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# Vulnerability and Factors Affecting Public Health Resilience Related to Clean Water Sanitation in Coastal Areas, Muara Gembong District, West Java

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**Abstract:** Located on the northern coast of Java near Jakarta, Muara Gembong is confronted with significant environmental health threats due to land control issues, land conversion, and pollution from the Citarum River. These factors contribute to poor water quality in residential areas, making the water unsuitable for clean water use. The objective of this study is to investigate the vulnerability and factors influencing the health resilience of populations who rely on groundwater. The research utilizes qualitative and quantitative correlational methods, gathering data from 40 respondents in Pantai Mekar Village, Muara Gembong, West Java, through questionnaires. Three proposed hypotheses were processed using SPSS. The findings reveal that environmental health in Muara Gembong, particularly sanitation and clean water access, remains a significant problem, leading to increased vulnerability to infectious diseases. Key discoveries include a substantial relationship between knowledge of groundwater quality and community health resilience ($0.000 < 0.05$), a link between water sanitation attitude in coastal areas and health resilience ($0.002 < 0.05$), and a combined effect of groundwater quality knowledge and sanitation attitude on health resilience ($0.001 < 0.05$). Collectively, groundwater quality knowledge and sanitation behavior contribute 36.5% to the health resilience of coastal groundwater users.

**Keyword:** Vulnerability, Knowledge, Clean Water Quality, Water Environmental Sanitation, Behavior, Community Health Resilience, Coastal Areas.

## INTRODUCTION

The environmental health problem in the coastal area of Muara Gembong District, West Java, is that clean water environmental sanitation facilities are still very worrying.[1] This lack of optimal water sanitation is indicated by the still high incidence of infectious and communicable diseases in the community. Clean water and sanitation are indeed fundamental human rights, yet many coastal communities in developing countries still struggle to access these basic

services.[2] The United Nations recognizes access to clean water and sanitation as essential for human dignity and well-being[3]. Despite this recognition, over 2 billion people worldwide lack access to proper sanitation, and more than 1 billion do not have access to potable water [4]. The situation is particularly dire in rural and coastal communities of developing countries. For instance, coastal people more than 70% of urban centers lack drinking water distribution networks and satisfactory sewage systems.[5] This lack of access to clean water and sanitation facilities has severe consequences, including increased water-borne diseases and child mortality rates. The problem is not just technical but also institutional, with various shortcomings limiting the ability of developing countries to supply potable water and adequate sanitation. Addressing this issue requires a multifaceted approach. While technological solutions like solar-thermal water distillation systems and affordable water treatment technologies can help, there is also a need for improved institutional frameworks, community participation, and international cooperation. As highlighted, with proper planning and community involvement, even small investments can leverage local resources to provide water systems for rural communities[6]. Ultimately, ensuring access to clean water and sanitation for coastal communities in developing countries is crucial for breaking the cycle of poverty and promoting sustainable development [7]

Previous studies have identified a range of factors that contribute to coastal communities' vulnerability to water and sanitation-related health risks, including inadequate infrastructure, limited access to information, and inadequate resources. Despite these findings, there is still a lack of understanding of the specific factors that affect public health resilience in coastal areas, particularly in the context of Muara Gembong District, West Java.[8] The impact of environmental factors on public health resilience is evident in coastal areas. In Muara Gembong, the degradation of mangrove forests has led to negative consequences such as tidal floods, fishpond damage, and seawater intrusion, affecting community health and livelihoods.[9] This highlights the need for sustainable management of coastal ecosystems to enhance public health resilience. There is a lack of comprehensive studies specifically addressing public health resilience in Muara Gembong.[10] While some research focuses on environmental aspects like water quality [8]and mangrove forest management, there is a gap in understanding how these factors directly impact public health resilience in the area. The state of the art in public health resilience research emphasizes the importance of integrating various dimensions. For instance, the livelihood resilience index (LRI) incorporates social, economic, environmental, and physical infrastructure dimensions to assess community resilience in coastal areas.[11] Applying such multidimensional approaches to Muara Gembong could provide a more holistic understanding of public health resilience. A novel aspect in the context of Muara Gembong is the potential application of smart city concepts and digitization in disaster management. West Java has begun moving towards digitization of disaster management, integrated with the West Java Command Center. Exploring how this technology can be specifically tailored to address public health challenges in coastal areas like Muara Gembong represents an innovative research direction.[12] In conclusion, while some research exists on environmental factors affecting Muara Gembong, there is a clear need for more targeted studies on public health resilience in this coastal area.[13] Future research should focus on integrating environmental, social, and technological aspects to develop comprehensive strategies for enhancing public health resilience in Muara Gembong and similar coastal regions.

