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Analysis of agricultural land carrying capacity and food availability using a grid system in the Hulu Sungai Tengah district

Muhammad Riswan[1,4], Syarifuddin Kadir[2], Mijani Rahman[3], Ahmad Jauhari[2]

[1]*Doctoral Program of Agriculture Science, Postgraduate Lambung Mangkurat University, Banjarbaru, South Kalimantan, Indonesia*

[2]*Faculty of Forestry, Lambung Mangkurat University, Banjarbaru 70714, South Kalimantan, Indonesia*

[3] *Faculty of Fisheries and Marine Science, Lambung Mangkurat University , Banjarbaru 70714, South Kalimantan, Indonesia*

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Abstract

An imbalance between the carrying capacity of land and the availability of water and food will have a negative impact and may even result in an environmental disaster if the carrying capacity of the environment is exceeded. For this reason, it is necessary to carry out an analysis of the carrying capacity of agricultural land by measuring food availability using a grid system as input for policies, plans and programs as the basis for preparing sustainable development planning documents. The carrying capacity of agricultural land in Hulu Sungai Tengah Regency in 2021 is 76,739.07 ha, while the availability of agricultural land is 72,708.02 ha, indicating an exceeded status of 5.25%. There are five sub-districts whose agricultural carrying capacity status is exceeded, namely, Barabai, South Batang Alai, North Batang Alai, Batu Benawa and South Labuan Amas Districts. Hulu Sungai Tengah Regency, with an area of 177,077 ha, has an area that has not been exceeded by its food carrying capacity of 94,768.33 ha. The carrying capacity of food with the status of having been exceeded is in Barabai Sub-District because it is the capital of the district with the consequence of the large conversion of agricultural land into settlements and offices, besides having the highest population.

* **Corresponding Author:** ✉ 1940511310001@mhs.ulm.ac.id

Introduction

Carrying capacity is the ability of the environment to support the activities or activities of the people living on it who use space for survival. Environmental degradation that occurs as a result of the impact of rampant development has led to various efforts to increase the fulfillment of the availability of water and food as a source of life. Conversion of agricultural land into other cultivated land or settlements makes agricultural land increasingly minimal as a support in the environmental balance cycle. Various studies have proven that the rate of increase in population or human population is not accompanied by the supply of food and food production. Therefore, in its sustainability, it is necessary to protect and control the use of space (Mulawarman *et al.*, 2020; Shui *et al.*, 2022). The carrying capacity imbalance that occurs will eventually have a negative impact and may even result in an environmental disaster if the carrying capacity of the environment for the availability of water and food has been exceeded. Determination of excess availability by water and food needs can be expressed through the status of environmental carrying capacity (Kusumawardhani, 2020).

South Kalimantan, with an area of 3,874,423 hectares, makes the agricultural sector the second largest mainstay of the economy after mining and quarrying. Rice production, which consists of lowland rice and upland rice, has decreased the harvested area of paddy fields in 2018 compared to 2017 from 506,823 ha decreased to 278,853 ha or 44.9 8 %; this indicates a decrease in the carrying capacity of the provision of agricultural land (BPS, 2020b). Types of food that are suitable for cultivation include lowland rice, upland rice, corn, soybeans, and peanuts (RPPLH Kalsel, 2017).

There was a decrease in the area of agricultural land in 2018, from 59,163 ha to 51,061 ha in 2019. Paddy production decreased to 267,490 tons in 2019 from the previous 301,909 tons in 2018 (BPS, 2020a). Since 2015 the contribution of the agricultural sector to the GRDP (Gross Regional Domestic Product) of Hulu Sungai Tengah Regency has continued to decrease from 25.53% to 24.03% in 2019 (BPS, 2020c). An increase in population causes a decrease in the area of agricultural land due to the conversion of agricultural land to built-up land. Land use change has an impact on increasing the amount of erosion and sedimentation on land resulting in the siltation of rivers, reservoirs, and irrigation canals. Floods and droughts can have a big impact on farmland productivity as they can cause crop failure and agricultural land puso, which leads to a decrease in power capability to support agricultural land. In this regard, it is necessary to carry out an analysis of the carrying capacity of agricultural land in Hulu Sungai Tengah by measuring food availability using a grid system as input for policies, plans and programs as a basis for preparing sustainable development planning documents.

Methodology

The population distribution model used depends on the type of land cover or land use and the length of the road. Land and road class weights used to model population density can be seen in Table 1.

The applied mathematical equation adopts the population density model (Nengsih, 2015); (Norvyani and Taradini, 2016)as follows:

$$P_{ij} = \frac{W_{total}}{\sum_{i=1}^{I} W_{total}} \times P_j \quad (1)$$

Where P_{ij} is the population of the ith grid in the district/city j (capita) , W_{total} is the weight of population density based on land class and type of road , P_j Population of district/city j (capita) , $\sum_{i=1}^{I} W_{total}$ Total population density weights from all grids in districts/cities j.

