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FINAL REPORT
MIRI, SARAWAK GIS AND MARINE DATA
OCTOBER 2022



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1. INTRODUCTION

The research is under project number P3317000 0120003 are entrusted to National Water Research Institute of Malaysia (NAHRIM) to carry out research. The Project under Sea level rise and coastal geomorphology research program (*Program Penyelidikan Kenaikan Aras Laut Dan Geomorfologi Pantai*) and which research was focused to scope 2 of geomorphology response and coastal erosion.

The study was carried out for two phase which 1st phase started from 20th July 2022 until 15th August 2022 while for 2nd phase, the site works started from 1st September 2022 until 10th October 2022. The objective of the present survey is to study the existing nearshore, seabed profiles and detailed profiles for existing breakwater or structures for the coastal area at Pantai Miri.

2. GIS OF THE MIRI

There are 4 major rivers involve in this survey and data collection phase: Sg. Niah, Sg. Sibuti, Sg. Baong and Sg. Baram. Most of the GIS data points are located along the involved river till the depth that satisfied which define with salinity almost 0 ppt.

2.1. GIS At Niah River

The total length of GIS tracking at Niah River is around 21 kilometres, with an average slope of 1.5% to 1.3%. (Figure 1, Figure 2 to 45 and Table 1). Throughout the study, the highest elevation is 19 metres above mean sea level (0 metres) and is found at Niah 14, 13.1 kilometres from the river mouth. Nevertheless, the lowest height is found at Niah_02, which is located 1.1 kilometres from the river mouth and has an elevation of 2 metres. The average monthly rainfall distribution in Niah watershed is 120 mm to 380 mm, and the catchment area of this river is around 1,316.20 km².

The average sea level increase is roughly 4.44 cm/decade, according to data reanalysis from The European Centre of Medium Range Weather Forecast (ECMWF) satellite altimetry. The built-up area is 18.7 kilometres from the river's mouth, with an average height of 10 metres above sea level and a slope of 1.6%. Its river's cross section is approximately 481m² at station Niah_04 and 323m² at station Niah_22. There is a cusplate foreland and spit near the river mouth that accumulated 179,118 m² of sand in 2013 but were eroded this year because of intense wave interaction and magnitude.

Most of the development in Point 20 have likely completed for community's facilities and buildings such as district government office, Niah's Waterfront, Dewan Masyarakat Majlis Daerah Subis Niah, and Community internet centre. Nevertheless, at point 19, there is a Niah River Bridge and Family Café. The junction of the Trus River and the Niah River made this river distinctive. This crossing was 6.6 kilometres from the river's mouth, between points 7 and 8. As a result, the Trus River provided pure freshwater to the main Niah River, allowing coastal villages to acquire cash and improve their economies. At point 10, there were oil palm farms and nypas growing beside Niah's Riverbank. The oil palm plantation area was 3.46 hectares, while the nypas growing area was 1.13 hectares and was positioned in front of the oil palm plantations.

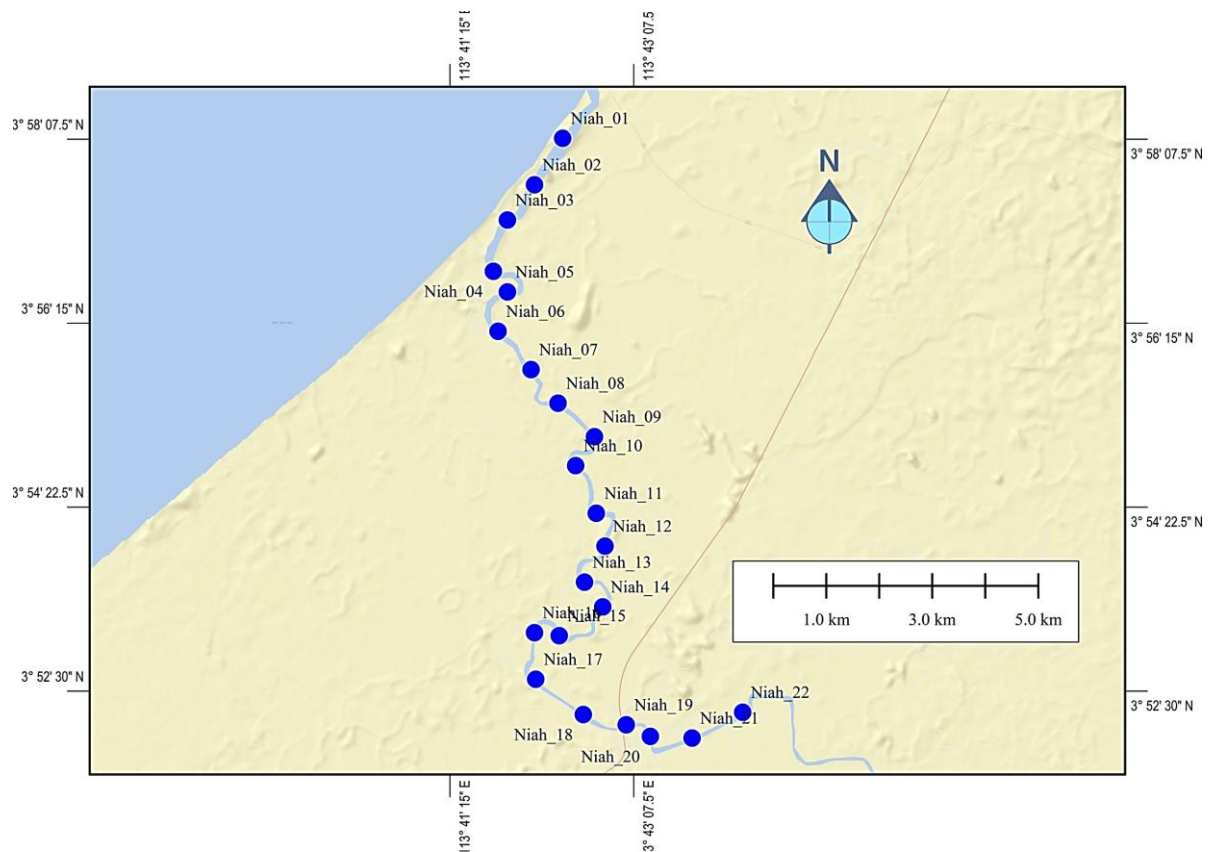


Figure 1: Mapping of salinity tracking points at Sg. Niah

Table 1: GIS data along Sg. Niah

GIS Point	Longitude (°)	Latitude (°)	Time	Location	Water Depth (m)	Salinity bottom (ppt)	Weather	Vegetation/ Infrastructure/ Socioeco.
Sal_Sg.Niah_01	113.7067	3.96890	1.33pm	Kg Kuala Sibuti	3.0	24	Clear	Nypa, Shrubs, Beting Pasir, Rhu Trees, Fallen Trees
Sal_Sg.Niah_02	113.7019	3.96100	1.24pm	Kg Kuala Niah	2.6	26	Clear	Nypa, Shrubs, Rumah Rakit
Sal_Sg.Niah_03	113.6973	3.95500	1.17pm	Kg Kuala Niah	3.4	26	Clear	Nypa, Shrubs, Walit Birds House, Mangroves
Sal_Sg.Niah_04	113.6949	3.9463	1.09 pm	Kg Tarikan	5.3	27	Clear	Nypa, Shrubs, Mangroves, Tebing Runtuh
Sal_Sg.Niah_05	113.6973	3.9428	1.01 pm	Kg Tarikan	4.6	26	Clear	Nypa, Shrubs, Mangroves, Tebing runtuh
Sal_Sg.Niah_06	113.6957	3.9361	12.54 pm	Kg Lajong	6.0	27	Clear	Nypa, Shrubs, Fallen Trees
Sal_Sg.Niah_07	113.7013	3.9296	12.47 pm	Kg Lajong	7.4	26	Clear	Nypa, Shrubs
Sal_Sg.Niah_08	113.7059	3.9239	12.41 pm	Kg Lajong	7.1	27	Clear	Nypa, Coconut Tress,Mangroves
Sal_Sg.Niah_09	113.7121	3.9182	12.33 pm	Kg Lajong	9.5	27	Clear	Nypa, Mangroves, Shrubs
Sal_Sg.Niah_10	113.7089	3.9133	12.25 pm	Kg Lajong	8.7	27	Clear	Nypa, Mangroves
Sal_Sg.Niah_11	113.7124	3.9052	12.20 pm	Kg Lajong	5.8	25	Clear	Shrub, Bush, Coconut Trees,

GIS Point	Longitude (°)	Latitude (°)	Time	Location	Water Depth (m)	Salinity bottom (ppt)	Weather	Vegetation/ Infrastructure/ Socioeco.
								Nypa, Mangroves
Sal_Sg.Niah_12	113.7139	3.89960	12.11 pm	SOPB Sg Balim	9.3	27	Clear	Shrub, Bush, Coconut Trees, Nypa
Sal_Sg.Niah_13	113.7104	3.8935	12.04 pm	SOPB Sg Balim	9.3	27	Clear	Shrub, Bush, Coconut Trees, Nypa, Rubber Trees
Sal_Sg.Niah_14	113.7135	3.8893	11.58 am	SOPB Sg Balim	6.9	25	Clear	Shrub, Bush, Fallen Trees, Nypa
Sal_Sg.Niah_15	113.7061	3.8844	11.48 am	Kuala Niah	9.1	26	Clear	Shrub, Bush, Coconut Trees, Nypa
Sal_Sg.Niah_16	113.7019	3.8849	11.40 am	Kuala Niah	8.0	24	Clear	Shrub, Bush, Small Garden, Nypa
Sal_Sg.Niah_17	113.7021	3.8770	11.31 am	Niah Bridge	8.3	23	Clear	Shrub, Bush, Small Garden, Nypa
Sal_Sg.Niah_18	113.7102	3.8710	11.24 am	Niah Bridge	10	25	Clear	Shrub, Bush, Small Garden, Nypa, Palm Oil Plantations
Sal_Sg.Niah_19	113.7216	3.8674	11.14 am	Niah Bridge	9.0	23	Clear	Coconut Trees, Aquaculture (Talapia), Nypa, Schrubs
Sal_Sg.Niah_20	113.7216	3.8673	11.04 am	Miri Waterfront	6.8	23	Clear	Shrub, Bush, Small Garden, Walit Birds House, Buddha Temple
Sal_Sg.Niah_21	113.7287	3.8670	10.53 am	Kg. Muhibah	9.1	20	Clear	Shrub, Coconut Tree, Small Garden
Sal_Sg.Niah_22	113.7373	3.8714	10.46 am	Kg. Dagang,	6.4	19	Clear	Shrub, Bush, Small Garden, Kg. Badang

Niah River

GIS_Niah_22



Figure 2: Nypas were lived mostly the river banks of Niah River



Figure 3: Some revetments were builded to protect Niah's River Bank

GIS_Niah_21



Figure 4: There are small village activities were observed near the river bank



Figure 5: Most of coconut trees are lived along the river

GIS_Niah_20



Figure 6: The warehouse for rural activities economy



Figure 7: The walit birds house for bird nesting production

GIS_Niah_19



Figure 8: There are several aquacultures mostly freshwater fish for local economy



Figure 9: The bridge which connected two villages

GIS_Niah_18



Figure 10: The walit birds house for bird nesting production



Figure 11: Local resident was fishing near the river banks

GIS_Niah_17



Figure 12: Nypas were lived associated with wide shrubs



Figure 13: Shrubs and high bushes were observed along the river

GIS_Niah_16



Figure 14: Local resident was fishing near the river banks. Looking for fish and shrimps



Figure 15: The long house were build near to river bank

GIS_Niah_15



Figure 16: Local resident was fishing near the river banks. Looking for fish and shrimps



Figure 17: Nypas were lived and grows well along this river

GIS_Niah_14



Figure 18: Nypas and associated bushes were lived and grows well along this river



Figure 19: High Bushes were observed at this point

GIS_Niah_13



Figure 20: The healthy nypas grows well



Figure 21: Nypas and palm oil plantations were observed

GIS_Niah_12



Figure 22: The fishing boat and local economic activities



Figure 23: The healthy nypas grows well

GIS_Niah_11



Figure 24: There are coconut trees, nypas and high bushes were observed during Niah River tracking



Figure 25: The healthy nypas grows well

GIS_Niah_10



Figure 26: The healthy nypas grows well



Figure 27: The healthy nypas grows well

GIS_Niah_09



Figure 28: The healthy nypas grows well



Figure 29: Some hard protections were observed to protect the river bank

GIS_Niah_08



Figure 30: Very high and healthy coconut trees were observed



Figure 31: High bushes thus no development around the river bank

GIS_Niah_07



Figure 32: Some boat jetties by local residents for local economic activities. The water has no clarity due to high content of chemical usage



Figure 33: The healthy nypas grows well

GIS_Niah_06



Figure 34: The healthy nypas grows well along the terrains



Figure 35: High erosion of river bank and produced flood prone areas

GIS_Niah_05



Figure 36: High erosion of river banks and also associated with died plants and trees



Figure 37: High erosion of river banks and also associated with died plants and trees

GIS_Niah_04



Figure 38: The healthy nypas grows well



Figure 39: High erosion of river banks

GIS_Niah_03



Figure 40: The walit house for bird nesting production done by local residents



Figure 41: Small jetties for local residents to logistic their needs and fish

GIS_Niah_02



Figure 42: Small jetties for local residents to logistic their needs and fish



Figure 43: The healthy nypas grows well to protect erosion of river banks

GIS_Niah_01



Figure 44: The sand tombolo was developing at Niah river estuary. Some high magnitude of wind strees at this area



Figure 45: The dried and dead logs were stranded at sand tombolo also observed

2.2. GIS At Sibuti River

The total length of GIS tracking along the Sibuti River is roughly 30.3 kilometres, with an average slope of 1.1% (Figure 46, Figure 47 to 74 and Table 2). The highest point in the survey is 16 metres above mean sea level (0 metres), and it is located 2.64 kilometres and 23.3 kilometres from the river mouth. However, the lowest height is found in Sibuti_17, which is 22.4 kilometres from the river's mouth. The average monthly rainfall distribution at Sibuti watershed is 150 mm to 300 mm, and the catchment area of this river is around 892.66 km². The average sea level rise is roughly 4.44 cm/decade, according to data reanalysis from The European Centre of Medium Range Weather Prediction (ECMWF) satellite altimetry. The built-up area is 19 kilometres from the river's mouth, with an average elevation of 9 metres above sea level and a slope of 0.9%. At station Sibuti_03, the average cross section of this river is roughly 322m². At the river mouth, there is a cusped foreland and spit, with 40,165 m² of sand accretion in 2017.

The point 22 at Kampung Balau was identified as a crocodile habitat (based on signboard observation—please refer to GIS location and photographs below) and may represent a risk to the public if they choose to organise any recreational activities there. The water was rather deep, but the salinity rating was quite low, allowing crocodiles to find food and nesting grounds. Together with GIS tracking and evaluation from upstream of this river, it was discovered that one village community lives here.

This village is located near the Sibuti_19 tracking point in Kampung Sinop. Between points Sibuti_15 and Sibuti_17, there was an urbanised area that gave more amenities to the Sibuti residents. Among the 72.3 hectares of urban area were the Al-Muttaqin Mosque, Grocery Store, Rumah PPWS Daerah Bekenu, District Education Office at Subis, and Balai Raya Kampung Bekenu Asli. This urbanised area was also determined to be near to Kampung Manjelin and Kampung Kawang.

At Sibuti 14, there were two village communities: Kampung Ranchah-Ranchah and Kampung Masjid, as well as one school for both kampung: Sekolah Jenis Kebangsaan Cina Chung Hua Sungai Lumut. It was also located on the Sibuti Wildlife Sanctuary, between Sibuti points 11 and 14. At point 1, which was located near Sibuti's Estuary, there was just one Kampung, Kampung Kuala Sibuti. There was only one school (Sekolah Kebangsaan Kampung Kuala Sibuti) and some homestays in these coastal settlements. The highest point in the survey is 16 metres above mean sea level (0 metres), and it is located 2.64 kilometres and 23.3 kilometres from the river mouth.

However, the lowest height is found in Sibuti_17, which is 22.4 kilometres from the river's mouth. The average monthly rainfall distribution at Sibuti watershed is 150 mm to 300 mm, and the catchment area of this river is around 892.66 km². The average sea level rise is roughly 4.44 cm/decade, according to data reanalysis from The European Centre of Medium Range Weather Prediction (ECMWF) satellite altimetry. The built-up area is 19 kilometres from the river's mouth, with an average elevation of 9 metres above sea level and a slope of 0.9%. At station Sibuti_03, the average cross section of this river is roughly 322m². At the river mouth, there is a cusped foreland and spit, with 40,165 m² of sand accretion in 2017.

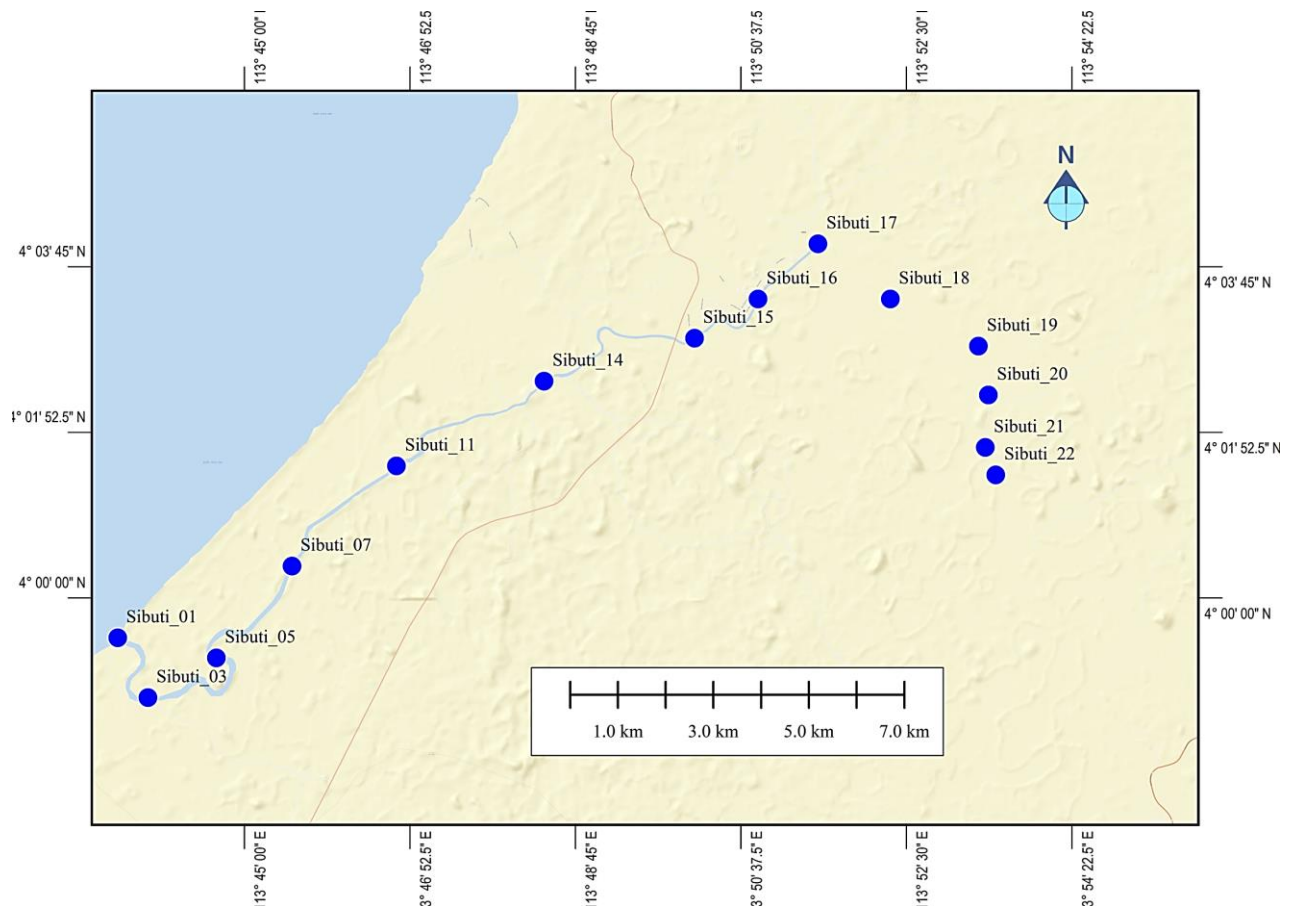


Figure 46: Mapping of salinity tracking points at Sibuti River.

Table 2: GIS data along Sg. Sibuti

GIS Point	Longitude (°)	Latitude (°)	Time	Location	Water Depth (m)	Salinity bottom (ppt)	Weather	Vegetation/ Infrastructure/ Socioeco.
Sal_Sg.Sibuti_01	113.7261	3.9925	2.11 pm	Muara	2.9	28	Clear	Depart from Jetty: 9.30am Coconut Trees, Shrubs, Rhu Trees and Mangroves, Fishing Zone
Sal_Sg.Sibuti_03	113.7318	3.9812	2.00 pm	Kg Belunu Kelulit	4.6	28	Clear	Nypas, Shrubs, Mangroves
Sal_Sg.Sibuti_05	113.7447	3.9887	1.48 pm	Kg Kuala Sibuti	6.7	28	Clear	Nypas, Shrubs
Sal_Sg.Sibuti_07	113.7590	4.0060	1.33 pm	Kg Padang Kelulit	7.4	28	Clear	Nypas, Shrubs
Sal_Sg.Sibuti_11	113.7787	4.0249	1.25 pm	Sibuti Wildlife Sanctuary	7.1	28	Clear	Nypas, Shrubs, Palm Oil Plantations
Sal_Sg.Sibuti_14	113.8066	4.0409	1.04 pm	Kg Ranchah-Ranchah	7.4	27	Clear	Nypas, Shrubs, Fishing Activities
Sal_Sg.Sibuti_15	113.8350	4.0490	12.47 pm	Kg Jengalas Bekenu	8.0	26	Clear	Nypa, Fishing Activities, Warehouse for Fish Market
Sal_Sg.Sibuti_16	113.8470	4.0564	12.30 pm	Pump Station Bekenu-Kg Rampai	6.5	25	Clear	Jetty, Coconut Trees,
Sal_Sg.Sibuti_17	113.8583	4.0668	12.17 pm	Kg Keluru Jaya	5.9	23	Clear	Nypa, Shrubs, Mangroves, Walit Birds House

GIS Point	Longitude (°)	Latitude (°)	Time	Location	Water Depth (m)	Salinity bottom (ppt)	Weather	Vegetation/ Infrastructure/ Socioeco.
Sal_Sg.Sibuti_18	113.8720	4.0564	12.05 pm	Kg Keluru Jaya	6.2	22	Rain	Nypa, Shrubs
Sal_Sg.Sibuti_19	113.8886	4.0475	11.48 am	Kg Mutap	5.2	19	Rain	Nypa, Shrubs, Palm Oil
Sal_Sg.Sibuti_20	113.8905	4.0383	11.40 am	Kg Mutap	3.0	3.5	Rain	Nypa, Shrubs, Bridge
Sal_Sg.Sibuti_21	113.8899	4.0284	11.29 am	Kg Mutap	3.7	6	Cloudy-Rain	Coconut Trees, Shrubs, Rumah Kg
Sal_Sg.Sibuti_22	113.8919	4.0232	11.22 am	Balau-Mutap	3.0	0.7	Cloudy	Coconut Trees, Shrubs

Sibuti River

GIS_Sibuti_22



Figure 47: This area was located as high risk for fishing due to crocodile habitat



Figure 48: Nypas, shrubs and bushes are located along the river bank

GIS_Sibuti_21



Figure 49: The small jetty for local residents.



Figure 50: High and green bushes located along the river bank

GIS_Sibuti_20



Figure 51: The moderate erosion of river banks adjacent to local residents house



Figure 52: The small jetty and long house were observed along the river bank

GIS_Sibuti_19



Figure 53: The destroyed jetty and Palm Oil plant were observed in this area



Figure 54: The wide Sibuti River associated with nypas dan small bushes

GIS_Sibuti_18



Figure 55: Destroyed of plants due to river bank erosion



Figure 56: The healthy nypas grows well to protect erosion of river banks

GIS_Sibuti_17



Figure 57: The healthy nypas grows well to protect erosion of river banks



Figure 58: The healthy nypas and bushes grows well to protect erosion of river banks

GIS_Sibuti_16



Figure 59: The healthy nypas grows well to protect erosion of river banks



Figure 60: The local residents house near to river banks

GIS_Sibuti_15



Figure 61: The roads were destroyed and vulnerable to fuel pump stations near to river banks



Figure 62: The high risk to do river activities due to crocodile habitat

GIS_Sibuti_14



Figure 63: The bridge to connected two villages



Figure 64: Local residents house near the river bank

GIS_Sibuti_11



Figure 65: destroyed nypas were observed along the river bank



Figure 66: Nice view of grass and nypas. They grows and create a beautiful scenery

GIS_Sibuti_07



Figure 67: The healthy nypas grows well to protect erosion of river banks



Figure 68: Very wide Sibuti River associated with nypas dan small bushes

GIS_Sibuti_05



Figure 69: The healthy nypas grows well to protect erosion of river banks



Figure 70: The healthy nypas grows well to protect erosion of river banks

GIS_Sibuti_03



Figure 71: The healthy nypas and rhu trees grows well to protect erosion of river banks



Figure 72: The healthy nypas grows well to protect erosion of river banks

GIS_Sibuti_01



Figure 73: The hard structures were build as revetment to protect river estuary



Figure 74: The local residents activities for fishing

2.3. GIS At Baong River

The total length of the survey for GIS tracking at Baong River is around 22.7 km, with an average slope of 0.9% (Figure 75, Figure 76 to 103 and Table 3). Throughout the survey, the highest point is 13 metres above mean sea level (0 metres) at Baong_23 and 20.7 kilometres from the river mouth. However, the lowest height is found at Baong_01, which is approximately 1.03 kilometres from the river's mouth. The average monthly rainfall distribution at Baong watershed is 150 mm to 320 mm, and the catchment area of this river is around 680.92 km². The average sea level rise is approximately 4.44 cm/decade, according to data reanalysis from The European Centre of Medium Range Weather Prediction (ECMWF) satellite altimetry.

The built-up area extends from the river mouth to Baong_01, with an average elevation of 4.5 metres (3 to 9 metres) above mean sea level and an average slope of 0.8%. At station Baong_01, the average cross section of this river is approximately 611m². There is a breakwater at the river mouth with a length of 618 metres, and as a result of this structure, sediments accumulate at the right breakwater with an area of 45,343.8 m². This GIS tracking location was discovered to be dominated by urbanised area that covered from point 1 to point 16 with a coverage area of about 4,500 hectares.

In Point 1, there was a Pullman Hotel, which was a high-class and executive-level hotel. The fee at this hotel was fairly exorbitant, yet there was still demand, particularly among oil refinery employees and foreigners. The ship terminal for export and import transactions was located at point 2, but it was gazetted as industrial and commercial land use at point 4. The majority of the activity here are vehicle workshops, a school, and a business sector. Nonetheless, at point Baong_06, a fish market was established for coastal people, such as fishermen, to sell their marine products.

However, at this moment, a lot of residential was built here, putting a strain on the local economy. From the site Baong_08 upstream, a modest residential area was discovered. The majority of the housing here was village housing, and most of the residents were unable to live owing to the significant risk of collapse. Due to limited money, it may be difficult for homeowners to repair their own homes. The land used in Baong_12 was dominated by residences and small shops.

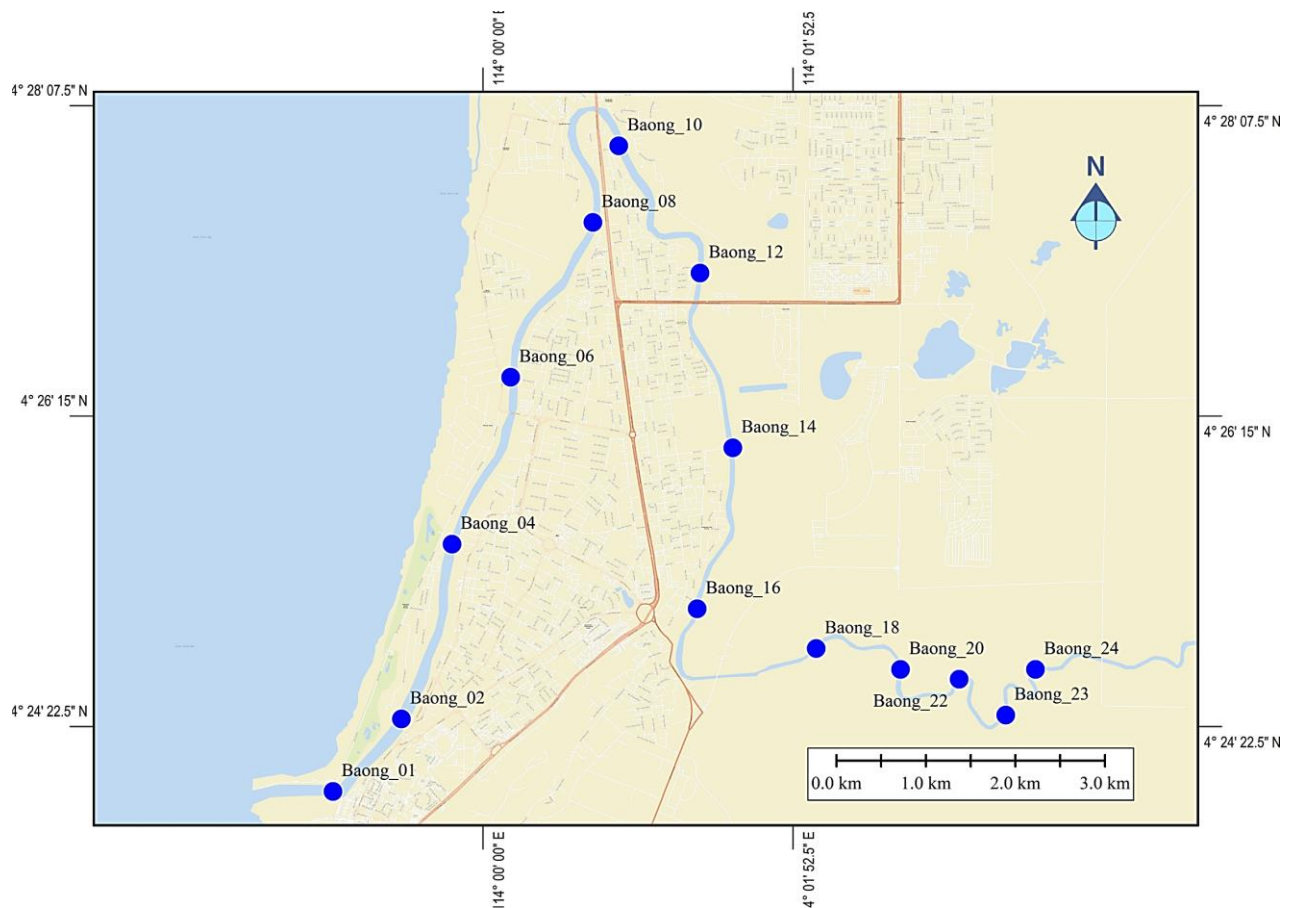


Figure 75: Mapping of salinity tracking points at Baong River.

