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Coastal protection strategies in sustainable landscape design at Kelanang Beach, Selangor

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Abstract

Natural attractions and distinctive geographical settings make the coastal environment a promising opportunity for economic and social development. However, coastal areas are susceptible to environmental change, as the recent event shows that sea level rise has damaged Kelanang Beach. Controlling and minimizing the damage caused by sea level rise in the coastal zone is important for the area's benefit and long-term survival. Coastal protection strategies are essential to the survival of coastal ecosystems and the communities that rely on them. This study proposes coastal protection strategies in sustainable landscape design for Kelanang Beach, Selangor. The study entails the collection of primary data through site observation, in addition to the collection of secondary data which both compiled in the stage of site inventory, analysis, and map synthesis. The proposed design focuses on three main areas: the Kelanang Beach area, the glamping site area, and the mangrove trail area. The aesthetic value and practicality of these areas are highlighted through the design process including a zoning diagram, functional diagram, spatial diagram, design idea plan, and master plan proposal. Coastal protection strategies suggested in the master plan proposal include the integration of hard and soft strategies such as breakwater, planting buffer, and mangrove replanting. The design emphasized vegetation richness to stabilize the beach embankment and maintain the coastal line in the near future. This master plan idea is one of the landscape planning mechanisms to develop coastal areas while strengthening positive symbiotic relationships between local residents, tourists, and the natural environment.

1. INTRODUCTION

Malaysia's coastline environment offers socio-economic potential due to its natural attractions and unique geographical settings (Ooi and Ann, 1996; Wong, 2021). The coastal zone specifically, not only serves as a sanctuary for the aquatic ecosystem but as a recreational destination for the public. However, coastal ecosystems and the communities that rely on them are susceptible to environmental change (He & Silliman, 2019; Lee, 2015; Rubinato *et al*., 2020). Globally, sea level rise has a significant impact on the coastal environment, creating beach erosion, land flooding, increased flood and storm damage, increase salinity of coastal aquifers, and coastal ecosystem loss. Even though the projected rise in sea level in Malaysia is far less than the projected rise in sea level worldwide, the long-term effects of sea level rise are expected to inundate coastal elements such as intertidal habitat and coastal land (Nor *et al*., 2013). While these effects are already present in coastal areas, sea level rise causes their severity. Furthermore, the combined effects of high spring tides, storm surges, surface waves, and river flooding will cause changes in the intensity and frequency of extreme events. These events lead to the vulnerability of the coastal community to further environmental hazards and cause serious socio-economic damage (Fency, 2018; Lan, 2021; Winterwerp *et al*., 2016). Controlling and minimizing the damage caused by sea level rise in the coastal zone is important for the area's benefit and long-term survival. Despite the risk of coastal hazards, the Malaysian government invests in infrastructure and facilities to improve tourist attractions along the country's coastal areas (Ahmad and Jusoh, 2019; Wong, 2021). Furthermore, numerous efforts such as large-scale replanting supported by scientific research and innovation were carried out along the country's coastlines to expand natural buffer zones and slow the rate of coastal erosion (Rashidi *et al*., 2021). Even so, coastal environments continue to pose risks and necessitate careful planning to ensure that they benefit both nature and humans. The purpose of this paper is to highlight the affected coastal

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area by mitigating coastal hazard impacts primarily caused by natural and human activities. With its contextualization and analysis of public beaches, this paper intends to propose strategies in a landscape design master plan that can aid decision-making in developing local action plans.

2. LITERATURE REVIEW

A coastal zone is the interface between the land and water (Lavalle *et al*., 2011) and is continually changing because of the dynamic interaction between the oceans and the land (Crossland *et al.*, 2004). An abundance and diversity of resources, as well as a concentration of human activities and settlements along the coasts and estuaries, distinguish these dynamic zones. Significant coastal infrastructure, including parks, natural areas, and industrial zones, is presently undergoing active development in many different regions across the globe (Elsharouny, 2016). The World Risk Index has determined that all tropical, coastal developing nations are the most vulnerable to natural disasters such as storms, floods, erosion, and sea level rise (Beck *et al*., 2018). Despite the threats posed by climate change and rising sea levels, this trend in coastal development continues, with large-scale plans in coastal areas still being realized (Lee, 2015; Priyanto, 2010). An increase in the number of proposed recreational projects in the coastal zone along the shoreline suggests that research into methods of coastal protection and beach design is needed.