Calculation of Availability (*Supply*) of Land, using the formula:

$$SL = \frac{\Sigma\,(Pi \times Hi)}{Hb} \times \frac{1}{Ptvb} \quad (2)$$

Where SL is the availability of land (ha) , Pi is the actual production of each type of commodity (unit depends on the type of commodity). The calculated commodities include agriculture, plantations, forestry, livestock and fisheries. H_i is The unit price of each type of commodity (Rp/unit) at the producer level, Hb is Unit price of rice (Rp/kg) at the producer level, Ptvb is Rice productivity (kg/ha).

The conversion factor used to equate non-rice products with rice is price.

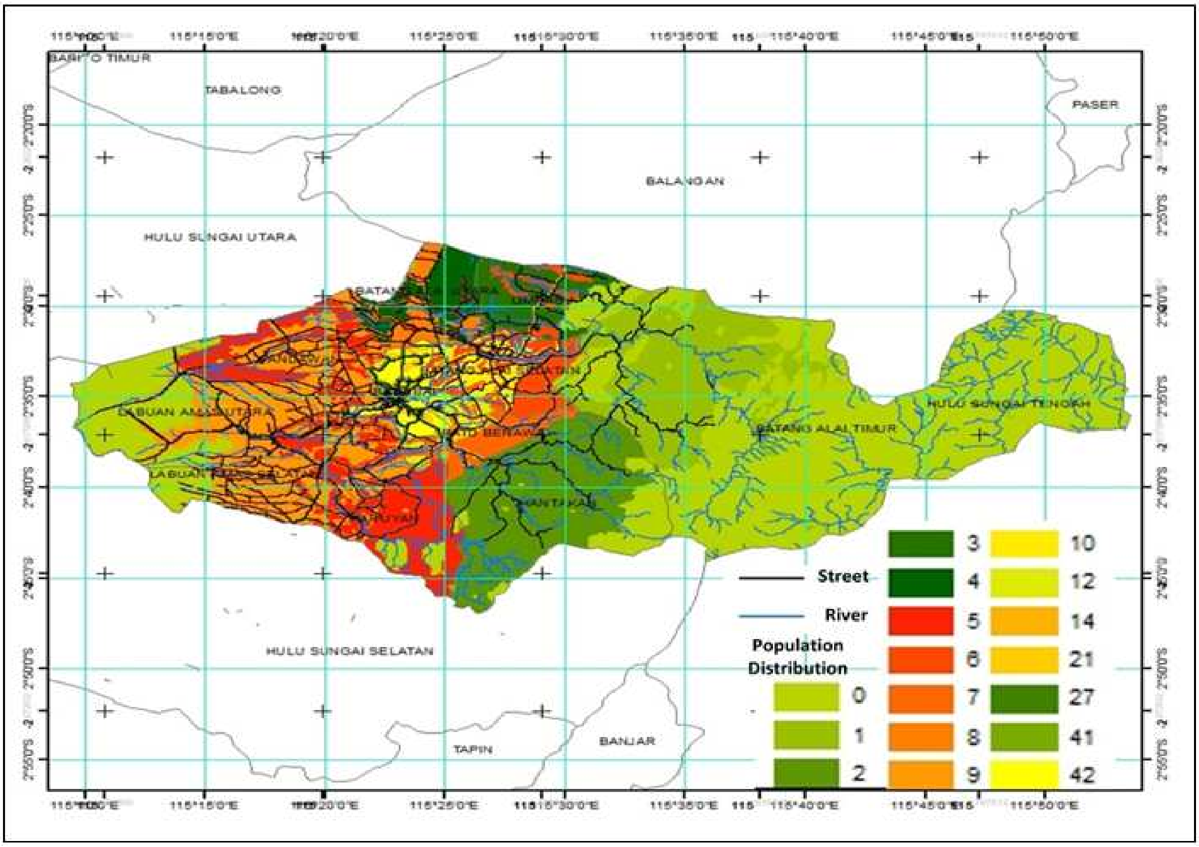

Fig. 1. Map of Population Distribution Based on Grid in HST Regency in 2021.

Calculation of Land Needs (*Demand*), using the formula:

$$DL = N \times KHLL \quad (3)$$

Where DL is Total land requirement equivalent to rice (ha), N is the number of inhabitants (people), KHLL is The area of land needed for decent living needs per inhabitant

1) The area of land needed for decent living needs per population is the decent living needs per population divided by the productivity of local rice.
2) The need for decent living per resident is assumed to be 1 ton of rice equivalent/capita/year.
3) Regions that do not have data on local rice productivity can use data on average national rice productivity of 2400 kg/ha/year.

(3) Determination of the Status of the Carrying Capacity of Agricultural Land.

