Geografia-Malaysian Journal of Society and Space 22 issue 3 (177-203)
 https://doi.org/10.17576/geo-2026-2203-11

Coastal resources, activities and challenges to local and indigenous Mah Meri community along the coastlines of Port Klang and the Klang Islands

Engku Aisyah Nasuha Engku Faris[1,2], Sanjeef Kumr Subramaniam[1,2], Qhaiyyum Azhar Ramli[3], Mozard Mohtar[4], Azni Zarina Taha[4], Hanafi Hussin[5], Lim Phaik Eem[1], Hanizah Idris[5], Archina Buthiyappan[2,5], Siti Aisyah Alias[2]

[1]Institute of Ocean and Earth Sciences, Advanced Studies Complex, Universiti Malaya
[2]Institute for Advanced Studies, Advanced Studies Complex, Universiti Malaya
[3]Department of Geography, Faculty of Arts and Social Sciences, Universiti Malaya
[4]Department of Management and Marketing, Faculty of Business and Economics, Universiti Malaya
[5]Department of Southeast Asian Studies, Faculty of Arts and Social Sciences, Universiti Malaya

Correspondence: Siti Aisyah Alias (email: saa@um.edu.my)

Received: 20 August 2025; Accepted: 25 June 2026; Published: 26 August 2026

Abstract

Malaysia's coastal zones provide significant environmental and socioeconomic value, particularly for resource-dependent and Indigenous communities. This study focuses on the coastal resources, livelihood activities, and challenges faced by the Indigenous Mah Meri community along the coastlines of Port Klang and the Klang Islands, Malaysia, with the aim of contributing to broader discussions on Indigenous resilience and sustainable coastal development. Five study zones were established, covering Klang, Pulau Ketam, Pulau Tengah, Northport, Pulau Indah, Pulau Che Mat Zin, Pulau Pintu Gedong, and Pulau Selat Kering. Data was collected through desktop study, field observations and supported by secondary spatial data, including satellite imagery and base maps, which were visualized using ArcMap software tool (version 10.8.2) to delineate the study area and identify the distribution of coastal features. The findings indicate that mangroves, coastal rivers, beaches, and coastal waters are the most dominant natural resources across the study area, forming the basis of key economic activities such as fisheries, tourism, shipping, and logistics. Pulau Ketam demonstrates a high concentration of small-scale fisheries and tourism-related activities, supporting local livelihoods. However, the Mah Meri community faces increasing challenges due to environmental pressures and surrounding development, which affect both resource availability and income stability. This study highlights the interconnected relationship between coastal resources and Indigenous livelihoods and contributes to sustainable development discourse by emphasizing the need for inclusive, community-based strategies to enhance resilience and ensure the long-term sustainability of coastal ecosystems.

Keywords: Coastal vulnerability, indigenous knowledge systems, mangrove dependency, small-scale fisheries, socio-ecological systems

Introduction

Coastal zones represent dynamic interfaces where ecological systems, economic development, and human livelihoods converge. In Malaysia, coastal areas are important socio-economic zones that support fisheries, trade, transportation, tourism, and settlement development (Alongi, 2015; Hamdan et al., 2020). Rapid coastal urbanisation and industrialisation, particularly in strategic hubs such as Port Klang, have intensified pressures on coastal ecosystems and the communities that depend on them. The expansion of port infrastructure, logistics, and industrial zones has contributed to land-use change, habitat degradation, and increased environmental stress.

Indigenous communities are among the most vulnerable to these transformations. The Mah Meri, part of the Orang Asli groups in Peninsular Malaysia, maintain strong socio-cultural and economic ties to coastal and mangrove ecosystems. Their livelihoods are closely linked to small-scale fisheries, forest products, and coastal resource use, making them particularly sensitive to environmental and spatial changes (Nicholas, 2000). However, coastal development, environmental degradation, and climate-related pressures have increasingly reduced access to traditional resources and heightened livelihood vulnerability among coastal communities (Bennett et al., 2016)

In regions surrounding Port Klang and the Klang Islands, including Pulau Ketam, these pressures are further compounded by large-scale industrial expansion and infrastructural development. Such changes alter coastal landscapes, reduce ecological resilience, and create competing demands for space and resources. These dynamics highlight a critical tension between economic growth and the sustainability of Indigenous, resource-dependent communities.

While geospatial technologies such as Geographic Information Systems (GIS) and remote sensing (RS) have significantly advanced the monitoring and management of coastal environments, their application in understanding Indigenous livelihoods remains limited. This study addresses this gap by examining coastal resources, livelihood activities, and the challenges faced by the Mah Meri community along the coastlines of Port Klang and the Klang Islands. By integrating field-based insights with spatial visualisation, this research provides a contextualised understanding of how environmental and spatial changes influence Indigenous livelihoods.

The study contributes to the broader discourse on sustainable coastal development by emphasising the importance of inclusive, community-based approaches that recognise both spatial dynamics and local knowledge systems. It aims to support more balanced development strategies that enhance resilience while safeguarding the well-being of Indigenous communities.

Literature review

Coastal socio-ecological systems and indigenous livelihoods

Coastal regions are increasingly understood as socio-ecological systems in which environmental processes and human activities are closely interconnected and mutually dependent (Partelow, 2018). In Southeast Asia, coastal communities depend heavily on ecosystem services such as fisheries, mangroves, and coastal protection for their livelihoods and well-being (Barbier et al., 2011). Mangrove ecosystems, in particular, provide critical provisioning and regulating services, including fish nursery habitats, shoreline stabilization, and carbon sequestration (Alongi, 2015).

For Indigenous communities, these ecosystems are not only economic assets, but also cultural landscapes embedded with traditional knowledge and practices. Indigenous knowledge systems play an important role in sustainable resource management and environmental stewardship by supporting adaptive and place-based management practices (Tengö et al., 2017). However, rapid coastal development and environmental degradation have increased livelihood vulnerability and reduced the adaptive capacity of coastal communities (IPCC, 2022).

In Malaysia, Orang Asli communities continue to experience socio-economic marginalization and limited participation in development planning processes, affecting access to traditional resources and livelihood opportunities. Recent studies also indicate that coastal Indigenous communities face increasing environmental pressures, restricted resource access, and limited inclusion in environmental governance and decision-making processes (Bennett et al., 2019).

Geospatial technologies in coastal resource assessment

GIS and remote sensing technologies are widely used to monitor coastal land-use changes, mangrove distribution, shoreline dynamics, and environmental degradation across spatial and temporal scales (Pham et al., 2019). Satellite imagery from platforms such as Landsat and Sentinel has been widely used to assess mangrove cover, shoreline dynamics, and land-use changes, providing valuable insights into coastal ecosystem transformations (Nguyen et al., 2020).

Recent advancements in high-resolution data acquisition, including unmanned aerial vehicles (UAVs), have further enhanced the accuracy and detail of coastal mapping (Casella et al., 2020). These tools support more precise environmental assessments, particularly in detecting small-scale changes in coastal morphology and vegetation.

Beyond physical mapping, geospatial technologies are increasingly applied within participatory and human-centered frameworks. Participatory GIS (PGIS) integrates local and Indigenous knowledge into spatial analysis, enabling more inclusive and context-sensitive planning processes (Brown & Kyttä, 2018; McCall & Dunn, 2012). Such approaches have been shown to improve decision-making outcomes by incorporating community perspectives and lived experiences into spatial datasets.

Integrating spatial and socioeconomic perspectives

Despite the growing use of geospatial tools in coastal research, a significant gap remains in integrating spatial analysis with socioeconomic and livelihood perspectives. Many studies focus primarily on ecological assessments or land-use changes, often overlooking how these spatial transformations affect local communities, particularly Indigenous groups (Bennett et al., 2016).

Recent studies emphasize the importance of interdisciplinary approaches that combine spatial analysis with qualitative and participatory methods to better understand human–environment interactions (Reed & Abernethy, 2018). Integrating GIS with field-based methods such as interviews and Focus Group Discussions (FGDs) allows researchers to contextualize spatial patterns within lived experiences, thereby providing a more holistic understanding of coastal systems.

In Malaysia, such integrative approaches remain limited, particularly in rapidly developing regions like the Klang Islands. While existing studies have documented coastal land-use changes and environmental degradation, few have explicitly examined their implications for Indigenous

livelihoods within a spatial framework. This highlights the need for research that bridges geospatial analysis with community-based perspectives.

Method and study area

This study adopts a mixed-methods approach that integrates spatial and qualitative methods to examine coastal resources, livelihood activities, and challenges faced by the Indigenous Mah Meri community along the coastlines of Port Klang and the Klang Islands. The methodological framework consists of two main components: (i) integrated spatial and field-based contextual assessment, and (ii) qualitative Focus Group Discussion (FGD) analysis. The combination of these approaches enables a more comprehensive understanding of the interactions between coastal environments and community livelihoods within a rapidly developing coastal setting.

