ORIGINAL ARTICLE

Comparison of Environmental Health of Fishermen's Settlements on Islands and Mainland: Case Study of Muara Siberut and Pasie Nan Tigo, Indonesia

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ABSTRACT

Introduction: In coastal settlements, especially among family fishermen, environmental health is crucial because their lives are closely tied to the condition of nature and local resources. This study compares the environmental health aspects of fishing communities on islands and the mainland, focusing on Muara Siberut, Mentawai Islands, and Pasie Nan Tigo, Padang. **Materials and Methods:** Environmental health is assessed through housing conditions, sanitation facilities, and pro-environmental behavior. The study involved 198 participants, 98 from the Island and 100 from the mainland, selected based on the inclusion criteria of working as fishermen for at least one year in their respective areas. Data were collected through interviews and observations using a validated questionnaire, capturing sociodemographic information and environmental health factors. The analysis was conducted using SPSS version 26. **Results**: The results reveal significant disparities in environmental health influenced by geographical factors, infrastructure accessibility, and local community awareness. Island communities face more significant challenges than mainland settlements, emphasizing the impact of limited resources on health outcomes. **Conclusion**: This research underscores the importance of targeted policies and interventions to improve environmental health in fishing settlements, especially in isolated coastal regions. The findings contribute to the field by highlighting the role of geography in shaping health disparities and offering actionable insights for policymakers to enhance sustainability and well-being in coastal communities.
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INTRODUCTION

Environmental health is a crucial aspect that includes various physical, chemical, and biological external factors that impact human well-being (1,2). The theory of human ecology emphasizes the reciprocal relationship between humans and their environment, where conditions such as housing and sanitation affect the welfare of individuals and society (3,4).

In coastal settlements, especially among family fishermen, environmental health is crucial because their lives are closely tied to the condition of nature and local resources [5, 6]. According to the Triple Bottom Line Theory (Elkington, 1997), sustainability is seen from the economic aspect, including social welfare and environmental sustainability [7].

This study additionally integrates the WHO framework on Social Determinants of Health to establish a more comprehensive analytical base. The WHO framework on Social Determinants of Health identifies housing factors, access to sanitation, and health behaviors as critical determinants influencing health outcomes. This study uses that approach to examine differences between island and mainland communities, enhancing the understanding of health equality in coastal regions.

For fishermen settlements, sustainability is achieved through adequate housing conditions, good sanitation, and pro-environmental behavior that supports a sustainable coastal ecosystem [5, 8]. This approach promotes overall community well-being and contributes to environmental health in coastal areas.

Previous studies have shown differences in health environments between remote island settlements and mainland settlements [9, 10]. However, studies are still limited to comparing housing conditions, sanitation facilities, and pro-environmental behavior among fishermen between islands and mainland settlements.

Research on the environmental health in coastal areas shows that fishermen's settlements in remote areas often experience a lack of proper sanitation facilities, with geographical isolation being the main reason for the gap in infrastructure access [5, 11]. Studies have found that coastal urban areas generally have better access to sanitation facilities compared to remote areas due to factors such as accessibility to power sources and more government-centered interventions [6, 12].

Additionally, studies on pro-environmental behavior in coastal communities indicate that environmental awareness and education are essential in maintaining environmental sustainability [13, 14]. Still, the level of education and awareness among fishermen in island areas tends to be lower than that of those on the mainland, affecting their pro-environmental behavior [15]. This study integrates the Human Ecology Theory and the Triple Bottom Line framework with models of sustainable behavioral change to analyze the impact of environmental conditions on health-related behaviors and public health outcomes in coastal communities.

These findings reveal that fishing settlements in both island and mainland areas encounter distinct environmental health challenges. Muara Siberut in the Mentawai Islands is a remote village with limited access to the sea and basic sanitation, and infrastructure. Its residents rely on rivers and traditional latrines and lack formal waste disposal services. Meanwhile, Pasie Nan Tigo in Padang City, although semi-urban with better public facilities, still faces issues such as informal housing and unequal access to services. These disparities support the need for a comparative analysis of coastal housing, sanitation, and environmental behavior to inform location-specific health interventions.

This study aims to compare the environmental health of fishermen's settlements on islands and the mainland with case studies in Muara Siberut, Mentawai Islands, and Pasie Nan Tigo, Padang City. The environmental health in this study covers three components: housing conditions, sanitation facilities, and pro-environmental behavior. Through a comparative analysis, the research will identify significant differences in these aspects, which are influenced by geographic factors, accessibility to infrastructure, and public environmental awareness.

