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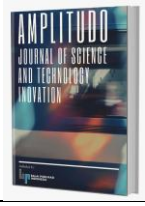

The Relationship between Sea Water Intrusion and Fresh Water Availability in the Provision of Clean Water Sources in Padang Pariaman Regency West Sumatra Province

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Abstract: The provision of clean water in Indonesia is a people's right guaranteed by the state, especially to meet the minimum daily basic needs for a healthy, clean and adequate quantity, maintained quality and affordable. The availability of fresh water as a source of clean water illustrates the potential for water availability and sustainability. The limited amount of fresh water is a challenge to meet community needs in the form of transportation facilities, toilets for local communities and aquaculture. This condition is also affected by climate change, especially for Indonesia which is in the tropics. The water parameters of the Batang Tapakis River illustrate that the quality of river water is influenced by the people around the river and seawater has entered the river. Community empowerment in providing access to drinking water through community-based activities is a strategic step to overcome the scarcity of fresh water. Participation of the community, government and various related parties can provide reinforcement and commitment so as to achieve the availability of water sources with an insight into sustainable development.

Keywords: Community participation; Clean water supply; Parameters Water quality

Introduction

Water Resources refer to the water, water sources, and the power of water contained within them. The utilization of water encompasses all human activities and environmental needs. Earth's water composition consists of 97% saltwater and 3% freshwater, the majority of which is frozen in glaciers and polar ice caps. Groundwater, located beneath the Earth's surface, dominates the availability of freshwater, more so than surface water or atmospheric water. Freshwater potential serves as a renewable source for clean water supply. The growing human population is directly proportional to the increasing demand for water, which exceeds the capacity for freshwater supply. The United Nations (UN) estimates that by 2050, the world population will reach 9.8 billion, with the population growth rate being spread across countries such as India, Nigeria, the Congo, Pakistan, Ethiopia, Tanzania, the United States, Uganda, and Indonesia. This growth rate will result in a limitation of water availability (Lestari et al., 2021).

The availability and sustainability of water resources have been set as targets in goals 6, 12, 13, 14, and 15 of the Sustainable Development Goals (SDGs). Indonesia's water resource potential reaches 3,906.5 billion m^3/year. This potential provides an overview of water availability and sustainability (Strategic Issues in the Management of Raw Water Reservoirs on Bintan Island et al., 2021).

The provision of clean water in Indonesia is a right guaranteed by the state, primarily to meet the basic daily needs of healthy living, cleanliness, sufficient quantity, maintained quality, and affordability. This right includes the entitlement to access and use a specified water quota, in accordance with government

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regulations. Therefore, water resources cannot be owned or controlled by individuals, community groups, or business entities (Republic of Indonesia Law No. 7, 2019).

According to Government Regulation No. 38 of 2011, rivers are natural containers or channels of water flow that start from the upstream to the mouth, bounded on both sides by the riverbank line. River water originates from rainwater and springs, and its quality is influenced by human activities, particularly those near the river, such as transportation facilities, community sanitation (MCK), and aquaculture. Public awareness to preserve river ecosystems can significantly influence the condition of these rivers.

Batang Tapakis River is one of the rivers located in Korong Batang Tapakis, Nagari Sintuak Toboh, Sintuak Toboh Gadang District. The local community utilizes this river for domestic activities such as washing, bathing, and sanitation, as well as for transportation, agricultural, industrial, livestock, recreational purposes, and sand mining. The degradation of Batang Tapakis River quality is caused by local activities such as domestic waste disposal, sand mining near the river, fish farming, and water transport. The disposal of domestic waste and fish farming in the river can increase the concentration of Chemical Oxygen Demand (COD) in the water. Meanwhile, sand mining activities around the River Basin Area (DAS) can reduce river biodiversity, create large holes that cause erosion, increase turbidity, and reduce the physical quality of the river (Riyandini, 2020).

Seawater intrusion refers to the entry of seawater beneath the ground surface through aquifers in coastal areas, caused by a decline in groundwater levels, excessive groundwater pumping in coastal areas, and the ingress of seawater through rivers, canals, channels, and swamps. Seawater intrusion impacts groundwater utilization, as it directly affects groundwater quality (Abdi, 2017).

The density of seawater is greater than that of freshwater, allowing seawater to displace freshwater. Under equilibrium conditions, the situation described above does not occur, as groundwater possesses a piezometric pressure that is stronger than that of seawater. However, cases of seawater infiltration have been observed in coastal areas, marked by water that appears unclear, yellow, and tastes somewhat salty. This infiltration has a negative impact on the environment, health, and economy.

Tiram Beach is located in Padang Pariaman Regency, specifically in Ulakan Tapakis District, where the local community sources its clean water from wells. The water's murky yellowish color and slightly salty taste indicate groundwater contamination in the area (Amri & Putra, 2014).