Integrated spatial and field-based contextual assessment

The first component of the study combines desktop study and literature review, spatial data collection and mapping, as well as field-based observations to establish the geographical and socio-environmental context of the study area. A comprehensive desktop study was conducted through the review of published literature, statistical reports, government documents, and previous studies related to coastal resources, land use, socio-economic conditions, and environmental changes in the Port Klang region. This process provided baseline information and contextual understanding to support the interpretation of field findings.

Spatial data were obtained from secondary sources, including satellite imagery from Google Earth and publicly available base maps. These datasets were processed and visualized using ArcMap software tool version 10.8.2 to delineate the study area and identify the spatial distribution of major coastal features such as mangroves, rivers, coastal waters, settlements, and built-up areas. The GIS application in this study is limited to descriptive mapping and visual interpretation, including the digitization of island boundaries and the identification of general land-use and activity zones. Advanced geospatial analyses such as supervised classification, spatial statistics, and temporal change detection were not conducted, as the primary role of GIS in this study is to provide geographical context for supporting qualitative interpretation.

Field observations were subsequently carried out in Pulau Ketam to obtain firsthand insights into environmental and socio-economic conditions within the study area. Observations focused on coastal features, settlement patterns, and resource-use activities, particularly along key access routes such as Sungai Lima. These observations also served as ground verification to support and validate the interpretation of spatial data derived from GIS mapping and satellite imagery.

Qualitative Focus Group Discussion (FGD) analysis

The second component of the study involved qualitative data collection through a Focus Group Discussion (FGD) with members of the Indigenous Mah Meri community. A purposive sampling approach was employed to select participants with relevant knowledge and lived experience related to coastal livelihoods and resource dependence. A total of five participants were involved in the discussion.

The FGD explored several themes, including livelihood activities, dependence on coastal resources, environmental and socio-economic challenges, and perceptions of coastal and environmental changes. Ethical approval for the study was obtained from the Universiti Malaya Research Ethics Committee (UMREC) (Reference No.: UM.TNC(P&I)/UMREC/3/5714), and all research procedures were conducted in accordance with the Universiti Malaya Research Ethics Guidelines.

The qualitative data were analyzed using thematic analysis, whereby responses were systematically coded and categorized into recurring themes related to coastal resources, economic activities, and community challenges. This approach enabled the identification of patterns and relationships within the data and facilitated the integration of qualitative findings with spatial observations. The combined analysis provided a more holistic understanding of the relationship between coastal environments and Indigenous livelihoods in the study area.

Study area

The study focuses on the coastal region of Port Klang and the Klang Islands, located along the Selangor coastline on the west coast of Peninsular Malaysia. This area represents a complex socio-ecological system where intensive industrial development intersects with ecologically sensitive coastal environments and traditional communities. In particular, the region highlights the interaction between large-scale port activities and Indigenous livelihoods.

The Klang Islands comprise a group of coastal islands characterized by extensive mangrove forests, mudflats, and coastal waterways that support biodiversity and provide important ecosystem services, including shoreline protection, carbon storage, and fish nursery habitats (Friess et al., 2019; Lee et al., 2014). At the same time, Port Klang functions as one of Malaysia's primary maritime and logistics hubs, contributing significantly to regional economic development while also intensifying land-use changes and environmental pressures in adjacent coastal areas (Ministry of Foreign Affairs, 2022).

Seven islands were included in this study: Pulau Klang, Pulau Ketam, Pulau Tengah, Pulau Indah, Pulau Che Mat Zin, Pulau Pintu Gedong, and Pulau Selat Kering. Among these, Pulau Ketam and Pulau Indah are inhabited, while the remaining islands are largely uninhabited and dominated by mangrove ecosystems. Pulau Indah is highly developed, with port and industrial infrastructure, whereas Pulau Ketam is characterized by traditional fishing settlements, including communities of the Indigenous Mah Meri.

The Mah Meri, an Orang Asli subgroup native to coastal Selangor, have historically depended on marine and mangrove resources for their livelihoods and cultural identity (Kunasekaran et al., 2015). However, socio-economic transformations, including industrial expansion and land-use change in areas such as Port Klang and Pulau Carey, have contributed to shifts in settlement patterns and resource accessibility. These changes have influenced the relocation and adaptation strategies of the Mah Meri community, particularly in Pulau Ketam.

To support spatial understanding, this study incorporates a map (Figure 1 and Figure 2) illustrating the study area. The map is developed using satellite basemaps and processed by the author using ArcMap software tool version 10.8.2 to provide geographical context for the analysis. Table 1 presents the coordinates and shoreline lengths of the selected study zones, which form the basis for spatial referencing in this study.