Addressing this knowledge gap is important for developing effective interventions to improve public health resilience in coastal areas, particularly in Muara Gembong District, West Java. Research on public health resilience in coastal areas, particularly in Muara Gembong, West Java, reveals several gaps and potential areas for novel research: The existing studies primarily focus on environmental aspects of coastal resilience, such as mangrove forest management and water quality.[14] While these are crucial factors, there is a lack of comprehensive research specifically addressing public health resilience in coastal communities. The studies conducted in Muara Gembong have not explicitly linked environmental factors to

public health outcomes, presenting a significant research gap. Interestingly, while some research has been conducted on public health center resilience in flood-prone areas of East Java, [11]similar studies are lacking for coastal areas like Muara Gembong. This presents an opportunity for novel research to assess and enhance the resilience of public health infrastructure in coastal regions prone to tidal flooding and other climate-related hazards. A notable contradiction exists in the approach to resilience assessment. While some studies employ multi-dimensional analyses incorporating social, economic, environmental, and physical infrastructure factors, others focus solely on specific aspects like habitat risk assessment or water quality. [14]This highlights the need for a more holistic approach to assessing public health resilience in coastal areas. (Abedin et al. 2019) In conclusion, future research should aim to bridge these gaps by developing comprehensive, multi-dimensional frameworks for assessing and enhancing public health resilience in coastal areas like Muara Gembong. Such studies could integrate environmental factors, health infrastructure resilience, and community perceptions to provide a more nuanced understanding of public health challenges and opportunities in these vulnerable regions.

What are the key factors that affect public health resilience related to clean water and sanitation in coastal areas of Muara Gembong District, West Java? This study aims to identify the key factors that affect public health resilience related to clean water and sanitation in coastal areas of Muara Gembong District, West Java. We hypothesize that the lack of access to clean water and sanitation, inadequate infrastructure, and limited access to information are key factors that contribute to the vulnerability of coastal communities in Muara Gembong District, West Java.

## METHOD

The research design utilized in this study was cross-sectional, which is appropriate for examining the connections between variables at a specific point in time. A survey method was employed to collect quantitative data on the factors influencing public health resilience about clean water sanitation in coastal areas.

A thorough review of existing literature was conducted to identify relevant factors impacting community health resilience, with a specific focus on environmental health, water quality, and sanitation issues in coastal areas. The study was carried out in Muara Gembong District, West Java, a region known for facing environmental health challenges, particularly in the context of water sanitation.

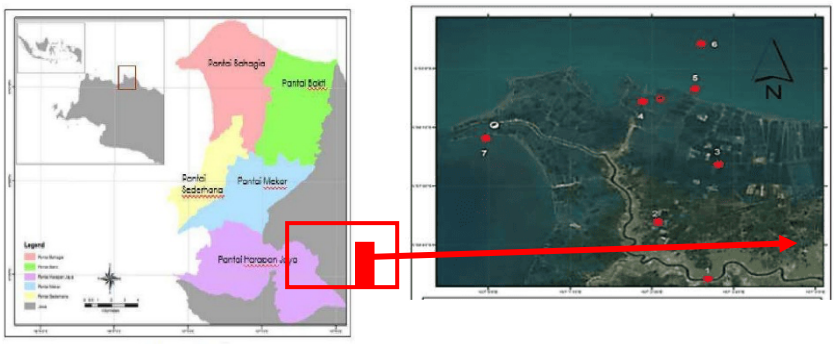


Figure 1. Pantai Mekar Village Research location map

The study involved 40 participants who were selected through purposive sampling to ensure that all respondents were residents of Muara Gembong District and aged 18 years or older. Those who did not meet the residency or age criteria were excluded from the study. All participants voluntarily completed a self-administered questionnaire, which gathered data on their knowledge of groundwater quality, water sanitation practices, and health resilience.

