

### *Temporary Shore Protection*

During the Northeast monsoon period where reclamation works cannot be carried out, temporary shore protection (Photo 5.2) shall be placed at areas where revetments have yet to be constructed to ensure sand is not washed away. This will be either a temporary rock revetment or geobags.



Photo 5.2 Example of temporary shore protection /13/.

### Vessels and Equipment

The principal vessels and equipment to be used for the reclamation works are set out in Table 5.5.

Table 5.5 Vessels and equipment for reclamation work.

Item No.	Description	Size or Capacity	Function
1.	Two trailing suction hopper dredgers (TSHD)	20,000 m <sup>3</sup>	Sand mining at the marine borrow area and transportation and pumping at the reclamation site
2.	Crane barge, flat barge, tug boat	-	Handling of floating / sub-sea pipeline Construction of revetment
3.	Flat top barge and tug	-	Supply of rock for revetment construction to the site from Hexatrend Quarry
4.	Passenger boat	-	Transport of personnel and small equipment and supplies
5.	Submarine pipeline, floating pipeline and onshore pipeline	-	Delivery of sand from the TSHD to the reclamation by hydraulic pumping
6.	Bulldozer	-	Spreading of sand fill from the pipeline discharge point, and forming bunds, levelling, etc
7.	Long arm excavators	-	Construction of perimeter revetments. May be operating from reclamation area or on flat top barge.

Item No.	Description	Size or Capacity	Function
8.	Wheel loader, backhoe	30 ton excavator	Re-handling sand fill, loading dump trucks, trimming and smoothing surface, etc
9.	Dump truck	25 ton	Transporting sand fill and rock for revetment construction within the reclamation area.

### Time required for reclamation

The estimated reclamation duration for each phase was calculated based on the following assumptions and is set out in Table 5.6 below:

- Estimated total daily delivery of sand from the offshore sand source 30,000 m<sup>3</sup>;
- No interruptions will occur throughout the sand mining and delivery process;
- Sand filling from the dredged spoil is additional to the material supply from the offshore sand source.

Table 5.6 Summary of estimated volume and duration of each reclamation phase based on the assumptions that two units of TSHDs with total daily reclamation volume of 30,000 m<sup>3</sup> are applied.

Phase	Area (ac)	Estimated Sand Volume (million m <sup>3</sup> )	Estimated duration (months)
1	612	14	14.9
2	430	16.5	9.8
3	240	10	11.1
4	383	14	15.6
5	233	7.5	8.3
<b>Total</b>	<b>1,898</b>	<b>62</b>	-

#### 5.4.2.3 Capital Dredging

Dredging for the marine facilities will be carried out during Phase 1 and Phase 2 with a total dredging volume of 8.3 million m<sup>3</sup>. The majority of the dredging is to be carried out in Phase 2 of the Project when the basin for the marine facilities is partially protected by the Phase 1 reclamation and the partially constructed breakwater. The dredging in Phase 1 is limited to the area immediately adjacent to the breakwater that should be dredged before the breakwater is constructed.

Dredging works are expected to be carried out by a combination of TSHD and a cutter suction dredger (CSD). These will be utilised as follows:

- The TSHD will be used to dredge the initial area adjacent to the breakwater in Phase 1, and the navigation channel in Phase 2. The TSHD is selected for these areas as it operates effectively in open water areas, and these locations are too far from the reclamation for the dredged material to be pumped directly into the reclamation.
- The CSD will be used to dredge the basin for the marine facilities for Phase 2. The CSD is well suited to this area as it is an enclosed site, and close to the

reclamation areas so that the dredged material can be pumped directly into the reclamation.

The estimated duration of the dredging works is approximately 1.6 months in Phase 1 and 8.1 months in Phase 2. The estimated daily production rate is 12,600 m<sup>3</sup>/day for the TSHD, and 24,000 m<sup>3</sup>/day for the CSD.

Working hours shall be 24 hours per day seven days per week including public holidays.

## Sequence of Works

### *Trailer Suction Hopper Dredger*

The procedure for dredging by TSHD is by lowering one or both drag heads to the seabed and hydraulically pumping dredged material into the hopper via the suction pipe(s). The dredging depth and position can be accurately controlled by an on-board GPS and control systems. While dredging the TSHD will maintain speed not exceeding approximately 2 knots.

All the dredged materials shall be pumped directly to reclamation site. The TSHD carrying out this capital dredging work will utilise the same floating pipeline that is being used for sand deliveries from the offshore sand source to pump the dredged material to the reclamation. The methods used shall be as described in Section 5.4.2.2.

### *Cutter Suction Dredger*

The CSD is a stationary dredger equipped with a cutter device (cutter head) which excavates the soil before it is sucked up by the flow of the dredge pump(s). During operation, the dredger moves around a spud pole by pulling and slacking on the two fore sideline wires /14/. All the dredged materials shall be pumped directly to reclamation site via a floating pipeline. This will be discharged into a bunded area and the material distributed in a similar way to material being supplied from the offshore sand source as described in Section 5.4.2.2.

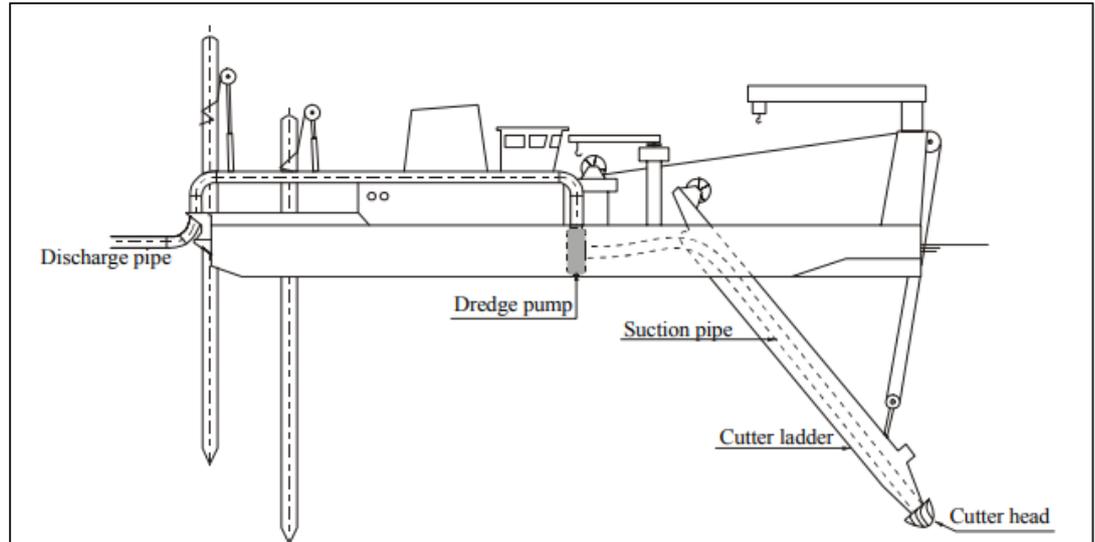


Figure 5.15 Typical CSD.

#### 5.4.2.4 Breakwater Construction

The breakwater will be constructed using a combination of floating and land-based equipment; a typical view of breakwater construction using both floating and land-based equipment is shown in Figure 5.16. Rock for the breakwater construction will be transported to the site by sea using a combination of flat top barges towed by tugs and specialist marine construction vessels. The concrete armour units will be prefabricated at the planned working area at the site and will be transported to the breakwater using specialist off road vehicles before placing.

The general construction method for the breakwater is described in the following:

- A geotextile layer will be placed on the sea bed covering the footprint of the breakwater. This will be transported to the site in rolls and placed on the sea bed using a crane mounted on a flat top barge. A layer of filter rock to protect the geotextile from the larger core and armour rock will be placed on it using either a specialist self-propelled side dump vessel, or a clam shell crane also working from a flat top barge.
- The core rock will be dumped into the sea up to approximately low tide level using a combination of bottom dump split hopper barges and self-propelled side dump vessels.
- The below water core will be trimmed to shape using either long armed excavators or a clam shell crane. The core material above low water level will be placed using the same equipment.
- The underlayer rock will be placed using either long armed excavators or a clam shell crane. The material will be supplied from the quarry on flat top barges. For the lower slopes the long arm excavator or crane will be operating from a flat top barge, however the upper slopes and crest may be constructed by equipment operating from the breakwater rest. Secondary armour placing using a specialist crane barge is illustrated in Figure 5.17.

- The armour layer acts as the primary defence against wave action and will consist of concrete armour units. Due to the weight of these units they will be placed either using a crawler crane operating on the breakwater crest, or a floating crane.



Figure 5.16 Breakwater construction using a combination of floating and land-based equipment.



Figure 5.17 Placing breakwater armour rock using a specialist crane barge.

#### 5.4.2.5 Construction of Roads and Bridges

The function of the bridges is to provide access from the Phase 1 reclaimed land to Phase 3, 4 and 5 reclaimed land. Although the exact bridge design is currently unknown, construction of the bridges will involve typical activities such as piling of bridge foundation, installation of precast concrete components, bridge decking and others. Road construction will entail activities such as sub-grade works (surface cleaning, slope protection etc.), pavement works and traffic facilities.

#### 5.4.2.6 Construction of Piled Platforms

The construction of the five piled platforms within the channel will involve piling work. These platforms are approximately 1 ha. Spacing interval between the piles are anticipated to be around 10 m.

#### 5.4.2.7 Management of Construction Activities

The project manager will have overall responsibility for the construction of the entire facility, supported by the project team including managers for HSE & security, project controls, field engineering and construction supervision among others. First aid facilities will be provided at site and panel doctors will be arranged with a medical clinic located in close proximity to the Project site. A health, safety and environment (HSE) management plan and an emergency response plan will be implemented, including provision of relevant training for all personnel working at the project site. Mitigation measures to avoid and to minimise environmental impacts as described within this EIA will be incorporated into this construction HSE management plan.

#### Hours of Operation

The site working hours will be 24 hours per day, 7 days per week.

#### Construction Workforce

The construction workforce will be recruited with the intention to maximise the use of local labour and contractors where appropriate skills exist. If foreign labour is required to supplement the local workforce, an official hire process will be adhered to prevent the engagement of illegal foreign nationals at the site. The construction workforce is estimated to be in around 500 persons. Offsite accommodation will be arranged for workers during the construction phase.

#### Transportation of Equipment and Materials

Most of the heavy bulk of construction materials (e.g. gravel, sand) will be delivered to site by barge, and hence expected construction land traffic is minimal and limited to the transportation of workers.

### 5.4.3 Post-construction Stage

No post-construction activities are considered in this EIA. Following the completion of the reclamation and dredging works, the topside development will be initiated. The

construction and operations of the Sunrise City development is not assessed in this EIA, apart from consideration of the conceptual land use.

#### 5.4.4 Project Abandonment/Decommissioning

In the event of Project abandonment and site closure, construction waste materials and machinery will be removed from the development area. Partially completed structures, if any, shall be dismantled. Depending on the phase at which the Project is abandoned, reclaimed land areas may remain unutilised.

