coastal area users is based on natural, cultural, and location resources [13] Successful implementation of rainwater harvesting requires cooperation from all parties in society. Research conducted by Karim [14] In Bangladesh, revealed that community perception of RWH was perfect as the primary source of drinking and cooking. The community stated that the rainwater in their area has satisfactory water quality. According to Asmuni [15], the community already has good knowledge and perceptions on RWH. However, the main reason underlying them to implement RWH is if it can reduce their household water bills. Barthwal [16] found that most respondents in Dehradun, India, were aware of the importance of adopting the RWH for their households. However, income, awareness, government policies, and incentives are the determining factors for RWH implementation at the household level.

4. Conclusion

The people acceptance of rainwater harvesting systems in fisheries settlement coastal area Muara Angke, North Jakarta was assessed through a questionnaire survey. It reveals from the study that there was a change in people perception before and after socialization. The people perception toward RWH became better after socialization, especially on indicators of ability to pay and quality of rainwater. However, it should be noted that there are respondents who have “average” perception of three indicators: ability to pay (26%), maintenance cost (23%), and quantity of rainwater (30%).

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Using Nemerow’s Pollution Index Method for Water Quality Assessment of Cimanuk River in West Java

Ihya Sulthonuddin¹, Djoko Mulyo Hartono², Chairil Abdin Abidin Said¹
{ihya.sulthonuddin@ui.ac.id¹, djokomh@eng.ui.ac.id², cabdini@gmail.com¹}

¹Environmental Science Study Program, School of Environmental Science, Universitas Indonesia, Jakarta, Jakarta, Indonesia, 10340
²Environmental Engineering Study Program, Faculty of Engineering, Universitas Indonesia, Depok, West Java, Indonesia, 16424

Abstract. The river water is one of the water resources that important in managing environmental sustainability, increasing economic growth, and realizing the social welfare of communities. This study aims to assess and analyze water quality of the Cimanuk river. The analyze of water quality in the Cimanuk river based on the Regulation of Governor of West Java (GWJ) Class 1, United Kingdom Technical Advisory Group (UKTAG), United States Environmental Protection Agency (USEPA), Ministry of Environmental Government Japan (MOEG), and Departement of Environmental Malaysia (DOE). Nemerow’s pollution index (NPI) method used to assess the water in the Cimanuk river from the years 2013 to 2018. River water sampling stations of the Cimanuk river are Boyongbong, Sukaregang, Tomo, and Jatibarang. Base on seven physicochemical parameters, this research found that the Cimanuk river is not meet the water quality standards with the value of TSS (81.57 ± 132.69 mg/L), BOD (8.41 ± 6.53 mg/L), COD (33.92 ± 26.51 mg/L), DO (5.54 ± 1.67 mg/L), and Ammonia (0.21 ± 0.31 mg/L). The degradation of river water quality in the Cimanuk river indicated by increasing NPI value. NPI value of the Cimanuk river ranging from 1.04 to 7.51. The water quality status of the Cimanuk river has been changing from slightly to moderately polluted. Nowadays, water from the Cimanuk river not suitable to be used as a drinking water source. However, it is still feasible to irrigate agricultural land and plantations.

Keywords: Cimanuk river, Nemerow’s pollution index, Water quality assessment.

1 Introduction

The river water is one of the water resources that important in managing environmental sustainability, increasing economic growth, and realizing the social welfare of communities. That is the function as a source of raw water for drinking water, clean water, environmental conservation, agricultural, fisheries, livestock, and others. Based on Environment Statistics of Indonesia in 2018, the rivers water quality in Indonesia are 46% highly polluted, 32% moderately to highly polluted, 14% moderately polluted, 8% slightly to moderately polluted, and no one river meet the water quality standards [1]. And four of the seven rivers in West Java liked the Citarum river [2], the Ciliwung river [3], the Cisadane river, and the Citanduy river highly polluted [1]. Some studies also show the Cilamaya river [2], the Cileungsi river [4], and the Cimanuk river [5] highly polluted. And actually, the seven rivers in West Java used as raw water for drinking water in the Regional Drinking Water Company (PDAM).
The river water pollution that occurs a lot in rivers is one of the environmental problems and important issues need to get serious action from the government (central and regional) and various parties, academics, researchers, the local communities, the private sector, and other stakeholders [5]. If linked to the Sustainable Development Goals (SDGs), the issue of river water pollution in West Java is important because it is closely related to the goal number 6 of SDGs, that in 2030 can ensure the availability, managing sustainable clean water and sanitation, improve the river water quality, and reduce the river water pollution. The river water pollution in the Cimanuk river are the weakness to the availability of clean water and the threat to the sustainability of water resources in West Java. So, to address these issues, this research aims to assess and analyze water quality of the Cimanuk river in West Java.

2 Methods

2.1 Water sampling stations

The water sampling stations of the Cimanuk river are at Boyongbong, Sukaregang, Tomo, and Jatibarang in West Java (Table 1).

<table>
<thead>
<tr>
<th>Segments</th>
<th>Sampling stations</th>
<th>Koordinates</th>
<th>Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Upstream</td>
<td>Boyongbong</td>
<td>107° 49' 33.6&quot; E 07° 15' 56.1&quot; S</td>
<td>Garut</td>
</tr>
<tr>
<td>Upstream</td>
<td>Sukaregang</td>
<td>107° 54' 33.3&quot; E 07° 11' 39.4&quot; S</td>
<td>Sumedang</td>
</tr>
<tr>
<td>Midstream</td>
<td>Tomo</td>
<td>108° 08' 03.1&quot; E 06° 45' 43.1&quot; S</td>
<td>Majalengka</td>
</tr>
<tr>
<td>Downstream</td>
<td>Jatibarang</td>
<td>108° 17' 45.6&quot; E 06° 28' 07.0&quot; S</td>
<td>Indramayu</td>
</tr>
</tbody>
</table>

2.2 Water quality analysis

The water quality analysis of the Cimanuk river based on the seven physicochemical parameters, Temperature, Total Suspended Solid (TSS), pH, Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolves Oxygen (DO), and Ammonia. The water quality of the Cimanuk river from years 2013 to 2018 obtained by comparing the test results with the water quality standards of Regulation of the Governor of West Java (GWJ) Class 1 [5][6]; United Kingdom Technical Advisory Group, Water Framework Directive (UKTAG) [7]; United States Environmental Protection Agency, Water Quality Standards for Surface Waters (USEPA) [8][9]; Ministry of Environmental Government Japan, Environmental Quality Standard for Water (MOEG) [10]; and Departement of Environmental Malaysia, National Water Quality Standards for Malaysia (DOE) [11] (Table 2).

<table>
<thead>
<tr>
<th>Physical parameters</th>
<th>Unit</th>
<th>GWJ</th>
<th>UKTAG</th>
<th>USEPA</th>
<th>MOEG</th>
<th>DOE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>25±3</td>
<td>25±3</td>
<td>25±3</td>
<td>25±3</td>
<td>25±3</td>
</tr>
<tr>
<td>Total Suspended Solid (TSS)</td>
<td>mg/L</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>50</td>
<td>25</td>
</tr>
<tr>
<td>Chemical pH</td>
<td>-</td>
<td>6.0-9.0</td>
<td>6.5-8.5</td>
<td>5.5-8.5</td>
<td>6.5-8.5</td>
<td>6.5-8.5</td>
</tr>
<tr>
<td>Chemical Oxygen Demand (COD)</td>
<td>mg/L</td>
<td>10</td>
<td>4</td>
<td>25</td>
<td>10</td>
<td>10</td>
</tr>
<tr>
<td>Biochemical Oxygen Demand (BOD)</td>
<td>mg/L</td>
<td>2</td>
<td>3</td>
<td>5</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Dissolves Oxygen (DO)</td>
<td>mg/L</td>
<td>6</td>
<td>7</td>
<td>8.5</td>
<td>7.5</td>
<td>7</td>
</tr>
<tr>
<td>Ammonia</td>
<td>mg/L</td>
<td>0.1</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
<td>0.5</td>
</tr>
</tbody>
</table>
2.3 Nemerow’s pollution index

The water quality status of the Cimanuk river assessed by Nemerow’s pollution index method based on the Decree of the Minister of Environment of Republic Indonesia Number 115/2003 concerning the Water Quality Status [12][13][14][15] and the United States Environmental Protection Agency (USEPA) [16][17][18]. Nemerow’s pollution index calculated by the following formula.

$$NPI_j = \sqrt{\frac{(C_i/L_{ij})^2}{M} + \frac{(C_i/L_{ij})^2}{R}}$$

Where: $NPI_j$ is Nemerow’s pollution index for a specified river water quality purpose $(j)$, $L_{ij}$ is standard water quality parameter for each parameter at specified river water quality purpose $(j)$, $C_i$ is measured river water quality parameters, $(C_i/L_{ij})M$ is $C_i/L_{ij}$ maximum, and $(C_i/L_{ij})R$ is $C_i/L_{ij}$ average. $NPI_j$ was then compared with the criteria of water quality status shown in Table 3.

<table>
<thead>
<tr>
<th>Nemerow’s pollution index</th>
<th>Water quality status</th>
</tr>
</thead>
<tbody>
<tr>
<td>$0.0 \leq NPI_j \leq 1.0$</td>
<td>Meet water quality standards</td>
</tr>
<tr>
<td>$1.0 \leq NPI_j \leq 5.0$</td>
<td>Slightly polluted</td>
</tr>
<tr>
<td>$5.0 \leq NPI_j \leq 10.0$</td>
<td>Moderately polluted</td>
</tr>
<tr>
<td>$NPI_j \geq 10.0$</td>
<td>Highly polluted</td>
</tr>
</tbody>
</table>

3 Results and Discussion

The Cimanuk river is the second-longest river in West Java with the river flow length 180 Km. The Cimanuk river rainfall average between 1,500 to 3,000 millimeters per year and 347,697 ha watershed area (Figure 1). The Cimanuk watershed divided into three segments or sub-watershed. (1) The Cimanuk upstream has an area 145,677 ha in Sumedang and Garut District. (2) The Cimanuk midstream has an area of 114,477 ha in Majalengka and Sumedang District. And (3) The Cimanuk downstream has an area of 81,299 ha in Indramayu District. The Cimanuk river is a water supply center river to Waduk Jatigede for irrigate agricultural land and PLTA in West Java. The Cimanuk river functions as a water resource used for raw water sources in 4 Regional Water Supply Companies (PDAM) such as “Tirta Intan Garut“, “Tirta Medal Sumedang“, “Tirta Darma Majalengka“, and “Tirta Darma Ayu Indramayu“ to support community activities. However, community activities (such as domestic, agricultural, livestock, and industrial waste disposal activities) that are uncontrolled at the Cimanuk river (from upstream to downstream) indicated to decreased the river water quality and increased the river water pollution [19]. Therefore, the river water quality in the Cimanuk river must be monitored by its river water quality, maintained by the availability of its water resources, controlled for its pollution level, and managed for its environmental sustainability.

Efforts to control the water pollution of the Cimanuk river by the regional government and related agencies have not been implemented properly. All of that, if not carried out the management of river water quality and control of river water pollution will result in highly polluted rivers and reduced availability of clean water and threaten the sustainability of the Cimanuk river. The Cimanuk river is not one of the government priority rivers for rehabilitation yet, but it would be the regional government priority in West Java to conserve it.
Based on data reported by the Environment Agency of West Java Province, most of the river water pollution in the Cimanuk river originates from domestic and small and medium-sized industrial waste disposal activities (Figure 2). Water quality management and control of Cimanuk River water pollution have been carried out by several government agencies or institutions such as Environmental Agency of West Java Province (DLH); The Cimanuk-Cisanggarung River Basin (BBWS Cimanuk-Cisanggarung); and Regional Task Implementing Unit of Cimanuk-Cisanggarung River Basin Management Agency (BPSDA Cimanuk-Cisanggarung).
Over the last six years (from 2013 to 2018), the test result of river water quality in the Cimanuk river has been declining dramatically. The river water quality of the Cimanuk river shown in Figure 3. Based on Figure 3, temperature and pH are the only parameters that meet the water quality standards (Figure 3.a and Figure 3.c) where the value of Temperature (from 19 to 32.70°C) and pH (from 5.80 to 11). On the other hand, parameters TSS, BOD, COD, DO, and Ammonia does not meet the water quality standards with the following values of TSS (from 2 to 892 mg/L), BOD (from 2 to 38 mg/L), COD (from 4 to 156 mg/L), DO (from 08 to 8 mg/L), and Ammonia (from 0.01 to 2 mg/L). Based on Figure 3.h, Nemerow’s pollution index of the Cimanuk river decreased annually from 2013 to 2018, but increased annually from Boyongbong (as upstream) to Jatibarang (as downstream).

The average NPI value of the Cimanuk river is 2.78±1.44 indicating moderately polluted (Figure 3.h). The highest NPI value the occurred in 2014 at Jatibarang based on the MOEG is 7.51 indicating the Cimanuk river downstream moderately polluted. The lowest NPI value the occurred in 2018 at Tomo based on the USEPA is 0.81 indicating the Cimanuk river midstream still meet the water quality standards. And the NPI value of the Cimanuk river base on GWJ (from 1.13 to 5.52), USEPA (from 1.09 to 3.51), UKTAG (from 1.04 to 6.51), MOEG (from 1.16 to 7.51), and DOE (from 1.13 to 7.39). Specifically, the NPI value base on the sampling station at Boyongbong (from 1.34 to 2.94), Sukaregang (from 1.74 to 5.52), Tomo (from 1.04 to 4.49), and Jatibarang (from 1.19 to 7.51).

The highest NPI value of the Cimanuk river is 7.51 in Jatibarang which means highly polluted. The high NPI value in Jatibarang because there are many uncontrollable waste disposal from domestic waste, fish crackers industries, batik industries, regional public hospital, agricultural, livestock, traditional and modern market waste along the Cimanuk River downstream. And many fish cracker industries and batik industries in the Cimanuk river downstream (Jatibarang, Indramayu District) I not yet wastewater treatment plant (WWTP).
**Fig. 3.** River water quality of the Cimanuk river (a) Temperature, (b) TSS, (c) pH, (d) BOD, (e) COD, (f) DO, (g) Ammonia, and (h) Nemerow’s pollution index.
Based on the results, TSS, BOD, COD, and Ammonia parameters are parameters that often increased the NPI value in the Cimanuk river. The highest NPI value based on TSS parameters (26.69) occurred in 2014 in Jatibarang which indicated the Cimanuk river downstream highly polluted. The highest NPI value based on BOD parameters (29.34), COD (29.98), and Ammonia (10.61) occurred in 2013 in Sukaregang which indicates that the Cimanuk river upstream highly polluted. The parameters that most influence the NPI value in the Cimanuk river downstream (Jatibarang) are TTS, BOD, COD, and Ammonia parameters. Based on the test results, the highest NPI value based on TSS parameters (26.69), BOD (18.39), and COD (18.89) occurred in 2014, indicating the Cimanuk river downstream was highly polluted. In 2018, there are no significant parameters that increase the NPI value to be highly polluted. Most of the NPI values in 2018 indicated the Cimanuk river slightly polluted (Figure 4).

Figure 4. shows that 88% of the water quality status of the Cimanuk river (from upstream to downstream) slightly polluted. The condition of the Cimanuk river (from upstream to downstream) poor. The water quality status of the Cimanuk river (from upstream to downstream) slightly to moderate polluted. Base on these results, the water from the Cimanuk river not suitable to be used as a drinking water source. However, it is still feasible to irrigate agricultural land and plantations. The water from the Cimanuk river can feasible to use as a source of raw water but more the water treatment and the high cost needed to produce clean water in the the Regional Drinking Water Company (PDAM). River water quality assessment of the Cimanuk river carried out as an effort to manage and control the water quality of the Cimanuk river so that the river can be harnessed and can be used to their usefulness. In this study, an increase in collaboration between regional government (Environmental Agency (DLH), Spatial and Urban Planning Agency (DTRW)), local communities, and private sectors needed to conserve and preserve the Cimanuk river.

The recommended of water pollution control strategy for the Cimanuk river management is a progressive growth strategy, which is to implement policies by (a) improving the water
pollution control infrastructure of the Cimanuk river (from Boyongbong to Jatibarang) through the establishment of integrated waste management and communal (WWTP), (b) increasing roles and participation of academics, researchers, and community groups in every activity of planning and implementing water pollution control in the Cimanuk river, and (c) increasing the coordination of government agencies/institutions with various parties in determining water pollution control policies in the Cimanuk river.

4 Conclusions

The water from the Cimanuk river not meet the water quality standards of Regulation of the Governor of West Java (GWJ) Class I; United Kingdom Technical Advisory Group, Water Framework Directive (UKTAG); United States Environmental Protection Agency, Water Quality Standards for Surface Waters (USEPA); Ministry of Environmental Government Japan, Environmental Quality Standard for Water (MOEG); and Department of Environmental Malaysia, National Water Quality Standards for Malaysia (DOE). Nemerow’s pollution index (NPI) of the Cimanuk river ranging from 1.04 to 7.51 (slightly polluted to moderately polluted). The water quality status of the Cimanuk river changing from slightly polluted to moderately polluted. Nowadays, the water from the Cimanuk river not suitable to be used as a drinking water source. However, it is still feasible to irrigate agricultural land, fisheries, and plantations.

Reference


Customary Law Aspect on the Role of Religious Judge in the Case of Divorce

Nur Mohamad Kasim
nurkasim@ung.ac.id
Universitas Negeri Gorontalo, Gorontalo, Indonesia

Abstract. Background. Marriage is a formal tie between man and wife to establish a family. It is founded based on state and religious laws, thus it may cause legal events, such as divorce. This study aims at studying the role of a judge in inspecting the divorce case through the aspect of customary law in Gorontalo. Methods. The researcher uses a descriptive method of analysis with a sociolinguistic and legal anthropological approach to see the influence of grammar and development of Gorontalonese culture in utilizing religious judge to solve the divorce case. Results and discussion. This study shows that the judge can utilize cultural approach in the context of customary law to investigate divorce case, through either sociolinguistic interaction or interpersonal emotional ways. Both cultural approaches enable stakeholders to discuss household problems; thus, it made possible for involved parties to change their minds based on their interpersonal interaction with the judge.

Keywords: Customary Law Aspect, Divorce, Religious Judge

1 Introduction

Indonesia is a legal state as the state aims at creating an orderly and prosperous state and community. The context of a legal state is grounded on Pancasila and the 1945 Constitution (hereinafter will be referred to as UUD 1945) as the highest source of law in this republic. UUD 1945 also serves as the unifier of its state and community, as Indonesia is the most culturally diverse nation.

Particularly, a community is arranged in the smallest social structure namely family, which consists of husband and wife. This smallest structure of the community is legally bounded by marriage. “Marriage is a formal tie between man and wife to establish a happy and eternal family, which is based on One Supreme God” [1].

The marriage bond is a relationship founded based on state and religious laws. Therefore, it may cause legal events, such as disintegration of the relationship between man and wife due to various factors. Factors, such as wife’s disobedience toward the husband, or husband’s violence or infidelity toward the wife, as well as other causes such as education, economic, ethics, moral, absence of harmony and responsibility can lead to disputes and can lead to divorce.

Ongoing disputes between husband and wife dominate the causes of divorce cases in Familial Courts in Gorontalo. Those cases often reach appeal and supreme courts.

The number of divorce cases is steadily increasing. Based on the data from 2013-2016, there are 2,575 divorce cases out reported at the Familial Court of Gorontalo.
(Pengadilan Agama Gorontalo, 2016). From this figure, it is known that the divorce cases increased by 50% annually.

![Graph showing increase in divorce cases](image)

**Fig. 1.** Divorce Case Granted by The Familial Court of Gorontalo

Common awareness, especially in divorce cases, is needed. This is because the case has been bad precedence for familial courts in Indonesia. The familial court should be an institution that helps this nation to develop and able to professionally solve divorce cases. The professionalism of the institution not only lays on how they solve a marriage relationship but also on how they mediate a disputing husband and wife. This authority lays on the familial court judges.

Regardless to the fact that most of the solution for divorce cases in the familial court ends up with a divorce, it cannot undermine the judges’ effort to make peace between the disputing parties as part of the case-solving mechanism. Therefore, a familial court judge in solving a divorce case is demanded to be credible and to possess the ability to solve cases peacefully without having to end a marriage relationship. A judge ability is not only on his or her professionalism but also in their ability to involve or make use of the local cultural aspect as an approach in solving a divorce case.

On this background, it is interesting to study the role of the judge in solving the divorce cases through Customary Law aspect in Gorontalo. In studying this aspect, the researcher uses a descriptive analysis method with sociolinguistic and legal anthropological approach to see the grammatical influence and cultural development of the Gorontalonese culture, which can be utilized by the familial court judge in solving the divorce case.

## 2 Methods

The researcher uses a descriptive method of analysis with a sociolinguistic and legal anthropological approach to see the influence of grammar and development of Gorontalonese culture in utilizing religious judge to solve the divorce case.
3  A Brief Study On Divorce

Before deciding to divorce, both the husband and wife shall think deeply of what will happen subsequently [2]. Therefore, during marriage, when there is no either spiritual or physical compatibility between them to create a harmonious family, then the procedure of divorce may be proposed to the court [3].

Marriage law stipulates equal rights for either the husband or wife to propose divorce. KHI (Kompilasi Hukum Islam, Compilation of Islamic Laws in Indonesia) Article 14 mentions that disintegrated marriage due to divorce may be caused by talaq or based on procedure of divorce. Divorce due to talaq or procedure of divorce is only validated if conducted in front of the Religious Court hearing [4].

Divorce happens due to various factors. Below are some popular reasons for divorce. The complexity of problems in Indonesian society has added the dynamic of people’s lives. As a result, life becomes more complex, and the burden of life and works have added to the stress level of people. These often become problems in marital lives as well.

In the modern era, every person is demanded to have not only a stable life but also to have a high level of socialization. These demands often become a problem in marital life. The most common problems in marital life are a financial problem. For instance, a working husband and wife have made it possible for the wife to have a larger income, and some of the financial burdens of that family has been the responsibility of the wife. As long as this is based on a common agreement, it should not be a problem. However, the husband often feels less dignified and does not want his role as the breadwinner for the family to be undermined by the wife. This can lead to problem or disputes that may lead to large disputes.

More complicated issue will appear when the husband is married with another woman within Islamic and customary legal traditions. It will deteriorate when the marriage ends up by having biological babies and when his divorce case from the previous marriage is judicially unfinished. More issues are about to rise then, when the wife from the second marriage (marrying within Islamic and customary legal traditions) divorces her sirri husband. She will unable to demand his responsibility and resolve it legally as only Islamic and customary legal marriage is considered a valid marriage. Moreover according to the Marriage Law Number 1 of 1974, invalid marriage will not be formally and judicially admitted [5].

Hurlock argues divorce constitutes a culmination of bad marriage customization. It occurs at the time the husband and wife cannot find any solution they cannot be satisfied with. The Law of the Republic of Indonesia Number 1 of 1994 Article 16 mentions divorce may happen when the interested husband and wife are impossibly united in a household. Meanwhile Article 18 mentions divorce is effective when the court has condemned it. Prior to the condemnation, the court will find attempts to unite the people, so divorce will take place when there is no attempt successful [6].

The second problem is marital adaptation. In this case, it is related to Indonesian culture that marital life often involves the husband and wife families. Some of the examples are the demand to have children or minimum frequency to visit family; these can trigger disputes that can endanger marriage. The third problem is that a husband or wife becomes too busy.

Divorce is the end of a marriage. Disputes often associate with unhappiness, spouse infidelity, or other problems in marriage; this may lead to a decision to divorce. Married couples often consider divorce as the final solution. Another reason for divorce is to teach spouse a lesson as a way out to end the misery in marriage. However, divorce is not always
solved problems in a marriage; some problems may still exist after divorce. Below are several major causes of divorce:

1. Communication failure
   Incompatibility due to communication failure between husband and wife often becomes the trigger for divorce. Lack of communication leads to lack of trust, understanding, and disputes. This will ultimately lead to divorce when both parties are unwilling or fail to make communication.

2. Infidelity
   Another main cause of divorce is spouse infidelity. The one being cheated on will feel hurt and unable to forgive and choose divorce as a solution. Sometimes, the cheating spouse often chooses to divorce his or her spouse for the new beau.

3. Domestic Violence
   Divorce due to domestic violence is also prominent. Many choose to save their lives through divorce rather than facing lifetime torture through marriage, either physically or mentally.

4. Economic Problems
   There are also divorce cases due to economic problems. Spouse is considered unable to fulfill the family needs. Hence, the spouse filed for divorce.

5. Early marriage
   Too young to get married made many young couples not ready to face various marriage challenges. Hence, divorce is considered a decision when facing a problem in a marriage.

6. Cultural changes
   Divorce was considered taboo. However, it has become a trend and even a lifestyle. Many spouses considered inconceivable disputes as a reason for a divorce. They rather decide to get divorced than saving their marriage.

The reasons for divorce as mentioned in Article 39 (2) or Law No. 1 of 1974 EW are as follows [1]:

1. One of the spouses, either husband or wife, commits adultery, a heavy drinker, a drug user, a gambler, and other things. Hence, it is hard to rehabilitate.
2. One of the spouses leaves his or her spouse for two consecutive years without any permit and without any legal reasons, or due to other things outside of his or her control.
3. One of the spouses is sentenced with five years of a prisoning sentence or other heavier sentence.
4. One of the spouses commits violence that endangers the spouse or another party.
5. One of the spouses is injured or become invalid or contract a disease that made him or her unable to carry out his or her function as husband and wife.
6. Constant disputes between husband and wife with no chances for reconciliation in marital life.

Compilation of Islamic Law (hereinafter will be referred to as KHI) in Article 116 has been explaining in detail several reasons as a basis for filing a divorce by adding two specific reasons as follow [7]:

1. One of the spouses, either husband or wife, commits adultery, a heavy drinker, a drug user, a gambler, and other things. Hence, it is hard to rehabilitate.
2. One of the spouses leaves his or her spouse for two consecutive years without any permit and without any legal reasons, or due to other things outside of his or her control.
3. One of the spouses is sentenced with five years of a prisoning sentence or other heavier sentence.
4. One of the spouses commits violence that endangers the spouse or another party.
5. One of the spouses is injured or become invalid or contract a disease that made him or her unable to carry out his or her function as husband and wife.
6. Constant disputes between husband and wife with no chances for reconciliation in marital life.
7. The husband violates the taklik talak (reasons for a talaq/divorce to happen).
8. Change of belief or denouncing Islam which made there is no peace in the household.

According to aforementioned causes, divorce is also potential to happen due to a classical reason, and hence enables the interested party to minimalize it. Divorce is not something new for us, as we know that a lot of celebrities and other people had divorced their partner. The great number is surprising when there are many effective solutions or methods offered to prevent divorce. Unfortunately, along with the world development, the number of divorces keeps increasing.

4 Divorce Case Checking By Judge

Legal existence is supported by the judge existence as the legal enforcer. The law and judge are strongly connected to and complement each other. Mr. R. Tresna argues, “When there is the law, there is the judge.” It impacts on the Islamic law and judge, issuing an adage clarifying that “when there is the Islamic law, there is the Islamic judge”. Today, apparently when there are Moslems, there is the Islamic law and judge. In Indonesia, the Islamic judge is embodied by the religious court, as confirmed by the Article 24 Paragraph (2) the 1945 Constitution. By this authority, the judge is able to investigate the issue for the sake of Justice by the Almighty God [8].

Based on Law No. 3 of 2006 [9], Familial court is obliged and authorized to investigate, make a decision, and solve cases on the first level between those who are Islamic believers in the case of (Article 49):

1. Marriage;
2. Inheritance;
3. Deed;
4. Grant;
5. Wakaf;
6. Zakat;
7. Infāq;
8. Shadaqah; and

The religious court will make attempts to unite both parties to return their harmonious life as a husband and wife. They will be given several days to ponder their decision over the divorce. When there is no agreement met, the court will condemn them to divorce [10]. Further, the judge is the familial court judge or religious court judge and appeal religious or familial court judge and/or officer that implement the judicative authority (Article 11). The familial/religious judge authority is directly under the authority of judicial authority of Religious/Familial Court either in district/city level or in provincial level.
In Article 13 of Law No. 3 of 2006 [9], it is mentioned that to be appointed as a judge in the religious/familial court, a person should meet the following requirements:

1. Indonesian Citizen;
2. Islam;
3. Pious toward the One Supreme God;
4. Loyal to Pancasila and UUD 1945;
5. Holds a degree in Sharia and/or Bachelor of Law and master Islamic law;
6. Mentally and physically healthy;
7. Has dignity, honest, fair, and of good morals and behaviors; and
8. Was not associated in a prohibited organization, the Indonesian Communist Party and its underwings, or not a person who directly involved in the 30th September movement which was organized by the Indonesian Communist Party.

Meanwhile, the judicial authority in adjudicating a divorce case based on Familial/Religious Court Law is described as follow:

1. The judge investigates/checks the divorce case in no later than 30 days after the case is filed to the court;
2. The judge investigates the case by listening to both plaintiff and defendant, then the witnesses;
3. The judge investigates the divorce case by trying to reconcile the husband and wife. When the reconciliation is reached, then the divorce case is discontinued and cannot be refiled in a new lawsuit using a similar reason. Whereas, when reconciliation is not reached, then the lawsuit is continued;
4. The judge continued the lawsuit investigation in a close manner related to the post-divorce rights and obligation of the husband and wife;
5. The judge adjudicates/decides the case.

The effort for reconciliation or mediation mechanism needs to be emphasized before the case is decided. The judge panel is obliged to advise the plaintiff or the defendant (husband and wife) during the court hearing. The judges try at their best to provide advice or best solutions to the plaintiff or defendant, and when judges could not find the best solution, then actions according to the court procedure can be taken.

Before deciding a case, judges need to carry out a deliberation with the plaintiff or defendant in the court hearing, when the deliberation has been carried out, but one of the party disagrees with the decision of the chief judge, then the judges advise or provide knowledge toward the disagreeing or dissatisfied party on the first level court hearing. The judge panel can ask the dissatisfied party to go for appeal level [11].

When a regulation is substantially unclear and ambiguous, hence different interpretations, in practical level, it will impact on different application levels. Perma Number 1 of 2008 also contains some interpretable articles; such as articles to comprehend duty for arranging mediation. Here, there are two different mindsets: firstly, mediation process shall be conducted in the level of civil dispute resolution proposed to the court and secondly, mediation shall be conducted in the level of civil dispute resolution proposed to the court when both parties are present in the court. Regardless their correctness or incorrectness, one of those understanding will give different practical implications [12].

Mediation procedure by a judge in a divorce case is a crucial procedure; this check becomes the most important benchmark to determine the future of a marriage relationship between the plaintiff and the defendant. The active role of the judge in mediation is not only carried out ex officio by providing advice or knowledge, but judges can also involve family, friends or other figures or agencies, which considered important to assist in the effort to reach
reconciliation between husband and wife. These efforts are as stipulated in Article 31 (2) of Government Regulation No. 9 of 1975 on Implementation of Marital Law [13].

5  Cultural Approach As An Effort For The Judge In Divorce Case In Gorontalo

The Law of the Republic of Indonesia and the Indonesian legislation take a great concern of local wisdom, because together with the Indonesian positive law, it constitutes one of the elements for the judge consideration to make decision. Why? Local wisdom contains policies made by the local people. They generated traditions philosophically containing moral values upheld by them.

In facing legal issues, every judge shall look up to the local wisdom, since people regards the wisdom as absolute justice. Furthermore, the local wisdom is crucial because [8]:

1. Local wisdom shall be prioritized as the legal source when the judge cannot find any written legal source as a positive law.
2. Local wisdom may be accompanied by the written law acting as a complementary law and helping the judge make a decision on a suit.
3. Local wisdom can also be the legal source as long as it does not contradict the supreme legal principle.

In checking a divorce case, divorce is not always the result. The judge can decide to reconcile the disputing parties. The initial step in the divorce case checking by the judge is by asking questions to the plaintiff or the defendant. The questions are usually detailed questions and demanding questions. These questions are to ensure the description of the parties and the witnesses are of no doubts in going through the trial process. Clear testimonies are important to ensure the judges as their basis for deciding a case. Therefore, the judge often repeats testimonies provided by parties or witnesses.

5.1 Cultural approach through sociolinguistics aspect

Considering the way the judges check the case above, it becomes important to study the language of a judge as an approach within the process of checking a case. Language influences changes in a person’s state of mind. For instance, when a person is under stress, it is possible for that person to think unclearly. Thus, often the way she or he communicates with others uncomfortably or even his/her communication may result in conflict. In this case, a familial/religious court judge is demanded to have good moral and integrity in his/her daily interaction, and more importantly within the process of adjudicating or checking a divorce case. It means that a judge should be considered as an advisor, who can provide advice or knowledge patiently and wisely.

In his book titled “How to Do Things with Words”, J.L Austin (1962) conveys that functions formed by utterances are parts of interpersonal communication expressed in a sentence. He adds that language is not only used as the message transmitter, but also an act creator consisting of two categories, i.e. performative sentence and constative sentence. The first sentence can be defined as an expression of: (1) When the judge declares, “Before you give any information, I shall take your oath,” (2) When the defendant says, “I apologize, Sir,” and (3) When the judge states, “I close the trial today” [14].
The expressions indicate that during the trial, the judge has applied the rule of using language correctly, and thus to make them more understandable. Good and polite speech is uttered by not only academicians (lecturers) to their students, teachers to their students, doctors to their patients, lawyers to their clients, but also judges to witnesses or defendants in courts. Court is a place to decide a case for all justice seekers. During the court process, the judge, attorney, defendant, and witness communicate by language. The use of polite, assertive, good, and correct language is the beginning of good, legal communication to manifest justice.

In the Religious Court in Gorontalo, many judges adjudicate cases using daily local language. This is due to the majority of disputing parties are Gorontalonese people who have difficulties speaking proper and correct Indonesian language. Therefore, it is appropriate for a judge in checking a divorce case to use the cultural approach from the sociolinguistic aspect.

Regarding the use of polite language in a court, we present an example in Gorontalo language. Here is the excerpt, directly taken from the trial of divorce issue.

Chief Judge : (Hari ini bawa saksi?) Do you bring any witness today?
Plaintiff (woman) : (Saksi yang kemarin so tidak mau pak) The last witness will not come, Sir.
Chief Judge : (Bukan saksi yang kemarin, so orang lain poli? ) It is not him/her, so you bring another one?
Plaintiff : (Cuma orang lain yang mau soalnya saksi yang lalu…) Only other people are willing to. The last witness …. 
Chief Judge : (Kenapa) Why?
Plaintiff : (Dia tarik-tarik di jilbab itu ti…) Someone pulled her veil.
Chief Judge : (Ti tante itu yang dari...) The one that was ….
Plaintiff : (Ya )Yes.
Chief Judge : (Dari apa itu…) Why?
Plaintiff : (Depe tante itu ) That was her aunt.
Chief Judge : (Aaa) Oh, I see.
Plaintiff : (Jadi kalo bakudapa deng saya dia so tida mau) She refuses to meet me now.
Chief Judge : (Tidak boleh bagitu, bagimana kong babuju pa maitua kong bagitu. Babuju, buju bae-bae. Jangan datang datang…. Saya juga kalo dibuju bagitu saya tetap tida mau. Buju itu bae-bae. Cuma babuju ta’u… (Diskusi dengan kedua hakim anggota) Saudara, kira- kira apa yang mau disampaikan?) No, she must not. How do you persuade your wife, then? You have to persuade people gently. If you persuaded me by that way, I would not like to grant your wish too. You shall do that well. It is only the matter of persuading. (Discussing with two member judges) Do you want to propose something?
Plaintiff : (Apa itu pak?) What is it, Sir?
Chief Judge : (Untuk meyakinkan saksi bahwa yang itu adalah butul-butul begitu selain saksi itu kan otomatis harus cari yang lain, ini mau disumpah kek, mau di apa kek) To make the witness believe your seriousness. If the last one does not come, we have to automatically look for another one. I would like her to take an oath.
Plaintiff : (Tunda..) Could we postpone this trial?
Chief Judge : (Ha..? Bersumpah?) What? Taking the oath?
The above excerpt, a conversation between the judge and plaintiff is dominated by Gorontalo language. Both speakers tried to understand what the other was trying to communicate. The use of polite, assertive, good, and correct and well behaving in a trial is regulated by the code of conduct in Paragraph 13b the Law of the Republic of Indonesia Number 49 Year 2009 on General Court. The regulation explains that judge shall do their duties professionally [15].

Language in a community serves to control social interaction. This statement is based on the fact of the shift of community structure due to the influence of a language. In Gorontalo, for instance, the local language is mostly used by the elders for daily conversation; but it is different when it comes to the younger people. There is a gap between those who use Gorontalo language and the group of young people who use Gorontalo language mixed with the Sulawesi dialect. The former will feel more civilized as their Gorontalo language is dominated by polite language.

Therefore, judges who adjudicate divorce cases in Gorontalo religious court should use the cultural approach from this sociolinguistic aspect in adjudicating divorce case as it has several benefits as follow:

a) The judge can adapt to the party that he/she is currently checking by using similar language. If Gorontalo language is used, the judge can ask a question in Gorontalo language to indirectly create an emotional bond between the judge and the party being investigated.

b) This developed emotional bond will ease the judge in digging information and finding the intention of the parties based their answers.

c) Cultural approach through this sociolinguistic aspect will ease the parties to provide their testimonies without feeling any pressure. Thus, the trial process will put disputing parties in a comfortable position. Thus, they can think clearly.

5.2 Judge processional approach through customary law

Such kind of approach can also be applied in the mediation stage or to reconcile. The cultural approach of the judge can be applied not only in ex officio manner; rather, it can also be applied by the judge as rechtvinder or an inventor of a new law for the purpose of common just among the parties. For this purpose, the judge can position himself/herself as a figure who understand religion and/or cultural elder who has knowledge on customary law about marriage.
In Gorontalo customary law, an elder is a man who knows the value of the local wisdom and the custom to be preserved. A cultural leader has the ability to provide advice for the community in upholding the values of the local wisdom for a better and orderly life.

The ability mentioned above is important to be mastered by a religious court judge. It is important that the effort to reconcile the disputing parties is not only providing legal understanding toward the disputing parties but also moral enhancement by providing the values of their own culture, and religious values toward the plaintiff and the defendant in order for them to be aware and try to preserve their marriage.

6 The Existence Of Customary Law To Influence Judge Role In Divorce Case

Customary law is a law growing and developing among the society. It represents national aim and cultural common sense. Hence the law is also referred to unwritten law with acceptable implications for all Indonesian citizens. Ter Haar argues that customary law constitutes all regulations applied in firm decisions and binding realization [16]. The argument is known as decision theory (beslissingenleer). Therefore customary law is realized and maintained by decisions of legal community. Furthermore legal functionary decisions cover legal functionary decisions stipulated by the judge, male village elder, village meeting, land representatives, and other village staffs.

Today legal configuration had been transformed and customary law is an organic part of the state law. The realization is stipulated in the Law Number 4 of 2004 on Power, Judge regulated in Article 24 Paragraph (1) stating that all court decisions shall contain not only logic and fundamental of the decision, but also a certain article of interested legislations or written legal sources as a base to adjudicate. The Article is strengthened by Article 28 stating that the judge shall dig, follow, and understand legal values and justice living among communities.

Based on those two articles, customary law can be a base for the judge to adjudicate and to write decision in the court because the written law source intended in Article 25 Paragraph (1) is customary law. Moreover legal values and people’s sense of justice are also manifested in customary law under an assumption that customary law is the law growing and developing in the society. Both articles authorize the judge to write decisions by referring to customary law [16]

In relation to the role of the judge in adjudicating a divorce case through a cultural approach, it is actually outside the above mechanism as stipulated by the Perma No. 1 of 2016 (Anonim, 2016). However, the divorce case is not merely a personal case, the bad impact of divorce needs to be minimized as it will leave a scar for life, especially for children that may exist within this broken marriage.

According to the above discussion, husband and wife relationship is the smallest structure of a community. A good marital relationship will ensure that interpersonal relationship within the community will be healthier and conflicts can be averted. Therefore, the role of religious court judge in adjudicating divorce case is expected to have more than just adjudicating the case. Judges should become those who mind the cultural values based on the customary law:
The ability of the religious court judge to position himself/herself as a person who understand religion and cultural values, which is a reflection of his/herself as mentioned in Article 12B (1) of Religious Court Law that

“Hakim harus memiliki integritas dan kepribadian tidak tercela, jujur, adil, profesional, bertakwa, dan berakhlak mulia, serta berpengalaman di bidang hukum/judge should have integrity and good moral, attitude of honesty, just, professional, pious, and experienced in law”.

In practice, a judge even can be considered as a Hakam, a trusted person to become a reference for two parties to freely share their feelings and thoughts, where parties that would like to divorce can tell their marriage problems from all aspects of life.

One of the Islamic teachings proposes, “al-Aadatu Muhkamat”, or “Customs and tradition may be regarded the law." Judges from either religious or other environments shall pay attention the fact for the sake of justice (Arto, 2018).

The practice of a judge in adjudicating a divorce case is custom within the community that can be implemented before a case is filed to the court. The position of a judge is as a neutral party, who try to bring back peace into the household through deliberation and agreement.

In the litigation process, the role of a judge can be replaced by judge or judge can position himself/herself as a judge, considering that one of the most important obligations of the judge in a divorce case is to reconcile the disputing parties and avert a divorce. The judge before adjudicating a divorce case should become a mediator and considered as an elder within a community structure but within the court context.

7 Conclusion

The role of a religious court judge is important in adjudicating a divorce case. This is because judges have their professional ethics as well as a trusted person in reconciling the disputing husband and wife.

The role of the judge in adjudicating divorce case can use cultural approach through customary law, either through sociolinguistic interaction or through interpersonal emotional ways. Both cultural approaches provide ways for the parties to discuss their marriage problems. Hence, it made possible for the disputing parties to change their pattern of thinking based on their own opinion and due to their interpersonal interaction with the judge.

References


Ecological Peril in Relation to Politics of Space Case Study: Dama Village, Loloda, North Maluku

Tommy Christomy¹, L.G. Saraswati Putri², Noor Fatia Lastika Sari³
{tommy.christomy@ui.ac.id¹, lg.saraswati@ui.ac.id², noorfatials@gmail.com³}

Faculty of Humanities, Universitas Indonesia; Kampus UI Depok, Jawa Barat 16424, Indonesia

Abstract. The distress of climate crisis has become the state of our human condition. We form our idea of politics in favor of our narrow anthropocentric interest. Our understanding of political space involves exclusively the interaction between human beings, disregarding the environment into the spectrum. Hence, politics is all about acquiring power, race to power among people, and the domination of human beings above nature. Our investigation should start with cases in Indonesia on how politics have gravely misconducted, marginalizing local people, and their environment. The eastern parts of Indonesia are often neglected, the extensive researches conducted for 2 years in Loloda, North Maluku have given us a based of understanding on problems of inequality and ecological exploitations. The people of Loloda have a strong history with the coastal tradition. They have an indigenous system called Kolano, or a form of Sultanate. Due to the array of disappointments to the central government, and even the provincial government, they resurrect the leadership of Kolano amidst facing poverty and losing their natural biodiversity to mining since the 1960s. This research utilizes interdisciplinary methods, from historical approach, linguistic and ecological philosophy analysis. This research discovers that the rising political subjects are indicated through the act of forming Kolano as a conscious and collective choice to protect Loloda’s heritage and environment. In conclusion, the important findings of the research underlines on how the people of Loloda recreate a social-ecology political space, contesting the current power exercised by the governments. We can view this act as their way to criticize the ruling power, moreover, their political way to survive.

Keywords: Politics of Space, Social-Ecology, Anthropocentrism, Kolano, Ecological Politics, Indigenous Community.

1 Introduction

Indonesia, as an archipelago country, has an extensive range of diversity in culture and language due to two reasons; historical and geological. These pluralities can become its own complex situation if it’s intertwined with the idea of decentralization. Decentralization aims to exert the blueprint from the central government and create a homogenous system into every city. Most of the time, in order to achieve this goal, it needs to change the existing structure in the society as well as their daily practices that have embedded into their culture.

When North Maluku was given their regional autonomy to manage itself as a province in 1999; it means that they become to be, geologically speaking, more compact. Loloda is one of the target that has been undergone several changes throughout the years in term of restructuring. Hence, it will be logical to think that the chosen representatives might have
better understanding to govern their people. However, the result points out in the other direction, the representatives and the central government still can not grasp what local people’s need.

The differences can be seen if we compare the value of government contrasted to the people of Loloda. In order to integrate Loloda to fit into their vision, the government wants to boost the economic growth by building a gold mine. The indigenous people from Loloda, on the other hand, sees this as means to damage their forest, which can be translated to destroying their environment. For local people, they always have close relationship with their own nature and understand it as part of their culture. They take refuge from the disruption to their culture or livelihood, by re-forming the ancient leadership of Kolano.

The people of Loloda believe Kolano will bring them prosperity through the chosen leader that arises out of their mythical and historical legend. It shows that Kolano is a belief system that has been bound deep into Loloda’s consciousness. Not only that, it is also their way to express their disappointment towards the current system that does not include their value. Furthermore, Kolano is not merely a system of belief, moreover, it is also a social fact for the people of Loloda.

2 Conceptual and Methodological Approach

This article use interdisciplinary methods from historical, linguistic, and emphasizing on ecological perspective. The initial problem for this article is the different basic value of modernization and industrialization by the central government against the demand of social space in Loloda. This article starts by explaining that every space is political space and it influenced how the structural framework for each society.

Whenever there are two clashing values in society, the end result usually the powerful value dominates the other, particularly if one able to overpower the other. On this case, the root of hegemony comes directly from the state in form of regional autonomy. The central government reap their values based on urban planning and try to homogenize every society in Indonesia that has rich variety of culture. That being said, every society from each culture has their own way to solidify their social-consciousness.

This article claims that the people of Loloda have tried to fight against subjugation by means of reconstructing a structure called Kolano. To put it even further, Kolano is a unified act of Lolodan as society, which can be translated into their community collective-consciousness.

The methodology used in this article is examining the people narratives on spatial issues related with environment. In doing so, we have been conducting field research in Loloda since 2017. In this ethnographic study we have tried to obtain various sources of data on spatial politics. A number of key figures such as Kolano Loloda, members of the DPR, lecturers, students, and journalists have helped us a lot in a series of FGDs.

2.1 Lefebvre’s Politics of Space

The reshaping of consciousness in Loloda substantially created a new space, to be more exact, a political space. Henri Lefebvre believes’ that space is not a valueless object such as scientific one that mainly concern about fact; space is always and has been political and strategic [6]. Nevertheless, its difficult to sense one because society normally taken space as is, as something that has been there or some natural thing. However, there is problem when
central government tries to impose a different value to Loloda; first, the government use the urban perspective to direct the course of society that leads only to economic growth, the second one is that Loloda prioritize their society based upon their relationship with the nature and their customs. So, in the process of building the gold mine, the people of Loloda does not see it as a improvement for their society, instead they feel threatened by this industrial existence.

This conflictual perception stems on each parties’ relation with the environment. Government, when they develop their cities, tends to fall into a relation that restrict and dominate the others to achieve the urban space [3]. For example, in the cities there is sharp distinction between what is public and private space. This distinction comes into play when government need justification to enforce a law that prohibit people to sleep on the bench in the public park, to put fence around government office, or even an information that public transportation only operates for certain hours. It implicates on the specific behavior that the state wants to have over their people. This is what Lefebvre called how the society produces its own space [5].

Thus, there is a hegemony and pattern of domination that state use to define its relation with their environment. However, in Loloda society, especially to indigenous people, the idea of dominating their environment is completely absurd. It’s true that Loloda also has its own specific space. Yet, the way they define their relationship with their environment is based upon ecological value, which is something that the government lacked of. This can be seen from the fact that they have distrust towards how the government manages their biodiversity—which is sacred for their relationship with nature. In addition to that, government overlook the importance of Kolano as a means to unite the society in search of fair leader and a belief that brings hope to Lolodan.

These two different political spaces is also affected by their mode of production [2]. Lefebvre called it “State Mode of Production” (or SMP for short) and it gives framework for each society to construct its own space [6]. However, as I stated beforehand, the society tend to perceive (social) space as given and transmitted natural space. Therefore, society does not realize that the current mode of production is characterized by state’s control over space and vice versa. The process of proliferation in political space can be traced back on how they interact with the others [6]. If the basis of interaction rests upon the idea of violence and domination, it will emerge on the process of reproduction their own space. Due to the reason that Lefebvre believe this process is a dialectical one when the society always in constant to reshape the space that they inhabit.

After describing why space is political and it constituted by certain value that the society have, the next section of this article will explain what is ecological politics according to Naess’. Ecological perspective can enlighten environmental problem regarding tendency of anthropocentric policies made by the central government.

### 2.2 Naess Community

Arne Naess considers that there is a strong distinction between environmental approaches, namely deep ecology and shallow ecology. Shallow ecology itself generally about tackling pollution or focusing on human prosperity in general [8]. Deep ecology on the other hand rejects the environment with mere human’s images. There is an intrinsic realization between the organism and its surroundings so there is a wholeness and equality in the relation [8]. Furthermore, Naess mentioned in his own philosophy, the need for something called Ecophilosophy or more closely ecosophy. Ecophilosophy or ecosophy assumes that there is an intrinsic importance from nature to humanity [10]. Then this implies that ecologically, there
are rules or laws that govern human morals, where morals are demarcating other life positions that have rights [10]. The right to another life, here requires wider consideration than the understanding of anthropocentric nature that tends to see changes and solutions in the hands of economic growth, legal matters, and standardized measurements. Since reasoning in general is not possible to be standardized so, from one place or say from one human to another, can promise prosperity or roughly in Naess’ language that technocracy sheltered under modern politics works as subordination [10]. In other words, the ecology of Naess upholds equality in the relations of nature with the creatures in it or in the biosphere; here Naess calls it Biospherical egalitarianism [8].

However, how ecosophy itself can be made possible cannot be separated from the locality in thinking. Where, excessive decentralization can result in much essence being wasted in the administrative process [8]. From the Loloda case, the government which focuses on its own development agenda, will assume that the administrative intensity, apart from bringing a mess on the work agenda, actually intensifies itself as a party that has more power than the existing locality. Because of the intensification of the center, then, the emotions that exist or in Naess’ language called gestalt [10] are absent. The way of thinking gestalt towards a certain local environment does not emerge, because the government only feels what is felt in its own environment and community or perhaps its luxury. The Loloda community, who thought that in the government of the sultanate, agreed to work in nature, such as the supernatural power of the sultan associated with nature (in this case, the ocean), would not be understood by Governments outside Lolodan. It can be said that the political community of the central government which is not based on gestalt thinking will have difficulty thinking how Lolodan can feel comfortable within the identity they have, because the thing that comes to mind is confirmation that something can be subject to extrinsic forces. The general consensus of Bhinneka Tunggal Ika, does not immediately recognizes identities as independent, and plurality as equality.

The focus of the central government (including up to its provincial derivatives) is on the welfare of the people. But welfare with a certain meter is part of a program that does not assume the best for the well-being of all its people. So, it can be said that even though the government considers that welfare is important, however, the government does not pay attention, that in certain communities, the local people therein have a more deeper understanding of what’s best for themselves and for the ecosystem around them [10].

The community has a deeper way of thinking, assuming Self-realization (in Naess's thinking, from W to T) [10]. Communities that think by Self-realization are inseparable from the way of thinking gestalt. This way of thinking, in which various intrinsic values exist in nature, is thus accepted [10]. That way, the relationship of perception with intuition is very close in someone forming their own way of thinking. Because, one can not be separated from its influence with nature, then, what happens to nature, will be perceived in such a way, so that it has its own effect on the feeling.

This will also be felt by communities in certain regions, such as Lolodan. For them, the close oceanic power with the sultan is part of how to understand there is an inseparable relationship between humans and nature. Even though it is not at the level coveted by the modeling of science, how the relationship creates its own comfort is a way to be aware of yourself and your position on the environment. In realizing that joy, the role of intuition works as an extension of perception. So, it might not be appropriate if one model can be applied in the community. Communities have cases and participations, which are motivated by habits and various relationships that have been built culturally or historically in them [10]. Thus, certain people always have their own approach, which they say brings more optimum
satisfaction, with the assumption of self-realization that is intensified in culture and history itself. In other words, this can be a form of criticism of decentralized government that refers to procedural without perceiving a way of life in a particular community. Reasonable disparities in political relations exist between the Loloda community and the central and regional governments of Indonesia.

Thus, it is clear that weakness in the government lies in the shallow ways of thinking that focus on certain models. Also how the community itself is ignored in the process. However, how the community's disappointment at the government's decision implies how in the central government itself, how to understand the community itself is still limited to welfare on certain models. Where, the implication is further, how the government cannot see the real relationship between humans and nature. The values that exist in the relationship between humans and nature are limited to instrumental values [9]. This relation also shows that the central government system of democratic government centralizes the scope of the community itself [10]. It can be illustrated in how the government sees that ecological problems are only limited to environmental problems or environments without populations [10], so that if the environment is improved, then there will be positive outputs that will be obtained for more sustainable programs. The anthropocentric mindset is still a disability in the eco-political relations of the government and community. Community becomes something that remains in the subordination of the government.

In the span of time during the year of 1999-2000, Indonesian government has introduced Law No. 2 concerning Regional Administration, since the concept of regional autonomy in context with the policy of the establishing regional administration were becoming a phenomenon in developing a New Autonomous Area (Daerah Otonomi Baru/DOB) at the provincial and district level. Maluku Utara Province was established in 1999, but once a part of Maluku Province. However the distribution of power and political rights between the two provinces didn’t rely on credible criteria; it was a mere geographical division that split the area evenly with a single straight demarcation line. Issues then came to the surface, as the division didn’t really consider on the existence of natural resources and the lingering tradition and customary practices that are still pretty much influential.

As an example, take the case of social commotion in 2014 at Roko, a village under the administration of West Galela District. Roko has particular point of interest, which is new and promising gold mines, that attracts immigrants from various area and ethnicity to establish settlements and join along with the “exploration”. Initially, the people of Roko consists of 80% Tobaru people (ethnic group) of Loloda, while the rest are those who came from Galela, Tobelo, Loloda, as well as Manado, Buton, and Sangir. Mentioning Loloda above, we would also like to highlight the area as a part of historical and cultural unity that once had been a prominent political entity, along with some other powerful kingdoms in the area of northern Maluku.

3 Cases of Environmental Issues in North Maluku

One of the prominent issues being faced by North Maluku Province, especially the island of Halmahera, is the dispute over the illegal mining that has been contributing to the deteriorating condition of public infrastructures, such as environmental pollution and trans-district road damage that is beneficial for ground transportation across districts. Recently, there has been a clear indication that the gold mine in the District of West Galela, Halmahera...
is actually belonged to *Tanah Rukun*, a piece of land believed to be owned by *Kolano*, the traditional leader of the people of Loloda who has the same political authority as the sultans of Maluku. West Galela is a district located in the very close proximity to the land of Lolodans, which were administratively divided into two Regency, West Halmahera and North Halmahera, so that half of the land of the Lolodans is located among the administration of West Halmahera, while the other half belongs to the local political establishment of North Halmahera.

**Fig. 1.** Map of North Halmahera, concerning the area of studies and environmental crises found along the proximity (Modified)

Such local political establishment was conducted, based on the availability of administrative region, economical values, and population, but disregarding the need of stringing historical and cultural aspect altogether. Both occupy two different domains; one domain manages space and people, while the other one manages the more elemental matter of history and culture within the context of spatiality. Eventually, in terms of historical aspects, the community exists way earlier than the development of its nation-state, let alone a modern
establishment named Indonesia. Harsja W. Bachtiar [11], a professor in societal history, in his dissertation, put a concept regarding the old and new concept of society forward. He identified the old society that filled with tradition and antiquity as “nasjon lama” (old nation), while the new one as “nasjon baru” (new nation), which is modern day Indonesia. This is where we could see that, as a modern concept, Indonesian-ness is worth to be presented as a “new political space”, with adjacent contemporary values, and without leaving the trace of tradition and the linkage to the narrative of origins.

After the establishment of North Maluku as a new province with its own regional administration, in the context of the flourishing development of New Autonomous Area (Daerah Otonomi Baru/DOB) at the provincial and district level, there had been a confusion regarding the arrangement in the cultural domain, apart from the new political establishment and administration matter. Such confusion was based on the inability, and impossibility, of any laws to reorganize the current cultural arrangement that has been installed among the people of the whole Maluku in the traditional concept of Maluku Kie Raha, an ancient belief that unite four sultanates in Maluku that consists of Ternate, Tidore, Jailolo (Halmahera), and Bacan. While the political domain, embodied in the concept of creating New Autonomous Area, manages spaces and people administratively, the cultural domain manages the more elemental matter of history and culture. It is, then, obvious that the establishment of the new province didn’t really consider all aspect divided, especially regarding the existence of shared natural resources, tradition, and customary practices that are still pretty much influential.

In 2014, at the village of Roko, there had been a social commotion that happened due to the newly found gold mines. Roko is the village located at the northwestern tip of West Galela District, within the close proximity to the border between North Halmahera, West Halmahera, and Loloda Utara District. To the east of the village, around the gold mines, there is an area known as Tanah Rukun, a traditionally claimed piece of land that is deemed to be owned by the Kolano of Loloda. To make it short, several groups claimed that the gold mines were belonged to the Kolano, thus it wouldn’t matter if the people of Roko wanted to explore the mines, since the people of Roko consists of 80% Tobaru people who actually came from Loloda [12]. The root of this issue was the dissection of Loloda, a prominent political entity in the course of history of Maluku, into two different districts and under two different regencies; North Loloda belongs to North Halmahera Regency, while South Loloda belongs to West Halmahera Regency, disrupting the historical and cultural chain [13].

Other than that, regarding the environmental and health issue, Inayati highlighted the hazardous effect of mercury (Hg) and cyanide (CN) that could risk the lives of many miners. She put her concern toward environmental damage and health issue forward, understanding that there was not much that she could do as the head of the district, since the business permit was issued by the provincial government. Thus, any complaints submitted by the district would be a mere lamentation, if there were no follow-ups from the provincial government. Besides, it turned out that the piece of land was under the jurisdiction of West Halmahera Province. [16]

Further concern from Inayati was when the long-established mining company in West Halmahera, Tri Usaha Baru Ltd., put interest in expanding the scope of its exploration to near Roko. In 2017/18, both province, North and West Halmahera were protesting the company for transporting heavy equipment through Trans Halmahera Utara Road, instead of establishing a road across West Halmahera that could benefit its people, accounted as a part of Corporate Social Responsibility (CSR). Such complication was considered as the inconceivable side effects of establishing new autonomous province and district.
According to Mustafa Mansur [14], the Appointed Secretary for Loloda’s Kolano, the village of Roko was previously belonged to Loloda of West Halmahera, but since the position of the village is too far away from the province’s capital, the village was then transferred into the administration of West Galela of North Halmahera. This fact was also intriguing because some people believed that Roko should at least be put under the administration of North Loloda District. The people of Roko went disoriented after the administrative separation, though they were culturally related to the people who lived in the village of Jano, Loloda of West Halmahera. The issue escalated into a more serious one when some groups of people proposed the formation of community around the mine to ensure the disbursement of any benefits that could be provided by the company under the responsibility of conducting CSR programs, in exchange to the land right given to be further explored, following the existing deals between the people of Kao-Malifut with Nusa Halmahera Minerals Ltd. The proposal was politically and economically correct, but failed to comply with the fact that the land was entitled with the traditional right of Kolano of Loloda.

In Christomy and Suharjo, Loloda was introduced, according to the description of ancient manuscript found, as a royal territory under Ternate. However, according to various oral story sources, Loloda seems to be less considered by the Ternatean government. Even so, Loloda still has a place in the agreement between Ternate and the Netherlands. The signatures of several Loloda officials were written in the agreement. King of Loloda (Kolano), Captain of the Sea of Loloda (Kapitalao), and Sangaji Melayu (Sangaji Loloda) were known to have given their signature on the treaty manuscript [17]. Loloda is one of the oldest kingdoms in Maluku [18]. It is known as Ngara Ma-Beno or the gate of Halmahera. Related to the above, Andaya says that Loloda is a unique region; “Though a King Loloda still existed, only a vague memory of a former kingdom remained” [19].

However, such traditional claim from the Kingdom of Loloda was also considered as premature proposition, since this traditional political entity doesn’t belong to the configuration of Maluku Kie Raha with Ternate, Tidore, Jailolo, and Bacan. It was said that the Kolano of Loloda didn’t fulfil the invitation to the Moti Confederation (Moti Verbond) in 1322 [13]. He was late to the meeting, due to the fact that his ship sank near Dufa-dufa, Ternate. As the consequences, Loloda was excluded from the confederation of Maluku Kie Raha, and then became forgotten in the course of history for quite a long time. The implication affected the people who lived in the proximity of Loloda, which is located up in the north, facing the open sea as one of the frontier area in the eastern part of the archipelago, up until today. During the rising trends of regional autonomy, Loloda had to be the thanksgiving turkey, carved by both West and North Halmahera. Loloda as a political and cultural entity once again lost the opportunity to establish its own authority and sovereignty. Thus, it is obvious that spatial concepts are open to modification imposed by global capitalism in the means of acquiring the right or access toward traditionally conserved natural resources.

Such similar occurrences, regarding the concern toward environmental health and sustainability, are found in most district of Halmahera, including in the village of Dama, which has been the centre of our discussion in this article. As an example, Morotai Island is also dealing with the environment damage caused by the iron mine, or other mine, such as nickel and gold. Turns out that the Corporate Social Responsibility (CSR) program runs by various companies had failed to comply with the deteriorating condition of the nature, which then affects the community even further. The program was proven to be mere practical and platonic solution toward the issue, without even considering such traditional patterns and cultural bonds that are still exist in North Maluku. The effect of the mining activities is somehow unbearable, noticing that it doesn’t only affect the land, but also the body of water.
surrounded the island, disrupting the traditional way acquired by the locals to meet their subsistent needs.

However, a human structuring agency, as a prime mover of the community, is needed in order to establish better handling toward the issue. Perhaps, the re-establishment of Kolano institution, as well as the Sultanate of Loloda, could be the medium of encouraging such agential power to rise. It could be the local political leader, or even religious leader. In West Galela, a woman stands tall as the “tip of the spear” of the struggle. Ahsun Inayati is the head of the district of West Galela whose agential role could be noticed and promoted further, in order to establish a strong and powerful stance in conserving Halmahera, North Maluku, within the framework of the unity of Loloda.

3.1 Kolano as Collective Consciousness

As mentioned above, indigenous people in Loloda perceive life as something that inherently distinct. Life is not an idea that exclusively belongs to human, but life is something that has intrinsic value [8]. Human, in this context, is also part of nature despite the fact that we can shape our own society by infrastructure. Thus, human always have the urge to ‘feel’ the nature in any form—urban people reconcile this tendency with green area. Naess called this phenomenon as friluftsliv, or roughly translated by Reed and Rothenberg as ‘open air life’ and ‘nature life’ [10]. However, the term itself is used to define the condition where the state of mind and body in nature. This goes along with the Self-realisation that has been mentioned above.

Therefore, every time that modernization comes in contact with nature and disrupts the relationship in term of ‘oneness’ in nature. Often times, it manifest as angst that need to be fulfilled with being surrounded by nature. Now, this is also the same reason why Loloda resurrect sultanate system. It happens because of the fact that the product of decentralization has increasingly decreased their nature. They are not only see it as a threat against nature, it is a direct threat against themselves. Lolodan does not see the distinction between the nature and them. So, the rejection shape in form of their custom beliefs, which is Kolano.

If we follow along this logic, when Lolodan do not see the difference between the nature and themselves, then Kolano is not an act over something, it is an act within them [1]. Thus, it cannot be seen as the ruling power from individual action to dominate others. There is a sense of ‘wholeness’ and ‘unity’ for Lolodan when they perform Kolano. So, it cannot be reduced to one consciousness, Kolano is an active and collective-consciousness. The ritual itself is a symbol of hope for their society and they truly believe it.

However, even though Kolano is a symbol of hope, it does not mean that they know the direction of their hope. At least, in their case, the hope works as the end result of their collective-consciousness. They do not see the importance if its going to affect the development or mining process in Loloda. They see it as a way to understand the complexity of human-nature relationship as a one [1].

Therefore, the resurrection of Kolano does not arise from meticulous plan to triumph over decentralization, but it derives from their concern with ethical guidance to respond the decentralization. Although, the government should position themselves accordingly to react at indigenous people’s voice. Kolano is the equivalency of urban way to vocalize their protest [7]. Thus, the government should treat it with the same degree of respect.
4 Conclusion

Kolano cannot be comprehend only as a romantic tradition, it also the Lolodan way to respond over the destruction that government has caused upon them. They do not see the distinction between their nature and themselves because of wholeness or oneness of their relation with nature itself. Hence, Kolano is an active action from Lolodan, especially when they feel threatened over the diminishing of their biodiversity. Therefore, it can be concluded that Kolano is Lolodan collective-consciousness that take shape in their custom beliefs.

The attempt from central government to bring decentralization to North Maluku does not go along well with the cultural establishment of Loloda. They try to reshape the cultural space of Lolodan society to become more urbanized. But, the result is only damaging their biodiversity and formed as a threat toward Lolodan itself.

References

[14] Interview with Mustafa Mansur on 4 July 2019 at Johana Homestay, Tobelo, North Halmahera (2019)


Analysis of Utilization of Electricity Renewed From Methane Gas Organic Waste Product

Muhammad Hasbi1, Yuspian Gunawan2, Jenny Delly3, Kadir4, Abdul Djohar5, Samhuddin6, Nanang Endriatno7, Adytia Rachman8, Lilis Laome9

{m.hasbi@uho.ac.id1, yuspiangunawanstmnt@gmail.com2, jenydelly09@gmail.com3, irkadir@gmail.com4, joharunhalu@yahoo.com5, samhuddinkbn@gmail.com6, nanang.endriatno@uho.ac.id7, aditya_rehmn@yahoo.com8, lhi2slaome@gmail.com9}

Jurusan Mesin Fakultas Teknik Universitas Halu Oleo1,2,3,4,6,7,8, Jurusan Elektro Fakultas Teknik Universitas Halu Oleo5, Jurusan Matematika Fakultas Matematika dan Ilmu Pengetahuan Alam Universitas Halu Oleo9

Abstract. The aim of the study was to determine the amount of electrical energy generated from methane gas produced from the volume of waste. The research method is carried out by literature review and field surveys, as well as theoretical calculations. Data was collected at the Tempat Pembuangan Akhir (TPA) and Kendari City Sanitation Office, by meeting and interviewing people directly related to the landfill management process, communities in energy independent settlements, as well as in the municipal sanitation office. The results of the study revealed that the energy produced from the Tempat Pembuangan Akhir (TPA) Puuwatu in the daily average was 288,466.5332 kWh. The amount of electrical energy that has been utilized by the Pemukiman Mandiri Energi is 1,080 kWh. The untapped energy is 287,386.5332 kWh.

Keywords: Energy independent settlements, Methane Gas, Organic Waste, Electric Energy.

