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Study of Environmental Carrying Capacity to Support Increased Agricultural Land Productivity in Bantaeng Regency

Studi Kapasitas Daya Dukung Lingkungan untuk Mendukung Peningkatan Produktivitas Lahan Pertanian di Kabupaten Bantaeng

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ABSTRAK

Salah satu fenomena perubahan iklim yang banyak dibahas belakangan ini adalah fenomena El Niño yang menyebabkan kekeringan berkepanjangan. Selain itu, konversi lahan juga berdampak buruk pada ketersediaan lahan di Kabupaten Bantaeng. Oleh karena itu, penelitian ini bertujuan untuk mengetahui daya dukung lingkungan termasuk daya dukung air dan daya dukung lahan di Kabupaten Bantaeng. Penelitian ini dilakukan dengan menggabungkan analisis deskriptif kuantitatif untuk membandingkan ketersediaan air dan lahan dengan kebutuhan air dan lahan, dan hasilnya kemudian diklasifikasikan ke dalam kelas daya dukung air (DDA) dan daya dukung lahan (DDL). Kemudian dilanjutkan dengan analisis SWOT dan IFAS-EFAS untuk menentukan strategi peningkatan produktivitas pertanian di Kabupaten Bantaeng. Berdasarkan hasil perhitungan Daya Dukung Air di Kabupaten Bantaeng, angka 4,72, yang termasuk kategori daya dukung air yang baik. Sementara itu, DDL di Kabupaten Bantaeng menunjukkan angka 0,007, yang dikategorikan sebagai daya dukung lahan berlebih atau buruk. Sementara itu, berdasarkan hasil analisis SWOT dan matriks IFAS-EFAS, strategi yang harus segera dilakukan berada di kuadran ST. Strategi ini mencakup: 1) Mengelola kualitas sumber air yang tersedia; 2) Memanfaatkan jenis tanah dan iklim yang mendukung melalui penanaman vegetasi yang memiliki nilai ekonomi dan ekologi tinggi; 3) Meminimalkan kegiatan konversi lahan menjadi permukiman dan tambang nikel, menggantinya dengan jenis lahan yang memiliki nilai ekonomi dan ekologi tinggi seperti hutan atau hutan bakau; dan 4) Penetapan aturan untuk mengurangi konversi lahan.

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ABSTRACT

One of the climate change phenomena that has been discussed in recent times is the El Nino phenomenon which causes prolonged drought. In addition, land conversion also has a bad impact on land availability in Bantaeng Regency. Therefore, this study aims to determine the environmental carrying capacity including water carrying capacity and land carrying capacity in Bantaeng Regency. The research was conducted by combining quantitative descriptive analysis to compare water and land availability with water and land needs, and the results were then classified into water carrying capacity (DDA) and land carrying capacity (DDL) classes. Then it continued with SWOT and IFAS-EFAS analysis to determine strategies to increase agricultural productivity in Bantaeng Regency. Based on the results of the calculation of the Water Carrying Capacity in Bantaeng Regency, the number 4.72, which is a category of good water carrying capacity. Meanwhile, DDL in Bantaeng Regency shows a figure of 0.007, which is categorized as excess or poor land carrying capacity. Meanwhile, based on the results of the SWOT analysis and the IFAS-EFAS matrix, the strategy that must be carried out immediately is in the ST quadrant. The strategy includes: 1) Managing the quality of available water sources; 2) Utilizing soil types and a supportive climate through planting vegetation that has high economic and ecological value; 3) Minimizing land conversion activities into settlements and nickel mines, replacing them with land types that have high economic and ecological value such as forests or mangroves and; 4) Establishment of rules to reduce land conversion

1. INTRODUCTION

1.1 Background

One of the climate change phenomena that has been discussed recently is the El Niño phenomenon, also known as the occurrence of an increase in sea surface temperatures in the central and eastern equator Pacific Ocean from normal conditions, which then reduces water vapor in the territory of Indonesia (Sub-Division of Climate Early Warning BMKG, 2018). El Niño has also been known as a natural disaster phenomenon since ancient times that affects several things, especially related to food production, economic, social, and also political (Sulaiman et al., 2018). Furthermore, the BMKG Climate Change Early Warning Division explained that the general impact of the El Niño phenomenon causes reduced rainfall, increased risk of forest fires, risk of crop failure and shrinkage of lake water. Indonesia, as a country located on the equator and bordering the Pacific Ocean in the east, also felt the negative impact of the El Niño phenomenon (Tongkukut, 2011). The El Niño cycle in Indonesia occurs every 3 to 5 years with varying degrees of severity. 2015 was the year with the highest severity of El Niño where almost all regions of Indonesia felt the impact of drought. Sulawesi is one of the regions that often feels the impact of the El Niño phenomenon, Prasetyo & Pusparini (2019). In their research, they found that the El Niño phenomenon that occurred caused a decrease in rainfall in the Sulawesi region, ranging from 4 to 24 mm, with the strongly affected areas including South Sulawesi, West Sulawesi, and also North Sulawesi.

In addition to the water availability factor that satisfies, the production of agricultural crops is closely related to the productivity of a land, where the land with the best productivity is the one that has physical, chemical, and biological properties that meet requirements ,which can then develop into critical land (Wahyunto & Dariah, 2014). The tendency to decrease land productivity (land degradation) will increase along with the increase in population (Wahyunto & Dariah, 2014). In addition to poor land use, land conversion and land degradation is also caused by several factors, such as the effects of climate change itself, which causes drought, flood, and erosion disasters that can reduce the quality of a land (Gupta, 2019). Until 2022, the total national critical land has reached an area of 12,744,925 ha, with details : forest areas covering an area of 7,410,751 ha, and outside Forest Areas covering an area of 5,334,174 ha (Ministry of Maritime Affairs, 2023). Krupnik et al. (2022) concluded that land degradation negatively and significantly causes low agricultural productivity activities.

