Scientific Research Publishing

Journal of Geoscience and Environment Protection, 2024, 12, 55-67
https://www.scirp.org/journal/gep
ISSN Online: 2327-4344
ISSN Print: 2327-4336

Analysis of the Factors That Cause Environmental Degradation of Lake Santa Maria Tasi Tolu Dili Timor-Leste

Antero Freitas Branco

Department of Biology Teaching, Faculty of Education Arts and Humanity, University National of Timor-Leste, Dili, Timor-Leste
Email: antero.branco@untl.edu.tl

How to cite this paper: Branco, A. F. (2024). Analysis of the Factors That Cause Environmental Degradation of Lake Santa Maria Tasi Tolu Dili Timor-Leste. *Journal of Geoscience and Environment Protection, 12,* 55-67.
https://doi.org/10.4236/gep.2024.1210004

Received: May 11, 2024
Accepted: October 22, 2024
Published: October 25, 2024

Abstract

This research aims to understand more closely the damage to the lake environment and the factors that cause pollution in Lake Santa Maria are the first factor of increasing urbanization, the use of the land around the lake as a place to live, the absence of maximum control from the local government this case, the Dili municipal authority. Types of solid waste consist of iron from car accidents, motorcycles, used building materials, plastic, used drink bottles and clothes, mosquito nets, food scraps from household waste, as well as old fishing nets from residents. In addition, household waste such as bath and bath, dishwashing, detergents, and waste from tempeh and tofu factories, including burnt oil from cars and motorcycles, are thrown into the lake. Municipal waste management is based on environmental standards to determine the quality of waste management in Dili Municipality. It is possible to identify the composition of waste and waste, as well as predict its environmental impact. Human (Anthropic) factors Domestic Liquid Waste, Domestic Solid Waste: Composed of organic and inorganic waste. Synthetic Waste, Disposal of Used Oil, Disposal of Domestic Animal Waste, Shallow Drains and Septic Tanks, Mountain Garbage, Garbage Thrown by Visitors, Natural Factors, Climate change, Prolonged drought, Low rainfall, El Niño and La Niña factors, Wind speed, Heat (high daily temperature pressure), Greater water evaporation, Dry wind. The occurrence of contamination necessarily implies an ecological imbalance. The impact introduced by residual compounds and waste that may be associated with the toxicity.

Keywords

Analysis, The Factors, Cause, Degradation, Environment, Santa Maria Lake, Tasi Tolu

1. Introduction

East Timor's climate is tropical, hot and humid, with a dry season and a rainy season. The country's average temperature is 25˚ Celsius, although there is a wide variation in temperature. In coastal areas, temperatures reach values of 35˚C and at high altitudes, in the mountains, we find very low temperatures, which in the months of June and July can reach around 50˚C. Lake Santa Maria Tasi Tolu is one of three lakes in Tasi Tolu, which is actually used as an open green space for the people of Dili city, appears to be not well maintained because the location around the lake is full of garbage and domesticated livestock and the area on the lakeshore Lake is inhabited by local people due to the uncontrolled flow of urbanization by the authorities in the capital of Dili. The most worrying thing about the current condition of Lake Santa Maria Tasi Tolu is that it is in critical condition. Where because it is inhabited by inhabitants because during the rainy season there are floods everywhere, as the area by the lake has no empty space as a place for rainwater to drain when the rainy season arrives. For this reason, preventive measures must be taken from now on to control the presence of residents in the lake area. Domestic wastewater is generally divided into gray water and black water, with sources coming from toilets, bathing, washing clothes and kitchen laundry (Shaikha & Rakib, 2013; Petta et al., 2008). Lake water pollution is caused by a lack of public awareness as well as the lack of a wastewater treatment system, which means that all wastewater from washing, bathing and toilets is dumped into the lake, as well as the inability of the lake's capacity for wastewater because the water is stagnant and cannot be neutralized, so it is necessary to monitor the state of water quality to determine the level of pollution occurring in Lake Santa Maria Tasi Tolu. Why seeing the condition of Lake Santa Maria Tasi Tolu case, is very worrying because the conditions in some of the lakes are already critical.

