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Research Paper

River Pollution and Human Health Risks: Assessment in The Locality Areas Proximity of Bengawan Solo River, Surakarta, Indonesia

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Abstract
Bengawan Solo River experiences a critical environment characterized by impurity and unsanitary on the part of its coasts. The locality inhabitants do not take the waste to appropriate places. This waste adorns streets, tributaries rivers and therefore ends up in the Bengawan Solo river during the rainy season. The discharge of waste in these various unconventional and unofficial places causes all kinds of nuisances, degrades the conditions of life and health of the population, and especially worsens the state of insalubrity of the river. This study goes over the problems of household waste management and potential impacts on the resident health surrounding the areas of Bengawan solo river. In the light of the results obtained, waste constitutes mountains of garbage dumped in the sides of the river, the gutters, along the rails, and especially in illegal dumps and very often, in places of stagnation of water. It turned out that this waste has an impact on the health of populations. From the objective through qualitative analyzes to research subjects, this research gives recommendations and contributions on Indonesian waste management regulations towards health risks prevention of inhabitants surrounding the riverbanks.

Keywords
Health, pollution, waste management, environment, landfilling.

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1. Introduction

Environment pollution by human activities-generated waste has been an issue since the 19^{th} century (Uglietti et al., 2015). This problem has become global because, with the advancement and development of technology, the amount of waste is increasing every year at an exponential rate (Sima et al., 2020). Current statistics show that the amount of waste emitted is expected to increase by 3.4 billions tons over the next 30 years (WB, 2018). Moreover, in addition to poverty, unemployment, health, housing, and environmental problems, many cities are increasingly under the influence of household waste produced by their populations (Bhakta, 2020).

Indonesia, considered as the first megalopolis of Southeast Asia, with an estimated population of over 273,523,615, these population, which aspire to a development dynamic likely to improve their lives, are faced with the harmful consequences of waste on the quality of life, the environment and public health (Surya et al., 2020). The expansion of villages, population growth, the universal spread of the way of life now exerts an extremely diverse and ever-increasing influence on environmental heath (UNEN, 2020). Across the country, a statistically significant decrease in air pollution has come from COVID-19 lockdowns (Caraka et al., 2020). This unexpected opportunity to observe air pollution patterns linked to human activity and containments will be invaluable for a better understanding of how regulations on air pollutants and greenhouse gas emissions can have. an impact on climate change. The decline intensity of human activities had also led to environmental recovery (Mollona et al., 2019). On the other hand, more waste such as disposable masks, medical and biohazardous waste, antibacterial soaps and gels, and single-use items has increased pollution in water and on land (Sangkham, 2020). Per capita waste generation has increased globally over the past 50 years (Gutberlet and Uddin, 2017), cities generate between 7 and 10 billion tons of waste per year, and according to the World Bank, this Figure is expected to increase or even double in African and Asian cities by 2050 Figure 1. This is strongly and positively correlated

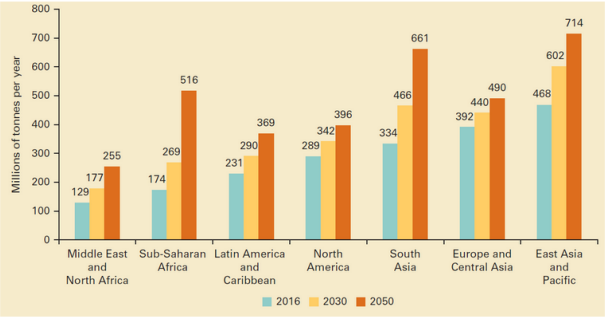

Figure 1. Waste Generation Projection by Region (Millions of Tons/Year)

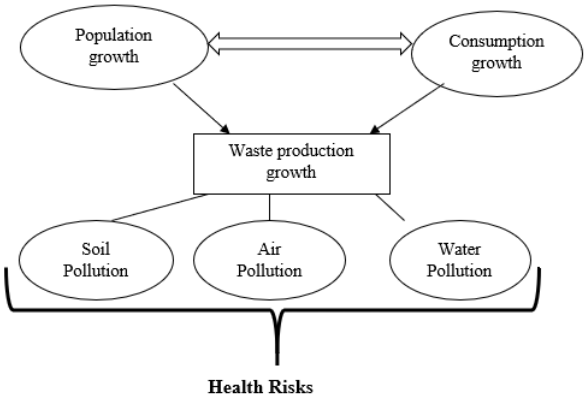

Figure 2. Pollution audit: Waste and Health Risks

with population growth and consumption growth Figure 2, (Abdel-Shafy and Mansour, 2018).

