The Green City Index as Indicators for Realizing Sustainable Cities and Communities in Semarang

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Abstract. This study aims to discuss the indicators used in the indexation of green cities in the world as indicators in realizing one of the sustainable development goals (SDGs), namely the goal 11th - sustainable cities and communities. There are 8 (eight) green city indicators, namely (1) green planning and design, (2) green community, (3) green open space, (4) green building, (5) green waste, (6) green energy, (7) green transportation, and (8) green water. In this study focus on one indicator, namely the green open space with the research location in Semarang City. The area of green open space (RTH) in Semarang in 2009 was 23,146.70 ha. In 2012, it changed to 17,149,902 ha, and in 2015 it was 19,541 ha. The dynamic change of open green space in Semarang showed a relatively diverse condition but still in good control, so that the percentage of green open space provision in accordance with the spatial planning law (Law No. 26 tahun 2007) is 30% of the total area, which can still be fulfilled. However, stronger efforts are needed to realize a balanced condition between public and private green open space.

Keywords: green city index, sustainable city, green open space, Semarang.

1. Introduction

Green City is a concept of urban area development by maintaining a balance between built up area and green open space. In other words, the green city is an embodiment of the sustainable development concept that balances social, economic and environmental aspects [1]. UNEP defines green city as a well planned city characterized by environmentally friendly conditions and capable of utilizing natural resources in a balanced manner to realize the welfare of its inhabitants [2].

The Economist Intelligent Unit (EIU), a research consultant based in the UK, in collaboration with multinational companies (Siemens AG) measure the greenness/green level of large cities around the world through a ranking system known as the Green City Index. Generally, cities chosen to be studied with various indicators are the capital of a country or city with a large population or a business center city. There are 30 indicators used to measure the Green City Index which summarized in eight categories, namely CO2 Emissions, Energy, Buildings, Transportation, Waste and Land Use, Water, Air Quality, and Environmental Governance [3].

The agenda related to the realization of green cities or environmentally friendly cities has basically been included in the Millennium Development Goals (MDGs) from 2000 to 2015 which were further strengthened in the 2015-2030 Sustainable Development Goals (SDGs) Agenda, especially in goal No. 11, namely Sustainable Cities and Communities [4]–[7]. The Indonesian government has responded to the agenda of development goals at the global level

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by launching the Green City Development Program (P2KH) in 2011 managed by the Ministry of Public Works and Spatial Planning [8]. P2KH is intended to outline the mandate of the Spatial Planning Law (UUPR) on the realization of 30% of the urban area as open green space and follow up on the 10 Bali Initiatives from the Sustainable Urban Development (SUD) forum specifically point 7 namely "Encouraging the role of urban stakeholders in realizing a green city" , in the form of a joint initiative between the Regency/City Government and the business community nationally.

In implementing P2KH, the Ministry of Public Works and Housing has its own indicators to guide Regency/City Governments. Actually the indicators called the Green City Attribute, is almost the same as the indicator used in the EIU and Siemens Green City Indexes. The eight green city attributes set in Indonesia are Green Planning and Design, Green Open Space, Green Community, Green Waste, Green Water, Green Energy, Green Transportation and Green Building [8], [9].

Semarang as one of the national center activities in Java has an important role to be a pioneer in realizing Green Cities in Indonesia. This study aims to examine one aspect/attribute of a green city, namely Green Open Space. In accordance with laws and regulations concerning spatial planning, the minimum green space (RTH) in a district or city is at least 30% of the total area. The RTH consists of 20% public green open space and 10% private green open space [10], [11].

Banyumanik Subdistrict is a peri-urban area of Semarang City that experiences significant land use change. This is influenced by the construction of residential areas and new housing lots which are scattered around Banyumanik. The access and transportation facilities support that began to be integrated in the city of Semarang, has encouraged commuters to choose to live in the suburbs, which are relatively has lower land prices than in the city center. This condition has more or less influenced the change in green open space (RTH) in Banyumanik District. This study aims to examine the changing conditions of green open space in Banyumanik Subdistrict and relate the results of the study to the context of the Green City Index or the Green City Attribute which is part of the Green City Development Program in Semarang City.

