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Adopting sustainable environmental policy based on quadruple helix model in Gorontalo city, Indonesia

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Abstract

Gorontalo City is an area that has potential natural resources. However, destructive natural resource management has caused a lot of environmental damage. Waste management, for example, is still a prominent problem in Gorontalo City. This research explains the environmental problems faced by Gorontalo City using the quadruple helix model. This research method uses an explanatory approach, to identify, mapping, and formulating alternative solution models for environmental problems based on sustainable development principles. The data collected is used as input in formulating environmental policies with a collaborative system using the quadruple helix model. The results of the study found that the policy for handling environmental problems in Gorontalo City has not been well optimized. The main problem originates from the lack of a creative and innovative collaboration system between the government, community, academia and industry. Gorontalo City Government basically has a strategic plan, but the formulation, implementation and evaluation process does not involve other strategic actors. The Quadruple Helix model could be a suitable local innovation model that is adjusted to the condition of resources in a local region.

Keywords: *environmental policy, sustainable development, quadruple helix*

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Introduction

Environmental problems are increasingly becoming a concern along with the increasing direct impact felt by humanity. It cannot be denied that the issue of environmental damage is no longer just a figment of imagination, but is a big warning for humans. The Covid 19 pandemic that hit the world at the beginning of 2020 increasingly proves that environmental damage can create increasingly massive impacts (Singh & Mishra, 2021). According to Google's report in "A Year in Search Engines," interest in "how to protect the environment" is breaking search popularity records worldwide. The search term 'climate change impacts' is searched more frequently than ever. In the summer of 2021, the words 'fire' and 'flood', then 'volcano', became increasingly popular (Wunarlan, 2019).

In reality, most environmental damage is the result of human activities themselves (Lihawa, 2019). Issues regarding forest destruction, rising earth temperatures, and hunger and the availability of clean water are consequences that must be addressed quickly. The rapid flow of modernization is a critical point in this matter. Where the concept of economic development is considered not in line with environmental conservation programs (Siregar & Nasution, 2020).

Economic development, which is characterized by increasing amounts of carbon emissions due to industrialization, not only contributes to air pollution but has an impact on thinning the ozone layer and increasing the earth's temperature (Nasrollahi & Saeed, 2020). The use of fuel and single-use materials contributes greatly to waste that damages land and aquatic ecosystems (Utami, 2020). Today we are already seeing the effects that scientists predicted, such as the loss of sea ice, melting of glaciers and ice sheets, rising sea levels, and more intense heat waves. Scientists predict global temperature increases from man-made greenhouse gases will continue. Severe weather damage will also continue to increase (NASA).

In the last twenty years, the concept of a healthy city has been recognized in academic studies and global environmental policy (Kumar, 2024). The quality of environmental development in Gorontalo City is greatly influenced by people's behavior in viewing the urban environment (Deng et al., 2024). One of the factors that affects the environment is the increasing population growth, where community growth in Gorontalo City has an impact on increasing waste generation (J. M. Davis et al., 2024). The increase in waste generation is due to the lack of adequate land for waste disposal and has an impact on health and environmental pollution (Rahayu & Pramitasari, 2024). According to (Mondal et al., 2024), pollution that occurs due to industrial activities can cause degradation in watersheds (watersheds).

The waste management policy through the Gorontalo City Regional Regulation Number 12 of 2017 has not run optimally because it is still constrained by lack of participation and inadequate waste management infrastructure (Thamrina et al., 2022). Waste management with the concept of pentahelix by involving academics, government, business, community, and the media in comprehensive and sustainable waste management (Ningrum et al., 2023). The concept of waste management with a psychological approach includes behavior, sociodemographic conditions and practices by sorting and handling waste well (Chaerul & Zatadini, 2020). Multiple effects are needed from increasing public awareness in managing and handling waste through TPS3R to the DLH level in the landfill area towards *zero waste* to *zero residue* in the future (Firmansyah et al., 2023).

