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The Influence of Farmland Conversion on Carrying Capacity in the City of Semarang

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***Abstract*—Population growth and activity progress of the city need area to support its life and consequently there will be very tight competition among individuals or groups in using the land. The need of land for residence, industry or service has annexed the farmland and converts it intensively and massively. Population growth will increase the need of land. Unproductive land especially the farmland will be converted, and the conversion of the farmland will cause the change of carrying capacity. Carrying capacity has a certain capacity. Population growth will increase consumption of sourcing. On the other hand, the conversion of farmland will decrease carrying capacity. Carrying capacity is the total bio capacity divided by total ecological footprint.**

Knowing the conversion of farmland for bio capacity and ecological footprint in the suburb of Semarang city is the purpose of this research. Resources consumption per capita is called ecological footprint with global hectare (gha). The conversion of of farmland will change the use of farmland. Of course this will give impact on the carrying capacity. Carrying capacity in this case is from the farming products and green open spaces.

Analytic descriptive method is applied for this research with the population is the agriculture area and total inhabitants in the suburb of Semarang city which consist of the district of Gunungpati, Mijen and Tugu. The districts are chosen because there were many area conversions and a rapid population growth from the year of 2000 to 2015. The main variable of this research comprises agriculture area, total population, inhabitant increase and carrying capacity.

The result of this research show that there is significant effects of decreasing farmland on agriculture product and green open space. This condition will influence food self-sufficiency that will increase food deficit and grow food import from other area. The carrying capacity of Semarang is 0,19 from 0 to 1. It shows a critical condition. The decrease in agriculture area will influence the green open space as a water absorption and city green area. Research result shows that decreasing farmland area will have a big impact on the decrease in the carrying capacity. It is suggested that the government control the conversion of agriculture area with a strict regulation.

Keywords— carrying capacity, farmland conversion

I. INTRODUCTION

The use of area in Semarang is changing dynamicly, especially the farmland area in the suburb which is shown by the conversions of agriculture area into non-farmland (residence, industry, infrastructure and so on). It is caused by the increasing population and the growing social economy. Unprofitable area tends to be condemned. Many farmlands are removed especially in the suburban for residence, offices, industries and city infrastructure. This changes the carrying capacity.

The increase of population causes the farmland tends to be smaller. This condition will increase people's stressing into farmland. Population density is increasing along with people's stressing for the land because of the increasing need for food as the vacant land is less [1]. The increased populatin density would exceed the carrying capacity. It shows that the land in the area cannot support total population for prosperity [2].

The farmland conversion in Semarang has a big impact on the decrease in carrying capacity. It means that the conversion decreases green open space and water habitat. From economical aspect, it will also reduce the food resistance for agriculture production. Many farmers will lose their job if they cannot change their profession. It reduces the power of buying. From environmental aspect, farmland conversion means loosing reservoirs such as rice field, fish ponds which potentially reduce the flood and reserve water. Loosing reservoir in the upper reaches of river will cause flood in the rainy season and dryness in the dry season at the downstream. The farmland also has function to reduce pollutants and absorb CO2 in the air. So the conversion of farmland will have an impact on the carrying capacity especially the protection function.

The farmland conversion causes multiplier effect on environment. It is started from the agriculture landscape changes into residence, industry, market, infrastructure and so on. It is followed by the changing of people's occupation, mobility, lifestyle and mindset. By the increasing price of farm area, the farmers can buy car

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with the price of hundred million rupiahs by selling their lands. The farmer's children are going anywhere by car as the result of selling their farm area. There is a car in the garage of the farmer's house now. From the environment physical aspect, this change has the impact on the carrying capacity like area availability, water resource, etc.

According to the Law number 33 the year of 2009 about protection and management of life environment, life environment is the unity of space with the things, power, condition, and creature including human being and their behavior who influence the nature, life continuing and prosperity of human and other creatures.

Farmland conversion is a phenomenon that cannot be avoided as a consequence of development. The farmland conversion will cause a reduce in agriculture production, loosing water resources, loosing rice field and the flora and fauna that live in it, loosing opportunity to work in the farming area and so on. Based on the description, this research is formulated in the following research questions:

a. How is the carrying capacity in the suburban of Semarang?
b. How is the influence of farmland conversion on the supporting area?
c. How is the ecological balance in the suburban of Semarang, is it surplus or deficit?

