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THE ANALYSIS OF CARRYING CAPACITY FOR AGRICULTURAL LAND IN TANAH DATAR DISTRICT

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ABSTRACT: This research aimed to find out the amount of carrying capacity for agricultural land in supporting food self-sufficiency in Tanah Datar District. Data analysis used is the level of carrying capacity for the agricultural land. The result of the study shows that the level of carrying capacity of agricultural land in Tanah Datar District is 3,5 with the lowest level of carrying capacity of agricultural land located in Lima Kaum sub-district which is 2,19 and the highest in Pariangan sub-district which is 5,49. This means that Tanah Datar District has been able to implement food self-sufficiency. The benefit of this research is expected to contribute the idea for the government of Tanah Datar District and other related instances in food security and overcoming land conversion, so that will not cause the problem in land carrying capacity toward food self-sufficiency. This research is expected to contribute in developing knowledge of area and economic land resources.

Keywords: Analysis, Carrying Capacity, Agricultural Land

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1. INTRODUCTION

Starvation and poverty are the main problems faced by human. The level of poverty in Indonesia in 2010 is 31,02 million or 13,33% higher from the target expected which is 7,5 %. Global financial crisis in 2009 caused significant reduction of food prices, but it recovered in the middle of 2010. The price increase in domestic market especially rice which affect toward inflation. The crucial problem is how to increase the productivity in agricultural and rural sector to increase the community income [1-4]

Environmental carrying capacity can be defined as the ecosystem capacity or ability in supporting the life of organism properly and maintain the productivity, the ability to adapt and renew themselves. It can be concluded that carrying capacity of environment is the capacity of environment in supporting human life. Each region has different geographical characteristic along with the human activity for various interests, so that the environmental carrying capacity is varies greatly. [5-8].

[9-11] Carrying capacity of the environment is the ability of the environment in supporting human's life, other living creatures, and the balances between the two. Development is an activity carried out for the welfare of the society who lived in that area. Human is a living creature which has more complex needs rather than other living creatures on this earth. One of the human basic needs is food. Indonesia is an agrarian country where most of the population works in agricultural sector. Agricultural land as the place for the farmer to work has changed. That happened because of the amount of population pressure toward agricultural land. The increasing number of population along with development activity has also took the benefit of agricultural land for producing food resources which slowly changed into other benefit, such as habitation, offices and others. The consequence is the agricultural land used to fulfill the needs of food for the population is decreasing.

The land owners who convert his land for the non-agricultural purposes are caused by the profit from the sale of their land. Economically, agricultural land such as rice field has a high selling price especially if the location is strategic as if in the development area. However, for the sharecropper and farm worker, land conversion becomes a threat because they cannot change their job. The farmers are getting stuck with the limitation of job opportunity that will lead into social politic problems. [11] Sustainable development is a conscious and planned effort to integrate environment, social, and economic aspect into development strategic in ensuring the integrity of environment and the safety, wellbeing, and quality of life for present and future generation.

The use of natural resources that is intended for the future directly needs to be linked into the

balance between population and natural resources. If the population needs too many goods and services, there will be a need that will cause the increasing the amount natural resources extraction both extractive in nature and other natural resources such as open fields, recreation areas, and clean air. But the impact is precisely in the form of the deteriorating of the earth physical condition and people are slow to find solutions to the emergent problems [9]

[10] [12-15] Sustainable development is a nonstop development with the level of life of the future generations cannot be worse or must be better than the level of life of the current generation. The meaning of sustainable development is that the future generation is not worse than the current generation, whatever the current generation does. So, the thing that must be considered in this concept is that future generations must be more prosperous than current generations. In other word, sustainable development will be succeeded if there is no gap problem between generations.

Many factors that cause the use of land which are not appropriate with its capability. Those factors are the rapid population growth, economic problems, and public awareness of land use. Rapid population growth promotes the need of land for housing, farming and other needs that continue to increase. This matter encourages the use of land which pays less attention to sustainability. Economic factor has encouraged some business person and public for taking the benefits as high as possible without paying attention to the carrying capacity of the land [5].

Most of our food comes from plants, with 98% calories, 90% protein, and 93% fat. The role of animals is very small in our food. The amount of each meat, eggs, milk and fish is less than 1% from the amount of the calories that we consume. Almost 3% protein that we consume comes from meat and almost 7% from fish and less than 1% comes from eggs and milk [6].

The more population growth, the more food resources is needed. Malthus express about the concern between rapid population growths compared to the population capability for serving the food. Population growth needs land, water resources, fertilizer, and energy which continue to increase, whereas the source of natural wealth has a limited amount [2].