The appropriate regulatory authorities including DOE and DOSH will be duly informed and representatives from these authorities may be present to ensure proper procedures are adhered. The necessary regulatory approvals and permits will be obtained.

### 5.5 Development Schedule

The Project will be carried out over five phases (Table 5.4), with a target commencement in the first quarter of 2020 and planned completion approximately six years later. This schedule is based on the expected reclamation and dredging plant outlined in sections 5.4.2.2 and 5.4.2.3, and accounts for anticipated weather downtime during the Northeast monsoon period. For every phase, reclamation works will be carried out followed by respective topside development works. An outline of the Project schedule is set out in Figure 5.18.

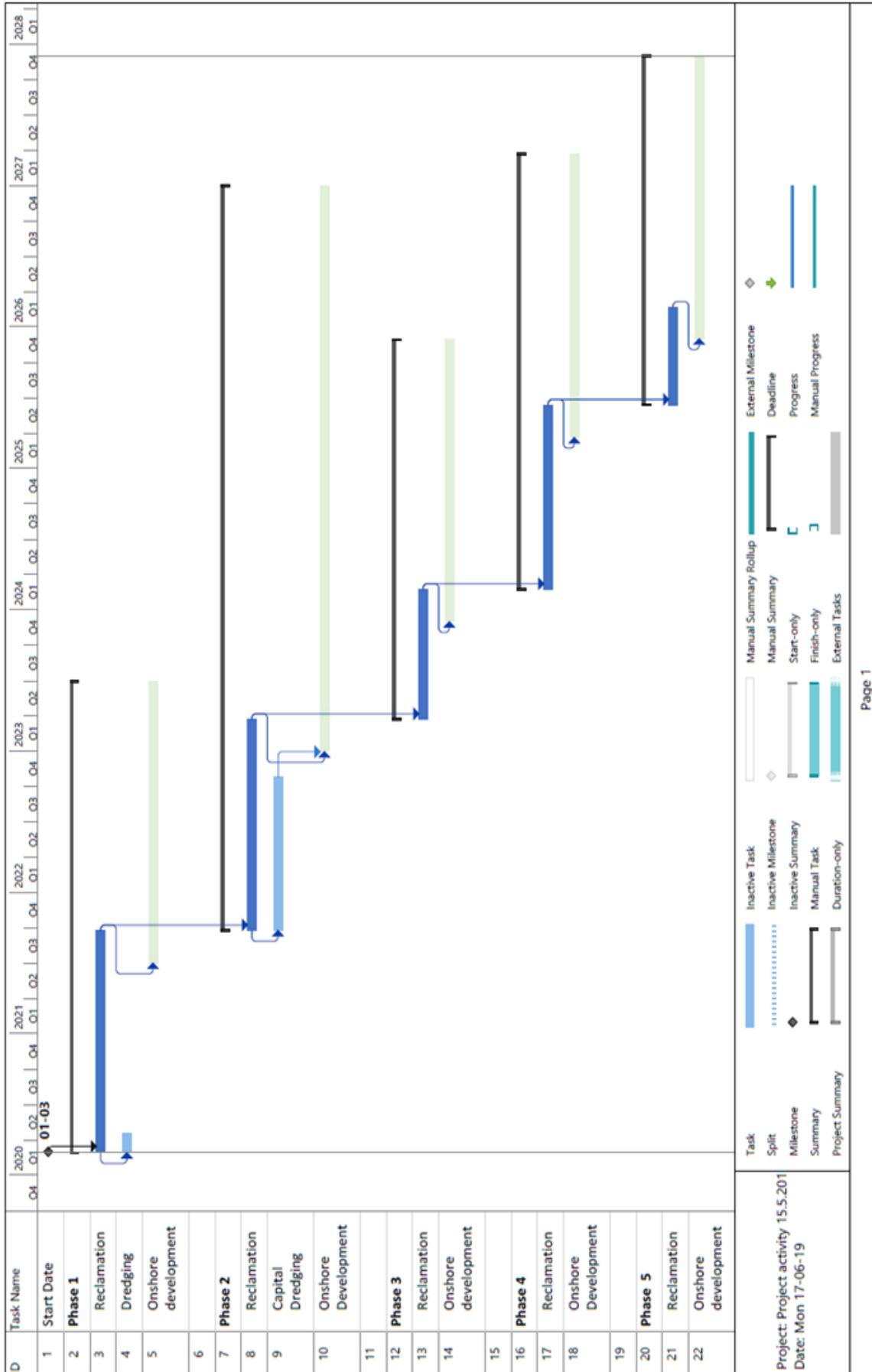


Figure 5.18 Project implementation schedule.

## 6 Existing Environment

This section provides background information on the existing physical-chemical, biological and human environment in the Project area and the assessment zones. The key sensitive environmental receptors are identified and described. The information is based on baseline surveys and secondary information from data, literature and other reports for the area as detailed in Appendix B.

The spatial areas of focus or extent around the Project area, are variable, depending on the environmental component in question, and have been based on the anticipated zone of impacts identified during the scoping phase as outlined in the approved TOR. As detailed in Chapter 2, the following assessment areas have been adopted:

- Marine physical and biological environment – 5 km radius from the Project area;
- Terrestrial physical environment – 1 km radius from the Project area; and
- Human Environment – 5 km radius from the Project area.

As a result, the following descriptions of the existing environment are focused on these areas.

### 6.1 Physiographic Context

The coastal region of Terengganu is largely formed of sandy beaches (from Quaternary geological formations) which are dynamic in nature as a result of seasonal variations in wind, waves and currents from the Southwest and the Northeast monsoons (Ariffin *et al.*, 2018) /15/.

Over the period between May and September<sup>2</sup>, during the Southwest monsoon season, the winds are south westerly and largely blow offshore or in parallel with the coast, leading to relatively benign conditions. In contrast, the period from November to March is dominated by the Northeast monsoon when winds are predominantly north easterly across the South China seas. The differences in impacts on waves of these two dominant seasons are illustrated in Figure 6.1. Note that there is not a big difference in current speeds. Each of these physical factors is discussed in greater detail below.

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<sup>2</sup> Note that the start and finish periods for these regional monsoons may vary considerably from year to year.

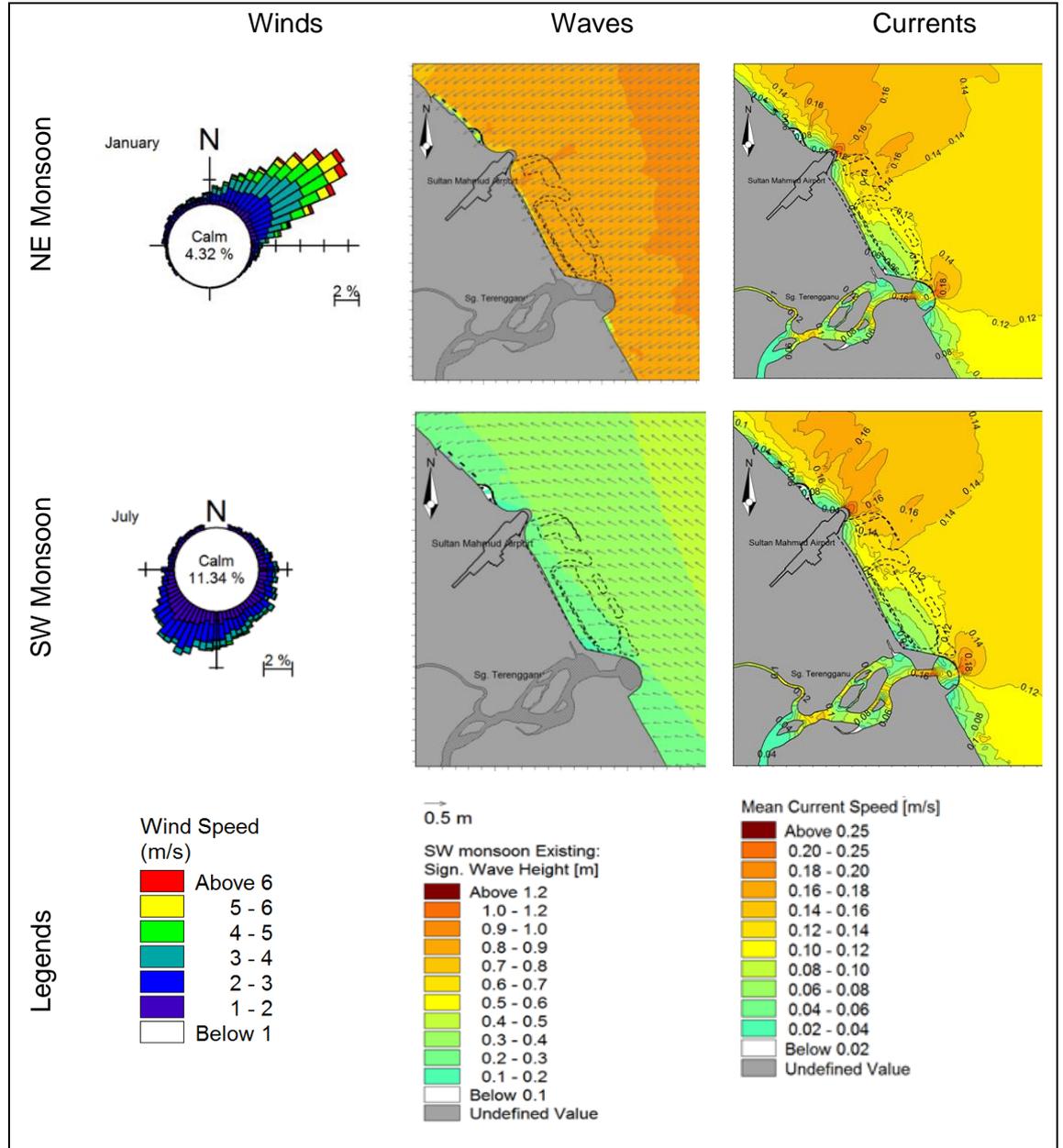


Figure 6.1 A comparison of wind direction, current speed and direction, and waves in the two monsoon periods. Wind roses are monthly estimates for 10 years of CFSR wind (year 2006 to 2015), waves are examples of modelled wave fields and currents are a snapshot of predicted mean current speed over a 28-days simulation during NE monsoon (top) and SW monsoon (bottom) periods.

Rainfall in the region shows a strong seasonal pattern that is also a product of the monsoons (Figure 6.2). The seasonal difference in rainfall is reflected in river outflow and sediment resupply to the coast. Nearshore coastal waters as a consequence can therefore be expected to be slightly lower in salinity and higher in turbidity during the rainy part of the year and vice versa during the drier period. This is in fact reflected in long term data analysed by Akhir *et al.* (2011) /15/ for the eastern Malaysian peninsular coast.

