

## STUDY OF THE CARRYING CAPACITY OF THE PASIRWANGI REGION, WEST JAVA

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### ABSTRACT

Pasirwangi Sub-district is located in Garut District, West Java, Indonesia. Pasirwangi has a protected area which is important to keep and remain its existence. This study aims to calculate the carrying capacity of the land (protection function) of the Pasirwangi protected area, estimate and predict also air pollution in Pasirwangi district. The method used in this study was carrying capacity analysis and system dynamic by implementing the system dynamic analysis stages. The result shows that the carrying capacity value of the protected function of the Pasirwangi sub-district is 0.23, which is suitable for the development of the cultivation area. Based on the emission parameters, the air quality in Pasirwangi District is still relatively good. The simulation result shows that currently the total amount of emissions released into the air is still able to be absorbed by the green open space and will increase in 2028.

### KEYWORDS

Carrying capacity, protection function, protected area, green open space, emission, system dynamics

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## Introduction

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Law number 32 year 2009 regulated that the government and local government are required to carry out development in a sustainable manner by considering the ability of the environment to support the implementation is the designation of some portion area to function as protected area. Protected areas are those which have a main function to protect the preservation function of natural resources, man-made resources as well as cultural and historical values of the nation, such as protected forest areas, mangrove forests and so on. This area must be protected from production activities and other human activities that can reduce or damage environmental functions [1].

Pasirwangi Sub-district is located in Garut District, West Java, Indonesia. Pasirwangi Sub-district has a total protected area of 2,459.29 hectares (ha). This protected area consists of a community forest area of 444.12 ha, tourism designated area of 28.41 ha, residential area of 517.15 ha and agricultural area (LP2B) of 1,469.60 ha (Garut Regency Environmental Service, 2020). In general, LP2B agriculture is the largest land area among other protected areas. This will benefit food production level when there are no significant land-use changes.

To find out the right policy recommendations related to optimization of land functions in protected area of Pasirwangi and the management of potential environmental impacts and risks, it is necessary to conduct research that examines the carrying capacity of land and the circumstance of air pollution within this area. This study aims to calculate the land carrying capacity (protection function) in Pasirwangi protected area, estimate and predict air pollution in Pasirwangi District.

## Method

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### A. Time and place

This research was conducted in Pasirwangi Sub-District, Garut Regency, West Java. The research took place from July to December 2020

**B. Type of Data**

The data used consists of primary data and secondary data. Primary data consists of protected area area, land use area, number of motorized vehicles, and air quality samples. Secondary data consists of maps and data on protected areas in Pasirwangi District

**C. Data collecting**

Data collection was carried out through observation and documentation and literature study. Observations are made through direct observation of the condition of the protected area. Documentation and literature studies were carried out by tracing documents that are relevant to the needs of research data.

**D. Data analysis**

**1. Analysis of Protection Function Carrying Capacity**

The carrying capacity of protected areas can be calculated using the following formulations (Kementerian Lingkungan Hidup, 2014):

$$DDL = \frac{\sum Lgl1. \alpha1 + Lgl2. \alpha2 + Lgl3. \alpha3 + \dots + Lgln. \alpha n}{LW}$$

Where:

DDL = carrying capacity of protection function

Lgln = area of land use type n (ha)

$\alpha n$  = coefficient of protection for land use n

LW = area (ha)

The carrying capacity of the protection function has a range between 0 (lowest) and 1 (highest). This means that the closer to 0, the carrying capacity of this protection function is getting lower, while the closer to 1 the carrying capacity of the protection function is getting better. The quality level of the carrying capacity of the protection function is based on the value of the protection function in the range of 0 - 1 (Table 1).

Table 1. Levels of Quality of Supporting Capacity of Protection Functions

Protective Function Carrying Capacity Quality Level	Value Range of DDL
Very Low	0 – 0,20
Low	0,20 – 0,40
Medium	0,40 – 0,60
Good	0,60 – 0,80
Very Good	0,80 - 1

Source: Ministri of of Environment (2014)

To calculate the carrying capacity of this land, there is a coefficient that must be adjusted according to the actual conditions in the study area. The land coefficient based on the type of land use can be seen in Table 2 below.