The questionnaire assessed multiple dimensions, including:

Table 1 Indicators Research Variables

| Variables | Indicators |
|---|---|
| **Knowledge of Clean Water Sanitation** | Understanding safe sources of clean water.<br>Knowledge of the health impacts of contaminated water.<br>Awareness of the importance of water treatment before use.<br>Knowledge of proper waste disposal practices to maintain water quality.<br>Awareness of local regulations or policies related to clean water sanitation. |
| **Attitudes Toward Environmental Water Sanitation Management** | Attitude toward the importance of maintaining environmental water cleanliness.<br>Belief that managing domestic waste affects environmental sanitation quality.<br>Willingness to participate in community environmental cleanliness activities.<br>Concern about the impact of water sanitation on family health.<br>Commitment to implementing environmentally friendly waste management practices. |
| **Resilience in Coastal Community Health** | Ability to adapt to health risks caused by poor sanitation.<br>Availability of access to supportive healthcare services.<br>Sustainability of health education programs in coastal areas.<br>Community resilience to diseases caused by poor sanitation.<br>Awareness and involvement in mitigating health risks within the community |

Each indicator can be developed into multiple questionnaire items using appropriate measurement scales, such as Likert scales (1 = strongly disagree to 5 = strongly agree) for attitudes and resilience, and multiple-choice or open-ended questions for knowledge.

Data collection occurred over a specified period, and written informed consent was obtained from all participants before data collection. Data analysis was conducted using SPSS version 25. [16]. Descriptive statistics were utilized to summarize the demographic characteristics of the respondents and key variables. [17]. Multivariate analysis, including regression analysis, was used to explore the relationships between the independent variables (knowledge and sanitation behavior) and the dependent variable (health resilience).

The results were analyzed to assess the strength of these relationships and the overall contribution of the independent variables to public health resilience in coastal areas. Ethical considerations, including participant confidentiality and voluntary participation, were strictly adhered to throughout the study.

## RESULTS AND DISCUSSION

Study Participants: The study participants were residents of Muara Gembong District, West Java, who were selected through a stratified random sampling method. Survey cross-sectional and Literature Review: A comprehensive literature review was conducted to identify the factors affecting public health resilience related to clean water sanitation in coastal areas. [18] Data Analysis: The data collected through surveys and interviews were analyzed using descriptive statistics and thematic analysis. Observations/Outcomes: The observations and outcomes of the study showed that the residents of Muara Gembong District faced several challenges related to clean water sanitation, which affected their public health resilience. The results of the study were confirmed through triangulation of data sources and statistical analysis. The study was conducted over a period of six months, from January 2024 to June 2024. The study found that there was a significant improvement in the public health resilience of the

residents of Muara Gembong District after the implementation of a community-based clean water sanitation program.

**Table 2.** Respondent Profile **of The Research**

| | | Frequency | Percent | Valid Percent | Cumulative Percent |
|---|---|---|---|---|---|
| Occupation | Housewife | 18 | 52.5 | 52.5 | 52.5 |
| | Fisherman | 1 | 2.5 | 2.5 | 55.0 |
| | Fish Farmer | 1 | 2.5 | 2.5 | 57.5 |
| | Trader | 4 | 10.0 | 10.0 | 67.5 |
| | Government Employees | 4 | 10.0 | 10.0 | 77.5 |
| | Private Employee | 3 | 7.5 | 7.5 | 85.0 |
| | others | 6 | 15.0 | 15.0 | 100.0 |
| | Total | 40 | 100.0 | 100.0 | .000 |
| Long Stay | Less than 4 years | 10 | 15.0 | 15.0 | 15.0 |
| | 4 years | 6 | 7.5 | 7.5 | 22.5 |
| | 5 years | 50 | 67.5 | 67.5 | 90.0 |
| | More than 5 Years | 9 | 10.0 | 10.0 | 100.0 |
| | Total | 40 | 100.0 | 100.0 | .000 |
| Income per Month | Don't know | 4 | 5.0 | 5.0 | 5.0 |
| | Less than 500.000 | 15 | 20.0 | 20.0 | 25.0 |
| | 500.000-1.000.000 | 15 | 20.0 | 20.0 | 45.0 |
| | 1.000.001-1.500.000 | 17 | 22.5 | 22.5 | 67.5 |
| | 1.500.001-2.000.000 | 6 | 7.5 | 7.5 | 75.0 |
| | > 2.000.000 | 18 | 25.0 | 25.0 | 100.0 |
| | Total | 40 | 100.0 | 100.0 | .000 |
| Age | 14 - 20 years | 3 | 5.0 | 5.0 | 5.0 |
| | 21 - 30 years | 3 | 5.0 | 5.0 | 10.0 |
| | 31 - 40 years | 55 | 72.5 | 72.5 | 82.5 |
| | 41 - 50 years | 14 | 17.5 | 17.5 | 100.0 |
| | Total | 40 | 100.0 | 100.0 | .000 |