Of course, environmental damage must be handled appropriately to minimize the potential damage caused. At the UN climate change conference in Paris, COP 21, governments agreed that mobilizing stronger and more ambitious climate action was essential to achieve the goals of the Paris Agreement. Action must come from governments, cities, regions, businesses and investors. Everyone has a role to play in implementing the Paris Agreement effectively (Benson & Jordan, 2015)**.**

The existence of commitment from all parties from the highest to the lowest level provides an opportunity that environmental conservation and saving the earth in the era of industrialization is not impossible. A long-term strategy with accurate formulation is needed so that economic development can be in line with environmental conservation programs. Empirical findings reveal that up to a certain threshold level, economic activities do not affect the ecological balance because nature can compensate for the resulting externalities, but beyond this threshold, the accumulation of waste and pollution exceeds nature's capacity to absorb (Nasrollahi & Saeed, 2020)**.**

The hope of a better environment, fresher air and healthier water encourages humans to make efforts to save the environment. Experts, observers and policy makers in the environmental sector have attempted to formulate a policy framework that is more environmentally friendly. Where the formulation of more environmentally friendly public policies is not only at the national and international level. At the international

level, countries through the UN have developed SDGs as a global policy framework. The implementation of this policy must of course be carried out holistically with the involvement and formulation of strategic policies at the lowest level down to the city and district. Districts and cities are determinants in handling environmental problems by making efforts to implement sustainable policy strategies. One example is Gorontalo City.

In environmental policy, *the quadruple helix* model can be an empowerment solution because of collaboration in creating new innovation and creativity through urban development policies and programs (Muzaqi & Hanum, 2020). Meanwhile, if waste management is carried out with pentahelix elements, it will create an environmentally friendly city and can realize sustainable development goals (SDGs) through a sustainable waste management system (Arif et al., 2024). Waste management by involving academics, sawasta, communities, the government, and the press to build cooperation through the unification of constructive thinking, joint decisions to be arranged by collaborating the penthahelix model in the *zero waste program* (Zitri et al., 2022)

According to Mondal et al., (2024), in general , the waste management system in Indonesia is still lagging behind compared to South Korea, both in terms of institutions, human resources, budget, law enforcement, and community and private participation. The full commitment of all relevant stakeholders is a key factor in the successful implementation of integrated and environmentally friendly waste management. At the level of community participation in waste management is still relatively moderate, some people have participated. However, in its implementation, it is still dominated by the government. So, the role of the community in waste management is not comprehensive. As an effort by the government to increase community participation, the construction of a main waste bank and a 3R TPS (Handayani & Agussalim, 2023).

Research Methods

This research method uses an explanatory approach, to identify, mapping, and formulating alternative solution models for environmental problems based on sustainable development principles. This study analyzed how existing policies address environmental problems such as water pollution, land pollution, air pollution and other problems that have an impact on the environment. This study will also discuss how public policy is implemented in overcoming environmental problems in Gorontalo City.

As part of our investigation of peer-reviewed publications, we used the SCOPUS database, one of the most comprehensive databases of peer-reviewed research literature, as well as the WoS and Google Scholar databases. Our study uses the Environmental Policy concept which is trying to be adopted in the policy making process in Gorontalo City.

This research was carried out by conducting research on four stakeholders who are determinants in environmental-based policy making, namely the government, private sector, academics and non-governmental organizations working in the environmental sector. In this research, data was obtained from Japesda Gorontalo, which highlights the impact of environmental damage in Gorontalo City and the extent of government intervention in overcoming it. The data obtained will be used to formulate a sustainable policy agenda based on environmental conservation.

To analyze public policy in dealing with environmental problems in Gorontalo City, it is necessary to carry out a descriptive study by conducting interviews and collecting data from certain sources such as the local environmental agency, local

government and local community. This study will also compare environmental policies in Gorontalo City with environmental policies in other areas that have similar environmental problems.

The model used is the Quadruple Helix model. This model is the most suitable model to be used in developing local government innovation. The Quadruple Helix innovation model is an innovation model that emphasizes cooperation between four elements, namely regional government/public authorities; industry; university/education system; and the community/users. These four elements work together dynamically and form a helix that overlaps towards regional development. The Quadruple Helix (QH) model can be used as a regional innovation model with a customized concept adapted to the existing resource conditions in the region itself.

The difference between Triple Helix (TH) and QH is the top-down perspective of TH and the bottom-up perspective of QH (Akmalluddin & Ediyono, 2023)**.** The same thing with these concepts Muzaqi & Hanum (2020) states that the fourth helix organization leading to the QH structure is an independent, non-profit and member-based organization. This fourth helix acts as a facilitator between the other three helixes. They are usually independent, non-profit organizations and leverage private and public investment to jointly fund research and development programs, and provide technical services and products.