**2. System Dynamics Analysis**

Analysis of system dynamics was conducted to determine the relationship between emission conditions and the availability of green open space (RTH) in Pasirwangi District showed on the Figure 1. The analysis begins with the determination of objectives in the system [2]. Next, determining system requirements, problem formulation, expert discussion brainstorming, system identification and model simulation[3]. The relationship between variables is reflected in the causal loop diagram. The causal loop function is also used to limit the system to be studied [4]. Technical analysis is done by building a structure (Stock Flow Diagram) using Powersim Studio 10 to be able to do simulations, where the grouping of data and input data is done in a structural model [5]. Thus it can be seen the behavior of the system formed. Validation needs to be done so that the model can be scientifically justified. Causal Loop Diagram Recreational and Ecotourism activities as a form of Environmental Services shown in the Figure 1.

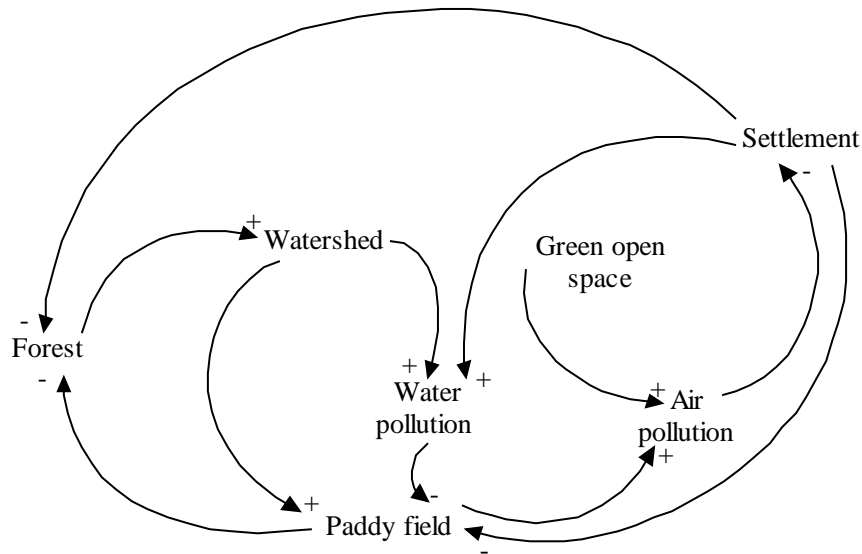


Fig 1 Causal Loop Diagram relationship between emission conditions and the availability of green open space (RTH)

## Result and discussion

### Carrying capacity of the Protection Function

The area of Pasirwangi District is 5,347.82 ha. There are several types of protected function land uses in this sub-district based on their respective designations, such as community forests, rice fields (LP2B), settlements and natural tourism areas (Figure 2).

