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The impact of land use changes on carrying capacity of sampean watershed in Bondowoso Regency

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Abstract. Sampean watershed which covers Bondowoso and Situbondo areas is a watershed which has a role in the rice provision for Bondowoso and East Java. The development activities in Sampean watershed both upstream and downstream are classified into highly intensive, while the population growth is quite high. The changes in land use, the increases of residential areas in upstream, midstream and downstream areas, have contaminated Sampean watershed with pollutants which could affect the agricultural products. Related to that, the specific objectives of this study were: 1) To find out the changes in land use in Sampean watershed area; 2) To know the total land requirements and the area of rice equivalent land available in Sampean watershed area to support the people's life; and 3) To know the carrying capacity of Sampean watershed in Bondowoso region. The comparison method to compare between availability and land requirements was used as a tool to analyze the carrying capacity of Sampean watershed area so that it could provide an overview of the impact of land use change. The results of data analysis showed that the Land Carrying Capacity of Bondowoso regency reached surplus around 206,708 ha. Meanwhile, the areas with deficits in Carrying Capacity were Grujugan sub-district (-1,213 ha), Tamanan (-147 ha), Tlogosari (-3,181 ha) and Bondowoso (-15,422 ha).

1. Introduction

Watershed is a land which conjoins a river and its tributaries, in which its functions are to store and to drain water from rainfall and to channel it naturally to the lake or sea. The land boundary becomes the topographical separators while the boundary of the sea up to water area are still affected by land activities. Basic consideration of the environmental carrying capacity in spatial planning is from the Law of Republic of Indonesia No. 26 Year 2007 on the Spatial Planning, and No 32 Year 2009 on the Environmental Management. A step that must be taken in the preparation and determination of spatial planning is to determine the conceptual direction on the development that will be achieved through the environmental carrying capacity. Environmental carrying capacity is the environment ability to support the lives of human-beings and other living things. Preservation of environmental carrying capacity is a series of efforts to protect the environment ability against the pressure of change and/or negative impacts caused by an activity, so that it can still be able to support the lives of human-beings and other living things [1].

Regional economic development is a part of carrying capacity concepts for human populations that has been applied since 1960s. Various consumption habits make it difficult to predict the carrying capacity of the earth for human-beings. Therefore, the environmental carrying capacity benefits for both the population of human beings and for the difference of the consumption level influenced by the production and consumption of technology. Carrying capacity models are the primary vehicle for the estimation of a population's self-sufficiency. From a resource perspective, the most important parameters determining carrying capacity are basic human needs essential for a population's physical survival including food, water, shelter and energy [2].

Sampean watershed has both social and economic functions. In Bondowoso and Situbondo area, Sampean watershed is an urban watershed that has a strategic role in the national context, which needs to be managed specially. Construction activities in it, both upstream and downstream, are classified into highly intensive while the population growth is quite high. The changes in the land use and the increase in residential areas in the upstream midstream and downstream have contaminated Sampean watershed with pollutants. The pollutant sources came from domestic waste, industrial waste, agricultural waste, and livestock waste [2].

Due to its emergence, the environmental carrying capacity of Sampean watershed needs to be investigated to know to which extent it provides benefits or carrying capacity for the people's lives. The results of this study could be a recommendation for the policy makers on the land use along Sampean watershed. Carrying capacity ratio is a construction planning tool that provides an overview of the relationship between population, land use and the environment. Carrying capacity analysis can provide information needed in assessing the level of land capability in supporting all activities in that area [3].

According to the Minister Regulations on Environment No. 17 Year 2009, consisting of the Guidelines in Determining the Environmental Carrying Capacity on Regional Spatial Planning of the Minister of Environment, environmental carrying capacity is divided into 2 (two) components, namely supportive capacity and waste capacity (assimilative capacity). In the guidelines, the study of environmental carrying capacity is limited to the capacity natural resources supplies, especially in relation to the capacity, the availability, and the need for land and water in a space/area [4].

The Guidelines for Determining Environmental Carrying Capacity in Regional Spatial Planning was carried out based on 3 (three) approaches, they were: (1) the ability of the land in allocating space utilization, (2) the comparison between the availability and requirement of the land, and (3) the comparison between the availability and need of water. Determining land carrying capacity was conducted by comparing the availability and the need of land. Land availability was determined based on the data on the actual local total production of each commodity in an area, by adding up the products of all commodities in the region. Meanwhile, the need of the land was calculated based on the need of decent living [5].

The determination of water carrying capacity was done by comparing the availability and need of water. Water availability was determined by using runoff coefficient method based on the information of land use and annual rainfall data. Meanwhile, water need was calculated from the conversion results on the need of decent living. The surplus situation indicated that the availability of water in an area was sufficient, whereas the state of deficit showed that the area was not capable to meet the need for water. In order to meet the need of water, environmental functions related to the water system must be preserved. The calculation result of this method could be used as an input or consideration to the preparation of spatial planning and evaluation of spatial utilization for the sake of providing sustainable water resources [6].