The status of land carrying capacity is obtained from a comparison between land availability (SL) and land demand (DL). If SL > DL, then the carrying capacity of the land is declared a surplus. If SL < DL, then the carrying capacity of the land is declared a deficit or exceeded. Referring to Permenkes Nomor 28 Tahun 2019 Tentang Angka Kecukupan Gizi Yang Dianjurkan Untuk Masyarakat Indonesia, the energy requirement for food is obtained by calculating the Energy Adequacy Rate (AKE) for each grid for a year. This calculation requires population distribution data in a grid system and AKE per capita for a year. Norvyani and Taradini (2016) calculate the AKE for each grid using the following equation:

$$K_{B_i} = P_{ij} \times AKE \times 365 \quad (4)$$

Where K_{B_i} is the AKE on the *i* grid for a year (kcal) , P_{ij} is the total population on the i grid *in* the *j district/city* , the AKG is the energy adequacy rate per capita (kcal); 2,150 (kcal/day).

Determination of the status of food carrying capacity is based on a threshold in the form of population and is determined through a comparison approach of availability to needs. The threshold for food carrying capacity is when the difference is zero, or when availability equals demand. The threshold value is the total of the threshold values for all grids, where the food-carrying capacity threshold for each grid is determined by the following equation:

$$TP_{ij} = \frac{K_{H_{ij}}}{AKE \times 365}$$

Where TP_{ij} is the DDLH threshold for environmental services as a food provider on grid i *in* district/city *j* (capita) , $K_{H_{ij}}$ is food energy on grid i *in* district/city *j* , AKE is energy adequacy rate per capita (kcal).

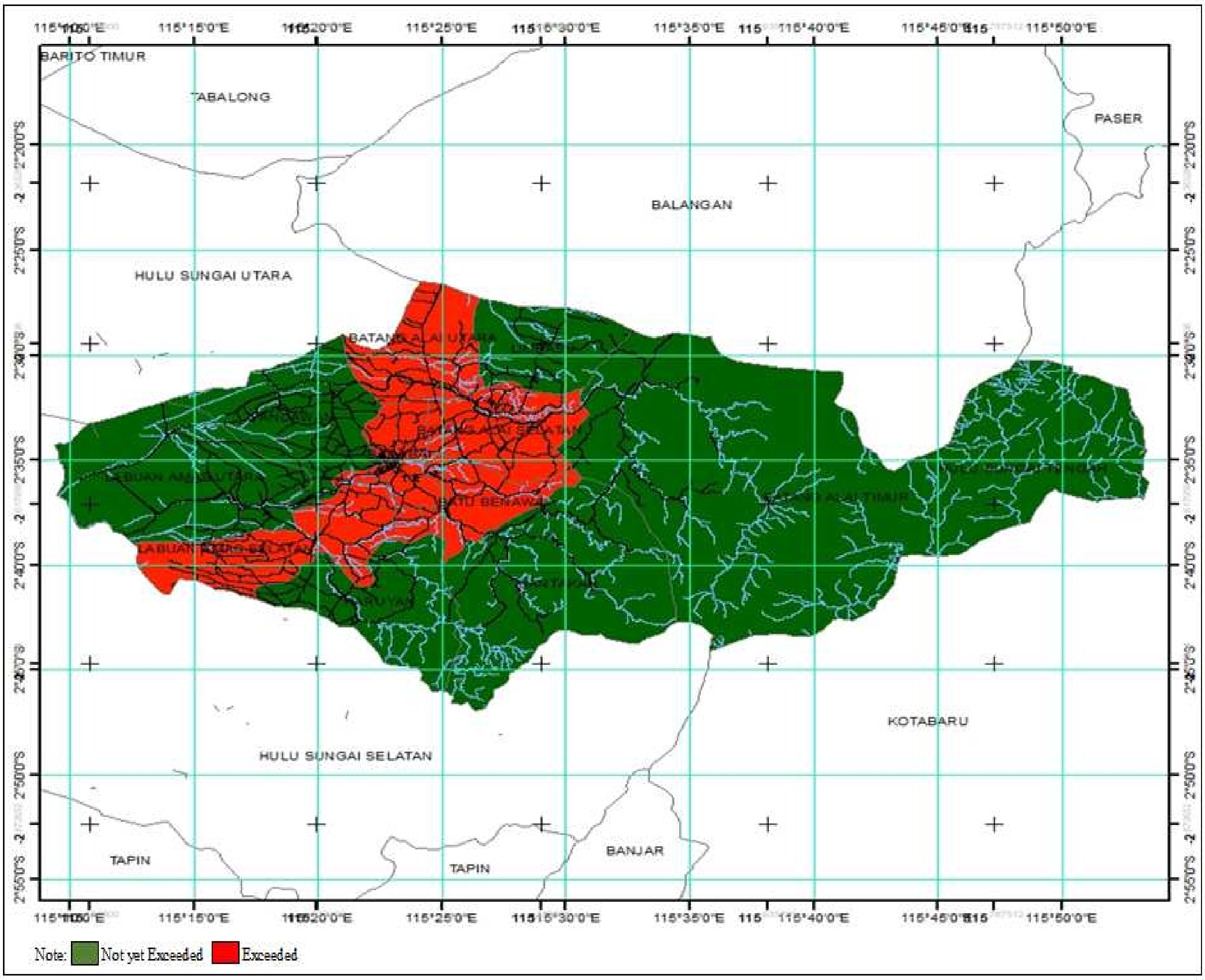

Fig. 2. Map of the Carrying Capacity of Agricultural Land in HST Regency in 2021.

