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## **COASTAL EROSION AND MONSOON STORMS DRIVING FISHERMEN TOWARD AN ALTERNATE OCCUPATION IN THE TOURISM SECTOR**

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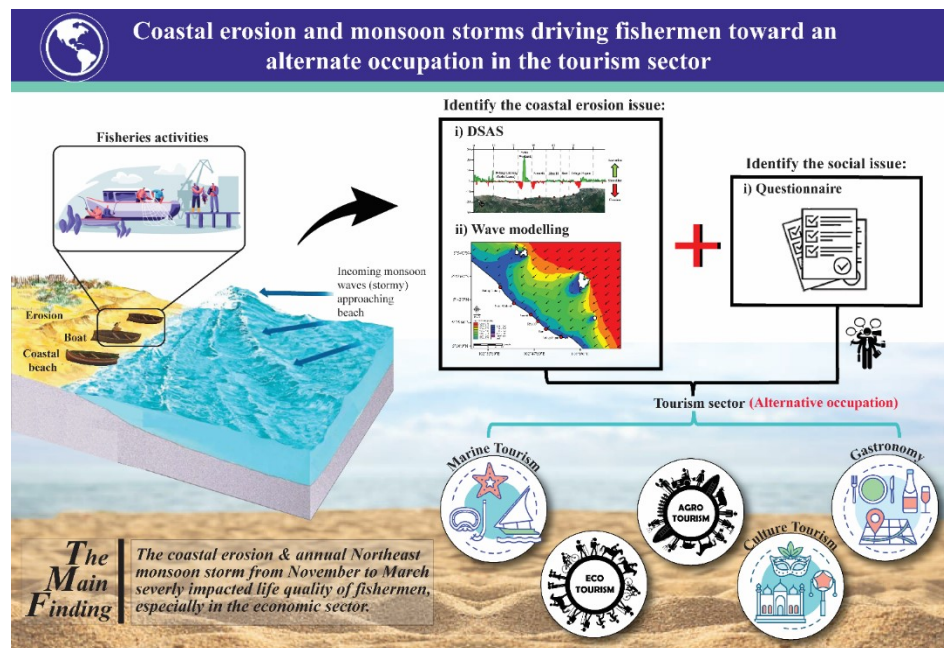
### **Abstract**

The Setiu coast in Terengganu is strategically located facing the South China Sea region, experiences the dry southwest monsoon and harsh northeast monsoon. The rough monsoon seasons cause devastating impacts in coastal areas and erosion, which affects fisherman activities. Thus, the stormy season may affect the fisherman, particularly small-scale fishermen, due to the intensity of the wave height near the coastal waters. In this study, the Digital Shoreline Analysis System (DSAS) and wave modeling were used to identify the erosion, causes of erosion, and wave height at coastal waters. Additionally, a quantitative method was performed to determine the impact of coastal erosion on fisherman activities, and alternative occupation in the tourism sector was recommended. The study found that parts of the Setiu shoreline faced the highest erosion due to high-intensity waves during the southwest and northeast monsoon season. The coastal erosion and annual northeast monsoon storm from November to March severely impacted the quality of life for the fishermen, especially in the economic sector. Consequently, the affected fishermen ventured into an alternative occupation as businessmen in the tourism industry. Thus, underdeveloped areas such as the Setiu district may serve as a prime example to the Association of Southeast Asian Nations (ASEAN) countries on fishermen's alternative occupation and survival during monsoon seasons.

**Keywords:** Coastal community, marine tourism, quantitative analysis, DSAS, ASEAN

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## GRAPHICAL ABSTRACT



## INTRODUCTION

In the Southeast Asian regions, a natural coastal erosion process typically occurs during monsoon storms where the sediment supply frequently decreases as huge waves erode the shorelines. Malaysia tends to have two monsoon seasons represented by the rainy season accompanied by storms during the northeast monsoon and a dry season during the southwest monsoon. These monsoonal seasons occur due to the wind (Kok et al., 2015), and the hydrodynamic process is involved because of its location facing the South China Sea (Akhir, 2012). Malaysia's 4890 km-long coastlines possess strong potential for the coastal community's socio-economy, especially in fisherman activities. Since their population was mostly concentrated in the coastal areas, these fishing communities relied heavily on marine natural resources as their source of income (Muhammad et al., 2016; Shaffril et al., 2017). According to Ghazali (2006), Terengganu was recorded as one of Malaysia's highest occurring erosion rates. However, mitigation was not prioritized in this region, especially in the Setiu district, due to the lack of development along the coastlines (Shariful et al., 2020). As a result, the erosion episodes caused negative impacts on the fishermen's activities, especially during monsoon storms (Ariffin et al., 2018a, 2018b; Hassan & Rahmat, 2016; Muhammad et al., 2016). The monsoon storms showed the

highest wave with a range from 1.0m to 3.5m (Ariffin et al., 2018a, 2018b; Ismail et al., 2020; Shariful et al., 2020) that prevented most fishermen activities, especially for the small-scale fishermen (Abu Samah et al., 2019; Hardy et al., 2013; Muallil et al., 2014; Muhammad et al., 2016; Shaffril et al., 2017). The small-scale fishermen inevitably drove towards other forms of occupation for survival (Abdul Halim et al., 2017) as studies suggested that they could not survive during severe monsoon seasons, especially in the Association of Southeast Asian Nations (ASEAN) countries such as the Philippines (Muallil et al., 2014), Indonesia, and Malaysia (Muhammad et al., 2016). Consequently, some fishermen were forced to undertake alternative occupations to support their livelihood and family, such as tourism. According to Anfuso et al. (2007), coastal work has been developing over the recent years due to increasing demand for tourism, owing to the impacts of natural disasters.

