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Study of settlements carrying capacity in Jebres Subdistrict, Surakarta with *das sein – das sollen* approach

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Abstract. *The calculation of urban settlements carrying capacity is intended to determine the availability and status of environmental aspects that are utilized by the community. This study aims to examine the availability of environmental support aspects in Jebres Subdistrict, Surakarta City, through the das sein and das sollen approaches. Quantitative – descriptive method was used to characterize and interpret all the aspects that have been assessed. The results of this study indicate that the availability of settlements and supporting aspects are still able to support the demand for housing in 2018 and projections until 2055. Analysis through the expectation approach (das sein) for 100% decent settlements and the quality of the supporting aspects capable has not been fully realized concretely (das sollen). The availability of green open space (GOS) in Jebres Subdistrict also does not meet the standards set by the government (30%), where the total area of green open space is 23% of the total. The results of this study are related to the 3rd, 4th and 11th environmental principles.*

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INTRODUCTION

Availability of lands, fresh water, and green open space (GOS) are some examples of environmental services in the form of resources found in urban areas where their existence is able to support settlements and human activities (Marcotullio 2012). Wide kind of human activities, such as transportation and industries, directly and indirectly, impact the availability and condition of resources in settlements, or concretely called the carrying capacity of settlements (Widodo et al. 2015). The increase in population growth both from natality and migration, has an impact on increasing the use of natural resources, including the use of space for human life activities and other living things (Febriarta and Oktama 2020). In Indonesia, there are many cases of land changes, one of which is due to development in watershed areas which results in overflowing water due to the loss of infiltration sites from plants. According to Ekawaty et al. (2018), the case of watershed damage in Java Island has reached a very critical stage, so it has become one of the characteristics where the utilization of resources is disproportionate and will affect the carrying capacity.

Environmental carrying capacity is the maximum number of populations that can be supported by habitat indefinitely and without permanently destroying habitat productivity (Rees et al. 1996 in Santoso et al. 2014). In the carrying capacity and its study, there is a concept that animates it, namely the concept of supply and demand relation (Syrbe and Grunewald 2017). In this concept, supply or availability is played by the ecosystem, the ecosystem plays a role in providing environmental services in the form of 4 environmental services, namely provisioning, regulating, socio-cultural, and supporting services (Depellegrin et al. 2016). Meanwhile, demand is played by the needs of an individual or group in these ecosystems apart. Human, as a part of the utilization of environmental services continue to grow, so if the capacity of environmental services is not directly proportional, the point of overloaded environment carrying capacity will be achieved.

The existence of carrying capacity serves to regulate and provide environmental services that are utilized to meet human needs, including the provision of settlements in urban areas through the Regional Spatial Plan. The regional landscaping plan must consider supporting factors, carrying capacity, as well as disaster risk in the region (Suharto et al. 2017). Identification of the carrying capacity of an area must understand the ability of the environment in order to support and support human life and understand the ability to provide benefits from the environment to absorb substances, energy or other components (Idajati et al. 2021). The identification of carrying capacity can be used in natural resource utilization planning, development planning, and spatial utilization planning to realize sustainable development (Ketjulan et al. 2019).

The concept of *das sein* and *das sollen* is a legal concept that can be used to determine the condition of the carrying capacity of settlements. *Sollen* can be interpreted as an expected state and is the result of the natural idea resulting from the accumulation of needs, while *sein* is the actual state that occurs and comes from ideas-hope (Avise 2004). If the conditions and carrying capacity of an area have not been exceeded, then reality can be in accordance with expectations, but if the conditions of carrying capacity have exceeded then achieving the expected conditions is very difficult or impossible (Widodo et al. 2015). In this research, the condition of the study area and results of carrying capacity analysis are judged by the 14 environmental principles based on Wuryadi (1984), the principle in science is basically a generalization of general conclusions, which are then used as a basis for describing more specific symptoms (phenomena) and situations. The principle can occur through a continuous and mature use and testing of the methodology, so that it is widely recognized as true by scientists.

