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ENVIRONMENTAL CARRYING CAPACITY BASED ON SPATIAL PLANNING

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ABSTRACT

The aims of this research were to examine environmental carrying capacity analyzed based on aspects of spatial planning and eco-region. The result showed that Kulonprogo Regency has low value of environmental carrying capacity and can only support as much as 79.81% of its total population. Analysis of variance showed significant difference of environmental carrying capacity of protected and cultivated area. The main factor among 12 variables determining the degree of environmental carrying capacity is man-land ratio (contributed 39.72%). Priority should be given to 28 villages or 31.81% of the area with low environmental carrying capacity. Eco-region and spatial plan approaches in environmental management practice are also strongly recommended.

Keywords: carrying capacity, eco-region, spatial planning

ABSTRAK

Tujuan dari penelitian ini adalah untuk menentukan daya dukung lingkungan yang dianalisis berdasarkan aspek perencanaan tata ruang dan eko-wilayah. Hasilnya menunjukkan bahwa Kabupaten Kulonprogo memiliki nilai daya dukung lingkungan rendah dan hanya dapat mendukung 79,81% dari total penduduk. Analisis varians menunjukkan perbedaan yang signifikan antara daya dukung lingkungan kawasan lindung dan budidaya. Faktor utama di antara 12 variabel yang menentukan tingkat daya dukung lingkungan adalah rasio/perbandingan manusia dan lahan (berkontribusi sebesar 39,72%). Prioritas harus diberikan kepada 28 desa atau daerah sebesar 31,81% dengan daya dukung lingkungan yang rendah. Eko-wilayah dan pendekatan tata ruang dalam praktik manajemen lingkungan juga sangat dianjurkan.

Kata kunci : daya dukung, eko-wilayah, perencanaan tata ruang

INTRODUCTION

Development always raises a paradox, one of which is the reduction in environmental quality and carrying capacity. Some experts mentioned that those trends are increasing along with the increasing human needs Meadows, in *Berry, et.al.* [1993]; *Djojohadikusumo,* [1981]. This condition, if continuously occurs, at some point will cause environmental crisis characterized by threat of air and water purity, threat of food ingredients availability, threat of the productivity of the natural wealth of flora and fauna continuity, and so on. If the ecological power has been so weakened, then achieved human welfare becomes meaningless.

Martopo, [1991] stated that many regional development plans pay little attention to environmental carrying capacity resulting in decreased ability of the carrying

capacity of region. *Sugandhy,* [1994] indicated that the variation of the environmental carrying capacity, especially agricultural land has not been considered in spatial planning. Therefore, frequent confusion occurred in decisions making concerning the areas and activities priority, particularly regarding to spatial utilization.

The opinion was supported by the Association of Planner [*IAP*, 2010], which stated that ideal planning should be synchronized with existing conditions as well as to the environmental carrying capacity so that the indication of decline in environmental carrying capacity and potential of disasters can be anticipated and minimized. Nevertheless, in reality, most of the current existing spatial plans have not accommodated or been based on the environmental carrying capacity.

This is understandable, given that there has been information scarcity of variation of environmental carrying capacity which is integrated with spatial planning. Thus, the environmental carrying capacity in a spatial perspective needs to be examined in relation to regional development and spatial planning. Besides the mentioned practical aspect, theoretical issues are also the reason for conducting this research. There is still lack of literatures linking environmental carrying capacity with spatial aspects.

From the above descriptions, a number of research issues are raised in this study:
1. What are the amount and variety of environmental carrying capacity in research location in terms of the variety of structures and spatial utilization?
2. What are the elements of environment that become the determinant of the amount of variation of environmental carrying capacity in research location?
3. What is the balance estimation between the population and environmental carrying capacity on a variety of structures and spatial utilization?
4. What is the policy implication of the spatial plan model that is integrated with environmental carrying capacity?

In general, this study aimed to 1) assess the amount of environmental carrying capacity in research location in terms of the variety of structures and spatial utilization, 2) analyze elements of the environment determining the amount of variation of environmental carrying capacity, 3) predict or estimate the balance between population and environmental carrying capacity on a variety of structures and spatial utilization, 4) prepare and determine an alternative of spatial plan integrated with the environmental carrying capacity as a prerequisite for sustainable development.

Region as "living systems" reflects the linkage between development and environment. Changes in it will affect the environmental components and quality. Often the changes bring negative impacts due to exceeding environmental carrying capacity. However, in a period, the carrying capacity can be increased due to factors of social change and technological intervention McConnell, and Daniel C. Abel, in *JCN,* [*UNEP*, *WWF*, 2007].

Environmental carrying capacity is the ability of the environment in supporting population resulting in a balance [*Young,* 1976; *Catanesse,* 1986; *Anonymous,* 2009]. During its development, carrying capacity is applied to various dimensions, for instance *Soemarwoto,* [1985] examined from the side of population pressure on agricultural land; Odum, Howard, and Issard in *Dasman,* [1992] examined from the harvested area and productivity approaches.

