Analysis of the Carrying Capacity and Environmental Capacity Based on Ecosystem Services in the Provision of Clean Water and Food in Pasuruan City

by Eva Banowati

Submission date: 05-Sep-2022 08:31AM (UTC+0700)
Submission ID: 1892682103
File name: es_in_the_Provision_of_Clean_Water_and_Food_in_Pasuruan_City.pdf (751.84K)
Word count: 4076
Character count: 21069

International Journal of Research and Review
Vol.8; Issue: 2; February 2021
Website: www.ijrrjournal.com
Case Report *E-ISSN: 2349-9788; P-ISSN: 2454-2237*

Analysis of the Carrying Capacity and Environmental Capacity Based on Ecosystem Services in the Provision of Clean Water and Food in Pasuruan City

Bintang Aulia Pradaya Pramita[1], Eva Banowati[2], Muhammad Lutfi Wirawan[3]

[1]Directorate of Regional Spatial Planning Region I, Ministry of Agrarian Affairs and Spatial Planning, Indonesia
[2,3]Department of Geography, Faculty of Social Science, Universitas Negeri Semarang, Indonesia

Corresponding Author: Eva Banowati

ABSTRACT

Ecosystem services are the benefits that humans derive from ecosystems. As the population increases, the need for clean water and foodstuffs also continues to increase. To determine the level of sustainability, it is necessary to provide the carrying capacity and environmental capacity of ecosystem services for clean water providers and food providers. This research took place in the Pasuruan City, East Java. The assessment and weighting of ecosystem services on land use and ecoregions were carried out using the Analytical Hierarchy Process (AHP) approach. The value obtained is an expert based valuation method on the role of each ecoregion on types of ecosystem services. The results showed that the Pasuruan City having the ability to provide clean water ecosystem services is very low with a percentage of 59.4% with a total area of 2,316.62 ha. Meanwhile, food providers are also dominated by the very low class, namely 36.5% and the total area reaches 1,425.63 ha.

Keywords: Ecosystem Services, Clean Water, Food, Pasuruan City

INTRODUCTION

Natural resources are an important component in meeting the needs of human life and other living things. The higher the population of living things, the more natural resources are needed and used to meet their daily needs. Population growth and economic development encourage the government to continue to carry out regional development to support human activities while still considering aspects of environmental sustainability in the future. Processing of natural resources needs to consider the sustainability of the availability of these resources so that they can be used continuously for a certain period of time. This is because nature has limitations to support human life.

According to Law Number 32 of 2009 concerning Protection and Management of the Environment defines ecoregions as geographic areas that have the same characteristics of climate, soil, water, endemic plants and animals as well as patterns of interaction between humans and nature that illustrate the integrity of natural systems and environment. Ecoregion boundaries do not depend on administrative boundaries. Ecoregions have a management function, determining the carrying capacity and environmental capacity as well as natural resource reserves. An ecoregion map usually contains information about the characteristics of the landscape in the form of geomorphology and morphogenesis, which is able to delineate the boundaries of these characteristics so that the differences in characteristics can be seen (Riqqi, et al.2018).

Information regarding ecosystem functions can represent the conditions of the carrying capacity and environmental capacity in other words, the carrying capacity and environmental capacity are the capacities of ecosystem functions and services in supporting human life or other creatures residing in a certain location or ecoregion (Riqqi, et al. 2018). The carrying capacity and environmental capacity are dynamic and complex in nature, considering that each region has different geographical characteristics, natural resource capabilities and different population (Mulawarman, et al. 2019).

One of the calculations of the carrying capacity and environmental capacity can use an ecosystem service-based approach. According to Millenium Ecosystem Assessment (2005) ecosystem services are the benefits that humans obtain from ecosystems. The benefits of identifying the carrying capacity and environmental capacity based on ecosystem services include being a guide for the central and regional governments in relation to the implementation of development plans, in the context of protecting and managing natural resources and the environment by maximizing the potential of natural resources in a comprehensive and sustainable manner (Dinas Lingkungan Hidup ekalongan City, 2018; P3EJ, 2017; Muta'ali, 2015; Santosa, 2010 in Febriarta, 2020)