1 Introduction

Improved landfill performance, in addition to increasing the rate of degradation of treated waste and leachate, can also increase the economic value of waste, and support the economic activities of the community. "We also look forward to the role of universities, to support applied research, related to the development of science and technology in the waste sector," said Budi, who also presented the Professors of Waste from ITB, Eanti Damanhuri [1]. According to the 2018 World Bank Group estimates, the annual global generation of waste was 1.3 billion tons and was expected to reach approximately 2.2 billion tons by 2025 [2].

From previous research, Kendari City Puwatu Landfill has the potential for electrical energy from methane gas generated from landfill activities. Puwatutan landfill methane gas in 2017 has the potential for electrical energy of 12,298,234.56 kWh. This potential continues to increase along with the increasing amount of waste entering the landfill. Based on the results of research by Nina Angriani and Ansar Suyuti in 2017, it is recommended that the waste processing system be an advanced product in the form of electrical energy in the Puwatu landfill can be applied in other landfills. Good waste management in addition to reducing
environmental problems, can provide economic benefits for managers, government, and society. It is necessary to study and analyze the benefits and costs that may arise from the development of Puwatu landfill electricity and how the development strategy [3].

The existence of waste power plants in the Puuwatu landfill that has been running for about 10 years should have increased in terms of electrical energy generated from processing organic waste into methane gas used to run the power generation engine. For this reason, we intend to conduct a study entitled "Analysis of the use of electricity generated from methane gas produced by organic waste treatment" [4].

More than half of that trash ends up in landfills where it generates methane, a greenhouse gas that's over 20 times more potent than carbon dioxide. This methane from waste can be used to produce energy [5].

The problem of solid waste management has been increased due to rapid increase of population, intensive agriculture and industrialization. Accumulation and improper methods of disposal of waste, including heaping, dumping, landfilling and incineration, cause pollution and hazards to human and environmental health [6]. The environmental aspect of the biomass power also has been an interesting object discussed in some studies [7].

The problem formulation of this research is how much methane gas is produced from the amount of waste in Puuwatu Landfill and how much electricity is generated from the amount of methane gas produced [8]. The purpose of this study was to determine the amount of methane gas produced from the amount of waste in the Puuwatu landfill and to determine the amount of energy obtained from the amount of methane gas available.

2 Literature Review

2.1 Trash

Garbage is a material that is wasted or thrown away from the source of the results of human and natural activities that do not yet have economic value. As for the definition of waste, it is waste that is unwanted residual material after the end of a process. In most of the recent EU member countries, as well as Spain and Greece, instead, sanitary landfilling is still the most-adopted waste management strategy (>50%) [9].

2.2 Organic Waste

Organic waste is waste that can be decomposed by microorganisms or can rot like household waste in the form of food scraps and natural waste in the form of leaves and wood. The municipal solid waste (MSW) generated by households is considered the third largest anthropogenic source of methane (CH₄) emissions, constituting 11% of all global CH₄ emissions [10].
2.3 Methane Gas

Methane gas in English Methane gas with the chemical element CH₄, is a major component of biogas. Methane gas is the simplest hydrocarbon compound in the form of gas. The properties of methane gas [11]:

1. Chemical Properties: Molecular weight 16, Freezing point 900 C, Boiling point 111.7, Critical point 190, Critical pressure, Critical volume 99.0 cm / g mol
2. Physical Properties: Is a gas that is flammable, odorless, is a colorless gas, has a specification of a flame of 500 - 700 k.cal/m³. So, methane is both odourless and colourless [12].

Methane has been rising rapidly in the atmosphere over the past decade, contributing to global climate change. Methane is the second most important greenhouse gas behind carbon dioxide causing global climate change, contributing approximately 1 Wm⁻² to warming when indirect effects are included compared to 1.66 Wm⁻² for carbon dioxide [13].

Atmospheric methane levels rose steadily during the last few decades of the 20th century before leveling off for the first decade of the 21st century. Since 2008, however, methane concentrations have again been rising rapidly. This increase, if it continues in coming decades, will significantly increase global [14].

2.4 Calculation of Biogas Energy Capacity From Waste Raw Materials

1. Amount of total Solid (TS), Volatile Solid (VS), and Biogas Production

   Based on the results of testing by Tanya Mc.Donald, Gopal Achari, and Bimbola Abiola in the article "Feasibility of Increased biogas production from the co-division of agricultural, municipal, and agro-industrial wastes in rural communities". By testing biogas production made from organic waste, the conversion value of organic waste to Total Solid (TS) and Volatile Solid (VS) is obtained, as shown in Table 1 below. In this literature the value of VS is equivalent to the value of biogas produced.

<table>
<thead>
<tr>
<th>Material Type (kg)</th>
<th>Total Solid (TS) (%)</th>
<th>Volatile Solid (VS) (%)</th>
<th>Biogas Production (m³/kg TS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Trash</td>
<td>27.7</td>
<td>74.1</td>
<td>0.676</td>
</tr>
</tbody>
</table>

(Source: Agung Sulistiyo, 2010).

Based on the table above, the equation for calculating Total Solid, Solid Volatile, and biogas production is as follows [15]:

\[ TS = 27.7\% \times Q \] (1)
\[ VS = 74.1\% \times TS \] (2)
\[ VBS = 0.676 \times VS \] (3)

Information:
\[ Q = \text{Waste Potential (kg / day)} \]
\[ TS = \text{Total Solid} \]
VS = Volatile Solid (kg / day)
VBS = Volume of biogas production (m³ / day)

2. Amount of Methane Gas Produced

To calculate the amount of potential methane gas produced in a landfill process.

Table 2. Amount of volume of methane gas from organic waste

<table>
<thead>
<tr>
<th>Biogas Production ((m³/day))</th>
<th>Amount of methane gas (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>VBS</td>
<td>60</td>
</tr>
</tbody>
</table>

(Source: Agung Sulistyo, 2010)

Based on the table above, the equation for calculating gas is:

\[ VGM = 60\% \times VBS \]

Information

VGM = Volume of methane gas (m³ / day)
VBS = Volume of biogas production (m³ / day)

3. The Potential of Electrical Energy Produced

The potential of methane gas in m³ must be equalized in units of electrical energy (kWh). In the book Renewable Energy Conversion, Transmission Storage, by Bent Seronsen, 1 m³ of methane is equivalent to \(6.13 \times 10^7\) Joules, while 1 kWh is equivalent to \(3.6 \times 10^7\) Joules. So that 1 m³ of methane produces electricity of 9.36 kWh.

Table 3. Energy conversion of methane gas into electrical energy [15]

<table>
<thead>
<tr>
<th>Type of Energy</th>
<th>Equivalent Energy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Kg Methane gas</td>
<td>(6.13 \times 10^7) Joule</td>
</tr>
<tr>
<td>1 kWh</td>
<td>(3.6 \times 10^7) Joule</td>
</tr>
<tr>
<td>1 m³ Methane gas</td>
<td>9.9 kWh</td>
</tr>
</tbody>
</table>

(Source: Agung Sulistyo, 2010)

3 Research Methods

This research is a descriptive study with a quantitative approach, which was conducted at Puuwatu Landfill in Kendari City. Yusuf, 2013, stated that the descriptive method was a conscious and systematic effort to provide answers to a problem and / or obtain more in-depth and extensive information on a phenomenon by using quantitative research stages. In this case, to calculate the potential methane waste in Puuwatu Landfill, Types and Sources of Data In this study include primary data and secondary data. Primary Data is data obtained directly at the research location. This data was obtained from field observations and through informant interviews. Primary data sources were obtained from the Puuwatu Landfill, the Sanitation, Parks and Cemeteries Office of Kendari City, and the Southeast Sulawesi Province BAPPEDA. The primary data needed is the composition of waste in the Puuwatu landfill, the volume of waste, the waste management policy in Kendari City and the regional energy
development policy. Secondary data obtained through various sources of written reports, libraries and other documents. Secondary data sources are the City of Sanitation, Parks and Cemeteries Office of Kendari City, BPS Office, and from literature studies. Secondary data needed includes population data (population, population growth) and waste management data. In addition, secondary data was also obtained from documents relating to the use of landfill gas as energy. The calculation is done using references from the library.

4 Data Analysis

4.1 Data on waste volume from January to July 2018

It is obtained from the TPA Puuwatu Unit Pelaksana Teknis (UPTD) as follows:

<table>
<thead>
<tr>
<th>Month 2018</th>
<th>Volume m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>4,950.5</td>
</tr>
<tr>
<td>February</td>
<td>4,410.0</td>
</tr>
<tr>
<td>March</td>
<td>4,560.0</td>
</tr>
<tr>
<td>May</td>
<td>6,330.5</td>
</tr>
<tr>
<td>June</td>
<td>5,892.5</td>
</tr>
<tr>
<td>July</td>
<td>6,523.5</td>
</tr>
<tr>
<td>Total</td>
<td>32,667</td>
</tr>
</tbody>
</table>

4.2 Biogas Energy Capacity from Materials Raw Waste

Calculation of biogas energy capacity from waste raw material in Puuwatu landfill per month.
1. January 2018
For conversion from m³ to Kg then at times with 169.44, so:

\[
\text{4950.5 m}^3 \times 169.44 = 838,812.7 \text{ Kg / Month}
\]

\[
\frac{838,812.7}{30} = 27,960.424 \text{ Kg / Day}
\]

\[
\text{TS} = 27.7\% \times Q
\]

\[
= 27.7\% \times 27,960.424
\]

\[
= 7,745.037448 \text{ kg}
\]

\[
\text{VS} = 74.1\% \times \text{TS}
\]

\[
= 74.1\% \times 7,745.037448 \text{ kg}
\]

\[
= 5,739.0727 \text{ kg}
\]

\[
\text{VBS} = 0.676 \times \text{VS}
\]

\[
= 0.676 \times 5,739.0727 \text{ kg}
\]

\[
= 3,879.613 \text{ m}^3
\]

For details, from January to July can be seen in the following table:
Table 5. Q and VBS values

<table>
<thead>
<tr>
<th>Month</th>
<th>Q (kg/day)</th>
<th>VBS (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 2018</td>
<td>27,960.424</td>
<td>3,879.613</td>
</tr>
<tr>
<td>February 2018</td>
<td>24,907.68</td>
<td>3,456.0336</td>
</tr>
<tr>
<td>March 2018</td>
<td>25,754.88</td>
<td>3,573.5857</td>
</tr>
<tr>
<td>May 2018</td>
<td>35,754.664</td>
<td>4,961.0931</td>
</tr>
<tr>
<td>June 2018</td>
<td>33,280.84</td>
<td>4,617.8414</td>
</tr>
<tr>
<td>July 2018</td>
<td>36,844.728</td>
<td>5,112.3435</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>184,503.22</strong></td>
<td><strong>25,600.5103</strong></td>
</tr>
</tbody>
</table>

4.3 Methane Gas Production

Energy production in biogas is comparable to the production of methane gas

VGM = 60% x VBS

Information:

VGM = Methane gas production (m³ / day)
VBS = Volume of biogas production (m³ / day)

1. January 2018

VBS = 3,879.613 m³

VGM = 60% x VBS

= 60% x 3,879.613

= 2,327.7678 m³ / day

For details, from January to July can be seen in Table 6

Table 6. Methane Gas Production Value (VGM)

<table>
<thead>
<tr>
<th>Month</th>
<th>VBS (m³)</th>
<th>VGM (m³/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January 2018</td>
<td>3,879.613</td>
<td>2,327.7678</td>
</tr>
<tr>
<td>February 2018</td>
<td>3,456.0336</td>
<td>2,073.6202</td>
</tr>
<tr>
<td>March 2018</td>
<td>3,573.5857</td>
<td>2,144.1514</td>
</tr>
<tr>
<td>May 2018</td>
<td>4,961.0931</td>
<td>2,976.6559</td>
</tr>
<tr>
<td>June 2018</td>
<td>4,617.8414</td>
<td>2,770.7048</td>
</tr>
<tr>
<td>July 2018</td>
<td>5,112.3435</td>
<td>3,067.4061</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>25,600.510</strong></td>
<td><strong>15,360.3062</strong></td>
</tr>
</tbody>
</table>

4.4 Electricity Energy Produced

From Table 3, 1 m³ of methane gas equals 9.39 kWh

E = VGM x FK (Correction Factor)

= VGM x 9.39

1. January 2018

VGM = 2,327.7678 m³ / day

E = VGM x 9.39

= 2,327.7678 x 9.39

= 21,857.7396 kWh

For details, from January to July can be seen in the following table:
Table 7. VGM and Electric Energy Value

<table>
<thead>
<tr>
<th>Month 2018</th>
<th>VGM (m³)</th>
<th>E (kWh)</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>2,327.7678</td>
<td>21,857.7396</td>
</tr>
<tr>
<td>February</td>
<td>2,073.6202</td>
<td>19,471.2933</td>
</tr>
<tr>
<td>March</td>
<td>2,144.1514</td>
<td>27,950.7905</td>
</tr>
<tr>
<td>May</td>
<td>2,976.6559</td>
<td>27,950.7905</td>
</tr>
<tr>
<td>June</td>
<td>2,770.7048</td>
<td>26,016.9184</td>
</tr>
<tr>
<td>July</td>
<td>3,067.4061</td>
<td>28,802.9433</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>15,360.3062</strong></td>
<td><strong>144,233.2666</strong></td>
</tr>
</tbody>
</table>

Amount of electrical energy in year:
\[ E_{\text{Year}} = E_{\text{Total}} \times 2 \]
\[ = 144,233.2666 \text{ kWh} \times 2 \]
\[ = 288,466.5332 \text{ kWh} \]

4.5 Estimated Electricity Energy

Estimates in the daily average value from January to July 2018, the energy produced from the Puuwatu landfill in the daily average is 288,466.5332 kWh. Whereas the energy flowing through the Independent Energy area the number of houses is 125 houses and each house has 450 VA (2 Ampere MCB), then the daily count used to fulfill the energy independent region is as follows:
\[ 125 \times 360 \text{ watts} = 45,000 \text{ watts} \]
\[ = 45 \text{ kw} \times 24 \text{ hours} \]
\[ = 1,080 \text{ kWh} \]
So that the untapped energy from the potential at Puuwatu Landfill is as big as:
\[ E_{\text{Not}} = 288,466.5332 \text{ kWh} - 1,080 \text{ kWh} \]
\[ = 287,386.5332 \text{ kWh} \]

5 Conclusion

The conclusion obtained from this study is the amount of methane gas produced from the annual Puuwatu landfill is 15,360.3062 m³ and the amount of energy generated is 288,466.5332 kWh.

Compared to other big cities in Indonesia, the amount of methane gas acquisition in Puuwatu Kendari City is very small. This is very much determined by the amount of rubbish produced by the people of Kendari City, which only ranges from hundreds of tons per day compared to big cities like Surabaya, Palembang, Makassar, Bandung, Bekasi, with an average of 1500 tons to 2800 tons per day.

So, it is very natural that the government, in this case the Ministry of Energy and Mineral Resources, has launched the construction of a Waste-Generated Power Plant in several cities that produce very large amounts of waste per day between 1500 tons per day to 2800 tons per day. And not including the city of Kendari.
References


[8] Puneeta Dandotiya. Et.all. AN ECO-FRIENDLY MANAGEMENT OF HOUSEHOLD ORGANIC WASTE. Entomology Research Unit, School of Studies in Zoology, Jiwaji University, Gwalior, M.P. 474011. *Corresponding author’s E-mail: dpunei@gmail.com. Received: 23rd April 2015 Revised: 9th May 2015 Accepted: 16th May 2015.


Methane Gas Utilization from Organic Waste Volume in Tpa Puuwatu, Kendari City

Yuspian Gunawan¹, Jenny Delly², Ridway Balaka³, Salimin⁴, Sudarsono⁵, Budiman Sudia⁶, Abd Kadir⁷, Indrayati Galugu⁸, Bunyamin⁹
{yuspiangunawanstnt@gmail.com¹, enydelly09@gmail.com², bridway@yahoo.com³}

Mechanic Engineering Department, Halu Oleo University, Kendari, Indonesia ¹,²,³

Abstract. The purpose of this research was to determine the amount of waste in TPA Puuwatu and the volume of methane gas produced. It used a quantitative descriptive method with data obtained from related institutions, such as the Sanitation and Parks Office and the Central Statistics Agency. The survey location was TPA, which is a Final Waste Processing Site, Puuwatu in Kendari City. The results showed that the average volume of waste from January to July 2018 was 5,278 m³, though the total was 32,667 m³ with potential waste (Q) of 184,503,216 kg/day. The volume of methane gas produced was 15,360.3062 m³/day.

Keywords: Methane Gas, Organic Waste, Final Waste Processing Site (TPA)

1 Introduction

With increasing growth rate of population, municipal solid waste generation is expected to grow even faster, making the solid waste scenario much worse and a major bottleneck for development in Asian developing countries, like India.[1]

The energy-independent settlement in Kendari had a positive impact on some residents, especially around the city. The electricity in this area is generated from the utilization of organic waste. The byproducts are processed to produce methane (CH₄), which is used as fuel for power generation engines. [2]

In general, methane forms the main component of biogas and the simplest hydrocarbon. The main physical characteristics of methane include being colorless and odorless gas, highly flammable at levels between 5-15% and a molecular weight of 16.04, specific gravity of 0.554, boiling point of 161°C, and water solubility of about 35 mg/L at a pressure of 1 atmosphere. [3]

Based on the data from the Central Statistics Agency (BPS) for 2017, Kendari City has a total of 370,728 population with a density of 54 /km² producing a lot of waste. To effectively address the waste issue, the local government has implemented the 3R, which primarily means Reduce, Reuse, Recycle. Moreover, the government also carry out processing with Sanitary Landfill to produce methane.[4]

Around 60% of household waste is organic, while approximately 40% is inorganic. The amount of gas produced depends on the volume of organic waste. To determine the volume of waste in the TPA of Kendari City, a study analyzing methane gas utilization from the organic
waste volume was conducted. The purpose of this research therefore was to determine the amount of waste per day and the volume of methane gas produced in the TPA Puuwatu. [5]

2 Literature Review

2.1 Energy

Energy sources can be classified as conventional, especially where they are obtained from sources available in limited quantities and cannot be regenerated. Generally, renewable energy is produced from natural sources such as the sun, wind, and water, which have the potential to be reproduced. These resources are always available and do not harm the environment. Conventional and renewable energy can be converted into secondary sources, such as electricity. It is often referred to as a carrier since it can be converted into other forms, such as mechanical work comfortably. In general, primary energy sources are needed to produce electricity. [5]

In most of the recent EU member countries, as well as Spain and Greece, instead, sanitary landfilling is still the most-adopted waste management strategy (>50%). [6]

2.2 Organic Waste

Waste is a material discarded from human and natural activities due to a lack of economic value. It can be defined as an unwanted residual material after the end of a process. It is a human-made concept since, in natural processes, there is no waste, but only inmovable products. Essentially, waste may either be in the form of a solid, liquid, or gas. In case it is released in the liquid or gaseous state, it referred to as emissions, a term linked with pollution. Generally, large amounts of waste come from industrial activities, such as mining, manufacturing, and consumption. Almost all industrial products become waste, with the amount released being approximately similar to what is consumed. [7]

1. Waste Based on the Source
   a. Household
   b. Agriculture
   c. Office space
   d. Company
   e. Hospital
   f. Market, etc.

2. Waste based on nature
   a. Natural Waste
      Waste produced is integrated through a natural recycling process, such as dry leaves in the forest that break down into the soil. Away from wildlife, these wastes might be problematic; for example, dry leaves in a residential environment.
   b. Human Waste
      Human waste is a term commonly used to refer to the byproducts of human digestion, such as feces and urine. These wastes can be hazardous since they lead to diseases caused by viruses and bacteria. One of the main developments in human dialectics is the reduction of disease transmission through human waste with hygiene and sanitary, including the development of plumbing theory. Also, human waste can be reduced and reused, for example, through a waterless urinal system.
c. Consumption Waste
This is waste produced from the use of goods that are often thrown in the trash by humans. It is still far smaller than the waste generated from mining and industrial processes.

The municipal solid waste (MSW) generated by households is considered the third largest anthropogenic source of methane (CH4) emissions, constituting 11% of all global CH4 emissions.[8]

The municipal solid waste (MSW) generated by households is considered the third largest anthropogenic source of methane (CH4) emissions, constituting 11% of all global CH4 emissions.[9]

More than half of that trash ends up in landfills where it generates methane, a greenhouse gas that is over 20 times more potent than carbon dioxide. This methane from waste can be used to produce energy.[10]

2.3 Methane Gas
Methane has been rising rapidly in the atmosphere over the past decade, contributing to global climate change. Methane is the second most important greenhouse gas behind carbon dioxide causing global climate change, contributing approximately 1 Wm^-2 to warming when indirect effects are included compared to 1.66 Wm^-2 for carbon dioxide.[11]

Atmospheric methane levels rose steadily during the last few decades of the 20th century before leveling off for the first decade of the 21st century. Since 2008, however, methane concentrations have again been rising rapidly (Fig. 1a). This increase, if it continues in coming decades, will significantly increase global.[12]

The problem of solid waste management has been increased due to rapid increase of population, intensive agriculture and industrialization. Accumulation and improper methods of disposal of waste, including heaping, dumping, land filling and incineration, cause pollution and hazards to human and environmental health.[13]

3 Calculations

4 Amount of Total Solid (TS), Volatile Solid (VS), and Biogas Production

The calculation is based by Tanya Mc. Donald, Gopal Achari, and Bimbola Abiola in the article "Feasibility of Increased biogas production from the co-digestion of agricultural, municipal, and agro-industrial wastes in rural communities." By testing biogas production from organic waste, the value of waste to Total Solid (TS) and Volatile Solid (VS) is obtained, as shown in table 1. In this literature, the value of VS is equivalent to the biogas produced.

<table>
<thead>
<tr>
<th>Material Type (kg)</th>
<th>Total Solid (TS) (%)</th>
<th>Volatile Solid (VS) (%)</th>
<th>Biogas Production (m³/kg TS)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic Waste</td>
<td>27.7</td>
<td>74.1</td>
<td>0.676</td>
</tr>
</tbody>
</table>
From the table, the equation for calculating Total Solid, Volatile Solid, and biogas production is (Agung Sulistyo, 2010);

\[ TS = 27.7\% \times Q \]
\[ VS = 74.1\% \times TS \]
\[ VBS = 0.676 \times VS \]

**Description:**
- **Q** = Potential Waste (kg/day)
- **TS** = Total Solid
- **VS** = Volatile Solid (kg/day)
- **VBS** = Biogas production volume (m³/day)

### 3.2 Amount of Methane produced
Calculation of the potential amount of methane produced in a landfill process.

**Table 2.** The total volume of methane gas from organic waste [14]

<table>
<thead>
<tr>
<th>VBS</th>
<th>Jumlah gas metan (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>60</td>
<td></td>
</tr>
</tbody>
</table>

From the table above, the equation for calculating the gas is

\[ VGM = 60\% \times VBS \]

**Description:**
- **VGM** = Volume of methane gas (m³/day)
- **VBS** = Volume of Biogas production (m³/day)

### 4. Data Analysis

#### 4.1. Data of Waste Volume from January to July 2018

The data was obtained from the Technical Implementation Unit (UPTD) of TPA Puuwatu, as follows shown in table 3 below.

**Table 3.** Total volume of waste per month in 2018

<table>
<thead>
<tr>
<th>Month</th>
<th>Volume m³</th>
</tr>
</thead>
<tbody>
<tr>
<td>January</td>
<td>4,950.5</td>
</tr>
<tr>
<td>February</td>
<td>4,410.0</td>
</tr>
<tr>
<td>March</td>
<td>4,560.0</td>
</tr>
<tr>
<td>May</td>
<td>6,330.5</td>
</tr>
<tr>
<td>June</td>
<td>5,892.5</td>
</tr>
<tr>
<td>July</td>
<td>6,523.5</td>
</tr>
<tr>
<td>Total</td>
<td>32,667</td>
</tr>
</tbody>
</table>

### 4.2. Biogas Energy Capacity from Waste Raw Materials

The calculation of biogas energy capacity from raw materials in TPA Puuwatu per month.

1. **January 2018**
   For conversion from m³ to kg, the values are multiplied by 169.44. Therefore, 
   4950.5m³ is equivalent to = 4950.5 x 169.44
   = 838,812.7 Kg/month
= 838,812.7/30 day
= 27,960.424 Kg/day

\[ TS = 27.7 \% \times Q \]
\[ = 27.7 \% \times 27,960.424 \]
\[ = 7,745.037448 \text{ kg} \]

\[ VS = 74.1 \% \times TS \]
\[ = 74.1 \% \times 7,745.037448 \text{ kg} \]
\[ = 5,739.0727 \text{ kg} \]

\[ VBS = 0.676 \times VS \]
\[ = 0.676 \times 5,739.0727 \text{ kg} \]
\[ = 3,879.613 \text{ m}^3 \]

Complete data from January to July is shown in the table below.

<table>
<thead>
<tr>
<th>Table 4. Q and VBS Values in 2018</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Month</strong></td>
<td><strong>Q (kg/day)</strong></td>
</tr>
<tr>
<td>January</td>
<td>27,960.424</td>
</tr>
<tr>
<td>February</td>
<td>24,907.68</td>
</tr>
<tr>
<td>March</td>
<td>25,754.88</td>
</tr>
<tr>
<td>May</td>
<td>35,754.664</td>
</tr>
<tr>
<td>June</td>
<td>33,280.84</td>
</tr>
<tr>
<td>July</td>
<td>36,844.728</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>184,503.216</strong></td>
</tr>
</tbody>
</table>

4.3. Methane gas production

Energy production in biogas is proportional to the yield of methane gas.

\[ \text{VGM} = 60 \% \times \text{VBS} \]

Description:

\[ \text{VGM} = \text{Methane gas production (m}^3\text{/day)} \]
\[ \text{VBS} = \text{Biogas production volume (m}^3\text{/day)} \]

1. January 2018

\[ \text{VBS} = 3,879.613 \text{ m}^3 \]
\[ \text{VGM} = 60 \% \times \text{VBS} \]
\[ = 60 \% \times 3,879.613 \]
\[ = 2,327.7678 \text{ m}^3/\text{day} \]

Complete data from January to July is shown in table below.

<table>
<thead>
<tr>
<th>Table 5. Value of Methane Gas Production (VGM) in 2018</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Month</strong></td>
</tr>
<tr>
<td>January</td>
</tr>
<tr>
<td>February</td>
</tr>
<tr>
<td>March</td>
</tr>
<tr>
<td>May</td>
</tr>
<tr>
<td>June</td>
</tr>
<tr>
<td>July</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
</tr>
</tbody>
</table>

5. Conclusions

Based on the findings, this study concludes that;
The amount of organic waste production in TPA Puuwatu in 2018 was 32,667 m³ or 5,535,096.48 Kg/Month. However, the amount of organic waste in 2018 was meager compared to the production in big cities such as in Surabaya, Palembang, Bekasi, Denpasar, Jakarta, Makassar, Manado, and South Tangerang with an average of 1500 to 2800 tons/day. Other essential values include; potential waste (Q) 184,503.216 kg/day, volume of Biogas (VBS) and methane production 25,600.5103 m³ and 15,360.3062 m³/day, respectively.

References


[2] Tasnim, Tasnim, and Maria Inge Lusida. "EFFECTIVITY OF COMMUNITY INVOLVEMENT IN FOOD CONTROL TO INCREASE THE QUALITY OF FAST FOOD IN KENDARI CITY INDONESIA."


Spatial Perspective on Thermal Comfort and Energy Consumption: a PLS-SEM approach

Bayu Andalas1,2, Haryoto Kusnoputranoto2, Suyud Warno Utomo2,3 and Raldi H. Koestoer2,4

1 Jakarta Provincial Government, Jl. Medan Merdeka Selatan Kav.8-9 Jakarta Pusat, Jakarta, 10000, Indonesia
2 School of Environmental Science, University of Indonesia, Jl. Salemba Raya, Jakarta Pusat, Jakarta, 10000, Indonesia
3 Faculty of Public Health, University of Indonesia, Depok, Indonesia
4 Coordinating Ministry for Economic Affairs, Republic of Indonesia, Jakarta, Indonesia

Corresponding author: bayu.andalas@ui.ac.id

Abstract. Jakarta has implemented Environmentally-friendly buildings and Energy-saving act policy. But the energy consumption in a building is moderately increased all the time. It dominated by consumption in building’s air conditioner and related to thermal comfort for building’s occupants and also the work performance of civil services employees. This research is providing statistical questionnaire-based of subjective answers by a public service employee of Jakarta Capital Government. This study was conducted by concerning spatial perspective or geographic location of the object in six administrative parts of Jakarta Capital City (center, east, north, west, south and Seribu archipelago). The questions is spreads to 367 buildings occupants during the dry-wet season (October-November). The study were performed in 311 Public service facility, then the data is analyzed by Partial Least Square Structural Equation Modeling (PLS-SEM) method to answer research questions about the link between thermal comfort and energy consumption. The results showed a significant result between two variables. A model using those variables was generated to show the link between them and suggested as a tool to conduct better building-related policies in Jakarta Provincial Government.

Keywords: Sustainable Building, Thermal Comfort, Energy Saving, Structural Equation Modelling

1 Introduction

Green building policy exists in Jakarta Capital City Government since 2012, but ironically, the energy consumption in a building is still increased all the time (Pemprov DKI, 2015). In several types of research [1], buildings consuming energy more than 40% in general global energy, and also provide more than 30% CO2 in general. This is mainly caused by the usage of Air Conditioning System which impacted by building occupants' thermal comfort, especially in the tropical region city like Jakarta [2].

Jakarta Provincial Government in this regime is eager to increase civil service employee’s productivity (Pemprov DKI, 2017). To provide better services to its inhabitants, Jakarta Provincial Government built standardized 311 regional offices in its sub-district (267) and
district (44) to provide any administrative services. The building Indoor Air Quality become a critical part of making the building occupant's comfort [3]. Every district offices and sub-district offices equipped with AC (Air Conditioner) in its service area or the working office, which will consume more energy to provide better services.

The current condition is not compatible with Sustainable Development principles by Salim and UN’s Sustainable Development Goals (Salim, 2015). Research conducted by [4] shows a link between Thermal comfort and energy consumptions. Thus variables also appear in research by [5] which show a connection between thermal comfort and work performance also a connection between energy consumptions and environmental-friendly perception of building’s occupants.

2 Literature Review

This research expected to examine the link between variables and visioned to develop a policy for environmentally friendly (low energy) state-owned government office to the environmentally-friendly concept and better work performance in buildings occupant.

2.1 Thermal Comfort

According to [6], Thermal comfort is influenced by physical condition of the buildings and also influenced by the individual preference [7]. In this study the seven-point scale of ASHRAE used in the questionnaire based on method developed by [8].

2.2 Work Performance

Work performance of the building’s occupants is related to thermal comfort [9] and [10], a modified work performance parameters from [9] deployed in this research is focused on work performance of civil servant employee of Jakarta Capital City Government based on questionnaire survey.

2.3 Environmentally-friendly perception

Environmentally-friendly perception in every building is measured by asking questions to each building occupants or building user, the question is adapted from [11] and [12], the question designed to determine how the building occupants aware and percept to environmentally friendly concept.

2.4 Spatial Perspective

Several researcher had discovered a link between geographical location to thermal comfort such as research by [13] or research by [14] in Jaipur India and [15] in Vietnam, mention how urban heat and temperature will be different based on locations and elevation of the measured object. In figure 1. below shown the location of each objects of each public building facility in Jakarta, Indonesia.
2.5 Building Energy Consumption

This research has focused on how human interacted with its building and impacted to building energy consumption, so the research focused in its human interaction based on research by [16] and also research by [17] a set of questions is arranged to measure people’s perception to building energy consumption.

3 Hypotheses

The hypotheses of this research is to examine:

Ha1: Thermal comfort influencing Building Energy Consumption

Ha2: Building perception to sustainable has a correlation to energy consumption

Ha3: Thermal comfort in government building influencing building occupants work performance

Ha4: Thermal comfort has a correlation to work satisfaction

Ha5: Public facility building will be environmentally sustainable if consider thermal comfort and work satisfaction

4 Materials and methods

This study is consist of: Subjective questionnaire survey to examine thermal comfort, work performance and environmentally friendly perception of 367 building occupants by adapting the questionnaire method of [8]. The variables compared to the energy consumption of 311 administrative office buildings by determine the Building Energy Consumption.

Population in this research is divided into 2(two) kinds as follows following method developed by [18]: (a) Building Occupants is a civil service employee who work in a state-owned (Jakarta Provincial Government) building counted 67.809 peoples consist of 33.477 (49.36%) males and 34.332 (50.63%) females and (b) State-owned buildings counted 311 buildings located in several locations (North, Central, South, East, West and Seribu Archipelago) of Jakarta Capital City Territory. Based on Slovin’s equation in [19] a minimum 367 samples of civil service
employee and based on Tabachnick’s equation [20], 58 buildings should be examined to conduct the research with a typical condition and shape like in the figure below:

**Fig. 2. Typical Government Office in Jakarta**

To compare the answers by the individual building occupants with the physical conditions of the buildings, this research using direct measurement of the physical condition of the building while the e-questionnaire spread during the office hour in each building.

Link between Environmental friendly perception and work satisfaction is appeared in several research like [21] and [22], then a connection between Environmentally friendly perception and energy consumption appear in many research such as [5], [12], [23] every research mentioned above show a direct relation and mutual relationship between both variables, the rest variables such as Thermal Comfort, Energy performance and work satisfaction is appeared in several research such as: [4], [9], [10], [17], [24]. Based on literature review studies to understand link and connection between variables, a chart is established in figure below:

**Fig. 3. PLS-SEM model**
to examine quantitatively between variables so Partial Least Structural Equation Modelling (SEM) were used to understand link using subjective questionnaire as shown in Figure 2. Those variables are measured in PLS-SEM using these assessments criteria based on research question in each criteria based on research by [25] in Table 1:

<table>
<thead>
<tr>
<th>No</th>
<th>Independent Variables</th>
<th>Objectives</th>
</tr>
</thead>
<tbody>
<tr>
<td>X</td>
<td>Environmentally-Friendly Perception</td>
<td></td>
</tr>
<tr>
<td>X1</td>
<td>Environmentally-friendly material</td>
<td></td>
</tr>
<tr>
<td>X2</td>
<td>Water Conservation</td>
<td></td>
</tr>
<tr>
<td>X3</td>
<td>Water Conservation and Rain Harvesting</td>
<td></td>
</tr>
<tr>
<td>X4</td>
<td>Energy Diversity</td>
<td></td>
</tr>
<tr>
<td>X5</td>
<td>Ozone Friendly Material</td>
<td></td>
</tr>
<tr>
<td>X6</td>
<td>Energy Efficient Lighting and Air Conditioning</td>
<td></td>
</tr>
<tr>
<td>X7</td>
<td>Domestic Waste Water Management</td>
<td></td>
</tr>
<tr>
<td>X8</td>
<td>Waste Separation</td>
<td></td>
</tr>
<tr>
<td>X9</td>
<td>Indoor Health Quality</td>
<td></td>
</tr>
<tr>
<td>X10</td>
<td>Sustainable Site</td>
<td></td>
</tr>
<tr>
<td>X11</td>
<td>Disaster Risk Facilities</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>X</th>
<th>Thermal Comfort in Public Facility/Government Building</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y1</td>
<td>Indoor Activity</td>
</tr>
<tr>
<td>Y12</td>
<td>Daily Activities</td>
</tr>
<tr>
<td>Y13</td>
<td>Clothing</td>
</tr>
<tr>
<td>Y14</td>
<td>Thermal Comfort Perception</td>
</tr>
<tr>
<td>Y15</td>
<td>Thermal Comfort Desire</td>
</tr>
<tr>
<td>Y16</td>
<td>Thermal Comfort Satisfaction</td>
</tr>
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<td>Y17</td>
<td>Thermal Comfort Dissatisfaction</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Dependent Variables</th>
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</thead>
<tbody>
<tr>
<td>Y2</td>
</tr>
<tr>
<td>Y21</td>
</tr>
<tr>
<td>Y22</td>
</tr>
<tr>
<td>Y23</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dependent Variables</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
<tr>
<td>Y31</td>
</tr>
<tr>
<td>Y32</td>
</tr>
<tr>
<td>Y33</td>
</tr>
</tbody>
</table>

<table>
<thead>
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<th>Dependent Variables</th>
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</tr>
<tr>
<td>Y41</td>
</tr>
<tr>
<td>Y42</td>
</tr>
<tr>
<td>Y43</td>
</tr>
<tr>
<td>Y44</td>
</tr>
</tbody>
</table>
5 Analytical methods

In this research, the data is analyzed using SPSS Statistics v.24 and SmartPLS v.3.2.2 [26], the
PLS is used due to the limitation of the data gathered from the respondents. Variance based
PLS-SEM also used because PLS-SEM able to handle reflective and formative model which
included in the proposed model of this research [27]. Moreover, PLS-SEM preference are made
because of its ability to estimate causal relationship in every latent construct in single time/real-
time while a pact with errors of measurement in a structural model.

[28] also suggest measurement model should be evaluated in different way while evaluating the
structural model. Moreover, in order to make sure the data consistency and quality of structural
model, several other test should be performed while conducting other validity and reliability
checks before conducting analysis of PLS-SEM.

Based on guideline performed by [26] an evaluation to assessment criteria should be made to
consider each questions be made correctly, the assessment criteria are shown in Table 2.

Table 2. Assessments criteria

<table>
<thead>
<tr>
<th>Evaluation</th>
<th>Indicators</th>
<th>Assessment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outer Model</td>
<td>1. Indicator reliability</td>
<td>Outer loading value 0,5 to 0,7 due to exploratory research</td>
</tr>
<tr>
<td></td>
<td>2. Discriminant validity</td>
<td>Variable indicator to latent variable Cross loading value should be higher</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rather than another latent variable Fornell-Lacker of every latent variable</td>
</tr>
<tr>
<td></td>
<td></td>
<td>should be higher than latent variables correlation</td>
</tr>
<tr>
<td></td>
<td>3. Internal consistency</td>
<td>Composite reliability ≥ 0,6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Cronbach’s alpha ≥ 0,6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Composite reliability ≥ 0,8</td>
</tr>
<tr>
<td></td>
<td>4. Convergent validity</td>
<td>Average Variance Extracted (AVE)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>should be higher than 0,5</td>
</tr>
<tr>
<td>Inner Model</td>
<td>Determinant Coefficient (R^2)</td>
<td>R^2&gt; 0,75 value is good</td>
</tr>
<tr>
<td></td>
<td>Structural Model Coefficient</td>
<td>Significant</td>
</tr>
</tbody>
</table>

6 Respondent Demographic

By examining the Location, educational level, and the age of the respondents specific
understanding of thermal comfort and its supporting factors based on each geographical
locations could be examined. Complete details about the respondents’ demographic attributes
are listed in Table 3.

Table 3. Demographic of Respondents

<table>
<thead>
<tr>
<th>Age years old (ya)</th>
<th>Sum</th>
<th>%</th>
<th>Location</th>
<th>Sum</th>
<th>Percentage</th>
</tr>
</thead>
</table>
During the survey, most respondents have an undergraduate degree education (Undergraduate/equal 54% and graduate degree 31%), so the questionnaire question confirmed to be understandable by the respondents. In the survey, respondents given a set of questions using a digital questionnaires in a cellphone applications with each questions asked individually. The questionnaire spreads during office hour GMT 07:30-17:00 and under specific month (September-October), these month is an intermediary month between dry-wet season in tropical area region like Jakarta (BMKG, 2018) recorded during these month the outdoor humidity level will be higher than other months. Hopefully, The objective to understand the thermal comfort will be achieved.

By using bootstrapping in PLS-SEM, each questions is measured and resulting value as follow:

![Diagram](image)

**Fig. 4.** Bootstrapping in PLS-SEM

7 Results and Discussions

Each variables (independent and dependent) divided into several objectives and questions as follow, every questions in the variables is merged to the PLS-SEM model as appeared in Fig.1, with several question reflecting every objective in the questionnaires. The result show Thermal
Comfort and Energy Consumption variables did not meet the criteria of Internal Consistency with the value of Composite reliability ≥ 0.8, the result shown in Table 4.

**Table 4. Variables and result**

<table>
<thead>
<tr>
<th>Latent Variables</th>
<th>Composite Reliability</th>
<th>Cronbachs Alpha</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmentally-friendly perception (EF)</td>
<td>0.886</td>
<td>0.869</td>
<td>Meet Criteria</td>
</tr>
<tr>
<td>Thermal Comfort (TC)</td>
<td>0.501</td>
<td>0.280</td>
<td>Not Meet Criteria</td>
</tr>
<tr>
<td>Energy Consumption (EC)</td>
<td>0.034</td>
<td>0.456</td>
<td>Not Meet Criteria</td>
</tr>
<tr>
<td>Work Satisfaction (WS)</td>
<td>0.864</td>
<td>0.765</td>
<td>Meet Criteria</td>
</tr>
<tr>
<td>Work Performance (WP)</td>
<td>0.808</td>
<td>0.692</td>
<td>Meet Criteria</td>
</tr>
</tbody>
</table>

Furthermore, each question in every variable also measured to understand the validity of each question to fit the proposed model, the results are shown below in Table 5:

**Table 5. Variables and conclusion**

<table>
<thead>
<tr>
<th>Variables</th>
<th>Indicator</th>
<th>Objective</th>
<th>Loading Factors</th>
<th>T Statistics</th>
<th>Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Environmentally friendly perception</td>
<td>X1</td>
<td>Knowledge of Environmentally friendly material</td>
<td>0.528472</td>
<td>24.736</td>
<td>Valid</td>
</tr>
<tr>
<td></td>
<td>X2</td>
<td>Indoor Water Conservation</td>
<td>0.313194</td>
<td>6.941</td>
<td>Invalid</td>
</tr>
<tr>
<td></td>
<td>X3</td>
<td>Rainwater Conservation</td>
<td>0.263194</td>
<td>5.105</td>
<td>Invalid</td>
</tr>
<tr>
<td></td>
<td>X4</td>
<td>Energy Diversification</td>
<td>0.313194</td>
<td>6.652</td>
<td>Invalid</td>
</tr>
<tr>
<td></td>
<td>X5</td>
<td>Ozone Friendly Air Conditioning</td>
<td>0.511805</td>
<td>22.402</td>
<td>Valid</td>
</tr>
<tr>
<td></td>
<td>X6</td>
<td>Energy Saving</td>
<td>0.521527</td>
<td>26.356</td>
<td>Valid</td>
</tr>
<tr>
<td></td>
<td>X7</td>
<td>Domestic waste water management</td>
<td>0.402777</td>
<td>10.161</td>
<td>Valid</td>
</tr>
<tr>
<td></td>
<td>X8</td>
<td>Waste Sorting</td>
<td>0.410416</td>
<td>14.105</td>
<td>Valid</td>
</tr>
</tbody>
</table>
Based on above table, not all indicator of every construct has a loading factor value above 0.5 so it can be concluded those invalid criteria can be put aside or removed to answering the
research questions. In the table 6 below, PLS SEM also measured the path coefficient and Structural Model Test.

### Table 6. Path Coefficient and Structural Model Test

<table>
<thead>
<tr>
<th>Path</th>
<th>T Statistics</th>
<th>R square</th>
</tr>
</thead>
<tbody>
<tr>
<td>X -&gt; Y2</td>
<td>-0.044</td>
<td>0.101</td>
</tr>
<tr>
<td>Y4 -&gt; Y2</td>
<td>-0.262</td>
<td>0.214</td>
</tr>
<tr>
<td>X -&gt; Y3</td>
<td>0.457</td>
<td>0.049</td>
</tr>
<tr>
<td>Y1 -&gt; Y3</td>
<td>0.313</td>
<td>0.047</td>
</tr>
<tr>
<td>Y1 -&gt; Y4</td>
<td>0.001</td>
<td>0.063</td>
</tr>
<tr>
<td>Y3 -&gt; Y4</td>
<td>0.499</td>
<td>0.054</td>
</tr>
</tbody>
</table>

As seen in Table above, A link between Environmental Perception (EP) and Work Performance to Energy consumption is measured 0.081. It means Energy consumption can be explained by Environmentally friendly perception and work performance for 8.1%. The rest of it (91.9%) could be explained by other unexamined variables. Based on other research by [3], [9] this might be related to unexamined variables in this research such as: Personal factors or even outdoor climate during the examination.

Moreover, link between Environmental Perception (EP) and Thermal Comfort to Job Satisfaction is measured 0.384. It means Job Satisfaction can be explained by Environmentally friendly perception and work performance for 38.4%. The rest of it (61.6%) could be explained by other unexamined variables. Based on other research by [3], [9] this might be related to unexamined variables in this research such as: Personal satisfaction or even outdoor climate during the examination.

Moreover, the PLS-SEM measurement is trying to answer the hypotheses shown above, the results can be seen in Table 7 below:

### Table 7. Test the hypotheses

<table>
<thead>
<tr>
<th>Hypotheses (Before intervention)</th>
<th>Path Coefficient (Before intervention)</th>
<th>( t_{\text{count}} )</th>
<th>( t_{\text{critical}} )</th>
<th>Result (Before intervention)</th>
<th>Path Coefficient (After intervention)</th>
<th>( t_{\text{count}} )</th>
<th>( t_{\text{critical}} )</th>
<th>Result (After intervention)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ha1</td>
<td>-0.044</td>
<td>0.2986</td>
<td>1.96</td>
<td>Rejected</td>
<td>0.006</td>
<td>0.096</td>
<td>1.96</td>
<td>Rejected</td>
</tr>
<tr>
<td>Ha2</td>
<td>-0.262</td>
<td>1.226</td>
<td>1.96</td>
<td>Rejected</td>
<td>-0.221</td>
<td>3.859</td>
<td>1.96</td>
<td>Accepted</td>
</tr>
<tr>
<td>Ha3</td>
<td>0.317</td>
<td>9.389</td>
<td>1.96</td>
<td>Accepted</td>
<td>0.327</td>
<td>9.348</td>
<td>1.96</td>
<td>Accepted</td>
</tr>
</tbody>
</table>
Ha1: Thermal comfort does not impact Building Energy Consumption
Ha2: Building perception to sustainable has a correlation to energy consumption
Ha3: Thermal comfort in government building influencing building occupants work performance
Ha4: Thermal comfort has a correlation to work satisfaction
Ha5: Public facility building is not related thermal comfort and work satisfaction

Acknowledgements. The authors would like to thank Universitas Indonesia for supporting our research under grand scheme Hibah Publikasi Internasional Terindeks untuk Tugas Akhir Mahasiswa A (PITMA-A) Number: NKB-0886/UN2.R3.1/HKP.05.00/2019

References


Urban Growth of Palembang and Its Impact on Land Surface Temperature Using Remote Sensing and GIS Technique

Johannes Adiyanto¹, Adhika Atyanta²
{johannesadiyanto@ft.unsri.ac.id¹, adhika.atyanta@gmail.com²}

Universitas Sriwijaya, Jl. Palembang - Prabumulih KM.32 Kabupaten Ogan Ilir, South Sumatera, Indonesia¹,²

Abstract. Palembang has a new identity after a sports event. Palembang transforms from river city to landed city. This research analyses the transformation of Palembang using remote sensing and spatial metrics. This research used 3 different images of the map taken from Landsat image. That maps separate into 4 categories: first maps from 2001 and 2003, before National sports event in 2004; second map, after SEA Games, map 2014; the third from the maps of 2015 and 2016 (before Asian Games 2018) and the last map at 2018, after all sport event at Palembang. Those maps are taken from Landsat 7 dataset and were analysed into two different categories, first categories were analysed the built-up index and second one about land surface temperature. This research shows that sports events can transform Palembang into a modern city. The result shows that the urban growth of Palembang brought the impact that the land surface temperature increased.

Keywords: Urban Growth, Remote Sensing Analysis, GIS Technique, and Land Surface Temperature

1. Introduction

Palembang is one of the oldest city in Indonesia. In past time, Palembang develops based on Musi river. There were many important places in kingdom era or old kampong located at Musi riverbank. This situation also happened when many oil companies build their refinery and dwelling area. Musi river becomes an important infrastructure in that time (Sevenhoven, 2015).

The urban growth of Palembang was spurred on urban transportation. It was occurred when the Dutch build their dwelling place at Talang Semut. That located little bit far from Musi riverbank. The Dutch government also build many roads in Palembang. Talang Semut become the first ‘real estate’ in Palembang and the first urban sprawl area. After that, Japanese also build a road from core old city to the airport, around 15 km. In 1962, Palembang has a big bridge to connect between North area (Ilir side) to South area (Ulu Side). That is Ampera Bridge, and today become an icon of Palembang (Santun, 2011). Right now, the road become ‘backbone’ of infrastructure in Palembang.

This research tries to show that information from remote sensing data can be basic information to plan the city in the future, like Batty describe how the growth of big data is shifting the emphasis from longer-term strategic planning to short-term thinking about how cities function and can be managed, although with the possibility that over much longer periods of time, this kind of big data will become a source for information about every time horizon (Batty, 2013).
This paper is the first steps of collecting data for complete big data of Palembang city. This paper show identifies the urban growth of Palembang. This identified the second phase of that transformation of Palembang city. Now, Palembang known as a sports city, because at the South area (Ulu side) already build a sports facility. That facilities build before PON XVI at 2004, called Jakabaring Sports city. The paper identifying urban growth at 2001 and 2003, before a national sports event, the second period after SEA GAMES, at 2014, the third period at 2015 and 2016, after before Asian Games and the fourth period at 2018. This result of identified is how the trend of urban growth of Palembang and how large urban sprawl in this city. This identification result can be interpreted how the infrastructure in Palembang support city growth.

The research using remote sensing data analysis for measuring the built-up area was already done in Yogyakarta (Hidayati, Suharyadi, & Danoedoro, 2018). The Improving the normalized difference built-up index to map urban built-up area also was already done by research team from Beijing Normal University (He, Shi, Xie, & Zhao, 2010). The research which have aim to count the air temperature using remote sensing data analysis already did in Beijing (Zhang & Du, 2019). This research try to get the connection between built-up area and UHI.

The main question of this paper, the first steps of research, is how is Palembang growth? And what is the environment impact? The main purpose of this paper is making critics of urban planning of Palembang. This paper explores the potential problem which can happen in the future time.

2. Method

This paper used remote sensing data analysis for main method. The data sources used Landsat 7 dataset. Generally, Landsat data are used for classification. Landsat data having several bands based on their wavelength (blue band, green band, red band, infrared band, thermal band, panchromatic). Panchromatic band is used for increase the resolution of data. Landsat 7 data having total of 8 band while Landsat 8 data having 11 bands. This is the detail of Landsat 7 dataset:

<table>
<thead>
<tr>
<th>No</th>
<th>Satellite</th>
<th>ID</th>
<th>Date time</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Landsat 7</td>
<td>LE07_L1TP_124062_20010713_20170204_01_T1</td>
<td>3-Jul-01</td>
</tr>
<tr>
<td>2</td>
<td>Landsat 7</td>
<td>LE07_L1TP_124062_20031023_20170124_01_T1</td>
<td>23-Oct-03</td>
</tr>
<tr>
<td>3</td>
<td>Landsat 7</td>
<td>LE07_L1TP_124062_20071002_20170101_01_T1</td>
<td>2-Oct-07</td>
</tr>
<tr>
<td>4</td>
<td>Landsat 7</td>
<td>LE07_L1TP_124062_20120913_20161129_01_T1</td>
<td>13-Sep-12</td>
</tr>
<tr>
<td>5</td>
<td>Landsat 7</td>
<td>LE07_L1TP_124062_20140802_20161111_01_T1</td>
<td>2-Aug-14</td>
</tr>
<tr>
<td>6</td>
<td>Landsat 7</td>
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<td>4-Jul-15</td>
</tr>
<tr>
<td>7</td>
<td>Landsat 7</td>
<td>LE07_L1TP_124062_20160807_20161009_01_T1</td>
<td>7-Aug-16</td>
</tr>
<tr>
<td>8</td>
<td>Landsat 7</td>
<td>LE07_L1TP_124062_20181117_20181214_01_T1</td>
<td>17-Nov-18</td>
</tr>
</tbody>
</table>

In build-up index side (right side of Fig 1.), this paper used work of Tek Bahadur Kshetri friends worked. They explained that land Surface Temperature (LST) is the temperature of the

1 https://landsat.gsfc.nasa.gov/landsat-7/
surface which can be measured when the land surface is in direct contact to the measuring instrument (Jeevalakshmi, Narayana Reddy, & Manikiam, 2017). Based on that dataset, this paper used this steps:

![Flowchart of analysis technique](image)

**Fig. 1.** Flowchart of analysis technique
3. Results And Discussions
3.1. Validation explanation

In Table 1, this paper used dataset from 2001, 2003, 2007, 2012, 2014, 2015, 2016, and 2018. This result needs validation. The correlation:

Table 2. Correlation All dataset

<table>
<thead>
<tr>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Correlations</strong></td>
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</tr>
<tr>
<td>Pearson</td>
<td><em><strong>0.997</strong></em></td>
<td>0.709</td>
<td>0.699</td>
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<td>0.940</td>
<td>0.911</td>
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<td>0.001</td>
<td>0.016</td>
<td>0.010</td>
<td>0.023</td>
<td>0.048</td>
<td>0.031</td>
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</tr>
<tr>
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<td>0.800</td>
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<td>0.723</td>
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<td>0.823</td>
<td>0.800</td>
<td>0.177</td>
<td>0.209</td>
<td>0.142</td>
<td>0.109</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<td>0.032</td>
<td>0.001</td>
<td>0.005</td>
<td>0.015</td>
<td>0.031</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<td>0.016</td>
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<td>0.142</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<td>0.003</td>
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<td>0.955</td>
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<td>1.000*</td>
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<tr>
<td>Pearson</td>
<td>0.862</td>
<td>0.955</td>
<td>0.955</td>
<td>0.955</td>
<td>0.955</td>
<td>0.955</td>
<td>0.955</td>
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<td>0.004</td>
<td>0.038</td>
<td>0.038</td>
<td>0.019</td>
<td>0.017</td>
<td>0.017</td>
<td>0.017</td>
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<tr>
<td>Pearson</td>
<td>0.862</td>
<td>0.955</td>
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<td>0.955</td>
<td>0.955</td>
<td>0.955</td>
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<tr>
<td>Sig. (2-tailed)</td>
<td>0.004</td>
<td>0.038</td>
<td>0.038</td>
<td>0.019</td>
<td>0.017</td>
<td>0.017</td>
<td>0.017</td>
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<td>4</td>
</tr>
</tbody>
</table>

** Correlation is significant at the 0.01 level (2-tailed).
* Correlation is significant at the 0.05 level (2-tailed).

Table 2 showed that in 2007 and 2012 was not valid data, because Var2007 has Pearson nya 0.86x, sig. 0.139 and Var2012 has Pearson 0.85x, sig 0.146. Valid data has sig>0.05 and Pearson >0.95. This was an argument why dataset in 2007 and 2012 be taken out from dataset.
After invalid data has been issued, this was the correlation:

Table 3. Correlation valid dataset

<table>
<thead>
<tr>
<th></th>
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<td>v2003</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Pears on Correlation</td>
<td>.999**</td>
<td>.996*</td>
<td>.995**</td>
<td>.971*</td>
<td>.957*</td>
<td>.991**</td>
<td></td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.001</td>
<td>.010</td>
<td>.005</td>
<td>.021</td>
<td>.038</td>
<td>.005</td>
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<tr>
<td>Pears on Correlation</td>
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<td>.990*</td>
<td>.999**</td>
<td>.998**</td>
<td>.991**</td>
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<td>Sig. (2-tailed)</td>
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<td>.001</td>
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<tr>
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<td>.995**</td>
<td>.999**</td>
<td>1</td>
<td>.995**</td>
<td>.995*</td>
<td>1.009**</td>
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<tr>
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<td>.005</td>
<td>.001</td>
<td>.005</td>
<td>.015</td>
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<td>v2016</td>
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<tr>
<td>Pears on Correlation</td>
<td>.971**</td>
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<td>.990**</td>
<td>.995**</td>
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<td>.999**</td>
<td>.994**</td>
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<tr>
<td>Sig. (2-tailed)</td>
<td>.029</td>
<td>.021</td>
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<td>v2018</td>
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<tr>
<td>Pears on Correlation</td>
<td>.952*</td>
<td>.962*</td>
<td>.991**</td>
<td>.985*</td>
<td>.999**</td>
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<td>.984*</td>
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<tr>
<td>Sig. (2-tailed)</td>
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<td>.038</td>
<td>.009</td>
<td>.015</td>
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<tr>
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<td>.995**</td>
<td>.999**</td>
<td>1.000**</td>
<td>.994*</td>
<td>.984*</td>
<td>1</td>
</tr>
<tr>
<td>Sig. (2-tailed)</td>
<td>.009</td>
<td>.005</td>
<td>.001</td>
<td>.000</td>
<td>.006</td>
<td>.016</td>
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<td>4</td>
<td>4</td>
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<td>4</td>
</tr>
</tbody>
</table>

**, Correlation is significant at the 0.01 level (2-tailed).
*, Correlation is significant at the 0.05 level (2-tailed).

If both dataset was compared with Cronbach's alpha, we could see the result below:

Table 4. Reliability Statistic

<table>
<thead>
<tr>
<th>Reliability Statistics</th>
<th>Cronbach's Alpha</th>
<th>Cronbach's Alpha Based on Standardized Items</th>
<th>N of Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Table 2 Correlation All dataset</td>
<td>.980</td>
<td>.987</td>
<td>8</td>
</tr>
<tr>
<td>Table 3 Correlation valid dataset</td>
<td>.990</td>
<td>.998</td>
<td>6</td>
</tr>
</tbody>
</table>
3.2. Built Up Area

Built-up Index which used NDBI and NDVI following this formulation: NDBI – NDVI = BU. The result of Built-up directly change to kilometre square area. The result of analysis can describe like this:

![Built Up Index of Palembang in KM²](image)

Based on result, the built area can describe like this table:

<table>
<thead>
<tr>
<th>Years</th>
<th>2001</th>
<th>2003</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non BU</td>
<td>278</td>
<td>276</td>
<td>246</td>
<td>238</td>
<td>233</td>
<td>225</td>
</tr>
<tr>
<td>BU</td>
<td>89</td>
<td>91</td>
<td>121</td>
<td>129</td>
<td>134</td>
<td>142</td>
</tr>
<tr>
<td>TOTAL</td>
<td>367</td>
<td>367</td>
<td>367</td>
<td>367</td>
<td>367</td>
<td>367</td>
</tr>
</tbody>
</table>

Table 5 showed that at 2014 there was an increase in built-up area. For detail, we can see below:

![Built Up Area Change](image)

Fig. 3. Growth Chart of Built-up Area
3.2. Land Surface Temperature.

The result of Land Surface Temperature (LST) can be visualized in this figure:

Fig. 4. LST of Palembang

A UHI is recognized as a climatic phenomenon in which urban areas have higher air temperature than their surrounding rural area as a result of anthropogenic modification of land surfaces, urban expansion, population growth, energy use, and its consequent generation of waste heat which causes alarming effects in many metropolitan areas (Lee, et al., September 2017).

Based on LST we can described UHI area of Palembang, like this figure:

Fig. 5. UHI area of Palembang
For detail area of UHI at Palembang, we can see in this table:

<table>
<thead>
<tr>
<th>Years</th>
<th>2001</th>
<th>2003</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non UHI</td>
<td>260</td>
<td>264</td>
<td>256</td>
<td>242</td>
<td>249</td>
<td>247</td>
</tr>
<tr>
<td>UHI</td>
<td>107</td>
<td>103</td>
<td>111</td>
<td>125</td>
<td>118</td>
<td>120</td>
</tr>
<tr>
<td>TOTAL</td>
<td>367</td>
<td>367</td>
<td>367</td>
<td>367</td>
<td>367</td>
<td>367</td>
</tr>
</tbody>
</table>

3.3. Discussions

3.3.1. Correlation

The correlation between Built-up and UHI can be described in this chart:

![Fig. 6. Chart of correlation between built-up and UHI](image)

This chart showed, there are positive correlation between UHI-BUI with R² = 0.7546

3.3.2. Detail Correlation

Based on this correlation, we can discuss more specific between Built-up and UHI. This part discusses about detail years and urban area. The area of built-up and UHI can showed like this:

<table>
<thead>
<tr>
<th></th>
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<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>UHI</td>
<td>107</td>
<td>103</td>
<td>111</td>
<td>125</td>
<td>118</td>
<td>120</td>
</tr>
<tr>
<td>BU</td>
<td>89</td>
<td>91</td>
<td>121</td>
<td>129</td>
<td>134</td>
<td>142</td>
</tr>
</tbody>
</table>
If Table showed in chart, can be showed like this:

![Chart Correlation between UHI and Built-Up](image.png)

**Fig. 7.** Chart Correlation between UHI and Built-Up

In Fig. 7, showing that in 2014 and 2015 BU and UHI have an increased data compared to previous years. After 2015, Built-up growth still continues, but in UHI has decreased. In this part, we focused at 2015.

That area which have increase data in 2014 to 2015 located in the north side of Palembang. There are four sub-districts in the north side of Palembang: sub-district Sako, sub-district Sematang Borang, sub-district Sukarami, and sub-district Alang-alang Lebar. This is the population growth of this north side of Palembang:

![Detail Analysis Growth Urban Area at 2014 and 2015](image.png)

**Fig. 8.** Detail Analysis Growth Urban Area at 2014 and 2015
In Fig 9, we can see that Sukarami sub-district is the greatest population in north side of Palembang. Sukarami sub-district is sub-urban area. This sub-district have an airport and also large residential area.

Back to main question, Was it urban growth of Palembang correlated with sport event? Palembang become the host of national sport event, PON XIV in 2004. Palembang also become co-host with Jakarta for sport event of South East Asia conturies, SEA Games XXVI, in 2011. After 2011, Palembang prepared to become co-host of Asian Games in 2018. Palembang build infrastructure for support that event in 2015. One of modern infrastructure is Light Rail Transit (LRT) which started in end of 2015. This modern moda transportation started at airport and the end station in Jakabaring sport city in the south side of Palembang. From figure 8 in previous, we can see that Jakabaring sport city in north side didn’t have increased data of UHI or BU, because this area already built in 2003, before PON XIV.

Sport event in Palembang have an indirect effect of Built Up and UHI. The urban growth of Palembang in the north side occurred due the infrastructure construction, like road and LRT. Urban growth of Palembang was dominated by housing development. The housing development was driven by roads and modern transportation (LRT).

3.3.3. Correction Image of Remote Sensing

In validation step of the result of remote sensing data image, this research did not used data from maps at 2012 and 2014. This paper also did not do the advance correction like Pons and team did (Pons, Pesquer, Cristóbal, & González-Guerrero, 2014).

---

4 Source: [https://palembangkota.bps.go.id/dynamictable/2015/12/07/24/jumlah-penduduk-kota-palembang-tahun-2010-2016.html](https://palembangkota.bps.go.id/dynamictable/2015/12/07/24/jumlah-penduduk-kota-palembang-tahun-2010-2016.html)
Table 8. Result of Built-Up (in KM²)

<table>
<thead>
<tr>
<th>Area (Km²)</th>
<th>2001</th>
<th>2003</th>
<th>2007</th>
<th>2012</th>
<th>2014</th>
<th>2015</th>
<th>2016</th>
<th>2018</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non BU</td>
<td>278</td>
<td>276</td>
<td>190</td>
<td>190</td>
<td>246</td>
<td>238</td>
<td>233</td>
<td>225</td>
</tr>
<tr>
<td>BU</td>
<td>89</td>
<td>91</td>
<td>177</td>
<td>177</td>
<td>121</td>
<td>129</td>
<td>134</td>
<td>142</td>
</tr>
</tbody>
</table>

Fig. 10. The Chart Of Buit-Up And UHI (In KM²)

The maps from 2007 and 2012 can be shown like this:

Fig. 11 Built-up Maps at 2007 and 2012

From data above shown that at 2007 and 2012 there is something ‘wrong’ in the Palembang image which capture from landsat 7. In map 2007 (fig 11), we can saw that Musi River become ‘build up’area. This data must be cross check with weather data of Palembang.
in 2007. This research didn’t did the cross check data analysis with weather data but did with Pearson corellation and Reliability Statistic with Cronbach's alpha method. This is the debility of the remote sensing, we must compare the ground data like a weather or cross check with the real data in the field.

4. Conclusion

This paper showed that remote sensing data analysis and GIS technique could measured the urban growth and environment impact, especially in temperature. The urban growth of Palembang driven by sport event indirectly. The infrastructure construction pushing the direction of urban growth. In Palembang case, the UHI phenomenon located in housing area in the north side of Palembang.

This paper also showed the weakness of this technique. Dataset in 2007 and 2012 was not valid to analysis. In this paper didn’t analized more about the failness of that data. There are several potential problem which predispose to dataset. The anomali of climate or clearness of landsat image and several aspect can affect in validation of dataset.

Acknowledgements. We are a greatfull to Mr. Hery Setiawan Purnawali for a kindness discussion in methodology phase. We also thank you for a member of urban growth and sprawl groups: Mr. Fajri Romdhoni, Mr. Adam Fitriawijaya, Mr. Anta Sastika and Mr. Hendi Warlika Sedoputro. This paper can not be completed without a great discussion in this grup.

References

Website Gis-Based Model of Settlement Development in Parepare City, South Sulawesi

Mulyawan¹, Hayati Sari Hasibuan², Ahyahudin Sodri³
{Mulyawanskom@gmail.com¹, Hayati.hasibuan@ui.ac.id², ahyasodri@gmail³}

School of Environmental Sciences, Universitas Indonesia
Jl. Salemba Raya, No. 4, Jakarta¹,²,³

Abstract. Population growth has a significant impact on land use for settlements. This article aims to build a model of residential development based on WEBGIS in the city of Parepare. The method used is the spatial analysis of overlay spatial and scoring data using software (GIS). Knowing the public's perception conducted interviews and distributed questionnaires to up to 296 respondents. The results of this study show that the development of settlements towards the suburbs. Forest area fell to 2,971 hectares in 2014, and rice fields were reduced by 837 hectares, and land for settlements increased to 923 hectares in 2015. This WEBGIS model can demonstrate the good distribution of space for the allocation of residential areas. This model is expected to be the benchmark for people who make decisions about the settlement area. This model can be a tool to anticipate the development of settlements in the city of Parepare.

Keywords: Model, Settlement, WEBGIS

1. Introduction

Population growth continues to increase over time, which has an impact on development [1], population growth is a phenomenon, a potential and a problem of sustainable development. Population growth is linked to the need for continuous space each year [2]. This phenomenon generally occurs in urban areas, where the evolution of land use is very dynamic [3]. Determining the location of land that can be turned into awake land needs to know the type of land use so that excessive land use does not occur [4]. The dynamic evolution of urban land use is very complex influenced by natural, social, economic, cultural, political and legal and other factors.

Today, the use of urban land is radically changing under the general influence of physical geography and the human environment system, affecting all aspects of sustainable urban development [5]. In addition to affecting physical land, the change in land use also affects the social problems of the community, including food security, health insurance, urbanization, loss of biodiversity, migration, preservation of the environment and Others [6]. Land transformation also contributes greatly to the modification of the ecosystem. Bare land, forest or agricultural
land is reduced due to the development of human habitation which produces a dynamic influence of the spatial patterns of the locality [7].