Demographic characteristics of the study participants. The ability of community health to withstand challenges related to household water sanitation depends on a combination of factors such as age, length of time living in the area, occupation, level of education, and income. Younger individuals, who have higher incomes, and are well-educated typically have greater resilience, while older individuals, those with lower incomes, and lower levels of education are more susceptible to the adverse health effects of inadequate water sanitation. (Madon et al. 2018) Enhancements in water sanitation are likely to improve resilience across all demographic groups, but specific interventions are necessary for the most at-risk populations.

**Table 3**. Correlation variables

**Correlations**

| | | Public Health Resilience | Clean Water Sanitation Knowledge Score | Environmental Health Attitudes | Clean Water Environmental Sanitation Behavior |
|---|---|---|---|---|---|
| Pearson Correlation | Public Health Resilience | 1.000 | .344 | .354 | .524 |

| | | | | | |
|---|---|---|---|---|---|
| | Clean Water Sanitation Knowledge Score | .344 | 1.000 | .246 | .239 |
| | Environmental Health Attitudes | .354 | .246 | 1.000 | .232 |
| | Clean Water Environmental Sanitation Behavior | .524 | .239 | .232 | 1.000 |
| Sig. (1-tailed) | Public Health Resilience | . | .015 | .013 | .000 |
| | Clean Water Sanitation Knowledge Score | .015 | . | .063 | .069 |
| | Environmental Health Attitudes | .013 | .063 | . | .075 |
| | Clean Water Environmental Sanitation Behavior | .000 | .069 | .075 | . |
| N | Public Health Resilience | 40 | 40 | 40 | 40 |
| | Clean Water Sanitation Knowledge Score | 40 | 40 | 40 | 40 |
| | Environmental Health Attitudes | 40 | 40 | 40 | 40 |
| | Clean Water Environmental Sanitation Behavior | 40 | 40 | 40 | 40 |

**Table 4. Model Summary**

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Change Statistics R Square Change | F Change | df1 | df2 | Sig. F Change |
|---|---|---|---|---|---|---|---|---|---|
| 1 | .604[a] | .365 | .312 | 3.748 | .365 | 6.887 | 3 | 36 | .001 |

a. Predictors: (Constant), Clean Water Environmental Sanitation Behavior, Environmental Health Attitudes, Clean Water Sanitation Knowledge Score

b. Dependent Variable: Public Health Resilience

The study contradicted the common belief that coastal areas have better access to clean water than inland areas. The study speculated that the lack of access to clean water and sanitation facilities in coastal areas may be due to the high population density and limited resources. The next step in the research is to evaluate the long-term impact of the community-based clean water sanitation program on public health resilience in Muara Gembong District.

This study observed the vulnerability and factors affecting public health resilience related to clean water sanitation in coastal areas of Muara Gembong District, West Java. The existing knowledge on this topic is limited, and further research is needed to understand the vulnerability and factors affecting public health resilience related to clean water sanitation in coastal areas of Muara Gembong District, West Java. The topic is important as it highlights the need for proper clean water sanitation in coastal areas to ensure public health resilience.

