Prediction Study of Built Area Based Cellular Automata Modelling In Sayung Sub-district, Central Java

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Abstract. Semarang city as a center of growth in Central Java province provide a high appeal in urbanization. Areas of high density triggers the development of the area extends out of Semarang. Sub-district Sayung as the region directly adjacent to the city of Semarang get fairly significant impact of the phenomenon, it is seen from changes in land use are quite dynamic in recent years. So in this study will examine the associated changes in built area in 2005, 2009, 2015 and 2019 as well as its development prediction in 2025 in Sayung Sub-district. The main data sources used were High-Resolution Satellite Imagery (CSRT) time series for the recording area Demak and surrounding areas, while some secondary data consisted of demographic data and some other spatial data in the form of thematic maps. Land use time series obtained from the CSRT visual interpretation to be done beforehand geometric correction on the entire image. Growth forecast and undeveloped land acquired by the raster model cellular automata using the software LanduseSim 2.0, where several parameters controller used include road networks and community centers. Results of prediction of undeveloped land in 2025 increased by 168.41 hectar of 2019 to the spatial distribution PANTURA lengthwise along the way.

Keywords: Predictions, Built Area, Cellular Automata Modelling.

1. Introduction

Some coastal areas in Indonesia is a place of economic activity with a high intensity that covers marine fisheries, transport, ports, mining, recreation and tourism, and the development of industrial zones[1]. High activity in the region makes environmental balance be maintained as the loss of mangrove ecosystems as buffer plants, this coupled with the growth of undeveloped land (settlements) are less controllable[2]. That phenomenon makes coastal areas appear dirty with coupled with a variety of disasters such as erosion, accretion, tidal flooding and saltwater intrusion[3] [4]. Massive land subsidence occurred mecpai 8-19 cm / year [5] [6] ,the higher the temperature increases [7], [8] stating the tidal flood that occurred in the coastal Semarang city in May 2005, has inundated about 14 villages along the coast.

In addition to having the potential for economic development, coastal areas also have a very important function ecologically[5] [9], declares that the coastal area acts as a buffer, protector and filter between land and sea where the region has some strategic ecological functions include nutrient providers, spawning place, where the cultivation and feeding areas for marine life [10] [2]. The potential of coastal areas should be utilized to the maximum benefit to society [11],[1], Today the coastal areas of Sayung Sub-district increasingly inundated by sea water [12]. Prompting people to move to the south away from the coast [13], economic development can provide a considerable advantage but in terms of the environment lead to damage [14] which resulted in new problems in the region [11]. Supposedly land conversion in more coastal areas can be controlled by the authorities so that utilization is not compromising environmental sustainability.

Demak is a coastal area located on the north coast of Java Island that are in the path of the famous PANTURA has a very high activity[1]. In addition to its location directly adjacent to the Semarang city, which has a very rapid development in coastal areas with a predominance of industrial buildings make this area has developed very rapidly, especially in the western coast [15][12]. The presence of the port of Tanjung Emas in Semarang and some other major industry makes the region experienced over the land very rapidly. The addition of the undeveloped land provide additional load on the ground. Other activities such as groundwater pumping to meet the needs of industry and population also causes cavities in the soil which affects the intrusion and land subsidence, where the phenomenon resulted in the inundation flooding at high tide (rob). It is as it was delivered by[1] [16] where the coastal region is a region highly vulnerable to hazards such as flood inundation and land subsidence [17] [18]. Increased undeveloped land evolving impact on environmental degradation due to land that was originally used as conservation land converted as productive oriented economic sectors so that the need for restrictions on development in the region. Required an analysis associated with changes in land use that occurred in the study area to determine how much of industrial areas in the coastal Semarang city has an impact on development in Sayung Sub-district which can lead to degradation of the environment[19].

Undeveloped land change analysis is very useful in determining the policy [20], development of the region is a key issue in a variety of highlights from experts planning[7]. Remote sensing is efficient in detecting packet in multi-temporal changes[21] [22] [23], remote sensing data is used as reference in the predicted direction of the development in the year - next year [20] [24], The combination of GIS and remote sensing allows the presentation of data that is capable of mapping the prediction and mapping of the area awakened[23] [22].

