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Lake Toba Water Pollution in the Estuary and Its Impact on the Environment

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Abstract: Lake Toba is a lake located in North Sumatra. The beauty of Lake Toba can be enjoyed from several district such as Samosir District, Toba District, Simalungun District and Dairi District. Currently, the government is trying to promote Lake Toba as a tourist attraction in Indonesia. This certainly has a positive or negative impact on Indonesian society in general and the community around Lake Toba in particular. The visible impact is that by building tourist attractions in strategic areas, this makes tourists come to visit. The establishment of restaurants, eating houses and home stays is currently also being widely encouraged. Not only that, the fleet of ships has also been increased to facilitate people visiting the desired tourist attractions. This certainly affects the economy of the people around Lake Toba. The community is working on building tourist attractions. Apart from the things mentioned in Lake Toba, floating net cages were made to catch fish.

Keywords: Pollution, Environment, Lake Toba, Water, Oikos.

INTRODUCTION

Nature is God's creation that must be cared for, protected, and cultivated by humans. Humans not only play a role as users of natural resources but also have a responsibility to maintain the sustainability of creation. From an environmental ethics perspective, humans are called to refrain from overexploiting nature. The ethics of stewardship positions humans as stewards of God's creation, who must use natural resources carefully and responsibly. Therefore, maintaining the cleanliness and sustainability of water is one form of human responsibility towards creation (Natar, 2022).

This issue becomes crucial when considering the condition of Lake Toba, particularly in the Muara area. Based on initial observations, Lake Toba's water appears cloudy and polluted by various human activities. This pollution is related to floating net cages, ship waste, and waste from cafes, restaurants, homestays, and residents dumped directly into the lake. As a result, the water becomes dirty, oily, and produces an unpleasant odor. Yet, some communities around Lake Toba still use the lake's water for various daily needs.

Water pollution in Lake Toba is not only a problem for humans but also impacts the environment. Polluted water can disrupt the lives of fish and other organisms living in the lake. For the Muara community, many of whom depend on agriculture and fishing for their livelihoods, this pollution also impacts their livelihoods, as fish are becoming increasingly scarce. Polluted water also hampers various activities of the community that relies on Lake Toba.

On the other hand, tourism development in the Muara area benefits the local economy through the presence of cafes, restaurants, homestays, and a harbor. However, this development also brings problems if not accompanied by proper waste management. Waste from these various activities can enter Lake Toba and increase pollution. This demonstrates the tension between the economic exploitation of Lake Toba and the responsibility to preserve the environment.

From a deep ecology perspective, humans are part of nature, and human life is interconnected with the sustainability of other natural elements. Nature is not merely viewed as a tool to meet human needs, but as a part of life that must be respected and preserved (Ibid., 26-27). This perspective helps us see that Lake Toba pollution is not simply a matter of dirty water, but rather a problem that concerns the relationship between humans and the environment.

Based on these issues, this research was conducted to determine and understand water pollution in Lake Toba in Muara and its impact on the environment. This research will specifically examine the forms and sources of pollution, as well as their impact on the environment surrounding Lake Toba. With this research, it is hoped that a better understanding can be found regarding the importance of human responsibility in maintaining Lake Toba as part of creation that must be maintained and preserved.

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LITERATURE REVIEW

Environment as an Ecosystem

The environment can be understood as oikos, a Greek term meaning home or dwelling. However, the environment refers not only to the place where humans live, but also encompasses the entire universe, including the relationships and interactions between humans, other living things, and the ecosystem. Thus, the environment is an interconnected and dynamically evolving system. Damage to one part of the environment can impact the sustainability of other parts (Peschke, 2003).

Understanding the environment as an ecosystem is crucial in addressing the issue of Lake Toba pollution. The lake is not only a source of water for humans, but also a habitat for various living creatures and an integral part of the lives of the surrounding communities. Therefore, water pollution cannot be viewed simply as a problem of dirty water, but as a problem that can disrupt the balanced relationship between humans, water, living things, and the environment as a whole (Ibid).

Environmental Ethics

Environmental ethics is an effort to discover the principles underlying human actions toward the non-human world. Environmental ethics has a practical purpose, namely guiding how humans should act toward nature and their environment (Deane-Drummond, 2016). In this context, humans are not only required to utilize nature but also to consider the consequences of every action on the environment.

In the discussion of environmental ethics, there are anthropocentric and biocentric approaches. Anthropocentricity places human interests at the center of consideration, while biocentricity extends moral concerns to other living creatures (Ibid., 81). Both approaches help us see that the issue of water pollution in Lake Toba is not only related to human needs for water, but also to the sustainability of life within the lake's ecosystem.