Parepare City area when viewed from the topography aspect consist of flat to wavy area, with a classification of about 80% area is the hilly area and the rest of the flat areas with a height of 25 - 500 meters above Sea level (MDPL), with undulating and hilly plateau (88.96%) With dominant functions for plantation land (18.56%), forest land (43.04%) and residential areas (1.57%), as well as a small piece of land that is flat to ramps (11.04%) Residential functions (2.80%), agriculture (9.40%) fishing (0.24%). Based on the spatial structure, the city of Parepare is divided into growth centers and municipal services. For the center of growth, the city of Parepare will evolve with the characteristics of the combination of the hilly city and the coastal city, with its main function being the center of the growth of the establishment, commerce and services, as well as the warehousing industry [8].

Table 1. Area Width Based on the Height of the Sea Level of Each District in the City of Parepare

<table>
<thead>
<tr>
<th>No</th>
<th>Districts</th>
<th>Area of Altitude (Ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>0-7m</td>
</tr>
<tr>
<td>Bacukiki</td>
<td>154,6</td>
<td>776,4</td>
</tr>
<tr>
<td>Ujung</td>
<td>87,16</td>
<td>214,78</td>
</tr>
<tr>
<td>Soreang</td>
<td>70,84</td>
<td>38,6</td>
</tr>
<tr>
<td>Bacukiki Barat</td>
<td>*</td>
<td>*</td>
</tr>
<tr>
<td>Total</td>
<td>312,6</td>
<td>1029,78</td>
</tr>
</tbody>
</table>

Source: Main Data of Parepare City 2012 and has been reprocessed

The acceleration of urbanization leads to problems of degradation in an urban environment. The population growth of the city of Parepare every year has increased even if it does not occur significantly. Land conversion is closely linked to the increase in population density.

Table 2. Parepare City Population growth rate for the period 2010-2017

<table>
<thead>
<tr>
<th>No</th>
<th>Districts</th>
<th>Total population</th>
<th>Population growth rate (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bacukiki</td>
<td>14.477</td>
<td>17.953</td>
</tr>
<tr>
<td>2</td>
<td>Bacukiki Barat</td>
<td>39.085</td>
<td>42.900</td>
</tr>
<tr>
<td>3</td>
<td>Ujung</td>
<td>32.231</td>
<td>34.305</td>
</tr>
<tr>
<td>4</td>
<td>Soreang</td>
<td>43.469</td>
<td>45.265</td>
</tr>
</tbody>
</table>

Source: BPS Parepare City 2018 reprocessed
A need accurate information on changes in land cover to better understand the changing environment and the interaction between man and the ecosystem [9]. This is done to determine the status of residential land in the present and plan for the future so that the planning of land for residential development in accordance with the potential and existing conditions and the negative impact of land use change can be minimized. After finding the suitability of land for residential development in the town of Pare Pare, will be formulated residential development model. Access to structured data in a vital need to support current and future services to manage existing home and build sustainable cities [10].

This study aims to produce a gis-web application to determine the location of housing and residential election in the town of Pare-pare. System development based website sig residential development to support the detection of changes in land protection and identify potential areas for development of settlements in accordance with the RTRW Parepare. WebGIS is beneficial to stakeholders who have up-to-date spatial information on residential and non-residential areas to guide the strategic implementation of sustainable land use planning and management [11]. So that this application building should facilitate the users, the system is based on an architecture that allows users to access applications via the Internet and to carry out operations on urban data [12].

2. Methods

Social context, the population in this study were all household heads of housing users in the Municipality of Parepare. Criteria for respondents are heads of households who have lived in the study site for more than 5 years. The determination of this sample is based on the assumption that the head of the family has a great influence on the behavior of family members, so that it is considered capable of providing responses to adaptability. Calculation of the number of samples determined in this research uses the issac and michael formula approach. Based on data from the Central Statistics Agency (BPS) of Parepare City in 2018, the number of family heads in the Municipality of Parepare is 35,929 households.

Based on the issac and Michael formula and with the consideration that this research applies a significance level of 10%, in order to achieve a confidence level of 90%, the total sample of respondents needed in this research is 268 in general to represent 35927 households. The number of samples will be added by 10% of the number of samples to anticipate if there is data that is
not good in research, so the total number of samples in this study amounted to 296 samples. The number of samples of each respondent in each kelurahan was determined proportionally. The sample selection is done by simple random sampling. This is done by selecting the first respondent randomly in a densely populated area in each Sub-district in the City of Parepare, then selecting the next respondent in an interval manner. Population and sample calculations can be seen in Table 3.

<table>
<thead>
<tr>
<th>No</th>
<th>Districts</th>
<th>Population (Total of KK) in 2018</th>
<th>Distribution of Samples in Each District</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bacukiki</td>
<td>4978</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>Bacukiki Barat</td>
<td>11009</td>
<td>91</td>
</tr>
<tr>
<td>3</td>
<td>Soreang</td>
<td>11410</td>
<td>93</td>
</tr>
<tr>
<td>5</td>
<td>Ujung</td>
<td>8712</td>
<td>72</td>
</tr>
<tr>
<td>TOTAL</td>
<td></td>
<td>35,929</td>
<td>296</td>
</tr>
</tbody>
</table>

3. Results and Discussions

GIS Application of Information System Web-based application uses the concept of a single page, this information is available by simply opening a page of the site. Users can access all existing maps on the site of the Map page that is directly connected to the home page. Each group will contain information on the information cards that came from the analysis of factors influencing the determination of the location to build housing and schools.

3.1 Identification of Community Characteristics

Based on the age of the respondents, the classification is divided into four groups of age. The most dominant group is the respondents with age less than 31 years old, which is about 49%. The least dominant is the group of respondents with age above 60 years old, which is about 6%. In general, the respondents of this research represent each group of age. The distribution of the respondents for each group are shown in Figure 1.
Based on the type of occupation of the respondents, the classification is divided into seven groups of occupation types. The most dominant group is private employee which is about 29%, and the group of entrepreneur has percentage about 25%, while the government employee and other occupation have percentage about 21% each. The rest is the group of the pensionary have the percentage of 4%. The distribution of the respondents for each group are shown in Figure 2 below.

![Figure 1. Distribution of each group of ages](image1)

![Figure 2. Proportion of Types of Work](image2)
Based on income level, respondents in this study were divided into five groups. The most represented group of respondents is the income level of Rp. 1,501,000 - Rp. 3,500,000 / month, which corresponds to 34%. Then, the group with income of Rp. 3,501,000 - Rp. 6,000,000 / month up to 30%, and the lowest income level groups represented are income groups above Rp. 6,000,000 / months, or 10%. Figure 3 shows the distribution of the proportion of respondents by income level.

![Figure 3. Proportion of Income Levels](image)

On the basis of reasons to stay, respondents in this study were divided into five groups. The most represented group of respondents was the reason of the original inhabitants of 68%, then the next group was the reason to participate to the parents of 20%, the least represented group being the group with the reason to join a husband of 4%. Figure 4 shows the distribution of the proportion of reasons for life in a locality.
Based on residency status, respondents to this study were divided into four groups: self-owners, parent owners, hitch-hiking, lease / contract. The group of respondents with the status of their own residence is the group with the highest number of respondents, 47%. In addition, followed by the parents' group respondents with 44%, the lease / contract respondents group with a figure of 6% and the constituency group respondents are the smallest group of respondents with a number of 3%. Figure 5 shows the distribution of the proportion of respondents by length of stay.
Based on the number of residents in the house, respondents to this study were divided into four groups, namely 1 to 3 people, 4 to 6 people, 7 to 9 people and more than 9 people. The group of respondents with the number of occupants of the home 4-6 persons in the group with the most respondents is 59%. Then, followed by respondents in the 1 to 3 resident group of 27%, the group of respondents was made up of 7 to 9 people with 9% and respondents in the group of residents of more than 9 people were the group of respondents the smallest with a figure of 5%. Figure 6 shows the distribution of the proportion of respondents by the number of residents.

**Fig. 6. Proportion of Number of House Residents**

Based on building age, respondents to this study were divided into three groups, namely less than 10 years, 10-20 years and over 20 years. The group of respondents with a total building age greater than 20 is the one with the highest number of respondents, at 48%. In addition, respondents from groups under the age of 10 and respondent groups aged 10 to 20 each receive 26%. Figure 7 shows the distribution of age proportions of buildings.
Based on the building area, the respondents to this study were divided into five groups, namely less than 21 m², 21 m², 36 m², 45 m², more than 45 m². The group of respondents with a building area of more than 45 m² is the one with the largest number of respondents, 18%. In addition, followed by respondents from the building area of 45 m² to 21%, then the group with an area of 36 m² to 20%. The group with a building area of 21 m² is 12% and the group of respondents is less 21 m² 6%. The distribution of the proportion of building area is shown in Figure 8.
3.2 Identification of Factors Influencing Communities to Choose Residential Locations

The formulation of the factors that influence the community when choosing a site for the environment is of particular relevance to existing empirical conditions. For the formulation of the factors that influence the community of the location of settlements in the city of Parepare, we can mention:

3.2.1 Physical Factor

Slope is an important factor as it is closely linked to vulnerability to disasters and the ability of a settlement to develop its territory. The results of this study indicate that existing settlements occupy the land in accordance with land suitability requirements, such as 0-20% slope, while in Ujung District the area with higher slope at 20% is still a settlement area. The majority of respondents in this study showed a neutral direction with a figure of 49%, 26% of the population said they chose to settle on a slope of more than 20%. Figure 9 shows the proportion of slope factors.

![Figure 9. Proportion of Slope Factor](image)

Fig. 9. Proportion of Slope Factor

Noson (2000) defines vulnerability as a specific condition or characteristic leading to increased damage, loss and loss resulting from a disaster, based on characteristics such as the type of building material, demographics, and geographic location. Based on the results of the study, it appears that the majority of respondents indicated a positive number of lands chosen for settlements not located in disaster-prone areas. 80% of those surveyed said that settlement construction should avoid areas prone to disasters. While 5% of the population said they chose a location for settlements in disaster-prone areas. Figure 10 shows the proportion of disaster risk factors.
3.2.2 Accessibility Factor

The accessibility factors are the convenience of the mall. The conclusions of this study are that the mall in question is a commercial center in the form of a market. Close access to markets is an important factor in meeting basic daily needs. The results of this study indicate a positive level of 71%, which indicates that the community determines the location of homes close to the market, while 4% of those surveyed said they chose land to settle not close to the market. Shopping malls in the form of a market are not evenly distributed in the study area, which is provided by the local government and is used to meet the daily needs of the inhabitants of the city. The location of this study has a wholesale market in each district.

3.2.3 Clean Water Availability Factors

The supply of drinking water is one of the main needs of the residential environment. In fact, 80% of the inhabitants will choose the location of agglomerations with access to safe water and
4% will choose establishments regardless of the availability of drinking water. Figure 12 illustrates the proportion of water availability.

![Proportion of Clean Water Supply Factors](image1)

**Fig. 12.** Proportion of Clean Water Supply Factors

### 3.2.4 Land Price Factors

The existence of residential areas in the downtown and downtown has variable land prices that are influenced by the value of the land. The existence of residential land in the downtown core is in high demand while land remains, there is a shortage of land in the downtown core, so the land has value and impact on the land. Higher land prices (Khoiriyah et al. 2017). The results of this study indicate that 70% of people choose economic land prices.

![Proportion of Land Price Factor](image2)

**Fig. 13.** Proportion of Land Price Factor

### 3.3. Priority Area Regional Development Housing and Settlements Under General Spatial Plan (RTRW) Parepare

RTRW is fundamental to provide a recommendation to direct the use of space, including also for residential areas, it is necessary to analyze the alignment between the analysis of the relevance of the regulation area in Parepare RTRW cities which aims to determine the spread of existing settlements between land and areas with the potential for institutions and home of
analytical results. spatial maps used, which is the city RTRW 2010-2030 Parepare. **Figure 14** is the map land use of Parepare city.

**Fig. 14. The Map of land use Parepare City**

3.4 Opera-Interface System Website Design Development Geographic housing

Based on the results of the discussion on the analysis of the influence of institutional development on planning planning for the city of Parepare and the factors that influence the choice of lands to be development of institutions is the solution. This situation affects residents' growing need for housing, transportation facilities and infrastructure, and other public amenities. Physical development and urban infrastructure in the form of housing development as a place to live. The physical construction activities of the agglomerations and urban infrastructure in the city of Parepare must support the RTRW as well as community access to information if it will build homes in the residential area.
3.3.1 Preparation of the website interface design

The web application interface is built using Macromedia Dreamweaver. In general, the navigation structure of web applications is composed of menus, namely the home menu, profiles, maps, and information. These menus can be directly connected to other pages without going through the main page. The navigation structure used in Web applications uses mixed types (a combination of nonlinear and hierarchical navigation structures). In the map menu, a link can be connected to the search map page. In the search map page, navigation makes it easy for users to use web applications. The rationale for the website features is presented in Table 4.

<table>
<thead>
<tr>
<th>NO</th>
<th>FITUR</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Digital Map Service (MAPS)</td>
<td>Digital map services use the Google Maps Application Programming Interface (API)</td>
</tr>
<tr>
<td>2</td>
<td>Tagging</td>
<td>Support for marking new coordinates or locations into a particular node type</td>
</tr>
<tr>
<td>3</td>
<td>Categories / filtration based on node type</td>
<td>Filtering certain types of nodes to display similar nodes, this feature is needed if the service that is owned has a variety of items.</td>
</tr>
<tr>
<td>4</td>
<td>List of alternative nearest node</td>
<td>Each node can display alternative node lists with the closest distance</td>
</tr>
<tr>
<td>6</td>
<td>Distribution of vertices of each region</td>
<td>Shows the number of node distributions for each region/city</td>
</tr>
<tr>
<td>8</td>
<td>Node description</td>
<td>Displays complete information of each node, for example the name,</td>
</tr>
<tr>
<td>9</td>
<td>List of available residential areas</td>
<td>Displays a selection of residential area types</td>
</tr>
<tr>
<td>12</td>
<td>Coordinate (Latitude &amp; Longitude)</td>
<td>Displays information on the location of coordinates in the form of latitude and longitude</td>
</tr>
<tr>
<td>13</td>
<td>Search Feature</td>
<td>Supports node search by name</td>
</tr>
<tr>
<td>14</td>
<td>Mobile friendly (responsive web)</td>
<td>The interface is responsive so it can be used on various types of desktop and smartphone devices with high display accuracy</td>
</tr>
<tr>
<td>15</td>
<td>Administrator Dashboard</td>
<td>Control panel page to update content, for example add, change or delete or adjust website content.</td>
</tr>
<tr>
<td>16</td>
<td>E-mail Domain</td>
<td>Administrators can use email according to the domain extension used by Exp. <a href="mailto:admin@domainname.institution">admin@domainname.institution</a></td>
</tr>
<tr>
<td>17</td>
<td>Header and Footer</td>
<td>Contains the signature of the institution that owns the portal</td>
</tr>
</tbody>
</table>
Card used in the web-gis is a land cover maps overlay, forest area and density of the population. Experiments, the map display is quite good, informative and was equipped with the functions of "basic operational tool" (basic tools) for the information system in the form of a card or depending magnification (zoom), movement (pan), map scale changes (scale), etc. Detailed information can be displayed directly by clicking on the data / information polygon you want to display, or information based on polygons district to district, as well as land use polygons for land use maps and card plans land use. Users can also set the map layer you want to view by clicking the map layer selection option on the right side of the displayed map image. 

**Figure 15** is GIS Web Design Interface and housing development regulations Parepare

This research is in line with [13] WebSIG displays an architecture consisting of three levels of architecture with customers or servers. On the client side it can be a web browser, while on the server side it consists of a web server, webSIG software and a database. The application to be built is a model for controlling settlement development in the City of Parepare, in line with [14] that this WebSIG must be developed by government agencies.
4. Conclusion

It was concluded that the results of the application of information systems GIS Web is instructive to describe the factors that people in the construction of housing and schools in each district. The information is grouped into six factors: slope, disaster areas, accessibility, distance from the center of commercial facilities and public services, the availability of water, land conversion the system must be tested on a limited basis with the participation of candidates potential users of information systems, which in this case is the decision-makers at local level.

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References


Strategy for Managing Public Park Maintenance as One Effort for the Implementation of Sustainable Green Open Space

Silia Yuslim  
siliayuslim@trisakti.co.id  
Department of Landscape Architecture  
Faculty of Landscape Architecture and Environmental Technology  
Universitas Trisakti, Kampus A Ged. K lt.6, Jl. Kyai Tapa No.1, Jakarta 11520

Abstract. The quality of green open space in DKI Jakarta is far from perfect. The management of maintaining Green Open Space which is still dominated by the government, especially in public parks, causes more than 50% of parks to be poorly maintained. Research Objectives are to provide management strategies to maintain public parks that involve the community (non-government) so that the park can benefit the community and the environment. Several studies in Europe revealed that community involvement can increase park maintenance activities, so the quality of the park can be improved. Research methods are using observation and descriptive qualitative analysis. Data is collected through a two-way assessment matrix of the Leopold Method to the parties that will be involved (purposive sampling). Matrix formulation is done through Delphi analysis, from the results of in-depth discussions related to the results of previous research studies with the government involved in maintenance activities. The results showed that maintenance activities require the rule of law, synergy, transparency, the possibility for community participation, and Human Resources. With this strategy, it is hoped that public parks can function sustainably for the community and the environment.

Keyword: Maintenance management strategy; Public parks; Sustainable Green Open Space

1. Introduction

The issuance of Law No. 26/2007 concerning Spatial Planning, particularly Article 29, explains that Green Open Space of a city area is required to have a minimum proportion of 30% of its area, consisting of 20% Public Green Open Space and private RTH by 10%. DKI Jakarta's Green Open Space in 2011 based on actual conditions was only 59.25 km² (8.9%) of its area. DKI Jakarta's Green Open Space requirement based on the provisions of the Act, which is 30% of the total area, is 198.70 km². So the shortage is still 134.45 km² (21.1%), both in the form of public and private green open space. This fact has led to the idea of optimizing the quality of Green Open Spaces, especially those that function as public spaces, which are already available. This quality improvement is very closely related to maintenance activities that must be carried out continuously.

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According to Law No. 26 of 2007 concerning Spatial Planning\(^2\), to be exact Article 28, explained that the form of green open space in a city developed as a public space (public park), includes an Environmental Park which is a RT Park, RW Park, Village Park, District Park, City Park, RTH Cemetery, Small Green Housing Neighborhood, Green Open on a narrow Environmental Road, Green Open on the river border, and Urban Forest. This research is focused on public parks that are more active in nature, so that the utilization of public involvement can be optimized.

At present, many public parks in DKI Jakarta are poorly maintained or receive less attention from visitors. Communities around the park are sometimes less interested in utilizing public parks. The first case, Taman Simanjuntak Timur which is located in Cipinang Cempedak Village, East Jakarta, is a poorly maintained public park. This park, which has quite a lot of visitors, looks pretty sad. Based on observations, it can be seen that there is a gap between the needs of the surrounding community and facilities in the park. The surrounding community also seems to be less concerned about the cleanliness and the existence of the park.

The second case, Taman Mataram Merah (Red Mataram Park) and Taman Mataram Putih (White Mataram Park) located in Selong District, Kebayoran Baru - South Jakarta. Red Mataram Park is very well maintained and well designed, but it is quiet of visitors. Park maintenance is carried out intensively by CSR Prudential for 2 years (2018 and 2019). This is because the park was designed and built as a Financial Literacy Park at the expense of Prudential CSR. If the maintenance contract expires, it will not be known what will happen to the park in the future. While the White Mataram Park, which is located across the Red Mataram Park, is poorly maintained and also empty of visitors. The maintenance of White Mataram Park is carried out by the South Jakarta Forest Service, which in this case is the government.

The third case, Taman Utama Raya, located in Cengkareng Barat Village, West Jakarta. The condition of the park is not maintained and is empty of visitors. Based on observations, there is a gap between the needs of the local community and park facilities. Local people do not appreciate the existence of the park. This can be seen from the amount of vandalism found there. Meanwhile, Child-Friendly Integrated Public Space, Pendongkelan Park, Cengkareng, West Jakarta is a public park that is managed jointly by the community and the local government. At the beginning of planning, local communities were involved to obtain input on their hopes for the park to be built. This is intended so that community expectations can be realized in the design of the park.

And the fourth case, the Monas public park, located in Central Jakarta, is adjacent to the government area. This park is quite well-maintained. On certain days or holidays, the park is quite crowded with visitors from various regions.

Based on the case study, it can be seen that the park is poorly maintained, causing its role to improve the quality of the city environment and the container of activities for city communities to be less than optimal. One reason is the maintenance of public parks that are still dominated by the government. Limited funds and human resources for maintenance activities, is the cause. As a result, maintenance activities are only focused on public parks in the city center.

The provisions regarding efforts to involve the public in the provision and use of parks related to maintenance activities are in the Minister of Public Works Regulation No. 5 / PRT /

\(^2\) Undang-undang Republik Indonesia No. 26 Tahun 2007 tentang Penataan Ruang
M / 2008 concerning Provision and Utilization of Urban Green Open Space in Urban Area. However, in its implementation, these efforts have not been able to be carried out optimally. Management of public park maintenance should be a joint responsibility between the government and the public (outside the government. For this reason, efforts are needed to activate the involvement of various parties outside the government, especially the local community. For this involvement to run optimally, maintenance management strategies that can facilitate the parties involved, so that maintenance activities can run effectively and efficiently. In the end, with a relatively limited area, public parks can still support the sustainability of green open space.

Research in several countries reveals the maintenance of public parks that implement public involvement. For example, the Danish City involved the community in maintaining various natural areas through the 'Give Nature a Hand' project4; maintenance of urban green spaces in Spain implements public involvement through cooperation with social organizations and voluntary associations which ultimately reduce the costs of financial maintenance activities5. This strategy at a relatively low level can be implemented in schools with roots in the Spanish tradition6. The results of the study indicate public sector budget funding for urban green space management7. In the work of managing public facilities, the stages of planning, designing, implementing, and maintaining public facilities can be done by involving all parties, to work together transparently and synergistically8. Although maintaining green space with public involvement still has weaknesses, many good things can be applied according to the needs of this research.

2. Method

This research uses descriptive qualitative observational analysis methods. Sampling is done by purposive sampling, by distributing a two-way assessment matrix of the Leopold Method to the parties involved. The preparation of the matrix begins with the Delphi analysis, which begins with the results of previous research studies discussed with those involved in maintenance activities.

The two-way assessment matrix of the Leopold method is created to obtain an assessment of the relationship between the functions played by public parks according to their location and the components that must be considered in developing public involvement in maintenance management. The research location used as an observation case was carried out by taking

3 Peraturan Menteri Pekerjaan Umum No. 5/PRT/M/2008 tentang Penyediaan dan Pemanfaatan Ruang Terbuka Hijau Kawasan Perkotaan
5 Ankestyrelsen: Det kommunale samarbejde med frivillige sociale foreninger. §18-redegørelsen Socialministeriet, København (in Danish) (2010)
samples of one or two public parks located in the four administrative city areas located in DKI Jakarta. The study was conducted in 2018.

From the results of observations, there are three groups of public parks related to the function played by public parks according to their location. The first group, public parks in a residential environment with a lower-middle economic level. The second group, public parks in residential neighborhoods with middle to upper economic levels. The third group, public parks in the office building or public facilities. Five components must be considered in efforts to implement public involvement in the management of maintaining public parks, namely the rule of law, participation, synergy, transparency, and human resources. The matrix is filled in by parties who will be involved in the management and maintenance of public parks, including the DKI Jakarta Provincial Office, several environmental observers, community leaders, and some professional Landscape Architects.

3. Result and Discussions

Based on comparative studies from previous research in several European countries, it appears that public involvement is an alternative that can also be applied in Jakarta. For this reason, this research focuses on efforts to maintain public parks that provide opportunities for the community to be involved. Regarding the application of public involvement that is applied to maintenance management in Europe, the management strategy of maintaining public parks with public involvement that will be pursued in Jakarta requires improvement.

<table>
<thead>
<tr>
<th>Component Supporters for Public Involvement</th>
<th>Activities</th>
<th>Maintenance Public Parks in Settlements with Medium economic level down</th>
<th>Maintenance Public Parks in Settlements with a medium economic level to the top</th>
<th>Maintenance Public Parks in Office Environment/Public Facilities</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rule of Law</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Synergy</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Participation</td>
<td>Private</td>
<td>1</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>Community</td>
<td></td>
<td>3</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Transparent</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>Human Resources</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

Information:

Value 1:
- Rule of Law, if clarity of rule of law is needed for the application of public involvement in the maintenance
- Synergy, if it is needed effective communication, fast feedback, trust and creativity
- Participation, if non-government participation is very necessary for the implementation of maintenance
- Transparent, if government transparency is needed in providing information related to maintenance
- Human Resources, if it is needed Human Resources with expertise as needed

Value 2:
- Rule of Law, if a clear rule of law is required for the application of maintenance public involvement
- Synergy, if needed effective communication, fast feedback, trust and creativity
- Participation, if non-government participation is needed in the maintenance implementation
- Transparent, if government transparency is needed in providing information related to maintenance
- Human Resources, if needed Human Resources with areas of expertise as needed

Value 3:
3.1 Rule of Law

Taman Mataram Merah (Red Mataram Park) is a public park located in Selong Village, Kebayoran Baru District, South Jakarta, where planning, design, implementation, and maintenance management utilize public involvement, in this case, the private sector. Based on the results of in-depth interviews with various parties involved ranging from planning, design, implementation, and management of the maintenance of the Red Mataram Park obtained information that can be used as input. This park was built at the expense of Prudential's Corporate Social Responsibility (CSR).

During the design process, the consultant made the design based on input from the funders, so that the design of the Red Mataram Park became a thematic park with the theme 'Financial Literacy Park'. The existence of this park is expected to provide education related to insurance. The location of the Red Mataram Park which is in a residential environment with middle to the upper economic level, the theme of Financial Literacy is not suitable. This is because basically a theme park with the theme of Financial Literacy will be more useful if applied to parks located in settlements with a lower-middle economic level. However, in the end, the park construction process can be carried out.

The park development process must go through several stages of bureaucracy to have a license for the implementation of less comfortable designs. Likewise, at the handover of the Mataram Park after the design was completed. This causes CSR Prudential, which is a funder, to feel deterrent from applying it to other public parks. Besides, when maintenance actions will be implemented, the same thing also happens. The accumulation of all these events caused the funding party, namely CSR Prudential and the maintenance sub-contractor, to no longer want to extend their maintenance contract.

Concerning public involvement as a management strategy for maintaining public parks, it is necessary to improve existing governance. This governance involves representatives from all parties involved in maintenance management. Also, the new government must have clear the role of law, division of authority and responsibilities, which in turn will regulate the division of labor and clear work procedures. This is because to realize a public park, it requires the involvement of various parties, including the government, consultants, project implementation contractors, maintenance contractors, and supervisors. The rule of law is a just legal framework, carried out indiscriminately, especially laws relating to human rights. With this, the existence of a clear organizational structure, as well as the clarity of the dimensions of the rules focusing on interaction/coordination between various parties involved, related to formal procedures and informal routines will cause the distribution of tasks to be clearer and decision making to be faster. Thus, budget efficiency can be achieved.

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3.2 Synergy

In one case, the Child-Friendly Green Public Open Spaces is one of the public parks that was built taking into account the expectations of the local community. Observation results show that the affection and ownership of the local community towards the park is quite good. The park is still well maintained. Through community and government involvement from the beginning, the community will also be motivated to maintain it. This can facilitate the process of technical outreach related to public park maintenance activities. With a smooth and communicative socialization process, maintenance management will also run well. Basically, in an activity involving several parties, good coordination is needed\(^{10}\). This is intended so that communication can run effectively and feedback can be conveyed quickly.

The above description shows that synergy is needed to produce optimal public involvement. To make this happen, it can be done through the implementation of Focus Group Discussion (FGD) to the parties involved (private and community) to socialize everything needed related to maintenance.

3.3 Participation

The participation component is divided into participation from the private sector and the community, or both. This component is intended to increase community ownership of public parks where they will be involved in maintenance activities. To optimally stimulate public involvement is to involve the local community from the beginning of the planning of the park. This is because basically they already have a simple knowledge of the process of making the park as a whole, such as planning, design, and management. This knowledge can be increased through the implementation of Focus Group Discussions (FGD). This fact is consistent with\(^{11}\) research on the use of local resources in urban park planning in Belgium, where basically local community members also think of an overall process that is no different from conventional stages such as planning, design, and management. This process has a picture that is almost the same as the stage in the project cycle\(^{12}\), namely the conceptual stage (the stage for compiling and formulating ideas); the planning and consolidation stage (the continuation stage of the conceptual stage, which prepares the design and discusses the parties to be involved); and implementation phase (implementation phase); and the operation phase (routine operations and maintenance). With full involvement, the sense of belonging to the park that has been planned and designed becomes even greater. This can reduce the desire to damage the park or vandalism.

The extent of involvement in the conventional stages of making (planning, designing, and implementing) and managing public parks cannot be equated in each public park maintenance group. In public park maintenance groups in the middle to lower level settlements, community involvement starting from the planning, design, and management/maintenance stages can be more optimal. For public park maintenance groups in upper-middle-class settlements,


community involvement is more common at the beginning (planning), but at the design and management/maintenance stages, private involvement can be further increased. For maintaining public parks in an office / public facility environment, community/manager involvement in the environment can be carried out starting from the planning, design and management/maintenance stages.

3.4 Transparent

Public involvement requires government openness in providing information related to maintenance. In the socialization of maintenance activities that will be carried out, it requires government transparency. Various information about regulations related to maintenance management, quality of maintenance actions, and maintenance activities, as well as the technical implementation of maintenance activities, must be accessible to the community or community organizations or private parties involved, especially those involved technically in the field. In addition, in the distribution of authority and responsibility for maintenance activities to the private sector and the community involved, there must also be openness. The socialization is related to all applicable rules, the implementation process, the technical implementation, and the quality of maintenance which is expected to be very good to be informed to all parties involved,

In the FGD process also must always maintain openness, so that discussions can be carried out so that consultants can find out exactly the community's needs for facilities in the park. The extent and limited funds, causing consultants to be able to filter, select, and place priorities in determining the facilities that best suit the needs of the local community

3.5 Human Resources

Regarding public involvement, research states that the perspectives, experiences and views of managers responsible for maintenance activities are an important focus. This is because in many cases citizens can start activities, but it is the manager who can make decisions if and how citizens can be involved. Therefore, key positions in government or authorities who are handed over responsibility for maintenance activities in an area require an educational background in the area of expertise, to guide their professional knowledge for the implementation of these activities. Therefore, maintenance managers and maintenance supervisors in the field are placed by people who are experts and skilled in their fields. This is because this position is the liaison and director for parties outside the government / public (public and private) in the implementation of maintenance activities.

In addition, in the field implementation, the supervisor directs and assists residents involved in maintenance activities, not only based on the results of personal experience from time to time but also based on their professional abilities. Thus, maintenance activities that can be dangerous can be avoided. This fact is consistent with the facts found in Jones's research,

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namely that park officials base their work relationships with residents on their skills and experience that results from time to time, so training is needed.

5. Conclusion

Based on the discussion, it can be concluded that the strategy for maintaining public parks is to utilize public involvement. This is following government directives contained in the Ministerial Regulation on Guidelines for Provision and Utilization of Green Open Space in Urban Area. However, efforts are needed to realize the components needed to make it happen in the field, including the provision of law, synergy, participation, transparency, and human resources, which always pay attention to Safety, Occupational Health and the Environment (K3LH). Through the implementation of this strategy, it is expected that efforts to achieve the sustainability of the role and existence of green open space, especially public parks, can be achieved. Public involvement in managing public park maintenance must be carried out throughout the project cycle (from the beginning of planning, design, implementation and maintenance).

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Sustainable fisheries subsidies for small scale fisheries in Indonesia

1Andre Notohamijoyo, 2Adhi Setya Wiyata, 2Mustaidz Billah
{andre.hamijoyo@gmail.com, adhisetya@dkp.or.id, mustaidz17@gmail.com}

1School of Environmental Science, Universitas Indonesia. Gedung Sekolah Ilmu Lingkungan, Jl. Salemba Raya No. 4 Jakarta 10430
2Ministry of Marine Affairs and Fisheries, Jl. Medan Merdeka Timur No. 16 Jakarta 10110

Abstract. As a country with enormous fisheries resources, Indonesia face threats to sustainability of the resources which are suspected because of the implementation of fisheries subsidies that did not consider the resources. On the other side, government provide subsidies to alleviate poverty and improve fishermen’s welfare. A number of countries, especially developed countries encourage the elimination of fisheries subsidies through WTO and other countries, especially developing countries opposed the proposal of the developed countries. Nevertheless, it is necessary to make a balance between community development and environmental protection in case of fisheries subsidies. This study reviews the implementation of fisheries subsidies in Indonesia. The research is based on a literacy study along with data and information on fishery subsidies that have been carried out so far by the Ministry of Marine Affairs and Fisheries as an authorized government agency. The results of the study indicate that there are benefits from providing subsidies to the welfare of fishermen and also support the sustainability of fisheries resources.

Keywords: fisheries subsidies, sustainable fisheries management, WTO, fisheries resources

1 Introduction

As the biggest archipelagic country in the world, Indonesia still face the threat caused by excessive, damage, illegal, unreported and unregulated fishing (IUUF) practices. The condition is suspected as a result of fisheries subsidies that do not consider the sustainability of fisheries resources.

In recent years, Indonesia's fisheries resources have jumped quite sharply. If in 2011 fishery resources reached 6.52 million tones1, currently the estimated fishery resources reach 12.54 million

1 Minister of Maritime Affairs and Fisheries Decree No. 47/KEPMEN-KP/ 2016 concerning Estimation of Potential, Number of Catches Allowed, Level of Utilization of Fish Resources in the State Fisheries Management Area of the Republic of Indonesia
Even though that the resources increased, it still faced the same problems due to the practice of overfishing, overcapacity, destructive fishing and IUUF. Overfishing is a situation in which the fishing in a region has exceeded the carrying capacity of the environment of fisheries resources in the region.

Indonesia waters still have experienced overfishing and overcapacity. Overfishing and overcapacity condition allegedly caused by fisheries subsidies. The provision of subsidies in the fisheries sector by the government is considered by many parties contribute excessive fishing. Subsidies assessed spur businesses to increase their fishing efforts.

Schachermayer stated in his research that the subsidy does not have a positive impact on improving the welfare of fishermen and ecological protection. UNEP in its annual report entitled *Fisheries Subsidies and Marine Resource Management: Lessons Learned from studies in Argentina and Senegal* expressed the same thing that fisheries subsidies has no positive impact on the welfare of fishermen.

As an archipelagic state, Indonesia has a vast sea area and requires complex handling in its management. Indonesian fishermen still need support from the government for the management of both policies and facilitation. Indonesia marine waters are divided into 11 fisheries management area (FMA) as set forth in the Regulation of the Minister of Marine and Fisheries no. 1 of 2009 on Regional Fisheries Management of the Republic of Indonesia.

The division can be seen in the figure 1 below.

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2 Minister of Maritime Affairs and Fisheries Decree No. 50/KEPMEN-KP/ 2017 concerning Estimation of Potential, Number of Catches Allowed, Level of Utilization of Fish Resources in the State Fisheries Management Area of the Republic of Indonesia


In some countries fisheries subsidies are prohibited because it has proven to cause overfishing and overcapacity. Nevertheless, several countries including Indonesia still retain subsidies for reasons of poverty alleviation. In Indonesia subsidies deemed not affect the condition of overfishing and overcapacity due to the structure of fisheries in Indonesia which are dominated by artisanal or small-scale fisheries thus considered not damage the environment. Table 1 shows the structure of Indonesia fisheries based on the ownership of the fishing vessel.

Table 1. The category of ownership of fishing vessel in Indonesia

<table>
<thead>
<tr>
<th>No.</th>
<th>Category</th>
<th>Number of Boat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Total number of boat</td>
<td>618,320 unit</td>
</tr>
<tr>
<td>2.</td>
<td>Without motor</td>
<td>165,990 unit (26.85%)</td>
</tr>
<tr>
<td>3.</td>
<td>Outboard Motors</td>
<td>252,590 unit (40.85%)</td>
</tr>
<tr>
<td>4.</td>
<td>&lt; 5 GT</td>
<td>137,620 unit (22.26%)</td>
</tr>
<tr>
<td>5.</td>
<td>5 – 10 GT</td>
<td>38,740 unit (6.27%)</td>
</tr>
<tr>
<td>6.</td>
<td>10 – 20 GT</td>
<td>11,650 unit (1.88%)</td>
</tr>
<tr>
<td>7.</td>
<td>20 – 30 GT</td>
<td>7,620 unit (1.23%)</td>
</tr>
<tr>
<td>8.</td>
<td>30-50 T</td>
<td>920 unit (0.15%)</td>
</tr>
<tr>
<td>9.</td>
<td>50-100 GT</td>
<td>1,670 unit (0.27%)</td>
</tr>
<tr>
<td>10.</td>
<td>100-200 GT</td>
<td>1,180 unit (0.19%)</td>
</tr>
<tr>
<td>11.</td>
<td>&gt; 200 GT</td>
<td>340 unit (0.05%)</td>
</tr>
</tbody>
</table>

Source: MOMAF Statistic (2013)

Based on table 1 above, nearly 90 per cent of fishing vessel ownership in Indonesia are dominated by small scale fisheries which is described by the the capacity of vessel. Government Regulation No. 45 Year 2009 stated that small scale fisheries is the fishermen which owned fishing vessel up
to 5 Gross Tonnes (GT). Fisheries subsidies still needed for fishermen especially small scale fishermen.

Indonesia still want to defending subsidies for small scale fishermen. In the other side, Indonesia should manage the subsidy which is save for the environment. The balance between the environmental protection and the welfare of small scale fishermen become the key of success for the government program in subsidies.

2 Problem Formulation

The balance between environmental protection and the welfare of fishermen is the main problem that must be resolved. The balance needs to be reviewed from the use of subsidies carried out in various regions. It needs to be seen further the relationship between the provision of fisheries subsidies with the welfare of fishermen and the preservation of fisheries resources in Indonesia. Based on that, it can be seen the extent of the influence of fishery subsidies.

3 Material and Methods

This study focus on literature on fisheries subsidies around the world. The study also analyst the type of the subsidy in Indonesia. It will find the provision of fisheries subsidies by compare the data of the type of the subsidy, fishermen exchange rate and fisheries resources.

Fishermen exchange rate use the data of NTN (Nilai Tukar Nelayan –Fishermens Exchange Ratio). NTN (Nilai Tukar Nelayan- Fishermen Exchange Ratio) is the ratio between the price index received by fishermen (It) and the index the price paid by fishermen (Ib), expressed as a percentage. More than 100 NTN means that fishermen have higher incomes compared to spending, or experiencing a surplus. NTN is lacking of 100 means that fishermen are spending on home consumption ladder and production costs are higher than yield income his effort.6

Whereas NTN is equal to 100 it means that operating income is the same as expenses for expenses household consumption and production needs. Fisheries resources refer the data of estimated fisheries resources.

4 Result

After conducting a review of the fisheries subsidy scheme provided by the Government of Indonesia (Ministry of Marine Affairs and Fisheries) from 2015 to 2018. The fisheries subsidy was grouped into four types. The four types are:

a. National Fish Logistic System (SLIN)

b. The Development of Community Salt Companies Program (PUGAR)

c. The Fishing Ship Vessels Construction Program

d. Fishers Insurance.

6 Website of Ministry of Marine Affairs and Fisheries, www.kkp.go.id
National Fish Logistic System (SLIN) is the subsidy which is purpose to preserve the quality of fish and to strengthen distribution, availability, and accessibility of fish for local consumption. The legislation under which the subsidy is granted are The Regulation of Minister of Marine Affairs and Fisheries No.5/2014 concerning National Fish Logistics System (SLIN). The subsidy is provided to all eligible fishers, in particular those who are in remote areas, in the form of cold chain system facilities and infrastructure. Duration of the subsidy are from 2015 to 2018.

The Development of Community Salt Companies Program (PUGAR) is the subsidy which is purpose to To improve the welfare of salt farmers, increase salt productivity and quality and to improve salt farmers’ skill. The legislation under which the Subsidy is granted are Law No. 7/2016 concerning the Protection and Empowerment of Fishers, Fish Cultivators and Salt Farmers, The Regulation of Minister of Marine Affairs and Fisheries No. 18/2016 concerning the Guarantee of Risk Protection for Fishers, Fish Farmers and Salt Farmers, The Regulation of Minister of Marine Affairs and Fisheries No. 60/2017 concerning the amendment of the Regulation of Minister of Marine Affairs and Fisheries No. 70/2016 concerning The General Guidelines for the Distribution of Government Assistances in the Ministry of Marine Affairs and Fisheries. The subsidy is provided to all eligible salt farmers, in the form of facilities and infrastructure for community salt company. Duration of the subsidy are from 2015 until present. The subsidy is not related to international trade.

The Fishing Ship Vessels Construction Program is the subsidy which is purpose to improving the welfare of small fishers with limited business capital and providing access to utilize the potential of fish resources while remain maintaining the sustainability of fish resources. The legislation under which the Subsidy is granted are Law No. 7/2016 concerning the Protection and Empowerment of Fishers, Fish Cultivators and Salt Farmers, The Regulation of Minister of Marine Affairs and Fisheries No. 60/2017 concerning the amendment of the Regulation of Minister of Marine Affairs and Fisheries No. 70/2016 concerning The General Guidelines for the Distribution of Government Assistances in the Ministry of Marine Affairs and Fisheries. The subsidy is provided to all eligible small fishers. The subsidy is provided in the form of fishing vessel, fishing vessels machines, and environmental friendly fishing gears. Duration of the subsidy are from 2015 until present.

Fishers Insurance is the subsidy to introduce advantages of fishers insurance regarding risk protection for fishing accidents at sea, promote awareness for fishers on the importance of insurance and to encourage self-insurance. The legislation under which the Subsidy is granted are Law No. 7/2016 concerning the Protection and Empowerment of Fishers, Fish Cultivators and Salt Farmers, The Regulation of Minister of Marine Affairs and Fisheries No. 18/2016 concerning Life Insurance for Fishers, Fish Farmers, and Salt Farmers, The Regulation of Minister of Marine Affairs and Fisheries No. 60/2017 concerning the amendment of the Regulation of Minister of Marine Affairs and Fisheries No. 70/2016 concerning The General Guidelines for the Distribution of Government Assistances in the Ministry of Marine Affairs and Fisheries. The subsidy is provided to small fishers (< 10 GT); small fishers who have a valid fisher card (KUSUKA); and small fishers who do not use prohibited fishing gears. The payment of life insurance premium will be only provided for the first year. Duration of the subsidy are from 2016 until present.

After discussing one by one regarding the fishery subsidies provided by the Government of Indonesia in this case the Ministry of Maritime Affairs and Fisheries, the provision of these subsidies is compared to the development of the welfare level of fishermen. The welfare level use the data of NTN (Nilai Tukar Nelayan –Fishermens Exchange Ratio).
The data of NTN from 2014 is 102,68, 2015 is 102,39, 2016 is 102,85, 2017 is 104,05 and 2018 is 105,99. The increase of NTN reflects the level of welfare of fishermen increasing every year. This is a proof that fishery subsidies have an impact on the welfare of fishermen.

5 Discussion

The debate on fisheries subsidies has been raised to the level of the World Trade Organization (WTO). WTO has even encouraged discussion of fisheries subsidies as one of the disciplines that must be specially arranged. Since the WTO 4th Ministerial Conference in Doha 2001, fisheries subsidies keep rolling into a crowded issue discussed.

The informal group *Friends of the Fish* in WTO states that fisheries subsidies should be removed for cause overfishing and overcapacity lever the issue until the last Ministerial Conference. Based on the FAO report (2010), nearly 80 percent of the waters around the world are experiencing the overexploited condition. The report referenced by various groups including Friends of the Fish to urge the immediate enactment of fisheries subsidies into one of disciplines in the WTO.

In the 11th WTO Ministerial Conference at December 2017 in Buenos Aires, Argentina, the Ministers of member countries agreed on one of Indonesia's proposals regarding fishery subsidies that can be given to small-scale and artisanal fishermen. The negotiations also agreed that the next meeting would discuss provisions leading to the prohibition of subsidies on industrial scale vessels7 (Ministry of Trade: 2017). Other agreements were reached by WTO Member Ministers to meet the Sustainable Development Goals (SDGs) target and strengthen fishery subsidy transparency. The agreement of the Ministers of the WTO members is contained in the Ministerial Decision on Fisheries Subsidies.

Although one of Indonesia's proposals was agreed upon, it seems that Indonesia's negotiations on fishery subsidies still require time. The different interests and views of each country complicate the agreement process regarding fisheries subsidies at the WTO. Ahead of the 12th WTO Ministerial Conference in the end of this year, negotiations on the prohibition of fishery subsidies will still be a work that needs to be completed. There is still a long way to go to reach the agreement.

Until now the discussion of fisheries subsidies still encounter barriers due to conflicts of interest between countries. Indonesia itself is still seeking a balance between the demands of economic development and improving the welfare of fishermen with the problem of sustainability of fish resources. In-depth study are required to fulfill “the needs of balance” in the fisheries subsidies.

Indonesia still needs to maintain the provision of subsidies in the fisheries sector because many people still depend on fisheries sector. It should be noted that 80% of the total Indonesian fishermen are live below the poverty line. On the other hand, it is recognized that some types of fisheries subsidies could threaten the sustainability of marine resources. Therefore, they need a balanced arrangement that both these interests can work well together.

In the ongoing negotiations, the countries are aware that the WTO is not only focused on trade but also focuses on environmental issues, particularly the optimal use of resources for sustainable development. Indonesia itself has submitted several proposals regarding some important things in the interest of Indonesia and also developing countries, including among others:

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7 Ministry of Trade: 2017
a. Special and Differential Treatment, in this case, Indonesia trying to get subsidies to artisanal fishing, small fishermen, ZEE developing countries, and the regional fishery management plans, still allowed.

b. Technical Assistance, that the developing countries need technical assistance in initiating, implementing and executing, and developing a fishery management plan. In addition, assistance to participate in RFMO and to establish inquiry points.

c. The concept of adverse effect on fisheries resource that does not exist in the ASCM for the analysis of actionable subsidy, and two remedies, namely through the domestic track and the multilateral track.

Other countries actively participate in providing proposals regarding discipline in this field. In 2007, WTO has published the Draft Chair’s Text that has been commented upon by the states through their proposals. Especially for the Special and Differential Treatment, WTO members have not reached an agreement because many developing and least-developed countries where people still depend on the fisheries sector. Many of them still need a subsidy from the government to support themselves and their families.

There are some research on fisheries subsidies. Schachermayer [1] stated in his research that the subsidy does not have a positive impact on improving the welfare of fishermen and ecological protection. UNEP [2] in its annual report 2001 entitled Fisheries Subsidies and Marine Resource Management: Lessons Learned from studies in Argentina and Senegal expressed the same thing that fisheries subsidies no positive impact on the welfare of fishermen.

Porter⁸ present a similar case but stated that if the fisheries subsidies given to fishermen for transition job to another job outside of the fishing, then it is a positive impact on the protection of fish resources. Sumaila et al. [3] stated that the fuel subsidy is a subsidy given to most fishermen around the world and should be reduced or discontinued to encourage the sustainability of natural resources.

Harpera (2012) supports research Sumaila on fuel subsidy removal. Additionally, Harpera [4] states that the provisions of the exemption in the draft text chair in the WTO fisheries subsidies can lead countries like the United States to exploit the gaps interests, such as the tax exemption for the fisherman who is one of the forms of fisheries subsidies.

Stokke and Coffey [5] stated that the need to cross-institutional learning related fisheries subsidies due to the lack of a strong compliance mechanisms in the WTO. Gooday [6] stated that Fisheries Subsidies convey about the discipline in terms of various perspectives of international cooperation organizations such as the OECD, APEC and WTO.

Cox [7] stated that removing or reducing the subsidy will reduce the pressure of stock to some extent although it will not remove it completely. Subsidy reform program and improved management and enforcement at sea must take place simultaneously.

In line with Cox, Jinji [8] stated that the effect of the reduction of fisheries subsidies on the output will be different, depending on economic conditions and the management of fisheries in various countries. Fisheries output will increase in countries where the catch quotas are not enforced and remained the same in countries where the catch quota is strictly regulated. In the short term, need to expand the total supply of fishery products and in the long term, the stock of world fishery resources

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⁸ Porter, Gareth (2001). Fisheries Subsidies and Overfishing: Towards a Structured Discussion. UNEP Report
can be reduced. The key is how the changes will affect the incentive subsidy of workers involved in the fishery.

Orellana [9] states that fisheries access agreement being a hindrance to the process of negotiations among WTO members, especially for small coastal states. These countries are worried that capital flows will stop when they are exposed to the subject of WTO disciplines. Research suggests that fisheries access agreements do not violate the ASCM. In another study, Orellana addressed the alternatives middle ground on Fishing Access Agreements in the Exclusive Economic Zone with Fisheries Subsidies in the WTO Agreements.

Jacquet and Pauly [10] in their study mentioned that most of the fisheries subsidies touch large-scale fisheries. Ecolabel certificate of no significant impact for the management of fisheries resources is sustainable because it does not touch on the small-scale fisheries. Fisheries subsidies are harmful to the environment should be eliminated. In line with Jacquet and Pauly,

Different opinions expressed by Tallontire [11] who said that the subsidies do not necessarily have a negative impact on overfishing and the environment. The presence of an effective fisheries management and sustainable is seen by Tallontire more important. Therefore, Special and Differential Treatment required by developing countries in the WTO fisheries subsidies disciplines.

Subsidies have contributed positively to the increase in fish production and export capacity in Indonesia. These condition is reflected on the fact that fish production and fisheries export are inclining continuously.

Indonesia should be aware that such subsidies many more enjoyed by large-scale fishermen. This is happen because:

a. Most of the small-scale fishermen do not enjoy subsidized diesel because they have to buy oil at a price of non-subsidized from retailers outside the gas station because of the limited supply of oil and the arrival time is uncertain supply. Even the subsidized diesel often been absorbed by the large-scale fishermen, fishing industry and retailers syndicate.

b. Subsidy recipients apparently were not fishermen but many people who have close relations with the authorities dealer distribution. This is because the selection process was not transparent subsidy recipients and selective logging.

c. Form of subsidy is not given as required by the fishermen.

d. Received subsidies absorbed by the costs to be paid fishermen for fishing activities to a collector who has financed the first fishing capital, which also determines the selling price of fish the fishermen.

Basically for a balanced arrangement, Indonesia has had the Law No. 45 of 2009 on the amendment of Law No. 31 of 2004 and its implementing regulations regarding the management of fish (Fishery Management). These laws regulate fisheries management aimed to achieve sustainable productivity of aquatic biological resources, including:

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b. Public awareness based Fisheries Management to preserve the fishery in the coastal region where they lived.

c. Community-based fisheries management (Panwasmas) formed by the local government throughout the study area, which consist of Police and the representative of the Fishermen.

Provision of subsidies in the fisheries sector is not referring to the specific patterns that the balance between the increase in the welfare of small fishing with the protection of fisheries resources. Ideally, there is a special formula which governs the granting of subsidies and the allocation to fishermen's welfare fisheries resources and can go hand in hand. The formula should pay attention to the principles of sustainable development that is socially acceptable, economically profitable, environmentally sustainable and technologically manageable.

The problem is there is no special formula like that in Indonesia. Ministry of Maritime Affairs and Fisheries as the lead sector subsidization programs still rely on the conventional pattern of such subsidies fuel oil for fishermen, fishing vessels as well as the provision of fishing gear and others.

The research in Indonesia can refer to Thi Duy Thanh Phama et al. (2013) and adjust with the condition in Indonesia. It is because Indonesia is not only the biggest archipelagic state in the world and also has more small scale fishermen. The support from government as subsidy still needed by small scale fishermen in Indonesia.

4 Conclusion

Fisheries subsidies are very important for countries whose population is heavily dependent on the fisheries sector. The thing to considered is the inappropriate mechanism may cause the subsidy is not well targeted and have a negative impact on the environment.

Indonesia need to formulate the right concept of fisheries subsidies based on the interests of small scale fishermen. It is very important to the position of Indonesia in WTO, particularly developing countries. Sumaila (2014) showed that fisheries subsidies apparently more widely enjoyed by fishermen from developed countries due to operational transfer to fishing vessels that increase boat efficiency. Future studies are recommended to find a formula of the balance between environmental protection by improving the welfare of fishermen.

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The Long Way of Ecolabel Scheme Acceptance in Indonesia: Case Study in Tuna Fisheries

Andre Notohamijoyo¹, Martani Huseini², Raldi H. Koestoer³, Syafril Fauzi⁴
(andre.hamijoyo@gmail.com, martani0703@yahoo.com, ralkoest@yahoo.co.uk)

School of Environmental Science, Universitas Indonesia, FKG Building 5th and 6th Floor, Jalan Salemba Raya No. 4, Jakarta 10430¹, Faculty of Administrative Science, Universitas Indonesia, Kampus Baru UI Depok², Coordinating Ministry of Economic Affairs, Republic of Indonesia, A. A. Maramis II Building, Jalan Lapangan Banteng Timur No. 2-4, Jakarta Pusat 10710³

Abstract. Ecolabel scheme develop along with the growing awareness of the people about the need for the sustainable resources. The ecolabel scheme has not been of particular concern of developing countries. Unfortunately, the existing schemes are more business-oriented. High requirements and costs of certification are the main problems of implementing ecolabel in developing countries. Indonesia is a developing country that gets around this condition through the issuance of various laws and regulations that encourage the scheme that is recognized internationally especially in the fisheries sector. As the largest archipelagic country in the world, the fisheries sector has extraordinary resources as well as a threat to its sustainability, especially tuna, the highest economic value species in the world. Various government regulations have been prepared to facilitate the implementation of the ecolabel scheme for tuna fisheries. The main challenge is the stakeholder understanding of the regulations. An intensive education and dissemination process is needed to build community awareness. Implementation success depends on sustainable education process.

Keywords: Sustainability, ecolabel, tuna fisheries, dissemination, education process

1 Introduction

Food security has become a very strategic international issue in the past few decades. Various international cooperation forums such as ASEAN, APEC, OIC, D-8 and others discuss cooperation in food security both regionally and multilaterally. The 1996 World Food Summit defined food security as follows: “when all people at all times have access to sufficient, safe, nutritious food to maintain a healthy and active life”[1].

Food security reflects the ability of a country to provide and fulfill the food needs of its population at a reasonable level. Food security for each country faces a variety of major challenges ranging from climate change, natural disasters, industrialization, environmental damage and so on.

Fish is an important component of supporting food security in Indonesia. The Government establishes this strategic role in Law No. 18 of 2012 concerning Food.¹ The increase in global fish

¹ Law No. 18 year 2012 concerning Food
consumption spurs hunting for fisheries commodities. The hunting encourages overfishing, overcapacity, destructive fishing, illegal, unreported and unregulated fishing (IUUF). Sustainability of fisheries resources in a country's territorial sea is a major challenge for the Government of that country including Indonesia.

Overfishing coupled with high demand from the international market raises concerns about the preservation of fish as a food source. The World Bank and FAO in their 2009 report entitled "Sunken Billion: The Economic Justification of Fisheries Reform" stated that since 2006, 75 percent of global fisheries resources were threatened with depletion or decline in stock due to excessive fishing practices and damage the environment [2].

This condition worries many parties about the scarcity of fisheries resources to meet the consumption needs of the global community. The 1992 Earth Summit became a starting point for environmentalists and activists to encourage sustainable production and consumption control mechanisms through environmental labeling or ecolabelling as one of the items in Agenda 21.2

Various policies to overcome challenges to the sustainability of fisheries resources have been carried out by the Government. As a developing country that has a wealth of abundant natural resources, Indonesia has great attention to its sustainability. Indonesia has adopted environmental economic instruments in legislation. Law No. 32 of 2009 concerning Management and Protection of the Environment (PPLH) regulates Environmental Economic Instruments. Definition of Environmental Economic Instruments based on its is: "Environmental economic instruments are a set of economic policies to encourage the Government both central and regional, or everyone towards the preservation of environmental functions."[3]

One of the instruments of environmental economics is the application of environmentally friendly labels. This is stated in Article 43 paragraph 3 letter c stating that the incentives and disincentives can be in the form of developing an environmentally friendly labeling system (ecolabel). As a derivative of the Law, Ministry of Environment declare the Minister of Environment Regulation No. 02 of 2014.3

Ecolabeling schemes have developed well in various countries. The following table contains information about the ecolabel program that has been implemented in various countries.

<table>
<thead>
<tr>
<th>No.</th>
<th>Countries</th>
<th>Ecolabel Program</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>German</td>
<td>Blue Angel</td>
</tr>
<tr>
<td>2</td>
<td>Australia</td>
<td>Environmental choice</td>
</tr>
<tr>
<td>3</td>
<td>United States</td>
<td>Green Seal</td>
</tr>
<tr>
<td>4</td>
<td>South Korea</td>
<td>Korea ecolabel</td>
</tr>
<tr>
<td>5</td>
<td>Japan</td>
<td>Green Mark</td>
</tr>
<tr>
<td>6</td>
<td>Singapore</td>
<td>Green Label</td>
</tr>
<tr>
<td>7</td>
<td>Malaysia</td>
<td>Sirim Ekolabel</td>
</tr>
</tbody>
</table>

3 Minister of Environment Regulation No. 02 of 2014
In Indonesia, the fisheries ecolabel scheme has not developed much, although it has long been developing in the international market. Based on research from Notohamijoyo, it is proven that international fisheries ecolabeling schemes cannot develop because they do not pay attention to the situation and condition of fisheries in developing countries. The scheme is also not yet understood by stakeholders in developing countries including Indonesia.

Referring to the research, it is necessary to know more about the understanding of the main fisheries stakeholders in Indonesia, namely small scale fishermen. Small-scale fishermen in Indonesia have a strategic position because based on data from the Ministry of Maritime Affairs and Fisheries, fishing vessel ownership in Indonesia at 90% is vessels under 5 Gross Ton (GT). This means that the structure of capture fisheries business in Indonesia is dominated by small fishermen. Table 2 below provides an overview of the structure of fishing boat ownership in Indonesia.

<table>
<thead>
<tr>
<th>No.</th>
<th>Category</th>
<th>Number of Boat</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Total number of boat</td>
<td>618,320 unit</td>
</tr>
<tr>
<td>2.</td>
<td>Without motor</td>
<td>165,990 unit (26.85%)</td>
</tr>
<tr>
<td>3.</td>
<td>Outboard Motors</td>
<td>252,590 unit (40.85%)</td>
</tr>
<tr>
<td>4.</td>
<td>&lt; 5 GT</td>
<td>137,620 unit (22.26%)</td>
</tr>
<tr>
<td>5.</td>
<td>5 – 10 GT</td>
<td>38,740 unit (6.27%)</td>
</tr>
<tr>
<td>6.</td>
<td>10 – 20 GT</td>
<td>11,650 unit (1.88%)</td>
</tr>
<tr>
<td>7.</td>
<td>20 – 30 GT</td>
<td>7,620 unit (1.23%)</td>
</tr>
<tr>
<td>8.</td>
<td>30-50 T</td>
<td>920 unit (0.15%)</td>
</tr>
<tr>
<td>9.</td>
<td>50-100 GT</td>
<td>1,670 unit (0.27%)</td>
</tr>
<tr>
<td>10.</td>
<td>100-200 GT</td>
<td>1,180 unit (0.19%)</td>
</tr>
<tr>
<td>11.</td>
<td>&gt; 200 GT</td>
<td>340 unit (0.05%)</td>
</tr>
</tbody>
</table>

Source: Statistics of Ministry of Marine Affairs and Fisheries (MOMAF), 2013

Cilacap and Padang was chosen as a research location. Cilacap is a tuna landing site by the largest small-scale fishermen on the island of Java. This condition is ideal for this study because tuna is a commodity that is the object of this study. Padang (Bungus Fishing Port) is a tuna landing by the largest small-scale fishermen especially for tuna on the island of Sumatra. The comparison between both city will give the comprehensive result of the small scale fishermen.

Table 3. Data on the Number of Ships at the Cilacap Fishery Port

Source: Suminto, The Center of Research and Development BSN, 2011


Statistics of Ministry of Marine Affairs and Fisheries (MOMAF), 2013

Ibid
The Cilacap Ocean Fishery Port is located in Tegalkamulyan Village, South Cilacap District, Cilacap Regency, Central Java Province. The exact location of the Fishery Port is 109°01' 18.4"BT and 07°43'31.2"LS, in the middle of Java on the south coast with a distance of 435 km from Jakarta and 568 km from Surabaya with access to land transportation sea and air. Cilacap PPS is located in a strategic position with WPP 573 (fishing ground area) and the largest business centers (Jakarta and Surabaya).

Table 4. Data on the Number of Ships at the Bungus Fishing Port

<table>
<thead>
<tr>
<th>No.</th>
<th>Category and Size of Ship</th>
<th>2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>&lt; 5 GT</td>
<td>7</td>
</tr>
<tr>
<td>2</td>
<td>&gt; 5 - 10 GT</td>
<td>20</td>
</tr>
<tr>
<td>3</td>
<td>&gt; 10 - 20 GT</td>
<td>2</td>
</tr>
<tr>
<td>4</td>
<td>&gt; 20 - 30 GT</td>
<td>12</td>
</tr>
<tr>
<td>5</td>
<td>&gt; 30 - 50</td>
<td>23</td>
</tr>
<tr>
<td>6</td>
<td>&gt; 50 - 100</td>
<td>0</td>
</tr>
</tbody>
</table>

Source: Statistic of Ministry of Marine Affairs and Fisheries (MOMAF), 2015

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8 Statistics of Ministry of Marine Affairs and Fisheries (MOMAF), 2015
Bungus Fishing Port was developed as a tuna landing center because of this is the only fishing port that has a major commodity tuna fish on the island of Sumatra which has facilities for landing fish tuna is like a tuna processing building. The location of Bungus PPS is very strategic dealing directly with the Western Indian Ocean. However the problem with Bungus PPS is very complex. One of them decline the number of ships that are anchored at the Ocean Fishery Port (PPS) Bungus thus reducing tuna production. A decrease in the value of tuna production because it is dominated by processed quality tuna so the price is much more low compared to exports of fresh tuna.

The arresting fleet is mostly doing activities at Bungus PPS is a tuna boat measuring > 30 GT with the dominant catch is longline tuna. In general, the types of fishing gear in Bungus PPS are identical with the type of ship used. The most dominant fishing gear in Operations at Bungus PPS include Rawai Tuna, Tonda Pancing, Pukat Cincin.

The fishermen at Bungus PPS come from local fishermen and migrant fishermen originating from regions outside West Sumatra, generally originating from Java usually a fisherman from a tuna boat. Based on the type of dominant fishing gear operating in Bungus PPS, the most dominant number of fishermen from the year 2008-2009 were fishermen purse seine (trawl ring), longline tuna and trolling fishing gear. The number of fishermen varies adjusted to the fishing gear that is operated.

2 Problem Formulation

Very minimal understanding of the main fisheries stakeholders, namely small scale fisheries makes it difficult to implement policies in the fisheries sector, which are issued by the Government. The ecolabeling scheme is not understood at all by fishermen. A study of appropriate programs and methods is needed to successfully implement government policies towards the interests of the fishing community in Indonesia.

3 Material and Methods

The methodology used in this research is the study of government policy literature in the field of marine and fisheries especially tuna fisheries management along with interviews with fishing communities in Cilacap Regency, Central Java and Padang City, West Sumatra. Intensive interviews were also conducted with the Head of the Cilacap Fishermen Group and the Head of the Padang Fishermen Group.

The literature study and interview were conducted to see the understanding of the small-scale fishermen on government policies in sustainable tuna fisheries management, especially regarding
the implementation of the fisheries ecolabel scheme. Sampling of respondents was carried out based on purposive sampling. The research was conducted through two stages, namely in-depth interviews with key informants and interviews with fishermen.

4 Result

Based on the results of a survey of 570 tuna fishing fishermen in Cilacap, it was found that none of the fishermen understood the fisheries ecolabeling scheme. Fishermen do not even follow the development of government regulations in the field of marine and fisheries, especially for tuna fisheries. Likewise, a survey conducted on fishermen in the city of Padang. 150 respondents of tuna fishing fishermen in the port of Bungus, Padang City said that they did not know what a fisheries ecolabel was. They do not understand about sustainable tuna fisheries management.

Fishermen only understand about tuna fishing season which is useful for managing fishing time. Nevertheless fishermen still see the need for support from the government to increase knowledge about sustainable tuna fisheries management. Fishermen also still see the need for facilitation and strengthening from the government for the ability of fishermen to manage sustainable fishing areas.

Intensive interviews were conducted with the Head of Cilacap and Padang Fishermen Group's informant. The results of the interview are presented in the following table in the next page:

<table>
<thead>
<tr>
<th>No.</th>
<th>Question</th>
<th>Answer from Head of Cilacap Fishermen Group</th>
<th>Answer from Head of Padang Fishermen Group</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>What are the types of fish caught in Cilacap (Padang)?</td>
<td>“Different types of catch fish are adapted to the catch season. There are lobsters, groupers, shrimp, tuna and others. At present tuna is the most catch in Cilacap.”</td>
<td>“Tuna is the most catch in West Sumatera, especially in the area around Mentawai Islands. Many tuna species are caught in the waters around the Mentawai Islands.”</td>
</tr>
<tr>
<td>2.</td>
<td>Does tuna have a season too?</td>
<td>“Yes, each fish has its own season of catch. In Cilacap, because the catch area in Indian Ocean, there are many tuna species migrate here.”</td>
<td>“Each fish has a certain time to catch including tuna. Tuna catches around the Mentawai Islands differ in type depending on the period.”</td>
</tr>
<tr>
<td>3.</td>
<td>How is the welfare of fishermen in Cilacap (Padang) now?</td>
<td>“The welfare of fishermen still depends on the quality and quantity of the catch. Fishermen still depend on fishing season and fish prices. Currently the price of fish in Cilacap still depends on the interests of the entrepreneurs in the”</td>
<td>“At present the welfare of the fishing community in Padang is still below the poverty line. The difficult thing is the lack of ability to catch tuna located in the waters around the Mentawai Islands. A ship is”</td>
</tr>
</tbody>
</table>
4. How do fishermen maintain the quality of fish catches?  