Fitria (2023) states that innovation arises because of the needs of users (user-driven innovation) so that users are formalized as the fourth helix. (Jannah Lailatul Fitria & Korespondensi, 2023) states that TH must be updated to include the role of Non-Governmental Organizations (NGOs), local and regional communities in the technology development process so that they can work together in their participation in regional innovation approaches. An NGO is an organization that represents the concerns of its members other than economic concerns, for example environmental and social aspects (Nasrollahi & Saeed, 2020)**.** By involving the fourth helix, namely environment-based NGOs, it will add to the object of analysis. Where in this case NGOs can be support or pressure groups that provide input in the formulation of government policies using bottom up principles.

The concept of environmental policy focuses on preserving the earth where humans live, so its formulation must be carried out inclusively with the involvement of all elements, especially society. In developing this policy later, it is not only the government that has an important role, but also the full involvement of all elements in the pentahelix model. The main focus in formulating environmental policy is to build public awareness through education and communication. This makes the QH model very appropriate to apply. Community institutions, which are an additional element apart from government, industry and academia, are a key part in creating public awareness which is at the core of environmental policy formulation.

The findings of this study are expected to serve as valuable input for the Gorontalo City government in formulating and implementing more effective environmental policies that lead to tangible improvements in environmental quality. By offering a deeper understanding of the challenges and opportunities in environmental management, these results aim to guide policymakers in adopting strategies that are both practical and impactful. Furthermore, this study seeks to raise public awareness about the role of government policies in addressing environmental issues and highlights ways in which citizens can actively participate in initiatives to mitigate environmental problems.