Thus, the study investigated the role of tourism activities as an alternative occupation among the fishermen during the monsoon storms and how they cope with these activities as part of their livelihood. Currently, the tourism industry significantly impacts the fishermen's quality of life with environmentally oriented tourism. Additionally, tourism activities changed, innovate, and competed in improving the accessibility to tourism products and recreational activities to meet the ever-changing demand for tourism (Mehmet & Hasan, 2017).

Hence, tourism is a natural part of the socio-economic fabric and is juxtaposed with fisheries in some coastal areas. Chen (2010) also found that diversifying fisheries into tourism was in line with the progress stated on the government agenda. Therefore, Setiu's fishermen in this context did not solely focus on the fishing industry, but also catered to tourists by offering recreational activities such as beach tourism, ecotourism, agro tourism, cultural heritage tourism, and travel/adventure tourism. In other words, these tourism activities can be portrayed as their socio-economic status towards improving their quality of life and well-being.

## **STUDY SITE**

This study focused on the influence of the coastline changes on the socio-economy of the coastal communities (fishermen) in the Setiu district, especially those who are facing the erosion issue.

### ***Environmental setting***

This study was carried out at the Setiu district with approximately 70 km coastline, and the focus areas were Beting Lintang (Setiu Lama), Setiu Wetland, Penarik, Rhu 10, Bari, and Telaga Papan (Figure 1). Generally, the environmental setting will experience the southwest monsoon (calm season) from May to

September and the northeast monsoon (storm season) from November to March (Kok et al., 2015). The northern part of Setiu's coastal area was selected due to its minimal or less extreme coastal erosion process. For instance, the coastal area is covered by an island, which acts as a natural barrier protecting the beach from strong waves, thus interrupts biological processes such as erosion and accretion (Ismail et al., 2020; Shariful et al., 2020).

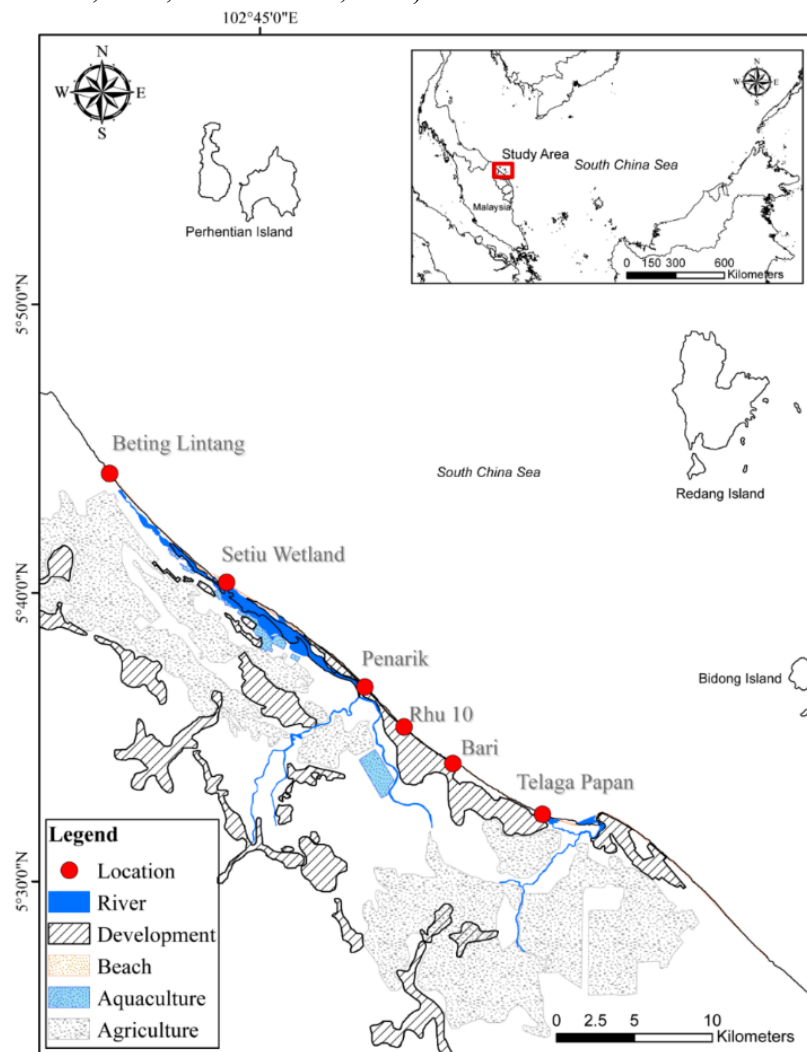


**Figure 1:** Map of study area located in the state of Setiu district at Terengganu.

Meanwhile, the southern part of Setiu's coastal area experienced an extreme coastal erosion process, which resulted in a natural coastal landform with

multiple headlands and a mini-port suitable for the silica industry (Ismail et al., 2020). According to National Coastal Erosion Study (2015), this area was identified as category 3 (lower index) in the erosion index, resulting in less population and development. The government did not prioritize mitigating erosion. Hence, the coastal community, especially fishermen, is impacted by this erosion issue.

### ***Fisherman activities***

The main activities along the Setiu's coastlines generally incorporate fisheries alongside tourism activities. Fisheries were quite common because the Terengganu coasts face the South China Sea, which provided an abundance of fish stocks to cater to local and export demands (Muhammad et al., 2016; Shaffril et al., 2017). For tourism activities, many tourists frequented the area, especially neighbouring tropical islands, namely Bidong Island, Redang Island, and Lang Tengah Island. Tourists also frequented Setiu because of its proximity to the capital, Kuala Terengganu, as well as Setiu's popular food stalls serving fried seafood, fish fritters (keropok lekor), fermented fish source, dried anchovies, and shrimp paste (belacan) (Figure 2).



**Figure 2:** Famous food production in Setiu district, Terengganu. (a and c) fermented fish; (b) belacan; (d) fried fish.