Ecosystem services are categorized into four, which include provisioning services, regulating services, cultural services, and supporting services (MEA, 2005). The classification of each category is further divided into 23 classes of ecosystem services as follows

a. **Provision Services :** foodstuffs, clean water, fiber, fuel and other basic materials, genetic material, medicinal and biochemical materials, ornamental species.
b. **Regulatory Services :** air quality regulation, climate regulation, prevention disturbance, water regulation, sewage treatment, soil protection, pollination, biological regulation, soil formation
c. **Cultural Services:** aesthetics, recreation, heritage and cultural identity, spiritual and religious, education
d. **Support Services :** breeding habitat, germplasm protection

Pasuruan City is one of the cities located on the north coast of East Java Province, Indonesia. Since 2014 - 2018, the population of Pasuruan City has increased every year with a growth rate of 1.51%. The highest population growth occurred in 2016-2017, namely 3.61% or an increase of 1,541 people. The increasing number of population raises various environmental problems including the increasing need for food and clean water. If this condition is allowed to continue, the availability of food and clean water will not be proportional to the needs of the existing population.

Assessment of the carrying capacity and environmental capacity of ecosystem services in Pasuruan City in the category of provisioning services, namely services providing clean water and food providers. The basis for consideration in determining ecosystem services discussed in the Kajian Lingkungan Hidup Strateis (Strategic Environmental Assesment) is that these 2 ecosystem services are priority environmental functions that able to provide services to humans to live in them which are influenced by the conditions of land cover in Pasuruan City.

From the description above, the purpose of this study is to determine the class of carrying capacity and environmental capacity of Pasuruan City using the calculation of ecosystem services providing food and clean water with the ecoregion approach and existing land use. Data analysis results are presented in spatial form using Geographic Information System (GIS) software.

MATERIALS & METHODS

The location taken in this study is Pasuruan City, one of the cities on the north

coast of East Java, Indonesia. The method used in the analysis of the carrying capacity and the environmental capacity for Pasuruan City refers to the carrying capacity index based on ecosystem services of East Java Province with a map scale of 1: 50,000 which is adjusted and analyzed based on the land cover map of Pasuruan City scale 1: 50,000 originating from the interpretation of the Pleiades image in 2017 with the 2018 survey.

Furthermore, from each map that has been made, a weighting or scoring is carried out for each ecosystem service followed by an overlay for assessment. The overlay results are classified into five classes starting from the Very High, High, Medium, Low, and Very Low categories. The assessment and weighting of ecosystem services on land use and ecoregions were carried out using the Analytical Hierarchy Process (AHP) approach. The value obtained is an expert based valuation method on the role of each ecoregion on types of ecosystem services (Febriarta, 2020). The results of this assessment can illustrate the role of ecosystem services, the higher the value, the more important their role is to ecosystem services (Kajian Lingkungan Hidup (Environmental Assesment), 2014 in Febriarta, 2020). Data processing is carried out by identifying land use and landform (ecoregion) ecosystem services, calculating the ecosystem services index (IJE), and visualizing the results of calculating the ecosystem services index (IJE) into a spatial form. The value of the Ecosystem Services Index (IJE) is an index value of the value of each ecosystem service with a range of 0 - 1.The value of the Ecosystem Services Index (IJE) is calculated by weighting the unit area based on the following equation (KLH, 2014).

IJE i, x = ((KJEi, ax Lpa) + (KJE i, bx LPb) + (KJE i, cx LPc) + ... (KJE i, nx LPn)) / (LA tot) ..... (1)

Information:

IJE i, x = ecosystem services index value type i (for example: food) in region x (for example: district / region)

KJE i, x = coefficient of ecosystem services index type i (for example: food) in polygon a (for example: district)

Lpa = area of polygon a with KJE value a

LA tot = total polygon area (km / m2)

RESULTS AND DISCUSSION

1. Research Location Overview

Geographically, Pasuruan City is located between 7°35 '- 7°45' South Latitude and 112°45 '- 112°55' East Longitude, which is one of the second level regions in East Java Province. Its territory is lowland with an average height of 4 meters above sea level. Based on the geographical position, Pasuruan City has waters, namely the Madura Strait in the North, and borders the mainland with Pasuruan Regency. The average height of the area of Pasuruan City which is only 4 m above sea level makes this city prone to flooding in the rainy season. Apart from that, the flood hazard is also caused by the area of this city which has a slope of 0-3% where part of it is a basin.