Food is one of the human basic needs which part of Human Rights (HAM) set forth in Universal Declaration of Human Rights in 1948 and the Act of Republic of Indonesia number 7 in 1996 concerning the food. In the law also explained the definition of food security, where the meaning of food security is the condition of food fulfillment for each person in every house which is reflected from the fulfillment of food in the amount, quality, safety, and affordability. If the food consumption is not fulfilled where carbohydrate as the main source for human energy, so the food scarcity will be vulnerable to happen which can reduce the quality of human life. Therefore, there is a need of ecological factor analysis both in physical and social economic which affects toward the level of human food consumption in many kinds of areal characteristics [7].

2. METHOD

The research location is in Tanah Datar District. Geographically, the Tanah Datar District is located at 00º17" SL - 00º39" SL and 100º19" EL – 100º51" EL. Level of carrying capacity for agricultural land can be formulated using math equation as follow [3]:

$$\boldsymbol{\sigma} = \frac{\mathbf{X}}{\mathbf{K}}$$

Where :

$\boldsymbol{\sigma}$ = Level of Land Carrying Capacity
X = Total of Plant Per Capita
K = Total Area of Land for Self-Suffiiency

With :

$$\mathbf{X} = \frac{\textbf{Total Harvest Area (Ha)}}{\textbf{Amount of Population (People)}}$$

$$\mathbf{K} = \frac{\textbf{Minimum Physical Need (MPN)}}{\textbf{Food Productivity Plant (Ha/Year)}}$$

[3] Area with capability of self-sufficiency is the area that can fulfill minimum physical need (NPM) of 2600/calories/person/day or equal to 265 kg rice/person/year. The area that can give proper living for population, where that area depend on food plant which capable in fulfilling population in proper standard which is equal to 650 kg rice/person/year 2,466 of NPM.

Based on those values above so the classification is set as follow: (1) Class I where $\boldsymbol{\sigma} >$ 2,47 area that capable of food self-sufficiency also give proper living for the population, (2) Class II where $1 < \boldsymbol{\sigma} <$ 2,47 area that capable of food self-sufficiency but cannot give proper living for the population, (3) Class III where $\boldsymbol{\sigma} < 1$ area that incapable of food self-sufficiency.

From the formulation above, it can be derived a formula to find out the total of optimal population number (OPN) which can be supported by the product of food plant from agricultural land in the area which is:

OPN = Land Carrying Capacity x Number of Population

3. RESULTS AND DISCUSSION

Tanah Datar District has 133.600 Ha (1.336 km^2) total area. It is consists of 14 sub-district.

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Tanah Datar District is agrarian area where more than 70% of the population works in agricultural sector such as food plantation, fishery and animal husbandry. The area of paddy fields in Tanah Datar District in 2019 is around 33.836 Ha.

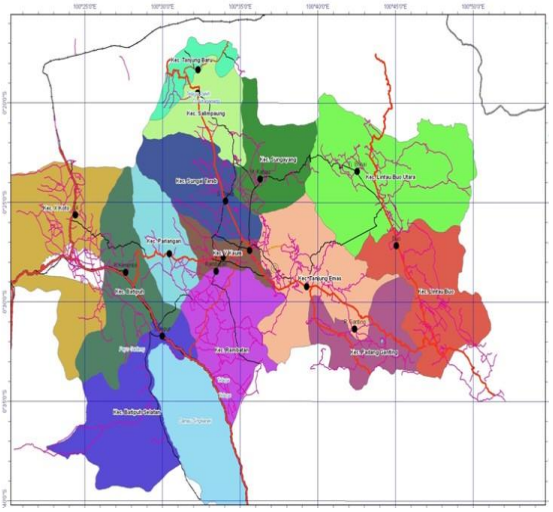
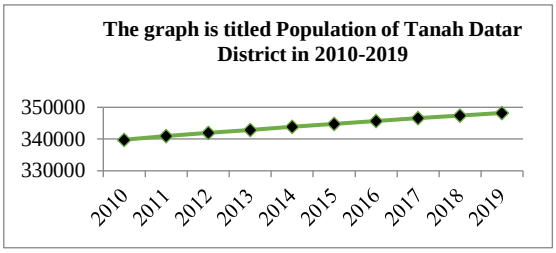


Fig 1. Map of Tanah Datar District Administration

In addition, in the span of 2010 - 2019 the population of Tanah Datar District increased by around 8,427 people or experienced a growth of around 2.5 percent, from initially 339,792 inhabitants in 2010 to 348,219 inhabitans in 2019 [1]. In other words, population growth in the Tanah Datar District is around 0.2 percent per year. The relatively high population growth has led to land use needs enhancement, both in agricultural and non-agricultural sectors.

