

The Carrying Capacity Analysis of Rice Plants Agriculture to Fulfill Food Needs in Pati Regency

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ABSTRACT

The fulfillment of food needs is one indicator of community welfare. The calculation of the carrying capacity of food crops is used to determine the extent to which an area meets its food needs. The aims of this study were: (1) to calculate the level of carrying capacity of rice plants in Pati Regency, (2) to plan land that has the opportunity to be used as a LP2B area, and (3) to find out the maximum population and year in Pati Regency to meet food needs. The technique of analyzing the carrying capacity of rice plants uses the calculation of the carrying capacity of natural resources and the analysis of determining land that has the potential to become sustainable food cropland using an overlay map analysis with ArcGIS. The results showed that the value of the rice plant commodity had a carrying capacity value of more than 1, which was 1,371. The results of the map-making, the land that has the opportunity to be used as permanent rice fields is 50.635 hectares. The maximum population that can be met by annual rice production is 1.622.356 people. The results of population projections using the geometric method, the maximum year Pati Regency can be self-sufficient in food is 2040. The fulfillment of sustainable food needs can be realized through monitoring the implementation of the LP2B program so that the conversion rate of agricultural land can be minimized.

Keywords : Carrying Capacity; Rice Plants; Food Needs

1. Introduction

Carrying capacity is closely related to the balance of supply and demand. Availability is generally limited, while demand is unlimited (Muta'ali, 2015). The environment, natural resources, and population have a very close relationship in development, which is reflected in the environmental carrying capacity of an area that has an unstable nature. Carrying capacity can change due to the influence of technological developments, but that often occurs due to changes in massive population pressure. The development of the agricultural sector, especially rice commodities, is important and strategic because, in addition to meeting food needs, it also provides job opportunities for farmers in rural areas (Saparto et.al, 2021). The scarcity or non-fulfillment of rice food needs in the community has an impact on inflation and social turmoil (Rohman & Maharani, 2017).

Pati Regency is one of the 5 largest contributors to rice production in Central Java after Grobogan, Sragen, Cilacap, and Demak Regencies (BPS Jawa Tengah, 2020). In 2020, rice production in Pati Regency reached 602,806.71 tons from a harvested area of 102,085.94 hectares (BPS Kabupaten Pati, 2020). During the 2015-2019 period, the average rice harvested area increased by 1.75 percent (BPS Kabupaten Pati, 2019). In addition, the average food balance surplus between the production and consumption of Pati Regency for rice commodities is 237.030,63 tons per year, equivalent to 1.05 percent of the national rice consumption needs (Suroso, 2018).

Pati Regency has geographical conditions that support agricultural activities. The agricultural potential in Pati Regency can be seen from the green land that is still able to support agricultural production optimally. It is recorded that the rice fields area of 56.660,04 hectares or 37.68 percent of the 150.368 hectares of the total area (BPS Kabupaten Pati, 2020). The role of the agricultural sector as a contributor to GRDP after the processing/manufacturing industry. Food crops are the most widely cultivated plants in addition to meeting the population's consumption, they are also developed as raw materials for regional industries (Sitindaon, 2017).

Agricultural land which is one of the agrarian objects has a strategic and dominant nature. It is said to be strategic because the area of agricultural land is limited from time to time and even tends to decrease, and is dominant because humans from time to time always need agricultural land to increase (Pareke, 2020). As the population continues to grow, land use becomes disrupted and is considered to be starting to experience problems. The complexity of the problem from the explosive population increase, the discovery and use of technology, as well as the dynamics of development, have caused land that originally functioned as a planting medium to turn into a multifunctional use (Satria et. al, 2018).

The population of Pati Regency continues to grow. In 2019 there were 1.259.590 people and experienced growth in 2020 to 1.324.188 (BPS Kabupaten Pati, 2021). The increase in population has the consequence of increasing food needs but is not accompanied by an increase in land area (Mubarokah et.al, 2020). If allowed to continue, it is not impossible if production does not match the needs of the population (Kuncoro, 2017). In this study, the minimum physical need of the population is one of the variables used in determining the food needs of the population in Pati Regency (Ministry of Health RI, 1981). The limited availability of non-agricultural land for the development of various sectors causes the threat to the existence of paddy fields to increase (Muryono & Utami, 2020). Although the land area does not always affect productivity, it cannot be denied that overall land shrinkage affects food crop production (Janti et. Al, 2016).

Development and the direction of political policies that are often oriented towards capitalistic economic growth often ignore the distribution of welfare (Handari et al., 2012; Kartini, et al. 2017) often at the expense of agricultural land for food whose availability is increasingly limited. This condition can certainly cause a threat to food security (Santoso et al, 2017; Taufik et al, 2018). Many areas that were previously self-sufficient in rice are now importing rice from other regions (Fikri et. Al, 2021). The existence of increasingly narrow agricultural land will also encourage massive urbanization because in rural areas the agricultural sector is the sector that absorbs the most labor (Muta'ali, 2019).

In Java, a lot of land conversion occurred during the period 1979 to 2013. It was recorded that there were 625,459 (38.43%) or 31,273 ha/year of converted paddy fields in Java (Apriyanto et.al, 2021). Rice fields are the main target in cases of land conversion because agricultural land rent is the lowest compared to the non-agricultural sector (Pribadi et al, 2017). Good land use must still pay attention to the physical limitations of land because it has different capabilities and characteristics to support its use (Duri, 2016). The activity of changing the function of agricultural land to non-agriculture is a natural thing, but of course, this activity must also remain under supervision and of course regulated by the government (Dhimas, 2018).