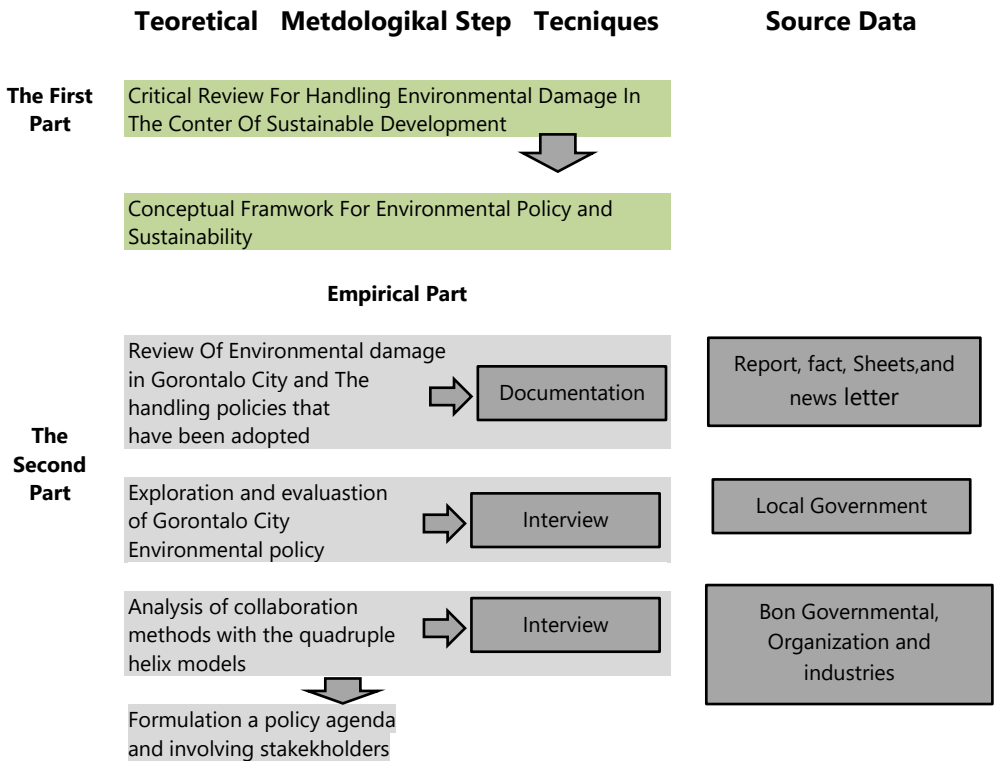

Figure 1. Research Map
Source: processed by author, 2024

Results and Discussion

Waste generation is a cross-border problem that requires joint commitment at the regional and global levels. The government encourages Gorontalo City to prepare a regional action plan to combat plastic waste and the implementation of the ASEAN Regional Action Plan to deal with plastic waste so that the environment is not polluted (Hendar et al., 2022). Environmental pollution is caused by piles of garbage that are not processed and thrown away. To overcome the problem of waste accumulation, efforts are needed to process waste into new products with economic value. One of the efforts to reduce the accumulation of household waste is to use waste as compost (Sumartini et al., 2021). In the assessment of the life cycle that is integrated into the study to evaluate environmental impacts by taking into account economic considerations and providing a comprehensive and sustainable view through recycling (J.-M. Davis et al., 2024).

As an effort to provide daily waste transportation services in accordance with Gorontalo City Regional Regulation Number 12 of 2017 and provide temporary waste management facilities (TPS3R) as a place to sort waste before the waste ends up at the Talumelito Regional Landfill. However, the utilization of TPS3R in Gorontalo City has not been maximized, marked by the large amount of waste that enters the Talumelito Regional Landfill that has not been sorted according to its type. While a good food waste disposal arrangement requires flexible adjustments. The model can serve as a decision-making tool for city managers to reduce carbon emissions in food waste processing (Deng et al., 2023).

Looking at a comparative study of waste management in Indonesia and Japan, it shows that Indonesia is a developing country, has a large population and has a very

serious waste problem. Meanwhile, Japan is known as a country that has succeeded in managing waste through an efficient waste management system supported by strict policies, community participation, and sophisticated infrastructure and technology (Mmereki et al., 2016). On the other hand, there are also many problems that create opportunities in waste management, especially regarding the potential for energy production from waste, which is an important approach to implementing a circular economy model and this study shows that the situation is very unfavorable in urban areas (Gegić et al., 2021).

Waste management is a complex and dynamic activity. Complex because it is influenced by various aspects such as regulatory, institutional, financial, technical, and community participation (Hertati et al., 2024). Dynamic because with the increase in the population, the amount of waste generation will continue to increase and waste management infrastructure also needs to be improved. In improving waste management services, it cannot be only in one aspect, but must be holistic. To analyze and select which policy scenario is best in improving waste management services, a modeler simulation can be used (Artika & Chaerul, 2020). The pentahelix element carried out in an effort to solve the waste problem can be carried out as a solution for waste management in Garut Regency, namely technology, processing, education, economy, institutions, policies and coordination (Hendra, 2016).

Result

Gorontalo is a city located in the northern part of Sulawesi, Indonesia. This city is the capital of Gorontalo Province and is famous for its rich culture and history. The city is surrounded by green tropical forests and beautiful beaches providing a unique combination of land and sea resources. This city is located on the Minahasa Peninsula, a peninsula that extends to Tomini Bay.

The area around Gorontalo is characterized by rolling hills, beautiful beaches, and a variety of flora and fauna. The city is located at an altitude of approximately 80 meters above sea level, which provides a cooler and more comfortable climate than other areas in the region. The city is also surrounded by several rivers which are important sources of water for local residents and for agriculture.

Gorontalo's geography plays an important role in the city's economy, because its coastal location provides easy access to the sea for fishing and transportation, and its fertile soil supports agriculture. The surrounding forests provide resources for the local timber industry, and the area's diverse landscape is a popular destination for tourists. Overall, Gorontalo's unique geography provides the city with a rich and diverse natural environment, which is an important foundation for its growth and development.

Gorontalo is also a transportation center, with a good road network and several ports that act as gateways to the surrounding area. The city is home to several tourist attractions, including historical sites, natural parks, and beautiful beaches. There is also a vibrant culture and arts scene in Gorontalo, with traditional music and dance performances being part of the city's events and festivals. In recent years, Gorontalo has experienced significant growth and development, especially in the fields of urbanization, infrastructure and tourism. Despite this, the city remains true to its roots, preserving its cultural heritage and trying to maintain a balance between modernization and tradition.

The natural landscape which is rich in natural resources certainly provides advantages for the City of Gorontalo, especially in the economic sector. However, a problem that often strikes growing cities is the clash between the development of the

economic sector and environmental conservation programs. The city of Gorontalo is also faced with the reality that the development it is trying to encourage will be hampered and will even ignore aspects of environmental conservation. This study tries to present some of the environmental problems faced by Gorontalo City, which are also experienced by most other cities.