<table>
<thead>
<tr>
<th>Process of purchasing fish that are caught.</th>
</tr>
</thead>
<tbody>
<tr>
<td>“Fish caught are directly sold at the fish auction place (TPI) and the price depends on the results of the auction conducted at the TPI. Fish that are not sold at TPI, are stored in a cold storage.”</td>
</tr>
<tr>
<td>“The fish that are caught are then directly put into cold storage. The tuna caught will then be processed by the company. Meanwhile some part have been bought by several parties both processing companies and food stalls or restaurants.”</td>
</tr>
</tbody>
</table>

5. Do you know about sustainable fisheries management?  

| “We have heard it but don't know it technically. We do not understand at all technically about it.” |
| “We have heard of it but do not understand its implementation. We only heard from the government representative at the Bungus port.” |

6. Is sustainable fisheries management necessary?  

| “If it can indeed encourage the preservation of fisheries resources it is certainly very necessary.” |
| “If there are benefits to the preservation of fisheries resources, of course it are needed.” |

7. Do you know about the fisheries ecolabel certificate?  

| “I've heard of it but can't understand it technically. There was never any socialization about fisheries ecolabel certificate in Cilacap.” |
| “We have never heard of that. We also don't know the benefits.” |

8. Is an ecolabel certificate required?  

| “For fishermen, if the benefits of the ecolabel certificate can be explained concretely, then the fisherman will join the ecolabel certificate program. Clean and clear information will enable fishermen to understand and practice it.” |
| “If the certification only makes it difficult for fishermen in Padang and provides additional costs for fishing, we will reject it. At present fishermen in Padang still have difficulty in fishing because of capital/cost constraints.” |

9. Do you agree that Ecolabel or MSC is implemented in Indonesia?  

| "Fishermen never get an explanation from any party related to the ecolabel and MSC program. Fishermen have never heard of Ecolabel so they cannot express their agreement or not.” |
| “We don't understand the certificate at all. If it only makes fishermen difficult, we reject it.” |

10. Are there alternatives to ecolabeling?  

| “For fishermen, schemes that can provide additional income to fishermen and benefit the survival of fishermen will be wholeheartedly supported. So it is with ecolabeling.” |
| We hope the government will encourage the welfare of fishermen in Padang. Disseminate the information to fishermen about preserving...
11. Do you trust the national ecolabel?  
“If the national ecolabel is able to prove that the certificate is beneficial for the survival and welfare of fishermen and guaranteed by the Government, fishermen will support it.”

12. What are the important components in certification?  
"As far as we know in various fishing programs, we are not involved enough so that fishermen do not get enough information about the benefits of a program because it is an order from above. Certification needs to involve fishermen if they want to be practiced and need to give a correct understanding of the importance of the certificate for the welfare of fishermen. The point is continuous communication with fishermen."

resource: Respondents' answers, processed by researchers

Based on the results of the interview, the fishermen's understanding of the ecolabeling scheme is still very minimal. Fishermen also do not understand about sustainable fisheries management. Fishermen understand about catching adjustments in certain seasons. Nevertheless, fishermen support the Government's policy if it provides benefits to the fishing community.

Fishermen also support the Government's policy in the field of ecolabeling if it provides benefits economically and ecologically. Fishermen need a special approach from the Government in the form of assistance in fishing and post-capture activities. The selling price of fish carried out in the auction process at the fish landing place (TPI) also largely determines the benefits that can be received by fishermen. Likewise, the involvement of the fishing community after the arrest.

5 Discussion

As a government agency authorized to issue policies and also facilitate stakeholders in the maritime and fisheries sector, especially small fishermen, the Ministry of Maritime Affairs and Fisheries needs to encourage the strengthening of stakeholder information on policies issued. The Ministry of Maritime Affairs and Fisheries (MOMAF) is also an authorized agency in the management of fisheries resources in Indonesia.

The pillars of marine and fisheries development at present are sovereignty, sustainability and prosperity. The three pillars support the initiation of ecolabeling because the three pillars are in line with the principles of sustainable development namely environmental protection, economic benefits
and socially inclusive. MOMAF policy is translated into various laws and regulations that support the existence of three pillars of marine and fisheries development.

MOMAF issued Minister of Maritime Affairs and Fisheries Regulation No. 107 of 2015 concerning the tuna fisheries management plan/RPP TCT\(^{10}\). The Ministerial Regulation mandates the establishment of an environmentally friendly capture fisheries certificate for tuna fisheries. The certificate will encourage sustainable fisheries management efforts. The Ministerial Regulation is in line with the National Capture Fisheries Management Architecture document issued by the CTF in 2016.\(^{11}\) The document is listed in item 5 on strengthening fisheries diplomacy where to improve the national standards of CCRF-based fishing need to be encouraged by certification and traceability systems national fish catches.

The legal basis for the national fisheries ecolabeling scheme is a factor that strengthens the foundation for fisheries ecolabeling. The support of government regulations related to fisheries ecolabeling is not yet widely known by the fishing community, especially small fishermen. The implementation of the fisheries ecolabel scheme will be difficult to implement without understanding from the stakeholders of the fisheries sector, especially small scale fishermen.

The readiness of government regulations to support the fisheries ecolabel scheme is in line with research conducted by Gulbrandsen\(^{12}\) which concludes the need for strong government regulation support for the implementation of an ecolabel scheme. Gulbrandsen\(^{3}\) states that “certification is not enough to overcome the decline in fish stocks”. In contrast, government regulations on marine reserves, restrictions on access to fish resources, strict distributive schemes and restrictions on IUU Fishing must be part of the solution. Ecolabel certification must be integrated with strong government regulations.

Support from small fishermen as the main stakeholders in the sustainable management of fisheries resources needs to be the main concern of the government. Based on research from Notohamijoyo\(^{13}\) it was found that the support of stakeholders including fishermen to the national fisheries ecolabel scheme was very large to reach 90.91 percent.

The high level of acceptance from respondents in the fisheries ecolabel model reflects the high level of respondents' trust in the government as an institution. It is also in line with the research from Notohamijoyo\(^{14}\). However, current research shows that fishermen’s low understanding of ecolabel schemes makes it difficult to implement fisheries ecolabel schemes in Indonesia. Information dissemination, education, training and assistance for fishermen are needed to implement the ecolabel scheme in Indonesia.

The high level of acceptance from respondents in the fisheries ecolabel model reflects the high level of respondents' trust in the government as an institution. However, current research shows that fishermen’s low understanding of ecolabel schemes makes it difficult to implement fisheries ecolabel schemes in Indonesia. Information dissemination, education, training and assistance for fishermen are needed to implement the ecolabel scheme in Indonesia.

\(^{10}\) Minister of Maritime Affairs and Fisheries Regulation No. 107 of 2015 concerning the tuna fisheries management plan (RPP TCT)

\(^{11}\) National Capture Fisheries Management Architecture, Ministry of Marine Affairs and Fisheries, 2016


\(^{13}\) Notohamijoyo, Andre. 2016. *loc.cit*

\(^{14}\) Notohamijoyo, Andre. 2018. ASEAN tuna ecolabelling (ATEL): the challenge and opportunity of the first seafood regional ecolabelling in the world. E3S Web of Conferences 74. 04004.
Klooster's research\(^{15}\) proves that acceptability in addition to rigor and legitimacy is one important element in the successful implementation of an ecolabel scheme. Likewise, several references such as Kvalvik \([5]\), Hadjimichael and Hegland\(^{16}\) show that the level of stakeholder acceptance in a country towards an ecolabel scheme influences the successful implementation of ecolabel in that country.

Stratoudakis et al.\(^{17}\) stated that specific approaches to developing countries need to be adapted to local and regional socio-economic conditions. Government assistance is needed to implement ecolabel certification in developing countries.

The implementation of fisheries ecolabeling in Indonesia cannot be seen from merely applying environmental principles but must also involve other sustainable development principles, namely economic principles and social principles. The aim is ultimately certification regulates people so that without involving them as the main actors in the process, the existence of the certificate will not be implemented properly.

6 Conclusion

Based on these results, MOMAF needs to develop a work plan program that encourages the implementation of the national fisheries ecolabel scheme for stakeholders, especially small fishermen. This research also provides a clear direction for MOMAF to initiate a national fisheries ecolabeling scheme that places small fishermen as the main stakeholders in Indonesia. Education and strengthening the capacity of fishermen is a chore to be done to encourage increased capacity and understanding of fishermen towards sustainable management of fisheries resources.

National fisheries ecolabeling must be a form of protection for the rights of fishermen and fisheries resources. The ecolabel will also be a form of branding Indonesian fishery products that are environmentally friendly in the global market.

References


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\(^{17}\) Stratoudakis, Yorgos, et al. (2016). Fisheries certification in the developing work: Locks and keys or square pegs in round holes? Fisheries Research. 182: 39-49


[7] Law No. 18 year 2012 concerning *Food*

[8] Minister of Environment Regulation No. 02 of 2014

[9] Minister of Maritime Affairs and Fisheries Regulation No. 107 of 2015 concerning the tuna fisheries management plan (RPP TCT)


Implementation of Spatial and Development Planning in East Kalimantan Province

Wedo Aru Yudhantoro1, Arty Dwi Januari1, Atiti Setyaning Utami M.1, Erline Fitridiah Pitaloka1, Kunny Izza Indah A.1, Nurul Rusdayanti1, Poerborini Damayanti1, Sindhung Wardana1, Siti Kardian Pramiati1, Siti Shara1, Hayati Sari Hasibuan1, and Rudy P. Tambunan1

{wedo.aru@ui.ac.id1, arty.dwi91@ui.ac.id1, atiti.setyaning@ui.ac.id1, erline.fitridiah@ui.ac.id1, kunny.izza@ui.ac.id1, nurul.rusdayanti@ui.ac.id1, poerborini.damayanti@ui.ac.id1, sindhung.wardana@ui.ac.id1, siti.kardian@ui.ac.id1, siti.shara91@ui.ac.id1, hayati.hasibuan@ui.ac.id1, rudyptamb@gmail.com1}

School of Environmental Science, Universitas Indonesia, Jakarta1

Abstract. This study is testing for the truth of development, and correctly implementation from spatial plans document in East Kalimantan, Indonesia. The most significant potential from East Kalimantan is mining products and palm oil products. Qualitative method are used on this research by using analysis process from the real development data from 2016 until 2019 using geospatial analysis process. In mining areal case, the most significant permission already developed in residential areas with number 75,22%, which mean 2.062.075,5 hectare areas. The same problem has happened in palm oil areal that develop in 46,7%, which mean 543.021,92 hectare areas. Another result was showed that in mining and oil palm areas already has overlapping areas in 3,53% or 449.753,53 hectare areas. There is a problem in the development process in the past three years. It needs to evaluate in real to make sure the urban land-use plan from 2016 until 2036 still in the right way.

Keywords: Development; Spatial planning; Spatial structure; Urban land use

1 Introduction

Indonesia national constitution about spatial planning number 26/2007 defined spatial planning as unity of spatial planning processes in a system, spatial use, & spatial use control. So that spatial planning can be defined as a process for determining the spatial structure and spatial patterns, which include the preparation and determination of spatial plans. Spatial planning based on administrative areas consists of national spatial planning, provincial spatial planning, and district/city spatial planning. The spatial planning was realized in the National, Provincial, and Regency / City Spatial and Regional Spatial Plans, and there are also Spatial Detail Plans covering the Sub-district area. Spatial planning is needed to overcome competition and conflict between various uses in a limited area. The effort to realize the spatial structure and spatial pattern following the spatial plan through the preparation and implementation of the program and its financing is called the use of space. Spatial utilization is carried out through the implementation of the spatial use program and its financing contained in the regional spatial plan. Spatial utilization refers to the spatial functions stipulated in the spatial plan carried out by developing land stewardship, water stewardship, air stewardship, and stewardship of other natural resources. Government and regional governments has fully priority to consider who can manage the stewardship land that has rights commitment to sure the land rights in the function. In the space of the land for protected
function rooms, the Government and the regional government give priority first to accepting the rights transfer of land from some holder who has already relinquishes the rights.

East Kalimantan Province, which has an area and land area of around 12,726,752 ha, which consists of a land area of 12,533,681 ha and inland waters covering 193,071 ha, also has the right to organize and utilize its own territorial space. As the third-largest province, East Kalimantan Province has abundant natural resource potential, where most of the potential has not used optimally. Most of the natural resources and their products exported abroad, so that this province is one of the leading foreign exchange earner provinces for the country, particularly from the mining, forestry and other yield sectors. Data related to the extent of plantation land in regencies and cities throughout East Kalimantan is still not synchronous with the provincial spatial plan. It was confirmed by East Kalimantan Governor H Awang Faroek Ishak at the East Kalimantan Plantation Development and Floating Evaluation Meeting in the Edge Meeting Room 1. One example, the area of land designated for plantations within the provincial spatial planning for Berau was around 425,645 hectares while the realization was only 126 thousand hectares. Also, the Regency of Kutim of the total area of land owned and contained in the provincial spatial structure is around 881 thousand hectares, but the realization has only reached 429 thousand hectares. Besides, there are indications that the plantation lands have already taken over the function of land carried out with the permission of the local area so that overlapping land occurs due to different or changing land use.

To achieve the objectives of the strategy, the provincial government realized that they needed a commitment from many interests, like stakeholders. Green Growth Compact (GGC) concept has taken by Governor of East Kalimantan in September 2016 as a tool for bringing together initiatives that come from some interests, like private sector, local & national government, communities, NGOs, until universities sector for research. During the 2017 Governor of the Climate and Forests Task Force (GCF) meeting already held in 2017 that contained 7 GGC pilot initiatives that help for develop the goals of the East Kalimantan development. However, in its implementation, there is a mismatch of the actual conditions with the target to be achieved. Deforestation rates in East Kalimantan from 2000 - 2015 are around 60,000 ha per year, more comprehensive than the city of Balikpapan, and 30 percent of those deforestations occur in forest areas.

This research used qualitative methods that needed analysis by the geospatial analysis process by using an application. The documents used in this research are spatial planning documents of East Borneo, mapping data from the Ministry of Villages, disadvantaged regions, and transmigration of the Republic of Indonesia. Another process to get the data is by literature review and compare it with the actual data. The location of the research is in East Borneo with a subject area of the research in mining subject area, agriculture area, settlement area, forest area, and land-use area. The population of the research consists of area mapping of East Borneo with the time of research basic from secondary data of spatial development planning in 2016 until the reality in 2019.

The result data from the interpretation process in real will have to compare with the public land-use planning data. After that, we will see how much the overlapping has happened already. For the next will gift some recommendations for being part of solving the problems or fixing the problems. The necessary procedure is to collect the data of East Kalimantan Province from actually of development from 2016 to 2019, combine and compare the real data with the urban land-use planning regulation of East Kalimantan Province. The next process is to collect the national regulation, region regulation, and combine it again with the real data after do combining it before. Moreover, after this, we will look for the best recommendation to solve the problems.
2 Geographic Condition

East Kalimantan Province is the second largest provinces in Indonesia Republic after Papua, having abundant natural resource potential where most of the potential has not used optimally. The natural resources and their products already exported abroad, so this Province is the primary foreign exchange earner for the country, especially from the Mining, Forestry, and other yield sectors. The province of East Kalimantan are located on the most east island of Borneo and is also a border region with Malaysia, especially Sabah and Sarawak. East Kalimantan is a province in Indonesia located between 113°35'31" to 119°12'48" east longitude, and between 2°34'23" north latitude to 2°44'14" south latitude with an area of 127,346.92 km² [3]. The province was beside with Malaysia in the north and some island of Indonesia like Sumatra, Sulawesi, and Java Island [1]. Based on Local Regulation of Kalimantan Number 1 of 2016 about Urban Land-use Planning of East Borneo Province from 2016 - 2036, East Borneo has potential land in 12,638.931 Ha (75.54%) from all the area of East Borneo Province.

Table 1. Data Administrative of East Kalimantan Province in 2016

<table>
<thead>
<tr>
<th>Regencies/City</th>
<th>Areal (Ha)</th>
<th>Number of sub-district</th>
<th>Number of villages</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paser</td>
<td>1,109,696</td>
<td>10</td>
<td>144</td>
</tr>
<tr>
<td>Kutai Barat</td>
<td>1,370,92</td>
<td>16</td>
<td>194</td>
</tr>
<tr>
<td>Mahakam Ulu</td>
<td>1,994,941</td>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>Kutai</td>
<td>2,598,808</td>
<td>18</td>
<td>237</td>
</tr>
<tr>
<td>Kertanegara</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kutai Timur</td>
<td>3,105,171</td>
<td>18</td>
<td>135</td>
</tr>
<tr>
<td>Berau</td>
<td>2,173,519</td>
<td>13</td>
<td>110</td>
</tr>
<tr>
<td>Penajam Utara</td>
<td>292,373</td>
<td>4</td>
<td>54</td>
</tr>
<tr>
<td>Paser</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Samarinda</td>
<td>71,653</td>
<td>10</td>
<td>59</td>
</tr>
<tr>
<td>Bontang</td>
<td>16,314</td>
<td>3</td>
<td>15</td>
</tr>
<tr>
<td>Kalimantan Timur</td>
<td>12,734,692</td>
<td>103</td>
<td>1,032</td>
</tr>
</tbody>
</table>

Source: Urban land-use plan of East Kalimantan in 2016

Based on the slope of the land and the altitude, the topographic characteristics of the Province of East Kalimantan are dominated by lands with slopes above 40 percent and elevations of less than 500 meters above sea level. Flatland (0-2%) in East Kalimantan Province is generally only found in coastal areas and large river basins, which cover about 10.70 percent of the total area. While the land has a sloping level (2-15%) reaches 16.16 percent. The rest is hilly land with a slope level of> 15%, with an area of around 73.14% of the total area of East Kalimantan Province. Food crop development is only possible in flat to sloping areas or areas with a slope of 0-15 percent, whereas the land with a higher slope level (> 15 percent) is only suitable for annual crops and conservation areas. Soil types in the East Kalimantan mainland area were dominated by latosol red and yellow podsolic soils and lithosols, which spread in the Central and North parts of East Kalimantan. There are 3 (three) major fault patterns in East Kalimantan Province. Among them Mangkalihat Fault,
Sangkulirang Fault, and Megashear Adang. Moreover, there is also the Samarinda Anticlinorium. Potential minerals found in East Kalimantan are coal, oil and gas, gold, galena, and others. The number of rivers in East Kalimantan Province is 157 large and small rivers, including the Mahakam River, which has a length of 920 km with an area of 77,913 km² of the river. There is also has Kelay River with 254 km length. The number of lakes is 18 (eighteen), with 3 (three) largest lakes being Lake Melintang covering 11,000 hectares, Lake Semayang covering 13,000 hectares, and Lake Jempang covering 15,000 hectares. Besides being used as transportation infrastructure and raw water sources, these rivers can also use as Hydroelectric Power Generation (PLTA) such as the Kelay River, Telen River, and Medang River [4].

3 Ecosystem Condition

The condition of the East Kalimantan Ecosystem is one of the mainland landscapes on the island of Kalimantan, which has a very varied geomorphological form. Here some mountains and hills have been famous since colonial times, such as the Meratus Mountains, the Schwaner Mountains, the Muller Mountains, and the Iban Mountains. In these mountains, the highest points in Kalimantan, Indonesia, are. The mountains are also the headwaters of almost all major rivers in Kalimantan. They are called the Heart of Borneo and are known as the Heart of Borneo. Besides, East Kalimantan also has extensive freshwater swampy plains. Kalimantan's major rivers play a significant role in shaping such plains because freshwater swamps are known as the "floodplains" of these rivers. Central Mahakam Swamps (East Kalimantan). The coastal areas of Kalimantan Island are, for the most part, characterized by mangrove swamps that grow on tidal plains. In addition to the morphological forms above, in the middle of the mainland of Kalimantan can also be found a reasonably extensive Karst / Cretaceous area, namely the Sangkulirang - Mangkalihat karst area which stretches across East Kutai Regency and Berau District. Meanwhile, the mainland on the coast of Kalimantan is a place to live for mangrove ecosystems (tidal swamps) and coastal forest ecosystems (non-tidal dry land).

4 Demographic Condition

The population of East Kalimantan in 2003 totaled 2,311,162 people. In 2010 based on the results of the population census, it reached 3,047,500 people. Therefore, during this period, the population of East Kalimantan increased by 736,338 people, with an average annual population growth of 3.60 percent. The population of 2013 was 3,300,517 people with the composition of the population according to sex consisting of 1,731,820 male population (52.47%) and 1,568,697 female population (47.53%). Based on the calculation of the Central Statistics Agency (BPS), demographic bonuses in Indonesia will occur between 2020 and 2030, while each province will get demographic bonuses at different times.
East Kalimantan has received a demographic bonus since 2013. It can see from the population of East Kalimantan's productive age (15-64 years), which has reached precisely 70 percent of the total population. Seventy percent of the productive age population bears 30 percent of the non-productive age population (aged <15 years and 65 years and above). At present, the dependency ratio or ratio between unproductive age population and productive age population in East Kalimantan Province has reached 42, which means that every 100 productive population in East Kalimantan bears 42 unproductive population. It can be analogous, a house with four people, three workings, and one were borne. This number is predicted to continue to decline until 2028, and after that, it will increase again and end in 2045. The occurrence of peak productivity is very beneficial in terms of development. The high number of productive age will encourage economic growth. East Kalimantan will potentially benefit in the form of rising gross domestic product (GDP). However, the benefits of a demographic bonus can obtain with a note that there are already job preparation, proper education, and adequate health and nutrition services. If this is not available, some problems will arise. Call it a high unemployment rate, rising crime rates, to the occurrence of social conflict [2].

5 Economic Condition

The province's main products are mining products such as oil, natural gas, and coal. Agriculture, tourism, and industries sector are another sector that already developing in East Kalimantan. Some regions, such as Balikpapan and Bontang, have begun to develop industrial estates in various fields to accelerate economic growth. While districts in East Kalimantan are now starting to open up their territories to make plantations such as oil palm and others. Derawan Islands in Berau, Kayan Mentarang National Park, and Batu Lamampu Beach in Nunukan, crocodile farms in Balikpapan, deer farms in Penajam, Dayak Pampang Village in Samarinda, Amal Beach in Tarakan City, Kumala Island in Tenggarong is some example of several attractive tourist destination in East Kalimantan. Asphalts road is one of obstacle in
East Kalimantan. Many cities of the province still do not have asphalt roads access, so for the accessibility many people travel by using boat and airplane, and it is no wonder that East Kalimantan has many pioneer airports. Also, there will be plans to make the Balikpapan – Samarinda – Bontang - Sangata Highway smooth the economy.

East Kalimantan is a mining and timber-producing province which has a significant contribution to Indonesia's economy. Gross Regional Domestic Product (GRDP) values from East Kalimantan province has always increased in each period, although the increase has increasingly seen to slow down until finally generally declines in 2015. However, in 2016, the value of the GRDP of East Kalimantan Province has increased with a magnitude of 507.07 trillion rupiahs, compared to 2015, reaching 503.69 trillion rupiahs. East Kalimantan Province GRDP is a sector related to coal and oil and gas so that if the dominance of the non-renewable resource sector is eliminated, the GRDP of East Kalimantan Province will only reach 241.69 trillion rupiahs.

**Fig. 2.** Economic Growth in East Kalimantan Province by Economic Sector
(Source: Central Bureau Statistics of East Kalimantan Province 2016)

Formation of the regional economy was dominated by mining and quarrying groups, which reached 43.34 percent. Nevertheless, the dominance of the economic structure of the mining and quarrying category has decreased significantly from year to year, as can be seen from the contribution of the sector and sector growth, which has slowed, even negative growth in 2016. This East Kalimantan Province will cause economic turmoil in the future if it not accompanied by the sustainable management of the developing economy. An exciting thing related to the economy in East Kalimantan Province is that although economic growth in the Province is far below the national economic growth, the contribution of the Province of East Kalimantan to national income is very high. It is due to the high contribution of the oil and gas sector in the
formation of the GRDP of East Kalimantan Province, which has an impact on the contribution of the National GRDP. However, what needs to be marked is the production of oil, gas, and coal continues to decline from year to year, which causes the added value to decline so that economic growth also declines, although the GRDP is still relatively high.

6 Implementation Study of the Urban Land-Use Plan in East Kalimantan Province

6.1 Plantation permission in the forest area

Based on PP 104/2015, plantation business activities whose licenses are issued by regional governments based on provincial or district/city regional spatial plans stipulated by regional regulations before the enactment of Law Number 26 on 2007 that concern in Spatial Planning and based on prevailing spatial planning are by the previous spatial plan but based on the Forestry Law, the area according to the latest Forest Area map [8]:

(i) is a convertible area for production forest area
(ii) is a permanent area for production forest and limited area for production forest that based on area processed through exchange of forest area

It has one year maximum period since the area entry into force of PP 104/2015 can submit applications for the Release of forest area or exchange of forest area that submitted to Indonesian Minister of Environment and Forestry ("Minister of LHKI"). Release of forest area and Exchange of forest area There are still provisions in the implementation, namely:

(i) Permanent guarantee of Forest Area area of at least 30% (thirty percent) of the total watershed (DAS), island, and province with proportional distribution.
(ii) Maintaining the carrying capacity of the Forest areas.
(iii) Exchange of Forest Areas can do with replacement land from: non-Forest Area land and Convertible Production Forest areas.

Based on the results of data processing, it known that the majority of plantation business licenses in the Province of East Kalimantan are in Other Use Areas (OUA), which are 1,085,754.72 Ha or 93.38%. Another area of use is the non-forest area. While plantation business permits in the Production Forest (PROFER) areas are 44,791.95 Ha or 3.85%, Limited Production Forest (LPF) area is 20,204.02 Ha or 1.74%, and in the Production Forest area can be converted, Protection Forest, Waters, Nature Reserve / Tourism Forest areas of 11,943.61 Ha or as much as 1.03%. Based on PP 104/2015, the plantation business permit of 5.59% in the area of permanent production Forest areas and limited production forest areas in East Kalimantan region does not necessarily violate the rules. It has been a request for release the forest areas or the exchange forest areas to Indonesian Minister of Environment and Forestry and has fulfilled the conditions of the exchange of forest areas.

6.2 Mining Permission in Forest Area

The interests of development outside forestry can only be carried out within PF and PROFER areas that are selective without changing the main functions of the forest area. In protected forest areas, mining prohibited using open mining patterns. The use of forest areas for mining purposes is done through the granting of a lease-to-use permit by the Minister by taking into account specific area and time limits and environmental sustainability. Based on the provisions of Article 38 of Law No. 41 of 1999, the Joint Decree between the Minister of Mines and Energy increasingly narrowing that mining activities in forest areas can only be carried out in forests precious protection for oil and gas and open mining in production forests. Based on the results of data processing, it known that the most significant mining business permit in East Kalimantan Province is in the PROFER area of 1,100,518.23 Ha or 38.54% and followed in OUA areas of 1,052,539.85 or 36.86%. LPF area of 544,686.38 Ha or
19.08%, and in Production Forest areas that can convert, Protected Forests, Waters, Nature / Tourism Reserves covering an area of 157,482.48 hectares or 5.52%. This percentage of forest use is the percentage of mining business permits in the forest area per overall mining business permit.

Management and handling of licensing systems, especially mining permits, are very complicated because they involve cross sectors. For example, the IUP process in other use areas OUA is issued by the Ministry of Energy and Mineral Resources (MEMR), but if the requested mining area included in a forest area, the IUP holder must take care of IPPKH at the Ministry of Environment and Forestry. The existence of Laws in Indonesia is still sectoral, which is more concerned with the sector because its drafting comes from ministries related to that sector. As a result, the licensing process in each sector, such as forestry, mining, and the environment regulated by a separate law and ministry (Rosadi, 2008). The conclusion is that although a mining activity permit has obtained, it has not yet been granted a borrowing-use permit from the forestry mining business that cannot carry out as long as the working area is in a forest area.

6.3. Plantation Permission in Land-use Area

Based on the results of data processing, the most substantial plantation business permit lies in the use of shrubland with an area of 370,324.10 hectares or 31.85%. Then followed by the use of secondary dryland forest land area of 280,981.37 Ha or 24.17%, dryland agriculture mixed with bush 11115.52 Ha or 13.86% area, bush/swamp shrubland area of 131,526.87 Ha or 11, 31%. (Secondary Swamp Forests, Swamps, Plantation Forests, Dry Land Agriculture, Settlements, Secondary Mangrove Forests, Open Land, Mining, Primary Dry Land Forests, Ponds, Primary Swamp Forests, Rice Fields) of 115,059.21 Ha or 9.90%. Whereas plantation business licenses that have completed are in the use of plantation land, which is 103,687.23 Ha or 103,687.23 Ha or 8.92%. The government has planned land use in its territory, but it
appears that between the land use planning and the actual location of the permit given is very much different.

6.4. Mining Permission in Land-use Area

![Image: Map of Mining Permission in Land-use Area]

Based on the results of data processing, the most substantial mining business permit is in the use of Secondary Dry Land Forest land, which is 1,084,739.46 Ha or 37.99%. Then followed by the use of 843,824.43 Ha of Shrubland, or 29.55%, others (Secondary Swamp Land, Swamp, Crop Land, Dry Land Agriculture, Settlement, Secondary Mangrove Forests, Open Land, Mining, Dry Land Htn Primary, Tambak, rice fields) with an area of 443,974.23 Ha or 15.55%, Agriculture of Mixed Mixed Land of Shrubland 325,717.24 Ha or 11.41%, and Swamp / Shrub area of 156,971.58 Ha or at 5.50%. As explained in the chapter on the granting of permits over land areas, the granting of a mining business permit is given by the Government, where the granting of the permit regulated in Law number 4 of 2009 about Mineral and Coal Mining Law. Granting of the permit will previously carry out a technical feasibility study, an economic feasibility study, and the preparation of environmental documents. When viewed from the data that exists between the land use map and the mining business permit, some things do not correspond even though contained in the MEMR Ministerial Decree No. 5 of 2018 about mastery of mineral and coal mining sector. Minister of Public Works Regulation No. 20 of 2007 concerning Technical Guidelines for Analysis of Physical and Environmental, Economic, and Socio-Cultural Aspects in Spatial Planning.

6.5. Plantation Permission in sustainability area
Land evaluation is a tool for identifying the suitability of business patterns of land use planning over diverse land resources [2]. The most widely used physical land evaluation method is the evaluation developed by FAO (1976) to assess land suitability for certain commodities. Conformity is express descriptively using the terms: very suitable (S1), entirely appropriate (S2), marginal appropriate (S3), not suitable now (N1), or not suitable forever (N2). Land suitability analysis used in this map is the suitability of residential land. Decree of the Minister of Agriculture No.837 / KPTS / Um / 11/1981 and Keppres No. 48/1983 explain the categorization of slopes, rainfall, and soil types used for the assessment of the category of area functions and suitability of residential land.

According to Suprapto and Sunarto (1990) [6], the suitability of land for settlements is related to the conditions of the location of settlements which emphasized on the relief variables (slope, flow density, and depth of the channel), geomorphological processes (floods, erosion levels, and rock mass movements), and variables rock material (rocks, weathering level, rock strength, bearing capacity, and wrinkle development). Land suitability for settlements is generally assessed based on land characteristics that affect building foundations, comfort, sustainability, building safety, rock strength, weathering levels, soil texture, landslide hazards, flood hazards, and soil permeability.

In the map of the results of data processing, the suitability of settlement land is expressed in class I-V, which are sequentially very suitable (S1), quite suitable (S2), marginally appropriate (S3), not suitable at present (N1) or not forever (N2). Based on the results of data processing, land suitability classes I, II, and III are suitable to be used as residential land, while land suitability classes IV and V are not suitable to be used as residential land. Based on the map overlay results, it is known that the most substantial plantation business permit is in the land suitability class IV of 396,818.39 hectares or 34.13%. Then followed by land suitability class III covering 392,215.78 Ha or 33.73%, land suitability class V covering 222,853.98 Ha or 19.17%, land suitability class I covering 98,674.94 Ha or 8.49%, and land suitability class II covering 52,131.20 hectares or 4.48%.
6.6. Permission of mining in sustainability area

Based on the results of data processing, land suitability classes I, II, and III are suitable to be used as residential land, while land suitability classes IV and V are not suitable to be used as residential land. Based on the map overlay results, it is known that the most significant mining business permit is in the land suitability class III, which is 1,049,708.43 Ha or 36.76%. Then followed by land suitability class I covering an area of 774,009.30 Ha or amounting to 27.11%, land suitability class IV area of 597,683.54 Ha or amounting to 20.93%, land suitability class II covering 238,357.77 Ha or 8.35 %, and land suitability class V covering 195,467.89 Ha or 6.85%. Based on the data above, it can see that mining business permit materials found in or in many areas which constitute land that has a land suitability value as a residential area, namely class I and class III land. When viewed in priority, mining business permits should be focused more on class IV and V regions than should be in class I, II, and III land areas. However, it also needs to be seen from the level of damage caused by the mining process. It is unfortunate if the land suitability class I is carried out by mining activities because it will experience land degradation and will require a very long time and a high cost to return the land to normal. The mining business has a high level of damage if it not followed by the application of efforts to protect the environment of the mining area both from the pre-mining process to the post-mining process.

6.7. Overlap of Mining and Plantation Area

East Kalimantan Province has a land area of 12,734,692 Ha. Some of the areas were permitted plantation and mining businesses. East Kalimantan Province plantation business permit covering 1,162,694.29 hectares or 9.13% of the total area. East Kalimantan Province mining business permit covering an area of 2,855,226.94 hectares or 22.42% of its area. Based on the results of data processing, it known that there is an overlap between plantation and mining business permits covering an area of 449,753.53 hectares or 3.53%. From 209 plantation business licenses and 1189 mining business licenses, there are 703 overlapping

![Fig. 8. Map permission of mining in the sustainability area](image-url)
regional permit issues. It triggers conflicts between business permit holders as an example of a plantation business permit owned by PT. Kartanegara Kumala Sakti overlaps with PT. Aditya Kirana Mandiri was covering an area of 4,464.39 Ha, as well as a plantation business permit owned by PT. Agrojaya Tirta Kencana overlaps with a mining business permit owned by PT. Trowels Energy covering an area of 3,934.05 Ha.

6.8. Plantation permission for business in the spatial planning area

Plantation business licenses covering 1,162,694.29 Ha or 9.13% from total land area of East Kalimantan Province as a whole spread over 209 plantation locations. Based on the plantation business permit granted, it is seen that 78.8% or an area of 916,178.83 Ha was grant according to the plantation spatial plan. While the incompatibility of granting plantation permits lies in the plan for the pattern of the rural settlement area of 121,780.57 hectares or 10.47%, this is because the closer the plantation location is to the settlement, it will make it easier for the community to manage and harvest the garden products. Furthermore, plantation business permits in Coastal Conservation Areas, Urban Settlements, Protected Forests, Grand Forest Parks, Road Buffers, Mangrove Conservation, Mining, Industrial Estates, Water Bodies, Nature Reserves, Food Crop Agriculture, Food Crop Agricultural Reserves, Geological Protected Areas (Karst), Limited Production Forest covering 46,593.61 Ha or 4.01%, Conversion Production Forest covering 45,460.63 Ha or 3.91%, and in Production Forest covering 32,680.67 Ha or 2.81%. The incompatibility of plantation business permits with the planned spatial patterns has become an evaluation for the government of East Kalimantan Province.

6.9. Permission of Mining Area in Spatial Planning

Mining business permits covering an area of 2,855,226.94 Ha or amounting to 22.42% of the total land area of East Kalimantan Province as a whole spread over 1189 mining sites in East Kalimantan Province. The use of forest areas for mining purposes is done through the granting of a lease-to-use permit by the Minister by taking into account specific area and time limits and environmental sustainability. Based on Table 4.10, it is known that the most significant mining business permit was granted in the production forest area, which is 1,022,874.24 Ha or 35.82%, followed by the plantation space pattern of 813,574.41 Ha or 35.82% and production forest limited area of 572,978.39 Ha or 20.07%. While for figures below 5%, mining business permits were granted in the Conversion Production Forest space pattern of 115,495.41 Ha or 4.05%; rural settlements covering an area of 105,094.12 hectares or 3.68%; Coastal Conservation Areas, Nature Reserves, Road Buffers, Mines, Industrial Estates, Plantation Reserves, Mangrove Conservation, National Parks, Grand Forest Parks, Water Bodies, Urban Settlements, Agricultural Plant Reserves covering an area of 105,110.79 Ha or 3.68%; Protection Forest covering an area of 60,134.92 Ha or 2.11%; and Food Crop Agriculture covering an area of 59,964.66 Ha or 2.10%. Based on the comparison between mining business permits and plantation business permits with the East Kalimantan spatial pattern, several problems can consider in the future development plan:

(i) It appears that economic transformation has not yet entirely gone well. This can also be seen from the composition of East Kalimantan's GRDP in the mining sector by 43.34%, followed by the manufacturing industry sector by 20.51%. For Regency / City, the most significant mining sector's contribution was in East Kutai Regency with 79.23% and
Paser with 71.31%. Whereas the most significant processing industry is in the Bontang region, 83.96%, and Balikpapan 47.62%. The low value of industrialization and processing is an indication that the downstream processing has not been processed either from the mining sector or from the forestry and fisheries sectors. It shows that economic transformation has not entirely gone well.

(ii) The continued reduction in forest land caused by the conversion of forest functions to mining or mining locations results in a decrease in environmental quality. So there is a need for monitoring and data collection again on the extent of forests that still function as forest land areas in the province of East Kalimantan.

6.10. Permission for Plantation and Mining Area in Structure Planning Area

Plantation business licenses covering 1,162,694.29 Ha or 9.13% of the total land area of East Kalimantan Province as a whole spread over 209 plantation locations in East Kalimantan Province. There are four national centers of activity in the Province of East Kalimantan, namely in the cities of Samarinda, Bontang, Tenggarong, and Balikpapan. There are plantation business licenses issued in the region, with the Tenggarong and Samarinda city areas being the center of the political activity with the most plantation business licenses granted. There are 19 local activity centers in the East Kalimantan region, 19 local activity centers are not located in the center of the distribution of plantation business licenses, but scattered around the edges of the plantation business permit location. Mining business permits covering an area of 2,855,226.94 Ha or amounting to 22.42% of the total land area of East Kalimantan Province as a whole spread over 1189 mining sites in East Kalimantan Province. There are four national centers of activity in the province of East Kalimantan, namely in the cities of Samarinda, Bontang, Tenggarong, and Balikpapan. There are mining business licenses issued in the region, with the Tenggarong and Samarinda municipal areas being the center of political activity with the most mining licenses granted. There are 19 local activity centers in the East Kalimantan region, 19 local activity centers are not located in the center of the distribution of mining business licenses, but scattered around the edges of the mining business permit location.

6.11. Green Growth Compact in East Kalimantan

The Minister of Environment and Forestry, Siti Nurbaya, on September 27, 2016, declared the Green Growth Compact (GGC) for East Kalimantan. There are three essential things related to the Green Growth Compact (GGC). The first is the context, the second relates to content, and finally, the coherence with Government policies, in this case, the Ministry of Environment and Forestry. On the context side, this GGC can inspire Indonesia from East Kalimantan. The best practices that have been carried out by East Kalimantan can make an excellent contribution to other regions in the context of green development. Meanwhile, in terms of GGC content, it certainly can encourage green economic growth such as green technology, a new engine for growth, low carbon for fossil fuel use, increase carbon sinks, and even green social forestry practices [7].
This GGC aims:

(i) Strengthen and expand existing initiatives
(ii) Filling existing gaps collaboratively
(iii) Integrate obligations that must be carried out with voluntary company commitments

7 Conclusion

Based on a comparison between mining business permits and plantation business permits with the East Kalimantan spatial pattern, it can see that the economic transformation has not fully implemented well. The low value of industrialization and processing is an indication that the downstream processing has not been processed either from the mining sector or from the forestry and fisheries sectors. The continued decline in forest land caused by the conversion of forest functions to mining or mining sites results in a decrease in environmental quality.

Green growth compact (GGC) is a framework agreement that guides the parties in developing more operational planning, performance-based policies within the regulatory framework, and the working practices of the parties to achieve common goals in support of East Kalimantan. Reduce deforestation minimum 80% by 2025, restore the forest into best condition and increase economic growth by 8% while reducing emissions by 1,000 tons CO2 e per the US $ 1 million of GDP on 2030 is some of the centered interrelated targets of GGC concept from East Kalimantan. The GGC will show how commitment and partnerships at the local level can have a global impact.

Acknowledgements. I want grateful thanks to all friends in the School of Environmental Science class Indonesia University who have already helped and created this paper into suitable material for study. I hope the material presented in this paper can help many people in terms of sustainable development, which will later need to seen as risks, mitigation, and the process of supervision.

References

The Criteria of Sustainability Economic and Social of Existance Geothermal Power Plant to Surrounding Community
(Case study on geothermal power plant at Sukabumi, West Java)

Raity Arief Hidajat¹, Suyud Warna Utomo², Iwa Garniwa³, Mahawan Karuniasa⁴ 
{raity.arief@gmail.com¹, suyudwarno@gmail.com², iwa@ee.ai.ac.id³, mahawanconc@yahoo.com⁴}

School of Environmental Science, Universitas Indonesia¹, School of Environmental Science, Universitas Indonesia², Electrical Engineering Department, Faculty of Engineering, Universitas Indonesia³, School of Environmental Science, Universitas Indonesia⁴

Abstract. Recently, electricity consumption in Indonesia continue to increase rapidly along with the increase in technology, economic growth and also the increase in the population. One potential source of electrical energy comes from geothermal energy, where Indonesia has enormous potential. In this research the aspects studied is sustainable development on economic and social as research variable, where the existence of geothermal power plants is expected to have a positive impact on the sustainability of economic and social of the surrounding communities. Locus of this research is Geothermal Power Plant that operated at Kalapanunggal sub-district, which is located in Sukabumi District, West Java. The method used is Analytical Hierarchy Process (AHP) to obtain assessment criteria. From the AHP results, the economic criteria from existence geothermal power plant is regional income from production bonus, and social criteria is the use of labour and local products.

Keywords: geothermal, sustainable development, community

1 Introduction

Population and economic growth make demand for electricity supply continue to increase. This is what makes the development of renewable energy power plants considered a national need that can no longer be delayed. Electrical energy has now become a major need in people's lives, the need for electricity in Indonesia which continues to increase rapidly along with the increase in development, economic growth and also the increase in the population in Indonesia.

One potential source of electrical energy is geothermal energy, where Indonesia has enormous potential source where until the end of 2016 there were at least 331 geothermal energy source locations throughout Indonesia, with a potential of 28,579 MWe and estimated reserves around 17,506 MWe and installed capacity (Ministry of Energy and Mineral Resources, 2017).

The connection with sustainable development is how to optimize the presence of this future power plant to improve the economic life and social life of the surrounding community.

Since 1987 the world has introduced the concept of sustainable development by the World Commission on Environment and Development, chaired by Gro Harlem Bruntland, the
Norwegian Prime Minister at the time. This commission produced a report known as "The Brundtland Report" which added economic aspects to the ecological and social aspects. Sustainable development is a development process that has the principle of meeting current needs without compromising the fulfillment of future generation’s needs. The factor that must be faced to achieve sustainable development is how to improve environmental destruction without sacrificing the needs of economic development and social justice. The 2005 World Summit outlined that sustainable development consists of three main pillars, namely economic, social, and interdependent and strengthening environments.

The existence of a large activity in an area is highly expected to have a positive impact that can be felt by the surrounding community. The Company carries out its business activities in the field are required to carry out social and environmental responsibility, however aspects that are really needed by the community according to their needs have not been clearly identified. For this reason, this study aims to capture the needs of the community based on the objective view of expert resource persons from both the government in charge of geothermal fields, academic, local regional leaders and references from other sources.

The locus was a geothermal power plant on Kalapanunggal sub-district, located in Sukabumi district, West Java. The population of Kalapanunggal Sub-district according to the results of the June 2010 population census was 55,587 persons, and the economic potential is agriculture, plantations, goat farm and arts. The Kalapanunggal Sub-district originally consisted of four regions which included: Kalapanunggal region, Cikidang region, Kabandungan region and Parakansalak region. The area of Kalapanunggal Sub-district is 7,501.37 hectares and consists of 7 villages, 56 citizens association, and 210 neighborhood association. The location of Kalapanunggal Sub-district is on the Gunung Salak area which has a height of between 500-1,000 meters above sea level.

2 Methods

Recognizing the importance of consideration economic and social as comprehensive aspects in the concept of sustainable development. We identified the criteria related to the economy and social based on interviews with expert resource persons, consisting of government, sub-district heads, academic and references from the Global Reporting Initiative. These parameters are processed by the Analytical Hierarchy Process (AHP) method to obtain assessment criteria and alternative choices. AHP was developed by Prof. Thomas L. Saaty as a decision making algorithm for multi-criteria problems. The multi-criteria problem in AHP is simplified in the form of a hierarchy consisting of 3 main components, namely the goal of decision making, assessment criteria and alternative choices. After the multi-criteria problem is modelled in a hierarchy, it can begin the pairwise comparison stage that will be used when searching for the weighted criteria and alternative weights for each assessment criterion. Pairwise comparisons are made based on subjective preferences of decision making.

AHP is often used as a method of solving problems compared to other methods, because AHP makes broad and unstructured problems into a model that is flexible and easy to understand, AHP also solves complex problems through a system approach.
Table 1. Table Scale 1-9 Saaty
(Source: Decision Making with the Analytic Network Process)

<table>
<thead>
<tr>
<th>Scale</th>
<th>Example</th>
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<tbody>
<tr>
<td>1</td>
<td>Equal Importance</td>
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<tr>
<td>2</td>
<td>Weak</td>
</tr>
<tr>
<td>3</td>
<td>Moderate importance</td>
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<td>4</td>
<td>Moderate plus</td>
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<td>5</td>
<td>Strong importance</td>
</tr>
<tr>
<td>6</td>
<td>Strong plus</td>
</tr>
<tr>
<td>7</td>
<td>Very strong demonstrated importance</td>
</tr>
<tr>
<td>8</td>
<td>Very, very strong</td>
</tr>
<tr>
<td>9</td>
<td>Extreme importance</td>
</tr>
</tbody>
</table>

Fig. 1. Map of Sukabumi District

The AHP method requires interaction with decision makers. Through interaction, the AHP will process it into a solution in the form of a priority scale for a number of alternatives.

This study aims to establish the right criteria related to the economic and social existence of a power plant to the surrounding community and has not yet led to a decision on a choice.
3 Results and Discussion

Economic and social criteria are based on interviews with several expert resource persons who are have a connection, experience and interest in the existence of a geothermal power plant in the Kalapanunggal sub-district. Expert resource person include:


b. Academic in the field of sustainability study and reporting from Bandung Institute of Technology (ITB).

c. Local government, head of Kalapanunggal sub-district (Camat).

d. Reference to the G4 Sustainability Reporting Guidelines from the Global Reporting Initiative (GRI).

Interview was conducted to each expert resource person to get their views on important criteria related to the economic and social aspects of the existence geothermal power plants in the Kalapanunggal sub-district based on their observation, experience and expertise.

3.1 Create a hierarchy structure

From the results of identifying the criteria of each resource person, a hierarchical model is drawn as illustrated below for both economic and social aspects:

![AHP hierarchy model for economic criteria](image)

![AHP hierarchy model for social criteria](image)
### 3.2 Pairwise comparison and consistency ratio

Pairwise comparison is to determine the comparison between one criteria with other criteria which is then modeled in a pairwise comparison matrix and the matrix goes through a normalization process to get priority order.

<table>
<thead>
<tr>
<th>Criteria 1</th>
<th>Criteria 2</th>
<th>Criteria 3</th>
<th>Criteria 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria 1</td>
<td>1</td>
<td>4</td>
<td>2</td>
</tr>
<tr>
<td>Criteria 2</td>
<td>0.25</td>
<td>1</td>
<td>0.33</td>
</tr>
<tr>
<td>Criteria 3</td>
<td>0.5</td>
<td>3</td>
<td>1</td>
</tr>
<tr>
<td>Criteria 4</td>
<td>0.25</td>
<td>2</td>
<td>0.5</td>
</tr>
<tr>
<td>Sum Result</td>
<td>2.00</td>
<td>10.00</td>
<td>3.83</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria 1</th>
<th>Criteria 2</th>
<th>Criteria 3</th>
<th>Criteria 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria 1</td>
<td>0.50</td>
<td>0.40</td>
<td>0.52</td>
</tr>
<tr>
<td>Criteria 2</td>
<td>0.13</td>
<td>0.10</td>
<td>0.09</td>
</tr>
<tr>
<td>Criteria 3</td>
<td>0.25</td>
<td>0.30</td>
<td>0.26</td>
</tr>
<tr>
<td>Criteria 4</td>
<td>0.13</td>
<td>0.20</td>
<td>0.13</td>
</tr>
<tr>
<td>Sum Result</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

From the normalization calculation, the priority vector of economic is obtained:

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria 1 - regional income from production bonus</td>
<td>49%</td>
</tr>
<tr>
<td>Criteria 2 - An increase in people's per capita income</td>
<td>9%</td>
</tr>
<tr>
<td>Criteria 3 - A community economic development in agriculture and livestock</td>
<td>27%</td>
</tr>
<tr>
<td>Criteria 4 - Direct economic value generated and distributed</td>
<td>15%</td>
</tr>
</tbody>
</table>
Consistency Index (CI) is 0.0202 and Consistency Ratio (CR) is 0.02, so the above assessment can be accepted because it is smaller than 0.1.

Table 4. Pairwise comparison for social criteria and normalization

<table>
<thead>
<tr>
<th>Criteria 1</th>
<th>Criteria 2</th>
<th>Criteria 3</th>
<th>Criteria 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria 1</td>
<td>1</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>Criteria 2</td>
<td>0.50</td>
<td>1</td>
<td>0.50</td>
</tr>
<tr>
<td>Criteria 3</td>
<td>0.25</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td>Criteria 4</td>
<td>0.25</td>
<td>2</td>
<td>0.50</td>
</tr>
<tr>
<td>Sum Result</td>
<td>2.00</td>
<td>7.00</td>
<td>6.00</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Criteria 1</th>
<th>Criteria 2</th>
<th>Criteria 3</th>
<th>Criteria 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria 1</td>
<td>0.50</td>
<td>0.29</td>
<td>0.67</td>
</tr>
<tr>
<td>Criteria 2</td>
<td>0.25</td>
<td>0.14</td>
<td>0.08</td>
</tr>
<tr>
<td>Criteria 3</td>
<td>0.13</td>
<td>0.29</td>
<td>0.17</td>
</tr>
<tr>
<td>Criteria 4</td>
<td>0.13</td>
<td>0.29</td>
<td>0.08</td>
</tr>
<tr>
<td>Sum Result</td>
<td>1.00</td>
<td>1.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>

From the normalization calculation, the priority vector of social is obtained:

Table 5. Priority vector of social

<table>
<thead>
<tr>
<th>Criteria</th>
<th>Priority</th>
</tr>
</thead>
<tbody>
<tr>
<td>Criteria 1 - Use of labor and local products</td>
<td>45%</td>
</tr>
<tr>
<td>Criteria 2 - Availability of access and educational media both formal and informal</td>
<td>14%</td>
</tr>
<tr>
<td>Criteria 3 - Repair of infrastructure (roads and uninhabitable house)</td>
<td>24%</td>
</tr>
<tr>
<td>Criteria 4 - Total number and rates of new employee hires and employee turnover</td>
<td>17%</td>
</tr>
</tbody>
</table>
Consistency Index (CI) is 0.0804 and Consistency Ratio (CR) is 0.09, so the above assessment can be accepted because it is smaller than 0.1.

4 Conclusion

Community leaders, policy makers and expert resource persons play an important role in reading the situation of the community against economic and social needs. This can be seen from the results of discussions with community leaders and policy makers in the area of research carried out. Community leaders, policy makers and expert resource person due to their interaction with the community can know for certain what the community needs more objectively. Community leaders, policy makers and expert resource person can play a role as a liaison to companies in their area to provide input on what economic and social programs are appropriate for the surrounding community so the level of community welfare can increase and the existence of the company can be sustained in the area.

Based on the AHP calculation above, the criteria for economic that are a priority to be carried out by geothermal power plant at Kalapanunggal sub-district is how to generate regional income from the production bonus given by the power plant to the community.

Criteria the social aspect that becomes a priority is how to utilize local labour and local products from surrounding communities at Kalapanunggal sub-district. Increased use of local labour and local products is directly correlated to the improvement of the community's economy.

AHP calculation can be used to compile an index of the sustainability of economic, social aspects of the existence of several geothermal power plants in a region by continuing the calculation of pairwise comparison up to the choice hierarchy.

References

Study of Slum Area Environmental Carrying Capacity for the Happiness of Slum Household Family Life (Case Study of Gender and Ecological Perspectives)

Sitti Nursetiawati1*, Dian Pertiwi Josua2
{*sitti-nursetiawati@unj.ac.id1, dian_pertiwijoshua@apps.ipb.ac.id2}

State University of Jakarta, Faculty of Engineering, Cosmetology Studies Program, Indonesia1, IPB University, Faculty of Human Ecology, Family and Child Development Studies, Indonesia2

Abstract. Adequate housing areas are difficult to find, especially in urban areas. At present, slums are an option for families to live and settle on the grounds of the lack of availability of a proper environment. There have been a lot of studies on the environment and happiness, but those that refer to happiness based on family units, and gender, are still few. This study is a joint study, with the aim of analyzing the influence of the environment in slums on the happiness of families who live in the area. This research involved 30 families, and differentiated happiness according to sex, which was based on the perspective of the father, mother, and children of one family. This research was conducted in the East Pisangan area, East Jakarta. Sources of research data sourced from primary data and secondary data. Primary data were obtained through the Oxford Happiness Questionnaire filled out by respondents based on their own reports, while secondary data came from interviews and observations. The results of the study stated that: (a) The environment affects the happiness of family slums, (b) Communities in slums have quite high happiness conditions, and (c) there are differences in happiness between men and women in slums.

Keywords: Ecological analysis, family happiness, gender studies, and the slum environment.

1 Introduction

DKI Jakarta Province has an area of 662.33 km² and is inhabited by 10,177,924 people, and the population of its inhabitants is relatively inadequate, both in terms of regional conditions and environmental health. There are 115 slum villages in DKI Jakarta Province, one of which is Pisangan Timur Village, Pulo Gadung District, East Jakarta. Problems with slums in Jakarta, including; (a) 40% of buildings inhabited by irregular residents, 9% of buildings did not meet the eligibility requirements in terms of roofs, floors and walls, (b) 22% of residential areas did not have adequate road access, (c) 26% of poor drainage, (d) 14% of the community does not meet their water needs of at least 60% / person / day, (e) 5% of houses do not have latrines or closets connected to septic tanks, 87% of household sewage in the form of water, mixed with environmental drainage, (f) 22% of household waste is transported to the TPS / TPA menu less than 2 times a week, and (g) 89% of settlements are
not equipped with fire protection infrastructure or facilities (Ministry of Public Works and Public Housing, 2017) [1].

The problems of slum households are motivated by economic problems and are related to health, food consumption, security, and other subjective and objective welfare issues. One indicator of subjective well-being which is psychological well-being is happiness. United Nation issued the World Happiness Report (2019) [2] and said that Indonesia is a country with a 92nd happiness rating out of 156 countries in the world. Happiness is seen from the income earned by citizens, freedom, trust, healthy life expectancy, social support, and kindness or generosity.

The data on the level of happiness assesses that the happiness of Indonesian people has increased from what was originally in the 96th position in 2018, to 92th in 2019. Indonesia’s happiness index in 2019 was also stated to have increased from 5,093 to 5,192 points. Methods of measuring the index of happiness seen based on money (index score 62.99), position (index score 67.15), family harmony (index score 80.05), social relationships (index score 75.45), positive relationships with others (index score 71.93), health (index score 71.12), security (index score 77.15) and feelings of pleasure (index score 75.06).

The survey on happiness in Indonesia was also carried out by the method of measuring the happiness index on the dimensions of life satisfaction (index score 71.07), feeling dimensions (index score 68.59), and life meaning index (index score 72.23). The happiness index indicator states that Indonesians feel the most dissatisfied with their level of education and achievement (index score 59.90). As for happiness as measured through the level of satisfaction, the most important factors considered happy in Indonesia are family harmony (index score 80.05) and environmental conditions (index point 76.09) (BPS, 2017) [3]. Therefore, it is considered important to conduct an analytical study of the environmental carrying capacity of slums towards the happiness of family life of slum households according to gender and ecological factors.

Looking at the background that has been presented, the formulation of the problem of this research is, (a) the carrying capacity of conditions in a slum household environment, and (b) the happiness of a slum household family life. Referring to this background, this study aims to (a) examine the environment of slums, and (b) analyze the influence of environmental carrying capacity on the happiness of the lives of families living in slums.

2 Literacy Study

2.1 Slum Household

Slums are defined as settlements that are not suitable for habitation because of irregular buildings, high levels of barriers and buildings, and the quality of buildings, facilities, and infrastructure that do not meet the requirements (Law No. 1 of 2001). Slum households have indicators of weighting criteria for low building resilience, access to drinking water and inadequate sanitation, and sufficient living area ≤ 7.2 m2 (Susenas, 2017) [4].

BPS (2016) mentions slum households in urban areas, which have the following characteristics, (a) The population is the lowest 40% expenditure group, (b) does not have access to adequate sources of drinking water, (c) Has no access to proper sanitation, (d) Do not have access to floor area ≤ 7.2 m2 per capita, (e) Do not have access to adequate roof, floor and wall conditions.
The condition of slum households in East Pisangan Village, has problems which are indicators of slums, these problems include: (a) 34.5% of houses were built irregularly, and 17.6% of buildings with roofs, floors, walls did not meet technical requirements, (b) 38.8% of residential areas did not have a network of access roads, (c) 22.2% of drainage in poor condition, (d) 25.0% of the community's water needs are not met, which is as much as 60% / person / day, (e) 3.3% of residential buildings do not have a toilet with a septic tank, 100% of household sewage drains mixed with environmental drainage, (f) 25.0% of the community's water needs are not met, which is as much as 60% / person / day, (g) 3.3% of residential buildings do not have a toilet with a septic tank, 100% of household sewage drains mixed with environmental drainage, (f) 29.8% of domestic household waste in residential areas are transported to TPS / TPA less than 2 times a week, (g) 100% of settlements do not have protection on fire facilities and infrastructure (Ministry of Public Works and Public Housing, 2017) [1].

The environment plays an important role in one's life. Environmental problems such as lack of facilities, noise, air pollution, and social crime can affect people's health and happiness. The environment is divided into two types, namely the physical environment such as structures and buildings and the social environment in the form of relationships and developments among citizens including honesty, trustworthiness, and cooperation (Abdullah and Zulkifli, 2018) [5]. Based on studies conducted several core characteristics of urban life with reference to a certain size and density contribute negatively to happiness, which can be interpreted as dense and the slums of the environment can reduce happiness (Okulicz-Kozaryn, and Mazelis, 2018) [6].

### 2.1 Happiness

Psychologists say that naturally and instinctively, humans always struggle for happiness, they want to be happy and will maintain the happiness they want. Human effort in achieving happiness has two sides positive and negative goals. On the positive side, happiness aims to eliminate pain and displeasure, while on the negative side, happiness is the feeling of wanting very strong pleasures (Freud, 1930) [7]. Happiness can also be interpreted as, (a) Temporary emotions that are synonymous with feelings of joy, (b) Experience fulfillment and achievement characterized by cognitive evaluation, (c) The long-term process of making meaning and developing identity by way of achieving individual potential and the pursuit of goals that are subjectively relevant (Fave et al., 2011) [8].

The theory of happiness, says that happiness is 3 basic views, namely: (a) Hedonism, happiness is a process of experiencing firsthand, as a whole, most of the pleasure, or so-called Hedonia, (b) The view of life satisfaction, where to be happy, one needs have a pleasant attitude about his life either as a whole or only in a certain period of time, known as Eudaimonia, (c) Affective state theory, that happiness depends on overall human emotions (Heybron, 2003) [9]. Psychology views happiness and divides happiness into three types; (a) Pleasure and satisfaction, (b) Embodiment of strength and virtue, and (c) Meaning and purpose (Seligman, 2018) [10]. Meanwhile, a survey measuring the level of happiness (SPTK) of Indonesia, seen based on three dimensions namely, (a) Life satisfaction, (b) Feelings (affect), and (c) The meaning of life (Eudaimonia).

People who live in urban areas, especially in urban areas, are always correlated with the level of happiness and life satisfaction. The happiness index, which is usually measured by other studies, is mostly focused on the environment (Kešeljević and Spruk, 2013) [11]. This study, complements the existing research, with the different units studied, that in this study looks at happiness based on the perspective of each family member, and the focus of the research is on gender and ecology. In addition, there is still little research about linking happiness to the physical environment.
3 Research Methods

This research is a cross-sectional study. The research location was taken purposively based on the area studied which is a slum area according to data from the Ministry of Public Works and Public Housing (2017) [1]. The study population was an intact family with at least 1 child in it living in a slum household area. This research was conducted in the Pisangan Timur area, East Jakarta. Before conducting field trips, researchers used a tool in the form of Google Earth to observe the research area and to be able to see a portrait of the slums to be examined as a whole. Samples were taken as many as 30 families purposively. The total sample in this study was 90 people, namely 30 fathers, 30 mothers, 15 daughters, and 15 sons. The study was conducted on qualitatively and quantitatively. Data analysis techniques through descriptive and inferential analysis techniques.

Descriptive analysis is processed using Microsoft Excel to see the results of observations of slum households. Inferencing analysis includes a different independent sample t-test to see differences in the happiness of family members according to sex, as well as an influence test using a regression test processed with SPSS to see the environmental influences and happiness of families living in slums.

4 Results and Discussion

Environmental conditions examined in this study include physical and non-physical conditions that can affect family happiness. On the environmental carrying capacity variable, the data is taken through a process of observation and self-report questionnaires regarding respondents' satisfaction with the slum households that they live in. As for the happiness variable, it was taken using the Oxford Happiness Questionnaire tool filled by each family member (Father/Husband, Mother/Wife, and one child). Physical environmental conditions in the study, as a whole were seen using Google Earth (See figure 1).

Fig. 1. Environmental density and congestion as indicators of slum environment of the study site
4.1 Physical Environmental

Conditions Floor area, yard, the distance between houses and the number of rooms. The results related to floor area show that the floor area of the house most inhabited by children in high-density family environments is 20-29 m² with a floor area of 50-69 m². The home page in the study shows a picture that there is no distance between one house and another. For the number of rooms, the average slum household has three to four rooms in one house.

Floor area is too narrow, causing children and parents to sleep in the same room so that it causes children to mature too quickly, and other influences are sexual interactions that are out of place, do not have adequate space for social interaction, and the absence privacy in family members. In this dirty household, the boundaries between rooms are unclear and only limited to a piece of cloth, cupboard, or pile of goods. The absence of a home page causes the child does not have a place to play, which impacts the child playing on the highway.

The results related to the floor area show that the floor area of the house most inhabited by children in high-density family environments is 20-29 m² with a floor area of 50-69 m². The home page in the study shows a picture that there is no distance between one house and another. For the number of rooms, the average slum household has three to four rooms in one house.

Building Type. The results showed that 67% of slum households in the study were of permanent type in small size, this was due to the influence of the family's economic level which was classified as low so it was difficult to build permanent houses that were livable.

Building Materials. The results of the study show that in a high-density home environment, building materials use cement to stir the floor material, the walls are half-walled, and the roof is in the form of ordinary roof tiles with the addition of plastic zinc. The remaining 24%, slum households in the study environment use better building materials, namely in the form of tiles, tiles for flooring, the walls are already in the form of walls, the roof is made of tiles.

House Ventilation. Based on the results of the study, stated that air ventilation is generally inadequate, especially the condition of the house is too tight between one house with another house, the distance between houses is narrow and there is no air circulation. The only place for ventilation holes is on the roof. This inadequate ventilation endangers its inhabitants because polluted air contains germs that emanate from internal residents of the house from inhaled dust, touch, germs or bacteria from other household items. The close to house land, the lack of ventilation, and the high level of density of occupants in the house, cause oxygen (O2) of the house air to be reduced a lot, because it is consumed by many people so that respondents complain of being weak, shortness of breath, increased body temperature, dizziness and achy aches in the joints.
Natural Lighting/Sunlight. The results of the study showed that there was not much sunlight coming into the house, due to the limited occupancy of land and no houses, so there was no distance between houses to other houses, people who lived in this slum household lived coexistent. Sunlight that contains ultraviolet X rays to reduce the humidity of the air in the house, kill the germs at a certain temperature, as well as activate the process of breeding the disease to a certain temperature. Due to the narrow floor of the house and the lack of air ventilation and associated with the sun's function as lighting during the day, generally, the children in the study area do not use the house to do many activities so that children prefer to play with their friends outside the home.

Water Sources. The results of the study stated, for the purposes of drinking water and toilets (Toilet Washing Toilet), dirty households in the study site used PDAM water, and as many as 74% of households chose to consume refill water without brands for consumption because PDAM water was yellowish.

Sanitation. Generally, slum households in the study have dirty drains, uncomfortable bathrooms, and latrines. Waterways are stagnant and clogged, often causing unpleasant odors, and flicking. While the bathroom and WC use a closed bathroom.

Household Waste. Based on the results of the study, residents at this location dispose of household waste in public garbage bins. The availability of trash bins is already private, using plastic bags and sacks for the disposal media for each household. The Final Disposal Site (TPA), coordinated by the head of the Rukun Tetangga (RT), then once a week the cleaning staff will help divert household waste to the general landfill.

Population Health. The results of the study indicate that the types of diseases that are often suffered by residents in the form of mild flu, aches in several parts of the body, and other diseases that are normal with normal frequency. There were no infectious diseases in the community environment at the study site.

Another result of the study is the condition of road access which can only be used for one type of vehicle from one direction, namely in the form of a motorcycle or bicycle, whereas for a car road is inadequate. Likewise, with the condition of gutters or waterways, it looks quite dirty and the house with one other house has no gaps.

4.1 Non-Physical Environmental

Conditions of Parents' Education. The results of the study showed that the average level of education of my father was junior high and high school. The low level of education results in the inability of the head of the family to understand that a slum household environment will have a negative impact on both the psychological and physical conditions of each family member. Other research results, states that the average education of mothers, namely vocational high school and high school, the low level of mother's education also contributes to the low awareness and environmental cleanliness of slum households.
Parents' Work. The results of the study stated that most of the fathers at the study site worked in the informal sector as traders (food, drinks, children's toys, and building materials). The other types of Father's work are administrative staff, day laborers, workshop workers, online motorcycle taxi drivers, and public transport drivers. In relation to the work of mothers, most of the mothers in slum households are housewives.

Economic Condition. The study data shows that the average amount of expenditure in the study location is Rp. 170,000 per day with the type of expenditure is for education, food, housing, paying for household goods, installments to buy land or houses in other places, and vehicles in the form of motorbikes. However, based on the results of the interview, families in this slum household, trying to be able to set aside money for savings in understanding forms that will later be used as investment in children's education, health care costs, and other unexpected costs.

Parents' Leisure. Time The results of the study stated that most of the time mothers are housewives, can be more freely used to take care of, and care for the household, including in educating children. The majority of families confess, that Dad's work that takes up a lot of time, encourages children to interact more often with Mother than Father.

Number of Life. Dependents and Length of Stay Research data shows the number of family members per household is 3-5 people. Meanwhile, the length of stay of the nuclear family is 6-10 years. Most residents are sedentary, with housing ownership being the right to private or long-term contracting.

Happiness. This research shows that in families living in slums, wives are happier than husbands. On the contrary, in children who live in slums, boys feel happier than girls (See tables 1 and 2). In addition, the influence test states that the physical environment (beta = 0.510), has a significant positive effect on happiness.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Husband</th>
<th>Wife</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happiness</td>
<td>50.00-72.00</td>
<td>44.56±5.19</td>
<td>53.00-75.00</td>
</tr>
</tbody>
</table>

Note: **) significance of 0.01; *) 0.05 significance

<table>
<thead>
<tr>
<th>Variable</th>
<th>Boys</th>
<th>Girl</th>
<th>P-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Happiness</td>
<td>60.00-87.00</td>
<td>75.11±6.66</td>
<td>60.00-80.00</td>
</tr>
</tbody>
</table>

Note: **) significance of 0.01; *) 0.05 significance

This means that each increase of 1 unit of the physical environment will increase the happiness of families living in slums by 0.510, and each increase of 1 unit of non-physical
environment quality will increase happiness by 0.344 points. Adjusted R Square value indicates that the model explains 32.4% of the influence of the variables studied in the happiness variable, the remaining 67.6% is influenced by other variables not examined (See table 3).