For this research, environmental ethics is used to examine how human actions in utilizing Lake Toba can impact the environment. Economic activities, households, tourism, fish cages, and other activities need to be viewed not only in terms of the benefits they provide to humans, but also from the perspective of responsibility for maintaining environmental sustainability.

Environmental Pollution

Pollution is the process of contaminating or polluting the environment. In the context of the physical environment, dirty or contaminated water can be referred to as polluted water. Robert P. Borrong explains that pollution is related to human actions that introduce certain elements into an ecosystem, thereby endangering the environment, especially when the amount of these elements exceeds the ecosystem's normal assimilation capacity (Borrong, 2009).

Pollution can essentially occur through various human activities. Waste generated from households, businesses, transportation, and economic activities can become sources of pollution if not managed responsibly. In such conditions, the environment experiences a greater burden than its natural capacity to recover.

Water pollution is a significant issue because water is a primary resource for human life and other living things. Polluted water not only undergoes physical changes, such as becoming cloudy, oily, or smelly, but can also disrupt the life of organisms living in it and reduce the water's function for society.

Stewardship of Creation from a Christian Perspective

From a Christian perspective, nature is understood as God's creation. Therefore, humans are not the absolute owners of nature, but rather managers or stewards of creation. Humans have a responsibility to use natural resources carefully and responsibly. An understanding of Genesis 1:28 should not be directed toward exploitative domination, but rather toward responsible stewardship of creation (Harmakaputra *et al*., 2022).

Adrianus Yosia explains that humans are called to be stewards of God's creation. If God is the owner of all creation, then humans must use the available resources responsibly. This stewardship can be realized through a simple life, wise use of resources, and a sustainable and environmentally friendly living and economic system (ibid).

This understanding is crucial in viewing Lake Toba. Lake Toba is not simply a resource that can be used to meet human needs or improve the community's economy. As part of God's creation, Lake Toba needs to be maintained to continue to support the lives of humans and other living creatures. Therefore, the use of the lake must go hand in hand with the responsibility to maintain its sustainability.

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Water Pollution and Its Impact on the Environment

Christian environmental ethics emphasize three important principles: stewardship, solidarity, and peace. Stewardship teaches that humans can benefit from nature, but must do so carefully and without damaging the environment. Humans are called to take what is sufficient, reduce the use of harmful materials, and avoid actions that result in pollution.

The ethics of solidarity positions humans as part of nature, not as beings standing outside of it. Because humans depend on nature, the suffering and destruction of nature should also be a concern for humans. The relationship between humans and nature needs to be built on harmony and harmony.

Furthermore, the ethics of peace directs humans to respect nature as part of God's love for all creation. This is manifested in, among other things, conserving natural resources, avoiding pollution and damage to the environment, and creating a prosperous life for all creation. These three principles form the basis for addressing the pollution issue of Lake Toba in Muara. The use of the lake for daily needs, economic activities, tourism, transportation, and fishing cannot be separated from the responsibility to maintain the cleanliness and sustainability of the lake's ecosystem.

Water Pollution of Lake Toba and Its Impact on the Environment

Water pollution in Muara Lake Toba is a pressing issue due to its close relationship with the lives of the surrounding communities. Based on initial observations that formed the basis of the research, the water around Muara appears cloudy, and there are suspicions that pollution originates from various activities around the lake. Communities living along the shores of Lake Toba also continue to rely heavily on the lake's water for various daily needs.

Some activities identified in the initial observations as sources of pollution include fish cages, ship waste, cafes and restaurants, homestays, and household waste dumped into the lake. These conditions indicate a link between human activities and changes in Lake Toba's environmental conditions. Dirty, oily, and smelly water are signs that the lake's environmental function is disrupted.

Water pollution can also impact community life. Muara residents, many of whom make their living as farmers and fishermen, depend on the surrounding environment for their livelihoods. Polluted water can impact fish populations and fishing activities. Furthermore, the use of unclean water for various daily activities can create problems for the community.

On the other hand, the development of tourism around Lake Toba provides economic benefits to the community. The presence of cafes, restaurants, homestays, and ports can open up economic opportunities and increase community activities. However, this development also needs to be accompanied by proper waste management. If waste from these activities is discharged into the lake, the economic benefits generated can go hand in hand with the emergence of ecological problems.