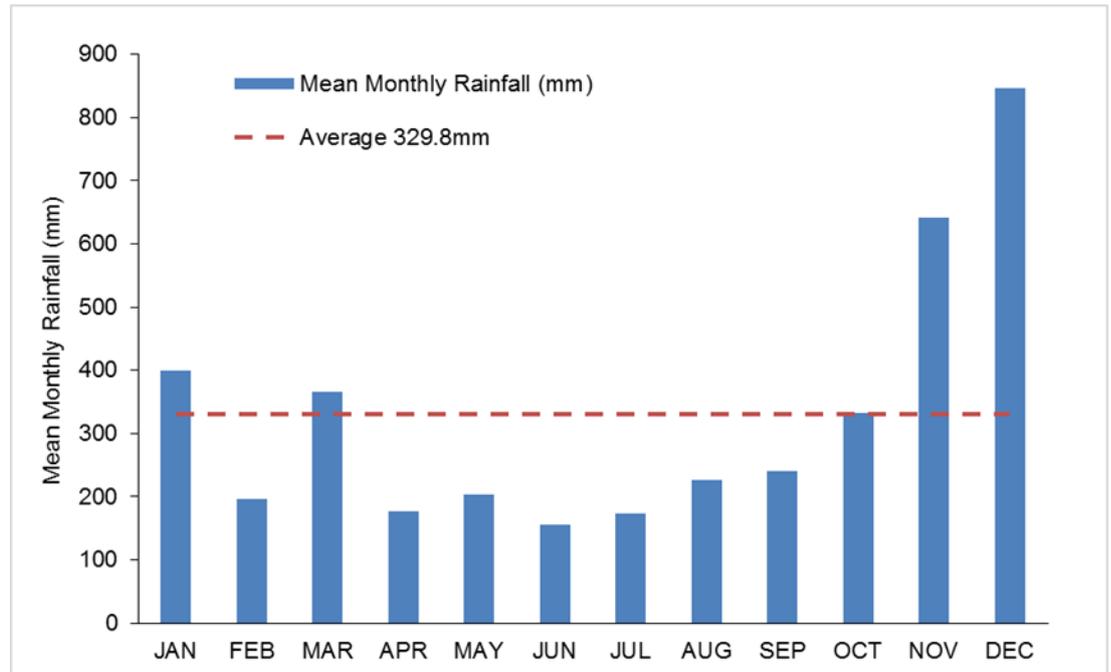


Figure 6.2 Mean monthly rainfall recorded in the Terengganu State (2009-2013) (Source: Chew, 2015 /16/).

In summary, beach dynamics, ecology and water quality are strongly influenced by the two monsoons impinging on a coastline that is dynamic in nature over seasonal and inter annual time scales. As a result, the Terengganu coastline is seen to be both eroding in some places and accreting in others.

The Project itself is located at Pantai Teluk Ketapang, a sandy beach between artificial headlands formed by the airport runway reclamation in the north and the Kuala Terengganu breakwaters to the south. The coastal road along the shoreline has recently been upgraded (Jalan Pantai Teluk Ketapang, an East Coast Economic Region (ECER) project). The Project is mostly located in the shallow area (approximately -1 m CD) extending out to a maximum water depth of -8 m CD (Figure 6.3).

#### PROJECT SITE VIDEO

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This coastline is also strongly modified where a number of coastal protection structures have been built near the Project site as shown in Figure 6.4. These structures are:

- Kuala Terengganu breakwater and a small-scale offshore breakwater completed in 2008.
- UMT Coastline Protection Structures by DID due to the erosive process observed north of the airport runway extension.
- Tok Jembal breakwaters were constructed in 2016 to create a sheltered area for the berthing of small boats and to support recreational activities.

- Jalan Pantai Teluk Ketapang is presently being constructed close to the Pantai Teluk Ketapang shoreline with rock revetment proposed as a protection measure.

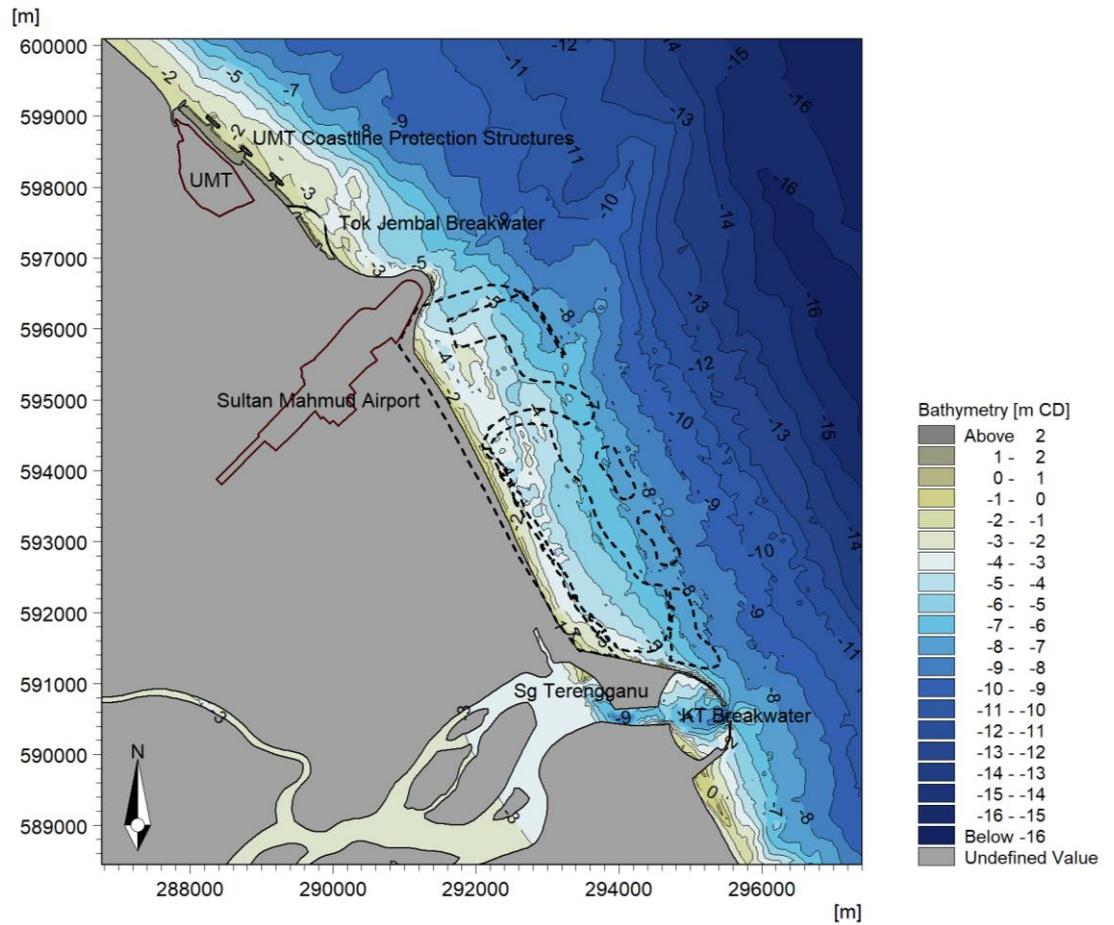


Figure 6.3 Bathymetry at the Project area (interpolated from bathymetric survey data October 2015 and April 2018, and navigation charts).

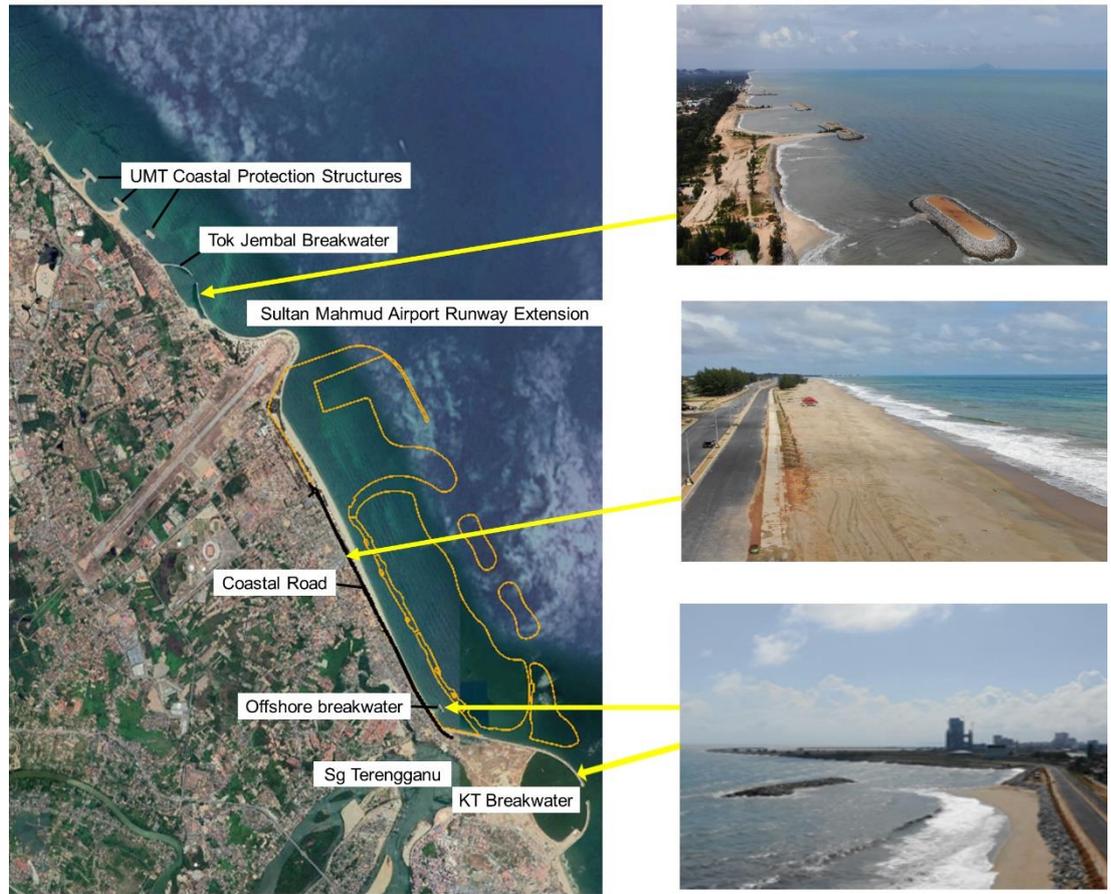


Figure 6.4 Satellite image (Google Earth) of the coastal strip in the immediate area of the Project showing existing coastal interventions. What is clear in this image is that the coastline is already highly modified with a need to defend against the erosion to the north, the extension of the airport runway, the development of the two training walls at the mouth of the Terengganu river and a major highway running very close to the coast.

## 6.2 Physical-Chemical Environment

The existing physical-chemical environment for the Project area is described within a radius of between 5 km from the boundary of the Project depending on the relevant component. The description of the physical-chemical environment is based on primary data supported by available published secondary data as detailed in Table 6.1.

Table 6.1 Details of data collection for physical-chemical environment.

