TALKS 4.0

E-Proceeding

OF

T.A.L.K.S 4.0

The Acclaimed Landscape Of Knowledge Sharing

ORGANISED BY

Landscape Architecture Program,
College of Built Environment
Universiti Teknologi MARA Selangor Branch
Puncak Alam Campus

CO-ORGANISED BY

Landscape Architecture Program,
Department of Built Environment Studies and Technology
College of Built Environment
Universiti Teknologi MARA Perak Branch
Seri Iskandar Campus

05 February 2025
Semester October 2024 - February2025

PUBLISHED

31 March 2025

e ISBN 978-967-2776-49-9

Unit Penerbitan UiTM Perak
(online)

Cover Design : Zawanie Fatini Mohd Jamzury

ORGANISING COMMITTEE

Chairman : Assoc. Prof. Ts. Dr. Siti Rasidah Md Sakip

MAIN SECRETARIAT

Project Leader:Muhammad Zulfikry Jaafar Sidek
Editorial Team:Nur Sazliana Pitderi
Nazmi Najiha Azmi
Nur salwani Mohd Rosle
Marketing and Promotion: Qamarina Izzati NikHim
Jihan Tsara Mohd Fadzly
Nurul Husna Abd Rahim
Design & Promotion Team: Zawanie Fatini Mohd Jamzury
Nur Raudhatul Athirah Nor Fauzi
Siti Syazana Sapuan
Certificate:Nur Adlin Saipudin
Atiqah Balqis Redzuan Teoh
Technical Support Team:Muhammad Luqman Hakim Sharuddin
Muhammad Nazmy Ashary Mohd Nazry

E-PROCEEDING EDITORS

Assoc. Prof. Ts. Dr. Siti Rasidah Md Sakip

LIST OF REVIEWER

Assoc. Prof. Ts. Dr Norhafizah Abdul Rahman
LAr. Ca. Dr Helmi Hamzah
IDr. Dr Nadiyanti Mat Nayan
LAr. Dr Norizan Mt Akhir
LAr. Dr Zulkefle Hj Ayob
Ts. Dr Izham Ghani
Dr Atikah Fukaihah Amir
Dr Huzeima Mohd Hussain
Dr Nor Izana Mohd Shobri
Dr Suriati Ahmad
Dr Wan Nor Anira Hj Wan Ali @ Yaacob
LAr. Ahmad Zamil Zakaria
LAr. Azran Mansor
LAr. Atikah Raihanah Amir
LAr. Ruwaidah Borhan
Mdm. Norasikin Hassan
Miss Siti Syamimi Omar

DEVELOPING STRATEGIES FOR MANAGING COASTAL LANDSCAPES AND MITIGATING COASTAL EROSION IN PANTAI MURNI, YAN, KEDAH

Nur Sazliana binti Pitderi[1] & Khairul Adham[2]*
***Corresponding**
[1,2]Department of Built Environment Studies and Technology, College of Built Environment, University Teknologi MARA Seri Iskandar Campus, 32610 Seri Iskandar, Perak

Published: 31 March 2025

ABSTRACT

Pantai Murni located along the coast of Yan, Kedah, Malaysia is facing increasing environmental threats, especially due to the rising sea levels and coastal erosion that the area facing. These challenging, which has made worse by global climate change, put both the natural environment and the wellbeing of the local community risk. Coastal erosion is gradually wearing away the shoreline, while rising sea levels are leading to more frequently flooding and loss of land. As result, the people who rely on this coastal areas for fishing, tourism and other living hood are finding it harder to sustain their way of life. This study aims to explore the main cause of these coastal threats, analyze theirs current and potential future impacts and develop a new effective strategies for sustainable coastal management in Pntai Murni. By using a mixed method, including geospatial analysis data, local community experiences and needs and observed the objectives is to formulate a holistic and strategies approach to effectively address these challenges. The findings reveal that residents of Pantai Murni perceive coastal threats differently based on their length of residence. Overall, the study emphasizes the need for intergrated solutions combining natural methods like mangrove planting with engineered structures like seawalls, while also involving the community to ensure the strategies effectively address both immediate and long term threats.