Table 3: GIS data along Sg. Baong

GIS Point	Longitude (°)	Latitude (°)	Time	Location	Water Depth (m)	Salinity bottom (ppt)	Weather	Vegetation/ Infrastructure/ Socioeco.
Sal_Sg.Baong_01	113.9849	4.3997	1.18 pm	Pullman Hotels	4.7	17	Clear	Depart from Jetty: 940 am, Shrubs, Rhu Trees, Commercial Area
Sal_Sg.Baong_02	113.9918	4.4070	1.10 pm	Kampong Pulau Melayu	4.0	20	Clear	Shrubs, Coconut Trees, Nypa
Sal_Sg.Baong_04	113.9969	4.4246	12.59 pm	Kurukop	6.0	24	Clear	Pier, Ships, Port, Mangroves and Shrubs
Sal_Sg.Baong_06	114.0028	4.4414	12.47 pm	Kg Pasar Utara	6.0	25	Clear	Shrubs, Village, Coconut Nypa, Walit Birds Building, Rumah Rakit, warehouse
Sal_Sg.Baong_08	114.0111	4.4570	12.35 pm	RPR Batu Enam	6.3	25	Clear	Shrubs, Village, Coconut Trees, Cemetery, Development Area
Sal_Sg.Baong_10	114.0137	4.4647	12.23 pm	Pengkalan Lutong, Kg Pujot 10	5.8	22	Clear	Shrubs, Coconut Trees, Nypa

GIS Point	Longitude (°)	Latitude (°)	Time	Location	Water Depth (m)	Salinity bottom (ppt)	Weather	Vegetation/ Infrastructure/ Socioeco.
Sal_Sg.Baong_12	114.0219	4.4519	12.10 pm	Kg Pujut 7	8.0	22	Clear	Shrubs, Village, Coconut Trees, River lettuce, Banana Trees
Sal_Sg.Baong_14	114.0252	4.4343	11.56 am	Kg Adong	8.1	22	Clear	Shrubs, Village, Coconut Trees, Walit Birds Nesting
Sal_Sg.Baong_16	114.0216	4.4181	11.43 am	Kg Pujut	6.1	16	Clear	River lettuce, Shrubs, Banana Trees, Palm Oil Trees, Nypa, Village
Sal_Sg.Baong_18	114.0336	4.4141	11.27 am	Kampung Pujut Tanjong Batu	9.4	13	Clear	Shrubs
Sal_Sg.Baong_20	114.0421	4.4120	11.17 am	CSTP Pump Station	8.4	14	Clear	Shrubs
Sal_Sg.Baong_22	114.0480	4.4110	11.06 am	Bandar Baru Permyjaya	9.6	15	Clear	River lettuce, Shrubs, Palm Oil Plantations, Construction Area
Sal_Sg.Baong_23	114.0527	4.4074	10.54 am	Bandar Baru Permyjaya	9.0	14	Clear	River lettuce, Shrubs, Piai
Sal_Sg.Baong_24	114.0557	4.4120	10.44 am	Bandar Baru Permyjaya	8.0	3.8	Clear	River lettuce, Shrubs

Baong River

GIS_Baong_24



Figure 76: Thick bushes were located along the river bank



Figure 77: Thick bushes were located along the river bank. The water create reflection and build beautiful scenery

GIS_Baong_23



Figure 78: Piai plants were grows well along the river bank



Figure 79: Piai plants were grows well along the river bank

GIS_Baong_22



Figure 80: The oil palm plantations were observed along the river



Figure 81: Some development were destroyed plants and fauna ecosystem

GIS_Sg.Baong_20



Figure 82: Thick bushes were located along the river bank.



Figure 83: Thick bushes were located along the river bank.

GIS_Sg.Baong_18



Figure 84: Thick bushes were located along the river bank. The water create reflection and build blue sky beautiful scenery



Figure 85: local resident was fishing along this river

GIS_Sg.Baong_16



Figure 86: Local residents house near the river banks



Figure 87: local resident was fishing along this river

GIS_Baong_14



Figure 88: The walit house for bird nesting production economic activities



Figure 89: The coconut trees and local residents house

GIS_Baong_12



Figure 90: Destroyd local residents house was observed along the river



Figure 91: The bridge to connected two villages

GIS_Baong_10



Figure 92: The big boat belongs to local residents for fishing



Figure 93: Nypas were grows near to local residents house

GIS_Baong_08



Figure 94: The river bank structue as revetment to protect river bank erosion



Figure 95: The river bank structue as revetment to protect river bank erosion

GIS_Baong_06



Figure 96: The luxury boat was observed near to ship docks



Figure 97: The navigation boat anchored near to ship docks

GIS_Baong_04



Figure 98: the headquarter of port authority



Figure 99: Very worst erosion near to river bank and vulnerable to district roads

GIS_Baong_02



Figure 100: The non-muslims cemetery near to river estuary



Figure 101: The local fishing boats for offshore fishing activities

GIS_Baong_01



Figure 102: The Pullman hotel near to river estuary



Figure 103: The revetments were build to protect river estuary erosion

2.4. GIS At Baram River

The overall length of the survey for GIS tracking at the Baram River is approximately 56.15 km, with an average slope of 0.2% (Figures 104, Figure 105 to 128 and Table 4). The highest point in the survey is 8 metres above mean sea level (0 metres) at Baram_12, which is 56 kilometres from the river mouth. The lowest elevation, however, is found in Baram_03, which is 11.2 kilometres from the river's mouth. The average monthly rainfall distribution at the Baram watershed ranges from 120 mm to 290 mm, and the river's catchment area is approximately 22,109 km². According to data reanalysis from The European Centre of Medium Range Weather Forecast (ECMWF) satelit altimetry, the average sea level rise is about 4.44 cm/decade.

The built-up area extends from the river mouth to Baram_01 and Baram_03 stations, with an average elevation of 1 metre (0 to 2 m) above mean sea level and an average slope of 0.4%. At station Baram_03, the average cross section of this river is approximately 3.458m². Because of the deep water level in this river, there is a port and ship site. The deep depth water is the key factor that may influence the location of ships and port structures.

Since 2019, totally sand dunes have grown near the mouth of the Baram River, and the accretion sediments have created roughly 522,244 m². The light commercial district, which includes workshops, a shipyard, and the Miri Port Authority, was located at the location Baram_03. This location is also close to Kampung Rentis and mild woodlands. There were no dense residential areas or villages along the planned river course, and the basin is mostly covered by forest. Nevertheless, along the country borders (Malaysia and Brunei), oil palm farms were discovered, which covered the tracking sites.

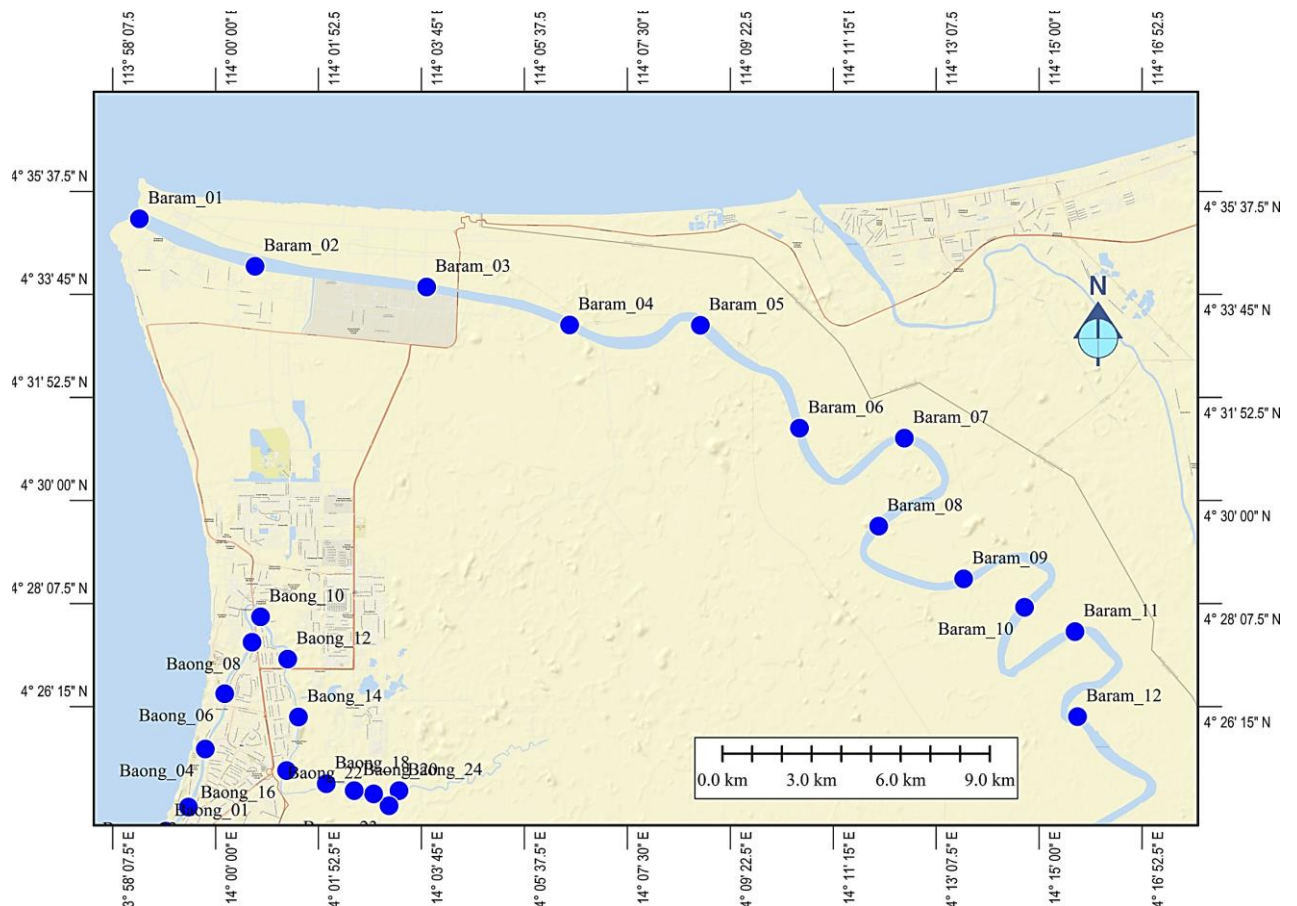


Figure 104: Mapping of salinity tracking points at Baram River.

Table 4: GIS data along Sg. Baram

GIS Point	Longitude (°)	Latitude (°)	Time	Location	Water Depth (m)	Salinity bottom (ppt)	Weather	Vegetation/ Infrastructure/ Socioeco.
Sal_Sg.Baram_01	113.9769	4.5854	12.10 pm	ILPL Kuala Baram	7.5	17	Clear	Depart from Jetty: 9.40 am, Shrubs, Coconut Trees, Rhu Trees
Sal_Sg.Baram_02	114.0120	4.5710	12.00 pm	Hua Seng Sawmill Co. Bhd	10.7	15	Clear	Shrubs, Nipah Darat, Palm Oil Plantations
Sal_Sg.Baram_03	114.0641	4.5647	11.50 am	Ship Dock	13	0	Clear	Shrubs, Palm Oil Plantations
Sal_Sg.Baram_04	114.1075	4.5532	11.39 am	Adong Palm Oil Mill	10	0	Clear	Shrubs, Nipah Darat, Palm Oil Plantations
Sal_Sg.Baram_05	114.1472	4.5531	11.30 am	Asam Paya	11	0	Clear	Shrubs, Nipah Darat, Kiambang, Timber pile
Sal_Sg.Baram_06	114.1773	4.5219	11.18 am	Asam Paya	8.8	0	Clear	Shrubs, Nipah Darat
Sal_Sg.Baram_07	114.2091	4.5189	11.08 am	Asam Paya	14	0	Clear	Shrubs, Nipah Darat
Sal_Sg.Baram_08	114.2013	4.4922	10.57 am	Kg Narum	7.3	0	Clear	Shrubs, Nipah Darat
Sal_Sg.Baram_09	114.2271	4.4762	10.46 am	Kg Narum	8.3	0	Clear	Shrubs, Nipah Darat
Sal_Sg.Baram_10	114.2456	4.4676	10.34 am	Kg Narum	7	0	Clear	Shrubs, Nipah Darat
Sal_Sg.Baram_11	114.2609	4.4602	10.22 am	Sekolah Kebangsaan Pengelayan	19	0	Clear	Shrubs, Nipah Darat
Sal_Sg.Baram_12	114.2617 ⁰	4.4344 ⁰	10.10 am	Kg Idaman	8.8	0	Clear	Shrubs

Baram River

GIS_Baram_12



Figure 105: Local residents house along the river



Figure 106: The stranded boat was observed along the river

GIS_Baram_11



Figure 107: High bushes and several palm oil plantations



Figure 108: High bushes and several palm oil plantations

GIS_Baram_10



Figure 109: High bushes along the river



Figure 110: Nypas were grows adjacent to high bushes

GIS_Baram_09



Figure 111: High bushes and several palm oil plantations



Figure 112: High bushes along the river

GIS_Baram_08



Figure 113: The sand dredging activity was observed along the river



Figure 114: High bushes and nypa plants

GIS_Baram_07



Figure 115: Clear bushes as reserved land to plant palm oil plantations



Figure 116: High bushes and several palm oil plantations

GIS_Baram_06



Figure 117: High bushes and coconut trees were located along the river



Figure 118: Nypa plants were grows well along the river

GIS_Baram_05



Figure 119: The stranded boat were observed along the river



Figure 120: Again the sand dredging activity was obseved along the river

GIS_Baram_04



Figure 121: The sand dredging activity was obseved. The sands were logisticted to the boat by the big crane



Figure 122: The bushes and shrubs were grows well plus with high mountainous trees were observed along the river

GIS_Baram_03



Figure 123: The big logistic ship flushed its water ballast near to river estuary



Figure 124: The boat crusing the river with towing logs

GIS_Baram_02



Figure 125: High bushes near to river banks



Figure 126: The sand dredging activity was obseved along the river

GIS_Baram_01



Figure 127: The rhu trees grows well to protect the Baram's beach from high magnitude of wind stress



Figure 128: The fish jetties of laocal residents at the river estuary

3. DATA OF THE ARIEL PHOTO

There are 30 all of the drone points (Figure 129) that had been retrieved for aerial photos along the selected point and Miri's shoreline area. This work scope has been successfully done for 3 days. Detail of the drone point information can be seen in Table 5.

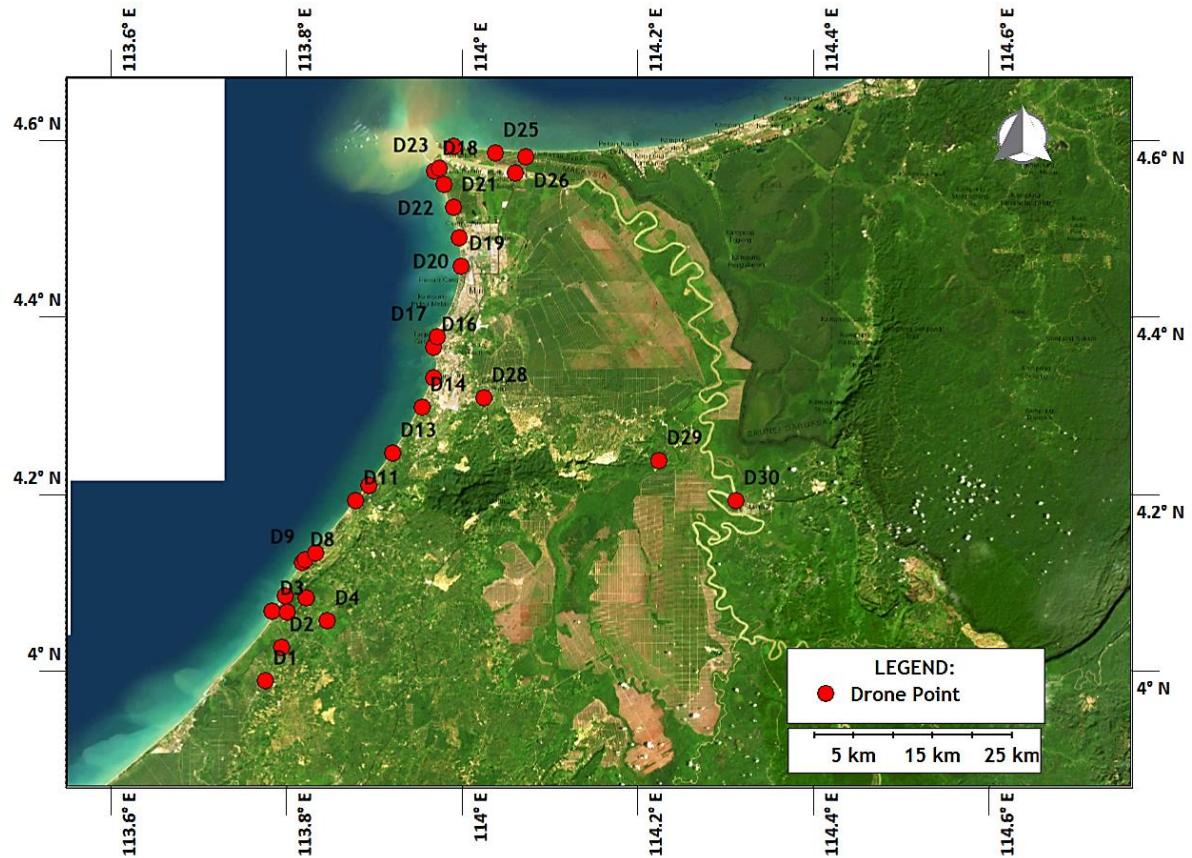


Figure 129: Drone points at Miri site

Table 5: Details of drone points for aerial photos

ID	Tarikh	Masa	X	Y	Location	Weather	Vegetation	Socioeco.	Infrastruc./Struc.	Topo.	Catatan
D1	24.08.2022	8:15	113.77683	3.98823	Kg. Padang Kelulut	Sunny	Fruits orchard, palm oil plantation, Bananas, coconuts, shrubs & herbs	agriculture	scattered settlements	lowland areas & marsh area	-
D2	24.08.2022	8:40	113.79536	4.02538	Kg. Kayu Kapor	Sunny	fruits orchard, palm oil plantation	agriculture, Livestocks	Aligned settlements	lowland areas & marsh area	-
D3	24.08.2022	10:13	113.78408	4.06703	Tg. Bungai beach	Sunny	Bananas farm, vegetable crop area	agriculture, recreational, fisheries	Mossy rocky, stalls	Hilly & rocky	Tp = 105, h = 0.3-0.5m, $\alpha =$
D4	24.08.2022	9:45	113.84638	4.05629	Kg. Dagang	Sunny	Bananas farm	agriculture, Perusahaan	shoplots, Bekenu Agricultural Dept.	Inundation area (up to 2m)	-
D5	24.08.2022	10:30	113.79890	4.08414	Peliau Beach	Sunny	melons & sweet corns farm, new forest	agriculture, recreational area	Community building	Sloping area	Tp = 105, h = 0.1-0.3m, $\alpha = 90^\circ$
D6	24.08.2022	10:50	113.80130	4.06543	Kg. Jambu Bungai,	Sunny	Farms, Orchards, forest, and palm oil plantation	Agriculture, Surau, KOSPEN Movement Center	Housing, community buildings , Aligned settlements	hilly	-
D7	24.08.2022	11:05	113.82348	4.08157	Kg. Angus	Sunny	Bananas farm & fruits orchard, forest	agriculture, Perusahaan Kecil, Bangunan Kerajaan, Immigration Detention Depot, SK Kg Anggus	Aligned & centered settlements	hilly	-

ID	Tarikh	Masa	X	Y	Location	Weather	Vegetation	Socioeco.	Infrastruc./Struc.	Topo.	Catatan
D8	24.08.2022	11:22	113.81849	4.12161	Tusan beach	Sunny	palm oil plantation	agriculture, Recreation Area	Horse farm	High Cliff	Tp = 85, h = 0.4-0.6m, $\alpha = 90^\circ$
D9	24.08.2022	11:43	113.82193	4.12500	Tusan Beach	Sunny	palm oil plantation	agriculture	Tusan recreational shoplots & facilities	High Cliff, Hilly, Sloping Beach	Tp = 105, h = 0.2-0.5m, $\alpha = 100^\circ$
D10	24.08.2022	12:14	113.83432	4.13300	Communication Substation Tower	Sunny	palm oil plantation	agriculture	garden storage	Hilly, Sloping Beach	
D11	24.08.2022	12:32	113.87955	4.19167	Beraya Satu village	Sunny	palm oil plantation, Banana & other fruit plantation orchards	agriculture	Scattered settlements	Hilly, Sloping Beach	Tp = 88, h = 0.1-0.3m, $\alpha = 90^\circ$
D12	24.08.2022	12:50	113.89396	4.20935	Tim Seaside Hideout Resort, Beraya Lama village	Sunny	Casuarinas, Cononuts	agriculture, recreational	Resort	Hilly, Sloping Beach	Tp = 105, h = 0.1-0.3m, $\alpha = 90^\circ$
D13	24.08.2022	13:05	113.92118	4.24538	Kg. Bakam, Sg. Rakut	Sunny	Casuarinas, Cononuts	Fisheries	Fishermen Building, Aligned settlements	High Cliff (Approx. 3m), Hilly, Sloping Beach	Tp = 105, h = 0.3-0.5m, $\alpha = 90^\circ$
D14	24.08.2022	13:28	113.95458	4.29759	Sg. Tukau,	Sunny	Casuarinas, Shrubs	Educational building, Airport Area, SMK Agama Miri, SJK© Tukau	Ditched & drainage	sloping areas	

ID	Tarikh	Masa	X	Y	Location	Weather	Vegetation	Socioeco.	Infrastruc./Struc.	Topo.	Catatan
D15	24.08.2022	13:53	113.96805	4.33158	Republik beach	Sunny	Casuarinas	Lusut & Republik beaches	Training wall, tributaries	sloping areas High erosion	Start Erode 113.967872,4.331670 Last Erode 113.967806,4.331727
D16	24.08.2022	15:35	113.96782	4.36546	Tg. Petra	Sunny	Forest	Educational building, Faith-Life Training Collage, Methodic Church, Tg. Lobang hiking area	Housing area & town	hilly	-
D17	24.08.2022	15:52	113.97272	4.37723	TM HQ	Rainy	Forest, casuarinas	Commercial area & recreational, Miri Mother And Child Health Clinic, Marriot hotel	Housing area & town, Brighton Cove - Park	Sloping area	Tp = 105, h = 0.3-0.5m, $\alpha = 90^\circ$, GK 340604, GK 34112, GO43122
D18	25.08.2022	16:38	113.96915	4.56516	Miri Central Prison	Sunny	palm oil plantation	Housing area & government building, Kg. Lambir, Kg. Tunku Abdul Rahman	Housing area	Aligned settlements	-
D19	25.08.2022	14:06	113.99983	4.45755	Lutong beach	Sunny	palm oil plantation, forest	Agriculture, Bayshore estate housing, town	Lutong airport remains	Hilly	-
D20	25.08.2022	15:38	113.99704	4.48993	Marudi Ferry Pier	Sunny	Swamp forest	Fisheries, commercial & housing	Jetty	Marshes & lowlands	-

ID	Tarikh	Masa	X	Y	Location	Weather	Vegetation	Socioeco.	Infrastruc./Struc.	Topo.	Catatan
D21	25.08.2022	15:18	113.99047	4.52396	Kilometer 4, Jalan Lutong	Sunny	Choppy	recreational	Recreational building & facility, Theme Park	Rocky along the coast, High Cliffs	Tp = 90, h = 0.4-1m, $\alpha = 85^\circ$
D22	25.08.2022	15:08	113.98014	4.54975	Nelayan Batu 4 village	Rainy	Marshes & swampy Forest	Housing, recreational, Reserve Ranger Station, Kg. Tulang, Star Sport Complex, Taman Bayshee	Centralize	Marshes & lowlands	Tp = 105, h = 0.2-0.6m, $\alpha = 90^\circ$, many 'sapok' blocking waterway, Drifting logs
D23	25.08.2022	15:01	113.97457	4.56873	Bt.1 Fish Market,	Sunny	Casuarinas	Industry, Fishing, Wood Mill, Factory, source of organic from logging activities calles 'sapok' by local community	Fisherman's Building, Factory	Mangrove, Rocky	Tp = 88, h = 0.3-0.6m, $\alpha = 90^\circ$
D24	25.08.2022	12:26	113.99033	4.59303	Lutong Firefighters Station,	Cloudy	Mangroves, Casuarinas	Enterprises, Utility Buildings, Wood Factory, Hardware	Factory Buildings	Mangrove, Marshes	-
D25	25.08.2022	12:49	114.03877	4.58555	Mini Crocodile Farm	Rainy	Marsh, Kuala Baram Wetlands	Beachside village, Recreation	Buildings, village	Marshes & swampy, Lowland	-
D26	25.08.2022	13:04	114.07326	4.58134	Sand Mining	Rainy	Bananas plantation, casuarinas	Industries	Mining Building	Swampy, Lowland	-
D27	25.08.2022	13:19	114.06082	4.56283	Kuala baram Wetlands Prawn ponds	Sunny	Casuarinas, coconuts	Kuala Baram Wetlands, industries	Shipping workshop buildings,	Swampy, sloping area	Tp = 145, h = 0.1-0.2m, $\alpha = 90^\circ$, less 'sapok' in the area

ID	Tarikh	Masa	X	Y	Location	Weather	Vegetation	Socioeco.	Infrastruc./Struc.	Topo.	Catatan
									dockyards, shipyards		
D28	25.08.2022	8:47	114.02509	4.30894	Kuala Baram	Sunny	Shrubs, casuarinas	Enterprise, Private Area	Prawn ponds	Tributaries, sloping area	
D29	25.08.2022	9:44	114.22391	4.23771	Immigration	Clear	palm oil plantation	agriculture, Government buildings	Government Buildings	Slope area, Swamp	
D30	25.08.2022	10:11	114.31158	4.19145	Sk. K. Baram,	Rainy	Mangrove trees, palm trees, banana plantations	Industry, Pertanian, Dockyard, Sand Mining	Shipping workshop buildings, dockyards, shipyards	Mangroves, Slopes, Swamps	

4. SALINITY OF THE RIVERS

Total length of survey for salinity tracking at Niah river is approximately 21km with average slope 1.5% to 1.3% (Figure 1). Figure 130 shows data regarding the water depth and salinity at specific location points of Niah River. Overall, the data indicates that the depth of the water will increase with distance from the sea. However, this change in water depth is quite small. The low water depth in the river mouth area is common as the high deposition rates of sediments always occur in river-mouth systems (Pasternack & Brush, 1998; Nardin, & Fagherazzi, 2012). The salinity bottom has only slightly changed as a result of the minimal change in water depth from the first location site (Niah 1) until the last location point (Niah 22). Even though it is approximately 20 kilometres from the sea, the salinity at location point Niah 22 is nevertheless high, at 19 ppt (Figure 1). To conclude, given the relatively flat bathymetry of this river, the site where the salinity of the river water reaches 0 ppt is still far away. This is because, according to a study by Shibuo et al. (2006), the amount of seawater and saltwater mixed in flat bathymetry situations is significant.

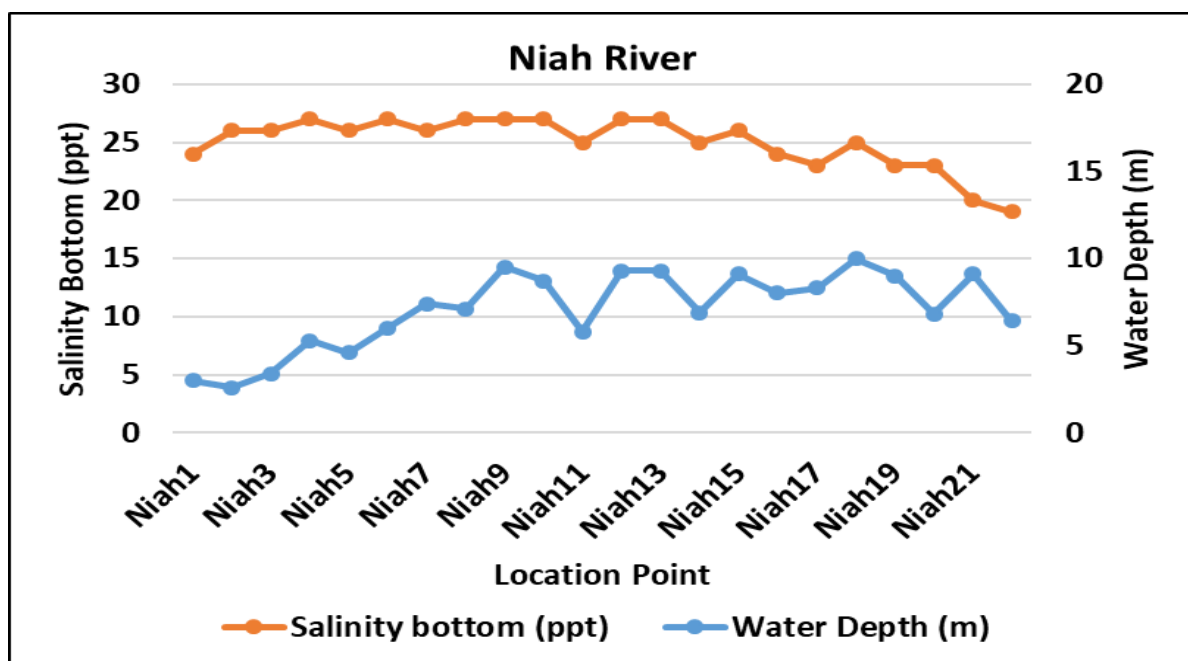


Figure 130: Graph of salinity versus river depth at Niah River.

Figure 131 shows the graph of salinity bottom and water depth at location points of Sibuti River with total length of survey for salinity tracking at this river is approximately 30.3km. Overall, the data indicate that although the water depth in this region does not vary significantly from one location point to another, the salinity bottom of the Sibuti River decreases as it gets further from the sea. At Sibuti_20 point, the salinity has dropped significantly, from 19 ppt to 3.5 ppt. According to Barathy et al. (2018), water must have a salinity of less than 0.2 ppt to be safe for human consumption. So, the location point Sibuti_22 (see Figure 3), which is the farthest point from the sea, the salinity is 0.7 which almost reached 0 ppt.

