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# Zoning Analysis of Temporary Landfill in Bandung City Based on Geographic Information System

**Arsal Widmarija[1, *], Andi Irsan Isumunandar[1], Bertho Fernando[1], Jaka Ramdani[1], & Iwan Kustiwan[2]**

[1]Master's Program of Development Studies, School of Architecture, Planning and Policy Development, Bandung Institute of Technology, Jalan Ganesa 10, Bandung 40132, Indonesia.
[2]Research Group of Regional and Rural Planning, School of Architecture, Planning and Policy Development, Bandung Institute of Technology, Jalan Ganesa 10, Bandung 40132, Indonesia.
[*]Email: 24021033@mahasiswa.itb.ac.id

**Abstract.** The growing population has resulted in an increased demand for basic human needs such as food and shelter, therefore this leads to higher production waste and environmental pollution. The existance of temporary waste disposal site (TPS) zoning becomes crucial in addressing environmental pollution through the implementation of Reduce, Reuse, and Recycle practices. In the mapping of TPS zoning in Bandung City using Geographic Information System, data analysis is conducted to solve the problem through spatial analysis approach and the DPSIR theory (Driving Force, Pressure, State, Impact, Response). The analysis findings of TPS mapping in Bandung City reveal the presence of TPS areas in Gedebage District and Rancasari District. The close proximity of residential areas to waste disposal sites causes alterations in the air quality, water quality, and soil quality in the surrounding areas of the temporary waste disposal sites. There are many temporary waste disposal sites still fail to meet the criteria established in accordance with Regulation of the Ministry of Public Works and Housing of the Republic of Indonesia No. 24/PRT/M/2016, and there is also a lack of public awareness and education regarding waste segregation and utilization in Bandung City.

**Keywords:** *TPS; Geographic Information System; DPSIR.*

## 1 Introduction

The population in recent years has increased significantly. The results of the population census noted that in September 2020, the population in Indonesia was 270.20 million people, showing an increase of 32.56 million compared to the results of the 2010 population census. Over the past ten years, population growth has continued by 1.25 percent per year [1]. The population level is increasing, and the basic human need for food and shelter continues to increase. It has led to land conversion, which was initially productive or conservative land to be

 

converted into residential land [2]. The increase in the population also has implications for increased production waste from economic activities. The high production waste from economic activities has a polluting impact on the ecological sustainability of the environment. Increasing economic activity without being based on 3R, namely Reduce, Reuse, and Recycle, will result in environmental pollution. So there needs to be an innovation in managing production waste, carried out by the Government through programs funded by the budget and the community so that the waste management system from upstream to downstream can run adequately and comprehensively.

Bandung is the capital city of West Java Province with a population of 2.44 million people [3], with an area of 167.31 $Km^2$ [4] and is administratively divided into 30 sub-districts with 151 sub-districts. Areas bordering the City of Bandung, such as Bandung Regency, West Bandung Regency, and Cimahi City, are areas that support population mobility and economic activity. It causes a change in the structure of regional spatial use. The area bordering the city of Bandung is a strategic land object for residents to live. Therefore, a collaboration between institutions is needed to overcome green-based environmental governance problems. Meanwhile, environmental governance is a specific form of broader governance and refers to processes and institutions that involve the community in making decisions that affect their living space.[5]. Waste management is one of the government's efforts to provide good governance in terms of environmental governance.

Waste management is divided into two types: local (individual) waste management or handling and centralized management or handling. Waste management is shown in the collection of waste from producers to landfill by creating temporary waste storage sites [6]. Bandung has several Temporary Waste Storage Sites, which are spread according to the condition of the area in each District so that the waste management process from upstream to downstream is mapped through zoning. The existence of temporary waste storage has excellent benefits for managing waste originating from the community. It is because the waste distribution process from the community will be distributed first through temporary waste storage according to the nearest zoning before finally being distributed to the landfill. Moreover, some people or scavengers usually take economic benefits by sorting plastic, glass, and metal waste at temporary waste storage sites. It also helps reduce the volume of waste, especially that is difficult to decompose. However, due to the lack of public awareness regarding waste disposal at TPS locations and the absence of waste sorting and utilization awareness, it becomes necessary to map the TPS location zone in the Bandung City area using GIS spatial analysis with the DPSIR theory approach.

