The Population Growth and Carrying Capacity in Semarang City

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Abstract. Population growth and development of city activities take some lands to carry them. As a result, land use competition happens among persons, society or sector. Land necessity for settlement, industry, or sector has taken over farm land, therefore farm land has been converted intensively and massively. Chronologically, population growth will cause land necessity increase. Unproductive land, especially farm land will be converted. Furthermore, farm land conversion will cause carrying capacity change. Carrying capacity has certain bio capacity. With the population growth, it will increase resource consumption; on the other side, farm land conversion will decrease carrying capacity. The objective of the study is to know about the influence of population growth towards carrying capacity (bio capacity) in Semarang city. Land consumption per capita is indeed influenced by city population, the higher the population is, the lower the land consumption per capita. With the population growth, it will influence carrying capacity. Carrying capacity here is the ratio of area to population. Analytical descriptive method is applied in the study with all sub-districts in Semarang city as the analysis unit. Population here is sub-district area and population per sub-district in Semarang city. Population growth data period is from 2000 until 2015. Main variables of the study are area per sub-district, population, population growth, carrying capacity. Result of the study shows significant influence of carrying capacity decrease, especially some outskirts in Semarang city. This condition happens because the outskirts in Semarang city tend to have dense population growth. Range of carrying capacity in Semarang city is from 0,007 to 0,117 of 0 to 1. Almost all sub-districts in Semarang city show miserable condition, except Mijen and Tugu. The conclusion of the study is that population will decrease carrying capacity. Therefore, the government should control population growth by paying attention to its distribution.

1 Background of the study

Land is a kind of important natural recourse for human life as it is needed in every human activity such as agriculture, industry, settlement, and so on. In other word, it is said that land has direct and indirect multiple purpose use. Land is useful to fulfil material need, health, psychological need, and it is also important to protect other natural resources like vegetation and water [1]. Land supply which is relatively constant will make it as a scare commodity, whereas population in Indonesia is growing.

Based on census in 2010, population in Indonesia was 237,556,363, and it became 245,862,034 in 2014 with 58 percent population distribution that was still concentrated in Java Island, followed by 21 percent in Sumatera Island. The growing population mostly happens in some big cities such as Jakarta, Surabaya, Semarang, etc. Semarang has an average population growth of 2.04 percent per year. Data from BPS shows that population in Semarang city has reached 1,763,370 (2015). It is bigger than population in 2001 that was 1,350,005.

In order to fulfil some needs of the growing population, land demand is also increased for many kinds of activities. This case has changed the function of the land (land conversion) that gives some disadvantages for environment conservation.

The function change often happens to the land which has important function for human life, like fertile farm land that is changed into settlement, infrastructure, and so on. The function change of farm land has changed rapidly and massively.

Kusumawati stated that industrial sector takes over agriculture sector, the higher the function change of farm land, the higher the miserable land will be [2]. Settlement that is extended to some rural areas causes the fertile farm land does not produce any more food material to fulfil people's need. This condition shows that farm land will keep on decreasing due to population problems and growing development in Indonesia. But unfortunately, the decrease of farm land is not followed by extensive farm (creating rice field out of Java island), therefore growing population affects the decrease of land capacity.

Farm land conversion is not merely caused by growing population, but also caused by growing

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economy of an area in form of growing urban sprawl. The growing urban sprawl can be infrastructure, settlement, industry, activity centre, etc. that will converse the farm land. The phenomena of farm land conversion are absolute impact for an urban growth [3].

2 Related literatures

Regulation of Indonesia Republic No.41 year 2009 about Sustainable Protection for Food Farm Land indicates that the growing population and economy and also industry will cause degradation, function change, and fragmentation for farm land. This phenomenon threaten nationally to have self-sufficiency in food. Through this case the government of Indonesia cannot deny that growing population can threaten farm land, or even worse than that, it can threaten self-sufficiency in food. The government of Indonesia used to appeal self-sufficiency in food, but actually Indonesia has imported some food materials instead [4].

3 Land capacity

Land capacity is carrying capacity to support life of the human beings and other living things that live around. It is measured by land demand which means maximum population that can be carried by available natural resources stated by absolute number in form of α [4].

4 Method of the analysis

Land capacity is calculated based on Regulation of Environment Minister Number 17 year 2009 about Guidance of Carrying Capacity Determination in an Area (Region) Spatial Planning. According to the regulation, in order to get to know land capacity of an area (region), the following steps should be conducted:

1. Land supply calculation with the following formula:

$$SL = \frac{\Sigma\,(Pi \times Hi)}{Hb} \times \frac{1}{Ptvb} \qquad (1)$$

Note:
SL : Land supply (ha).
Pi : Actual production for each commodity (its unit depends on type of commodity). Calculated commodity includes agriculture, plantation, forestry, husbandry, and fishery.
Hi : Price of each commodity per unit (Rp/unit) on producer level.
Hb : Price of rice per unit (Rp/kg) on producer level.
Ptvb : Productivity of rice (kg/ha).