2. Research Method

Data and information collection was conducted by primary and secondary surveys. Primary data obtained from the results of Landsat 7 and Landsat 8 image data processing in different time (2005, 2010 and 2017). In addition, primary data also obtained from the results of measurements directly on the field. Field observations were conducted to test the accuracy of satellite image processing data about land use in Banyumanik District (Semarang). While secondary data obtained from literature studies related to the general description of the location of the study.

Image interpretation carried out in this study was digitally processed using the multispectral classification method to obtain an overview of land use in 2005, 2010 and 2017. The data analysis method used in this study was qualitative descriptive analysis. The results of satellite image processing are compared with the data in the field and the appropriate parameters to subsequently produce a land use change map. In addition, spatial studies are also carried out quantitatively using comparative analysis of patterns or comparisson patterns.

3. Result and Discussion

Banyumanik District is one of 16 districts in Semarang. This district is an administrative area located in the southernmost part of the Semarang Government Center with hilly topography. The total area of Banyumanik District is 2,816.94 ha with the dominant land use is yard/building area or settlement area covering 1,935.56 ha (68.7% of the total area). Other consecutive land uses include moor/shrub covering 608.66 ha; agricultural land 94.66 ha; grassland 64.96 ha; and other uses covering 113.10 ha [12].

The population in Banyumanik District in 2016 was 132,508 people with a composition of 65,158 men (49.2%) and 67,350 women (50.8%). The average population density is 5,158 people/km^2. The development of Banyumanik District area could be said to be quite rapid. The growth of new housing in this region is quite significant. The number of houses in Banyumanik District in 2015 reached 23,446 units.

In accordance with the Semarang City Spatial Planning (RTRW) for 2011-2031, Banyumanik District is part of the VII city area (BWK VII) which has functions as a military office area. However, BWK VII also has a secondary function (city scale) for settlement activities with medium-low density, transportation and recreation categories. Activities supporting secondary functions include mixed education, trade and service activities. Regarding residential areas, the Banyumanik Subdistrict area is allocated as a medium-low density residential area spread throughout the subdistricts. Such allocation of land use has sepecial purpose, i.e. to accommodate the overflow of residents from downtown Semarang. Development of new housing such as in Pudakpayung and Gedawang subdistricts shows a trend towards the development of settlement areas in accordance with the indications of the main function of this region. This is also supported by the existence of the education area (Diponegoro University and other campuses) and the existence of regional roads that increase the strategic value of Banyumanik District.

Land use change in Banyumanik Subdistrict could be observed through satellite image processing. Table 1 is an overview of the land use changes in Banyumanik District from 2005, 2010 and 2017.

Table 1. Land Use Change in Banyumanik District 2005-2017

No	Land Use/ Land Cover	Area (Ha)			Change (ha)		
		2005	2010	2017	2005	2010	2017
1	Agricultural land	90,75	85,05	77,15	-	-5,7	-7,9
2	Non-settlement-built area	3,56	3,80	6,97	-	0,24	3,17
3	Settlement area	1.061,59	1.503,90	1.774,64	-	442,31	270,74
4	Open field	210,75	161,28	147,87	-	-49,47	-13,41
5	Garden/farm	1.443,17	1.228,30	1.001,53	-	-214,87	-226,77
6	Moor/shrub	467,72	39,23	10,65	-	-428,49	-28,58
7	Road	35,71	45,23	47,98	-	9,52	2,75
Total		3.066,79	3.066,79	3.066,79	-	-	-

Source: Satellite image analysis of 2005, 2010 dan 2017.

Accuracy test of satellite image interpretation of land use in Banyumanik District were conducted by comparing the number of land use samples in the field with the results of sample points interpretation in the image. The results are presented in Table 2.

Tabel 2. Accuracy Test Result of Landuse Intepretation in Banyumanuk District

Intepretation \ Image Test	A	B	C	D	E	F	G	Total Points
A	**12**				**1**			**13**
B		**8**	**2**					**10**
C			**6**				**1**	**7**
D				**2**				**2**
E	**1**				**4**			**5**
F						**5**		**5**
G	**1**						**7**	**8**
Jumlah								**50**

Information:
A : Settlement
B : Garden/farm
C : Agricultural land
D : Moor/shrub
E : Non-settlement buildings
F : Road
G : Open field

The accuracy calculation of each land cover class is as follows:

A. Settlement : $\frac{12}{13}$ x 100 % = 92,30%
B. Garden/farm : $\frac{2}{10}$ x 100% = 80,00%
C. Agricultural land : $\frac{6}{7}$ x 100% = 85,71%
D. Moor/shrub : $\frac{2}{2}$ x 100% = 100%
E. Non-settlement built : $\frac{4}{5}$ x 100% = 80%
F. Road : $\frac{5}{5}$ x 100% = 100%
G. Open field : $\frac{7}{8}$ x 100% = 87,50%
Overall accuracy : $\frac{44}{50}$ x 100% = **88%**

Based on calculation results, the accuracy of land cover intepretation in Banyumanik District in 2017 was 88%. Referring to the opinion of McCoy [13] that the minimum results of interpretation accuracy test permitted is above 85%, so that the interpretation that has been conducted has met the minimum percentage level of accuracy. It means that the maps compiled can be used for subsequent analysis. The error of interpretation is largely due to the similarity of the spectral reflections (spectral values) of some objects, that create difficulties in visual interpretation. Such as the spectral reflection value of agricultural land with garden/farm, moor/shrub and setlement buildings with non-settlements.

Based on calculation results of land use changes in Banyumanik District, it is known that the area of three (3) built land units (settlement, non-settlement and road) in Banyumanik District has increased. The dominant change is for settlement area. The changes from 2005 to 2010 were 442.31 ha of new settlement area. Likewise in the period of 2010-2017, there has been an increase of 270.74 ha. The expansion of new settlement was also followed by the

addition of road network area from 35.71 ha in 2005 to 47.98 ha in 2017. In addition, the area of non-settlement built land also increased from 3.56 ha in 2005 to 6.97 ha in 2017.

Built area changes in Banyumanik District, followed by a decrease in the area of four (4) units of non-built area, which includes agricultural land, open land, garden/farm and moor/shrub. The most decreasement occurred in moor/shrub area from 467.72 ha in 2005 to 10.65 ha in 2017. This means that 457.07 ha of moor/shrub possibly converted into setlement area. The next big decreasement was occured in garden/farm area, which is from 1,443.17 ha in 2005 to 1,001.53 ha in 2017, or there has been 441.64 ha lost/change.

The vast change of open space/non-built area become built area in Banyumanik District is inseparable from the spatial planning policy in Semarang City which directs development in Banyumanik District as part of the city area (BWK) VII to be an area with the main function as military offices and settlements area. In addition, the development of the city service sub-center in Banyumanik District which includes three (3) subdistrict/villages, namely Srondol Kulon, Srondol Wetan and Banyumanik, has encouraged the development of trade and service, educational, health and other public/social service facilities. Therefore, the settlement development is also growing rapidly along with the development of infrastructure and public service facilities in Banyumanik District. The land use change in Banyumanik District are presented in Figure 1.

Based on laws and regulations, the minimum area of green open space in a region/city is at least 30% of the total area of the regency/city (Law No. 26/2007 concerning Spatial Planning). The details are 20% is public green open space (provided by the Government) and 10% is private green open space (including gardens/farm, moor and agricultural land which owned by the community). The conditions in the city of Semarang, in contrast to the applicable regulations, namely 47.64% are private green open spaces and 7.3% public green open spaces (Table 3).

Table 3. Green Open Space in Semarang

No	Type of GOS	Area (ha)	Total (ha)
1.	City Park	15.70	15.70
2.	Sport field	72.99	72.99
3.	City Forest		1377.22
	a. Non cultivation forest	1083.00	
	b. Cultivation forest	294.22	
4.	Graveyard	270.50	270.50
5.	Riverside/Riverbank Protected Area	996.5	996.5
	Total		2732.91
	Percentage from Total GOS		13.31%
	Percentage from Total Area of Semarang		7.3%

Source: Development Planning Agency at Sub-National Level of Semarang, 2015 [14].