In the 2021 Gorontalo City Regional Environmental Management Performance Information Document, it is stated that Gorontalo City has determined 5 (five) priority environmental issues, namely (1) land use; (2) river water quality; (3) air quality; (4) disaster risk and (5) urban areas. In this research, the author tries to divide it into three large parts, which are explained next.

Garbage and Waste Management

One of the environmental problems that occur in Gorontalo City is related to waste management. Waste is a problem that haunts the urban area of Gorontalo City due to not being managed properly (Usman et al., 2017). The problem of waste in Gorontalo City is increasing, but its management is still very minimal. Of the 140 tons of waste per day, only 70 tons are lifted by the Gorontalo City Environmental Agency to the Talumelito Regional Landfill, Gorontalo. This shows that 70 tons of waste are not managed properly and are neglected and risk of causing negative impacts on the environment (Benson & Jordan, 2015). Because a poor waste and waste management system affects the poor quality of the environment, including having an impact on water quality, where the quality of water does not meet health standards, both in terms of taste and smell, as well as the content in the water (Permana, 2019).

In the achievement of realizing waste reduction for the potential for waste generation from 2019 to 2023 with the target and realization of the Gorontalo city government is increasing. The target of potential waste generation in 2019 is 231,238,840 tons/year and the realization of waste generation is 39,128,30 tons/year. The potential for waste generation with the potential for generating household waste has increased the target in 2020 by 234,938,661 tons/year and the realization of waste generation is 126,185.94 tons/year. Meanwhile, the largest target occurred in 2023 as much as 243,228,840 tons/year and the largest realization of household waste generation occurred in 2021 as much as 175,992.31. This shows that the target of the Loyal Government this year has increased, but the realization of waste generation peaked in 2021 and decreased in 2023 to *149,528.30 tons/year*.

Table 1. Potential Generation of Household Waste and Similar Household Waste in Jakstranas (Tons/Year) Gorontalo City for 2019-2023

No	Year	Target	Realization
1	2019	231,238.840	39,128.30
2	2020	234,938.661	126,185.94
3	2021	238,697.680	175,992.31
4	2022	242,516.842	149,443.88
5	2023	243,228.840	149,528.30

Source: primary data processing results, 2024

The Gorontalo City waste reduction target in the table shows that the lowest household waste reduction target occurred in 2019 by 20% with the realization of 4.05%. However, in 2020 there was an increase in the target to 22% with the realization of reducing household waste by 4.49%. The target has increased the percentage in 2021 to 24% with the realization of waste reduction of 10.67%. Meanwhile, the highest waste reduction target occurred in 2023 to 27% with a realization of 16.88%. The data shows that the target for reducing household waste and similar household waste in Jakarta Gorontalo City between 2019-2023 continues to increase, although it is not significant considering that the percentage of realization is always lower than the percentage of waste reduction target.

Table 2. Target Percentage Reduction of Household Waste and Household Waste in Gorontalo City Jakstrada for 2019-2023

No	Year	Target	Realization
1	2019	20%	4,05%
2	2020	22%	4,49%
3	2021	24%	10,67%
4	2022	26%	14,11%
5	2023	27%	16.88%

Source: primary data processing results, 2024

The target for reducing household waste in Gorontalo City in table 3 shows that the target for reducing household waste and similar waste shows that from 2019 to 2023 it has increased. Where the lowest target occurred in 2019 with a target of reducing household and similar household waste by 46,247,768 tons/year. The highest target for reducing household and similar waste occurs in 2023 with a target of 66,527,220 tons/year. Meanwhile, the realization of the lowest reduction in the process of reducing household waste and similar household waste in the gorontalo coat occurred in 2019 as much as 6,065.77 tons/year. The data shows that the achievement of waste reduction realization in Gorontalo City is still low compared to the target set by the government.