Efforts to suppress the rate of conversion of paddy fields and maintain sustainable food availability, the government made a policy of Law no. RI. 41 of 2009 concerning the Protection of Sustainable Food Agricultural Land (abbreviated LP2B). In addition to Law no. 26 of 2007 concerning Spatial Planning also explains the importance of allocating land for food agriculture on an ongoing basis. Protection of agricultural land is inseparable from agrarian reform (Arnawan & Surata, 2019). The law is one of the efforts to overcome the problems of degradation, conversion, and fragmentation of agricultural land due to an increase in population, economic development, and industrialization that have the potential to threaten food security, independence, and sovereignty (Prasada & Priyanto, 2019).

In addition, the policy also aims to regulate the existence of agricultural land so that it remains stable, does not narrow, and is not easily or quickly damaged due to human use (Ikhwanto, 2019). The problem that arises is that no policy provides information related to (operational) methods to support the establishment and determination of LP2B (Pridasari & Muta'ali, 2018). Another problem that also arises is the inaccuracy of planning and determining which is in the wrong corridor because some districts place LP2B in the RTRW, whereas LP2B and LCP2B or Sustainable Food Agricultural Reserves (LCP2B). must be in the Detailed Spatial Plan (RDTR) (Rusono et al, 2015).

The policy for the protection of sustainable food agricultural land is carried out by the state as an effort to guarantee the right to food as a human right of every citizen and in the context of realizing self-reliance, resilience, and food sovereignty as well as the welfare of farmers (Pitaloka, 2020). The implementation of LP2B in the Pati Regency is also expected to maintain the existence of agricultural land and food crop production, especially in rice fields. The vigilance of the Pati Regency Government is strengthened through the Pati Regency Regional Regulation Number 5 of 2011 concerning the Pati Regency Spatial Plan for 2010-2030. Furthermore, a plan for the establishment of LP2B in Pati Regency is needed while still paying attention to development by providing space for the development of other sectors.

A study related to the balance of resource-based agricultural land and population is important to be able to predict food availability for the population. Guaranteed food needs as an indicator of community welfare. Analysis of agricultural carrying capacity in the Pati Regency is used to determine current and future food demand scenarios (Sriutomo & Christanto, 2015). Several studies have discussed the issue of the carrying capacity of agriculture and focused on the problem of the ability of agricultural land or the production of crops. In this study, the researchers tried to combine the two variables so that sustainable results can be obtained.

In this study, the researchers tried to conduct a similar study in Pati Regency. This study aims to determine the extent to which the Pati Regency can be self-sufficient in food through the calculation of food crop production and land determination for LP2B. so that the objectives of this study are (1) to calculate the level of carrying capacity of rice plants in Pati Regency, (2) to plan land that has the opportunity to be used as a LP2B area, and (3) to find out the maximum population and year in Pati Regency to meet food needs.

2. Methods

The research was conducted in Pati Regency (Figure 1) using a quantitative approach, data collection techniques using the method of observation, and documentation related to the research (Figure 2). Observation techniques are used to find out how the agricultural conditions in Pati Regency are and documentation is used to collect the data needed for research.

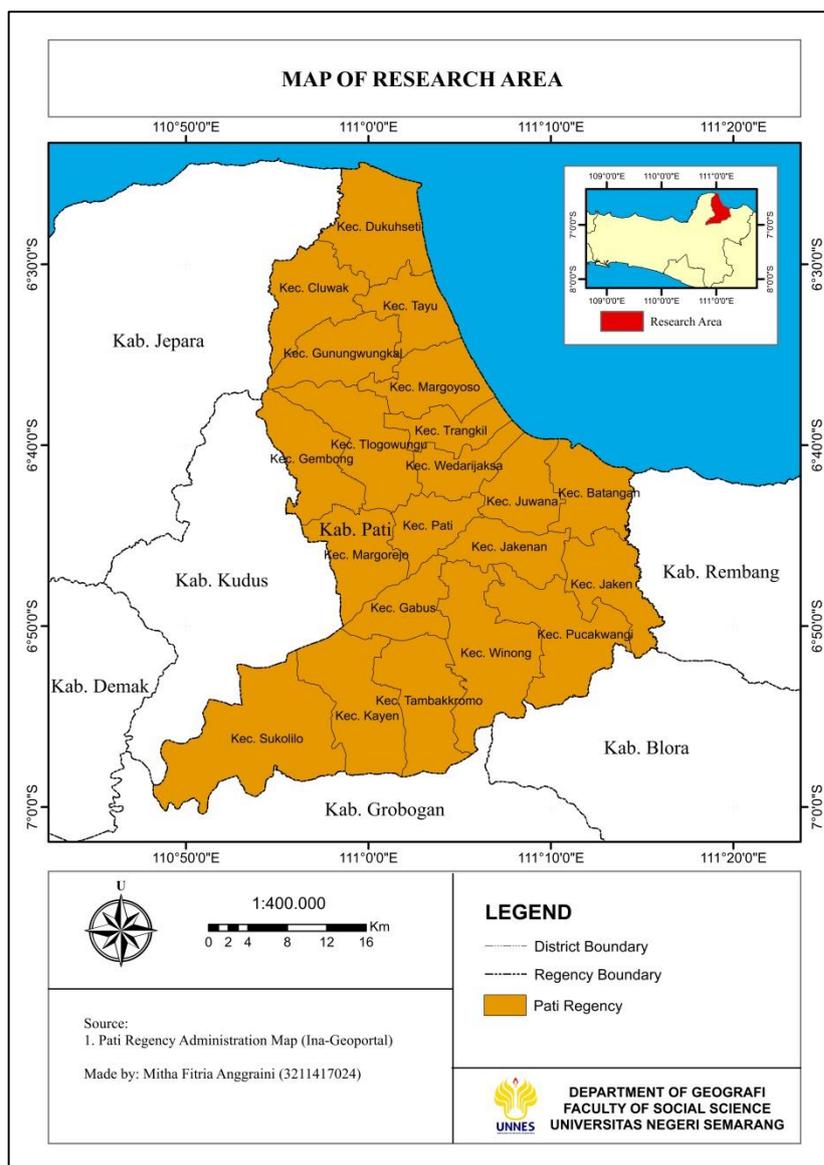


Figure 1. Study area

Data analysis using 5 steps as follows :