Keywords: *Coastal erosion, Coastal Landscape, Climate change, Sustainable coastal management*

INTRODUCTION

Coastal areas are among the most vulnerable environments, increasingly threatened by the effects of climate change. In Malaysia, these impact are especially pronounced along rural coastlines, where local livelihoods and biodiversity face continuous risk. Pantai Murni, a scenic coastal village in the district of Yan, Kedah epitomizes the fragility of such areas. Known for its beaches and rich biodiversity, Pantai Murni is increasingly affected by rapid coastal change with significant implications for both the environment and the well-being of local residents.

Over recent decades, global warming has led to accelerated melting or polar ice caps and thermal expansion of seawater, which are primary contributors to rising sea levels. According to the intergovernmental Panel on Climate Change (IPCC), global sea levels have increased by approximately 20 centimeters over the last century. Projections indicate a potential rise of up to 98 centimeters by 2100, depending on greenhouse gas emission scenarios (IPCC, 2014; Nicholls et al., 2018). For low lying regions like Pantai Murni, even minor increases in sea levels amplify risks of coastal flooding, shoreline erosion and habitat degradation (Church, 2011). These environmental threats also disrupt local economies, especially those dependent on fishing and tourism, further underscoring the need for adaptive coastal management strategies (Abdullah et al., 2019).

In addition to sea levels rise, Pantai Murni faces severe coastal erosion. Erosion occurs when natural forces such as waves, tides and currents wear away the shoreline, causing land loss and environmental instability. In Pantai Murni, erosion is worsened by human activities such as coastal development and deforestation, which degrade natural barriers like mangroves and sand dunes that protect against wave action (Othman, 1994; Goh, 2021). Studies have shown that Pantai Murni beach has been retreating at an alarming rate, endangering the natural landscape and vital socioeconomic activities in the area (Thompson, J.W. & Smith, P., 2010)

Given these pressing challenges, effective coastal management is essential to safeguard Pantai Murni. Developing a strategy that integrates both engineered solutions like seawalls and breakwaters and nature- based approaches such as mangroves restoration and dune stabilization could offer

a balanced solution for long term sustainability (Temmerman et al., 2013; Chee et al., 2017). This research aims to explore these potential strategies, evaluate their feasibility and recommend approaches that align with the ecological and social needs of Pantai Murni. By addressing both immediate and future threats, this study seeks to provide a framework for protecting and preserving this vulnerable coastline in the face of increasing erosion.

LITERATURE REVIEW

Global Impact of Climate Change on Coastal Areas

The impact of climate change on coastal erosion has been increasingly highlighted as a critical issue. According to the Intergovernmental Panel on Climate Change (IPCC), global sea levels have been rising at an accelerated rate due to the melting of polar ice and the thermal expansion of ocean water, primarily because glaciers and ice sheets at the poles are melting faster adding more water to the oceans. Projections suggest that the sea levels could rise between 0.26 to 0.98 meters by 2100, putting low-lying coastal areas such as Pantai Murni at high risk for flooding and land erosion (IPCC, 2014). In Southeast Asia, including Malaysia the exposure to coastal risks is intensified by high population densities and the concentration of economic activities along coastlines, making adaption and resilience efforts increasingly critical (IPCC, 2019). Emphasized the socio-economic vulnerabilities of coastal regions, particularly in low-lying areas. Coastal erosion destroys natural habitats and threatens the risk of flooding, leading to further displacement and damage. Global perspective underscores the urgency of developing effective coastal management strategies (Nicholls et al., 1999).

Coastal Landscape and Erosion in Malaysia

Coastal erosion is driven not only by climate change factor like rising sea levels and intense storm but also by human activities such as coastal development and deforestation. These activities disrupt the ecosystem and natural sediment balance, weaken shorelines and degrade protective ecosystem like mangroves and coral reefs, which is serve as natural barriers against wave action (Cochard et al., 2014). In Pantai Murni, the

loss of mangroves forests has been a particular concern as they play a significant role in stabilizing costal soil and buffering the wave impact. The effectiveness of mangroves as a sustainable natural solution for coastline protection, emphasizing their ability to mitigate erosion while supporting biodiversity and carbon sequestration (Alongi, 2008). In kedah, where Pantai Murni is located, and the loss of mangrove forest has significant weakened the natural defenses against coastal erosion (Mokhtar and Ariffin, 2017), reported mangrove along Malaysia's coastline has left many areas exposed to wave action and storm surges. Saltwater intrusion caused by rising sea levels has degraded agricultural land, affecting local food security and livelihoods.