Component	Type of Data	Source	Date of Collection
Coastal Hydraulic	Primary	Numerical models calibrated with site surveys of water levels and current speeds	<ul style="list-style-type: none"> <li>• ADCP 1: 15 to 31 October 2015</li> <li>• ADCP 2: 15 to 31 October 2015</li> <li>• ADCP 3: 5 to 26 October 2017</li> </ul>

Component	Type of Data	Source	Date of Collection
			<ul style="list-style-type: none"> <li>• ADCP 4: 5 to 25 October 2017</li> </ul>
Bathymetry	Primary	Site survey	<ul style="list-style-type: none"> <li>• October 2015</li> <li>• April 2018</li> </ul>
Hydrology and hydrogeology	Secondary	Mapping using satellite image and verified by site observations	<ul style="list-style-type: none"> <li>• Base map – year 2019</li> <li>• Site observations 8 April 2019 and 28 June 2019</li> </ul>
Coastal Morphology	Imagery	Satellite and published papers	Historical satellite images sourced from GoogleEarth Pro.
Water Quality	Primary and secondary	<ul style="list-style-type: none"> <li>• 11 sampling stations sampled twice at three depths</li> <li>• Secondary data from DOE sampling stations and FIA study.</li> </ul>	<ul style="list-style-type: none"> <li>• Neap and spring ebb tides in September and October 2017;</li> <li>• Secondary data from neap and spring ebb tides on 12 March, 20 March 2019 and 29 Sept 2017</li> <li>• Spring ebb: 4 October 2017</li> </ul>
Air Quality	Primary	6 sampling stations	24 to 30 October 2017
Ambient Noise	Primary	6 sampling stations	
Marine Sediment	Primary	Grab sample	October 2017

## 6.2.1 Coastal Hydraulics

### 6.2.1.1 Water Levels

The water level regime along the Terengganu coastline is complex, being primarily influenced by the convergence of three tidal regimes, namely:

- The South China Sea tide which propagates NE to SW;
- The Gulf of Thailand tidal system; and
- The tide propagating from the Java Sea.

An illustration of predicted water levels in the study area based on the tidal harmonic components derived from the Sg. Terengganu tidal station /17/ is presented in Figure 6.5. The tidal levels at the Project area corresponds to diurnal tides with one high water and one low water in one day.

The typical spring tidal range (MHHW – MLLW) is in the order of 2.04 m and the maximum range (difference between HAT and LAT) is 3.02 m as shown in Figure 6.5. These values describe tidal effects produced by gravitational forces, induced primarily by the moon and the sun, and do not include other effects as wind and barometric pressure (induced by regional pressure fields). When these effects interact with the

tides, they can induce water levels that lie outside of this range. Seasonal changes to mean sea levels are generally in the order of +/- 0.1 m, with the exception of the months off January and February, where water levels are generally 0.2 m higher, again coinciding with the peak of the NE monsoon period (see Table 6.2).

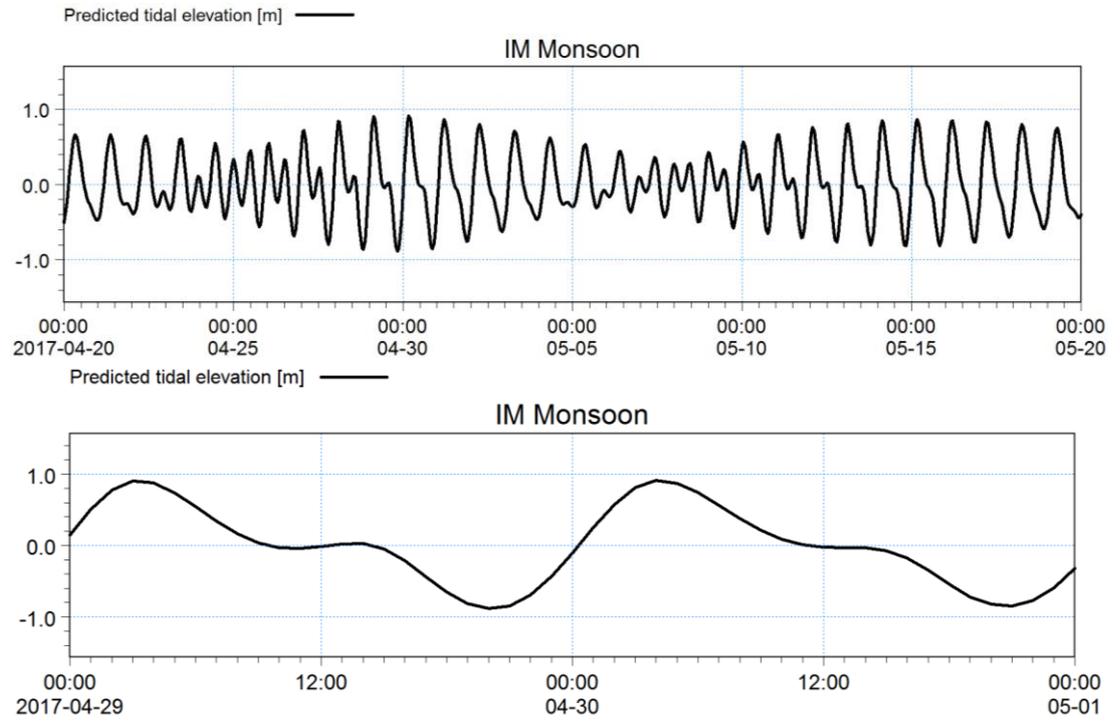


Figure 6.5 Example of predicted water levels (in meter MSL) in the study area vicinity based on the harmonic constituents at Sg Terengganu tidal station /17/.

Table 6.2 Tidal elevations at Sg. Terengganu /17/.

Tidal Levels	Abbreviations	Values (m CD)
Highest Astronomical Tide	HAT	3.02
Mean Higher High Water	MHHW	2.47
Mean Lower High Water	MLHW	1.93
Mean Sea Level	MSL	1.45
Mean Higher Low Water	MHLW	0.97
Mean Lower Low Water	MLLW	0.43
Lowest Astronomical Tide	LAT	0.00

Table 6.3 Seasonal changes to mean level in the study area vicinity based on the Sg Terengganu tidal station /17/.

Month	Changes to mean level (m)	Month	Changes to mean level (m)
January	+0.2	July	-0.1
February	+0.2	August	-0.1
March	+0.1	September	-0.1
April	0.0	October	0.0
May	-0.1	November	+0.1
June	-0.1	December	+0.1

### 6.2.1.2 Currents

Hydraulic modelling of water levels and ocean current flows at the site using a two-dimensional (2D) numerical model (MIKE 21 FM HD)<sup>3</sup>, showed the flow pattern in the study area is streamlined, with currents flowing towards the south (Figure 6.6) under tidal flood conditions and towards the north during ebb tides (Figure 6.7).

The mean and maximum currents calculated over a 28-day period for the different seasons are shown in Figure 6.8 and Figure 6.9. They indicate similar speeds during the monsoons, but lower speeds during inter-monsoon conditions. Modelled currents for the existing conditions show mean current speeds up to 0.16 m/s, with maximum current speeds reaching up to 0.4 m/s at the Project area.

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<sup>3</sup> All modelling in this report was undertaken in accordance with the Department of Irrigation and Drainage (DID) guidelines for numerical modelling.

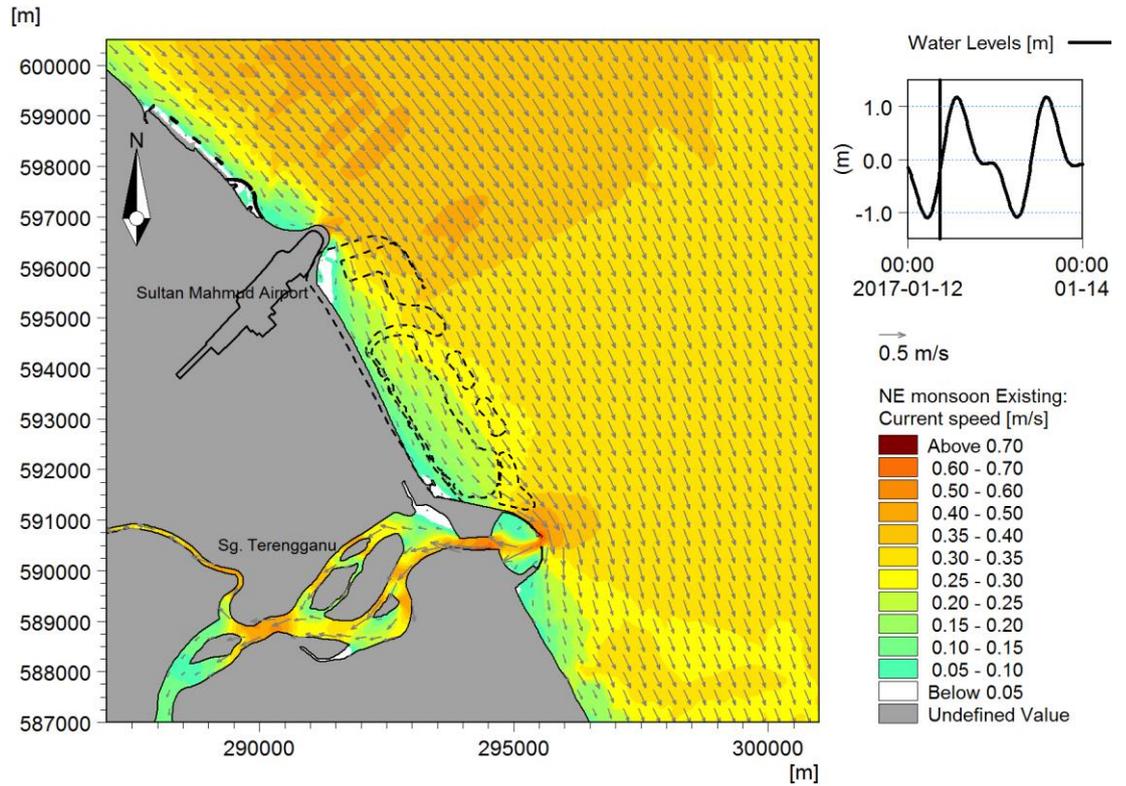


Figure 6.6 Snapshot of predicted current flow conditions during NE monsoon - spring flood tide.