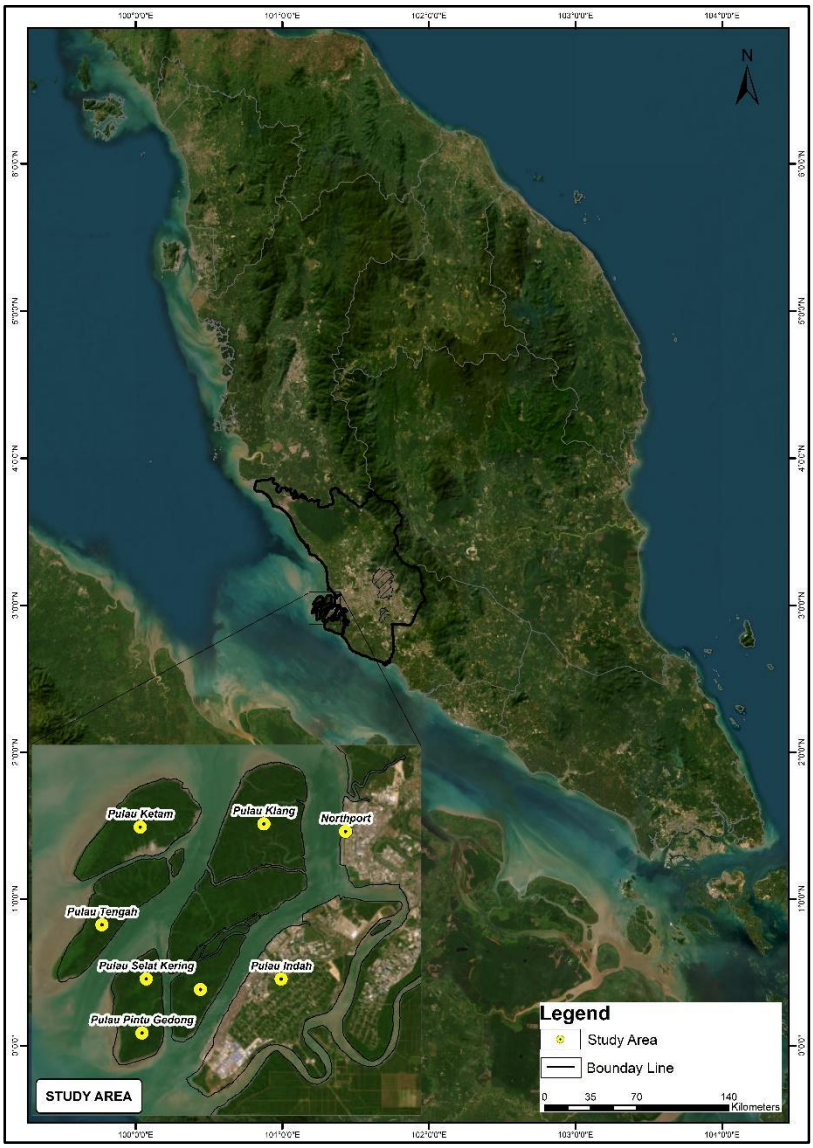


Figure 1. Map of study area

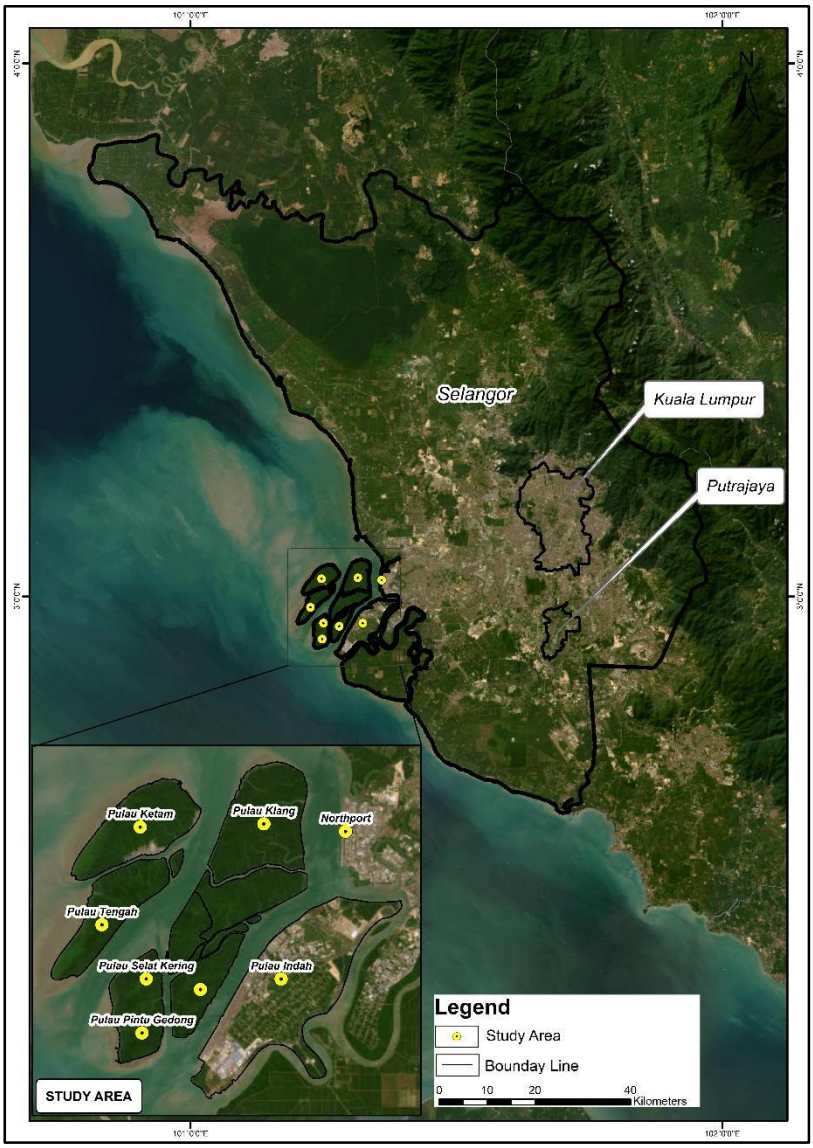


Figure 2. Coastal and island regions in the study area

Table 1. Coordinates of study area and length of coastline

Zone	Shoreline area	Coordinate (°N, °E)	Shoreline length (km)
1	Pulau Klang	3.0351, 101.3146	48.3
2	Pulau Ketam	3.0334, 101.2467	21.7
	Pulau Tengah	2.9942, 101.2354	26.8
3	Northport	3.0310, 101.3595	5.93
4	Pulau Indah	2.9578, 101.3175	44.6
5	Pulau Che Mat Zin	2.9442, 101.2798	17.1
	Pulau Pintu Gedong	2.9203, 101.2477	11.1
	Pulau Selat Kering	2.9942, 101.2433	12.9

Results and discussion

Coastal resources in Port Klang and Klang Islands

a) Pulau Klang

The KIMFR status of this island ensured that the mangrove ecosystems have limited human intervention. This statement aligns with findings by Rozainah et al. (2018) who described the mangrove forests to be in an "undisturbed pristine" condition. This is suggestive of the fact that the mangrove ecosystem should have greater biodiversity and higher carbon stock. Findings by Rozainah et al. (2018) confirmed this hypothesis where Pulau Klang had a relatively high tree density of 1627 trees ha^{-1}, second to Pulau Ketam. The biomass values for *R. apiculata*, were the highest at 41.63 and 80.51 t ha^{-1} for below-ground and above-ground biomass respectively (Rozainah et al., 2018). Findings by Zakaria et al. (2021) supported the claim that the mangrove forests at Pulau Klang had high carbon stock with the total tree carbon stock noted at 68.79 ± 43.26 Mg C ha^{-1}, second to Pulau Teluk Gong. Meanwhile, the soil carbon stock was highest where the soil carbon concentration ranged between 6.10 and 10.28% while the total soil organic carbon was at 507.03 ± 100.24 Mg C ha^{-1} (Zakaria et al., 2021).

Pulau Klang is dominated by extensive mangrove ecosystems, which provide critical ecological services such as shoreline stabilization, carbon sequestration, and habitat provision. While these ecological functions are often discussed in technical terms, their practical importance lies in supporting fisheries and protecting nearby settlements from coastal erosion.

For communities such as the Mah Meri, the health of mangrove ecosystems directly influences fish stocks and coastal safety. Degradation of these habitats can lead to declining catches and increased vulnerability to environmental hazards. Thus, the ecological condition of Pulau Klang has indirect but significant implications for livelihood sustainability in surrounding inhabited areas. Table 2 summarizes the six coastal resources identified along the coastline. The results of verification conducted on-site at three verification points (A, B, and C), as shown in Figure 3, confirmed the prevalence of mangroves along the island's coastline.

Table 2. Coastal resources along Pulau Klang coastline

Resource	Description	Reference
Mangroves	● Most abundant resource	Google Earth
	● Crucial environmental and economic services	Kathiresan (2012)
	● Long-term carbon sequestration	Dicen et al. (2019)
	● Among the most carbon-rich ecosystems	Shedage et al. (2019)
	● Can store approximately 10–15% of the carbon in coastal sediments	Alongi (2015) Marois & Mitsch (2015)
	● Provide coastal protection, nurseries and fishing grounds for aquatic species, erosion control, and storm defense	Barbier (2016) Aguilar-Perera & Hernández-Landa (2017)
	● Bio accumulators for the heavy metal pollution from industrial activities of Port Klang	Chow (2018) Usman et al. (2013)
Beaches	● May have formed from the deposition of sand and gravel by waves along the shoreline	Orr et al. (2005) Google Earth

	● Have little foreshore (< 0.2 km); possibly the erosion of the sandy beaches is at a much more rapid rate than its deposition	
Fauna	● No fauna was observable by Google Earth and visual observation ● There were birds, small mammals, and reptile species on the island ● Hardly animals, such as civets and pigs, which are adaptable to stressful environments were noted ● Diversity is not as extensive as that of Pulau Indah which includes a greater distribution of benthic macroinvertebrates	Norhayati et al. (2019) Kasihmuddin & Cob (2021a) Kasihmuddin & Cob (2021b)
Rivers	● Dendritic pattern, which is common to estuarine mangrove swamps ● Dendritic patterns are common in coastal mudflats with very little slope elevation	Aung (2019) Cohen et al. (2020) Twidale (2004)
Coastal waters	● The waters offshore the coastline appear brown nearshore due to the presence of dense sediment deposition, such as mud and suspended sand ● Progressively green offshore due to high algae and phytoplanktonic contents	NASA (2013)

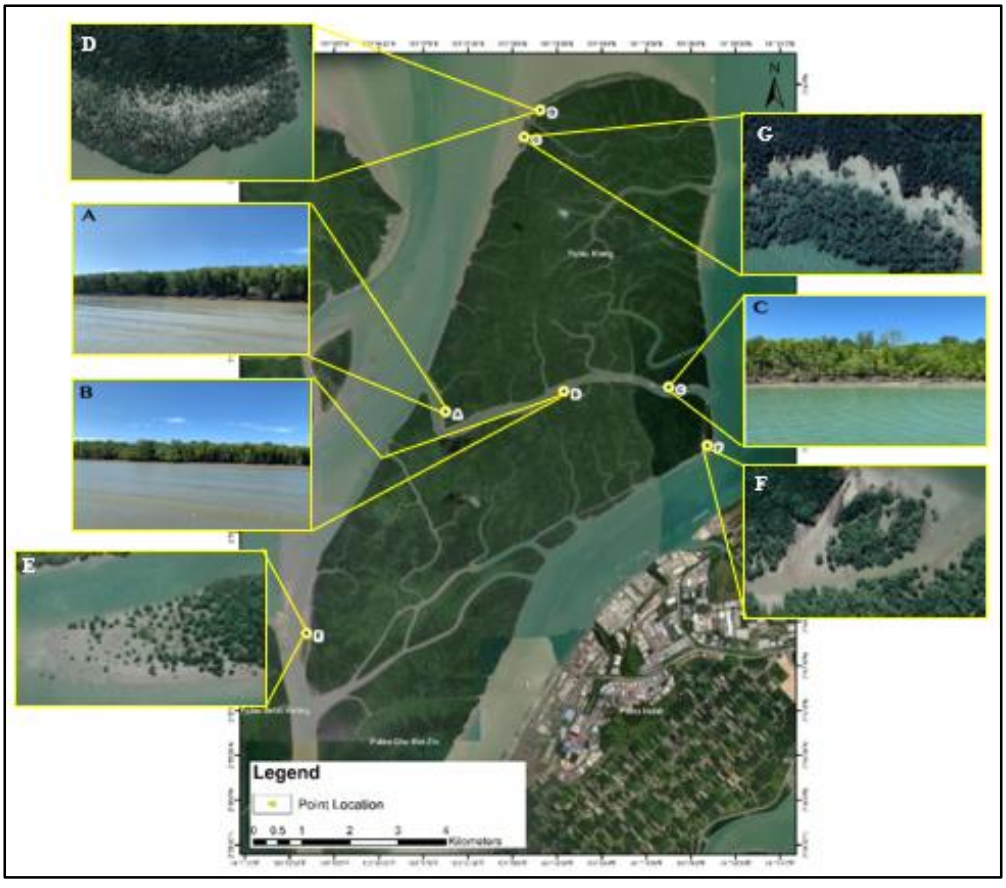


Figure 3. Coastal resources along Pulau Klang coastline: mangroves (A-C); beaches (D-G)

b) Northport and Pulau Indah

The large number of shrublands in the Northport will help to improve the sanitary conditions of the port, reduce the air pollution caused by shipping, and play an important role in the sustainable development of the port by providing good economic benefits.