2. Working Methodology

Environmental carrying capacity is the carrying capacity of the natural environment based on the biomass of plants and animals which can be collected and captured per unit of area and time around that area [4].

A. Research Area

The research areas took place around the Sampean River Basin Area in Situbondo and Bondowoso Regencies covering 6 observation stations started from February to October 2017.

B. Data Collection Method

The data used in this research were primary data and secondary data. Primary data was collected through direct observation and questionnaire in the field and secondary data was obtained from periodic reports of various agencies and the previous researches. The equipment used to process the obtained data were stationery and counting tool, a camera, and a set of computers. The data used in this study can be seen in table 1.

Table 1. The Used Data

No	The Type of Data	The Source of Data
1	Water quality, Industry type alongside of Sampean river	Field Observation
2	Demographic Data	Department of Demography and Civil Registration
3	Map (topography, land closure, administration)	Environment Agency
4	Land Use Changes	Regional Development Planning Agency

Analysis Method

The impact of the land-use change on land carrying capacity in Sampean watershed can be seen in the form of analysis as follows [4][7] :

- The Calculation of Land Availability
  The calculation was performed through the following stages:

1) The Calculation of Land Supply

$$SL = (\sum(Pi \times Hi) / (Hb \times Ptvb) \quad (1)$$

Notes:
SL : Land Availability (ha).
Pi : Actual Production of Each Type of Commodity
Hi : Unit price for each type of commodity at producer level
Hb : Unit price of rice (Rp / kg) at producer level.
Ptvb : Rice Productivity (kg/ha).

In this calculation, the conversion factor used to equalize non-rice product with rice was the price.

2) The Calculation of Land Demand

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

Notes:
DL : The total demand of land is equivalent to rice (ha).
N : Total population (people)
KHLL : The area of land needed for decent living needs per population.

3. Results and Discussion

Administratively, Sampean watershed area consisted of Jember regency (1 district/ 4 villages) covering 4.115,36 Ha (3.05%); Bondowoso regency (23 districts/ 195 villages) covering about 120.397,63 Ha (89.6%); Situbondo regency (4 districts/ 33 villages) covering 10.520,02 Ha (7.73%). The total area of Sampean watershed was 135.033 Ha with 64 km main river length.

A. Land Carrying Capacity at Bondowoso Regency

The number of Sampean river observation points in this research were coded by *KSP.* There were 6 KSPs that can be seen in table 2.

Table 2. Sampean river research observation points

No	Location code	Village	Districts
1	KSP. 0	Penanggungan	Maesan
2	KSP. 1	Tegalmejin	Grujugan
3	KSP. 2	Tenggarang	Tenggarang
4	KSP. 3	Taman	Wonosari
5	KSP. 4	Besuk	Klabang
6	KSP. 5	Kotakan	Situbondo
7	KSP. 6	Widuri	Prajekan

Bondowoso regency has 1.560,10 km^2 wide with various topography conditions such as flatland, hills, and mountains. Bondowoso regency is located in three watershed areas, namely Sampean watershed, Deluwang watershed, and Banyuputih (Kalipahit) watershed.. There were 119 water springs spread all over the area and three hot springs in Sempol districts which was mostly functioned to fulfil the needs for daily water, irrigation, fishery, and tourism.

The land use with that composition was distributed in 23 districts areas in Bondowoso regency with the widest area located in Sempol districts (20.720 ha), followed by Seumberwringin districts, Cermee districts, Botolingo districts, and Tlogosari districts. The dominant land use in the widest districts was forest, dry land, and farming. Whereas, the narrowest districts were Bondowoso districts with 2.315,80 ha followed by Sukosari districts, Tenggarang districts, and Tamanan districts. These districts were very potential to have a high number of population density.

Bondowoso regency was divided into 23 districts, 209 villages, and 10 sub-districts. The land carrying capacity analysis of Bondowoso regency was shown in table 3. The main livelihood of Bondowoso regency inhabitants was in the farming sector. It is shown by the majority of the household earnings which was predominated by those from farming sector. Based on table 3, the land carrying capacity of Bondowoso regency had reached surplus of 54.276 ha.

The analysis of 23 districts at Bondowoso regency depicted that there were several districts which had surplus in land carrying capacity while some had deficit in it as shown in table 4.

Table 3. Land Carrying Capacity Analysis at Bondowoso Regency.

Land Needs		
Factor	**Unit**	**Value**
Total Population	Soul	756.989
Decent life land area	Ha	0,17
Land needs	**Ha**	**126.868**
Status		
Factor	**Unit**	**Value**
Land Availability (SL)	Ha	181.143
Land Needs (DL)	Ha	126.868
Carrying capacity Status	Surplus, If SL>DL Deficit, If SL<DL	**SURPLUS**

Table 4. Land Carrying capacity Condition of each district at Bondowoso regency.