Therefore, the issue of Lake Toba pollution in Muara requires a holistic approach. This issue concerns not only the condition of the water but also the sustainability of the ecosystem, community life, livelihoods, and human responsibility towards God's creation. This research will examine how water pollution occurs, its impacts on the environment and society, and how the issue can be understood from the perspective of environmental ethics and stewardship of creation.

RESEARCH METHODS

This study uses a qualitative approach with descriptive methods to understand and describe water pollution in Lake Toba in Muara and its impact on the environment. Data were obtained through observation, in-depth interviews, and documentation of Lake Toba water users and parties involved in activities around the lake. Data validity was verified through triangulation of sources and techniques, while data were analyzed by grouping information based on identified themes and then drawing conclusions.

RESULTS AND DISCUSSION

Based on research findings, water pollution in the Muara area of Lake Toba demonstrates a close relationship between human activity, economic needs, and environmental conditions. Observations and interviews revealed that community and tourist waste, household waste, boat activities, and floating net cages are all contributing factors to the lake's environmental conditions. These findings demonstrate that pollution does not originate from a single source, but rather is the accumulation of various human activities around Lake Toba. This aligns with Robert P. Borrong's understanding that pollution occurs when human activity produces

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waste that exceeds the environment's natural capacity to process or assimilate it. Therefore, the pollution problem in Muara cannot be viewed solely as a hygiene issue, but as an ecological problem related to how humans treat the environment.

The research also demonstrates a shift in the community's relationship with Lake Toba. Before the PDAM (Regional Water Company) reached homes, most residents relied heavily on Lake Toba water for their daily needs. However, with the arrival of the PDAM and growing concerns about the lake's water quality, people began to reduce its use, particularly for drinking and cooking. In fact, some residents who still use lake water must take it from the center of the lake, believing it to be cleaner. This finding indicates that pollution has diminished Lake Toba's role as a source of life for the community. Water, once a vital part of daily life, is now seen as a resource to be avoided due to doubts about its cleanliness. This also demonstrates that environmental damage ultimately impacts the people who depend on it.

Floating net cages are one issue that demonstrates the dilemma between economic needs and environmental sustainability. Based on interviews, residents are aware that leftover fish feed can impact water quality, but some continue to operate the cages due to economic needs and the demand for fish from both the public and restaurants. This finding suggests that residents do not always engage in activities that have the potential to damage the environment because they are unaware of the impacts. In the case of Muara, residents are aware of the risks, but economic needs dictate the activities. This situation demonstrates the importance of environmental management that not only prohibits fishing but also provides economic alternatives that allow them to meet their needs without further stressing the lake ecosystem. Research on Lake Toba also shows that cage farming activities can be a source of pollution load, while at the same time cage farming has a relationship with people's livelihoods.

The impact of pollution is also evident in the economic life of the community, particularly those dependent on the fisheries of Lake Toba. Interviews indicate that the decline in fish populations has resulted in fishing no longer providing the same income as before. Some people have shifted to working in rice fields and gardens. In this case, water pollution not only creates ecological problems but also impacts the sustainability of livelihoods. However, research data indicates that the decline in fish populations cannot be entirely attributed to water pollution. The presence of predatory fish such as redfish is also cited by the community as a factor disrupting other fish populations. Therefore, the fish problem in Lake Toba is more accurately understood as an issue of ecosystem balance and biodiversity related to various factors, not just water pollution.

In terms of environmental management, the government has taken several steps, including providing trash bins, separating organic and inorganic waste, employing waste collectors, and educating the community about the dangers of plastic waste. These efforts demonstrate the government's responsibility to protect the environment. However, research also indicates that the community still questions the effectiveness of waste management, as the results of waste separation at the community level have not yet been fully felt. This demonstrates that environmental issues cannot be resolved simply by providing facilities, but require oversight, consistent management, community participation, and coordination between stakeholders.

Research findings also indicate that tourism development in Muara has two sides. On the one hand, the presence of ports, restaurants, homestays, and tourist activities provides economic opportunities for the community. On the other hand, increased human activity around the lake can generate waste and garbage if not accompanied by proper environmental management. Therefore, economic development and environmental preservation should not be at odds. What is needed is tourism management that takes into account the environmental carrying capacity. The North Sumatra Provincial Government has highlighted the issue of waste in Lake Toba and the dilemma of floating net cages, as these activities are related to the community's livelihoods.

From a Christian environmental ethics perspective, this situation demonstrates the need to re-establish awareness that humans are not the absolute owners of nature. Humans are called to be stewards of God's creation and to use natural resources responsibly. In the research, the concept of stewardship emphasizes that humans can benefit from nature, but must maintain its sustainability and not exploit it. Therefore, the use of Lake Toba for household needs, fisheries, transportation, and tourism must be accompanied by responsibility to maintain water quality and the balance of its ecosystem.