In the midst of natural phenomena that occur and directly affect agricultural production in an area, an analysis of the carrying capacity of an area is needed to achieve a strategy in agricultural production. The carrying capacity referred to in the purpose of this study includes how the carrying capacity of water sufficiency in the midst of the El Niño phenomenon in South Sulawesi Province, especially in Bantaeng Regency, as well as how the quality of the land in the area is related to its support for existing agricultural production. In general, sustainable agricultural patterns are needed to maintain land quality (Land Productivity) through the use of land that is in accordance with the ability of the land in order to maintain important factors that support land quality such as physical conditions, topography, and other characteristics (Alwi & Marwah, 2015).

1.2 Research Objectives

This research aims to determine the environmental carrying capacity including water carrying capacity and land carrying capacity in Bantaeng Regency

2. METHOD

2.1 Research Location and Time

The research was conducted in Bantaeng Regency, South Sulawesi. Bantaeng Regency was chosen as the research locus because researchers see great potential in the agricultural sector to be developed in Bantaeng Regency. The research lasted throughout 2023.

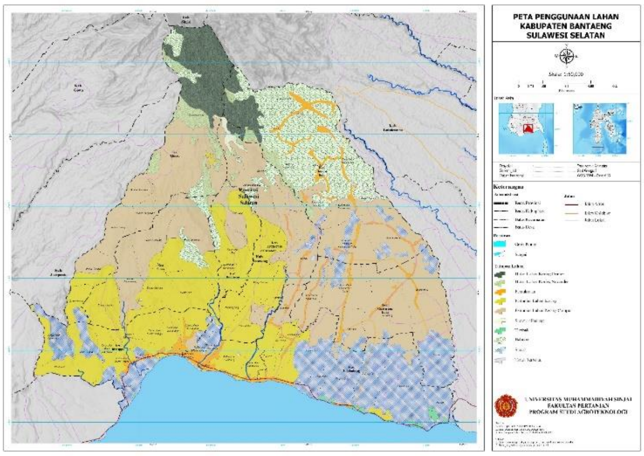

Figure 1. Research Location Maps

2.2 Data Collection

The data used are rainfall data, area data, land use maps, and population in Bantaeng Regency. Primary data were collected through a field survey, while secondary data were obtained from several sources in the literature. Details of the data and data sources can be seen in Table 1.

Table 1. Data and data sources used

Variable	Source
Land use area	Digital RBI Map
Rainfall	(BPS Bantaeng Regency, 2021, 2022, 2023)
Area study	Digital RBI Map
Total population	(BPS Bantaeng Regency, 2023)
Water needs for a decent life	(National Standardization Agency, 2002)
Commodity productivity	(BPS Bantaeng Regency, 2023)
Commodity prices	Primary data

Figure 2. Primary data collection process in the field

2.3 Data Analysis

Water Carrying Capacity Analysis

Water availability analysis determines the volume of water available to meet community needs. The calculation of water availability is carried out based on research by Brontowiyono (2016) by using the flow coefficient approach (Run Off) modified, to be Equation 1.

$$SA=10\times C\times R\times A \quad (1)$$

SA : Water availability
C : Weighted flow coefficient
R : Average annual rainfall
A : Land use area
10 : Conversion factor from mm.Ha to m^3

Meanwhile, the values of C and R can be calculated based on Equation 2.

$$R=\Sigma\ Ri/m\ ;C=\Sigma\ ((Ci\times Ai))/Ai \quad (2)$$

R : Average annual rainfall
Ri : Annual rainfall at station i
m : Number of rainfall observation stations
C : Weighted flow coefficient
Ci : Land use flow coefficient
Ai : Land use area

Water demand analysis is carried out to find out the volume of water needed by the community in a place. The results of water demand are obtained based on the variables of the population and the volume of water needs per head, based on the Minister of Environment Regulation No. 17 of 2008. The calculation of water needs is carried out using Equation 3 (Brontowiyono, 2016).

$$DA=N\times KHL\_A \quad (3)$$

DA : Water needs
N : Population
KHLA : Water needs for a decent life

A water-carrying capacity study is conducted to determine whether the available water volume meets the community's needs in a given location. The calculation of water carrying capacity can be done by combining the availability and need of water in accordance with Equation 4 (Brontowiyono, 2016).

$$DDA= SA/DA \quad (4)$$

DDA : Water carrying capacity
SA : Water availability
DA : Water needs

The results of the calculation are then classified into water-carrying capacity classes. The water carrying capacity class can be seen in Table 2.

Table 2. DDA class classification

DDA < 1	Excess or poor water carrying capacity
DDA 1 – 3	Conditional or medium safe water carrying capacity
DDA > 3	Safe or good water carrying capacity

Land Carrying Capacity Analysis

The calculation between the availability and demand of land is carried out based on the Regulation of the Minister of Environment Number 17 of 2009 concerning Guidelines for Determining Environmental Carrying Capacity in Regional Spatial Planning, with the following formula:

$$S_L = \frac{\Sigma\,(P_i\times H_i)}{H_b} \times \frac{1}{Ptv_b} \quad (5)$$

SL : Land availability (Ha)
Pi : Actual production of each type of commodity (units depending on the type of commodity). Commodities that are accounted for through agriculture, plantations, forestry, livestock and plantations
Hi : Unit price of each type of commodity (IDR/Unit) at the producer level
Hb : Unit price of rice (IDR/kg) at the producer level
Ptvb : Commodity productivity

Meanwhile, to calculate the total land requirement, the following equation is used:

$$D\_L=N\times KHL \quad (6)$$

DL : Total land demand equivalent to rice (ha)
N : Total population (people)
KHL : The area of land needed for a decent living per population

A water-carrying capacity study is conducted to determine whether the available water volume meets community's needs in a given location. The calculation of land carrying capacity can be done by comparing the availability and needs of land in accordance with Equation 6 (Brontowiyono, 2016)

$$DDL= SL/DL \quad (7)$$

DDL : Land carrying capacity
SL : Land availability
DL : Land needs

The results of the calculation are then classified into the land carrying capacity class. The water carrying capacity class can be seen in Table 3.