### ***Tourism resources in Setiu***

In recent years, tourism impacts the community and environmental resources that emerge from a community development approach, using tourism as a tool to build up the local community's ability to manage tourism resources, particularly in rural

areas. For example, in Setiu, Terengganu has been divided into five (5) tourism resources: beach tourism resources, ecotourism resources, agro-tourism resources, cultural heritage tourism resources, and travel/adventure tourism.

#### ***Beach tourism resources***

Beach tourism resources in the Setiu district include attractive beaches such as Penarik, Bari, and Rhu 10, ideal for a scenic drive. This route is a state route that serves as the main road from Kuala Terengganu to Kampung Raja. Furthermore, the Bari to Penarik beach area is identified as part of the environmentally sensitive area. Therefore, the development of the scenic route must be controlled as not to affect the quality of the environment.

#### ***Ecotourism resources***

Ecotourism is nature-oriented tourism based on learning that intends to sustain the environment, economy, and socio-culture (Weaver, 2002). The positive impacts of ecotourism include incentive effects to protect natural habitats, funding, and voluntary activities from enhancing venues and stimulating economic activity in peripheral areas. Conversely, the adverse effects, which tend to be unintentional, include infrastructure development that can destroy habitats, wildlife stress-induced observations, and illegal invasions to a destination. Satyanarayana et al. (2017) recorded that ecotourism conserved the environment and improved local people's well-being. In particular, Setiu is an ecotourism area listed in the National Ecotourism Plan framed by the Malaysian Ministry of Culture, Arts, and Tourism. Setiu's District Council Area itself provides nature tourism, including rivers, waterfalls, and parks for recreational facilities. Hence, ecotourism destinations provide a positive experience for both visitors and hosts.

#### ***Agro-tourism resources***

Terengganu is one of the major suppliers of agricultural and fishery products in Malaysia. The agricultural and fisheries activities are the leading contributor to the economic development of the Setiu district compared to the industrial and agro-tourism sectors, as a potential tourism destination. The agro-tourism resources in the Setiu District Council area consist of agricultural and aquaculture activities, such as sea habitats farming and the cultivation of fruits. Products such as herbs (arboretum), aquaculture, and Roselle plants are offered in Peladang Setiu Agro Resort, Laguna Setiu, and Kampung Merang, with Setiu Wetland providing a variety of aquacultural activities.

#### ***Cultural heritage tourism resources***

Cultural heritage tourism resources are a medium to maintain the Malay cultural heritage and preserve the environment, including the sea and land life, towards

sustainable development of the Setiu district. Setiu district is well-known for its seaport catchment site, which caters to various tourism activities through cultural heritage tourism resources, in line with the Terengganu's cultural products. The cultural heritage tourism of Setiu district offers several attractions, such as the fishing village homestay, craft production skills, and food product manufacturing.

#### *Travel/adventure tourism*

Adventure tourism activities are based on natural and rugged outdoor locations that interact with the environment and nature (Tshipala & Coetzee, 2012). Given the current growing trend towards adventure-orientated holiday behavior, it is vital to identify the potential adventure tourism attractions and help communities develop and attract the adventure tourism market. Adventure tourism resources are located at Peladang Setiu Agro Resort, Merang Beach Recreation Park, and Seri Bari Camp. Among the adventure travel products offered are camping sites, jungle trekking, and water sports.

## **RESEARCH METHODOLOGY**

An assessment study of shoreline evolution was carried out on a 70 km stretch of the Setiu coastline. The monsoon identification was investigated using wave modeling to reveal the comparison between the calm and storm seasons. A questionnaire survey was also conducted to understand the natural disaster effects along the coastline and identify alternative occupations for the fishermen in the tourism sector. Additionally, the questionnaire survey was suitable as it gathered statistical information about the attributes, attitudes, or actions of a population by administering standardized questions to some or all of its members (Buckingham & Saunders, 2004). Numerous research questions and topics may be addressed using information collected with questionnaire surveys, provided that the respondents possessed knowledge of the issue and were competent to answer the questions (Preston, 2009).

### ***Shoreline evolution***

The Digital Shoreline Analysis System (DSAS) software was used to determine the shoreline evolution (Thieler et al., 2009) along the Setiu coastline. The aerial photographs from 2009 to 2019 were first processed by geometric correction using a UTM 48 - WGS 1984 projection. The GPS points were set by utilizing recognized and identified landmarks (i.e., buildings) extracted from Google Earth (Satyanarayana et al., 2017) for the validation of DSAS (Ariffin et al., 2018a, 2019, 2020; Mathew et al., 2020; Selamat et al., 2019; Zulfakar et al., 2020). Transects at 100 m intervals were generated by the results incorporated only using the End Point Rate (EPR) approaches. This approach presented negative and positive values for erosion and accretion rates, which enabled the researchers to establish an erosion impact influenced by the monsoon season.

### ***Monsoon identification***

Wave models along the coastline during calm and storm seasons were compared to investigate the erosion from the impact of the monsoon on fisherman activities. It should be noted that the hydrodynamic setting analysis used Mike 21-SW for the wave regime (DHI, 2011) to identify the monsoon seasons from January to December 2019.

### ***Data collection from fisherman***

The analysis in this study was based on cross-sectional data derived from quantitative surveys and focused explicitly on the head of the fishermen's family as the primary respondent. The questionnaire for this study was divided into five parts: demographic information, family profile, quality of life, fisherman's tendency towards the tourism sector, and the impact of the tourism sector on fishermen's quality of life.