In addition, inlet rivers are tidally influenced by coastal waters connected to river systems supplying freshwater and sediment, and estuaries often have important shipping channels to inland ports located in densely populated areas. Human disturbance of estuaries has led to increasing mud problems such as high turbidity with adverse ecological effects and siltation of sediments in waterways and harbors. The intertidal area is an important ecological habitat.

Northport, as an industrial port, has very limited natural resources and the following Table 3 summarized three coastal resources near Northport, and Figure 4 shows the satellite images of Northport.

Table 3. Natural resources at Northport, Klang

Resources	Description	Reference
Shrubland	● Reducing the negative impact of industrial areas on the environment and improving the level of environmental management. ● Act as a harbor green belt to improve the quality of the natural environment in the harbor area.	Google Earth Oniszczuk (2018)
Rivers	● Including common estuarine mangrove swamps ● Common in coastal mudflats at river mouths	Braat (2019)
Coastal waters	● Heavy marine traffic has resulted in increased sediment deposits in the waters near the port ● Marine pollution leads to eutrophication offshore, with elevated levels of algae and phytoplankton and greening of the water column.	Tavakoly (2013)
Fauna	● Industrial areas and no fauna were observable through Google Earth	Google Earth

© 2026, e-ISSN 2682-7727 https://doi.org/10.17576/geo-2026-2203-11

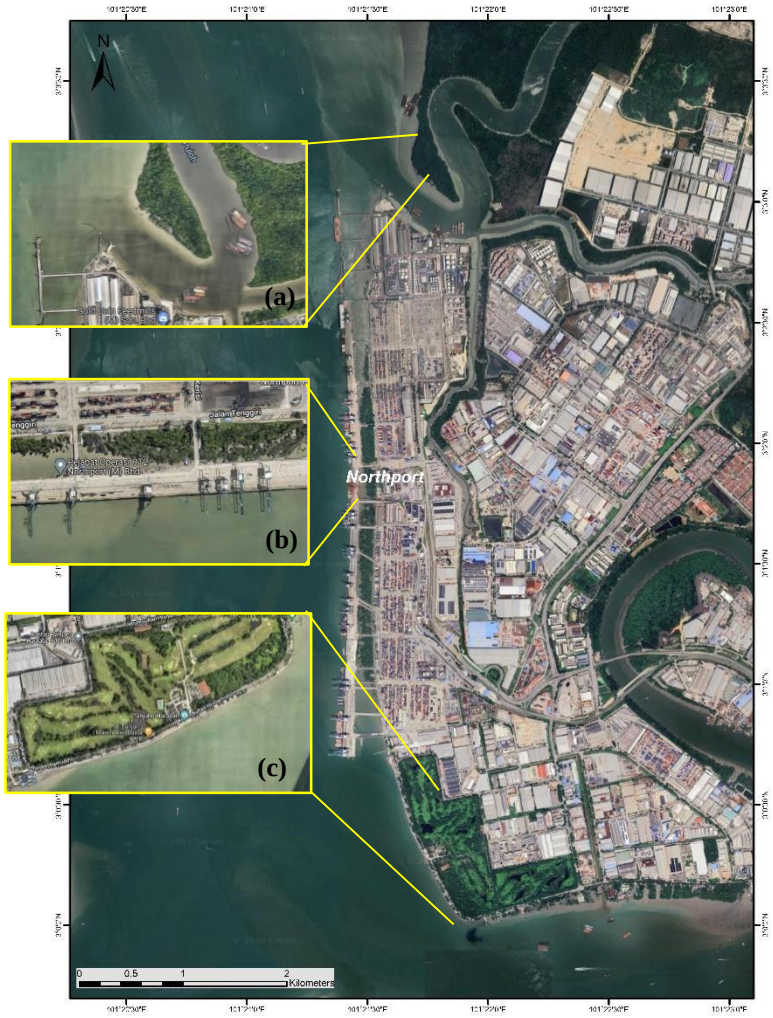


Figure 4. (a) sediment at the mouth of the river near the Northport, (b) offshore waters of the Northport, (c) situation of the green belt in Northport

In Table 4, the five natural resources along the coastline of Pulau Indah are summarized, as shown in Figure 5 for the three estuaries in the coastal area, where we observe dense mangrove shrub growth near the river mouths on both sides and the development of a coastal marina industry in Pulau Indah. Northport and Pulau Indah represent highly developed zones characterised by port infrastructure, logistics operations, and industrial activities. These areas contribute significantly to regional and national economic growth but also introduce environmental challenges, including water pollution, habitat fragmentation, and increased marine traffic.

While much of the existing literature focuses on industrial outputs and environmental indicators, the implications for nearby communities, particularly Indigenous groups are often underexplored. Pollution and water quality degradation can affect fish populations and marine biodiversity, thereby impacting small-scale fisheries that communities rely on. For the Mah Meri, such environmental changes translate into reduced income opportunities and increased livelihood vulnerability.

Table 4. Coastal resources along Pulau Indah coastline

Resources	Description	Reference
Mangroves	● Protect water quality by removing nutrients and contaminants ● A productive and biodiverse wetland environment ● Provides relief from strong winds, stabilizes shorelines and protects coastal communities	Google Earth Suratman (2008)
Beaches	● Probably formed by erosion and deposition of rocks by seawater	Google Earth Shamshuddin et al. (2013)
Fauna	● No fauna was observable by Google Earth and visual observation ● Include a greater distribution of benthic macroinvertebrates	Kasihmuddin & Cob, (2021a) Kasihmuddin & Cob (2021b)
Coastal waters	● Shorelines are being eroded at an accelerated rate by coastal waters due to the loss of mangroves	Google Earth Ahmad et al. (2021)
Rivers	● The satellite image of Google Earth shows that the estuary is surrounded by mangrove bushes, and the estuary shows a dendritic pattern along the coastline	Google Earth

Figure 5. Satellite image of resources along Pulau Indah coastline: mangroves (A-B); beaches (C-E); coastal waters (F-G); estuaries (H-I), processes using ArcMap

c) Pulau Che Mat Zin, Pulau Pintu Gedong and Pulau Selat Kering

The Klang district encompasses several islands, including Pulau Che Mat Zin, Pulau Selat Kering, and Pulau Pintu Gedong, all situated within the administrative jurisdiction of the Selangor State and falling under the three-nautical-mile boundary of coastal waters. These islands, part of the Klang River delta, are primarily mangrove-covered and designated as forest reserves, with Pulau Pintu Gedong and Pulau Selat Kering forming a single landmass divided by the Selat Kering channel. While the islands remain uninhabited and reserved for conservation and rehabilitation, the surrounding waters are actively used for aquaculture. Pulau Che Mat Zin, in particular, is a notable spot for recreational fishing, contributing to localized economic activities. The conservation of these ecosystems is therefore indirectly linked to the sustainability of Indigenous livelihoods. Degradation in these areas could disrupt ecological connectivity and reduce the availability of marine resources in nearby fishing grounds. This highlights the importance of considering both inhabited and uninhabited areas within an integrated coastal management framework. Table 5 and Figure 6 shows the coastal resources of Pulau Che Mat Zin, Pulau Pintu Gedong, and Pulau Selat Kering.

Table 5. Coastal resources of Pulau Che Mat Zin, Pulau Pintu Gedong, and Pulau Selat Kering

Resources	Description	Reference
Rivers	No branches	Google Earth
Mangroves	Covering most of the islands	Google Earth
	Among the most carbon-rich forests in the tropics	Kathiresan (2012)

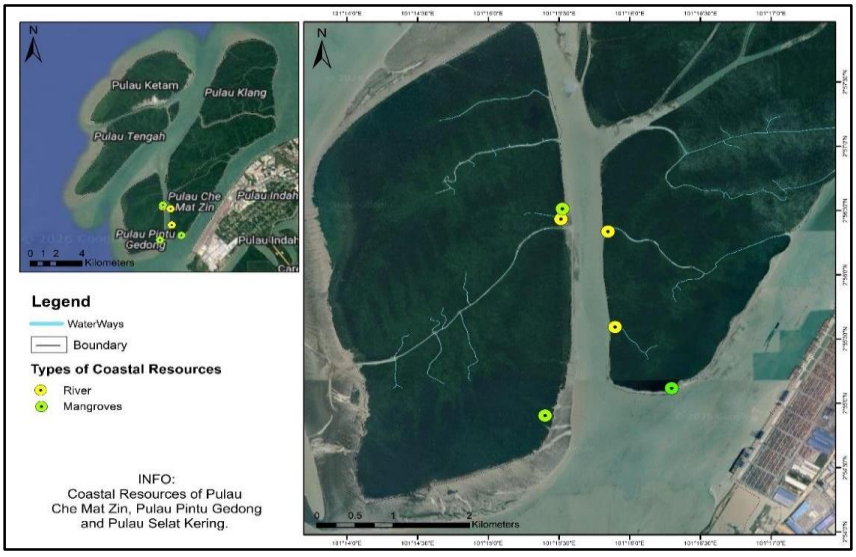


Figure 6. Resources along Pulau Che Mat Zin, Pulau Pintu Gedong, and Pulau Selat Kering: rivers; and mangroves

d) Pulau Ketam

Pulau Ketam represents the central focus of this study, as it is home to active fishing communities, including members of the Mah Meri. Table 6 summarizes the five coastal resources identified along the coastline, with verification and satellite images in Figure 7 shows each of the resources.