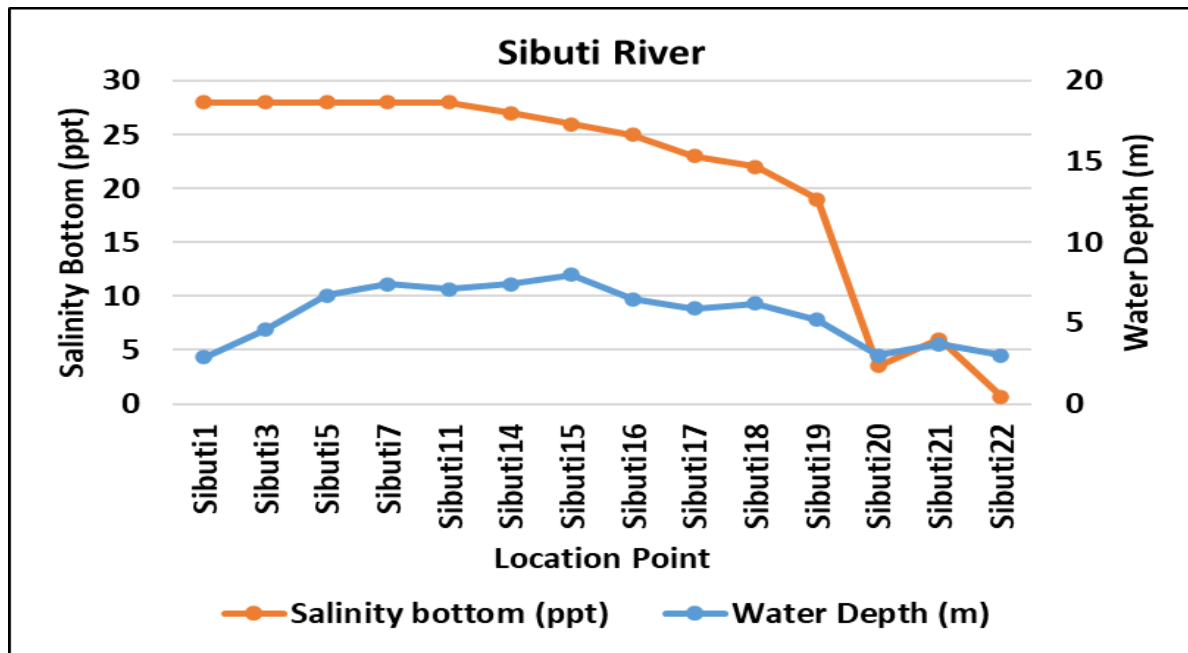


Figure 131: Graph of salinity versus river depth at Sibuti River.

Figure 132 shows the data of salinity bottom and water depth at location points of Baong River with total length of survey for salinity is approximately 22.7 km. In general, the graph has shown that the bottom salinity of the Baong River decreases as water depth rises. Baong_24 point (see Figure 6) which is the farthest from the sea has experienced a substantially decreased in the salinity bottom and reached 3.8 ppt.

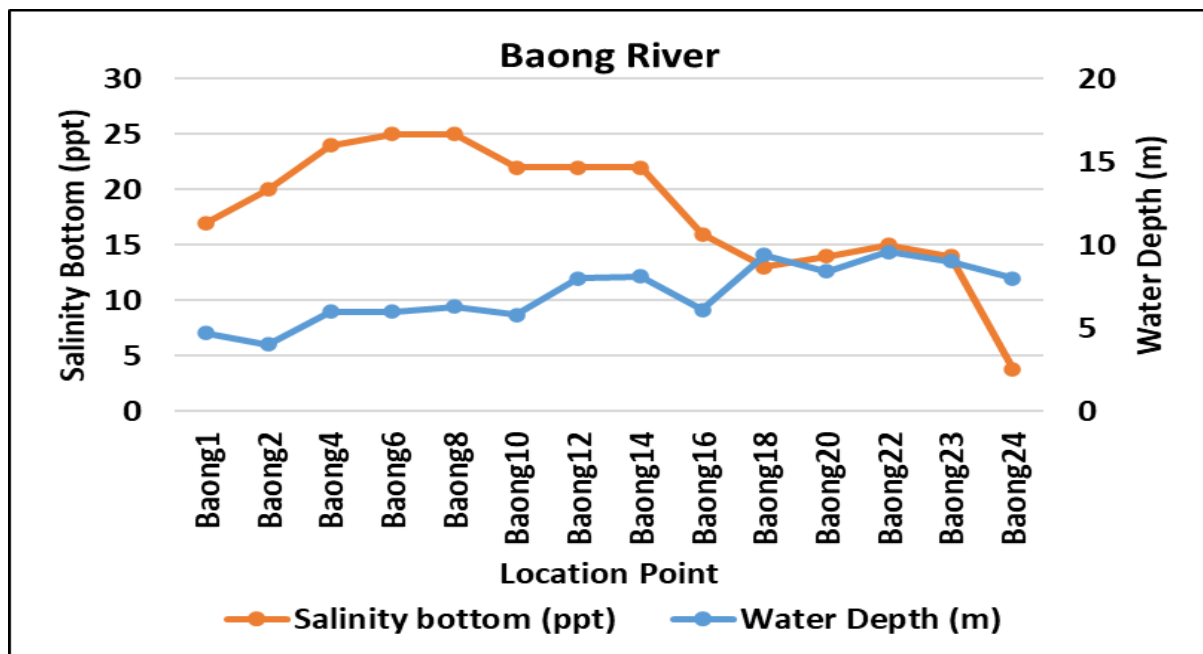


Figure 132: Graph of salinity versus river depth at Baong River.

Figure 133 shows the data of salinity bottom and water depth at location points of Baram River with total length of survey for salinity is approximately 56.15 km. Overall, the data shows that water depth alternates between increasing and decreasing. The salinity data

indicates that at point Baram_3 (refer Figure 8), the salinity has decreased to 0 ppt. In comparison to Sibuti and Baong Rivers, which reached 0 ppt of salinity after travelling 20 km from the sea, Baram River achieved 0 ppt barely 10 km from the sea. Because the Baram River is broader and deeper than other rivers, the probability of groundwater discharge there is also higher. As a result, this river is extremely low in salinity, which high river flow in this area may also reduce salinity concentration value along this river during spring tidal phenomenon.

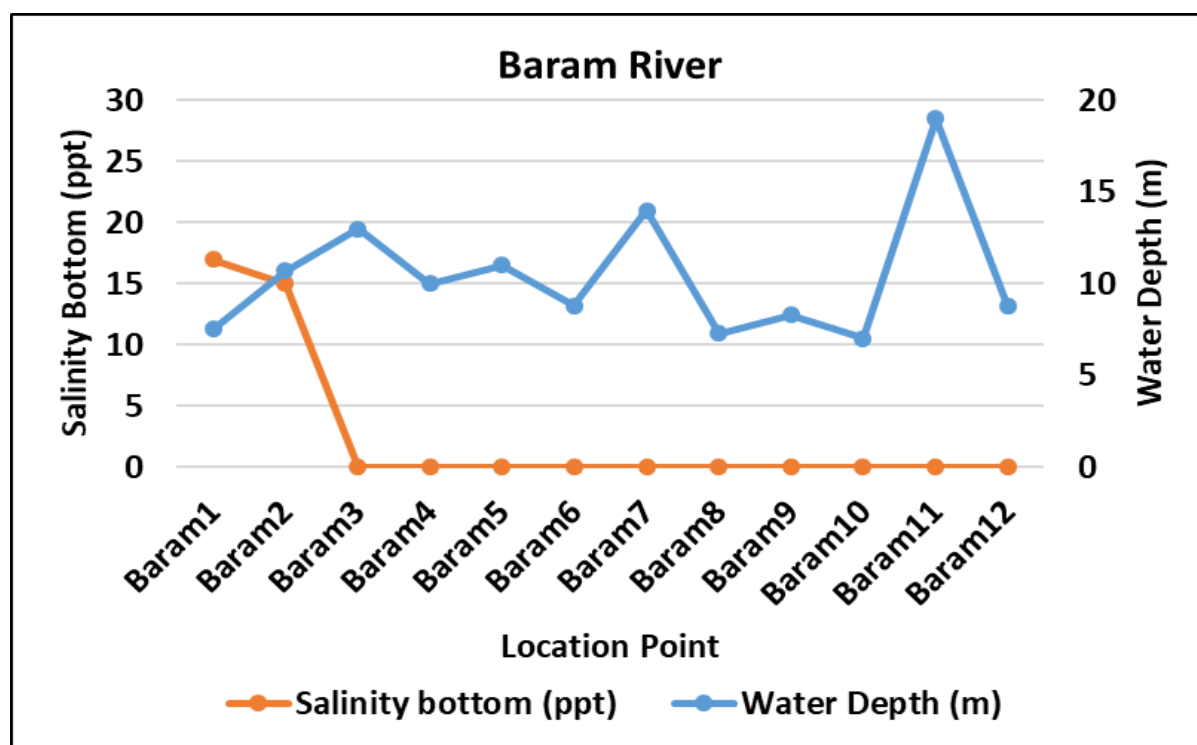


Figure 133: Graph of salinity versus river depth at Baram River.

5. ACOUSTIC DOPPLER CURRENT PROFILERS (AWAC) DATA

Current measurement using ADCP carried out at 2 stations, ADCP-1 Miri and ADCP-2 Miri to measure the current speed and current direction. The time interval of current measurement is 10 minutes. The duration of the current measurement was fifteen (15) days per phase, concurrent with the water level measurement, covering neap tide and spring tide. The ADCP were deployed from 12th August 2022 to 28th August 2022. The details of current measurement at Miri coastal area are shown in Table 6 to 7 and in Figure 134.

Table 6: Details of Current Measurements at Miri coastal area for 1st phase

Sample ID	Coordinate		Deployment		Depth (m)	Retrieval	
	X (°)	Y (°)	Date	Time		Date	Time
ADCP-1	113.7854	4.1871	12-08-22	12.00pm	16m	28-08-22	10.00am
ADCP-2	113.5935	3.99971	12-08-22	11.20am	14.5m	28-08-22	12.20pm

Table 7: Details of Current Measurements at Miri coastal area for 2nd phase

Sample ID	Coordinate		Deployment		Depth (m)	Retrieval	
	X (°)	Y (°)	Date	Time		Date	Time
ADCP-1	113.7854	4.1871	25-09-22	3.00pm	15m	10-11-22	11.00am
ADCP-2	113.5935	3.99971	25-09-22	1.00pm	13m	10-11-22	12.00am

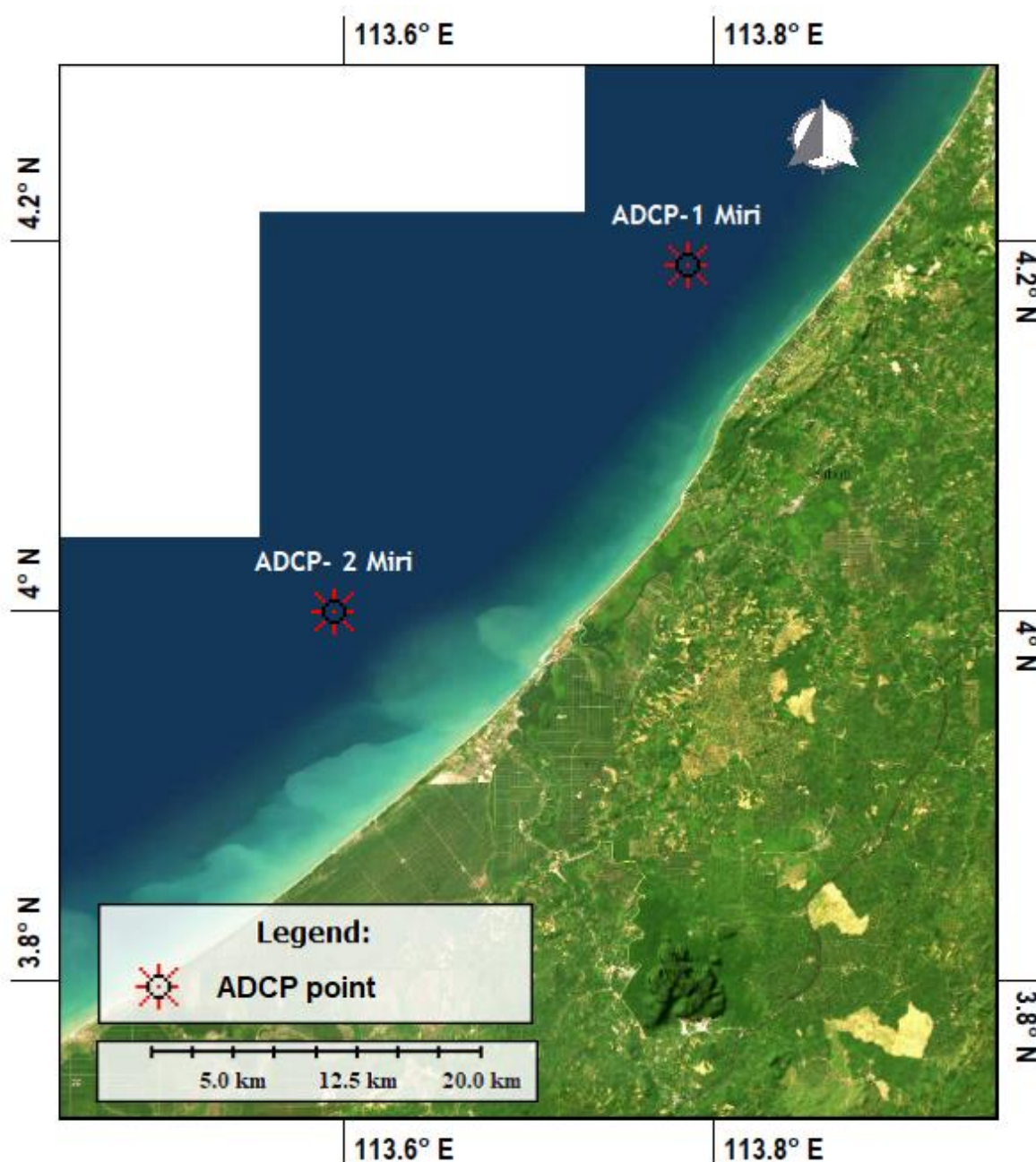


Figure 134: ADCP Measurements location at Miri coastal area

Based on rose plot (Figure 135 - 136 and Figure 139-140)) and significant wave height (Figure 137-138 and Figure 141-142), mean wave direction for both phase of ADCP_1 & ADCP_2 is 290° until 340°. Significant wave height for both phase of ADCP_1 is 0.1273 m until 0.1545 m and 0.1364 m until 0.1818 m while for ADCP_2 is 0.2818 m until 0.3091 m, and is 0.2727 m until 0.3273 m.