This study aims to examine the ability of aspects in the carrying capacity of settlements through the *das sein – das sollen* approach in Jebres Subdistrict, Surakarta City. A spatial approach is carried out to calculate the settlement carrying capacity index (SCCI) according to the Guidebook for Writing Environmental Carrying Capacity published by the Ministry of Environment and Forestry in 2014. The SCCI calculation is carried out in the year of writing the article and projections until 2060 to find out the point of its oversight. Then the area of geographic information system (GIS) and land cover classification is calculated with a spatial approach compared to literature studies in the form of Surakarta City in 2020 Figures and Jebres Subdistrict in 2020 Figures published by the Central Statistics Agency of Surakarta City. From these two approaches, a causality analysis was then carried out with a descriptive explanation.

METHOD

Research Location and Time

The implementation of primary data collection of this study is entirely located in the Jebres Subdistrict, Surakarta City. Main reasons of choosing Jebres Subdistrict was its strategical function in academic and economy development in Surakarta City in recent 40 years. Those reason is relating to population density, traffic jam, and environmental pollution through all aspects. Then the running this research took place from October 2021 to February 2022.

Data Collection Methods

This research is a combination of exploratory, descriptive, and modeling that takes data both primary and secondary. Primary data was collected through a questionnaire through Google Form with respondents from Jebres Subdistrict and supported by interviews with local development and environment section chief speakers. Secondary data were collected through spatial analysis using ArcGIS from Indonesian Geospatial Information Agency (BIG) as well as literature studies from books and journals sourced from the Central Statistics Agency of Surakarta City, the Ministry of Environment and Forestry of the Republic of Indonesia, and others.

Data Analysis Methods

Based on the concept of the study, this research was analyzed by qualitative methods with a combination of causality and descriptive techniques in it. The data sourced from interviews and literature studies were combined with the results of spatial and statistical analysis, giving rise to an alleged influence between cause and effect and supported by the results of the dissemination of questionnaires. In statistical analysis, researchers used references in the form of equations and methods for determining the SCCI obtained from the Guidebook for Writing Carrying Capacity published by the Ministry of Environment and Forestry in 2014, as follows:

$$\mathrm{SCCI} = \frac{\left(\frac{\mathrm{ASL}}{\mathrm{NoI}}\right)}{\alpha}$$

The equation above can be described, namely the carrying capacity of settlements = the area of settlement land divided by the number of inhabitants, then divided by the α (universal carrying capacity index). From the results of the SCCI equation, it is then known the feasibility level of residential areas classified in intervals: (a) SCCI > 1, the area is able to accommodate residents to settle; (b) SCCI = 1, there is a balance between the residents who live and the existing area; and (c) SCCI < 1, the area is unable to accommodate residents to settle.

After counting the settlements carrying capacity index, the result should be synchronized with the urban carrying capacity to accommodate activities in Jebres Subdistrict comprehensively in the future. That was caused by the governmental Regional Spatial Plan, which stated that Jebres is one of city's central of trading, education, and public services for intercity and several districts around Surakarta. According to Su et al. (2019), there are seven primary indicators of urban comprehensive carrying capacity shown in table 1 below. The writer conducts each indicator with state condition in the research location and then gives the 3 score categories: poor, average, or good based on SCCI, focused interview, and actual literature study.

Table 1 Primary indicators of urban carrying capacity identification

ID	Representative word
2	Resources and environmental constraints
3	Infrastructure
7	Science and technology
8	Social culture
5	Urban security
4	Ecological civilization
6	Public service

RESULTS AND DISCUSSION

An Overview of Urban Condition in Jebres Subdistrict

In assessing the carrying capacity of settlements in Jebres Subdistrict, Surakarta City is compiled by the area and land cover, the number and population growth, as well as supporting aspects in the form of access and availability of clean water. Along with the development of an urban area, the use of land for development is indispensable. This causes land use change. Based on Table 2, the largest type of land cover in Jebres Subdistrict is settlements and places of activity, namely 10,398,917.87 m^2 (71.85%). In the Area of Jebres Subdistrict one of the centers of Surakarta City, there are many facilities such as shops, centers of economic activity, hospitals, universities, recreational areas, and schools spread throughout the area. With the availability of these facilities, this area is widely used as a place to live. In the other hand, based on data on geodesy and disaster potential indicates that almost of the soil in Jebres Subdistrict is composed by a form of a calcareous structure. This condition was the cause of lacking freshwater quality and can lead to several soil disasters, such as a landslide or local erosion in the future. The point of those issues is a part of the limiting factor in the distribution of settlements and urban development.