Table 3. Results of Regression Test Between Variables Researched

<table>
<thead>
<tr>
<th>No</th>
<th>Variable</th>
<th>Beta Unstandardized</th>
<th>Std Error</th>
<th>Beta Standardized</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Constanta</td>
<td>-19.208</td>
<td>13.644</td>
<td>0.155</td>
<td></td>
</tr>
<tr>
<td>1.</td>
<td>Physical environment</td>
<td>0.510</td>
<td>0.126</td>
<td>0.428</td>
<td>0.000</td>
</tr>
<tr>
<td>2.</td>
<td>Non-physical environment</td>
<td>0.344</td>
<td>0.186</td>
<td>0.220</td>
<td>0.031</td>
</tr>
</tbody>
</table>

*Adjusted R Square: 0.324*

Other results in the study show that the reasons why households continue to choose to live in slums are inherited culture and internalization of a culture of goodness that is already thick, in addition to the low economic factors and low family income, encouraging households to retain their homes, even though classified as a slum environment (Figure 2).

**Fig. 2.** The results of the interview of household factors choose to live in a slum environment

Regarding the reasons for happiness felt by slum households, there are two things that keep them happy. The reasons are in the form of internal reasons and external reasons. Internally, happiness comes because of high religiosity and great gratitude. External factors that encourage slum households to remain happy living in unfavorable environments is because they want to continue to inherit cultures from their ancestors, and because of the kindness and tolerance between neighbors that makes them assume that happiness is present not only seen in the physical environment only (Figure 3).

Religiosity is one of the internal factors that encourage respondents’ happiness, this reinforces previous research that philosophically beliefs and religions are the backgrounds of happiness because happiness is not only about emotions and feelings. According to other studies that people who live in hunger with high poverty rates, and inadequate physical environments, in countries that still feel happiness, this proves that religion and belief in God will bring happiness (Diener, Tay, and Myers, 2011) [12].

The results of the research that have been mentioned, contrary to studies that have been done before, which states that high levels of happiness do not depend on environmental degradation (Tiwari and Mutaschu, 2015) [13]. Instead, this study reinforces research that says that humans who spend their time in a good physical environment, will improve their psychological well-being, one of which will feel happier. In addition, physical environmental
factors, including green areas, community spatial planning, and social services affect human happiness (Chen and Zhang, 2018) [14].

Happiness and the environment are said to be closely related to each other, this refers to Aristotle's happiness theory which explains that the happiness of life is a virtue which is a reciprocal process between humans giving goodness to others, and he will receive goodness from that environment. Greek philosophers based on the theory of 'Eudaimonia' founded by Aristotle believed that the definition of happiness is happiness achieved by humans through well-being or contentment and that happiness is an act that reflects one's well-being (Kenny, 2014) [15].

Components of the environment that can bring happiness between each human being will differ in perceptions and ideas, however, when the environment provides a sense of comfort even without having to refer to the physical environment, the residents will feel happy. Because the environment, can bring positive impacts and negative feelings for those who live and settle in it (Abdullah and Zulkifli, 2018).

5 Conclusions and Suggestions

Based on the results of the study it can be concluded that: (1) physical and non-physical environment affects the happiness of families living in slums, (2) there are differences in happiness between husband and wife who live in slums, where wives are more happy than husband, (3) in boys living in slums, happiness is higher than in girls. Suggestions that can be given to several parties include: (1) the government is expected to be able to expand the program to eradicate slums, and (2) for NGOs there is a need for volunteers who can complete facilities and infrastructure in slum households to build a non-slum environment physically in order to increase family happiness in a dirty household.
References

The Impact of American Oil Company’s Existence on the Sakai Community In Riau Province

Agus Setiawan
{a_setiawan55@hotmail.com}

History Department Faculty of Humanities Universitas Indonesia
Gedung III. Lt. 3 Fakultas Ilmu Pengetahuan Budaya Universitas Indonesia
Depok 16424

Abstract. This paper focuses on the influence of the existence of foreign oil companies that has been operating in the territory of the Sakai Tribe as one of indigenous tribes in Riau. Sakai tribe has inhabited the area which later became the oil mining area of PT. Chevron Pacific Indonesia (PT CPI). Oil mining undertaken in Riau contributes to environmental changes including in the areas where the Sakai people live. The environmental changes also change the pattern of society activity and character because of some changes in terms of patterns of working and settlements. This research uses historical method where historical sources are also obtained through interview with people of Sakai tribe and PT.CPI officers. The results of the research show the existence of environmental pollution caused by mining activities and it also influences on social mobility among members of Sakai community.

Keywords: Mining Act, Oil Company, Oil Exploration, Pollution, Sakai Tribe

1. Introduction

Before World War I oil had replaced the role of coal as a major energy source of the world. Oil was the main target of industrialized countries to meet the energy they needed to run their industries. In the middle of the competition for oil among industrialized countries, World War I took place in Europe. The oil company's partisanship to those that fought in World War I and World War II became the determinant factor of the Allies victory in the two World Wars. Oil was the most important energy since the early twentieth century until the present day because oil was the main fuel to power industrial machines in large quantities besides it was also necessary to operationalize the war machines especially during The World War I and The World War II.

Some oil drilling companies also had competed to get larger marketing area in order to gain as much profit as possible. In Indonesia, or during the Dutch colonial rule precisely, oil has been begun to be exploited by Dutch and American oil companies. A number of foreign oil companies are even continuing their mining activities after Indonesia's independence. At this point the operational area of the mining area became wider, especially after the issuance of the Foreign Investment Act in 1967. However, the wider the mining area, the greater the impact
on environmental damage. Social problems later arose because the damaged environment was home to indigenous tribes that had inhabited the area for years.

Research on the existence and mining activities of foreign oil companies has been written. However, until now, academic research on the history of infrastructure and environment as the impact of oil exploration in Indonesia has not been done. Environmental changes and infrastructure development in Indonesia, especially in Langkat, Cepu and some areas in Riau as the first areas where the oil exploration were conducted in the colonial period until now has been contributing to the local government income, however the local people economic growth have not changed much. Such conditions increase some important research questions regarding the existence and empowerment of communities living around the oil exploration.

Related to the existence of oil exploration, does the government both in colonial times and in the independence period as well as government and private oil companies pay close attention to the fate and livelihoods of communities around oil exploration areas? How about the reaction of the surrounding communities especially Sakai people related to oil exploration that certainly changes the environmental situation where they live?

### 2. Method

This research uses the historical method which consists of four stages namely heuristic, verification, interpretation and historiography. The heuristic stage is data collection carried out at the National Archives of the Republic of Indonesia, National Library, Regional Library of Riau Province in Pekanbaru, PT. Chevron Pacific Indonesia (CPI) and the Siak Sultanate Museum. The data collection was carried out in January to June 2018 and succeeded in finding various information and documents related to the oil mining industry in Riau, especially oil mining activities in the Riau region. In addition, research in a number of these libraries also found information about empowerment programs for local communities conducted by PT. CPI.

Data collection was also carried out by interviewing a number of people including the manager of PT. CPI, oil mining workers in a company that is a partner of PT. CPI, Chairperson of the Sakai Tribe in Batin Sebanga, owners of oil palm lands whose land is contaminated with oil mining waste and community members who live around the mining area. A number of interviews were conducted during fieldwork in Pekanbaru, Siak, Duri and Dumai in May and June 2018. Through these interviews, this study obtained information on the current conditions regarding mining activities carried out by PT. CPI and environmental conditions due to oil mining activities. In addition, the impact of oil mining activities on socio-economic conditions was also obtained through direct field observations in Duri Subdistrict and Dumai City.

### 3. Results and Discussions

Riau is one of the provinces in Indonesia that is rich of natural resources, especially mining and marine fisheries. The geographic situation of Riau Province is special, because the province consists of many islands (3,214 islands) with extensive waters. Etymologically, the
word Riau itself comes from Portuguese, *Rio*, which means river. Following its history, the origin of the discovery of Riau itself can be obtained from various folktales in various versions. One of them that can approach the truth is that the word 'Riau' comes from the word *Riuh* which means crowded. In the sixteenth century when residents and merchants met in the ocean, they always said “going to *Riuh.*” They pointed towards a crowded place among the Bintan islands. Eventually this continued, until finally there was a change in sound, which was previously ‘*Riuh*’ became ‘Riau’. This country in its history then continued to grow rapidly as a trading market that was crowded by traders to sell marine products and surrounding forests [Ridwan, M. 1999].

In the previous source itself, the name Riau was first referred to in writing in the Malay text, entitled Memorial of the History of Johor. In the text it is stated that Sultan Abdul Djalil Syah ordered his fleet to go to Bintan to make the country on the Carang river, which was later called a person by the name “Riau”. Since then, the name Riau has become known by the people around it. Referring to this statement, this fits into the colonial record written by Governor Bort in Malacca in 1673 which stated that he had received a letter from Admiral Tun Abdul Djamil from Johor who told him that he had gone to Bintan Island to protect the island and equip the ships that are there [Kratz 1973, 43]. Based on that, the name Riau is then relevant to a river that flows from the West towards the present city of Tanjung Pinang. The place was indeed a place of trade activity, as well as a center of empire and defense in the sixteenth century until the nineteenth century [Ridwan M. 1999].

Administratively, Riau province consists of one municipality, five districts, one administrative municipality and two administrative cities with 78 sub-districts and 1,142 villages or *kelurahan*. The waters of this province, including the Exclusive Economic Zone (EEZ), are estimated to reach around 379,000 km². The boundaries of Riau Province when viewed from its position with other provinces are in the north bordering the Malacca Strait and North Sumatra Province, on the south bordering Jambi Province and West Sumatra Province, on the east bordering the Riau Islands Province and the Malacca Strait, while in the West it borders the Provinces of West Sumatra and North Sumatra. The specificity that is the location of this province is because the province is directly adjacent to neighboring countries (Singapore and Malaysia) and is directly confronted with international waters (the Malacca Strait), which has very heavy traffic. The land area is 94,562 km² which stretches from the slopes of Bukit Barisan to the Malacca Strait. which means it ranks the second largest compared to other provinces on the island of Sumatra [Manuwoto 1996].
Riau Province which has large land is a province that has rather typical conditions compared to other Indonesian provinces. Its existence extends from the slopes of Bukit Barisan to the Straits of Malacca and is astronomically located between 01 ° 05 '00" South Latitude - 02 ° 25' 00" North Latitude or between 100 ° 00 '00" - 105 ° 05' 00" East Longitude. The spread of land in this province is divided into two, namely the landscape which is the eastern part of the island of Sumatra and the islands bordering neighboring countries namely Malaysia and Singapore. About 80 percent of Riau province is waters. Parts of the land are scattered with different heights, ranging from sea level to above 1000 m above sea level with slope ranging from land to very steep (> 45 percent). Based on its physiography, the land in Riau Province consists of plains (floodplains, coastal plains, deltas and others) which are located in the eastern part of Riau province, the hills which are scattered towards the island of Sumatra and covered with mountains which are included in the Bukit Barisan mountain range. In this area found land with an altitude of more than 1000 m which is in the area of Kampar Regency. The climate of Riau Province is included in a wet tropical climate which has rainfall between 1500 - 3000 mm/year, with high temperatures and humidity throughout the year. Based on agro-climate clarification, Riau Province is mostly included in type B climate. Based on the distribution of its land, in Riau Province in general there was land from mineral materials (mineral soil) covering an area of 5,153,217 ha and organic soil (peat) with a thickness of >100 cm covering 4,302,943 ha. With the existence of land resources that have a wide range of soil properties, the agricultural development in this region has broad consequences, both in terms of the variety of plants developed and managed [Manuwoto 1996].

In the economic sector, Riau province is one of the country's largest foreign exchange earners, especially in the oil sector with a production of more than 600,000 barrels per day (around 60 percent of total national oil and natural gas production). Besides oil and gas, Riau is also rich in natural resource potential in the form of forest products, agriculture, plantations, various mines and minerals and marine products (fisheries). In the economic structure of Riau itself, there are three sectors that make a considerable contribution, namely: agriculture, industry and trade. The contribution of these three sectors is significant to the existing development in Riau province with a total achievement of 80.93 percent (2005 data), and is expected to reach a higher level for its establishment [Erlangga 2007, 39].

In terms of its own social culture, Riau is known for its high level of ethnic heterogeneity. In
addition to the native population (Riau Malay tribe), the other ethnic groups that are also quite
 dominant are Minangkabau, Batak, Javanese, and Chinese. The high level of immigration to
 the province is one of the main factors in the diversity of ethnic groups that exist and live in
 Riau province. Despite the large flow of urbanization, the solidity of the community still
 appears to be strong enough, this in itself is caused by several factors, including the similarity
 of religion and cohesiveness among fellow community leaders. The vision statement of Riau
 as a "Center for Malay Culture" which is synonymous with the religion of Islam, makes the
 similarity of religion as a binding factor that is important for society at the social and cultural
 level. In addition, there are similarities in views among community leaders which are divided
 into 3 (three) pillars, namely traditional leaders (adat institutions), religious leaders (Majelis
 Ulama Indonesia), and intellectual leaders (incorporated in Riau's intellectual community
 institutions) in responding to daily activities carried out by the government [Erlangga 2007,
 40].

Until now there has been no definitive historical data or evidence and can be used as an
 academic backing for when minerals and mining activities were first carried out in the
 archipelago. However, based on several archaeological discoveries, at least in some regions of
 the archipelago, humans have begun to carry out simple metal and mineral mining activities
 since the 5th century AD. Other further evidence is found on Bangka Island and is estimated
to be an ancient tin mine from the period of the Srivijaya Kingdom's rule of around 600-700
 M. Various studies on the possibility of mining activities in the BC period itself have actually
 been shown various studies related to the discovery of various objects made of metal in the
 archipelago which is believed to have originated from the period 3000-2000 BC. The Bronze
 Age in Southeast Asia itself began around 500-200 BC [Bellwood 2007, 268].

Metal mining activities are believed to be growing along with the increasing trade relations
 between India and China involving the archipelago. Geographically, the archipelago is in the
 trade route between India and China, coupled with cultural influences including the influence
 of religion that has developed in the archipelago, namely Hinduism and Buddhism. The
 development of these two religious influences more or less contributed to the development of
 metal mining considering both Hindu and Buddhist teachings depicted gods or Buddhists in
 the form of statues made of stone or metal as objects of worship in temples or monasteries.
 Both Sriwijaya and Majapahit had ruled the archipelago in the 7th and 14th centuries AD,
 control of the area which became a source of metals, especially precious metals was one of the
 priorities [Simbolon 2007, 427].

Until the arrival of Europeans to the archipelago, especially the Dutch merchants who later
 formed the VOC trading partnership (Verenigde Oost Indische Compagnie), no single ruler in
 the archipelago issued a written law to regulate mining activities even though the VOC itself
 had been involved in tin trading with the sultan the Palembang sultan was even able to
 monopolize and then take control of trade and tin sources belonging to the Palembang
 Sultanate on Bangka and Belitung Islands [Tagliazzo 2011, 28].

1 To oversee gold mining in the Upper Batanghari River, King Hayam Wuruk sent Adityawarman in
 1347 AD to become a ruler in the Minangkabau region.

2 During the period 1723-1730 the tin that was sent by the Palembang Sultanate from Bangka and
 Belitung Island to VOC reached 175 tons per year. When contract workers from Guangdong came and
 started to work in Bangka and Belitung, tin production increased thanks to the more efficient mining
 methods introduced by the Chinese workers.
In general, until the beginning of the Dutch colonial era, metal and mineral mining in the archipelago was still traditional because it was only for the daily needs of the community or individuals and mining had not been carried out on a large scale for commercial purposes. This also allows for the absence of a significant impact on environmental changes or the impact that can be caused by mining activities on people living around the mining area.

Commercial mining was only begun by the Dutch along with the discovery of various sources of mining in large quantities. The discovery of various mining material sources is inseparable from the existence of research activities carried out by Dutch scientists who are members of the Dutch Geographical Society (Nederlandsch Aardrijkskundig Genootschap). This association is a scientific professional organization based in Amsterdam and conducts several scientific expeditions and research in the archipelago. The Dutch colonial government itself provides assistance for various research activities that they do. In addition to research carried out by this organization, the Dutch government also conducted rainfall-related mapping and surveys conducted by the Ministry of Marine Affairs [Metzger 1888].

Various results of research on the source of mining goods in the archipelago attracted attention not only to the Dutch Colonial Government but also from private companies which subsequently sought to obtain mining concessions from the colonial government. Mining goods are one of the raw materials that are very much needed especially with the eruption of the Industrial Revolution in England. Western European countries which in fact have colonies in Asia and Africa and South America are competing to obtain sources of raw materials including mining materials and mineral sources for energy purposes.

One source of energy which then plays a very important role in driving industrial machinery is petroleum. The presence of large quantities of petroleum in Titusville, United States, replaces the role of coal as a world energy source that is contested by various forces wherever this energy source is located. In the Netherlands East Indies, oil was found in large quantities in the Langkat region, North Sumatra. The discovery was followed by the discovery of various new oil sources in various regions in the Dutch East Indies including in the Cepu (Central Java), Tarakan and Bunyu regions (East Kalimantan) and Cirebon (West Java).

The new petroleum sources in the Dutch East Indies invited not only Dutch oil companies, but also foreign oil companies from other countries, especially from the United States, to invest in them while expanding their network and business control. The desire of these foreign companies made the Dutch colonial government worried about the dominance of foreign companies in the mining industry in the Indies. To avoid foreign domination, the Dutch colonial government issued the Dutch East Indies Mining Act in 1899. The law, besides being one of the efforts of the Dutch colonial government to regulate mining activities in the Dutch East Indies, was also a political economic maneuver to prevent entry foreign capital which can result in the strengthening of foreign economic dominance.

Oil exploration activities in the area around the city of Cepu and Riau have been carried out by Dutch companies and the United States in the colonial period, but the Dutch colonial government succeeded in reducing the investment of foreign oil companies, especially from the United States, through regulations stipulated in the Dutch East Indies Mining Law or Indische Mijnwet in 1899. Unlike the colonial period even during the Old Order government,
the New Order government actually invited the entry of foreign oil company investment along with the issuance of the Foreign Investment Law in 1967. The entry of foreign capital is expected to stimulate the economy in the region. Even though the oil mining area on the other hand will also have a negative impact on environmental damage. These environmental changes certainly helped to change the pattern of activities and character of the community because of some changes in terms of patterns of work and residence.

The discovery of oil in Telaga Said, Langkat, was a milestone in the commencement of the commercial oil mining era in the Indies. Not only the Dutch oil companies, some foreign oil companies, especially from the United States, were interested to invest their capitals in the Netherlands Indies. Related to the desire of foreign oil companies that wanted to invest in the Dutch Indies, the Dutch colonial government issued the Dutch Indies Mining Law or De Indische Mijnwet in 1899. The law was a legal effort of the Dutch government to withstand the entry of foreign investment, especially from The United States in oil mining sector. This could not be separated from the competition between Dutch and American oil companies to get oil fields in the Dutch Indies.

Thus the Dutch Indies Mining Law itself essentially aimed to limit the involvement of foreign companies other than those originating from the Netherlands in order for the benefits of oil mining concessions to fall only to the colonial government or Dutch private companies. One of the first oil fields in the Dutch Indies was in Pangkalan Brandan that since 1885 was controlled by the Royal Dutch Company and did not change hands to other foreign companies. Even in 1890 it was formed a partnership organization to run oil mining business in North Sumatra. With the legal protection provided by the Dutch colonial government, the Royal Dutch Company was increasingly free to expand its oil mining business. Along with that, new oil wells were discovered even with more oil deposit. To store and to process the petroleum into more specific products, the company needed oil refineries with large capacity based on the size of that period. Royal Dutch Company exploited the calm situation by building oil refineries in Pangkalan Brandan. The refinery was known as the first oil refinery in the Dutch Indies. Processing plants were established near the river for more efficient waterways transportation. The people of Pangkalan Brandan who work for the oil companies usually carried a variety of processed petroleum products that had been packed in large cardboard boxes to the boats by the river. Near the river was also established a kind of dormitory and settlement for the factory workers so that the distance between where they worked and their houses became closer. In addition to waterways, transportation to the banks of the river was also conducted by train. The railway was built specifically for use as a means of transporting oil processed products. In its development, the company also built an oil pipeline which connected Perlak in Aceh to Pangkalan Brandan in 1901 [Verslag Over 1900, 1901:25].

This policy was an attempt of the Dutch colonial government to improve the economic and social life of the indigenous population and at the same time the colonial government tried to erase previous exploitative economic policies. The issuance of the ethical political policy was inseparable from the pressure of the socialist group in the Dutch parliament that called for the improvement of the lives of indigenous peoples who had suffered so much when at the same time the Dutch capitalists got much profits from various businesses in the colonies. The pressure of the socialist group continued until the publication of the new Indies Mining Act in 1913. The publication of the act essentially gave the colonial government greater authority to manage mining activities in the Indies.
Until the outbreak of the Pacific War, Dutch and American private oil companies dominated oil mining activities in the Dutch Indies as more oil resources were found mainly in South and Central Sumatra. Oil exploration and exploitation in South and Central Sumatra reached its peak when the oil potential areas were occupied by Japanese forces during the Pacific War (1942-1945). In the region of Riau, Japanese troops managed to find some new oil production centers, especially Minas well 1 that have been producing until now. For the purposes of exploitation, the Japanese occupation government recalled the experts who had previously worked in several oil fields in Sumatra after previously examining the various records owned by American oil company namely Caltex. Not only the records, according to a Japanese oil expert who participated in drilling activities in Minas, Riau, Toru Oki, the ease of drilling was also inseparable from the equipment left by Caltex during the Japanese invasion of the region [Jasjfi 1985, 65]. Drilling locations in Minas were also easily accessible and it made easier for workers and to transport the necessary tools for drilling. Since then, the commercial oil drilling in Riau had entered a new era which further affected the life of the people in the Riau region. Along with that, the consumption of petroleum in Indonesia also increases from year to year. Increasing oil demand will affect efforts to expand areas that have potential oil deposits as well as potential for widespread environmental damage due to mining activities.

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<td>Oil Consumption (in million barrel)</td>
<td>1,303</td>
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People who live in oil mining areas in Minas and Duri or generally in the Riau region prior to oil exploration was conducted on a large scale, were more to work in the plantation and agricultural sectors. The local people further interacted with the migrants who were mostly planters whom were imported from Java and China for cheap wages. The livelihoods of the people who live in Riau increasingly stretched along with the opening of oil mines after some new concession were signed. The private oil companies generally recruit locals to work in oil drilling centers as crude as pushing tools to drill the ground.

In addition, the company also recruited locals to work as porters in petroleum processing centers processed into various processed oil products to be shipped to other parts of the Netherlands East Indies or exported abroad. But so far, the most beneficiaries of petroleum exploration in Riau are private oil companies from the Netherlands and the United States. The American oil company, NPPM which later turned into Caltex and then changed again to Chevron in 2007, which became an oil drilling operator in Minas, for example, not only gained favorable concessions from the Dutch colonial government but also received protection from the Dutch colonial government to conduct oil mining activities.

When Indonesia gained the independence, the existence of national and foreign oil companies continued its oil mining activities in the Minas and Duri regions. Partly due to obtaining new concessions from the Indonesian government especially since the issuance of the Foreign Investment Act in 1967 which resulted in the flow of foreign capital to Indonesia including in the mining sector. This condition in the end gave birth to a contradiction when the effects of
mining began to be seen in the early 2000s, especially when viewed from the social and economic side. A contradictory view is visible where the local community including the Sakai community just become the marginalized not only from the economic and social but also in the physical sense. This is because the encroachment of forests for expansion of oil mining activities makes their presence also marginalized. The Sakai tribe is an indigenous tribe living in the forests of Riau.

The Sakai tribe is one of the indigenous tribes in Riau Province that has inhabited the area which is now a place of oil mining by several foreign oil companies since the colonial period. Since the colonial period, a number of foreign companies have obtained oil concessions from the Dutch colonial government and then in the independence period to get concessions from the Indonesian government to conduct exploration and exploitation in Riau. Along with that the opening of new oil fields which also means opening new areas for oil mining activities further erode the existence of forests in the Riau region. Among these forests are the residence of the Sakai Tribe that has long inhabited the area so that forest encroachment becomes a crucial point for the Sakai people because it makes them have to step aside and think of their next place to live.

Some members of the Sakai community strive to survive in their changing neighborhood, but there are also some who are trying to adapt to a new environment that is to live in residential areas around Duri City along with other communities. For the Sakai people living and living together with other tribal communities in urban areas is a challenge in itself considering that they generally live in forest areas that seem alienated from urban life.

The challenges faced by the Sakai community in urban areas vary from job to customary problems that sometimes require adjustments to urban mobility that require one to make the most of the time as efficiently as possible. In addition, the Sakai community skill problem that wants to work in urban areas also becomes another challenge that must be answered. Until now, there are enough members of the Sakai community who have completed education at the college level and are able to compete in getting jobs. Nevertheless, the whole Sakai community is required to be able to raise their level of education and skill to increase their competitiveness.

Oil mining activities conducted by foreign private oil companies in Riau, especially CPI, provide great benefits to the company mainly due to the availability of high quality oil sources and the use of modern technology in mining and oil processing. The big profits should be enjoyed by the people of Riau especially those living around the oil fields because they are directly affected by the impact of the existence of CPI oil fields. To help improving the people welfare of Riau, PT. CPI makes various community empowerment programs including educational programs to improve the quality of human resources in Riau.

PT. The CPI regards education and training as a long-term investment that contributes to local development and can enhance constructive relationships between companies and surrounding communities. When Caltex was named, the company began to pay attention to the education sector with the establishment of SMAN 1 in Pekanbaru in 1957 and helped to renovate the classrooms in the Rangau River, Pauh-Libo, Pematang Pudu, Jiat, Rangau Petani and Minas Barat.
At the college level, PT. CPI established Polytechnic Caltex Riau (PCR) in 2001. Polytechnic is the first polytechnics established in Riau region in cooperation with Riau Province Government. Until now the number of students who are studying in CPR amounted to 1600 students. In addition to the establishment of educational institutions CPI also provides a scholarship named Darmasiswa Chevron Riau (DCR). This scholarship is aimed at helping gifted high school students to continue their education at university level. Another program in education is to set up vocational training for young people and drop out students. This program is implemented not only in Riau Province but also in East Kalimantan and West Java.

In addition to the education sector, the CPI also gives attention to the small businesses of society to improve the social and economic life where there are CPI operations. To create sustainable livelihoods through small and micro businesses, CPI offers the Local Business Development (LBD) program which was launched in 2001. This program is aimed at helping small companies and cooperatives in Riau, East Kalimantan and West Java. The scheme is intended to help communities in CPI operating areas to become competent, professional and reliable suppliers of goods and services while at the same time promoting regional economic growth.

In addition to supporting local businesses, CPI also encourages various entrepreneurs including in order to preserve local heritage and traditions such as supporting the traditional art woven preservation program that produces beautiful Malay cloth. The CPI provides training and donations of 12 looms following building a center and a weaving gallery. CPI also provides Batik Riau training starting from August to October 2012. Participants of this training are housewives and young women drop out from 11 urban villages in Rumbai and Rumbai Pesisir Subdistrict, Pekanbaru City, Riau. They are introduced and trained using batik tools and techniques, coloring techniques and washing. In the next stage which was held in June 2013, participants are equipped with post-production skills so that the batik produced has a high selling value.

It can not be denied that the various oil mining activities conducted in Riau Province by the national oil companies and foreign oil companies have changed the geographical features of Riau Province as well as contributing to environmental pollution. Oil mining conducted by US oil company NKPM (Nederlandse Koloniale Petroleum Maatschappij) in the colonial period and continued by PT. Caltex and later PT. CPI in the independence period have contributed to the increasing economy of communities around the oil mining activities, especially in the areas of Rumbai, Duri and Dumai. In all three areas, the existence of PT. The CPI and its activities provide so much impact for the surrounding community both positive and negative impacts including the impact on the environment. On the other hand, foreign oil companies recognize that the sustainability of their existence in a region is also inseparable from the acceptance of the surrounding community, so there should be a mutually beneficial relationship, especially towards the end of the New Order government. Toward the transition of government into the Reform Order, people began to question various cases as a result of mining activities during the New Order government as a taboo to protest.

Through various programs that can maintain its presence in Riau, PT. Chevron Pacific Indonesia (CPI) seeks to improve relations with the people of Riau, especially those living in oil mining areas. Based on various information collected by researchers either through interviews with local communities including those working at PT. CPI and its subsidiaries,
literature sources from various libraries and field observations and brochures and leaflets published by PT.CPI, various programs have been launched and run by PT. CPI to support improving the quality of life of surrounding communities including efforts to improve the quality of human resources. According to Manager of PT. Chevron Pacific Indonesia (PT CPI) based in Rumbai, Pekanbaru, Mr. Deswandi, since the beginning of existence of PT. The CPI formerly named Caltex has contributed to the economic progress of the people of Riau both directly and indirectly. In the infrastructure sector, the company has built roads connecting Dumai and Pekanbaru. Although the road built is a requirement for the company to be able to send oil mines to oil refineries located in Dumai Port, yet another impact that arises is the increased flow of goods and services in the region. In addition, various trading centers appear along the way because the road is also intended for the community in running an increasingly crowded economic activity. On the other hand, however, the impacts of forest destruction around the mining area continue to occur and this directly touches the living and dwelling communities by utilizing forest products.

In addition to efforts made by PT. CPI to improve the social and economic life of the people of Riau, there are also various complaints made by some parties related to the existence of the oil fields. It is undeniable that the existence of various operations related to oil mining activities has a significant impact on the environment in Riau including the contamination of ground water and rivers in some areas in Riau. This condition also affects the lives of indigenous tribes living in Riau, including the Sakai tribe who rely on their livelihood by catching fish in the river. With pollution of their rivers due to the impact of oil mining waste, their fish catches are much reduced. This is because the death of river microorganisms such as plankton into fish food. In addition, fish consumed by the Sakai community are also at risk of being polluted by oil mining waste so they can endanger their lives.

In addition to complaining about the diminishing of fish in the river, Sakai people in Bengkalis, Riau also complained of the smell of rotting pollution caused by the river Batang Pudu. The demonstration conducted by the Sakai community on May 27, 2007 was directed against PT. Chevron Pasific Indonesia (CPI) is suspected to have disposed of waste oil processing plants. Sakai Chief of Sakai in Bengkalis, Bathin Matan, ultimately wants a peaceful effort with the CPI with some of the conditions such as for Sakai children to work in PT. CPI in addition to asking for compensation for the waste they dispose into the River Batang Pudu for the last two years. Demonstrations conducted by the Sakai people themselves are inseparable from the economic disparities that occur between CPI workers and local residents.

In addition to environmental pollution and economic disparities, another problem that often triggers the tension between society and oil miner companies is the problem of land use over the existence of indigenous tribes in Riau. They seemed pressured by the expansion of the oil company's operating areas until some were forced to move to other areas as well as leaving the area that they and their parents have lived for so long. Riau Regional Government itself has been trying to anticipate various problems that can trigger disputes between the surrounding community with the company but the surrounding community suspects the existence of regional government alignments to foreign oil companies as in the case of river pollution due to disposal of waste oil processing plants. In Duri precisely in an environment close to oil refineries, community leaders have even brought environmental pollution cases to Jakarta but did not get the best solution and the case has not been resolved.
4. Conclusion

The presence of oil companies and their mining activities has both negative and positive effects. What has been done by foreign oil companies in Riau, especially PT. CPI is a form of empowerment of surrounding communities including efforts to improve the quality of human resources, which until now has been perceived benefits by surrounding communities. In many brochures published by PT. CPI shows the number of community empowerment activities around by companies to improve the economy of the community. Various recognition of community leaders and students who get scholarship from PT. The CPI shows all the positive aspects of the existence of foreign oil companies and the community empowerment programs that have been running. Environmental pollution conducted by PT. CPI even seemed to disappear along with the brochure on clean water treatment facility in Duri. The brochure is even accompanied by the facts surrounding the water treatment facility that is clearly contrary to the conditions of the Sakai Tribe who protest against river pollution and result in the destruction of ecology and natural balance in Duri area.

On the other hand, the negative impacts arising from oil mining activities in some areas of Riau are groundwater contamination and reduced natural balance. In the Duri area the level of ground water pollution has even started to be feared by the residents around the activities of mining and oil processing. In the Duri region there are areas where the color of the groundwater has changed colour yellowish so it is not feasible to be used for bathing let alone consumed. Social inequality is also a problem that can be erupted at times, especially if there is no attempt to defuse the situation. Both impacts should be the attention of all parties, especially the Regional Government of Riau and PT. CPI that holds various decisions because the surrounding community can be said is a new passive party will react if there are things that are considered harmful to them. Until now the existence of foreign companies is still a pro and cons in the community. For those who get a lot of benefits with the presence of oil in Riau would be a community group that supports the existence of oil companies and all its activities. But people living in oil mining and processing areas as well as experiencing direct impacts of environmental pollution and affecting their health levels are disadvantaged groups due to the existence of oil companies. They deserve attention because it is a disadvantaged group.
References


Educational Aspects in Environmental Problem in Indonesia

Mortaza A Syafinuddin Hammada

dinmandar@gmail.com

1 Lecturer of The Faculty of Engineering, Cokroaminoto University of Makassar and Member Indonesia of Indonesian Environmental Scientist Association (IESA)

Abstract. Sustainability is an important topic in environmental studies. All country agree on sustainable development. In addition, special studies are need to look at educational factors in environmental studies. The Indonesian Government now have a program to build an environmental awareness in the school, namely Adiwiyata. In fact, the influence of the program is very low. Therefore, the objective of the research is to find and describe the perspective of educational aspect in the environmental problem in Indonesia. This study use qualitative research method (grounded research and phenomenology research). The study is use purposive sampling method. During two year of this research, it was found that the main environmental problem in Indonesia were knowledge and awareness. Education is no longer interpreted as formal process of knowledge transfer in existing educational institutional. Education have to change immediately into a cultural transformation, and needs to be expanded to reach various sectors.

Keywords: Environmental education; Environmental culture; Adiwiyata.

1 Introduction

The world’s attention to environmental issues has been long enough. Various concept agreed at the head of state meeting since World Summit June 5, 1972, in Stockholm, Sweden. The whole world even agreed on June 5 as the World Environment Day. This is to encourge the citizens of the world to have increasingly advanced environmental awareness every year. Twenty years later, the United Nation introduce a document called Agenda 21. The Agenda 21 is a declaration accepted by the head of the state in the Earth Summit held at Rio De Jeneiro, Brazil, 1992. The document introduce the concept of how to implement the sustainable development with a systematic plan. (Selman & Parker, 2007). This concept has been emphasize by various countries as one of the considerations in each policy. Indonesia is a country that includes environmental aspects in various official regulations.

Along with the progress of the development program, there are still many cases of the environmental damages, even though the government issued some regulations regarding environmental protection and preservation. Therefore, it need strong effort to find the problem solving all of those cases. Theoretically, the concept used to solve these problems are
environmental management and environmental engineering. The interrelation between various parties in environmental management also influences the successful resolution of environmental problems. (Groffman et al., 2006). Likewise, the principle of inseparability between nature and humans should be an accepted part of the most important part of ecological engineering. (Bergen et al., 2001).

Environmental management is the concept of developing of protection and prevention that expected to overcome the weakness of handling existing environmental problem. This concept, carry out simultaneously from the planning to evaluation program stages. Environmental management presented to meet the demands of integrated protection involving all sectors. The concept of environmental management starts with the ability to identify environmental problems more thoroughly. Environmental problems that can identified will produce the best plans to protect and preserve the environment. (Dreyfus, 1970).

The environmental management progress given a big change in many policies but occasionally failed in change an affective dimension of public acts. The environmental management are all of the management aspects that have relation with the environmental policy. (Sturm, 1998). What was Sturm emphasized just for policies need.

The fundamental of environmental management is closed relationship to the educational aspects. (Roth, 1970). It means what are we create for making good environment condition must effected to the shifting citizens behavior. Therefore, the environmental management has relation to the public education to change their awareness.

The latest document that confirms the world commitment to environmental preservation is the Sustainable Development Goals (SDGs). This commitment states that in 2015 all countries have provided effort to eliminate poverty and hunger, education for all, gender equality and empowerment of women, reducing child mortality, improving maternal health, resisting various infectious diseases, preserving the environment, and global cooperation to progress. One of SDGs indicators is education for all. It means the education factors is a very important to point for sustainability vision as well as environmental perspectives.

This concept has shown a serious idea about the importance of sustainability and efforts to prevent the impact of environmental damage. SDGs have indicators that are attached to; human development, namely education and health; socio-economic environment, namely facilities and pre-facilities and economic growth; development of the physical environment (environment development), namely the availability of natural resources and good environmental quality. Both human development and environmental development as a part of SDGs indicators are basis of environmental principles. The Indonesian government has developed the principles of sustainable development through the concept of Education for Sustainable Development. This program is expect to be able to leverage environmental awareness in a wider area. School influence is highly expected in the program.

Environmental education will strengthen the conventional education system so that it can foster the ability to make policies about environmental literacy in the classroom. For this, David T. G. (1974) explains as follows:

“Environmental education, in most contemporary educational practice, amounts to nothing more than a revitalized form of conservation education. The natural environment and its preservation serve as convenient outlets into which the subject matter of the more conventional sciences are plugged. Some have extended the concept to the built/urban environment and its social aspects, with considerable success. But the possibilities and process of making decisions about the structure of the environment are of central importance. If the physical setting does affect the inhabitants of classrooms, it is logical, if not essential, to begin the exploration of environmental literacy with the classroom itself and the dimensions of its influence.”
Environmental education also related to changes in culture or social character. Culture will formed with a habituation process. Habit will be more effective if carried out in a systematic, measurable, and sustainable program in educational institutions. Cultivation can strengthen environmental awareness and the concept of sustainability. The concept of environmental education is perform a tasks affectively, that is vital that the citizenry be knowledgeable concerning their biophysical environment and associated problem, aware of how they can help solve their problems, and motivated to work toward affective solution. (Stapp, 1969). Environmental education is a transfer of knowledge, aware, and skill to preserve and protect the environment resources.

The Indonesian government has launch a program as a part of an environmental education, through the Ministry of Environment in collaboration with the Ministry of Education and Culture. The program namely Adiwiyata. Adiwiyata consist of two word; ADI mean great, and WIYATA means the place for everyone to get knowledge, norm and ethics for their social life. So, Adiwiyata is defined as the best and ideal place where everybody to get knowledge, norm, and ethics values to be base of human life toward welfare society and manifested the sustainable development vision.

During 13-year the program after launched, Adiwiyata schools has brought several changes, including the habit of saving energy, processing and utilizing waste, saving water, awareness of tree functions and vegetation in nature, and so on. These achievements bring hope, especially to foster the habits and culture of the environment of the school community.

After 13 years, the program showed different results. Not only concerning to the ability of schools to maintain their achievements (Adiwiyata Award), but also the influence of program outside of school. Many schools that cannot continue to care for the environment. However many schools can maintain their environmental culture because of adiwiyata programs, but those are still limited in the school environment.

The transfer of knowledge about the environment cannot guarantee a change in behavior to be more environmentally friendly. Similar to the implementation of the systematically designed programs, such as the Adiwiyata. On the other hand, many people apply the principles of environmentally friendly in their daily lives. This shows that there are problems in the process of environmental education in Indonesia, even the concepts and perspectives.

Thus, it is necessary to search for new perspectives on environmental education that are reliable for changing human behavior. Therefore, this study aims to explain the gap between expectations for environmental education programs and the facts of environmentally friendly behavior in Indonesia, as well as to build a new perspective on environmental education.

Based on these reason, the temporary conjecture that functions as a working hypothesis in this study is that the understanding of education has been very narrow and limited to the process of interaction in classrooms. Therefore, environmental education is less functioning to transform environmentally conscious behavior, especially in the wider community.

2 Method

The research method is qualitative research. The design of this study consisted of two groups of informants. The grouping is based on purposive sampling. The first group are people who have implemented an environmentally conscious life, while the second group is the opposite. The indicators are a culture of energy saving, water saving, sensitivity to pollution,
concern for the effects of waste and efforts to overcome it, initiatives to carry out engineering to overcome environmental problems, and so on.

This study uses observation guidelines about the facts of environmentally conscious behavior, open interviews that ask the reasons for applying or not applying environmental principles, as well as tracing their relationship with education. The last stage was conducting FGD with five experts and environmental practitioners to create a new perspective on environmental education.

This research was carried out for four years, September 2011 to September 2013 in South Jakarta. The location of this research is SD Ciganjur Elementary School as one of the Adiwiyata Mandiri award-winning schools and SDN No. No. residents. 6 Cilandak Barat, South Jakarta. This research is to explain the environmentally conscious behavior of school residents in both places. Furthermore, the research was further developed to look at the environmentally conscious behavior of residents around the school who gained knowledge about the environment through curricular programs in schools with residents who obtained inspiration from other sources. This research development was carried out for one year, January 2017 to January 2018 at the same location (Ciganjur dan Cilandak Barat).

3 Result and Discussion

The categories of Adiwiyata school development seen from the culture of environmental awareness are three, namely; influencing out of school, only developing within the school area, failing to maintain environmental culture. Based in observations of SD Alam Ciganjur, school predicated on Adiwiyata Mandiri for year 2009, information was obtained that only five percent of them could have a positive influence on community around the school, even ninety five percent of them failed to maintain cultural behavior in their communities.

Interviews conducted to several informants proved that habituation that was only done to deal with certain events, including the Adiwiyata assessment, would cause the process to be unsustainable. That is, it is likely that it will fail to continue and give birth to a culture of environmental awareness.

By comparing between schools that apply Adiwiyata's principles and indicators with those who have not one, both of them are differences. Knowledge and environmental insights from school residents who apply Adiwiyata criteria are better than those who do not apply them. However, over time, there is a tendency that these habits cannot survive and as a culture of the school community as a whole. Likewise, the effect on the culture of the community outside or around the school.

However, if it is implemented in a long period of time, it is very possible that changes will occur because Adiwiyata meets Education for Sustainable Development (ESD). ESD has been tried in several places and proven successful, for example in Banjarmasin, South Kalimantan. The findings of this study indicate that the Adiwiyata concept contains the ESD criteria. The following is a comparison of the Adiwiyata concept with ESD.

<p>| Table 1. Conception relation between ESD and Adiwiyata |</p>
<table>
<thead>
<tr>
<th>No.</th>
<th>ESD Criteria</th>
<th>Adiwiyata Indicators</th>
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<tbody>
<tr>
<td>2.</td>
<td>Interdisciplinary and holistic education</td>
<td>“Integrated learning between environmental subject and others, insides the monolithic one.” (Adiwiyata Guideline Book, 2011)</td>
</tr>
<tr>
<td>3.</td>
<td>Multi approaches, variety, and method education</td>
<td>“Implementing varieties learning methods focused on learner (learner centered) according to their needs.” (Adiwiyata Guideline Book, 2011)</td>
</tr>
<tr>
<td>5.</td>
<td>Encourages the values</td>
<td>There is a norm and ethics education in the spirit of Adiwiyata as well. “” (Adiwiyata Guideline Book, 2011)</td>
</tr>
<tr>
<td>6.</td>
<td>Using te local culture approach, local issues besides global issues, and understanding meanings for all parties/stakeholders.</td>
<td>“Local wisdom and cultural values utilizing in environmental learning.” ” (Adiwiyata Guideline Book, 2011)</td>
</tr>
<tr>
<td>7.</td>
<td>Long life learning</td>
<td>All of the school citizens are well inform on vision, mission, and the aims of the environmental insight school. All of them are taking a part in responsibility on realializing the environmental culture education together.” (Adiwiyata Guideline Book, 2011)</td>
</tr>
</tbody>
</table>

Source: Hammada (2015)
Based on the findings of the above research, if it assumed that the condition of each school in Indonesia is the same as the school sample observed in this study, it is probable that the expected outcomes of the Adiwiyata program will not be optimal enough. Of course, other research still needed that considers other factors and variables to get more accurate information and analysis. However, it can concluded that educational factors are very influential in raising awareness of environmental protection and preservation. Habituation in the process of environmental education requires considerable time because it involves changes in knowledge, attitudes, and awareness and human behavior in it.

Experience in the Adiwiyata program, choosing environmental education must not only be interpreted as a program approved by educational institutions. Environmental education received is interpreted as a way to inspire people to be able to grow environmental awareness in themselves.

If all environmental engineering designs use devices that can be seen by the community as designs intended for natural and social resources, then the community will gain a new perspective on environmental management. Similarly, the policies governing the concept of environmental management. If he manages to be seen as deliberate by collecting policies to protect the environment, then he will inspire to encourage community participation in environmental preservation.

Schools that apply the principles of education for sustainable development as affirmed and modified in Adiwiyata as a model of environmental education in Indonesia, in general can educate their school community to take inspiration from environmental engineering designs that are found outside. Likewise the ability to produce innovative ideas to create technical tools and design a policy based on environmental management concepts, is higher.

In the future it is necessary to develop a new perspective on environmental education as an overall effort to put forward ways to inspire the public to know the need to protect the environment. This kind of environmental education will further enhance awareness of the environment in a wider field. Likewise, this education will inspire the public to find ways that can be done to realize these goals.

This new perspective on environmental education which is not only based on educational institutions will give new awareness to the public to get accustomed to knowing the reasons for an environmental engineering product or an environmental policy made. People who are accustomed to living in an environment that is designed to protect the natural resources in it, appear to be more aware and have the ability not to do activities that damage these natural resources. This can be seen from the traditional communities of indigenous tribes in various regions, such as the Bedouin, Kajang, and Anak Dalam tribes. Likewise, people in developed cities, such as cities in Japan, the Netherlands, Finland are automatically educated when looking at city tools that are designed to be environmentally friendly, as well as city rules made based on good environmental management systems.

Assume that environmental education is an activity that takes place only within educational institutions, has fatal weaknesses. Education which has been interpreted as an activity of knowledge transfer, changes in attitudes and behavior, and improvement of students' skills, contains two weaknesses at once. First, it separates the education process into one particular area. Similarly, it is said that this perspective seems to localize environmental education only in certain places, namely schools.

Second, limiting the subject of environmental education to only those who are studying in a school. This means that those who have graduated from the school are no longer required to carry out the mission of environmental education. Moreover, the general public, of course, feels...
not part of the mission of environmental education specifically and environmental preservation in general.

According to the characteristics of the environment, which contains diversity, there is a chain of interactions between the components in it, which describes the unity of living systems, requires harmony, shows interdependence, and requires sustainability, environmental education should also be interpreted as a living system as a whole. There are no components that must be separated from living systems in the dynamics of the environment. Thus, the localization of environmental education into educational institutions alone is tantamount to attracting and separating education and awareness from the community.

Such environmental education will foster a new culture in environmental preservation. The existence of a new culture is guaranteed to last in a longer period of time. That is, attitudes and behavior conscious of the environment as well as motivation and ability to innovate environmental protection and conservation can last a long time even can be passed on to the next generation.

Another thing that also determines is the individual character and cultural construction. Both can be in the form of the results of the inspirational education process earlier. As a summary of this argument, the following will display cultural positions in the context of individuals and society.

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Individual</th>
<th>Community</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spirit of values</td>
<td>Character of moral,</td>
<td>Culture, Ideology, Social ideals</td>
</tr>
<tr>
<td></td>
<td>Individual believes,</td>
<td></td>
</tr>
<tr>
<td></td>
<td>The ideals</td>
<td></td>
</tr>
<tr>
<td>Transformation process</td>
<td>Character education</td>
<td>Construction of culture</td>
</tr>
</tbody>
</table>

Source: Hammada (2015)

Based on interviews conducted with informants in this research it is known that those who have a new awareness of the environment are generally inspired by the design of environmental engineering and management systems in certain places. On the other hand, those who have not been inspired by a physical engineering or environmental management can only know about the theory of environmental preservation but cannot develop cultural behavior for the preservation of the environment.

It seems that this perspective needs to be supported by a fairly basic paradigm shift. This change starts from the redefinition of the nature of the environment through a new basic principle of cosmology. An in-depth philosophical research is needed about the change in the way humans view the universe and the resources within it. Likewise about man and his role in space and time, place and time he lived, and the future of the universe and humans, as well as other creatures in it.

Environmental damage prevention program have been carry out by developing environmental techniques. Such engineering is indeed successful, but efforts to control the potential for environmental damage do not seem to considered. That means, if we only rely on technical aspects, there may still be negligence in the prevention of the environment. The occurrence of environmental damage will only addressed as an opportunity to get a project. Therefore, environmental prevention will be a high cost.
It means we faced a problem on the environmental issues, for example, each product of environmental technology are not bring a message to the public conscious. Therefore, pubilcs are observe the environmental technology as a technology as well. There are no design for a shifting perspectives and public awareness about environmental, especially in sustainable world. Publics do not find a learn by the environmental technic products, or environmental management policy.

5 Conclusions

Based on the discussion of the results of this research, it can be concluded that environmental education is a process of growing knowledge and awareness that can affect the emergence of changes in one's attitude and skills to protect and preserve the environment. The process is not only obtained from the learning space at the existing educational institutions, but the process of inspiration that is engineered in life in the form of physical environmental engineering and environmental management.

6 Limitation of The Research

This study should be able to see a quantitative relationship between certain variables, such as the number of schools with certified or the Adiwiyata Mandiri predicate with environmental awareness behavior in the surrounding community. Thus, we can find out whether there is a significant relationship between the environmentally conscious behavior of the community members and the number of Adiwiyata Mandiri predicated schools in their area.

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References

Evaluation of Sustainable Impacts on Wastewater Treatment of Tofu Industry

L. A. Wardani¹, S. W. Utomo², H. Kusnoputranoto³
{larasandria90@gmail.com¹, suyudwarno@gmail.com², haryoto_k@yahoo.com³}

School of Environment, University of Indonesia¹, School of Environment and Department of Environmental Health – Faculty of Public Health, University of Indonesia², School of Environment and Department of Environmental Health – Faculty of Public Health, University of Indonesia³

Abstract. Currently, tofu wastewaters from CV. Proma has been treated using anaerobic technology up-flow Fixed Bed reactor. The aim of the research is to evaluate three impacts (environmental, social, and economic) of sustainability on wastewater treatment at CV. Proma tofu industry. This research method was conducted using direct observation in the field and interviewing to community. The evaluation environmental results show that technology can be reducing organic materials in wastewater up to 83% and reducing 2.863,981,8 kg of CH₄ emission/years. The evaluation social and economic result show that the technology can be produced biogas equivalent to 5903 kg of LPG/years, which is able to meet the cooking needs of 40 households. Community perceptions show a positive impact because these activities provide economic benefits around Rp. 35,418,169/years for the community around the tofu industry. Wastewater treatment technology in Proma tofu industry can be integrate the three dimensions of sustainability.

Keywords: Tofu, Wastewater, Biogas, Emission, Sustainable, Environment, Social and Economy.

1 Introduction

The industry is all forms of economic activity that processes raw materials and/or uses natural resources to produce goods and/or services that have higher economic value and benefits.¹ Tofu is one of the processed foods from soybeans which is quite potential in Indonesia because the price is cheap and has high nutrition. In general, the tofu industry is included in the types of industries that are classified as small and medium scale, so that its existence can be found together with residential areas. On the other hand, every tofu industry will produce Non-Product Output which can be called waste. Waste generated in the process of making tofu is divided into two, namely wastewater and solid waste. The resulting solid waste is usually sold and used as animal feed, while the wastewater is only disposed of directly into water bodies. Soybean wastewater belongs to high concentration organic wastewater.² Due to its composition (COD: 17,000–26,000 mg/L) and the large volumes generated, this represents an environmental problem.³ This proves that the value of organic content in tofu wastewater is very high, so special treatment is needed first so that the tofu industry's wastewater does not pollute the environment.
One of the tofu industries located in the City of Probolinggo named CV. Proma used to dispose of its wastewater directly into the river behind the factory. Proma tofu industry produces wastewater of 5 m³/day with a capacity of ±700 kg of soybeans/day. Based on this statement, it can be calculated that 1 kg of soybean produces 7.14 liters of wastewater/day or smaller than research Fardiaz states that one kilogram of soybean used in making tofu will produce 8 liters of tofu wastewater. Disposing of wastewater tofu industry to the environment without any treatment can cause pollution impacts. The odor pollution caused by decay is increasingly felt by the community when the dry season arrives. This has led to protests by residents of tofu industry owners to process their waste before being discharged into the river.

![Fig. 1. The tofu wastewater disposal channel in the Proma tofu industry goes directly to the river.](image)

Public protests about the odor pollution caused by decaying organic material in wastewater tofu that has not been utilized make Proma tofu owners at that time trying to process their waste. The wastewater treatment technology CV. Proma is the Fixed Bed type anaerobic reactor. Anaerobic processing technology has two main challenges, namely: (i) operational instability and (ii) the quality of processing produced. If the process conditions are handled correctly, the anaerobic treatment process will run stable. The estimated age of this reactor can range from 20 years to 25 years. This latest waste treatment technology runs well until now, where the organic pollutant load on the waste is reduced so that the wastewater does not cause unpleasant odors anymore.

Even though the wastewater tofu industry CV. Proma has been processed, however despite many studies of wastewater treatment, in Indonesia there are not yet studies that have proposed a sustainable approach that can be applied to wastewater treatment facilities that integrate the three dimensions of sustainability (social, economic, and environmental). The aim of the research is to evaluate three impacts (environmental, social, and economic) of sustainability on wastewater treatment at CV. Proma tofu industry.
2 Methods

The research location is in the tofu industry CV. Proma is located on Jalan Raya Kedung Asem 555/A, RT 2/RW 7, Kedung Asem Sub-District, Wonoasih District, Probolinggo City. This research was conducted for 5 months, starting from December 2017 to April 2018. This research generally uses a quantitative approach, while the research method used is a combination of quantitative and qualitative research methods. Quantitative methods are used to analyze the environmental evaluation of the tofu industry waste treatment CV. Proma, while the qualitative method is used to analyze the socio-economic evaluation of the community about the benefits of biogas from tofu industry wastewater treatment. The community is one of the important aspects of seeing the impact of operations because it is the community that is most aware of the impact of environmental changes arising from the effects of industrial activities.

The study population was divided into two, namely 1) wastewater tofu industry and 2) the community. wastewater of the tofu industry consists of two parts, namely wastewater tofu's before treatment and wastewater tofu's after treatment. The second data of this industrial wastewater sample is secondary data obtained based on the combined time method according to SNI 6989.59: 2008.\textsuperscript{10} The combined time method is a method of mixing samples taken at different times with the same volume. The wastewater sample is taken with a polyethylene plastic container and brought to the laboratory to be able to measure the quality of the waste container. Furthermore, an environmental evaluation analysis will be carried out including:

- Formula for the efficiency of the performance wastewater tofu treatment
  \[
  \text{% Efficiency COD} = \left( \frac{\text{COD}_{\text{in}} - \text{COD}_{\text{out}}}{\text{COD}_{\text{in}}} \right) \times 100\%
  \]  \hspace{1cm} (1)

- Formula for the quantity of biogas produced:\textsuperscript{11}
  \[
  \text{Volume (m}^3\text{)} = Ps \times \text{COD reduced}
  \]
  \[
  \text{Volume (m}^3\text{)} = Ps \times \left\{ Q \times (\text{COD}_{\text{in}} - \text{COD}_{\text{out}}) \right\}
  \]
  Where: \(Q\) = Wastewater debit (m\(^3\)/day)
  \[
  Ps = \text{the specific gas production (L/Kg)}
  \]
  Ps is given in Figure 2. Temperature effect on gas production.

Looking for Ps value by using a graph of the relationship between temperature and gas production at CV. Proma and obtained \(Ps = 0.675 \text{ kg/m}^3\), at a temperature of 30\(^\circ\)C.

![Fig. 2. Temperature effect on gas production\textsuperscript{12}](image-url)
Formula for CH₄ Emission:\(^{13}\)

\[ \text{CH}_4 \text{ emissions (kg/year)} = \text{COD (Kg COD/year)} \times B_o \text{ (Kg CH}_4\text{/Kg COD)} \times \text{MCF} \]  

Where:
- COD = Chemical Oxygen Demand
- \(B_o\) = Maximum methane producing capacity of certain amount wastewater (0.21 Kg CH₄/Kg COD)
- MCF = Methane conversion factor (0.378 with assumes full anaerobic degradation at 30°C)

Community population is a married woman, who lives around the Proma tofu industry, is approximately 250 meters away, has lived more than 5 years, and uses biogas from tofu industry waste processing. Married women who are assumed to feel more of a direct impact on saving household expenses due to biogas utilization. 1 m³ of biogas is equivalent to 0.46 kg of LPG.\(^{14}\) In Indonesia, the price of 3 kg LPG in 2019 is Rp. 18,000,-.

Analysis of community socio-economic evaluation through interviews using a questionnaire to the community around the tofu industry. The total population is 40 households, while the determination of the number of samples is done by the Slovin formula with a degree of error of 5%. The Slovin formula is described in equation (4).

\[ n = \frac{N}{1 + Ne^2} \]  

Where:
- \(N\) = The Number of Population
- \(n\) = The Number of Sample
- \(e\) = Fault tolerance limit

Based on these criteria, the total sample of respondents obtained was 36 household. The number of samples will be added 5% of the total sample to anticipate if there is data that is not good in research, so the total number of samples in this research is 38 household.

3 Results

In 2015, the Proma tofu industry overcame the problem of wastewater by building tofu wastewater treatment using Fixed Bed type anaerobic reactor technology with a buffer material useful as a place to attach bacteria. The total capacity of anaerobic reactors built for processing industrial wastewater tofu is 43 m³ and the capacity of the gasholder is 27 m³. Anaerobic wastewater treatment can help reduce of pollutants load from organic wastewater in the environment and can produce biogas. Biogas will be channeled into a temporary gas reservoir or gas holder before distribution to residents' homes. Processing wastewater tofu industry CV. Proma, Probolinggo can be seen in Figure 3.
In this study an evaluation of the Proma tofu industry wastewater treatment with three dimensions of sustainability (social, economic, and environmental sustainability) can be explained as follows:

A. Environmental impact

Environmental impacts are felt after the wastewater treatment CV. Proma reduces the organic content of wastewater which can be seen in Table 1.

Table 1. Decreased organic wastewater content of the Proma tofu industry

<table>
<thead>
<tr>
<th>No</th>
<th>Date</th>
<th>COD In (mg/L)</th>
<th>COD Out (mg/L)</th>
<th>Load (mg/L)</th>
<th>Eff (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>19 March 2015</td>
<td>7743,40</td>
<td>1545,65</td>
<td>6197,75</td>
<td>80</td>
</tr>
<tr>
<td>2</td>
<td>24 March 2015</td>
<td>7458,80</td>
<td>1491,10</td>
<td>5967,70</td>
<td>80</td>
</tr>
<tr>
<td>3</td>
<td>28 July 2015</td>
<td>7212,20</td>
<td>714,10</td>
<td>6498,10</td>
<td>90</td>
</tr>
<tr>
<td>4</td>
<td>29 Augs 2017</td>
<td>7849,13</td>
<td>1647,33</td>
<td>6201,80</td>
<td>79</td>
</tr>
<tr>
<td>5</td>
<td>30 Augs 2017</td>
<td>4397,91</td>
<td>1193,86</td>
<td>3204,05</td>
<td>73</td>
</tr>
<tr>
<td>6</td>
<td>26 Sept 2017</td>
<td>7960,71</td>
<td>1842,64</td>
<td>6118,07</td>
<td>77</td>
</tr>
<tr>
<td>7</td>
<td>27 Sept 2017</td>
<td>7426,37</td>
<td>1836,4</td>
<td>5589,97</td>
<td>75</td>
</tr>
<tr>
<td></td>
<td>Averages</td>
<td>7149,79</td>
<td>1467,30</td>
<td>5682,50</td>
<td>79</td>
</tr>
</tbody>
</table>

Based on the data in Table 1, it can be seen the performance of the Fixed Bed CV. Proma can be described as follows:

- In 2015 the average COD (in) content of tofu wastewater before it was processed was 7471.47 mg/l, while the average COD content (out) of tofu wastewater that came out of the waste treatment reactor was 1250.22 mg/l. The average efficiency of the tofu wastewater treatment was 83% with an average COD load is 6221.18 mg/l and the reactor was operated according to the actual tofu wastewater condition at temperatures around 30°C.
- In 2017, the average COD content of tofu wastewater before processing (in) was
6908.53 mg/l, while the average COD content of tofu wastewater after processing (out) was 1630.05 mg/l. The average efficiency of COD of tofu wastewater treatment is 75% with an average COD load of 5278.48 mg/l and temperature around 30°C.

B. Social and Economy Impact.

The social and economic impact is obtained from the results of the questionnaire which is divided into 3 categories and explained as follows:

1) Characteristics of Respondent

Characteristics of respondent divided into four (4) questions are ages, education, job, and long stay.

<table>
<thead>
<tr>
<th>No</th>
<th>Indicator</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Age</td>
<td></td>
</tr>
<tr>
<td></td>
<td>8-28 years</td>
<td>4 (11%)</td>
</tr>
<tr>
<td></td>
<td>29-39 years</td>
<td>10 (28%)</td>
</tr>
<tr>
<td></td>
<td>40-50 years</td>
<td>14 (39%)</td>
</tr>
<tr>
<td></td>
<td>51-61 years</td>
<td>2 (6%)</td>
</tr>
<tr>
<td></td>
<td>62-100 years</td>
<td>6 (17%)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36 (100%)</td>
</tr>
<tr>
<td>2</td>
<td>Education</td>
<td></td>
</tr>
<tr>
<td></td>
<td>SD</td>
<td>23 (64%)</td>
</tr>
<tr>
<td></td>
<td>SMA</td>
<td>4 (11%)</td>
</tr>
<tr>
<td></td>
<td>SMP</td>
<td>5 (14%)</td>
</tr>
<tr>
<td></td>
<td>S1</td>
<td>4 (11%)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36 (100%)</td>
</tr>
<tr>
<td>3</td>
<td>Jobs</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Employee at CV Promatun Sarroyan</td>
<td>4 (11%)</td>
</tr>
<tr>
<td></td>
<td>Farmers</td>
<td>2 (6%)</td>
</tr>
<tr>
<td></td>
<td>Labors</td>
<td>6 (17%)</td>
</tr>
<tr>
<td></td>
<td>Traders</td>
<td>6 (17%)</td>
</tr>
<tr>
<td></td>
<td>Housewifes</td>
<td>16 (44%)</td>
</tr>
<tr>
<td></td>
<td>Teachers</td>
<td>2 (6%)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36 (100%)</td>
</tr>
<tr>
<td>4</td>
<td>Long stays</td>
<td></td>
</tr>
<tr>
<td></td>
<td>0-5 years</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>5-15 years</td>
<td>3 (8%)</td>
</tr>
<tr>
<td></td>
<td>16-30 years</td>
<td>9 (25%)</td>
</tr>
<tr>
<td></td>
<td>31-45 years</td>
<td>6 (17%)</td>
</tr>
<tr>
<td></td>
<td>&gt;45 years</td>
<td>18 (50%)</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>36 (100%)</td>
</tr>
</tbody>
</table>

2) Community Knowledge

Community knowledge divided into five (5) questions are wastewater from tofu industry, complaints, wastewater treatment, benefit of wastewater treatment, wastewater impact to environment.
Table 3. Community Knowledge

<table>
<thead>
<tr>
<th>No</th>
<th>Indicator</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Wastewater from tofu industry</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Wastewater</td>
<td>11, 31%</td>
</tr>
<tr>
<td></td>
<td>Solid waste</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Air waste</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Air waste and Wastewater</td>
<td>17, 47%</td>
</tr>
<tr>
<td></td>
<td>Wastewater and Solid waste</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Solid waste and Air waste</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Solid waste, Wastewater, and Air waste</td>
<td>8, 22%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>36, 100%</strong></td>
</tr>
<tr>
<td>2</td>
<td>Complaints</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Yes</td>
<td>1, 3%</td>
</tr>
<tr>
<td></td>
<td>No</td>
<td>35, 97%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>36, 100%</strong></td>
</tr>
<tr>
<td>3</td>
<td>Wastewater treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Important</td>
<td>36, 100%</td>
</tr>
<tr>
<td></td>
<td>Not important</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>36, 100%</strong></td>
</tr>
<tr>
<td>4</td>
<td>Benefit of wastewater treatment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Nothing</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td>Clean environment</td>
<td>2, 6%</td>
</tr>
<tr>
<td></td>
<td>Biogas</td>
<td>12, 33%</td>
</tr>
<tr>
<td></td>
<td>Biogas and clean environment</td>
<td>22, 61%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>36, 100%</strong></td>
</tr>
<tr>
<td>5</td>
<td>Wastewater impact to environment</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Not damage</td>
<td>20, 56%</td>
</tr>
<tr>
<td></td>
<td>damage</td>
<td>4, 11%</td>
</tr>
<tr>
<td></td>
<td>Damage and incur losses</td>
<td>12, 33%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>36, 100%</strong></td>
</tr>
</tbody>
</table>

3) Utilization of Biogas

Utilization of biogas divided into ten (10) questions are long time using biogas, utilization of biogas, people in one house, fuel for cooking before using biogas, fuel before using biogas, after using biogas, cooking stove, how long time for cooking, reasons for using biogas, reasons for using biogas, and barriers while using biogas.