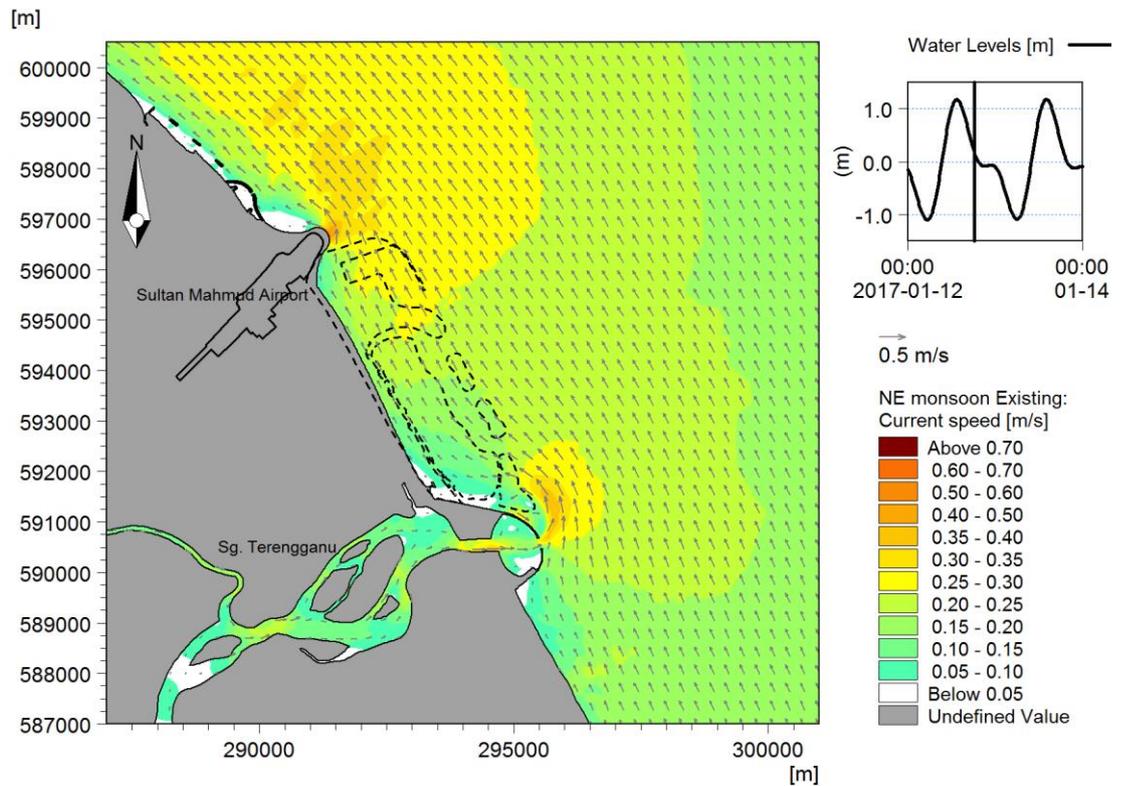


Figure 6.7 Snapshot of predicted current flow conditions during NE monsoon - spring ebb tide.

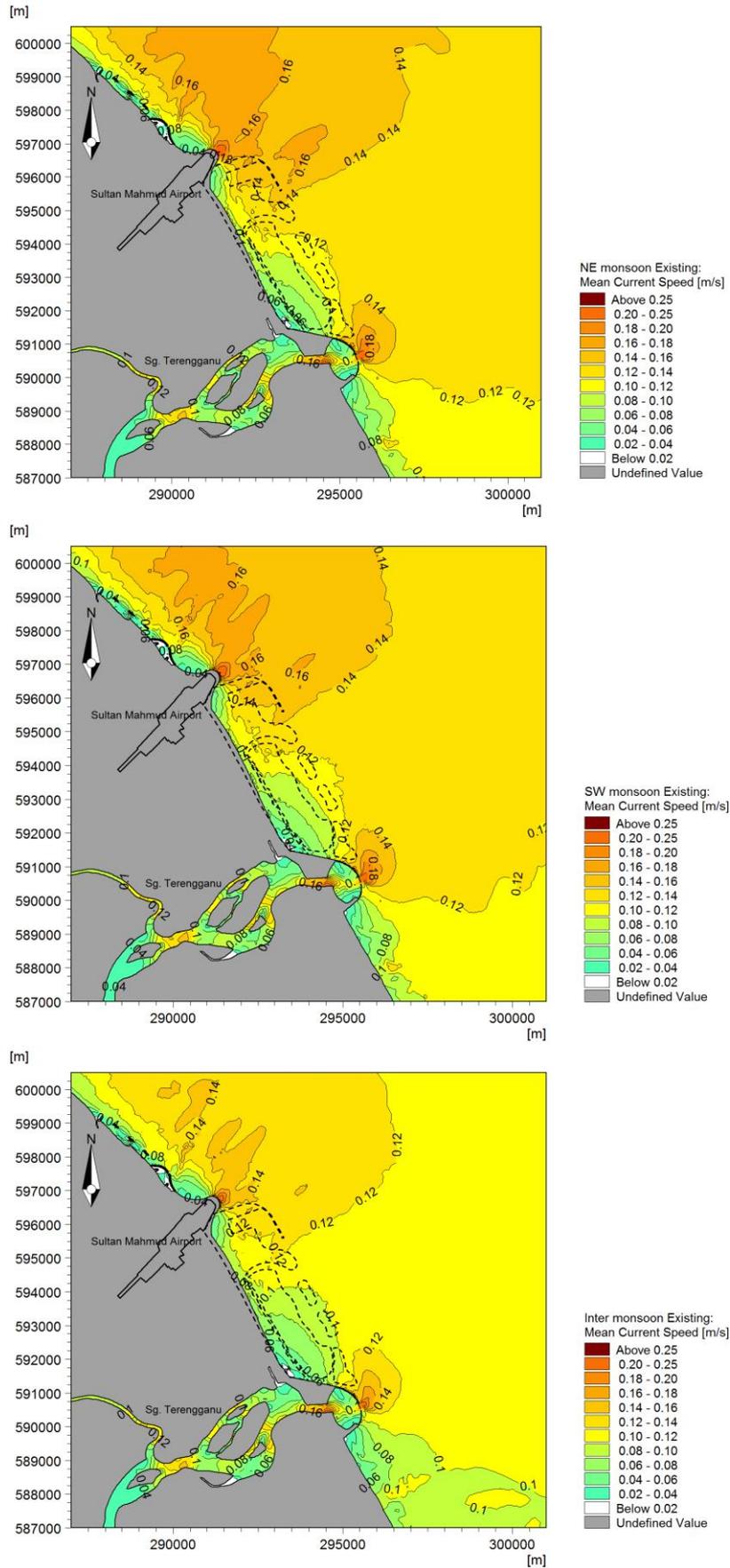


Figure 6.8 Snapshot of predicted mean current speed over 28-days simulation during NE (top), SW (middle) and inter-monsoons (bottom).

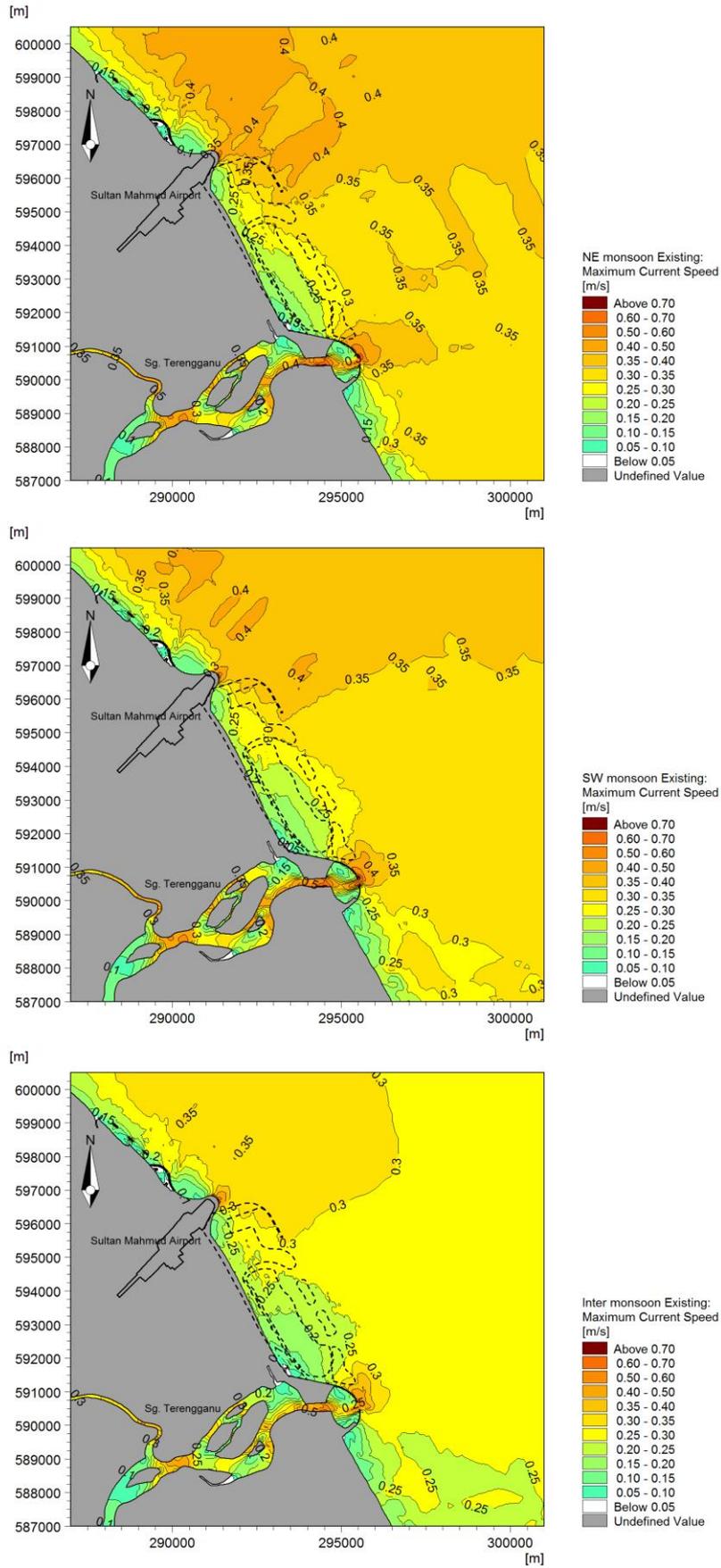


Figure 6.9 Snapshot of predicted maximum current speed over 28-days simulation during NE (top), SW (middle) and inter-monsoons (bottom).

### 6.2.1.3 Wave Conditions

The wave climate offshore of Kuala Terengganu is composed of locally generated short period wind waves and longer period swell waves from the South China Sea. The Mike 21 Spectral Wave Model was used with 10-years (2006 to 2015) of Climate Forecast System Reanalysis (CFSR) wind data to estimate the wave propagation processes in the study area. Results of the model were used to extract significant wave height, wave direction and wave periods.

The correlations between the offshore and the nearshore wave conditions was established for selected locations along the coastline of Kuala Terengganu as illustrated in Figure 6.10. The predominant wave directions are northeast and southeast, with the significant wave height generally less than 2 m.

Analysis of the mean and maximum wave heights during the simulation period for the seasonal conditions indicate significantly higher waves are experienced during the NE monsoon compared to the SW and inter-monsoon conditions as shown in Figure 6.11 and Figure 6.12.