2. Fundamentals Theory

Water pollution is understood as the alteration of its characteristics due to any actions or interference, whether natural or man-made. These changes can produce aesthetic, physiological and ecological impacts. In its origins, the word pollution is associated with the act of staining or dirtying, which demonstrates the aesthetic connotation given to pollution when it began to be perceived. It is important to distinguish the difference between the concepts of pollution and contamination, as both are sometimes used interchangeably. Contamination refers to the transmission of substances or microorganisms that are harmful to health through water. The occurrence of contamination does not necessarily imply an ecological imbalance. Thus, the presence of pathogenic organisms harmful to humans in the water does not mean that the aquatic environment is ecologically unbalanced. Similarly, the occurrence of pollution does not necessarily imply risks to the health of all organisms that use the affected water resources. And pollutants can be classified according to their nature and the main impacts caused by their release into the aquatic environment. Water pollution is mainly a consequence of human

(anthropogenic) activities such as release of domestic and industrial effluents without prior treatment. Specific geochemical conditions, like that as rainfall and volcanic activity, can also increase the concentration of some compounds in a given ecosystem, which can cause local problems (natural pollution). Water pollution can be classified as water pollution that arises from the disposal of large amounts of solid and liquid waste into rivers and lakes which can damage the water body environment and be contaminated with heavy metal elements. The consequences gather a reduction in the lifespan of aquatic species and changes in reproductive cycles, a decrease in the solubility of gases, including the concentration of dissolved oxygen, making it difficult for fish and aquatic animals to breathe. The increase in temperature can also enhance the action of pollutants present in the water, as it increases the speed of reactions, as well as the solubility of compounds. Sediment pollution occurs through the accumulation of suspended particles (soil particles and/or insoluble organic or inorganic chemicals). Such particles block the entry of solar rays into the water surface, interfering with the photosynthesis of aquatic plants, and can also carry chemical and biological pollutants absorbed on its surface.

2.1. Factors That Cause Lake Degradation

Climate Change, Climate change is not, by any means, the only factor that affects water quality. Integrated into the concept of global change, the evolution of land use, deforestation, urban expansion and sealing of the area can also contribute to the degradation of water quality. However, more frequently, water pollution is directly related to human activities of urban, industrial or agricultural origin, and climate change may lead to the degradation of surface water quality as an indirect consequence of these activities. When point source pollution has been reduced in many countries (although wastewater treatment plants are beginning to reach capacity limits), the impacts of (global) climate change could tend to increase diffuse pollution with, for example, leakage agricultural or urban. The determinants of climate change that affect water quality are mainly ambient (air) temperature and the increase in extreme hydrological events. Soil drying and rewetting cycles and increased solar radiation can also be considered, (Delpla et al., 2011). A fundamental element of climate change is the impact on Earth's hydrological cycle, which continually distributes water from our oceans to the atmosphere, to the land, to rivers and lakes, and back to our seas and oceans. Climate change is increasing water vapor levels in the atmosphere and is making water availability less predictable. This situation could lead to torrential rains in some areas, while other regions could face more severe drought conditions, especially during the summer months. According to the European Environment Agency's report on the impact of climate change on Europe and its vulnerability to it (Climate change, impacts and vulnerability in Europe), many regions of Europe are already facing more extreme floods and drought conditions. Glaciers are melting; snow and ice cover is decreasing. Precipitation patterns are changing, generally making Europe's wet

regions wetter and its dry regions drier. At the same time, extreme climate-related episodes, such as heat waves, heavy rains and droughts, are increasing in frequency and intensity. Household waste and synthetic waste deliberately dumped into the lake environment can directly pollute the lake as seen in Figure 1 below.

Figure 1. This is evidence of environmental degradation of the lake due to the dumping of synthetic waste by residents living around the lake. Source: October 2023 observations.