Table 4. Utilization of Biogas

<table>
<thead>
<tr>
<th>No</th>
<th>Indicator</th>
<th>Respondents (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Long time using biogas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>&lt;1 year</td>
<td>1, 3%</td>
</tr>
<tr>
<td></td>
<td>1-2 years</td>
<td>13, 36%</td>
</tr>
<tr>
<td></td>
<td>3-4 years</td>
<td>22, 61%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>36, 100%</strong></td>
</tr>
<tr>
<td>2</td>
<td>Utilization of biogas</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Cooking food for family</td>
<td>33, 92%</td>
</tr>
<tr>
<td></td>
<td>Cooking food for sale</td>
<td>3, 8%</td>
</tr>
<tr>
<td></td>
<td><strong>Total</strong></td>
<td><strong>36, 100%</strong></td>
</tr>
<tr>
<td>3</td>
<td>People in one house</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1-2 people</td>
<td>5, 14%</td>
</tr>
<tr>
<td>No</td>
<td>Indicator</td>
<td>Respondents</td>
</tr>
<tr>
<td>----</td>
<td>-----------------------------------------------</td>
<td>-------------</td>
</tr>
<tr>
<td>3-4 people</td>
<td>16</td>
<td>44%</td>
</tr>
<tr>
<td>5-6 people</td>
<td>14</td>
<td>39%</td>
</tr>
<tr>
<td>7-8 people</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100%</td>
</tr>
<tr>
<td>4</td>
<td>Fuel for cooking before using biogas</td>
<td></td>
</tr>
<tr>
<td>LPG</td>
<td>29</td>
<td>81%</td>
</tr>
<tr>
<td>Firewood</td>
<td>5</td>
<td>14%</td>
</tr>
<tr>
<td>LPG and Firewood</td>
<td>2</td>
<td>6%</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100%</td>
</tr>
<tr>
<td>5</td>
<td>Fuel before using biogas</td>
<td></td>
</tr>
<tr>
<td>1 tube LPG 3kg</td>
<td>6</td>
<td>19%</td>
</tr>
<tr>
<td>2 tube LPG 3kg</td>
<td>10</td>
<td>32%</td>
</tr>
<tr>
<td>3 tube LPG 3kg</td>
<td>9</td>
<td>29%</td>
</tr>
<tr>
<td>4 tube LPG 3kg</td>
<td>5</td>
<td>16%</td>
</tr>
<tr>
<td>8 tube LPG 3kg</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>31</td>
<td>100%</td>
</tr>
<tr>
<td>6</td>
<td>After using biogas</td>
<td></td>
</tr>
<tr>
<td>0 tube LPG 3kg</td>
<td>36</td>
<td>100%</td>
</tr>
<tr>
<td>1 tube LPG 3kg</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100%</td>
</tr>
<tr>
<td>7</td>
<td>Cooking stove</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>3</td>
<td>8%</td>
</tr>
<tr>
<td>2</td>
<td>31</td>
<td>86%</td>
</tr>
<tr>
<td>3</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>4</td>
<td>2</td>
<td>6%</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100%</td>
</tr>
<tr>
<td>8</td>
<td>How long time for cooking</td>
<td></td>
</tr>
<tr>
<td>1-2 hour/day</td>
<td>28</td>
<td>78%</td>
</tr>
<tr>
<td>3-4 hour/day</td>
<td>7</td>
<td>19%</td>
</tr>
<tr>
<td>5-6 hour/day</td>
<td>1</td>
<td>3%</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100%</td>
</tr>
<tr>
<td>9</td>
<td>Reasons for using biogas</td>
<td></td>
</tr>
<tr>
<td>Saving</td>
<td>2</td>
<td>6%</td>
</tr>
<tr>
<td>Safe and saving</td>
<td>9</td>
<td>25%</td>
</tr>
<tr>
<td>Safe, saving, and environmental friendly</td>
<td>25</td>
<td>69%</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100%</td>
</tr>
<tr>
<td>10</td>
<td>Barriers while using biogas</td>
<td></td>
</tr>
<tr>
<td>Nothing</td>
<td>19</td>
<td>53%</td>
</tr>
<tr>
<td>Biogas cannot be used on certain days</td>
<td>17</td>
<td>47%</td>
</tr>
<tr>
<td>Total</td>
<td>36</td>
<td>100%</td>
</tr>
</tbody>
</table>

4 Discussion

A. Environmental impact Analysis

The efficiency of COD in 2017 decreased when compared to 2015, this could be due to changes in the volume of wastewater filling entering the reactor and the excessive use of water resulting in dilution. The decline in wastewater production is also caused by the existence of trade competition between fellow tofu industries to make the tofu production CV. Proma decreases, and the waste it produces also decreases. At present, the Proma tofu factory only
produces 630 kg of soybeans per day, while in 2015 the Proma tofu factory can process around 700 kg per day.

If calculated the average efficiency of the performance of the wastewater treatment industry CV. Proma as a whole is 79%. This is consistent with the theory of Metcalf and Eddy which states that the efficiency of the fixed bed type reactor performance can reach 75-85%.15

The composition of the organic content of the degraded tofu industry wastewater greatly influences the amount of biogas formed. Organic substrates play an important role in the stability of anaerobic treatment systems because some raw materials can have an inhibitory effect on the anaerobic treatment process.16 The best conditions were obtained when filling the wastewater in a fixed bed reactor at a maximum of 7,700 liter/day with a COD load of 6221.18 mg/L, producing biogas of 35.158 Liter/day with an average methane gas content of 66%. This shows that organic fatty acids formed in the anaerobic treatment system can be put to good use by methane-forming bacteria at a maximum of 66%. Based on the theory of Bourrier11 theoretical biogas production can be calculated through the multiplication between the reduction in COD load (kg COD/hari) with the specific gas production factor (kg/m3). The theoretical biogas production Bourrier11 obtained in the condition of waste filling was 7700 liters, the average COD load was 6221.18 mg/l and the temperature of 30°C was 32,334 liters per day, whereas in actual conditions the maximum biogas production produced was 35,158 liters per day. This shows that the biogas production produced is greater than the biogas production theoretically calculated. This can be made possible because anaerobic bacteria can process the solids contained in the wastewater of tofu such as pieces of crushed tofu, soybean shells, etc., which are accidentally included in the reactor and break down into biogas.

Decreasing the organic content of wastewater from the Proma industry also produces another advantage, namely reducing greenhouse gas emissions. If calculated using the AM0013, CDM-UNFCCC/CCNUCC method13, then from the 7700 liters of Proma tofu industry wastewater treatment using anaerobic fixed bed reactor can reduce air pollution emissions by 2,863,981.8 kg CH4/year. With the application of this technology in every tofu industry in Indonesia, it is expected to become one of the sectors that can support the Action Plan for Reduction of Greenhouse Gas Emissions specifically for industry and help support environmental sustainability providing benefits to the community.

B. Social and Economy Impact Analysis

The social and economic impact is obtained from the results of the questionnaire which is divided into 3 categories and explained as follows:

1) Characteristics of Respondent

The survey results show that the majority of respondents are in the age range of 40-50 years which is equal to 39%, and the minority of respondents are in the age range of 51-61 years which is equal to 5%. This condition certainly has a picture that all respondents have reached the ideal age for a person or individual to be more mature and mature in terms of the views and insights of the surrounding environment. Education is one indicator that is considered to be able to determine the mindset of respondents regarding good environmental management. The survey results show that the majority of respondents have an elementary education background, and the rest only a small proportion of respondents have junior high, high school, and undergraduate education. The main livelihood of the majority of respondents is housewives. The average respondent has lived long enough to stay in that location, so it is assumed that the
respondent is familiar with the changes in the environment that occur around him.

2) Community Knowledge

Questionnaire data on community knowledge is used to describe the extent to which community knowledge of the waste produced by the tofu industry, the impacts that occur in the environment, and public concern for the environment. Descriptive description of the respondent's knowledge can be explained as follows:

- The survey results state that the community knows that the tofu industry produces wastewater because they feel the direct benefit of processing tofu wastewater into biogas, but the majority of the community is also not aware of any solid waste produced by the tofu industry, because they consider that solid waste from tofu industry still has economic value to be sold as animal feed.

- Based on the results of a questionnaire about the respondents' knowledge of the discharge of wastewater into the environment, it was found that as many as 56% answered it was not dangerous. This happens because in the past the wastewater produced by the Proma tofu industry was directly discharged into the big river Kedungsem and directly carried by the water flow to the estuary.

- Based on questions about community protests against the waste produced by the tofu industry, the majority of respondents answered that they had never protested, and only 1 family had stated that he had once protested against the owner of the Proma tofu industry. Other reluctance of the community towards tofu industry owners is the main reason for the majority of residents who have never protested against the waste dumped in the environment. Palmerg and Kuru show that motivation to act for environmental problems can be stimulated by increasing awareness and knowledge about environmental action strategies. In reality, the nature of sympathy for the environment is not always directly proportional to high education. This can be seen in one of the questionnaires which stated that only one respondent dared to express his protest to the owner of the Proma tofu industry and that the respondent had only an elementary school education. The respondent claimed to protest because he felt the environment around his residence was polluted due to the smell of rotting liquid. His concern paid off because tofu industry owners tried to treat their liquid waste before it was discharged into the environment. This is consistent with the research of Erdogan and Ozsoy which states that there is no relationship between education and environmental awareness.

- Based on questionnaire questions to the public about how important tofu wastewater must be treated, a yield of 100% of respondents considers that wastewater treatment is important to be treated, because it benefits the economy of the community.

- Based on the questionnaire distributed to the public about the benefits of tofu industry waste treatment, it was found that the majority of residents by 61% answered that tofu industry wastewater treatment produced biogas benefits and the environment became clear. Most of the residents consider that the Proma tofu industry now does not directly dispose of its waste into the river so that the river water becomes cleaner than before.

3) Utilization of Biogas

Questionnaire data regarding the use of biogas is used to calculate a simple evaluation of the use of biogas. Descriptive description of the use of biogas can be explained as follows:
The average community has felt the use of biogas for 2-3 years. The majority of people use biogas to cook their daily needs, while the rest use biogas to cook food that can be sold, such as fried food, steam food, etc. The direct impact on the use of biogas is felt by the community because it can save LPG purchases for cooking needs.

Characteristics of respondents based on the number of people in one house will affect the length and number of biogas used. The more inhabitants, it is directly proportional to the length of cooking activities so that more biogas is used. Likewise, the increasing number of furnaces and the length of cooking time are the main factors affecting the amount of biogas used.

In the past, the majority of people used LPG fuel for cooking needs, and on average a month could take 2-3 LPG tubes of 3 kg. After the existence of biogas, most people no longer use LPG because the biogas already meets the needs of the community. Based on several comments from the community, it is stated that they still have 3 kg LPG gas cylinders which are used as a backup if at any time the tofu industry CV. Proma is not operating or is on holiday.

From an economic side, with the use of biogas, the community gets monthly cost savings. If it is assumed biogas produced by wastewater treatment tofu industry CV. Proma is 35.158 Liters/day or equivalent to 12,832.670 liters of biogas/year, then the equivalent of 5903 kg of LPG per year, and economic savings of the community with the use of biogas is Rp. 35,418,169 per year.

The majority of people stated that the reasons for using biogas include safe, saving and environmentally friendly. The safe use of biogas is because the largest component in biogas is containing methane gas, where methane gas has a pressure low so that it is not easy to explode. Biogas is a neutral energy source of carbon dioxide (CO₂). Biogas has pressure under ambient air, while the maximum biogas pressure can reach 10 mbar above atmospheric pressure.

Barriers while using biogas, the majority of respondents answered biogas cannot be used on certain days because it coincides with the holiday, which is accompanied by the cessation of the process of making tofu so that no liquid waste is produced and the biogas does not produce. Nevertheless, the community claimed to be happy with the provision of biogas as a sign of compensation from the owner of the tofu industry to the community. In addition to biogas for daily cooking needs, the community also received other compensation in the form of distribution of holiday gifts to the community, as well as the existence of cooperatives for the welfare of the community around the Proma tofu industry. This shows that public perceptions of the Proma tofu industry have a positive impact and interrelationship with the principle of usefulness so that there arises greater community tolerance for not protesting about the environmental conditions of the tofu industry. Protecting nature and the environment and maintaining it for future generations are the main things that must be considered by every community, not only based on the value of benefits but also aware of the commitment and responsibility towards the environment.
5 Conclusion

Wastewater treatment technology in Proma tofu industry can reduce organic materials and CH₄ emissions from the environmental side, provide economic benefits from the economic side, and community support from the social side. It shows Wastewater treatment technology in Proma tofu that it can integrate the three dimensions of sustainability (social, economic, and environmental).

6 Declaration of Interest

The authors report no declarations of interest. The authors alone are responsible for the content and writing of the paper.

References


Enforcement Deterrence In Tackling Haze Pollution: Insight From In-Depth Interview

Firman Tatariyanto
firmantatariyan@fuji.waseda.jp
Graduate School of Asia Pacific Studies - Waseda University, 1-chome-21-1 Nishiwaseda Shinjuku Japan

Abstract. Reaching a better understanding of the enforcement of current regulatory approaches will provide a baseline for enhancing future policy choices for deterring and controlling the devastating effects of haze pollution. Using in-depth interviews with prominent actors who have direct and indirect involvement on the law enforcement process, this paper investigates how insufficient power and law enforcement capacity could hamper and deter policies for tackling haze pollution. The paper shows that an inadequate probability of detection for environmental offenses, especially in South Sumatra, causes economic agents to incorrectly receive signals to not engage in unsustainable and illegal activities. More specifically, the paper finds that the absence of a special arrangement for the recovery of environmental costs and direct financial mechanisms for how fines would be utilized has been hampering law enforcement. The establishment of a policy regime that is inclusive of fiscal provisions in mixed environmental management cannot be overlooked as a reference point for effective future solutions.

Keywords: Deterrence, enforcement, haze pollution

1 Introduction

The palm oil plantation and industrial processing sector have been one of the leading sectors for the development of the Indonesian economy. However, at the same time, the Indonesian plantation sector has also been identified as the most significant driver of forest and peatland clearing, which creates major haze pollution and is a source of greenhouse emissions [1], [2]. The burnt areas that create haze pollution within the Riau and South Sumatra Provinces are in company concession areas [3],[4]. Moreover, in the agricultural process, people use burning to clear and convert the land for palm oil plantation [5],[6],[7],[8]. Unfortunately, the clearing is also in the peatland area, and the fire spread out of control, creating peatland burning [9]. Peat fires are producing a large amount of smoke and contributing to a massive fraction of pollutant emissions factors in the atmosphere, in the end, causing health problems [10], [11]. Even a low intensity of peatland burning will produce significant emissions of pollution [10].

Haze pollution is defined as smoke resulting from land and forest fires, which cause deleterious effects that endanger human health; harm living resources, ecosystems and material property; and impair or interfere with amenities and other legitimate uses of the environment [12]. The government of Indonesia has enacted command and control regulations for tackling the haze pollution issue but with limited success and a lack of public trust. Please
see: [13],[14]. The need for regulatory enforcement policies that deter and control emissions by increasing the responsibility of the economic agents that pollute the environment is inevitable for future policy choices.

By focusing on the enforcement deterrence, this paper primarily aims to identify the state of implementation of current policies, especially enforcement obstacles for land/forest fires, through the perceptions of actors. Deterrence theory draws on a rational choice phenomenon in which an economic agent is assumed to weigh the costs and benefits of an action to avoid a sanction; when the likelihood of detection and punishment outweighs the benefits, a deterrent effect can be observed [15]. Understanding how to enhance deterrence is vital because in regulatory enforcement studies, improving enforcement in a country where the governmental capacity is limited and societal support is emerging is a puzzling task [16], [17].

Simorangkir and Sumatri [18] stated that the weak enforcement of laws and regulations is becoming the biggest problem in managing Indonesia’s land and forest fires. Carmenta [19] analyzed the perceived effectiveness of Fire Management Interventions using the Q method to quantify contention and consensus among stakeholders. In the hard measures against substantial actor factors, the enforcement of diverse Fire Management Interventions, including sanctions, would be preferred as an effective solution. Even though there are discrepancies related to the sources of fires, the findings reveal that there is a need to move from an oversimplification of fire phenomena and blaming for setting fires to multistakeholder policy engagement that considers the environment, the economy, and health. Furthermore, Budiningsih [4] showed that a lack of coordination among governmental agencies was less than optimal in the context of fire suppression.

Based on existing studies of land/forest fires in Indonesia, this paper extends the results of Carmenta [19] and follows the study of Matland [20] by distinguishing the obstacles in the regulatory enforcement process, including the implementation of policies and within internal enforcement agencies. To the best of our knowledge, no previous study on environmental policies has considered deterrence from the perspective of law enforcement actors for the study areas of the Riau and South Sumatra Provinces. This paper addresses the following question: how does insufficient power and law enforcement capacity hamper deterrence in South Sumatra and Riau Provinces?

The actor perspective, consisting of both internal and external stakeholders and including regulatory enforcement policies to address deterrence, is critical for improving the design of policies and on-the-ground implementation [21], [22]. Furthermore, actor insights can provide a valuable piece of the puzzle in helping to focus on primary problems [23].

The remainder of the paper is structured as follows. Section 2 discusses the in-depth interview analysis and study area selection. Section 3 presents the interview results, followed by the research findings and discussion. Section 4 contains the conclusions and highlights possible future policy options for tackling haze pollution.

2 Methods

The paper uses in-depth interview analysis, a technique that includes intensive individual interviews with a few respondents to elaborate on their perspectives, in the context of detecting possible risk deterrence issues. Moreover, these interviews were designed to be semistructured, with open-ended questions funneling the discussion from general law enforcement experience in land/forest fires to the incidence of hotspots and a discussion of
obstacles to the enforcement of deterrence. Once the obstacles have been discussed, the respondent is asked to describe, in more detail, their subjective perceptions about the nature of the obstacles, especially in the context of political implementation and regulatory capacity. Follow-up questions then stimulate discussion with the respondent and a spontaneous inquiry about the probability of enhancing deterrence. Using qualitative in-depth interviews allows for a broader subjective understanding of deterrence that includes the detection of perceptions and the severity of sanctions. The interviews were conducted in Bahasa (the formal language of Indonesia), and supporting data were gathered through fieldwork in the Riau and South Sumatra Provinces in Indonesia during October 2018.

The Riau and South Sumatra Provinces were selected as a background of the study because they provide opportunities to observe the complexities of haze pollution in Indonesia. First, the Riau and South Sumatra Provinces are among the 14 provinces in Indonesia located on Sumatra Island, which has been profoundly influenced by the occurrence of hotspots. Second, both provinces have been critical in exposing the natural forest through land-use changes and forest destruction. The 2017 land cover quality index (Indeks Kualitas Tutupan Lahan) values for both provinces is among the lowest on Sumatra Island, with 51.89% for Riau Province and 42.55% for South Sumatra Province. On the other hand, the National Peatland Ecosystem Areas in the Riau and South Sumatra Provinces are the largest areas on Sumatra Island at 5,042,561 Ha and 1,955,103 Ha, respectively. Previous studies have shown that aggressive human-made burning practices to clear and convert the land for palm oil plantations, especially in peatland, are a driving factor for haze pollution [7], [8].

During the interviews, the conversations were recorded after obtaining permission from the interviewees through written consent. Notes were also taken to complement and emphasize the critical points expressed by the respondents. The respondents were selected from among various law enforcement stakeholders to enable the elaboration of different perspectives. Please refer to Table 1. The interviews started with prominent representatives who have direct involvement in the law enforcement process, namely, an Investigator and a Prosecutor who handle cases in the Riau and South Sumatra Provinces. The Investigator is a Police and Government Official (i.e., an Investigator in the Ministry of Environment and Forestry and Local Government) who has been given exclusive authority by law to conduct investigations.

Moreover, the Prosecutor is a Public Prosecutor who is authorized by law to conduct prosecutions in the courtroom and execute the decisions of judges. Furthermore, we interviewed an Expert who gives statements in the courtroom related to land and forest fire cases and people in a Non-Governmental Organization (NGO) who independently monitor the law enforcement process, specifically for haze pollution in Indonesia.

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1 The index describes the condition of the surface appearance of physical land in terms of both the natural appearance in the form of vegetation and the human-made appearance. The quality of the land cover is currently measured by the existing forest as one of the crucial components in the ecosystem.

2 Based on the Ministry of Environmental and Forestry Decree No. SK.130/MENLHK/SETJEN/PKL.0/2/2017 on Establishment Map of National Peatland Ecosystem Function

3 Article 6, Law Number 8 / 1981 on Criminal Law.

4 Article 13, Law Number 8 / 1981 on Criminal Law.

5 Article 186, Law Number 8 / 1981 on Criminal Law.
Due to interviewees were the critical determinant of the data and to reduce the interview biased law enforcement representatives were selected for interviews based on the endorsement of their respective office, which assigned a specific officer as a respondent for the in-depth interview. Unfortunately, the Riau Local Environmental Agency did not respond to inquiries related to conducting the research. The selected enforcement officers were knowledgeable and experienced in enforcing environmental externalities, especially for haze pollution. Moreover, another respondent, from NGO and expert, is selected based on capabilities and personal attributes in the case of haze pollution.

The interview data were coded using Microsoft Excel and Word. The raw interviews were analyzed by developing a raw table of important aspects and a summary of the interviewees’ answers. Each important aspect of the study was organized and coded.

<table>
<thead>
<tr>
<th>ID</th>
<th>Respondent</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>D-1-RPolice</td>
<td>Riau Regional Police</td>
<td>Investigator</td>
</tr>
<tr>
<td>D-7-SSPolice</td>
<td>South Sumatra Regional Police</td>
<td>Investigator</td>
</tr>
<tr>
<td>D-2-RAAttorney</td>
<td>Riau High Attorney General</td>
<td>Prosecutor</td>
</tr>
<tr>
<td>D-6-SSAttorney</td>
<td>South Sumatra High Attorney General</td>
<td>Prosecutor</td>
</tr>
<tr>
<td>D-5-SSLocalEA</td>
<td>South Sumatra Local Environmental Agency</td>
<td>Investigator</td>
</tr>
<tr>
<td>D-3-MinEAF</td>
<td>Ministry of Environmental and Forestry</td>
<td>Investigator</td>
</tr>
<tr>
<td>D-4-ExpertW</td>
<td>Professor in Forest Fire from Bogor Agricultural University</td>
<td>Expert in Criminal Court</td>
</tr>
<tr>
<td>ID-2-EnvNGO</td>
<td>Coordinator – JIKALAHARI</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>ID-3-EnvNGO</td>
<td>Executive Director – Green Trade Initiative</td>
<td>Non-Governmental Organization</td>
</tr>
<tr>
<td>ID-4-EnvNGO</td>
<td>Forest Campaigner – GREENPEACE</td>
<td>Non-Governmental Organization</td>
</tr>
</tbody>
</table>

3 Results and Discussion

3.1 The Incidence of Hotspots in Indonesia

In the first part of this chapter, the paper discusses the points of view of the respondents as they relate to the nature of hotspots. The subjective knowledge of respondents in identifying the primary source of a land/forest fire is becoming an essential foundation for building enforcement policies.

An Investigator from the Ministry of Environmental and Forestry (D-3-MinEAF) argued that the fires in Indonesia are 100% triggered by humans. He believed that the tropical rainforest in Indonesia, compared to the temperate forest, is unlikely to burn naturally. Moreover, the Investigator from the Riau Regional Police (D-1-RPolice) stated that based on legal fact-finding during criminal investigations, land/forest fires are deliberately initiated by palm oil companies and smallholder plantation farmer. The Expert in the criminal court for haze pollution cases from Bogor Agriculture University (D-1-ExpertW) stated that 99.9% of fires are triggered by humans, and in most cases, cigarettes and mosquito repellent, which are
used as a timer, are connected to a matchstick starter and placed in a stack of wood and branches that have been cut down. The Forest Campaigner from Greenpeace (ID-4-EnvNGO) argued that land forest fires in the peat areas are mainly caused by changes in the land-use change to plantations by extensive peatland draining through the opening of canals.

In contrast, the paper also identified a counternarrative related to intentional land and forest fires from South Sumatra Regional Police Investigator (D-7-SSPolice), who made the following argument:

Investigator: *In my opinion, there is no intentionally burning except by smallholders who use fire to efficiently clear their plantation. Moreover, it is unlikely for a palm oil plantation to carry out a deliberate burning because it will result in the loss of productive palm oil trees that burn down.*

With regard to further detail on the area of burning, the coordinator of JIKALAHARI, an Environmental NGO based in Riau (ID-2-EnvNGO), stated that most of the fires in Riau Province occur inside the concessions of companies. Table 2 shows the Plantation Companies that have HGUs and IUPHHK with fires occurrence in their concession areas during 2015-2017 in Riau Province. In 2017, seven companies with HGU, or 54% of the companies, had three consecutive years of burning on their land. A total of 65 companies with IUPHHK had burned land in 2017, and 82% of the land of 53 companies burned during the 2015-2017 period. As a result, the coordinator argued that plantation companies should be responsible for maintaining and extinguishing fires on their concession areas.

### Table 2. Hotspots in Concession Area – Riau Province

<table>
<thead>
<tr>
<th>Year</th>
<th>HGU – Repeated Hotspot – 2 Years (3 Years)</th>
<th>IUPHHK Repeated Hotspot- 2 Years (3 Years)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>12 (7)</td>
<td>23 (53)</td>
</tr>
<tr>
<td>2016</td>
<td>111 (21)</td>
<td>1,859 (76)</td>
</tr>
<tr>
<td>2017</td>
<td>28 (13)</td>
<td>902 (65)</td>
</tr>
<tr>
<td></td>
<td>HGU – Repeated Hotspot – 2 Years (3 Years)</td>
<td>IUPHHK Repeated Hotspot- 2 Years (3 Years)</td>
</tr>
<tr>
<td>2015</td>
<td>389 (41)</td>
<td>3,641 (108)</td>
</tr>
<tr>
<td>2016</td>
<td>111 (21)</td>
<td>1,859 (76)</td>
</tr>
<tr>
<td>2017</td>
<td>28 (13)</td>
<td>902 (65)</td>
</tr>
</tbody>
</table>

In general, the first finding on the nature of hotspots shows that almost all respondents agreed that the land/forest fires that create haze pollution are triggered by intentional human action to clear and convert land for palm oil plantations, consistent with previous studies. Please see: [6], [7], [8]. However, the interviews also reveal a different law enforcement perspective related to the nature of fires, which is critical in the context of gaining a common understanding of officer perceptions about potential responsibility and observable policy implementation gaps [5].

Before presenting further respondent perceptions on the nature of hotspots and the detection probability of current policies, this paper presents an overview of enforcement action data in the Riau and South Sumatra Provinces for land/forest fires by law enforcement actors. Please refer to Tables 3.3a and 3.3b. Tables 3.3a and 3.3b show a downturn pattern related to the number of hotspots and burning areas in the Riau and South Sumatra Provinces in the
2015-2017 period, but interestingly, the latest data in the year 2018\(^6\) show a dramatic increase. However, the tables also present a low pattern in the enforcement coverage and monitoring process from the year 2015 until 2017 for the case of land/forest fires. On average, the Police were able to apprehend a suspect in only 8.10% of hotspot cases in Riau Province and 0.13% of hotspot cases in South Sumatra Province.

Furthermore, given the higher hotspot occurrence in South Sumatra Province, as shown in Table 3b, the coverage of punished burning land to the overall burning area based on a court case in South Sumatra is lower compared to Riau Province (Table 3a), with values of 4.41% compared to 1.09%. However, in the same table, the paper also shows that the court was likely to punish guilty individual suspects and companies that had already been apprehended by the Police in South Sumatra Province compared to Riau Province. The data reveal that the less stringent actual enforcement and low detection probability, especially in South Sumatra Province, highlight the inadequacy of deterrence for environmental offenses. As a result, economic agents do not correctly receive signals not to engage in unsustainable and illegal activities. In the next section, more detail on how enforcement obstacles shape deterrence perceptions is presented.

\(^6\) The latest data from SiPongi (Karhutla Monitoring System) show 296 hotspots in Riau Province (an increase of 275%) and 394 hotspots in South Sumatra Province (an increase of 39%), \(<\text{http://sipongi.menlhk.go.id/home/main}>\text{ as of 01/27/2019.}\)
Table 3a. Enforcement on Land and Forest Fires in Riau Province

<table>
<thead>
<tr>
<th>Year</th>
<th>Hotspot</th>
<th>Total Burning Area (000 Ha)</th>
<th>Plantation Area (000 Ha)</th>
<th>Suspect Company</th>
<th>Suspect Individual</th>
<th>Apprehension by Riau Regional Police</th>
<th>Court Decision on Land / Forest Fire</th>
<th>Ratio</th>
<th>Monitoring Process</th>
<th>Enforcement Coverage</th>
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<tr>
<td>2015</td>
<td>1,927</td>
<td>183.81</td>
<td>2,290.74</td>
<td>19</td>
<td>56</td>
<td>21,418</td>
<td>1,296.00</td>
<td>26</td>
<td>3.89%</td>
<td>36.00%</td>
</tr>
<tr>
<td>2016</td>
<td>393</td>
<td>85.22</td>
<td>2,430.51</td>
<td>2</td>
<td>77</td>
<td>120</td>
<td>2.80</td>
<td>3</td>
<td>20.10%</td>
<td>3.80%</td>
</tr>
<tr>
<td>2017</td>
<td>79</td>
<td>6.87</td>
<td>2,493.18</td>
<td>0</td>
<td>21</td>
<td>0</td>
<td>11.28</td>
<td>1</td>
<td>0.31%</td>
<td>4.76%</td>
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Table 3b. Enforcement on Land and Forest Fires in South Sumatra Province

<table>
<thead>
<tr>
<th>Year</th>
<th>Hotspot</th>
<th>Total Burning Area (000 Ha)</th>
<th>Plantation Area (000 Ha)</th>
<th>Suspect Company</th>
<th>Suspect Individual</th>
<th>Apprehension by Riau Regional Police</th>
<th>Court Decision on Land / Forest Fire</th>
<th>Ratio</th>
<th>Monitoring Process</th>
<th>Enforcement Coverage</th>
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<td></td>
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</tr>
<tr>
<td>2015</td>
<td>3,264</td>
<td>646.30</td>
<td>1,002.20</td>
<td>1</td>
<td>4</td>
<td>0</td>
<td>6,104.00</td>
<td>4</td>
<td>0.00%</td>
<td>80.00%</td>
</tr>
<tr>
<td>2016</td>
<td>266</td>
<td>8.78</td>
<td>1,064.37</td>
<td>1</td>
<td>8</td>
<td>0</td>
<td>203.70</td>
<td>1</td>
<td>0.10%</td>
<td>11.11%</td>
</tr>
<tr>
<td>2017</td>
<td>283</td>
<td>3.63</td>
<td>1,020.33</td>
<td>1</td>
<td>10</td>
<td>0</td>
<td>0.50</td>
<td>1</td>
<td>0.30%</td>
<td>9.09%</td>
</tr>
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3.2 The Political Implementation of Regulatory Approaches

In policy implementation, securing compliance is an essential part to ensure that goals are reached and not thwarted by opponents of the policy. Moreover, compliance depends on whether or not regulators have enough power over others. The more regulatory power required for an action, the more likely it is that an economic agent will comply with a request. As a result, the central principle of political implementation states that implementation outcomes are determined by power [20].

A penalty, as part of the regulatory power in enforcing compliance, which equals a percentage or fraction of the evasion, ultimately reduces the ability to hide noncompliance and therefore improves overall deterrence [24]. However, the inability to execute a penalty as part of a lack of power will hamper the enforcement deterrence.

Three major laws have been enacted in Indonesia to punish the violators in the case of land/forest fire as follows:

1. Law No. 1/1946 on Criminal Law. The defendant will be facing punishment for intentionally causes a fire or explosion faces a minimum of 12 years and a maximum of 20 years imprisonment.
2. Environmental Management Law No. 23/1997, which was amended by Law No. 32/2009 on Environmental Protection Management. The defendant who causes haze pollution and intentionally commits an action that violates the ambient standard will be criminally prosecuted with a minimum punishment of three years and a maximum of 10 years imprisonment as well as a minimum fine of Rp3 billion and a maximum fine of Rp10 billion.
3. Plantation Law No. 18/2004, which was amended and strengthened by Law No. 39/2014, imposes criminal sanctions through severe fines and sentencing for burning opening plantations. The punishment on the offender who uses the burning method in opening/cultivation plantation land (Art. 108) faces imprisonment for ten years and a maximum fine of Rp10 billion.

The interviewee, a Prosecutor from the Riau High Attorney General Office (D-2-RAAttorney), explained the existence of obstacles in the execution of environmental recovery fines based on court verdicts, not including detailed regulations in the Act related to the land and forest fire. Furthermore, there are no special arrangements in the case of defendants proposing installments, as part of state debts, for paying environmental recovery costs. The Investigator from the Ministry of Environmental and Forestry (D-3-MinEAF) also strengthened the argument by giving an example:

Investigator: I am using an example from the criminal cases related to a palm oil plantation company that was found guilty by the court. The company was fined Rp1 billion and required to restore the burning environment at the cost of Rp13 billion or USD916,331. However, this verdict has become an “advantageous” for the company as a defendant because there is no direct financial mechanism that clearly stated how these fines will be utilized implemented, and as a result, the Rp13 billion restoring cost has never been paid by the company.

In contrast, the Investigator from South Sumatra Local Environmental Agency (D-5-SSLocalEA) noted the existence of obstacles in the early stage of the law enforcement process, namely, high political pressure on the Environmental Agency. As a result, the Local Environmental Agency could not independently build law enforcement cases on land/forest fires in South Sumatra Province; rather, they could only provide a monitoring and fire prevention function. Moreover, the Investigator argued that the lack of support and prioritization on land/forest fire cases by the Provincial Government has undermined his role in the South Sumatra Environmental Agency.

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9 The Bank of Indonesia transaction exchange rate in June 21, 2019 is 1 USD = Rp14,187.
Furthermore, given the high political and economic costs to the Local Government, the obstacles will also create lower incentives for agriculture development [25], [26]. The Executive Director of Green Trade Initiative (ID-3-EnvNGO) argued that an incentive mechanism must be built in to provide “rewards” for those who are already effectively developing the sustainable palm oil sector. For example, Local Governments that are able to manage highly productive palm oil plantations in their region without fire outbreaks or environmental damage will be rewarded an additional transferable fund (General Allocation Fund\textsuperscript{10}) from the National Budget. In addition, palm oil companies that maintain proper environmental governance and prevent fire in their concession areas will be given a channel to strengthen their investments or provided with further financing schemes. Commodity governance is still needed as a safeguard to prevent the negative spillover on the environment.

In all, the present study analyzed obstacles to enforcing deterrence and reaching policy goals. Thornton [27] studied deterrence and found that economic agents will reassure their compliance when someone else is caught and penalized. The paper identified insufficient penalty enforcement in the Riau and South Sumatra Provinces, which is critical in the context of building regulatory deterrence. The existence of obstacles to enforcing penalties reflects the inability of law enforcement to send a signal of deterrence not to violate legal procedures and influence compliance. Furthermore, the paper also identified a patronage network that creates failure for the government to uphold effective policies against influential companies who ignore illegal commercial fires. The high pressure and political influence in the region, especially in corporate criminal cases, is one of the reasons that regional investigators are not as strong as investigators from the Police and Central Government Office. This finding is in line with Varkkey \[14\], who discussed the difficulty of overturning the system of patronage politics. The collusion of local elites and plantation owners at the local level creates a failure to comply with formal legal permit procedures [28].

### 3.3 The Regulator Organization Capacity

The central principle in administrative policy implementation to ensure desired outcomes is through sufficient organizational capacity or resources [23]. Therefore, law enforcement must have adequate financial and political capital support from government agencies to successfully implement regulations. Gajduschek [29] defined regulatory enforcement capacity as the ability of regulatory agencies to deter potential externalities. Furthermore, a normative mechanism that induces compliance through the legitimacy of the person requesting an action is generally sufficient in administrative implementation. However, administrative policy implementation problems may occur because of poor coordination, insufficient resources, or insufficient time [30]. To identify the real obstacles in law enforcement implementation, the interviewees were asked to describe their own experience in their respective offices.

The majority of the respondents indicated insufficient budget resources in the Budget Execution (Allotment) Document\textsuperscript{11} as a challenge in enforcing land/forest fire cases. Moreover, the Investigator from Riau Regional Police (D-1-RPolice) stated that the

\textsuperscript{10} Law No. 33/2004 defined the General Allocation Fund (DAU) as a Central Government transferable fund to Local Governments from the National Budget, with the aim of equalizing the distribution of financial capacity between regions in Indonesia in the context of decentralization.

\textsuperscript{11} Article 1, Ministry of Finance Decree No. 171/PMK.02/2013 define Budget Execution Document (DIPA) is a budget implementation document prepared by budget user (Government Institution) and served as the base for budget execution or implementation.
enforcement process is without specific budget allocation but only under a routine budget. However, the Prosecutor from Riau High Attorney General Office (D-2-RAttorney) stated that land/forest fires are treated as individual cases and there is a specific allocation for law enforcement in the Budget Execution (Allotment) Document. However, the expenditure allocation is for the completion of only two land/forest fire cases per year. As a result, given the insufficient budget, the Investigator from Riau Regional Police (D-1-RPolice) and the Forest Campaigner from NGO – Greenpeace (ID-4-EnvNGO) stated that gathering substantial evidence to determine the actor that triggered a land and forest fire is challenging for law enforcement.

The Prosecutor from South Sumatra High Attorney General (D-6-SSAttorney), in line with Budiningsih [4], pointed out that coordination is also a problem in the land/forest fire enforcement process.

Prosecutor: The existence of an egocentricity and lack of coordination between public prosecutors and police investigators have resulted in a limited number of land/forest fire cases prosecuted in the Criminal Court.

There is another point of view when discussing coordination to tackle haze pollution. The Expert Witness (ID-1-ExpertW) argued that establishing a multidoor enforcement coordination approach to handle land/forest fire cases is the key answer due in part to the complexity of cases and the limited capacity of law enforcement, for example, in identifying the extent of a plantation area with an illegal status occupied by plantation companies.

Expert Witness: There was a company that received cultivation right in 2014 but has been operating since the early 1990s. Moreover, there are non-sustainable plantation areas that have been harvested to supply the existing market demand for fresh fruit brunch but only operate with location permits.

In parallel to the multidoor coordination arrangement, the Investigator from the Ministry of Environmental and Forestry (D-3-MinEAF) also indicated the necessity of multidisciplinary knowledge in tackling haze pollution:

Investigator: the economic valuation for the lost benefit in the case of land/forest fires is needed because the burning creates fertile land that is ready to be planted. In addition, the value of the ecological or recovery losses should use an economic valuation to avoid double counting and to increase data accuracy.

In sum, this paper found that the obstacles that shape deterrence were not solely based on political implementation but also emerged from the implementation of administrative policies. The obstacles emanate from budgets and a lack of coordination among law enforcement officers and institutions. Law enforcement interventions involving the deployment of an investigation and prosecution in the case of land and forest fires need more support, especially in terms of financial resources, to avoid deterrence failure among violators. Previous studies have shown that a lack of sufficient financial resources for the enforcement of environmental regulations creates low deterrence [31], [32]. Furthermore, the outcomes of the paper, which include a lack of coordination between law enforcement institutions in South Sumatra Province, extend the study by Budiningsih [4]. The chance of environmental policy violators being caught or punished is reduced by ineffective law enforcement coordination. Moreover, enforcement that creates deterrence is related to not only the severity of penalties but also the probability of detection as a crucial element that drives compliance [33].
3.4 Possible Ways for Strengthening Deterrence with Tax Policy

Tax as a market-based instrument would be placing a direct cost on environmental damage [34]. Knorring and Welzel [35] showed that compliance with regulatory policies might be improved by punitive taxes. Based on these conditions, the implementation of a strengthened regulatory approach with tax policies and administration to tackle haze pollution will increase the probability of detection and punishment for violators of the law. Moreover, regulations to hold firms liable for potential damages from their pollution may improve policy compliance [36]. Moreover, the incentive policies are acceptable and create deterrence that mitigates resistance and the unacceptability of environmental management policies.

Furthermore, tax policy is a possible way to link the scale of revenue to the degree of a problem in the Indonesia National Budget (APBN). Maatta [37] stated that environmental taxes are taxes with the primary purpose of generating revenue that also have a significant positive effect on the environment. The ability of tax administrations to identify entities subject to a tax as the underlying structure in tax policy design will increase the strength factors in identifying noncompliant economic agents. As a result, the tax administration will be able to tag personal characteristics, income, and land ownership records from data pool integration and measure the economic value of the benefits lost to land and forest fires. Based on Crowding Theory, the way a tax administration identifies a taxpayer (as external intervention) has an impact on the taxpayer’s behavior (as intrinsic motivation) [38].

4 Conclusion

Deterrence emanates from the probability of detection and the severity of sanctions. The in-depth interviews reveal that current regulatory enforcement is still limited in sending a strong signal about the punishment of intentional fire behavior. This paper contributes to the literature through revealing enforcement obstacles that hamper deterrence and create the persistence of haze pollution at South Sumatra and Riau Provinces. The lack of special arrangements for environmental recovery costs and direct financial mechanisms for how fines are to be utilized has hampered the enforcement of deterrence. Moreover, the limited budget and lack of coordination of agencies indicate a low probability of being inspected. As a result, the benefit of noncompliance is relatively high, and noncompliance practice prevails.

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12 The Presidential Instruction Decree No 16/2011 that amended with No. 11/2015 stated that the Ministry of Finance, as part of the Government Institution, was involved in Controlling Land and Forest Fires. However, the role of the Ministry of Finance is not clearly defined in the supporting process. Moreover, in the Ministry of Environmental and Forestry Decree No. P.32/MenLHK/Setjen/Kum.1/3/2016 for the national level of coordination, the Ministry of Finance and the Directorate General of Taxes are not part of an Organizational Structure.

13 Following Mirrless’s concept that the optimal tax depends on the identification of personal characteristics [39], [40].

14 Based on Government Regulation No.31/2012 Government Agencies (Including: National Land Agency and Ministry of Domestic Affairs), Institutions (Including: Bank and Financial Industry), Associations and other agencies must provide data to the Directorate General of Taxes at the Tax Administration.
There are many ways to strengthen regulatory enforcement policies, especially when dealing with substantial political influence. The establishment of policy regimes that include fiscal instruments for environmental management cannot be overlooked as a reference point for the best future solutions. The ability to impose taxes to regulate pollution and generate revenue for the government should be considered, and an improved capacity can enhance the enforcement of haze pollution deterrence in Indonesia. Taking this into account, future research will carefully investigate tax policies that influence environmental management during the implementation stage of the law enforcement process as part of mixed policy instruments for land and forest fires that create persistent haze pollution in Indonesia.

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References


Indonesia Palm Oil as Issue Insight of Environmental Non-Governmental Organizations

Dwi Ajeng Zahrotun Noor
{dwiajengznoor@gmail.com}

Universitas Indonesia, Indonesia

Abstract. This paper is one of response towards the growing of recognition influence of non-governmental organization in world politics, especially in environmental issue. European Union policy to ban Indonesia oil palm is one of example the advocacy power of environmental non-government organizations. This paper would examine the nature of environmental non-governmental organizations in Indonesia. Particularly, this paper focus on the issue of Indonesia palm oil. Most studies focus on environmental impacts or economic benefits derived from the growing of palm oil plantations. Some studies also show that the economic benefits generated are not comparable to environmental impacts. In addition, several studies found that the environmental damage that occurred not only harm the local community. To close the gaps, several studies on palm oil governance were carried out. However, several studies mention the role of non-governmental organizations on the Indonesian palm oil issue. Some studies only explain how the role of non-governmental organizations in certain political phenomena. Narratives of non-governmental organizations are only considered part of the tools for advocacy.

Keywords: Biodiversity, Climate Change, Deforestation, Environmental Non-Governmental Organizations, Oil Palm

1. Introduction

Environmental non-governmental organization has important role in international politics. The involvement of environmental non-governmental organizations had been recognized since 1972. The environmental non-governmental organizations became one of actor who contribute in making The Declaration of the United Nations Conference on the Human Environment. The Declaration of the United Nations Conference on the Human Environment is basic framework of international agreement in environment issue. In recent years, the number of participation environmental and other non-governmental organization rapidly increases. Nowadays, several environmental non-governmental organizations can actively joint international conference. Environmental non-governmental organizations are working closely together with other non-governmental organization that have similar interest. This action is needed in order to increase their influence on outcome of conference. Environmental non-governmental organizations are work effectively outside and inside the conference time[1]. Environmental non-governmental organizations are continuously discussing and lobbing between their group or other parties. Besides that, environmental non-governmental organizations has role as supervise implication.
environment policies[2]. In Agenda 21 United Nations Sustainable Development 1992, Environmental non-governmental organization recognized as one of the supporting actor to achieve sustainable development. As advocacy agent, environmental non-governmental organizations gaining power by created or involve in network outside state border[3]. The existence of network helping environmental non-governmental organizations exchanging information and materials.

Environmental non-governmental organizations committing advocacy focuses on selected issues. The issues are selected based on interests of Environmental non-governmental organizations. One of the issue that selected by environmental non-governmental organizations is Indonesia palm oil. However, most of previous studies did not emphasized the existence on environmental non-governmental. Some research emphasized on economic impact of oil palm plantation expansion. For example, the development of palm oil increases the household income of farmers [4] and communities around the plantation [5]. On the other hand, the development of oil palm plantations has a negative impact on the environment. The negative environmental impact of the expansion of palm oil plantations is a decrease in the number of wildlife populations [6], increased carbon dioxide emissions [7], potential flooding [8] and water scarcity [9]. Previous studies have shown that negative environmental impacts are not only experienced by local people [10]. In addition, the study found that the growth of palm oil plantations changed social structures. This is marked by the emergence of new minorities [11]. To solve this problem, oil palm governance was established. Previous research has criticized the governance of palm oil siding with one party [12], [13].

A series of research on palm oil is growing. Some research focuses on developing narratives in studying the issue of palm oil. Several studies appear to emphasize the growth of the palm oil industry in the development narrative. The narrative explains how the ministry as a government agent regulates the growth of the palm oil industry through legislation [14]. Other research found that the narrative of palm oil development contradicts the reality faced by communities faced by local communities [15]. The research found that development narratives are used without reflecting on the complexities faced by local communities. In addition, previous research found that the narrative of palm oil issue between environmental non-governmental organizations and peasants had different interests [16]. Both of interest often intersect with each other. This article focuses on the development of narratives used by environmental non-governmental organizations, how the issue of palm oil is projected as a form of threat to the environment. This article uses the concept of strategic narrative. The narrative is considered as a form of strategy that projects the interests and identity of actors. By studying narratives, this research found a connection between palm oil issues and other environmental issues.

### 2. Narrative as Part of Strategy

In the development of international politics, the narrative has an important role in describing the socio-political phenomenon. The narrative is a reflection of the behavior of political actors. A developing narrative carries the values and interests of political actors [13], [17]. The narrative does not necessarily appear, it comes through the communication process[18], [19]. The communication process allows shared meaning between political actors. Political actors try to describe phenomenon according to the reality that experienced or believed. In other words, the narrative is not fiction. The narrative is a part of a reality that is owned by political actors.
Political actors constructed narrative based on the reality that happened in the past, present and possibly in the future[18], [20].

International politics is a battleground for narratives. The international political system is determined by the dominant of narrative of a political actors. To understand socio-political phenomena, the development of narratives needs to be understood. Narrative is not just a fairytale from political actors. Narrative can be used as a weapon. Weapons of political actors to suppress targets to achieve goals[17], [21]–[23]. Over time, understanding of the narrative is necessary to understand the development of international politics. Disagreement in international politics is not only marked by coercive action. The international political system is also characterized by a battle of ideas between political actors[19]. Each political actor tries to develop the reality of an ideal system based on their own identities and interests[17], [18], [24]. The development of information technology supports the creation of new forms of ecology. The ecology is known as "new media ecology" where the internet has an important role in distributing narratives[18], [19].

The existence of narrative is interpreted as a part of non-material power or soft power. A new form of power that emphasizes the ability to influence targets without being coercive[17], [21], [23]. Political actors use representations of reality based on their views. Manifested representations not only explain how phenomena occur. Political actors represent phenomena as part of the reality of the target[21], [22]. This is done by emphasizing how big the threat might be faced by the target. In addition, political actors use collective value to attract the sympathy of the target[17]. The use of words in representing reality is very influential on the success of the narrative[21]. Therefore, emotional elements need to be added to increase persuasion. The depiction of the relationship between targets and political actors as a whole is a form of emotional element[23]. Based on this explanation, narrative can be assessed as a form of political actor strategy. Narrative can be perceived as a framework that symbolizes the ideal goals, obstacles and ideal reality of political actors[19]. In addition, studying narrative can explain the position and dynamics that experienced by political actors.

3. Methods

This article uses content analysis by focusing on articles and publications on Greenpeace Indonesia's and WWF Indonesia's official websites. The research is limited to articles and publications that discuss the issue of Indonesian palm oil, Greenpeace (2007-2018) and WWF (2003-2018).

4. Environmental Non-Governmental Organization Narration

4.1 Greenpeace Narration

Palm oil issue has been part of Greenpeace campaign since 2006. Greenpeace recognized the expansion of palm oil plantation is the main causes of increasing the amount of carbon dioxide into the atmosphere. An increase in the amount of carbon dioxide is caused by deforestation and peatland fires[25]. If the problem is not taken seriously, it can have an impact on increasing the earth temperature. The increase of earth temperature is not only experienced
by local residents, but all the world's population will also feel the impact of the increase in earth temperature [26]. The increase of earth temperature will directly affect climate condition. Greenpeace emphasized that increasing the amount of oil palm plantation would certainly reduce the area of forest and peatlands [25]. Greenpeace refers to the Guinness book of world record 2008 that Indonesia as a one of country that has the world's fastest deforestation rate. The Guinness book of world record 2008 notes that every year the destruction of Indonesia's forests occurs every 1.8 million hectares in the period 2000 to 2005 [27]. The high rate of Indonesia's forests destruction makes Indonesia one of the contributors to greenhouse gas emissions up to 25 percent from the process of forest land clearing [27].

In 2007, Greenpeace began to place more serious attention on the development of oil palm plantations. In carrying out the action, Greenpeace Indonesia decided to conduct a Forest Defender Camp (FDC) activity. This activity was held to study the impact of the expansion of oil palm plantations on the environment. The activity was held in the middle of PT. Duta Palma Nusantara oil palm plantation, Riau[28]. Greenpeace found that PT. Duta Palma and its subsidiary corporation are responsible for peat forest fires[29]. Peat forest is one of the natural ecosystems that needs to be protected. Greenpeace emphasizes that peat forests have high carbon stocks. Greenpeace estimates that Riau's peatlands have 14.6 billion tons of carbon[30]. In its "cooking the climate" report, Greenpeace explained that international companies had an involvement in the agenda of destroying Indonesia's peat forests. International companies take advantage of nature by promoting biofuels. Biofuels are narrated as new fuels that are more environmentally friendly than diesel fuel[31]. In fact, the narrative is only used to increase economic profit only. Increasing the use of biofuels can lead to highest number of deforestation or peatland fires. Greenpeace assesses the way to minimize the effects of climate change is to restore forests and peatlands. Greenpeace emphasizes that forests and peatlands have an important role in stabilizing the earth's temperature. By restoring forest and peatland, earth temperature can be reduced by -2 °C[32].

The development of the palm oil industry also has a negative impact on biodiversity. One of the biodiversity that is threatened is orangutan. Greenpeace reports that the distribution of orangutan habitat has decreased in Kalimantan since 1999[33]. The main cause of the decline in orangutan habitat is reduced forest land. Orangutans are animals that fully depend on the forest. The loss of forest land makes life increasingly isolated. In addition, the reduced number of orangutan populations is due to attacks by palm oil plantation workers. Greenpeace found that more than 5 concessions of Unilever suppliers were built in orangutan habitat[33]. At present, the existence of a Central Kalimantan orangutan can be found in certain locations along the border between oil palm plantations[34]. In the latest report, the Kalimantan-Sumatran orangutan population is estimated to be less than 150,000[35]. The decline in population is also experienced by Sumatran tigers. In 2013, the presence of the Sumatran tiger population was estimated at 400[36]. Reduced tiger population due to conversion of forests into plantations. Palm oil plantations are estimated to be responsible for the loss of 15 percent of Sumatran tiger habitat[36]. The loss of Sumatran tiger habitat lead to conflict between tigers and humans. This conflict occurs because tigers cannot find food sources. This conflict directly impacts on the decline in tiger population.

Greenpeace explained that the expansion of industrial land for palm oil and forestry led to the reduction of one of the rare tree species, such as Ramin (Gonystylus bancanus). Ramin has a high sale value in the international wood market. Ramin is used as a raw material for household furniture, such as chairs, tables and wardrobes. Over time, the presence of ramin is increasingly
threatened due to illegal logging practices and the expansion of palm oil fields. The International Union for Conservation and Nature (IUCN) categorizes ramit as an endangered rare plant[37]. In addition, the action of expanding palm oil plantations threatens the productivity of other plantations, such as rice[38]. Rice is the staple food of the majority of Indonesia's population. Over time, this condition can threaten Indonesia's food security.

Greenpeace considers that the issue of palm oil directly affect people's lives. Greenpeace found that the existence of oil palm plantations was detrimental to the local community. The conversion of forest functions into oil palm plantations closed the livelihoods of local community around area of plantation. Greenpeace refers to the fact that 70 percent of West Kalimantan's Kapuas river water polluted by palm oil plantation waste[35]. Decrease quality of water causes the community unable to catch fish or consume water. In addition, negative impacts are also experienced by the Papuan people. The existence of palm oil plantations eliminated the staple food of the local community, namely sago[39]. Papuan people are also threatened with the loss of other sources of life, such as nipah. Nipah is known by the people of Papua as the basic material to build houses[39].

Greenpeace describes the forest is an important for living creatures. Forests play an important role as climate regulators[32]. However, the growth of the palm oil and forestry industry makes forests vulnerable to dry season and fires. Every year, the dry season increases the potential for forest fires. This condition is exacerbated by the deliberate burning of peatlands due to the expansion of palm oil plantations. To solve this problem, the role of industrialized countries as consumers of Indonesian palm oil is important. Industrial countries also enjoy economic benefits from the expansion of Indonesia's palm oil plantations. This statement refers to the fact that industrial countries play a role in granting licenses to Indonesian palm oil consumer companies. Strengthen industrial state regulations regarding consumption patterns of palm oil could be one problem solving[40], [41]. In addition, Greenpeace emphasized that the climate change issue is part of a shared responsibility. Greenpeace is encouraging industrialized countries to provide funding for forest conservation through the Forest For Climate (FFC) mechanism. Forest For Climate (FFC) is an international funding mechanism as a solution to reduce carbon emissions and tropical deforestation[42]. Greenpeace estimates that each year the conservation of Indonesia's tropical forests is US$ 15-30 billion[43]. Therefore, international funding is needed in efforts to conservation forests due to the growth of the palm oil and forestry industries.

Greenpeace recognizes the importance of the awareness of palm oil business people on environmental and social impacts. To make palm oil business aware, Greenpeace publishes a report related to the involvement of palm oil consumer companies in deforestation and peatland fires. The report is intended to put pressure on palm oil consumer companies to improve supplier company behavior[35], [44]. Therefore, Greenpeace emphasized the importance of palm oil consumer companies to find out the practices of palm oil plantation companies. In addition, Greenpeace is aware of the important role of smallholder farmers in the Indonesian palm oil industry[45]. In order to achieve the national target for palm oil, developing the potential of smallholder farmers can be one solution. The potential of smallholder farmers is hampered due to lack of knowledge about management techniques and management. By providing knowledge to smallholder farmers, the productivity of palm oil will increase. In addition, deforestation and peatland fires will be reduced.
The financial sector, especially banking, has a role behind the bad practices of palm oil supplier companies. The role of the financial sector by providing loans to palm oil supplier companies[36], [46]. The financial sector indirectly supports deforestation and peatland fires. Greenpeace emphasized that the financial sector should providing loans or investments based on the zero deforestation, zero destruction of peatlands policy. In addition, public awareness is needed to stop bad palm oil practices. The public as a customer has an important role in the development of the palm oil industry. Public pressure can drive palm oil suppliers and consumers to follow sustainable principles. Greenpeace invites the public to contribute as an online activist by filling petitions to palm oil consumer companies[47]. Besides that, Greenpeace encourages the public to be more critical in choosing processed palm oil products.

4.2 WWF Narration

WWF narrates the development of the palm oil plantation industry as environmental impacts. Environmental impacts directly affect the development of biodiversity. Since 2003, WWF has noted that the development of palm oil plantations has resulted in conflicts between wildlife and humans. Sumatran elephant is one of the endangered wildlife. Riau is one of the areas that is experiencing environmental impacts from the development of oil palm plantations. WWF noted that the remaining Riau forests are 25 percent, 10 percent of which are suitable forests for Sumatran elephant habitat. The loss of habitat makes Sumatran elephants forced to enter residential areas. Lack of access to food sources makes Sumatran elephants consume agricultural products from residents. Because of that, Sumatran elephants are often poisoned or killed. Residents assume the existence of the Sumatran elephant as an agricultural pest. This condition causes the Sumatran elephant population to decrease every year. In 2004, WWF estimated the Sumatran elephant population around 350[48]. On the other hand, WWF noted the economic benefits derived from the development of palm oil plantations in elephant habitat were not proportional with economic losses. Riau is estimated to suffer a loss of 900 billion annually [49]. The amount is almost as big as the Riau regional income and expenditure budget for 1 year [49]. Economic losses are caused by the entry of Sumatran elephants into residential and plantation areas.

The decline in population is also experienced by other wildlife, such as orangutans. WWF refers to the 1993 IUCN data which states that around 80 percent of Sumatra orangutan habitat has been lost [50]. Orangutan habitat has been replaced by the development of plantation industries, such as palm oil. The loss of habitat makes orangutans live in limited space. Orangutans lose the forest as a place to live and a source of life. This certainly affects the development of the orangutan population. WWF considers that the orangutan population is at an endangered level. In addition, habitat destruction causes conflicts between orangutans and humans. Conflicts occur due to the entry of orangutan populations into palm oil plantations. The loss of food sources forced orangutans to consume oil palm fruit [51].

WWF found that the existence of palm oil plantations not only threatens forest ecosystems, but also river ecosystems. One wildlife whose population is threatened is Irrawaddy dolphin. Recent data states that Irrawaddy dolphin has a low population level. In one year, the Irrawaddy dolphin population only increased by eight [52]. One factor driving the low population of the Irrawaddy dolphin is the development of oil palm plantations. WWF argues that the development of palm oil plantations is eliminating the place where Irrawaddy dolphin breeds. In addition, river ecosystems are found to be polluted due to toxic waste produced from palm oil production. The declining quality of river ecosystems also affects the development of other
fish species as a source of food. WWF found that the expansion of palm oil plantation is damaging watershed ecosystems. Damage to watershed ecosystems directly affects the quality of water sources. This problem is affects the cost of producing clean water. People are forced to pay more to get clean water [53]. In addition, the economic activity of the community is disrupted. The community cannot use the river as a transportation route and as a source of daily life necessities [54]. The most significant environmental impact is the absence of water absorption. The absence of water absorption causes the area around the river prone to flooding [55].

WWF realizes that the issue of palm oil cannot be separated from the issue of forest conservation. WWF narrates the forest as the source of life for all living creatures. Human, animal and plant life is directly dependent on the forest [56]. In fact, exploitation of forests often occurs. One form of forest exploitation is land use change. The function of forest land has been transferred to support economic development. Palm oil plantations are one example of land use change. Since 2003, WWF has predicted that the development of palm oil plantations threatens forests. The statement was confirmed by the land expansion activities carried out by palm oil plantations. Evidence of changes in the function of forests into palm oil lands can be found in Riau. WWF reports that palm oil plantations are undertaking land expansion efforts. In the 2003-2012 period, WWF stated that around 52,266.5 ha of Tesso Nilo forest had been turned into oil palm plantations, 15,714 ha were within the national park area [57]. WWF narrates the forest as a "bank" that holds "savings" for the lives of indigenous peoples [58]. The use of the word "bank" symbolizes the function of the forest as a source of community life. Therefore, forest conservation action is very necessary. The conversion of forest functions into palm oil plantations directly eliminates the existence of indigenous peoples.

WWF emphasizes that palm oil plantations contribute to climate change. The widespread growth of non-sustainable palm oil plantations worsens climate conditions. In other words, WWF criticizes the actions of deforestation and peatland destruction carried out by palm oil plantations. The statement referred to the fact that Kalimantan's deforestation contributed to an increase in global carbon emissions by 20 percent [59]. Therefore, WWF encourages the restoration of forests and peatlands as an effort to tackle climate change. Besides that, WWF states that palm oil plantations are responsible for forest and peatland fires. For example, the Riau forest fire in July 2006. WWF found that oil palm plantations contributed to the emergence of 295 hot spots or 20.79 percent in Riau [60]. Peatland fires contribute 45 percent of greenhouse gas emissions [61]. WWF emphasizes that the impacts of climate change due to the expansion of palm oil are experienced by orangutans [62]. The orangutan population is decreasing with the increasing bad practices of palm oil plantations. Forest and peatland fires cause a rise in temperature affecting the food sources of orangutans. In addition, rising temperatures cause the growth of diseases and new pests attacking the orangutan's immune system. WWF found the loss of orangutans was also caused by natural factors, such as flood. WWF emphasized that flood can occur due to damage to watershed ecosystems due to the expansion of palm oil plantation.

The strength of the economic narrative drives actions to change the function of forest land into palm oil plantations. This action directly makes the lives of smallholder farmers dependent on oil palm fruit production. Meanwhile, WWF is aware that the length of the harvest and fluctuations in the price of fresh fruit bunch yields affect the income of smallholder farmers [63]. Solutions are needed to avoid economic problems that result in expansion of oil palm plantations. WWF assesses the importance of communities developing other natural potentials.
This action can be carried out by planting several types of plants that have a sale value, such as rubber, psidium guajavaa and gold dwarf orinoco [64]. In addition, WWF emphasized that the potential of livestock commodities that can still be developed. In general, WWF found that the development of the Indonesian palm oil industry minored smallholder farmers. Smallholder farmers have a small chance to enter the market [65]. In fact, 40 percent of palm oil production comes from 76 percent of the yield of smallholder farmers[66]. This condition often makes the reason for the expansion of palm oil. Therefore, WWF emphasizes the importance of embracing smallholder farmers in order to achieve sustainable palm oil.

To deal with the problem of palm oil, WWF realizes the important role of palm oil business players. Transformations in production and consumption patterns are needed to reach the goal. The certification scheme is one of the ways proposed by WWF. WWF believes that the certification scheme can be a platform that unites the interests of palm oil business players without eliminating environmental and social factors. WWF actively encourages business people to become part of the Roundtable on Sustainable Palm Oil (RSPO) and Indonesia Sustainable Palm Oil (ISPO) certification schemes[67], [68]. In addition, WWF described the certification scheme specifically Roundtable on Sustainable Palm Oil (RSPO) as a concrete commitment to the palm oil business. WWF emphasizes as a member of the Roundtable on Sustainable Palm Oil (RSPO) palm oil business players are bound by an agreement to carry out the practice of managing products and plantations based on sustainable principles [57]. Besides that, WWF is of the opinion that the Roundtable on Sustainable Palm Oil (RSPO) and Indonesia Sustainable Palm Oil (ISPO) certification schemes can become instruments of Indonesia's palm oil competitiveness [69]. This opinion refers to the fact that global consumer demand for environmentally friendly products. In other words, the certification scheme opens the way for palm oil business players to the global market. In addition, WWF explained that through the Roundtable on Sustainable Palm Oil (RSPO) and Indonesia Sustainable Palm Oil (ISPO) certification programs, businesses could optimize their potential through information related to plantation practices and palm oil management.

To support the transformation of palm oil production patterns, WWF considers the role of financial institutions is needed. Financial institutions indirectly support the bad practices of expanding palm oil plantations. Evidence is supported by the discovery of a flow of funds provided by international banks in bad practices of palm oil producer companies [70]. WWF expects increased responsibility from financial institutions. Financial institutions should not only act as a channel of funds, but also act as a supervisor of the flow of funds. WWF emphasizes the provision of loan, investment or funds should adhere to environmental, social and governance principles[71]. By adhering to these three basic principles, the behavior of palm oil business players can change towards sustainable principles. In addition, WWF does not deny the existence of the public as consumers of processed palm oil products. WWF views the public as the strongest actor in suppressing the actions of palm oil business players [72]. The public has the power to ask for sustainable palm oil products. Therefore, public awareness is needed to achieve sustainable palm oil.

5. Discussions

Greenpeace and WWF use narratives as part of an advocacy strategy. Each issue of palm oil is highlighted for specific objectives. Operation targets are determined based on highlighted
issues and socio-political conditions. Socio-political conditions are the main element influencing the selection of highlighted issues - see Tablet 1 and Tablet 2. In general, both environmental non-governmental organizations look at the issue of palm oil in one lens. The issue of palm oil is considered as a form of threat to the environment and the welfare of local communities. This problem cannot be solved independently. Both environmental non-governmental organizations emphasized the importance of multi-shareholder partnership in dealing with the palm oil issue. The differences between both environmental non-governmental organizations can be seen from the way they project problems and position themselves. The differences between both environmental non-governmental organizations do not distinguish the ideal reality. Both environmental non-governmental organizations have the same ideal reality which is the preservation of Indonesia's forests and peatlands. This research found that two main components in the narrative strategy between Greenpeace and WWF. First, the complexity of the problem of palm oil. Second, the target's role in resolving the issue of palm oil.

Table 1. Greenpeace Narrative of Palm Oil 2007-2018

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Social-Political Condition</th>
<th>Highlighted Issue</th>
<th>Explanation</th>
<th>Aim</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>2007-2008</td>
<td>Increasing demand for Palm Oil, SBY's statement at the Japan G8 meeting: intersect half of Indonesia's emissions in 2009</td>
<td>Climate Change Issue</td>
<td>The increasing amount of greenhouse emissions is due to the expansion of oil palm plantations in forests and peatlands.</td>
<td>Encouraging the government's commitment to dealing with the climate issue.</td>
<td>Indonesia Government, Oil Palm Consumer Companies</td>
</tr>
<tr>
<td>2008</td>
<td>Development plan: the road construction Trans Papua-West Papua</td>
<td>Indigenous people rights Issue</td>
<td>Development policy: The road construction of Trans Papua-West Papua threatens the source of life of the local community.</td>
<td>Increasing awareness of the importance of forests for the lives of local people.</td>
<td>Indonesia Government</td>
</tr>
<tr>
<td>Year</td>
<td>Event Description</td>
<td>Issue</td>
<td>Approach</td>
<td>Stakeholders</td>
<td></td>
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<td>----------</td>
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<td>------------------------------------------------------------</td>
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<td>----------------------------------------------------------------------------</td>
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</tr>
<tr>
<td>2009-2010</td>
<td>Postponement of the moratorium plan</td>
<td>Forest Conservation Issue</td>
<td>An important role of multi-stakeholders is needed to stop the bad practices of the palm oil industries.</td>
<td>Indonesia Government, Oil Palm Consumer States, Oil Palm Consumer Companies, Supplier Oil Palm Companies, Public</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Encouraging multi-stakeholder partnerships to stop acts of destruction of forests and peatlands.</td>
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<td></td>
</tr>
<tr>
<td>2011-2012</td>
<td>Moratorium Policy</td>
<td>Forest Conservation Issue</td>
<td>The forest moratorium policy does not fully reflect the Indonesian government’s commitment to stopping deforestation.</td>
<td>Indonesia Government</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Encouraging government commitment to address the issue of deforestation.</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2012-2013</td>
<td>Finding: increasing illegal expansion of oil palm plantation</td>
<td>Sustainable Development Issue</td>
<td>The involvement of the multi-parties in achieving sustainable palm oil has not been optimal, strengthening commitment and practices is needed.</td>
<td>Indonesia Government, Oil Palm Consumer Companies, Supplier Oil Palm, Scientist, Non-Governmental Organization, Public</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Implementing sustainable principles in palm oil industries.</td>
<td></td>
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</tr>
<tr>
<td>2013-2014</td>
<td>Report: fire hotspot is on palm oil plantation</td>
<td>Wildlife population decrease issue</td>
<td>Deforestation and peatland fire due to expanding palm oil plantations threatens the</td>
<td>Indonesia Government, Oil Palm Consumer Companies, Supplier Oil Palm, Public</td>
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<td></td>
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<td></td>
<td>Increasing consumer awareness of sustainable palm oil products</td>
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</tr>
</tbody>
</table>
existence of wildlife (orangutans and tigers).

