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Environmental Carrying Capacity Based on Ecological Footprint in Pattallassang District, Gowa Regency

Febrianto*, Kukuh Murtilaksono, Syaiful Anwar
Regional Planning Science Study Program IPB University, Bogor, Indonesia

ABSTRACT

Development and space are one entity because space is a medium in development. Good development, optimally regulating the space and natural resources contained in it to preserve the environment. In the future, Pattallassang Sub-District will be designated as the largest economic region in Eastern Indonesia. This plan is regulated in PP No. 55/2011. The plan has also set Pattallassang District as a New City with satellite city functions. However, after several years of development, the construction of the New City Pattallassang, which is based on economic growth, has produced built-up land that has converted the functioning of agricultural land, forests and other productive agriculture in the last five years. Therefore, a follow-up plan is needed for land use for the environmental carrying capacity that is expected to produce an independent and optimal spatial planning. The purpose of this study was to analyze the ecological footprint, and environmental carrying capacity in Pattallassang Subdistrict in 2019. The analytical tool used analysis of ecological trace values consisting of calculation of ecological footprint (demand) population and biocapacity (supply) land use, and analysis environmental carrying capacity. The results showed that the population ecological footprint was 0.6368 gha/capita and land use biocapacity was 0.6371 gha/capita. The total value produced was 1.15 or deeper than the surplus used by bioproductive of at 1,108.17 ha.

Keywords : Ecological Footprint, Ecological Services, Sustainable Development

I. INTRODUCTION

Kantaatmadja (1994) explained that space as both a container and as a natural resource is very limited. As a container it is limited to the size of the region. while on the availability of resources, it is limited to its carrying capacity. Therefore a spatial planning process is needed which has the role of allocating resource utilization, minimizing environmental damage while increasing harmony between land uses (Imran, 2013). Pattallassang District through PP No. 55 of 2011 has designated Pattallassang District as the center of the largest economic region in Eastern Indonesia. The regulation also stipulates as a New City with satellite city functions.

The implications of the establishment of Pattallassang Sub-District as New City, then began to have an impact on increasing population growth in Pattallassang Subdistrict, where Gowa Regency Central Bureau of Statistics (BPS) data in 2018 showed the population increase of 5.18% in the last 4 years, where the condition followed by an increase in residential land in the last 5 years amounting to 165.05 ha or growing by 1.94%.In addition, there are at least a number of things that must be considered in anticipating the various impacts caused by the construction of the New City Pattallassang. The first is related to the problem of the high rate of population urbanization which has resulted in a drastic increase in population in Pattallassang Sub-District. This part is important, because an increase in population will increase people's living needs, so the production pressure on land use is so large. On the other hand, the pressure on the use of the land to produce in order to meet the living needs of the population above it becomes a dichotomy with urban conditions, where agricultural land is occupied by the population's needs.

The second that are important to know are related to the carrying capacity of the environment in Pattallassang District. Optimal population, and optimal land area that is capable of being supported must be analyzed as a basis in determining the policy of spatial planning. It also serves to restore development which has a negative impact on the quality of the environment.

Thirdly, control is needed on housing development in Pattallassang District. Because of the private property project that was built by developers today, it has had an impact on the occurrence of large-scale conversion of agricultural land to non-agriculture, and this has played a major role in the loss of farmers' livelihoods as the main livelihood in Pattallassang District. BPS data from Gowa Regency illustrates that the economic growth trend in Gowa Regency in the last 5 years (2013-2017) has decreased significantly by 2.19%, from the previous 9.42% in 2013 to 7.23% in 2017. BPS South Sulawesi (2017) said that the factor that made economic growth slow was due to a slowdown in growth in the agricultural business field, which was largely due to a slowdown in rice production.

In this regard, it is necessary to conduct a review of the spatial planning directives of the Mamminasata Metropolitan Area in Pattallassang District. Because of the construction process of the New City Pattallassang that has taken place today, it was assessed that the development had a negative influence on the condition of natural and environmental resources and the socio-economic conditions of the people in Pattallassang District. Where this is described as threatening the future availability of natural resources, and creating environmental damage, as well as decreasing the quality of the welfare of the population dominated by the farmers profession. Therefore this study aims to analyze the ecological footprint, and environmental carrying capacity in Pattallassang District in 2018.

II. METHODS AND MATERIAL

A. Material and Tools Analysis

The material used consisted of primary data obtained through field surveys, as well as secondary data sourced from the BPS and the Regional Government of Gowa Regency The analytical tools are equipped with Microsoft Office, Excel, GIS, and field survey equipment such as digital cameras, and questionnaires.