- a. The calculation of the carrying capacity of rice plants agriculture using Eq. 1 (Odum, 1967).

$$DDSDA = \frac{\sum_{i=1}^n P_i \times N_i}{P_d \times KFM} \tag{1}$$

Where DDSA is carrying capacity of natural resources (In Indonesian called Daya Dukung Sumber Daya Alam – abbreviated DDSA), P_i is commodity production i , N_i is commodity selling value i , P_d is total population, and KFM is minimum physical need is equal to 2100 calories/capita/day (in Indonesian called Kebutuhan Fisik Minimum – abbreviated KFM) (KFM value is calculated in rupiah and each resident is considered the same)

Classification of agricultural carrying capacity of food crops:

DDSDA < 1 indicates that the carrying capacity of rice plants agriculture is exceeded

DDSDA > 1 indicates that the carrying capacity of rice plants agriculture is not exceeded

- b. Calculation of the area of agricultural land needed using Eq 2 and Eq. 3 (Sriutomo & Christanto, 2015).

$$LP = \frac{(Pd \times KFM) / Ni}{\text{Land Productivity}} \quad (2)$$

$$KL = \frac{\text{Harvest Area}}{\text{Harvest Land Capability(per year)}} \quad (3)$$

Where KL is land requirement (Ha), LP is minimum harvest area required (Ha), Pd is total population, and Ni is commodity selling value i.

- c. The criteria for determining land that has the opportunity to be used as sustainable food agricultural land refers to Subroto & Susetyo (2016).

Determination of land for LP2B is done by selecting paddy fields through spatial data using ArcGIS. Then the determination of rice fields according to the LP2B criteria is carried out. The criteria used to determine LP2B are as follows:

- (1) Conformity with the Pati Regency Spatial Planning Map;
- (2) It is a wetland agricultural land, both irrigated and rainfed rice fields;
- (3) Land located on a stretch of rice fields with an area of > 5 hectares;
- (4) Have basic infrastructure such as irrigation system and road access; and
- (5) The suitability of the type of soil suitable for agriculture.

- d. Prediction of maximum population self-sufficiency in food (Sriutomo & Christanto, 2015) at Eq. 4 and Eq. 5.

$$Pr_Ricefield = (Ls/Lu) \times Pi \quad (4)$$

Where Pr_ ricefield : Production produced by perpetual rice field plan, Ls is eternal rice field area, Lu is the current area of rice fields, and Pi is current commodity production.

$$Pd_m = (Pr_Ricefield \times Ni) / KMF \quad (5)$$

Where Pd_m is maximum population, Pr_Ricefield is production produced by the perpetual paddy field plan, and Ni is commodity selling value i.

- e. Calculation of the geometric population projection for the maximum year of food self-sufficiency referring to (Eq. 6)

$$Pn = Po.(1+r)^n \quad (6)$$

$$r = 1/n.Ln(Po/Pn)$$

Where P_n is population in year n , P_0 is population base year, n is number of year intervals, and r is population growth rate.