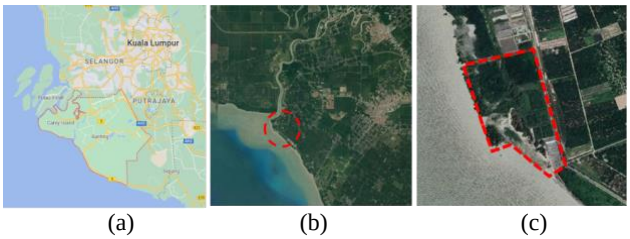
Coastal protection refers to measures aimed at protecting, preserving, or restoring the shore and the dynamic coastal landscape, as well as preventing scour and erosion caused by wave behaviour (Masria and Negm, 2015). Given the natural dynamics of most sandy coasts, numerous measures to mitigate the effects of coastal erosion caused by sea level rise can be incorporated into the design strategies (Sauv *et al.*, 2022). According to Masria and Negm (2015), protection measures around the world can be categorized into four primary categories: hard, soft, combined, and innovative. Rubinato *et al*., (2020), however, categorized this protection primarily as hard strategies and soft strategies. Among all categories, environmentally friendly coastal structures or soft categories are better suited to solving the majority of coastal problems, saving the ecosystem, and reducing the expenses incurred for protection. With reference to a study by Lee, (2015), the proposed strategies used systematic adaptation plans to reveal the topographical connections and material movements of each area by connecting the pine forest and the seashore to allow for sand circulation. As a result, the pine forest act as the natural influx of soil and sand as well as a natural buffer. Hence, the loss of sandy beaches, damage from storm surges, and high swells issue could be resolved indicating the natural adaptation design strategy to reduce coastal erosion is more sustainable than the hard engineering structure.

Another natural coastal defence using mangrove planting provides the greatest flood reduction benefits to countries in West and East Africa, Central America, and the South Pacific (Beck *et al*., 2018; Wilms *et al*., 2019). Mangroves are trees that live along tropical coastlines, rooted in salty sediments, often underwater. Mangrove conservation and restoration can be an important part of the solution for reducing the risks to coastal communities, especially as those risks increase with climate change. Wilms *et al.*, (2019) solve the sea level rise issue by integrating mangrove and river restoration, small-scale engineering, and sustainable land use. Both engineering and ecological concepts demonstrate the significance of mangrove trees in protecting the coastline from erosion and flooding that could affect the community's quality of life. Developments along coastlines, in general, require studies such as coastal impact studies and beach design studies to protect the sandy coast from potential threats.

3. RESEARCH METHODOLOGY

3.1. Site Location

The study area is Kelanang Beach, which is located in the Kuala Langat district, the closest beach to Kuala Lumpur at coordinate N02° 47.384', E101° 24.710'. Kelanang Beach is authorized by Majlis Perbandaran Kuala Langat (MPKL) and is flanked by dense clumps of mangrove trees that divide sections of the beachfront. The site study is surrounded by oil palm plantations and coastal plants. The 65-acre area is made up of a mangrove forest, beach forest, recreational park, and open space. The area selected for this study is specifically at the coastal zones that include mangrove and recreational areas near the coastlines. The majority of activities in the study area are recreational in nature. Some examples of these activities include looking for clams or mussels on the beach at low tide and relaxing in the park specially prepared for that purpose.



(a) (b) (c)

Figure 1: Study area; (a) Key plan, (b) Location plan, (c) Site plan (Google, 2021).

3.2 Coastal Morphology

Numerous tools are capable of defining and characterizing coastal and river channels, including Google Earth Engine (GEE) images (Boothroyd et al., 2020; Silva et al., 2020). Based on the available images from the GEE, Figure 2 compares the coastal morphology of Kelanang Beach from the year 2001 to 2021. The coastal defences of Kelanang Beach are at risk due to the beach's soil erosion issue. As was discovered in 2001, Kelanang Beach was

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once dominated by a mangrove habitat. This habitat serves as a natural buffer to the beach's inland area, preventing erosion brought on by climatic change. The habitat is safe from destruction because fewer human activities are present at the site. The beach zone of Kelanang in 2001 is about 275 meters wide due to the assistance of the mangrove habitat that holds the coastal line. In 2014, however, the mangrove habitat was replaced with parking for Kelanang Beach visitors as part of an effort to develop the site study as a tourist destination. Since there are not enough mangroves to protect against waves and rising sea levels, the coastline is eroding. As a result, the beach zone decreased to 46 meters from the coastal line in 2014. In 2018, the effects of cutting down mangrove trees became more severe as there was no natural buffer to help protect the shoreline from natural phenomena. The coastal lines are shifting inland as the soil erodes due to sea level rise. In 2018, local governments took action to protect the coastlines by constructing beach embankments and groynes to the coastal line zone to support the eroded soil, with the area of the beach zone recorded about 120 meters from the coast. Each groyne catches a portion of the sand that is transported by the littoral transport system *(*Lebbe *et al*., 2021; Syakir *et al*., 2020).