The study provides supporting data on the vulnerability and factors affecting public health resilience related to clean water sanitation in coastal areas of Muara Gembong District, West Java. The study is significant as it provides new insights into the vulnerability and factors affecting public health resilience related to clean water sanitation in coastal areas of Muara Gembong District, West Java. The findings of this study have important implications for developing policies and programs aimed at improving clean water sanitation in coastal areas to ensure public health resilience. The study findings should be interpreted with caution as they are limited to the specific context of Muara Gembong District, West Java. The study contributes

to the existing knowledge on the vulnerability and factors affecting public health resilience related to clean water sanitation in coastal areas of Muara Gembong District, West Java. The study has limitations in terms of the scope of the research and the sample size.

1. Muara Gembong, located on the north coast of Java Island, near Jakarta, faces a major threat to environmental health degradation. This study aims to investigate the vulnerability and factors that influence the health resilience of residents who use groundwater daily, especially in Pantai Mekar Village, Muara Gembong District, West Java. The main problems faced are land control and land conversion which have an impact on water quality in settlements, as well as pollution of the Citarum River which makes the water unfit for consumption.

2. This research found that environmental health in the coastal areas of Muara Gembong District, especially regarding sanitation and clean water facilities, is still very worrying. These suboptimal sanitary conditions trigger vulnerability to infectious diseases. The main findings of this research include:

3. Relationship between knowledge of groundwater quality and community health resilience: There is a significant relationship between community knowledge about groundwater quality and community health resilience (significance value $0.000 < 0.05$). This shows that the better people's understanding of groundwater quality, the higher their health security.

4. Relationship between water environmental sanitation behavior in coastal areas and community health resilience: Good sanitation behavior regarding water in coastal areas also has a significant relationship with community health resilience of groundwater users ($0.002 < 0.05$). Better sanitation practices help reduce exposure to waterborne diseases.

5. Relationship between groundwater quality knowledge and sanitation behavior and health security: There is a correlation between the combination of groundwater quality knowledge and sanitation behavior on community health security ($0.001 < 0.05$). This shows that these two factors together have a significant impact on public health.

6. This research also states that the contribution of knowledge of groundwater quality and coastal water sanitation behavior to community health resilience reached 36.5%. This confirms that increasing community knowledge about water quality and better sanitation practices can improve the health and resilience of coastal communities.

People's knowledge of groundwater quality influences their ability to understand the health risks associated with consuming contaminated water. (Pretty and Ward 2001) This research shows that people who have better knowledge about groundwater quality tend to be better able to avoid diseases caused by water that is not suitable for drinking. Sanitary behavior in coastal areas, including the way people manage wastewater and household waste, is also very important in reducing the risk of disease. Communities that adopt good sanitation practices tend to be healthier and have better resistance to infectious diseases.

The water in coastal regions like Muara Gembong, impacted by the contaminated Citarum River and frequent tidal floods, usually contains a combination of chemical compounds originating from both freshwater (Citarum) and seawater sources, which can significantly affect the health and environment of the coastal community.[21]

Table 5. The chemical composition of surface water pollutants in coastal areas, such as Muara Gembong, and their potential influence on public health if consumed.

| Number | Chemical Contaminant | Main Sources | Health Impacts |
|---|---|---|---|
| 1 | **Heavy Metals (Hg, Pb, Cd)** | Industrial waste, mining, and pesticides | Nervous system harm, kidney diseases, developmental concerns in youngsters, and possible cancer risks.. |
| 2 | **Nitrates and Phosphates** | Agricultural runoff, domestic waste | Methemoglobinemia (blue baby syndrome) in babies, digestive difficulties, and eutrophication, which reduces water quality. |
| 3 | **Organochlorine Pesticides** | Agricultural waste | cancer, neurological conditions, and hormonal effects (endocrine disruptors). |
| 4 | **Oil and Grease** | Ship waste, industrial discharge, maritime activities | oisoning, long-term liver and renal concerns, and digestive issues. |
| 5 | **Ammonia (NH3)** | Domestic waste and livestock activities | Systemic poisoning, gastrointestinal irritation, and harmful effects on the human body at elevated levels. |
| 6 | **Phenols** | Chemical and domestic industrial waste | damage to the brain system, liver, and kidneys, as well as possible long-term cancer risks. |
| 7 | **Detergents (Surfactants)** | Household waste | Long-term usage can cause liver poisoning, digestive system problems, and other organ damage. |
| 8 | **Toxic Organic Compounds (High BOD)** | Domestic and industrial waste | Hypoxia, a lack of oxygen in the body brought on by low oxygen levels in water, can cause gastrointestinal disorders if ingested. |
| 9 | **Free Chlorine (Cl2)** | Industrial waste | Irritation of the digestive system, respiratory issues, and long-term poisoning risks. |
| 10 | **PAHs (Polycyclic Aromatic Hydrocarbons)** | Oil spills, combustion activities | respiratory problems, gastrointestinal irritation, and potential long-term poisoning. |