A total of 251 useable questionnaires were received from 400 questionnaires sent to the selected respondents. This method used convenience sampling among the fishermen in Setiu district based on ten main fishing villages in Beting Lintang (Setiu Lama), Setiu Wetland, Penarik, Rhu 10, Bari, and Telaga Papan. Likert scale responses varying from strongly agree to disagree strongly were employed. Therefore, the estimation of 400 respondents was suitable to ensure adequate returns of the questionnaire. The questionnaire returns between 70 to 80 percent were acceptable (Cohen et al., 2002), while the returns of over 80 percent were considered satisfactory (Kerlinger, 1970). The focus of the questionnaires was to identify the fisherman's tendency towards the tourism sector, such as marine-tourism (beach area), ecotourism, agro-tourism, culture-tourism, and gastronomy-tourism. Respondents were asked whether they needed any assistance in tourism activities they were involved in. Next, they were asked about the type of training or program needed to increase their knowledge and skills in that activity and identify possible forms of government assistance.

## **RESULTS AND DISCUSSION**

This section is divided into three parts. The first part presents the historical rate of shoreline evolution that shows the rate of erosion and accretion. The second part describes the significant wave height from the seasonal monsoon that gives impact to the fishermen. The third part shows findings from the questionnaire surveys of fishermen involved to identify the alternative occupation in the tourism industry.

### ***Historical rates of shoreline evolution***

Overall, the shoreline change leaned towards the accretional occurrences generated from the northern to the southern region that can be noticed by the rate

values, which are mostly situated on the line of zero change. This idea described the evolution of over ten years (from 2009 – 2019) did not significantly vary from the statistical calculation of the obtained EPR values.

The shoreline change of EPR value ranged from 22.23 m/year accretion and -7.18 m/year erosion. In Figure 3, it was observed that there was a dynamic location that demonstrated a substantial accretion at a kilometer of 26 (Setiu wetland area), which caused approximately 24 m of sediment enhancement over a decade. This area was scattered with agro-tourism, such as aquaculture activities, which poses a potential for the fisheries industries. Between the sites, erosion cases were observed at Beting Lintang beach and Penarik beach, with an approximate loss of 7 m for each location, respectively. Consequently, the erosion will affect several areas, such as Penarik Beach, which offers various tourism activities such as seafood stalls serving fish fritters (keropok), fermented fish sauce, dried anchovies, and shrimp paste (belacan). Furthermore, a maximum of -6.4 m erosion was remarked at a kilometer of 53 (Bari beach area), which might affect the tourism activities along the beach. Besides that, the stable conditions along the Setiu shorelines stem from the fact that the shorelines were protected by the various islands (Ismail et al., 2020; Shariful et al., 2020), such as Perhentian Island, Redang Island, and Bidong Island (refer in Figure 1).

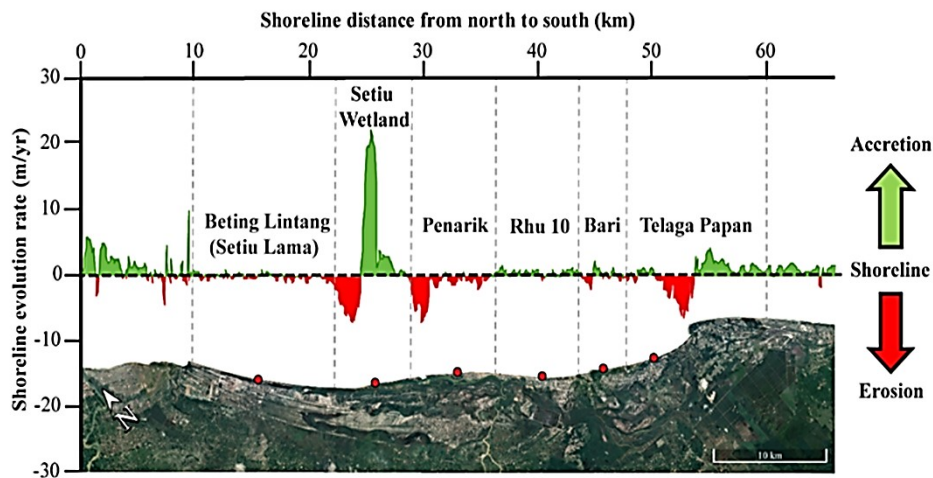


**Figure 3:** Spatial variation of shoreline change rates along the Setiu coast between 2009 and 2019. Shoreline distance is measured from north to south (km), while the vertical axis represents shoreline evolution rate ( $\text{m yr}^{-1}$ ). Green bars indicate accretion (shoreline advancement) and red bars indicate erosion (shoreline retreat). Key coastal locations including Beting Lintang (Setiu Lama), Setiu Wetland, Penarik, Rhu 10, Bari, and Telaga Papan are marked along the transect. The base satellite image shows the coastline and reference transect points used for shoreline change analysis.

### **Wave distribution**

Figure 4 shows the significant wave height ( $H_s$ ) distribution of the entire field at different seasonal monsoons on the southwest and northeast monsoon in 2019 provided by the MIKE-21 SW model simulation. Overview, Penarik, Rhu 10, and Bari beach showed high-intensity waves during southwest and northeast monsoon in 2019, which inevitably affected the erosion along the coastlines. According to Ismail et al. (2020) and Shariful et al. (2020) studies in the Setiu coastline, the beaches eroded despite being protected by the islands. Thus, the gab of islands may cause a larger intensity of wave and directly impact the coast. This phenomenon can be observed in other places within the Terengganu region, which possessed offshore breakwaters due to its design and location (Ariffin et al., 2020; Zulfakar et al., 2020).

**Southwest Monsoon 2019 (calm season):** In Terengganu, the southwest monsoon season occurs from May to September (Ariffin et al., 2018, 2019; Kok et al., 2015). In this study, the  $H_s$  displayed a clear pattern on the Terengganu waters with a maximum significant wave height between 0.8 m to 1.0 m, equally found from Ariffin et al.'s (2016) study.  $H_s$  progressively decreased along the coastlines, which were protected by the island on the coastal waters. However, the Penarik, Rhu 10, and Bari beach revealed a significant increase in wave height.