Current Strategies for Coastal Management in Malaysia

Malaysia with it extensive coastline, faces significant challenges from coastal erosion, sea levels rise and extreme weather events which are intensified by climate change. One of the key strategies in Malaysia's coastal management approach is the use of nature-based solution such as mangroves restoration and coral reef rehabilitation. Mangroves are highly effective in reducing coastal erosion, buffering wave energy and stabilizing sediments. Research highlight the value of Malaysia's mangrove forest in combating erosion, especially along the western coastline (Hashim & Catherine, 2013). These restoration efforts are critical because mangroves serve as natural barriers that mitigate the impact of storm, protect the shoreline and provide habitat for diverse species. Coral reef restoration is also prioritized, as healthy reefs play a role in wave attention, reducing the direct impact of waves on the coastline (Chong, 2005). Mangroves in particular play a vital role in stabilizing coastlines. They reduce wave energy, trap sediments and serve as critical habitats for marine life (Alongi, 2008). In Malaysia, successful mangrove restoration projects in Selangor and Johor have demonstrate their effectiveness in mitigating erosion and enhancing ecological resilience (Shamsudin, 2009). Coral reef also act as natural breakwaters, reducing the energy of incoming waves before they reach the shore. The potential on combining coral reef restoration with mangroves rehabilitation to create hybrid system that provides robust coastal protection (Cheong et al., 2013). Nature based solution area effective and adaptable to local conditions, making them suitable for Pantai Murni.

Engineered Solution to Coastal Erosion

Nature based solution including mangrove restoration and beach nourishment, promote ecosystem health and resilience. Engineered solution such as seawalls and breakwaters offer immediate structural protection but can have environmental tradeoff including altering sediment flow and impacting nearby ecosystem (Dean & Dalrymple, 2002). Traditional engineering methods, such as seawalls, groynes and revetments have been widely used to stabilize coastlines (Dean & Dalrymple, 2002). These, structures are designed to dissipate wave energy and protect infrastructure. (Neumann et al, 2015) suggest that hybrid approaches that integrate both natural and engineered defenses are effective in providing long term, sustainable coastal protection. The concept of Integrated Coastal Zone Management (ICZM) has been widely advocated for addressing coastal issue holistically. ICZM promotes a balanced approach that considers ecological, social economic and cultural aspect aiming for sustainable coastal development (Sorensen, 2000). Case study from development nations, like the Netherlands's Delta Works and the Thames Barrier in UK, shows the effectiveness of ICZM frameworks when applied challenges in implementing ICZM due to limited resources and technical expertise, draw attention to community engagement and local capacity building in places like Pantai Murni (IPCC, 2019). Hybrid solution that combine engineering with natural approaches have gained prominence. Offshore breakwaters for example can reduce wave energy while allowing sediment to accumulate naturally. In Pantai Murni, such structures could be used alongside mangroves restoration to create a balanced approach. Study by (Woodroffe, 2002) suggest that these hybrid strategies area not only effective but also more sustainable in the long term, as they work with natural processes rather than against them.

RESEARCH METHODOLOGY

Pantai Murni, located in the Yan District of Kedah, Malaysia is a coastal area known for its scenic beaches. The area is home to a predominantly Malay community whose primary live-hoods include fishing, agriculture and tourism. The mangroves forests and estuaries in PantaiMurni play a critical role in maintaining the forest and estuaries in Pantai Murni play a critical role in maintaining ecological balance by acting as natural

buffers against wave energy, coastal erosion, and storm surges (Harvey & Nicholls, 2008). Over the region has faced significant environmental challenges, including rapid shoreline retreat, coastal erosion and rising sea levels, primary driven by climate change and human activities such as deforestation and unsustainable land use practices. These changes have led to habitat loss, reduced fishery yields, and threats to infrastructure and the livelihood of local communities (Bird, 2008). This study adopt a mixed-method approach, combining geospatial analysis, field observation, and questionnaires to address the challenges of coastal erosion in Pantai Murni. The integrating of quantitative and qualitative methods ensures a comprehensive understanding of physical, ecological, and socio economic dynamics of the area. Geospatial analysis utilizing tools such as remote sensing, satellite imagery and geographic information system (GIS) will be using to examine historical shoreline changes and predict future trends based on current erosion rates (Woodroffe, 2002; Harvey & Nicholls,2008). Field survey observation, structure checklist are used to systematically observe and document key indicators such as sign or erosion, the health of coastal vegetation and the condition of existing infrastructure (Bird,2008). To gain insight into the socio economic impacts, a sample of at least 30 respondents will be surveyed including a diverse group of residents, fishermen, business owner and government officials. This sample size was chosen to ensure a range of perspective and capturing the multifaceted impact of coastal erosion on the community (Ng, 2012).