Table 3. DDA class classification

DDL < 1	Exceeded or poor land carrying capacity
DDL 1 – 3	Conditional or medium safe land carrying capacity
DDL > 3	Safe or good land carrying capacity

Preparation of a Strategy to Increase Agricultural Land Productivity in Bantaeng Regency

The preparation of recommendations for strategies to increase coffee productivity is carried out using the Strength, Weakness, Opportunity, Threat (SWOT) analysis method, which is equipped with the Internal Strategic Factors Analysis Summary (IFAS) and External Strategic Factors Analysis Summary (EFAS) assessment matrices. SWOT analysis is used to map the potentials and problems found in the study area, while the IFAS and EFAS matricesare used to determine priority strategies for problem-solving (Anjani et al., 2023).

3. RESULTS AND DISCUSSION

3.1 Water Carrying Capacity of Bantaeng Regency

Clean water is an important element in the daily lives of the community members (Dayfullah et al., 2021). Communities use water for domestic, livestock, and agricultural purposes (Amru & Makkau, 2023). Water demand tends to increase with population growth and industrial development (Anggraeni et al., 2021; Sitompul & Efrida, 2018). One of the water sources used in Bantaeng Regency is rainwater. Rainwater can be used as one of the water sources, both through harvesting methods and the use of rainwater infiltration as groundwater (Marni, 2019). Table 4 Describe the average rainfall in Bantaeng Regency in the period 2021 – 2023

Table 4. Average rainfall in Bantaeng Regency

Year	2021			2022			2023		
	Rainy day (hh)*	**Rainfall (mm)***	**∑ (mm/year)**	**Rainy day (hh)***	**Rainfall (mm)***	**∑ (mm/year)**	**Rainy day (hh)***	**Rainfall (mm)***	**∑ (mm/year)**
Total amount	110	2,036	223,960	208	4,234	880,672	209	4,651	972,038
Average amount	9	509.00	18,663.33	17	1,058.50	73,389.33	17	1,162.73	81,003.18
Average				910.08 mm/year					

Source:*(BPS Bantaeng Regency, 2021, 2022, 2023)

Based on Table 4, the number of rainy days in Bantaeng Regency fluctuates with an average of 14 rainy days per month. Rainfall in Bantaeng Regency has also changed from 2021 to 2023 reaching 509.00 mm/year, 1,058.50 mm/year, and 1,162.73 mm/year. This value tends to increase every year with an average rainfall of 910.08 mm/year. Susilokarti et al. (2015) stated that rainfall is one of the indicators of climate change.

Naturally, rainwater will be absorbed through the pores to be stored in the groundwater layer. The permeability of water will vary depending on the type of land cover and water movement (Wahjunie et al., 2021) and has an impact on water availability. The movement of water will be different for each type of land cover; it is not always uniform and changes according to the function of the place and time (Kamiana, 2018). Water availability for each land cover type and its drainage coefficient are shown in Table 5. The flow coefficient is a comparison between the peak of surface flow and the intensity of precipitation (Krisnayanti et al., 2018). Based on the drainage coefficient in Table 5, the largest volume of water runoff is in water bodies and ponds (drainage coefficient = 0.00), while the smallest volume is found in residential land cover (drainage coefficient = 0.65).

Table 5. Area and flow coefficient for each land use

Land Use	Land Area (Ai)* (ha)	Flow Coefficient (Ci)**	Ci X Ai (ha)
Water bodies	54.36	0.00	0.00
Shrub	1,014.66	0.35	355.13
Primary dryland forests	25.96	0.18	4.67
Secondary dryland forest	1,085.71	0.18	195.43
Settlement	1,352.36	0.65	879.03
Dryland agriculture	177.88	0.30	53.36
Mixed dryland agriculture	480.56	0.30	144.17
Savanna	28.48	0.35	9.97
Paddy	2,148.46	0.30	644.54
Pond	224.04	0.00	0.00
Total	6,592.46		2,286.30

Based on Table 5, the dominant land use in Bantaeng Regency is rice fields, with a total area of 2,148.46 ha or 32.59% of the total area of Bantaeng Regency. Other types of land cover that are widely found are secondary land forests (1,085.71 ha), bushes (1,014.66 ha), and settlements (1,352.36 ha). This information will be used to determine the estimated volume of water reservoirs in Bantaeng Regency.

Table 6. Water Availability in Bantaeng Regency

Variable	Value
Conversion factor from mm.ha to m^3	10
Weighted flow coefficient (C)	0.35
Average annual rainfall (R)	910.08
Land use area (A)	6,592.46
Total water availability (SA)	20,807,057.29

The volume of available water is influenced by several parameters, including rainfall and drainage coefficients. The flow coefficient greatly affects the volume of water runoff (Saidah et al., 2023). The smaller the flow coefficient, the more likely the water is to stay and not flow. And vice versa, if the flow coefficient is large, water tends to flow resulting in smaller runoff volume Based on calculations, the total water availability in Bantaeng Regency is 20,807,057.29 m3/year.

The calculation of water needs in Bantaeng Regency is carried out using the approach of the number of people, with the volume of water needed per person in one year. The results of the calculation of water needs in Bantaeng Regency can be seen in Table 7.