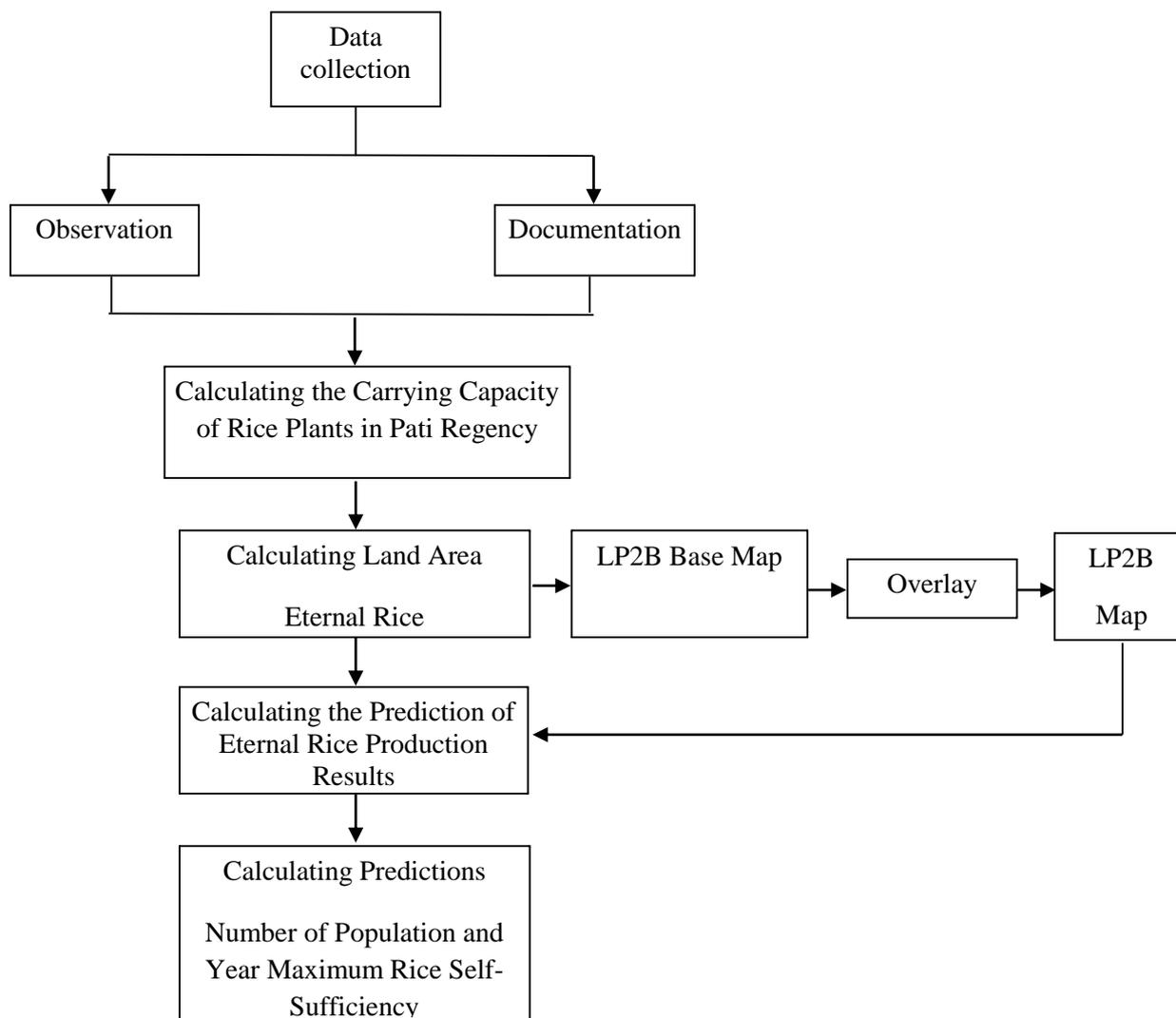


Figure 2. Research flowchart

3. Results and Discussion

The problem of food and its sufficiency is a national problem and a global problem as stated in SDG's goal 2, namely eliminating hunger, achieving food security and good nutrition, through the achievement of sustainable agriculture. The targets listed in the SDGs are unresolved targets in the MGDs which only increase income and end poverty and hunger (Erwandari, 2017). In this study, the results of the analysis were obtained as follows.

3.1 Value of Carrying Capacity of Food Crops

The carrying capacity analysis is carried out with the availability-needs approach which is used to show an area can be self-sufficient or not (Kunu, 2020). Overall, the carrying capacity of rice plants is 1.371 (Table 1). This carrying capacity value shows that Pati Regency can still meet the food needs of its population. The carrying capacity of high rice plants in Pati Regency is distributed in 6 sub-districts: Pucakwangi, Jakenan, Sukolilo, Jaken, Winong, and Gabus. The six sub-districts have the

carrying capacity of rice crops more than 2, in the high carrying capacity classification. Indicates having agricultural land and production of rice commodities that can meet regional food needs, and are sold to other regions. The value of high carrying capacity is built by the optimal planting area and harvested area. The existence of the Juwana River which crosses three sub-districts, namely Jakenan, Gabus, and Kayen makes the area fertile.

Table 1. Value of rice commodity carrying capacity in Pati Regency

No	Districts	Rice Plants
1	Sukolilo	2.519
2	Kayen	1.910
3	Tambakromo	1,896
4	Winong	2.293
5	Pucakwangi	3.206
6	Jaken	2.286
7	Batangan	1.036
8	Juwana	0.426
9	Jakenan	2.696
10	Pati	0.748
11	Gabus	2.079
12	Margorejo	1.353
13	Gembong	0.270
14	Tlogowungu	0.535
15	Wedarijaksa	0.418
16	Trangkil	0.532
17	Margoyoso	0.882
18	Gunungwungkal	1.266
19	Cluwak	1.013
20	Tayu	1.356
21	Dukuhseti	0.924
Total		1.371

The carrying capacity of the rice crop on a district scale is still fulfilled, but only a few sub-districts can meet the food needs of the population. The uneven distribution of the population is one of the causes of the carrying value that is exceeded in some sub-districts and not exceeded in some other sub-districts. The more people in an area, the higher the need for food. There are 13 sub-districts with a carrying capacity value > 1 and there are 8 sub-districts with a carrying capacity value < 1 (Table 2).

Table 2. Carrying capacity of rice plants in Pati District

No.	Value	Districts
1.	$>-> 1$	Sukolilo, Gabus, Kayen, Winong, Tambakromo, Pucakwangi, Jaken, Jakenan, Batangan, Margorejo, Tayu, Cluwak, Gunungwungkal.
2.	< 1	Juwana, Tangkil, Wedarijaksa, Gembong, Pati, Dukuhseti, Margoyoso, Tlogowungu.

Spatially the difference in the carrying capacity of each sub-district in Pati Regency cannot be separated from the geographical influence of a region (Figure 3). Differences in soil type, slope, rainfall,

temperature, and water network affect rice production and population activities. Most of the sub-districts located on the coast have low carrying capacity because the population is mostly engaged in fish cultivation and salt farming. In highland areas, such as Gembong District and Tlogowungu District, the land is mostly used for the cultivation of fruit crops and biopharmaceuticals. Planting for food crops is not too extensive and not all types of food crops are suitable for cultivation in highland areas.