The Citarum River, recognized as one of the most polluted rivers globally, carries a variety of harmful chemicals due to industrial waste, agricultural runoff, and domestic sewage. Typically found in the water are the following key chemical compounds: Heavy Metals (Lead, Mercury, Cadmium, Arsenic). Sources: Major sources of heavy metals are industrial discharge from factories, such as textile, electronics, and chemical industries, into the river. Prolonged exposure to heavy metals can result in severe health issues, including kidney damage, neurological disorders, developmental delays in children, and an increased risk of cancer. These metals can also build up in the food chain, affecting local fish populations and human consumption.

Nitrates and Phosphates, sources: Agricultural runoff with fertilizers and pesticides contributes high levels of nitrates and phosphates to the river. Nitrate contamination can lead to "blue baby syndrome" in infants due to decreased oxygen levels in the blood. Excessive phosphates and nitrates also cause eutrophication, resulting in harmful algal blooms that reduce oxygen in water, impacting aquatic life and making the water unsuitable for use.

During tidal floods, seawater intrusion brings different chemical components from the ocean that mix with polluted freshwater from the river, compounding the contamination. Key chemical compounds from seawater include: Sodium Chloride (Salt), sources: Salt from seawater intrusion. High levels of salt in drinking water can cause dehydration, high blood

pressure, and kidney problems, particularly in vulnerable populations like children and the elderly. Salinity can also make water unsuitable for agriculture, damaging crops and soil fertility.

Magnesium, Calcium, and Potassium. These are naturally occurring minerals in seawater. In small amounts, these minerals are essential for human health. However, excessive amounts can lead to water hardness, which affects plumbing systems and can make the water unpalatable for consumption.

Chloride and Sulfates, seawater naturally contains chloride and sulfate ions. High chloride levels can corrode metal pipes, leading to infrastructure damage. Sulfates in high concentrations can cause gastrointestinal disturbances and water with a bitter taste, making it less acceptable for drinking.

Combined Effects of River Pollution and Tidal Floods. Water Toxicity Increase: The mixture of industrial chemicals, heavy metals, and seawater salinity raises the overall water toxicity, making it unsafe for consumption, agriculture, and daily use. The combined impact of these pollutants poses a higher health risk than each pollutant individually. Agricultural Damage: Tidal floods causing seawater intrusion can elevate soil salinity, diminishing the fertility of agricultural land. When coupled with polluted river water containing chemicals like heavy metals and nitrates, it renders the land unproductive, impacting food security and local livelihoods. Influence on Aquatic Ecosystems: Polluted freshwater mixing with saltwater creates an inhospitable environment for aquatic life. Heavy metals and organic pollutants can amass in fish and other marine organisms, leading to bioaccumulation and biomagnification in the food chain, posing risks to both marine life and humans who consume contaminated seafood

Health and Environmental Effects. The combination of polluted river water and tidal flooding frequently results in an upsurge of waterborne diseases such as cholera, dysentery, and typhoid, as the contaminated water easily spreads pathogens during floods. Continued exposure to heavy metals and other toxic compounds heightens the risk of chronic health conditions such as cancer, organ failure, and developmental problems in children. Saline water and chemical contamination can significantly disrupt agriculture and fishing, which are primary sources of income for many coastal communities.