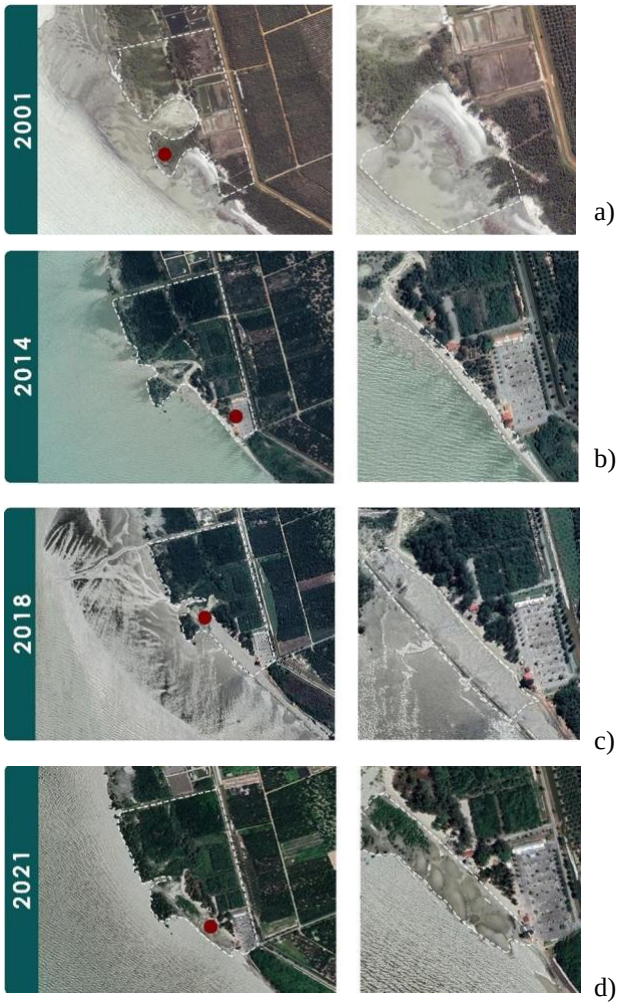

Figure 2: Coastal Morphology; a) 2001, b) 2014, c) 2018, d) 2021

Because of previous government efforts to safeguard the coastline, 2021 images shows the sand area on Kelanang Beach has become a mini-island where visitors use the area for mussels collecting activity during low tide. The site investigation specifies that Kelanang Beach is accessible to the public for recreational purposes. In addition, the beach is currently undergoing the process of upgrading and maintaining its amenities and infrastructure, and the National Hydraulic Research Institute of Malaysia (NAHRIM) is carrying out research to ensure that the beach is not susceptible to being damaged (Mohamad *et al*., 2014).

3.3 Site Inventory and Analysis

Site inventory is the process of gathering primary data and information for an on-site investigation. This process is crucial, as it is the most efficient way besides the secondary data collection to learn about the site study prior to the design phase. In April 2022, site observations were conducted for a total of fourteen days as part of the process of gathering primary data at the site study. Data collection methods used include taking photographs, recording events, and conducting interviews with people in the area. Following this, an analysis of the data was performed, focusing on the strength, weaknesses, opportunities, and threats that were observed during the site study. The inventory and analysis cover the components of (1) Land use, (2) Vegetation, (3) Wildlife, (4) Meteorological condition, (5) Hydrology, (6) Topography, and (7) Circulation (McHarg, 1967).

3.3.1 Land Use

The land use of this study area has been categorized into three main classes, which are the beach area, recreational area, and forest area.

3.3.1.1 Beach area

In an effort to provide visitors with a better visual experience, the authority has removed some mangrove trees to improve visibility towards the beach. The opening of the site study as a tourist destination spawned new beach activities, such as the sale of food and the performance of buskers, to attract visitors. As the closest beach to Kuala Lumpur, visitors to the site study come to relax due to its strategic location.

3.3.1.2 Recreational area

A camping site and an open park are the two different types of recreational spaces at the site study. Visitors prefer to spend their time in an open park since it has more chairs and accessible than a camping site. The location of the campsite is more secluded to give campers a feeling of privacy. Due to the facilities accessible to all visitors, the camping area has been one of the main draws for people to visit the site.

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3.3.1.3 Forest area

The site observation reveals the presence of both mangrove forests and beach forests. Campers can access a section of beach forest near the campground, but there are no mangrove trails in the area that would allow them to explore the mangrove forest. Mangrove forests cover roughly 70 percent of Kelanang Beach and protecting them is essential if the area is to continue serving as a tourist destination. Kelanang Beach has the potential to become a popular tourist destination; however, in order to do so, it will require effective landscape management of the public facilities as well as programming that is designed to entice tourists from the surrounding areas of Kuala Lumpur and Selangor.

a) Mangrove Forest

Avicennia germination L., *Sonneratia caseolaris L.*, and *Rhizophora apiculata* are the three different types of mangrove species identified during primary data collection. *Rhizophora apiculata* is known as the most common native mangrove species in Malaysia (Faridah-Hanum *et al.*, 2014; Kanniah *et al*., 2015). It lives in large groups on the thick, soft mud of estuaries flooded by high tides. The species 'avoids' harder ground mixed with sand, favours tidal rivers with high freshwater input, and are the primary species in the site study. With up to 80 percent of the vegetation on the site, it has the potential to be dominant.

b) Beach Forest

A beach forest is defined as a narrow strip of woodland along the sandy and gravelly beaches of the seacoast and hosts a diverse range of flora and animals (Göltenboth *et al*., 2006). The beach vegetation identified in the site study is *Hibiscus tiliaceus L.*, *Terminalia catappa L.*, and *Acacia mangium* which was planted along the beach park. Low-growing herbaceous creeping plants were also present as part of the natural ground cover.