**Northeast Monsoon 2019 (storm season):** The northeast monsoon season occurs from November to March (Ariffin et al., 2018, 2019), the highest on the significant wave height in the Terengganu coast. The significant wave height was higher (up to 2.0 m near the beach area) than the southwest monsoon. Under these circumstances, the northeast monsoon exhibited a storm season characteristic, affecting most fisheries activities along the coastal waters and giving a decreasing number of small-scale fishermen (Muhammad et al., 2016).

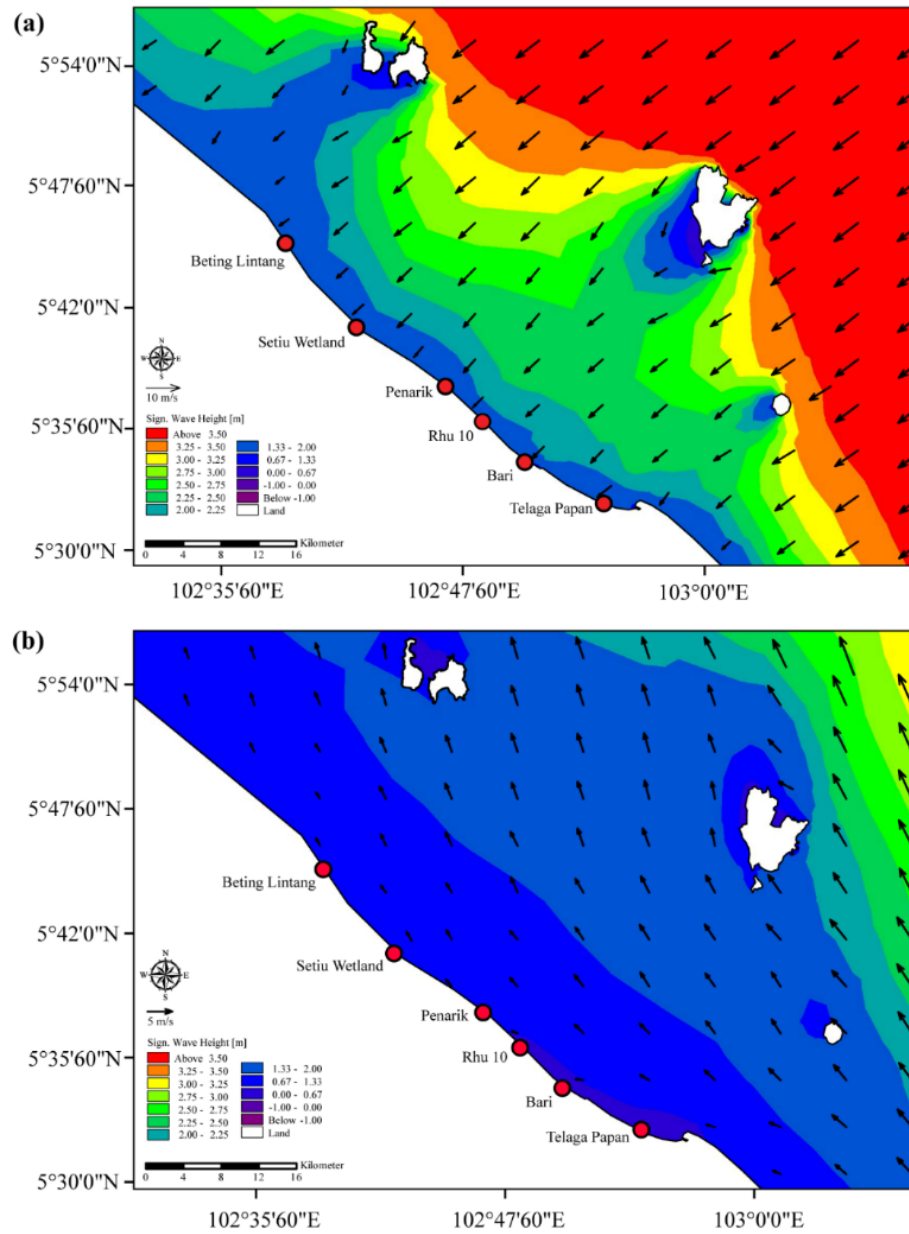


**Figure 4:** The significant wave height at Setiu coastal water during (a) southwest monsoon 2019 and (b) northeast monsoon 2019.

### ***Fishermen perception of an alternative occupation***

In this part, the elaboration will emphasize five main points, such as demographic information, quality of life, fisherman's tendency towards the tourism sector, and the impact of the tourism sector on fishermen's quality of life. These findings were analyzed using questionnaire analysis, and the test values indicated that all the variables used met the law of reliability. In other words, the reliability of a measure indicates stability and consistency with which the instrument measures the concept and helps assess the "goodness" of a measure (Sekaran & Bougie, 2016). The accepted value of Cronbach's alpha was 0.7. However, values above 0.6 were also accepted (Griethuijsen et al., 2015; Taber, 2018). The score value for the reliability test is shown in Table 1 below.