The goals of this research were:

a. Knowing the space pattern of farmland conversion in Semarang.
b. Knowing the change of carrying capacity, area supporting capacity, and agriculture support in the suburban of Semarang.
c. Knowing the influence of farmland conversion on carrying capacity.
d. Analyzing the impact of farmland conversion on ecological footprint in the suburban of Semarang.

II. METHOD

According to the law no.23/ 1997, carrying capacity is the ability of life environment to support people's and other creature's life and the balance of both. According to [1], carrying capacity is basically natural carrying capacity which is based on plant and animal biomass that could be collected and caught per square in the certain of time in that area. According to [3], carrying capacity consists of 2 components, that is supportive capacity and waste assimilative capacity. This research is focused on supportive capacity only.

The definition of carrying capacity according to the Directorate General of Space Management of Public Works Department is as follow:

a. Total organism or specific species as maximum and balance that can be supported in an environment.
b. Total inhabitant that can be supported by an environment maximally without damaging that environment
c. Total creature that can survive in an environment in long term period without endangering the environment
d. Total maximum population of a specific organism that can be supported by an environment without damaging that environment
e. The average density of one population or a measured population of one group of people under capacity number of supporting factor that will be predicted increase and over capacity number that is predicted decrease because of lack of resources. Carrying capacity will be different for each group of people in the environment they live which is caused by the type of food, living place, and social condition of each environment they live.

According to [2] carrying capacity is the ability of an area to provide resources for the people. It is indicated operationally by the dynamic people's stressing for the farmland. Attention to carrying capacity is the key for the realization of more comfortable and continuous living space. Carrying capacity means environment capability to support human being activities and all of creatures that live on it based on nature and resources availability. It is also the ability of environment to tolerate negative impact caused by that activity [2].

According to the Law number 32 in the year of 2009 about live environment management, carrying capacity is environment ability to support people's and other creatures' live. Carrying capacity consists of two aspects that is supporting power as an ability of nature resources and capacity power. It is environment ability to process the waste as a result of human's activity. This research is focused on carrying capacity as a supplier. The formula to calculate carrying capacity (*DDL*) is as follows

$$DDL = (E\ (Lg1.a1+Lg2.a2 +Lg3.A3+\ldots.))/LW \quad (1)$$

DDL = carrying capacity
Lg = wide of land use
A = coefficient protected areas
LW = total area

The application of that formula in this research is as follow: firstly, we have to decide the width of each use of land in the research area. Then the width of each use of land is multiplied with coefficient protect. The result is divided by the width of area. This is the value of supporting power of protection function. The same calculation is applied in two different years (year of 2001 and 2015). The number of DDL is between 0-1. The result which is closer to 1 means that the protection function is getting better. On the contrary, the fewer the number (close to zero), the worse the protection function is.

Conceptually, ecological footprint is not allowed to exceed bio capacity. Bio capacity is a supporting power or biologic supporting power. Wackernagel [4] defines bio capacity as a measure of productive land availability ecologically. Carrying capacity is the ability of a land to support living biota and population in the certain area.

Supporting power in one area could be up and down depends on ecologic and biologic condition, and people's use of nature resources. The decrease in the supporting power is caused by the increase in human advantages and then the dissaster happens. In this case, carrying capacity could be presented in the number of industries which can be developed in that location. It can be supported by bio capacity. Carrying capacity is the total bio capacity divided by total ecological footprint.

Carrying capacity is the supporting power in one area which is completed by resources availability, energy needed, and productivity. Consumption and productivity in an area is resulted from the analysis of ecological footprint. From this, we can know the supporting power in an environment to support the life in one region. If carrying capacity is decreasing, peoples' consumption in various activities for nature resources will reduce and the productivity will increase without any continuing advantages.

Bio capacity is available per capita globally. There is 12 billion hectares of productive land or wet land in the year of 2011. If it is divided by total numbers of people of that year, which is about 7 billion, it will result 1,72 hectares global per person (gha), under assumption that there is no place or land for other species consuming organic material like human. Area demanded could be bigger than area supplied if the demand in ecosystem exceeds the capability of the ecosystem to provide [4].