3.3.2 Vegetation

There are a number of non-native plants planted around the site study for both aesthetic and agricultural reasons. The term "non-native species" refers to a plant that does not grow natively in a region but has been brought by humans, either intentionally or unintentionally (Nor Rasidah et al., 2010). Unlike invasive species, non-native species may not hinder or prevent the survival of others within the ecosystem. There are four types of non-native plants planted in the site study which are *Casuarina equisetifolia L.*, *Elaeis guineensis*, *Sterculia foetida*, and *Cocos nucifera*.

3.3.3 Wildlife

Since the majority of the land in the site study is a mangrove forest, it is home to a wide range of animals. Many species of wildlife rely on forests for survival, making them especially sensitive to forest disturbance and removal. Large mammals were not seen during the site observation, probably due to the absence of required habitats. One of the mammal species found in the site study is *Macaca fascicularis* (Long-tailed macaque) inhabit in the lowland and mangroves area. Clearing of the mangrove environment eventually ruined their habitat, causing discomfort to Kelanang Beach visitors because these species have been observed stealing food from those who came for a picnic at the beach. For other species in the mangrove area, a large group of arthropods was found in the site study such as *Scylia serrata* (Crab), and *Exopalaemon styliferus* (Roshna prawn). The *Nephilia pilipes* (Golden web spider) and *Pteroptyx tener* (Firefly) were found near *Sonneratia caseolaris*, known as the Firefly mangrove. This species has the potential to improve the mangrove ecosystem and turn into one of the attractions where visitors may take in the scenery of the firefly habitat. Another dominant species observed in the mangrove was the *Periophthalmoodon* (Mudskipper), which is the unique and odd fish in the mangroves. Other wildlife observed in the site study is a smaller reptile; the *Varanus salvator* (Water monitor lizard) is also a common inhabitant of the mangroves. The giant lizard is carnivorous, feeding on smaller animals such as birds, fish, and insects. The *Halistur indus* (Brahminy kite) and the *Haliaeetus leucogaster* (White-bellied sea eagle) are the birds of prey that are often associated with mangroves. They are frequently observed soaring above the mangroves of Kelanang, which were claimed by the locals.

3.3.4 Meteorological condition

The climate of an area or region is dependent on a multitude of factors. Some of these include geographic location, elevation, latitude, and topography (He & Silliman, 2019). Due to extreme global climatic change, the site study is also affected when the tidal phenomenon occurs and brings damage to the site study. Meteorological conditions data in this study were gathered from the Meteoblue database (www.meteoblue.com). For the average temperature and precipitation graph in Figure 3, the highest mean daily maximum reach is 30 degrees Celsius which is considered very hot while the lowest mean daily minimum is 24 degree Celsius which is categorized as slightly warm due to its location next to the beach. Precipitation increases from June to December due to Southwest Monsoon where tidal phenomena occur. Based on the data, the overall maximum temperature for the site study is >30 degree Celsius because the land absorbs and radiates heat much faster than the sea. Maximum temperature of >20 degree Celsius occurs only in November and December due to the Southwest Monsoon where a sudden spurt of rainfall activity occurs. The highest precipitation days occur in October the latest tidal

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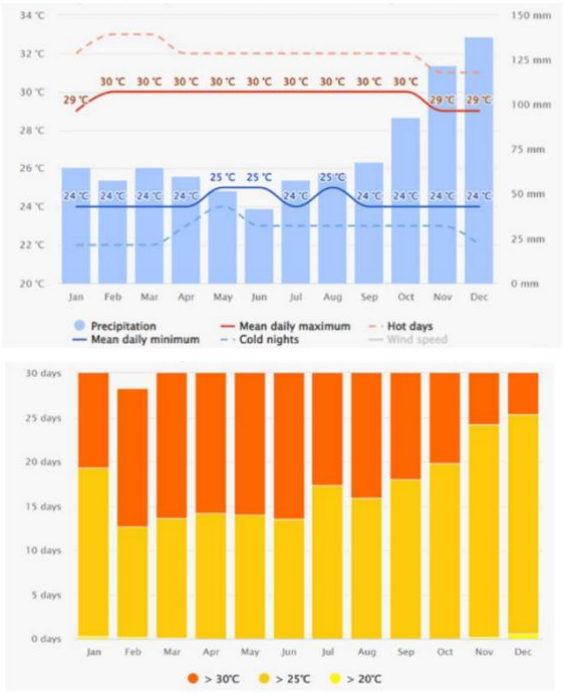
phenomenon occurs in October 2020. Sunny days are most common in the early months of the year, making Kelanang Beach an ideal destination for visitors.



a)

b)

