

KURSUS PEMODELAN HIDRAULIK BAGI PROJEK PEMBANGUNAN DI PANTAI DAN LUAR PANTAI

Pemahaman Parameter Utama di Pinggir Pantai

16 – 20 April 2018

Akar Beach Resort, Port Dickson

Sr. Dr. Khairul Nizam Abdul Maulud

Department of Civil & Structural Engineering/

Earth Observation Center (EOC)

Universiti Kebangsaan Malaysia

Coastal Hydrodynamics

Coastal
Structures
Designs

Why it is important to unravel the mysteries
regarding Coastal Hydrodynamic behavior?

Morphological
alteration and its
Assessment

Sediment
Transport



Coastal Hydrodynamics

Nearshore Currents

- Water motion caused by differences in water elevation.
- Causes: local wind, wind generated-wave, tidal and river discharges.
- Type: cross-shore current, long-shore current, rip current.

Offshore and Nearshore Waves

- Wave derive their energy from the wind.
- In deep waters, wave is confined to the vicinity of the surface, while in shallow waters, waves undergo transformation on the bottom area.
- Wave transformation in shallow water: wave shoaling, wave refracting, wave diffracting and wave breaking.
- Parameters: significant wave height (H_s), mean wave period (T_m), peak wave period (T_p) and mean wave direction (θ_m)

Tidal

- Created by the gravitation force of the moon and to a lesser extent the sun.
- When tide arise, called “floodtide”, when fall called “ebbtide”
- Type: *semi-diurnal* and *diurnal*
- Characteristic: microtidal, macrotidal and mesotidal

Coastal Modelling

Physical Model

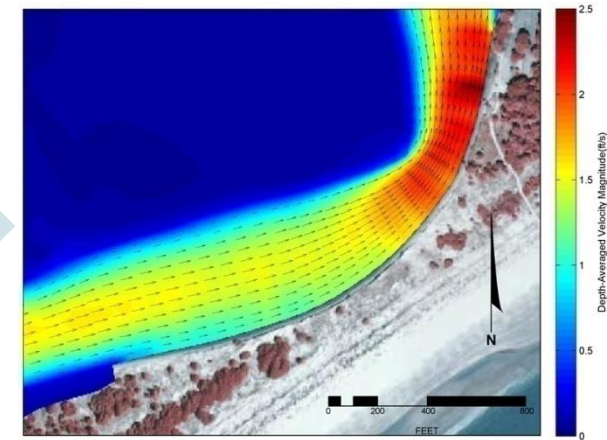
- Difficult in selecting appropriate scale,
- High cost,
- Randomness of natural phenomena,
- Non-availability of complete 3D-understanding of coastal hydrodynamic behaviour.



VS

Numerical Model

- Facilitate the hydraulic study with complex systems
- Can handle the irregular domain in the coastal water bodies
- Limited cost
- However, they need to be calibrated and validated against measure condition.



- ❖ **Numerical models have been under intensive development in the past 30 years, such as MIKE 21, ICEM, DELF** (*Rakha, 1998; Archetti & Zanuttigh, 2010; DHI, 2014; Nam et al., 2011*)
- ❖ **Based on previous study, MIKE 21 model by DHI has proved the accurate prediction of hydrodynamic characteristics** (*Eissa & Lebleb, 2015; Patra et al., 2015; Sravanthi et al., 2015*)