MATERIALS AND METHODS

This cross-sectional survey was done in Muara Siberut and Pasie Nan Tigo to compare the environmental health of fishermen's settlements on the islands and the mainland. Figure I shows the geographic locations of Muara Siberut and Pasie Nan Tigo.

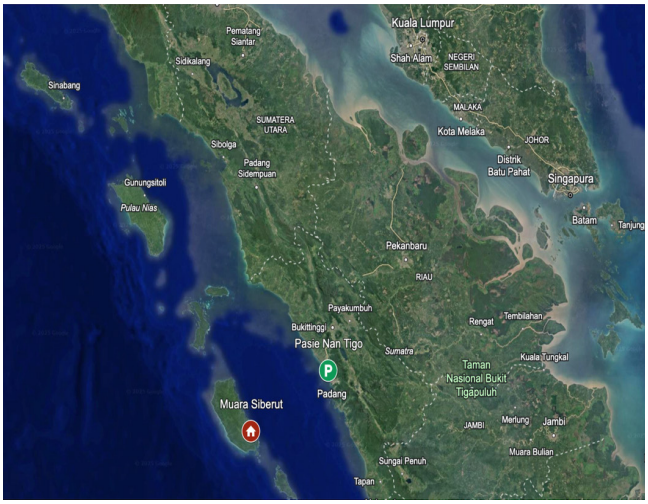

Figure 1: the geographic locations of Muara Siberut and Pasie Nan Tigo

The environmental health in this study covers three components: housing conditions, sanitation facilities, and pro-environmental behavior. Housing conditions refer to floor material, wall types, lighting, and ventilation. Sanitation facilities encompass water sources, various latrine types, and waste disposal methods. Pro-environmental behavior encompasses waste handling, yard maintenance, and footwear usage. Ethical clearance was obtained from the Faculty of Public Health Research Ethics Commission, Universitas Andalas. All participants provided informed consent before their involvement.

The population included households in both areas where the head of the household had worked as a fisherman for at least one year. A total sample of 198 respondents (98 island-based and 100 mainland-based) was involved, with a significance level (alpha) of 0.05 and a 95% confidence interval, which is considered standard in public health research. This number meets WHO guidelines (Lwanga & Lemeshow, 1991) and is therefore methodologically and practically justifiable for comparative analysis between the two populations. [16]. Systematic random sampling was applied to ensure representativeness of the target fishing populations in Muara Siberut and Pasie Nan Tigo.

Data is collected through structured interviews conducted by trained researchers. Statistical analyses were conducted using the SPSS 26 software, with a significance level set at $p < 0.05$ for all tests. Descriptive statistics such as frequencies and percentages are calculated to summarize the distribution of sociodemographics, housing conditions, sanitation facilities, and pro-environmental behavior variables within the sample population. A chi-square analysis was applied to compare the environmental health of fishermen with parameters.

This study was registered by the Health Research Ethics Committee at the Faculty of Public Health, Universitas Andalas, Padang, Indonesia, with reference number B/23.a/UN16.12.D/PT.01.00/2024, dated 23 May 2024.

RESULTS

This study involved a total of 198 participants. Table I shows the sociodemographic characteristics of the participants. Most of the participants on the Island were adults, while on the mainland, the composition was almost the same, namely adults of productive age. The participants' gender on the Island was more female, while there were more males on the mainland. The level of education was almost the same among participants on the Island, while on the mainland, it was evenly distributed between low, middle, and high education.

Table I: Characteristics of the Participants

Variable	Island	Mainland
Age category, n (%)		
Adult	73 (74.5)	52 (52.0)
Older adults	25 (25.5)	48 (48.0)
Sex, n (%)		
Male	36 (36.7)	55 (55.0)
Female	62 (63.3)	45 (45.0)
Education level, n (%)		
Elementary school	26 (26.5%)	33 (33.0)
Junior high school	27 (27.6)	33 (33.0)
Senior high school	39 (39.8)	32 (32.0)
College	6 (6.1)	2 (2.0)