Table 7. Total water demand in Bantaeng Regency

Variable	Value
Bantaeng population 2023*	200,900
Water needs for a decent life (m^3/capita/year)**	2193
Total Water Demand (DA)	4,405,737

Source:*(BPS Bantaeng Regency, 2023) **(National Standardization Agency, 2002)

Based on Table 7, information was obtained that the population in Bantaeng Regency reached 200,900 people (BPS, 2023). Based on the Minister of Environment Regulation No. 17 of 2008, the volume of water needed by the community to be able to live properly reaches 21.93 m3/capita/year. Thus, the estimated total water demand in Bantaeng Regency in 2023 is 4,405,737m3/year.

Table 8. Water carrying capacity

Variable	Value
Total water availability (SA, m^3/year)	20,807,057.29
Total water requirement (DA, m^3/year)	4,405,737
Water carrying capacity (DDA)	4.72

Environmental carrying capacity is determined based on environmental capacity information and resources that function to support human activities (Brontowiyono, 2016). The carrying capacity of water is obtained by comparing the total water availability with the water requirement. Based on the calculation results, the water carrying capacity value in Bantaeng Regency shows a figure of 4.72, which is categorized as safe.

3.2 Land Carrying Capacity of Bantaeng Regency

Land carrying capacity is the ability of the region to provide land to meet the needs of the community, especially in food scarcity. Bantaeng Regency has very complex regional conditions, ranging from the coastline used by residents to plant seaweed to agricultural areas that are used by the community to cultivate high-value agricultural products. Bantaeng has a high altitude that is suitable for developing agricultural and livestock areas. Evaluatingthe environment and economic development of a region can be seen from its carrying capacity indicators (Widodo et al., 2015). Based on observations in the field, Bantaeng Regency, through the Agriculture and Fisheries sectors has a large contribution to the economic wheel of its community. Massiseng & Ummung (2018) stated that the main sector that determines the economy of Bantaeng district is the Agriculture, Forestry, and Fisheries sector, which contributes up to 31.74%

Table 9. Actual production of each type of commodity in Bantaeng Regency

Commodities	Quantum (Pi) Production 2023*	Price (Hi)**	Unit	Unit Production Value in rupiah (Pi x Hi)
Rice	70,338	13,000	kg	IDR 914,394,000
Corn	161,654	6,600	kg	IDR 1,066,917,588
Cassava	351	4,000	kg	IDR 1,404,840
Pumpkin spice	527	6,000	kg	IDR 3,159,300
Peanut	516	14,000	kg	IDR 7,221,060
Green beans	50	16,000	kg	IDR 800,640
Soybean	0		kg	IDR0
Dairy	0		individuals	IDR0
Cow	1,772	14,000,000	individuals	IDR24,808,000,000
Buffalo	59	30,000,000	individuals	IDR 1,770,000,000
Horse	1,710	13,000,000	individuals	IDR 22,230,000,000
Goat	2,903	3,000,000	individuals	IDR 8,709,000,000
Sheep	0		individuals	IDR0

Rabbit	0		individuals	IDR0
Purebred chickens	125,997	35,000	individuals	IDR 4,409,895,000
Free-range chickens	91,073	50,000	individuals	IDR 4,553,650,000
Duck	866	30,000	individuals	IDR 25,980,000
Quail	843	16,000	individuals	IDR 13,488,000
Total				IDR 68,513,910,428

Source:*(BPS Bantaeng Regency, 2023) **(Primary Data)

From the results of the calculation in Table 9. The total production value in Bantaeng Regency reaches IDR 68,513,910,428. This value will be the basis for calculation to determine the total availability of land there.

Table 10. Calculation of land availability in Bantaeng Regency

Variable	Value
Total unit production value in rupiah ∑(Pi x Hi)	IDR 68,513,910,428
Unit price of rice (IDR/kg) at the producer level (Hb)*	IDR 13,000
Commodity productivity (Ptvb) (kg/ha)**	7,069.40
Total land availability (SL) (ha)	745.51

Source: *(Primary Data) **(Figures After Rice GKG Conversion – Year 2023)

From the calculation results in Table 10, the total land availability in Bantaeng Regency will reach 745.51 ha in 2023. This value will be the basis for calculation to determine the carrying capacity of the land in Bantaeng Regency.

Table 11. Results of calculation of land needs in Bantaeng Regency

Variable	Value
Bantaeng population 2023*	200,900
Land needs for decent living (ha)*	0.54
Total land requirement (DL)	109,249.42

Source:*(BPS Bantaeng Regency, 2023)

Based on the results of the calculation in Table 11, the land needed in Bantaeng Regency in 2023 is 109,249.42 ha. The number of land needs exceed the land there.

Table 12. Results of land carrying capacity analysis

Variable	Value
Total land availability (SL, m^3/year)	745.51
Total land requirement (DL, m^3/year)	109,249.42
Land carrying capacity (DDL)	0.007

Based on the results of the analysis, the score (DDL) of Bantaeng Regency < 1 is 0.007, which means Land Carrying Capacity is exceeded or poor. This means that based on the amount of land available, it is no longer possible to develop areas that are expansive and exploratory to land, because it will threaten the ability of land to meet the basic needs of the population. This refers to a comparison of the need for land area that produces food crops and the number of people in an area. The smaller the minimum physical requirement (KFM) and the higher the food production rate, the greater the increase in carrying capacity of good land (Talumingan & Jocom, 2017). The condition of the partly hilly area makes it difficult to increase the area of land as the population is increasing. A higher population can lead to higher demand for land (Rakuasa et al., 2022).