Waste collection in Indonesia has been a critical issue (Global Plastic Action Partnership , GPAP). Yet rates collection vary largely by income households levels (Brotosusilo et al., 2020). It is often mischief to think of technology as the solution to the problem of unmanaged and increasing waste. Technology is not a panacea and is usually just one factor to consider when managing solid waste. Most of the waste generated by households still ends up in final disposal sites. Meanwhile, the capacity of the disposal sites for garbage, especially in big cities is getting full. Data from the Ministry of Environment and Forestry (KLHK, 2019: Indonesia language) in February 2019, released that Indonesia currently produces at least 64 million tons of waste piles every year. Based on these data, about 60 percent of the waste are transported and dumped to the TPA, 10 percent of the waste is recycled, while the other 30 percent is not managed and pollutes the environment. It is often supported by traditional and informal management structures. However, as the population continues to increase and the culture of consumption continues to increase, traditional methods and informal waste disposal (dumped into rivers, ditches, oceans, or dumped carelessly) create problems for the environment (Colombijn and Morbidini, 2017). Environmental problems that arise include clogging of rivers and waterways due to garbage, becoming a source of disease, causing pollution to groundwater, soil layers, as well as air pollution (Ferronato and Torretta, 2019). Waste management involves a wide range of different actors and different practices and the form in which the waste is treated is important. The diverse form of waste management institutions or agencies in the country are limited and encounter several problems (Qodriyatun, 2015), we will mention:

- Financial constraints due in particular to insufficient financial resources mobilized for waste management in the cities. This results in an insufficient number of vehicles, personnel, containers, but also in the absence of taxes and charges specific to waste management, which makes it difficult to develop a cost recovery system.
- The technical constraints, mainly linked to the inadequacy of the material resources mobilized for the collection and transport of waste, the absence of technical prescriptions and control standards for the various operations of the waste management system (collection, transport, transfer, treatment, etc.), but also to waste disposal methods that are not up to the standard. Without forgetting the problem of illegal, uncontrolled, and often badly located dumps, which constitute a public health problem. Besides, these landfills are often located near residential areas and large cities to reduce transport costs, which creates foul odors.
- Constraints are linked to the incivility of the inhabitants and which refer to aspects of education and awareness.

According to the Indonesian Marine Hotspot, 2018, the capacity or ability of the agencies or waste managers in different cities is smaller than the amount of waste to manage. The amount of national waste generation is 175,000 tons per day or the equivalent of 64 million tons per year if using the assumption of 0.7 kg of waste produced per person per day (KLHK, 2019). It is revealed that the existence of various forms of solid waste management institutions makes it difficult for guidance to be carried out by the central government. As a result, the absence of mismanagement of basic infrastructure will have serious consequences for human and environmental health.

Currently, most poor city dwellers are more vulnerable to hazards and natural disasters as they live in informal settlements and unsafe sites where basic services are often lacking (Abunyewah et al., 2018). Many live in tens of thousands of small urban centers and in hundreds of thousands of large towns with several thousand inhabitants that can also be considered small urban centers. In these neighborhoods, the surface dumping of solid waste generates soil and water contamination as well as emissions of methane and other gases, posing risks to human and environmental health (Boelee et al., 2019). The problem of household waste is becoming more and more worrying because of the polluting nature, even toxic, in some cases (Ferronato and Torretta, 2019). Much more, the overflow of runoff due for the most

part to the obstruction of the gutters following the storage of waste in pipes, rivers, streams on the public highway is the basis of very significant material and human damage (Ayilara et al., 2020). In some communities, the dumps are in the open next to the houses. These different dumps are reservoirs of harmful insects and microbes responsible for several deadly diseases, which constitute real public health problems (Khatri and Tyagi, 2014).

Within Audi, 2019 study on solid waste, waste is currently scattered in nature without respecting hygiene rules and legislation on waste management. Thus, this waste can spread in the environment by the percolation of leachate, the runoff of leaching water towards neighboring watercourses, or even by degassing the volatile compounds trapped in the matrix of the waste which escapes into the outside air or by flying debris and dust. This study goes over the problems of household waste management and potential impacts on the resident health surrounding the areas of Bengawan solo river. From the objective, this research should give and contribute any recommendation about waste management that pollutes the river.