New concept was developed by *Rusthan,* [1998], who examined the protection ability in each land use. His research resulted in the following protection

coefficient value: natural reserve (1.00), wildlife (1.00), tourism parks (1.00), hunting parks (0.82), protected forest (1.00), reserved forest (0.61), production forest (0.68), large plantation (0.54), community plantation (0.42), rice field (0.46), field (0.21), pasture (0.28), lakes/ponds (0, 98), timber plant (0.37), urban settlement (0.18), vacant land (0.01).
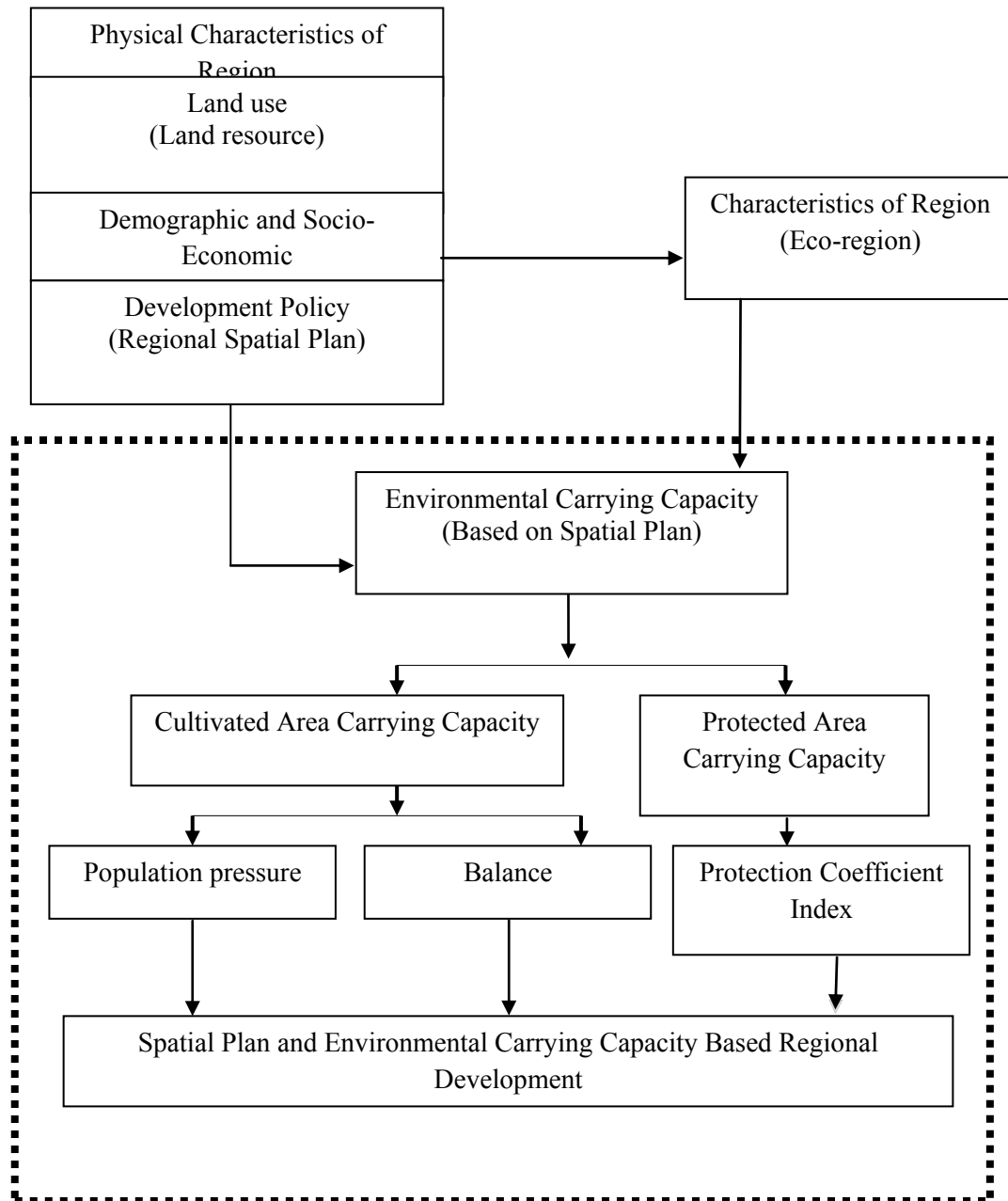

Figure 1. Framework showing the link between concepts and environmental carrying capacity based on spatial planning

THE METHODS

This research was an analytical descriptive study with analysis of secondary data and field observations (primary data). To obtain a spatial phenomenon, spatial analysis approach was used.

The study was conducted in Kulonprogo Regency with village as the unit of analysis, 88 villages are divided into 12 districts with a variety of spatial functions. The substance of the research related to indicators and variables of the study are illustrated in Table 1.