<table>
<thead>
<tr>
<th>Timeline</th>
<th>Social-Political Condition</th>
<th>Highlighted Issue</th>
<th>Explanation</th>
<th>Aim</th>
<th>Target</th>
</tr>
</thead>
<tbody>
<tr>
<td>2014-2016</td>
<td>Report: 40% of Riau's three quarters fire hotspots in peatlands</td>
<td>Restoration Peatland Issue</td>
<td>The high level of peatland fires is caused by drainage and deforestation actions carried out by the palm oil industries.</td>
<td>Encouraging the Indonesian government to take action peatlands conservation</td>
<td>Indonesia Government, Oil Palm Consumer Companies, Supplier Oil Palm, Public, Financial Sector</td>
</tr>
<tr>
<td>2017-2018</td>
<td>Report: increased conversion of forest and peatland functions into palm oil plantations in the moratorium area</td>
<td>Forest and peatland Fire Issue</td>
<td>The moratorium policy is not effective, the practice of burning forests and peatlands is still carried out due to of expanding oil palm plantations.</td>
<td>Encouraging the adoption of concrete practices to stop deforestation and peatland fires</td>
<td>Indonesia Government, Oil Palm Consumer Companies, Supplier Oil Palm, Public, Financial Sector</td>
</tr>
<tr>
<td>Year</td>
<td>Issue</td>
<td>Issue Description</td>
<td>Goal</td>
<td>Responsible Party</td>
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<tr>
<td>2003-</td>
<td>The rise of conflict between wildlife and humans in Riau</td>
<td>The development of the palm oil industry has led to the loss of wildlife habitats</td>
<td>Make the community aware of the impact of the disappearance of wildlife habitat.</td>
<td>Indonesia Government, Local Community</td>
<td></td>
</tr>
<tr>
<td>2004</td>
<td>Wildlife population decrease issue</td>
<td>(Sumatran elephants and Sumatran Tigers). Habitat loss causes conflicts between humans and wildlife. This condition leads to a decrease population of wildlife.</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>2005-</td>
<td>forest fires 2005: 90% of forest and peat fires in Riau international conference on climate and biodiversity</td>
<td>Decreased amount of forestry land, especially conservation high value forests.</td>
<td>Increasing awareness of the importance of forests and peatlands for the life of living creatures.</td>
<td>Indonesia Government, Local community</td>
<td></td>
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<tr>
<td>2007</td>
<td></td>
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<td></td>
<td></td>
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<tr>
<td>2009</td>
<td>Bangkok Climate Change Conference (September 28 – October 8)</td>
<td>The impact of climate change is getting worse due to forests and peatlands burning.</td>
<td>Encouraging the government's commitment to dealing with climate change issues.</td>
<td>Indonesia Government</td>
<td></td>
</tr>
<tr>
<td>Year</td>
<td>Event Description</td>
<td>Development Issue</td>
<td>Description</td>
<td>Sectors/Entities</td>
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</tr>
<tr>
<td>2010-2014</td>
<td>WWF Report 2013: increasing illegal oil palm expansion in Riau</td>
<td>Sustainable Development Issue</td>
<td>The widespread practice of bad palm oil plantations is directly supported by a series of international trademarks.</td>
<td>Indonesia, Government, Oil Palm supplier companies, Oil palm consumer companies, Smallholder farmers</td>
<td></td>
</tr>
<tr>
<td>2014-2015</td>
<td>WWF Palm Oil Buyers Score Card 2013: 53% sustainable palm oil products is absorbed by global buyers.</td>
<td>Sustainable Development Issue</td>
<td>Consumption patterns that do not pay attention to sustainable principles contribute to the development of bad palm oil practices</td>
<td>Increasing consumer awareness of sustainable palm oil products. Public</td>
<td></td>
</tr>
<tr>
<td>2016-2017</td>
<td>Aidenvironment Report 2017: The role of Nordic Banks investment in Indonesia’s Palm Oil Deforestation.</td>
<td>Sustainable Development Issue</td>
<td>Financial institutions, especially banks, have an indirect role in forest burning and deforestation.</td>
<td>Suppress the funding channel for bad practices of palm oil industries. Financial Institutions</td>
<td></td>
</tr>
<tr>
<td>2017-2018</td>
<td>Joko Widodo's program: Replanting palm oil</td>
<td>Economic dependence Issue</td>
<td>Dependence on palm oil production can weaken the community's economy and lead to poverty.</td>
<td>Community empowerment and reducing possibility of forest land loss to oil palm plantations. Local community</td>
<td></td>
</tr>
</tbody>
</table>

### 5.1 The Complexity of Palm Oil Issue

The issue of palm oil is a complex issue, solutions cannot be done by one actor. Greenpeace and WWF emphasized the importance of collaboration between palm oil business players and...
related institutions. The complexity of this problem lies in the lack of awareness of the behavior of the palm oil business about environment and local communities. WWF and Greenpeace are aware of economic interests as main motive of palm oil business behavior. WWF underlined that the awareness of local communities, especially smallholder farmers, is one of the main solutions[66], [73]. Local communities as actors who experience the direct impact of the expansion of palm oil plantations. Local communities need to be aware of the impact of bad palm oil practices on the environment. Local communities must have the awareness that forests do not only belong to humans. The forest is a place for wildlife and plant life. Therefore, conflict between humans and wildlife is not the fault of wildlife. Conflict between humans and wildlife is caused by human selfishness. Meanwhile, Greenpeace emphasizes the role of palm oil supplier companies as the main source of deforestation and peat fires. Greenpeace demands the awareness of palm oil supplier companies to practice sustainable principle.

In fact, the commitment of palm oil supplier companies cannot be trusted. The high global demand for palm oil is the main reason for the expansion of plantations. The International certification schemes Roundtable on Sustainable Palm Oil (RSPO) and Indonesia Sustainable Palm Oil (ISPO) cannot solve the problem. The majority of palm oil consumer companies do not check the source of palm oil supplier companies. In addition, most of palm oil consumer companies refuse to publish information and data of palm oil plantation supplier company practices[74]. The high cost of Roundtable on Sustainable Palm Oil (RSPO) and Indonesia Sustainable Palm Oil (ISPO) certification is the reason some palm oil supplier companies and smallholder farmers are not bound by sustainable principle commitments[68]. Besides that, the uncertainty of the nominal economic benefits gained from applying the principle of sustainable palm oil is the reason. Practice deforestation and peatland fires practices promise huge profits with low capital. On the other hand, international fund for the restoration of Indonesia's forests is not proportional to the amount of forest land lost[75]. This condition is exacerbated by the existence of corrupt practices in the Ministry of Forestry and Environment[76]. The actual practice of restoring forests and peatlands is not carried out by the Indonesian government. The Indonesian government does not provide law enforcement to stop bad practices of palm oil industry[77].

5.2 The Role of Target in Palm Oil Issue

As member of Roundtable on Sustainable Palm Oil (RSPO), WWF places the palm oil business players as the main target of advocacy. WWF encourages palm oil business players to be part of the Roundtable on Sustainable Palm Oil (RSPO). By becoming a part of the Roundtable on Sustainable Palm Oil (RSPO), palm oil business players expressed their commitment to carry out sustainable palm oil practices. In fact, WWF found that the bad practices of palm oil still exist within the Roundtable on Sustainable Palm Oil (RSPO) international certification scheme. To encourage the commitment of palm oil business players, WWF believes that there is a need to increase public awareness of sustainable palm oil products[72]. This condition will strengthen the commitment of palm oil business players. Meanwhile, Greenpeace argued that the Roundtable on Sustainable Palm Oil (RSPO) international certification scheme did not stop bad palm oil practices. This statement is based on the Roundtable on Sustainable Palm Oil (RSPO) member palm oil bad practices report. Besides that, sanctions for membership removal are not effective. The palm oil business players
is still doing practice deforestation and burning peatlands[78]. Greenpeace considers that the commitment of palm oil business behavior cannot be trusted.

Therefore, Greenpeace encourages the increasing role of the Indonesian government in the palm oil issue. The Indonesian government needs to take action in making laws that regulate the protection of forests and peatlands[79]. Forest protection is not only given to primary forests, but also secondary forests and industrial forest plantations. In addition, the Government of Indonesia is expected to make legislation explaining the real practices of the conservation of forests and peatlands[77]. To stop the bad practices of the palm oil and forestry industry, Greenpeace emphasizes the importance of law enforcement against environmental criminals. Greenpeace considers strengthening the coordination of the Indonesian National Police and the Ministry of Forestry and the Environment in dealing with environmental criminals[80].

Greenpeace demands transparency of data and information related to forests and natural resources[81]. Transparency of data and information facilitates the role of the community in monitoring the state of Indonesia's forests and natural resources. Greenpeace pressured the government to implement a One map policy as a source of information on forest land ownership[82]. One map policy enables people and government of Indonesia know the actors behind deforestation and the burning of peat lands.

6. Conclusion

This article shows that in conducting a campaign on the issue of palm oil, environmental non-governmental organizations use narratives as a strategy. In order to achieve its objectives, Greenpeace and WWF select highlighted issues based on socio-political conditions. The selection of highlighted issues was carried out to illustrate the urgency of the Indonesian palm oil problem. Highlighted Issue does not eliminate other environmental issues. The selection of highlighted issue is used to get the attention of the target.

The research found that to achieve sustainable palm oil, Greenpeace and WWF encountered obstacles. These obstacles are inseparable from economic interests. The palm oil industry is still one of Indonesia's main commodities. The failure of the Greenpeace and WWF narrative is that it cannot project the economic benefits of applying the principles of sustainable palm oil. The narrative of economic benefits delivered is still in a small context, such as the smallholder farmers.

References


power and the new world order. 2014.


Model Predictive Control of Precision Air Conditioning System with Secondary Condenser

Iput Kasiyanto\textsuperscript{1}, Aries Subiantoro\textsuperscript{1}
iput.kasiyanto@ui.ac.id, biantoro@ee.ui.ac.id
Universitas Indonesia\textsuperscript{1}

Abstract. Due to high specification of ASHRAE requirements, a data center (DC) must have sophisticated cooling system to maintain its environment conditions. Its high dimensional coupling system dynamics makes controller design very challenging and complicated. A non-linear system model of a precision air conditioning (PAC) system with secondary condenser has been previously developed and then linearized at steady state operating point. Based on the model, a model predictive control (MPC) based controller is designed to deal with coupling state variables (i.e. temperature and relative humidity). The controller also has ability to improve energy efficiency of the PAC system. The performance of the proposed controller is validated through simulation. The results showed the effectiveness of MPC based controller against the defined constraints.

Keywords: Energy efficiency; Model predictive control; Precision air conditioning.

1 Introduction

For the last two decades, as the strengthening people awareness on sustainable energy future, energy saving strategies have become top priority in energy policies in many developed countries all over the world, especially with the significant increase of energy consumption in buildings\cite{1}. For example, in 2004 building consumption in the EU was 37\% of final energy\cite{2}, bigger than industry (28\%) and transport (32\%). Meanwhile, the USA’s building energy consumption accounted for 41\% of primary energy consumption in 2010\cite{3}. Mostly, the categories of building services and heating, ventilation, and air conditioning (HVAC) systems in developed countries constitute the major sources of energy use in buildings\cite{1},\cite{2}. Thus, the research and development and their subsequent implementations of effective control strategies for HVAC systems become primarily important and urgent.

Precision air conditioning (PAC) systems, which belong to HVAC applications, are widely used in data centers (DCs) to maintain the temperature and relative humidity of DCs in an appropriate condition as specified by ASHRAE requirements\cite{4}. PAC system typically eliminates heat produced by the DC equipments using vapour-compression process cycle. Early studies on HVAC control focusing on multiple loops of system-input–system-output (SISO) PI-based controllers have proved that the control strategies only benefited low gains. In addition, its tedious and (sometimes) inaccurate tuning of classical PI-based HVAC controllers contributed to poor performance\cite{5},\cite{6}. Also, SISO controllers are unable to handle cross-coupling nature in an HVAC system. Therefore, multivariable control strategies become interesting options. Among many multivariable control strategies, model predictive control (MPC) approach has several advantages\cite{7}, which include: utilize of a mathematical model for antici-
patory control actions instead of corrective control, incorporation of a disturbance model for disturbance rejection, ability to deal with constraints and uncertainties, ability to handle slow-dynamics processes with time delays, use of a cost function for satisfying multiple objectives, and utilize of advanced optimization methods for computing of control vectors. The basic concept of MPC approach is to use a system model to predict the future states of the system using the current and past measurements. The controller, then, generates a control vector that minimizes a certain cost function over the prediction horizon in the presence of disturbances and constraints. Many MPC applications in HVAC systems have been studied and implemented, for instances: in controlling VAV zone temperature and damper position[8], for the charging and discharging control of an ice storage system[9], in reducing energy consumption of heat pump of a solar house[10], in controlling the optimal temperature of a commercial building[11], in reducing the operating and maintenance cost in a district heating power plant[12], for maintaining the indoor thermal comfort in IoT Smart Space[13], and many others.

In order to overcome the drawbacks of conventional-method-based controller as mentioned before(i.e.: being not able to handle coupled variables in MIMO system, not able to incorporate constraints in control design, and the irksomely need of retuning controller parameters), the new method of controller was proposed. This paper presents MPC controller design based on the previously developed model by Subiantoro et al[14]. The PAC system model is derived using psychrometric data and underlying physics laws, i.e.: the conservation of mass and energy balance principles. The previous work was only the dynamic model of PAC system with new additional component, namely a secondary condenser to improve regulation of relative humidity. But the controller for the system was not designed yet. Thus, based on the model, a model predictive control (MPC) is designed to deal with coupling state variables(i.e: temperature and relative humidity) and to improve energy efficiency of the PAC system. The performance of the proposed controller is validated through simulation.

2 Methods

This section consists of two sub sections. The first part describes briefly the PAC model used as controlled plant. Then, the controller design which applied to the plant is explained in the second part.

2.1 PAC System Model

As mentioned before, the model used in the controller design is developed by Subiantoro et al[14]. The schematic representation of the model is shown in Figure 1. The system consists of basic HVAC components, namely: a compressor, heat exchanger components (an evaporator, two condensers and a cavalier pipe), two fans and regulation valves (an electronic valve and a check valve). It is mainly composed of two parts, refrigerant-side and an air-side. The secondary condenser is placed at PAC outlet to work as an air heating coil. The system uses refrigerant R134a as its working fluid, with a total charge of 0.5 kg.

The dynamic model is derived using energy and mass conservation laws for components composing the PAC system, which includes: compressor model, evaporator model, secondary condenser, and cabinet model. For detail derivation, one can refer to[14].
The developed model is nonlinear. The model can be represented in state-space form as

$$\dot{x} = H^{-1}f_1(x, u, t) + H^{-1}f_2(n, t)$$  \hspace{1cm} (1)$$

where \(x\) is state variables vector defined as \(x = [T_{cab}, \omega_{cab}, T_1, T'_1, T_2, T_{we}, \omega_1]^T\), \(u\) is input variables vector defined as \(u = [f, s]^T\), and \(n\) is disturbance variables vector defined as \(n = [T_{air-in}, \omega_{air-in}, Q_{load}, M]^T\). \(H^{-1}\) is defined in Appendix A of the preliminary work[14].

In order to be convenient for designing multivariable control, the nonlinear model should be linearized about its operating point as described in Table 1.

**Table 1.** The Operating Point of the PAC System.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Numerical value</th>
<th>Variable</th>
<th>Numerical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>(T_{cab})</td>
<td>25.2051 °C</td>
<td>(T_{we})</td>
<td>3.0266 °C</td>
</tr>
<tr>
<td>(T_1)</td>
<td>22.4299 °C</td>
<td>(T'_1)</td>
<td>23.0859 °C</td>
</tr>
<tr>
<td>(T_2)</td>
<td>23.4183 °C</td>
<td>(T_{we2})</td>
<td>24.8727 °C</td>
</tr>
<tr>
<td>(\omega_1)</td>
<td>0.0102 kg/kg</td>
<td>(\omega_{cab})</td>
<td>0.0104 kg/kg</td>
</tr>
<tr>
<td>(s)</td>
<td>60 rps</td>
<td>(f)</td>
<td>0.04722 m³/s</td>
</tr>
</tbody>
</table>
Applying Taylor series method to equation (1) and calculate it about its operating point, the linearized dynamic model can be written as state-space representation in the following compact form

\[
\dot{x} = A_{op} x + B_{op} u + V_{op} n
\]

where \( A_{op} \), \( B_{op} \), and \( V_{op} \) defined in [14].

Meanwhile, the output of the PAC system is calculated using linear regression method considering linear relationship between the relative humidity of cabinet and the specific humidity of cabinet. The output of the system can be written as follows

\[
y = C_{op} x + d_{op}
\]

where \( y \) is output variables vector defined as \( y = [T_{cab}, \phi_{cab}]^T \), with \( C_{op} \) and \( d_{op} \) defined in [14].

2.2 MPC Controller Design

As digital controller, the MPC controller performs all estimation and optimization computations in discrete-time domain. Therefore, the model described in equation (2) and (3) have to be discretized in the following form

\[
\begin{align*}
\{x_{k+1} &= A_d x_k + B_d u_k + V_d n_k \\
y_k &= C_d x_k + d_k
\end{align*}
\]

where \( A_d \), \( B_d \), \( C_d \) and \( V_d \) respectively are discrete form of matrices \( A_{op} \), \( B_{op} \), \( C_{op} \) and \( V_{op} \). Meanwhile, \( x_k \), \( u_k \), \( n_k \) and \( y_k \) respectively are discrete form of vector \( x \), \( u \), \( n \) and \( y \) defined as in the previous subsection.

The main idea of MPC, as indicated by its name, is to predict the future states of the controlled system and subsequently to generate a control vector that minimizes a certain cost function over finite prediction horizon in the existence of disturbances and constraints. For each sampling period only the first computed control element is applied to the system input, and the remainder is eliminated. The process is repeated again in the next instant. Thus, the described algorithm is also called receding horizon control. For a current system state \( x_k \), the control input is determined by the solution of

\[
u_k^* = [1 \ 0 \ \cdots \ 0] \left( \arg \min_{u_k \ldots u_{k+n_{C}}} J(x_k, u_{k-1}) \right)
\]

subject to system, control and optimization constraints[15]. \( u_k^* \) is the first control input from the calculated set of optimal control inputs \( \{u_{op}, \ldots, u_{op}^{*+M}\} \) for a control horizon of length \( n_{C} \). The MPC uses the cost function \( J_k \) to penalize (a) deviations of the predicted outputs from a reference (setpoint) trajectory and (b) the smoothness of manipulated variable.
The cost function can be expressed in a discrete-time linear quadratic functional as follows:

$$J_k = \sum_{i=0}^{n_p} \|r_{k+i} - \hat{y}_{k+i|k}\|^2_w + \sum_{i=0}^{n_c-1} \|\Delta u_{k+i}\|^2_{w^u}$$  \hspace{1cm} (6)

where $k$ is the current time index, $n_p$ is the prediction horizon, $n_c$ is the control horizon, $r_{k+i}$ is the reference vector at step $k$, $\hat{y}_{k+i|k}$ is the predicted output vector at step $k + i$, $\Delta u_{k+i} = u_{k+i} - u_{k+i-1}$ is the variation of manipulated variable [11], $\|\cdot\|^2_w$ indicates a square of an Euclidean vector norm weighted over a specified matrix ($\|x\|^2_w = x^T W x$), $(WY)^T \succ 0$ and $(WU)^T \succeq 0$.

The $n_p$-step output prediction used in $J_k$ is determined in the following equation:

\[
\begin{bmatrix}
\hat{y}_{k+1|k} \\
\hat{y}_{k+2|k} \\
\vdots \\
\hat{y}_{k+n_p|k}
\end{bmatrix} = \begin{bmatrix}
CA \\
CA^2 \\
\vdots \\
CA^{n_p}
\end{bmatrix} \hat{x}_{k|k} + \begin{bmatrix}
CB \\
CAB + CB \\
\vdots \\
\sum_{i=1}^{n_p} CA^{i-1} B
\end{bmatrix} u_{k-1} + \\
\sum_{i=1}^{n_p} CA^{i-1} B \begin{bmatrix}
\Delta u_k \\
\Delta u_{k+1} \\
\vdots \\
\Delta u_{k+n_c-1}
\end{bmatrix}
\]

The quadratic programing problem of MPC can defined as

$$\min_{\Delta u} J_k = \frac{1}{2} \Delta u^T \psi \Delta u + \theta^T \Delta u$$  \hspace{1cm} (8)

subject to:

$$y_{\text{min}} \leq y_k \leq y_{\text{max}}; \quad u_{\text{min}} \leq u_k \leq u_{\text{max}}$$  \hspace{1cm} (9)

where:

$$\psi = S_\theta W^T S_\theta + W^U$$

$$\theta = -S_\theta^T W^T \varepsilon$$

$$\varepsilon = r - \theta$$

$$r = [r_{k+1} \ r_{k+2} \ \cdots \ r_{k+n_p}]; \quad W^Y = \begin{bmatrix}
w^Y & \cdots & 0 \\
\vdots & \ddots & \vdots \\
0 & \cdots & w^Y
\end{bmatrix}; \quad W^U = \begin{bmatrix}
w^U & \cdots & 0 \\
\vdots & \ddots & \vdots \\
0 & \cdots & w^U
\end{bmatrix}$$
The control process of MPC is schematically described in Figure 2. It consists of two main blocks, namely: MPC block and plant block. The MPC block calculates the optimal control \( u_k^* \) and uses it to control the plant so that it can follow the setpoint trajectory and fulfill the constraints and cost function criteria. Meanwhile, the plant block is the dynamics model for the controlled process as derived in [14]. It contains system parameters and typically includes uncertainties, both model uncertainty and disturbances.

3 Results and Discussions

For the simulation, the following parameters have been set: prediction horizon \( n_p = 200 \) s, control horizon \( n_c = 25 \) s, sampling time \( T_s = 5 \) s. Meanwhile the constraints for fan and compressor are defined as follows

\[
0.01416 \leq f \leq 0.04722 \\
20 \leq s \leq 73.33
\]

The simulation was conducted using well-known general purpose software, Matlab® 2018b. Simulation of MPC controller gave satisfying result as depicted in Figure 3. The controlled variables, i.e: temperature and RH, can follow the setpoint trajectory smoothly. Even there is small overshoot when the setpoint changes, the output variables relatively well decoupled using the controller. The choosing of horizons, both prediction and control horizon, are very crucial in order to get the expected result. Due to the slow dynamics of the system, value of \( n_p = 200 \) s and \( n_c = 25 \) s for duration 7000s are reasonable [7].
When setpoint of $T_{in-cab}$ is changed from 25°C to 26°C in $t = 2000s$ while maintaining setpoint $RH_{cab}$ constant, it can be seen that actual value $RH_{cab}$ changes as well, though very small amount. In a similar way, the change of setpoint $RH_{cab}$ from 65% to 64% in $t = 4500s$ while maintaining setpoint $T_{in-cab}$ constant still effects in actual value $T_{in-cab}$. The both cases show that there is interaction between the two variables ($T_{in-cab}$ and $RH_{cab}$) or in another term, they are coupled each other. However, in both cases, the amount of change responses are very small. Thus, it proved that MPC controller performs very well in decoupling the multivariable system.

Besides the ability of decoupling the MIMO system, there is another advantage of MPC which makes it become preference among process engineers in controlling multivariable systems. It is the ability to handle constraints in a fashionable way. From Figure 4 it can be seen that the values of fan speed ($f$) and compressor speed ($s$) are limited in particular range as defined in constraints, i.e.: between 0.01416 $m^3/s$ and 0.04722 $m^3/s$ for $f$, while for $s$ between 20 $rps$ and 73.33 $rps$. In $t = 2000s$, the fan and compressor speed decrease to make system follow setpoint $T_{in-cab}$ change. The same way happens when setpoint $RH_{cab}$ is changed in $t = 4500s$. The control inputs change as well, but again still in their range limits. The fan speed is around 0.0142 $m^3/s$ while the compressor speed is about 25 $rps$.

![Fig. 4. The value of control input of PAC System using MPC.](image)

As illustrated in Figure 4, the optimization algorithm inside MPC computed the optimal control law such that the value of control inputs will not outside the defined range while in the same time it also satisfies the setpoint conditions.

### 4 Conclusion

An MPC based controller has been designed and validated through simulation. Its performance to control cabinet temperature and relative humidity of PAC system is very well. The controller can handle the cross-coupling variables with satisfying result. It can be seen from the responses in both cases (changing one variable and maintaining the another constant), i.e.: the amount of overshoot responses are very small. Its superiority, particularly in dealing with constraints and cost function, is demonstrated by simulation. Despite the changing of setpoint $T_{in-cab}$ and $RH_{cab}$, the control inputs ($f$ and $s$) still change in their range limits as defined in constraints.
Acknowledgments. This research is funded by Research Grant of Beasiswa Saintek Kementerian Riset, Teknologi, dan Pendidikan Tinggi.

Nomenclature

\[ T_{cab} \]: air temperature in cabinet (°C)  
\[ f \]: compressor speed (rps)  
\[ T_{we} \]: evaporator wall temperature (°C)  
\[ \phi_{cab} \]: relative humidity of the cabinet (kg/kg)  
\[ T_{air-in} \]: air temperature in Datacenter room (°C)  
\[ \omega_{cab} \]: specific humidity of the cabinet (kg/kg)  
\[ M \]: humidity load of the cabinet (kg/s)  
\[ s \]: air flow speed (m³/s)  
\[ T_{1} \]: air temperature of evaporator output (°C)  
\[ T_{2} \]: air temperature of secondary condenser (°C)  
\[ Q_{load} \]: heat sensible load from the IT equipment (kW)  
\[ T_{wc2} \]: secondary condenser wall temperature (°C)  
\[ \omega_{air-in} \]: specific air humidity in the Datacenter room (kg/kg)  
\[ \omega_{1} \]: specific humidity from evaporator output (kg/kg)  
\[ T_{1}' \]: air temperature between the evaporator dry and wet region (°C) 

References

Dispersion of Iodine-131 Radioactive Airborne in the Chemical Form of CH₃I, HOI and I₂ from Radioisotope Production Facility Stack to The Environment

Gatot Suhariyono¹ and Makhsun²
{g_suhariyono@batan.go.id¹, makhsun@batan.go.id²}

National Nuclear Energy Agency (BATAN), Center for Technology of Radiation Safety and Metrology (PTKMR), Jl. Lebak Bulus Raya, Pasar Jum’at, Jakarta, 12440, Indonesia¹²

Abstract. The purpose of this research is to develop a method for measuring radioactive release I-131 in the stack of isotope production facilities and in the environment (outdoor) in the form of: organic Iodine methyl Iodide (CH₃I), elemental iodine (I₂) and inorganic hypoiodous acid iodine (HOI). Charcoal filters are used to adsorb organic Iodine methyl Iodide (CH₃I). Silver coated gauze is used to adsorb elemental Iodine (I₂). Glass fiber paper filters are used to adsorb inorganic hypoiodous acid iodine (HOI). The discharge of I-131 activity concentrations on average from the stack and in seven outdoor places around the isotope production installation are still underneath the standard level within the air (530 Bq/m³) based on controls of Nuclear Energy Supervisory Agency (BAPETEN) Head, No. 7/2013. The activity concentrations of I-131 in stack from large to sma’s were CH₃I (63.03%), I₂ (30.27%) and HOI (7.70%) respectively. While average I-131 concentration in the outdoors were CH₃I (61.12%), I₂ (20.37%) and HOI (18.39%).

Keywords: I-131, Iodine-131, charcoal, stack, CH₃I, HOI, I₂, Methyl Iodide, Elemental Iodide, Hypoiodous acid.

1 Introduction

Radioisotope Production Facility at Serpong, produces and processes I-131 that can disperse to the housings (community) and the environment around the Serpong nuclear area (SNA). The Radioisotope Production Facility is surrounded by densely populated housings. The population in the 5 km radius from the facility in 2019 is around 241,821 people with a growth of 2.22 percent per year [1, 2, 3]. This has come to the attention of BATAN (National Nuclear Energy Agency) and BAPETEN (Nuclear Energy Regulatory Agency) to conduct radiation protection studies on the release of radionuclides in general, specifically Iodine-131 (I-131) from the nuclear installation stack which produces I-131.
I-131 is produced routinely for medical purposes in hospitals and pharmacies, for both domestic and export. I-131 is a beta and gamma emitting radioactive material. Radioiodine (I-131) is one of the large enough radioactive substances to get attention, because of its volatile nature and can damage the thyroid gland from the people health. I-131 causes mutations and death to penetrated cells, and can cause thyroid cancer. I-131 is the largest radionuclides released from a nuclear accident. For example, the activity of I-131 radionuclide released from the nuclear accident in Chernobyl (Russia) on 1986 amounted to 1,850 PBq (1 PBq = 1.10^{15} Bq), and in Fukushima (Japan) on March 2011 amounted to 400 PBq [4, 5, 6, 7, 8, 9, 10].

The purpose of this study is to develop a method for measuring radioactive release I-131 in the stack of isotope production facilities and in the environment (outdoor) in the form of: organic Iodine methyl Iodide (CH$_3$I), elemental iodine (I$_2$) and inorganic hypoiodous acid iodine (HOI). Previous research only measured I-131 concentrations by using a charcoal (indirect method), without measured the chemical forms of CH$_3$I, I$_2$ and HOI [10]. The measurement method of I-131 in the stack and the environment is usually done only by using charcoal, while the development of the I-131 measurement method is done not only by using charcoal filters to measure CH$_3$I, but also using silver coated gauze to measure I$_2$ and glass fiber paper filters to measure HOI.

## 2 Methods

### 2.1 Description of Research Locations

This research was carried out within the seven yards of houses (outdoor), Serpong Nuclear Region, and within the stack of I-131 radioisotope production installation. The research was conducted as numerous as seven houses with five wind headings for 15 to 22 hours at the same time to product and discharge of I-131 radioactive to the stack. Research locations map at Serpong Nuclear region is shown on Figure 1. Seven research locations of the stack are at Sengkol (North and 0.8 km from the stack), BATAN Indah (North and 2.6 km from the stack), Jaletreng (North and 4.2 km from the stack), Puri Serpong (East and 2.2 km from the stack), Muncul (North East and 1.3 km from the stack), Pabuaran (South and 1.9 km from the stack), and Suradita (West and 3.2 km from the stack) [10].

### 2.2 I-131 concentration Measurement Method

**I-131 Concentrations Measurement Method in the Stack.** I-131 concentrations measurement method of in the stack has been explained in detail in my paper, 2017 [10]. Basically, the measurement method for I-131 on the stack is explained in Figure 2. The difference between the development method and the previous method is that the development method is modified from the previous method where the concentration of I-131 is measured using a charcoal filter, silver plated gauze and glass fiber paper filter. Previous research method only measured I-131 concentrations by using a charcoal (indirect method), without measured the chemical forms of CH$_3$I, I$_2$ and HOI [10]. Charcoal filters are used to adsorb organic Iodine methyl Iodide (CH$_3$I-131). Silver coated gauze is used to adsorb elemental Iodine (I$_2$-131). Glass fiber paper filters
are used to adsorb inorganic hypoiodous acid iodine (HOI-131). Grade of the standard quality level of radioactivity in the air is 530 Bq / m³ based on the direction of PERKA BAPETEN No. 7/2013 [11].

Fig. 1. Research locations map at Serpong Nuclear Area.

Fig. 2. I-131 concentration measurement system within radioisotope production stack.
**I-131 Concentration Measurement Method at Outdoor.** The method of measuring the I-131 concentration at outdoor has also been explained in detail in my paper, 2017 [10]. Basically, the measurement method for outdoor I-131 is explained in Figure 3. The difference with the previous method is that in this study concentration of I-131 was measured using indirect methods in charcoal filters, silver coated gauze and glass fiber paper filters. Charcoal filters are used to adsorb organic Iodine methyl Iodide (CH$_3$I-131). Silver coated gauze is used to adsorb elemental Iodine (I$_2$ -131). Glass fiber paper filters are used to adsorb inorganic hypiodous acid iodine (HOI-131).

Measurement of I-131 concentration at outdoor coincides with production of I-131 radioisotope at the Radioisotope Production Facility. Thus, measurement of I-131 concentration in the form of CH$_3$I-131, HOI-131 and I$_2$-131 in stack and outdoors was carried out at the same time during 24 hours.

![Image of air sampling equipment](image_url)

**Fig. 3.** Air sampling at outdoor by using charcoal, silver coated gauze and glass fiber paper filters.

**Elemental Iodine Sampling Method (I$_2$).** Elemental Iodine (I$_2$-131) needs attention, because elemental iodine with a very small diameter (ultrafine) will be very easy to enter the body and
can interfere with health. In addition, the concentration in the air at a nuclear facility is quite large, ranging from 17.3% to 66.1% [12].

Elemental iodine is present in the atmosphere in the form of vapors or aerosol particles with a diffusion coefficient of 0.08 cm$^2$/second. This diffusion coefficient is used to determine the diameter of the elemental iodine aerosol particles, it is known that based on the calculation of the diameter of the elemental iodine aerosol particles is 0.835 nm [13, 14]. There are various types of elemental iodine sampling that are commonly used, namely:

a. Cadmium Iodide on cromosorb [14]. This sample has high efficiency, but is not durable, expensive and only one-time use.

b. Silver plated silica gel (AgS) [15]. The efficiency is quite high, but only one use.

c. Sampling gauze shape (copper or silver) [13]. This sample has a high efficiency, is durable, and can be decontaminated.

Iodine gas (I$_2$) is produced from stable KI crystals (20 mg) which are activated neutrons in the reactor. After activation, KI crystals is taken into a glove box, then a chemical reaction takes place producing I$_2$ gas. The chemical reaction equation for I$_2$ production is as follows: [16]:

$$2\text{KI} + 2\text{KNO}_2 + 2\text{H}_2\text{SO}_4 \rightarrow \text{I}_2 \uparrow + 2\text{NO} \uparrow + 2\text{H}_2\text{O} + 2\text{K}_2\text{SO}_4$$

Elemental iodine sampling (I$_2$) used in this research was silver coated gauze type. I$_{131}$ in the form of I$_2$ adsorbed silver coated gauze is affixed to charcoal with a 25 lpm vacuum pump flow rate. This silver coated (Ag) gauze is best contaminated and durable, so that it is economically quite cheap [17]. Elemental iodine that passes through silver-plated brass gauze will be adsorbed on the gauze with Van der Walls bonds and react chemically to form covalent bonds between I$_2$ and Ag. The chemical reaction is:

$$2\text{Ag (s)} + \text{I}_2\text{-131 (g)} \rightarrow 2\text{AgI-131}$$

Measurement of the concentration of the element iodine (I$_2$) in the gauze sample was carried out with a gamma spectrometer system using an in-situ NaI(Tl) detector. I-131 concentration in gauze (C) is calculated by equation (1), in this case $N_t$ is the I-131 count of gauze. Concentration of I-131 in charcoal is counted utilizing the following formula:

$$C = \frac{(N_t-N_{Bg})}{Y\cdot\eta\cdot(ts\cdot t)}$$  \hspace{1cm} (1)

Information:

$C$: Concentration of I-131 (Bq/m$^3$)

$\eta$: Counting efficiency of calibration standard source with gamma detector of NaI(Tl) (cps/Bq)

$N_t$: I-131 radionuclide counts in charcoal at 364 keV energy(counts)

$N_{Bg}$: background (no sample) counts without I-131 radionuclide counts (counts)

$t$: duration of measuring (s)

ts: length of sampling (s)
F: sampling flow rate (m$^3$/s)

Y: plenitude of I-131 in nature (81.21%)

**Organic Iodine Sampling Method (CH$_3$I).** Iodine (I-131) in form of organic methyl iodide (CH$_3$I-131) is produced in radioisotope production facilities can penetrate aerosol filters. Sampling is done by pulling the sample stream through an aerosol filter containing an Iodine filter material, such as activated charcoal, silver zeolite or other material with a vacuum pump on flow rate of 25 lpm. Increasing the efficiency of organic methyl iodide (CH$_3$I-131) sampling Iodine is done by mixing activated charcoal and a chemical called tri ethylene diamine (TEDA). The efficiency of CH$_3$I sampling is influenced by physical parameters, such as air temperature, water vapor, organics and time. Efficiency will decrease, if sampling is done for a long time (aging). Warming air flow to reduce water content in charcoal is an effective method for collecting organic iodine [18]. The charcoal extracting cartridge is shown in Figure 4. Methyl Iodide (CH$_3$I) is produced by mixing TEDA and Dimethyl Sulfate ((CH$_3$O)$_2$SO$_2$) according to the following equation:

\[
\text{TEDA-I-131} + (\text{CH$_3$O})_2\text{SO$_2$} \rightarrow \text{CH$_3$I-131} + \text{TEDA-CH$_3$SO$_4$}
\]

The CH$_3$I-131 concentration in charcoal (C) is calculated to be equal to equation (1), while N$_t$ is the I-131 count in the form of CH$_3$I in charcoal (counts).

![Charcoal filter](image)

Fig. 4. Charcoal filter used in this study contains TEDA

**Inorganic Iodine Sampling Method (HOI).** The filter paper used for air sampling is Whatman GF/A fiber glass. This filter has Dioctyl Phthalate (DOP) sampling efficiency at a diameter of 0.3 um of 99.99%. This paper filter is used to adsorb I-131 in the form of inorganic Iodine Hypoiodic Acid (HOI). HOI is formed from the chemical process elemental Iodine (I$_2$) which undergoes a process of hydrolysis with water (H$_2$O). The chemical reaction for HOI formation is [19]:

\[
\text{I$_2$ -131} + \text{H$_2$O} \rightarrow \text{HOI -131} + I^- + H^+
\]

Concentration of I-131 within the shape of HOI in-filter paper (C) is calculated equal to equation (1), while N$_t$ is the count of I-131 in the form of HOI in-filter paper (counts).

**3 Results**

The results of measurements and calculations of I-131 activity concentrations within radioisotope production stack are shown in Figures 5, 6, 7, 8, 9, 10 and 11. Overall the order of
concentrations of CH₃I, HOI and I₂ with activity concentrations of large to small within stack, namely CH₃I, I₂ and HOI respectively.

The highest total activity concentration of the measurement system on December 11-12, 2013 in the stack was 470.35 Bq/m³ on time of 19.00 to 20.00 (Figure 5). The total activity concentration was high on time of 19.00 to 20.00, because at those times the method of changing the phase from the solution phase to the gas phase amid the disintegration handle of Mo-99 into I-131 gas. There was an I-131 gas that get away through the sidelines of the elastic connector to the stack during this gas phase, so that the concentration of the I-131 movement rises quickly between 19.00 and 20.00. I-131 measurement was done every 1 hour. Overall the average concentration of I-131 activity (103.03 Bq/m³) were still underneath the quality standard of the I-131 radioactivity level in the air which is 530 Bq/m³ based on PERKA BAPETEN control of No. 7/2013 [11].

Fig. 5. Measurement results of I-131 activity concentrations within stack on December 11 to 12, 2013

Fig. 6. Measurement results of I-131 activity concentrations within stack on December 18 to 19, 2013
Fig. 7. Measurement results of I-131 activity concentrations within stack on December 27 to 28, 2013

Fig. 8. Measurement results of I-131 activity concentrations within stack on January 22 to 23, 2014

Fig. 9. Measurement results of I-131 activity concentrations within stack on Feb 5 to 6, 2014
Measurement results of the overall I-131 activity concentrations in radioisotope production stack are shown on Table 1 and Table 2. Total activity concentrations of measurement system on December 27-28, 2013 were low, compared to the values of the activity concentrations in the stack on December 11-12 and 18-19, 2013. These cases were due to the fact that during the radioisotope production process were instrument damage, so that the production of I-131 was not optimal. The activity concentrations of CH3I-131, I2-131, HOI-131 and the highest total average in the stack on December 18-19, 2013 were 136.24; 68.12; 12.89 and 217.24 Bq/m³ respectively. Concentrations measurement of I-131 activity in radioisotope production stack on 18-19 December 2013 were at the same time measured concentrations of I-131 activity at outdoor BATAN Indah housing. By and large concentrations of the I-131 activity on normal within the stack were still underneath the quality standard of the I-131 radioactivity level in the air which is 530 Bq/m³ based on PERKA BAPETEN control of No. 7/2013 [11].

The measurement results of I-131 activity concentrations at outdoor Puri Serpong housing on December 11 to 12, 2013 are shown on Figure 12. The order of I-131 activity concentration in the form of CH3I, HOI and I2 from large to small at outdoor Puri Serpong housing were CH3I, HOI and I2 respectively. The arrange of I-131 concentrations at outdoor were diverse in arrange with the I-131 concentrations within the stack. The order of I-131 concentrations within the stack from huge to little were CH3I, I2 and HOI. These differences prove elemental Iodine aerosol particles (I2) in the stack during dispersion to the housing undergo a chemical process that is the process of hydrolysis with water (H2O) in the air to form inorganic Iodine Hypoiodic Acid (HOI) with chemical reactions as follows [19]:

\[(I_2) - 131 + H_2O \rightarrow HOI - 131 + I^- + H^+\]
Table 1. Summary of measurements result from CH₃I dan I₂ activity concentration in Stack

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>I-131 Concentration (Bq/m³) and Time in Stack</th>
<th>CH₃I</th>
<th>I₂</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
<td>Average</td>
</tr>
<tr>
<td>Puri Serpong</td>
<td>11-12 Dec 2013</td>
<td>1.59</td>
<td>16.99</td>
<td>8.90</td>
</tr>
<tr>
<td>E, 2.2 km</td>
<td>17:00-05:00</td>
<td>17.40-18.40</td>
<td>19.45-20.45</td>
<td>17.40-18.40</td>
</tr>
<tr>
<td>BATAN Indah</td>
<td>18-19 Dec 2013</td>
<td>8.79</td>
<td>36.21</td>
<td>20.65</td>
</tr>
<tr>
<td>Muncul</td>
<td>27-28 Dec 2013</td>
<td>2.60</td>
<td>18.87</td>
<td>7.70</td>
</tr>
<tr>
<td>NE, 1.3 km</td>
<td>13:30-05:00</td>
<td>13:30-14:30</td>
<td>21:45-22:45</td>
<td>13:30-06:40</td>
</tr>
<tr>
<td>Sengkol</td>
<td>22-23 Jan 2014</td>
<td>2.36</td>
<td>20.49</td>
<td>12.02</td>
</tr>
<tr>
<td>N, 0.8 km</td>
<td>14:00-01:30</td>
<td>06:00-07:50</td>
<td>18:25-19:25</td>
<td>14:10-07:50</td>
</tr>
<tr>
<td>Pabuaran</td>
<td>5-6 Feb 2014</td>
<td>7.22</td>
<td>20.93</td>
<td>13.23</td>
</tr>
<tr>
<td>S, 1.9 km</td>
<td>12:30-21:30</td>
<td>06:30-08:30</td>
<td>16:45-17:45</td>
<td>15:15-08:30</td>
</tr>
<tr>
<td>Suradita</td>
<td>19-20 Feb 2014</td>
<td>0</td>
<td>19.50</td>
<td>8.90</td>
</tr>
<tr>
<td>W, 3.2 km</td>
<td>11:00-21:00</td>
<td>14:05-16:30</td>
<td>23:35-24:35</td>
<td>14:05-09:00</td>
</tr>
<tr>
<td>Jatareteng</td>
<td>13-14 Mar 2014</td>
<td>0</td>
<td>21.60</td>
<td>10.77</td>
</tr>
<tr>
<td>N, 4.2 km</td>
<td>11:00-21:00</td>
<td>15:10-16:10</td>
<td>02:00-03:20</td>
<td>15:10-06:09</td>
</tr>
</tbody>
</table>

The highest total concentration of I-131 activity at outdoor Puri Serpong housing measured at 30.14 Bq/m³ was on time of 19.45 to 20.45. Most of the total concentration which 56% concentration came of Methyl Iodide (CH₃I), 25% concentration of HOI and 19% concentration of I₂. The highest I-131 activity concentrations of CH₃I, HOI and I₂ were 16.99 Bq/m³ on 19.45-20.45, 8.52 Bq/m³ on time of 24.35 to 01.35 and 5.66 Bq/m³ on time of 19.45 to 20.45. Decreased concentration of I-131 activity occurred on time of 22.10 to 23.10. This decrease is due to high wind speeds of around 3.1 m/s during those times.

Table 2. Summary of measurements result from HOI and Total activity concentration in Stack

<table>
<thead>
<tr>
<th>Location</th>
<th>Date</th>
<th>I-131 Concentration (Bq/m³) and Time in Stack</th>
<th>HOI</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Minimum</td>
<td>Maximum</td>
<td>Average</td>
</tr>
<tr>
<td>Puri Serpong</td>
<td>11-12 Dec 2013</td>
<td>0.22</td>
<td>14.90</td>
<td>4.67</td>
</tr>
<tr>
<td>E, 2.2 km</td>
<td>17:00-05:00</td>
<td>22:00-23:00</td>
<td>17:00-18:00</td>
<td>17:00-09:00</td>
</tr>
<tr>
<td>BATAN Indah</td>
<td>18-19 Dec 2013</td>
<td>1.98</td>
<td>33.45</td>
<td>12.89</td>
</tr>
<tr>
<td>N, 2.6 km</td>
<td>11:30-21:40</td>
<td>21:30-09:40</td>
<td>12:30-10:30</td>
<td>10:30-09:40</td>
</tr>
<tr>
<td>Muncul</td>
<td>27-28 Dec 2013</td>
<td>0.28</td>
<td>10.21</td>
<td>5.67</td>
</tr>
<tr>
<td>NE, 1.3 km</td>
<td>13:30-05:00</td>
<td>10:00-11:30</td>
<td>18:15-19:15</td>
<td>10:00-04:40</td>
</tr>
<tr>
<td>Sengkol</td>
<td>22-23 Jan 2014</td>
<td>0.14</td>
<td>6.64</td>
<td>1.96</td>
</tr>
<tr>
<td>N, 0.8 km</td>
<td>14:00-01:30</td>
<td>01:00-10:00</td>
<td>15:00-16:00</td>
<td>15:00-10:00</td>
</tr>
<tr>
<td>Pabuaran</td>
<td>5-6 Feb 2014</td>
<td>0.14</td>
<td>5.90</td>
<td>2.92</td>
</tr>
<tr>
<td>S, 1.9 km</td>
<td>12:30-21:30</td>
<td>22:30-09:40</td>
<td>15:30-16:30</td>
<td>11:30-09:40</td>
</tr>
<tr>
<td>Suradita</td>
<td>19-20 Feb 2014</td>
<td>0.07</td>
<td>4.04</td>
<td>0.65</td>
</tr>
<tr>
<td>W, 3.2 km</td>
<td>11:00-21:00</td>
<td>21:00-11:00</td>
<td>13:00-14:00</td>
<td>11:00-10:00</td>
</tr>
<tr>
<td>Jatareteng</td>
<td>13-14 Mar 2014</td>
<td>0</td>
<td>5.07</td>
<td>1.71</td>
</tr>
<tr>
<td>N, 4.2 km</td>
<td>11:00-21:00</td>
<td>09:00-11:00</td>
<td>16:00-17:00</td>
<td>11:00-10:00</td>
</tr>
</tbody>
</table>
The measurement results of I-131 activity concentrations at outdoor BATAN Indah housings on December 18 to 19, 2013 are shown in Figure 13. The average concentrations of I-131 activity in the form of CH₃I, HOI and I₂ from large to small at outdoor housings of BATAN Indah were CH₃I, I₂ and HOI respectively. The order of I-131 activity concentrations (CH₃I, I₂ and HOI) at outdoor BATAN Indah housing was the same as the concentration of I-131 activity in the stack (CH₃I, I₂ and HOI). However, there are differences in spectrum patterns. The CH₃I, I₂ and HOI spectrum patterns are respectively the same in the stack, while the I₂ spectrum patterns are different from the CH₃I and HOI spectrum patterns in the BATAN Indah housing. This difference is likely due to elemental Iodine (I₂) in the stack during dispersion to the housing there is a chemical process (at 13.30-15.30) which is the process of hydrolysis with water in the air to form an inorganic Hypoiodic Acid (HOI) [19].

The highest total concentration of I-131 activity at outside BATAN Indah measured was 54.34 Bq/m³ at time of 21.20 to 22.25. Measurement of I-131 concentration was only until time of 24.40 to 01.40, due to the limitations of charcoal filters. Most of the total concentration which 66.96% concentration came of Methyl Iodide (CH₃I), 22.31% concentration of I₂ and 10.70% concentration of HOI. The highest concentrations of CH₃I, and I₂ at times of 21.20 to 22.25 were 36.21 and 12.07 Bq/m³ respectively. The highest concentration of I-131 activity from HOI is 6.51 Bq / m³ at 13.30-14.30. Decreased concentration of activity I-131 occurred at 22:40 to
24:40. This decrease occurs, because the wind speed is quite high around 4.0 to 5.1 m/s at those times.

The measurement results of I-131 activity concentration at outdoor Muncul housing on December 27-28, 2013 are shown in Figure 14. The average I-131 activity concentrations sequence in the form of CH₃I, HOI and I₂ from large to small at outdoor Muncul housing were CH₃I, HOI and I₂. The order of concentrations of I-131 activity in outdoor (CH₃I, HOI and I₂) were different with order of the concentration of I-131 activity in the stack (CH₃I, I₂ and HOI). However, there are differences in spectrum patterns. The CH₃I, I₂ and HOI spectrum patterns in each stack are the same, while the HOI spectrum patterns were different from the CH₃I and I₂ spectrum patterns in the Muncul housing.

The highest total concentration of I-131 activity in the outdoor was measured at 40.68 Bq / m³ at 21.45-22.45. The method of measuring the concentration of I-131 is only until 05.40-06.40, due to the limitations of the charcoal filter. Most of the total concentration which 52.98% concentration came of Methyl Iodide (CH₃I), 29.36% concentration of HOI and 17.66% concentration of I₂. The highest concentration of I-131 activity from CH₃I, HOI and I₂ at time of 21.45 to 22.45 was 22.85; 10.21 and 7.62 Bq/m³ respectively. The decrease in the concentration of activity I-131 occurred on time of 20.00 to 21.00 and 23.25 to 24.25. This decrease occurs, because the wind speed is quite high around 1.8 to 3.1 m/s at those times. Wind speed at time of 21.45 to 22.45 is quite low at around 0.6 m/s.

The results of measurements of outdoor I-131 activity concentrations at Sengkol housing on January 22-23, 2014 are shown in Figure 15. The average order of I-131 activity concentrations in the form of CH₃I, HOI and I₂ from large to small in outdoor, Sengkol housing, respectively namely CH₃I, HOI and I₂. The order of concentration of I-131 activity at outdoor (CH₃I, HOI and I₂) is different in order with the concentration of I-131 in the stack (CH₃I, I₂ and HOI). However, there are differences in spectrum patterns. The CH₃I, I₂ and HOI spectrum patterns in the stack are the same, while the HOI spectrum pattern is different from the CH₃I and I₂ spectrum patterns in the Sengkol housing. This difference is probably due to the elemental Iodine aerosol (I₂) in the stack during dispersion to the housing at times of 14.10 to 17.40 and 23.20 to 07.50 undergoing a chemical process that is the process of hydrolysis with water (H₂O) in the air to form an inorganic Hypoiodic Acid (HOI) [19].

Fig. 14. Concentration of I-131 activity at outdoor Muncul on 27 to 28 December 2013
The highest total concentration of I-131 activity in the outdoor was measured at 30.39 Bq/m³ on time of 18.25 to 19.25. Most of the total concentration of the method, 56.16% concentration came from Methyl Iodide (CH₃I), 25.16% concentration of HOI and 18.72% concentration of I₂. The highest concentration of I-131 activity of CH₃I and I₂ at 18:25-19:25 hours were 20.49 and 6.83 Bq/m³, while the highest I-131 concentration of HOI was at time of 03.15 to 04.15 at 9.12 Bq/m³. Decrease in concentration of activity I-131 occurred at 22.05-23.05 and 24.40-01.40. This decrease occurs, because the wind speed is quite high around 2.1 to 3.0 m/s at these hours. Wind speed at 23.20-24.20 is low, which is around 1.1 m/s.

The results of measurements of outdoor I-131 activity concentrations, Pabuaran housing, on 5 and 6 February 2014 are shown in Figure 16. At the time of the study at home of Pabuaran Village from 13.53 to 15.00 on 5 February 2014, a power outage occurred, so there is no study of I-131 activity concentration at outdoor at those times. The order of concentration of I-131 activity averages in the form of CH₃I, HOI and I₂ from large to small in outdoor of Pabuaran housings were CH₃I, I₂ and HOI respectively. However, there are differences in spectrum patterns. The CH₃I, I₂ and HOI spectrum patterns in the same stack, respectively, while the HOI and I₂ spectrum patterns differ from the CH₃I spectrum patterns in the Pabuaran housing. The concentration of HOI and I₂ activities at time of 20.45 to 21.45, 23.15 to 24.15 and 24.30 to 01.30 is almost the same. This is possible because elemental Iodine aerosols (I₂) in the stack during dispersion to the housing undergo a chemical process that is the process of hydrolysis with water (H₂O) in the air to form inorganic Iodine Hypoiodic Acid (HOI).

Fig. 15. Concentration of I-131 activity at outdoor Sengkol on 22 to 23 January 2014
The highest total concentration of I-131 activity in the outdoor was measured at 32.33 Bq/m$^3$ at 16.45-17.45. The highest concentration of I-131 activity at these hours, because at time of 15:30 to 16:30 the method of changing the phase from the solution phase to the gas phase amid the disintegration process of Mo-99 into I-131 gas in the hot cell. There is an I-131 gas that get away through the sockets of the elastic connector to the stack amid this gas phase, so the concentration of I-131 activity rises.

The total concentration came from 64.01% concentration were in the shape of Methyl Iodide (CH$_3$I), 21.34% concentration in the shape of I$_2$, and 14.66% concentration in the shape of HOI. The highest concentration of I-131 activity from CH$_3$I and I$_2$ at 16:45 to 17:45 was 20.93 and 6.98 Bq / m$^3$, while the highest I-131 concentration of HOI was at 20.45-21.45 at 6.63 Bq / m$^3$. Decrease in concentration of activity I-131 occurred at 18.00-20.30 and 22.00-01.30. This decrease occurs, because the wind speed is quite high around 1.1 to 2.8 m/s at these hours. Wind speed at 16.12-17.12 and 20.12-21.12 is low at around 0.5 m/s.

The results of measurements of outdoor I-131 activity concentration at Suradita housing on February 19-20, 2014 are shown in Figure 17. The average concentration of I-131 activity in outdoor of Suradita housing in the shape of CH$_3$I, HOI and I$_2$ from large to small were namely CH$_3$I, I$_2$, and HOI respectively. The order of concentration of outdoor activity I-131 (CH$_3$I, I$_2$, and HOI) was in the same sequence with the concentration of I-131 in the stack (CH$_3$I, I$_2$, and HOI). The CH$_3$I, I$_2$, and HOI spectrum patterns in each stack are the same, while the CH$_3$I and I$_2$ spectrum patterns are different from the HOI spectrum patterns in Suradita housing. The highest I-131 activity concentrations of I$_2$ and HOI were 6.50 Bq / m$^3$ at 23.35-24.35 and 2.67 Bq / m$^3$ at 18.00-19.20, respectively. Thus, aerosol elemental Iodine (I$_2$) in the stack during dispersion to the housing at 18.00-19.20 undergoes a chemical process that is the process of hydrolysis with water (H$_2$O) in the air to form inorganic Iodine Hypoiodic Acid (HOI), so that the highest HOI activity concentration is at 18.00-19.20 19.20.

The highest concentration of I-131 activity from I$_2$ and CH$_3$I at 23.35-24.35. Decrease in concentration of activity I-131 occurred at time of 19.30 to 21.55 and 01.15 to 02.15. This decrease is due to high wind speeds, which is around 0.9 to 1.4 m/s at those times.

The most elevated total concentration of I-131 activity within the open air (27.95 Bq/m$^3$) was measured at time of 23.35 to 24.35. The total concentration of I-131 activity (19.82 Bq/m$^3$) was high at time of 18.00 to 19.20, due to the method of changing the phase from the solution phase to the gas phase amid the disintegration process of Mo-99 into I-131 gas in the hot cell. There is an I-131 gas that get away through the sockets of the elastic connector to the stack amid this gas phase, so the concentration of I-131 activity rises.
The total concentration came from 68.78% concentration of organic Iodine within the shape of Methyl Iodide (CH$_3$I), 22.95% I$_2$ and 8.27% HOI. The highest concentration of I-131 activity of CH$_3$I and I$_2$ at time of 23.35 to 24.35 were 19.50 and 6.50 Bq/m$^3$, while the highest I-131 concentration of HOI at time of 18.00 to 19.20 was 2.67 Bq/m$^3$. Decrease in concentration of activity I-131 occurred at time of 19.30 to 21.55 and 01.15 to 02.15. This decrease occurs, because the wind speed is quite high around 1.1 to 2.8 m/s at these hours. Wind speed at times of 18.06 to 19.06, 23.06 to 24.06 and 03.06 to 04.06 is low at around 0.5 m/s.

The results of measurements of outdoor I-131 activity concentrations, Jeletreng housing, on March 13-14, 2014 are shown in Figure 18. The average order of I-131 activity concentrations in the form of CH$_3$I, HOI and I$_2$ from large to small in outdoor, Jeletreng housings, respectively namely CH$_3$I, I$_2$ and HOI. The order of concentration of outdoor activity I-131 in the same sequence with the concentration of I-131 in the stack namely CH$_3$I, I$_2$ and HOI. The CH$_3$I, I$_2$ and HOI spectrum patterns in each stack are the same, while the CH$_3$I and I$_2$ spectrum patterns are different from the HOI spectrum patterns in the Jeletreng housing. Spectrum patterns I$_2$ and HOI almost coincide.

The highest I-131 activity concentrations of CH$_3$I, I$_2$ and HOI were 21.60; 7.20 and 5.31 Bq/m$^3$ at 02.00-03.20. I-131 activity concentrations of I$_2$ and HOI almost coincided at 20.40-24.30 and 03.45-07.15. Thus, aerosol elemental Iodine (I$_2$) in the stack during dispersion to the housing at these hours undergoes a chemical process (hydrolysis) with water (H$_2$O) in the air to form inorganic Iodine Hypoiodic Acid (HOI). The highest concentration of I-131 activity from CH$_3$I, I$_2$ and HOI at the time of 02.00-03.20. This phenomenon is quite interesting, because around 23:00 to 02:00 there was a big rain, but the highest I-131 concentration. Diminish in concentration of I-131 activity happened, after coming to the most elevated concentration of I-131 beginning from 03.20. This decrease is a result of high wind speeds of around 1.4 m/s to 2.7 m/s during these hours.
Fig. 18. Concentration of I-131 activity at outdoor Jeletreng on 13 to 14 March 2014

The highest total concentration of I-131 activity in the outdoor was measured at 34.11 Bq/m³ at 02.00-03.20. Concentration of I-131 activity is tall at these hours, due to the method of changing the phase from the solution phase to the gas phase amid the disintegration process of Mo-99 into I-131 gas in the hot cell. There is an I-131 gas that get away through the sockets of the elastic connector to the stack amid this gas phase, so the concentration of I-131 activity rises.

The results of measurements of the overall I-131 concentration in outdoor housing are each shown in Table 3 and Table 4. The most elevated average I-131 concentration of the seven investigate areas were exterior the BATAN Indah Housing, which were 30.84 Bq/m³. The maximum I-131 concentration in BATAN Indah differs in time and magnitude, because the measurement is only until time of 01.40. The most elevated total concentration of I-131 activity (54.34 Bq/m³) was at time of 21.20 to 22.25. The concentration of I-131 is the biggest in BATAN Indah from 7 research locations, because most (37%) of wind direction goes between North-North-West and North-North-East on 18 and 19 December 2013 and most of the wind direction goes between to North-West and to the North with a velocity between 2.1 to 5.7 m/s in September 2012 to August 2013. Thus, the dispersion of I-131 average from the stack to the houses in the North direction of the stack, the concentration of I-131 shaped a parabolic curve beginning to ascend from the Sengkol housing (distance of 0.8 km), the most elevated in BATAN Indah (distance of 2.6 km) and diminishing in Jaletreng (distance of 4.2 km). Overall the concentration of I-131 activity in seven investigate destinations is still underneath the standard quality of I-131 radioactivity level in the air which is 530 Bq/m³ based on PERKA BAPETEN rule No. 7/2013 [11]. The RQ (Risk Quotient) value of the I-131 concentration in seven locations measured outdoor is below 1 (RQ < 1), the I-131 concentration measured in outdoor and indoor housings does not present a significant risk to public health [20].
Table 3. Summary of the measurements result of CH$_3$I and I$_2$ activity concentration at Outdoor

<table>
<thead>
<tr>
<th>No.</th>
<th>Location</th>
<th>Date</th>
<th>Minimum</th>
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<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
<th>Average</th>
</tr>
</thead>
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<td>32.07</td>
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<td>3</td>
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<td>27-28 Des 2013</td>
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<td>7.70</td>
<td>1.30</td>
<td>9.43</td>
<td>3.85</td>
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<td>2.56</td>
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<td>12.02</td>
<td>2.81</td>
<td>6.83</td>
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<td>Poburan</td>
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<td>7.22</td>
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<td>3.59</td>
</tr>
</tbody>
</table>

<table>
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<tr>
<th>No.</th>
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<th>Minimum</th>
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<th>Average</th>
<th>Minimum</th>
<th>Maximum</th>
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<td>4.60</td>
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<td>2</td>
<td>BATAN Indah</td>
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<td>8.52</td>
<td>4.31</td>
<td>4.60</td>
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<tr>
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<td>Poburan</td>
<td>5-6 Feb 2014</td>
<td>0.90</td>
<td>6.63</td>
<td>3.03</td>
<td>3.01</td>
<td>12.33</td>
<td>20.67</td>
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</table>

Table 4. Summary of the measurements result of HOI and Total activity concentration at Outdoor

4 Conclusion

The discharge of I-131 activity concentrations on average from the stack and the concentration of I-131 activity in seven outdoor places around the isotope production installation are still underneath the standard level of I-131 radioactivity concentration within the air (530 Bq/m$^3$) based on controls of Nuclear Energy Supervisory Agency (BAPETEN) Head, No. 7/2013. Potential risk of removable dispersion radioactive iodine-131 from the stack of radioisotope production facility for the health of residential communities around radioisotope
production facility does not pose a significant risk to public health (Risk Quotient <1). 1-131 Dispersion from the stack to the housing average with the north of the stack, the concentration of I-131 shapes a parabola beginning to ascend from the Sengkol housing (distance of 0.8 km), the most elevated in BATAN Indah (distance of 2.6 km) and diminishing in Jaletreng (distance of 4.2 km). The activity concentration of I-131 during rain and high humidity tends to rise, while the presence of sunlight decreases the activity concentration of I-131. The activity concentrations of I-131 in stack from large to small were CH3I (63.03%), I2 (30.27%) and HOI (7.70%) respectively. While the activities concentration of I-131 on average in the outdoors were CH3I (61.12%), I2 (20.37%) and HOI (18.39%).

References

Effect of Unwanted Pregnancy on Antenatal Care in Rural and Urban Areas In Indonesia

Martya Rahmaniati¹, Desya Mulyaningrum²
{tya_makful@yahoo.com¹, desyamulyaningrum@gmail.com²}
Faculty of Public Health, Universitas Indonesia¹²

Abstract. The definition of unwanted pregnancy is a pregnancy that occurs outside of planning, because the husband or wife partner does not want to use contraception, there is no access to family planning services which causes pregnancy. The purpose of this study about unwanted risk factors for pregnancy to the completeness of antenatal care [ANC]. The study design using IDHS study design with cross sectional design. The sample in this study was a live birth in the five years prior to the survey report birth weight rural and urban areas in Indonesia. Data analysis used multivariate logistic regression analysis for risk factor models. Unwanted pregnancies have an influence on ANC in both rural and urban areas. Individual variables that affect rural areas are influenced by employment, economic status, age and parity, while in urban areas they are influenced by economic status and age.

Keywords: Antenatal Care, Public Health, Rural, Urban, Unwanted Pregnancies

1. Introduction

Unwanted pregnancy is a pregnancy that occurs outside of planning, because the husband or wife does not want to use contraception, there is no access to family planning services and the couple is physically and psychologically unprepared and reject the occurrence of pregnancy. Meanwhile, describing an unintended pregnancy is an unwanted pregnancy and a mistimed pregnancy. Unwanted pregnancy, that is, an unwanted pregnancy at any time or not wanting to have another child. Whereas, mistimed pregnancy is a pregnancy that is not timely, the pregnancy is anticipated but not at a certain time [1].

The proportion of unwanted pregnancies at all in Indonesia is based on data from the 2007 Indonesia Basic Health Survey [IDHS] of 7.4% of 18,168 births of women aged 15-49 during the five years before the survey, including pregnancy during the survey. Then based on the 2012 IDHS data, the proportion of unwanted pregnancies at all in Indonesia was 7.1% from 18,898
births of women aged 15-49 during the five years before the survey, including pregnancy during the survey. Furthermore, based on the 2017 IDHS, the proportion of unwanted pregnancies at all in Indonesia was 7.1% of the 18,952 births of women aged 15-49 during the five years before the survey. It can be seen from the two periods of the IDHS that the proportion of unwanted pregnancies has not changed and is still stable so that a good birth planning pattern is needed.

The need for effective programs and strategies to improve access to contraceptive services and information related to contraceptive tools and methods. Increasing access to family planning services is the key to reducing unwanted pregnancies, these efforts require cross-sectoral policy makers to increase access to family planning services. Improved access needs to be accompanied by an increase in the quality of care and availability of information about the effective use of family planning methods [2,3]. Examination of pregnant women [Antenatal Care] both physically and mentally with the aim to save the mother and child during the pregnancy, childbirth and the puerperium so that conditions can return to normal. Determinants of unwanted pregnancies in Indonesia are the level of maternal education, area of residence, status of living with a partner, parity, complications of pregnancy, use of contraception and illnesses suffered by the mother. Information and education on how to prevent the occurrence of unwanted pregnancy still needs to be improved [4].

Early antenatal care [ANC] initiation is a way to detect the early management of potential complications related to pregnancy. Although some research shows that ANC does not always show a relationship with pregnancy to maternal age and parity [5]. Unwanted pregnancy can increase the risk of problems for the mother and the baby she is carrying. If the pregnancy is not planned before conception, then the woman may not get optimal health care. The purpose of this study is to obtain an unwanted pregnancy model with the completeness of the ANC in urban and rural areas. Many aspects of health care during pregnancy or ANC that need to be considered to ensure good delivery outcomes, one of which is a good final impact of childbirth is the weight of the baby born.

2. Methods

The subjects of this study were mothers who gave birth alive in the five years before the survey with a report having a history of pregnancy examinations and residing in rural and urban areas in Indonesia. This study uses secondary data from the 2017 IDHS data, with the
approval of the IDHS for further analysis. The research design of the SDKI is a cross sectional design because the measurements and observations are made at one time. The dependent variable ANC visits made by mothers during pregnancy with a high risk category if the ANC visit is less than 4 times during pregnancy and low risk if the ANC visit is more than or equal to 4 times during pregnancy.