Can mistreated waste harm our lives?

The accumulation of waste quantities in a city generates problems that degrade its living environment: foul odors, breeding grounds, pollution of the air, water, soil, etc. As attested by Godswill et al., 2020, waste is material, other than radioactive material, called to be eliminated or treated by reasons and with a specific elimination process. The disposal of this waste, which is the responsibility of local communities, poses problems of cost and choice of sites. How to get rid of these multiple amounts of household waste in a profitable way and without causing damage to the environment and human health? Organizational, technical and institutional deficits, inadequate infrastructure as well as a lack of good citizenship push people to leave their waste anywhere (Qodriyatun, 2015). The mistreatment of this waste can cause nuisance and impacts on the soil, water, air, fauna, flora, and human health. Studies like Palaniveloo et al., 2020 have already shown that household waste is a source of pathogenic microbes. Infection with resistant microbes delays the healing of disease increases the rate of mortality and morbidity with subsequent economic consequences (Dadgostar, 2019).

Waste has an impact on the living environment (WHO, 2020). They occupy large areas that increase with the evolution of the population and time. The absence of their removal offers a sad sight because they pollute the living environment (visual quality of the landscape). Such a situation tarnishes the image of the city by obstructing gutters and drainage works for wastewater and rain. The situation is worsened especially during the rainy season with consequences such as pollution of groundwater and surface water as well as degradation of the human environment.

Capacity building in waste management is about social and political relationships that aim to empower people to overcome discriminatory practices that limit their chances in life. It is a collective learning process that enables people to determine and improve their livelihoods. This includes making information available, as information reduces uncertainty and expands options for decision making.

Figure 3. Waste Dump on The Riverbanks-Bengawan Solo

On the riverbanks of Bengawan Solo river, it is common to see wild discharges that multiply especially with mountains of rubbish that develop in the collection points to the right-of-way of the roads Figure 3. The edges of the surface water are degraded because of the discharge of waste by the population. Also, some biomedical waste from clinics, care utensils for children, and sludge from inappropriate waste from septic tanks are discharged into these places without treatment. Such a practice is at the root of the disturbance of the aquatic environment by excessive deposition of mineral elements. This phenomenon corresponds to eutrophication or dystrophication according to WHO, 2014, which may have repercussions on aquatic resources. Besides, waste affects the receiving environments through its discharge (nature pollution). This can lead to substances produced by leaching from the soil and from solid wastes to contaminate underground and surface sources, thus exacerbating the problems caused by insufficient access to safe drinking water and sanitation. One of the corollaries of such a situation is the increased risk of disease transmission (M.T et al., 2019).

Water is the main vector of pollution generated by wastes abandoned or disposed of in unsatisfactory ecological conditions (Palaniveloo et al., 2020). Thus, the pollution of groundwater which contributes to the drinking water supply appears to be the result of infiltration and the diffusion of leachate in the permeable or cracked subsoil. As for the pollution of surface water, it can result from the overflow and flow of leachate storage basins in the hydrographic network or from runoff water causing part of the waste to deposit in yards of water.

Apart from dealing with the problem of environmen-

tal damage, the Bengawan Solo watershed has also been polluted by its rivers. The existence of pollution by liquid waste has resulted in a decrease in the quality of its tributary rivers (Roosmini et al., 2018). Water quality has continued to decline over the years to a year, this is illustrated by the results of the measurement of the pollution load for BOD, COD, and NH_3−N carried out in the Central Java Province Prokasih. The Ecoton research team collected water samples from seven locations on the Bengawan Solo river, representing the upstream, middle, and downstream segments from August to October 2020. After testing them, the research team discovered microplastic contamination in the upstream part of Ngawi Regency at 76 particles per 100 liters. The amount of microplastic pollutants increased in the downstream area and was found between 115 and 119 particles per 100 liters on the north coast of the province of East Java. They revealed that the consequences are not only for aquatic life but poses threat to human health as well.