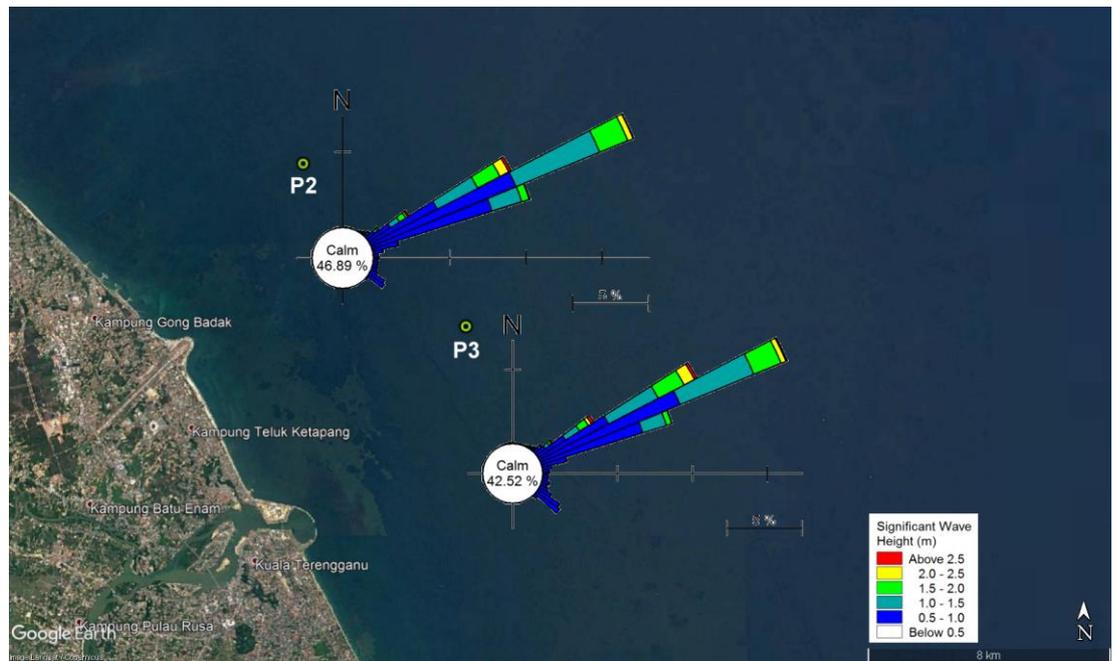


Figure 6.10 Extraction point of wave roses at offshore of Terengganu coastline.

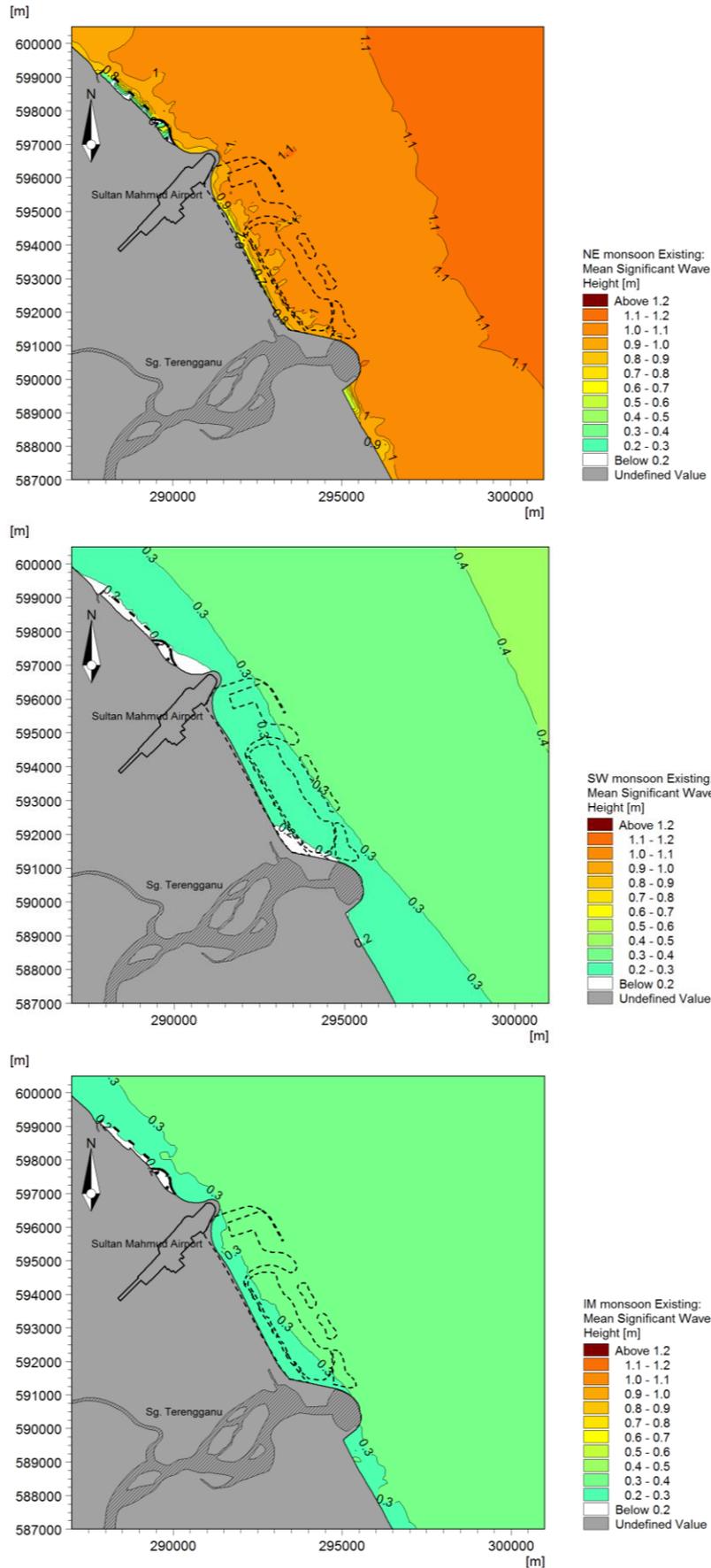


Figure 6.11 Predicted mean significant wave height over 28-days simulation during NE (top), SW (middle) and inter-monsoons (bottom).

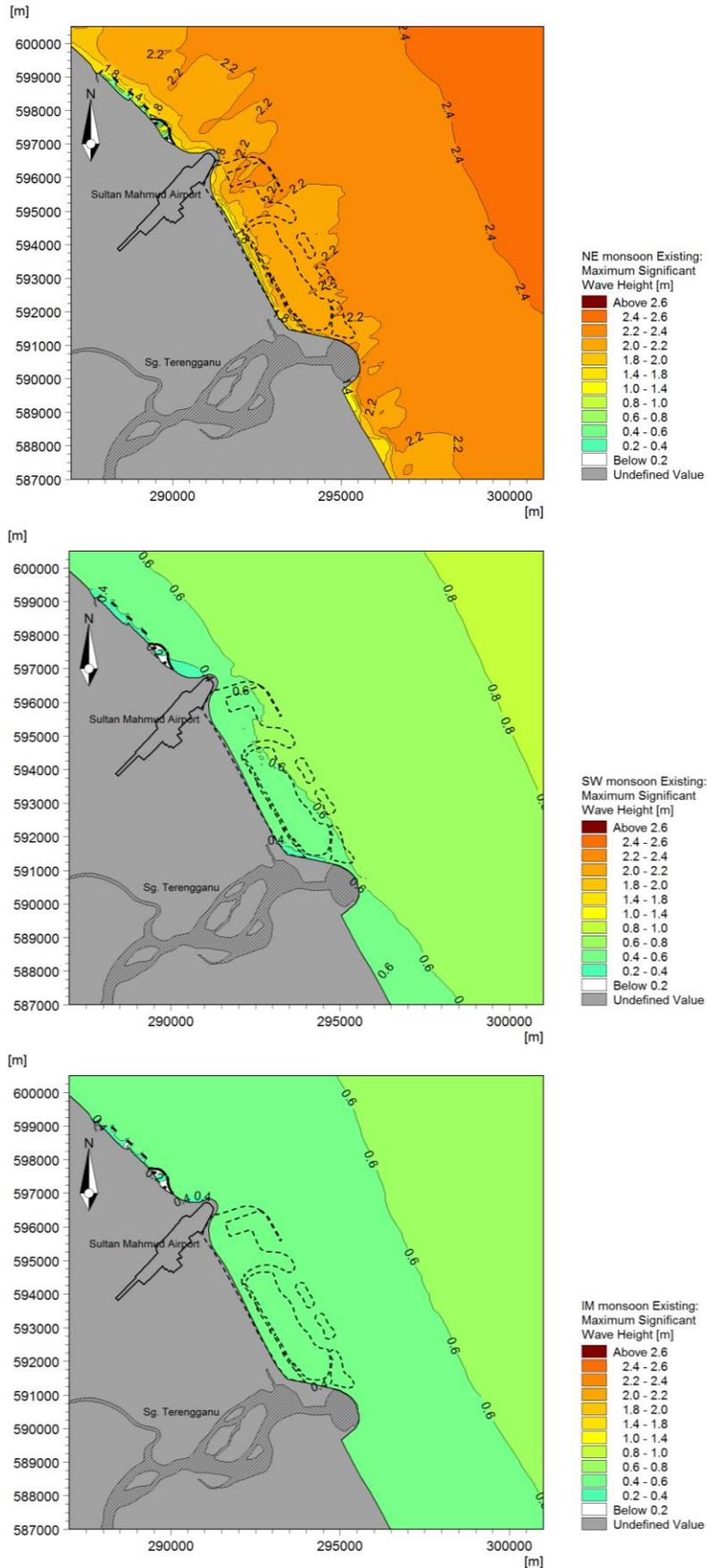


Figure 6.12 Predicted maximum significant wave height over 28-days simulation during NE (top), SW (middle) and inter-monsoons (bottom).

## 6.2.2 Coastal Morphology

As mentioned earlier, the coastal region of Terengganu is largely formed of sandy beaches which are dynamic in nature; however these natural coastal changes have been exacerbated by man-made changes from coastal structures as has been discussed in detail by Ariffin *et al.* (2018) /15/ (Figure 6.1). While these studies have established a strong framework for understanding the regional context for the coastal morphology and the associated changes in erosional risk it was considered important to look specifically at changes over time in relation to the Project site.

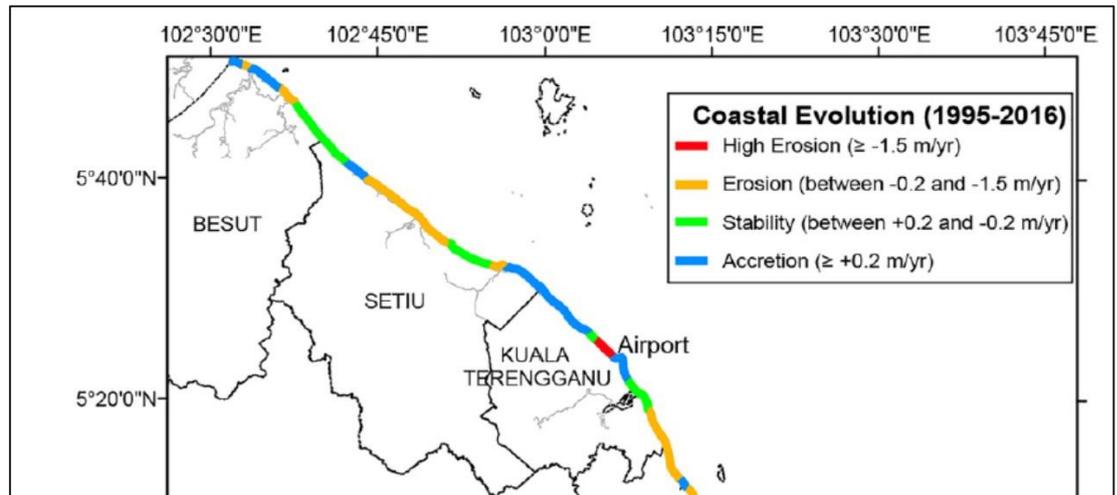


Figure 6.13 Results of a study identifying areas of net erosion, stability, or accretion along the Terengganu coastline. Note that the Project site south of the airport is characterised as partially accreting and further to the south is considered stable (abstracted from Ariffin *et al.* (2019)).