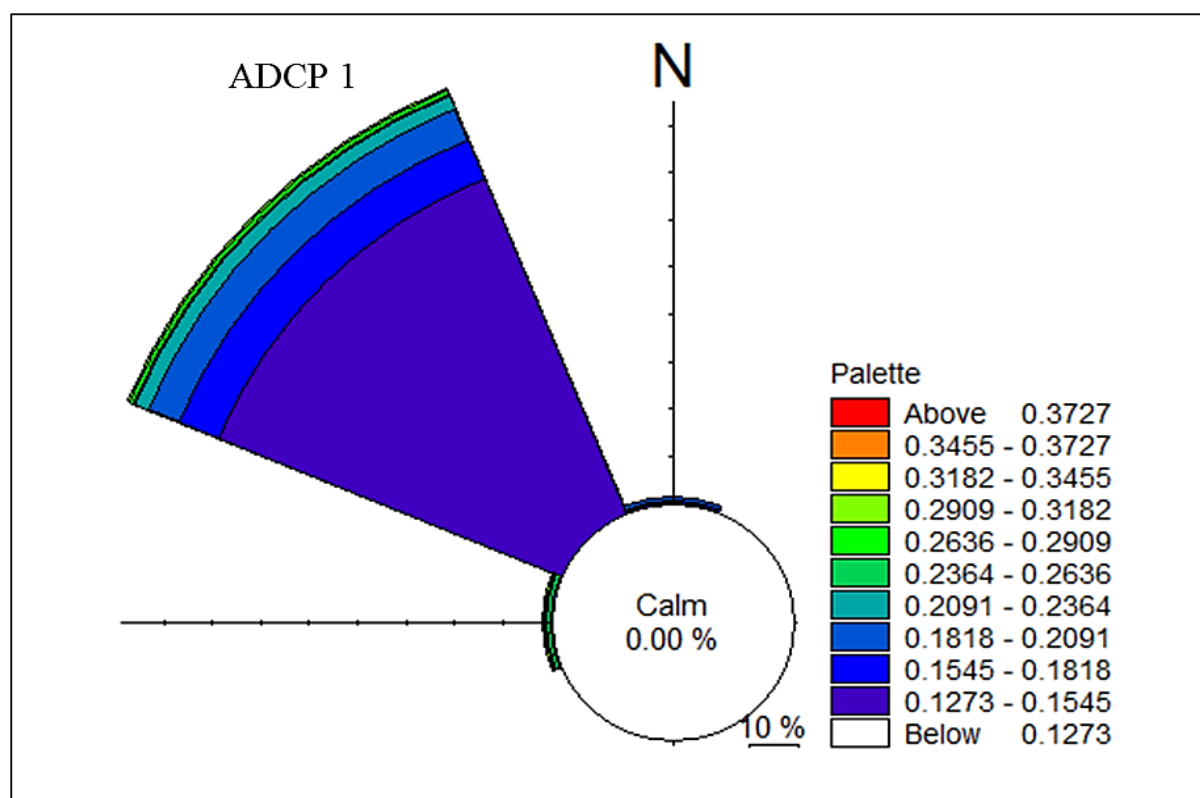


Figure 135: Rose plot of ADCP_1 for 1st phase

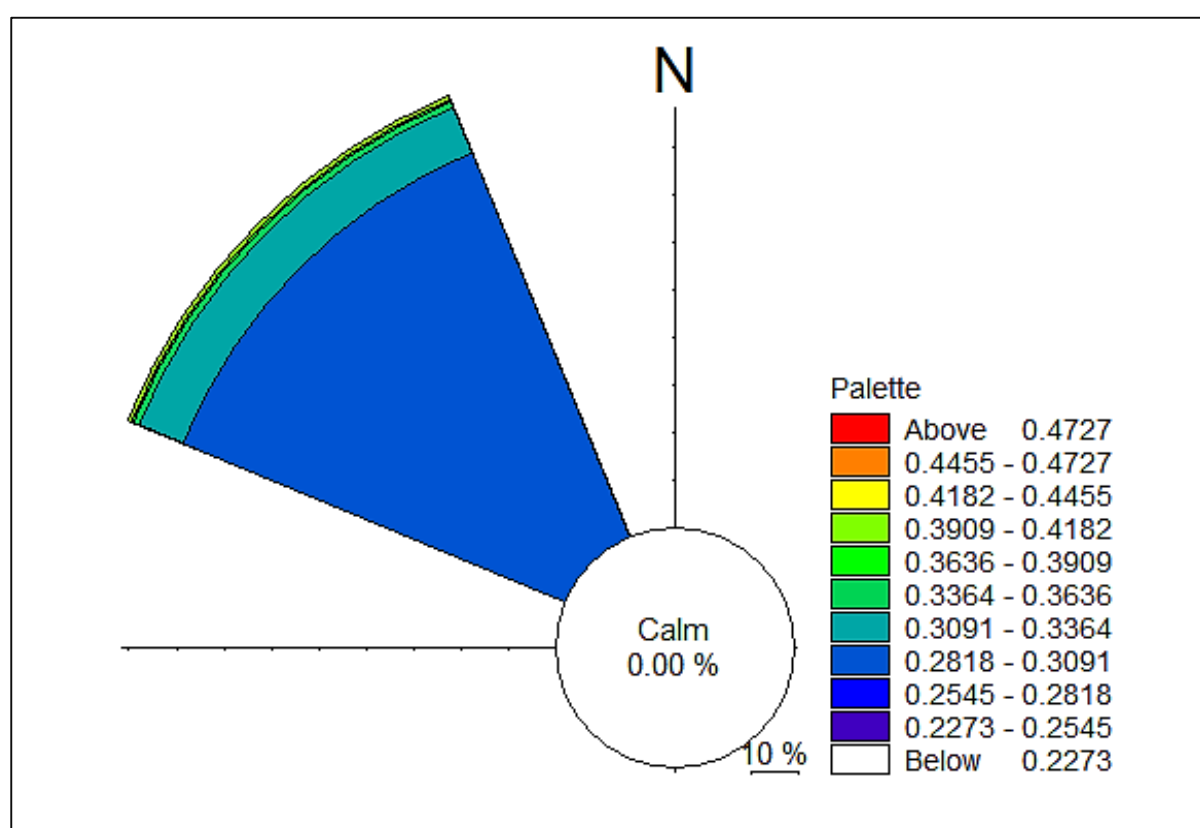


Figure 136: Rose plot of ADCP_2 for 1st phase

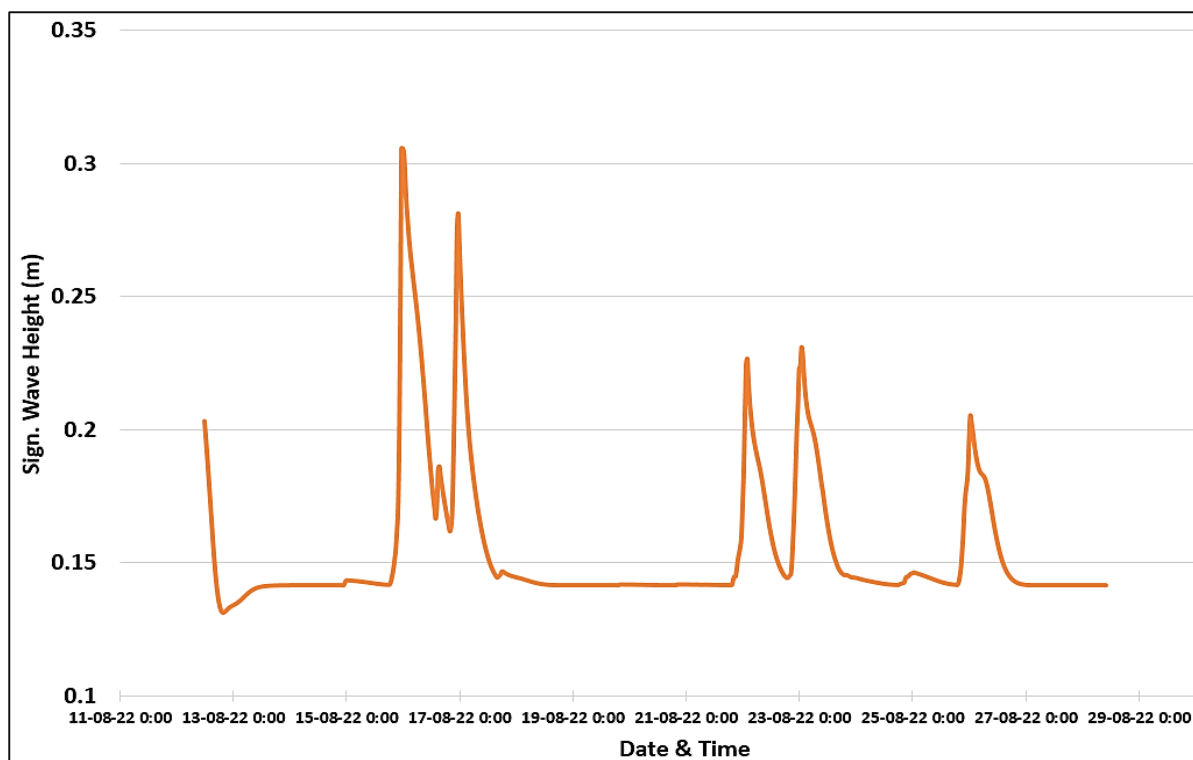


Figure 137: Significant wave height plotting for ADCP_2 in 1st phase

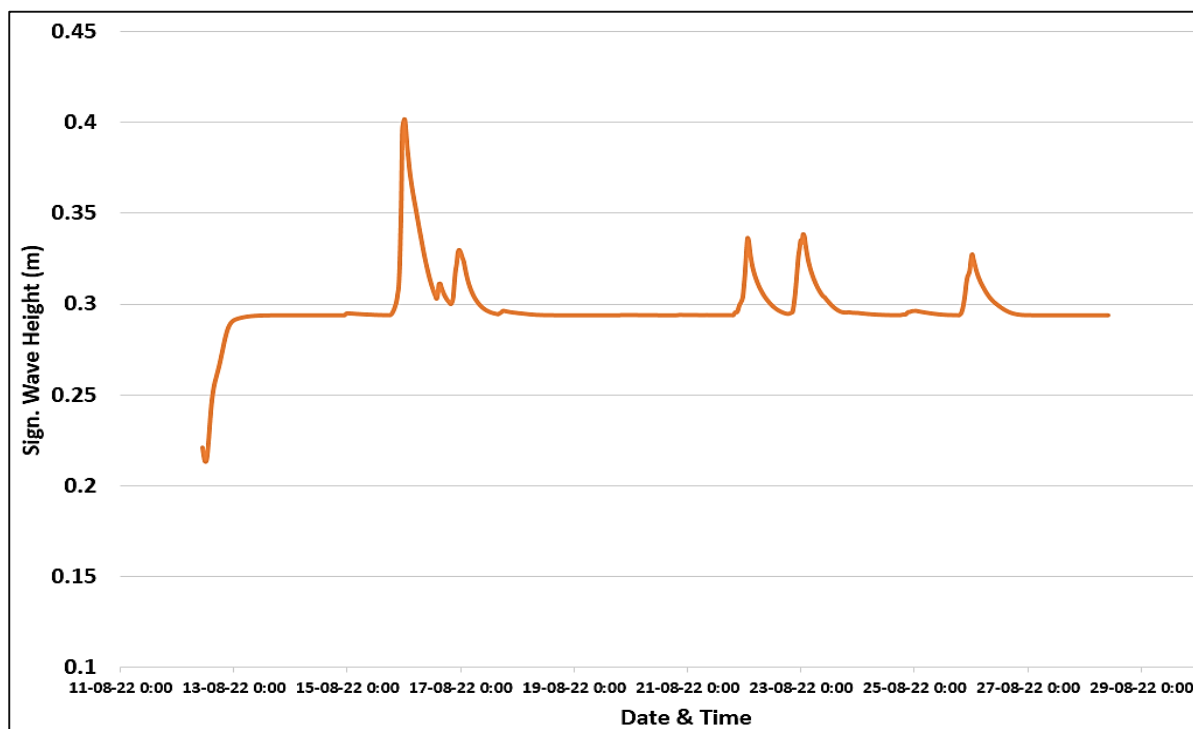


Figure 138: Significant wave height plotting for ADCP-2 in 1st phase

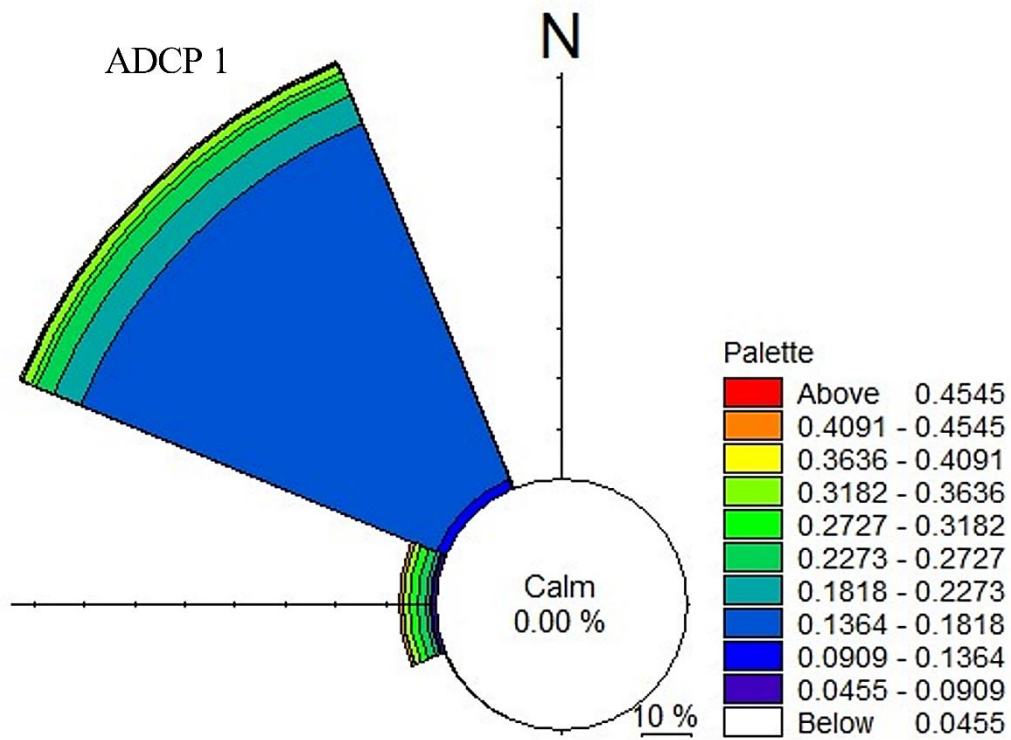


Figure 139: Rose plot of ADCP_1 for 2nd phase

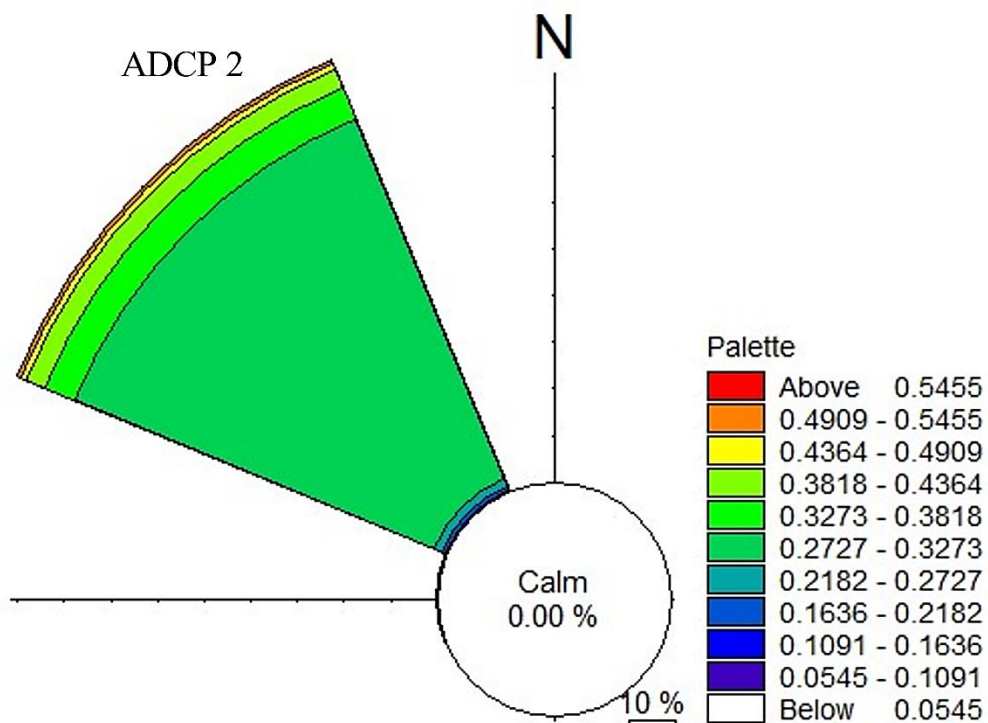


Figure 140: Rose plot of ADCP_2 for 2nd phase

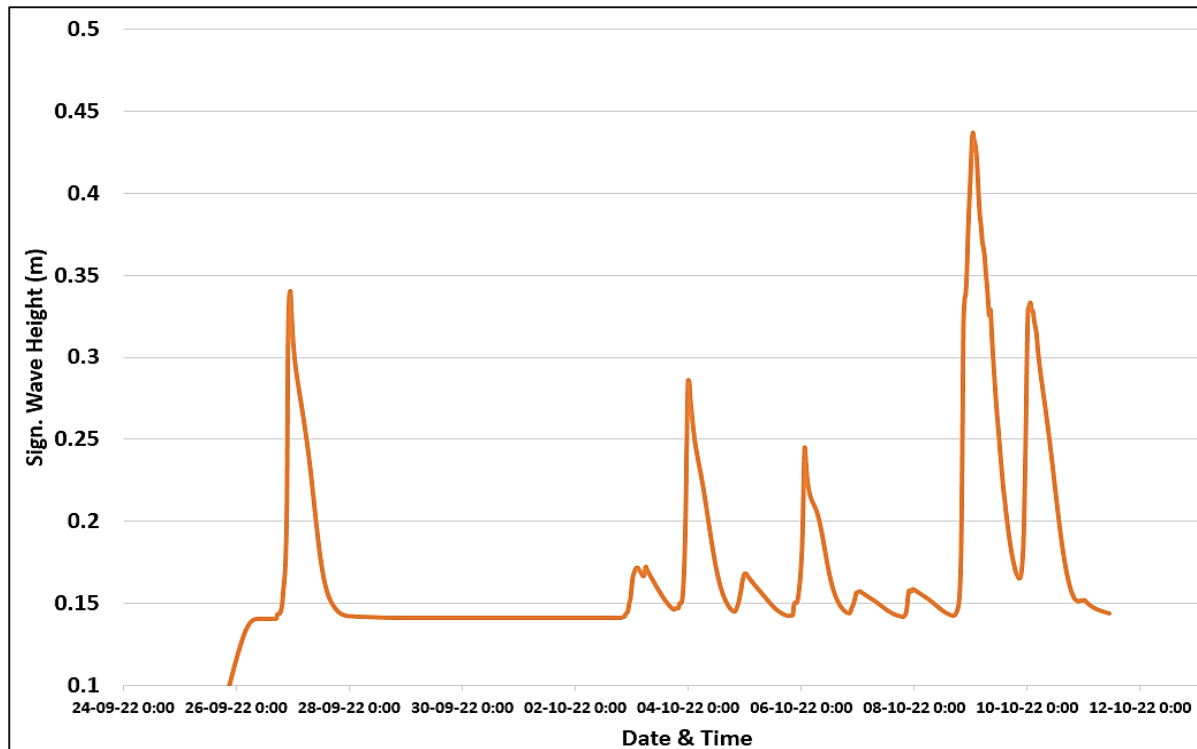


Figure 141: Significant wave height plotting for ADCP-1 in 2nd phase

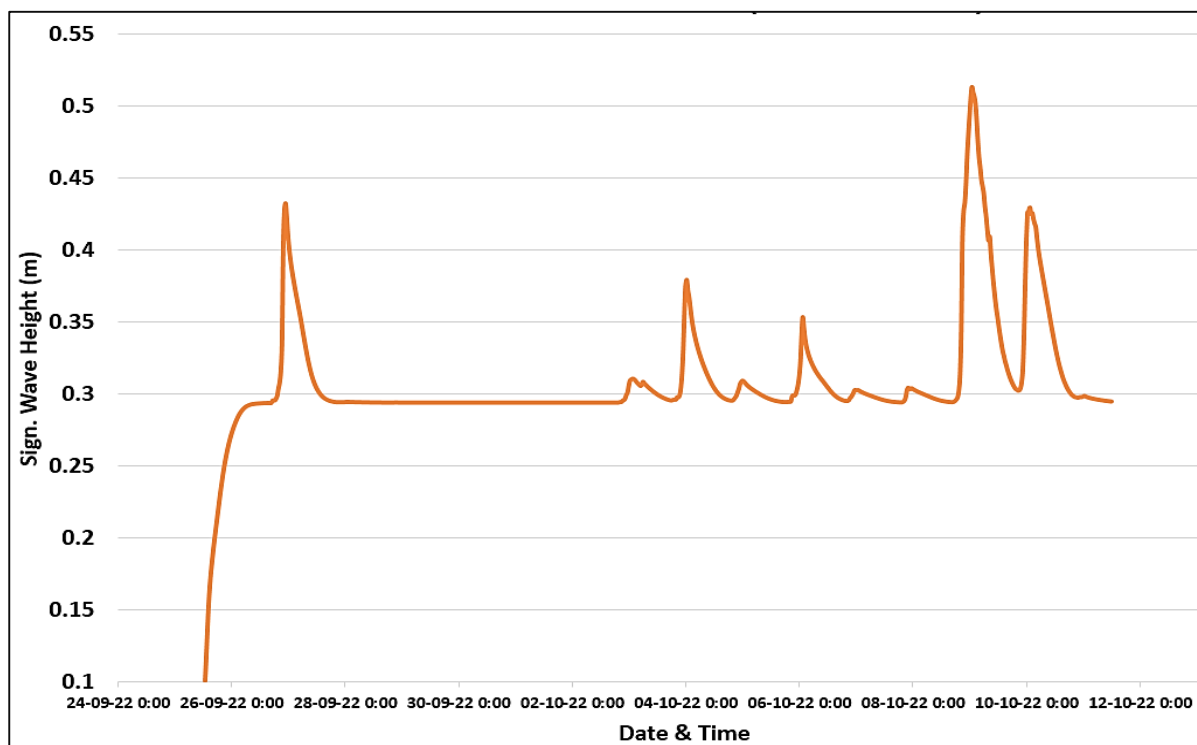


Figure 142: Significant wave height plotting for ADCP-2 in 2nd phase

ADCP also were used to measure for current speed and direction through the water column at study area. Measurements of the current speed and direction were analysed to determine the dominant direction of flow over the deployment period around study area. Station 1 (ADCP-1), maximum current speed 1.134 m/s and the lowest 0.002 m/s were recorded (Figure 143). The dominant of the current direction shows variations during the

flood and ebb tide. The observed measurements show dominant current direction is around 30° to 70° during ebb tide and 200° to 250° during flood tide. Figure 144 until Figure 146 shows the average current speed and current direction average at ADCP-1 and Figure 147 show water level for Station 1 (ADCP-1).

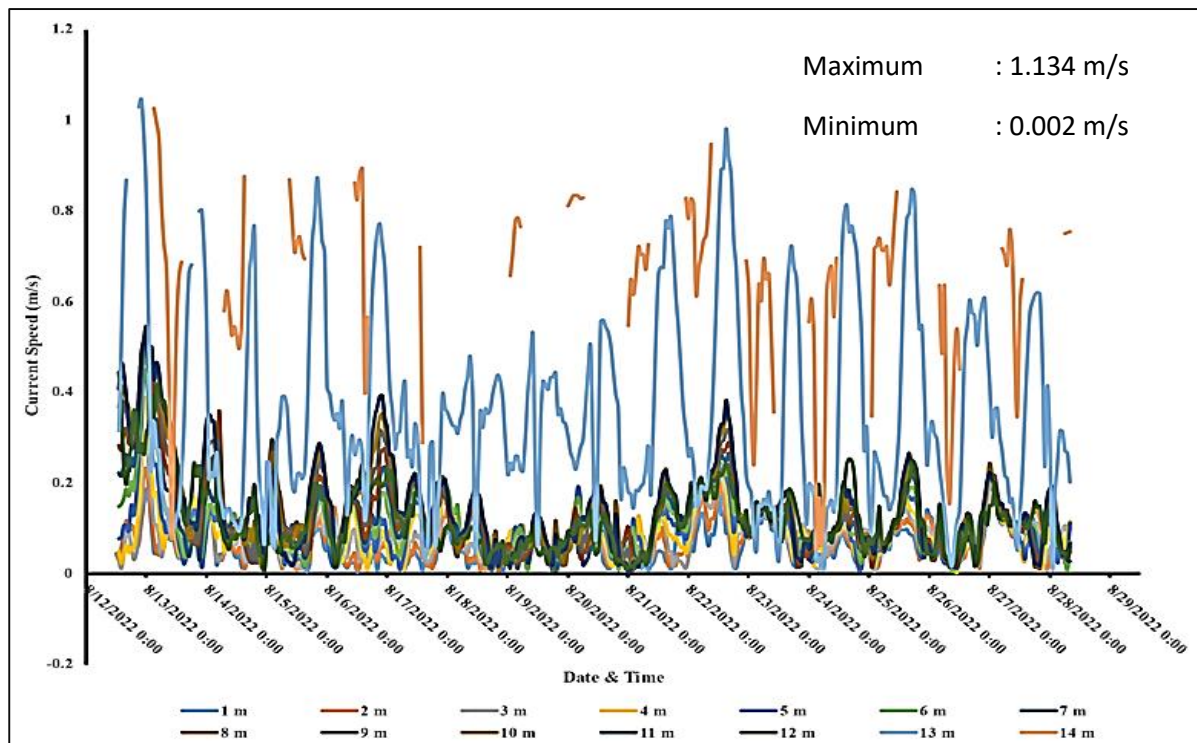


Figure 143: Current speed pattern at Station 1, Pantai Miri for 1st phase

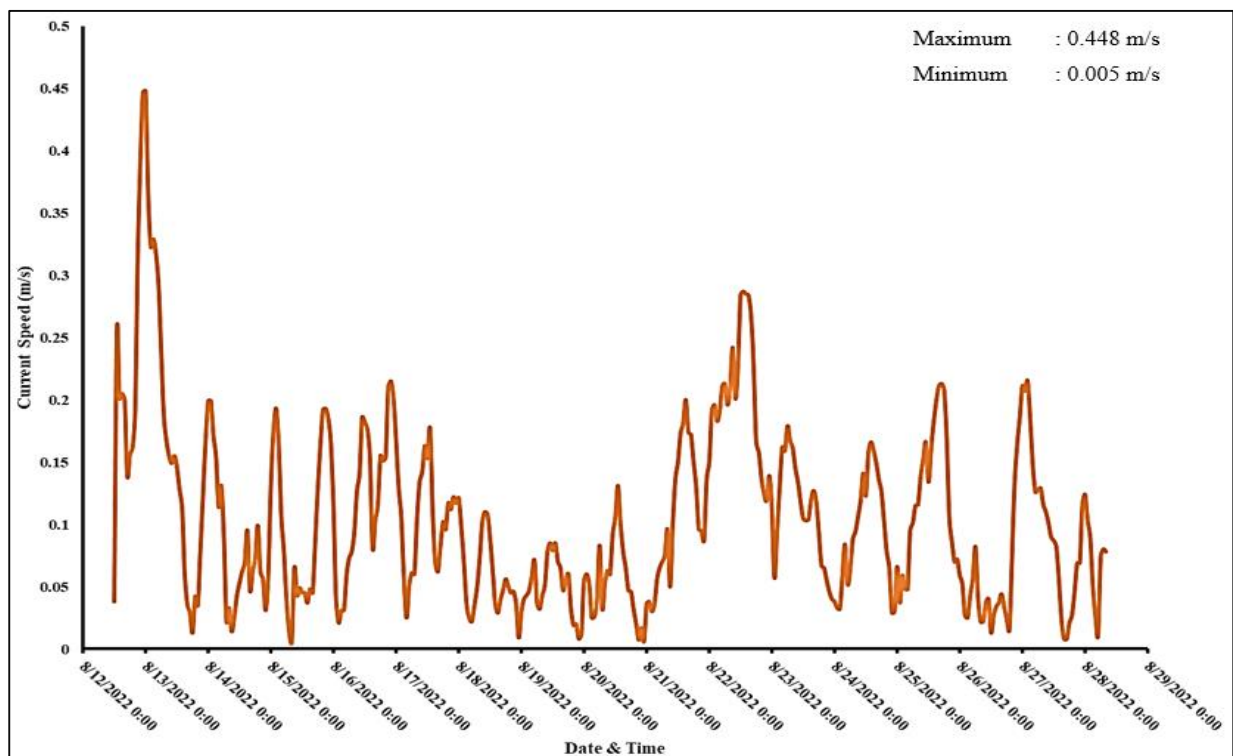


Figure 144: Average current speed pattern at Station 1, Pantai Miri for 1st phase

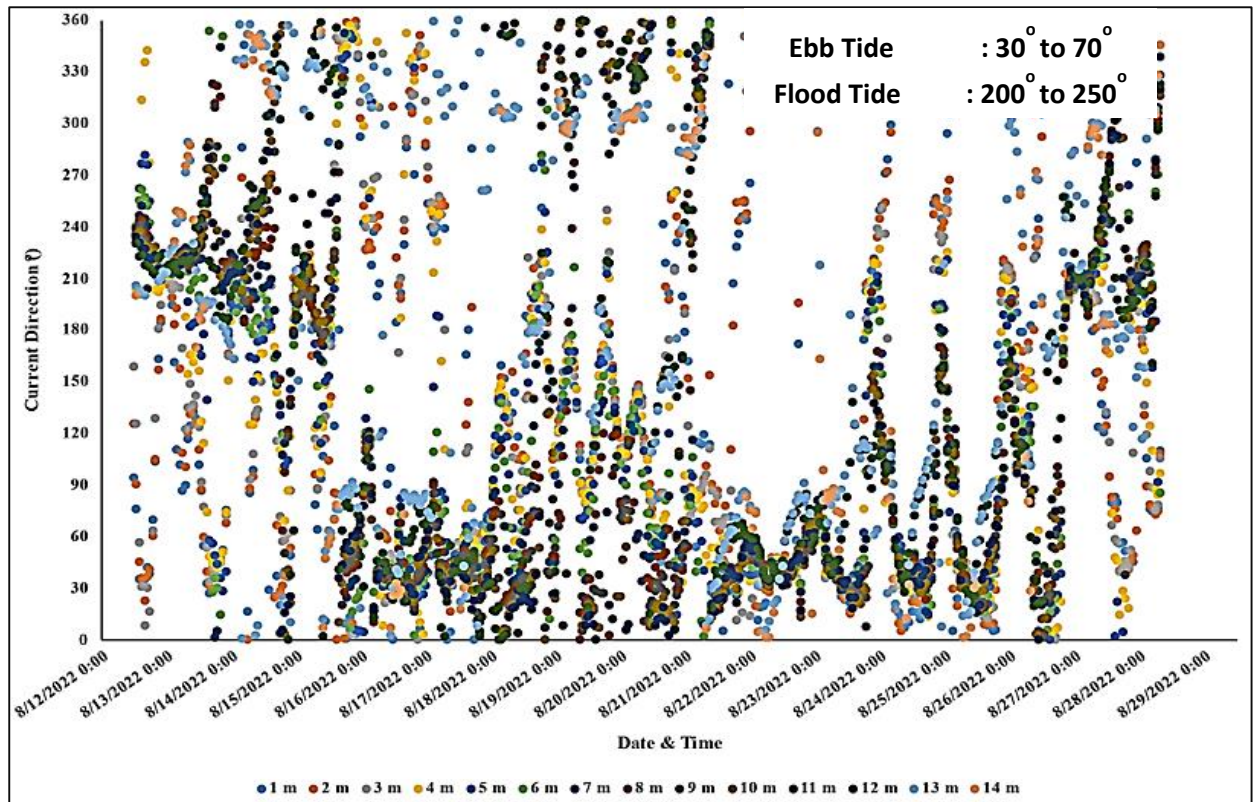


Figure 145: Current direction pattern at Station 1, Pantai Miri for 1st phase

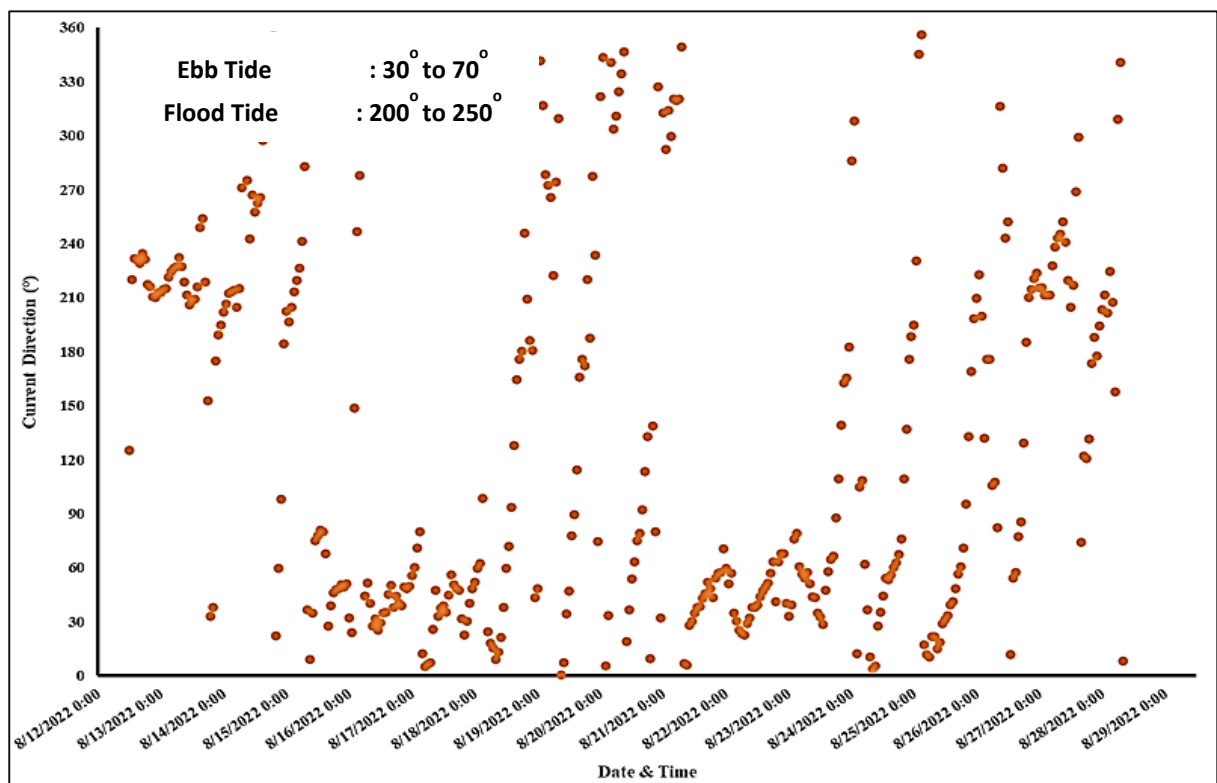


Figure 146: Average current direction pattern at Station 1, Pantai Miri for 1st phase

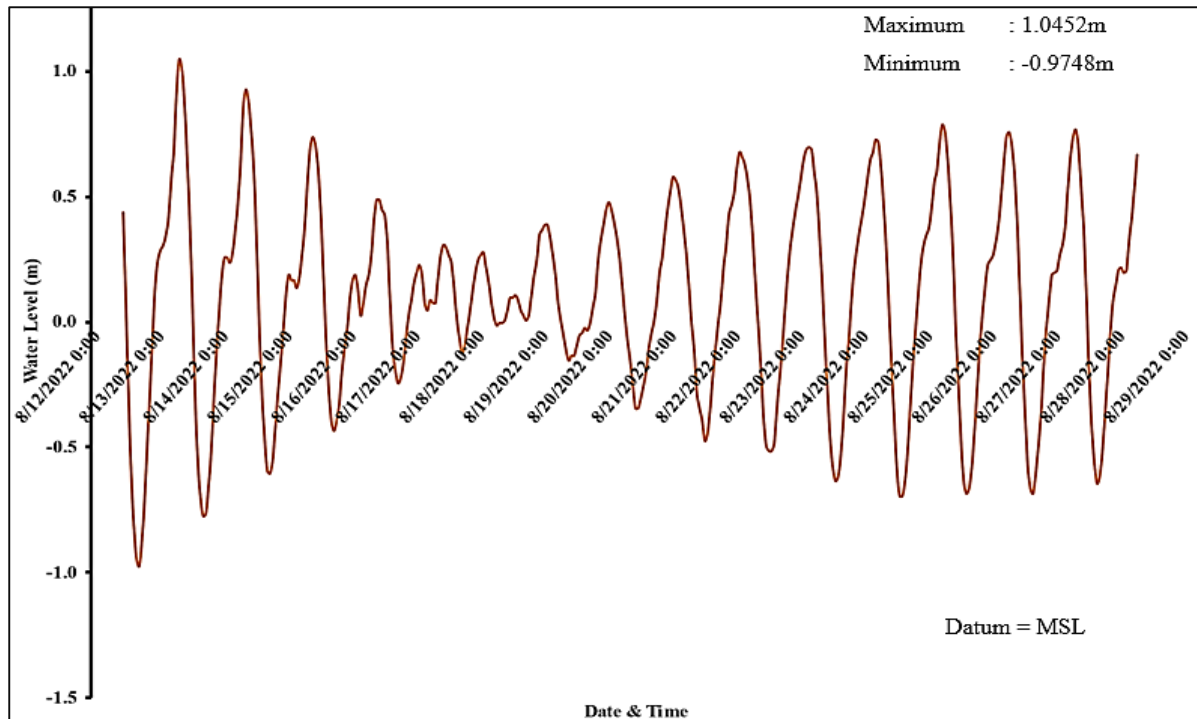


Figure 147: Water level pattern at Station 1, Pantai Miri for 1st phase

Station 2 (ADCP-2), the maximum current speed recorded at 0.965 m/s and the minimum is recorded at 0.001 m/s (Figure 148). The observed measurements show dominant current direction is around 20° to 60° during ebb tide and 200° to 250° during flood tide. The average current speed and direction was revealed in Figure 149 and 151 while Figure 152 show water level for Station 2.

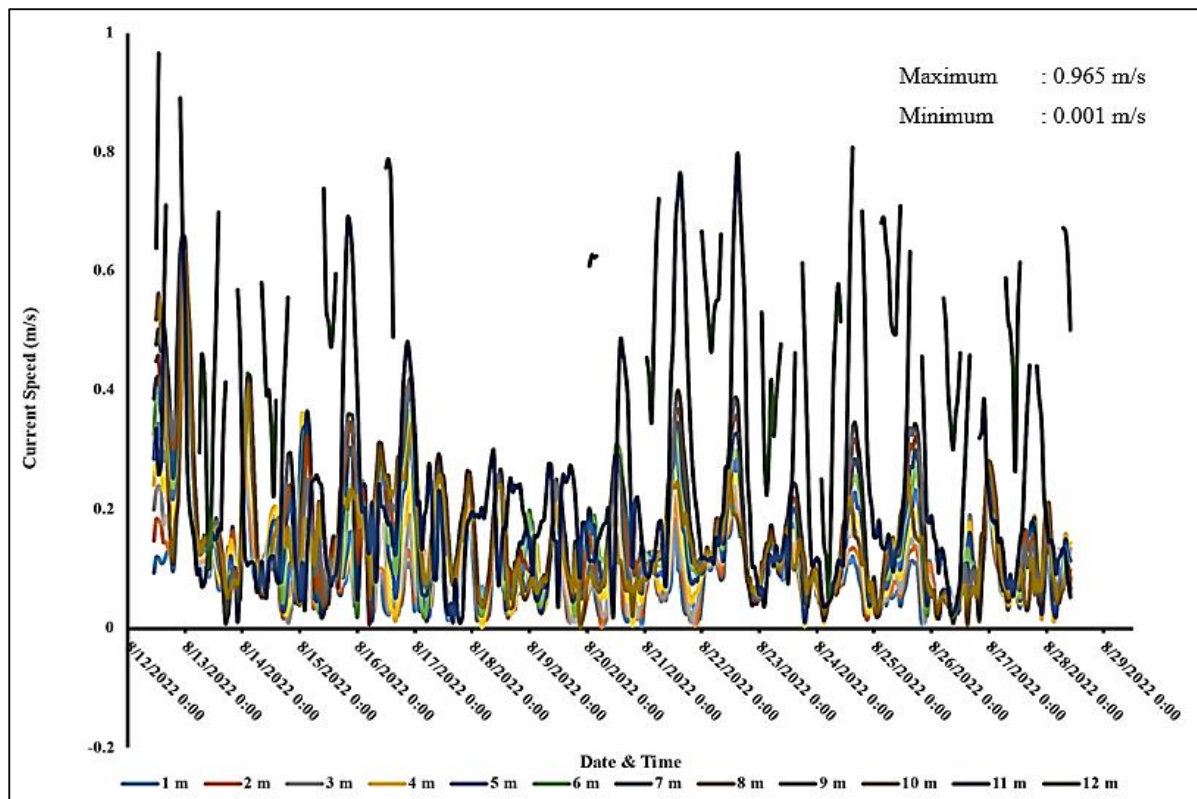


Figure 148: Current speed pattern at Station 2, Pantai Miri for 1st phase

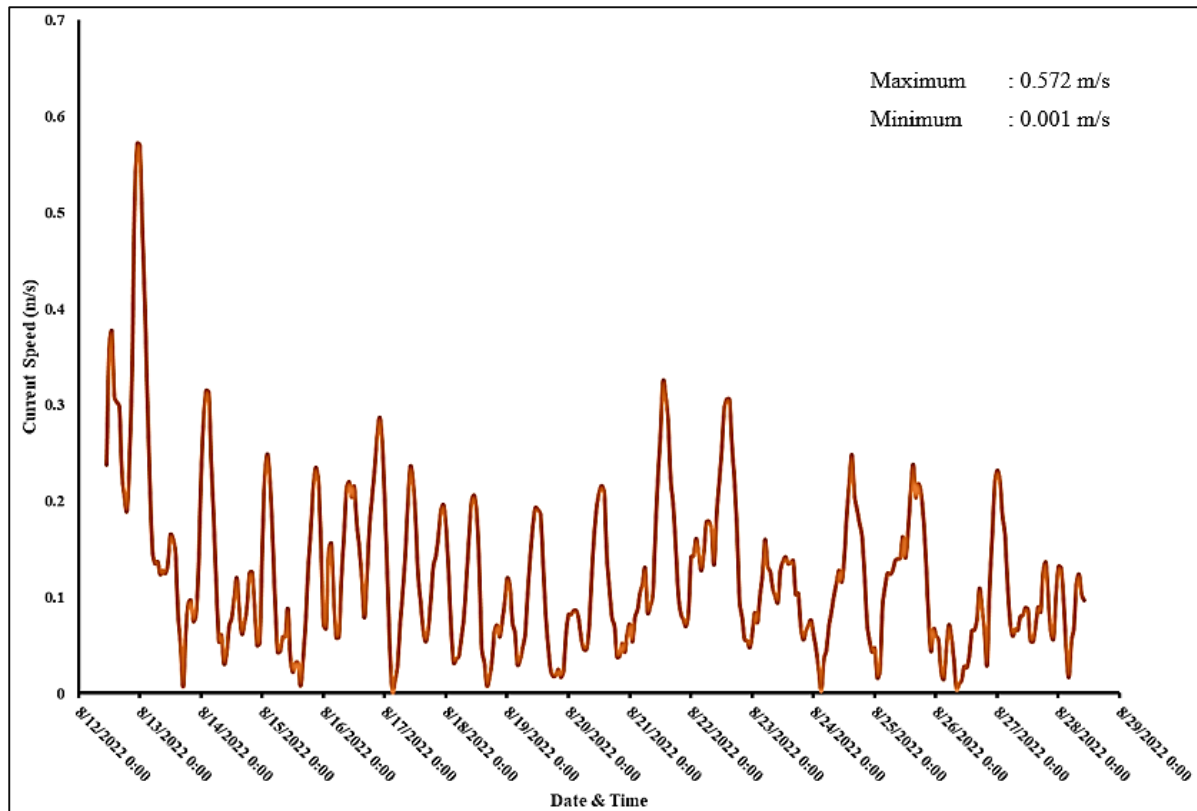


Figure 149: Average current speed pattern at Station 2, Pantai Miri for 1st phase