## 2 Literature Review

### 2.1 Temporary Garbage Disposal Sites

In Law Number 18 of 2008, waste management is the residue of daily human activities and/or natural processes that are formed. A temporary waste collection site is before waste is transported for recycling, processing, and integrated waste management. In principle, the process of organizing a temporary waste storage site refers to the 3R concept, namely Reduce, Reuse, and Recycle. Establishing a temporary waste storage site aims to reduce the amount of waste processed at the final landfill. The processing of recycled waste has become a community escalation and is processed into solid compost, liquid compost, and biogas. According to the Directorate General of Human Settlement [7], the main matters related to the operational basis for the establishment of a temporary waste storage site are as follows:

1) Handle areas prone to solid waste according to the City Sanitation Strategy (SSK);
2) Minimum service capacity of 400KK;
3) Garbage collection using garbage carts or garbage trucks;
4) The process of processing waste by segregation (physics), processing organic waste (biological), collecting and transporting waste to landfills for residual waste that has been processed physically (compacting or chopping) or residual waste that is no longer processed;
5) Required an allocation of operational and maintenance costs, which the District/City Government subsidies.

With some of these operational bases, establishing a temporary waste storage site should not be built immediately without looking at these aspects. Also, there is Minister of Home Affairs Regulation Number 33 of 2010 concerning Guidelines for Waste Management, which regulates the pattern of waste distribution within Regency/City Governments.

From the pattern that regulates the distribution of the waste, it can be seen through the Geospatial Information System, which points to the zoning distribution map for temporary waste storage. As well as a radius or distance of approximately 1km from the number of residents' houses, and the radius between residents' houses can be seen clearly.

## 2.2 Geographic Information System

### 2.2.1 Definition of Geographic Information System

Geographic Information System (GIS) is a system designed to capture, store, manipulate, analyze, organize, and display all types of geographic data [8]. GIS consists of four subsystems, that is 1) input data, this subsystem is responsible for collecting and preparing spatial and attribute data from various sources and is responsible for converting the original data format into a format that GIS can use; 2) data output, this subsystem displays or produces the output of all or part of the database, either in the form of softcopy or hardcopy, such as tables, graphs, maps, and others; 3) data management; 4) organize spatial and attribute data into a database so it is easy to call, update and edit; 5) data manipulation and analysis. This subsystem determines the various information that geographic information systems can generate.

### 2.2.2 Spatial Data

Spatial data has meaning as data that refers to positions, objects, and the relationship between them in earth's space. Spatial data is an item of information in which there is information about the earth, including the earth's surface, below the earth's surface, waters, oceans, and under the atmosphere [9]. Spatial data generated through GIS processing is always related to maps, so maps are needed in extracting the data contained therein. In general, maps are divided into topographic maps and thematic maps. The map has a scale that compares the distance on the map and the actual field distance. The components that build a geographic information system are as follows:

a. Computer system and software is a computer system and a collection of software used to process data.
b. Spatial Data, is spatial data with spatial and geo references to be processed.
c. Data management and analysis procedure, data management and procedure analysis by Database Management System (DBMS).

### 2.2.3 Spatial Analysis

Spatial analysis is a set of methods for finding and describing the level of a pattern of a spatial phenomenon so that it can be understood better. Using spatial analysis can bring up new information to be used as a basis for decision-making in the field studied. The methods vary greatly, from visual observation to applied mathematics/statistics.
Based on its purpose, it can be broadly distinguished as follows:

a. *spatial exploratory analysis*, this analysis detects a particular pattern in a spatial phenomenon and develops a research hypothesis. This method is beneficial when the thing being studied is something new, where the researcher does not/does not yet have much knowledge about the spatial phenomenon being observed;
b. s*patial confirmatory analysis*, this analysis was conducted to confirm the research hypothesis. This method is advantageous when the researcher already has enough information about the spatial phenomenon being observed so that the validity of existing hypotheses can be tested.