2. Research Methods

This research was conducted in the Sayung Sub-district coastal region, as the region directly adjacent to the Semarang city on the east. Sayung Sub-district coastal areas are most affected areas of activity of the Port of Tanjung Emas. The impact of the reclamation which lead to damage such as abrasion coast [12] acroding almost all the coastline, resulting in the RT population should be relocated to a safer place[13]. In addition rob also a phenomenon that often occurs up to this time, even if the tide is high enough water can rob to get into settlements [25] [26]. The main data sources used are high-resolution satellite imagery Digital Globe time series of data provider of open source, where high-resolution image recording used is a 2005, 2009, 2014 and 2019 for

recording region Sayung Sub-district and surrounding areas. Furthermore, some of the supporting data used include: roads and community centers all of which are in the form of digital data, while the other supporting data is the demographic data in the last period.

Data processing stages starting from the preparation of maps of land use imagery sourced from Digital Globe, where the initial stages starting from the pre-processing image geometric correction by the method of image to image [19] [27]. Stages of this correction is done with the aim to put back in accordance with the original pixel values[27] [19] [14] [28]. Furthermore, after the entire image corrected interpretation geoemtric next step is done visually to obtain an overview of land use in time series, the selection of visual interpretation methods in order to obtain a map of the land use study site in more detail[28]. Furthermore, from land use maps of the time series analysis of the changes made to each class, in which the results of the analysis that will be used to predict the development of undeveloped land for the next few years, of course, also consider population growth data within a certain time. Preparation of maps and undeveloped land development predictions based on the model of cellular automata raster by utilizing LanduseSim 2.0 software, [20] where there are several controller parameter distribution and undeveloped land development consists of a network of roads and community centers.
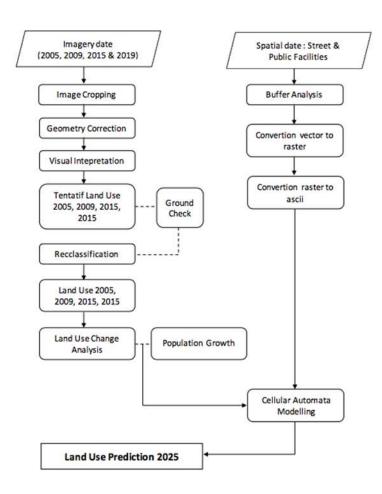
Figure 1. Research Flow chart

3. The Results and Discussions

Visual interpretation of the results, provides an overview of the existing land use are classified in 9th grade. Most of the area is dominated by the use of the Sayung Sub-district Fishpond area of 4417,10 hectar land where the pond is a type of fish and shrimp ponds are managed by the local community with traditional methods. The rice field has 1096,70 hectar which has a spatial distribution in the north. Built area has an 1131,80 hectar (residential and non-residential), where the settlement discount pattern that extends all the way PANTURA and most follow the flow of a river that has a spatial distribution almost evenly across all locations. The use of mangrove land

has an area of 297,20 hectar distributed lengthwise in the dike embankment and clustered along the shoreline. In complete types of land use in the study site in Table 1.

Table 1. Land use distribution in Sayung Sub-district

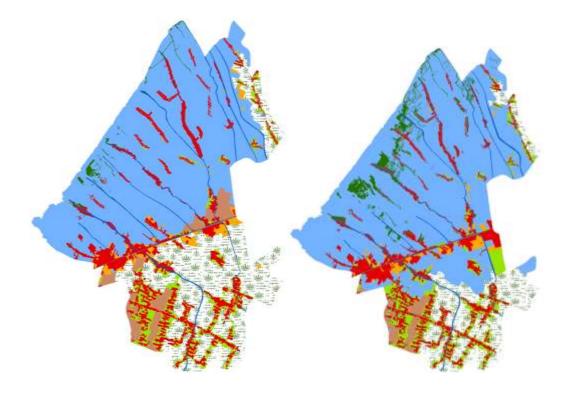| landuse	Area (hectar)			
	2005	2009	2015	2019
built area	905.8	944.6	1099.1	1131.8
Roads	14.3	14.29	14.3	14.3
River	202.8	202.8	202.8	202.8
Mangrove	95.3	58.0	258.1	297.2
Fishpond	3711.0	3774.9	3836.3	4417.1
Mixed garden	380.4	328.6	215.4	158.7
Rice field	1873.0	1941.0	1630.8	1096.7
open field	118.7	171.6	201.9	145.2
Vegetation non mangrove	567.3	433.1	410.2	405.1
Total	**7869.0**	**7869.0**	**7869.0**	**7869.0**