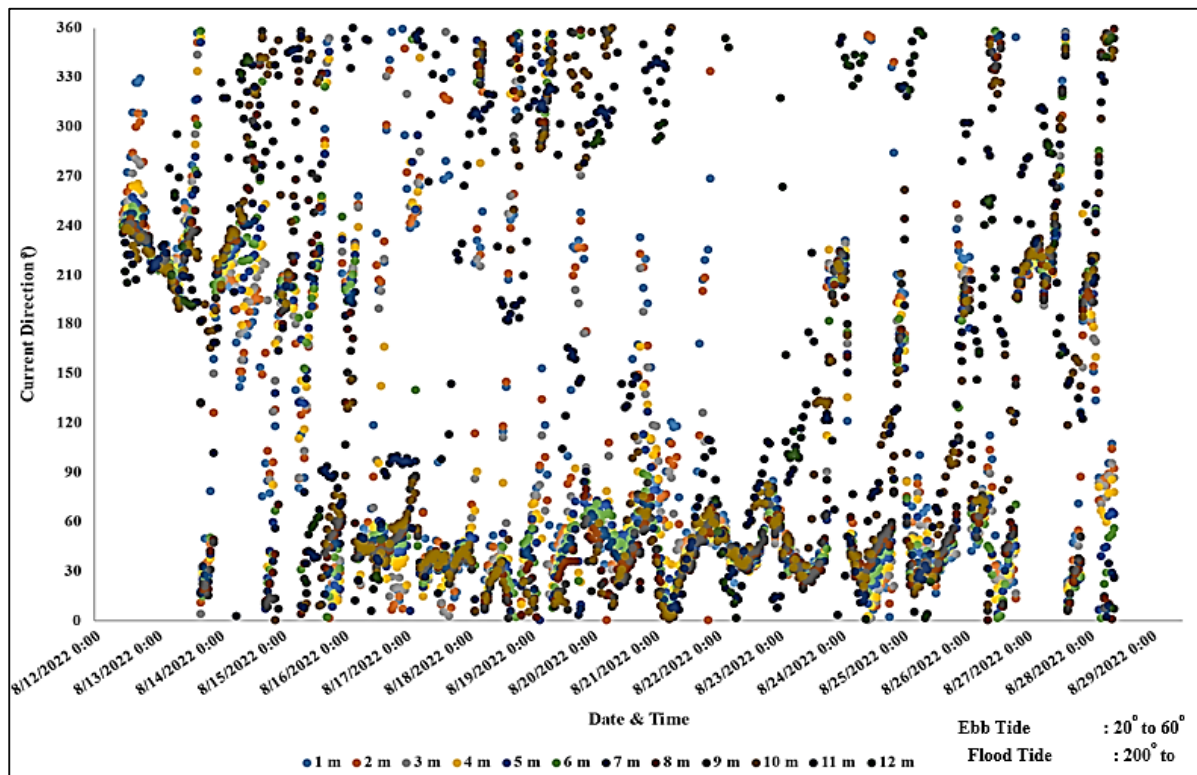


Figure 150: Current direction pattern at Station 2, Pantai Miri for 1st phase

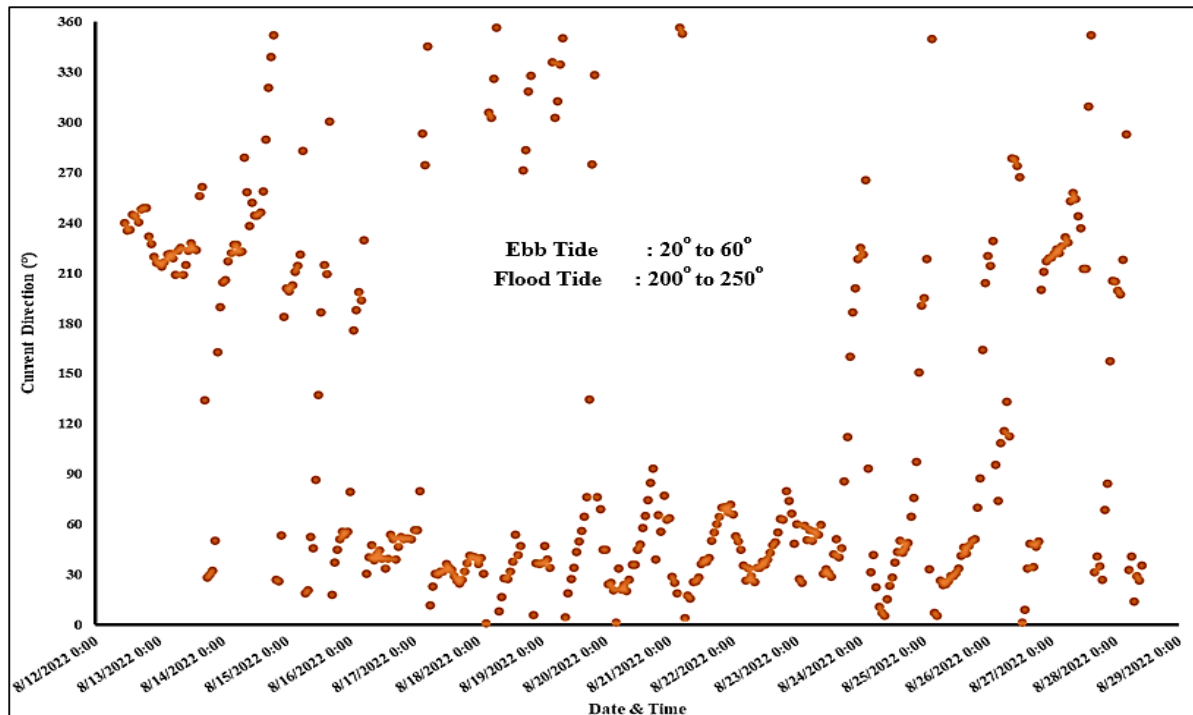


Figure 151: Average current direction pattern at Station 2, Pantai Miri for 1st phase

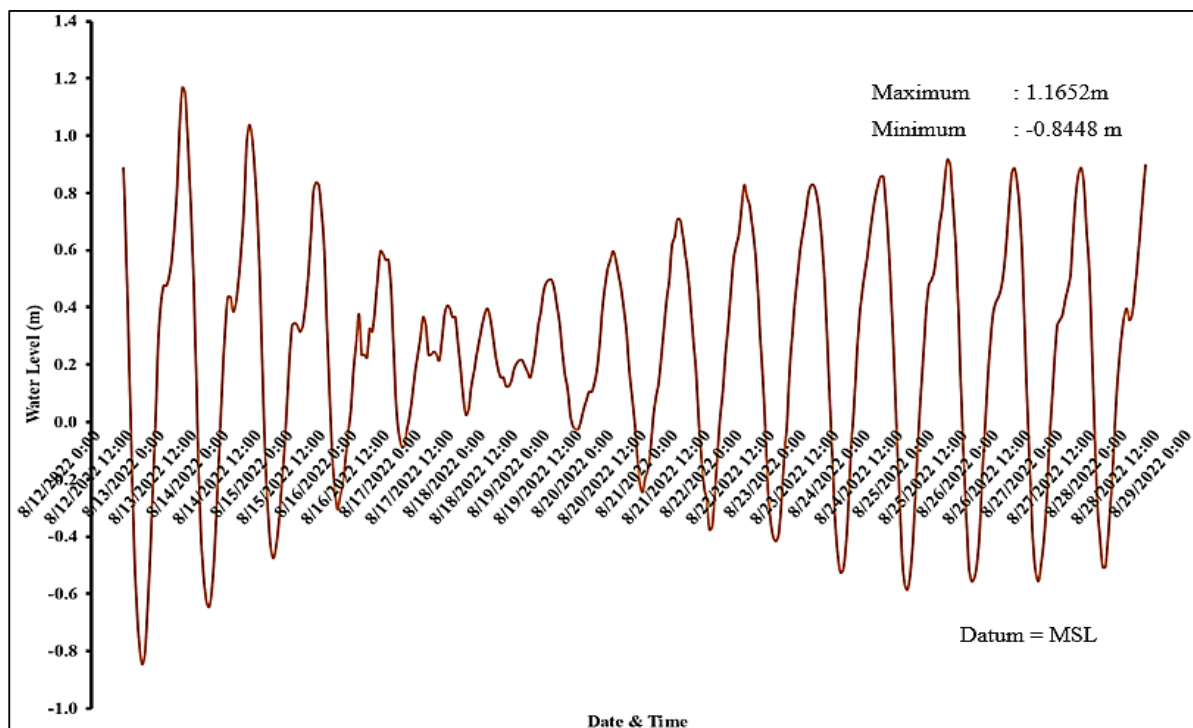


Figure 152: Water level pattern at Station 2, Pantai Miri for 1st phase

6. BATHYMETRY DATA

Bathymetry survey data was gathered from two types of areas. It was involved in nearshore bathymetry, and further locations were obtained from selected rivers. For nearshore bathymetry, the survey was carried out from the farthest boat that could reach 0 m mean sea level (msl) and extend to -10 m msl while for river bathymetry survey was till reach 20km of the river length.

6.1. Bathymetry Of Miri Nearshore

Bathymetry survey also required as part of the field measurement to attain the requirement of the study. It provides an initial broad-scale of physical characterization of the seafloor and the beach slope over the area. The details of bathymetric survey and concept were outlined in Figure 153. The survey area is approximately 621 km² for Miri coastal area. The bathymetry survey cover from Mean Low Lowest Water (MLLW) line until -10 m MSL depth and interval 1.0 km along the existing shoreline as shown in Figure 156 and 157. This bathymetry survey was conducted starting from 15 August 2022.

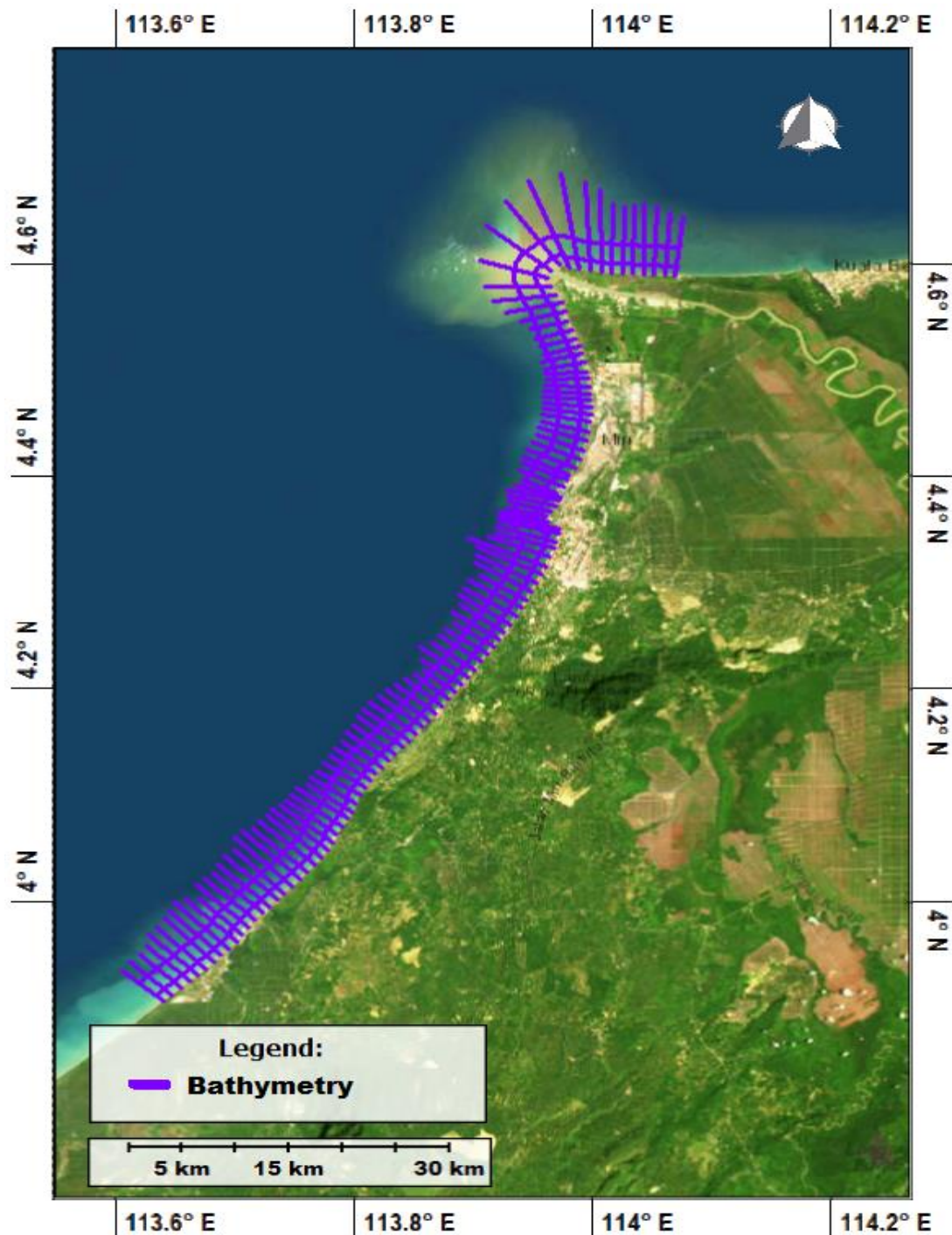


Figure 153: Bathymetry Survey at Miri nearshore

6.2. Bathymetry Of Rivers

River cross section one of requirement for the field measurement of the study. It provides an initial broad-scale of physical characterization of the river bed. The details of river cross section survey plan were outlined in Figure 154 and Figure 155. Four (4) rivers were included in Pantai Miri with 20km survey for each river except 110km for Sg Baram and each river was surveyed during two (2) different phase, 1st phase and 2nd phase as per requirement. Bathymetry survey results shown in Figure 156 and 157.

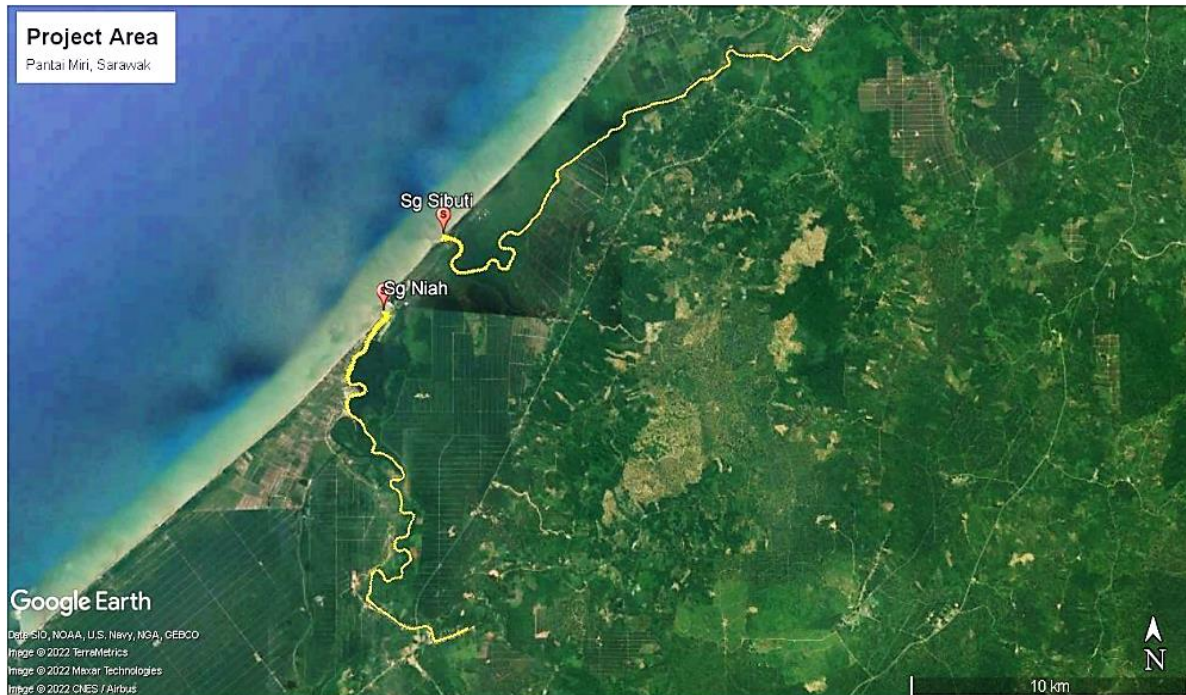


Figure 154: River bathymetry for Sg Niah and Sg Sibuti

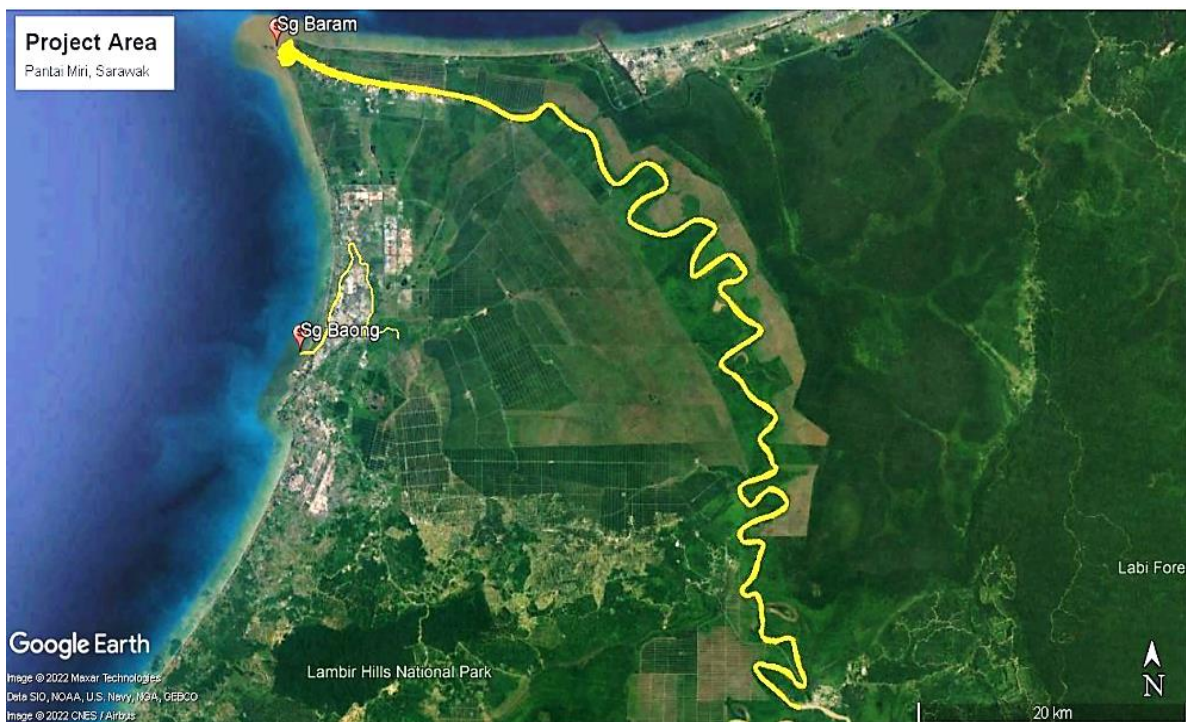


Figure 155: River bathymetry for for Sg Baong and Sg Baram

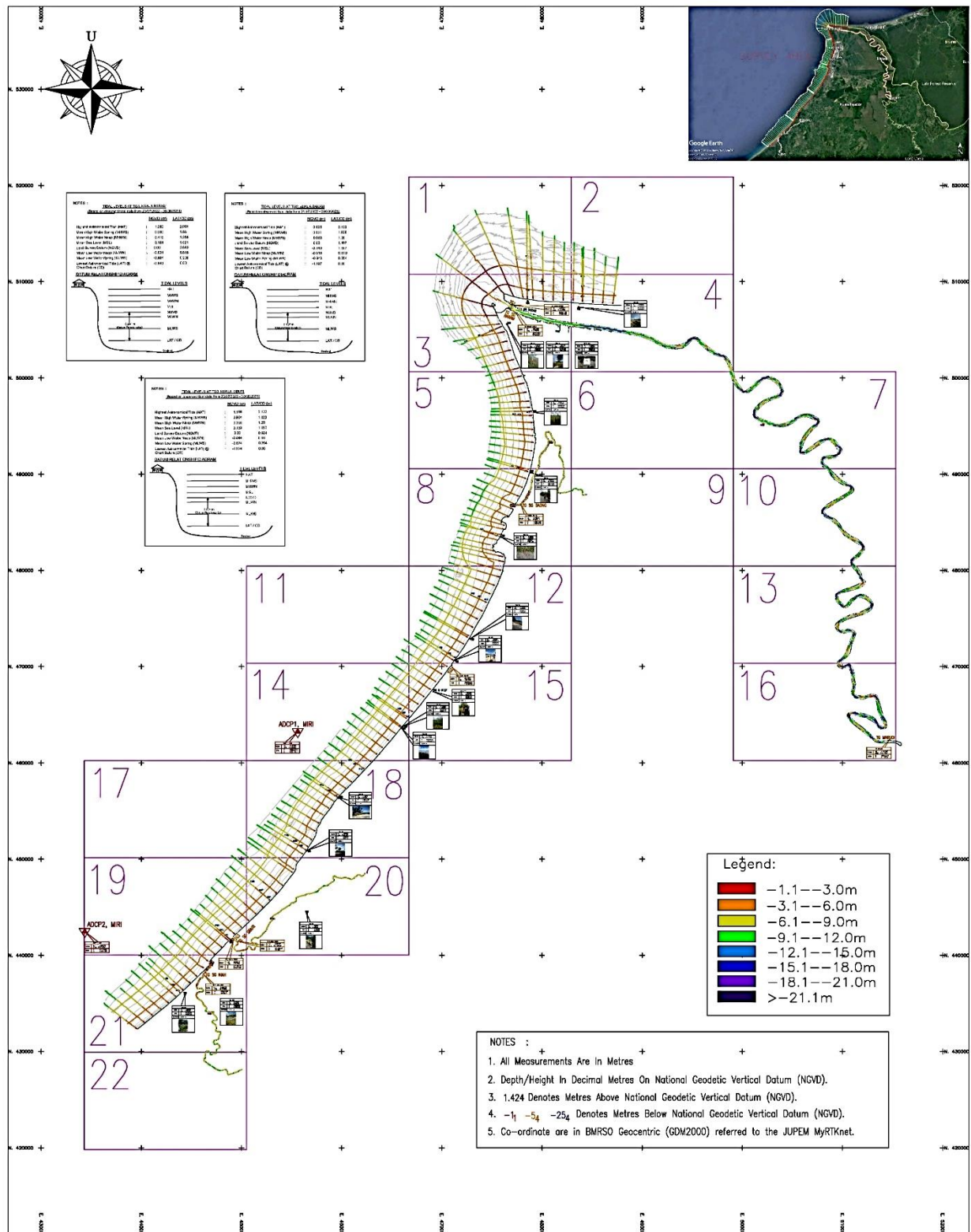


Figure 156: Nearshore & river bathymetry survey output at Miri coastline for 1st phase

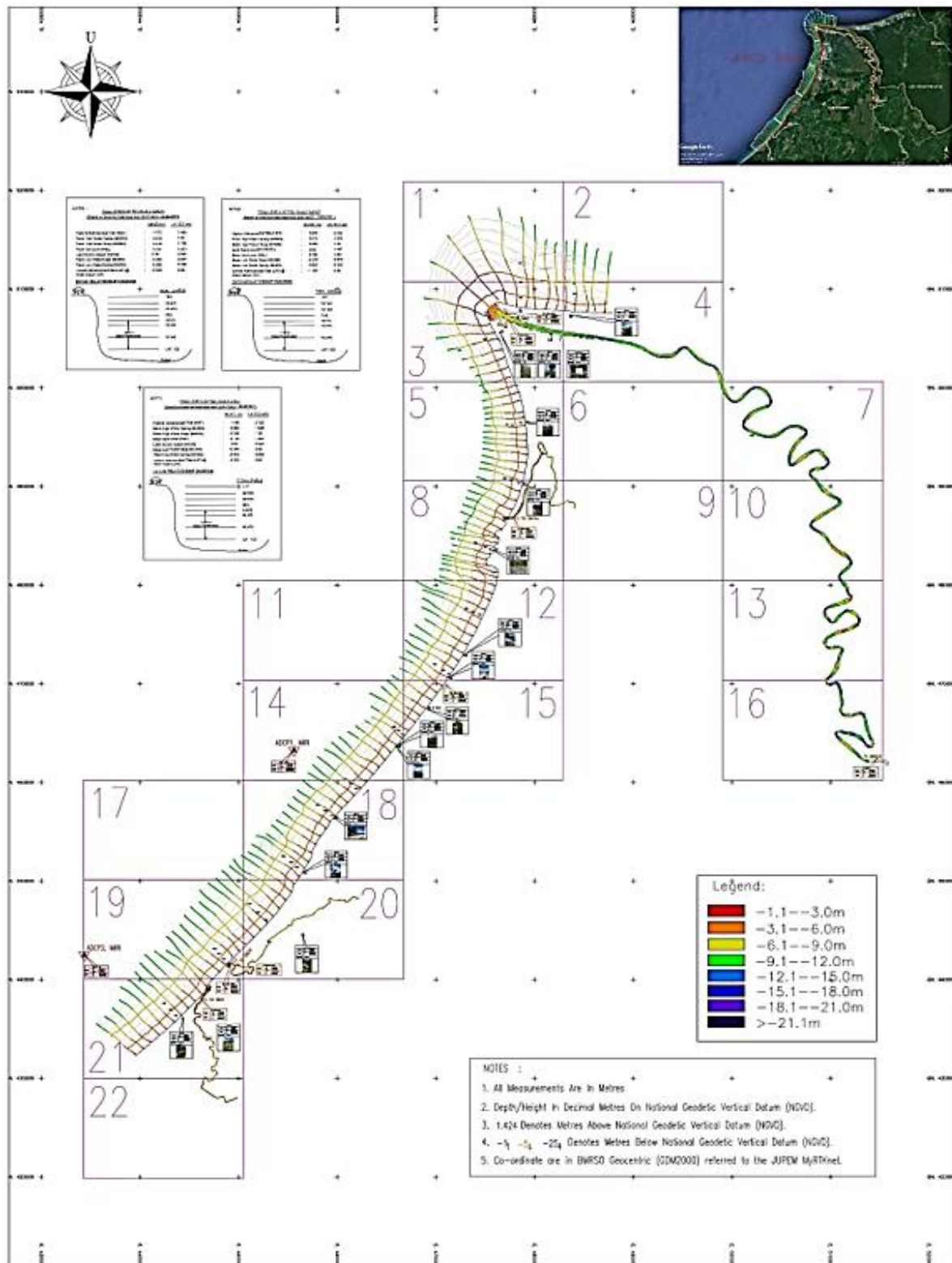


Figure 157: Nearshore & river bathymetry survey output at Miri coastline for 1st phase

7. MIRI'S CROSS-SECTION DATA MEASUREMENT

Fifteen (15) coastline profiling was measured 100m inland until -10m MSL with interval 1m for each point. The survey was carried out in two (2) different phase, 1st and 2nd phase and the survey was carried out using acceptable procedures. Anyhow, as the period between phase 1 and 2 not too far of the gap, then the profiling are not much changes. The location,

TBM and elevation on each profiling line are summarized as in Table 8 while details can refer in Table 9 and Figure 153 to Figure 173.

Table 8: Coordinate for coastline profiling line

ID	X (°E)	Y (°N)	ELLIPSOID	EASTING	NORTHING	ELEVATION(Z)
T1	113.681399	3.940276	49.4486	798018.6550	435979.7849	2.6252
T2	113.725709	3.990908	48.6079	802690.2596	441623.0502	1.7845
T3	113.762165	4.028406	47.8404	807462.0279	444449.5515	1.0169
T4	113.794045	4.075163	49.3824	810167.6002	451010.9526	2.5589
T5	113.822208	4.124920	59.1815	813327.9795	456518.7700	17.772
T6	113.879250	4.190076	50.0947	819596.5245	463786.1184	2.9241
T7	113.886337	4.199014	49.8100	819721.1114	463901.2728	2.8183
T8	113.928380	4.255412	43.6340	824924.7068	470815.4973	2.2247
T9	113.940795	4.274288	49.5854	826450.2934	473053.3774	2.4153
T10	113.967855	4.369865	46.0338	829508.4797	483655.1091	2.0306
T11	113.995383	4.430365	45.8668	832468.9941	490364.5244	1.8137
T12	113.999106	4.487987	44.8125	832699.1295	496625.8673	0.7593
T13	113.975316	4.570106	45.8668	832468.9941	490364.5244	0.4374
T14	113.992655	4.589107	44.0450	832137.311	508174.5622	0.3242
T15	114.042301	4.583031	45.0843	837220.8606	507567.7785	1.3636

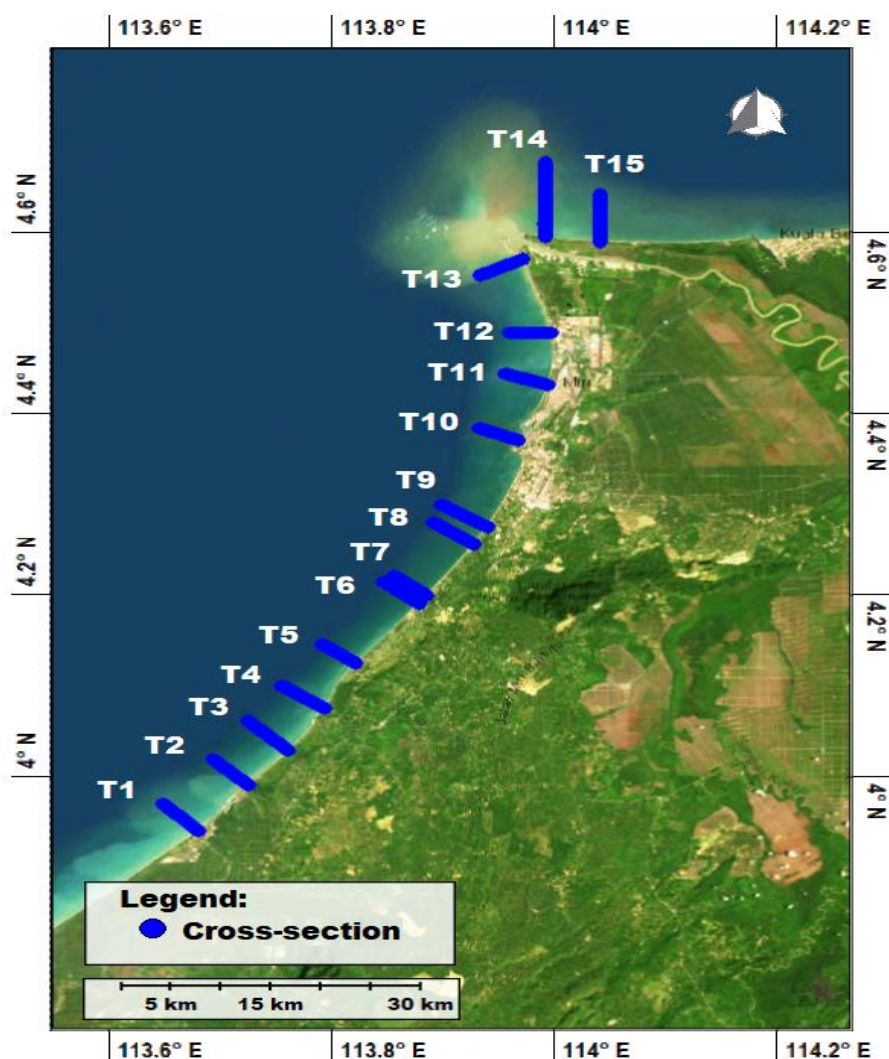


Figure 158: Cross Section line for coastal profiling along Miri shoreline

Table 9: Coordinate for coastline profiling line

ID	X (°E)	Y (°N)	Socio-Eco.	Infrastruc./ Struc.	Vege. / Geomor phology	Image Transect Area/ steepness
T1	113.681399	3.940276	No housing and population	Drainage outlet	Pokok Rhu	 mild steep
T2	113.725709	3.990908	Housing area and population. SK Kpg Kuala Sibuti around 250m from shoreline. Homestay and café available around this housing area. Villager house	Sg Sibuti river.	Pokok Rhu, shrubs, and coconut tree.	
T3	113.762165	4.028406	No housing and population	3 small pond.	Pokok Rhu, shrubs, and coconut tree, beach slope started to steep in this area	
T4	113.794045	4.075163	Housing area. Tourist attraction. Villager house	Peliau beach and Pantai Bunga. Small river	Pokok Rhu and coconut tree, beach slope started to steep	