## 3 Methodology

### 3.1 Analysis of DPSIR Waste Management

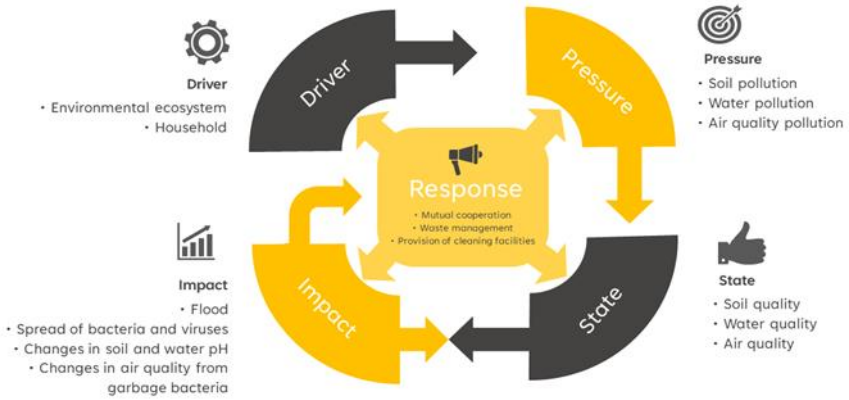


**Figure 1** DPSIR Framework Management

Giupponi [10] provides an explanation of the DPSIR framework as follows:

1. Driving force refers to conditions that cause change, typically manifested in global economic and social growth.
2. Pressure, within this analysis, encompasses any human activity that applies pressure or accelerates changes in the initial environmental conditions.
3. State is defined as the quality of the environment, including factors such as water, soil, air, and so on. The state is a consequence of pressures that

drive humans to engage in activities that impact environmental quality in order to meet their needs.

4. Impact refers to the negative effects resulting from changes in environmental conditions or systems, leading to the surpassing of the environmental carrying capacity. These impacts can affect the quality of human life, such as social, economic, and cultural inequalities that may result in conflicts.
5. Response represents the efforts made by the community, including both local communities and government/policy makers, to address the issues described in the other four components. Responses can take the form of policy reviews or action plans aimed at resolving environmental problems.

## 3.2 Study Approach

The approach in this study is carried out by bringing together the normative side stipulated in laws and regulations and from theories and concepts with factual or empirical reality. The factual or empirical data are compared with normative references to see the gap between an actual requirement and look for data that causes the discrepancy between factual and normative data. Data analysis was carried out for problem-solving with a spatial analysis approach to formulate conclusions so that the implications of these conclusions are translated into recommendations from the study results for making policies and utilizing the results of this study.