3.3 Strategies to Increase Agricultural Land Productivity in Bantaeng Regency

The productivity of agricultural land in Bantaeng Regency is important to be optimized. This is not only related to the use of available natural potential, but will also have a positive impact on improving the economy of the community, especially for farmers. Not only that, but the agricultural sector is one of the main components of economic growth in various regions. This is in accordance with research by Happy (2022), which states that the agricultural subsector is the first flagship that affects economic growth in Merangin Regency and research by Squirming (2018) in Tomohon City. Even Tanjung et al. (2022) stated that agriculture is one of the priority sectors in economic development in Belitung Regency.

The determination of the strategy must go through the analysis stage to obtain one that is relevant to the existing conditions. Many strategy preparation methods use a combination of SWOT analysis and other analyses, including the Quantitative Strategic Planning Matrix (QSPM) (Qanita, 2020), Internal Factor Evaluation-External Factor Evaluation (IFE-EFE), and Business Model Canvas (Hartatik & Baroto, 2017). In this study, strategies to increase agricultural land productivity in Bantaeng Regency were determined using SWOT analysis combined with IFAS-EFAS analysis, with the following analysis results.

Table 13. SWOT analysis matrix

Internal / External	Weaknesses 1. Lack of agricultural land 2. High slope 3. Hilly farmland	Strengths 1. Water sources for agriculture abound 2. Soil type supports for agriculture 3. Climate support for agriculture 4. High government support for agriculture
Opportunities 1. Most of the population works as farmers 2. Has good road access for the distribution of agricultural products 3. Have a network to the international market through cooperation with foreign parties	WO 1. Addition of agricultural land and optimization of available agricultural land 2. Application of agricultural technology that matches the contours of the region 3. Utilizing road access to facilitate the distribution of agricultural products 4. Utilization of market networks to increase the distribution of agricultural products	SO 1. Construction of irrigation canals to increase agricultural yields 2. Planting optimization to increase agricultural yields 3. Increasing the capacity of farmers to utilize all existing agricultural potentials 4. The use of road access to facilitate the distribution of agricultural products through cooperation with the government 5. Increased role and government support in leveraging available market networks
Threats 1. High risk of land erosion 2. The emergence of agricultural pests due to forest conversion 3. The rise of forest conversion into residential areas, mines, etc.	WT 1. Addition of farmland in areas with low erosion risk 2. Agricultural pest control 3. Minimize land conversion activities into settlements and nickel mines, replacing them with types of land that have high economic and ecological value such as forests or mangroves	ST 1. Manage the quality of available water sources 2. Utilizing the type of soil and climate that supports it through the planting of vegetation that has high economic and ecological value 3. Minimize land conversion activities into settlements and nickel mines, replacing them with types of land that have high economic and ecological value such as forests or mangroves 4. Determination of rules to reduce land conversion

Based on Table 13 above, Bantaeng Regency is supported by excellent natural conditions for agriculture. Abundant and easily accessible water sources, fertile soil types, and a conducive climate are internal factors that can increase the productivity of agricultural land. Water availability has a great effect on the productivity of agricultural land, especially in dry land. Fulfilling water needs is a determinant of crop productivity (Sutrisno & Heryani, 2020). Another strength was found in external factors, including local and regional government support, in the implementation of various efforts to increase agricultural land productivity. Government support is very crucial. This is in line with research by Saraan & Rambe (2023), which states that government commitment and policies are urgently needed to increase agricultural productivity even though high-precision technology is available.

However, some weaknesses were also found, namely the limited land area with land topography in hilly areas with high slopes. The slope of the land affects crop productivity. This is reinforced by the results of the research by Nisaa (2019), where the lowest productivity of robusta coffee plants in Malang Regency is obtained at a land slope above 25%. As stated by Andhika et al. (2024) in research in the agricultural area of Batu City, the land's topography will affect production.

The livelihood of the local population, which is dominated as farmers, is one of the opportunities to increase the productivity of agricultural land in Bantaeng Regency. Ilindamon et al. (2022)stated that a similar thing where agriculture is the main sector that affects the income of the Indonesian people, which is dominated by farmers. In addition, the ease of marketing agricultural products is also an opportunity that must be utilized. Currently, the product marketing network is available in both local, national, and international markets through collaboration with various parties. Coupled with supporting infrastructure such as road access that facilitates the process of distributing products to consumers in various destination areas. This is in line with research by Anjani et al. (2024) where accessibility is able to move the product marketing process.

Optimizing agricultural land productivity in Bantaeng Regency is not without threats. The rise of land conversion, especially forests, into settlements, mines, and others actually increases the risk of land erosion. Soil erosion will result in soil loss of nutrients and impact land productivity (Andhika et al., 2024). In addition, forest conversion can result in the emergence of wild boar pests due to the destruction of native habitats. Wild boar pests l threaten agricultural land reducing its productivity Similar finding were also conveyed by Dewi et al. (2023) related to monkey and wild boar pests that interfere with avocado production in Sumberahyu Village, Kendal.

The strategy for optimizing agricultural land productivity in Bantaeng Regency is prepared based on the results of the SWOT analysis, according to the matrix in Table 13 above. Ideally, all strategies are carried out simultaneously, but time constraints and implementation costs result in the need to determine priority strategies. The priority strategy is determined through the IFAS-EFAS analysis based on the calculation of weights and ratings as shown in Figure 2 below.

Figure 2. IFAS-EFAS matrix for priority strategy determination

Based on the results of the IFAS-EFAS analysis, the ST strategy was chosen as a priority strategy that must be carried out to increase the productivity of agricultural land in Bantaeng Regency. IFAS-EFAS analysis is commonly used to determine priority strategies of different types depending on the situation and conditions of the research area, such as in the study by Anjani et al. (2023), where the SO strategy is the chosen strategy for the development of mangrove-based ecotourism in Indramayu and Mangrovesari ecotourism in Brebes (Anjani et al., 2024).