According to Fernández-González et al., 2020, integrated and sustainable waste management should not be given top priority but must go beyond technical aspects to include various key elements and supports of sustainability to ensure the success of any waste management project. As attested by the Indonesian news brief and action alert Tristan, 2018, Indonesia has failed to take action to manage waste. With 65 million tons of waste produced per day, 15 million tons end up in ecosystems and communities. Poor municipal waste management leads to a significant increase in GHG emissions from landfills and lower quality of life. The vast majority of methane-released organic waste material is still uncaptured. With 24% of waste unmanaged and plastic consumption increasing, Indonesia is falling behind in waste management.

2. Approach and location description

This study uses first a narrative review and a qualitative approach to report the environmental issue of the Bengawan Solo river. The physical settings are based on reports documentation, field observation, location of vulnerable places such Mojo Bridge and Jurug Bridge, and informal interview on respondents living in the location. To triangulate the evidence in the qualitative study, a semi-structured questionnaire is used as the basic tool to collect primary data and intends to explore the behavior of individuals in the study area concerning waste management and health risks and to understand how they affect the phenomena in question.

Bengawan Solo River Figure 4 is the longest river on the island of Java. The river has a length of 548.53 km and crosses two provinces, namely Central Java and East Java. This river has its upstream on the slopes of Mount Lawu and flows through various big cities such as Wonogiri, Solo, Ngawi, and Bojonegoro before finally emptying into the Java Sea. Due to budget constraints, we are limited to the location which is nearby our University. The circled areas on the map Figure 4 show the study locations.

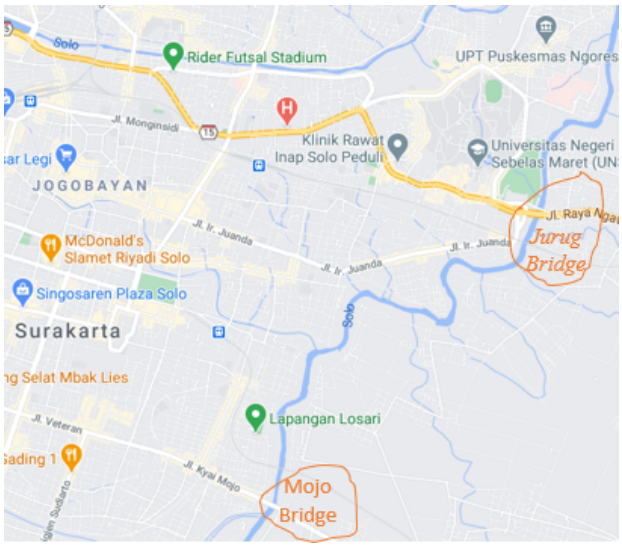

Figure 4. Bengawan Solo River Map in Surakarta

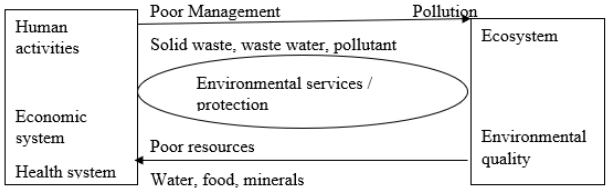

Figure 5. Relation Human Activities and Environment

3. Research findings and discussions on perceptions of resident health risks

Poor waste management is one of the irrefutable sources of harm to human health (WHO, 2020). Indeed, the substances included in household waste are likely to cause adverse effects or damage to human health. Figure 4 establishes a relationship between poor waste management, health, and environmental quality. When not well managed, they attract animals such as stray dogs, cats, rats, mice, etc., pests like mosquitoes, flies, and cockroaches but also harm the health of the population. These insects are the dominant factor in the creation of vector production nests offering bioecological conditions favorable to the development of pathogenic germs (viruses, bacteria, parasites) responsible for many diseases and causing several diseases including malaria, hepatitis, yellow fever, typhoid fever, diarrhea, cholera.

Residents meet at the place complain about the unsanitary conditions of their place of residence because of waste accumulation which brings problems such as mosquitoes, flies and which can also cause diseases, the foul odors. Inhabitants are aware of the dangers that threaten them due to waste exposure: ‘In these neighborhoods, we are anesthetized by odors, also the condition of these small rivers leaves something to be desired and this has harmful con-

sequences on our health, but whos 'worry!'. They deplore the lack of money and the absence of composting garbage and when that exists, they are not emptied regularly, which leads people to throw the garbage nearby. 'We throw the rubbish in a corner under the bridge, sometimes we find dead animals, clothes and sometimes the remains of food'. Some accuse the weakness to the informal institution responsible for waste collection. The essence of the problem would be controlled because nobody controls the work of the collectors and when they come to collect the trash, they just pick up the easy-to-recover garbage and leave the rest, without anyone being worried. Residents complain about the discomfort and annoyance over the garbage.