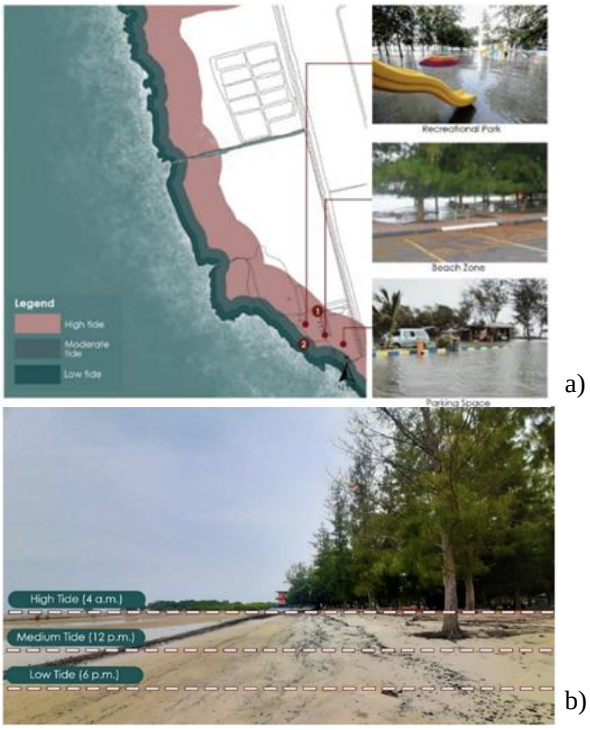
Figure 3: Meteorological condition; a) Average Temperature and Precipitation Graph. b) Maximum Temperature Graph. (Meteoblue)

3.3.5 Hydrology

Hydrology is the science that studies the occurrence, distribution, movement, and qualities of the earth's waters, as well as their interactions with the environment at each stage of the hydrologic cycle (Wang & Yang, 2014). Based on water level Langat River data provided by the Department of Irrigation and Drainage (DID), December collected the highest water level in 2018 followed by November, which can be concluded that the water level increased at the year-end season. Due to climate change, it has recently begun to rise again and could rise by as much as 1 meter over the next 100 years, resulting in shoreline retreat, flooding, and erosion. The difference in tidal level occurs during low tide occurs at 6 (p.m.), medium tide occurs at 12 (p.m.), and high tide occurs at 4 (a.m.).

3.3.6 Topography

The topography for Kelanang Beach is low land surrounded by the sea with its highest peak reaching approximately 7 meters above sea level. The land was naturally sloping, directing rainwater toward the shoreline (Figure 5).



a)

b)

Figure 4: Hydrology; a) Hydrology Map, b) Tidal Level Zone

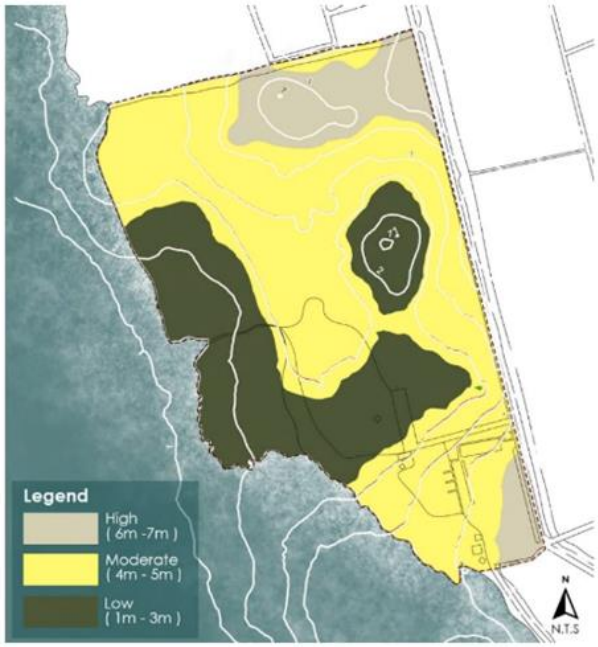


Figure 5: Topography Map

3.3.7 Circulation

There are two entrances to access to site study; the main entrance area at the parking space of Kelanang Beach and the second entrance at the camping area of the site study. The main road is mainly used by visitors to enter the site study, with sufficient parking spaces that are accessible by visitors from Pekan Banting to enter the beach zone. The existing signage of Kelanang Beach proposed by MPKL provides a sense of welcome as visitors enter the site. Camping sites with unclear entrances and poor

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signage tend to have fewer visitors, and as a result, secondary roads tend to be less used.

4.0 RESULTS AND DISCUSSION

4.1 Synthesis map

The overlaid technique was applied to create a final synthesis map (McHarg, 1967). The site study's final synthesis map showed where conservation or sustainable development could possibly help meet the study's goals for sustainable coastal design. Figure 7 displays the results of six analyses map categorized into three types of sensitivity, which were performed based on the information gathered from the site observation. These analyses maps are as follows:

(a) Hydrology sensitivity map

Figure 7 (a) shows the water areas identified as red zone (highly sensitive) that need to be preserved in the site study. According to Jabatan Perancangan Bandar dan Desa Semenanjung Malaysia (2000), the yellow zone indicates the buffer zone which requires 60 meters from the water body to be preserved, mostly at the coastal strips of the site study. This area required design treatment due to coastal erosion occurring at the coastlines that might lead to other consequences. The green zone is the less sensitive area where any activity can be programmed.