Table 6. Coastal resources along Pulau Ketam coastline

Resources	Description	Reference
Coastal waters	● The water closer to the settlements appears to be brown in color due to the presence of sediments	Onion (2021)
Beach	● The area that separates the sea and the land, usually consisting of sand or weathered rocks	
Fauna	● Most of the fauna were found near the coastline and the sea ● Visible examples include crabs, marine birds, and marine invertebrates, which are commonly found in mangrove forests.	Zakaria (2015)
Rivers	● Numerous rivers can be found, some straight, while some have dendritic patterns ● Most common type of river pattern generally and also in mangrove areas ● Appears to be brown in color when viewed from satellite image	Ogston et al. (2019) Cohen et al. (2020) Twidale (2004)
Mangroves	● Can be seen covering almost the entire island, except for the area where the fishing villages are located ● Protected area, therefore minimal human interference ● Generally, it serves as coastal protection, nurseries and fishing grounds for aquatic species, erosion control, and storm defense	Google Earth LUAS (n.d)

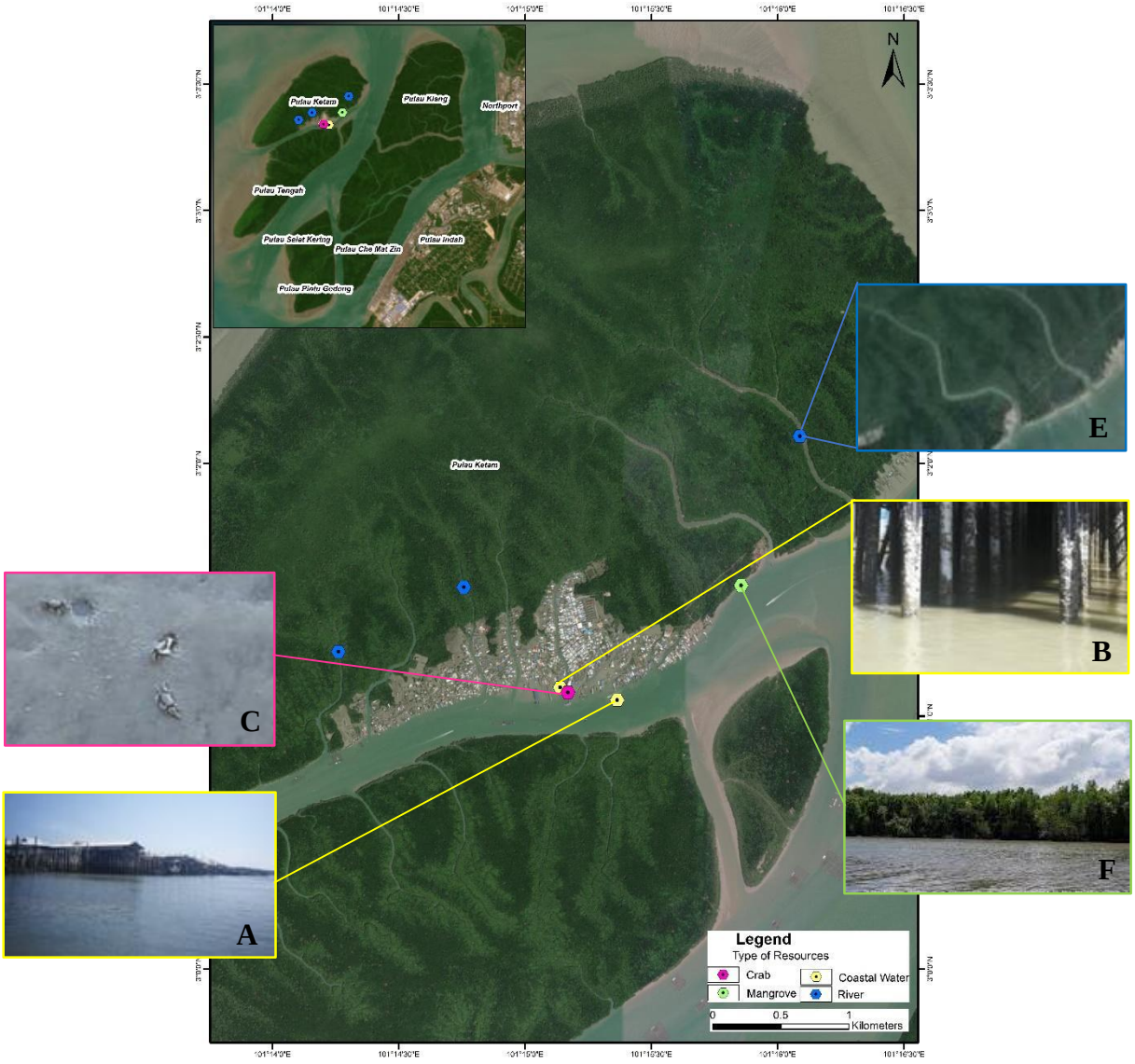
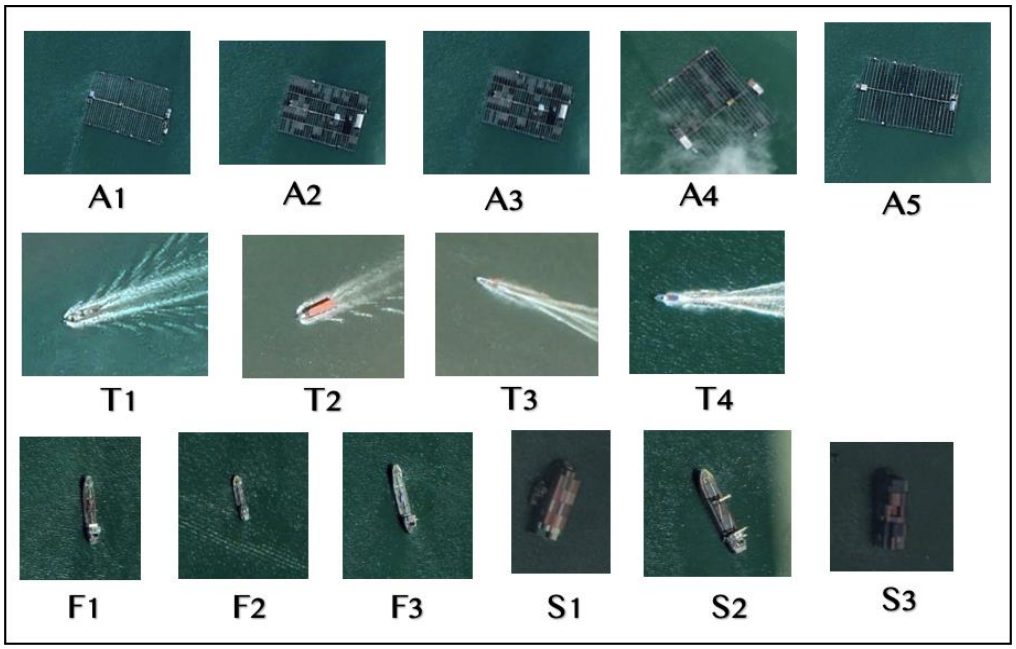


Figure 7. Resources on Pulau Ketam: coastal waters of two different colors (A-B); crabs found on the beach (C); rivers (E); mangroves (F)

Activities and challenges in Port Klang and Klang Islands

a) Pulau Klang

There are four activities identified along Pulau Klang which were aquaculture (A1-A5), tourism (T1-T4), fisheries (F1-F3), and shipping and logistics (S1-S3). Cage aquaculture was observed to be the main coastal activity as these waters account for around 25% of Peninsular Malaysia's fish harvest, as claimed by Sulaiman and Vijayan (n.d.). Table 7 describes the coastal activities and their problems, while Figure 8 shows images of coastal activities along Pulau Klang.



Source: Satellite Imagery from Google Earth

Figure 8. Coastal activities along Pulau Klang

Table 7. Coastal activities and problems at Pulau Klang

Activity	Description	Problem
Aquaculture	● Five cage aquacultures were observed around 0.2 km away from the west shoreline of the lower island	● Coastal/ water pollution due to pesticide runoff
Tourism	● Ferries and speedboats travel along the stream separating the upper and lower islands for tourists to travel from Port Klang to Pulau Ketam	● Coastal/ water pollution due to an increase in sediment load and increase of coastal litter
Fisheries	● Large fishing boats were observed between waters off Pulau Klang and Port Klang	● Oil and grease pollution due to fishing boats and exhaustion of coastal resources
Shipping and logistics	● Large container/cargo ships were observed carrying items to and from Port Klang	● Coastal and oil pollution and coastal erosion due to the constant shore area activity

b) Northport and Pulau Indah

Northport is among the biggest multi-purpose ports in the nation's ports system, with specific facilities and services for a wide range of cargoes. A few main activities or services could be found at Northport, including shipping and logistics, Roll On-Roll Off (RORO) service, and warehousing

services. (Figure 9). Table 8 shows the coastal activities/services at Northport and the potential problems created.