1. The need of food is based on 4 health 5 perfect
2. The need of housing uses the standard of the house type 76 in which 90 meter square is for the family consisting 3 people or 20-30 meter square each person
3. The need of transportation is equal to 120 kg rice per year
4. The need of energy is equal to 120 kg rice per year
5. The need of recycle (water, CO2, water, garbage and others) are equal to 120 liter of water per day. The forest has ability to recycle water of 0,3 liter with the rainfall average of 2000-2500 mm and 56 kg CO2 per hectare of forest.

The method used to calculate the ecological footprint is the method improved by Global Footprint Network (GFN-USA). There are 2 factors needed to be concerned to calculate ecological footprint. They are equivalency factor and harvest factor.

A. Equivalency Factor

Equivalency factor is used to combine ecological footprint from different areas. Coefficient is applied to convert certain local material unit into universal unit, global hectare (gha). The equal factor has been defined by Global Footprint Network (GFN) for 6 area categories. Those are: agriculture area (2,64), fishing area (0,40), animal husbandry area (0,50), forestry area (1,33), developed area (2,64) and carbon absorption area which is needed to absorb CO2 from fossil fuel (1,33).

B. Harvest Factor

Harvest factor shows comparison between the width of bio productive area in a region with the same width of bio productive area at other region for each and the same commodity. This factor can show the ability of one population to enclose technology mastering and management of taking care the region. Each area has different harvest factor and is counted yearly.

Ecological footprint shows the need of goods and services required by people from the nature. It is reflected in net consumption of products category such as agriculture products, animal husbandry products, forestry products, fishing products, room and space needed and energy consumption. Net consumption is indeed an actual consumption influenced by trading (export-import) activity.

According to the data, ecological footprint value of Indonesia is 1,21 gha/person and bio capacity is 1,35 gha/person. It means that each person in Indonesia needs productive space of 1,21 hectare including water that can be used to produce something useful for their life and to process the waste by themselves. This value is obtained by approaching the formula that has been explained before. It has also considered behavior of people in Indonesia in the sector of food, place to live, carbon emission, energy used and renewed, people's act to the water, and things surrounding. America has ecological footprint semester of 9,8 gha/person, China 1,6 gha/person,India 0,8 gha/person, and japan 4,8 gh/person [5].

III. RESULTS AND DISCUSSION

The land conversion in Semarang city especially from agriculture land into non agriculture land is intensive, in the suburban. It is caused by the expensive pricing of land in downtown and the developing infrastructure in the suburban.

The result of carrying capacity/DDL of Semarang city is 0,19 of the range of 0 to 1. That number indicates that the carrying capacity of Semarang city has been very critical. It is because land used for residence, industry, and infrastructure is getting wider , and the blank/void area has low coefficient.

Agriculture land conversion has negative impacts on carrying capacity. The wider of agriculture land conversion means the lower carrying capacity. The conversion of space pattern of agriculture land happened intensively in Mijen, Gunungpati, Tembalang. The pattern is the change from rice field or dry field into residence. The land conversion trend happens close to main road or center of activities.

The green open space of trees is the widest space (26,67) which spreads out at the suburban of Semarang city. The use of land for residence is the second with 24,84%. It is predicted that in the future, the land for residence will go to the first rank as it is getting more and more. Green open space of rice field which is 5,01% is aimed for residence expansion too.

IV. CONCLUSION AND SUGGESTION

The conversion of agriculture land has negative impacts on carrying capacity. The more the conversion of agriculture land is, the lower the carrying capacity is. The conversion of space pattern of agriculture land happens in Mijen, Gunungpati and Tembalang intensively. The exchange pattern is from rice field or dry field into residence. The land conversion trend happens close to main road or center of activities. Carrying capacity of Semarang city is 0,19. It indicates that carrying capacity is in a critical condition.

Suggestion to the government: it is necessary to issue special and vertical regulations for the type of land and where the conversion could be applied. Moreover, strict supervision for violation of land use should be applied.

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