Table 1. Used indicators and variables of this research

No	Indicators	Variables	Remarks
1	Geographical characteristics	• Location, boundary, area, status of region, climate, rainfall, hydrology, geology, physiographic, geomorphology, location accessibility.	• Spatial and non-spatial data
2	Eco-region	• Hill of Menoreh • Hill of Sentolo • Alluvial plain • Alluvial plain of Progo • Coastal area	• Images and field observation
3	Characteristics of land resource *(Supply side)*	• Total area of agricultural land • Area of rice field • Area of dry land • Area of settlement • Area of farmer-owned land • Area of other agricultural land • Land productivity • Land capability	• Quantitative data
4	Characteristics of demographic and socio-economic *(Demand side)*	• Number and density of population • Number of household • Economic capability of household • Livelihood of population • Income of population and farmers • Number of population work in agricultural and non-agricultural sector • Population increase • Fraction of farmers population	• Quantitative data
5	Environmental carrying capacity	• Index of population pressure to land • Index of environmental carrying capacity • Distribution of environmental carrying capacity • Determining factor of environmental carrying capacity	• Mathematic result
6	Spatial function utilization	1. Protected area * 2. Cultivated area **	• Mapping of RTRW (Spatial Plan)
7	Development policy	• Sectoral policy • Spatial policy	• RPJP (Long-term Development Plan and RPJM (Middle-term Development Plan) • RTRW (Spatial Plan) and RDTR (Detail Spatial Plan)

Description:
*) Consists of Subordinate Protected Area (Forest Protection and Water Infiltration); Local Protected Area, Natural reserves, conservation and heritage; Disaster Prone Areas and Geological Protection
**) Consists of the Forest Zone (production forest and community forest), Agriculture, Fishery, Livestock, Mining, Industry, Tourism, Settlement (Rural and Urban Area)

The technique of determining the environmental carrying capacity was conducted by using two approaches, namely the concept of population pressure on agricultural land by Soemarwoto, Otto, [1984] modified to index of environmental carrying capacity and protection function index of [*Rusthon; Uton,* 1998] (Appendix-1). In addition to these carrying capacity indices, a number of analytical techniques were used as well, namely: (1) overlay techniques and geographic information systems, result

maps of the determination of environmental carrying capacity on various spatial utilization, (2) correlation analysis to determine the relationship of protection index and environmental carrying capacity, (3) analysis of variance to analyze differences in protection index and environmental carrying capacity in various types of eco-regions, and (4) factor analysis, to assess the determinants of environmental carrying capacity.

RESULT AND DISCUSSION

Environmental Carrying Capacity of Kulonprogo Regency

Two main approaches used to assess the environmental carrying capacity in Kulonprogo Regency are the index of protection and carrying capacity. Protection index describes the environmental conditions and carrying capacity describes the ability of the environment in supporting activities of people living on it. Protection index ranges from 0 to 1. The closer the number to 1 signifies better environmental conditions, otherwise the farther the number from 1 signifies worse environmental conditions. Likewise the carrying capacity value, the higher the value (above 1), the better its ability to support population activities. Conversely, the lower the value (<1), the worse its ability to support activities of people living on it.

The result of the calculation of environmental capacity in Kulonprogo Regency illustrated that the current environment of Kulonprogo Regency is less capable of supporting current existing population (carrying capacity value of 0.85).
Several districts in Kulonprogo need to be concerned if there are restrictions on land conversion program due to the population pressure, including district of Pengasih, Lendah, and Wates. Environmental

conditions in those districts are relatively low compared to other districts. Socio-economic activities, such as industry, trade, and services look fairly crowded. In addition, the availability of basic service facilities is also more complete. As a result, there is a relatively high concentration of population and increase of land pressure. Fertile eco-region condition of district of Wates, Pengasih, and Lendah, where most of their territories consist of alluvial plains, is another factor that causes the high land pressure (see Table 2).

Kulonprogo Regency Protection Index (Table 2) described the environmental conditions of Kulonprogo. Protected Index was compiled by taking into account wide variations of land use for the utilization of protection and cultivation functions. Constant value was given for each utilization function reflecting its ability to support the environment. The main concept was the utilization of protected functions which has a constant value higher than the utilization of cultivation function. As the implication, the broader the availability of land intended for protection function, the higher the value of protection index.

Based on these limitations, the environment in Kulonprogo regency is relatively still in good condition. Protected areas, both subordinate and local protection still function as their roles. In addition, flood and landslide-prone areas are also well maintained. Cultural heritage area is well managed although its existence is not too large. The roles of each region to environmental conditions of region of Kulonprogo are presented in Table 3. Land designated for subordinate protection functions have a big enough role to environmental index of Kulonprogo.