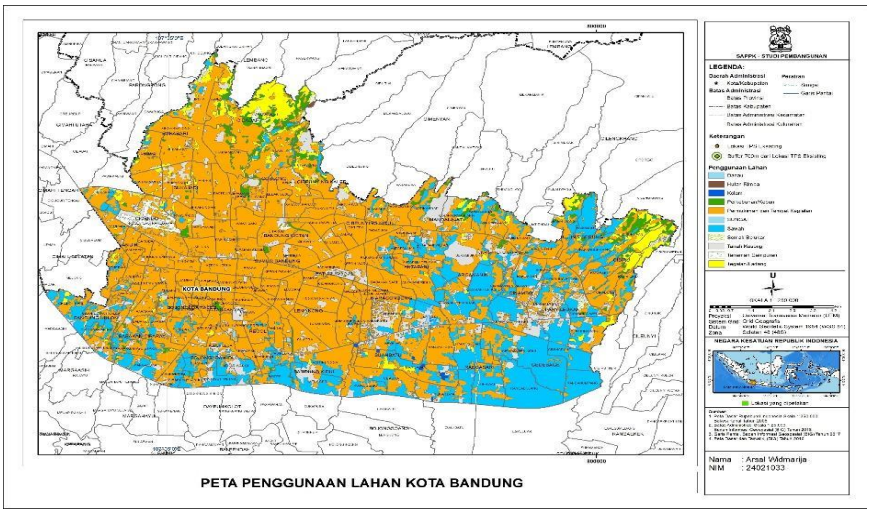


**Figure 2** Results of Data Processing 2021 Land Use Map of The City of Bandung

The source of land use data is from (overlay) a map of TPS locations based on land use in Bandung so that people can see a map of the distribution of the population living in the Bandung City area.

### 3.3 Distribution Map of Existing Waste Disposal Locations in Bandung City

This study uses secondary data in the form of processed data from Bandung open data as a data source. The types of data and data sources used to serve as guidelines for the distribution of the number of temporary waste storage sites, with a distribution of 154 locations. The data is in accordance with the location by determining the coordinate points. The distribution map of the 154 locations is as follows:

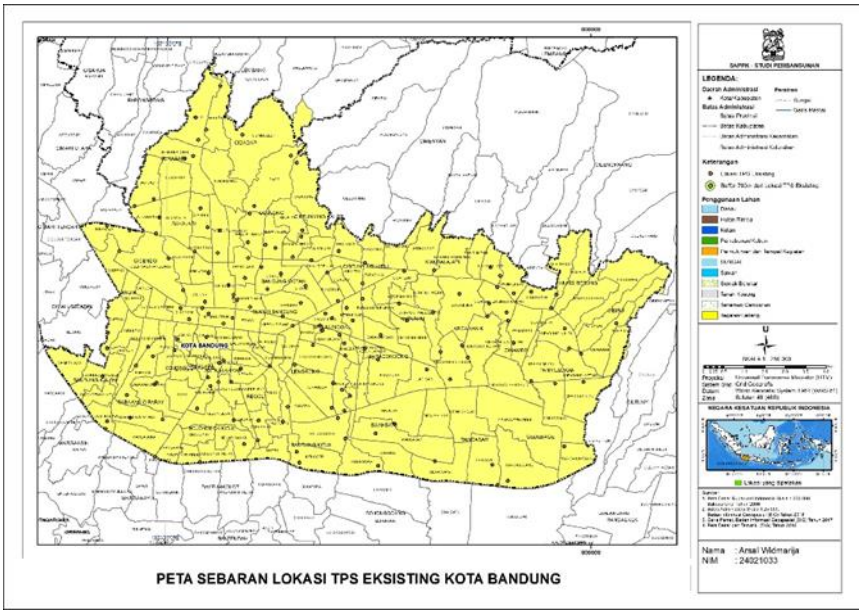


**Figure 3** Distribution Map of Existing TPS Locations in Bandung City

# 4 Result and Discussion

## 4.1 TPS Zoning Based on Bandung City Geographic Information System

The results show that several sub-districts in the city of Bandung still tend to lack TPS. It can be seen from the technical guidelines for waste processing sites at the Directorate General of Human Settlements, Ministry of PUPR, which is a follow-up to PUPR Ministerial Regulation Number 24/PRT/M/2016. It shows that TPS can accommodate garbage with a radius of no more than 1 Km.