The DDLH status is the total of the DDLH status values of all grids. The DDLH status of each grid is determined by the difference between the population threshold and the population on the grid. The equation for determining the DDLH status per grid is:

$$S_{ij} = T_{ij} - P_{ij} \quad (6)$$

Where S_{ij} is the DDLH threshold status value on grid i *in* district/city *j* (capita) , T_{ij} is DDLH threshold for environmental services on grid i *in* district/city *j* (capita) , P_{ij} is the population on grid *i* in district / city *j* (capita).

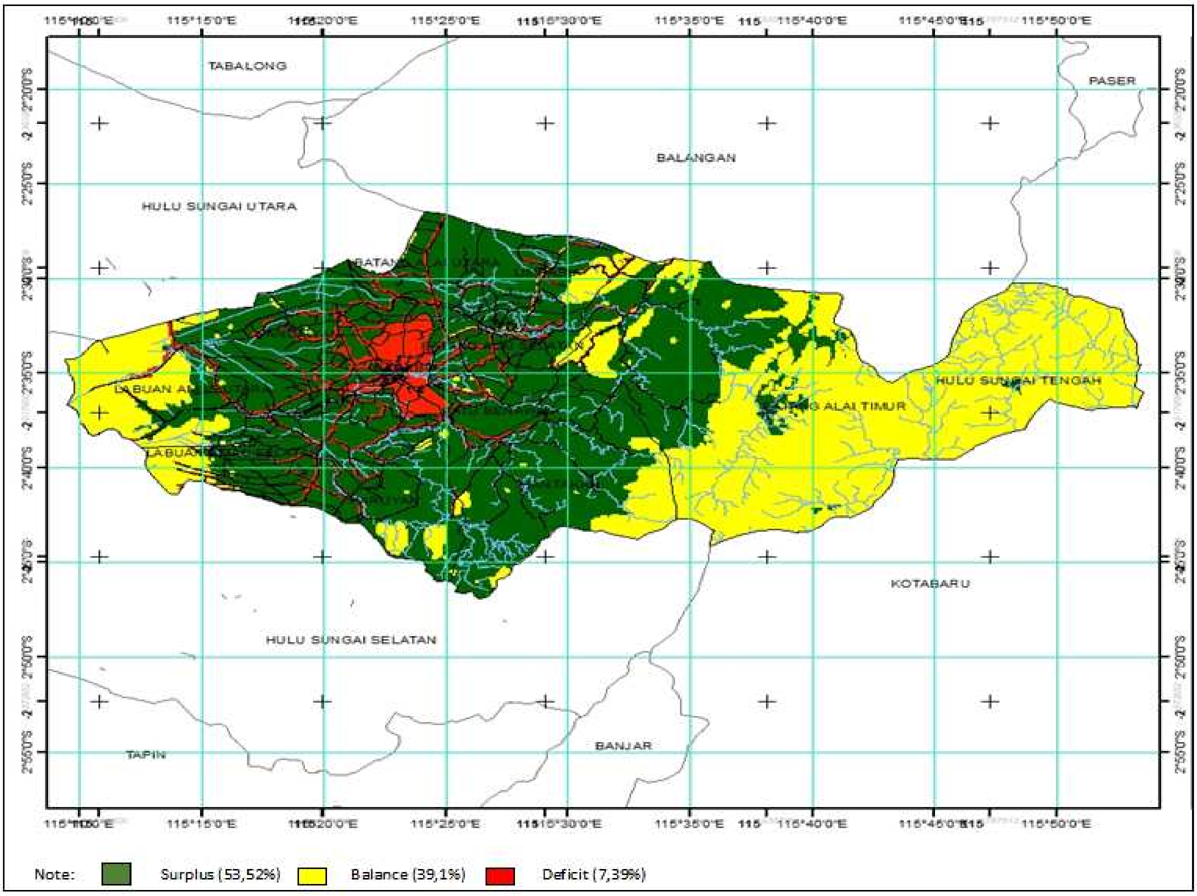

Fig. 3. Map of Food Supporting Capacity in HST Regency in 2021.

Results and discussion

Population and distribution

Demographically, the population of Hulu Sungai Regency Center is based on projection in 2021 as 260,754 people consisting of 131,045 souls of the male population and 129,709 female souls. Temporary that's the sex ratio year 2021 male population against female residents of 101.0. The population density in Central Hulu Sungai District in 2021 will reach 147 people/km. The highest population density is located in Barabai District, with a density of 1,380 people/km ^{2} and the lowest is in Batang Alai District East, with 9 people/km^2, see Table 2.

Table 1. Weight Based on Road Type and Land Class.

Road Type and Land Class	Weight
Arterial Road	0.095
Local Road	0.180
Collector Street	0.009
Settlement	0.270
Rice fields	0.272
Moor/Field	0.142

Source:(Nengsih, 2015; Riqqi, 2008).