Figure 1. Show the Location of the Research

FINDING AND ANALYSIS

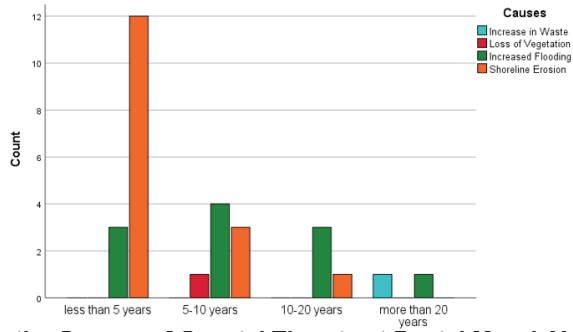

Figure 2. Display the Causes of Coastal Threats at Pantai Murni, Yan, Kedah

This bar chart illustrates the perceived causes of coastal threats among residents of Pantai Murni, Yan, Kedah based on their length of residence categories "less than 5 years", "5-10 years", "10-20 years" and "more than 20 years". The primary causes categorized as "increased in waste", "loss of vegetation", "increased flooding" and "shoreline erosion" are color coded and show notable variation.

Among residents who have lived in Pantai Murni for less than 5 years, shoreline erosion emerged as the dominant concern with 12 responses, followed by increased flooding with 3 responses. This pattern suggests that the new residents perceive shoreline erosion as a critical issue affecting the area. Similarly, for those residing in the area for 5-10 years, shoreline erosion and increased flooding (3 and 4 responses, respectively0. Interestingly, the category "increased in waste" received no responses from residents in these two groups (Shah et al, 2021; Abdullah et al., 2022).

For individual who have lived in Pantai Murni fpr 10-20 years, increased flooding and shoreline erosion are also acknowledged but to a lesser extent. Notably, residents who have lived in the area for more than 20 years identified "increased in waste" as a cause of coastal threats, though the frequency of this responses was minimal (Yusoff et al., 2020). Overall, perceptions vary depending on the length of residence, with long term residents potentially having a more nuanced view of the historical changes contributing to these threats (Jusoh et al., 2019).

These findings emphasized the importance of understanding the diverse perspectives of different residents groups when addressing coastal challenges. For instance, newer residents may prioritize immediate, visible issue like shoreline erosion, while long term residents might have insight into underlying drivers, such as waste accumulation or changes in vegetation (Hassan et al., 2021). Such data can inform the development of socio ecological strategies tailored to the concerns and experiences of local communities, fostering more effective and inclusive coastal management plans (IPCC, 2014).

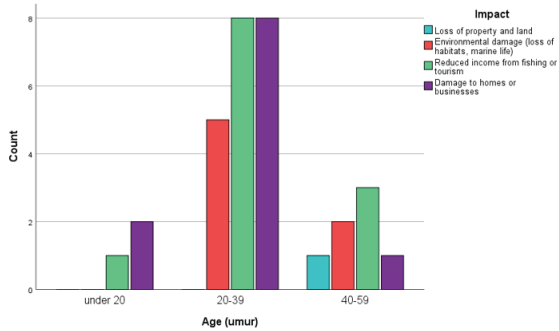

Figure 3. Display the Currents Impact at Pantai Murni, Yan, Kedah

This bar chart provides a comprehensive illustration of the concerns expressed by different age groups in a community impacted by coastal erosion and flooding, based on survey data collected at Pantai Murni. The x-axis categorizes respondents into three age groups "under 20", "20-39" and "40-59" while the y-axis represents the frequency of responses for each concern. The concerns are divided into four categories "Loss of property and land", "Environmental damage", "Reduced income from fishing or tourism" and " Damage to homes or business" each represented by distinct color codes.