Table 2. Environmental carrying capacity Index of Kulonprogo Regency

No	Districts	Village	Eco-region *)	Environmental Carrying Capacity	
				Carrying capacity index	Protection index
1	Temon	15	Coastal area and alluvial plain	0.8843	0.4176
2	Wates	8	Coastal area and alluvial plain	0.6705	0.4086
3	Panjatan	11	Hill of Sentolo, coastal area and alluvial plain	0.9080	0.4238
4	Galur	7	Coastal area and coastal alluvial plain	0.7373	0.4214
5	Lendah	6	Hill of Sentolo and coastal alluvial plain	0.5127	0.3731
6	Sentolo	8	Hill of Sentolo and alluvial plain	0.8160	0.3652
7	Pengasih	7	Hill of Sentolo, Hill of Menoreh, and alluvial plain	0.5182	0.3233
8	Kokap	5	Hill of Menoreh	1.0567	0.3119
9	Girimulyo	4	Hill of Menoreh	1.5034	0.3522
10	Nanggulan	6	Hill of Menoreh and alluvial plain of Progo	0.9168	0.3974
11	Kalibawang	7	Hill of Menoreh	1.0379	0.3589
12	Samigaluh	4	Hill of Menoreh	1.0237	0.3410
	Total	88	Average	0.8537	0.3835

Environmental index value in each district does not tend to be much different, especially in the southern districts of Kulonprogo like Temon, Wates, Panjatan, and Galur. The average of environmental index values in those areas is over 0.4. Protection functions in flood prone areas dominate the role of utilization function to index establishment. Whereas in other districts such as Sentolo, Girimulyo, Nanggulan, Kalibawang, and Samigaluh, the role of protection functions in flood prone areas is relatively low.

The value of protection index in cultivation area is not much different from the value of the index in the protected area. This fact illustrated that the environmental conditions in the cultivated area is still fairly good. Meanwhile, when examined from the utilization, it can be seen that the wetland and dry land have a dominant role to the environment conditions in Kulonprogo. The contribution of the environmental index of wetland and dry land is 0.3556 and 0.3535 consecutively.

Of the 12 analyzed districts, it was identified that three districts need the attention associated with the efforts to increase environmental functions. These three districts are Kokap, Pengasih, and Samigaluh. The value of the environmental index of the three villages is lower compared to other districts, which is 0.350 lower. Efforts to improve environmental conditions are primarily focused on the utilization functions of fishery and industrial areas. It is based on the low index value of the role of the environment, amounting to 0.00 (Table 4).

It was identified that Kulonprogo Regency required an optimal area of 49,767.10 hectares of agricultural land to support the balance of the environmental carrying capacity. In fact, Kulonprogo currently lacks of about 8246.49 ha of agricultural land (Table 6). Meanwhile, of the 12 districts in Kulonprogo, there are four districts that still have agricultural land above the optimum area, i.e. districts of Girimulyo, Kalibawang, Samigaluh, and Kokap. Other districts have less agricultural land. In those areas, agricultural production is only able to meet the food needs for half of the population, so that the food needs must be imported from other regions to meet the needs of the other half of the population.

Relations Index of Environmental Protection and Carrying Capacity

Identification of relationships between Index of protection and Environmental Carrying Capacity was conducted using a cross-table of two components of the environmental carrying capacity. The results of the correlation analysis showed that, although not too closely, the relationship between the index of protection and environmental carrying capacity is positive, meaning that the higher the protection indexes, the higher the environmental carrying capacity. Based on the analysis of the cross-table, nine types of environmental control are also proposed as presented in Table 7, and shown spatially in Figure 2. (Appendix-2).

Table 3. Protection index in protected areas of Kulonprogo

No	Districts	Number of Village	Protection Index	Index of role of each protected area				
				Subordinate protection	Local protection	Flood prone area	Landslide prone area	Heritage
1	Temon	15	0.4176	0.0000	0.0426	0.9358	0.0216	0.0000
2	Wates	8	0.4086	0.0000	0.0755	0.9131	0.0114	0.0000
3	Panjatan	11	0.4238	0.0000	0.0312	0.9688	0.0000	0.0000
4	Galur	7	0.4214	0.0000	0.5597	0.4403	0.0000	0.0000
5	Lendah	6	0.3731	0.0000	0.7745	0.2255	0.0000	0.0000
6	Sentolo	8	0.3652	0.0000	1.0000	0.0000	0.0000	0.0000
7	Pengasih	7	0.3233	0.5707	0.0579	0.0068	0.3646	0.0000
8	Kokap	5	0.3119	0.6538	0.0028	0.0012	0.3421	0.0000
9	Girimulyo	4	0.3522	0.3975	0.0041	0.0000	0.5984	0.0000
10	Nanggulan	6	0.3974	0.8060	0.0881	0.0000	0.1058	0.0001
11	Kalibawang	7	0.3589	0.3728	0.0683	0.0000	0.5185	0.0404
12	Samigaluh	4	0.3410	0.4353	0.0001	0.0000	0.5646	0.0000
	Total/ Average	88	0.3835	0.4552	0.0563	0.0771	0.4066	0.0048

Description: The value of 0.000 indicates that in the region there is no corresponding spatial function.

Table 4. Protection Index on Cultivated area of Kulonprogo.