Table 3. Target for Reducing Household Waste and Household Waste (Tons/Year) Gorontalo City for 2019-2023

No	Year	Target	Realization
1	2019	46,247.768	6,065.77
2	2020	51,686.505	10,612.85
3	2021	57,287.443	18,779.73
4	2022	63,054.379	21,086.40
5	2023	66.527.220	30,389.09

Source: primary data processing results, 2024

Seeing that the waste handling target is still higher than the realization, it is necessary to handle waste properly. In handling waste in Gorontalo City, the involvement of the government, industry and MSMEs, NGOs, and academics is needed. This is done through efforts to increase public awareness of the importance of protecting the environment by processing waste by sorting waste from the source, paying

contributions or levies, reducing the accumulation of household waste, delivering waste to TPS3R or to the waste bank and utilizing recycled/composted TPS3R products. Meanwhile, the role of the Gorontalo City government is needed through *demand* & *supply creation* mapping for waste management, preparing regulations, building conditions that support investment and creating incentives for waste managers, preparing a waste management financing budget, and providing a cross-sectoral action platform in the implementation of waste management and public campaigns. The industrial sector and small and medium enterprises play a big role by implementing a sustainable waste management business, and there are policies and abilities from *Offtakers* to be able to utilize the results of waste processing. NGOs can also act as custodians of government policies and continue to promote smart and sustainable policies. Philanthropy and development partners can provide support through financing and investment in circular initiatives. The role of academics is needed in carrying out an important role in ensuring that the right policies are built/proven on a strong academic foundation.

Land Use and Forest Damage

The challenge currently faced by Gorontalo City is the increasingly rapid economic and development center. Investment also grows in competition with limited space. In Gorontalo, every year there is a loss of two percent of forest cover, due to conversion, gold miners without permits, illegal logging and plantation businesses. Pollution of the sea and coastal areas is also very serious. In the last 10 years, an estimated 6,000 hectares of mangrove forests have been damaged, while 70 percent of coral reef cover remains(Arifin, 2022)**.**

The water absorption area in Gorontalo City is also very critical. Likewise, groundwater conditions are threatened. Several rivers in the watershed area have high discharge when it rains, but when it doesn't rain the river recedes. This threatens raw water, because most of the large drinking water comes from raw river water. (Arifin, 2022)**.**

On a provincial scale, damage in the upstream areas of rivers in Gorontalo Province is also in poor condition. Data from the Bone Bolango River Watershed and Protected Forest Management Center (BPDAS-HL), of the 520 river watersheds (DAS) in Gorontalo Province, only 27 watersheds are still maintained (in good condition). Meanwhile, 493 or 94 percent of other watersheds are being restored; in other words, his condition is critical (Lihawa, 2019)**.**

Based on calculations by the Gorontalo City Spatial Planning Service, an increase in land requirements for residential and business/activity space will have an impact on decreasing green open space and water catchment which is very useful in preventing flooding, which is a major issue in Gorontalo City.

The current issue is the increasing air temperature in Gorontalo City due to global warming and the lack of protective tree cover or green open space. In March 2022, BMKG determined that Gorontalo City received the first title of Hottest City in all of Indonesia. Apart from the rapid development and excessive use of air conditioning, felling of trees occurs everywhere for development purposes. Funds from the National Economic Recovery Program (PEN) which was launched to reduce the impact of the COVID 19 pandemic, was used to build road and park infrastructure so that many trees were cut down along the road**.**

According to BMKG data (2020), Daily temperatures in the Gorontalo area and its surroundings range between 24oC at night and 31oC during the day. The highest surface temperature in Gorontalo City is in the city center area which is around 31-32o C, and the temperature in the Pulubala residential area, Kota Tengah District is between 31-33 oC (Koto, 2015). Even though the amount of vegetation cover reaches 49 percent, the surface temperature in residential areas, trade and service areas, road areas and several parks is still high, so it is necessary to add green open space spread across the city center covering all areas based on urban land use (Arifin, 2022).

Disaster Risk

The city of Gorontalo is located at The slope is quite high, which is the factor that most influences the occurrence of landslides. The Bone River estuary is an area that is very vulnerable to landslides (Asiki et al., 2019). The city of Gorontalo is located on the banks of the Bolango, Tamalate and Bone rivers. This city has developed and triggered changes in land use to meet economic and social infrastructure needs. The speed of land function change in both upstream and river basin areas has a negative impact on the environment, such as natural disasters and loss of open space that functions as a water catchment area. One of the problems faced by Gorontalo City as an alluvial area is annual flooding (Wunarlan, 2019).