A detailed breakdown reveals that individuals under the age of 20 had the lowest frequency of concerns, with "Damage to homes or businesses" being the most commonly cited issue, followed by "Reduced income from fishing or tourism." This suggests that younger individuals, while not directly involved in economic activities or property ownership, are still affected by household-level challenges associated with coastal hazards (Clark et al., 2016; Wong et al., 2014). The 20-39 age group, in contrast, exhibited

the highest number of concerns across all categories. Notably, "Reduced income from fishing or tourism" and "Damage to homes or business" were the most frequently mentioned issues, with both receiving the highest count of eight responses each. This highlights the significant economic and structural vulnerabilities faced by demographics, which is likely to include active members of the workforce and heads of households (Adger et al., 2005; Neumann et al., 2015). The 40-59 age group demonstrated a distinct pattern of concerns, with "Environmental damage" being the most frequently cited issue, followed by "Reduced income from fishing or tourism." This trend suggests that older individuals may have a broader perspective on environmental challenges and their long-term implications, possibly due to their prolonged experience in the community and reliance on natural resources (Menéndez et al., 2020; Temmerman et al., 2013). The findings reveal clear age-related differences in the prioritization of concerns. Younger individuals tend to focus on structural and immediate economic impact, while older generations exhibit a heightened awareness of environmental degradation and its potential consequences. This variation in perspectives underscores the importance of designing community-based adaptation strategies that are tailored to address the specific concerns of different age groups (IPCC, 2014; Rahman et al., 2022). These insights are further supported by the context in which the survey data was collected. The responses were gathered during peak visiting hours at Pantai Murni, ensuring a diverse representation of community members.

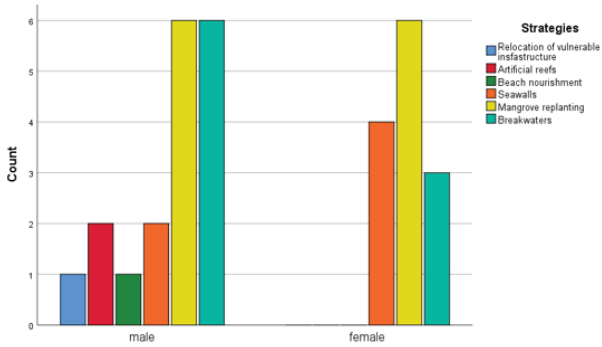

Figure 4. Display an Effective Strategies for Coastal Landscape at Pantai Murni, Yan, kedah

This bar chart provides a detailed representation of the preferences for various coastal protection strategies expressed by male and female respondents in a community impacted by coastal erosion and flooding. The x-axis categorizes respondents by gender "male" and "female", while the y-axis indicates the frequency of responses for each strategy, which are divided into six categories "Relocation of vulnerable infrastructure," "Artificial reefs," "Beach nourishment," "Mangroves replanting," "Seawalls," and "Breakwaters" each represented by distinct color codes.

A closer examination of the graph reveals noticeable gender differences in preferences. Male respondents demonstrated a broader range of preferences, with some support shown for all six strategies. In particular, six male respondents expressed strong support for both "Mangrove replanting" and "Breakwaters" making these the most popular strategies within this group. Moderate support was observed for "Artificial reefs" and "Seawalls" with each strategy garnering two responses, while "Relocation of vulnerable infrastructure" and "Brach nourishment" received the lowest levels of support, with one response each. In contrast, female respondents displayed a more focused range of preferences, "Mangrove replanting" emerged as the most preferred strategy among females, with six responses, while "Seawall" and "Breakwaters" were also moderately supported, with four and three responses, respectively. However, no female respondents indicated support for "Relocation of vulnerable infrastructure," "Artificial reef," or "Beach nourishment," suggesting a lack of interest or perceived relevance for these strategies among women (Temmerman et al., 2013; Menéndez et al., 2020). The overall trend highlights a strong preference for strategies that combine natural elements with hard engineering solutions, such as "Mangrove replanting" and "Breakwaters" which were the most frequently supported options across both genders. This suggests that community members value approaches that balance ecological restoration with structural defenses to address coastal erosion and flooding (Wong et al., 2014).

ANALYSIS AND DISCUSSION

Figure 5: Display a Sensitivity Map using GIS Analysis for Pantai Murni, Yan, Kedah

The spatial distribution of sensitivity levels at Pantai Murni, Yan plays a crucial role in shaping informed land use planning and development strategies, particularly in the context of coastal vulnerability and resilience. By carefully analyzing areas with high sensitivity identified as red zone decision makers can take proative steps to ensure that critical infrastructure, such as roads, hospital, schools and residential communities, are not located in these highly vulnerable areas (Wong et al., 2014. This approach is vital to reducing the potential risks posed by coastal hazards, such as flooding, erosion and storm surges, which are projected to intensify with rising sea levels and climate change (IPCC, 2014; Neumann et al., 2015)

Moreover, prioritizing low sensitivity areas for new development can lead to more sustainable and cost effective land use. Reducing exposure to high risk zone helps minimize not only immediate damage from coastal disaster but also the long term financial burden of repair and adaptation efforts (Temmeman et al., 2013). For instance, policymakers could promote the establishment of buffer zones, such as mangrove forest or green spaces, in red zones to absorb wave energy and reduce erosion while simultaneously foresting ecological preservation (Menéndez et al., 2020).