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From an environmental ethics perspective, the issues in Muara also demonstrate the importance of solidarity between humans and nature. Humans are part of nature, and their lives depend on its sustainability. When lake water is polluted and fish populations decline, the impacts are ultimately felt by the community. The ethical principle of solidarity demands that humans be mindful of the plight of nature and build a life in harmony with the environment. Likewise, the principle of peace and prosperity demands that humans use resources sparingly, not pollute nature, and strive for a good life for all creation.

Thus, the research results indicate that the pollution problem of Lake Toba in Muara is not merely a technical issue of waste or water quality, but also an ethical issue concerning how humans use and treat nature. The community needs Lake Toba for life and the economy, but these needs must go hand in hand with the responsibility to maintain its sustainability. In this context, government and community efforts need to be strengthened through consistent waste management, waste control, fish cage management that takes the lake's carrying capacity into account, and sustainable environmental education.

Church involvement is also crucial because environmental issues concern not only government policy but also the shaping of congregational lifestyles. The church can make environmental awareness part of its faith practice through sermons, congregational education, community service, and concrete actions to protect the environment. This aligns with the 1996 HKBP Confession, which affirms human responsibility to care for God's creation and rejects actions that damage and pollute water and air. Therefore, concern for Lake Toba can be understood as part of our faith responsibility, not merely a social activity.

Ultimately, the pollution of Lake Toba in Muara demonstrates that the ecological crisis is linked to how humans view and use nature. If Lake Toba is viewed solely as an economic resource, then the pursuit of profit can easily override the pursuit of environmental sustainability. Conversely, if Lake Toba is understood as part of God's creation that sustains the lives of humans and other creatures, then its use must be accompanied by responsibility, self-control, and concern for the sustainability of the ecosystem. Therefore, resolving the pollution problem requires changes not only in societal behavior, but also in how humans understand the relationship between themselves, others, nature, and God.

CONCLUSION

Nature and all its contents are gifts from God entrusted to humans to cultivate and care for. This is in accordance with Genesis 2:15, "The Lord God took the man and put him in the garden of Eden to work it and keep it." Research shows that the water pollution of Lake Toba in Muara indicates that humanity's relationship with nature is not yet fully balanced. Lake Toba provides numerous benefits to the community, both as a water source and as a source of livelihood and economic development through fishing, tourism, restaurants, homestays, and various other activities. However, this use can also put pressure on the environment if not accompanied by responsibility for maintaining its sustainability.

Water pollution in Lake Toba in Muara is related to the presence of community and tourist waste, household waste, activities around the port, and floating net cage activities. The impact is not only visible on the water condition but also affects the lives of the communities dependent on the lake. People who previously used Lake Toba water for various daily needs are now increasingly switching to using PDAM water due to concerns about its cleanliness and quality. This situation demonstrates that when the environment is damaged, the humans who depend on that environment also feel the impact.

In addition to water pollution issues, research has also found problems affecting fisheries in Lake Toba. Locals complain about the decline in jahir (whitebait), tilapia, carp, and other fish species that were previously more readily available. The presence of redfish is seen by the community as a contributing factor to this decline, as they prey on smaller fish. This problem is more accurately understood as a disruption to the balance of the ecosystem and the community's fisheries. The reduced catch then impacts the community's economic livelihood, leading some who previously relied on fishing to shift to agricultural work.

From a Christian ethical perspective, this situation demonstrates the importance of repentance and self-control in treating nature. Humans are not called to take as much as possible from nature to satisfy their desires and economic interests, but are called to use and care for God's creation responsibly. An attitude that solely pursues profit without regard for the sustainability of nature can lead to resource exploitation. Therefore,

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environmental preservation must be understood as part of a life of faith, through lifestyle changes, self-control, responsibility, and love for all creation. Jesus' warnings about the dangers of mammonism in Matthew 6:19–24 and 1 Timothy 6:6–10 are relevant as a reminder to humanity not to be so consumed by the love of wealth that it neglects the preservation of nature.

The preservation of Lake Toba is not solely the responsibility of the people living around the lake, but rather a shared responsibility. The government, community, churches, businesses, tourists, and all parties who utilize Lake Toba have an ethical obligation to safeguard its sustainability. Humans need to recognize that well-being is inseparable from environmental health. A clean and well-maintained Lake Toba is crucial not only for the preservation of nature but also for the health, social life, livelihoods, and economic sustainability of the community.

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