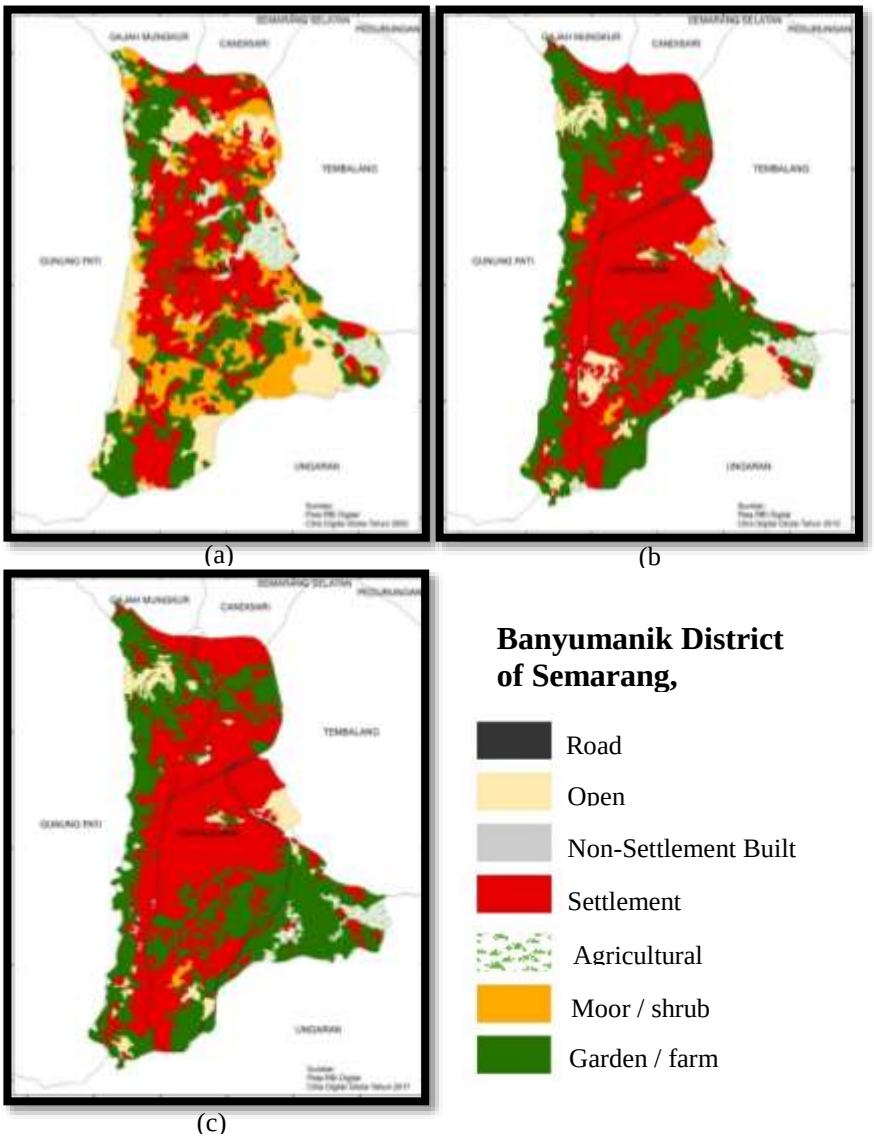

Fig. 1. Map of Landuse Change in Banyumanik District in 2005 (a), 2010 (b) and 2017 (c)

Green open space has an important role for urban society as well as for environmental balance [14]–[18]. The existence of an adequate green open space can provide comfort for city dwellers. Generally in large cities in the world, people take advantage during weekend of vacation for refreshing by visiting parks or urban forests. Even in summer, the city park is a favorite place for residents to sunbathe and relax. For the environment itself, green open space can balance the hydrological cycle or control the weather and local ambient. In addition, green open space can control air pollution with the selection of the right trees. Therefore, green open space as a green city attribute or part of a green city index has a strategic value to create a

comfortable and sustainable living space for the community [19].

4. Conclusion

Land use change in peri-urban of Semarang, especially in Banyumanik District, occured in a fairly large area. Green open space (covering agricultural land, gardens/farm and moor/shrub) decreased by 898.71 ha in during period of 2005 - 2017. Whereas the built land (including settlement, non-settlement and road) increased by 728.73 ha.

This condition needs to be considered by the Government because the existence of green open space is one of the main indicators of green cities to realize sustainable urban space for people's lives. The balance between public and private green open spaces needs to be improved because private green open spaces tend to be easier to switch functions/uses which are generally due to economic impulses. Therefore, the Semarang City Government needs to control the change in the use of green open space into built area or other uses by trying to increase the availability of public green open spaces. For realizing the ideal green open space conditions, support from all stakeholders is needed, especially from the business sector and community.

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