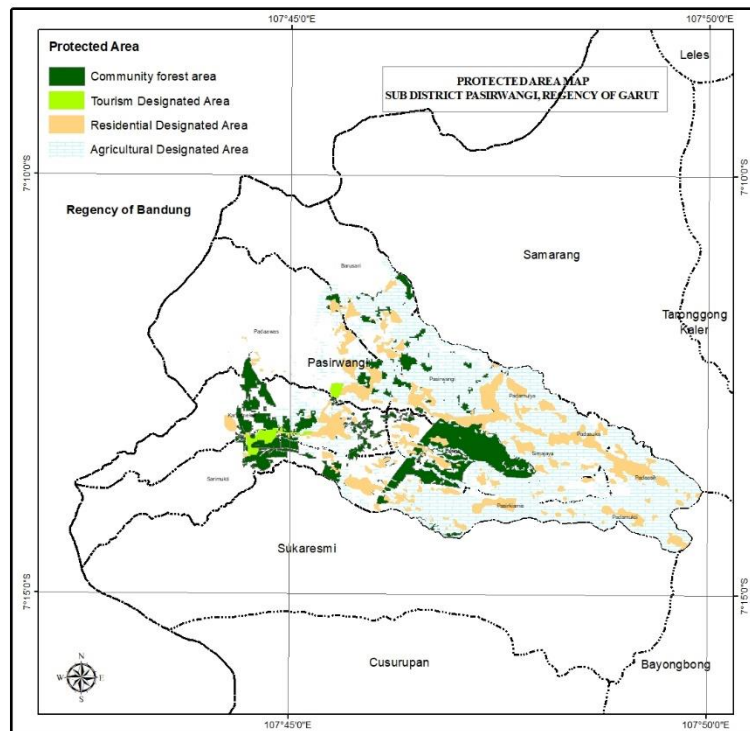


Fig 2 Map of Protected Areas  
(Source: Garut Regency Environmental Service, 2020)

The agricultural designation area (LP2B) has the largest land-use area of 676.02 ha. The total land-use area (luas guna lahan/Lgl) in the protected area in Pasirwangi Sub-District is 1,241.63 ha (Table 2).

Table 2. Protected Functions of Protected Areas

Protected Area	Area (ha)	Coefficient	Land Use Area/Lgl (ha)
Area Designated for Community Forest	444.12	1.00	444.12
Area Designated for Tourism	28.41	1.00	28.41
Area Designated for Settlements	517.15	0.18	93.09
Area Designated for Agriculture (LP2B)	1,469.60	0.46	676.02
Jumlah			1,241.63

The calculation of the value of the land carrying capacity within protected area in Pasirwangi Sub-district is measured by using the following formulation.

$$DDL = \frac{1,241.63}{5,347.82} = 0.23$$

Based on the measurement and analysis, Pasirwangi Sub-district has protective function land carrying capacity of 0.23. In the hedging function scale, this value belongs to the low class. When viewed further, Pasirwangi District, which has a low protection function, would be suitable as a cultivation area. However, the carrying capacity of the protection function must be maintained so that its function can maintain environmental balance [6]. This is because the movement of land values can be influenced by several factors such as the provision of infrastructure and regulations related to spatial planning [7][8]. Changes in land-use may also exist, for example changing wetlands to residential areas. Changes due to the influence of biophysical factors occur because agricultural land is saturated and no longer shows high productivity so that land owners change the form of land-use into a more productive form of land [9][10].

#### B. Estimation of Air Pollution

Areas that have the capacity to support a protected function indicate that it still need green open space[3]. One of the functions of green open space is to absorb various kinds of air pollutants. Air pollutants are formed from various types of gases, droplets / splashes of particles that cause decreased air quality. This can happen both in cities and in villages. In cities, such as cars, public transport and airplanes, as well as industry and building construction are likely causes of pollution. In the village, the dust of plowing tractors, trucks and cars on gravel roads, coal mines, smoke from firewood, burning rice straw also has impact on air pollution.

Environmental impacts and risks can be measured from several environmental media, namely land, water and air. Pasirwangi Sub-district has calculated the Environmental Quality Index (IKLH) so that environmental risk assessments can use this data.

Data from the Carrying Capacity (Daya Dukung dan Daya Tampung/DDDT) Study for Utilization of the Darajat Area showed that the concentration for H2S geothermal activities ranges from 3.13 to 3.82 mg / m3. This average value was still far below the threshold value (35 mg / m3). The results of this study were smaller than the measurements for ammonia NH3 pollutants, the results ranged from <0.02 mg / m3, and this average value was still below the threshold value (0.5 mg / m3). This air quality sampling was conducted at PT. Chevron Geothermal Indonesia and PT. Indonesia Power.

Based on these data, the air quality in Pasirwangi Sub-district tends to be classified as good. Of all the tests carried out, none exceeded the maximum threshold that had been set. With the low level of air pollution, it is expected to keep it below the threshold. The prevention can be done by reducing the emission of pollutants or adding green open space (Ruang Terbuka Hijau/RTH) to absorb air pollution.