Table II: Components of Houses among Island and Mainland Participants

Variable	Island	Mainland	p-value
Floor, n (%)			
Board or plastering ground	26 (25.5)	9 (9.0)	
Smooth cement without tiles /ceramics	36 (36.7)	58 (58.0)	0.001
Plastered/tiled/ceramic/stilt house	36 (36.7)	33 (33.0)	
Wall, n (%)			
Not wall	34 (34.7)	12 (12.0)	
Semi-permanent	40 (40.8)	32 (32.0)	0.000
Permanent	24 (24.5)	56 (56.0)	
Living room window, n (%)			
Nothing	10 (10.2)	11 (11.0)	
Yes, it can not be opened/closed	18 (18.4)	31 (31.0)	0.100
Yes, it can be opened/closed	70 (71.4)	58 (58.0)	
Room window, n (%)			
Nothing	1 (1.0)	11 (11.0)	
Yes, it can not be opened/closed	19 (19.4)	17 (17.0)	0.013
Yes, it can be opened/closed	78 (79.6)	72 (72.0)	
Ventilation, n (%)			
Nothing	3 (3.1)	20 (20.0)	
Yes, it does not meet the requirements	30 (30.6)	35 (35.0)	0.000
Yes, it meets the requirements	65 (66.3)	45 (45.0)	
Ceiling, n (%)			
Nothing	29 (29.6)	35 (35.0)	
Yes, dirty, hard to clean and accident-prone	14 (14.3)	25 (25.0)	0.049
Yes, dirty, clean, and not accident-prone	55 (56.1)	40 (40.0)	
Lighting, n (%)			
Not bright	5 (5.1)	4 (4.0)	
Less bright	28 (28.6)	12 (12.0)	0.012
Bright and not dazzling	65 (66.3)	84 (84.0)	
Kitchen smoke hole, n (%)			
Nothing	10 (10.2)	20 (20.0)	
Yes, it does not meet the requirements	37 (37.8)	38 (38.0)	0.123
Yes, it meets the requirements	51 (52.0)	42 (42.0)	

Based on Table II, which shows the physical components of the house between participants on the Island and the mainland, there are several significant differences between the two groups. First, the type of house wall shows a significant difference with a p-value of 0.000. More than half of the fishermen's houses on the mainland (56.0%) use permanent materials such as bricks or concrete blocks; on the Island, only 24.5% use bricks. In contrast, houses on the Island use more non-permanent materials, such as wood or bamboo (40.8%), compared to the mainland (32.0%).

The difference in the floor of the house is also significant, with a p-value of 0.001. Almost all houses on the mainland (91.0%) use cemented floors, while on the Island, 25.5% still have planks or dirt floors. This shows that houses on the mainland tend to be more permanent in construction than on the Island.

Another significant difference is seen in the ventilation of the house ($p = 0.000$). As many as 20.0% of houses

on the mainland do not have ventilation, while on the Island, only 3.1% do not. This shows that houses on the Island have better ventilation than those on the mainland.
Furthermore, there is a significant difference in lighting with a p-value of 0.012. As many as 84.0% of houses in the mainland area have bright and non-glaring lighting, while in the island area, only 66.3% meet the lighting criteria. This shows that houses in the mainland area have better lighting than those on the Island.

However, no significant differences were found in components such as living room windows (p = 0.100) and kitchen smoke holes (p = 0.123). This shows that both groups have living room windows and kitchen smoke holes that are relatively the same in condition.

Table III: Sanitation facilities among the Island and Mainland Participants

Variable	Island	Mainland	p-value
Clean water source, n (%)			
Nothing	7 (7.1)	0 (0.0)	0.000
Yes, it's not owned and doesn't qualify	2 (2.0)	10 (10.0)	
Yes, owned and not eligible	10 (10.2)	29 (29.0)	
Yes, it's not owned and eligible	18 (18.4)	29(29.0)	
Yes, owned and eligible	61 (62.2)	32 (32.0)	
Toilet, n (%)			
Nothing	8 (8.2)	15 (15.0)	0.014
There is not a gooseneck, no lid, and it is piped into the river	1 (1.0)	5 (5.0)	
There is, instead of a gooseneck, a cap, and it is channeled into the river	9 (9.2)	3 (3.0)	
Yes, it is not a gooseneck; there is a lid and a septic tank	20 (20.4)	9 (9.0)	
Yes, gooseneck, there is a lid and septic tank	60 (61.2)	68 (68.0)	
Sewage drainage channel, n (%)			
Nothing	14 (14.3)	32 (32.0)	0.040
Yes, it is absorbed, but it pollutes water sources	7 (7.1)	7 (7.0)	
Yes, it flows into an open drain	64 (65.3)	49 (49.0)	
Yes, it absorbs and does not pollute water sources	5 (5.1)	7 (7.0)	
Yes, it is channeled into a closed channel	8 (8.2)	5 (5.0)	
Garbage dump, n (%)			
Nothing	29 (29.6)	29 (29.0)	0.730
Yes, not waterproof, and no lid	58 (59.2)	56 (56.0)	
Yes, it's waterproof and has a lid	11 (11.2)	15 (15.0)	