The main strategy that needs to be done is to manage the quality and quantity of available water sources because water is an important factor in the use of agricultural land, especially dryland types. Agricultural products depend on meeting water needs, so good management is needed to ensure optimal yields. Water needs can be met through various technologies that continue to be developed to date, one of which is the water-saving irrigation model (Sutrisno & Heryani, 2020) and solar water pumps (Sairi et al., 2024). The management of water quality and quantity must also be accompanied by the management of supporting infrastructure and by increasing knowledge, awareness, capacity, and community involvement of the importance of water source management. Increased knowledge is also positively correlated with agricultural productivity. Ilindamon et al. (2022)state that the low quality of human resources in the process of cultivating agricultural land is one of the factors that contribute to low productivity. Increased community involvement is also applied in the management of irrigation canals through the establishment of farmer institutions (Sutrisno & Heryani, 2020)

Soil types and favorable climates also need to be optimally utilized through the process of planting vegetation that has high economic and ecological value. Vegetation with high economic value can improve people's standard of living, especially farmer's, while vegetation with high ecological value can benefit the environment and even reduce the rate of climate change, which has been worsening recently. Agroforestry model with the cultivation of local fruit crops is able to contribute 26% of total annual household income (Ardini et al., 2020). The selection of vegetation is also able to have an impact on increasing community resilience, especially from the economic sector. Improving the economic level of community businesses in various sectors, such as ecotourism, will increase household resilience (Kasmiati et al., 2016).

The population increase that also occurs in Bantaeng allows the conversion of land, especially forests, into settlements, mining, etc., in order to meet human needs. Similar findings are stated by Prabowo et al. (2020), where land conversion is triggered by the fulfillment of the needs of residential areas. Land conversion needs to be minimized through the establishment of rules such as selecting less productive areas and avoiding land conversion that has high economic and ecological value such as primary forests and mangrove forests. For example, the calculation of the economic value of carbon stores in the Jompie Botanical Garden, Pare-Pare, that reaches 60.67 tons per year or equivalent to IDR. 7,845,899 per year (Ichwan, 2021). The overall strategy needs to be strengthened with binding rules, monitoring, and rewards and punishments to encourage optimal strategy implementation.

4. CONCLUSION

Based on the calculation results, the water carrying capacity in Bantaeng Regency is 4.72, which falls within the good category. Meanwhile, based on the results of the calculation of land carrying capacity in Bantaeng Regency, the number 0.007 is categorized as the carrying capacity of the land is exceeded or poor. Therefore, to increase agricultural productivity in Bantaeng Regency, it is necessary to carry out a development strategy. Based on the results of the SWOT analysis and the IFAS-EFAS matrix, the strategy that must be carried out immediately is in the ST quadrant. The strategy includes: 1) Managing the quality of available water resources; 2) Utilizing the type of soil and climate that supports through the planting of vegetation that has high economic and ecological value; 3) Minimize land conversion activities into settlements and nickel mines, replace them with types of land that have high economic and ecological value such as forests or mangroves and; 4) Determination of rules to reduce land conversion.

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REFERENCES

Alwi, L. O., & Marwah, S. (2015). Analisis Dampak Perubahan Penggunaan Lahan terhadap Degradasi Lahan dan Pendapatan Petani di DAS Wanggu Sulawesi Tenggara. *Jurnal Pengkajian Dan Pengembangan Teknologi Pertanian*, *18*(2), 117–130.

Amru, K., & Makkau, B. A. (2023). Analisis Kualitas Air Sungai Palopo Akibat Pencemaran Limbah Domestik dengan Metode Index Pollution. *Jurnal Teknologi Lingkungan*, *24*(2), 137–142. https://doi.org/https://doi.org/10.55981/jtl.2023.288

Andhika, Y., Sudarto, S., & Widianto, W. (2024). Pengaruh Variabilitas Topografi Dan Sifat Fisik Tanah Terhadap Produksi Kentang Di Kecamatan Bumiaji, Kota Batu. *Jurnal Tanah Dan Sumberdaya Lahan*, *11*(1), 87–94. https://doi.org/10.21776/ub.jtsl.2024.011.1.10

Anggraeni, N. L., Yusrianti, Y., Auvaria, S. W., & Amrullah, A. (2021). Analisis Daya Dukung DAS Berdasarkan Kriteria Tata Air dan Daya Tampung Beban Pencemaran Sungai Gedek. *Jurnal Serambi Engineering*, *6*(3), 2180–2189. https://doi.org/10.32672/jse.v6i3.3252

Anjani, R., Amru, K., Herningtyas, W., Aryantie, M. H., Ikhwanuddin, M., Winanti, W. S., & Sudinda, T. W. (2024). Penilaian Ekowisata Mangrovesari di Kabupaten Brebes melalui Studi Kelayakan serta Perumusan Strategi Pengembangannya Assessment of Mangrovesari Ecotourism in Brebes Regency through Feasibility Study and Its Development Strategies. *Jurnal Teknologi Lingkungan*, *25*(1), 059–070.

Anjani, R., Ihsan, I. M., Amru, K., Aryantie, M. H., Oktivia, R., Saraswati, A. A., Ikhwanuddin, M., Winanti, W. S., Sudinda, T. W., Kujaeri, S., & Listiani, T. (2023). Analisis potensi, penentuan strategi, dan penyusunan green map untuk pengembangan eco-village berbasis mangrove di Kabupaten Indramayu. *Jurnal Teknologi Lingkungan*, *24*(2), 207–219.