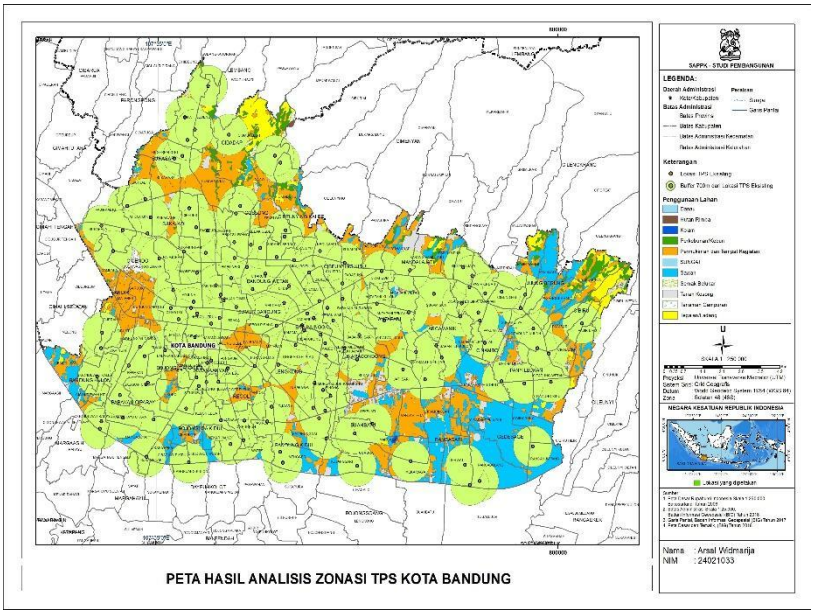


**Figure 4** Results of Data Processing 2021 Zoning Analysis Map of Bandung City TPS

The research results based on the geographical mapping above show that 2 sub-district administrative areas have few temporary waste storage sites, namely Gedebage District and Rancasari District. It has an impact on waste disposal from the RT/RW level, which will accumulate in one of the temporary waste disposal sites.

## 4.2 Driving Force, Pressure, State, Impact, Response (DPSIR)

Administratively, temporary waste storage sites focus on the administrative area of Bandung City. One hundred fifty-four locations functionally serve as temporary waste disposal sites originating from economical production waste

from the resident or community waste at the RT/RW level with a radius of ±1 Km. The waste is distributed by community groups at the RT/TW level administratively. Several aspects must be determined criteria for temporary shelters, based on the study are as follows:

1. Basic physical condition;
2. Vulnerability to disasters;
3. The distance from the location of the temporary waste disposal site to the settlement;
4. Distance from water bodies;
5. Distance between TPS and TPA;
6. Residential areas;
7. To residents;
8. Not in a protected area;
9. Undeveloped areas;
10. Easily accessible location.

In conditions in the field, many temporary shelters do not meet the established criteria, so it impacts the surrounding environment, both on the ecological environment (water, soil, air), which will have implications for public health. Therefore, it is necessary to update aspects that must be met from the criteria for temporary shelters. One example is a temporary shelter in the North Bandung area, a temporary zoo shelter located on Jalan Tamansari with Latitude -6.893971 and Longitude 107.608394.

### 4.2.1 Driving Force

Garbage is one of the fundamental problems all elements of Bandung City society face. Overcoming the waste problem cannot only be resolved and is only the responsibility of the Government, but there must be collaboration and participation between elements of society. Bandung City area with a population density of 14.93 thousand people/km2 with a type of Metropolitan city. The city of Bandung's waste production reaches 1600 tons per day, of which the government does not handle one-third[11] .

The growing number of financial services has an impact that will become one of the triggers, namely waste generation in household groups. Household waste management is a solution to the problem from the beginning before it is distributed to temporary waste storage sites.

### 4.2.2 Pressure

Increasing the amount of economic activity will impact the amount of waste produced. The volume of waste the community generates increases from the waste distributed to temporary waste storage sites. Currently, the waste generated mainly from the manufacturing technology industry, from the distribution of goods resulting from buying and selling online, is increasingly unpredictable. The percentage of households that handle waste transported by officers in the province of West Java and urban type, according to 2021 data, is 46.53, and for rural areas, it is 7.70. These data show that the level of waste generated from urban areas in West Java is very high compared to waste generated from rural areas. Hence, the pressure from managing residents' waste to temporary storage is very high.