Residents recognize that the problem is above all an education problem and that a great responsibility rests with the citizens who must change their behavior if the institutions also do the necessary: People are not civilized, no follow-up, it is necessary that there is a control and sanctions can inflict on the malicious. In neighborhoods near rivers of water, it is often families with children, considered to have no anchoring or emotional connection with the living neighborhood, who are accused of urban ignorance and anarchic waste in the neighborhood.

The comments of some of our interlocutors during the surveys confirm these results:

Thank you for giving me the speech, because the problems of this garbage dump are numerous nearby. Before, when the trucks and people came to drop the waste here, we didn't say anything. But afterward, when the mess started, we drew people's attention to the state of the landfill and its unsuccessful misdeeds. We are forced to block access to people coming to unload theirs here by writings. And that too nothing has come of it in practice. Over time, with the smell of the garbage that we breathe in, many epidemics and many other diseases can strike very soon (especially our children). Sincerely, Sir, nobody knows who does this but it's between us.

From the field observations made to the entourage, people do not care about these warning signs "Dilarang membuang sampah disini" Translated into the Indonesian language "It is forbidden to throw trash here". When people throw garbage in these places, for example, they think that these places do not belong to them rather belong to the government. The community does not think that the place of waste collection is a public place for which they are also responsible. This is due to a lack of knowledge and public awareness of the impact of waste.

Approaching in the same sense, another declares:

Waste is a source of disease. For those who want to preserve their health, it is not good to stay nearby this place for even a second, let alone a dump, given the smell it gives off. So, our kids are sick all the time, even us. As if that were not enough, some people come to fish here without worrying about the waste that emerges with unbearable odors. But what to do? Every day our children took their time hereafter studying. Others hurt themselves all the time with sharp objects. Despite all this, people continue to engage in such activity.

The awareness of some people in these places to protect the environment is minimal. The proof is that there are still people who fish in the banks of the river without worrying about the water foul-smelling. The discharge of untreated wastes into river banks can have serious effects on human health and the environment, including outbreaks of food and water-borne vector diseases, as well as pollution, loss of biological diversity, and ecosystem services. The exposure of vulnerable groups, including children, to partially treated or untreated wastewater, requires special attention. Limited knowledge of the health risks associated with the use of wastewater, due to poverty and poor education, contributes to these risks.

We are poor. We can only suffer the consequences of this poverty. Everything is thrown in this viaduct and when it is time, the rain will take all far from here. Our children often have pimples on their skin, they have diarrhea, and are often injured by picking up objects from in. Look at that kid covered in scabies. This is one of the consequences of the discharge.

For the risks associated with the presence of waste to be reduced, the population that produced this waste must be involved in the management process. If the household doesn't make effort to take her waste to recyclers. He burns it, or throw it into the nearby stream, the health risks return to him and the community.

The hypothesis of this text highlights a so-called self-management system that corresponds to the informal management system. The term self-management highlights the fact that populations without access to dump collection are those who organize their tours. If these practices have a certain usefulness, they generate the production of many risks. The health of residents or the local environment is greatly affected by this self-management. Finally, it is important to support the poorest and most marginal populations in waste process management.

A resident questioned at the place expresses himself in these terms;

If I'm not mistaken it has been since yesterday, the water in here is like that, blackish-brown looks like it has been hit by waste. Usually, it is before the rainy season or when the downstream area starts to rain, the water in Bengawan Solo turns cloudy, usually for a while. But this time I think the worst is compared to the previous ones because this is like being subjected to waste, he said.

Residents demand the right to cleanliness, more cleanliness, and hygiene for the collective good, especially the inhabitants of disadvantaged localities where passers-by are forced to cover their noses in front of the piles of garbage on their way. Without any treatment, small business has no choice but discharge their waste in here Figure 6, one of the interlocutors said. During the rainy season, all types

Figure 6. Waste Discharge at The Route Edges-River Mojo Bridge.

of trash will be seen here. To reduce the smell and pile of garbage, I sometimes burn it with a liter of oil.