2.2. Anthropogenic (Action of Human)

Many anthropogenic factors affect biodiversity in ponds and lakes and often several factors act in concert to cause the extinction of a certain species. For example,

the number of threats affecting endangered freshwater species in the USA ranges from one to five per species (average 4.5). Climate change is all changes in the climate caused by nature and human action. They include the increase in the Earth's surface temperature and its side effects, such as melting glaciers, intense and unseasonal rains and droughts. The consequences of climate change can be felt in everyday life. They have impacts on global issues, such as economic development, resource management, social inequality and sustainable development. Water is one of the natural resources most affected by the effects of climate change, considering changes in precipitation patterns and the availability and distribution of river flows. The fight against climate change has gained increasing strength among the world's main social, economic and political organizations. Some adaptation measures aim to efficiently manage water resources in certain intensive use sectors, such as agriculture. The United Nations (UN), for example, established a sustainable development goal in the 2030 Agenda, in order to seek urgent measures to combat climate change and its impacts, which reinforces the need to create global interventions. Initiatives to raise awareness and change habits to save water, preserve natural resources and reduce climate change that have the support of the population are of great importance and generate significant effects. Anthropogenic disturbances, such as eutrophication or acidification may drastically alter the abiotic environment of a lake or pond, and thus change the position of the abiotic.

2.3. Environmental Degradation of the Lake

The water quality of Lake Toba is influenced by human activities in the surrounding area, especially residential areas, livestock, agriculture, tourism, and commercial activities, including markets, hotels, and restaurants, as well as water transportation activities. The most important influence of all these activities is the production of garbage and waste that directly or indirectly enters the lake's waters. It thus affects the physicochemical quality of the waters of Lake Toba, which will undergo changes caused by various activities in the watershed and the waters of Lake Toba. Degraded areas are related to exploration and extraction, transformation and refining activities of raw materials; production of various substances; product storage and handling; accumulation of waste of different species; among the main ones, which have developed in the past or are currently in operation. Degraded areas are places where there are almost always problems with contamination of soil and subsequently water resources. The approach and study of these degraded areas require a systematization of their problems for the best assessment and definition of the most appropriate rehabilitation solution. This also happens with the problem of degradation of the lake environment by human presence and activities around the lake environment that have a direct impact on the conditions of the lake. The effects caused by residents around the lake through their various activities directly affect the environmental conditions of the lake's water body, such as throwing away garbage, catching fish, pets around the lake, throwing away

garbage, and dumping domestic wastewater into the lake. Lake and cleaning up pet waste in the lake. In addition, waste from expired vehicles is thrown into the lake, such as car and motorcycle chassis, car seats and the disposal of used oil in the lake environment, which is very dangerous as it contains heavy metals. Such as the problem of garbage in various places, that for various reasons humans intentionally or unintentionally dump solid and liquid waste into the water environment which has a serious impact on the quality of lake water bodies and the surrounding environment, as in Figure 2 below.

Figure 2. This is the environmental condition of the lake which has experienced degradation because the lake area has been polluted by rubbish and domestic wastewater. Source: October 2023 observations.

2.4. Water Pollutants by Garbage and Household Waste

Water pollution is understood as the alteration of its characteristics due to any actions or interference, whether natural or man-made. These changes can produce aesthetic, physiological and ecological impacts. In its origin, the word pollution is associated with the act of staining or dirtying, which demonstrates the aesthetic connotation given to pollution when it began to be perceived. Effluent (sewage) is the term used for water that, after human use, presents its natural characteristics altered. They are made up of human excreta (feces and urine) and water of domestic, commercial and industrial origin. As Timor-Leste's population and economy grow, pollution can be controlled so as not to spoil the pleasure of living in Timor-Leste. We therefore, therefore, introduce regulations to control air, water and soil pollution, as well as noise pollution. Urban waste management based on environmental standards, in order to establish standards for waste treatment in Dili and other major cities. We will encourage waste-to-compost and plastic, paper and glass recycling facilities. We will continue to implement the urban waste management policy, providing domestic rubbish bins for waste collection.