This insight into sensitivity levels also enable developers and urban planner to implement adaptive strategies tailored to the unique coastal dynamics of Pantai Murni. Integrating geospatial data with risk assessments

ensure that land use decisions align with sustainability goals, enhancing the regions overall resilience to coastal hazards (Arkema et al., 2013). Additionally, involving local communities in this process can lead to better awareness and cooperation, further reinforcing the effectiveness of planning measures (Ostrom, 1990). By leveraging these sensitivity maps as decision making tools, the region can move toward sustainable coastal development, balancing the needs for growth with the imperative of environmental stewardship and community safety.

Figure 6. Display a Suitability Map using GIS Analysis at Pantai Murni, Yan, Kedah

The spatial distribution of suitability levels at Pantai Murni, Yan serve as a critical tool for guiding land use planning and development decisions in a sustainable manner. By identifying areas with high suitability (green zone) for development, policymakers and developers can strategically prioritize locations that pose minimal risk to the environment and infrastructure while ensuring optimal use of available land resources (Wong et al, 2014). Conversely, avoiding low suitability areas (red zones) helps mitigate potential adverse impacts, such as increased vulnerability to coastal hazards, habitat degradation and community displacement (Neumann et al., 2015).

This approach promotes a balance between economic growth and environmental conservation. For instance, green zones may be earmarked for constructing essential infrastructure, residential housing and economic facilities, ensuring that development aligns with the region's natural strengths and minimizes ecological disruption (Temmerman et al., 2013).

Meanwhile, red zones often characterized by their proximity to erosion prone shorelines, flooding risks, or sensitive ecosystem, can be designated for preservation or adaptive use, such as creating natural buffers like mangroves plantations or conservation zones to protect biodiversity (Menéndez et al., 2020).

Integrating this suitability analysis into the planning process fosters more efficient resource allocation and reduces long term costs associated with disaster response and environmental restoration. Developers can avoid expensive remediation efforts by preemptively steering clear of areas with inherent risk, while local communities benefits from enhanced safety, improved livelihoods and reduced exposure to hazards (Thompson, J.W. & Smith, P., 2010)

Additionally, engaging stakeholders including government agencies, local communities and environmental organizations can further strengthen the effectiveness of these decisions. Incorporating community input ensures that the suitability maps address local needs priorities, creating a collaborative framework for sustainable coastal development (Ostrom, 1990). By leveraging thw spatial distribution of suitability levels, Pantai Murni can pave the way for a development model that not only enhances the regions resilience to climate change but also preserves its natural beauty and ecological integrity for future generations.

STRATEGIES AND SOLUTION

To address the challenges of coastal erosion and coastal landscape at Pantai Murni, Yan, Kedah an integrated strategy that combines ecological, engineering and community driven approaches is essential. Restoration of natural ecosystem such as mangroves and sand dunes should be prioritized, as these natural barriers provide critical protection against wave energy and sediment loss (Menéndez et al., 2020). Initiatives like mangroves reforestation and sand dune stabilization can enhance the resilience of the coastal environment while preserving biodiversity.

In addition, nature based solutions like vegetative buffers and artificial reef should be implemented to strengthen the shoreline against erosion

(Shamsudin, I., 2009). These efforts can be complemented by groynes, strategically designed to minimize disruptions to sediment transport (Wong et al., 2014). Beach nourishment program, which involve replenishing eroded beaches with sand, can help restore lost shorelines (Dean, R.G., & Dalrymple, R.A., 2002).

Engaging the local community is crucial for the long term success of these strategies. Education campaigns can raise awareness about the cause and consequences of coastal erosion, while participatory programs can empower residents to take part in restoration efforts, such as mangroves planting (Bird, 2008). Policymakers should also implement land use zoning regulations to avoid construction in high risk areas and develop integrated Coastal Zone Management (ICZM) plans to coordinate efforts among stakeholders (Woodroffe, CD, 2002).