Table III shows the differences in sanitation facilities between fishing settlements on the Island and the mainland, and there are several significant differences between the two groups. First, regarding the source of clean water, there is a significant difference, with a p of 0.000. While all households on the mainland indicated access to a clean water source, only 32.0% utilized sources that met health eligibility standards. Conversely, whereas 7.1% of island homes lacked access to any clean water source, a greater percentage (62.2%) utilized sources that met health standards.

Regarding the existence of latrines, there is a significant difference with p of 0.014. As many as 15.0% of houses on the mainland do not have private latrines; on the Island, only 8.2% do not. On the other hand, as many as 68.0% of houses on the mainland have latrines that meet health requirements, which is higher than 61.2% of houses on the Island.

The waste disposal system also significantly differs (p = 0.040). As many as 32.0% of houses on the mainland do not have a household waste disposal system, while on the Island, only 14.3% do not have similar disposal. More houses on the Island (65.3%) dispose of waste into open channels or the surrounding environment than on the mainland (49.0%). However, the difference is insignificant regarding waste disposal (p = 0.730), where the same number of houses do not have waste disposal sites on the Island and mainland. If there are any, they are not waterproof and do not have covers.

Table IV: Pro-environmental behavior among Island and Mainland Participants

Variable	Island	Mainland	p-value
Waste disposal methods, n (%)			
Thrown into the bushes	31 (31.6)	13 (13.0)	0.000
Dumped into the drain	5 (5.1)	5 (5.0)	
Burned	60 (61.2)	66 (66.0)	
Thrown into a temporary landfill	2 (2.0)	16 (16.0)	
Vector control, n (%)			
No vector found	92 (93.9)	95 (95.0)	0.730
Vector found	6 (6.1)	5 (5.0)	
Wearing footwear, n (%)			
Never	8 (8.2)	0 (0.0)	0.000
Sometimes	28 (28.6)	13 (13.0)	
Always wear footwear when outdoors	62 (63.3)	87 (87.0)	
Opening windows, n (%)			
Nothing	6 (6.1)	12 (12.0)	0.278
Sometimes	18 (18.4)	21 (21.0)	
Always open the windows when at home during the day	74 (75.5)	67 (67.0)	
Cleaning the yard, n (%)			
Never	3 (3.1)	0 (0.0)	0.017
Sometimes	38 (38.8)	25 (25.0)	
Always keep the yard clean and dry	57 (58.2)	75 (75.0)	

Table IV shows pro-environmental behavior between participants on the Island and the mainland, and there are several significant differences in pro-environmental behavior in the two areas. First, a significant difference was found in waste disposal behavior with a p of 0.000. Most houses on the mainland (77.0%) throw garbage into landfills or burn it, while on the Island, more houses (36.7%) throw garbage into bushes or throw it into rivers or the sea than on the mainland (18.0%), indicating less environmentally friendly behavior in the island area.

No significant difference was found for the existing

closed trash bins, with a p of 0.759. Most houses in both areas use closed trash bins, 94.7% on the islands and 95.0% on the mainland.

The behavior of using footwear also shows a significant difference with a p of 0.000. There are no members of the fishing families on the mainland who never wear footwear, while there are still 8.2% on the Island who never wear footwear. Most houses on the mainland (87.0%) always wear footwear outside the house, while in the island area, as many as 75.5% of houses show the same behavior. This shows that the behavior of wearing footwear outside the house on the mainland is better than in the island area.

The yard cleaning behavior also significantly differs (p = 0.017). As many as 75.0% of houses on the mainland are always maintained clean and dry, while on the Island, only 58.2% have similar behavior. On the Island, 3.1% of houses still never clean their yards compared to the mainland (0.0%).