3. Method

According to (GOLDENBERG, 2011), the case study is not a specific technique, but a holistic analysis, as complete as possible, that considers the social unit studied as a whole, be it an individual, a family, an institution or a community, with the aim of understanding them in your own terms. This research was based on the collection of the main analysis of the Factors that Cause Environmental Degradation of Lake Santa Maria Tasi Tolu. Direct exploration, Exploratory research is carried out to understand the context of a subject that is the object of study. Its objective is to find all evidence related to the topic of which there is no knowledge and increase the possibility of carrying out a complete investigation. The main ones are: Prioritizing people's points of view, showing a unique and innovative meaning through knowledge of the topic, as there is no mandatory structure, the researcher can follow the process that seems simplest, finding a solution to problems that were not taken into account in the past. The following are the steps in collecting data: This exploratory research was carried out by the standards and procedures of regular exploration from the starting point evenly to the end point of observation, determined according to the lake edge path used as the research location (can be seen in **Figure 3**). So that, the first thing to do is determine the research location and prepare tools and materials for the research and observation process. Determine the boundaries of the research area according to the coordinates of the lake. Determine priority points in data collection and determine the number of limits to be used as the main problem. After that, the researcher explored the entire research location according to the direct data collection procedure. Observe and calculate each of the main factors causing lake pollution by recording and describing conditions directly in the field by photographing the condition of the lake directly. All data that has been successfully collected is then identified and categorized in a data tabulation for temporary analysis. After that,

samples of lake water at each observation point are to be analyzed in the laboratory to determine the condition of the water body. After all the data has been collected and then all the data is tabulated, then it is analyzed according to the existing analysis method, and the final results are compared with more relevant and valid reference sources to interpret the final results according to the objectives of this study.

Figure 3. This is the appearance of Lake Santa Maria Tasi Tolu, the location where the research observation was carried out, seen from Google Earth Map with coordinate point photo, and observation area. Source: October 2023 observations.

3.1. Results and Discussion

In accordance with the objective of this study, the results of direct field observations based on the above case study show that the pollution of Lake Santa Maria Tasi Tolu is influenced by several factors that have not received attention and solutions until now. Therefore, it can be simplified as a result of this research, there are only two main factors, namely human factors and natural factors. Human (Anthropic) Factors: Domestic Liquid Waste: Including wastewater from bathing, washing, and domestic manufacturing activities such as tempeh and tofu. Domestic Solid Waste: Composed of organic and inorganic waste. Synthetic Waste: Such as car wheels, vehicle scrap, used clothes and mosquito nets. Disposal of Used Oil: From nearby vehicle repair shops. Disposal of Domestic Animal Waste: Including pigs, cows and ungulates. Shallow Drains and Septic Tanks: Contributing to Pollution. Mountain Garbage: Transported by floods during intense rains, containing trunks, branches and leaves. Garbage Thrown by Visitors: During tourist tours and events. Natural Factors: Climate change (global warming), Prolonged drought, Low rainfall, El Niño and La Niña factors, Wind speed, Heat (high daily temperature pressure), Greater water evaporation, Dry wind. In addition, the factors that cause damage to the lake are as follows: 1) Residents have occupied the lake area due to the lack of sufficient land to live on in Dili city. 2) The problem is that there is pressure from economic factors due to uneven development, so residents come to the city in search of better job opportunities. 3) The problem is that Lake Tasi