Administratively, Pasuruan City has an area 3,901.24 Ha. Which is divided into 4 subdistricts and further divided into 34 villages. The name of the subdistrict and its size can be seen in the following table.

Table 1. Area of Sub-Districts in Pasuruan City

No.	Sub-districts	Area (Ha)
1	Kidul Bugul	1,492.54
2	Gadingrejo	867.38
3	Panggungrejo	710.14
4	Purwerejo	831.18
Total		3,901.24

Source: Revised Version of RTRW for Pasuruan City, 2019 and Permendagri No. 47 of 2007

The population of Pasuruan City has increased every year from 2014-2018. The largest population in 2018 was Panggungrejo Subdistrict with 63,663 people or 31.98% of the total population of Pasuruan City. The population in Pasuruan City tends to increase every year with an average growth rate of 1.51% from 2014 to 2018. The highest population growth occurred in 2016-2017, namely 3.61% or an

increase of 1,541 people. The highest population density was in Panggungrejo Subdistrict, namely 72 people / ha and the lowest was in Bugul Kidul Subdistrict, which was 27 people / ha. The population growth rate of Pasuruan City from 2014 - 2018 can be seen in the following diagram:

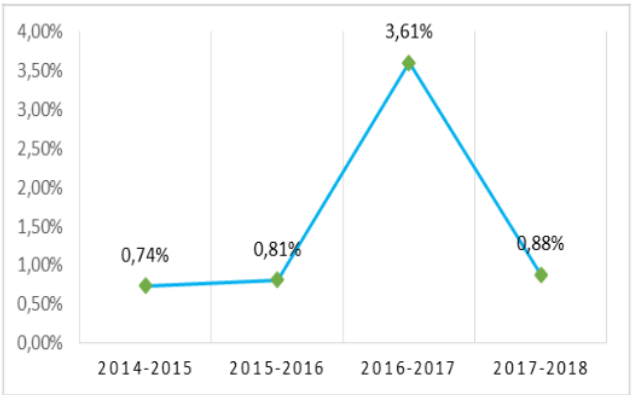

Figure 1. Population Growth Rate of Pasuruan City

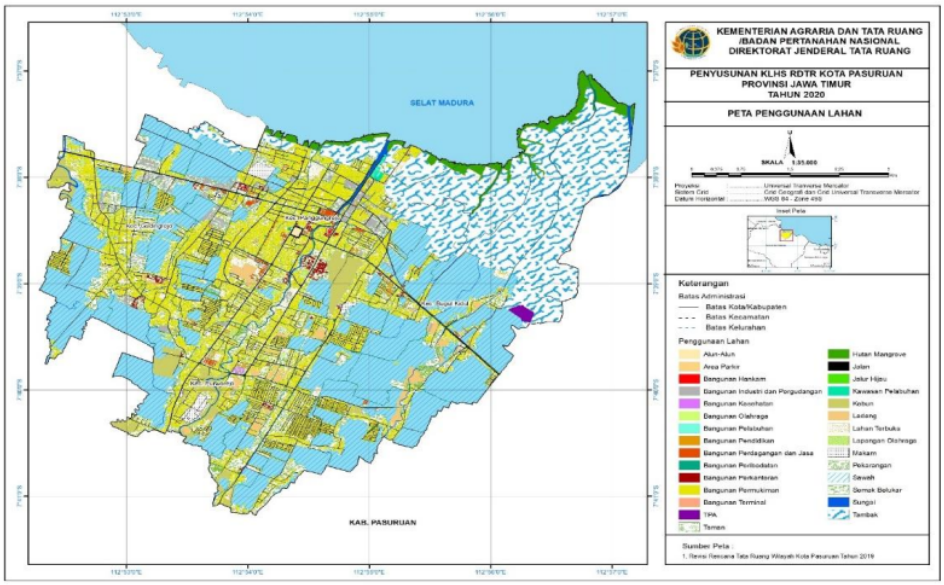

Figure 2. Landuse Map of Pasuruan City in 2019

In general, land use in Pasuruan City is still dominated by wetland agricultural areas such as rice fields, covering an area of 847.08 hectares. And the land use for settlements has an area of 815.51 hectares. From the results of landuse survey in Pasuruan City, 65.85% is a built-up area. Bugul Kidul Subdistrict is the largest area. It covers almost half of the city's area with the built-up area nearly 70% of the sub-district area. Meanwhile, Panggungrejo Subdistrict is a sub-district with the smallest area (less than a quarter of the city's area), but the built-up area is nearly 70% of its area. If the area of landuse for each Subdistrict in Pasuruan City is broken down, it can be seen in the following table:

Table 2. Use of Existing Land in Pasuruan City by Subdistrict

Space Pattern	Area (Ha)				
	Kidul Bugul	Gadingrejo	Panggungrejo	Purworejo	Grand Total
Lidung Area Plan					
Beach Border	12.82	-	15.82	-	28.64
Rail Border	3.99	4.46	5.13	-	13.58
River Border	17.91	2.80	9.21	8.85	38.76
Green open space	40.89	41.65	49.01	61.39	192.95
Mangrove forest	28.66	-	10.90	-	39.56
Cultivation Area Plan					
Brackish Water Aquaculture	536.47	6.90	40.08	-	583.45
Wetland Agricultural Area	509.42	244.40	15.81	77.45	847.08
Dry Land Agricultural Areas	6.58	7.57	-	5.73	19.88
Medium Industry & Warehousing	25.26	105.75	61.38	9.37	201.76
Trade and Services	11.89	9.27	115.78	45.26	182.20
Offices	10.73	2.47	33.19	5.92	52.31
Settlement	158.35	178.63	260.11	218.41	815.51
Resettlement Plan	191.05	175.27	136.17	97.70	600.19
Nature Tourism	6.74	-	3.30	-	10.04
Educational Facilities	-	-	0.94	-	0.94
Public facilities	5.72	11.74	20.50	16.17	54.13
Transportation Infrastructure	1.90		0.10	-	2.00
Port Area	-	-	45.74	-	45.74
Defense & Security Area	-	0.93	7.42	-	8.35
Landfills	6.23	-	-	-	6.23
Street	24.47	21.94	39.07	18.23	103.72
River	15.75	3.02	5,53	7.33	31.64
Grand Total	**1,614.83**	**816.82**	**875.19**	**571.82**	**3,878.67**

Source: RTRW of Pasuruan City

There are two types of soil scattered in Pasuruan City, namely alluvial soil and gray hydromorphic soil. Gray hydromorphic soil, with a limited distribution area along the coast, covering approximately 15% of the area of Pasuruan City. This type of soil is formed from the parent material of a mixture of new sediment from rivers and seas. In a wet state, the soil expands and is sticky, when dry the soil is wrinkled, there are gaps and is hard, making the soil difficult to cultivate. Soil acidity is neutral to close to alkaline with high levels of N, F, K, Ca and Mg nutrients. But because the levels of Na and Cl are also high, this type of soil is actually not suitable for agricultural land. This land is more suitable for added cultivation and salting.

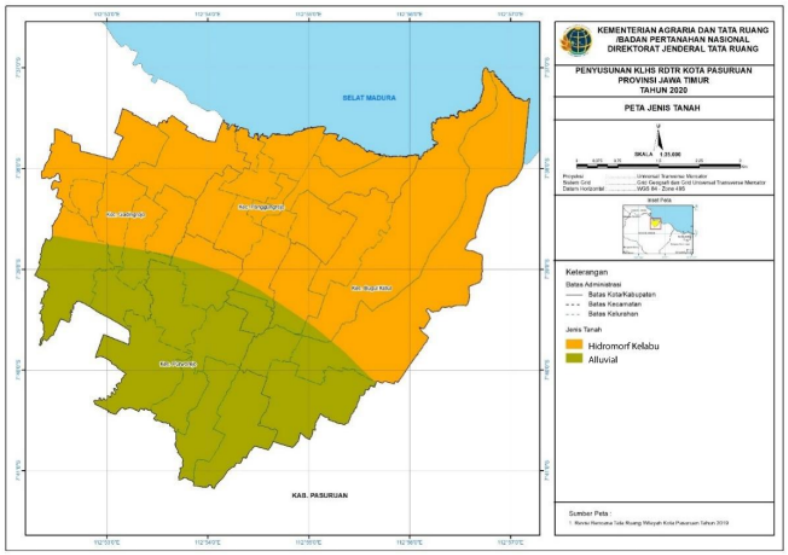

Figure 3. Distribution Map of Pasuruan City Types of Soil

Alluvial soils, spread in the central area to the south of the city, are formed from sediment from the surrounding area, especially those from the south of the city. Has not had a cross-sectional development, dark gray, dusty clay textured to heavy clay. In a wet state, the soil expands and sticks, if it is dry the soil will be wrinkled and hard. Naturally, the soil is rather airtight and the aeration system is not smooth, so that drainage is generally hampered. The soil acidity level is neutral with a pH of 6.5 - 7.5, low N nutrient content, medium P2CO5 and very high K2O. This type of soil is suitable for crop cultivation provided that it requires special attention to its water disposal system.