However, no significant differences were found in vector control behavior (p = 0.730) and opening windows (p = 0.278). Almost the same number of houses on the Island and the mainland were found to have disease vectors. Similar to the habit of opening windows, the same number is between the Island and mainland houses

DISCUSSION

This study highlights significant differences in environmental health between fishing communities on islands and mainland areas. The study findings reveal that geographic factors, access to infrastructure, and environmental awareness contribute to disparities in housing conditions, sanitation facilities, and pro-environmental behavior. Fishing communities on islands face more significant challenges in environmental health due to limited resources and infrastructure than mainland ones. These environmental and behavioral differences may, in part, reflect underlying socioeconomic disparities between the two communities. Lower income levels and limited educational attainment, particularly in the island settlements, may influence residents' access to information, resources, and infrastructure that support healthy living.

By advancing knowledge about these gaps, this study underscores the need for targeted interventions, including sustainable housing programs, improved sanitation systems, and community-based environmental education. These measures can improve health outcomes and environmental sustainability in fishing settlements. Future studies should focus on designing and evaluating intervention models that integrate green technologies, community participation, and policy support to address environmental health challenges in remote coastal areas.

This study uses a cross-sectional design, which limits the ability to infer causality. Future research using longitudinal approaches would help capture temporal changes in environmental health and behavior. Additionally, post-COVID-19 shifts in residential patterns, as noted in recent studies, may have reshaped daily ecological exposures. These structural changes in living patterns could influence pro-environmental behaviors and access to sanitation.

Physical Components of House

This study shows significant differences in the physical components of houses, environmental sanitation facilities, and pro-environmental behaviors between fishing settlements on islands and the mainland. These findings have profound implications for environmental health that contribute directly and indirectly to public health.

The physical condition of houses, such as floor and wall materials, room windows, ventilation, and lighting, show significant differences between islands and the mainland. Houses on islands that use more non-permanent materials, such as wood or bamboo, tend to be more vulnerable to structural damage, pest attacks, and extreme weather changes, which can increase health risks. Previous studies have shown that houses with non-permanent materials often become breeding grounds for disease vectors such as mosquitoes that carry malaria and dengue fever [17–19].

Using non-permanent materials can also increase exposure to harmful toxins and pollutants, significantly impacting island communities' overall health and well-being [20, 21]. In contrast, houses on the mainland that use more permanent materials, such as concrete or brick, tend to be more resilient to these risks [22]. As a result, island communities may face more significant health risks and challenges in maintaining their infrastructure [23]. This can lead to increased vulnerability during natural disasters and climate events. These risks can also exacerbate existing social and economic disparities within these communities.

Inadequate ventilation on islands can have significant health consequences. The lack of optimal cross-ventilation raises the risk of exposure to indoor air pollution, such as smoke from biomass fuels, which is linked to chronic respiratory diseases. Additionally, insufficient natural lighting can negatively impact mental health, increasing the risk of depression due to inadequate sunlight exposure [22, 24].

Furthermore, the combination of poor ventilation and limited natural light can also lead to issues with mold growth, which can exacerbate respiratory problems and allergies. Inadequate ventilation can also result in high humidity levels, creating a breeding ground

for bacteria and viruses, further compromising the health of island residents [25]. Additionally, the lack of proper ventilation can contribute to poor indoor air quality, trapping pollutants and allergens inside living spaces [26, 27]. This can lead to respiratory issues and exacerbate allergies for island residents.

There is a pressing need for housing intervention programs that prioritize enhancing the quality of building materials and implementing sustainable house design in island regions. For instance, adopting durable local material technologies and incorporating passive ventilation could be effective solutions. Furthermore, government policies that offer subsidies for construction materials to island communities could promote the development of adequate housing.

Environmental Sanitation Facilities

Significant differences in access to clean water, private toilets, and waste disposal systems between islands and the mainland indicate significant environmental sanitation disparities. Limited access to clean water on islands increases the risk of spreading water-borne diseases like diarrhea and parasitic infections [17, 28]. The absence of private toilets in many island homes also has severe environmental impacts, with open defecation contaminating water sources and worsening environmental health [20].

The lack of a closed waste disposal system on islands directly impacts environmental pollution, especially in coastal areas that are essential ecosystems. Poorly managed household waste can cause eutrophication, damage marine biodiversity, and reduce the productivity of fisheries, which are the primary source of livelihood for island communities [22]. Previous studies have shown that the concentration of urban areas and industrial activities in coastal regions has led to large-scale disposal of various household, commercial, and industrial wastes in the coastal zone, which can have severe environmental legacies [23, 29].