T5	113.822208	4.124920	No housing.	High erosion. Very steep beach, sand delta, Building at Pantai Tusan. Nearby Tusan Beach.	Pokok Rhu, grass, shrubs, has steep cliff	
T6	113.87925	4.190076	No housing and population	Breakwater. Steep beach	Coconut tree, grass, shrubs, has steep cliff	
T7	113.886337	4.199014	1 house around 60m from shoreline	Steep beach. No structure	Pokok Rhu, coconut tree, grass, shrubs, has steep cliff	
T8	113.928380	4.255411	Housing area	Nearby Bakam Beach. Small jetty for fisherman	Coconut tree, shrub, grass.	
T9	113.940795	4.274288	1 house around 60m from shoreline	No structure, erosion	Coconut tree, grass, shrubs	

T10	113.967855	4.369865	Tourist attraction, shop lot, parking area	Groins, Pantai Tanjung Lobang	Pokok Rhu, grass.	
T11	113.995383	4.430364	No housing and population. Sand delta	No structure	Pokok Rhu, tree, grass, shrubs	
T12	113.999106	4.487987	Few villages houses. Around 250m from factory and Sribima Maritime Training Centre	Breakwater	Pokok Rhu, grass, shrubs	
T13	113.975316	4.570106	No housing and population. Sand mining activity	No structure.	Pokok Rhu, grass, shrubs	
T14	113.992654	4.589107	No housing and population. Nearby SK Kuala Baram (500m from shoreline)	No structure.	Grass, shrubs	
T15	114.042301	4.583030	3.6km from Malaysia Brunei border, sand delta	No structure.	Grass, shrubs	

