Analysis of The Carrying Capacity of Agricultural Land in South Sulawesi Province

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Abstract. *The agricultural sector is the field sector that contributes the largest Gross Regional Domestic Product (GRDP) in South Sulawesi, which has a valueof more than 109 billion. This study aims to analyze the carrying capacity offood agriculture land to be useful for evaluation and ongoing planning management of food agricultural land in South Sulawesi. The data obtained is secondary data originating from South Sulawesi in Figures 2021 published by the Central Statistic Agency (BPS). The method used is adescriptive quantitative approach to describe relationships between variables. The calculation of Carrying Capacity of Agricultural Land in this study used a combination of theories from Odum, Christeller, Ebenezer Howard, and Isard. The variables used in the calculation included the harvested land area (Ha), population size, average rice production per hectare (Kg/Ha), and the Minimum Physical Requirement with apredetermined value of 265. The result showed that there are 7 class I where Barru, Bone, Soppeng, Waju, Sidenreng Rappang, Pinrang, and East Luwu Regencies are included. While for class two classification consists of 10 districts and the remaining seven are included in class 3 indicating the lowestcarrying capacity among all urban districts in South Sulawesi.*

1 Introduction

Indonesia is a predominantly agricultural nation with a large agricultural workforce. Agriculture is the most significant economic activity, so agricultural land is crucial for their ability to survive. Agricultural land where farmers conduct their operations has been steadily declining recently. The cause of this condition is the increasing demand for agriculturalland due to population growth. As a result, the agricultural land's ability to hold the world's food supply is declining [1].

Environmental carrying capacity refers to an ecosystem's capacity to sustain healthy organism life while maintaining productivity, adaptability, and self-renewal. Because each region has unique geographical features and engages in human activity for a variety of reasons, the environmental carrying capacity varies greatly. The carrying capacity of an agricultural land can affect the carrying capacity of land in an area, determining whether or not agriculture can still be sustained there. The carrying capacity of agricultural land refers to the amount of agricultural land that can sustain the welfare of people in a region, particularly in terms of meeting food needs [2][3][4]. Therefore, it is crucial to conduct an analysis of the carrying capacity of agricultural land because it ensures the long- term viability of the industry. The harvested area and agricultural productivity are linked by analysis of the carrying capacity of agricultural land, and this relationship suggests that these two factors may have an impact on the rise in carrying capacity of agricultural land [5]

South Sulawesi has a vast area in Sulawesi Island. South Sulawesi has an area of 46.717,48 kilometers square. This province has 21 regencies and 3 city with Makassar becoming its capital. The agricultural sector is the field sector that contributes the largest Gross Regional Domestic Product (GRDP) in South Sulawesi, which has a value of more than 109 billion. South Sulawesi produced 5,054,166.96 tons of rice in 2020 from 978,192.54 ha of harvested rice plantation land. The district with the highest yields of rice, corn, and soybean sis Bone Regency. The district of Bone produces the most rice, 772,874.27 tons [6]. Sulawesi Selatan also produces horticultural products in addition to food crops. According to [6] South Sulawesi is the top five provinces with the largest rice production in Indonesia with 4 708 464,97 ton of rice production in 2020. However, the increasing population in South Sulawesi will impact the agricultural land and its carrying capacity.

The amount of food that is available in a region will depend on the agricultural land that is constantly changing. The state of the carrying capacity of the land will be affected by the declining food supply, whether it gets better or worse. More food resources are required as there is a greater increase in population. As based more than 150 years ago on the Malthusian theory of

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population and the environment. Malthus discusses the tension between population growth that is too rapid and the population's capacity to feed itself. In contrast to the finite supply of natural resources, population growth requires more land, water, energy, fertilizer, and other resources.

The use of agricultural food land including the size and productivity of rice fields owned as well as the population have an impact on the availability of food in a region. Therefore, it is important to take intoaccount the area of rice fields, the productivity of rice fields, and the population in order to calculate the carrying capacity of a region's food agriculture. This study aims to determine the carrying capacity of food agriculture in South Sulawesi Province. In order to determine sustainable agriculture policy strategies, it is expected to give direction and guidance based on knowledge of the effects of land use change andpopulation growth in this province.