**Table 1:** Reliability test for the instruments.

| <b>Variables</b>                                                                 | <b>Reliability Test<br/>Cronbach's Alpha</b> |
|----------------------------------------------------------------------------------|----------------------------------------------|
| <i>Fishermen's perception towards quality of life</i>                            |                                              |
| Emotional well-being                                                             | 0.879                                        |
| Community well-being                                                             | 0.851                                        |
| Economic well-being                                                              | 0.882                                        |
| Social-cultural well-being                                                       | 0.747                                        |
| Environmental, security, and health well-being                                   | 0.829                                        |
| <b>Overall</b>                                                                   | <b>0.939</b>                                 |
| <i>The impact of tourism activities in improving fishermen's quality of life</i> | <b>0.959</b>                                 |

In terms of demographic information in Table 2, the respondents comprised 98.9 percent male and 1.2 percent female. The majority of the respondents were middle-aged and above, with 25.5 percent aged 50 to 57 years old. Over 87.6 percent of the respondents were married. Together with the total respondents, 56.2 percent acquired at least a primary education, with 46.61 percent earning between RM 601.00 to RM 900.00 per month. Only 2 percent were reported to have earned more than RM 1501.00. Additionally, 68.5 percent of the respondents acquire between 16 to 20 years of experience as a fisherman.

**Table 2:** Demographic profile

|              | <b>Frequency</b> | <b>Percentage</b> |
|--------------|------------------|-------------------|
| Gender       |                  |                   |
| Male         | 248              | 98.8              |
| Female       | 3                | 1.2               |
| <b>Total</b> | <b>251</b>       | <b>100.0</b>      |

|                                | Frequency  | Percentage   |
|--------------------------------|------------|--------------|
| <b>Age</b>                     |            |              |
| 18-25 years old                | 8          | 3.2          |
| 26-33 years old                | 14         | 5.57         |
| 34-41 years old                | 23         | 9.16         |
| 42-49 years old                | 57         | 22.70        |
| 50-57 years old                | 64         | 25.5         |
| 58-65 years old                | 56         | 22.31        |
| 66-73 years old                | 19         | 7.56         |
| 74 years old and above         | 10         | 4.0          |
| <b>Total</b>                   | <b>251</b> | <b>100.0</b> |
| <b>Marital Status</b>          |            |              |
| Single                         | 26         | 10.4         |
| Married                        | 220        | 87.6         |
| Single Parent                  | 4          | 1.6          |
| Divorce                        | 1          | .4           |
| <b>Total</b>                   | <b>251</b> | <b>100.0</b> |
| <b>Level of education</b>      |            |              |
| No school                      | 11         | 4.4          |
| Primary school                 | 141        | 56.2         |
| Lower secondary school         | 54         | 21.5         |
| Upper secondary school         | 44         | 17.5         |
| Degree/master and above        | 1          | .4           |
| <b>Total</b>                   | <b>251</b> | <b>100.0</b> |
| <b>Income</b>                  |            |              |
| No income                      | 3          | 1.19         |
| RM300 and below                | 6          | 2.39         |
| RM301 – RM600                  | 39         | 15.53        |
| RM601– RM900                   | 117        | 46.61        |
| RM901-RM1,200                  | 68         | 27.1         |
| RM1,201-RM1,500                | 13         | 5.18         |
| RM1501-RM1800                  | 0          | 0            |
| RM1801 and above               | 5          | 2.0          |
| <b>Total</b>                   | <b>251</b> | <b>100.0</b> |
| <b>Experience as fishermen</b> |            |              |
| < 5 years                      | 20         | 8.0          |
| 6-10 years                     | 15         | 6.0          |
| 11-15 years                    | 14         | 5.6          |
| 16-20 years                    | 28         | 11.2         |
| > 21 years                     | 172        | 68.5         |
| Not applicable                 | 2          | .7           |
| <b>Total</b>                   | <b>251</b> | <b>100.0</b> |
| <b>Interest in tourism</b>     |            |              |
| Marine tourism                 | 56         | 22.3         |
| Ecotourism                     | 16         | 6.4          |
| Agro-tourism                   | 145        | 57.8         |
| Culture tourism                | 7          | 2.8          |
| Gastronomy                     | 21         | 8.4          |
| No interest                    | 6          | 2.4          |
| <b>Total</b>                   | <b>251</b> | <b>100.0</b> |

Moreover, the fisherman's tendency towards the tourism sector can be described in six options, namely marine tourism, ecotourism, agro-tourism, culture tourism, gastronomy, and 'no interest' at all. Based on the findings, the highest interest was in the field of agro-tourism (57.8 percent), followed by marine tourism (22.3 percent), gastronomy (8.4 percent), ecotourism (6.4 percent), and lastly, culture tourism (2.8 percent). The remaining respondents were not interested and refused to engage in tourism activities. Hence, this statistic can prove that most respondents are willing to alternate their occupation in the tourism sector to support their main income.

Additionally, the fishermen's perception towards the quality of life revealed in this study presented the mean and standard deviation for the selected domains of quality of life, namely, emotional well-being, community well-being, economic well-being, social-cultural well-being, and lastly, environmental, security, and health well-being (Table 3). The variable of community well-being, economic well-being, and social-cultural well-being indicated the highest mean score (mean = 4.27 – 4.39; standard deviation = 0.502 - 0.604) while emotional well-being and environmental, security, and health well-being displayed a moderate mean score (mean = 2.99, standard deviation = 0.947; mean = 3.55, standard deviation = 0.853).

**Table 3:** Fishermen's perception towards quality of life.

| Variables                                      | Mean | SD   |
|------------------------------------------------|------|------|
| Emotional well-being                           | 2.99 | .947 |
| Community well-being                           | 4.39 | .502 |
| Economic well-being                            | 4.27 | .517 |
| Social-cultural well-being                     | 4.32 | .604 |
| Environmental, security, and health well-being | 3.55 | .853 |

The basic definition for these variables was based on the Economic and Social Research Council (ESRC) Well-being in Developing Countries research group (WeD). The University of Bath defines well-being as a state of being with others, which arises when human needs are met, where one can act meaningfully to pursue one's goal, and where one can enjoy a satisfactory quality of life (McGregor, 2004). While many frameworks for well-being exists, the concept measurement for well-being used in this study consisted of a three-dimensional approach, such as material well-being, relational well-being, and subjective well-being, as suggested by Britton and Coulthard (2013). This study emphasized more on the five main variables stated above to adapt to the concept of well-being in the discussion.