Calculation of the population of each grid is done by using a comparison of weights based on density class land and road in each grid to the density weight of the total whole grids each in Hulu Sungai Tengah District. Amount resident in each grid generated is a multiplication weight to sub-district population in

Hulu Sungai Tengah District. Data validation was carried out to find out the calculation of the total population from the total population in each grid. The results show there is a difference of 0.05 % between the total population from BPS data and the total population on the grid system in Table 3.

Table 2. Number of Population in HST Regency in 2021.

Subdistrict	Residents (soul)	Rate growth (%)	Density (per km ^{2})
Haruyan	21.790	0,54	215
Batu Benawa	19.869	0,65	365
Hantakan	12.490	0,59	60
Batang Alai Selatan	23.772	0,67	313
Batang Alai Timur	7.122	0,24	9
Barabai	56.162	0,55	1.380
Labuan Amas Selatan	28.707	0,71	293
Labuan Amas Utara	27.071	0,13	159
Pandawan	34.506	0,88	296
Batang Alai Utara	18.147	0,44	278
Limpasu	11.118	0,95	182
Hulu Sungai Tengah	260.754	0,58	323

Source: Department of Population and Civil Registration of HST Regency (BPS, 2022).

The difference between the numbers of residents from the grid system to the population based on BPS data can be accepted with a 95% confidence level, so the population distribution in this study can produce good information about population distribution within each grid. The resulting difference is caused by the application of rounding in the process of distributing the number of inhabitants in each grid.

Table 3. Number of Population in HST district in 2021.

Total population (people)			Percentage
BPS	Grid System	Difference	
260.754	260.896	142	0,05

Source: Analysis results.

Agricultural land Carrying Capacity

The carrying capacity of agricultural land is calculated with the aim of knowing the current availability of land and the demand for agricultural land at the end of the planning year in an area, in accordance with the Minister of Environment Regulation No. 17 of 2009 concerning Guidelines for Determining Environmental Carrying Capacity in Spatial Planning. The result of calculating the analysis of the carrying capacity of agricultural land is to find out whether the carrying capacity of a region's land is in a surplus or deficit. The condition of a deficit carrying capacity of land indicates that the availability of land is no longer able to meet the need for food production in the region, while the condition of the carrying capacity of agricultural land is surplus indicating that the availability of land in an area can still meet the demand for food production (Mirajiani, 2021).

Data and actual prices for each type of commodity produce the total production value (NPT) per sub-district, then rice productivity is calculated, which is the result of the division of rice production, which has been converted by 64.02 % to rice production according to the harvested area.

The area of land needed for decent living needs per inhabitant (KHLL) is a decent living need per resident (1 ton of rice equivalent/capita/year) divided by local rice productivity, seen in Table 4.

Table 4. Rice Productivity and Total Value of Commodity Production in HST District in 2021.

Subdistrict	Production Rice (kg)	Wide Harvest (ha)	Productivity Rice (kg/ha)	Npt (Rp.)	khll
Haruyan	33.387	6.356	3.540,82	384.799.971.020	0,28
Batu Benawa	13.390	2.462	3.572,49	215.436.927.400	0,28
Hantakan	7.061	1.926	2.332,09	173.114.203.060	0,43
Batang Alai Selatan	18.214	3.264	3.539,57	213.549.231.440	0,28
Batang Alai Timur	7.056	1.937	3.481,84	150.904.322.760	0,29
Barabai	11.941	2.159	2.347,07	131.100.557.860	0,43
Labuan Amas Selatan	25.264	4.490	3.362,87	307.936.146.440	0,30
Labuan Amas Utara	28.743	5.198	3.602,23	332.504.531.780	0,28
Pandawan	37.018	6.704	3.540,07	394.274.559.280	0,28
Limpasu	14.950	2.704	3.494,24	192.210.208.000	0,29

Source: Data Analysis.

Table 5. Status of the Carrying Capacity of Agricultural Land in HST Regency in 2021.

Subdistrict	Need land (ha)	Availability Land (ha)	Support Power _	Status
Barabai	15.837,684	3.196,18	-126.41,504	exceeded
Batang Alai Selatan	6.656,16	5.027,09	-1.629,070	exceeded
Batang Alai Timur	3.055,338	6.655,5	3.600,162	Not yet exceeded
Batang Alai Utara	5.135,601	4.751,28	-384,321	exceeded
Batu Benawa	5.702,403	5.272,87	-429,533	exceeded
Hantakan	5.320,740	7.006,18	1.685,440	Not yet exceeded
Haruyan	6.471,630	9.942,43	3.470,800	Not yet exceeded
Labuan Amas Selatan	7.980,546	7.778,28	-202,266	exceeded
Labuan Amas Utara	7.634,022	8.890,25	1.256,228	Not yet exceeded
Limpasu	3.179,748	3.355,89	176,142	Not yet exceeded
Pandawan	9.765,198	10.832,07	1.066,872	Not yet exceeded

Source: Data Analysis.