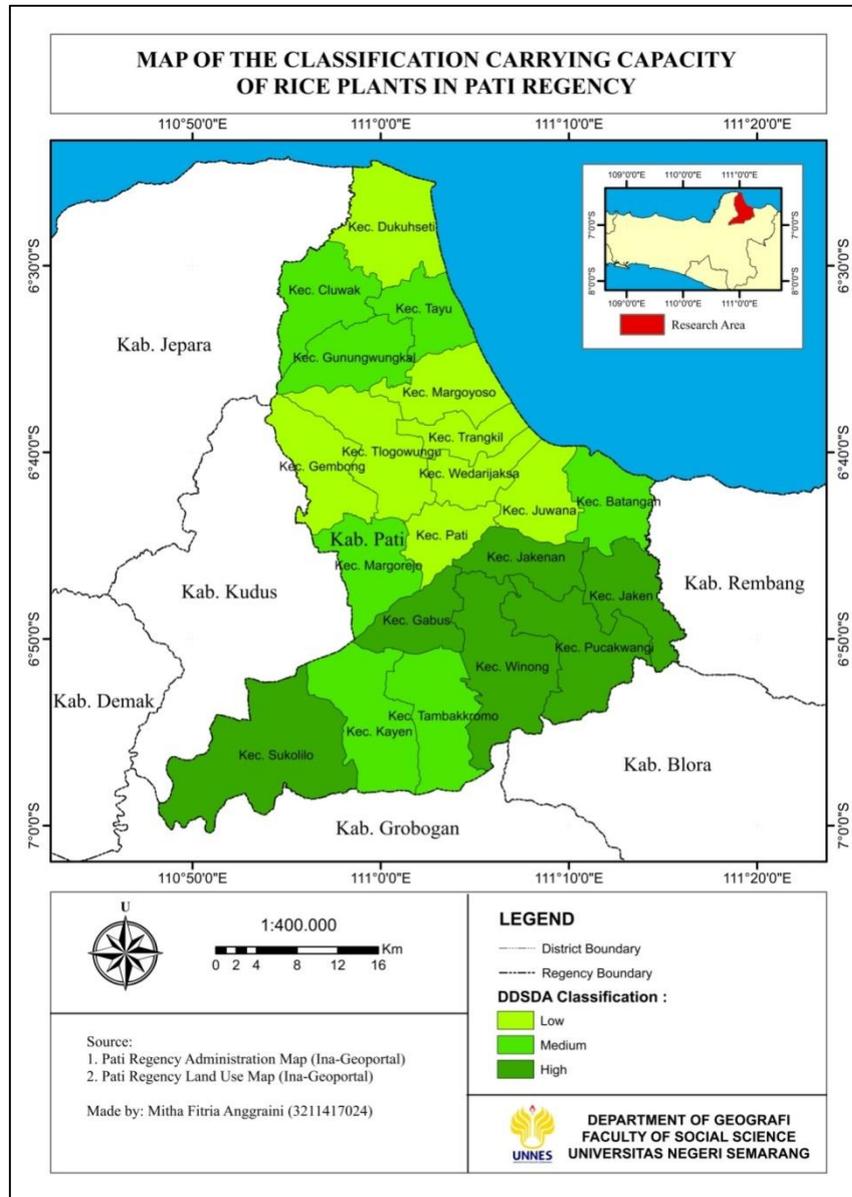


Figure 3. Classification map of commodity carrying capacity rice plants in Pati Regency

Food availability cannot be separated from the existence of land in producing food (Abrori & Priyana, 2021). The conversion of agricultural land has a wide impact in various fields, so control efforts are needed to control the rate of conversion of agricultural land to non-agricultural uses (Andriawan et al., 2020). The calculation of the minimum harvested area of rice per year is 76,653.28 hectares. Until now, Pati Regency requires a minimum of 38,326.64 hectares of agricultural land in order to be self-sufficient in rice food crops. Calculation of the minimum need for paddy fields is used to determine areas that have the potential to be used as sustainable food agricultural land (LP2B). Determining potential LP2B areas is based on consideration and suitability of criteria. Considerations are made by

Determination of the area of land that has the opportunity to become permanent rice fields is based on the assumption that the land is a stretch of rice fields of at least 5 hectares, in accordance with the regional spatial plan (RTRW) of Pati Regency, which has basic infrastructure such as a network of roads and rivers, as well as the suitability of soil types for agriculture. The agglomeration element is an additional consideration in determining LP2B. The consideration is based on the fact that the agglomeration makes it easier to monitor and supervise the implementation as well as the facilities needed to protect LP2B.

The administrative areas of the sub-district that have extensive agricultural land to support LP2B in Pati Regency are the sub-districts: Sukolilo (6,603 Ha), Kayen (4,491 Ha), and Winong (4,868 Ha). Control of land change needs to be done to maintain the existence of agricultural land so that the food needs of the community can still be met from the area (Ragil, 2017). The sub-districts that have not been able to meet the needs of LP2B in Pati Regency are: Juwana, Pati, Gembong District, Tlogowungu District, Trangkil District, Margoyoso District, Gunungwungkal, Cluwak, Tayu, and Dukuhseti (Table 3).

Table 3. LP2B land area of each district in Pati Regency

No.	Districts	Total population	Rice Field (Ha)			Explanation
			BPS Data	LP2B (DPUPR)	Need (Calculate)	
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1.	Sukolilo	90,270	7,253	6,603	2,612.73	Surplus
2.	Kayen	78,540	4,937	4,491	2,273.22	Surplus
3.	Tambakromo	55,616	2,947	2,716	1,609.72	Surplus
4.	Winong	63,638	4,221	4,868	1,841.91	Surplus
5.	Pucakwangi	47,934	5,023	3,994	1,387.38	Surplus
6.	Jaken	46,174	3,595	3,578	1,336.44	Surplus
7.	Batangan	44,619	2,088	2,051	1,291.43	Surplus
8.	Juwana	95,933	1,536	776	2,776.64	Deficit
9.	Jakenan	47,568	3,963	3500	1,376.78	Surplus
10.	Pati	108,398	2,558	1,806	3,137.42	Deficit
11.	Gabus	62,279	4,075	3,494	1,802.57	Surplus
12.	Margorejo	64,091	2,750	2,149	1,855.02	Surplus
13.	Gembong	47,370	823	188	1,371.05	Deficit
14.	Tlogowungu	54,300	1,829	1,105	1,571.63	Deficit
15.	Wedarijaksa	63,808	2,178	2,221	1,846.83	Surplus
16.	Trangkil	63,275	1,040	667	1,831.40	Deficit
17.	Margoyoso	74,267	1,265	878	2,149.55	Deficit
18.	Gunungwungkal	37,898	1,627	1,015	1,096.90	Deficit
19.	Cluwak	47,338	1,344	1,094	1,370.13	Deficit
20.	Tayu	70,022	2,184	1,775	2,026.68	Deficit
21.	Dukuhseti	60,850	2,063	1,666	1,761.21	Deficit
Total		1,324,188	59,299	50,635	38,326,64	Surplus

The results of calculations that apply the formula from Sriutomo and Christanto (2015), as stated in column 6, show that the overall results of LP2B covering an area of 50.635 hectares can meet the food land needs of the Pati Regency population of 38.326,64 hectares. Several sub-districts that have a deficit LP2B area include the following sub-districts: Juwana, Pati, Gembong, Tlogowungu, Trangkil, Margoyoso, Gunungwungkal, Cluwak, Tayu and Dukuhseti. Based on the RTRW and other LP2B criteria, the area is not good enough to be designated for LP2B.