Table 2 The Land cover area of Jebres Subdistrict in 2021 is processed from BIG

No	Types of land cover	Area (m^2)	Percentage (%)
1	Lake/situ	5,895.308754	0.04
2	Buildings	467,852.9998	3.23
3	Meadow	997,887.4835	6.89
4	Plantation/garden	725,435.4908	5.01
5	Settlements and urban facilities	10,398,917.87	71.85
6	Paddy	1,426,175.52	9.85
7	River	231,929.59	1.60
8	Wildlife parks	172,523.82	1.19
9	Other fields[a]	46,241.87559	0.32
	Total	12,582,153.96	100.00

[a]other land is thought to be an unused *brown field*

Green Open Space and Settlements Problems

When viewed from 2018 to 2020, Jebres Subdistrict experienced a significant increase in land use change. Land conversion in Jebres Subdistrict is caused by the expansion of built-up lands such as settlements, industry, and education. This has resulted in the narrowing of GOS land, even though the role of GOS is very vital in dense cities. Apart from being the largest contributor to oxygen in urban areas, GOS functions as a water catchment area. In addition, the expansion of built-up land will automatically trigger a decrease in environmental quality, such as air, water, and soil. The availability of land for GOS as water absorption and oxygen producer is decreasing, this is supported by the results of interviews and the distribution of questionnaires that the function of land as a settlement and the function of GOS tends to be less. Reflecting on this, it can be concluded that the supply availability of residential land has not been able to meet the demand for the population, which is still growing.

Based on the results of in-depth interviews, the local government does not plan to increase the area of settlements and focuses on increasing the quality and quantity of vertical settlements. This is aimed at reducing slums and making them public GOS, but there are several obstacles in the form of land acquisition, and the demand for vertical settlements has exceeded the current supply. Based on the results of data mining through questionnaires also showed that respondents assessed that there were still several cases of inappropriate settlements, especially in Mojosongo, Gandekan, and Pucangsawit Village. This is in line with the difference in the concept of "*das sein* and *das sollen"* where the expectations of the government and the

population are not fully realized in concrete implementation on the ground. Respondents and interviewees assessed that the Surakarta City Government is working to alleviate the problem with the following schemes: (a) providing assistance in the form of building materials and human resources; (b) relocation of residents to a more decent, adequate, and accommodative place.

Conduction by The 14 Environmental Principles

With regard to the 14 environmental principles, the condition of the carrying capacity of the Jebres Subdistrict settlements is still mathematically included in the category of 'good' or 'feasible'. This condition has experienced a downward trend over time where the SCCI value is getting closer to the limit to be categorized as 'feasible' or 'good' due to the narrower area of residential land coupled with the projected increasingly massive population. Field observations, interviews, and analyses that have been carried out by the author have concluded that SCCI in quality and quantity is uneven throughout the area of settlements. This means that there are gaps and unevenness where the underprivileged are the disadvantaged parties. The advice that the author can put forward to the government and all elements of the authorities is to be more objective and focused on alleviating the problem of decent settlements. Then the solutions implemented need to be analyzed scientifically, both ecologically and sociologically in order to be sustainable.

Settlements Carrying Capacity Index Assessment

After analyzing the driving factors, impacts, and justification of the carrying capacity of settlements with environmental principles, it is necessary to calculate the determination of the status of SCCI scientifically. Basically, before determining the category of oversight of the carrying capacity of settlements, it is necessary to calculate the area of settlements in a coverage area, but because the data is already available from the local Surakarta City Statistic Centre (BPS), the SCCI is immediately calculated. It is good to calculate the carrying capacity of settlements using data in the form of settlement area and population. However, due to the difficulty of finding data and spatial analysis that has a fairly high level of bias and is not accurate, it is calculated as a whole at the subdistrict level.