The carrying capacity of agricultural land in Hulu Sungai Tengah Regency in 2021 with the calculation of the need for agricultural land is 76,739.07 ha while the availability of agricultural land is 72,708.02 ha so that it shows an exceeded status of 5.25%. There are five sub-districts whose agricultural carrying capacity status is exceeded, namely, Barabai, South Batang Alai, North Batang Alai, Batu Benawa and South Labuan Amas Districts, see Table 5 and Fig. 2. The economic posture (viewed from the GRDP distribution) of Upper Sungai Tengah shows that the economy of Upper Sungai Tengah is still agrarian. This can be seen from the large share of the agricultural category, which in aggregate contributes 23.53 percent (a decrease of 0.64 percent from 2020) to the total GRDP of the Central Upper River in 2021. This is due to the decreasing role of Agriculture, Forestry and Fisheries. The role of the sub-sectors of Agriculture, Livestock, Hunting and Agricultural Services. This sub-sector is estimated to have a role of around 82.56 percent of NTB (Gross Added Value) in the agricultural category in general, so the decline in this sub-sector has a big impact.

Table 6. Availability, Demand and Difference in Food Energy (Rice) in HST District in 2021.

Availability of Food Energy (kcal/year)	480.174.584.400
Food Energy Needs (kcal/year)	204.626.701.500
The difference in Food Energy (kcal/year)	275.547.882.900

Source: Data Analysis.

The decline that occurred was caused by flooding, which resulted in the failure of planting or harvesting as well as the shift of land from agriculture to plantations (BPS, 2021). The decline in the carrying capacity of the land is affected by the increasing population, the decreasing land area, the percentage of the number of farmers and the area of land needed for a decent life (Yanti, 2018). Meanwhile, to overcome the decline in land carrying capacity, according to (Irsan *et al*., 2018; Zhang *et al*., 2021), This can be done, among others, by 1) Land conversion, namely changing the type of land use to a more profitable business but adjusted to the area; 2) Land intensification, namely in using new technology in farming; 3) Land conservation, namely efforts to prevent land conversion from increasing.

Table 7. Value of Food Carrying Capacity Status in HST District in 2021.

Population Threshold (Soul)	Total population (Soul)	Food DD Status Value (Soul)
611.875	260.754	351.121

Source: Data Analysis.

Food Carrying Capacity

In the distribution of food energy in a grid system, the input data used is total food production (rice) of 133,381,829 kg, which is converted into energy units (3,600 kcal), so that the figure for food energy availability is 480,174,584,400 kcal/year. Food energy needs are calculated based on the number of residents in the grid multiplied by the AKG (2,150 kcal) for a year (365 days) so that a figure of 204,626,701,500 kcal/year is obtained. The difference in food energy is obtained from the result of reducing the number of availability to the number of food energy needs in HST Regency, which can be seen in Table 6. The calculation of the population threshold for each grid is carried out by dividing the availability by the energy demand for food per capita per year. The status of food carrying capacity is determined based on the difference between the 2021 population and the threshold population. The results of calculating the threshold and status of the food-carrying capacity

in the grid system are shown in Table 7.

The percentage of area based on food carrying capacity status that has not been exceeded is calculated based on the total grid area that has a food carrying capacity value of > 0 compared to the total grid in HST District so that a figure of 53.52% is obtained, which can be seen in Table 8.

Table 8. Percentage of Area of Food Supporting Capacity in HST District in 2021.

Area (ha)		Percentage (%)
District area	Not yet Over	
177.077	94.768,33	53,52

Source: Data Analysis.

Hulu Sungai Tengah Regency, with an area of 177,077 ha, still has an area that has not been exceeded by the food carrying capacity of 94,768.33 ha. Barabai District has exceeded the food carrying capacity because it is the capital of the district and has the consequence of reduced agricultural land being converted for housing and offices, in addition to having the highest population of 56,162 people or around 21.54% of the total population in HST District, see Table 9. The deficit of the carrying capacity of food shows that the availability of food at a location in HST Regency is not able to support the needs of the population for food energy. The locations represented by the grid get food energy from other regions to be able to meet the food needs of the population. The decline in the carrying capacity of food is related to employment in the agricultural sector. The population working in the agricultural sector tends to experience a decline. Where in 2017, the population working in the agricultural sector was 25.42% percent, continuing to decrease until 2021 to 23.53% (BPS, 2021).

Table 9. Status of Food Supporting Capacity per District in HST District in 2021.