Correspondingly, the impact of tourism activities on improving the fishermen's quality of life can be portrayed in Table 4. The table shows the mean and standard deviation values with 15 items of questionnaires related to tourism

activities. Most of the respondents agreed that the tourism activities had generated their income with a mean value between 4.06 to 4.39, while the standard deviation being between 0.62 to 0.89. Unfortunately, the statement 'tourism can induce tourism revenue to be more critical than other revenues' showed the lowest mean score (mean = 3.87, standard deviation = 0.99). This result indicated that tourism revenue was a part of the fishermen's overall revenue (income generation).

**Table 4:** Impact of tourism activities in improving fishermen's quality of life.

| No | Statement                                                                                   | N   | Min | Max | Mean | SD  |
|----|---------------------------------------------------------------------------------------------|-----|-----|-----|------|-----|
| 1  | Tourism activities able to increase my income                                               | 251 | 1   | 5   | 4.33 | .72 |
| 2  | Tourism activities offered job opportunities to fishermen                                   | 251 | 1   | 5   | 4.34 | .71 |
| 3  | Tourism activities diversified economy activities                                           | 251 | 1   | 5   | 4.34 | .71 |
| 4  | Tourism activities open a business network opportunities with outsider                      | 251 | 1   | 5   | 4.39 | .65 |
| 5  | Tourism activities able to enhance our living standard                                      | 251 | 1   | 5   | 4.35 | .62 |
| 6  | Tourism activities enhance a business opportunities with external                           | 251 | 1   | 5   | 4.1  | .87 |
| 7  | Tourism activities can increase standard of living                                          | 251 | 1   | 5   | 4.25 | .67 |
| 8  | Tourism activities enhance business opportunities                                           | 251 | 1   | 5   | 4.25 | .70 |
| 9  | Tourism can caused tourism revenue more important than other revenue                        | 251 | 1   | 5   | 3.87 | .99 |
| 10 | Income that generate can contribute to development in this area                             | 251 | 1   | 5   | 4.06 | .89 |
| 11 | Tourism can enhance power of buying and quality of life which is more better than this area | 251 | 1   | 5   | 4.13 | .81 |

Essentially, tourism activities offered job opportunities based on the diversified economic activities mentioned, namely beach tourism resources, ecotourism resources, agro-tourism resources, cultural heritage tourism resources, and travel/ adventure tourism. Therefore, the tourism activities in Setiu presented promising opportunities for the fishermen to better their livelihood. The diverse variety of tourism activities to be potentially ventured by the fishermen can provide an added value to their existing skillset.

Consequently, once the area becomes increasingly developed, these tourism activities might enhance the purchasing power and the quality of life for the fishermen, ultimately reducing the poverty rate among the residents. Equally important, when many tourists come to the Setiu district, the fisherman, mostly from primary school background, can improve the skill opportunities and knowledge individuals in this village. There can improve the skill opportunities and knowledge individuals based on handling the tourist with the public relations, language, marketing, etc. Moreover, the government should develop an

infrastructure that can be integrated into various tourism activities, thus increasing the service quality among the local community.

### **Suggestions for young fisherman on marine edu-tourism**

The statistical data for the age of respondents shows almost 20 % of those below 18 – 41 years old that proves the young generation does not interest in fisherman occupation. This factor is because fishermen's income is lowest compared to other occupations, less than RM 900.00 per month. Hence, the alternate occupation in the tourism sector can give the young fisherman generation to involve in marine edu-tourism, which can give more income with this alternative.

On the other hand, the conservation and preservation of Setiu's marine life need to be prioritized. This idea focuses on sea habitats such as the mackerel, sea horse, fish, and shrimp as examples of commodities that are difficult to obtain from any other place. Thus, the state government, fisheries department, and the fishermen community should rejuvenate Setiu as the location for the tourism industry.

Additionally, this activity can be integrated into the 'marine edu-tourism' program in the Setiu community, particularly on developing sea horses and mushrooms. In the future, they can be trained as marine life tourist guides catered for the tourists and the local communities. Prospectively, they can pursue employment with the Malaysian Fisheries Development Board to develop a knowledge-based approach to tourism products. Correspondingly, the tourism product may become a social innovation when a piece of new knowledge is translated into a product. However, social innovation is time-consuming and requires effort and commitment to supporting the communities and stakeholders, accompanied by the ability to translate the knowledge into a community development insight.

Marine activities can also establish new opportunities to increase fishermen's family life and living standards. The new approach, namely social innovation, can be implemented by the fishermen, especially inexperienced fishermen. Additionally, these activities may provide other forms of income besides the earnings as a fisherman by becoming a boat driver that brings tourists to exciting locations, ergo increasing the fishery activities around the coastal areas of Setiu. The inexperienced fisherman may also undergo training to become a marine guide familiarizing the tourists about marine life, accompanied by touring the sea habitats in Setiu. Eventually, the social innovation approach to the community can provide new exposures to develop their communication skills and competencies.