Ardini, M., Marsela, A., Mustika, R., Subakti, R., Khairani, S., & Suwardi, A. B. (2020). Potensi Pengembangan Agroforestri Berbasis Tumbuhan Buah Lokal. *Jurnal Ilmiah Pertanian*, *17*(1), 27–34. https://doi.org/10.31849/jip.v17i1.4113

Badan Standarisasi Nasional. (2002). SNI 19-6782.1-2002 Penyusunan Neraca Sumber Daya Bagian 1 : Sumber Daya Air Spasial. *Sni 19-6728.1-2002*, *ISSN No. 2*(1), 25–31.

BPS Kabupaten Bantaeng. (2021). *Kabupaten Bantaeng Dalam Angka 2021*.

BPS Kabupaten Bantaeng. (2022). Kabupaten Bantaeng Dalam Angka 2022. *Badan Pusat Statistik (BPS) Kabupaten Bantaeng*.

BPS Kabupaten Bantaeng. (2023). *Bantaeng Regency in Figures 2023*. 353.

Brontowiyono, W. (2016). KLHS Untuk RTRW dengan Pendekatan Daya Dukung Lingkungan. In *Universitas Islam Indonesia*. Gre Publisher.

Dayfullah, H. F., Diwangkoro, R. G., & Thoyibah, F. (2021). *Peningkatan pendapatan masyarakat kampung surupan melalui penyaluran air bersih dari sumber mata air*. *1*(2), 46–50.

Dewi, R. N. H., Ariyani, A. M., Widodo, R. C., Miharjo, E. S. R., Mutohhar, A., & Nursyahidah, F. (2023). Pencegahan Hama Kera sebagai Upaya Mengatasi Permasalahan Petani Alpukat Desa Sumberahayu. *Jurnal Pemberdayaan Masyarakat*, *2*(2), 80–88. https://doi.org/10.46843/jmp.v2i2.287

Gupta, G. S. (2019). Land Degradation and Challenges of Food Security. *Review of European Studies*, *11*(1), 63. https://doi.org/10.5539/res.v11n1p63

Hartatik, H., & Baroto, T. (2017). Strategi Pengembangan Bisnis Dengan Metode Business Model Canvas. *Jurnal Teknik Industri*, *18*(2), 113–120. https://doi.org/10.22219/jtiumm.vol18.no2.113-120

Ichwan, M. (2021). Nilai Ekonomi Simpanan Karbon Kebun Raya Jompie Kota Parepare. *Gorontalo Journal of Forestry Research*, *4*(2), 126–139.

Ilindamon, A., Yobo, Y. B., & Endah Dwi Lestari. (2022). Peran Petani Dalam Meningkatkan Ekonomi Keluarga di Abepantai Distrik Abepura Kota Jayapura. *ARBITRASE: Journal of Economics and Accounting*, *3*(2), 461–465. https://doi.org/10.47065/arbitrase.v3i2.517

Kamiana, I. M. (2018). Pengendalian Debit Limpasan Permukaan Berbasis Pemanenan Air. *PROTEKSI (Proyeksi Teknik Sipil)*, *4*(2), 176–183.

Kasmiati, Darmawan, A. H., & Bratakusumah, D. S. (2016).

Ekowisata, Sistem Nafkah, Dan Decoupling Sustainbility di Wakatobi, Sulawesi Tenggara. *Sodality: Jurnal Sosiologi Pedesaan*, *4*(2). https://doi.org/10.22500/sodality.v4i2.13391

Kemenkomarvest. (2023). *Ketahanan Pangan dari Lahan Kritis dan Terdegradasi*. https://maritim.go.id/detail/ketahanan-pangan-dari-lahan-kritis-dan-terdegradasi

Krisnayanti, D. S., Karels, D. W., & Nursyam, N. A. (2018). Koefisien Pengaliran Embung Kecil Di Pulau Flores Bagian Barat. *Jurnal Teknik Sipil*, *7*(1), 1–14. https://jurnalindustri.petra.ac.id/index.php/jurnal-teknik-sipil/article/view/21001

Krupnik, S. P., Rajnath, S. K., & Nirmala, S. R. (2022). Effect of Land Degradation on Agricultural Productivity in West Bengal, India. *African Journal of Emerging Issues*, *12*, 66–75.

Marni, E. (2019). Analisis Potensi Pemanenan Air Hujan Sebagai Salah Satu Alternatif Penghematan Pemakaian Air Tanah Pada Kawasan Universitas Ekasakti. *Journal of Scientech Research and Development*, *1*(1), 052–060. https://doi.org/10.56670/jsrd.v1i1.7

Massiseng, A. N. A., & Ummung, A. (2018). Analisis Sektor Unggulan Berdasarkan Potensi. *Octopus Jurnal Ilmu Perikanan*, *7*, 709–717.

Nisaa, M. K. (2019). *Pengaruh Berbagai Kemiringan Lahan Terhadap Produktivitas Tanaman Kopi Robusta (Coffea canephora)*. Universitas Brawijaya.

Plamonia, N. (2020). *Improving The Coverage Area of Drinking Water Provision by Using Build Operate and Transfer Investments in Indonesia. An Institutional Analysis*.

Prabowo, R., Bambang, A. N., & Sudarno. (2020). Pertumbuhan Penduduk dan Alih Fungsi Lahan. *Jurnal Ilmu-Ilmu Pertanian*, *1*(April), 26–36.

Prasetyo, B., & Pusparini, N. (2019). Response of Rainfall to El Nino Modoki in Celebes. *Jurnal Meteorologi Dan Geofisika*, *20*(1), 21–29.