No	District	Number of village	Protec-tion index	Index of role of each cultivated area					
				Wet land	Dry land	Fishery	Settle-ment	Industry	Trade
1	Temon	15	0.4176	0.4206	0.3096	0.1093	0.1421	0.0068	0.0117
2	Wates	8	0.4086	0.4219	0.3010	0.0791	0.1629	0.0042	0.0310
3	Panjatan	11	0.4238	0.6677	0.2549	0.0460	0.0313	0.0000	0.0000
4	Galur	7	0.4214	0.7633	0.1521	0.0351	0.0430	0.0000	0.0066
5	Lendah	6	0.3731	0.3418	0.2681	0.0000	0.0750	0.3151	0.0000
6	Sentolo	8	0.3652	0.1528	0.2326	0.0000	0.1782	0.4284	0.0080
7	Pengasih	7	0.3233	0.1165	0.5925	0.0442	0.2465	0.0000	0.0004
8	Kokap	5	0.3119	0.0251	0.9169	0.0000	0.0580	0.0000	0.0000
9	Girimulyo	4	0.3522	0.6364	0.1542	0.0000	0.1989	0.0000	0.0105
10	Nanggulan	6	0.3974	0.2146	0.4714	0.0000	0.3140	0.0000	0.0000
11	Kalibawang	7	0.3589	0.5521	0.1668	0.0000	0.2407	0.0000	0.0404
12	Samigaluh	4	0.3410	0.0765	0.1492	0.0000	0.7743	0.0000	0.0000
	Total / Average	88	0.3835	0.3556	0.3535	0.0280	0.1680	0.0841	0.0108

Description: The value of 0.000 indicates that in the region there is no corresponding spatial function.

Table 5. Balance of Environmental Carrying Capacity and Population of Kulonprogo

No	Districts	DDL	Population	JPO		JPTT	
			Inhabitant	Inhabitant	(%)	Inhabitant	(%)
1	Temon	0.8843	24428	22038	90.21	-2391	3.69
2	Wates	0.6705	27698	16306	58.87	-11392	17.59
3	Panjatan	0.9080	30707	28810	93.82	-1897	2.93
4	Galur	0.7373	27653	21803	78.85	-5849	9.03
5	Lendah	0.5127	38438	18706	48.67	-19732	30.47
6	Sentolo	0.8160	39391	32934	83.61	-6458	9.97
7	Pengasih	0.5182	82697	55501	67.11	-27196	41.99
8	Kokap	1.0567	41230	40947	99.31	283	+0.44
9	Girimulyo	1.5034	43569	33019	75.78	10550	+16.29
10	Nanggulan	0.9168	25725	23814	92.57	-1910	2.95
11	Kalibawang	1.0379	31364	30493	97.22	871	+1.34
12	Samigaluh	1.0237	27378	27019	98.69	359	+0.55
	Total/Average	0.8536	440279	351391	79.81	-64762	100.00

Environmental Carrying Capacity (*DDL*), Number of optimum population able to be supported by agricultural land (*JPPO*), JPPO = DDL. f. Po $(1 + r)^t$, Number of Population not able to be supported by agricultural land (*JPTT*), JPTT = (1-DDL). f. Po $(1 + r)^t$

Table 6. Balance of Environmental Carrying Capacity and Area of Land of Kulonprogo

No	Districts	DDL	Agricultural land	LPO		LPKT	
			Ha.	Ha.	(%)	Ha.	(%)
1	Temon	0.8843	3049.54	2759.10	90.48	-290.44	-3.52
2	Wates	0.6705	3220.06	1953.10	60.65	-1266.96	-15.36
3	Panjatan	0.9080	4127.26	3917.00	94.91	-210.26	-2.55
4	Galur	0.7373	3526.33	2814.00	79.80	-712.33	-8.64
5	Lendah	0.5127	5482.08	2659.10	48.51	-2822.98	-34.23
6	Sentolo	0.8160	5669.56	4716.70	83.19	-952.86	-11.55
7	Pengasih	0.5182	11603.61	7968.60	68.67	-3635.01	-44.08
8	Kokap	1.0567	6569.79	6614.70	100.68	44.91	0.54
9	Girimulyo	1.5034	3381.81	5011.60	148.19	1629.79	19.76
10	Nanggulan	0.9168	3257.29	3042.90	93.42	-214.39	-2.60
11	Kalibawang	1.0379	4314.70	4452.30	103.19	137.60	1.67
12	Samigaluh	1.0237	3811.56	3858.00	101.22	46.44	0.56
	Total / Average	0.8536	58013.59	49767.10	85.79	-8246.49	100.00

Environmental Carrying Capacity (*DDL*), Area of Optimal Agricultural Land (*LLPO*), LPO = b.Ltot x (1/DDL), Area of additional agricultural land to support population (*LPKT*), LPKT = (1/DDL–). b.Ltot

Table 7. Relationship of Index of Protection and Environmental Carrying Capacity

Protection Index	Environmental Carrying Capacity		
	High	Moderate	Low
High	Type 1: = 7 villages (7, 95%)	Type 2: = 11 villages (12, 50%)	Type 3: = 9 villages (10, 23%)
Moderate	Type 4: = 10 villages (11, 36%)	Type 5: = 12 villages (13, 64%)	Type 6: = 7 villages (7, 95%)
Low	Type 7: =11 villages (12, 50%)	Type 8: = 10 villages (11, 36%)	Type 9 = 11 villages (12, 50%)

Based on those assumptions, from the table above, it can basically be grouped into three priority areas, namely:

1. The first priority, consisting of region of type 6, type 8 and type 9, has the characteristics of the low carrying capacity and moderate to low protection index.