2. Clean Water Provider Ecosystem Services

The availability of water in an area depends on the supply and reserves of ground and surface water. Soil characteristics affect the ability to absorb and drain water. The rock type for each ecoregion will represent the potential for the aquifer. Pasuruan City is included in the Java North Coast Plains (M1) ecoregion unit. Hydrological conditions are controlled by rivers with high flow rates and sediment loads, especially during the rainy season, and groundwater conditions are generally brackish to salty, which is almost evenly distributed throughout the muddy coastal plain (alluvium deposits) (KLH, 2013). In other words, the hydrological conditions in Pasuruan City are controlled by three main rivers, namely Welang River, Gembong River, and Petung River.

Table 3. Area and Percentage of Water Providing Ecosystem Services.

	Category	Area (Ha)	%
Water Provider Ecosystem Services	Very low	2,316.62	59.4
	Low	191.98	4.9
	Moderate	435.63	11.2
	High	73.13	1.9
	Very high	883.87	22.7
	total	**3,901.24**	**100.00**

Source: Analysis Results, 2020

From the table above, Pasuruan City is dominated by ecosystem services that provide water with very low categories reaching 2,316.62 Ha or 59.4%. Then followed by the category of very high low water providers as much as 883.87 hectares or 22.7%. Most of the areas with high water supply are in rice fields with alluvial soil types. Soil characteristics in alluvial plains and volcanoes are dominated by sand with cavities between soil pores, in relatively large sand textured soils that can accommodate groundwater. The large pore distance between the soil also makes it easier for rainwater to enter and flow. The differences in soil and rock characteristics between ecoregions cause variations in the ability to absorb and drain water. There are 2 types of soil scattered in this city, namely alluvial soil and Gray Hydromorphic soil.

The percentage of areas with clean water supply ecosystem services in the very high class is 22.7%. Most of the land uses in this area are rice fields. Meanwhile, when compared to existing land uses, most areas that have a very low level of ecosystem service water supply are ponds and settlements.

In the use of pond land, it is logical that clean water is difficult to find because it uses salt water to support the ecosystem. However, different things can be seen in the use of land as a settlement. The low level of clean water supply ecosystem services in settlements can indicate a state of clean water crisis for residents in Pasuruan City. If this has not happened in the present, it is very possible that a clean water crisis in Pasuruan City can occur in the future. As predicted, in 2040 the north coast of Java will experience a clean water crisis (Public Relation of Indonesian Institute of Sciences, 2019) including Pasuruan City. In the use of rice fields, the opposite occurs. Rice fields have a very high supply of clean water ecosystem services and are scattered in suburban areas.