Community participation is a strategic step in sustainable development. Community involvement in water supply and sanitation programs, especially those based on local community participation, plays a crucial role. This commitment will ensure the availability of water resources, which have significant potential to improve the quality of life and overall well-being (Wadu et al., 2020).

Method

The method used for this study is a literature review. The type of data utilized is secondary data from the Central Bureau of Statistics of Padang Pariaman Regency, data on the water parameters of Batang Tapakis River, and relevant journals related to the discussion topic.

Result and Discussion

Padang Pariaman Regency has an area of 1,343.09 km² and is geographically located between 00°19′25.68″ – 00°48′59.868″ South Latitude and 99°57′43.325″ – 100°27′28.94″ East Longitude. Based on its geographical position, the boundaries of the region are as follows: North – Agam Regency; South – Padang City; West – Pariaman City and the Indonesian Ocean; East – Solok Regency and Tanah Datar Regency. Padang Pariaman Regency consists of 17 districts, with a coastline length of 42.11 km and contains 11 rivers. The Batang Tapakis River, which is 46.0 km long, flows through the areas of Lubuak Aluang, Sintok Toboh Gadang, Nan Sabaris, and Ulakan Tapakih (No Title, n.d.).

The study, conducted in August 2020, involved water samples from the Batang Tapakis River. The samples, once collected in bottles, were labeled with the date and location of sampling. The samples were then stored in a Cold Box and transported to the laboratory for analysis of water quality parameters. The parameters analyzed included pH, electrical conductivity (EC), Total Suspended Solids (TSS), Total Dissolved Solids (TDS), Chemical Oxygen Demand (COD), Phosphates, and Phenols.

The results of the parameter measurements were compared with Government Regulation No. 28 of 2001 concerning Water Quality Management and Water Pollution Control. Through interviews with local residents, it was found that the utilization of the Batang Tapakis River falls under class II, which is designated for water used in recreational facilities, freshwater aquaculture, livestock farming, irrigation, and other purposes.

Table 1. River Water Quality Parameter Testing Methods

Parameter	Testing Methods
pH	SNI 6989.11 – 2019
DHL	SNI 06-6989.1 - 2004
TSS	SNI 6989.2 - 2019
COD	SNI 6989.15 - 2019
Fenol	SNI 06.6989.21 – 2004
Pospat	SNI 06.6989.31 – 2005

Table 2. Results of Observations on the Physical Condition of the Batang Tapakis River

Parameters	Results
Water body conditions	Flowing
Type of sampling	Single
Temperature	27.50C
Hydrocarbons	A Little
Foam	A Little
Aquatic plants	A Little
Floating objects	A Little
Mud	A Little
Water color	A Little
Turbidity	A Little
Odor	A Little
Weather during sampling	A Little

Table 2 provides an overview of the physical parameters of the water quality of the Batang Tapakis River. Hydrocarbon compounds detected in the water are the result of transportation activities, which have been shown to contribute significantly to water pollution in various aquatic environments (Nokelaynen, 2018). According to interviews with the local community, it was found that the water transport activities in the river contribute to the presence of oil on the surface of the water, which originates from fuel spills, a common issue in areas with active transportation networks (Nokelaynen, 2018). Meanwhile, foam observed on the water surface comes from surfactants such as detergents, softeners, and air fresheners, typically used in households. The presence of surfactants in river systems has been documented to lead to foam formation, indicating pollution from domestic sources (Lin et al., 2021). The foam indicates the presence of phosphates in the water, as surfactants often contain phosphate compounds that can affect aquatic ecosystems (Sharma et al., 2018). The color of the river is influenced by wastewater and rainwater that mix into the river, which is a known phenomenon where urban runoff and untreated sewage contribute to the degradation of water quality (Adjid et al., 2022).

Water quality based on chemical parameters provides an indication of the chemical compounds present in the water, including pH, electrical conductivity (EC), total suspended solids (TSS), chemical oxygen demand (COD), phosphate, and phenol. The pH parameter indicates the concentration of hydrogen ions in the water, giving an overview of the acid-base equilibrium. The Batang Tapakis River has a pH value of 6.88, which falls within the acceptable range for class II water as stipulated by Government Regulation No. 82 of 2001 (Orlandi et al., 2018). Therefore, the pH of the Batang Tapakis River falls within the safe range, aligning with findings that indicate a pH between 6 and 9 is generally acceptable for aquatic life (Ghodsi et al., 2021).

The electrical conductivity (EC) parameter measures the ability of a solution to conduct electricity. A higher EC value suggests a greater concentration of salts, indicating the presence of dissolved minerals in the water. The measurement of EC in the Batang Tapakis River yielded a value of 214.8 µS/cm, suggesting a significant ion concentration in the water, which is consistent with the presence of salts (Bai et al., 2021). For river water, EC values generally range from 30 to 200 µS/cm, and elevated levels can indicate pollution from agricultural runoff or urban waste (Anis, 2023).