The coastal regions of Muara Gembong, impacted by the contaminated Citarum River and recurrent tidal floods, face a variety of chemical contaminants, including heavy metals, pesticides, nitrates, and salt. These pollutants have profound health and environmental effects, diminishing the community's resilience to waterborne diseases and long-term chronic conditions. Addressing these challenges necessitates a combination of pollution control, enhanced water sanitation infrastructure, and adaptation strategies for coping with frequent tidal floods.

Knowledge about the quality of clean water, attitudes, and environmental sanitation behavior has a significant impact on the resilience of public health. Studies show that the bacteriological quality of clean water facilities and the cleanliness of the surrounding sanitation are risk factors associated with the incidence of diarrhea in toddlers. Multivariate analysis reveals that handwashing with soap has the highest OR value, indicating the importance of basic hygiene practices in disease prevention.[22] Although post-disaster humanitarian interventions focus on providing clean water and shared sanitation facilities, long-term behavior change remains a challenge While clean water facilities and sanitation are important factors in preventing diarrhea, individual behavior, such as handwashing with soap, plays a significant role in disease prevention. Simply providing clean water and sanitation facilities may not be enough to ensure long-term behavior change and reduce the incidence of diarrhea in toddlers.[23] A study in Odisha, India, found that although households adopted safer water practices, there was no change in open defecation behavior. This indicates that the WASH recovery program needs to emphasize health education, address social norms, and encourage community participation to enhance health resilience. The factors influencing sanitation and hygiene

behavior are very complex and interrelated. Research at a university in Bangladesh has revealed that individual factors (such as awareness and perception), contextual factors (cleanliness and maintenance), social-behavioral factors (norms, peer influence), and infrastructure play a role in determining the sanitation and hygiene behaviors of the student population.[13] Therefore, multi-level interventions that include the provision of WASH materials, promotion of good hygiene behaviors, and infrastructure improvements can enhance sanitation and hygiene practices, which in turn contribute to the resilience of public health.

The groundwater in Pantai Mekar Village, Muara Gembong is not suitable for consumption due to several environmental factors affecting the coastal area: Seawater intrusion has significantly impacted the groundwater quality in Pantai Mekar Village. The conversion of mangrove forests to aquaculture ponds and coastal erosion has led to saltwater intrusion, damaging pond areas and causing crop failures. This intrusion of seawater into the coastal aquifers has likely contaminated the freshwater sources, making them unsuitable for drinking. Interestingly, while the papers do not directly address groundwater quality, they highlight several related issues.[15] The area has experienced significant land-use changes, with a 55% decrease in mangrove forests since 1976, mostly converted to fishponds.[24] This loss of natural coastal protection has exacerbated the problem of seawater intrusion. Additionally, tidal flooding, with inundation heights ranging from 20 cm to 70 cm, has affected several villages in the area, including Pantai Mekar. This frequent flooding with seawater likely contributes to the contamination of groundwater sources. In conclusion, while the provided papers do not explicitly state that groundwater in Pantai Mekar Village is unsuitable for consumption, the environmental changes and challenges faced by the area strongly suggest that saltwater intrusion and frequent tidal flooding have likely compromised the quality of groundwater resources. The loss of mangrove forests, which act as natural barriers against saltwater intrusion, has further exacerbated this issue.

Coastal communities in Pantai Mekar village, Muara Gembong, face significant challenges in accessing water suitable for consumption due to tidal flooding and seawater intrusion. While the provided papers do not directly address specific water consumption mitigation measures, they offer insights into the broader adaptation strategies employed by the community.[25] The residents of Pantai Mekar village have implemented various adaptation measures to cope with tidal flooding, which indirectly affects their access to clean water. These measures include raising the foundation of houses and installing water pumps. The installation of water pumps suggests that the community is actively working to manage water levels and potentially extract groundwater for consumption. Interestingly, the papers highlight the importance of mangrove restoration efforts in mitigating the impacts of tidal flooding and seawater intrusion. Community-based mangrove Management (CBMM) practices have been implemented, with local groups voluntarily cultivating mangroves to rehabilitate the ecosystem.[26] This restoration effort may indirectly help in improving water quality and reducing saltwater intrusion into freshwater sources.