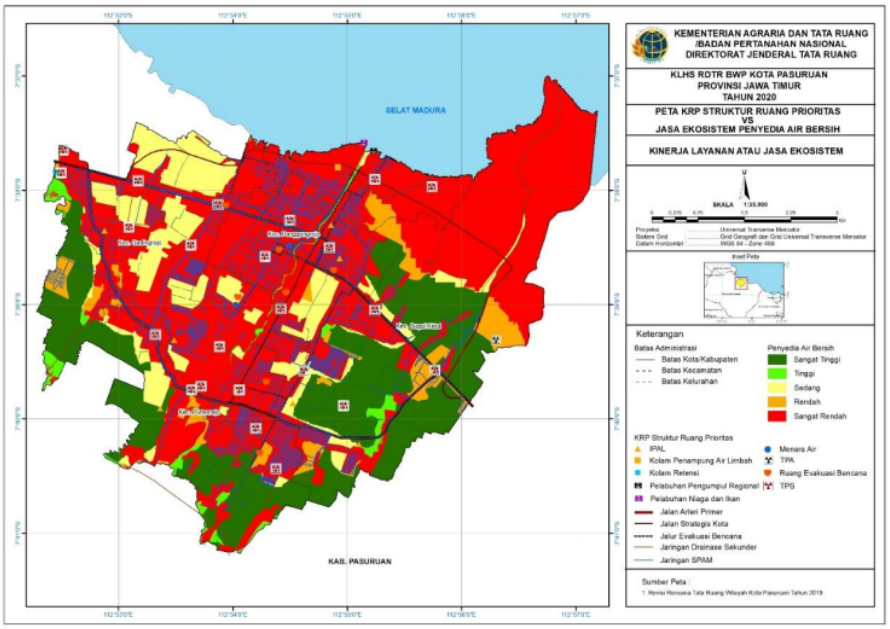

Figure 4. Map of Water Provider Ecosystem Services

3. Food Provider Ecosystem Services

An ecoregion describes the geographical characteristics of a region. Each characteristic reflects the potential and problems of each ecoregion. Agricultural activities and wetlands require fertile land and sufficient water availability. There are two types of soil scattered in the city of Pasuruan, namely alluvial soil and gray hydromorphic soil.

Pasuruan City is dominated by food supply ecosystem services with a very low category of 1,425.63 Ha or 36.5% and a very high category of 890.06 Ha or 22.8%. The complete condition of the ecosystem services that provide food in Pasuruan City can be seen in the following table.

Table 4. Area and Percentage of Food Provider Ecosystem Services

	Category	Area (Ha)	%
Ecosystem Services Food Provider	Very low	1,425.63	36.5
	Low	360.49	9.2
	Moderate	746.94	19.1
	High	478.11	12.3
	Very high	890.06	22.8
	total	**3,901.24**	**100.00**

Source: Analysis Results, 2020

The status of the ecosystem services that provide food in the city of Pasuruan is dominated by the very low class of 36.5% with a total area of 1,425.63 ha. On the other hand, the very high class is in the second rank, amounting to 22.8% with a total area of 890 ha. The very high class of ecosystem services that provide food is located in Bugul Kidul Subdistrict. This condition is influenced by the existence of quite extensive rice fields in Bugul Kidul Subdistrict so that the food availability is adequate. The availability of rice fields is also supported by alluvial soil types that are fertile and suitable for agriculture. Alluvial plains and volcanoes have high soil fertility because they are rich in nutrients.

However, it is necessary to increase agricultural productivity in this region because the areas with very low class food providers are much wider than areas with very high class food service providers. This effort is intended to create food self-sufficiency both in the present and in the future. Meanwhile, the very low class is dominated in Panggungrejo and Purworejo Subdistricts because most of the areas are

residential areas. In the use of pond land, it has a medium to high class of ecosystem services that provide food. This is because fishery products from the ponds are also food consumed by the population. In addition, the pond land is on a gray hydromorphic soil type whose characteristics are more suitable for pond cultivation and salting.

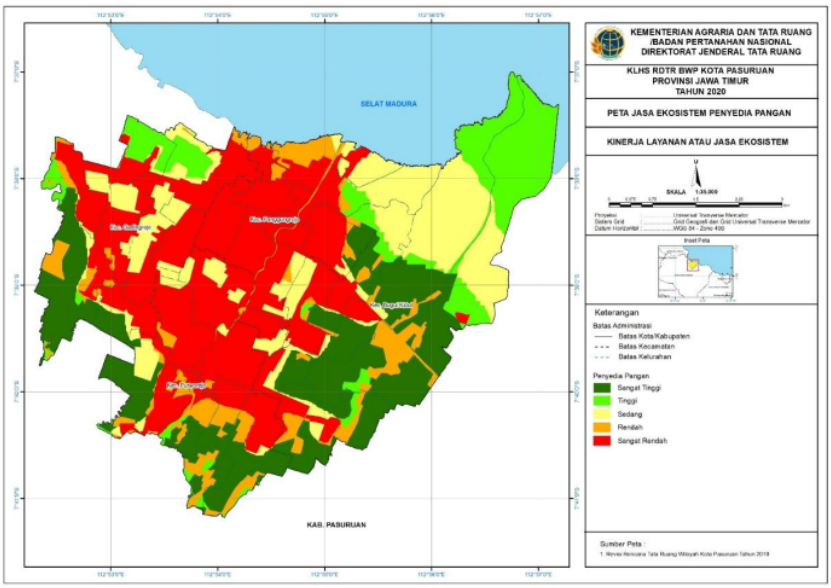

Figure 5. Map of Food Provider Ecosystem Services

CONCLUSION

Based on the results of the study, it can be concluded that the research area has a very low ability to provide ecosystem services with clean water with a percentage of 59.4% with a total area of 2,316.62 ha. Meanwhile, food providers are also dominated by the very low class, namely 36.5% and the total area reaches 1,425.63 ha. When compared with land use maps, there are several similarities. On residential land, ecosystem services providing food and clean water are classified as low because of the existence of residents as consumers of these two resources. Meanwhile, rice fields have high ecosystem services for the provision of food and clean water.