Source : Digital globe imagery precessing, 2019

Land use in Sayung Sub-district within the last 14 years has developed quite dynamically, where one of the factors that influence the phenomenon is the growing industrial sectors in the coastal area of Semarang [13] [4]. Land use has increased quite significantly is a pond with an increase of 705.9 hectar, the increase caused by the extensive pondabrasion occurred in the last few years which resulted in some of the houses should be relocated so that the land used for farms [13]. Spatial distribution of pond area extends along the coastline, with the movement of abrasion to the south is getting closer PANTURA, it is also supported by research methods NDWI (Normalized diffrent Water Index) performed by [12].

Furthermore, there is undeveloped land which increased by 226.01 hectar, which amount is comprised of residential and non-residential. The vast increase will increase the pressure on the soil surface which will further depress the soil and rocks beneath so may result in land subsidence [5] [6] [29]. That phenomenon will lead to rob because it allows sea water is higher than the plains [30] [26], any other use that has increased is the extent of mangrove ecosystems, which from the year 2005 - 2014 in the coastal mangrove Sayung Sub-district increased about 201.84 hectar. The addition of the result of the mangrove planting programs conducted by several parties, both of stakeholders and private with a model of community empowerment. Mangrove planting with patterns clustered along the shoreline, hopefully with the pattern more to prevent abrasion.

One of land use decreased paddy area is agricultural land, which in the period 2005 - 2019 was reduced by 776.48 hectar. One cause of the reduction in the fields due to increased need for land for housing so that going over the land of the use of the land. The limited paddy fields have an impact on the decrease of agricultural production so that if this continues in the long term could

lead to a food crisis. The following figure presents the trend of change in land use in the Sayung Sub-district from 2005 to 2019.
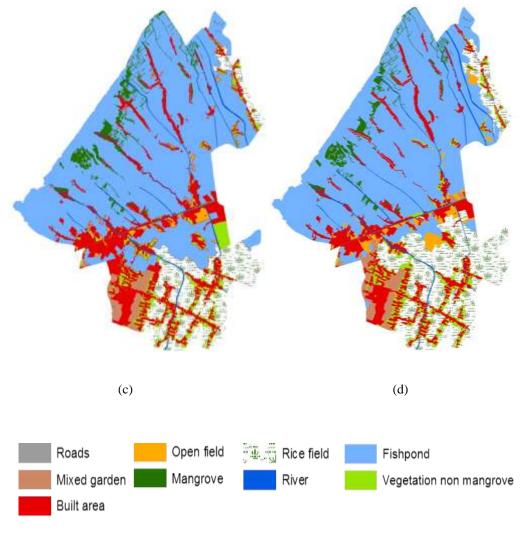

(a)   (b)

(c)   (d)

	Roads		Open field		Rice field		Fishpond
	Mixed garden		Mangrove		River		Vegetation non mangrove
	Built area						

Figure 2. Land use change in Sayung Sub-district in 2005 (a), 2009 (b) 2015 (c)
and 2019 (d)
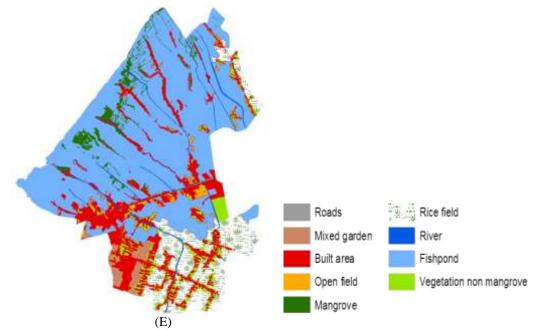(Source : Digital Globe Imagery Visual Intepretation, 2019)