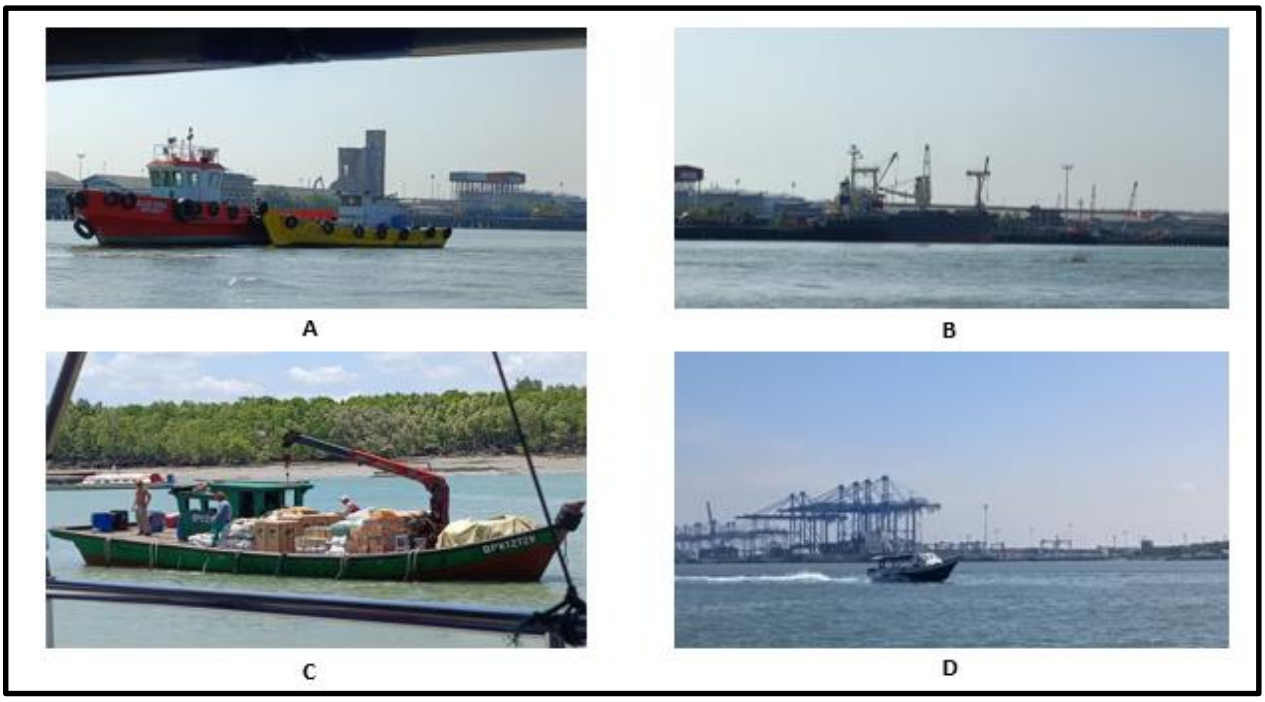


Figure 9. Shipping and logistics at Northport

Table 8. Coastal activities/services and potential problems created at Northport

Activities/Services	Description	Problem
Shipping and logistics	● Liquid bulking (crude oil and refined products, liquefied gases) storage ● Transloading & transshipment of cargoes	1. Oil and grease pollution due to leaking chemicals or oil-based products into the coastal system 2. Air pollution results from ships' exhaust gas
Roll On-Roll Off (RORO) service	● Northport has allocated a 20-acre area as the Vehicle Transit Centre to provide port coordination services to fulfill the need for domestic, regional, and worldwide automotive trades	1. Siltation of the Klang River 2. Deterioration of water quality
Warehousing cargoes	● Large containers with sufficient storage capacity for the port transportation business	● Air pollution results from ships' exhaust gas

Figure 10 shows nine activities identified along Pulau Indah which were foundation steel manufacturing, passenger cruise terminal, storage and logistics, cement manufacturing, liquid bulk

terminal, dry bulk terminal, vehicle terminal, container terminal, leisure, and recreation. Table 9 describes the environmental problems facing Pulau Indah coastal activities.

Figure 10. Satellite images of coastal activities along Pulau Indah

Table 9. Coastal activities and challenges at Pulau Indah

Activity	Description	Problem
Foundation steel manufacturing	● Oriental Steel Pipe is a manufacturing plant that produces heavy gauge and large spiral steel pipe. It produces 100,000 metric tonnes of pipe annually and has ocean access at Port Klang	● Air pollution. Steel particularly requires coal for energy, so a lot of emission is caused by coal combustion ● Heavy metal leaching pollution. The steel industry disposes of huge amounts of slag containing toxic heavy metals as by-products
Passenger cruise terminal	● The Centre provides facilities for Collection, Handlin,g and Transfer (CHT) as well as disposal of garbage	● Improper waste management as a cruise ship is a closed

	from the cruise ships that pass through the terminal	vessel and it accommodates large numbers of people
Storage and logistics	● Global Petro Storage (GPS) introduced its new Liquefied Petroleum Gas (LPG) storage facility in Port Klang. It has primary activities of storage, blending, break-bulk, handling, and distribution to domestic and international consumer markets	● LPG is a flammable substance and has a high risk of leakage which can lead to fire and explosion in the presence of spark or flame in the facility
Liquid bulk terminal	● The terminal spans 25 acres and includes access to Westport's jetty that is medium range or long-range vessel capable, cargo lines, fuel and chemical tanks and gantry facilities	● Water and soil pollution. There is a risk of accidental discharge of oil into the sea and soil, loss from deposit tankers and pipeline through operations on terminals and fuel deposits
Dry bulk terminal	● Cargill Feed Sdn Bhd, Prestasi Flour Sdn Bhd and Soon Soon Flour Mill is located at this terminal which focuses on wheat, grains and seed processes	● Noise pollution from heavy machinery and milling processes of grain
Vehicle Terminal	● Giga Car Terminal Sdn Bhd operates a 39.6-acre facility in Westport, Klang for the storage, import, export and trans-shipment of vehicles	● Oil spills. Cargo spills frequently occur while loading or unloading in port, due to handling errors or equipment problems
Container terminal	● This terminal spans up to 6 km along the shoreline of Pulau Indah and is being used by Westports Holding to store containers and vessels. Logistics of ships also occurs at this terminal	● Noise and vibration pollution
Leisure and recreation	● Tanjung Piai Beach, Pulau Indah Beach, Acheh Beach and Angler's resort are the tourism activities that are situated at the southernmost part of Pulau Indah. Mangroves inhabit the areas near this coastal area and visitors often come here for swimming and fishing	● Littering and plastic pollution. Tourists and even locals like to visit beaches for leisure which may increase the amount of waste produced ● Coastal degradation from tourism activities. Unsustainable land and water usage of resorts and building of infrastructure can destabilize coastal ecosystems

c) Pulau Che Mat Zin, Pulau Pintu Gedong and Pulau Selat Kering

Pulau Che Mat Zin, Pulau Selat Kering, and Pulau Pintu Gedong are among the forest reservation and rehabilitation areas in front of the ports of Pulau Indah which are currently covered in mangrove swamps and are uninhabited. There are three activities identified along these three islands (see Figure 11) which were aquaculture (A1), fisheries (F1), and dredging (D1). Table 10 describes the coastal activities and their problems.

A1: Aquaculture F1: Fisheries D1: Dredging

Figure 11. Coastal activities along Pulau Che Mat Zin, Pulau Selat Kering and Pulau Pintu Gedong

Table 10. summarizes the activities and problems around the islands

Activity	Problem
Aquaculture	● Aquaculture effluent pollution
Fisheries	● Oil pollution is caused by fishing boats ● Depletion of coastal resources
Dredging	● The riverbed may rise, making it a danger zone; The coast is vulnerable to breaches of levees and floods ● Downstream is easy to produce siltation, and flood discharge is not smooth, endangering the life and property safety of nearby residents

d) Pulau Ketam

Pulau Ketam is characterized by a diverse range of coastal-based economic and socio-cultural activities that are closely linked to the surrounding mangrove and marine ecosystems. Fisheries remain the primary livelihood activity among local communities, particularly small-scale fishing, crab harvesting, cockle collection, and aquaculture. The surrounding coastal waters and mangrove areas provide important nursery and feeding grounds that support local fisheries productivity. In addition, small-scale businesses such as seafood processing, seafood restaurants, retail shops, and boat transportation services contribute significantly to the local economy. Settlement patterns in Pulau Ketam are predominantly concentrated along coastal and riverine areas, reflecting the community's historical dependence on marine resources and waterways for transportation and

livelihood activities. For the Indigenous Mah Meri community, livelihoods extend beyond economic activities to include cultural practices such as woodcarving and mask-making, which are recognized as important elements of their cultural heritage. These cultural industries also provide alternative income sources, particularly through tourism-related activities.