No	Districts	Land Carrying capacity	
		Surplus (Ha)	Deficit (Ha)
1	Maesan	964	
2	Grujugan		**1,213**
3	Tamanan		**147**
4	Jambesari	1,001	
5	Pujer	68,261	
6	Tlogosari		**3,181**
7	Sukosari	34,655	
	Sumber		
8	Wringin	1,769	
9	Tapen	27,031	
10	Wonosari	582	
11	Tenggarang	28,513	
12	Bondowoso		**15,422**
13	Curahdami	10,874	
14	Binakal	1,029	
15	Pakem	3,129	
16	Wringin	26,594	
17	Tegal Ampel	751	
18	Taman Krocok	6,665	
19	Klabang	5,246	
20	Botolinggo	1,571	
21	Sempol	0	
22	Prajekan	1,644	
23	Cerme	6,437	

B. Land Use

The land use in Bondowoso regency indicated there were some changes as shown in the table 5 below [6]:

Table 5. Land use changing at Bondowoso regency 2011 - 2016

No.	Land Use	2011 (Ha)	2014 (Ha)	2016 (Ha)
1	Fresh Water	220.97	220.27	219,70
2	Bush	25,948.75	25,944.35	25,941,74
3	Rocky Hill	25.27	25.27	25,27
4	Forest	22,573.57	22,573.57	22,570,70
5	Estate	14,387.67	14,353.58	14,301,91
6	Settlement Lands	10,694.88	11,166.83	12,468,42
7	Grass	2,837.84	2,828.38	2,818,46
8	Rice Field Irrigation	36,687.68	36,353.10	35,583,14
9	Rainfed Rice Field	11,675.51	11,591.76	11,390,05
10	Farmlands	3,0552.1	30,547.13	30,284,85
Total		**155,604,24**	**155,604.24**	**155,604.24**

From the table 5, it was known that the changes of land use in Bondowoso regency was decreased on fresh water, bush, forest, garden, grass, rice field irrigation, rainfed rice field, and farmlands.

The further analysis showed that the changing of land use that was quite significant happened in settlement sector, which increases as much as 1773,54 ha (1.1398% total wide) and rice field irrigation sector that was decreased by 1104,54 ha (0.7095% total wide) spreading in some districts including Sampean watershed area as shown in table 6.

Table 6. The Percentage of Land use changing at Bondowoso regency

No.	Land Use	The Change of Land Use (Ha)			
		2011-2014	%	2011-2016	%
1	Fresh Water	-0.7	-0.0004	-1.27	-0.0008
2	Bush	-4.4	-0.0028	-7.01	-0.0045
3	Rocky Hill	0	0.0000	0	0.0000
4	Forest	0	0.0000	-2.87	-0.0018
5	Estate	-34.09	-0.0219	-85.76	-0.0551
6	Settlement Lands	471.95	0.3033	1,773.54	1.1398
7	Grass	-9.46	-0.0061	-19.38	-0.0125
8	Rice Field Irrigation	-334.58	-0.2150	-1,104.54	-0.7098
9	Rainfed Rice Field	-83.75	-0.0538	-285.46	-0.1835
10	Farmlands	-4.97	-0.0032	-267.25	-0.1717

4. Conclusion

Land carrying capacity in Bondowoso regency gained surplus.The areas with deficits in Carrying Capacity were Grujugan sub-district (-1,213 ha), Tamanan (-147 ha), Tlogosari (-3,181 ha) and Bondowoso (-15,422 ha). The changing of land use in Bondowoso regency had decreased except on the rocky hill and settlement lands. The settlement sector has experienced the biggest land use change while the rice field irrigation experienced a decrease in land use change.

5. References

[1] Effendi H., 2015, Puslitbang Quality and Enviromental Laboratory, Ministry of Environment and Forestry, Jakarta, 16 October 2015.
[2] Hopfenberg, R. and Pimentel, D., 2001, Environment, Development and Sustainability, 3:1-15.
[3] Sari I.K., Lily Montarcih Limantara, Dwi Priyantoro, 2011, Irrigation Journal Vol. 2 No. 1: 29 - 41.
[4] Alvan Pahuluan, Tri Retnaningsih Soeprobowati, Hady Hadiyanto, 2017, Journal of Ecological Engineering,2017
[5] R M Subekti, D S A Suroso, 2018, IOP Conference Series: Earth and Environmental Science.
[6] Asmaranto R, Ery Suhartanto, Mike Yuanita, 2011, Irrigation Journal Vol. 2 No. 1: 79 - 85
[7] Saraswati S.P, Sunyoto, Bambang Agus Kironoto dan Suwarno Hadisusanto, 2014, Human and Environmental Journal Vol. 21, No.2 : 129-142.
[8] Bappeda Bondowoso, 2016.

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