To endure the effectiveness of these strategies, scientific monitoring using geospatial technologies like GIS and drone should be conducted to track shoreline changes and erosion patterns (Neumann et al., 2015). Collaboration with research institutions to analyze data on erosion rates, sediment characteristics and tidal behavior will support evidence based decision making (Harvey, N., & Nicholls, R.J.). Furthermore, socio economic strategies such as providing alternative livelihoods for affected communities and improving disaster preparedness plans can mitigate the impact of coastal hazards on local residents (Church, 2011). This multi-faceted approach aims to address the roots cause of coastal erosion and flooding, promote sustainable development and safeguard the livelihoods of the local community in Pantai Murni.

CONCLUSION

In conclusion, the research on managing coastal landscapes and mitigating coastal erosion at Pantai Murni, Yan, Kedah, highlights the pressing need for integrated and sustainable strategies to address the growing challenges posed by climate change and human activities. The study underscores the importance of combining ecological restoration, engineered solutions, and community engagement to enhance the resilience of the coastal environment and protect the livelihoods of local communities.

Natural ecosystems such as mangroves and sand dunes play a critical role in buffering against erosion and flooding, and their restoration should be prioritized alongside nature-based solutions like vegetative buffers and artificial reefs. Engineered approaches, including seawalls, breakwaters, and beach nourishment, can provide structural support, but their design must minimize environmental disruptions and complement natural defenses. Community involvement is essential to the success of these strategies. Educational initiatives and participatory programs can empower local residents to actively contribute to restoration and conservation efforts.

Furthermore, scientific monitoring using technologies like GIS and drones will provide valuable data to track changes and inform decision-making. Socio-economic strategies, such as offering alternative livelihoods and improving disaster preparedness, are crucial for mitigating the impact of coastal hazards on affected communities.

By adopting this comprehensive and multi-faceted approach, Pantai Murni can achieve long-term coastal resilience, preserve its unique biodiversity, and secure the well-being of its people, contributing to the broader goals of sustainable coastal management in Malaysia.

REFERENCES

Alongi, D. M. (2008a). Mangrove forests: Resilience, protection from tsunamis, and responses to global climate change. In Estuarine, *Coastal and Shelf Science .76*(1), pp. 1–13). https://doi.org/10.1016/j.ecss.2007.08.024.

Alongi, D. M. (2008b). Mangrove forests: Resilience, protection from tsunamis, and responses to global climate change. In Estuarine, *Coastal and Shelf Science, 76*(1), pp. 1–13). https://doi.org/10.1016/j.ecss.2007.08.024.

Calvo, E. (2014). *IPCC Fifth Assessment Report*, 2014.

Christian, J. E., & Science, B. S. M. (2023). *Community-based monitoring: shoreline change in southwest Alaska.*

Fazira binti Mohammad, B., & Darul Ridzuan, P. (2017). *Determination of Mangrove Adequacy as Natural Coastal Defence against Wave Dynamics Using Remote Sensing Analysis for Southern Kedah Coastline.*

Hamid, A. I. A., Din, A. H. M., Yusof, N., Abdullah, N. M., Omar, A. H., & Abdul Khanan, M. F. (2019). Coastal vulnerability index development: a review. International Archives of the Photogrammetry, *Remote Sensing and Spatial Information Sciences - ISPRS Archives, 42*(4/W16), 229–235. https://doi.org/10.5194/isprs-archives-XLII-4-W16-229-2019.

Imbrenda, V., Coluzzi, R., Lanfredi, M., Loperte, A., Satriani, A., & Simoniello, T. (2018). Analysis of landscape evolution in a vulnerable coastal area under natural and human pressure. *Geomatics, Natural Hazards and Risk, 9*(1), 1249–1279. https://doi.org/10.1080/19475705.2018.1508076.

IPCC. (2015). *Climate change 2014 : synthesis report :* longer report. [Intergovernmental Panel on Climate Change].

Jin, H., Yuan, J., Kulp, S., Wang, H., Li, D., & Wang, G. (2024). Substantial reduction in population exposure to sea level changes along the Chinese mainland coast through emission mitigation. *Environmental Research Letters, 19*(11). https://doi.org/10.1088/1748-9326/ad801d.

Kathiresan, K. (2012). Importance of Mangrove Ecosystem. *International Journal of Marine Science*. https://doi.org/10.5376/ijms.2012.02.0010.

