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Environmental carrying capacity of Garang River basin in Central Java Province

M A Setiawan[a] **and A Masduqi**[b]

Department of Environmental Engineering, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia

[a] setiawanariefmuhammad@gmail.com; [b]masduqi@its.ac.id

Abstract. Changes in land use cannot be avoided by the increasing number of people in need of settlement land. Studies on environmental carrying capacity and supporting capacity need to be undertaken to obtain an overview of land capability in support of human livelihoods that occupy the living environment adequately. The research location is in Garang River Basin covering 3 administrative areas, namely Semarang Regency, Kendal Regency and Semarang City, with 52,965.199 ha of catchment area. Analysis of carrying capacity and environmental capacity of Garang River Basin stated that the environmental support capacity of Garang River Basin for settlement land from segment 1-5 is medium status (DDLb>1), segment 6 and 7 is bad status (DDLb<1). The carrying capacity of agricultural land in all segments is exceeded or deficit (DDLp<1).

1. Introduction

Based on [1,2] that local governments should develop spatial plans of the region with due regard to the carrying capacity and support capacity of the environment. The compilation of environmental carrying capacity and carrying capacity in the national, island / local area, ecoregion across districts / municipalities, ecoregions of districts/municipalities and ecological areas. River Basin is a unity of river areas that need to be studied the carrying capacity and its capacity. [3] define River Basin as a union of naturally formed water areas/regions where water is captured (coming from rainfall), and will flow from these regions towards the rivers and streams concerned. The carrying capacity of the environment covers the aspects of land carrying capacity and the carrying capacity of water availability, while the capacity of the environment includes aspects of water quality capacity of the river, air quality and soil capacity.

Increasing population is always followed by an increase in settlements demand, which resulted in reduced agricultural land due to land conversion. This resulted in agricultural and plantation production. [4]. According the concept of environmental carrying capacity is divided into six concepts covering economic, social, food, board (settlement) concept, environment, mobility and spatial.

The concept of environmental carrying capacity and support capacity can be described through demand and supply. The demand side is based more on the needs and consumption patterns of natural resources. The supply side describes quantities (both quantity and quality) of natural resources capable of supporting human needs, with the approach of mass balance method [5]. The interaction of provision and use will illustrate the carrying capacity of natural resources and the environment (carrying capacity). This method can be known overview whether the carrying capacity of a region's land in a state of surplus or deficit. The surplus situation shows that the availability of local land in a region can still meet the need for biological production in the region, while the deficit state is the opposite condition.

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In order to utilize the space in an area in accordance with the capacity of the environment and resources, the allocation of space utilization must heed the ability of the land. Considering the carrying capacity of the environment cannot be limited by administrative boundaries, the implementation of spatial planning should take into account aspects of ecological linkage, effectiveness and efficiency of space utilization, and in its management to pay attention to interregional cooperation.

This study was conducted in Garang River Basin, Central Java Province. The Garang River Basin lies in a position between 110° 15' 43" - 110° 30' 37" east longitude and 6° 54' 49"- 7° 11' 51" LS, with an area of 52,965.199 ha comprising 11 sub catchments. The administrative area that enters the Garang River Basin consists of 3 regions, the area is within the area of Kendal regency, Semarang regency and the city of Semarang. Based on Spatial Plans in Semarang Regency, Semarang City, and Kendal Regency, Garang River is divided into 5 zones, namely: Conservation Zone, Preservation Zone, Rural Zone, Urban Zone, and Coastal Zone. Based on [6] on Water Allotment and Water Quality Management, Garang River is divided into 7 segments. Map of River and Garang River Basin can be seen in Figure 1.

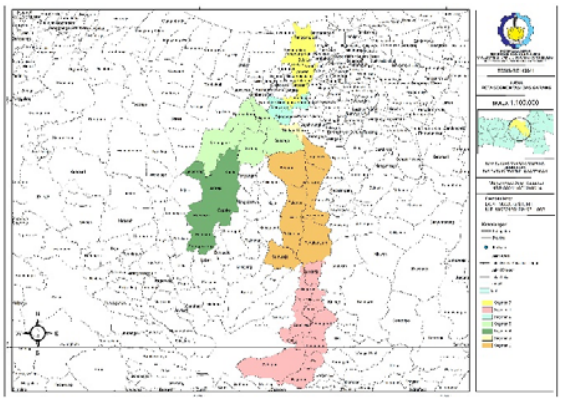

Figure 1. River and Garang River Basin

2. Methodology

Environmental carrying capacity is divided into two components, namely the supportive capacity and assimilative capacity.

2.1. Residential land carrying capacity

[5] According calculation of land carrying capacity for buildings using the formula as follows:

$$DDLB = \frac{\alpha \, x \, Lw}{LTb} \quad (1)$$

with DDLB is the carrying capacity of the land for the building, Lw is the area (ha), α is the coefficient of maximum constructed land area (30% for green open space), and LTb is the area of built land (ha), covering the building area and the land area for infrastructure such as roads, rivers, drainage and others (ha). [4, 6] According, the calculation results are categorized as follows:

- DDLb <1, means the carrying capacity of residential land is exceeded or poor,
- DDLb = 1-3, means the carrying capacity of conditional settlement land or medium,
- DDLb> 3, means the carrying capacity of the settlement land is safe or good.