Tolu is a protection zone as a whole, but there are no special regulations for Lake Tasi Tolu as a waterfowl protection zone. 4) The authorities, especially the municipal authorities in Dili, are not firm in enforcing the rules regarding protection zones that should not be occupied by residents. 5) There is evidence that the authorities, at the lowest levels, facilitate the offer of payment opportunities through the policy of buying and selling land to immigrants. In this observation there are two main problems, namely the rubbish problem and the household waste problem which greatly affect the environmental conditions of the lake, namely: In the first graph, the waste problem that dominates is the type of inorganic waste which has the highest value with an average of 5 tons per day and 150 tons per month. Organic waste is 3 tons per day and 90 tons per month. Synthetic waste is 3 tons per day and 90 tons per month. Used building waste with the lowest value of 2 tons per day and 60 tons per month. This indicator is one of the factors causing lake pollution and a solution must be sought. with the types and types of waste in Lake Santa Maria Tasi Tolu and indications of an increase in the volume of waste per day and per month that pollutes the lake's water environment as seen in **Figure 4** below. In the second graph, the domestic waste problem that dominates is the type of laundry and bath waste that has the highest value with an average of 1500 liters per day and 45,000 liters per month. Household furniture laundry waste is 1000 liters per day and 30,000 liters per month. Home product waste is 1200 per day and 36,000 liters per month. Used oil waste has the lowest figure of 500 liters per day and 1500 liters per month. Pet drum washing waste is 1500 liters per day and 45,000 liters per month. Shallow toilet drains 1000 liters per day and 30,000 liters per month. Looking at the very large liter volume of domestic wastewater produced by residents living around the lake, it certainly greatly affects environmental conditions and the quality of the lake water becomes very polluted. That the existence of many types and kinds of household waste in Lake Santa Maria Tasi Tolu is the result of daily and monthly waste disposal, there are indications of an increase in the amount as seen in **Figure 5** below. Even though there are many different types of waste, the main problem that must be faced is domestic waste in the form of plastic waste and water hyacinth. Plastic waste and rubbish are the main problems faced by the world in water areas. In addition to the factors that cause pollution in Lake Tasi Tolu are the other factor of increasing urbanization, the use of the land around the lake as a place to live, the lack of maximum control by the local government in this case the Dom Aleixo area. Types of solid waste consisting of iron from car accidents, motorcycles, used building materials, plastic, used drink bottles and clothes, mosquito nets, food scraps from household waste, as well as old fishing nets from residents. In addition to solid waste, there are also types of liquid waste, namely dirty water from washing clothes, used bath water, water from washing kitchen utensils, sewage water from sewers and the presence of liquid automobile oil discharged into the water. of the lake. With the presence of these pollutants, the lake condition becomes eutrophic, there are signs of growth of various types of algae and seaweed in the lake. This is compounded by the shrinkage of water in the dry season, where the condition of Lake Tasi Tolu

has the potential to suffer from toxicity, in addition to solid and liquid waste which are the main pollutants, also due to the presence of algae and algae in the shallow water banks of the lake. After testing the water quality, water samples from Lake Santa Maria were found in the reservoir water (Table 1), highlighting the level of turbidity/turbines, which is 73.2 NTU, acids/pH 7.43, salinity/salinity of 150%, Dissolved Oxygen (DO) 0.00726 Mg/L and Biochemical Oxygen Demand 40.32 Mg/L. While the test is for water from household waste, the results of the tests carried out on the domestic wastewater in the collector (Table 2), namely the level of turbidity, which is 107 NTU, acids/pH 7.06, salinity/salinity 8%, Dissolved Oxygen (DO) 0.686 Mg/L and Biochemical Oxygen Demand 201.61 Mg/L. There is a big difference in the salinity level of the Santa Maria Lagoon, which is currently double 150% compared to two years ago, when it was only 71.5%, i.e. only half the current value. The current pH of Lagoa de Santa Maria has dropped to 7.43% compared to two years ago, standing at between 9.3% and 9.4%. The changes in pH values and salinity levels in the Santa Maria lagoon over two years have resulted in changes in ecological indicators due to uncontrolled pollution. According to Faria et al. (2023) that Looking at the salinity levels in general, the position of the Santa Maria lagoon or research site has a salinity level of 71.5% compared to the other two lagoons. The depth of the lake water is shallower, with the lowest being 15 cm and the highest 100 cm. The average pH is over 9.3, compared to the other two lakes, whose average pH is only 8.6. As for the electrical conductivity, it scored 18.61 compared to the other two lakes which only scored 12.53. The temperature in Lake Santa Maria is the lowest, 38˚C, and the highest, 45˚C, compared to the other two lakes, where the lowest temperature is 30.5˚C and the highest is 33.6˚C. Urban waste management based on environmental standards, in order to establish standards for waste treatment in Dili and other major cities. We will encourage waste-to-compost and plastic, paper and glass recycling facilities. We will continue to implement the urban waste management policy, providing domestic rubbish bins for waste collection. Solid waste management methods are used for the collection and storage of waste but also for the treatment and reuse of organic waste. Used oils will be collected through tanks, both in Dili and in municipalities, with a view to being recycled, reused or disposed of. It is possible to identify the composition of waste, as well as predict its environmental impact and hold the producing agent responsible. Examples include: the discharge of effluents from industries and water/effluent treatment plants. Diffuse sources: they have different characteristics and are spread across numerous locations, making them difficult to determine due to the intermittent characteristics of their discharges and their coverage over large areas. Agricultural activities, atmospheric deposition and construction waste are examples of diffuse sources of pollution. Contamination refers to the transmission of substances or microorganisms that are harmful to health through water. The occurrence of contamination does not necessarily imply an ecological imbalance. Thus, the presence of pathogenic organisms harmful to humans in the water does not mean that the aquatic environment is ecologically unbalanced. Similarly, the occurrence of pollution does not necessarily imply risks