(b) Vegetation sensitivity map

Site observation shows that the red zoning indicates an abundance of mangrove species planting which is vital to maintain the ecosystem that provides shelter to flora and fauna. Therefore, according to NAHRIM, it is necessary to protect the red zoning from sea level rise. The yellow zoning indicates the buffer zone that requires 60 meters of vegetation area (Jabatan Perancangan Bandar dan Desa, 2017). The green zoning shows the least sensitive area where human activities are allowed (Figure 7 b).

(c) Wildlife sensitivity map

The red zoning on the wildlife sensitivity map indicates the most sensitive area for wildlife species because it is covered with unexplored mangrove forests. Wildlife lives mostly in the mangrove forest where anthropogenic activity is absent at the red zoning. Jabatan Perancangan Bandar dan Desa (2017) states that the buffer zone of the wildlife sensitivity map requires 500 meters from the origin of the wildlife habitat. Wildlife also migrates to the yellow zoning temporarily and back to the red zoning which is known as their home (Figure 7 c).

(d) Water tide sensitivity map

Observation on this site for the water tidal zone indicates that the red zone has high sensitivity area. It has more tendency to be affected by the tidal phenomenon because it is the closest area to the water body, which is very vulnerable to the rise in sea level during global climatic change. The yellow zone is a moderately sensitive area of site study where the water tidal may reach the yellow zone level when heavy rainfall occurs due to a lack of sea defence. The green zoning indicates the least sensitive area of site study, however water tidal can reach green zoning in the future when if there are no further actions taken in coastal protection strategies to mitigate the sea level change from penetrating to the inland of the coastal zone (Figure 7d).

(e) Soil erosion sensitivity map

The coastal erosion occurred at the site study due to a few factors that lead to coastal erosion such as wave phenomenon, tidal phenomenon, sea-level change, and removal of natural bio-shield. Observation on this site for the soil erosion indicates that the red zoning has a highly sensitive area, which has more tendency for soil erosion due to the absence of natural defence by the mangrove trees at the coastlines. These issues need to be solved through a natural approach to achieve a sustainable environment (Wilms *et al.*, 2017). The yellow zoning has a moderately sensitive area where the water level has reached the yellow zone such as the tidal phenomenon that occur in November 2020. The green zoning is the least sensitive area of the site study, where the sea level rarely reaches the area (Figure 7e).

(f) Topography map

The topography map was not described in its sensitivity, as the concern was to indicate the topography influence towards tidal phenomenon or heavy rainstorms, where rapid rises of water spread through the site study. Figure 7 (f) shows the red zoning as the highest contour line of the site study at 7 meters from the sea level. The yellow zone represents a moderate zone with 4 meters to 5 meters from the sea level. The lowest contour line is labelled as a green zone at 1 meter to 3 meters from the sea level.

The composite map is the result of the overlaying of the hydrology, vegetation, wildlife, water tide, soil erosion, and topography map. The most sensitive area can be identified through the composite map which indicates the red zone area, is highly sensitive due to the lack of mangrove species that usually act as natural sea defence of the coastal zone (Figure 8).

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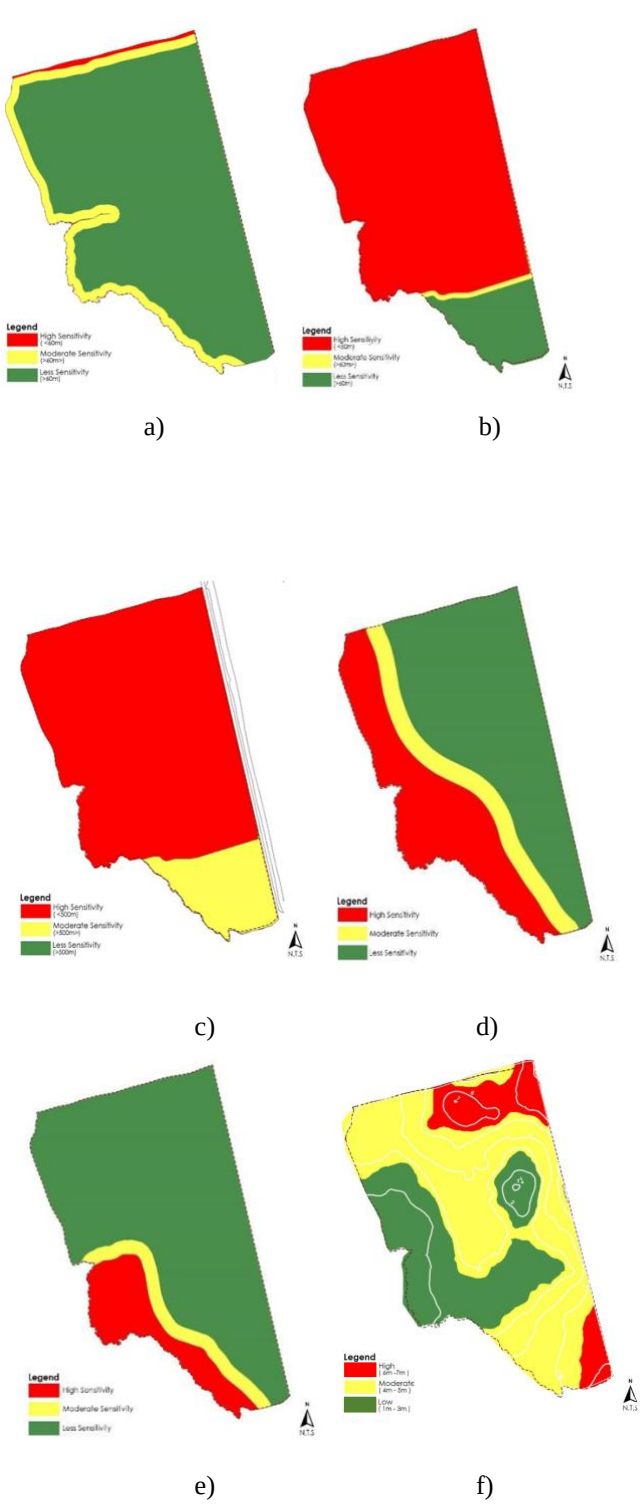