Kirishanthan, P. (2022). Physical and social vulnerability to coastal erosion: An assessment of Kalutara Coastal Belt, Sri Lanka. *IOP Conference Series: Earth and Environmental Science, 1109*(1). https://doi.org/10.1088/1755-1315/1109/1/012077.

Melton, G. (2008). *Assessing coastal erosion vulnerability: a case study of Georgetown County, South Carolina.*

Muhammad, I., & Othman', A. (1991). *Value of Mangroves in Coastal Protection.*

Noor, N. M., & Abdul Maulud, K. N. (2022). Coastal Vulnerability: A Brief Review on Integrated Assessment in Southeast Asia. *In Journal of*

Marine Science and Engineering, 10(5). MDPI. https://doi.org/10.3390/jmse10050595.

Palinkas, L. A., Horwitz, S. M., Green, C. A., Wisdom, J. P., Duan, N., & Hoagwood, K. (2015). Purposeful Sampling for Qualitative Data Collection and Analysis in Mixed Method Implementation Research. Administration and Policy in Mental Health and Mental Health Services *Research, 42*(5), 533–544. https://doi.org/10.1007/s10488-013-0528-y

Solohin, E. (2024). *The effects of natural and human-induced environmental change on tidal wetlands.*

Stockdon, H. F., Long, J. W., Palmsten, M. L., Van der Westhuysen, A., Doran, K. S., & Snell, R. J. (2023). Operational forecasts of wave-driven water levels and coastal hazards for US Gulf and Atlantic coasts. *Communications Earth and Environment, 4*(1). https://doi.org/10.1038/s43247-023- 00817-2.

Törnqvist, T., Potter, C., & Friess, D. (2024). *Assessing coastal Louisiana's wetland vegetation greenness at a local and regional scale via remote sensing.*

Zolkaply, S. Z. B., Alam, L., Rahman, L. F., Bari, M. A., Halim, S. A., & Mokhtar, M. (2019). *Climate Change Impact on Fisheries Sector in West Coast of Malaysia: Adaptive Strategy and Measures to Mitigate the Environmental Issues.*

Bird. (2008). Coastal Geomorphology: An Introduction. John Wiley & Sons.

Cheong et al. (2013). *Coastal Adaptation with Ecological Engineering. Nature Climate Change.*

Cheong, S.M., Silliman, B., Wong, P.P., van Wesenbeeck, B., Kim, C.K., & Guannel, G. (2013). *Coastal Adaptation with Ecological Engineering. Nature Climate Change*. 3, 787-791.

Church, J. &. (2011). *Sea-Level Rise from the Late 19th to the Early 21st Century.*

Dean, R.G., & Dalrymple, R.A. (2002). *A comprehensive resource on coastal processes and engineered solutions to coastal erosion.* Cambridge

University Press.

Harvey, N., & Nicholls, R.J. . (n.d.). *Global Change and Integrated Coastal Management: The Asia-Pacific Region.* Springer. 2008.

Mokhtar, M.B., & Ariffin, Z. (2017). (2017). *Sustainable Development in Malaysia: A Case Study of Coastal Erosion in Terengganu.* Universiti Teknologi Malaysia Press.

Neumann, B., Vafeidis, A.T., Zimmermann, J., & Nicholls, R.J. (2015). *Future Coastal Population Growth and Exposure to Sea-Level Rise and Coastal Flooding*: A Global Assessment.

Ng. (2012). *Adaptation to Climate Change: The Resilience of Malaysian Coastal Communities.* Universiti Sains Malaysia.

Nicholls et al. (2015). *Coastal Risk Management in a Changing Climate.*

Nicholls, R.J., Hoozemans, F.M.J., & Marchand, M. (1999). *Increasing Flood Risk and Wetland Losses Due to Global Sea-Level Rise: Regional and Global Analyses*. Global Environmental Change.

Shamsudin, I. (2009). *The Role of Mangroves in Coastal Protection: The Malaysian Experience. Malaysian Nature Society.*

Thompson, J.W. & Smith, P. (2010). *Engineering Approaches to Coastal Protection in Southeast Asia.* Oxford University Press.

Woodroffe, CD. (2002). *Coasts: Form, Process, and Evolution.* Cambridge University Press.

PROCEEDING OF 4TH SEMINAR ON THE ACCLAIMED LANDSCAPE KNOWLEDGE SHARINGS

e ISBN 978-967-2776-49-9

9 789672 776499

Unit penerbitan UiTM Perak (online)