B. Analysis Techniques

Analysis of Ecological Trace Value: The analysis of ecological trace value is the latest related concept to operation of the condition of carrying capacity of the environment. Lenzen (2003) explains that Analysis of ecological trace values is the need for human life from the environment which is expressed in the area needed to support human life. For this reason, Putri *et al.* (2016) emphasized that analysis of ecological trace values is very much needed to be planned, where it is the beginning of development activities towards a sustainable environment, this should be effective and efficient land use . Analysis of ecological trace values of two calculations, namely calculating the ecological footprint (demand) and land use biocapacity. to find out the population's ecological footprint (demand), the equation used is:

$$JEi = Ki \times Efi$$

with: JEi = ecological trace value for each land use (gha/capita), Ki = value of land needs for each land use (ha/capita), Efi = equivalent factor.to find out the value of population land use needs, the calculation is done using a formula (Table I)

TABLE I. CALCULATE THE AREA OF LAND USE REQUIREMENTS

No	Land Use	Formula	Information
1	Paddy Fields/ Upland/ Mixed Gardens (e)	a x b = ab, ab x 60% = c, f/g = h, c x h = e	a = Population b = Rice Concumtion (ton/capita/day) ab = Rice Production (ton/capita/year) c = rice production (ton/year) f = Raw Area of Rice Fields g = Rice Field Harvest Area h = Plant Index e = extensive needs of rice fields ha/capita)
2.	Settlement	Area of House/ Number of Occupants	Survey
3.	Educational Area	Population/ Land Area	KepmenKimpraswil No. 534/KPTS/M/ 2005
4.	Landfill	L = v x 300/T x 0,70 x 1,15	L = Land Was Required Every Year. V = A X E A = The Volume of Waste to Be Wasted. E = Compaction Rate (kg/m³), on Average. 600 kg / m³. T = The Height of The Embankment Planned (m), 15% Land Ratio Cover..
5.	Forest		
	Concumption of O_2 Population (a)	a/(54) x (0,9375)	54 = Constants which indicate that 1 m2 of land produces 54 plant dry weight per day. 0.9375 = Constants which indicate that 1 gram of plant dry weight is equivalent to O2 production of 0.9375 gr.
	Production of CO_2 Population (b)	b/k	K = The ability of tree vegetation to absorb CO2 (kg/day/ha) = 567.07 tons/ha/year (Prasetyo *et al* in Panie, 2000)
	Vehicle CO_2 Production (c)	c/k	
	H_2O Population Needs (d)	d/P	P = Ability of city land in storing water = 900 m³/ha/year (Muis, 2010)

The next step, to calculate biocapacity land use, the equation is:

BKi = (0.88 x LPLi x Efi)/JP

with: BKi = land use biocapacity (gha/capita), LPLi = land use area for each land use (ha), 0.88 = constant (maintaining biodiversity 12%), JP = total population.

The equivalent factor is used to convert local units of land into universal units (Apriyeni*et al.*, 2017). Each land use has different equivalent factors (Table II).

TABLE II. EQUIVALENT FACTOR FOR EACH LAND USE

No	Land Use	Equivalent Factor (*gha/ha*)
1	Forest	1,29
2	Settlement	2,52
3	Mixed Garden	2,52
4	Paddy Fields/ Upland	2,52
5	Green Open Space/Empty Land	0,46
6	Landfill	0,46
7	Body of Water	0,37

Source: (Global Footprint Network, 2018)

Analysis of environmental carrying capacity:Sustainable development related to environmental improvement, which can be operationally calculated on the value of environmental carrying capacity (Fauzi and Oxtavius, 2014). Environmental carrying capacity (ECC) analysis is calculated using the formula:

ECC = biokapacity / ecological footprint

ECC value> 1 means surplus, and ECC <1 means the deficit of natural and environmental resources for the needs of the population. Furthermore, the ECC value is used to identify the status of environmental carrying capacity (Table III) which serves as a basis for consideration of evaluating land use actions in 2018 in Pattallassang District.

TABLE III. FORMULA FOR CLASSIFYING THE STATUS OF ENVIRONMENTAL CARRYING CAPACITY

Formula	Classification
JPO = EEC x JP	JPO = The optimal population that can be supported
JPT = (1-EEC) x JP	JPT = Number of residents who cannot be supported
LLO = Ltot x (1/EEC)	LLO = Optimal area of land
LLT = (1/EEC-1) x Ltot	LLT = Lual additional land to support the population

III.RESULTS AND DISCUSSION

A. Value of the Ecological Footprint

The ecological trail (demand) value of forest land use, fields/moor, settlements, mixed gardens, rice fields, and garbage dump in Pattallassang Subdistrict is 0.0210 gha/capita, 0.2082 gha/capita, 0015 gha/capita, 0.1411 gha/capita, 0.2646 gha/capita, and 0.0004 gha/capita. The overall ecological footprint value is 0.6368 gha/capita (Table IV).