Table 3 The result of the calculation of the carrying capacity of settlements

Year	Number of Inhabitants (NOI)	Area of Settlement Land (ASL) (m^2)	Coefficient of Per capita Space Requirement (α) (m^2)	SCCI value[a]	Category
2018	146051	6,985,678	26	1.84	The territory is still able to accommodate residents to settle
2021	155909	6,983,278	26	1.72	The territory is still able to accommodate residents to settle
2024	165767	6,980,878	26	1.62	The territory is still able to accommodate residents to settle
2027	175625	6,978,478	26	1.53	The territory is still able to accommodate residents to settle
2030	185483	6,976,078	26	1.45	The territory is still able to accommodate residents to settle
2033	195341	6,973,678	26	1.37	The territory is still able to accommodate residents to settle
2036	205199	6,971,278	26	1.31	The territory is still able to accommodate residents to settle
2039	215057	6,968,878	26	1.25	The territory is still able to accommodate residents to settle
2042	224915	6,966,478	26	1.19	The territory is still able to accommodate residents to settle
2045	234773	6,964,078	26	1.14	The territory is still able to accommodate residents to settle
2048	244631	6,961,678	26	1.09	The territory is still able to accommodate residents to settle
2051	254489	6,959,278	26	1.05	The territory is still able to accommodate residents to settle
2054	264347	6,956,878	26	1.01	The territory is still able to accommodate residents to settle
2057	274205	6,954,478	26	0.98	The territory is no longer able to accommodate residents to settle
2060	284063	6,952,078	26	0.94	The territory is no longer able to accommodate residents to settle

[a]SCCI: the carrying capacity index of settlements

The data, located in table 3 in appendix pages 7 and 8, are calculated in 2018 and every 3-year multiple to 2060 using a projected population growth rate of an additional 9,858 inhabitants every 3 years. Then the area of residential land below is based on spatial analysis and literature studies covering an area of 6,985,678 m^2. Over a multiple of 3 years, the author assumes that there is a reduction in the area of residential land by 2,400 m^2. This reduction is based on the facts in the case, where there were several evictions of unfit settlement land for the purpose of structuring. From the calculation results, when compared with the results of an in-depth interview with the Head of Development and Environment in Jebres Subdistrict along with the results of researchers' observations, it was found that almost the same thing, namely the demand for settlements (demand) has not exceeded the limit of the ability to support settlements as an environment (supply). Not only settlements, but facilities to support settlements, such as access to clean water also, according to respondents, are considered quite well even though in some urban villages/subdistricts there are problems with clean water quality and sometimes uneven flow.

Conduction by The Urban Carrying Capacity

To realize sustainable urban environment of Jebres Subdistrict with adequate settlements, trading center, and public facility, the Urban Carrying Capacity (UCC) assessment is needed alongside the SCCI. Based on respondent's scoring on questionnaire and focused interview, there are state condition and score of UCC that definite by 7 indicators shown in table 4 below.

Table 4 Score of UCC assessment

ID	Representative words	Status
2	Limiting environmental constraints	Average
3	Infrastructure	Good
7	Science and technology	Average
8	Social culture	Good
5	Urban security	Poor
4	Ecological civilization	Poor
6	Public service	Good

CONCLUSION

Scientifically, the availability of settlements and aspects of environmental services in Jebres Subdistrict is still able to support the demand for residents to live in 2018 and projections in 2054. Then from 2057 to 2060, there has been an overload which, from the calculations, indicates the inability of the environment to accommodate the population density. Concretely, that the residential area of 6,985,678 m^2 was inhabited by 146,051 residents in 2018. There are environmental aspects such as clean water, disaster risk, and clean air, but there are still some problems at some point. The environment, ecologically as a supplier of environmental services and ecosystem services, is still considered capable of meeting the demand of the population as its users. The expectation (*das sein*) for a 100% decent settlement, along with the quality of qualified supporting aspects, has not been fully realized concretely (*das sollen*). Researchers recommend that the government make a system of purchasing or leasing brown field land for the addition of green open space, especially fruit crops and air pollutant absorbers.

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