### 4.2.3 State

The temporary shelter is close to several strategic locations, such as the ITB Ganesha Campus, the Zoo, and residents of the local community. Typologically, the temporary shelters are above the residents' houses so that the water that falls into them will flow and enter the residential areas if it rains. Because this will affect the water quality in the environment around the temporary shelter, indicators that environmental water has been polluted are changes or signs with physical observations such as the level of water clarity, changes in temperature, and color [12]. The study's results found a relationship between temporary shelters and residential locations. So it is necessary to be vigilant about the water quality around the temporary shelter, so it is not recommended for consumption.

The air quality within a 50-meter radius at the location of the temporary shelter is indicated to be unsanitary, which will impact the health of the people around the temporary shelter. The soil quality for temporary shelters that meets the criteria uses cement (concrete) wall insulation media. It minimizes the accumulation of accumulated waste so that it does not spread to the environment around the temporary shelter. It can also prevent contamination of soil quality in the environment around the temporary shelters.

### 4.2.4 Impact

Garbage is one of the leading causes of flooding, which has become crucial because this waste can cause clogged drains. Slum housing along the riverbanks and the lack of awareness of community discipline to dispose of garbage in a predetermined place are still unsuitable. Many violate it by throwing garbage directly into the river channel, which can raise the flood water level due to

blocked water flow[13]. The risk factors that cause health impacts on the people who live around temporary shelters are that they can cause disease due to the accumulation and accumulation of garbage, which causes the proliferation of bacteria, disease vectors, and viruses [12].

### 4.2.5 TPS Zoning Response to the Community

TPS's response to the people at the temporary waste disposal site is a need for more sensitivity towards the temporary shelters in the area. Because people are not able to understand how the 3R pattern is Reduce, Reuse, and Recycle. As for the community's response, if we want to increase the sense of cooperation and a sense of belonging to an understanding of waste management, it needs to be encouraged by socialization about excellent and proper waste management. It is also necessary for the public to understand that waste management can make money so that the community will be enthusiastic about proper and massive waste management.

The Bandung Government is one of the stakeholders in waste management because all zoning in the Bandung City administration area is the responsibility of the Bandung City Environment and Sanitation Service. So that in order to give an excellent response to the community, they must provide socialization and education about innovative and collaborative waste management. At the Neighborhood (hereafter: RT/RW) level, there is a need for innovative waste management, namely, waste from the community must be sorted, which waste can be recycled, and which waste can be used as compost so that the waste at the RT/RW level has a value that has value.

The activities carried out by the Bandung Government, namely Kang Pisman (Reduce, Separate and Utilize Waste), with this activity, the handling of waste problems in the City of Bandung must start from the source, namely households, by involving the active participation of the community. The purpose of this activity is to provide the community's understanding and ability to carry out waste management so that they have the social awareness to change the behavior and mindset of the community in carrying out waste management through the "Kangpisman Movement." Apart from this socialization, there is also education through managing organic and inorganic waste, making Local Micro-Organisms (MOL), introducing urban farming, introducing waste recycling crafts, door-to-door education, and door-to-door collection [11].

## 5 Conclusion

Waste management is a responsibility not only for the Bandung Government but also for all society's living elements. The results of a study on the zoning analysis of temporary landfills in the city of Bandung based on the geographic information system have several conclusions:

1. Locations of residential areas close to temporary garbage collection sites must maintain health because all the waste collected from the entire community at the RT/RW level will be collected. So that this causes changes in air quality, water quality, and soil quality around the temporary shelter;

2. There are still many temporary waste storage sites that do not meet the criteria set according to PUPR Regulation Number 24/PRT/M/2016, so these temporary waste storage areas need rehabilitation;

3. There needs to be the socialization of the "Kangpisman Movement" to Reduce, Segregate, and Utilize Waste. So that people can have the social awareness to change behavior in managing Waste. So that people who are in temporary waste storage zoning can have added value from recycled Waste, such as processing organic and inorganic Waste, making Local Micro-Organisms (MOL), introducing urban farming, and processing crafts from recycled Waste.

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