to the health of all organisms that use the affected water resources. Heavy metals are considered a group of pollutants that cause serious environmental problems due to their cumulative, toxicological effect and their non biodegradability. Contamination of water by heavy metals has harmful effects on consumers, such as carcinogenic, toxic, malformations, genetic mutations or even causing death.

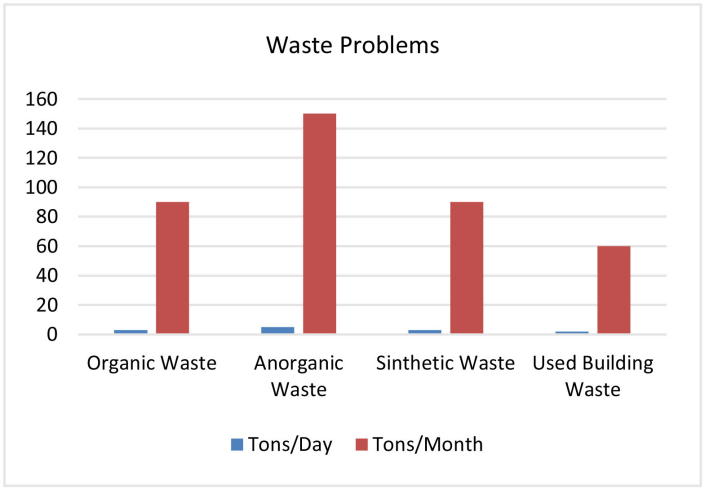

Figure 4. Waste problems. Source: October 2023 observations.

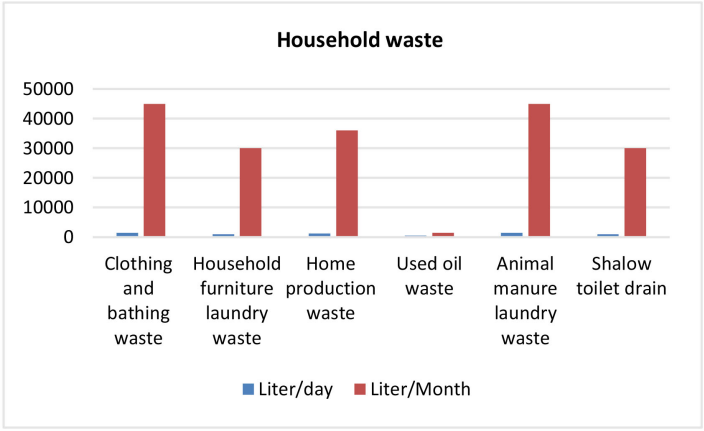

Figure 5. Household waste. Source: October 2023 observations.

Table 1. Test sampling point Lake Santa Maria Tolu lake water.