Subdistrict dp status	Wide region (Ha)	Percentage (%)
Barabai	4.071,00	
Deficit	4.071,00	100
Batang Alai Selatan	7.606,00	
Deficit	1.057,02	13,897
Balanced	308,94	4,062
surplus	6.240,04	82,041
Batang Alai Timur	77.871,00	
Deficit	378,11	0,49
Balanced	56.630,05	72,72
surplus	20.862,83	26,79
Batang Alai Utara	6.536,00	
Deficit	913,26	13,97
Balanced	70,89	1,08
surplus	5.551,85	84,94
Batu Benawa	5.444,00	
Deficit	790,31	14,52
Balanced	130,97	2,41
surplus	4.522,73	83,08
Hantakan	20.855,00	
Deficit	180,51	0,87
Balanced	3.290,03	15,78
surplus	17.384,46	83,36
Haruyan	10.135,00	
Deficit	614,74	6,07
Balanced	1.175,33	11,60
surplus	8.344,93	82,34
Labuan Amas Selatan	9.782,00	
Deficit	1.262,35	12,90
Balanced	1.549,27	15,84
surplus	6.970,38	71,26
Labuan Amas Utara	17.032,00	
Deficit	1.495,53	8,78
Balanced	6.363,99	37,36
surplus	9.172,48	53,85
Limpasu	6.104,00	
Deficit	408,47	6,69
Balanced	1.010,32	16,55
surplus	4.685,21	76,76
Pandawan	11.641,00	
Deficit	1.831,54	15,73
Balanced	79,84	0,69
surplus	9.729,61	83,58

Source: Data Analysis.

This is because the results obtained are considered unable to meet the needs of a decent life. Another cause is reduced agricultural production due to land conversion, which continues to increase, and the tendency of the productive workforce to choose to work in the trade and manufacturing sectors (which are considered to provide better income than the agricultural sector.

The carrying capacity of food can be described through a comparison of the amount of resources that can be managed to the total consumption of the population. This comparison shows that the carrying capacity of food is directly proportional to the amount of environmental resources and inversely to the amount of consumption. That is, population growth without an increase in the number of resources causes the carrying capacity of food to get closer to its threshold. This problem is in accordance with what was conveyed by (Khorsandi *et al.*, 2022) that population growth will exceed food production, so there is potential for hunger everywhere. The population growth rate is a geometric progression, while food growth is an arithmetic progression.

The status of food carrying capacity in which most of the areas are surplus is found in Batu Benawa, Batang Alai Utara, Hanntak, Haruyan and Pandawan Districts. Paddy production in these subdistricts is quite high, especially in Haruyan Subdistrict, with 33,387 tons and Pandawan Subdistrict, with 37,018 tons. Hanntak sub-district is a water catchment area that provides protection for the area beneath it.

The status of food carrying capacity tends to be balanced in several sub-districts, namely Batang Alai Timur District, Labuan Amas Utara and Labuan Amas Selatan, see Fig. 3. Rice production in Batang Alai Timur District is the lowest at only around 7,056 tons, but the population is only 7,122 people in 2021 East Batang Alai District is also a water catchment area which provides protection for the areas under it.
The RTRW Spatial Pattern Plan for Hulu Sungai Tengah Regency for 2016-2035 divides Hulu Sungai Tengah Regency into 2 (two) areas, namely protected areas and cultivation areas. Protected areas in Hulu Sungai Tengah Regency are in the form of protected forest areas, namely areas that provide protection to their subordinate areas, locally protected areas, cultural and natural science conservation areas, natural disaster-prone areas, and geological protected areas. The largest distribution of food availability in the grid system is found in North Labuan Amas, South Labuan Amas and Pandawan Districts, which are designated areas for wetland agriculture. Batang Alai Timur, Hanntak and Haruyan sub-districts are designated areas for dry land agriculture.

Conclusion

The carrying capacity of agricultural land in Hulu Sungai Tengah Regency in 2021 with the calculation of the need for agricultural land is 76,739.07 ha, while the availability of agricultural land is 72,708.02 ha, indicating an exceeded status of 5.25%. There are five sub-districts whose agricultural carrying capacity status is exceeded, namely, Barabai, South Batang Alai, North Batang Alai, Batu Benawa and South Labuan Amas Districts. Hulu Sungai Tengah Regency, with an area of 177,077 ha, still has an area that has not been exceeded by the food carrying capacity of 94,768.33 ha. Barabai District has exceeded the food carrying capacity because it is the capital of the district and has the consequence of reduced agricultural land being converted for housing and offices, in addition to having the highest population, namely 56,162 people or around 21.54% of the total population in HST Regency.

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References

Bhaduri B, Bright E, Coleman P, and Urban ML. 2007. LandScan USA: a Hight-Resolution Geospatial and Temporal Modeling Aproach for Population Distribution an Dynamics. GeoJurnal, **69 (1–2)**, 103–117.

BPS. 2020a. Hulu Sungai Tengah District in Figures. 2020b. South Kalimantan Province in Figures 2020. South Kalimantan BPS.
2020c. Central Hulu Sungai District Statistics 2020.
2022. Hulu Sungai Tengah Regency in Figures 2022.

BPS R. 2010. Grain to Rice Conversion Survey 2018 (SKGB) .2019. Consumption of Staples.

2021. Gross Regional Domestic Product of Hulu Sungai Tengah Regency by Business Field 2017-2021 . BPS Central Hulu Sungai District.

FAO. 1996. World Food Summit 1996: Rome Declaration on World Food Security.