REFERENCES

1. Center for Ecoregion Management of Java Island, Ministry of Environment. 2013. Environmental Status of the Java Ecoregion.
2. Darmawan, K., & Suprayogi, A. (2017). Analysis of Flood Hazard Level in Sampang Regency Using Overlay Method with Scoring Based on Geographical Information System. Undip Journal of Geodesy, 6 (1), 31-40.
3. Febriarta, E., & Oktama, R. (2020). Mapping of Ecosystem Services-Based Environmental Supporting Services for Food and Clean Water Providers in Pekalongan City. Journal of Environmental Science, 18 (2), 283-289.
4. Law Number 32 of 2009 Concerning Protection and Management of the Environment. Jakarta: State Secretariat.
5. MEA (Millenium Ecosystem Assessment). (2005). Ecosystem Assessment and Human Well-being: Synthesis.
6. Ministry of Environment (KLH), (2014). Guidelines for Environmental Capacity Supporting Capacity, Ministry of Environment Deputy 1 for Environmental Management Assistant Deputy for SA & LH Utilization Planning & Environmental &

Environmental Policy StudiesSector: Jakarta.
7. Mulawarman, A., Paddiyatu, N., & Sumarni, B. (2019). Supporting capacity of water and food availability in Sukamaju Subdistrict. Linears Journal, 2 (2), 92-99.
8. Public Relations of LIPI (Indonesian Institute of Sciences). 2019. "The Water Crisis in Java and How We Should Respond to It".http://lipi.go.id/berita/krisis-air-di-jawa-dan-bimana-kita-harus-menyikapinya/21725 (Accessed February 1, 2021)
9. Riqqi, A., Hendaryanto, H., Safitri, S., Mashita, N., Sulistyawati, E., Norvyani, DA, & Afriyanie, D. (2019, February). Mapping of ecosystem services. In the National Seminar on Geomatics 3, 237-246.

How to cite this article: Pramita BAP, Banowati E, Wirawan ML. Analysis of the carrying capacity and environmental capacity based on ecosystem services in the provision of clean water and food in Pasuruan City. *International Journal of Research and Review*. 2021; 8(2): 607-615.

******

Analysis of the Carrying Capacity and Environmental Capacity Based on Ecosystem Services in the Provision of Clean Water and Food in Pasuruan City

ORIGINALITY REPORT

3%	1%	2%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	R V Aryani. "Effectiveness of Strategic Environmental Studies in Supporting Sustainable Development Goals", IOP Conference Series: Earth and Environmental Science, 2020 Publication	1%
2	Bertness, Mark. "Marine Community Ecology and Conservation", Oxford University Press Publication	<1%
3	Submitted to University of Portsmouth Student Paper	<1%
4	Submitted to Universitas Diponegoro Student Paper	<1%
5	Atikah Mardhiya Rohmy, H Setiyono, Supriyadi Supriyadi. "Corporate Criminal Sanction in Omnibus Law for Forest Destruction in Indonesia: Review of Law Number 11 of 2020 on Job Creation", Al-	<1%

	Risalah: Forum Kajian Hukum dan Sosial Kemasyarakatan, 2021 Publication	
6	www.nusantarahasanajournal.com Internet Source	<1 %
7	www.coastal-saf.eu Internet Source	<1 %

Exclude quotes	On	Exclude matches	< 10 words
Exclude bibliography	On		

Analysis of the Carrying Capacity and Environmental Capacity Based on Ecosystem Services in the Provision of Clean Water and Food in Pasuruan City

GRADEMARK REPORT

FINAL GRADE

/0

GENERAL COMMENTS

Instructor

PAGE 1

PAGE 2

PAGE 3

PAGE 4

PAGE 5

PAGE 6

PAGE 7

PAGE 8

PAGE 9