Nu.	Parameter	Unit	Test Result	Test Method
	Physics			
1.	Turbidity	NTU	73.2	SNI 06-6989. 25-2005
	Chemistry			
2.	Acidity (pH)	-	7.43	SNI 6989. 11-2019
3.	Salinity	‰	15	Salinometer
4.	Dissolved Oxygen (DO)	Mg/L	0.0726	SNI 6989. 14-2004
5.	Biochemical Oxygen Requirement (BOD)	Mg/L	40.32	SNI 6989. 72. 2009

Source: October 2023 observations.

Table 2. Test sampling point household wastewater Lake Santa Maria Tasi Tolu.

Nu.	Parameter	Unit	Test results	Test Method
	Physics			
1.	Turbidity	NTU	107	SNI 06-6989. 25-2005
	Chemistry			
2.	Acidity (pH)	-	7.06	SNI 6989. 11-2019
3.	Salinity	‰	8	Salinometer
4.	Dissolved Oxygen (DO)	Mg/L	0.0686	SNI 6989. 14-2004
5.	Biochemical Oxygen Requirement (BOD)	Mg/L	201.61	SNI 6989. 72. 2009

Source: October 2023 observations.

3.2. Solutions

It is hoped that the local government should conduct a feasibility study of the problem of water quality analysis in Lake Santa Maria Tasi Tolu due to domestic wastewater pollution. Human resources: The government through the Secretary of State for the Environment must prepare enough human resources to manage this problem of Domestic Wastewater Pollution in these areas of Lake Tasi Tolu. Allocation of Funds; After feasibility study the government seriously allocate funds for research preparation general conditions Lake Tasi Tolu. Whether the government wants to partner or cooperate with international agencies to be able to finance this Domestic Wastewater Pollution program. Adequate information; on Domestic Wastewater Pollution; the local government to provide adequate and informative information to the communities on the pollution of Domestic Waste Water in the aforementioned Lake and involve the public health system in the daily life of the communities and specifically all organisms that live in the Lake environment. Legislation by law; After all the emerging situations have been resolved, the government will legislate the use of the surroundings of Lago through law or decree law to regulate all activities of any type, which must be carried out through environmental licensing. Involvement of communities in this area; In addition to the authority of Dom Aleixo, and the authorities of the municipality of Dili, it will be important to involve communities in these areas to guarantee and maintain the law and environmental conditions of the Lake.

4. Conclusion

It is possible to identify the composition of waste, as well as predict its environmental impact and hold the producing agent responsible. However, it is an imprecise measure, as it does not consider the activity of anaerobic microorganisms. Continue to develop campaigns to encourage the use of paper bags as an alternative and develop a recycling scheme for all used plastic material. The impact introduced by organic compounds of this type is associated with their toxicity and not with the consumption of oxygen used for their decomposition. To find a solution in overcoming the environmental pollution of the water of this lake, the

local government, in this case, all authorities must have an integrated program in protecting the condition of the lake in order to reduce the factors that cause pollution and a project financed by the government is carried out to create an environmental rehabilitation program of the lake, involving the local community to receive sufficient information so that the local community does not harm the lake water environment.

References

Abedin, S. B., & Rakib, Z. B. (2013). Generation and Quality Analysis of Greywater at Dhaka City. *Environmental Research, Engineering and Management, 64,* 29-41. https://doi.org/10.5755/j01.erem.64.2.3992

Delpla, A. V., Jung, E. et al. (2011). *Impactos da mudança climática na qualidade da água da superfície em relação à produção da água de beber I.* Revista de Saúde Meio Ambiente e Sustentabilidade.

Faria, M. J. et al. (2023). Assessing Future Flooding Risk in a Coastal Lagoon Using Hydrogeological Approaches and Analysis of the 2021 Flood Event: A Case Study of Tasi-Tolu Lagoon, Dili, Timor-Leste. *Journal of Water Resource and Protection, 15,* 276-298. https://www.scirp.org/journal/jwarp https://doi.org/10.4236/jwarp.2023.156016

Petta, L., Petta, L., Kramer, A., & Al Baz, I. (2008). EMWater Guide and Recommendations on Wastewater Treatment and Water Reuse. In I. A. Baz, R. Otterpohl, & C. Wendland (Eds.), *Efficient Management of Wastewater* (pp. 19-28). Springer,