Furthermore, from the trend of change in land use from year 2005 - 2019 will be combined with population growth data to predict the land area in the Sayung Sub-district awakened. That is because of population growth in the region will have an impact on the space requirements for settlements resulting in increased undeveloped land. Based on the results of visual interpretation in times series increased by 226,00 hectar built area during the period 2005-2019, while the

population has increased the number of population of 22.943 inhabitants and in 2025 is predicted to increase to 148.017 inhabitants. Based on both these data are then used to simulate the land area woke up in the study site because these parameters have a value that is linear, so in 2025 is predicted to land awaken in Sayung Sub-district around 1300,20 hectar. The following figure presents the correlation between the growth of population to built area in the Sayung Sub-district.
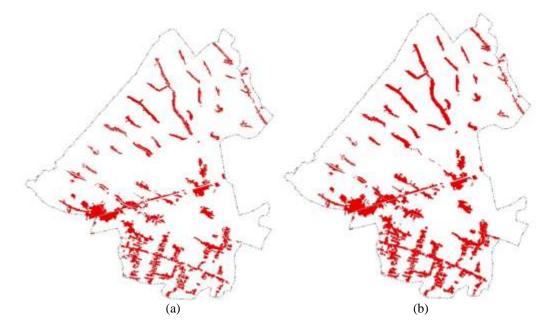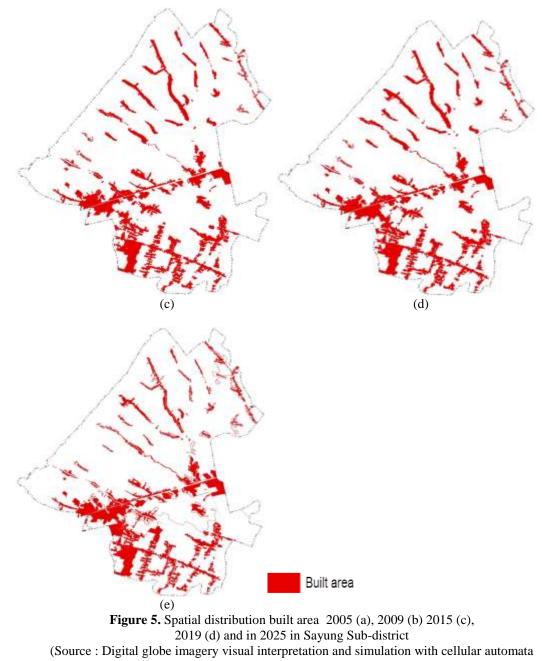

Figure 3. Correlation the population growth with Land use change in Sayung Sub-district
(Source : Analysis results, 2019)

As for the spatial distribution of built area using the model of cellular automata by using software LanduseSim 2.0, where the estimated distribution of spatial use two parameters of the controller, the highway and the center of community activities, it is based generally undeveloped land will be developed in the area there is access road and close with a community center. Increased undeveloped land will also be an impact on loss contributing to other uses, so that in this simulation predicted land use can be turned into smaller plots, among others: open field ,rice fields, vegetation non mangrove and mixed garden. The following picture presents a map of the land use cellular automata simulation results in 2025 and the spatial distribution of plots in the year 2005 to 2025 in the Sayung Sub-district.

(E)

Figure 4. Land use prediction 2025 in Sayung Sub-district
(Source : Processing with cellular automata modelling, 2019)

(a)   (b)

(c)   (d)

(e)

Built area

Figure 5. Spatial distribution built area 2005 (a), 2009 (b) 2015 (c),
2019 (d) and in 2025 in Sayung Sub-district
(Source : Digital globe imagery visual interpretation and simulation with cellular automata
modelling, 2019)

Based on the simulation results, it can be seen that the predicted growth of undeveloped land in the District of Sayung most have elongated pattern PANTURA way with an increase of 168,40 hectar. While the use of other land converted into built area among other lowland (106,44 hectar), open field (35.97 hectar), mixed garden (18 hectar) and vegetation non mangrove (8 hectar).

4. Conclusions

1. Based on the results of this study indicate that in the period 2005-2019 increasing land area of approximately 226,10 hectar awakened and widely predicted in 2025 reached 1300,21 hectar built area to the spatial distribution pattern PANTURA lengthwise along the way.
2. Increased land area in 2025 awakened an impact on the decrease in the extent of other land uses, where most rice fields converted 106.44 hectar, open field 35.97 hectar, mixed garden 18,00 hectar and vegetation non mangrove 8.00 hectar.
3. Modeling cellular automata with LandusSim 2.0 can be used to simulate land use change, and assist the planning

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