2. Method

The research location covers the area of South Sulawesi Province which is geographically located at 116° 48'-122°36' East Longitude and 0° 12' - 8° South Latitude. South Sulawesi Province has 3 cities and 21 districts. South Sulawesi was chosen as the object of study because it is one of the highest rice producers in Indonesia. The data obtained is secondary data originating from South Sulawesi in Figures 2021 published by the Central Statistic Agency (BPS) [7]. The data obtained are the population in 2020, harvested area (ha) in 2020, and production (kg). The level of carrying capacity of agricultural land can be calculated based on the combined theory of Odum, et al. The theory is used as a calculation because it uses data that is easy to obtain compared to Soemarwoto's theory. The calculation of the carrying capacity of agricultural land can be seen in the following formula:

$$\sigma = \mathbf{X/K}$$

Where :

σ = Level of Land Carrying Capacity

X = Total of Plant Per Capita

K = Total Area of Land for Self-Suffiiency

With :

X = Total Harvest Area (Ha) / Amount of Population (People)

K = Minimum Physical Need (MPN) / Food Productivity Plant(Ha/Year)

Regions with self-sufficiency capability are area that is able to meet the minimum physical needs (NPM) of 2600/calorie/person/day or equivalent 265 kg of rice/person/year. Areas that can deliver decent livelihood for the population, where the area depend on capable food crops meet the standard of living of a decent population that is equal to 650 kg of rice/person/year 2,466 NPM. Class I where $\sigma > 2.47$ area who are able to be self-sufficient in food and at the same time provide decent livelihood for the population, class II where $1 < \sigma < 2$, 47 regions are capable of self-sufficiency food but unable to provide a stable livelihood feasible for the population, class III where $\sigma <$ 1 area who are unable to be self-sufficient in food [8].

3. Result And Discussion

The results of the calculation of the carrying capacity of agricultural land in South Sulawesi Province in 2020 from all Regencies/Cities show various levels of carrying capacity of the land. The distribution of land carrying capacity in South Sulawesi Province can be classified into three classes as can be seen in table 1 and 2 below.

Table 1. Carrying Capacity Index of agricultural land for regencies/cities in South Sulawesi

No	Regency/City	Index	No	Regency/City	Index
1	Kepulauan Selayar	0,21	13	Wajo	5,78
2	Bulukumba	1,57	14	Sidenreng Rappang	5,39
3	Bantaeng	0,97	15	Pinrang	4,85
4	Jeneponto	1,07	16	Enrekang	0,75
5	Takalar	1,31	17	Luwu	1,68
6	Gowa	1,19	18	Tana Toraja	0,75
7	Sinjai	1,31	89	Luwu Utara	1,90
8	Maros	1,78	20	Luwu Timur	2,89
9	Pangkajene Kepulauan	1,42	21	Toraja Utara	1,17
10	Barru	2,70	22	Kota Makassar	0,03
11	Bone	3,55	23	Kota Parepare	0,11
12	Soppeng	4,23	24	Kota Palopo	0,35

Table 2. Classification of Carrying Capacity of Agricultural Land Index for regencies/cities in South Sulawesi.

No	Regency/City	Class	No	Regency/City	Class
1	Kepulauan Selayar	III	13	Wajo	I
2	Bulukumba	II	14	Sidenreng Rappang	I
3	Bantaeng	III	15	Pinrang	I
4	Jeneponto	II	16	Enrekang	III
5	Takalar	II	17	Luwu	II
6	Gowa	II	18	Tana Toraja	III
7	Sinjai	II	89	Luwu Utara	II
8	Maros	II	20	Luwu Timur	I
9	Pangkajene Kepulauan	II	21	Toraja Utara	II
10	Barru	I	22	Kota Makassar	III
11	Bone	I	23	Kota Parepare	III
12	Soppeng	I	24	Kota Palopo	III

There are 7 districts with class I of land carrying capacity, which illustrates that these districts will be able to be self- sufficient in food in 2020 and their residents can live a decent life. Another classification result shows that 10 districts are included in the category of carrying capacity of class II agricultural land which indicates that the area can be self-sufficientin food for the next twenty years, but its population has not been able to make a decent living from the existing agricultural sector. There are 7 districts classified into the carrying capacity of class III agricultural land with the most deficit or the lowest level indicating not being able to be self-sufficient in food. For more details, the distribution of the carrying capacity of the South Sulawesi Province's landcarrying capacity in 2020 is presented in the following map.