2.2. Agricultural land carrying capacity

[5] According the carrying capacity of agricultural land becomes the maximum limit due to the unavailability of extensive data of livestock and plantation. The availability of land and total land requirement is calculated by the following formula:

$$SL = \frac{\sum(Pi \, x \, Hi)}{Hb} \, x \frac{1}{Ptvb}$$
$$DL = N \, x \, KHL_L \quad (2)$$

with SL is the availability of land (ha), Pi is the actual production of each type of commodity including agriculture, plantation, forestry, animal husbandry and fishery. Hi is the unit price of each type of commodity (Rp / unit) at the producer level, Hb is the unit price of rice (Rp / kg) at the producer level, Ptvb is the rice productivity (kg / ha). DL is the total land requirement equivalent of rice (ha), N is the number of people (people), and KHLL is the area of land needed for the needs of decent living per population [4]. According [7], the calculation results categorized as follows

- SL> DL, the carrying capacity of the land is declared surplus,
- SL <DL, the mean carrying capacity of the land is declared deficit or exceeded.

3. Result and discussion

3.1. Settlemend land

The results show that all segments of bearing capacity of moderate residential areas (DDLb values in the range 1 to 3, see Table 1) for segments 1 to 5 or surplus conditions. The need for residential land space can meet the population to settle for now. There has been a balance between residents who live (build houses) with the existing area.

Table 1. Carrying capacity of settlement land.

Segment	Area (Lw)(ha)	LTb (ha)	DDLb	Status
1	2.480,15	1.008,82	1,72	surplus
2	3.295,31	1.638,45	1,41	surplus
3	674,97	238,76	1,98	surplus
4	3.344,02	1.018,49	2,30	surplus
5	2.225,19	854,83	1,82	surplus
6	729,94	575,54	0,89	defisit
7	845,20	939,17	0,63	defisit

While segments 6 and 7 in the category of less or deficit, ie the ratio of building area is bigger than open land area. Segments 6 and 7 are located to the north, largely a center of economic growth. Here there is a change of land conversion from open land to building land in the form of shop and residence. The large population growth in segments 6 and 7 resulted in an increase in the need for viability for residence.

Strategies that can be applied in meeting the needs of residential spaces in segments that have low environmental carrying capacity or high space requirement is intensification strategy. Intensification technique is to allocate additional space requirement on existing space allocation by intensifying function and activity more intensively, for example vertical development. The allocation of intensified settlement space is carried out on segmentation that has been unable or accommodate the development of the region, by means of changes in land use or the compaction of land functions. Compaction of land functions can also be done with vertical development as in settlements or shops.

The strategy applied for the needs of residential space on segmentation that has high carrying capacity or low space requirement is done by extensification technique. Extensification technique is to allocate extra space needs extensively by way of development spreading horizontally or extensively allocating it by jumping at other locations outside of existing functions and activities toward a new location.

Eligible programs applied to urban settlements are land consolidation programs, village improvement programs and apartment development projects. Land consolidation is a settlement arrangement through the re-arrangement of land use and control, and the settlement of old settlements and new settlements. According to the Act of the Republic of Indonesia Number 1 of 2011 on Housing and Settlement Area,

the settlement area is part of the environment outside the protected area and the area is free from natural disasters.

3.2. Agricultural land

The carrying capacity of agricultural land includes the production capability of a food crop in the region, namely rice, maize, cassava and peanuts, as the main staple food of the Indonesian people. The results of the calculation, all segment states that the carrying capacity of agricultural land is bad or deficit, that agricultural land is exceeded or bad that is capable of not able to self-sufficiency in food and region unable to support the basic needs of the population. This is because the decent living needs of the people in the region is not met. The area of harvested land for each segment is decreasing, due to changes in land use, which used to be a settlement land. Increasing population cannot compensate for the need of rice in the segment.

Based on the results of conformity evaluation, land use that does not match its capability should be recommended to change its use, or applied technology in accordance with the conditions required by the land, so the land is not damaged and can be used sustainably.

Table 2. Carrying capacity of agricultural land.

Segment	SI (ha)	DI(ha)	DDLp	Status
1	7,123.64	662,174,000	0	deficit
2	2,018.20	349,314,000	0	deficit
3	1,236.77	325,399,000	0	deficit
4	5,931.78	442,311,000	0	deficit
5	2,463.85	391,563,000	0	deficit
6	682.61	676,482,000	0	deficit
7	24.80	409,271,000	0	deficit

The use of land that is suitable with its ability does not need to be changed. The use of forest land where the ability class is suitable for agriculture can be converted to agricultural land, but the amendment must be in accordance with the provisions of Indonesian Act No. 41 of 1999 on Forestry. However, if the area of forest in the area does not reach 30%, the use of forest land should be maintained.

The decrease in land carrying capacity is influenced by population growth in a region, reduced agricultural land area, decreased number of farmers and the area of land needed for decent living. Factors affecting population growth include job structure, land capability and aggregate density. It makes great exploitation to meet the needs of the population. The role of development planning needs to be improved in order to regulate the use of resources professionally so as to achieve optimal environmental quality to overcome the limitations of agricultural resources.

4. Conclusion

Result of analysis of environmental carrying capacity and supporting capacity of Garang River Basin stated that the environmental carrying capacity of Garang River Basin Central Java Province, for settlement land from segment 1 to 5 with medium status, on segment 6 and 7 obtained bad status. The carrying capacity of agricultural land for all segments is exceeded or deficit.

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