The TSS parameter measures the total suspended solids, which include microorganisms, mud, and fine sand resulting from water erosion entering the riverbed. The turbidity caused by these suspended solids limits the penetration of sunlight into the water, affecting photosynthesis in aquatic plants (Nwoye & Ifeyinwa, 2020). The measured TSS value for the Batang Tapakis River was 0.00316 mg/L, which is below the threshold of 50 mg/L set by Government Regulation No. 82 of 2001, indicating that the water quality is within acceptable limits for this parameter (Caesar, 2024).

Chemical oxygen demand (COD) is the amount of oxygen required to oxidize organic compounds in the water. Laboratory results showed that the COD level in the Batang Tapakis River was 114 mg/L, exceeding the maximum acceptable COD for class II water, which is set at 25 mg/L Orlandi et al. (2018). This indicates a higher concentration of organic material from activities such as domestic waste disposal and the accumulation of feed from freshwater fish farming, which are known contributors to elevated COD levels in aquatic systems (Zhong et al., 2019).

The phosphate parameter reflects the balance of the aquatic ecosystem. Low phosphate levels indicate that the growth of aquatic organisms or plants may be hindered. The phosphate concentration in the Batang Tapakis River was 0.113 mg/L, which is below the acceptable phosphate level for class II water of 0.2 mg/L, suggesting that while phosphate levels are low, they may still be influenced by agricultural runoff and domestic waste (Sharma et al., 2018). The phosphate levels are likely attributed to fertilizer residues (N, P, K),

pesticides, and domestic waste activities around the river, which have been identified as significant sources of nutrient pollution in freshwater systems (Hefnawy et al., 2020).

The phenol parameter, as measured in the Batang Tapakis River, was 0.062 mg/L. Government Regulation No. 82 of 2001 specifies that the maximum allowable phenol concentration for class II water is 1 mg/L, thus the phenol concentration in the river is below the standard (Orlandi et al., 2018). The source of phenols is linked to water transport activities, which can lead to oil layers on the surface of the water, as phenolic compounds are often associated with petroleum products (Sharma et al., 2018). Phenol compounds and their derivatives are hazardous and difficult for decomposer organisms to process, posing risks to aquatic life (Zhong et al., 2019).

Water resources have the potential for renewal through the hydrological cycle. The availability of water is crucial for the survival of living organisms. However, 40% of the clean water demand is still unmet, primarily due to the continuous increase in population and improper management of water resources (Kapustin et al., 2019). This scarcity of freshwater is exacerbated by climate change, which alters rainfall patterns and increases the frequency of extreme weather events (Yuji, 2023).

Climate change, including rising temperatures and extreme natural events, is contributing to the reduction in available freshwater resources. Thus, it is essential to address these issues to ensure the sustainable provision of clean water (Kapustin et al., 2019). Factors influencing the water supply system include both physical and non-physical aspects. Physical factors such as topography affect installation costs and production expenses, while geographic factors are crucial in system planning and design (Nokelaynen, 2018). Non-physical factors, such as water loss, financing, and institutional aspects, also play a significant role in the management of water resources (Kapustin et al., 2019).

The government has committed to improving the welfare of the population by expanding access to drinking water and sanitation. Community-based activities encourage local involvement in meeting basic needs, particularly through the application of clean and healthy living behaviors (Adjid et al., 2022).

Conclusion

Indonesia faces limitations in freshwater resources, yet with a coastline extending 81,000 kilometers and a maritime area of approximately 5.8 million square kilometers, it holds significant potential for managing seawater. Seawater treatment can serve as an alternative raw material through the process of seawater desalination. The capacity of water as a source for providing clean water can be assessed using measurable parameters that reflect its quality. The activities of communities surrounding these water sources significantly influence water quality and its suitability for consumption. Therefore, it is essential to consider the mechanisms involved in supplying water from the Batang Tapakis River. Using physical and chemical parameter benchmarks, the supply of drinking water should comply with established regulations, emphasizing the importance of implementing values and behaviors associated with clean and healthy living to achieve the target of 100% access to drinking water and sanitation. Community empowerment in providing access to drinking water through community-based initiatives is a strategic approach to addressing freshwater scarcity. The participation of the community, government, and relevant stakeholders can strengthen commitment and facilitate the availability of water sources within the framework of sustainable development.

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Conceptualization: Author 1; Methodology: Author 2; Writing – Original Draft: Authors 1 and 2; Review & Editing: Author 3.

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Conflicts of Interest
The authors declare no conflict of interest.

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