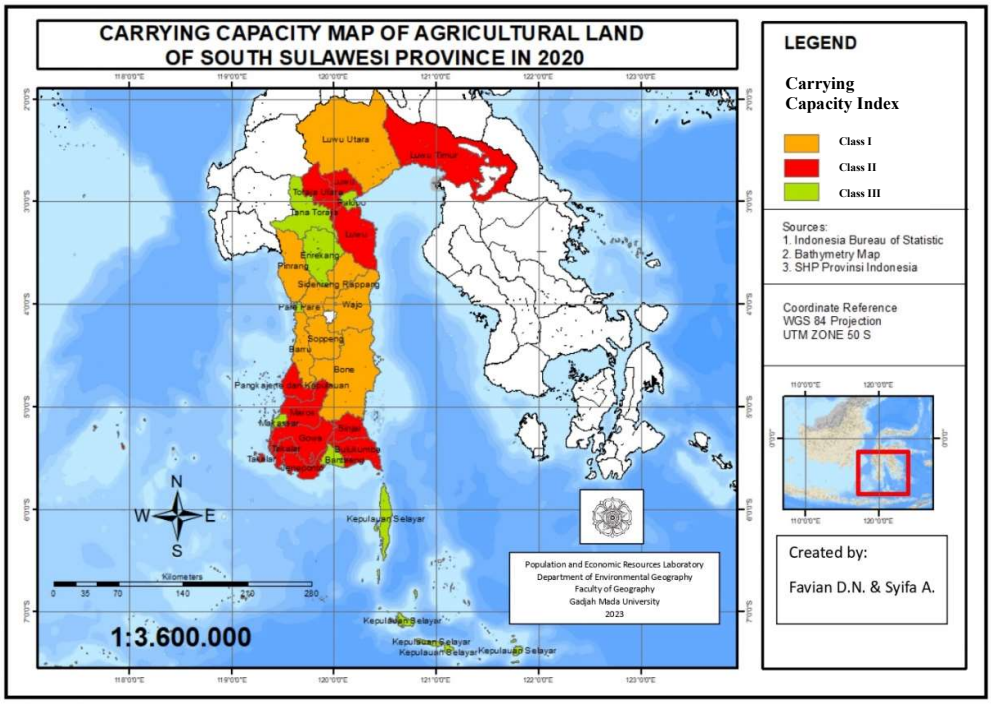

Fig.1. Carrying Capacity Map of Agricultural Land of South Sulawesi Province in 2020

Based on Odum et al's calculations, South Sulawesi Province is divided into 3 classes of carrying capacity of agricultural land. Selayar Regency included has a DDL value of 0.21 which belongs to class III. Bulukumba has a DDL value of 1.57 with class II. Bantaeng Regency has a DDL value of 0.97 with class III. Jeneponto Regency has a DDL value of 1.07 with class II. Takalar Regency has a DDL value of 1.31 which belongs to class II. Gowa Regency has a DDL value of 1.19 which belongs toclass II. Sinjai Regency has a DDL value of 1.31 which belongs to class II. Maros Regency has a DDL value of 1.78 with class II. Pangkajene and the archipelago districts have a DDL value of 1.42 with class II. Barru Regency has a DDL value of 2.7 with class I. Bone Regency has a DDL value of 3.5 with class I. Soppeng Regency has a DDL value of 4.23 which is in class I. Wajo Regency is in class I with a DDL of 5.78. Sidenreng Rappang Regency has a DDL value of 5.39 with class I. Pinrang Regency is included in class I with a DLL value of 4.85. Enrekang Regency has a DDL value of 0.75 with class II. Luwu Regency has class II with a DDL value of 1.68. Tana Toraja Regency which has a DDL of 0.75 with class III with class II. North Luwu Regency has a DDL value of 1.9 with class II. East Luwu Regency hasa score of 2.89 with class I. North Toraja Regency has a DDL of 1.17 with class II. Makassar City has a DDL value of 0.03 which belongs to class III. Parepare City has a DDL of 0.1 with class III. Palopo City has a DDL value of 0.35 with class III. From the all regencies and cities in South Sulawesi, there are 7 class I where Barru, Bone, Soppeng, Waju, Sidenreng Rappang, Pinrang, and East Luwu Regencies are included. This means that the district can fulfill self-sufficiency in food in its area and is able to meet food needs properly. Meanwhile, 10 districts namely Bulukumba, Jeneponto, Takalar, Gowa, Sinjai, Maros, Pangkajene and Islands, Luwu, North Luwu and North Toraja fall into class II. This indicates that the region is capable of self- sufficiency in food but has not been able to meet food needs properly. Meanwhile, 7 other regencies/cities are included in class III where there are Selayar Islands, Bantaeng, Enrekang, Tana Toraja, Makassar City, Parepare City, and Palopo City. This states that the regions have not been able to achieve self-sufficiency in food and have not been able to meet food needs properly in their regions.