2. Land demand calculation with the following formula:

$$DL = N \times KHLL \quad (2)$$

Where : DL : Total of land demand equals to rice (ha)
N : Population (person/people)
KHLL : Land area that is needed for well-lived per individual [5]

Land area that is needed for well-lived per individual (KHLL) is a demand of welfare life for every individual divided by local rice productivity. The demand of welfare life is as worth as 1 ton of rice per capita per year. Data from national rice productivity on average, which is 2400 kgs/ha/year can be used
For some regions that have no data about local rice productivity

Table 1. Population in Semarang in 2001 – 2015

No	Sub-district	Population in 2001	Population in 2010	Population in 2015	Population in 2001-2015
1.	Mijen	38.843	48.923	69.382	78,6
2.	Gunungpati	58.130	65.465	91.075	56,7
3.	Banyumanik	106.834	121.855	147.449	38,0
4.	Gajahmungkur	58.482	61.668	66.499	13,7
5.	Semarang Selatan	84.103	85.591	84.496	0,5
6.	Semarang Utara	122.929	126.765	143.469	16,7
7.	Semarang Tengah	106.090	74.228	69.896	-34,1
8.	Semarang Barat	148.753	159.425	176.575	18,7
9.	Semarang Timur	84.044	81.747	82.542	-1,8
10.	Candisari	78.336	77.937	89.983	14,9
11.	Tembalang	106.090	127.008	177.333	67,2
12.	Pedurungan	141.695	163.562	200.726	41,7
13.	Genuk	63.904	80.600	108.252	69,4
14.	Gayam sari	64.104	70.782	78.395	22,3
15.	Tugu	24.400	26.976	34.622	41,9
16.	Ngalian	92.548	109.108	140.676	52,0
	Total	**1.350.005**	**1.481.640**	**1.763.370**	30,6

Source: Statistics Central Bureau (BPS) of Semarang city in 2016 [6]

3. Determination of land capacity status

Land capacity status is obtained from the ratio between land supply (SL) and land demand (DL). If SL > DL, it means surplus land capacity, but on the contrary, if SL < DL means deficit land capacity.

5 Discussions

The population growth will increase resource consumption, not only in quantity but also in quality. This causes the decrease of carrying capacity, for sure. Something noticeable from the table above is that outskirts of the city like Mijen, Gunungpati, Genuk, Tembalang, and Ngaliyan Sub-districts have high population growth. While subdistrics in the downtown like *Semarang Tengah* (Central Semarang) and *Semarang Timur* (East Semarang) have lower population, due to some big projects that have taken over the settlements. The growing population in the outskirts is because of urbanization, or urban people who just want to have a comfortable place to live.

5.1 Land capacity formula

Land capacity can be determined by capacity, and it is calculated based on land function area divided by population. So, the concept of land capacity formula is on the contrary to population density concept.

The formula is:

$$A = L/P$$

Where, A = Land capacity
L = Land area (ha)
P = Population.

Land consumption depends on population of the city. The more population in a city, the land consumption per capita will be smaller. Look at the following table.

Table 2. Land Consumption per Capita

No	Population (person)	Land Consumption per Capita (ha/capita)
1	10.000	0,100
2	25.000	0,091
3	50.000	0,086
4	100.000	0,076
5	250.000	0,070
6	500.000	0,066
7	1.000.000	0,061
8	2.000.000	0,057

Based on data of Semarang city population, the most populous sub-district is Pedurungan with the population of 200,726 persons, therefore the land consumption is as follows:

Population 250,000 – 100,000 , land consumption 0.076 – 0.070

150,000 = 0.06

25,000 = 0.01

If the population in Pedurungan 200,726 people, it is between 100,000 and 250,000.

Yeates scale limit = ((200,726 – 100,000) x 0.01) – 0.076 = 0.072.

With the same way, the Yeates scale limit can be applied for all sub-districts.

Table.3 Carrying Capacity in Semarang City

No (1)	Sub-district (2)	Population (3)	Land area (ha) (4)	Carrying capacity (5)=(4)/(3)	Yeates scale limit (6)	Carrying Capacity Status (7)= (5)-(6)
1	Mijen	69.382	5.755	0,083	0,087	Threshold
2	Gunungpati	91.075	5.411	0,059	0,082	Overshot
3	Banyumanik	147.449	2.569	0,017	0,073	Overshot
4	Gajahmungkur	66.499	907	0,014	0,084	Overshot
5	Semarang Selatan	84.496	593	0,007	0,081	Overshot
6	Semarang Utara	143.469	1.097	0,008	0,075	Overshot
7	Semarang Tengah	69.896	605	0,008	0,081	Overshot
8	Semarang Barat	176.575	2.174	0,012	0,074	Overshot
9	Semarang Timur	82.542	770	0,009	0,080	Overshot
10	Candisari	89.983	654	0,007	0,079	Overshot
11	tembalang	177.333	4.420	0,024	0,074	Overshot
12	Pedurungan	200.726	2.072	0,010	0,072	Overshot
13	Genuk	108.252	2.739	0,025	0,079	Overshot
14	Gayamsari	78.395	618	0,008	0,081	Overshot
15	Tugu	34.622	3.178	0,117	0,090	Quite safe
16	Ngaliyan	140.676	3.799	0,035	0,077	Overshot
	SEMARANG	**1.763.370**	37.370	0,021	0,063	Overshot

Source: Data from Analysis Statistics

Based on yeates scale, the carrying capacity status of 14 sub-districts out of 16 sub-districts (87.5%) is overshot. The other two are quite safe (Tugu) and threshold (Mijen). The highest range of carrying capacity is Tugu (0.117) and the lowest is Candisari (0.007). Mijen and Tugu are predicted to be overshot in the near future due to high population growth in the outskirt areas.

5.2 Conclusion and suggestion

Rapid population growth in Semarang city tends to happen in the outskirt areas such as Mijen, Gunungpati, Genuk, Tembalang, and Ngaliyan. This indicates that outskirt areas are more attractive than downtown areas, especially for immigrants, even downtown dwellers have moved to outskirt areas.

Among 16 sub-districts in Semarang, only Tugu sub-district is quite safe and Mijen sub-district is in threshold. It indicates that 87.5% areas in Semarang city has overshot carrying capacity, especially downtown areas like Candisari and South Semarang sub-districts.

The government of Semarang city should control population growth by restricting Building Permit (IMB) or controlling farm land conversion.

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