Figure 7: Analysis Maps; a) Hydrology sensitivity map, b) Vegetation sensitivity map, c) Wildlife sensitivity map, d) Water tide sensitivity map, e) Soil erosion sensitivity map, f) Topography map

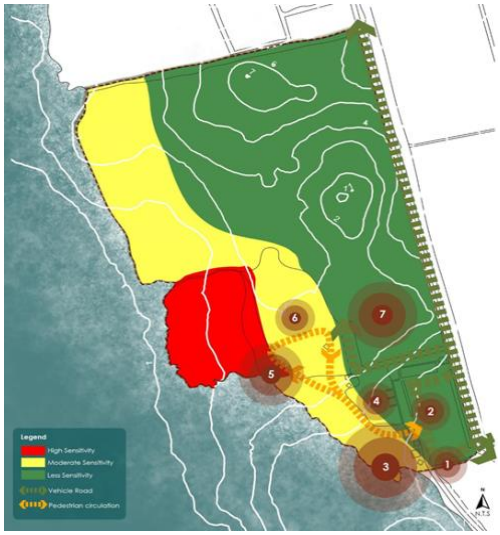

Figure 8: Composite Map of Site Study

4.2 Design Concepts and Strategies

A conceptual diagram gave a graphical representation of the framework of design purpose. The process of conceptual development is starting with the main issue of the site. The main purpose is to treat the coastal line with a natural approach by focusing on mangrove replantation as the main solution or a natural bio shield to the coastlines. Other than retreating the line of the coastal, this approach also focuses on reconnecting the line interaction between humans and nature (Figure 9).

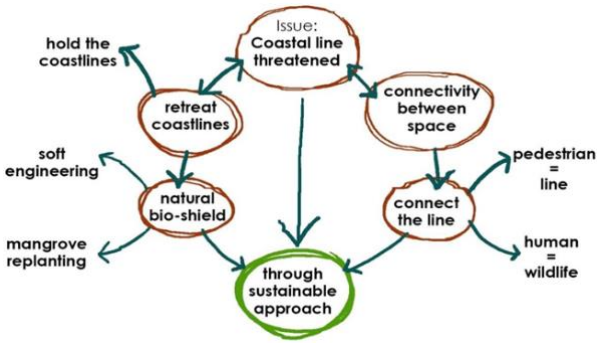

Figure 9: The conceptual diagram flow

Before producing the final master plan, design strategies were shown in a design process consisting of the process of brainstorming and consultation to produce a zoning diagram, functional diagram, spatial diagram, and a design idea (Gottfredson, 2014). This study shows the result of the final design process which includes preliminary ideas before finalizing the design strategies into the master plan.

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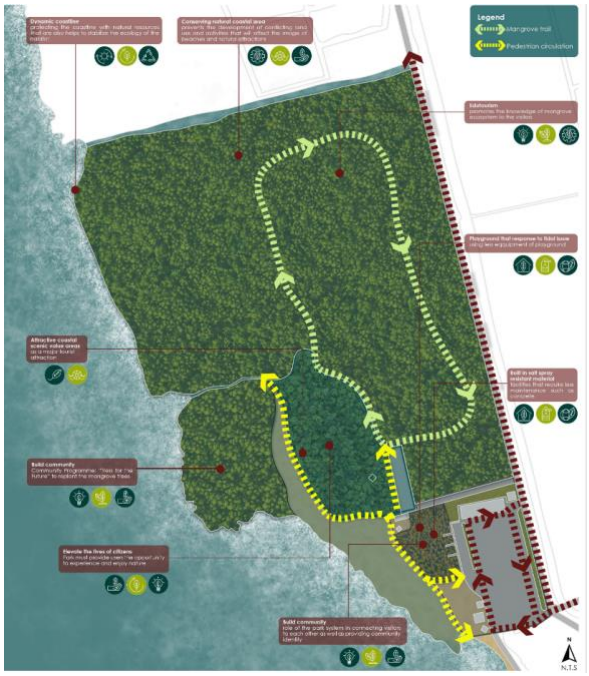

Figure 10: Design idea

4.3 Landscape Design Master Plan

The master plan shows the final design approach and strategies to solve all issues, which concern mainly coastal erosion and mangrove degradation as well as strategizing the recreational amenities and infrastructures of the site study. The proposed design is focusing on three main areas, which are the Kelanang beach zone, the glamping site, and the mangrove trail. These three main areas have their own significance for aesthetic and ecological functions (Figure 11).