3.3 Number of Population and Maximum Year of Food Self-Sufficiency

Regional development planning cannot be separated from studies related to population. The existence of population information will make development plans more accurate and on target (Huda et al, 2017). An area that has a good carrying capacity is an area that can provide and ensure the sustainability of food supply for its population and can carry out food self-sufficiency (Pratama et.al, 2021). The consumption needs of the people must be fulfilled to avoid the occurrence of turmoil in society. It is necessary to do a plan to prepare for future community needs by analyzing needs and predicting future community needs (Rohman & Maharani, 2017). Based on the results of calculations that have been carried out, the maximum population that can be met by perennial rice production in Pati Regency is 1,645,016 people. This amount is used as a reference for calculating population projections in Pati Regency. The calculation uses the geometric population projection method (geometric growth rate). The calculation results show that the population in Pati Regency in 2040 is 1,609,968 people. The projection calculation can be seen in the Table 4.

Table 4. Population projection of Pati Regency

No.	Year	r	Projection
(1)	(2)	(3)	(4)
1.	2020		1.324.188
2.	2030	1.03%	1.467.078
3.	2040		1.609.968

The results of the maximum population projection for food self-sufficiency in Pati Regency are still considering if at any time there is a population explosion. Population growth in the last 10 years (2010-2020) reached 1.03 percent. Population growth has increased quite drastically from the previous 10 years (2000-2010) which was only 0.37 percent. The population explosion has made the demand for rice plants higher because the population is increasing. In addition, the decline in production and land-use change is also one aspect that poses a threat to food availability in Pati Regency. The results of the calculations carried out have the opportunity to cause the prediction year to go forward or backward. Land management to maintain its fertility needs to be considered so that productivity does not decrease and affect rice production. The participation of related parties is needed to maximize agricultural potential as an effort to maintain food availability in Pati Regency.

The results of this study are relevant to previous studies that the value of carrying capacity of food crops is influenced by the amount of food crop production and population. Land area also affects the production of food crops produced. Therefore, to realize the condition of food self-sufficiency, the condition of agricultural land in an area also needs to be considered. The increase in population needs to be controlled so that there is no population explosion that will have an impact on food availability in an area.

4. Conclusion

The value of the carrying capacity of rice crops in Pati Regency is 1.371 which indicates the fulfillment of rice plants in Pati Regency. The results of the LP2B map show that the potential LP2B land in Pati Regency is 50,635 hectares. The LP2B map-making is based on several assumptions such as a stretch of rice fields with an area of > 5 hectares; having basic infrastructures such as access roads and river networks; conformity with the Pati Regency RTRW map; and has the type of soil suitable for agriculture. The agglomeration element provides additional consideration in monitoring the LP2B program. The maximum population that can be met for food needs is 1,622,356 people. Pati Regency

can meet the food needs of the population until 2040 or the next 20 years with a population of 1,609,968 people.

Conflicts of Interest

The authors declare no conflict of interest.

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References

- Abrori, S., & Priyana, Y. (2021). *Analisis Daya Dukung Lingkungan Terhadap Ketersediaan Pangan di Kecamatan Jatipurno Kabupaten Wonogiri*. Doctoral dissertation, Universitas Muhammadiyah Surakarta.
- Andriawan, R., Martanto, R., & Muryono, S. (2020). Evaluasi kesesuaian potensi lahan pertanian pangan berkelanjutan terhadap rencana tata ruang wilayah. *Tunas Agraria*, 3(3). <https://doi.org/10.31292/jta.v3i3.126>.
- Apriyanto, M., Fikri, K. N. S., & Azhar, A. (2021). Sosialisasi konsep lahan pertanian pangan berkelanjutan di Kecamatan Batang Tuaka, Kabupaten Indragiri Hilir. *PaKMas: Jurnal Pengabdian Kepada Masyarakat*, 1(1), 08–14. <https://doi.org/10.54259/pakmas.v1i1.24>.
- Arnawan, G. E., & Surata, I. G. (2019). Peranan kantor pertanahan kabupaten buleleng dalam perlindungan lahan pertanian pangan berkelanjutan di Kabupaten Buleleng. *Kertha Widya*, 7(1).
- BPS. (2019). *Kabupaten Pati dalam angka*. Pati: Badan Pusat Statistik.
- BPS. (2020). *Provinsi Jawa Tengah dalam angka*. Jawa Tengah : Badan Pusat Statistik.
- BPS. (2020). *Kabupaten Pati dalam angka*. Pati: Badan Pusat Statistik.
- BPS. (2021). *Provinsi Jawa Tengah dalam angka*. Jawa Tengah : Badan Pusat Statistik.
- BPS. (2021). *Kabupaten Pati dalam angka*. Pati: Badan Pusat Statistik.
- Ministry of Health RI (1981). *List Ingredients for food*. Jakarta: Bhratara Karya Aksara.
- Duri, A., Priyono, K. D., & Sigit, A. A. (2016). *Analisis kesesuaian arahan fungsi kawasan terhadap penggunaan lahan dengan pemanfaatan SIG di Kabupaten Pati tahun 2015*. Doctoral dissertation, Universitas Muhammadiyah Surakarta.
- Erwandari, N. (2017). Implementasi sustainable development goals (SDGs) dalam meningkatkan ketahanan pangan di Provinsi Riau. *Jurnal Ilmu Hubungan Internasional*, 5(3), 875-888.
- Fikri, K. M. S., Apriyanto, M., & Novitasari, R. (2021). Lahan pertanian pangan berkelanjutan di Kabupaten Indragiri Hilir. *Selodang Mayang: Jurnal Ilmiah Badan Perencanaan Pembangunan Daerah Kabupaten Indragiri Hilir*, 7(2), 77-82. <https://doi.org/10.47521/selodangmayang.v7i2.202>.