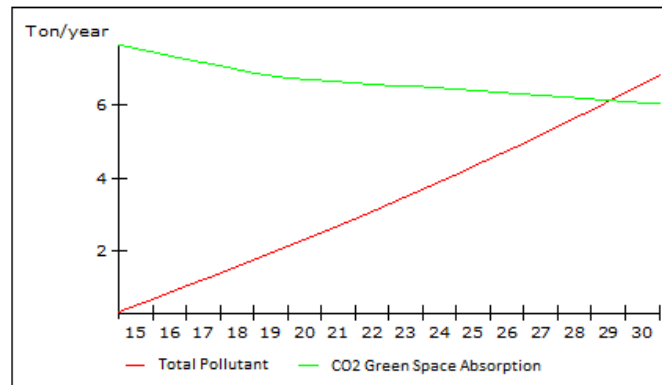


Fig 2 Simulation of relation between total pollutants and absorption of Green Open Space

Along with the increase in motorized vehicles, which produce pollutants from combustion residues, the higher too. In this graph, it can be seen that in 2028, the state of air pollution will exceed the absorption capacity of green open space. When this happens, air pollution will be even higher. To prevent this from happening, it can be done by adding green open space as the main means of absorbing pollutants. It is also possible to add more types of vegetation in the form of trees because they can absorb more emissions than other types of vegetation. Trees have a CO<sub>2</sub> gas absorption capacity of 129 kg/ha/hour or 569.07 tons/ha/year [11].

## Conclusions

The carrying capacity value of the protected function of the Pasirwangi sub-district is 0.23. It means that this protected area is suitable for the development of the cultivation area.

Based on the H<sub>2</sub>S and NH<sub>3</sub> emission parameters, the air quality in Pasirwangi District is still relatively good. The simulation results show that currently the amount of emissions released into the air is still able to be absorbed by the green open space and will increase in 2028.

## Suggestion

It is necessary to add green open space as the main pollutant absorber to anticipate conditions where air pollution exceeds the absorption capacity of existing green open space.

## References

- [1] Law of The Republic of Indonesia Number 32 Year 2009 about Environment Protection and Management.
- [2] Sterman, J.D. (2000). *Business Dynamics: System Thinking and Modeling for Complex World*. USA. The Mc Graw-Hill Companies.
- [3] Firmansyah, I. (2015). *Powersim Studio Application for System Dynamic*. System Dynamics Center-Indonesia. Bogor. Triwala Press.
- [4] Muhammadi, Aminullah Em Susilo B. 2001. *Analisis Sistem Dinamis*. Jakarta. UMJ Press
- [5] Firmansyah I. 2016. *Model pengendalian konversi lahan sawah, studi kasus di DAS Citarum*, Institut Pertanian Bogor
- [6] Gafuri, LH and Kurniawan, A.. (2013). *Study of Regional Carrying Capacity in Suburbs of Semarang City*. [Thesis]. Faculty of Geography, Universitas Gadjah Mada. Yogyakarta.
- [7] Pramana, A.Y.E. 2017. *Analysis of Factors Influencing Land Values in Urban Areas: A Case Study of Ngaglik District, Sleman Regency, Special Region of Yogyakarta*. Prosiding Seminar Nasional XII "Rekayasa

- Teknologi Industri dan Informasi (ReTII) Ke-12 Tahun 2017. Sekolah Tinggi Teknologi Nasional Yogyakarta. Yogyakarta, 9 Desember 2017
- [8] Weng QH. 2002. Land Use Change Analysis in the Zhujiang Delta of China Using Satellite Remote Sensing, GIS and Stochastic Modeling. *Environ Manage.* 64:273-284.
- [9] Irza, H and Syabri, I. 2016. Faktors Affecting Land Use Change in Northern Ringroad of Padang Panjang. *Jurnal Pembangunan Nagari.* 1(2): 53-70.
- [10] Lin, Tao, et al. 2015. *Spatial Pattern of Urban Functional Landscape along an Urban-Rural Gradien: A case Study in Xiamen City, China.* Elsevier: International Journal of Applied Earth Observation and Geoinformation Vol. 46 (2016) 22-30.
- [11] Tinambunan, R. 2006. Analysis of the Need for Green Open Space in Pekanbaru City. Institut Pertanian Bogor. Bogor.