Burning garbage can cause neighborhood disturbances, whether through the odors or smoke emitted. On the other hand, if fires are poorly controlled, they can cause fires. The compounds from burning waste can increase the risk of lung infections and disorders of the nerves, heart disease, and cancer (Nti et al., 2020).

Even though waste management projects in communities are well designed from a technical point of view. The systems for their implementation can fail if planners do not take into account the dynamics of social acceptance. The discharge of waste to unsuitable places often meets strong resistance from public opinion, due to a lack of awareness and confidence in the risks to human health. Awareness and education are the main instruments to overcome social, cultural, and consumer barriers.

The results of a later study carried out by an environmental expert from Sebelas Maret University have shown that infections (caused by endocrine hormones from chicken waste), diarrhea, and skin diseases are the main health problems cited in these neighborhoods. Residents of located districts are exposed to the poor sanitation system, in particular the respiratory problems such as the irritation of the bronchi or asthma in reaction to the pollution, young children are much more exposed than adults because those chicken waste can accelerate puberty and interfere with reproduction, the author concludes.

From a certain dose, polluting substances have a toxic effect on a living being (Manisalidis et al., 2020). This means that when they enter the body, they are harmful to its survival or health. On aquatic organisms, if there are still types of fish that can survive in a polluted environment, one of them is a broomstick: the content of waste will enter the fish body, if it is consumed by humans, it will cause itching of the skin, diarrhea, decreased nervous system, kidney disorders, reproductive system, blood circulation disorders, Minamata disease, kidney cancer, liver and blood, skin disorders, respiratory system, eye disorders, liver, respiratory organs, gastrointestinal tract. The risk for humans can come from the consumption of these aquatic organisms that have been in contact with water, fish, crabs, and crustaceans, etc.

The informal recyclers at waste disposal sites scour the waste looking for bottles, boxes, or paper to resell for their livelihood. These people are looking for all kinds of vials, syringes, plastic bags, scrap metal. Also, direct contact with littered garbage can increase the risk of diseases transmitted by animals (such as rats and mosquitoes). Piles of garbage and standing water can put a person at risk for dengue fever. Both malaria and dengue fever, if not treated immediately, can lead to various complications and even death. Garbage scattered about due to littering habits can also increase the risk of leptospirosis. Usually, these bacteria are found in the urine of animals such as rats and cows. A person can become infected with leptospirosis if they are in contaminated water for a long time or through contact with open wounds.

4. Conclusion and Forwards Implications

The narrative review presented in this article explores the impacts of unsustainable waste management on human health. In an interdisciplinary approach, the qualitative method adopted was a combination: stories have become raw data. The end of our work which explores attitudes and practices of the population towards waste management near the Bengawan Solo river has allowed us to make several observations: waste management remains one of the major challenges for these inhabitants. Indeed, like along the river, Mojo Bridge and Jurug Bridge are in the grip of an invasion of the quantities of household waste produced by the population surrounding the place. The partial collection of waste has created mountains of rubbish visible everywhere along the river and has caused the open gutters to be filled, resulting in a multiplication of insects and pests (flies, cockroaches, mosquitoes, rats, etc.) to health. Population growth and above all the improvement in living standards which has resulted in the modification of the consumption patterns of the populations have led to increased production of those waste of various kinds: plastic waste, electronic equipment waste, batteries, solvents, which must be managed properly and sustainably.

The study made it possible to understand that the major orientations proposed do not put forward effective policies, programs, and/or projects for a better consideration of waste management. Besides, the other mark of disarticulation is that the public authorities which must play the central role in the organization and the financing of the collection, elimination, treatment, and/or recovery of waste are struggling to ensure good management. Indeed, these powers have not yet managed to mobilize the necessary resources to ensure the activities of this sector. With their top priority being to get waste out of sight, they often choose simplistic and easy methods characterized by carelessness. However, poor waste management is a threat to the environment, human health, quality of life, and the economy. Insofar as the generation, collection, transport, and treatment of waste can contribute to the increase in the concentration of greenhouse gases in the atmosphere, pollution of surface and groundwater as well as soil.

Besides, for a rational, efficient, and ecological management of waste, the study proposes to the authorities through Environment institutions, the launch of the political reform activities necessary for the establishment of selective collection and installation systems of waste treatment centers in compliance with health and environmental standards. The vision to be defended consists of achieving a zero-waste society based on optimizing waste prevention and treating waste as a resource within the framework of a circular economy of materials in the Indonesian context.

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