- Handari, M. A. W., Bambang, A.N., Purnaweni, H. (2012). Strategi perlindungan lahan pertanian berkelanjutan di Kabupaten Magelang. In *Seminar Nasional Pengelolaan Sumberdaya Alam dan Lingkungan*.
- Huda, I. A. I. S., Suwargany, M. H., & Anjarika, D. S. (2017). Analisis daya dukung dan kebutuhan lahan pertanian di Kabupaten Lamongan Tahun 2035. *Prosiding Seminar Nasional Geografi UMS 2017*.
- Ikhwanto, A. (2019). Alih Fungsi Lahan Pertanian menjadi lahan non pertanian. *Jurnal Hukum dan Kenotariatan*, 3(1), 60-73. <http://dx.doi.org/10.33474/hukeno.v3i1.1919>.
- Pratama, I. D. J., Arrasyid, R., Zidan, M., Alfiah, N. S., & Rahma, S. D. A. (2021). Analisis daya dukung dan kebutuhan lahan pertanian di Kabupaten Purwakarta tahun 2028. *Jurnal Samudra Geografi*, 4(1), 16-29. <https://doi.org/10.33059/jsg.v4i1.2505>.
- Janti, G. I., Martono, E., & Subejo, S. (2016). Perlindungan lahan pertanian pangan berkelanjutan Guna memperkuat ketahanan pangan wilayah (Studi di Kabupaten Bantul, Daerah Istimewa Yogyakarta). *Jurnal Ketahanan Nasional*, 22(1), 1-22. <https://doi.org/10.22146/jkn.16666>.
- Jocom, S. G. (2017). Kajian daya dukung lahan pertanian dalam menunjang swasembada Pangan di Kabupaten Minahasa Selatan. *Agri-Sosioekonomi*, 13(1), 11-24. <https://doi.org/10.35791/agrsosek.13.1.2017.14881>.
- Kartini, D. S., Mulyawan, R., & Yuningsih, N. Y. (2017). Kapitalisme pedesaan di Kawasan Ekonomi Khusus (Kek) Tanjung Lesung Kabupaten Pandeglang Propinsi Banten. *CosmoGov: Jurnal Ilmu Pemerintahan*, 3(1), 55-64. <https://doi.org/10.24198/cosmogov.v3i1.12636>.
- Kuncoro, R. D. S. (2017). Analisis daya dukung dan kebutuhan lahan pertanian di Kabupaten Madiun Tahun 2032. *Prosiding Seminar Nasional Geografi UMS 2017*.
- Kunu, P. J. (2020). Analisis daya dukung lahan pertanian untuk menjamin keamanan pangan di Kepulauan Kei Besar Kabupaten Maluku Tenggara. *Agrologia*, 9(2). <http://dx.doi.org/10.30598/ajibt.v9i2.1162>.
- Law of the Republic of Indonesia Number 41 (2009) concerning Protection of Sustainable Food Agricultural Land.
- Law of the Republic of Indonesia Number (2007) concerning Spatial Planning.
- Mubarokah, N., Rachman, L. M., & Tarigan, S. D. (2020). Analisis daya dukung lahan pertanian tanaman pangan Daerah Aliran Sungai Cibaliung, Provinsi Banten. *Jurnal Ilmu Pertanian Indonesia*, 25(1), 73-80. <https://doi.org/10.18343/jipi.25.1.73>.
- Muryono, S. (2016). Kajian upaya pengendalian penggunaan tanah di Kabupaten Temanggung Provinsi Jawa Tengah. *BHUMI: Jurnal Agraria Dan Pertanahan*, 2(1), 84-101.
- Muryono, S., & Utami, W. (2020). Pemetaan potensi lahan pertanian pangan berkelanjutan guna mendukung ketahanan pangan. *BHUMI: Jurnal Agraria Dan Pertanahan*, 6(2), 201-218.