High rainfall which is exacerbated by the decreasing number of water catchment areas means that flood disasters always occur in Gorontalo City. In June 2020, 6 villages were affected by major floods and 13,768 people had to be evacuated (Kemenpu, 2020). From the mapping results, flood zones from very high to low are spread almost throughout the Gorontalo City area (Doda, 2013). The findings show that flood disaster management in Gorontalo City itself has not been effective. For this reason, sustainable planning is needed not only for spatial planning and disaster mitigation, but also policies regarding environmental preservation as the root of the problem.

Discussion

The Gorontalo City Government has basically realized that the potential for environmental damage that the City of Gorontalo must face is very large. In response to this, the Regional Government is trying to carry out prevention and control measures. There are 6 (six) management innovation activity programs in the environmental sector in 2020 consisting of 5 APBD budget sources and 1 The Specific Allocation Fund budget source, namely as follows: Waste Management System Development Program, Environmental Recovery Program, Environmental Capacity Increasing Program, Management Program and Development of Domestic Waste Water Systems, Green Open Space (RTH) Management Program and Improvement of Maintenance Operations for Waste Infrastructure and Facilities Providing Waste Transport Equipment (Lihawa, 2019)**.**

As a form of public accountability and transparency as well as fulfilling the obligation to provide, deliver and/or publish information relating to the public interest, in 2021 the Gorontalo City Government will provide accurate information and data through the preparation of the Regional Environmental Management Performance Information Document of Gorontalo City**.**

Gorontalo City has also revised the Gorontalo City Regional Regulations regarding Gorontalo City Regional Spatial Planning 2019-2039, this is very important to minimize land use that is not in accordance with the carrying capacity and capacity of the environment and reduce the potential for misuse of land conversion and in

accordance with Gorontalo City Regional Regulation Number 09 of 2019 concerning Gorontalo City Regional Spatial Plan 2019-2039, there will no longer be any change of land function, especially agricultural land which is used as residential/residential land or trade and service areas. In addition, for every application for a Building Permit (IMB) for a house/residence/business premises, the applicant, both individuals and business entities, MUST provide private green open space of 20% of the building area. This is done to minimize the potential for inundation or flooding that occurs in Gorontalo City (DIKPLHD Kota Gorontalo, 2021).

This step is also in line with the concept of the Regional Medium Term Development Plan of Gorontalo City. The 422 indicators in the Regional Medium Term Development Plan, 167 of them intersect with the green economy road map. This is an achievement for Gorontalo City where at the Indonesian SDGs event, out of 457 regions, Gorontalo City was in the top 10 that received awards and success for sustainable programs in the region. (darilaut.id).

Handling environmental problems in Gorantolo City should have entered a new phase. From the results of studies conducted by researchers, it was found that the policy for handling environmental problems in Gorontalo City has not been optimal. The main problem comes from the lack of harmony in the roles between government, society and the industrial world. The Gorontalo City Government has basically established a strategic plan, only the formulation, implementation and evaluation process does not involve other determinant elements.

From the data analysis carried out, problems in implementing environmental policy in Gorontalo City can be identified as follows:

- economic sector planning documents do not adequately reflect the diversity of environmental factors;
- lack of public understanding of the long-term dependence on the availability of natural resources;
- lack of long-term systematic scientific studies of the potential impacts of climate change on the environment;
- lack of funds to control compliance with statutory requirements.

In its application in society, environmental policy requires an environmental management mechanism. Environmental policy has a more general and broader function than environmental management. Environmental management provides the practical implementation of environmental policies. By paying attention to the importance of community involvement, environmental management has the main goal of building public awareness. In order to build public awareness, the stages that must be met are conveying information and providing education.

Solving environmental problems directly depends on the level of knowledge of society on environmental protection. Communication, information and education and the environment are the main tools for increasing public awareness. Communication becomes a medium for continuous two-way information exchange between decision makers and the general public. The most important thing is how to provide information to the public. Information becomes a medium to attract public attention to interact, discuss and try to solve problems. By providing good information, the public will feel involved and will increase their sense of responsibility for environmental conservation and rehabilitation.

In line with this, providing information must of course be based on the latest developments, where there will be an exchange of ideas and knowledge. data obtained through environmental studies. To educate people about the environment and nature,

increasing the level of knowledge and opportunities for self-education to involve responsible organizations, educational institutions, experts and enthusiasts in the environmental education process, thereby supporting national and local initiatives.