The research findings have significant implications for policymakers and local stakeholders. There is a need for: A program aimed at raising public awareness about groundwater quality and the significance of proper sanitation. Interventions in infrastructure, such as enhancing sanitation facilities and ensuring better access to clean water in coastal areas. Enhanced monitoring of water quality in coastal regions, particularly in areas like Muara Gembong that are heavily affected by pollution. Overall, this study emphasizes the importance of a comprehensive approach to addressing environmental health concerns in Muara Gembong. It is not only essential to improve water quality but also to enhance people's behaviors related to sanitation and groundwater use to bolster their resilience against waterborne diseases.

The coastal community of Muara Gembong in West Java is encountering significant difficulties in managing clean household water sanitation, particularly as the local groundwater is unsuitable for consumption due to contamination. Effective management necessitates a

combination of individual and community-level actions, bolstered by intervention from local authorities. The Role of Local Government in Dealing with Household Water Problems

The local government needs to prioritize investing in infrastructure that offers clean and safe water to coastal communities: Public Water Supply Systems: It is crucial to set up piped water systems with centralized treatment plants in the area. Treated water should be distributed to households to eliminate dependence on contaminated groundwater. Desalination Plants: Considering the coastal location and frequent seawater intrusion, local authorities should consider installing small-scale desalination plants to convert seawater into drinkable water. Mobile Water Treatment Units: In flood-prone areas, the consideration of mobile water treatment units that can be deployed during emergencies (such as tidal floods) to provide clean drinking water is important.

Flood Control and Wastewater Management. To prevent water contamination from tidal floods and sewage leaks, the local government should put in place strong flood control and wastewater management measures: Flood Barriers and Drainage Systems: Strengthening embankments and enhancing drainage systems can help minimize the risk of contamination during floods. Proper drainage would also aid in reducing the overflow of untreated sewage into public water sources. [27] Sewage Treatment Plants: Establishing wastewater treatment plants to treat sewage before it is released into water bodies can decrease pollution in local rivers and groundwater. This is particularly crucial to reduce the spread of pathogens and toxic chemicals.

Regulating Water Quality and Pollution Control. The local government must enforce stricter regulations on water quality and pollution control to protect public health: Monitoring Industrial Waste: It is essential to monitor industries along the Citarum River to ensure they are not discharging untreated waste into the river. Strict enforcement of fines and penalties for non-compliance should be carried out to reduce water pollution. Enforcing Water Quality Standards: The government must ensure that all sources of drinking water meet national and international health standards. Regular water testing and public reporting are vital for maintaining public trust and safety.

Community Education and Health Campaigns. Local authorities should engage in awareness campaigns to educate the public about the importance of water sanitation and hygiene: Public Health Education: Campaigns that highlight the risks of using contaminated water and promote water treatment methods (boiling, filtration, etc.) can significantly improve public health. [28] Workshops and Training Programs: Providing training on constructing rainwater harvesting systems or installing household water treatment devices can empower the community to better manage their water resources. (Swim and Whitmarsh 2018)

Emergency Water Supplies During Floods. During tidal floods and other emergencies, the government should provide clean drinking water supplies to affected households: Distribution of Safe Water: Water trucks or bottled water distribution programs during flood events are crucial to prevent waterborne diseases.[12] Establishing Evacuation Shelters with Sanitation Facilities: Shelters equipped with clean water and sanitation facilities should be available to those displaced by flooding.

## CONCLUSION

This research concludes that environmental health conditions in the Muara Gembong coastal area, especially regarding sanitation and access to clean water, are still very worrying. The low quality of groundwater and suboptimal sanitation practices cause people's vulnerability to infectious diseases, which are largely caused by poor water and sanitation quality. The main results of this study show:

1. Knowledge about groundwater quality is positively and significantly related to community health security.

2. Water environmental sanitation attitude in coastal areas also has a significant relationship with the health resilience of groundwater users.
3. The combination of knowledge of groundwater quality and sanitation attitude contributes 65.9% to the health resilience of groundwater user communities in coastal areas. This indicates that increasing community knowledge and improving sanitation behavior will significantly increase their health security resilience.

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