2. The second priority, consisting of region of type 4, type 5 and type 7, has the characteristics of moderate to high carrying capacity and the moderate protection index.

3. The third priority, consisting of region of type 1 (low protection index, high environmental carrying capacity), type 2 (low protection index, moderate environmental carrying capacity), and type 3 (low protection index, low environmental carrying capacity), has the characteristics of low to high carrying capacity and low protection index.

Based on the priority model in controlling environmental problems, typology table of environmental management is created (Table 8).

Determinant Factors of Environmental Carrying Capacity

Environmental carrying capacity is influenced by many factors. Some identified factors are the number and density of population, number of farmer population, percentage of population income from non-agricultural sector, land area for a decent living, intensity of land use, area of irrigated field, rained rice field, garden, field, settlement, and other non-agricultural land use.

Statistically, the *KMO* test and Bartlett's test to 12 variables show that those variables are worth further analysis to measure the environmental carrying capacity. This stated that the 12 variables are mutually independent and have adequate variance to the formation of the carrying capacity of Kulonprogo. Therefore, the tests are able to simplify variance of 12 variables into four variables in explaining the environmental carrying capacity (Table 9).

Table 8. Environmental Controlling Priority Based on the Spatial Plan of Kulonprogo

PRIORITY	PRIORITY SCALE		
	1	2	3
FIRST	TYPE 9: Giripeni, Wates, Jatirejo, Sidorejo, Salam Rejo, Tawangsari, Karangsari, Kedungsari, Margosari, Pengasih, Sendangsari = 11 villages (12, 50%)	TYPE 8: Jangkaran, Tuksono, Kaliagung, Sentolo, Hargorejo, Hargowilis, Hargotirto, Banjarsari, Gerbosari, Ngargosari = 10 villages (11, 36%)	TYPE 6: Bendungan, Depok, Panjatan, Brosot, Bumirejo, Gulurejo, Ngentakrejo = 7 villages (7, 95%)
SECOND	TYPE 7: Sidomulyo, Hargomulyo, Kalirejo, Jatimulyo, Giripurwo, Purwosari, Banjarharjo, Banjaroyo, Kebonharjo, Purwoharjo, Sidoharjo =11 villages (12, 50%)	TYPE 5: Sindutan, Palihan, Temon wetan, Gotakan, Kembangan, Karangsewu, Demangrejo, Sukorejo, Banguncipto, Wijimulyo, Tanjungharjo, Banjararum = 12 villages (13, 64%)	TYPE 4: Glagah, Bugel, Cerme, Banaran, Sri Kayongan, Pendowoharjo, Banyuroto, Donomulyo, Banjarsari, Pagerharjo = 10 villages (11, 36%)
THIRD	TYPE 3: Kedundang, Demen, Temon Kulon, Kulwaru, Ngestiharjo, Triharjo, Tayuban, Nomporejo, Pondowan = 9 villages (10, 23%)	TYPE 2: Kalidengen, Kulur, Kaligintung, Kebon Rejo, Kanoman, Bojong, Kranggan, Tirtorahayu, Wahyuharjo = 11 villages (12, 50%)	TYPE 1: Plumbon, Janten, Karangwuluh, Karangwuni, Sogan, Garongan, Pleret = 7 villages (7, 95%)

Table 9. Variance Test, Number of Component Factors Formed on the Environmental Carrying Capacity Variable of Kulonprogo Regency.

Component	Initial Eigenvalues			Extraction Sums of Squared Loadings		
	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	5.561	39.719	39.719	5.561	39.719	39.719
2	1.959	15.990	55.709	1.959	13.990	53.709
3	1.482	8.587	64.296	1.482	10.587	64.296
4	1.053	7.518	71.814	1.053	7.518	71.814

To determine the role and relationship strength of each variable on the formed factors, the calculation of the loading factor (figures in the table) by conducting the rotation of matrix components was conducted. Component or factor 1 is formed by five variables marked with (*) i.e. (sorted from the biggest influence) the income of non-agricultural, non-farm worker population, land area for a decent living, the population of farmers, and land-use intensity. Factor 2 is formed by area variable for irrigated and rained agricultural land and settlements. Factor 3 is formed by agricultural potential variables, and the potential of gardens and fields, whereas Factor 4 is formed by other non-agricultural variables. More can be examined in Table 10.

Table 10. Rotated Component Matrix Test in Factor Analysis, Variables Forming the Environmental Carrying Capacity of Kulonprogo Regency.