TABLE IV. EXTENT OF PER CAPITA LAND USE NEEDS IN PATTALASANG DISTRICT IN 2018

No	Land Use	Needs	Unit	Ecological Footprint (gha/capita)
1	Forest			
	Concumption of O_2 Population	0,87	kg/capita/day	0,0019
	Production of CO_2 Population	0,97	kg/capita/day	0,0022
	Vehicle CO_2 Production	9,24	kg/capita/day	0,0210
	H_2O Population Needs	175,00	liter/capita/day	0,0003
2	Upland	0,17	ton/capita/year	0,2082
3	Settlement	5,62	m^2/capita	0,0015
4	Mix Garden	0,09	ton/capita/year	0,1411
5	Paddy Field	0,17	ton/capita/year	0,2646
6	Garbage Dump	103,94	kg/capita/year	0,0004

Biocapacity is the value of the availability of bioproductive land use in an area that is used as a comparative value of the population ecological footprint, so that the comparison can then produce environmental carrying capacity that informs how much the level of sustainability in a region. Based on the actual land of Pattallassang Sub-District in 2018 which includes eight classes. The biocapacity value (supply) of forest land use, fields/moor, settlements, mixed gardens, rice fields, green open space (RTH), vacant land, and body of water are respectively 0.019 gha/ha, 0.234 gha/ha, 0.051 gha/ha, 0.124 gha/ha, 0.286 gha/ha, 0.003 gha/ha, 0.002 gha/ha, and 0.002 gha/ha. The overall biocapacity value is 0.721 gha/capita (Table V).

TABLE V. THE VALUE OF BIOCAPACITY OF POPULATION LAND USE PER SOUL IN PATTALLASSANG SUBDISTRICT IN 2018

No	Land Use	Land Area (ha)	Equivalent Factor (gha/ha)	Bicapacity(gha/capita)
1	Forest	409,43	1,29	0,019
2	Upland	2.569,63	2,52	0,234
3	Settlement	562,77	2,52	0,051
4	Mix Garden	1.362,29	2,52	0,124
5	Paddy Field	3.140,99	2,52	0,286
6	Green Open Space*	203,35	0,46	0,003
7	Empty Land*	126,93	0,46	0,002
8	Body of Water**	120,61	0,37	0,002
		8.496,00	-	0,721

Description: * (Substituted into the land use ecological footprint Trail, ** (Substituted into the forest ecological footprint of needs H_2O)

B. Section Environmental Carrying Capacity

The value of the environmental carrying capacity of Pattallassang Subdistrict in 2018 is 1.15 (0.721 / 0.6368) or Pattallassang Sub-District can still support the lives of the residents living above it (Table VI).

TABLE VI. VALUE OF ENVIRONMENTAL CARRYING CAPACITY (EEC) IN PATTALLASSANG DISTRICT IN 2018

No	Land Use	BKi (gha/ha)	JEi (gha/ha)	EEC
1	Forest			
	Concumption of O_2 Population	0,019	0,0019	10,00
	Production of CO_2 Population	0,019	0,0022	8,64
	Vehicle CO_2 Production	0,019	0,0210	0,90
	H_2O Population Needs	0,021	0,0003	70,00
2	Upland	0,234	0,2082	1,12
3	Settlement	0,051	0,0015	34,00
4	Mix Garden	0,124	0,1411	0,88
5	Paddy Field	0,286	0,2646	1,08
6	Garbage Dump	0,005	0,0004	12,50
		0,721	0,6368	1,15

Overall the condition of environmental carrying capacity in 2018 in Pattallassang Subdistrict is in a sustainable condition, where the value of environmental carrying capacity resulting from a comparison of biocapacity and ecological footprint is 1.15. This means that the condition of the area in Pattallassang Subdistrict can still support the life above it. However, the accumulation then does not broadly describe the carrying capacity of each land use in Pattallassang District. In the carrying capacity of mixed garden land use, the condition of carrying capacity of the environment has a deficit condition. The value of the environmental carrying capacity produced is 0.88. In the use of forest land against CO2 production - motorized vehicles, the value of environmental carrying capacity produced is 0.90. In contrast to the carrying capacity of residential land use, the condition of carrying capacity of the environment experiences a surplus condition. The value of the carrying capacity of the environment produced is 34. The environmental carrying capacity of land use / moor value of the carrying capacity of the environment is 1.12. The value of carrying capacity of paddy fields and landfill is 1.08 and 12.50, respectively.