Figure 11: Landscape design Master Plan (Credit: © Farah Intan Liyana Mohamad Sukri; used with permission)

In the master plan, the Kelanang Beach area is designed with a prominent main entrance, followed by a multipurpose parking lot that has been set up with areas for a variety of event functions, such as a carnival that permits hawker activity. Near the parking area, adequate public amenities are proposed, including a park for light recreational activities, such as sightseeing, relaxing, and picnicking, as well as an upgraded sustainable playground design with a gentle slope. The recreational park is separated from the coastal zone by a green buffer, which reduces the amount of salt spray particles that can travel through the area and damage the equipment and facilities, as has recently occurred before at the site. A breakwater has been proposed for the area close to the coast to protect it from the waves.

Second, the glamping site area enhances the campsite's functionality and aesthetics while also giving visitors a chance to experience the natural resources through their senses. The glamping site which is named "*Bayu Bakau Glamping Site*" is intended to highlight that this glamping site provides an experience on the mangrove natural environment and the sea breeze of the beach. This area is being separated from the adjacent area with a beach forest to create an inclusive environment for users. Finally, the mangrove trail zone starts at the third entrance, far from the Kelanang beach area. In addition to this, there is a sufficient quantity of parking space and amenities that have been specifically designed for the location. There are three design objectives implemented specifically for the mangrove trail, which are:

i) To create zoning for rehabilitation areas according to the vulnerability level of each zone.
ii) To restore wetland and mangrove replanting through a natural approach.
iii) To create an inclusive environment where humans and wildlife can co-exist.

This proposal for a mangrove trail incorporates a number of different design strategies, one of which is designing for a dynamic coastline by protecting the coastline by strengthening the mangrove habitat's function as a natural bio-shield, conserving natural coastal areas by conserving and managing the biodiversity of the mangrove habitat and wildlife habitats on the mangrove and respect the local landscape by following the contour line in constructing the mangrove trail and building the community by connecting human and natural resources (Figure 12).

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a) b) c)

Figure 12: Types of Mangrove Trails; a) Odyssey of Wildlife, b) Rehabilitation Line, c) Odyssey to Coastlines

The "Odyssey of Wildlife" trail is an example of the thoughtful planning that went into creating a mangrove trail, as it allows visitors to learn about the unique ecology of mangrove forests while also getting a glimpse of the diverse wildlife that calls these forests home. The “Rehabilitation Line” trail is the trail that connected the entrance to the “Trees for the Future” which is a community program designed for mangrove seeding and planting activities for community development projects. The "Odyssey to Coastlines" trail encourages experiences for the visual and auditory senses, ranging from the natural scenery of mangroves to the scenery of the beach.

5.0 CONCLUSION

Coastal areas serve as refuges for marine life, but they are also popular destinations for people looking to unwind and enjoy the outdoors. The sustainability of coastal areas can be studied at various levels, and it always requires careful research from numerous experts. The participation of landscape architects, planners, designers, engineers, and environmentalists will contribute to the provision of useful and high-quality advice regarding the site's challenges and opportunities. This study has taken into account recommendations based on detailed attributes related to the study’s context, such as plants, meteorological condition, hydrology, wildlife, and topography condition. It is believed that the strategy embedded in the sustainable landscape design approach will be able to preserve and revitalize the land use morphology, in addition to the plant and animal species that have been around since before the study area was inhabited. The coastal protection, using a breakwater that has been proposed in this study need additional insight, and the designer's experience will be essential to developing a sustainable breakwater design that is safe, economical, and constructible. Given the issue on the site study, vegetation is vitally important to stabilize the beach embankment so it can maintain the coastal line in the near future. Although plants only cannot defend the beach from wave attacks or groundwater seepage on their own, they can assist to minimize surface runoff and wind erosion. Planting vegetation is a much more cost-effective method of controlling erosion than the use of structural erosion control methods. Additionally, the newly planted vegetation will provide habitat, food, and nutrients for the creatures that live in the environment surrounding the coastline. Mangrove trees should be replanted to their original locations to bring back the area's natural beauty while also protecting the local ecosystem. Including such activities in the planning of mangrove swamp areas can help educate and raise awareness, but only if the planning is done in a sustainable manner. This study offers potential landscape design solutions that might be able to address straightforward coastal issues, but additional expert judgment in the field of coastal morphology can be used to validate the design and suggest potential next steps in the investigation. This lowers the possibility that the master plan will need to be modified later, and in some cases, it results in cost savings at an early stage of the project. In general, issues related to increasing sea levels can be solved by employing environmentally responsible design solutions, which can be found while the design is being developed, in order to achieve an optimal solution that is satisfactory to all parties involved.

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