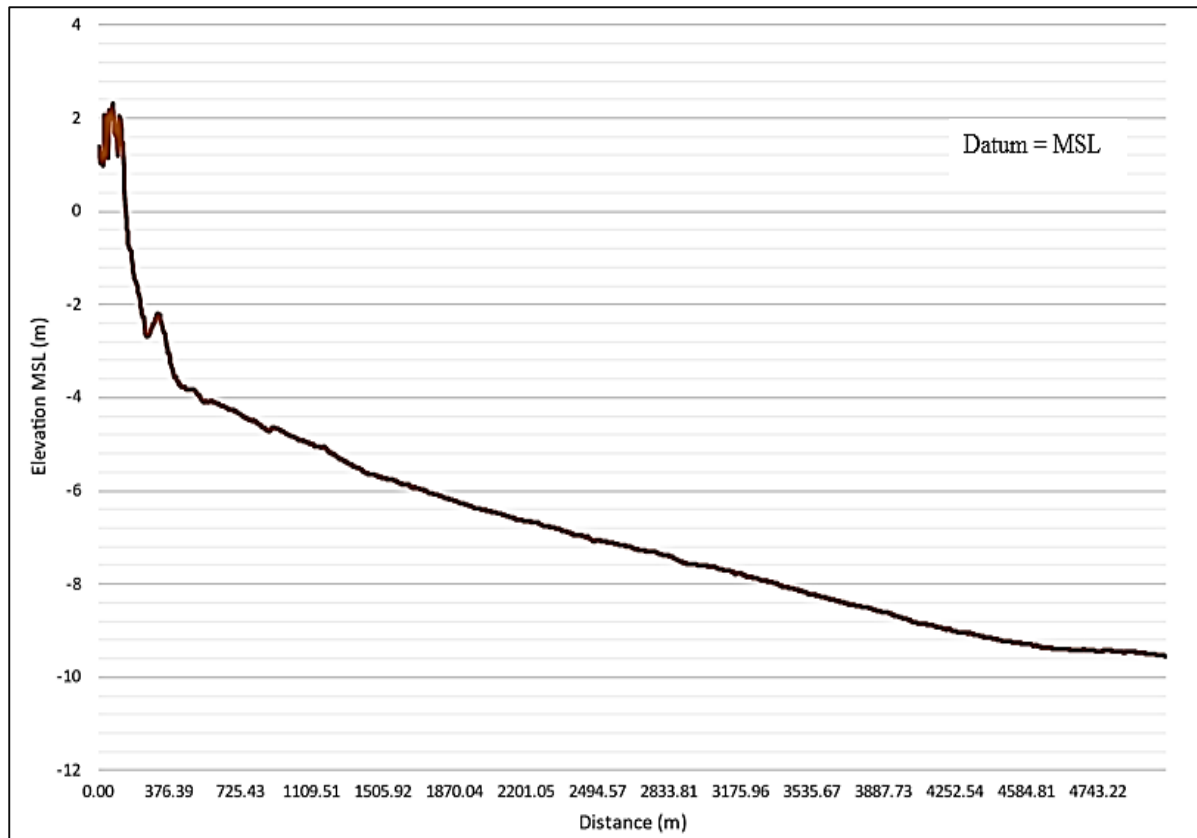


Figure 159: Coastline profile for T1

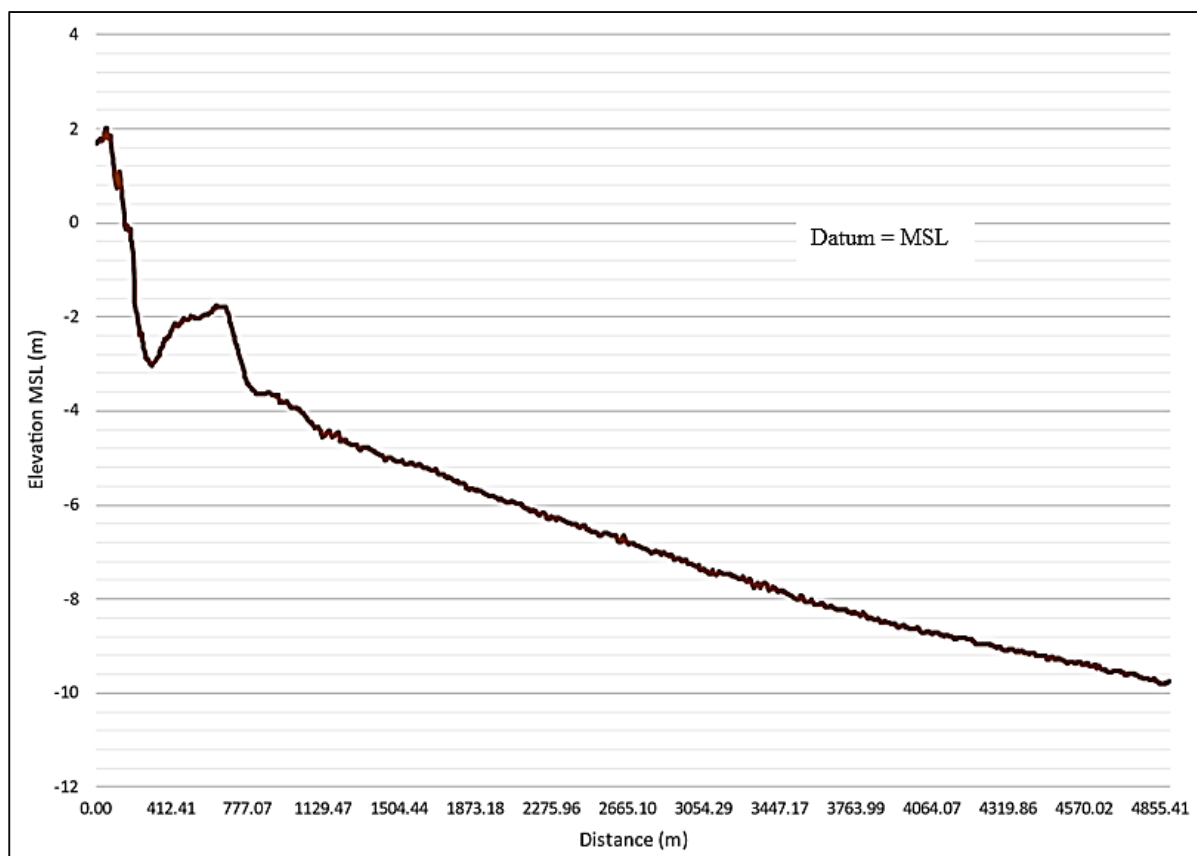


Figure 160: Coastline profile for T2

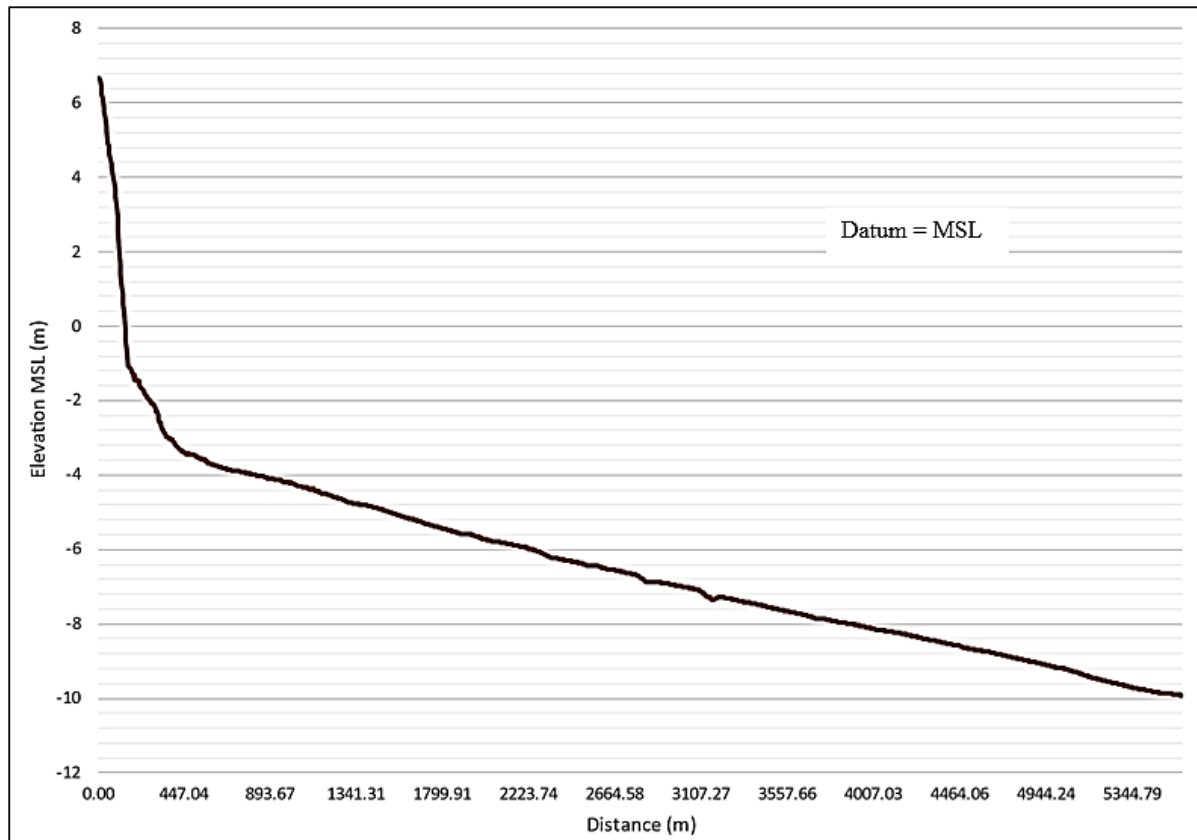


Figure 161: Coastline profile for T3

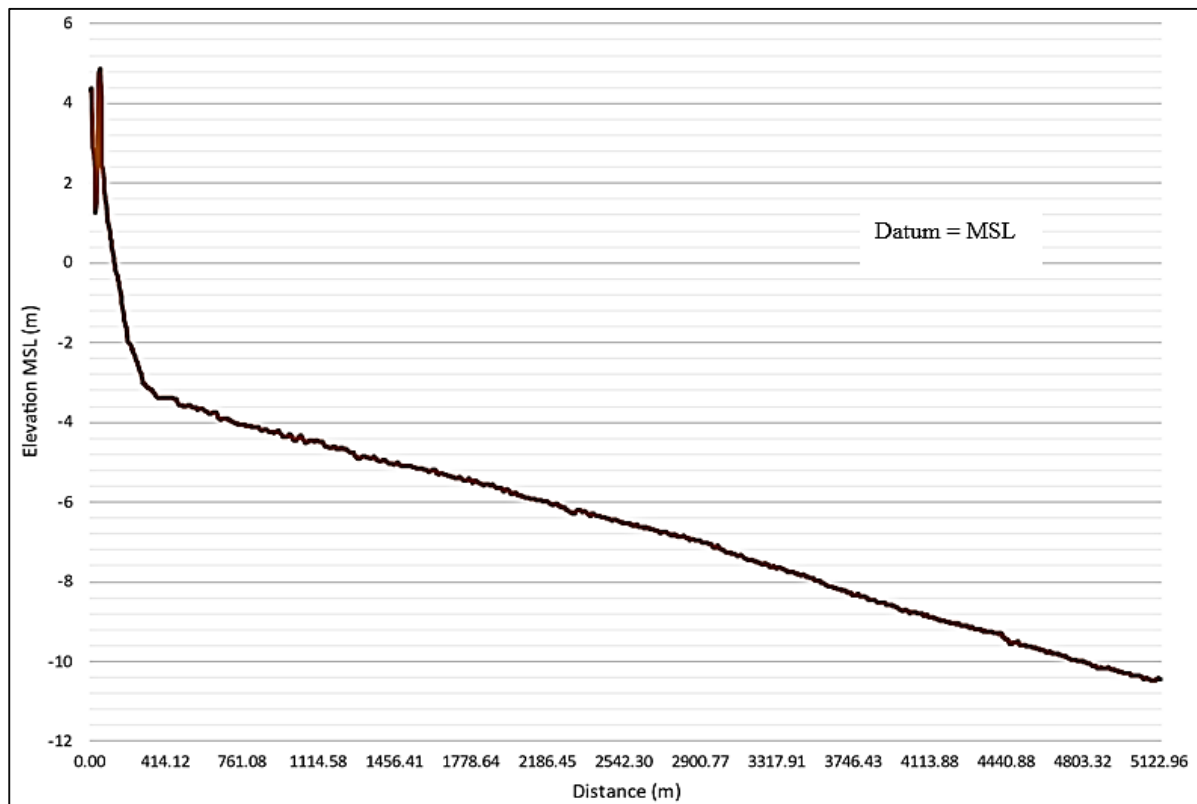


Figure 162: Coastline profile for T4

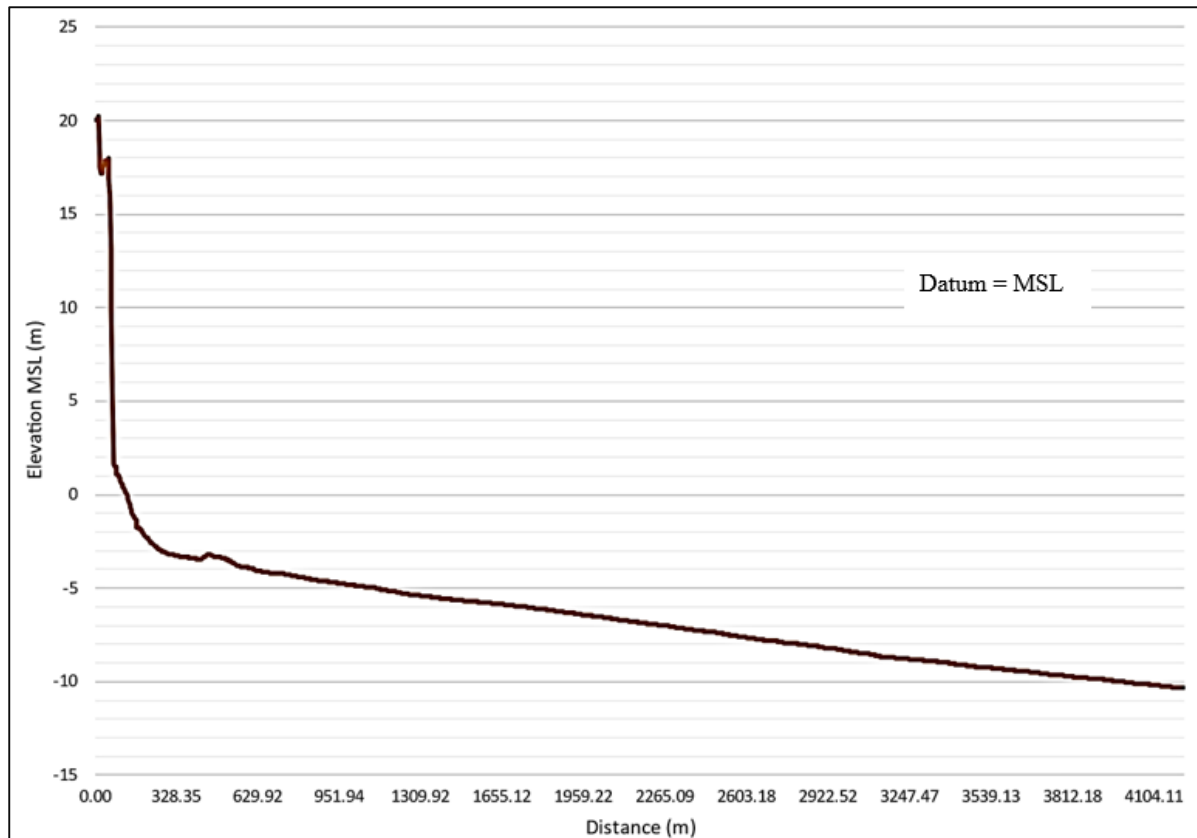


Figure 163: Coastline profile for T5

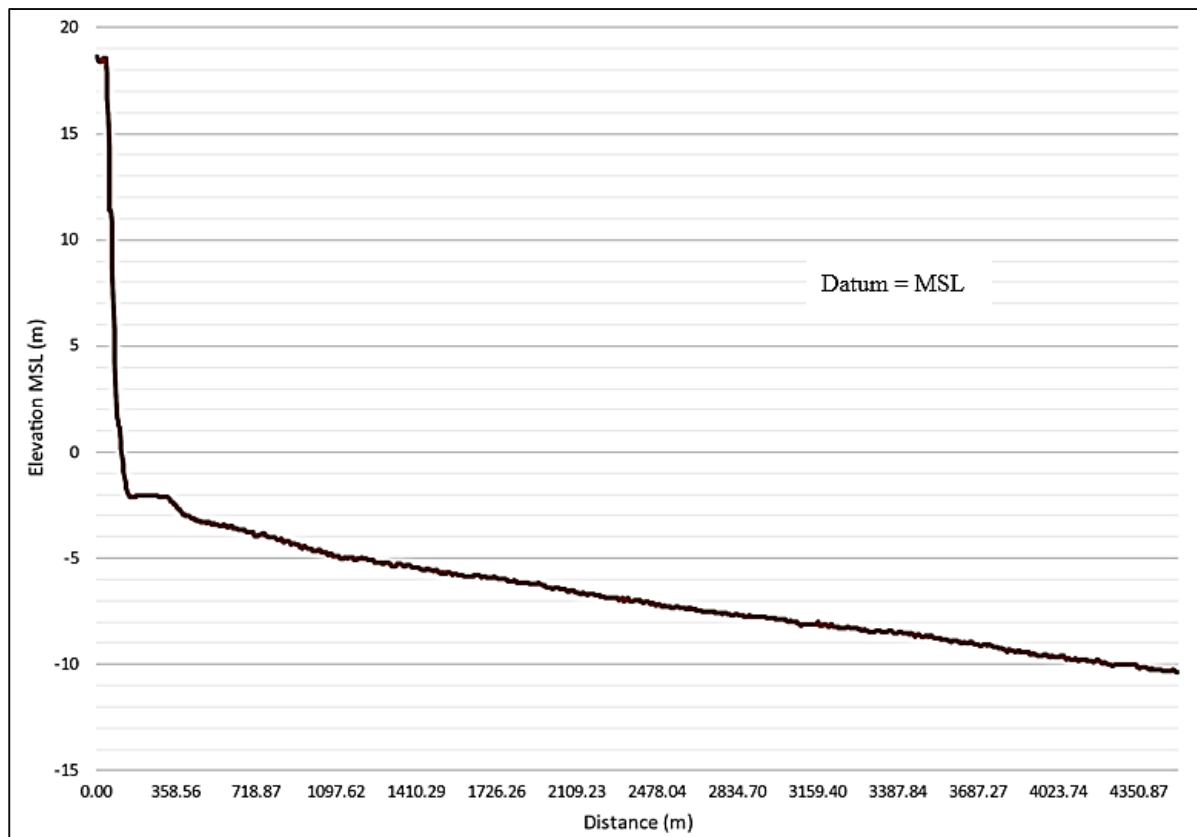


Figure 164: Coastline profile for T6

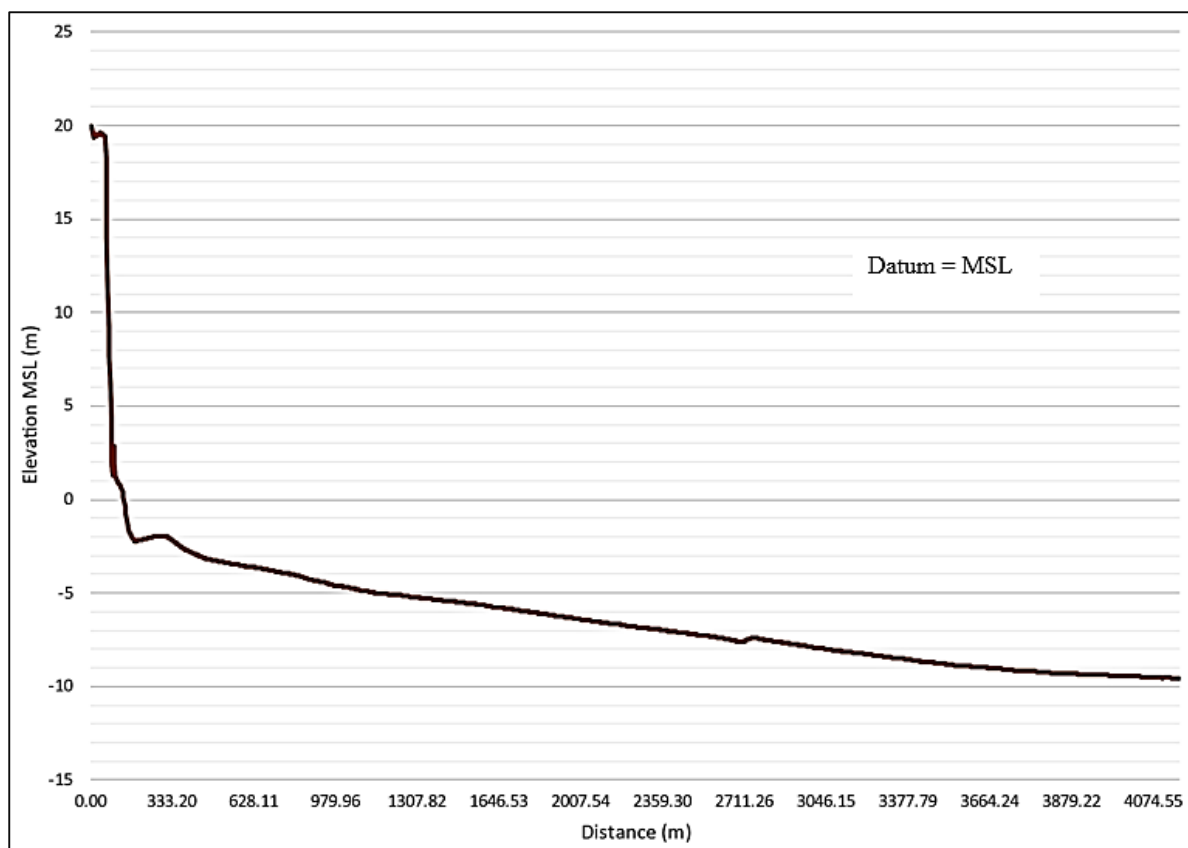


Figure 165: Coastline profile for T7

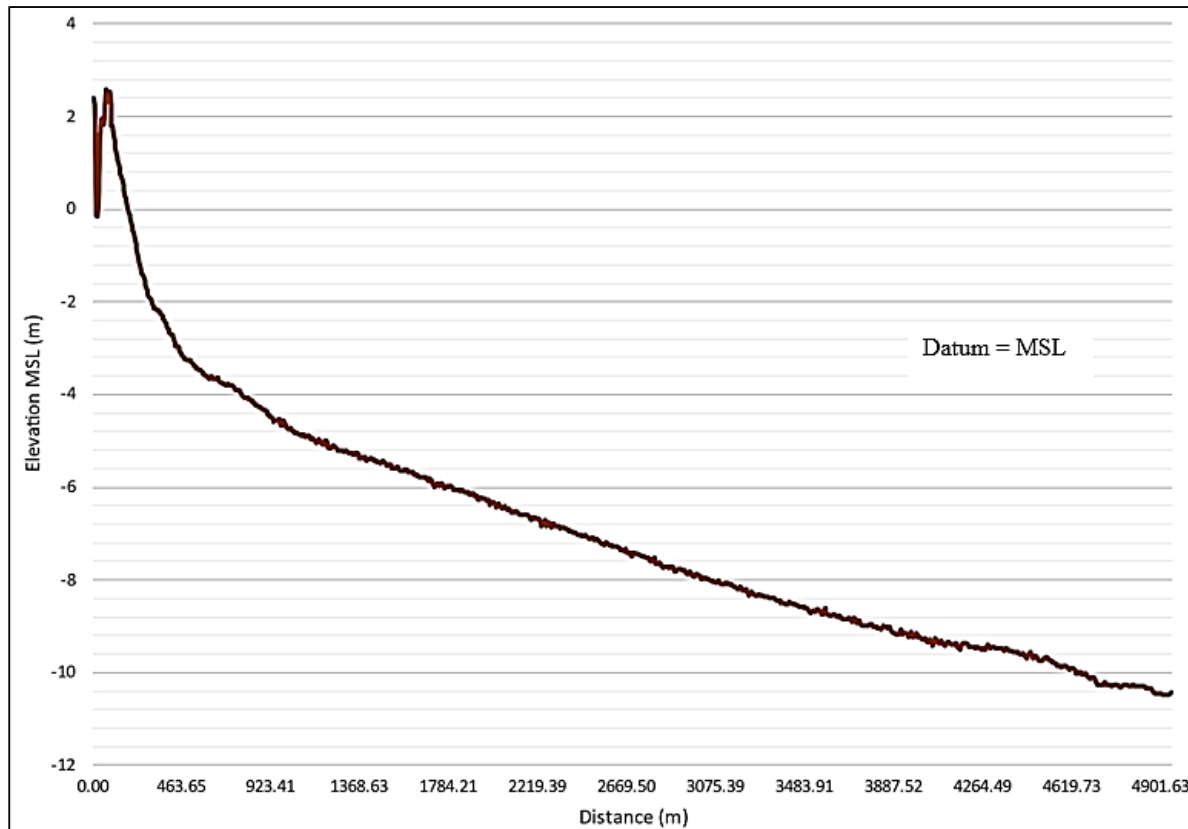


Figure 166: Coastline profile for T8

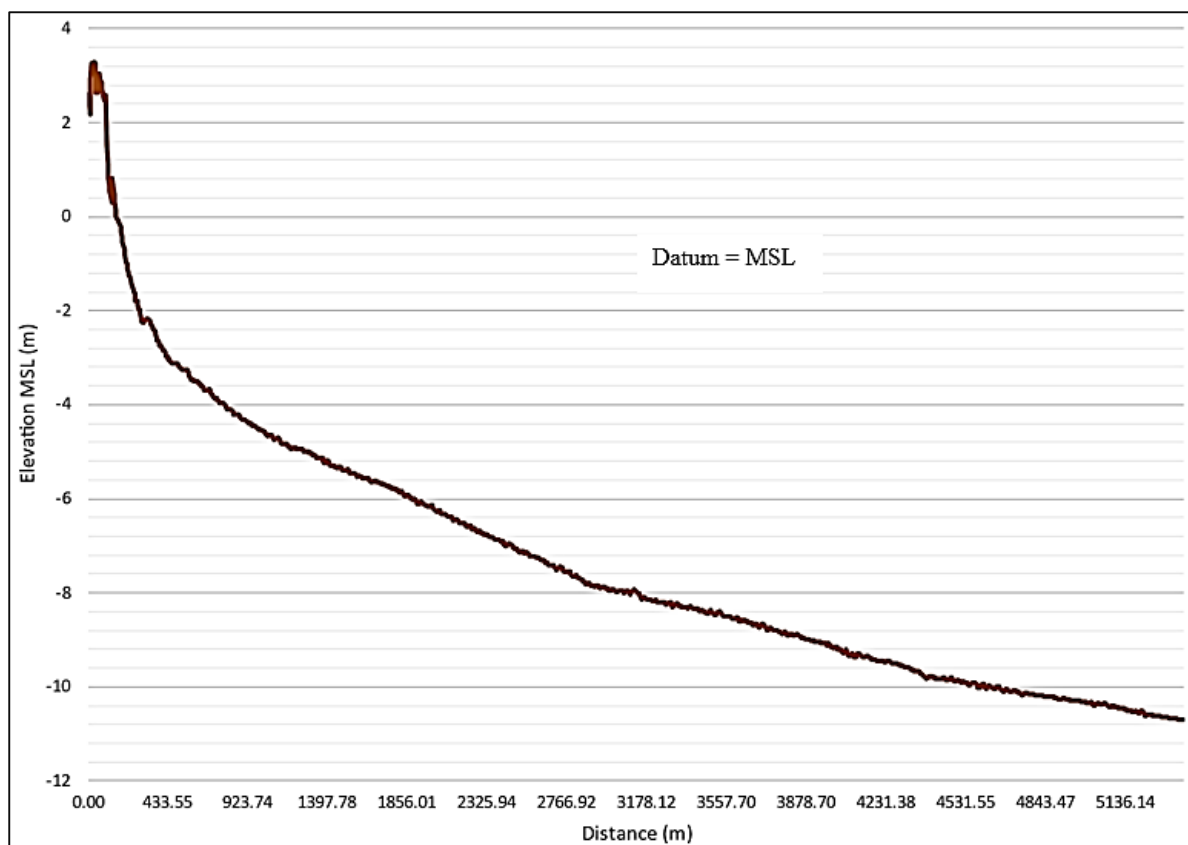


Figure 167: Coastline profile for T9

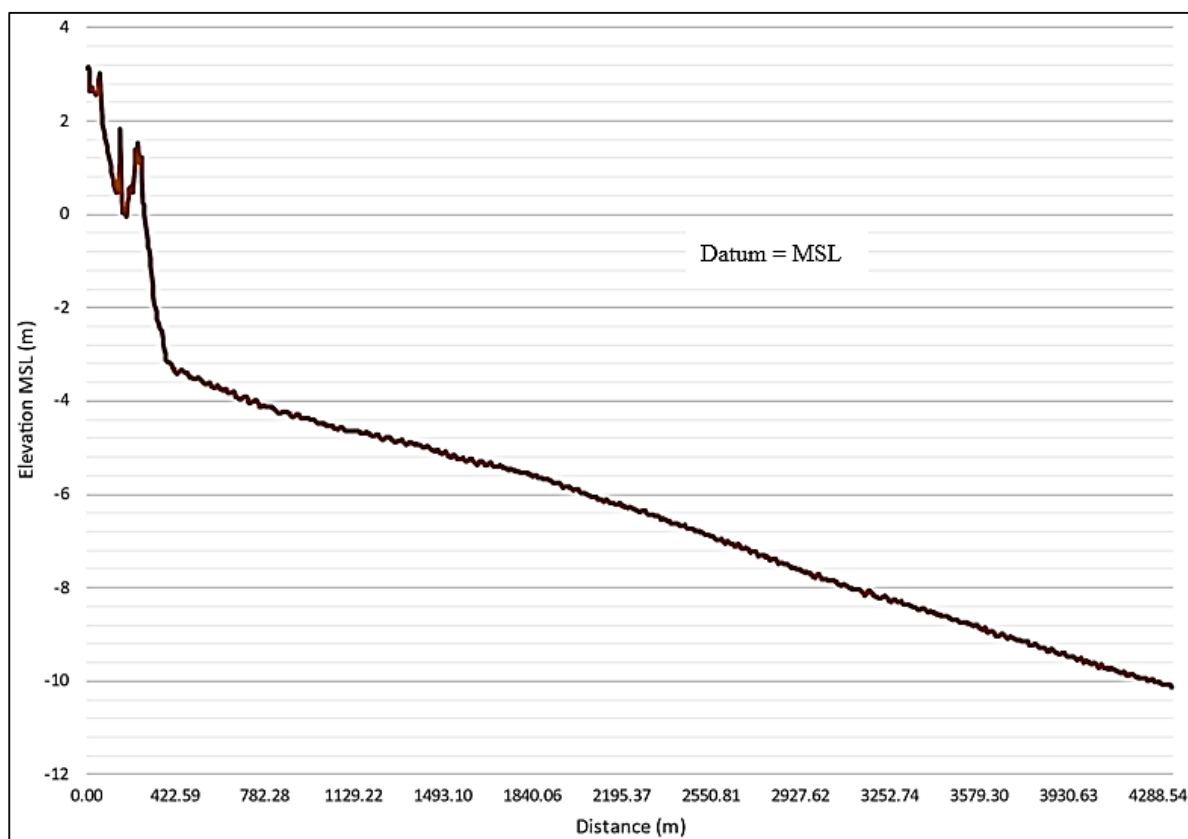


Figure 168: Coastline profile for T10

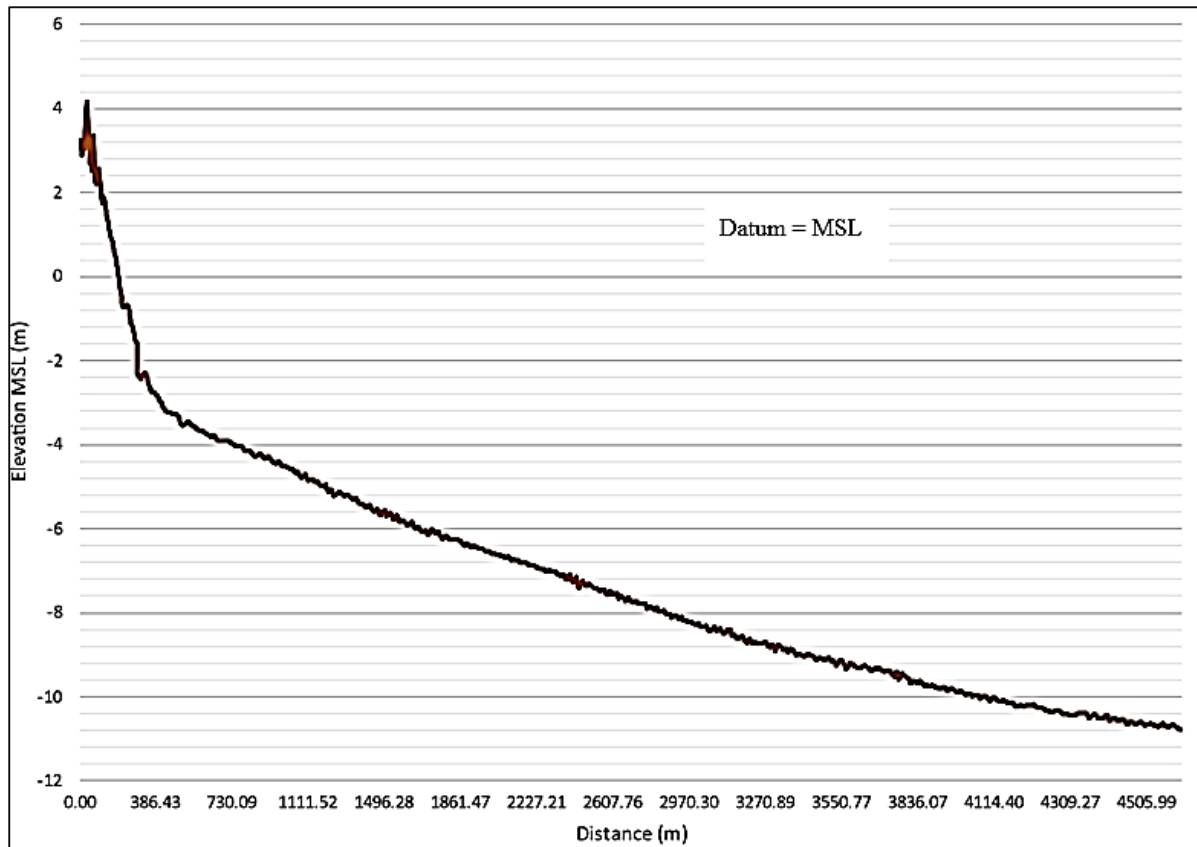


Figure 169: Coastline profile for T11

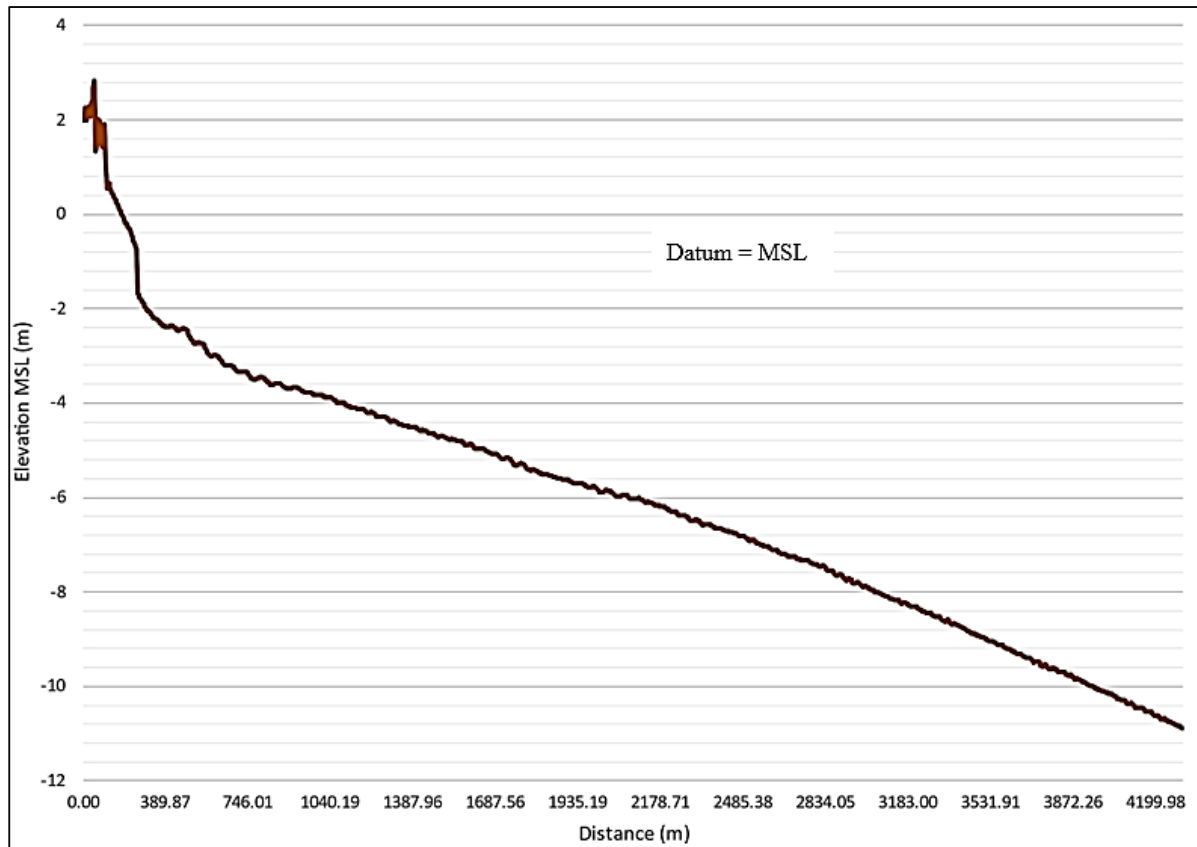


Figure 170: Coastline profile for T12

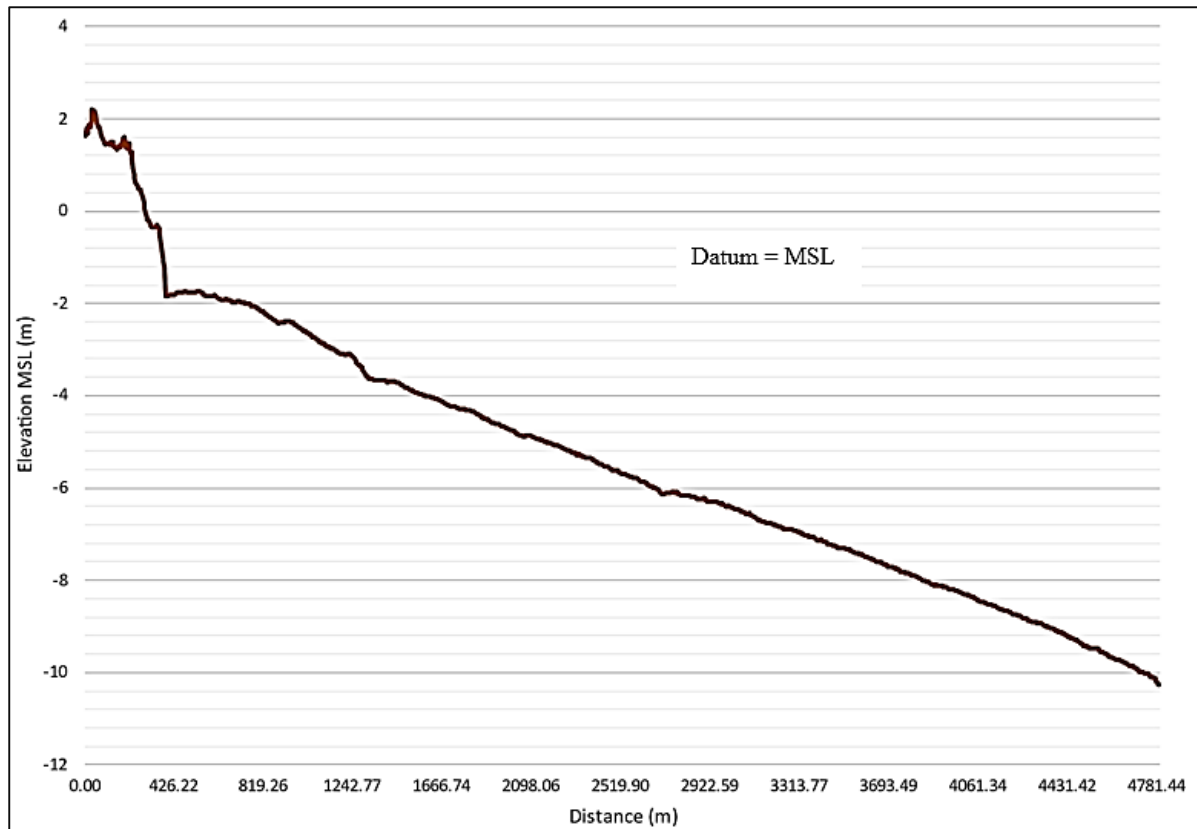


Figure 171: Coastline profile for T13

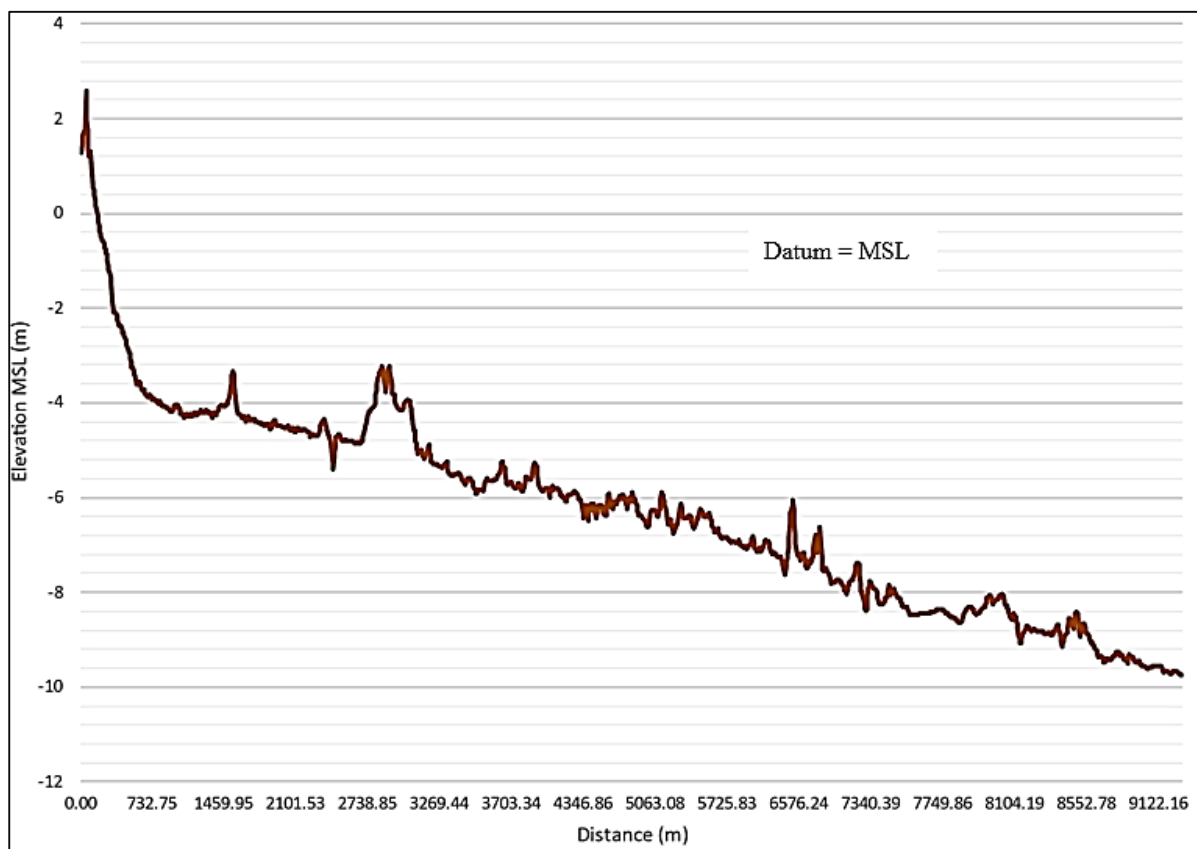


Figure 172: Coastline profile for T14

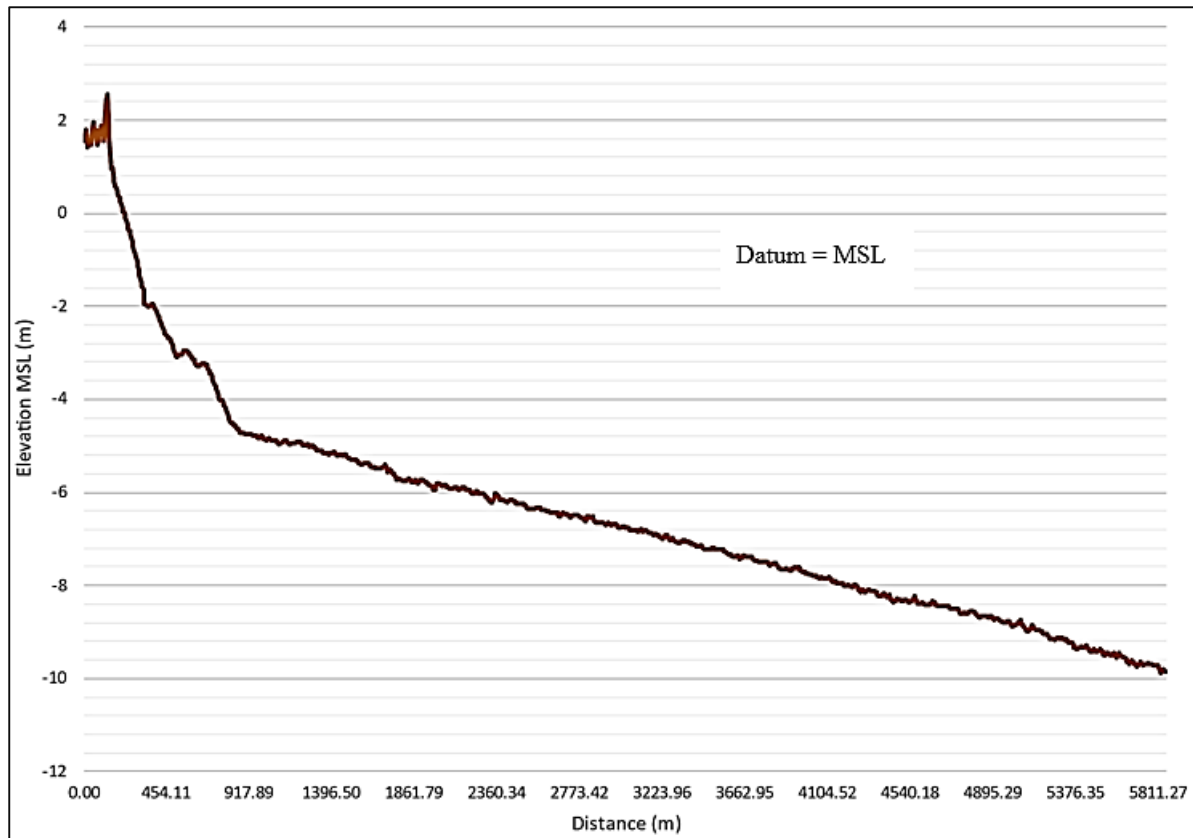


Figure 173: Coastline profile for T15

8. SEDIMENT SAMPLING

Data observation for Grab sampling has been done covering 2 areas, namely sediment sampling in the coastal area and in the river.

8.1. Seabed Sediment Sampling

Grab sample were carried out at forty-five (45) points around the proposed area for both seasons, 1st phase and 2nd phase. The sample was carried out using acceptable procedures. The sediment sample sent to laboratory for analysis of particle size distribution in accredited laboratory. Seabed sediment sampling location details are summarized in Table 3.4 and the illustrated shown in Table 10 and 11, and Figure to .

Table 10: Details on Grab Sampling along Miri nearshore for 1st phase

X	Y	ID	TYPE	X	Y	ID	TYPE
114.042276	4.595293	G1(2)	Medium Silt	113.914059	4.265485	G8(5)	Coarse Silt
114.042515	4.604819	G1(3)	Medium Silt	113.884346	4.201139	G9(2)	Fine Sand
114.042276	4.614107	G1(5)	Medium Silt	113.880842	4.204470	G9(3)	Fine Sand
113.992947	4.601313	G2(2)	Medium Silt	113.876858	4.208120	G9(5)	Fine Sand
113.993228	4.615538	G2(3)	Medium Silt	113.842261	4.151729	G10(2)	Coarse Silt
113.992650	4.633178	G2(5)	Medium Silt	113.837166	4.156490	G10(3)	Coarse Silt
113.960134	4.563191	G3(2)	Fine Sand	113.832070	4.160300	G10(5)	Fine Sand
113.949860	4.558639	G3(3)	Coarse Silt	113.820085	4.126704	G11(2)	Medium Silt
113.937298	4.553230	G3(5)	Coarse Silt	113.813876	4.131466	G11(3)	Coarse Silt
113.993162	4.486605	G4(2)	Coarse Silt	113.806869	4.136706	G11(5)	Fine Sand
113.985134	4.484600	G4(3)	Coarse Silt	113.787784	4.079703	G12(2)	Coarse Silt
113.980436	4.484886	G4(5)	Medium Silt	113.782688	4.084146	G12(3)	Coarse Silt
113.991061	4.431468	G5(2)	Coarse Silt	113.775358	4.089698	G12(5)	Coarse Silt

X	Y	ID	TYPE
113.984374	4.434326	G5(3)	Medium Silt
113.978323	4.435755	G5(5)	Coarse Silt
113.965126	4.370549	G6(2)	Coarse Silt
113.960505	4.372923	G6(3)	Coarse Silt
113.951416	4.376724	G6(5)	Coarse Silt
113.955093	4.310734	G7(2)	Fine Sand
113.948879	4.313586	G7(3)	Coarse Silt
113.943141	4.316440	G7(5)	Coarse Silt
113.926500	4.256601	G8(2)	Fine Sand
113.921878	4.259931	G8(3)	Fine Sand

X	Y	ID	TYPE
113.759109	4.031445	G13(2)	Fine Sand
113.752263	4.038110	G13(3)	Coarse Silt
113.744297	4.046204	G13(5)	Fine Sand
113.720590	3.995690	G14(2)	Fine Sand
113.716608	4.000609	G14(3)	Coarse Silt
113.712467	4.004894	G14(5)	Fine Sand
113.677229	3.943840	G15(2)	Coarse Silt
113.672492	3.949087	G15(3)	Coarse Silt
113.666287	3.955010	G15(5)	Coarse Silt

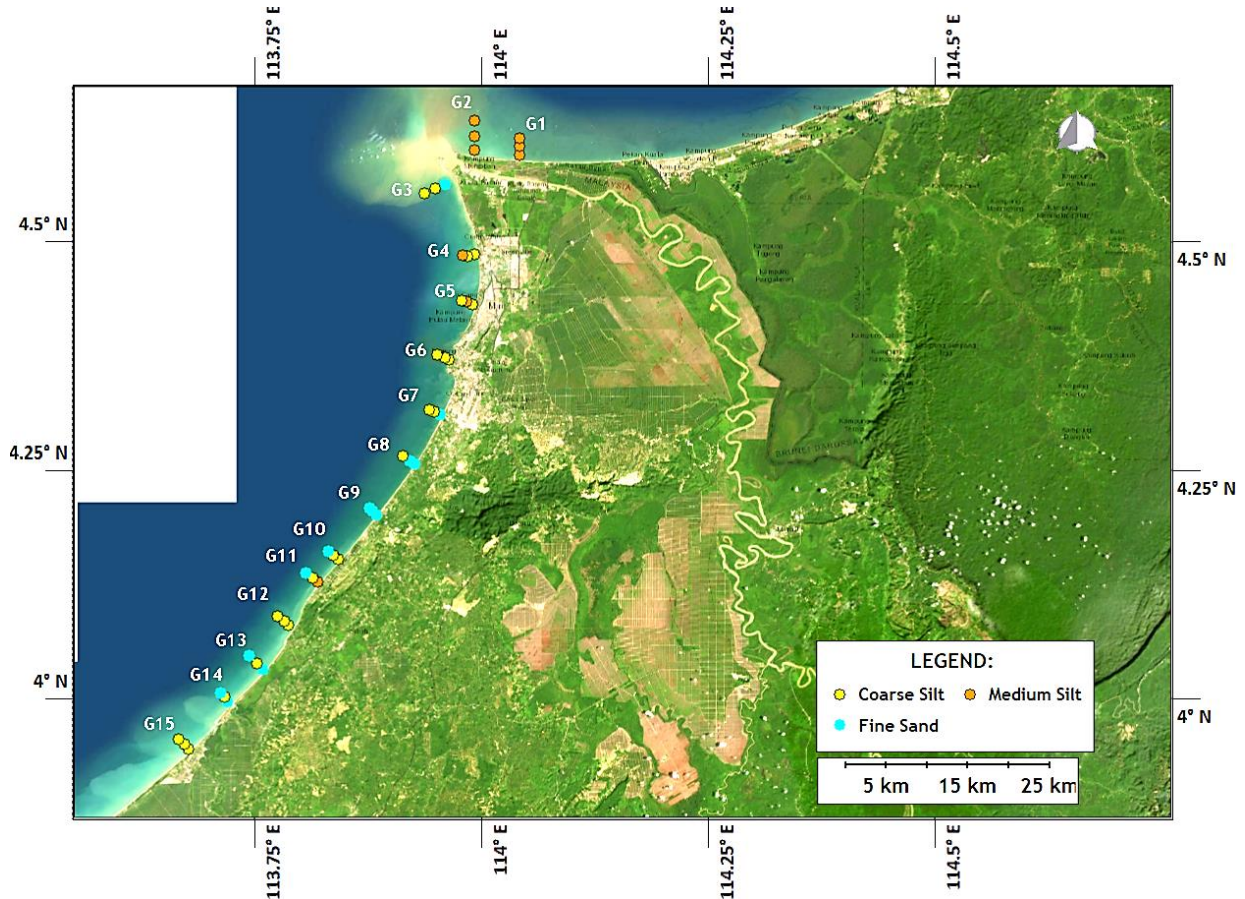


Figure 174: Grab Sample Locations along Miri coastal area for 1st phase.

Table 11: Details on Grab Sampling along Miri nearshore for 2nd phase

X	Y	ID	TYPE
114.042276	4.595293	G1(2)	Medium Silt
114.042515	4.604819	G1(3)	Medium Silt
114.042276	4.614107	G1(5)	Medium Silt
113.992947	4.601313	G2(2)	Medium Silt
113.993228	4.615538	G2(3)	Medium Silt
113.992650	4.633178	G2(5)	Medium Silt
113.960134	4.563191	G3(2)	Fine Sand
113.949860	4.558639	G3(3)	Coarse Silt
113.937298	4.553230	G3(5)	Coarse Silt
113.993162	4.486605	G4(2)	Coarse Silt
113.985134	4.484600	G4(3)	Coarse Silt
113.980436	4.484886	G4(5)	Medium Silt
113.991061	4.431468	G5(2)	Coarse Silt
113.984374	4.434326	G5(3)	Medium Silt
113.978323	4.435755	G5(5)	Coarse Silt
113.965126	4.370549	G6(2)	Coarse Silt

X	Y	ID	TYPE
113.914059	4.265485	G8(5)	Coarse Silt
113.884346	4.201139	G9(2)	Fine Sand
113.880842	4.204470	G9(3)	Fine Sand
113.876858	4.208120	G9(5)	Fine Sand
113.842261	4.151729	G10(2)	Coarse Silt
113.837166	4.156490	G10(3)	Coarse Silt
113.832070	4.160300	G10(5)	Coarse Silt
113.820085	4.126704	G11(2)	Medium Silt
113.813876	4.131466	G11(3)	Coarse Silt
113.806869	4.136706	G11(5)	Fine Sand
113.787784	4.079703	G12(2)	Coarse Silt
113.782688	4.084146	G12(3)	Coarse Silt
113.775358	4.089698	G12(5)	Coarse Silt
113.759109	4.031445	G13(2)	Fine Sand
113.752263	4.038110	G13(3)	Coarse Silt
113.744297	4.046204	G13(5)	Fine Sand

X	Y	ID	TYPE
113.960505	4.372923	G6(3)	Coarse Silt
113.951416	4.376724	G6(5)	Coarse Silt
113.955093	4.310734	G7(2)	Fine Sand
113.948879	4.313586	G7(3)	Coarse Silt
113.943141	4.316440	G7(5)	Coarse Silt
113.926500	4.256601	G8(2)	Fine Sand
113.921878	4.259931	G8(3)	Fine Sand

X	Y	ID	TYPE
113.720590	3.995690	G14(2)	Fine Sand
113.716608	4.000609	G14(3)	Coarse Silt
113.712467	4.004894	G14(5)	Fine Sand
113.677229	3.943840	G15(2)	Coarse Silt
113.672492	3.949087	G15(3)	Coarse Silt
113.666287	3.955010	G15(5)	Coarse Silt

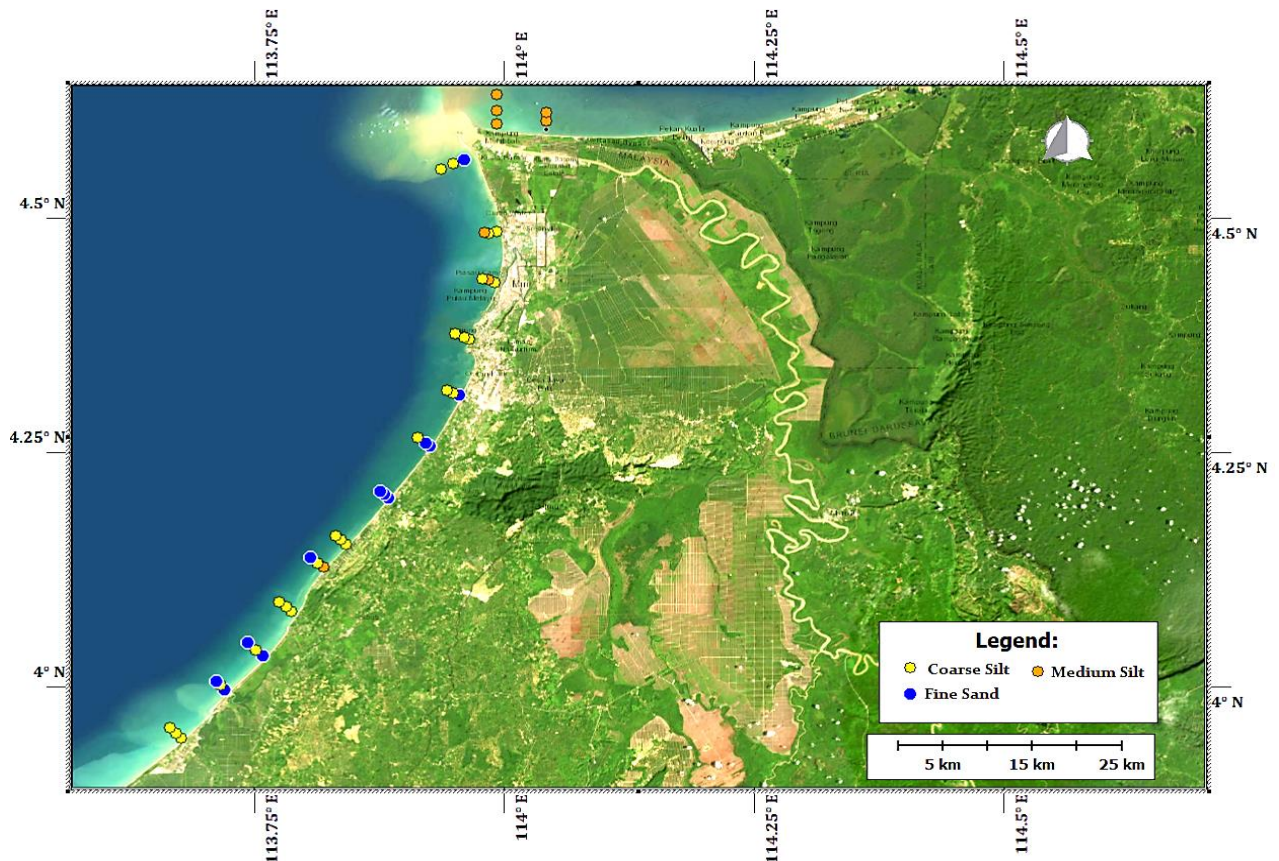


Figure 175: Grab Sample Locations along Miri coastal area for 2nd phase.