- Muta'ali, L. (2012). *Daya dukung lingkungan untuk perencanaan pembangunan daerah*. Yogyakarta: Universitas Gadjah Mada.
- Muta'ali, L. (2015). *Teknik Analisis Regional*. Yogyakarta : Universitas Gadjah Mada.
- Muta'ali, L. (2019). *Daya dukung dan daya tampung lingkungan berbasis jasa ekosistem untuk perencanaan lingkungan*. Yogyakarta : Universitas Gadjah Mada.
- Odum H.T. (1967). *Energetics of world food production*. In: The President's Science Advisory Committee. Report of Problems of World Food Supply, vol 3. White House, Washington DC, pp 55–94.
- Rusono, N., Sunan, A., Zulfriandi, J. I., Muharam, A., Avianto, N., & Hersinta, D. (2015). Evaluasi implementasi kebijakan Lahan Pertanian Pangan Berkelanjutan (LP2B). *Jakarta Pusat: Direktorat Pangan dan Pertanian*.
- Pareke, J. T. (2020). *Penataan ruang kawasan perdesaan berbasis perlindungan lahan pertanian pangan berkelanjutan dalam rangka mewujudkan kedaulatan pangan di Indonesia (melalui pendekatan trinity protection of sustainability concept)*. Zifatama Jawa.
- Pribadi, D. O., Zasada, I., Müller, K., & Pauleit, S. (2017). Multifunctional adaption of farmers as response to urban growth in the Jabodetabek Metropolitan Area, Indonesia. *Journal of Rural Studies*, 55, 100-111.
- Pitaloka, E. D. A. (2020). Kebijakan perlindungan lahan pertanian pangan berkelanjutan dalam dimensi politik hukum penataan ruang. *Jurnal IUS Kajian Hukum dan Keadilan*, 8(1), 49-78. <http://dx.doi.org/10.29303/ius.v8i1.718>.
- Prasada, I. M. Y., & Priyanto, M. W. (2020). Dampak implementasi perda perlindungan lahan pertanian pangan berkelanjutan (LP2B) di Provinsi Jawa Barat. *Agritech: Jurnal Fakultas Pertanian Universitas Muhammadiyah Purwokerto*, 21(2), 140-154. <http://dx.doi.org/10.30595/agritech.v21i2.4252>.
- Pridasari, S. A., & Muta'ali, L. (2018). Daya Dukung Lahan Pertanian dan Penentuan Lahan Pertanian Pangan Berkelanjutan di Kabupaten Bantul. *Jurnal Bumi Indonesia*, 7(1), 228898.
- Ragil, C. (2017). Arahan pengembangan kawasan LP2B (Lahan Pertanian Pangan Berkelanjutan) padi berbasis D3TLH (Daya Dukung dan Daya Tampung Lingkungan Hidup) di Kabupaten Kulon Progo. *ReTII*. Retrieved from [//journal.itny.ac.id/index.php/ReTII/article/view/728](http://journal.itny.ac.id/index.php/ReTII/article/view/728).
- Regional Regulation of Pati Regency Number 5 (2011) concerning Spatial Planning of Pati Regency for 2010-2030.
- Regional Regulation of Pati Regency Number 2 of (2021) concerning Amendments to Pati Regency Regulation Number 5 of 2021 concerning Pati Regency Spatial Planning for 2010-2030.
- Rohman, A., & Maharani, A. D. (2017). Proyeksi kebutuhan konsumsi pangan beras di Daerah Istimewa Yogyakarta. *Jurnal Caraka Tani: Journal of Sustainable Agriculture*. 37(1), 29-34. <https://doi.org/10.20961/carakatani.v32i1.12144>.

- Rusono, N., Sunan, A., Zulfriandi, J. I., Muharam, A., Avianto, N., & Hersinta, D. (2015). *Evaluasi pelaksanaan kebijakan Lahan Pertanian Pangan Berkelanjutan (LP2B)*. Jakarta : Bappenas.
- Sadali, M. I. (2018). Ketahanan pangan berkelanjutan di Kabupaten Sukoharjo. *Jurnal Geografi*, 10(1).
- Santoso, P. B. K., Widiatmaka, W., Supiham, S., Machfud, M., & Rusastra, I. W. (2017). Analisis pola konversi lahan sawah dan struktur hubungan penyebab dan pencegahannya (Studi kasus Kabupaten Subang, Provinsi Jawa Barat). *Jurnal Pengelolaan Sumberdaya Alam dan Lingkungan (Journal of Natural Resources and Environmental Management)*, 7(2), 184-194. <https://doi.org/10.29244/jpsl.7.2.184-194>.
- Saparto, S., Wiharnata, A. I., & Sumardi, S. (2021). Perbedaan pendapatan dan kelayakan usahatani padi inpari 32 dan inpari 42. *AGRISAINTELIKA: Jurnal Ilmu-Ilmu Pertanian*, 5(1), 75-82. <https://doi.org/10.32585/ags.v5i1.1027>.
- Satria, J., Falatehan, A. F., & Beik, I. S. (2018). Strategi perlindungan lahan pertanian pangan berkelanjutan di Kabupaten Bogor. *Jurnal Manajemen Pembangunan Daerah*, 10(2). https://doi.org/10.29244/jurnal_mpd.v10i2.27786.
- Sitindaon, M. (2017). Analisis potensi ekspor hasil pertanian tanaman pangan di Kabupaten Pati. *Economics Development Analysis Journal*, 6(1), 62-68. <https://doi.org/10.15294/edaj.v6i1.22202>.
- Sriutomo, U. R. P., & Christanto, J. (2015). Daya dukung pertanian tanaman pangan terhadap kebutuhan pangan penduduk di kabupaten Grobogan, provinsi Jawa Tengah. *Jurnal Bumi Indonesia*, 4(2).
- Subroto, G., & Susetyo, C. (2016). Identification of Variables Affecting the Determination of Sustainable Food Agricultural Land in Jombang Regency, East Java. *ITS Engineering Journal* 5(2).
- Suroso S. (2018). The role of regions in supporting the national food supply study in Pati Regency. *Journal of Food and Nutrition*. 8(2), 139-156.
- Taufik, M., Kurniawan, A., & Pusparini, F. M. (2017). Penentuan lahan pertanian pangan berkelanjutan (LP2B) menggunakan metode multi data spasial di Kecamatan Ngadirojo, Kabupaten Pacitan. *GEOID Journal of Geodesy and Geomatics*, 13(1), 63-68 <http://dx.doi.org/10.12962/j24423998.v13i1.3679>.
- Dhimas, A. W. (2018). *Mekanisme pemberian izin perubahan penggunaan tanah pertanian ke non pertanian utuk pt dua kelinci di kantor pertanahan Kabupaten Pati*. Doctoral dissertation. Universitas Diponegoro.
- Wiyanti, D. P., & Purnomo, N. H. (2018). Prediksi kebutuhan pangan pokok padi dan jagung terhadap perubahan jumlah penduduk tahun 2018–2038 di Kabupaten Pasuruan. *Swara Bhumi*, 5(7).