Groffman PM, Baron JS, Blett T, Gold AJ, Goodman I, Gunderson LH, Levinson BM, Palmer MA, Paerl HW, Peterson GD, Poff NLR, Rejeski DW, Reynolds JF, Turner MG, Weathers KC, Wiens J. 2006. Ecological thresholds: The key to successful environmental management or an important concept with no practical application. Ecosystems **9(1),** 1–13. https://doi.org/10.1007/s10021-003-0142-z

Hardjasoemantri. 1989. Environmental Management Law (Edition). Gadjah Mada University Press.

Implementing the Water – Energy – Food – Ecosystems Nexus and achieving the Sustainable Development Goals. nd.

Irsan R, Muta'ali L, Sudrajat S. 2018. the Carrying Capacity on Ecosystem Services of Land Use Change At Border Entikong . Geosphere Indonesia, **3(2),** 11. https://doi.org/10.19184/geosi.v3i2.7896

KLH R. 2014. Guidelines for Determining the Carrying Capacity and Capacity of the Environment. Ministry of Environment.

MOEF. 2019a. Guidelines for Determining the Carrying Capacity and Accommodation Capacity of the Regional Environment.

KLHK R. 2019b. Guidebook for Determining Regional DDDTLH.

Kusumawardhani NP. 2020. Analysis of Water Carrying Capacity for Regional Planning Development in Malang Regency. Jaur (Journal of Architecture and Urbanism Research) **3(2),** 166–174. https://doi.org/10.31289/jaur.v3i2.3331

Karabulut A, Egoh BN, Lanzanova D, Grizzetti B, Bidoglio G, Pagliero L, Bouraoui F, Aloe A, Reynaud A, Maes J, Vandecasteele I, and Mubareka S. 2016. Mapping water provisioning services to support the ecosystem-water-food-energy nexus in the Danube river basin. Ecosystem Services, **17(2011),** 278–292. https://doi.org/10.1016/j.ecoser.2015.08.002

Khorsandi M, Homayouni S, Van Oel P. 2022. The edge of the petri dish for a nation: Water resources carrying capacity assessment for Iran. Science of the Total Environment **817**, 153038. https://doi.org/10.1016/j.scitotenv.2022.153038

Mirajiani. 2021. Environmental Carrying Capacity for Food Availability in Pandeglang Regency, Banten Province . IOP Conference Series: Earth and Environmental Science, **715(1).** https://doi.org/10.1088/1755-1315/715/1/012007

Mulawarman A, Paddiyatu NBS, Haupea RA. 2020. Carrying Capacity of Water and Food Availability in Sukamaju District. Journal of Linears, **2(2),** 92–99. https://doi.org/10.26618/j-linears.v2i2.3126

Muta'ali L. 2012. Environmental Carrying Capacity for Regional Development Planning. Gadjah Mada UniversityPress.

Nengsih SR. 2015. Development of a High Resolution Population Distribution Model for Indonesian Regions Using a Variety Scale Grid System. Geomatics **21(1),** 31–36.

Norvyani DA, Taradini J. 2016. Mapping of Food Supporting Capacity Thresholds in West Bandung Regency Using a Variety Scale Grid System. Geo-Environment Student Challenge **1(1),** 1–8.

Permenkes. Number 28 of 2019 concerning Recommended Nutrition Adequacy Rates for

Ramlan M, Soerjani M, Rofiq A, Rozi M. 1987. Environment: Natural Resources and Population in Development (M. Soerjani, A. Rofiq, and M. Rozy, Eds.; 1992 ed.). University of Indonesia (UI-Press).

Riqqi A. 2008. Development of Geographic Mapping based on a Variety Scale Approach for Coastal Area Management. Bandung Institute of Technology.

RPPLH South Kalimantan. 2017. Environmental Protection and Management Plan for South Kalimantan Province.

Salvatore M, Pozzi F, Ataman E, Huddleston B, Bloise M. 2005. Mapping Global Urban and Rural Population Distribution. Environment and Natural Resources Series **24** (FAO).

Shui W, Wu K, Du Y, Yang H. 2022. The trade-offs between supply and demand dynamics of ecosystem services in the bay areas of metropolitan regions: A case study in quanzhou, China. Land, **11 (1).** https://doi.org/10.3390/land11010022

Tian P, Li J, Cao L, Pu R, Gong H, Zhang H, Chen H, Yang X. 2021. Assessing matching characteristics and spatial differences between supply and demand of ecosystem services: A case study in Hangzhou, China. Land **10(6).** https://doi.org/10.3390/land10060582

Law of the Republic of Indonesia Number 4 of 2011 concerning Geospatial Information. 2011.

Yanti R. 2018 . The Sustainable of Environmental Carrying Capacity to Support on Food Security (Nagari Difficult Water, X Koto Diatas District, Solok, West Sumatra) . IOP Conference Series: Earth and Environmental Science, **197(1).** https://doi.org/10.1088/1755-1315/197/1/012030

Zhang S, Hu W, Li M, Guo Z, Wang L, Wu L. 2021. Multiscale research on spatial supply-demand mismatches and synergic strategies of multifunctional cultivated land. Journal of Environmental Management, **299(8),** 113605. https://doi.org/10.1016/j.jenvman.2021.113605