Tourism has become an increasingly important economic sector in Pulau Ketam, attracting both domestic and international visitors through its traditional stilt-house settlements, seafood attractions, mangrove landscapes, and local cultural experiences. Popular tourism activities, as shown in Figure 12, include temple visits and sightseeing (A), eagle feeding tours (B), mangrove and river cruises (C), and seafood-based tourism (D), among others. These activities generate supplementary income for local residents through homestays, food services, tour operations, handicrafts, and transportation services. However, the growth of tourism and coastal development has also increased environmental and infrastructural pressures within the island environment, as summarized in Table 11. In addition, the community faces multiple challenges, including declining fish stocks, pollution, environmental degradation, and limited access to economic opportunities. Overfishing and changing coastal conditions have made traditional livelihood activities increasingly uncertain, particularly for resource-dependent communities such as the Mah Meri.

The importance of supporting the resilience of Indigenous communities is emphasized in global frameworks such as the United Nations Declaration on the Rights of Indigenous Peoples (UNDRIP), which advocates for the protection of Indigenous livelihoods, cultural heritage, and participation in decision-making processes (United Nations, 2007). In the Malaysian context, policies related to Orang Asli development also highlight the need for inclusive and culturally sensitive approaches in development planning (Human Rights Commission of Malaysia, 2010).

Sources: Whereismai.com (A), Amitravel.my (B), Alibaba Pulau Ketam Cruises at Facebook.com (C), Chowtimes.com (D)

Figure 12. Coastal activities in Pulau Ketam

Table 11. summarizes the activities and problems around the island

Coastal activities	Associated challenges
Small-scale fisheries and crab harvesting	Declining fishery resources due to environmental degradation, overfishing, and water pollution
Aquaculture and cockle farming	Water quality deterioration, disease outbreaks, and fluctuating market prices
Mangrove resource dependence	Mangrove degradation and reduced ecosystem resilience due to nearby coastal development
Boat transportation and river-based activities	Rising fuel costs, river sedimentation, and navigation constraints
Seafood businesses and local trade	Economic uncertainty and dependency on tourism and fisheries sectors
Temple visits and cultural tourism	Increased waste generation and pressure on local infrastructure
Eagle feeding and mangrove tours	Disturbance to wildlife behaviour and ecological sensitivity from uncontrolled tourism activities
Recreational fishing and river cruises	Environmental pollution and carrying capacity concerns
Homestays and tourism-related services	Seasonal tourist fluctuations and limited infrastructure development
Coastal settlements on stilts	Exposure to flooding, coastal erosion, and climate-related risks such as sea-level rise

Thematic analysis of Indigenous livelihoods and challenges

To further understand the lived experiences of the Indigenous Mah Meri community, qualitative data obtained from Focus Group Discussions (FGDs) and interviews were analyzed using thematic analysis. The responses were systematically coded and grouped into key themes reflecting the community's relationship with coastal resources, livelihood strategies, and the challenges they face.

a) Theme 1: Dependence on coastal and mangrove resources

Findings indicate a strong dependence on coastal ecosystems, particularly mangroves and marine resources, for both subsistence and income generation. Fishing remains the primary livelihood activity, supplemented by small-scale aquaculture and the collection of forest products.

Participants emphasized the importance of mangrove ecosystems as critical fishing grounds: "Kami bergantung kepada laut dan hutan bakau untuk mencari rezeki setiap hari." ("We depend on the sea and mangroves for our daily livelihood.")

This highlights the close relationship between ecological health and economic sustainability, where any disruption to coastal ecosystems directly affects household income and food security.

b) Theme 2: Environmental change and declining resource availability

A recurring theme across discussions was the perceived decline in marine resources, which participants attributed to environmental degradation, pollution, and increased development activities in surrounding areas such as Port Klang and Pulau Indah.

Respondents noted changes in water quality and reduced fish catch: “Sekarang ikan semakin kurang, dan air sudah tidak bersih seperti dahulu.” (“Now there are fewer fish, and the water is not as clean as before.”)

These observations are consistent with broader environmental concerns in coastal regions, where industrial activities and overfishing contribute to ecosystem degradation. The findings demonstrate how environmental changes translate into tangible socio-economic impacts for the community.

c) Theme 3: Livelihood adaptation and diversification

In response to declining natural resources, the Mah Meri community has adopted various adaptation strategies to sustain their livelihoods. These include diversifying income sources through tourism-related activities, small businesses, and cultural industries such as woodcarving and traditional mask-making.

Such diversification reflects a form of community resilience, where traditional knowledge and cultural practices are leveraged as alternative economic opportunities. However, these activities are often limited by market access, financial constraints, and external dependencies.

d) Theme 4: Cultural identity and knowledge systems

Beyond economic considerations, coastal resources are deeply embedded in the cultural identity of the Mah Meri. Traditional ecological knowledge, including understanding of tides, fishing grounds, and mangrove ecosystems, plays a crucial role in sustaining their way of life.

The preservation of cultural practices, including craftsmanship and rituals, is closely tied to environmental continuity. As such, environmental degradation not only threatens livelihoods but also risks eroding cultural heritage.

e) Theme 5: Perceived marginalization and limited participation

Participants also expressed concerns regarding limited involvement in decision-making processes related to coastal development and resource management. Many felt that their perspectives were not adequately considered in policies affecting their environment and livelihoods.

This reflects broader challenges faced by Indigenous communities, as highlighted in frameworks such as the United Nations Declaration on the Rights of Indigenous Peoples (United Nations, 2007), which emphasizes the importance of participation, consultation, and rights to traditional resources.

Conclusion

This study highlights the important role of coastal ecosystems in Port Klang and the Klang Islands, particularly Pulau Ketam, in supporting local livelihoods and economic activities. Mangroves, coastal waters, rivers, and mudflats provide essential resources for fisheries, aquaculture, tourism, and small-scale businesses, while also contributing to ecological functions such as coastal protection and biodiversity conservation. For the Indigenous Mah Meri community, these ecosystems are closely linked not only to income generation but also to cultural identity and traditional knowledge.

The findings show that environmental pressures such as pollution, habitat degradation, and coastal development have increasingly affected resource availability and livelihood stability. These impacts are particularly significant for resource-dependent communities such as the Mah Meri, whose daily activities and well-being are closely connected to coastal ecosystems. Despite these challenges, the community continues to demonstrate resilience through livelihood diversification and adaptation to changing environmental and socio-economic conditions.

By integrating spatial visualization with field-based community insights, this study provides a more contextual understanding of the relationship between coastal environments and Indigenous livelihoods. The findings emphasize the need for inclusive and sustainable coastal management approaches that incorporate Indigenous knowledge, strengthen community participation, and balance economic development with environmental conservation.

More broadly, the study supports the importance of integrating Indigenous perspectives into coastal planning and policy frameworks in line with the United Nations Sustainable Development Goals (SDGs), particularly SDG 11 (Sustainable Cities and Communities), SDG 12 (Responsible Consumption and Production), SDG 13 (Climate Action), and SDG 14 (Life Below Water). Ensuring the meaningful inclusion of Indigenous communities in decision-making processes is essential for achieving equitable and sustainable coastal development in Malaysia and other rapidly developing coastal regions.

Acknowledgment

This project was supported by Universiti Malaya Impact-Oriented Interdisciplinary Research Grant Programme (IIRG) CYCLE 5/2022 (IIRG003C-2023). Risk and Resiliency: Impacts of Climate and Environmental Changes on Mah Meri Community in Pulau Ketam, Selangor.

Author contribution statement

Engku Aisyah Nasuha and Sanjeef Kumr Subramaniam developed the search query and performed the desktop study and qualitative analysis. Siti Aisyah Alias, Mozard Mohtar, and Hanafi Hussin verified the findings of this work both from the methods and field study. All authors discussed the results and contributed to the final manuscript.

References

Aguilar-Perera, A., & Hernández-Landa, R. C. (2017). The rainbow parrotfish (Scarus guacamaia) does not depend on mangroves as nursery habitats in the Parque Nacional Arrecife Alacranes, Southern Gulf of Mexico. *Marine Biodiversity, 47*(1), 13–14.

Alongi, D. M. (2015). The Impact of climate change on mangrove forests. *Current Climate Change Reports, 1*(1), 30–39.

Aung, D. C. (2019). Spatio-temporal variations in sedimentary processes in the tidal river to estuarine reach of the Ayeyarwady Delta, Myanmar.

Barbier, E. B., Hacker, S. D., Kennedy, C., Koch, E. W., Stier, A. C., & Silliman, B. R. (2011). The value of estuarine and coastal ecosystem services. *Ecological Monographs, 81*(2), 169–193.

Bennett, N. J., Blythe, J., Cisneros-Montemayor, A. M., Singh, G. G., & Sumaila, U. R. (2019). Just Transformations to Sustainability. *Sustainability, 11*(14), 3881.

Bennett, N. J., Blythe, J., Tyler, S., & Ban, N. C. (2016). Communities and change in the anthropocene: Understanding social-ecological vulnerability and planning adaptations to multiple interacting exposures. *Regional Environmental Change, 16*(4), 907–926.