### **Policy Implications for Erosion Mitigation and Livelihood Resilience**

Government policies must pivot from siloed coastal engineering to integrated, climate-adaptive frameworks that address both biophysical erosion drivers and human dimensions. In Malaysia, the National Coastal Zone Physical Plan (NCZPP) provides a foundation, yet implementation gaps in Terengganu—such as delayed beach nourishment and inadequate wave barriers—amplify Setiu's vulnerabilities. The study's evidence of monsoon wave heights correlating with erosion hotspots implies a policy imperative for dynamic forecasting systems. Integrating real-time wave models with DSAS into the Malaysian Meteorological Department's (METMalaysia) early warning platforms could enable predictive zoning, restricting fishing during high-risk periods and reducing asset losses by 30-50%, as modeled in similar Philippine case studies. Economically, the shift of affected fishermen toward tourism entrepreneurship reveals untapped potential in underdeveloped districts like Setiu. This aligns with Malaysia's Shared Prosperity Vision 2030, which emphasizes blue economy diversification, yet current policies undervalue small-scale actors. Erosion-induced displacement has spurred informal ventures in homestays, eco-guides, and seafood tourism, boosting household incomes by 15-20% per our quantitative survey. However, without formal support, these transitions risk failure amid regulatory hurdles (e.g., licensing delays) and skill mismatches. For ASEAN-wide applicability, Setiu exemplifies how erosion hotspots can catalyze "monsoon-resilient occupations," informing the ASEAN Strategic Action Plan for Coastal and Marine Environment (2021-2025) by prioritizing fisher-to-tourism pathways in storm-prone nations.

### **Recommendations for Government Action**

To mitigate erosion impacts, governments should adopt a multi-tiered strategy:

1. **Enhance Physical and Nature-Based Defenses:** Prioritize hybrid interventions, such as offshore breakwaters combined with mangrove restoration, targeting high-erosion zones identified via DSAS. Allocate RM50-100 million from the 12th Malaysia Plan for pilot projects in Setiu, monitoring efficacy with annual shoreline surveys. Nature-based solutions could reduce wave energy by 40%, per regional analogs, while enhancing biodiversity for eco-tourism appeal.
2. **Develop Adaptive Livelihood Programs:** Establish a "Monsoon Resilience Fund" under the Ministry of Rural and Regional Development, offering micro-grants (RM10,000-20,000 per fisher) for tourism upskilling—e.g., digital marketing for halal coastal experiences and heritage tours leveraging Setiu's wetlands. Partner with Universiti Malaysia Terengganu for vocational training, aiming to transition 20% of affected fishers within two years.

3. **Strengthen Institutional and Regional Coordination:** Mandate integration of wave-erosion models into district-level disaster risk reduction plans, with ASEAN-wide data-sharing via the ASEAN Coastal Management Network. Enforce setback zones (50-100m from high-water mark) to prevent maladaptive rebuilding, coupled with insurance subsidies for fishing assets.
4. **Promote Sustainable Tourism as a Buffer:** Zone Setiu for Muslim-friendly eco-tourism, capitalizing on its South China Sea proximity and UNESCO-recognized wetlands. Policies should incentivize community cooperatives for reef-safe snorkeling and cultural immersion, projecting a 10-15% GDP uplift for Terengganu while buffering erosion losses.

These recommendations, if operationalized, could position Setiu as an ASEAN model for erosion-resilient coastal governance, transforming vulnerabilities into opportunities for sustainable development.

## CONCLUSION

In conclusion, the middle of the Setiu shoreline tends to erode as a factor of high-intensity waves during the southwest and northeast monsoon seasons. The beach erosion and the annual northeast monsoon storm occurring from November to March have dramatically impacted the fishermen's quality of life, which influenced their position in the economic sector. Regardless, this issue inevitably pressured the fishermen to undertake an alternative occupation as businessmen in the tourism industry. Accordingly, the tourism activities showed increased production, and the government might help develop this domain. Underdeveloped regions like the Setiu district can serve as a prime example to other nations in the ASEAN countries to understand the fishermen's lives and survival during the monsoon storm. Therefore, provided that the small-scale fishermen could not fish during this season, they acquired an alternative income in the tourism industry.

## Limitations of the Study

The primary limitation lies in the use of convenience sampling for the quantitative assessment of erosion impacts on fishermen activities. With a sample of 251 respondents drawn from accessible coastal villages in Setiu district (e.g., those proximate to high-erosion hotspots identified via DSAS), participants were selected based on availability and willingness to cooperate during the field visits. This non-probability method, while efficient for preliminary data collection in remote, monsoon-disrupted areas, introduces selection bias by overrepresenting individuals who were onshore, more severely affected by fishing disruptions, or inclined toward tourism diversification discussions.

### **Implications for Generalizability**

Convenience sampling undermines the external validity and generalizability of findings beyond Setiu's immediate context. The sample likely skews toward more local or economically strained fishers—those with eroded beach access and prior informal tourism ventures—potentially inflating reported income losses (25-40% during northeast monsoons) and transition successes (15-20% gains via homestays). Less affected fishers operating further offshore or in less eroded sectors may be underrepresented, leading to an overestimation of vulnerability and underestimation of adaptive capacity across Terengganu's 200+ km coastline. For instance, comparative DSAS studies in adjacent Dungun report heterogeneous erosion rates (-1.79 m/year average versus Setiu's -7.0 m/year hotspots), suggesting that Setiu-specific wave impacts may not extrapolate to accretion-prone areas without probability-based sampling.

### **Mitigating Future Research Directions**

To enhance generalizability, subsequent studies should employ stratified random sampling (e.g., proportional to village erosion rates and fisher demographics) targeting 300-500 respondents via fisher cooperatives, yielding representative power (>80% for 5% margins). Longitudinal panels tracking pre/post-monsoon incomes would further isolate causality from self-selection. Integrating mixed methods—e.g., administrative fisheries data from the Department of Fisheries Malaysia—could triangulate survey biases, strengthening claims for NCZPP integration and ASEAN blue economy frameworks. These refinements would elevate Setiu from a case study to a benchmark for coastal resilience policy.

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**Effi Helmy Ariffin:** Project administration, Methodology, Writing-Original Draft preparation. **Lee Shin Yun:** Software, Validation, Visualization. **Zaleha Mohamad:** Investigation, Resources, Writing-Review & Editing. **Mohd Nizam Lani:** Writing-Review & Editing. **Noorhaslinda Kulub Abd. Rashid:** Methodology & Editing.

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