Forming variables of environmental carrying capacity	Component			
	1	2	3	4
Population density	.725*	0.445	-0.194	-0.003
Land use intensity	.713*	0.224	-0.126	-0.107
Population of Farmers	.780*	0.038	-0.091	0.175
Percent income from non-agricultural population	.861*	0.156	-0.151	0.152
Area of land for a decent living	.756*	0.073	0.097	0.197
The area of garden	-0.479	-0.081	.687*	0.195
The area of rained rice field	-0.053	.645*	0.333	0.306
The area of irrigated rice field	0.21	.838*	-0.137	0.024
Other non-agricultural area	0.241	0.356	-0.2	.688*
Population	0.54	0.552	0.032	0.343
Area of field	0.066	0.075	.917*	-0.021
Area of settlement	0.35	.736*	-0.012	-0.233

Extraction Method: Principal Component Analysis. Rotation Method: Varimax with Kaiser Normalization.

*) Variable-forming factors

Based on the above variable characteristics of determining factors, then the naming of factors was performed:

1. Factor 1, with contribution of 39.72%, is MAN-LAND RATIO
2. Factor 2, with contribution of 15.99% is RICE LAND FACTORS
3. Factor 3, with contribution of 8:58% is NON-RICE FIELD FACTOR
4. Factor 4, with contribution of 7:52% is NON AGRICULTURAL LAND

Thus, the factor of environmental carrying capacity of Kulonprogo Regency is determined by the MAN-LAND RATIO. The higher the ratio of land and population characterized by the magnitude of land-population ratio, then it is expected that the environmental carrying capacity process will increase.

The second factor affecting the environmental carrying capacity is agricultural land, especially the rice field that includes both irrigated and rained rice fields, and settlement variables. As an agricultural area, the environmental carrying capacity in Kulonprogo is largely determined by the presence of agricultural land. On the other hand, although the contribution of the settlement area is not too high, there is a tendency that the more the density of the settlement increases, the lower the environmental carrying capacity. Two other influential factors are the variable of agricultural land, especially non-agricultural land (garden and field) and other utilization areas (trade and industry), although the effect is not too large. Based on the components of the above factors, it a model of environmental carrying capacity of Kulonprogo Regency can be set up as follows:

Y = a + b1 MAN-LAND RATIO + b2 RICE FIELD FACTOR + b3 NON-RICE FIELD AGRICULTURAL LAND FACTOR + b4 NON AGRICULTURAL LAND

Y = dependent variable (carrying capacity)

a = constant

b_n = regression coefficients

CONCLUSION

Based on the results of the study and analysis, it can be concluded that:

1 Environmental condition in Kulonprogo Regency is only capable of supporting 79.8 percent of the population. This condition indicates that its environmental carrying capacity is relatively low. Of the 12 districts, there are only four districts that are still able to provide adequate support. Based on the eco-region, the terrain experiences high pressure, whereas in hilly eco-region, although the protection index is small, the intensity of the utilization and population pressure is very high.

2 The result of the analysis of the environmental carrying capacity based on the spatial pattern also shows the variation in the role of utilization functions. In the utilization of protected areas, the highest contribution index is in the subordinate protected area (0.45), while in the cultivated area, it is located in the cultivation of wetland agricultural and dry land (0.350).

3. The tests of *KMO* and Bartlett's identified 12 variables used to measure environmental carrying capacity. Of the 12 variables, there are four groups of important factors that contributed 71.8 percent of the total information. The first factor that gives the largest contribution of 39.72% is the man-land ratio. Furthermore, based on the analysis of these factors, a model of levels of environmental carrying capacity can be set up as follows:

Y = a + b1 MAN-LAND RATIO + b2 RICE FIELD FACTOR + b3 NON-RICE FIELD AGRICULTURAL LAND FACTOR + b4 NON-AGRICULTURAL LAND.

4. Based on the analysis of the relationship patterns of index of protection and environmental carrying capacity (cross tab), 9 typology regions, which can further be simplified into three priorities of development and environmental management, are obtained. The first priority should be given to as much as 28 villages, or 31.81%, with the characteristics of low carrying capacity, and the protection index of moderate to low.

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Appendix-1.

Techniques of Analysis of Environmental Carrying Capacity
Some of the methods used to analyze the results of the study:
1. To determine the environmental carrying capacity, the modified concept of population pressure on agricultural land by *Otto Soemarwoto,* [1984] was used.

DDL   = 1/TP
DDL   = Environmental Carrying Capacity
TP   = Pressure of Population
TP   = Z (1-a) $\underline{\text{f. Po } (1 + r) \text{ t}}$
             b. L tot

Description:
Z   = Area of land for a decent life, operationally land use approach will be used
A   = non-agricultural income of farmers (%)
F   = population of farmers (%)
Po   = population at the beginning of the year
R   = Population growth
T   = Period of the year
B   = agricultural land that can be utilized by residents (%)
Ltot   = Total area of agricultural land

The higher the index values of environmental carrying capacity, the better the environmental conditions of a region. To determine balance of population and resources, modified formula of Muta'ali was used (1993)

Number of optimal population able to be supported by agricultural land (*JPPO*)
JPPO = DDL. f. Po $(1 + r)^{t}$
Number of population not able to be supported by agricultural land (*JPPTT*)
JPPTT = (1-DDL). f. Po $(1 + r)^{t}$
Area of optimal agricultural land (*LLPO*)
LLPO = b.Ltot x (1/DDL)
Area of additional agricultural land to support population (*LLPT*)
LLPT = (1/DDL - 1). b.Ltot