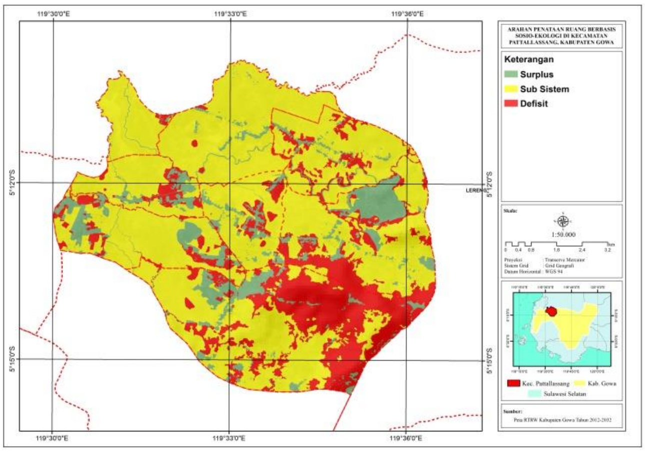

Figure1:Map of Environmental Carrying Conditions in Pattallassang District in 2018

In Figure 1 it is clear how the Strengths are. However, if viewed spatially, the status of environmental carrying capacity in Pattallassang Subdistrict is dominant in the security subsystem or land use capability that still supports the lives of the people above it, but is very vulnerable to activities that can improve the quality of the environment.

The optimal population that can be supported as well as the optimal land area used in PattallassangSubdistrict After further identification, the results show that the optimal population that can be supported by 28,021 people or still can accommodate as many as 3,655 people (15%) of the current total population. Whereas spatially, the optimal land area used by 24,366 inhabitants in Pattallasssang District is currently 5,646 ha or 66.67% of the total area in Pattallassang District (Table VII).

TABLE VII. VALUE OF ENVIRONMENTAL CARRYING CAPACITY (EEC) IN PATTALLASSANG DISTRICT IN 2018

Status of Environmental Carrying Capacity	Description
JPO = EEC x JP = 1.15 x 24,366 = 28,021 population	JPO = The optimal population that can be supported
JPT = (1-EEC) x JP = (1.15-1) x 24,366 = 3,655 souls	JPT = Number of residents who cannot be supported
LLO = Ltot x (1/EEC) = 8,496 x (1/115) = 7,388 ha	LLO = Optimal area of land

Based on Table VII, it is known that there are 1,108 ha (13.04%) of land that can still be utilized with various desirable uses of land. Except saw the condition of several land uses in deficit conditions. Required calculation of the carrying capacity of the environment for each land use, to find out how much area each land use is surplus and deficit. The results of these calculations are used as material for consideration in the process of planning the action to improve spatial utilization planning in Pattallassang District.

The analysis of environmental carrying capacity per land use in PattallassangSubdistrict shows that residential land use has the status of the largest surplus carrying capacity with an ecological footprint (ef) value of 34 optimal land area used by the population of only 16.45 ha or more 543.00 ha (96,97%) of the land use area utilized. Conversely, mixed garden land use produces the smallest carrying capacity with an ef value of 0.88 gha / capita, the optimal land area that should be supported is 1,548.06 ha or less 185.77 ha (12%) than the total area of mixed garden land use in Pattallassang District. Furthermore, the use of paddy fields with the largest land use area in Pattallassang District has a value of environmental carrying capacity of 1.08 or in a condition of a surplus of 232.67 ha. The smallest carrying capacity of the final processing environment (TPA) is 26.42 or a surplus of 303.86 ha. The status of environmental carrying capacity per land use is presented in Table VIII.