The implication is the need for a community-based approach to improving island sanitation facilities, including providing clean water through local water filtration technology and constructing affordable communal toilets [30, 31]. Environmental education programs involving communities in waste management and coastal ecosystem conservation are essential to ensuring environmental sustainability and public health. Proper waste disposal and management are crucial for protecting coastal environments and island communities' livelihoods [32].

Engaging local communities in these programs enables them to assume responsibility for their sanitation infrastructure and act as custodians of their environment. This comprehensive strategy enhances public health while cultivating community pride and responsibility. Sustainable sanitation methods are essential for maintaining the fragile equilibrium of island ecosystems and safeguarding the welfare of future generations.

Pro-environmental Behavior

The differences in pro-environmental behavior between Island and mainland communities reflect gaps in environmental education and access to supporting facilities. Dumping waste into rivers or the sea, dominant on islands, indicates low environmental awareness and a lack of waste management infrastructure. This contributes to marine pollution, which impacts the environment and human health through bioaccumulating pollutants in the food chain [17, 33] This can lead to serious health problems and long-term environmental damage.

Enhancing environmental education and improving island waste management facilities is essential for tackling these challenges. By promoting awareness of proper trash disposal and adopting sustainable practices, communities may mitigate their environmental impact and safeguard public health [34]. Moreover, investing in recycling and waste treatment facilities helps mitigate ocean pollution and foster a cleaner, healthier environment for everyone [35]. Collaboration between island and mainland communities is crucial for fostering a more sustainable future for the globe.

In addition, the low habit of washing hands before eating on islands increases the risk of spreading infectious diseases that can be prevented through simple hygiene practices. This suggests more intensive public health education interventions in island communities [20]. The implication is that environmental education programs based on local culture must be developed to increase awareness and environmentally friendly behavior on islands. For example, training on community-based waste management, such as composting from organic waste, can reduce environmental pollution while providing economic benefits [22].

This program must be accompanied by increased access to hygiene facilities such as covered trash bins and handwashing stations [23]. Overall, the findings of this study indicate that fishing settlements on islands have more significant environmental health challenges than the mainland. Poor physical conditions of houses, inadequate sanitation, and environmentally unfriendly behaviors create double risks to individual health and ecosystems [30].

Therefore, a multi-sectoral approach involving government, non-governmental organizations, and local communities is needed to create healthy and sustainable residential environments [36]. Future research can focus on developing effective intervention models to improve environmental health in island areas, such as integrating green technologies into housing and sanitation, and evaluating the impact of sanitation policies on public

health [37]. Thus, this study provides a strong basis for designing more inclusive and sustainable policies to support the lives of fishing communities in remote areas [32]. It also emphasizes the importance of considering environmental and health factors when making policy decisions.

Daily activities and awareness of environmental hygiene have undergone significant changes due to the COVID-19 pandemic [38]. The behavioral adaptations observed in our coastal study area may be similar to how emergencies alter urban activity patterns, as demonstrated by Wang et al (2025) [39]. These findings suggest that post-pandemic changes may influence pro-environmental and hygiene practices in fishing communities. The current study didn't directly look at changes that happened after the pandemic, but the disparities in hygiene practices may be partly due to changes in behavior that were caused by recent health emergencies.

This study provides practical implications for improving environmental health among coastal populations in Indonesia. Policy interventions should consider decentralized approaches that empower local communities, such as revitalizing the CLTS (Community-Led Total Sanitation) program with tailored education on pro-environmental behavior [40]. In remote island areas like Muara Siberut, infrastructure investments and culturally sensitive health promotion are critical to bridging service gaps.

CONCLUSION

This study highlights significant differences in environmental health between fishing communities on islands and mainland areas. The findings reveal that geographical factors, access to infrastructure, and environmental awareness contribute to disparities in housing conditions, sanitation facilities, and pro-environmental behavior. Fishing communities on islands face more significant challenges in environmental health due to limited resources and infrastructure than mainland ones.

By advancing knowledge on these disparities, this research underscores the need for targeted interventions, including sustainable housing programs, improved sanitation systems, and community-based environmental education. These measures can promote better health outcomes and environmental sustainability in fishing settlements.

Future studies should focus on designing and evaluating intervention models integrating green technology, community participation, and policy support to address the environmental health challenges in remote coastal areas.

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