8.2. River Sediment Sampling

River sediment sampling were carried out at eight (8) location around the proposed area the seabed grab sampling was carried out using acceptable method for both season, Pre Monsoon and Post Monsoon. The equipment used for seabed sediment sample is Van Veen Grab. The sediment sample sent to laboratory for analysis of particle size distribution in accredited laboratory. River sediment sampling location details are summarized in Table 12 to 13 and Figure 176 to 177.

Table 12: Coordinate for river sediment sampling at Miri

ID	X (°E)	Y (°N)	Depth (m)	Mechanical and Hydrometer Analysis (%)				d10 (mm)	d16 (mm)	d50 (mm)	d84 (mm)	d95 (mm)	Sediment Characteristics
				Clay	Silt	Sand	Gravel						
G_Sg1	113.707166	3.968291	6.7	0	5	93	2	0.071	0.082	0.183	0.442	0.943	Fine Sand
G_Sg2	113.707486	3.922962	7.2	7	65	25	3	0.005	0.016	0.047	0.145	0.637	Coarse Silt
G_Sg3	113.724982	3.991881	3.4	0	1	99	0	0.237	0.278	0.379	0.532	0.687	Medium Sand
G_Sg4	113.762077	4.011143	8.4	2	36	34	28	0.012	0.018	0.786	3.018	0.000	Coarse Sand
G_Sg5	113.977962	4.399096	5.7	0	13	84	3	0.055	0.070	0.174	0.348	1.272	Fine Sand

ID	X (°E)	Y (°N)	Depth (m)	Mechanical and Hydrometer Analysis (%)				d10 (mm)	d16 (mm)	d50 (mm)	d84 (mm)	d95 (mm)	Sediment Characteristics
				Clay	Silt	Sand	Gravel						
G_Sg6	114.011651	4.459376	5.5	3	50	9	38	0.009	0.013	0.039	0.000	0.000	Coarse Silt
G_Sg7	113.977143	4.585451	8.4	1	93	6	0	0.006	0.008	0.014	0.031	0.079	Medium Silt
G_Sg8	114.205905	4.477067	9.7	0	59	41	0	0.015	0.022	0.054	0.126	0.229	Coarse Silt

Table 13: Coordinate for river sediment sampling at Miri

ID	X (°E)	Y (°N)	Depth (m)	Mechanical and Hydrometer Analysis (%)				d10 (mm)	d16 (mm)	d50 (mm)	d84 (mm)	d95 (mm)	Sediment Characteristics
				Clay	Silt	Sand	Gravel						
G_Sg1	113.707166	3.968291	6.5	0	13	87	0	0.050	0.080	0.186	0.282	0.351	Fine Sand
G_Sg2	113.707486	3.922962	7.3	21	39	40	0	0.001	0.001	0.044	0.112	0.141	Coarse Silt
G_Sg3	113.724982	3.991881	3.1	0	1	99	0	0.189	0.212	0.257	0.311	0.413	Medium Sand
G_Sg4	113.762077	4.011143	8.4	8	26	24	42	0.002	0.006	0.557	4.211	6.110	Coarse Sand
G_Sg5	113.977962	4.399096	5.8	0	3	97	0	0.008	0.102	0.176	0.241	0.311	Fine Sand
G_Sg6	114.011651	4.459376	5.4	16	50	34	0	0.001	0.002	0.031	0.110	0.145	Coarse Silt
G_Sg7	113.977143	4.585451	8.4	25	57	18	0	0.001	0.001	0.011	0.081	0.121	Medium Silt
G_Sg8	114.205905	4.477067	9.5	11	42	47	0	0.001	0.004	0.057	0.112	0.156	Coarse Silt

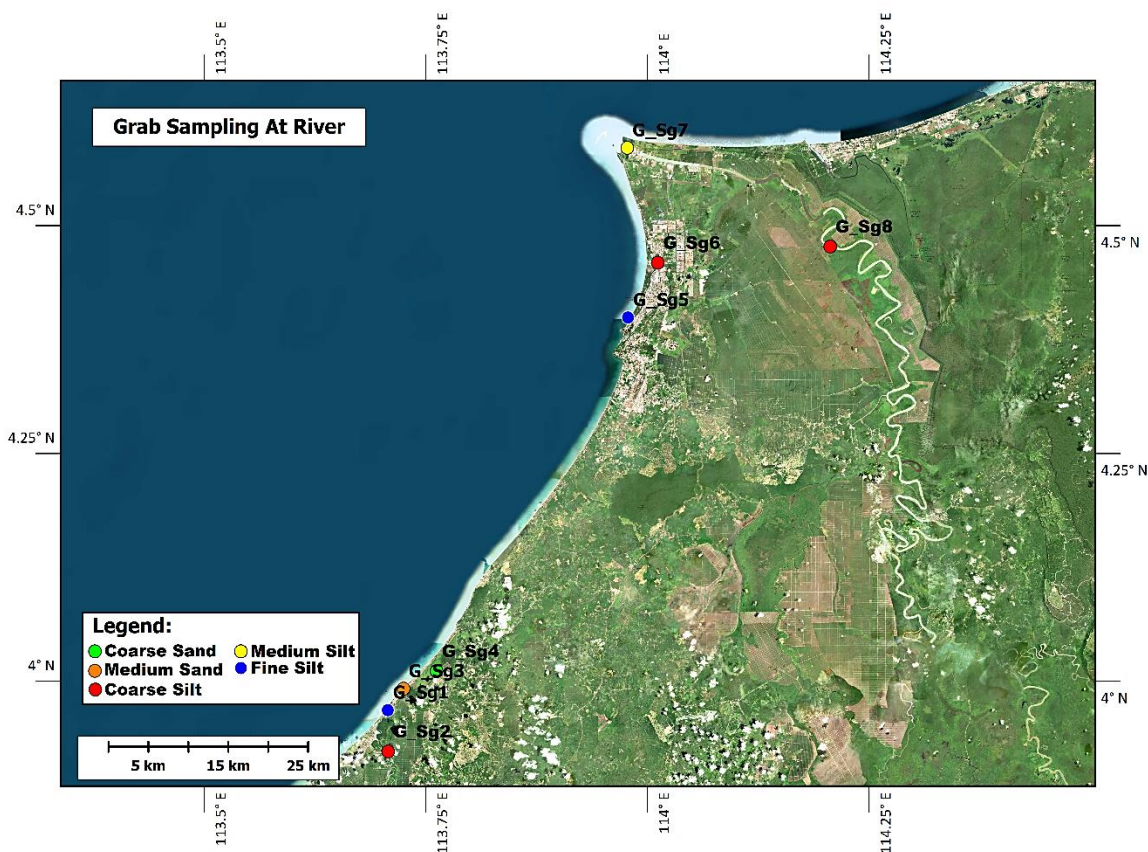


Figure 176: River Sediment Sampling Locations along Miri coastal area for 1st phase

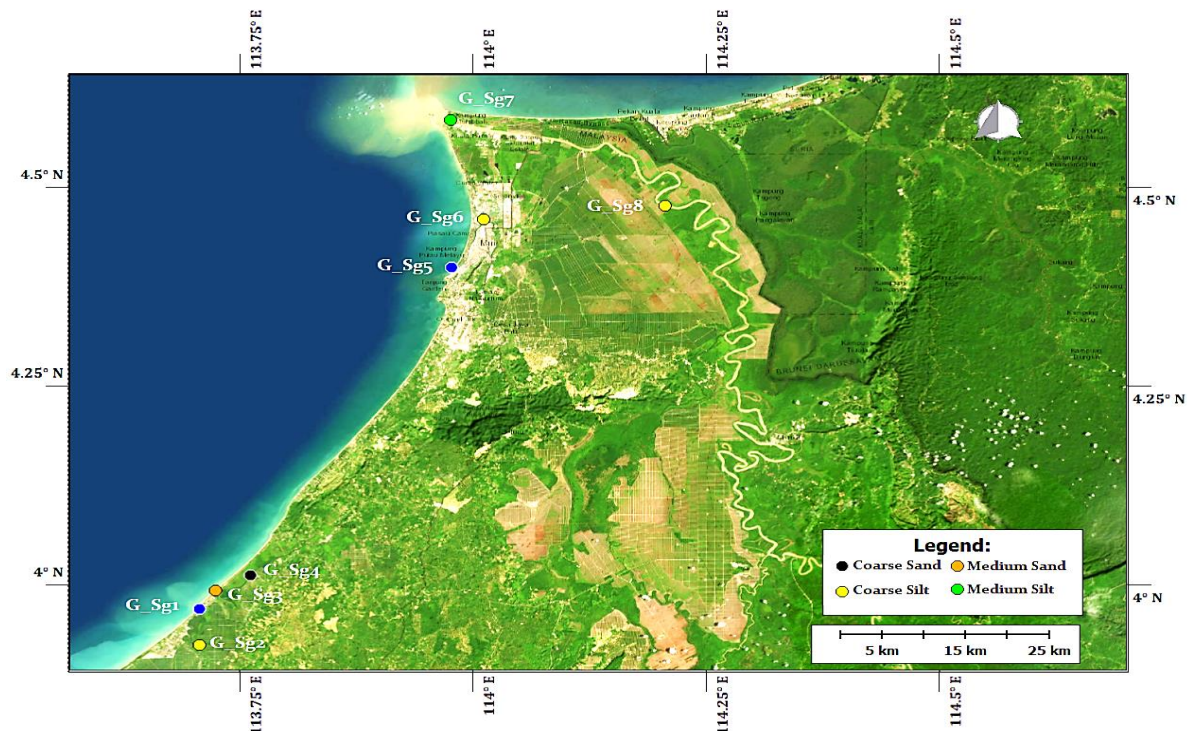


Figure 177: River Sediment Sampling Locations along Miri coastal area for 2nd phase

9. TOTAL SUSPENDED SOLID (TSS) SAMPLING

TSS sample were collected at eight (8) location with three (3) different depth (0.2d, 0.6d and 0.8d) for two (2) different season around the proposed area. The sample was carried out using acceptable procedures. The sample was sent to laboratory for analysis of Total Suspended Solid in accredited laboratory. Location of the sampling shown in Figure 178 and details are summarized as shown in Table 14 to 15 and Figure 179 to 182.

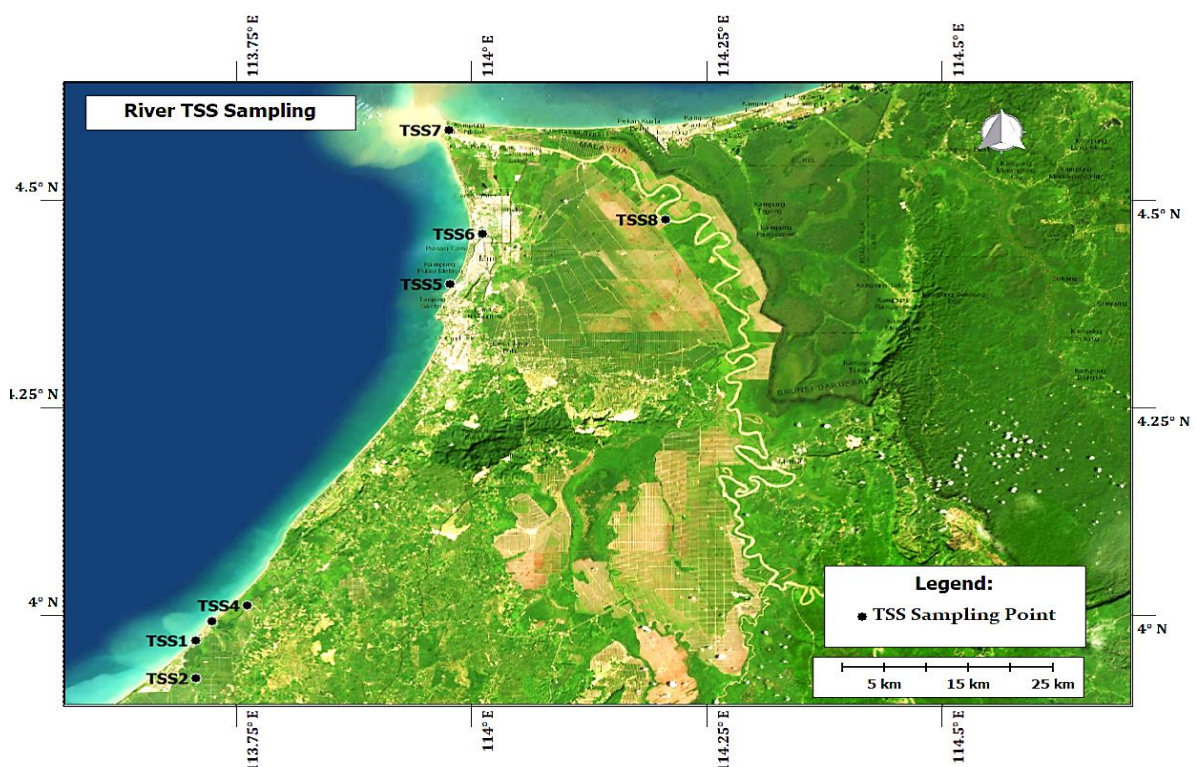


Figure 178: Map of TSS sampling point along Miri shoreline

Table 14: TSS Sampling at Pantai Miri for 1st phase

ID	X (°E)	Y (°N)	Depth (m)	TSS (mg/L)					
				0.2 D	TSS (mg/L)	0.6 D	TSS (mg/L)	0.8 D	TSS (mg/L)
TSS1	113.707166	3.968291	6.7	1.3	41	4.0	43	5.4	40
TSS2	113.707486	3.922962	7.2	1.4	20	4.3	22	5.8	22
TSS3	113.724982	3.991881	3.4	0.7	54	2.0	48	2.7	44
TSS4	113.762077	4.011143	8.4	1.7	19	5.0	17	6.7	18
TSS5	113.977962	4.399096	5.7	1.1	58	3.4	21	4.6	23
TSS6	114.011651	4.459376	5.5	1.1	13	3.3	8	4.4	9
TSS7	113.977143	4.585451	8.4	1.7	18	5.0	11	6.7	26
TSS8	114.205905	4.477067	9.7	1.9	9	5.8	13	7.8	12
MIN					9		8		9
MAX					58		48		44

Table 15: TSS Sampling at Pantai Miri for 2nd phase

ID	X (°E)	Y (°N)	Depth (m)	TSS (mg/L)					
				0.2 D	TSS (mg/L)	0.6 D	TSS (mg/L)	0.8 D	TSS (mg/L)
TSS1	113.707166	3.968291	6.5	1.3	53	3.9	52	5.2	49
TSS2	113.707486	3.922962	6.9	1.4	26	4.1	21	5.5	20
TSS3	113.724982	3.991881	3.2	0.6	49	1.9	49	2.6	45
TSS4	113.762077	4.011143	8.6	1.7	24	5.2	25	6.9	20
TSS5	113.977962	4.399096	5.5	1.1	48	3.3	45	4.4	43
TSS6	114.011651	4.459376	5.4	1.1	15	3.2	12	4.3	10
TSS7	113.977143	4.585451	8.2	1.6	24	4.9	20	6.6	18
TSS8	114.205905	4.477067	9.5	1.9	13	5.7	9	7.6	9
MIN					13		9		9
MAX					53		52		49

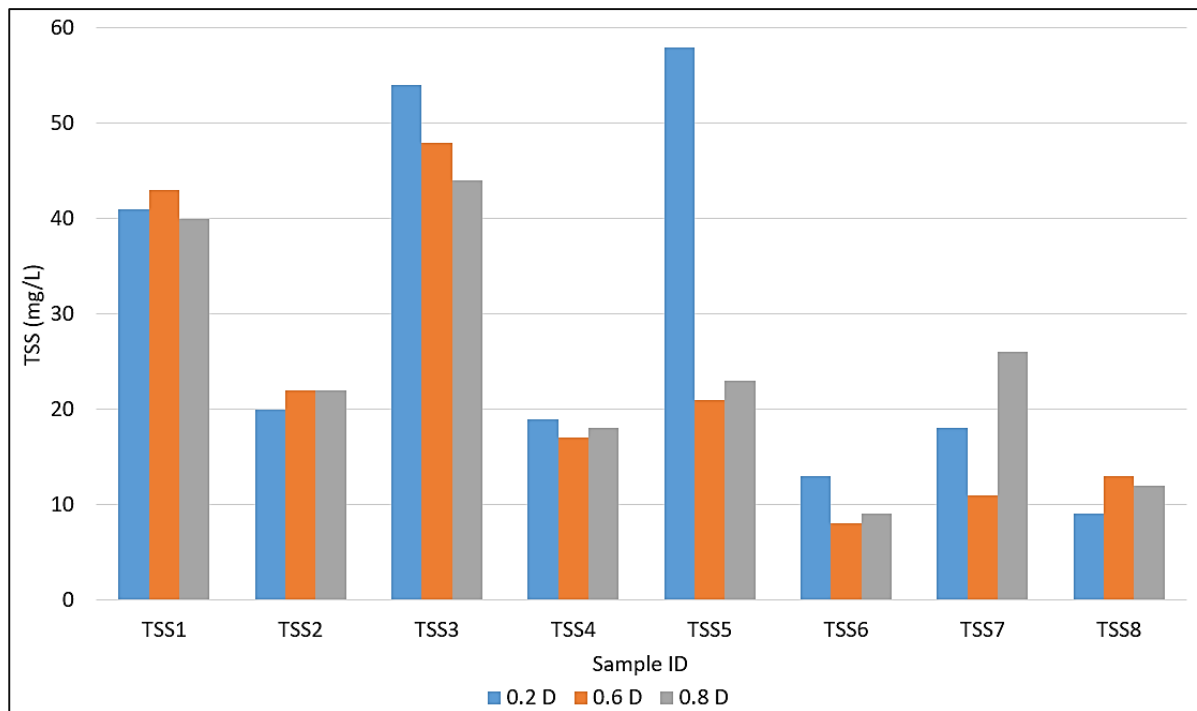


Figure 179: Chart bar plotting for 1st phase of TSS

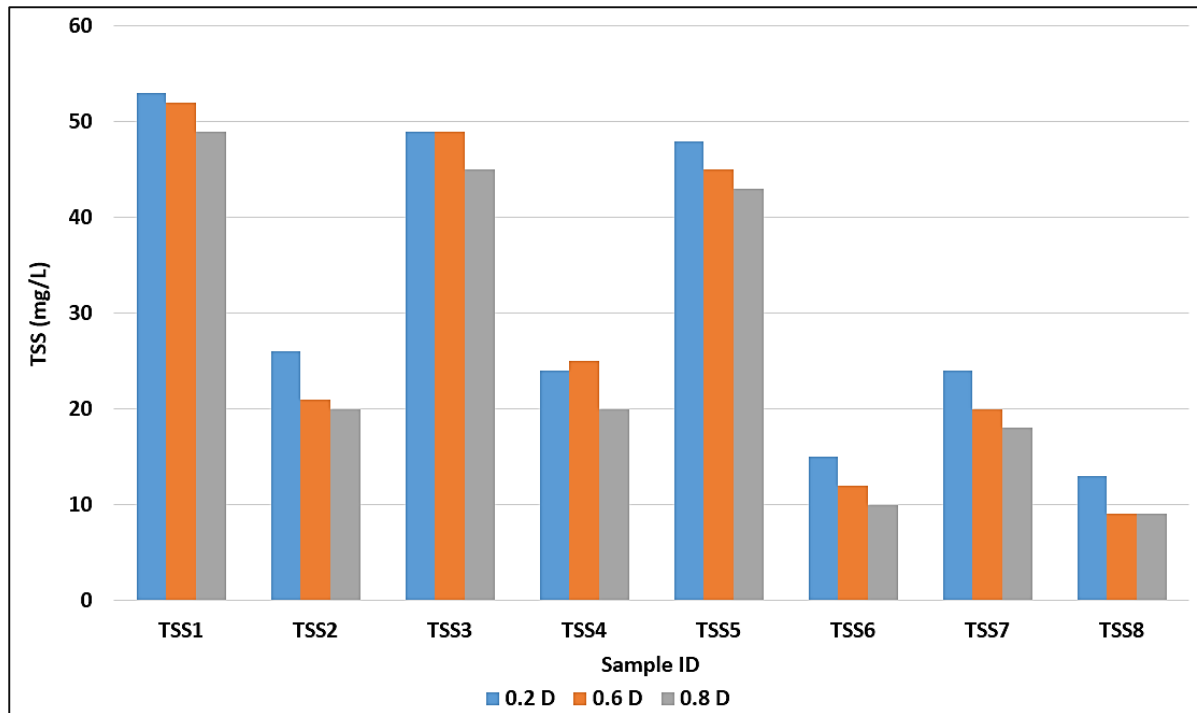


Figure 180: Chart bar plotting for 2nd phase of TSS

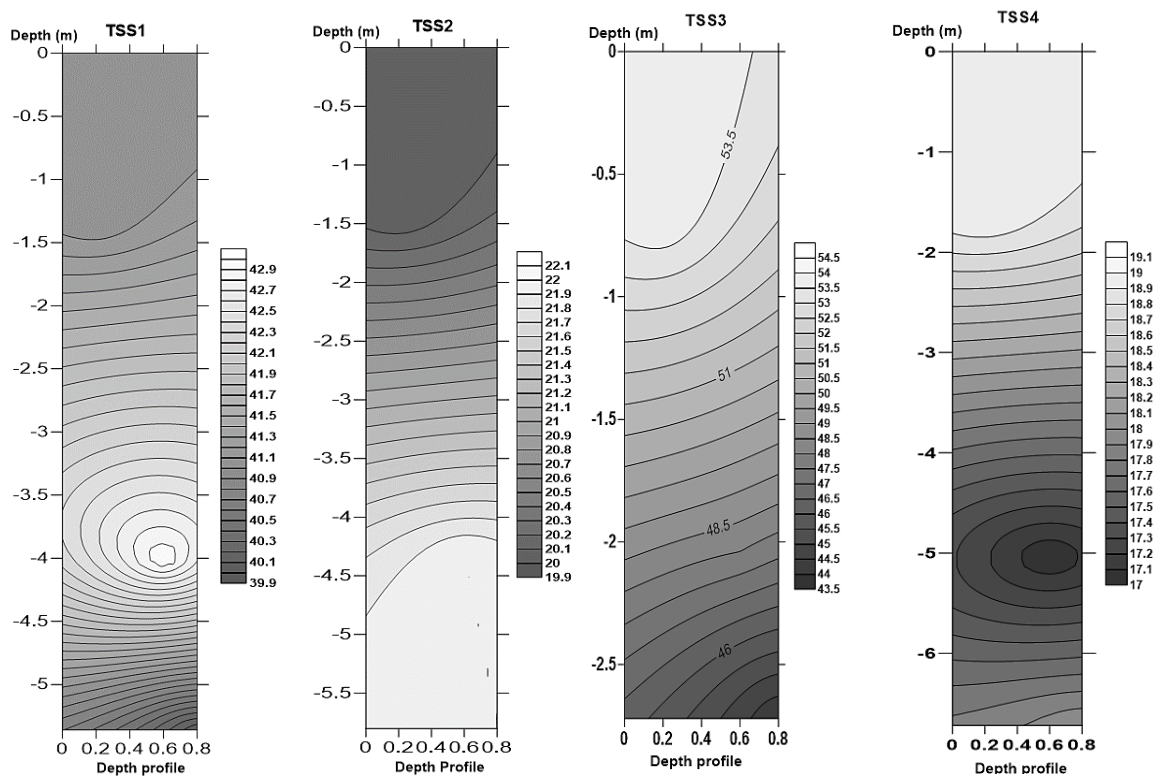


Figure 181: Plotting of the TSS sampling over the depth for TSS1 to TSS4

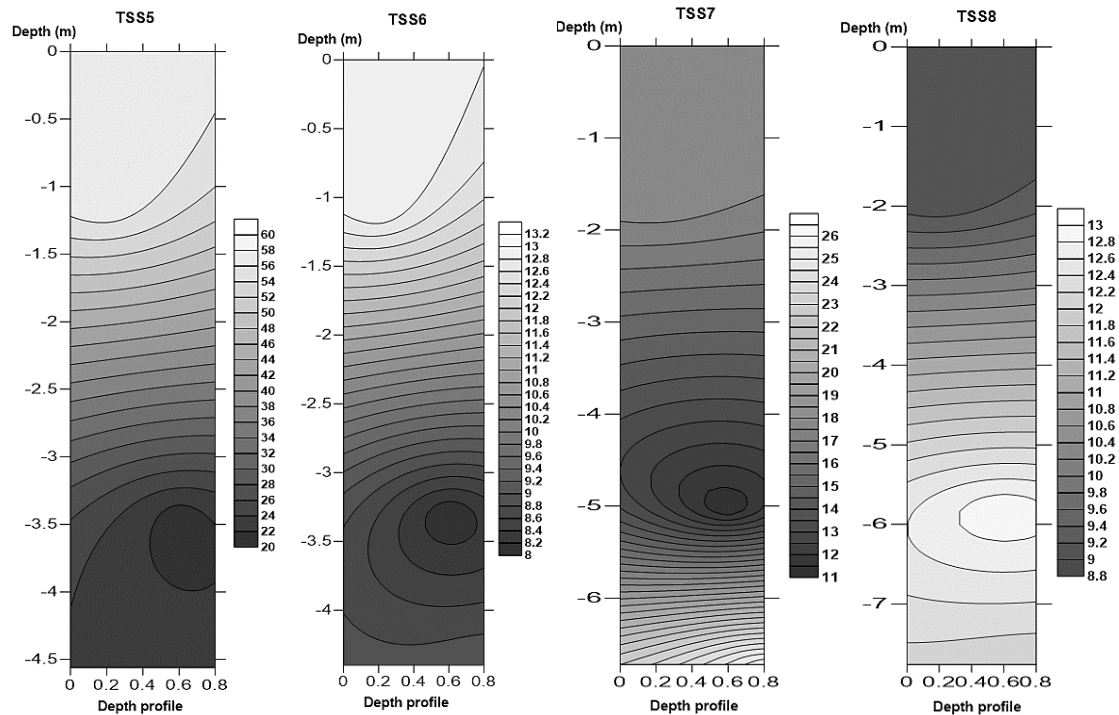


Figure 182: Plotting of the TSS sampling over the depth for TSS5 to TSS8

10. SUMMARY OF THE FINDINGS

The project scopes were achieved as planned and requirements. All the field measurement data were analysed and presented as shown. Current and water level measurement show that during Ebb and flood tide, both phase of ADCP-1 and 2 recorded that the current speed is in range 0.002-1.134 m/s and 0.001-0.965 m/s, while current direction is in range 30°-70°, 200°-250° and 20°-60°, 200°-250° respectively (Table 16). Nearshore and river bathymetry for both phase shown not much changes.

Table 16: Current and water level measurement

ID	1 st Phase				2 nd Phase			
	Current Speed		Current Direction		Current Speed		Current Direction	
	Max (m/s)	Min (m/s)	Ebb Tide	Flood Tide	Max (m/s)	Min (m/s)	Ebb Tide	Flood Tide
ADCP-1	1.134	0.002	30° – 70°	200° – 250°	1.134	0.002	30° – 70°	190° – 220°
ADCP-2	0.965	0.001	20° – 60°	200° – 250°	0.965	0.001	20° – 60°	200° – 240°

Tidal levels for each phase was surveyed and all the data has been shown as per requirement, as in summarize Table 17. Total Suspended Solid (TSS) analysis show that TSS 5 (0.2D) has higher value with 58 mg/L and TSS6 (0.6D) has lowest value with 8 mg/L (Table 18).

Table 17: Tidal level at 3 stations along Miri shore

ID	1 st Phase		2 nd Phase	
	Tidal varied (m)	Tidal range (m)	Tidal varied (m)	Tidal range (m)
TG1	-0.502 to 1.302	1.804	-0.404 to 1.231	1.635
TG2	-0.940 to 0.925	1.865	-0.510 to 1.1790	1.689
TG3	-0.682 to 1.173	1.855	-0.585 to 1.183	1.768

Table 18: Analysis of TSS sampling

	1 st Phase	2 nd Phase
Minimum	8 mg/L TSS 6 (0.6D)	9 mg/L TSS 8 (0.6D & 0.8D)
Maximum	58 mg/L TSS 5 (0.2D)	53 mg/L TSS1 (0.2D)

All 15 transects was surveyed from 100m inland until -10m CD depth as per requirement and from the survey found that the cliff of the shore start to build up from T3 and gradually increase of the cliff height till to T7. The summary findings of the wave measurement at Sg. Niah to Sg. Baram nearshore area can be describe as in Table 19.

Table 19: Nearshore wave measurement summary

	1 st Phase		2 nd Phase	
	ADCP 1	ADCP 2	ADCP 1	ADCP 2
Mean Wave Direction (°)	290 – 340	290 – 340	290 – 340	290 – 340
Significant Wave Height (m)	0.127 - 0.155	0.282 – 0.309	0.136 – 0.182	0.273 – 0.327

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