The main independent variable is the unwanted pregnancy at all by the mother. The unwanted pregnancy desire categories are divided into unwanted pregnancy and desired pregnancy. Pregnancy is not desired if the respondent answers that he does not want to at all, while pregnancy is desired if he wants to get pregnant soon, wants to get pregnant later, and wants to get pregnant, while the other variables are the level of education, work status, family economic level, age at risk of giving birth, complications of pregnancy and parity.

The data used in this study were obtained from a questionnaire of women of childbearing age from the Basic Health Survey Indonesia data in 2017. Large samples were obtained using a different sample size proportions, the number of samples obtained for urban areas was 8,104 and rural areas were 7,919. needed. Data processing uses descriptive statistical analysis which aims to provide a descriptive description of each variable used in research and multivariate analysis with logistic regression statistical tests because the dependent and independent variables in this study are categorical data.

3. Results and Discussions

Researchers can not control the quality of secondary data from survey interviews with female respondents aged 15-49 years who had a live birth in the five years prior to the survey report birth weight rural and urban areas in Indonesia. In the 2017 IDHS, recall can occur. Recall bias is the bias caused by respondents' mistakes in remembering events related to research variables. In this study recall bias can occur when asking the weight of a baby born by a respondent, even though it has been minimized by limiting live births in the 5 years before the survey. In addition, recall bias can occur when asking the total number of ANC visits made during pregnancy.

Pregnancy and problems contribute to a very high proportion of maternal deaths. Around 830 women die from pregnancy or related complications around the world every day [6]. Unwanted pregnancy is an important public health problem throughout the world. It not only affects women, but also affects their families and communities [7].
Table 1 shows that unwanted pregnancy among respondents in urban areas is greater [8.9%] than in rural areas [6.3%]. Women in rural areas are more likely to experience unwanted pregnancies than in urban areas. This study shows the same results with research conducted in Egypt [7]. These results do not agree with other studies conducted in Sudan [8] which reported no significant differences between urban and rural women.

<table>
<thead>
<tr>
<th>Pregnancy Category</th>
<th>Frequency [n]</th>
<th>Percentage [%]</th>
<th>Frequency [n]</th>
<th>Percentage [%]</th>
</tr>
</thead>
<tbody>
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<td>7.382</td>
<td>91.1</td>
<td>7.416</td>
<td>93.7</td>
</tr>
<tr>
<td>unwanted</td>
<td>722</td>
<td>8.9</td>
<td>502</td>
<td>6.3</td>
</tr>
<tr>
<td>Total</td>
<td>8.104</td>
<td>100</td>
<td>7.918</td>
<td>100</td>
</tr>
</tbody>
</table>

[Source: the data processing, 2019]

An unwanted pregnancy results in unhealthy behavior during pregnancy [9]. Thus, unwanted pregnancy has a direct relationship with the utilization of maternal health care services during pregnancy such as delayed initiation, or low attendance at antenatal care visits [10,11].

Unwanted pregnancies pose many important public health risks, and their adverse consequences have been extensively studied [12] Several studies explain the relationship between unwanted childbirth and maternal health problems, such as maternal depression [13,14], anxiety, poor psychological well-being and poor use of ANC or childbirth care. A study states that women who experience an unwanted pregnancy are less likely to seek pregnancy care than women who do want a pregnancy. However, most of these studies are carried out in developed countries while the evidence is limited and sometimes inconsistent in developing countries [15].

Community in Indonesia, the work is an important thing that should be a priority as it relates to the revenue that can be used for subsistence. This is a model that has been developing, especially in developed countries like Indonesia. A pregnant woman in a urban area is more likely to spend her time doing work activities that are owned compared to having to visit antenatal care. In communities with a lower middle economy, behavior to make work a priority
is a natural thing considering that so far the existing health services have not been able to provide the best service to the community, especially in people with a lower middle economy. This will indirectly reduce the motivation of pregnant women to conduct antenatal care visits.

Table 2. Relationship between pregnancy and ANC in urban and rural areas

<table>
<thead>
<tr>
<th>Pregnancy Category</th>
<th>ANC Low Risk</th>
<th>ANC High Risk</th>
<th>P value</th>
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<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
<td>%</td>
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<tr>
<td>Wanted</td>
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<td>91,6</td>
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</tr>
<tr>
<td>Unwanted</td>
<td>669</td>
<td>8,4</td>
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<td>18,5</td>
</tr>
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<td></td>
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<tr>
<td>Wanted</td>
<td>6,690</td>
<td>94,7</td>
<td>668</td>
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<tr>
<td>Unwanted</td>
<td>377</td>
<td>5,3</td>
<td>74</td>
<td>10</td>
</tr>
</tbody>
</table>

[Source: the data processing, 2019]

Table 2 shows that unwanted pregnant with ANC examination that has a high risk in urban areas shows a greater value [18.5%] compared to respondents in rural areas. Studies conducted in developing and developed countries shows that women with unwanted pregnancies do not use ANC or do not receive adequate care during pregnancy [11,16]. This can be caused by women who are financially and emotionally unprepared for the demands of pregnancy and childbirth [17] and also, most likely due to delays in recognizing pregnancy. The results show a significant relationship and the OR values are not much different, where the OR values in urban areas indicate that mothers who have a desire not to become pregnant are at risk of 3.12 not to do an ANC examination.

Table 3 shows the characteristics of respondents in rural areas more high risk mothers in all variables compared to mothers in urban areas. Higher education of a mother who does not want a pregnancy to do ANC as much as 81% in urban areas and 59.2% in rural areas. This shows that education has an important role in the knowledge of a pregnant woman to carry out antenatal care [ANC]. In the status of working mothers, pregnant women who work continue to do ANC, this can be caused by working mothers who can have income so that they can carry out antenatal care.

Table 3. Characteristic of Respondent

<table>
<thead>
<tr>
<th>Variable</th>
<th>Category</th>
<th>Urban</th>
<th>Urban</th>
</tr>
</thead>
</table>


Unwanted pregnancy and in early pregnancy there is an effort to end of ANC examination. Mothers who experience an unwanted pregnancy have a 1.79 chance of not taking pregnancy care compared to the desired pregnancy; have the same opportunity for behavior that does not provide exclusive breastfeeding and does not provide complete basic immunization. The results of stratification analysis show the effect of unwanted pregnancy status on behavior: pregnancy care; exclusive breastfeeding and complete basic immunization which is also influenced by economic status. The wealthier tend to take care [18].

Table 4. Multivariat Analysis Result

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<tr>
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<tr>
<td>ANC high Risk</td>
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<tr>
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[Source: the data processing, 2019]
Urban

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<tr>
<td>HR</td>
<td>1.527</td>
<td>2.665</td>
</tr>
<tr>
<td>OR</td>
<td>1.237</td>
<td>2.175</td>
</tr>
<tr>
<td>CI</td>
<td>1.885</td>
<td>3.264</td>
</tr>
</tbody>
</table>

Rural

<table>
<thead>
<tr>
<th></th>
<th>Education</th>
<th>Working</th>
<th>Economic status</th>
<th>Age</th>
<th>Parity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Value</td>
<td>0.171</td>
<td>-0.212</td>
<td>0.638</td>
<td>0.338</td>
<td>0.285</td>
</tr>
<tr>
<td>p</td>
<td>0.040</td>
<td>0.007</td>
<td>0.001</td>
<td>0.001</td>
<td>0.003</td>
</tr>
<tr>
<td>HR</td>
<td>1.187</td>
<td>0.809</td>
<td>1.893</td>
<td>1.403</td>
<td>1.330</td>
</tr>
<tr>
<td>OR</td>
<td>1.008</td>
<td>0.694</td>
<td>1.577</td>
<td>1.191</td>
<td>1.100</td>
</tr>
<tr>
<td>CI</td>
<td>1.397</td>
<td>0.943</td>
<td>2.274</td>
<td>1.651</td>
<td>1.608</td>
</tr>
</tbody>
</table>

[Source: the data processing, 2019]

Multivariate results indicate that unwanted pregnancy of ANC in urban areas is influenced by age and economic status variables affecting unwanted pregnancy, whereas in rural areas the variables that influence are education level [moderate education, graduated junior high school], employment, economic status, age and parity.

Economic status is the same variable of the relationship model between unwanted pregnant and ANC visits in rural and urban areas. Family income is all revenues in cash or goods either from the other party as well as of the parties themselves. Per capita income is the average family income of a family obtained from the income distribution of all family members. The intended income is a level of income derived from basic work and side jobs of parents and other family members [19]. Family income is an enabling factor for someone to utilize health services. Family income also determines the socioeconomic status of the family. Socio-economic is a picture of a person's level of life in society that is determined by variables of income, education and employment, because this can affect aspects of life including health care. A pregnant woman who has an adequate family income will indirectly make it easier for pregnant women themselves to visit antenatal care for pregnant women not to think about financing must be prepared to perform antenatal care visits [20,21].

Age of mothers who are at risk of influencing mothers in carrying out antenatal care in cities and villages. Age influences one's comprehension and mindset. Increasing age will also develop the power of catching and mindset, so that the knowledge gained is getting better, this is as a result of the experience and maturity of the soul, so that the more mature the age of...
pregnant women can influence in receiving information about antenatal care and visits during pregnancy. The more a woman is old enough, the better the level of maturity in thinking so that she will be motivated to have a pregnancy check up, also to know the importance of antenatal care. The younger the mother's age, the less understanding of the importance of antenatal care [22].

The level of maternal education is related to the incidence of unwanted pregnancy in Indonesia. The higher the level of maternal education, the risk of unwanted pregnancy also decreases. In other words education will reduce the risk of unwanted pregnancy [4]. This is consistent with research conducted in India which shows the higher the level of maternal education, the unwanted pregnancy decreases. A woman's education level is related to her ability to capture information such as awareness, value of small family benefits and knowledge about contraception and family planning. Illiterate women or those with low education are more prone to unwanted pregnancies because their ability to capture information to prevent the incidence of unwanted pregnancy is lower than those with higher education [23]. A low level of maternal education increases the risk of having a low birth weight compared to a high level of education. Mothers with low education tend to have behaviors that do not support health [24]. Pregnant women who have an educational background in a good category, in themselves already have a basis for being able to think logically to respond to antenatal care visits. Mothers will try to weigh the pros and cons of conducting antenatal care visits. If what appears is a positive aspect then the mother will be motivated to make antenatal care visits, but if what appears is a negative aspect, pregnant women will certainly be reluctant to make antenatal care visits.

Parity has a significant relationship with the incidence of unwanted pregnancy. The more children ever born, the higher the chance of an unwanted pregnancy. The 2012 IDHS results showed that the proportion of unwanted pregnancies also increased with the sequence of children born. Research in Ethiopia and India also found that the more children ever born the possibility of a desired pregnancy is also greater. Women who have many children but are still pregnant and unwanted pregnancies may be due to unmet need for contraception or because of the impact of contraceptive failure. Mothers who have given birth to many children also feel that the number of children who have reached the ideal number so that with another pregnancy the possibility of unwanted pregnancy is also greater [23,25].
The results of an analysis that show that unwanted pregnancies tend to be at risk 3.2 times make mothers not want to check their pregnancy compared to pregnancies that are desirable and planned. The issue of pregnancy care is an important key in implementing maternal and other health programs. Health care workers who understand the status of unwanted pregnancy need to provide education so that all pregnant women want to do a pregnancy check-up and still pay attention to the nutritional intake and health care needs of their children since the fetus.

4. Conclusion
The results of this study indicate that economic status and age are important variables in urban and rural areas. Where both of these variables both have a high OR value for antenatal care. This unwanted pregnancy can affect the behavior of the mother not to do or if it does not perform optimally, visits to antenatal care, childbirth, childbirth, and infants.

Acknowledgements. The author would like to thank Desya Mulyaningrum for granting permission to use the IDHS data for 2017 and assisting in the processing of the data.

References


[16] Dibaba Y, Fantahun M, Hindin MJ. The Effects of Pregnancy Intention on The Use of


Monitoring System for Producing and Utilizing Fly Ash and Bottom Ash Waste from Coal Fired Power Plant to support The Cost Efficiency of Infrastructure Development

Mekkadinah1, Suyud Warna Utomo2, Iwa Garniwa3, and Haruki Agustina4

{mekkadinah@gmail.com1, suyud.si@ui.ac.id2, iwa.garniwa@ui.ac.id3}

Environmental Science School, Indonesia University, SIL-UI, Jakarta, Indonesia1,2
Electrical Engineering Department, Indonesia University, Depok, Jawa Barat, Indonesia3

Abstract. Coal fired power plant (CFPP) capacity in Indonesia continues to grow, that also increase the amount of fly ash and bottom ash (FABA) waste produced from the CFPP. The FABA waste can be used as a mixture of cement in infrastructure development. The management of FABA waste is currently 70% utilized by the cement industry for activities located outside the power plant region, so that additional transportation costs are needed for the management of the waste. How to systematically organize institutional infrastructure and physical infrastructure to sustain recycling mechanisms or waste management is the problem. This research has an objective to find out the aspect of waste management system that could increase the usage of FABA to support cost of raw material efficiency in infrastructures. The method to find this research objective is using the sequential mixed methods. A monitoring system for the establishment and utilization of FABA waste can be built to improve waste utilization, prevent environmental and cost impacts due to further waste travel, then build the ‘sound material cycle society’ to promote FABA as raw material.

Keywords: System, Fly Ash, Bottom Ash, Waste, Material cycle

1 Introduction

The Government of Indonesia has set a National Energy General Plan that called by RUEN for the 2017-2050 period, with the dominance of the use of coal as the main energy source of power generation at 30% in year 2050. Supply of electricity using coal beside producing waste air emissions, also produces Fly ash and Bottom ash (FABA) which is generally called coal combustion products (CCPs). According to Government Regulation number 101 of 2014 (PP 101) concerning the management of hazardous waste, FABA is categorized as a waste containing hazardous material, its management regulations and permits are needed to reduce environmental impact [6]. Meanwhile Indonesia is currently increasing infrastructure development. The construction of both roads and housing requires materials which can be substituted by FABA [3], [4], [9]. Best practice for this substitute has applied in Japan, that can use FABA 97% for infrastructure [14].
Development of infrastructure need cement as raw material that costly. Several researches already implemented that FABA could substitute cement [1], [10], [12]. Recently, global concern to implement reduce, reuse and recycle in every sector, including energy and infrastructure. Then, the CFPPs as the producer of FABA need to inform the infrastructure sector about their product and so vice versa. The objective of this research is to find out the aspect of waste management system that could increase the usage of FABA to support cost of raw material efficiency in infrastructures.

2 Methods

This research was carried out in stages, starting with a quantitative calculation of the number of FABA formed based on the number of CFPPs operating, then a qualitative analysis of the relationship between the FABA producer and its beneficiaries was carried out. The methodology of this research is the sequential mixed methods.

3 Results and Discussions

3.1 Waste Production

The domination of electricity energy supply in Indonesia generated from coal combustion on CFPP, with data stated in Indonesia Electricity Plan 2017-2024 that called as RUPTL [13]. Consumption of coal in the CFPP show as Table 1.

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume (Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>25,802,724.2</td>
</tr>
<tr>
<td>2012</td>
<td>43,901,826.4</td>
</tr>
<tr>
<td>2013</td>
<td>52,639,394.9</td>
</tr>
<tr>
<td>2014</td>
<td>61,045,859.3</td>
</tr>
<tr>
<td>2015</td>
<td>66,223,221.9</td>
</tr>
<tr>
<td>2016</td>
<td>75,946,240.1</td>
</tr>
</tbody>
</table>

From data consumption of coal in CFPP show that increase from year 2011 until year 2016, it is mean that the waste that produce from the CFPP also increasing. Ramme and Tharaniyil [12], has calculated that CCPs productions as FABA from the CFPP approximately 5% of the coal consumption. The production of FABA show in Table 2.
Table 2. FABA Production

<table>
<thead>
<tr>
<th>Year</th>
<th>Volume (Ton)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2011</td>
<td>1,290,136.21</td>
</tr>
<tr>
<td>2012</td>
<td>2,195,091.32</td>
</tr>
<tr>
<td>2013</td>
<td>2,631,969.75</td>
</tr>
<tr>
<td>2014</td>
<td>3,052,292.97</td>
</tr>
<tr>
<td>2015</td>
<td>3,311,161.09</td>
</tr>
<tr>
<td>2016</td>
<td>3,797,312.01</td>
</tr>
</tbody>
</table>

Production of FABA increase from year to year, this should treat as material resource, because waste is equal with useful resources [7].

3.2 Waste Utilization

Before utilizing the FABA it is needed to have quality test of FABA, to ensure that FABA meet the requirement of construction standard. Quality test of FABA as CCPs in Indonesia has conducted by PLN and PUSJATAN [11] to ensure that FABA characteristics meet requirement as substitution material for cement and concentration of hazardous compound are below the limit of PP 101 regulation. The result shown that Fly Ash meet class F standard and Bottom Ash meet class C standard as substitution material for cement, with very trace hazardous compound.

Utilization of FABA in Indonesia only from 6 of 70 unit CFPP that produce FABA. In the other side Indonesia need to development infrastructure that several material could replace by FABA. Munir [10] and Suseno et al. [16] has analize that FABA could replace cement consumption around 25 – 50 % in production of paving block for construction infratructure.

3.3 Monitoring System and Regulation Support

How regulation encourage sustainability in case of utilized FABA as CCPs that UNEP [14] has analyzed that Japan experience shows that a mix of policies helped it turn challenges into opportunities. Regulations to hold waste generators responsible, voluntary measures for industries, market-based instruments to subsidize city-level action, and awareness-raising program were all part of the mix that helped change attitudes and practices in industrial waste management [14]. Japan and India are best practices in policies that encourage the use of CCPs. Government partnerships in setting regulations with industry roles in harmony. India even utilizes CCPs not only for construction but also as fertilizer, land restoration, increased absorption of ground water etc. all efforts to increase the utilization of these CCPs while still monitoring the utilization process. However, it does not require complex permit for these uses. Through comparison lessons from the ‘sound material cycle society’ policy of Japan, recycling is not only about technical solutions or engineering of resource-recovery from waste. Rather, it is an issue of how to systematically organize institutional infrastructure and physical infrastructure to sustain recycling mechanisms or waste management. Both countries show that how regulation could encourage sustainability in case of utilized CCPs. It is different policies in Indonesia, that CCPs regulate as Hazardous Waste without any supporting system to drive
the utilization of FABA as recycle resources. Indonesia has FABA as CCPs that could manage as useful resources [7], with volume increase from 1,290,136.21 ton in 2011 year to 3,797,312.01 ton in 2016 year. Recently Environmental Ministry has developed SIRAJA LIMBAH as monitoring system, but it is only for internal information for the government. It is need to improved by developed Monitoring System that will give an information for the user of waste as raw material because to day globally face the industry 4.0 [2]. The information added are about location, volume and quality of the FABA. This Monitoring System should could be access by the FABA Producer and the User that will utilize the FABA. A monitoring system for the establishment and utilization of FABA waste can be built to improve waste utilization, prevent environmental impacts due to further waste travel as LCA in infrastructure, and support increased infrastructure development in the region at a lower cost because it utilizes FABA as a substitute for cement as raw material in the industry 4.0. The monitoring system by establishing special regulations that facilitate the relationship between FABA producers and FABA beneficiaries to form regulations with the use of waste as a sound material-cycle society as driver to support sustainability in terms of SDGs number 12 and number 17 [15].

4. Conclusion

Monitoring system is needed to support development of infrastructure maximizing the utilization of FABA as raw material, then support increased infrastructure development in the region at a lower cost because it utilizes FABA as a substitute for cement as raw material. This also support the green infrastructure as LCA performance. This is a mutualism relation between the producer of FABA with the user to utilizing it. Developing Monitoring System also by establishing special regulations that facilitate the relationship between FABA producers and FABA beneficiaries to form regulations with the use of waste as a sound material-cycle society driver to support sustainability in terms of SDGs number 12 and number 17.

References

Impacts of Land Use and Land Use Change In River Basin to Water Quality of Cirarab River, Indonesia

Kus Indriyani1, Hayati Sari Hasibuan*2, Misri Gozan3
{kusindriyani2110@gmail.com1, hayati.hasibuan@ui.ac.id*2, mrgozan@gmail.com3}

School of Environmental Science, Universitas Indonesia, Jakarta 10430, Indonesia1,2, Department of Chemical Engineering, Universitas Indonesia, Depok 16242, West Java, Indonesia3

Abstract. Land use and land cover (LULC) changes are two main factors contribute to the decreasing water quality. This research aims to assess the impacts of LULC changes on the river basin towards water quality of Cirarab River. This research applied GIS analysis with LULC data changes from 2013 to 2018. The potential pollution load originating from residential on the river basin was calculated and compared to the maximum pollutant load. Water samples were collected five times a day in three locations. The result showed residential and industrial areas increased respectively of 110.08ha and 388.37ha; while shrub/vacant land decreased by 407.15ha. Potential pollution load amounted to 2615.78 kgBOD/day and 3713.87 kgCOD/day. This study found almost all monitoring points of COD and BOD parameters exceeded the required quality standard. Water samples collected from river basin with shrubs/vacant land has relatively better water quality compared to those collected from residential and industrial areas.

Keywords: land-use change, land cover, water quality, pollution load, river.

1 Introduction

Water is a basic human need that is at the core of sustainable development and is critical for socio-economic development, healthy ecosystems, and for human survival itself [1]. The availability of clean water is heavily influenced by pollution [2], and most of the water quality problems are caused by wastewater from human activities to meet their livelihoods such as industrial, household, and agricultural activities [3] that cause changes in land use [4]. Further, river water quality is also influenced by land use in the river basin because human activities can be described by land used on river basin [5]. As the city grows, the riparian zone is forced by the increasing pressure to convert urban riparian zone, where riparian vegetation decreases while built and agricultural land increase [6]. The Population increase has an impact on land-use change around the river area, which will expand the built land and areas that are unable to absorb water.

Further, this will cause water flowing to the river to become faster and with higher volume. Land use will also affect river water quality. Land use and land-use changes are the main drivers of the decline in river water quality [7] [8] [9]. The declining river water will decrease the river's carrying capacity to receive waste from human activities. Understanding the relationship between land use and water quality is useful to identify what are the primary threats towards water quality, and principal for adequate water quality management [7].
Many recent studies have provided an understanding between land use and river water, but the results are inconsistent. For example, the impact of agricultural land to be weakly related to water quality [7] [10]. These results contradict most results from other researchers stating that agricultural land is strongly correlated with river water quality and primary source of river water pollution [11]. However, all the reviewed studies agreed that urban land is the primary source of the decline in water quality, and forest land has a strong influence on improving river water quality [7] [11] [12] [13].

Cirarab river basin covers three regencies/cities, namely, river upstream situated in Bogor Regency (around Rumpin District), the middle river is in Tangerang Regency and Tangerang City, and the river downstream is in Tangerang Regency. Cirarab River holds great importance for it acts as raw water for drinking water in Tangerang City. This particular function requires the river not to be polluted. However, based on the calculation of STORET index, the result shows that the water quality status of the Cirarab River is heavily polluted [14]. This tainted water condition is due to urbanization and industrialization in the Cirarab watershed. To the author's knowledge, little research has focused on the Cirarab River as a study area, whereas its function as raw water is vital for controlling water pollution and managing the river's water quality.

The purpose of this study is to analyze the impact of land use and land-use changes on the water quality of the Cirarab River by doing two things, namely: (1) analyzing the impact of land use and land use changes on the water quality of the Cirarab River in Curug District, (2) analyzing land use changes that have the most significant impact on water quality by calculating pollutant loads.

2 The Methods

2.1 Study Area

This research was conducted in Cirarab River basin Curug Tangerang Regency, covering the eastern part of the river (Curug Kulon Village, Cukang Galih Village, and Kadu Jaya Village) and western part of the river (Bunder Village, Bitung Jaya Village, Dukuh Village, and Ciakar Village) for as long as 13,546 km (Figure 1). The said areas were chosen because they are situated in the upstream of Cirarab River before entering Tangerang City area.
Cirarab river basin is illustrated in Figure 1(a). Cirarab River is located in Java Island, passes through three regencies/cities, namely Bogor Regency, Tangerang Regency, and Tangerang City. This research was carried out in the middle part of the river, that is in Curug District segment, and in three monitoring points, which are: (A) Kadu Jaya sub segment, (B) Cukang Galih sub segment, and (C) Curug Kulon sub segment, as shown in Figure 1(b). The number of people living in the study area is 59,195 in the eastern part of the river, and 95,204 in the western part of the river with details in each village are presented in Table 1.
Table 1. Number of People Living in Cirarab River Basin

<table>
<thead>
<tr>
<th>No</th>
<th>Sub segment</th>
<th>Western Part</th>
<th></th>
<th>Eastern Part</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Village</td>
<td>Number of people</td>
<td></td>
<td>Village</td>
<td>Number of people</td>
</tr>
<tr>
<td>1</td>
<td>Kadu Jaya (A)</td>
<td>Kadu Jaya</td>
<td>23,028</td>
<td>Bitung Jaya</td>
<td>15,060</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Bunder</td>
<td>16,373</td>
</tr>
<tr>
<td>2</td>
<td>Cukang Galih (B)</td>
<td>Cukang Galih</td>
<td>14,485</td>
<td>Dukuh</td>
<td>17,589</td>
</tr>
<tr>
<td>3</td>
<td>Curug Kulon (C)</td>
<td>Curug Kulon</td>
<td>21,682</td>
<td>Ciakar</td>
<td>46,182</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>59,195</td>
<td></td>
<td>95,204</td>
</tr>
</tbody>
</table>

Source: [15] [16] [17] (compiled)

2.2 Study Method

Primary data are in the form of Cirarab River water samples, photo documentation in the study area, and land use maps. Secondary data are in the form of industrial wastewater quality data obtained from the Tangerang Regency Department of Environment and Forestry/DLHK, and population data obtained from the Tangerang Regency Central Bureau of Statistics/BPS.

The 2013 and 2018 land use maps were obtained by extracting maps from Google Earth in 2013 and 2018. Land use was classified into six categories, namely (1) residential/housing, including offices, (2) industry, (3) shrubs/vacant land, (4) paddy field, (5) dryland agriculture, and (6) water bodies. Land-use change was analyzed by comparing land use maps over a period of 5 years (2013 and 2018).

Water sampling was conducted by using water sampler, by collecting sample in the middle section of the river. Water sample collecting was carried out in three monitoring points, namely in Curug Kulon Village (S: 06° 15’ 38.718” E: 106° 32’ 18.78”), Cukang Galih Village (S: 06° 15’ 05.6484” E: 106° 32’ 26.0124”), Kadu Jaya Village (S: 06° 13’ 24.4088” E: 106° 33’ 17.9136”). Sampling collection was conducted in five collection times that represent a 24-hour cycle (07.00; 11.00; 14.00; 18.00; and 22.00 PM) in the same three monitoring points during dry season/summer, for the reason that the concentration of pollutants in the river flow was not diluted by rainwater during dry season. Physical data in the sample field were in the form of data of: (1) river water discharge, (2) pH, and (3) temperature measured; and concentration analysis conducted in the laboratory were (4) Biochemical Oxygen Demand/BOD and (5) Chemical Oxygen Demand/COD. The results of the sample analysis were then further assessed of its quality by comparing with Government Regulation No. 82 of 2001 concerning Management of Water Quality and Water Pollution Control.

Analysis to determine which land use had the greatest impact was conducted by calculating the potential pollutant load that entered Cirarab River. The potential pollutant load measured was the pollutant load ascribed to residential and industrial activities [18] [19]. The total potential pollutant load was then compared to the maximum pollutant load allowed into the Cirarab River. The formula for calculating potential pollutant load from residential activities is presented in Formula (1). The potential pollutant load is calculated is presented in Formula (2).

\[
P pollutant = \frac{\text{Population} \times \text{Emission factor} \times \text{equivalence ratio} \times a}{1,000}
\] (1)
Emission factor:  
1. BOD = 40 gr/person/day  
2. COD = 55 gr/person/day  

Urban equivalence ratio:  
1. Urban area = 1  
2. Suburb area = 0.8125  
3. Countryside = 0.625

Alpha (α): Load transfer coefficient (0.3 - 1)  
α = 1 for location 0-100 meter from river  
α = 0.85 for location 100-500 meter from river

Population is calculated based on comparison of the total residential area with residential that occupy areas with a distance of 100 meters, 100-500 meters, and more than 500 meters

\[ \text{Maximum Pollution Load } \left( \frac{kg}{day}\right) = C_{max} \times Q \times 86.4 \]  

Where:  
- Cmax = Concentration maximum on river (mg/L), base on PP 82/2001  
- BOD = 3 mg/L  
- COD = 25 mg/L  
- Q = river’s debit (m³/s)  
- 86.4 = conversion factor to kg/day

3 Result and Discussion

3.1 Land use and land-use change

Land use was dominated by paddy field, dryland agriculture, and bush in 2013; and by residential and industry in 2018 (Figure 2). Land use pattern in Cirarab river basin segment Curug District (Table 2 and 3) consisting of land use pattern in the eastern and western part of the river. In 2018 in the eastern part of the river, land use in sub-river basin in Curug Kulon village was dominated by residential of 145.10 hectares (46.28%), followed by paddy field of 65.98 hectares (21.05%) and dryland agriculture of 39.54 hectares (12.61%). Industrial area in this part was only 25.33 hectares (8.08%), the lowest compared to the other two villages; Cukang Galih village at 54.08 hectares (12.09%) and Kadu Jaya village at 88.00 hectares (21.32%). In the same year, paddy field was dominant in Cukang Galih of 136.30 hectares (30.48%), followed by residential of 104.00 hectares (23.26%), and dryland agriculture of 76.96 hectares (17.21%). Kadu Jaya village was dominated by shrub/vacant land of 187.80 hectares (45.50%), followed by residential of 70.48 hectares (17.08%).
In 2018 in the eastern part of the Cirarab River (Table 2), the land use of Ciakar village was dominated by residential of 251.77 hectares (42.48%), followed by paddy field of 156.8 hectares (26.45%), and dryland agriculture of 131.19 hectares (22.13%). Industrial area in this village was 39.89 hectares (6.73%), the lowest compared to the other villages. In the same year, land use in Dukuh village was dominated by dryland agriculture of 84.37 hectares (29.82%), followed by industry of 62.85 hectares (22.22%), and residential of 56.1 hectares (19.90%). Bunder and Bitung Jaya were dominated by industry of 436.59 hectares (more than 50% of land use in the two villages), followed by residential of 112.43 hectares, and dryland agriculture of 107.65 hectares. The two villages were merged to adapt to the appropriate segment length, that is Kadu Jaya sub segment (A).

Table 3. Land Use Pattern in The Western Part of Cirarab River

<table>
<thead>
<tr>
<th>Types of Land Use</th>
<th>Bunder + Bitung Jaya</th>
<th>Dukuh</th>
<th>Ciakar</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2013</td>
<td>2018</td>
<td>2013</td>
</tr>
<tr>
<td></td>
<td>Surface Area (ha)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Residential</td>
<td>104.15</td>
<td>112.43</td>
<td>34.51</td>
</tr>
<tr>
<td>Industry</td>
<td>130.47</td>
<td>436.59</td>
<td>18.68</td>
</tr>
<tr>
<td>Shrub/Vacant</td>
<td>345.2</td>
<td>50.19</td>
<td>43.00</td>
</tr>
<tr>
<td>Paddy field</td>
<td>68.51</td>
<td>65.16</td>
<td>57.75</td>
</tr>
<tr>
<td>Dryland agriculture</td>
<td>123.69</td>
<td>107.65</td>
<td>107.63</td>
</tr>
<tr>
<td>Water Body</td>
<td>1.43</td>
<td>1.43</td>
<td>21.34</td>
</tr>
<tr>
<td>Total Surface Area</td>
<td>773.45</td>
<td>773.45</td>
<td>282.91</td>
</tr>
</tbody>
</table>
This research finds that the farther towards downstream, the higher dominance of residential and industrial land use. This result is consistent with previous findings. The farther towards river downstream in Pesanggrahan River, Indonesia, the higher land use in river basin is dominated by built land, including residential and industry [18]. Land use in Code River basin, Indonesia, was also dominated by residential area [4]. However, this result is slightly different with land use in uMngeni river basin, South Africa, was dominated by natural vegetation, cultivation, and plantation [9]. Land use in Xitiaoxi catchment of Taihu Basin, China, was dominated by forest, urban area, and agriculture [12]. Land use in the middle of
Chao Phraya River Basin, Thailand, was dominated by paddy land and urban/built-up area [20]. Analysis on land-use change was carried out by comparing changes in surface area in each land use category within a period of 5 years (2013-2018). Land-use change in each Ciracab segment Curug District river basin are analyzed as presented in Table 4, where negative symbol (-) marks the declining land-use. In general, residential land use has increased significantly with varying surface area (ha) in the three sub river basins, along with the significant increase in industrial land use in the western part of Ciracab River. These have simultaneously reduced paddy field and dryland agriculture, and shrub/vacant land.

### Table 4. Land-Use Change in Cirarab Segment Curug District River Basin

<table>
<thead>
<tr>
<th>Types of Land Use</th>
<th>Change in Surface Area (Ha)</th>
<th>Kadu Jaya (A)</th>
<th>Cukang Galih (B)</th>
<th>Curug Kulon (C)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Eastern</td>
<td>Western</td>
<td>Eastern</td>
<td>Western</td>
</tr>
<tr>
<td>Residential</td>
<td>8.31</td>
<td>25.84</td>
<td>21.79</td>
<td>63.63</td>
</tr>
<tr>
<td>Industry</td>
<td>306.12</td>
<td>16.66</td>
<td>44.17</td>
<td>8.51</td>
</tr>
<tr>
<td>Shrub/Vacant</td>
<td>-295.01</td>
<td>0.00</td>
<td>-35.31</td>
<td>0.00</td>
</tr>
<tr>
<td>Paddy field</td>
<td>-3.35</td>
<td>-7.88</td>
<td>-7.56</td>
<td>-30.80</td>
</tr>
<tr>
<td>Dryland agriculture</td>
<td>-16.04</td>
<td>-34.62</td>
<td>-23.26</td>
<td>-41.34</td>
</tr>
<tr>
<td>Water Body</td>
<td>0.00</td>
<td>0.00</td>
<td>0.16</td>
<td>0.00</td>
</tr>
</tbody>
</table>

In Tangerang Regency, the largest increase in residential development occurred in Curug Kulon (C) sub segment of 85.86 hectares in its eastern part and 49.75 hectares in its western part; followed by Cukang Galih (B) sub segment of 63.63 hectares in its eastern part and 21.79 hectares in its western part, and in Kadu Jaya (A) sub segment of 8.31 hectares in its eastern part and 25.84 hectares in its western part. This increase is a result of population growth. In addition, Tangerang Regency has experienced urbanization as an impact of growing industry. From urban development perspective, the rapid growth of elite residential (public housing) is one of the main factors in land-use change [4]. Land conversion from paddy fields and dryland agriculture and shrubs/vacant land to industrial area, did occur in the research area. The largest land conversion took place in Kadu Jaya sub segment (A) of 306.12 hectares from shrubs/vacant land, paddy fields, and dryland agriculture. These findings concur that land use change occurred as a result of urbanization and industrialization. Urbanization and industrial expansion are potential to changing land use [21]. Population growth followed by industrial increase leads to the declining water quality in Asia [22].

### 3.2 River water quality of Cirarab River segment Curug District

The assessment of river water quality based on four physical and chemical parameters, namely (1) temperature, (2) pH, (3) BOD, and (4) COD. The measurement results compared with river water quality standards set by the Government of the Republic of Indonesia through the Government Regulation of the Republic of Indonesia No. 82 the year 2001 about Management of Water Quality and Control of Water Pollution.
Table 5. Cirarab River Segment Curug District Water Quality, 2018

<table>
<thead>
<tr>
<th>Monitoring Points (MP)</th>
<th>Collection Time</th>
<th>Water Discharge (m³/s)</th>
<th>Temperature (°C)</th>
<th>BOD (mg/L)</th>
<th>COD (mg/L)</th>
<th>pH</th>
</tr>
</thead>
<tbody>
<tr>
<td>MP 1 (Curug Kulon)</td>
<td>07.00</td>
<td>4.9</td>
<td>28.3</td>
<td>15</td>
<td>70</td>
<td>7.18</td>
</tr>
<tr>
<td></td>
<td>11.00</td>
<td>5.4</td>
<td>29</td>
<td>17</td>
<td>72</td>
<td>7.05</td>
</tr>
<tr>
<td></td>
<td>15.00</td>
<td>3.1</td>
<td>28.8</td>
<td>24</td>
<td>73</td>
<td>7.25</td>
</tr>
<tr>
<td></td>
<td>18.00</td>
<td>6</td>
<td>28.3</td>
<td>21</td>
<td>61</td>
<td>7.09</td>
</tr>
<tr>
<td></td>
<td>22.00</td>
<td>5.8</td>
<td>27.8</td>
<td>19</td>
<td>61</td>
<td>7.05</td>
</tr>
<tr>
<td>MP 2 (Cukang Galih)</td>
<td>07.00</td>
<td>1.1</td>
<td>27.9</td>
<td>6</td>
<td>36</td>
<td>7.27</td>
</tr>
<tr>
<td></td>
<td>11.00</td>
<td>1.6</td>
<td>28.8</td>
<td>13</td>
<td>43</td>
<td>8.08</td>
</tr>
<tr>
<td></td>
<td>15.00</td>
<td>1.6</td>
<td>28.8</td>
<td>3</td>
<td>15</td>
<td>7.4</td>
</tr>
<tr>
<td></td>
<td>18.00</td>
<td>1.2</td>
<td>27.9</td>
<td>18</td>
<td>60</td>
<td>6.89</td>
</tr>
<tr>
<td></td>
<td>22.00</td>
<td>1.5</td>
<td>27.6</td>
<td>13</td>
<td>39</td>
<td>6.73</td>
</tr>
<tr>
<td>MP 3 (Kadu Jaya)</td>
<td>07.00</td>
<td>2</td>
<td>29.4</td>
<td>6</td>
<td>35</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>11.00</td>
<td>2.6</td>
<td>30.1</td>
<td>7</td>
<td>42</td>
<td>7.24</td>
</tr>
<tr>
<td></td>
<td>15.00</td>
<td>2.6</td>
<td>29.3</td>
<td>21</td>
<td>68</td>
<td>7.58</td>
</tr>
<tr>
<td></td>
<td>18.00</td>
<td>1.9</td>
<td>28.7</td>
<td>57</td>
<td>124</td>
<td>6.92</td>
</tr>
<tr>
<td></td>
<td>22.00</td>
<td>1.8</td>
<td>28</td>
<td>8</td>
<td>48</td>
<td>6.77</td>
</tr>
<tr>
<td>Water quality standard</td>
<td>-</td>
<td>Dev.3</td>
<td>3</td>
<td>25</td>
<td>6-9</td>
<td></td>
</tr>
</tbody>
</table>

Curug Kulon sub segment had the most abundant water discharge with an average of 5.4 m³/s, followed by MP 3 (Kadu Jaya sub segment) of 2.18 m³/s and MP 2 (Cukang Galih sub segment) of 1.4 m³/s (Table 5). The amount of river water discharge is directly proportional to the cross-sectional area of the river, and the cross-sectional area of the river is directly proportional to the depth and width of the river. So, put the more extensive the river, the larger the water discharge. Based on observations in MP 3 and MP 2, the river width is per water discharge; namely, MP 3 has a large river width and large water discharge, and MP 2 has a narrow river width and small water discharge. However, MP 2 has a large width but small water discharge. This condition caused by the presence of garbage along the water body that causes river narrowing and siltation.

Results from pH and temperature (Table 5) testing in all monitoring points met the required environmental quality standards, even at relatively high levels. The water quality standard used in this research was deviation three temperature, which means air temperature is ± 3°C. Tangerang Regency had air temperature ranging from 24-30°C. MP 3 had the highest air temperature with a range of 28-30.1°C, followed by MP 1 with a range of 27.8-29 °C, and MP 2 with a range of 27.6-28.8°C. The highest pH concentration was in MP 2 (from 8.89-8.08), this high concentration still met the required water quality standard (6-9); MP 3 had a range of 6.77-7.58 and MP 1 had a range of 7.05-7.25. Table 5 shows high temperature in all
MPS. One of the causes of the relatively high air temperature was because there was no forest land use in the research area, whereas forest is crucial to decrease physical (pH and air temperature) and chemical parameters concentration [7] [11].

Concentration of BOD and COD (Table 5) in each MP failed to meet the required water quality standard (3 mg/L and 25 mg/L). The concentration values vary between COD and BOD, where COD value being was higher that BOD. BOD variation was caused by the concentration of biodegradable organic waste, e.g. protein, sugar, and carbohydrates, and Nitrogen in free form (e.g. NH4), which is immeasurable in COD. Therefore, COD has higher values than BOD because COD laboratory analysis involves more stable compounds in biological reactions, which may be oxidized during analysis [23].

The highest concentration of BOD and COD was in MP 3 with a range of 6-57 mg/L and 35-124 mg/L, followed by MP 1 with a range of 15-24 mg/L and 61-73 mg/L, and MP 2 with a range of 3-18 mg/L and 15-60 mg/L. Fascinatingly, when the sample collected in MP 2 at 15.00, the concentration of BOD and COD met the required water quality standard. Further, the lowest concentration of BOD and COD was found in MP 2 because paddy field, dryland agriculture, and shrub/vacant land dominated land use in MP 2 river basin, while the residential area was scarce. Agricultural land use contributes little to river pollution [10] [7]. MP 3 had the highest concentration of BOD and COD. MP 3 was the most extended area in Cirarab river basin. Although in the eastern part of the river was dominated by shrub/vacant land use, but it was not located right in the river basin. In the western part of the river was dominated by the industrial area that sat on more than 50% of total surface area in the particular area. Field observation affirmed that industry and residential dominated the river basin. People in the residential area throw their domestic waste directly in the river.

Moreover, this condition worsened by only very few industries that have waste treatment installations. River water quality is mainly affected by incompletely treated waste entering river flow [24] [7] [20]. Meanwhile, residential contributed the most pollutant in MP 1. Residential is strongly correlated to river water quality [25]. Urbanization thus expands water-resistant areas which cause waste to flow faster into the river with an enormous amount of runoff, which will increase the pollutant concentration in the river [7].

### 3.3 Potential Pollutant Load

Land use in 2018 was dominated by residential, thus it is necessary to understand pollutant load from residential activities. Residential activities put pressure on Cirarab river water quality due to domestic wastewater disposal. Number of people living in each sub river basin from eastern and western part, was calculated based on method approach of percentage residential area with a distance of <100 m, 100-500 m, and >500 m.
Table 6. Population in Each Cirarab Sub Segment

<table>
<thead>
<tr>
<th>No</th>
<th>Sub segment</th>
<th>Part</th>
<th>Total residential area (ha)</th>
<th>Distance to river (m)</th>
<th>Residential area (ha)</th>
<th>Number of people</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Curug Kulon</td>
<td>eastern</td>
<td>145.10</td>
<td>&lt; 100</td>
<td>3.07</td>
<td>2%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-500</td>
<td>23.7</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 500</td>
<td>118.33</td>
<td>82%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>western</td>
<td>251.77</td>
<td>&lt; 100</td>
<td>24.39</td>
<td>10%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-500</td>
<td>11.1</td>
<td>4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 500</td>
<td>216.28</td>
<td>86%</td>
</tr>
<tr>
<td>2</td>
<td>Cukang Galih</td>
<td>eastern</td>
<td>104</td>
<td>&lt; 100</td>
<td>3.22</td>
<td>3%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-500</td>
<td>31.61</td>
<td>30%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 500</td>
<td>69.17</td>
<td>67%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>western</td>
<td>56.31</td>
<td>&lt; 100</td>
<td>9.54</td>
<td>17%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-500</td>
<td>24.39</td>
<td>43%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 500</td>
<td>22.38</td>
<td>40%</td>
</tr>
<tr>
<td>3</td>
<td>Kadu Jaya</td>
<td>eastern</td>
<td>70.48</td>
<td>&lt; 100</td>
<td>4.55</td>
<td>6%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-500</td>
<td>31.27</td>
<td>44%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 500</td>
<td>34.66</td>
<td>49%</td>
</tr>
<tr>
<td></td>
<td></td>
<td>western</td>
<td>112.43</td>
<td>&lt; 100</td>
<td>18.48</td>
<td>16%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>100-500</td>
<td>54.35</td>
<td>48%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&gt; 500</td>
<td>39.60</td>
<td>35%</td>
</tr>
</tbody>
</table>

Population of people living 100 meters from river is mostly located in Kadu Jaya sub segment as many as 6,653, followed by Curug Kulon sub segment as many as 4,933, and Cukang Galih sub segment many as 3,428 (Table 6). Population living within 100 meters distance from the river put higher pollution pressure compared to population living more than 100 meters. Population living within 100-500 meters also put great pressure towards water quality. These two types of population (living < 100 m and 100-500 m) mostly lived in Cukang Galih and Kadu Jaya sub segment, while population in Curug Kulon sub segment was mostly lived more than 500 meters from the river.
Table 7. Pollutant Load in Each Sub Segment

<table>
<thead>
<tr>
<th>No</th>
<th>Sub segment</th>
<th>Number of people</th>
<th>Distance to river (m)</th>
<th>alpha (α)</th>
<th>Emission factor</th>
<th>Pollutant Load (kg/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>BOD COD</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Curug Kulon</td>
<td>4,933</td>
<td>&lt; 100</td>
<td>1</td>
<td>40</td>
<td>160.31          220.42</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5,578</td>
<td>100-500</td>
<td>0.85</td>
<td>55</td>
<td>154.08          211.86</td>
</tr>
<tr>
<td></td>
<td></td>
<td>57,354</td>
<td>&gt; 500</td>
<td>0.3</td>
<td>0.8125</td>
<td>559.20          768.90</td>
</tr>
<tr>
<td>2</td>
<td>Cukang Galih</td>
<td>3,428</td>
<td>&lt; 100</td>
<td>1</td>
<td>40</td>
<td>111.42          153.21</td>
</tr>
<tr>
<td></td>
<td></td>
<td>12,021</td>
<td>100-500</td>
<td>0.85</td>
<td>55</td>
<td>332.08          456.61</td>
</tr>
<tr>
<td></td>
<td></td>
<td>16,625</td>
<td>&gt; 500</td>
<td>0.3</td>
<td>0.8125</td>
<td>162.09          222.87</td>
</tr>
<tr>
<td>3</td>
<td>Kadu Jaya</td>
<td>6,653</td>
<td>&lt; 100</td>
<td>1</td>
<td>40</td>
<td>216.23          297.32</td>
</tr>
<tr>
<td></td>
<td></td>
<td>25,412</td>
<td>100-500</td>
<td>0.85</td>
<td>55</td>
<td>702.01          965.26</td>
</tr>
<tr>
<td></td>
<td></td>
<td>22,396</td>
<td>&gt; 500</td>
<td>0.3</td>
<td>0.8125</td>
<td>218.36          300.24</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>154,399</td>
<td></td>
<td></td>
<td></td>
<td>2,615.78        3,596.69</td>
</tr>
</tbody>
</table>

Total potential pollutant load entering Cirarab river in 2018 based on calculation was 2,615.78 kgBOD/day and 3,596.69 kgCOD/day (Table 7). The highest BOD and COD pollutant load occurred due to residential activities in Kadu Jaya and Cukang Galih sub segment from residential located within 100 meters and 100-500 meters from the river. In general, 200 meters riparian zone landscape had a slightly greater effect on the water than sub-catchments [12]. Pollutant load from residential activities is directly proportional to the number of people living in the area, in addition to being affected by distance to the river and urban equivalent ratio. Since Tangerang Regency is a suburb, its equivalent ratio is 0.8125. Pollutant load from human activities closer to the river was higher than human activities farther from the river. Based on the calculation, Kadu Jaya sub segment produced the most waste compared to the other. This result is consistent with water quality in each sub segment.

Fig. 3. Comparison between maximum pollutant load existing parameter (a) BOD (b) COD
The result of comparison between the maximum pollutant load existing parameter (Figure 3), showed that Kadu Jaya sub segment had the highest pollutant waste of 1,136.59 kgBOD/day, followed by Curug Kulon sub segment of 873.59 kgBOD/day, and Cukang Galih sub segment of 605.59 kgBOD/day. For COD pollutant load, Kadu Jaya sub segment produced the highest pollutant waste of 1,378.72 kgCOD/day, followed by Curug Kulon sub segment of 1,201.18 kgCOD/day, and Cukang Galih sub segment of 1,133.97 kgCOD/day. The three sub segment did not exceed the maximum pollutant load for COD parameters. However, for BOD parameters, the pollutant load entering the river far exceeded the maximum pollutant load in Kadu Jaya and Cukang Galih sub segment. High pollutant load increases BOD and COD values. High BOD and COD values, increases the Oxygen needed by microorganism to break down organic matter, which results in a decrease in dissolved oxygen in the river. Low dissolved oxygen content indicates that the river has been contaminated [19].

4 Conclusion

The result reveals that residential area acts as the primary contributor to water river pollution, due to the rough treatment of domestic waste disposal. The largest residential area is in the Curug Kulon sub segment of 396.87 hectares, followed by Kadu Jaya sub segment of 182.91 hectares, and Cukang Galih sub segment of 160.31 hectares. However, a larger residential area does not guarantee the highest pollution pressure to the river since the distance of the residential area from the river also contributes to it. Land-use change occurs to meet human needs. Urbanization and industrialization in the research area caused land conversion from non-residential area to the residential area. The most significant land-use change is from paddy field and dryland agricultural area to the residential area. From calculating the amount of pollutant load from residential activities that enter the river, this research concludes that the most significant pollutant load is consistent with the worst water quality. Kadu Jaya sub segment with pollutant load of 1,136.59 kgBOD/day and 1,378.72 kgCOD/day, and produced high BOD and COD value of 57 mg/L and 124 mg/L. This high BOD and COD value far exceeded the allowed water quality standard. Despite its complexity, land use in the river basin has become a proper indicator to predict water quality. Understanding the impact of land use in the river basin is useful to formulate the correct strategy in river management and land use treatment in the river basin.

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Jakarta Readiness in Facing Clean Energy Public Electric Vehicle Charging Stations Need Analysis

Toni Prasetyo¹, Muhamad Rizky², Robertus Irwan Putrantomo³, Tiara Yasinta⁴
{toni.pras@gmail.com¹, baros2002@outlook.com², tuschemeng2012@gmail.com³}
School of Environmental Science, University of Indonesia, Salemba Raya street No. 4, Jakarta Pusat, Indonesia

Abstract. Indonesia is one of countries committed to reducing greenhouse gas emissions. To support this commitment, Indonesia enact regulation regarding Acceleration of the Battery-Based Electric Motor Vehicle Program for road transportation (Perpres RI No. 55/2019). Since the enactment of these regulations, developments in the demand for electric vehicles (EV) have increased. The main impact of the transition is the construction of electricity charging infrastructure for EV. Currently Jakarta already have 721 public EV charging station to support EV population in Jakarta and this study will analyse if the current number and area that have been determined is already sufficient. The study will use population-based equation from literature review to compare ideal number of public EV charging station with actual number that have been installed. The result is number of existing installed public EV charging station in Jakarta (721 ea) is still sufficient to support EV development program in Jakarta, however from physical observation it is necessary to reassess current area that had been installed for public EV charging station to be comply with minimum requirement of public EV charging station. Future work will require assessment of all installed public EV charging station and efficiency of the charging station in term of location and ease of usage.

Keywords: electric vehicle; charging station; analysis

1. Introduction

Population and transportation needs growth in Indonesia continue to increase from year to year. In line with the statement of BPS [1], the projected population growth in Indonesia shows that the population of Indonesia over the next twenty-five years continues to increase, from 238.5 million in 2010 to 305.6 million in 2035. Increasing population is directly proportional with increased transportation needs. Demand for transportation needs has increased significantly from year to year over the past 10 years. According to BPPT Data [2], the number of vehicles increased from 18.98 million units in 2000 to 77.13 million units in 2010 or grew by an average of 15.1% per year. At present the largest share is the use of motorbikes which reaches 79% of the total number of motor vehicles [2]. The increase in vehicle demand has an impact on increasing the demand for fuel energy. The increase demand for fuel energy will increase the concentration of greenhouse gas emissions. The use of fuel derived from petroleum until now has not been substituted with materials or energy sources of other types [3], so it is predicted to decrease so that energy for transportation requires innovative steps into the future, one of the main alternatives is to use electric vehicle (EV).
Indonesia is one of the countries committed to reducing greenhouse gas emissions [4]. To support this commitment, President Joko Widodo on August 8, 2019 established a policy regarding Presidential Regulation of the Republic of Indonesia Number 55 Year 2019 concerning the Acceleration of the Battery-Based Electric Vehicle for road transportation. Electric vehicles have an obvious advantage in energy utilization rate and emission rate. In general, EVs produce fewer emissions that contribute to smog and climate change than conventional vehicles. Because most emissions are lower for electricity generation than burning gasoline or diesel [5]. Since the enactment of these regulations, developments in the demand for electric vehicles have increased. With the electric vehicle market expanding, the investment opportunities for incoming electric vehicles are even greater [6].

Electric Vehicle will always be related to electricity needs [7]. In addition the Electrical Vehicle will need a system to charge electricity for its operation, the Electrical Vehicle charger. Because if it is not refilled or charging, the Electrical Vehicle becomes useless. Charging or recharging power sources which are generally in the form of lithium ion or nickle ion batteries and others are the main things in building an electrical vehicle system.

The transition to the use of fuel vehicles to EV will have implications in urban spatial planning, especially in Jakarta. Jakarta is one of the cities with the largest amount of transportation in Indonesia. However, an increase in the number of vehicles was not followed by adequate urban planning. The main impact of the transition is the construction of electricity charging infrastructure for EV. EV Charger is an electrical device that converts alternating current energy to regulated direct current for replenishing the energy of an energy storage device (i.e. battery) and may also provide energy for operating other vehicle electrical systems [8].

Based on research, in 2010 according to the Jakarta Spatial General Plan the proportion of land use that was openly developed in Jakarta was 87:13[9]. It shows that Jakarta's current environmental burden has almost exceeded its carrying capacity. This paper aims to analyze the land area and location readiness of EV Charging Station in Jakarta.

Generally, there are 3 categories of charging systems for electric vehicle in Indonesia: conductive, inductive, and battery swap. There are pros and cons for each charging systems. Conductive charging system can be vary in charging time and locations but it requires complex charging infrastructure [10]. Inductive charging system involves no danger of such wiring on conductive charging and can be done in wet, sandy, dusty, or snowy conditions, but the system is still under development [10]. Battery swap charging system has unlimited vehicle mileage with available battery swap stations and 100% of battery will be fully restored in less than 1 minute, but expenses on monthly battery will possibly be greater than the charging conventional vehicles [10].

Potential consumer of electric vehicles should be identified as its preference will be the basis of public charging stations infrastructure’s design. In terms of economic aspect, full-time workers living in small to medium-sized municipalities have the most suitable mobility profiles, therefore they are encouraged to shift towards electric vehicle first [11]. It is found that middle-aged, male, and live in multi-person households are more interested towards electric vehicles [11]. Residents of smaller settlements are more likely to be the early adopters, it is because people from large cities typically do not drive enough kilometres per year so that electric vehicle can become cost-effective [11]. In terms of gender, male drivers become the typical early adopters for electric vehicles [12]. Early adopters of electric vehicles also has some other typical characteristics such as they are belong to rather higher end of salaries and have a relatively high level of education [12]. People with college education is 20% more likely to adopt electric vehicles while people in the middle to high-income groups is 16% more likely to adopt electric vehicles [13].
It is important to identify the motivations and barriers of electric vehicle users. Based on previous research, most of electric vehicle consumers use their car for private purposes [12]. It is also found that 69% of respondents are very satisfied with their electric vehicles and 29% are satisfied, but they will consider only use an electric vehicle in the near future [12]. Main reason for people to use an electric vehicles is because of the lower impact caused to the environment, followed by cost-efficiency which refers to the charging cost and other costs such as maintenance [12]. As for the barrier that existed are electric vehicles relatively more expensive rather than the conventional ones. There is also range anxiety caused by limited of driving range compared to conventional ones and lack of strong incentive programs as the barriers to implement transition to electric vehicles [12]. Variety of solutions have been proposed to overcome the barriers, such as separating the selling of battery and electric vehicle itself, since the battery is the most expensive component which makes it much more expensive rather then the conventional ones [14]. Intelligent Transportation System (ITS) also has been developed to reduce range anxiety of consumers towards the electric vehicles. Consumers will be able to monitors the battery’s energy status and get a reminder when the battery reaches a lower threshold level, in case of malfunction, ITS will also give a signal [14].

Based on Presidential Regulation No. 55/2019, Indonesia government at least have five programs to accelerate EV development which one of the programs is to support EV charging station installation. EV requires charging station to supply its need for electric energy and also battery to store the energy inside. According to [15], not having enough access to efficient charging station rank third as barrier to EV purchase next to EV price and driving range. It is also important to first raise the environmental awareness of people to allow better penetration of electric vehicles [12].

EV battery capacity varies from 20 to 60 kWh and various charging technology have been developed from single phase AC system with up to 3 kW charging power that will take about 7 hour to charge 20 kWh battery until current fast charging level that will fully charge the battery in 20 – 30 minutes[16]. See Table 1 for detail of EV charging station type and their standard use.

There are typically three charging station types for EVs, i.e. private charging piles [17], public charging stations [18], and mobilized chargers [19]. In high density cities, development of private charging piles is not achievable due to limited amount of space in owners garage thus it will depend on availability of public charging station to support wide application of EVs [20].

<table>
<thead>
<tr>
<th>Type</th>
<th>Power (volt)</th>
<th>Time (hours)</th>
<th>Standard Use</th>
</tr>
</thead>
<tbody>
<tr>
<td>AC Level 1</td>
<td>120</td>
<td>6-10</td>
<td>Staff use during work day, long term parking at commuter lots or vehicles parked overnight.</td>
</tr>
<tr>
<td>AC Level 2</td>
<td>204 – 240</td>
<td>1-3</td>
<td>Commercial use or work vehicles that are heavily used and need a midday charge.</td>
</tr>
<tr>
<td>DC fast charger</td>
<td>480</td>
<td>0,5</td>
<td>Best for highway sites to enable longer vehicle trips</td>
</tr>
</tbody>
</table>

Source: [21]
General EV charging station will include power source, parking surface, barrier or mounting option and sign or pavement marking. Majority of workplace and public EV charging station will be located in parking lots with perpendicular parking layout [22]. A minimum width of 9 feet and length of 18 is required per connector [23] or area of 25 m² is required per connector in EV charging station. Figure 1 describe typical EV charging station layout.

![Typical EV charging station layout](image)

Figure 1. Typical EV charging station layout [23]

Previous studies related with sizing and siting of public EV charging station already abundant in recent publications. For example, [24] that determine optimal EV charging station as a function of parking demand and access cost (walk distances). The study attempts to best satisfy demand for public charging of EVs on the basis of parking duration, land use attributes, and (in the case of individual parking duration) trip characteristics.

There is a proposal new approach for optimal placing and sizing for EV charging stations [23]. The approach minimizes the total cost of station development and electrification costs and also considers urban roads to find candidate station points and calculate EV energy loss by formulating the problem as Mixed-Integer Non-Linear (MINLP) problem which is finally solved by genetic algorithm (GA).

While another research proposes a novel Geographic Information System (GIS) assisted optimal design method of solar powered charging stations for promoting EV applications in high density cities [20]. By selecting the optimal locations and optimal number of the renewable powered charging stations with the considerations of the existing charging stations and renewable potentials, the proposed method is able to minimize the life cycle cost of the charging stations while satisfying a user defined area coverage ratio. To verify the proposed method, case studies were conducted in a real district of Hong Kong. The results were analysed and compared with other non-optimal options in terms of life cycle cost and district coverage ratio.

Planning of infrastructure to support electric vehicles is an important matter. Preferences of user need to be addressed. Choosing a new vehicle involves factors such as reliability, ahead of fuel economy, price, and safety [25]. Placement of public charging stations also play an important role towards the successful transition of fossil fuel vehicles to electric ones. Places like grocery stores, work, mall, near home, and near freeway are much preferred rather than gym or school [25]. Willingness to pay also vary for every possible scenario, for example people will pay more for level 2 grocery store access rather than quick charging near freeway [25]. In case of parity between gasoline and electricity refuel cost, people would be willing to wait 8 minutes longer to recharge [25].

Number of quick charging stations also will affect the trend of population growth [26]. Tradeoffs between battery capacity, charging infrastructure coverage, and charging power

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should be addressed since development of charging stations infrastructures are not an easy matter. Combination of battery capacity 112.8 kWh with home charging at 3.68 kW will give result of 91% portion of mileage that is electrically drivable, the same result given from the combination of 37.6 kWh battery capacity and public charging locations with 50 kW at 40% of the parking locations and with combination of battery capacity 56.4 kWh and public charging locations with 120 kW at 10% of the parking locations available [27]. Combination between all of those factors are important towards the sustainability of electric vehicle usage in Indonesia.

There are some factors that influence the overall assessment of public charging infrastructure: basic charge, density of charging station, and charging duration [28]. Charging duration has the most leverage towards the assessment of public charging infrastructure [28]. Willingness to pay of potential consumer still relatively low, despite the very well proposed equipped public charging stations, therefore additional information such as comparison of refueling cost between fuel and electric vehicles should be clearly provided [28].

Presidential Regulation Number 55/2019 already set the target area for public charging stations in Indonesia: fuel stations, gas stations, government offices, mall, and public parking areas on the roadside. Government will also give incentives to stakeholders that helps the acceleration of battery electric vehicles (BEV) program such as manufactures, research and development, provider of public charging stations, battery waste management, and consumers of electric vehicles. Based on the regulation, public charging stations should be reachable, provide special parking areas, and will not disrupt traffic in nearby areas.

The number of EV public charging station plays important role on electric vehicle development especially in urban city. Even Jakarta the number of electric vehicles is still relatively small, which based on data from Korlantas Polri that the number of electric vehicles in Jakarta about 1.150 units in 2019. But the government already start to build charging Station on many points in Jakarta, the Government Electric Company (PLN) already invest and installed about 721 charging unit in Jakarta area only [29], this is because the readiness of the infrastructure needs to be done first to support and encourage people to shifting to electric vehicles. It is important to study about three categories: charging demand, stations coverage, and target market, to finally be able to find the optimal locations for public charging stations as per figure below:

The study in this paper will focus on needs analysis of current EV charging station installation in Jakarta city as a case of study. The adequacy of existing EV public charging station will be determined using population based equation as used in [26]. Physical observation of existing EV public charging station in Jakarta also conducted in this study to get
understanding of current EV public charging station installation layout compared with common typical layout based on literature.

The rest of this paper is arranged as follows. Section **Methods** present details of population based equation that is used to estimate optimal amount of EV public charging station. Section **Result and Discussion** present adequacy evaluation of existing EV public charging station compared to optimal amount from the equation. Result of physical observation of EV public charging station also presented in this section. Conclusive remarks are given in **Conclusion** section.

2. Method

To estimate the ideal number of charging station in Jakarta, in this study we will use population based equation [26] as below:

\[
N_{\text{station}} \geq \frac{A \times \rho_{\text{density}} \times \rho_{\text{BEV}}}{sh \times ncp \times nst}
\]  \hspace{1cm} (1)

where:
- \( A \): size of an area (sq.km); 
- \( \rho_{\text{density}} \): population density (man/km²); 
- \( \rho_{\text{BEV}} \): proportion of the EV owners per the number of population in an area (in this case is Jakarta), 
- \( ncp \): number of charging sockets in a charging station; 
- \( nst \): number of services per hour of the charging station per hour of charging time in EVs are equal to \( nst = \frac{1hr}{r_{ev}} \); and 
- \( sh \): number of services per hour of the charging station in a day.

From the equation we could estimate that the number of EV public charging station in Jakarta whether it is ideal or not in term of numbers.

3. Result And Discussion

The basic thinking of the calculation is we could determine the current number of charging station whether the number is ideal or not in term of the number of electric vehicles which already operated in Jakarta area. By this method we also determine the maximum ideal of number of vehicles that could be cover by the current amount of charging station. This calculation also could give the current and future condition of relation between electric vehicles vs charging station in order to give clear insight for the government or private sector that related to electric vehicle.

Given the equation (1), we could generate the result based on the equation with the current condition value.
Table 2. EV public charging station calculation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Definition</th>
<th>Current Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>$A$</td>
<td>Size on an Area</td>
<td>662,3</td>
</tr>
<tr>
<td>$\rho_{\text{density}}$</td>
<td>Population density</td>
<td>15.663</td>
</tr>
<tr>
<td>$p_{\text{BEV}}$</td>
<td>Proportion EV Owner/population</td>
<td>0,01%</td>
</tr>
<tr>
<td>$n_{\text{st}}$</td>
<td>Number of services per hour</td>
<td>0,3</td>
</tr>
<tr>
<td>$T_{\text{ev}}$</td>
<td>Charging time of each EV</td>
<td>3</td>
</tr>
<tr>
<td>$s_{\text{h}}$</td>
<td>number of services per station</td>
<td>6</td>
</tr>
<tr>
<td>$n_{\text{cp}}$</td>
<td>number of sockets</td>
<td>6</td>
</tr>
<tr>
<td>$N_{\text{station}}$</td>
<td>Charging Station number</td>
<td>721</td>
</tr>
</tbody>
</table>

\[
721 \geq \frac{662,3 \times 15.663 \times 0.01}{6 \times 6 \times 0.3}
\]

\[
721 \geq 96,0519
\]

By this result we could determine that current condition the number of charging station is still in ideal number. The number of charging station in term of quantity is still satisfied the necessity of electric vehicle for battery charging. We also could determine by the equation the estimation of maximum number of electric vehicles could be bear by the current amount of charging station.

This formula can also be used to estimate the capacity of electric vehicles can be handled with these number of charging stations. If we input 721 as the charging station number, we will get result 8,652 electric vehicles. This result is approximate of maximum amount of number electrical vehicles in ideal condition.

Concerning amount of area required for EV public charging station, from [23] it is estimated that efficient area per charging socket is 25 m². Therefore for 6 socket charging station, area required will be 150 m². With 721 unit public charging station in Jakarta, total area required will be 108,150 m².

However from physical observation as exampled in Figure 3, it is then we see that even though the number of EV public charging station is sufficient for current EV population in Jakarta, total area that have been determined need to be improved to support EV development program in Jakarta.

Figure 3. Example of current EV public charging station in Jakarta
It is stated that the minimum of electric vehicle public charging stations should be approximately 25 m² and it also should near public building like mall or grocery stores. An example can be seen from the electric vehicles public charging stations in America by Walmart in Figure 4.

![Figure 4 Example of EV public charging station in America [30]](image)

It can be compared from both figures that while Indonesia might have reach sufficient public charging stations in term of number, but the choice of locations and facilities still far from ideal.

4. Conclusion

Currently Jakarta has 721 public EV charging station to support EV development program. The number of current public EV charging station (721 ea) is sufficient for current EV population in Jakarta. The total area required for the 721 public EV charging station will be 108.150 m² ideally from literature review. However compared with existing public EV charging station, it is required further assessment so that area that already been installed will comply with ideal area for public EV charging station. Future work will require assessment of all installed public EV charging station and efficiency of the charging station in term of location.

References


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