There are still many areas that have not been able to meet food needs properly in their regions indicating that there are still many areas with low land carrying capacity which can be caused by population, rice field harvest area, average rice production which has an impact on high and low agricultural land support. in South Sulawesi. The high population but not in line with the high average rice production can result in low carrying capacity of agricultural land. This happens because rice production cannot meet the food needs of a very high population so that the carrying capacity of the land is low.

4. Conclusion

It was found that the carrying capacity of agricultural land in South Sulawesi is 7 districts that are included in class I, namely Barru, Bone, Soppeng, Waju, Sidenreng Rappang, Pinrang, and East Luwu Regencies. Class II consists of 10 districts namely Bulukumba, Jeneponto, Takalar, Gowa, Sinjai, Maros, Pangkajene and Islands, Luwu, North Luwu, and North Toraja. Class III has 7 regencies/cities namely Selayar Islands, Bantaeng, Enrekang, Tana Toraja, Makassar City, Parepare City, and Palopo City. The carrying capacity of agricultural land in South Sulawesi is still classified as being able to carry out food self-sufficiency but has not been able to meet food needs properly. This is caused by factors such as population, rice field harvest area, and average rice production. This shows that agriculture in South Sulawesi has not been able to properly meet the food needs of the region. In the future it is hoped that agriculture in South Sulawesi can meet their food needs properly.

References

1. S.I. Wayan, A.M. Ruslin, Soemarno, Jurnal Bumi Lestari 13, 115-123 (2011).
2. U. Kafafa, H. Nadia, G. O. Fadilah, A. W. Abadi, R. F. Putri, *Carrying capacity trend and projection analysis for Sumatra Selatan agricultural land in 2030,* in IOP Conf. Ser.: Earth Environ. Sci. 451 0120. (2020).
3. M.Nurlaila, R.L. Mahir, T.S. Darma, Jurnal Ilmu Pertanian Indonesia 1 (2020)
4. N. Salma, M. Askarina, S. Romadhoniastri, A. F. Azahra, D. Karim, M. N. Isnain, R. F. Putri, *Study of agricultural economic potential in West Kalimantan using Regional Analysis Techniques* in E3S Web of Conferences 325, 07008 (2021)
5. M.V.R.Bernhard**,** *Analisis Daya Dukung Lahan Pertanian ASE.* Manado: Jurusan Sosial Ekonomi Fakultas Pertanian Universitas Sam Ratulangi (2011).
6. BPS, Luas Panen, Produksi, dan Produktivitas Padi Menurut Provinsi 2020-2022. https://www.bps.go.id/indicator/53/1498/1/luas- panen-produksi-dan-produktivitas-padimenurutprovinsi.html.
7. BPS Sulawesi Selatan, Sulawesi Selatan Dalam Angka Tahun 2021. Makassar: Badan Pusat Statistik, 2022.
8. S. Barita, I. Dewata, Journal of Disaster, Geography, and Geography Education 4, 68-71 (2020).