2. To determine the environmental carrying capacity, the concept of protection function index (*IL*) by Uton Rusthon was used (1998).
IKLL   = ((il + 1.a1 + il2.a2 il3.a3 iln.an +) / LW
IKLL   = Index of Environmental Protection Area
a1   = Area of land use type 1
il   = Protection coefficient for land use i
LW   = Area of region

The protection coefficient values: natural reserve (1.00); wildlife (1.00), tourism parks (1.00); hunting parks (0.82), protected forest (1.00); reserved forest (0.61), production forest (0.68); large plantation (0.54), community plantation (0.42), rice field (0.46); field (0.21), pasture (0.28); lakes/ponds (0, 98); timber plant (0.37); urban settlement (0.18); vacant land (0.01).
The higher the protection coefficient value, the greater the ability of regions to give environmental protection and maintain sustainable development
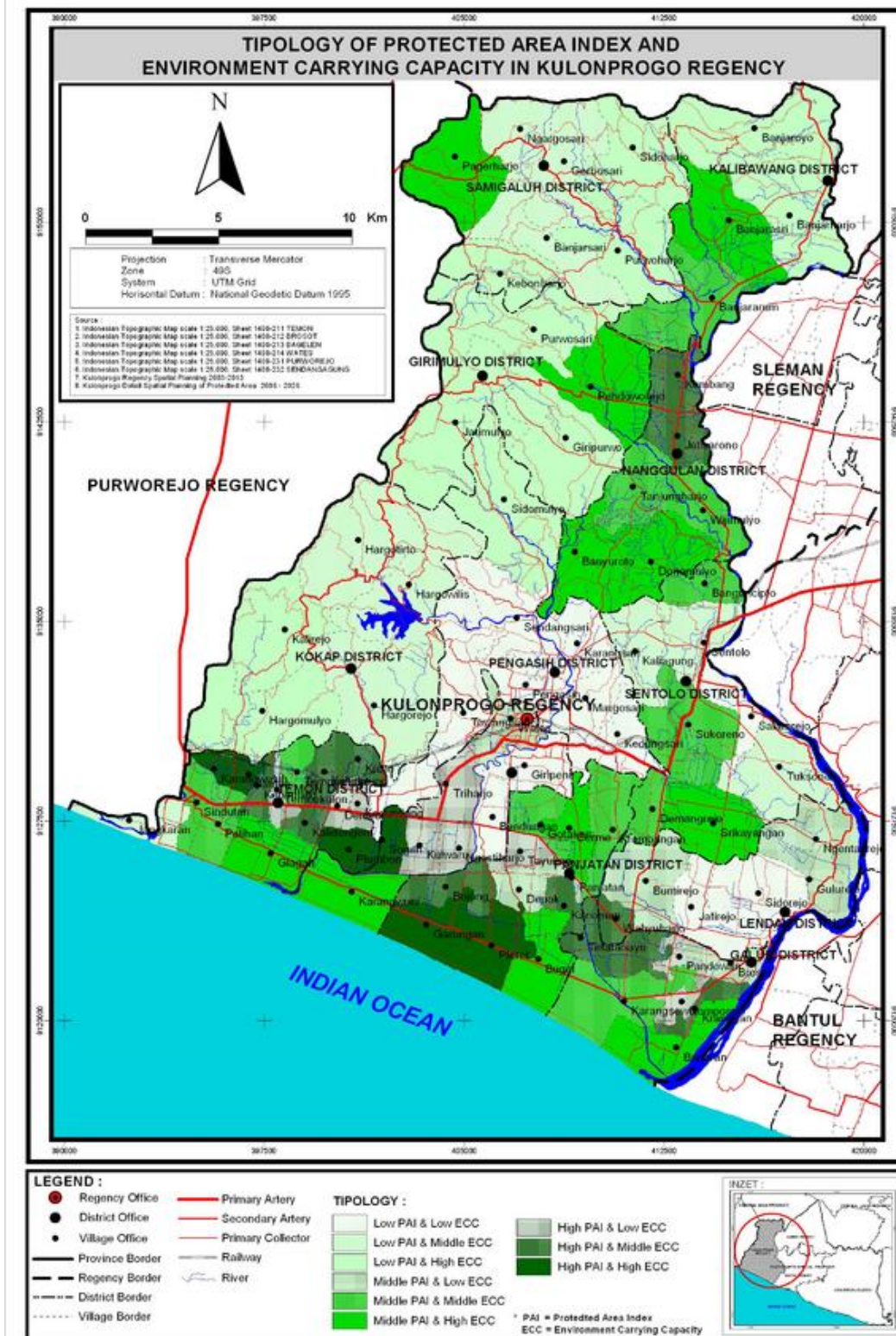
Appendix-2

Figure 2. Tipology of protected area index and environment carrying capacity in Kulonprogo regency