In schools, environmental education and education for sustainable development are generally integrated into various subjects according to their specific content, thereby ensuring continuity and coordination in various stages of education.

Environmental information should enlighten scientists, politicians and people working in environmental management, so that they can make informed policy decisions that is, match the actual situation and environmental challenges in the region and to make informed and rational policies.

It is important to realize that Environmental Policy is a policy that should prioritize inclusiveness. The government cannot afford to be the sole element in environmental policy. The earth is a place where humans live together, so efforts to protect and preserve it must involve every element of society. For this reason, this study will provide an overview of environmental policy design using the Quadruple Helix method.

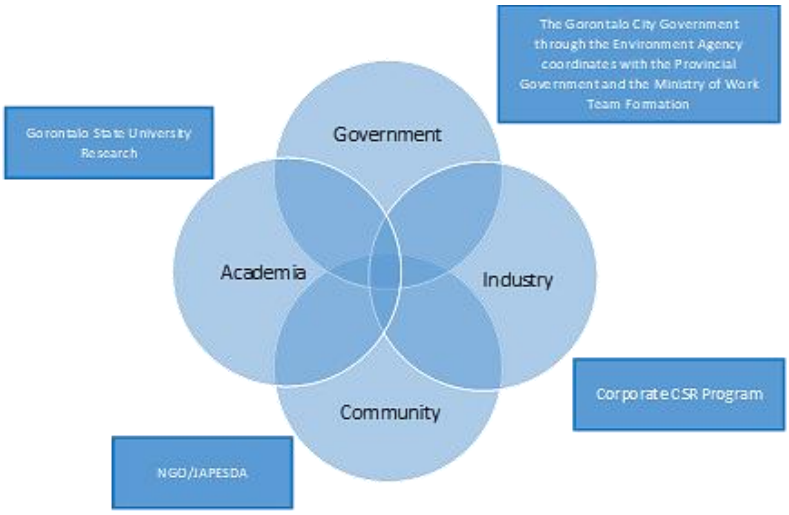

Figure 2. Quadruple helix diagram
Source: processed by author, 2024

The diagram above tries to illustrate the collaboration between the four elements of the Quadruple Helix in the process of forming environmental policy designs. The Gorontalo City Government is of course the central actor in this matter. In this case, the Gorontalo City Regional Government always coordinates with the Gorontalo Provincial Government and the Ministry of Forestry and Environment. In carrying out its functions, the Gorontalo City Regional Government delegates tasks to the Environmental Service.

The industrial sector, which is required to carry out CSR as a form of contribution to society, should coordinate with the government so that the distribution of CSR programs is directed at environmental preservation.

Furthermore, it is related to the results of research and observations which are the main input in policy formulation. For this reason, academics must have space facilitated by the regional government. Research related to environmental conservation and potential disasters must be further encouraged. In this case, it is important to maximize the involvement of educational institutions and innovation.

Public is an essential element in the process of formulating and implementing policies, especially in relation to environmental policy. An environmentally based policy will not be effective without active involvement from the community. For this reason, an appropriate management mechanism is needed.

Conclusion

Environmental issues in Gorontalo City have not been addressed optimally due to the lack of alignment and coordination between key stakeholders, such as the government, community, and industry sectors. Although the Gorontalo City Government has prepared a strategic plan, the formulation, implementation, and evaluation processes have not fully involved other important elements, such as the community, academics, and industry. In addition, economic development planning documents do not reflect the diversity of environmental factors, so efforts to balance economic growth and environmental sustainability are limited. Public understanding of long-term dependence on natural resources is still limited, and systematic scientific studies on the impacts of climate change are still lacking. Limited funding further weakens enforcement of environmental regulations.

To address these challenges, the Gorontalo City Government must implement its strategic plan in a more inclusive manner by actively involving the industry sector, academic institutions, and the wider community. Collaboration between stakeholders will ensure a participatory approach to addressing environmental issues while encouraging sustainable solutions. Adequate funding, public education initiatives, and evidence-based research are essential to increasing Gorontalo City's resilience to environmental challenges. By integrating these efforts, cities can achieve sustainable environmental management, support economic growth, and improve the quality of life for their citizens.

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