Qanita, A. (2020). Analisis Strategi Dengan Metode Swot Dan Qspm (Quantitative Strategic Planning Matrix): Studi Kasus Pada D’Gruz Caffe Di Kecamatan Bluto Sumenep. *Komitmen: Jurnal Ilmiah Manajemen*, *1*(2), 11–24. https://doi.org/10.15575/jim.v1i2.10309

Rahayu, S. (2022). Potensi Ekonomi Sektor Pertanian, Kehutanan Dan Perikanan Kabupaten Merangin. *Bussman Journal : Indonesian Journal of Business and Management*, *2*(1), 147–163. https://doi.org/10.53363/buss.v2i1.45

Rakuasa, H., Supriatna, S., Karsidi, A., Rifai, A., Tambunan, M. P., & Poniman, K. A. (2022). Spatial Dynamics Model of Earthquake Prone Area in Ambon City. *IOP Conference Series: Earth and Environmental Science*, *1039*(1). https://doi.org/10.1088/1755-1315/1039/1/012057

Saidah, H., Wirahman, L., & Hidayaturrohmi, L. (2023). Evaluasi Kinerja Metode Perhitungan Koefisien Pengaliran. *Jurnal Sains Teknologi & Lingkungan*, *9*(1), 74–85. https://doi.org/10.29303/jstl.v9i1.405

Sairi, A. P., Apriyani, A., & Arohmah, L. D. (2024). Pembuatan Alat Pompa Air Tenaga Surya untuk Sistem Irigasi Pertanian: Uji Coba di Laboratorium. *Juwara Jurnal Wawasan Dan Aksara*, *4*(1), 160–169. https://doi.org/10.58740/juwara.v4i1.99

Saraan, M. I. K., & Rambe, R. F. A. K. (2023). Kebijakan Pengembangan Inovasi Teknologi Pertanian Presisi di Provinsi Sumatera Utara. *Jurnal Kajian Agraria Dan Kedaulatan Pangan (JKAKP)*, *2*(1), 1–5. https://doi.org/10.32734/jkakp.v2i1.13319

Sitompul, M., & Efrida, R. (2018). Evaluasi Ketersediaan Air DAS Deli Terhadap Kebutuhan Air (Water Balanced). *Jurnal Rekayasa Sipil (JRS-Unand)*, *14*(2), 121. https://doi.org/10.25077/jrs.14.2.121-130.2018

Sub Bidang Peringatan Dini Iklim BMKG. (2018). *El Nino La Nina di Indonesia*.

Sulaiman, A. A., Agus, F., Noor, M., Dariah, A., Irawan, B., & Surmaini, E. (2018). *Jurus Jitu Menyikapi Iklim Ekstrem El Nino dan La Nina Untuk Pemantapan Ketahanan Pangan* (I. Las & Yulianto (eds.)). IA ARD PRESS.

Susilokarti, D., Arif, S. S., Susanto, S., & Sutiarso, L. (2015). Identifikasi Perubahan Iklim Berdasarkan Data Curah Hujan di Wilayah Selatan Jatiluhur Kabupaten Subang, Jawa Barat. *Jurnal Agritech*, *35*(01), 98. https://journal.ugm.ac.id/agritech/article/view/13038/15155

Sutrisno, N., & Heryani, N. (2020). Pengembangan Irigasi Hemat Air untuk Meningkatkan Produksi Pertanian Lahan Kering Beriklim Kering. *Jurnal Sumberdaya Lahan*, *13*(1), 17. https://doi.org/10.21082/jsdl.v13n1.2019.17-26

Talumingan, C. . ., & Jocom, S. G. (2017). Kajian Daya Dukung Lahan Pertanian Dalam Menunjang Swasembada Pangan Di Kabupaten Minahasa Selatan. *Agri-Sosioekonomi*, *13*(1), 11. https://doi.org/10.35791/agrsosek.13.1.2017.14881

Tanjung, G. S., Pujiyanto, M. A., Farichah, L., & Eka, F. (2022). *Potensi Sektor Pertanian Dalam Prioritas Pembangunan Ekonomi Kabupaten Belitung*. *19*(2016), 110–123.

Tongkukut, S. H. J. (2011). El-NINO DAN PENGARUHNYA TERHADAP CURAH HUJAN DI MANADO SULAWESI UTARA. *Jurnal Ilmiah Sains*, *11*(1), 102. https://doi.org/10.35799/jis.11.1.2011.51

Tumangkeng, S. (2018). Jurnal Berkala Ilmiah Efisiensi Volume 18 No . 01 Tahun 2018 ANALISIS POTENSI EKONOMI DI SEKTOR DAN SUB SEKTOR Jurnal Berkala Ilmiah Efisiensi Volume 18 No . 01 Tahun 2018. *Jurnal Bekala Ilmu Efisiensi*, *18*(01), 127–138.

Wahjunie, E. D., Baskoro, D. P. T., & Tarigan, S. D. (2021). The Peranan Pergerakan Air Dalam-Tanah dalam Menurunkan Aliran Permukaan. *Jurnal Ilmu Pertanian Indonesia*, *26*(2), 292–300. https://doi.org/10.18343/jipi.26.2.292

Wahyunto, & Dariah, A. (2014). Degradasi Lahan di Indonesia: Kondisi Existing , Karakteristik, dan Penyeragaman Definisi Mendukung Gerakan Menuju Satu Peta. *Jurnal SUmberdaya Lahan*, *8*(2), 81–93.

Widodo, B., Lupyanto, R., Sulistiono, B., Harjito, D. A., Hamidin, J., Hapsari, E., Yasin, M., & Ellinda, C. (2015). Analysis of Environmental Carrying Capacity for the Development of Sustainable Settlement in Yogyakarta Urban Area. *Procedia Environmental Sciences*, *28*(SustaiN 2014), 519–527. https://doi.org/10.1016/j.proenv.2015.07.062