Braat, L., Leuven, J. R. F. W., Lokhorst, I. R., & Kleinhans, M. G. (2019). Effects of estuarine mudflat formation on tidal prism and large-scale morphology in experiments. *Earth Surface Processes and Landforms, 44*(2), 417–432.

Brown, G., & Kyttä, M. (2018). Key issues and priorities in participatory mapping: Toward integration or increased specialization?. *Applied Geography, 95*, 1–8.

Casella, E., Collin, A., Harris, D., Ferse, S., Bejarano, S., Parravicini, V., Hench, J. L., & Rovere, A. (2017). Mapping coral reefs using consumer-grade drones and structure from motion photogrammetry techniques. *Coral Reefs, 36*(1), 269–275.

Chow, J. (2018). Mangrove management for climate change adaptation and sustainable development in coastal zones. *Journal of Sustainable Forestry, 37*(2), 139–156.

Cohen, M. C. L., Figueiredo, B. L., Oliveira, N. N., Fontes, N. A., França, M. C., Pessenda, L. C. R., De Souza, A. V., Macario, K., Giannini, P. C. F., Bendassolli, J. A., & Lima, P. (2020). Impacts of Holocene and modern sea-level changes on estuarine mangroves from northeastern Brazil. *Earth Surface Processes and Landforms, 45*(2), 375–392.

Dicen, G. P., Navarrete, I. A., Rallos, R. V., Salmo, S. G., & Garcia, M. C. A. (2019). The role of reactive iron in long-term carbon sequestration in mangrove sediments. *Journal of Soils and Sediments, 19*(1), 501–510.

Friess, D. A., Rogers, K., Lovelock, C. E., Krauss, K. W., Hamilton, S. E., Lee, S. Y., Lucas, R., Primavera, J., Rajkaran, A., & Shi, S. (2019). The state of the world's mangrove forests: Past, present, and future. *Annual Review of Environment and Resources, 44*(1), 89–115.

Hamdan, O., Tariq, M. H., & Ismail, P. (n.d.). Status of Mangroves in Malaysia (No.50). Forest Research Institute Malaysia 2020.

Intergovernmental Panel on Climate Change (IPCC). (2023). Climate Change 2022 – Impacts, Adaptation and Vulnerability: Working Group II Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change (1st ed.). Cambridge University Press.

Jayson-Quashigah, P.-N., Appeaning Addo, K., Amisigo, B., & Wiafe, G. (2019). Assessment of short-term beach sediment change in the Volta Delta coast in Ghana using data from Unmanned Aerial Vehicles (Drone). *Ocean & Coastal Management, 182*, 104952.

Kathiresan, K. (2012). Importance of mangrove ecosystem. *International Journal of Marine Science, 2*(10), 80-89.

Kunasekaran, P., Gill, S. S., & Talib, A. T. (2015). Community resources as the Indigenous tourism product of the Mah Meri people in Malaysia. *Journal of Sustainable Development, 8*(6), p158.

Lee, S. Y., Primavera, J. H., Dahdouh-Guebas, F., McKee, K., Bosire, J. O., Cannicci, S., Diele, K., Fromard, F., Koedam, N., Marchand, C., Mendelssohn, I., Mukherjee, N., & Record, S. (2014). Ecological role and services of tropical mangrove ecosystems: A reassessment. *Global Ecology and Biogeography, 23*(7), 726–743.

Lembaga Urus Air Selangor. (n.d) *Crab Island (Pulau Ketam)*. Port Klang ICM Webpage.

Marois, D. E., & Mitsch, W. J. (2015). Coastal protection from tsunamis and cyclones provided by mangrove wetlands – A review. *International Journal of Biodiversity Science, Ecosystem Services & Management, 11*(1), 71–83.

McCall, M. K., & Dunn, C. E. (2012). Geo-information tools for participatory spatial planning: Fulfilling the criteria for 'good' governance?. *Geoforum, 43*(1), 81–94.

Ministry of Foreign Affairs. (2022). Port development in Malaysia: An introduction to the country's evolving port landscape. Netherlands Enterprise Agency.

Mohd Kasihmuddin, M. S., & Che Cob, Z. (2021a). Distribution of benthic macroinvertebrates in seafloor northward of Pulau Indah, Klang. *Pertanika Journal of Science and Technology, 29*(1), 641-662.

Mohd Kasihmuddin, M. S., & Che Cob, Z. (2021b). Ecological roles of benthic community in seafloor northwards of Pulau Indah, Klang, Malaysia. *Pertanika Journal of Science and Technology, 29*(2), 1267-1288.

Moskwa, E., Bardsley, D. K., Robinson, G. M., & Weber, D. (2018). Generating narratives on bushfire risk and biodiversity values to inform environmental policy. *Environmental Science & Policy, 89*, 30–40.

NASA (2013, November 18). How to interpret a satellite image: Five tips and strategies.

Nicholas, C. (2000). The Orang Asli and the contest for resources: Indigenous politics, development and identity in Peninsular Malaysia. International work group for indigenous affairs.

Norhayati, A., Shukor, M. N., & Juliana, S. (2009). Mangrove flora and fauna of Klang Islands mangrove forest reserves, Selangor, Malaysia. *Malaysian Journal of Science, 28*(3), 275–288.

Onion, A. (May 13, 2021). *Why is the ocean different colors in different places?*. HowStuffWorks. https://science.howstuffworks.com/environmental/earth/oceanography/why-is-ocean-different-colors-different-places.htm

Oniszczuk-Jastrząbek, A., Pawłowska, B., & Czermański, E. (2018). Polish sea ports and the Green Port concept. *SHS Web of Conferences, 57*, 01023.

Orr, M., Zimmer, M., Jelinski, D. E., & Mews, M. (2005). Wrack deposition on different beach types: Spatial and temporal variation in the pattern of subsidy. *Ecology, 86*(6), 1496–1507.

Partelow, S. (2018). A review of the social-ecological systems framework: Applications, methods, modifications, and challenges. *Ecology and Society, 23*(4), art36.

Pham, T., Yokoya, N., Bui, D., Yoshino, K., & Friess, D. (2019). Remote Sensing approaches for monitoring mangrove species, structure, and biomass: Opportunities and challenges. *Remote Sensing, 11*(3), 230.

Rozainah, M. Z., Sofawi, A. B., Joharee, N. A., & Pauzi, A. Z. (2018). Stand structure and biomass estimation in the Klang Islands mangrove forest, Peninsular Malaysia. *Environmental Earth Sciences, 77*(13), 486.

Shamshuddin, J., Kang, M. E., Fauziah, C. I., & Panhwar, Q. A. (2013). On the pyritization of the coastal sediments in the Malay Peninsula during the Holocene and its effects on soil. *Malaysian Journal of Soil Science*, *17*(1), 1-15.

Shedage, S., Shrivastava, P. K., & Behara, L. K. (2019). Carbon rich mangrove forests: An overview for strategic management and climate change mitigation. *Advances in Research, 18*(2), 1–9.

SUHAKAM. (2010). Suhakam's report on the roundtable discussion on the rights of ethnic minorities and marginalised communities in Malaysia. Human Rights Commission of Malaysia.

Suratman, M. N. (2008). Carbon Sequestration Potential of Mangroves in Southeast Asia. In F. Bravo, R. Jandl, V. LeMay, & K. Von Gadow (eds.), *Managing Forest Ecosystems: The Challenge of Climate Change* (pp. 297–315). Springer Netherlands.

Tavakoly Sany, S. B., Salleh, A., Rezayi, M., Saadati, N., Narimany, L., & Tehrani, G. M. (2013). Distribution and contamination of heavy metal in the coastal sediments of Port Klang, Selangor, Malaysia. *Water, Air, & Soil Pollution, 224*(4), 1476.

Tengö, M., Hill, R., Malmer, P., Raymond, C. M., Spierenburg, M., Danielsen, F., Elmqvist, T., & Folke, C. (2017). Weaving knowledge systems in IPBES, CBD and beyond-Lessons learned for sustainability. *Current Opinion in Environmental Sustainability, 26–27*, 17–25.

Twidale, C. (2004). River patterns and their meaning. *Earth-Science Reviews, 67*(3–4), 159–218.

United Nations. (2007). United Nations Declaration on the Rights of Indigenous Peoples (A/RES/61/295). United Nations General Assembly.

Usman, A. R. A., Alkredaa, R. S., & Al-Wabel, M. I. (2013). Heavy metal contamination in sediments and mangroves from the coast of Red Sea: Avicennia marina as potential metal bioaccumulator. *Ecotoxicology and Environmental Safety, 97*, 263–270.

Zakaria, M., & Rajpar, M. (2015). Assessing the fauna diversity of Marudu Bay mangrove forest, Sabah, Malaysia, for Future Conservation. *Diversity, 7*(2), 137–148.

Zakaria, R., Chen, G., Chew, L. L., Sofawi, A. B., Moh, H. H., Chen, S., Teoh, H. W., & Adibah, S. Y. S. N. (2021). Carbon stock of disturbed and undisturbed mangrove ecosystems in Klang Straits, Malaysia. *Journal of Sea Research, 176*, 102113.