The coastal morphology and erosion risk assessment was carried out based on:

- Historical google earth images;
- Modelling works to calculate the wave induced sediment transport (littoral drift); and
- Other information such as National Coastal Erosion Study for Malaysia 2015 (NCES 2015), Terengganu Local Plan and published papers.

The shoreline analysis has been carried out and is presented for three main areas:

- Coastline immediately north of Sultan Mahmud Airport runway extension;
- Coastline in between Sultan Mahmud Airport runway extension and KT breakwater; and
- Coastlines immediately south of KT breakwater.

### 6.2.2.1 Coastline Immediately North of Sultan Mahmud Airport runway extension

As of 2008, after the extension of the airport runway, this area has experienced significant erosion. Figure 6.14 shows the coastlines north of the airport runway extension in 2008 where an initial deficit has led to a loss of coastline between 2008 and 2013. At its worst in 2011, the erosion caused the collapse of the coastal road and in January 2016, large waves also wreaked havoc causing large coastal erosion.

Protection works carried out by JPS along the UMT shore (designed and constructed in 2016) together with the Tok Jembal breakwaters have stabilized this stretch of coast, however, erosion still persists north of the protected area and this is referenced in the NCES 2015 report that indicates critical erosion.



Figure 6.14 Historical satellite images, for Jul 2008, Aug 2011, Sep 2014 and Aug 2017. The green line denotes the vegetation line digitised from imagery dated Aug 2017. (Source: Google Earth Pro).

#### 6.2.2.2 Coastline Between Sultan Mahmud Airport Runway Extension and KT Breakwater

This stretch of coast is located between the airport extension reclamation and the Kuala Terengganu breakwaters, both of which have blocked the sediment movements from this location to neighbour areas and therefore acting as an independent coastal cell. Overall the area is stable, particularly the northern end, however the southern

part experiences some shoreline changes over time due to the sheltering effect of the northern KT breakwater during different monsoon seasons. As a mitigation measure of this erosion and as part of the KT breakwaters design, an offshore detached breakwater has been built and this has mostly stabilized this stretch of coast. The NCES carried out by JPS in 2015 /18/ shows that the northern parts of this cell are stable, and the southern part show shoreline changes expected to happen during the monsoon seasons.

It should be noted that in 2018, along the southern end of this coastal area, a new coastal road known as the Jalan Pantai Teluk Ketapang with a length of approximately 3.9 km was constructed with the objective to provide a direct connectivity and reduce the travel time between KTCC and KT airport. Along the southern part of this new coastal road, the setback from high water mark is less than 60 m and therefore the road could suffer erosion during monsoon conditions. To stabilize this area and protect the road, construction of a rock revetment and artificial sand nourishment is presently being carried out.



Figure 6.15 Historical satellite images for Aug 2017 and Dec 2018. The blue line denotes the vegetation line digitised from imagery dated Dec 2018. (Source: Google Earth Pro).

### 6.2.2.3 Coastline Immediately South of KT Breakwater

Although showing some inter-annual variability, this stretch of coastline is seen to be stable or slightly accreting since 2012 (see Figure 6.16).



Figure 6.16 Historical satellite images Jul 2017 and Dec 2018. The blue line denotes the vegetation line digitised from imagery dated Dec 2018. (Source: Google Earth Pro).

#### 6.2.2.4 Conclusions

A detailed assessment of the historical shoreline changes along the coastline from Sultan Mahmud Airport runway extension to KT breakwater was undertaken that was complemented with research works by Ariffin *et al.* (2019), which considered changes from 1995 to 2016 for the region. The analysis shows that the area north of the airport extension has been protected and is now stable, and the coastal cell of the Project area is also stable but subject to shoreline changes during the different monsoon conditions. The area south of KT breakwaters consists of sandy stable beaches. The area with critical erosion is located north of the UMT coastline where JPS implemented coastal protection works, this is indicated in the NCS 2015 as shown in Figure 6.17.

**SHORELINE CHANGE TIMELAPSE VIDEO**

Scan this QR code to watch a timelapse of the shoreline change from 1984 – 2018.

If your smartphone does not have a reader, download one at [get.neoreader.com](http://get.neoreader.com)



A summary of the present coastline status around the study area is presented in Figure 6.18.

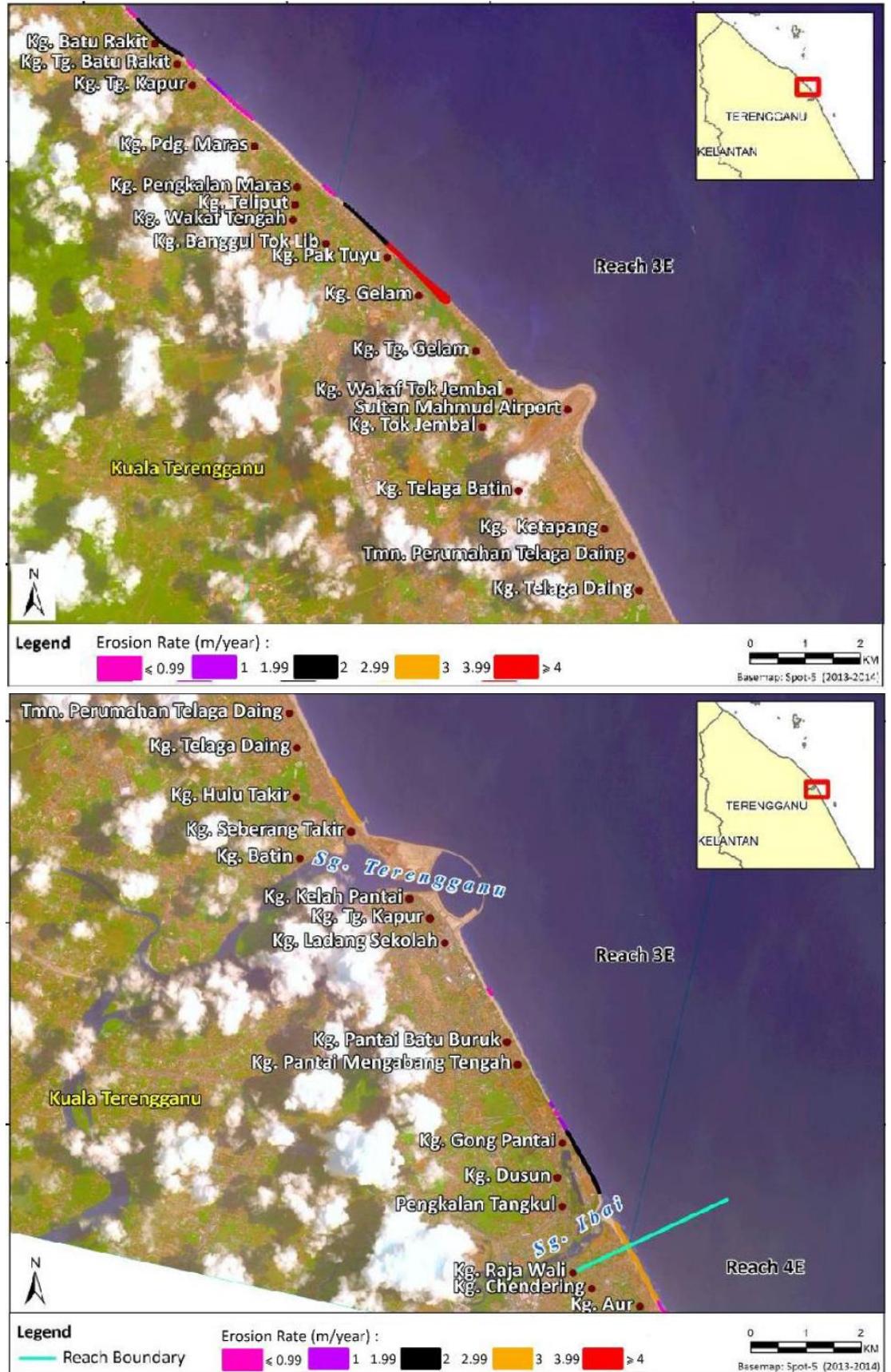


Figure 6.17 Average annual erosion from Kampung Batu Rakit to Kampung Aur, Kuala Terengganu, Terengganu. (Source: NCES 2015) – Red areas indicate critical erosion where infrastructure is at risk.