TABLE VIII. VALUE OF ENVIRONMENTAL CARRYING CAPACITY (ECC) IN PATTALLASSANG DISTRICT IN 2018

No	Land Use	EEC	LLO	Lahan Non Optimal (ha)
1	Forest			
	Concumption of O_2 Population	10,00	40,94	368,49
	Production of CO_2 Population	8,64	47,39	362,04
	Vehicle CO_2 Production	0,90	454,92	-45,49
	H_2O Population Needs	70,00	7,57	522,47
2	Upland	1,12	2.294,31	275,32
3	Settlement	34,00	16,45	543,00
4	Mix Garden	0,88	1.548,06	-185,77
5	Paddy Field	1,08	2.908,32	232,67
6	Garbage Dump	12,50	26,42	303,86
		1,15	7.387,83	1.108,17

Based on the status of the carrying capacity of the environment for each land use, it is known that the carrying capacity of residential land use is very excessive, while the carrying capacity of mixed garden land experiences deficit conditions. In the use of paddy fields and fields / upland conditions the carrying capacity of the environment is very vulnerable to deficits because it is influenced by an increase in population and the conversion of agricultural land. Therefore, in the future it is important that the Gowa Regency Government pay attention to the growth of settlements/housing in Pattallassang District. Occupation is indeed a basic human need other than clothing, and food, but with the condition of over-availability of settlements, it is time to limit the establishment of new housing permits, specifically for the housing growth that is so rapidly developing in Pattallassang Subdistrict (Figure 2).

Observation in the field shows that there are at least 15 points of location for housing construction in Pattallassang Subdistrict, one of the largest being controlled by Sinar Mas Galesong and Ciputra companies. The construction of housing that has been built is 154.99 ha in 2018 and in the future it is planned to be expanded to reach 1,444.68 ha or cover the entire Pallantinkang Village, Pattallassang District. According to the villagers of Pallantikang, all the land they owned except for residential land, had been fully sold 20 years ago to the development party at a price of Rp.3,000-Rp.4,000 / meter. In the future, the construction of the housing complex will divert 1,052.55 ha of paddy fields, 42.66 ha of green open space (RTH), 150.57 ha of mixed garden land, and 34.03 ha of residential settlements in Pallantikang Village. For this reason, the Gowa Regency Government must prepare conflict resolution. Setianto (2014) provides four principles in conflict resolution, namely: (1) Conflict is a social phenomenon. (2) Conflict has a cycle that is not linear. (3) Conflict is not a matter of 1 variable, and (4) Conflict resolution must be combined with a relevant conflict resolution mechanism.

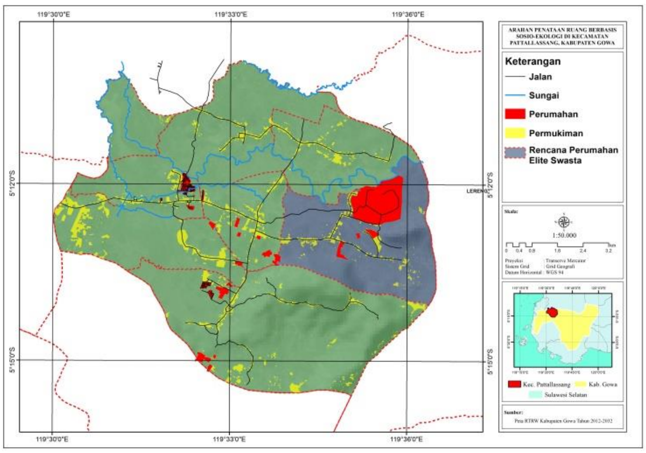

Figure2 : Map of Housing Settlements in Pattallassang District in 2018

Based on the planning pattern that will be built in New City Pattallassang, the role of the private sector in changing the conditions of space has a very large influence. Tobing (2013) sees that new city policies in Indonesia provide broad freedom to the private sector to plan the use of land they have, including the procurement of infrastructure. The impact of government policy is that it cannot control the rapid growth of new cities in Indonesia, resulting in conflicts which create ecological damage and social inequality.

Shen et al (2010) examined a conflict for infrastructure development planning, in its identification results it was found that the core problem was the lack of communication between the affected population of development and the developer during the development planning period. The result is a long-running social and ecological conflict. A conflict resolution approach is needed that accommodates social-economic-economic interests, this is described by Tusianti (2013) in a model of sustainable development that aims to generate productivity growth and economic efficiency and social justice, equity and economic opportunities. and environmental protection.

IV.CONCLUSION

The ecological (demand) trace value of the population in Pattallassang Subdistrict in 2018 is 0.6368 gha/capita, the land use biocapacity (supply) is 0.721 gha/capita

In the condition of population needs and land use in 2018 the value of environmental carrying capacity is 1.15, which means surplus or can still support the living needs of living things on it.

The optimal population that can be supported by Pattallassang Subdistrict is 28,021 people, or can still accommodate an additional 3,655 people (13.04%). The optimal area of land used by residents in Pattallasssang Subdistrict in 2018 is 7,388 ha with a total population of 24,366 ha

Strategies for Control of Space Utilization by Limiting Permit to building residential property based on the carrying capacity and capacity of the area.

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