Fig 2. Graph is titled Population of Tanah Datar District in 2010-2019



The result of the study shows that the level of carrying capacity for agricultural land in Tanah Datar District in 2019 is 3,50 or placed in class I based on the classification of level carrying capacity for agricultural land. According to the classification above, Tanah Datar District is capable to give proper living for the population. After that, the result of the study shows that in 2019 Tanah Datar District, only 3 out of 14 sub-districts that the level of carrying capacity for agricultural land are in class II where in this class the sub-districts are capable to implement food self-sufficiency but are not capable to give proper living for the population. While 11 sub-districts are in class I where in this class the sub-districts are capable to implement food self-sufficiency and give proper living for the population.

Table 1. Carrying Capacity for Agricultural Land in Tanah Datar District in 2019

No	Sub-District	Total Population (2019)	Total Area of Rice Field Harvest/Ha	Productivity of Rice Farm Plant /Kg/ha	Production of Rice Farm Plant/Kg	Value of X	Value of K	Land Carrying Capacity
1	X Koto	44207	4793	5781	27710000	0,11	0,05	2,37
2	Batipuh	30115	5637	5829	32858000	0,19	0,05	4,12
3	Batipuah Selatan	10664	2414	5755	13890000	0,23	0,05	4,92
4	Pariangan	19618	4900	5821	28523000	0,25	0,05	5,49
5	Rambatan	33527	4982	5674	28266000	0,15	0,05	3,18
6	Lima Kaum	37103	3769	5707	21509000	0,10	0,05	2,19
7	Tanjung Emas	22505	3922	5511	21615000	0,17	0,05	3,62
8	Padang Ganting	13894	2541	5518	14024000	0,18	0,05	3,81
9	Lintau Buo	18910	2200	5583	12282000	0,12	0,05	2,45
10	Lintau Buo Utara	36250	6590	5686	37472000	0,18	0,05	3,90
11	Sungayang	17294	3062	5658	17322000	0,18	0,05	3,78
12	Sungai Tarab	29958	6283	5726	35977000	0,21	0,05	4,53
13	Salimpaung	21233	3253	5667	18433000	0,15	0,05	3,28
14	Tanjuang Baru	12941	2265	5651	12801000	0,18	0,05	3,73
	Tanah Datar	348219	56611	5700	322682000	0,16	0,05	3,50

In completion, sub-districts in Tanah Datar District according the class of carrying capacity for agricultural land in 2019 can be seen in table 1. Based on the number of carrying capacity for land agriculture and the number of population resulted to the amount of Optimal Population Number. Result of the study, as shown in table 2, shows the optimal population number that can be carried out by the agricultural land in Tanah Datar District in 2019.

Table 2. Sub-Districts in Tanah Datar District Based On The Level of Carrying Capacity 2019

Class	Carrying Capacity for Agricultural Land	Number of Sub-District	Sub=District
I	$\sigma > 2,47$	11	Batipuh, Batipuah Selatan, Pariangan, Rambatan, Tanjung Emas, Padang Ganting, Lintau Buo Utara, Sungayang, Sungai Tarab, Salimpaung, Tanjuang Baru
II	$1 \leq \sigma \leq 2,47$	3	X Koto, Lima Kaum, Lintau Buo
III	$\sigma < 1$	0	-
Total	-	14	-

Table 3. The Amount of Optimal Population Number Each Sub-District in Tanah Datar

No	Sub-District	Total Population (2019)	Land Carrying Capacity	Optimal Population Number
1	X Koto	44207	2,37	104771
2	Batipuh	30115	4,12	124074
3	Batipuah Selatan	10664	4,92	52467
4	Pariangan	19618	5,49	107703
5	Rambatan	33527	3,18	106616
6	Lima Kaum	37103	2,19	81256
7	Tanjung Emas	22505	3,62	81468
8	Padang Ganting	13894	3,81	52936
9	Lintau Buo	18910	2,45	46330
10	Lintau Buo Utara	36250	3,90	141375
11	Sungayang	17294	3,78	65371
12	Sungai Tarab	29958	4,53	135710
13	Salimpaung	21233	3,28	69644
14	Tanjuang Baru	12941	3,73	48270
	Tanah Datar	348219	3,50	1218767

If the result of optimal population number is less than the number of population that has already recorded, it is very important to add the total area of farm rice which capable to support the population. Beside the addition of farm rice total area and plant total area, it can be done through the enhancement of food plant productivity through intensification efforts to support the population.

4. CONCLUSIONS

Tanah Datar District generally are already capable to do food self-sufficiency and give proper living for the population. There only 3 sub-districts that are in class II and 11 other sub-districts are in class I. The analysis of carrying capacity for agricultural land is an analysis that is used to find out the carrying capacity of land toward the need of calories for each population. The analysis of Carrying capacity for land agriculture is used to find out the capability of the area whether capable or incapable to implement food self-sufficiency, based on the need of calories of the population. The result of the analysis intended to find out the amount of optimal population number that can be carried out by the agricultural land.

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