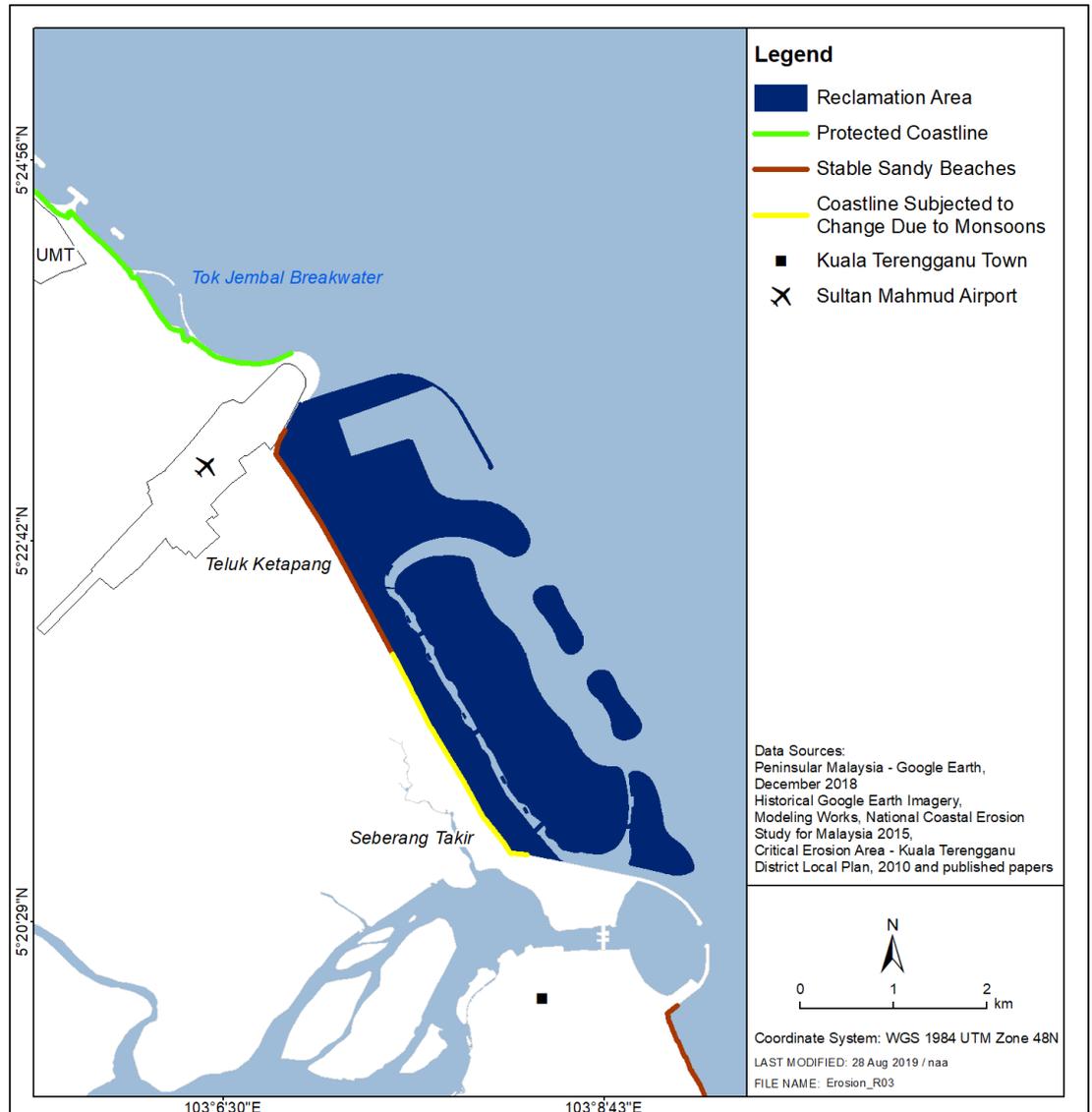


Figure 6.18 Status of the study area coastline based on the present assessment.

### 6.2.3 Hydrology and Drainage

The Project is located adjacent to the trained river mouth of Sg. Terengganu, which is the main river in the Sg. Terengganu basin originating from the upper watershed of Kenyir Lake. The main tributaries flowing into Sg. Terengganu are Sg. Nerus, Sg. Telemung, Sg. Berang and Sg. Tersat with a total catchment area of approximately 5,000 km<sup>2</sup>.

Monthly minimum, averaged, and maximum discharge rates for Sg. Terengganu have been obtained from DID data from year 1960 to 2000 from a stream gauge located roughly 35 km upstream Sg. Terengganu (Sg. Terengganu at Kg. Tanggol) as shown in Figure 6.19.

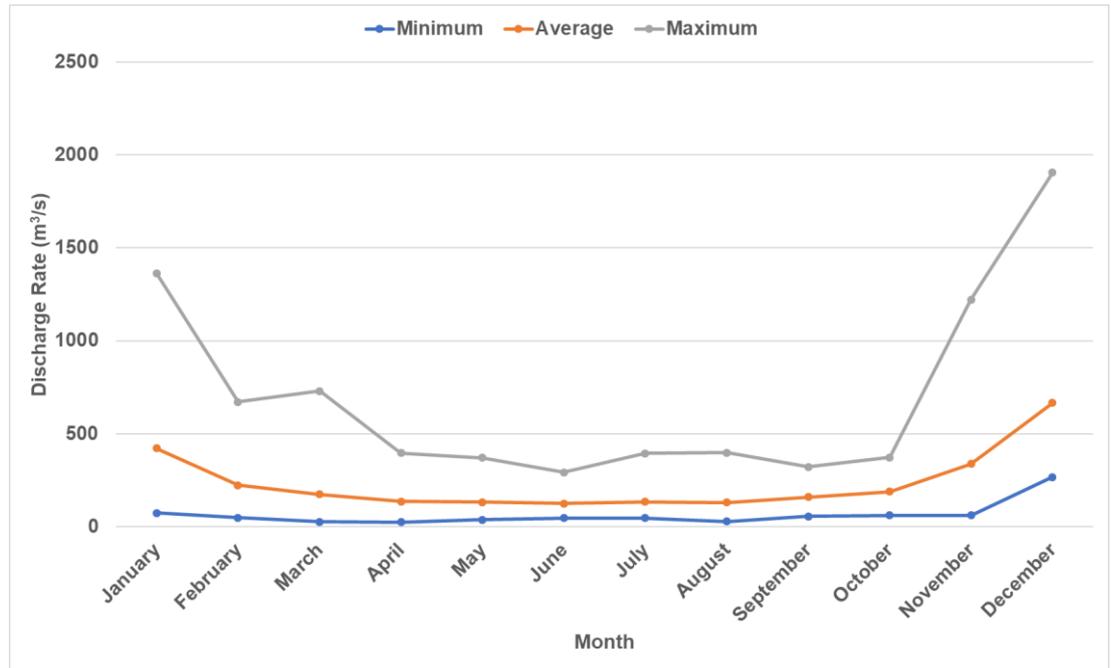


Figure 6.19 River discharge rates based on data collected from the year 1960 to 2000 at station Sg. Terengganu at Kg. Tanggol – 5130432. (Source: JPS).

Flooding occurs in the Terengganu during most years primarily during the Northeast monsoon. In recent years, Terengganu has experienced short major rainfalls, which caused flash floods. Among the worst hit places in recent years is Hulu Terengganu, whereby on 1 January 2017, Sg. Nerus and Sg. Telemong recorded a significant rise in river water levels /19/. On 30 November 2016, some areas in Kuala Terengganu were also hit by flash floods following a 247 mm rainfall in 24 hours /20/.

Figure 6.20 shows the areas vulnerable to floods identified in the Kuala Terengganu Local Plan 2010. Flooding areas reported by respondents to the socioeconomic survey for the present EIA conducted in 2019 are also shown in Figure 6.20 and are consistent with the flood prone area as reported in the Local Plan 2020.

The flooding in the hinterland of the reclamation area is mainly caused by increased water levels in Sg. Terengganu and its tributaries that runs parallel to the shoreline /21/.

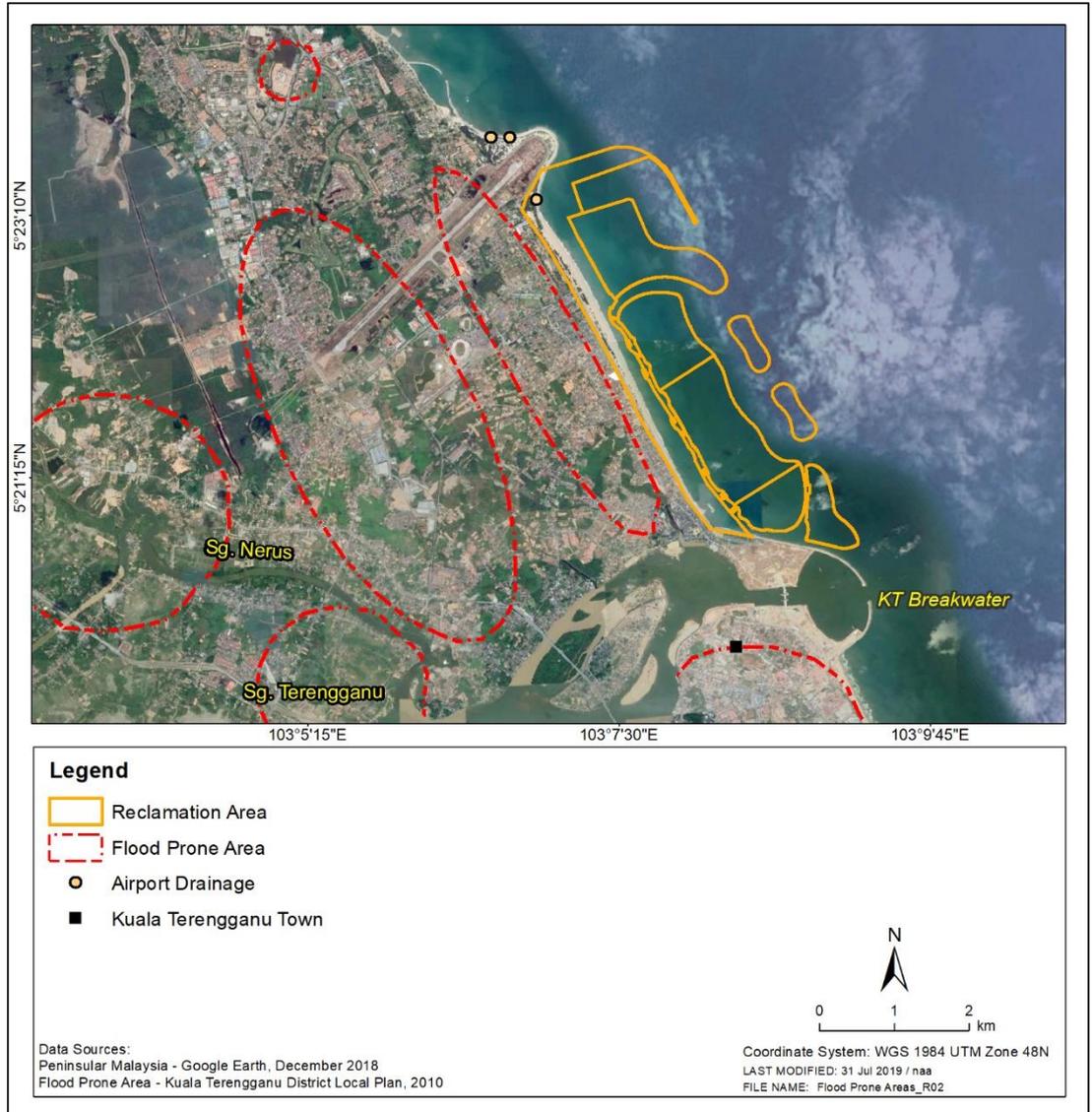


Figure 6.20 Flood prone areas identified in the Kuala Terengganu Local Plan 2010. It can be seen that these flood prone areas drain inland to Sg Terengganu. The airport drainage outlets are located to the north and south of the airport.

Three discharge outlets draining runoff from the airport runway are located along the shoreline, two draining northwards away from the reclamation area and one located on the south side of the airport runway extension draining into the reclamation area (see Figure 6.20 and Photo 6.1). In terms of overall drainage for the airport this discharge outlet deals with only a relatively small area of the airport.

Three soakaways<sup>4</sup> are also located along Pantai Teluk Ketapang (Photo 6.2 and Photo 6.3). Their locations are as per Figure 6.21. These soakaways drain the areas hinterland of the shoreline.

<sup>4</sup> A soakaway is a pit into which waste- or in this case, storm-water is piped so that it drains slowly out into the surrounding soil.



Photo 6.1 Sultan Mahmud Airport's drainage outlet, draining into the reclamation area.



Photo 6.2 Soakaway No. 1 located by the roadside northern shoreline of Pantai Teluk Ketapang.