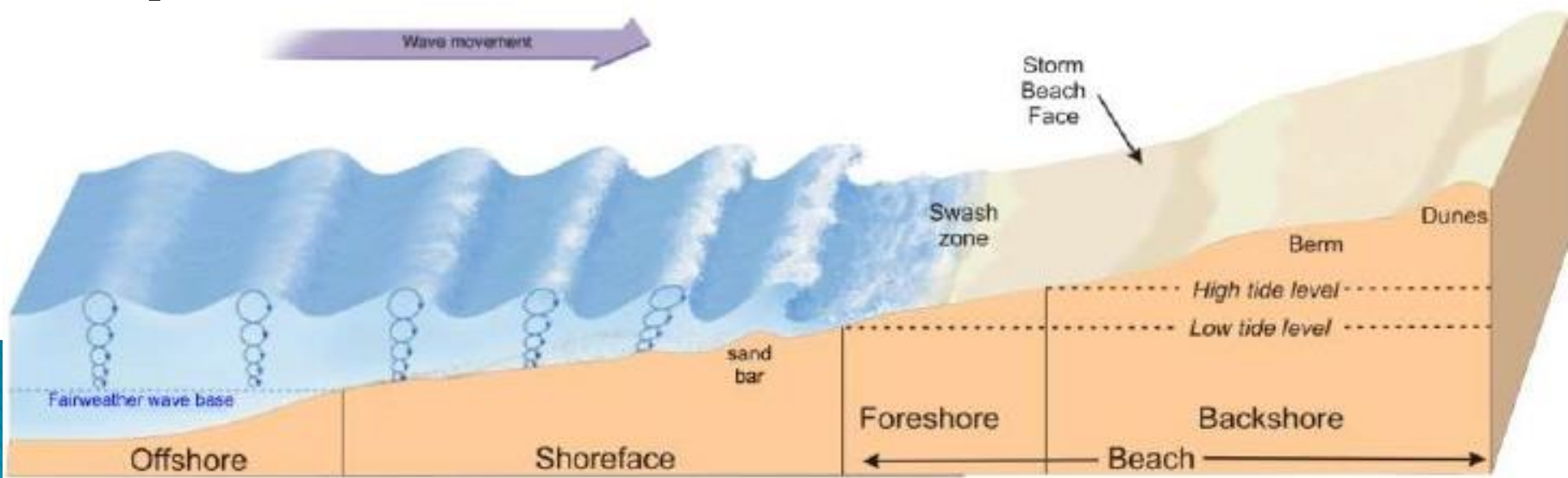
MIKE 21 Numerical Model

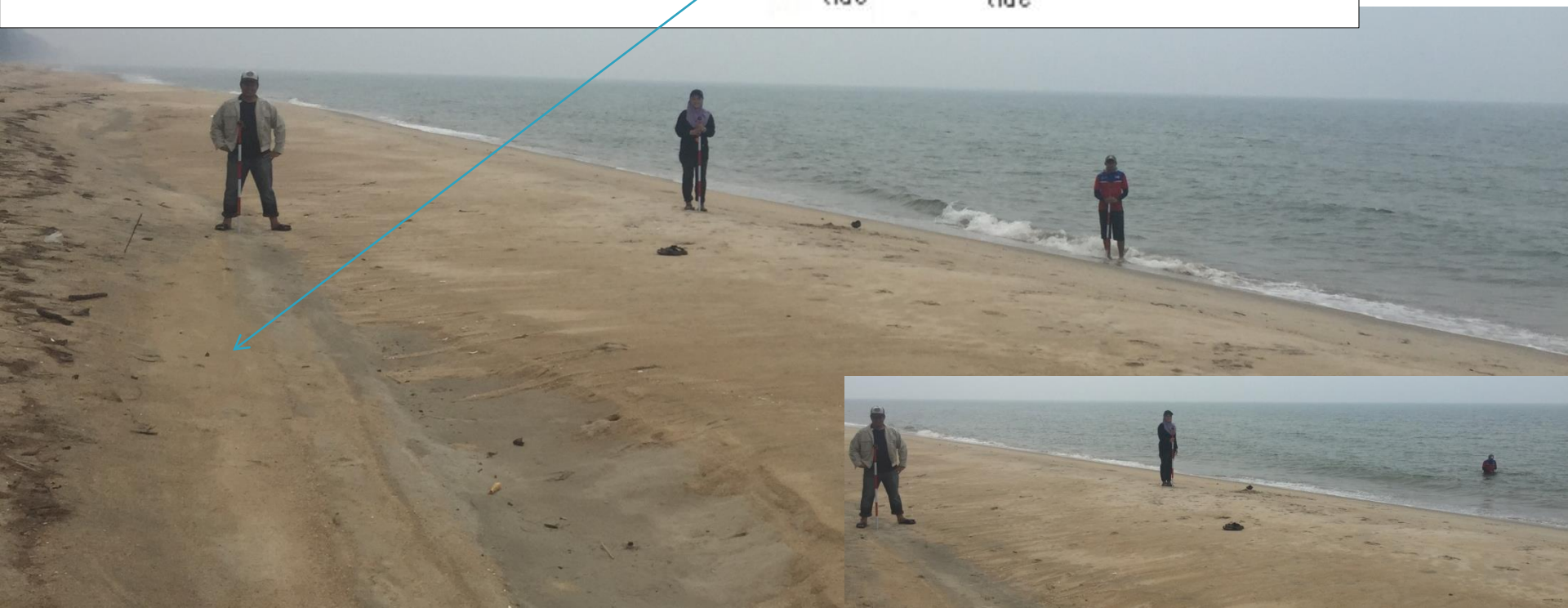
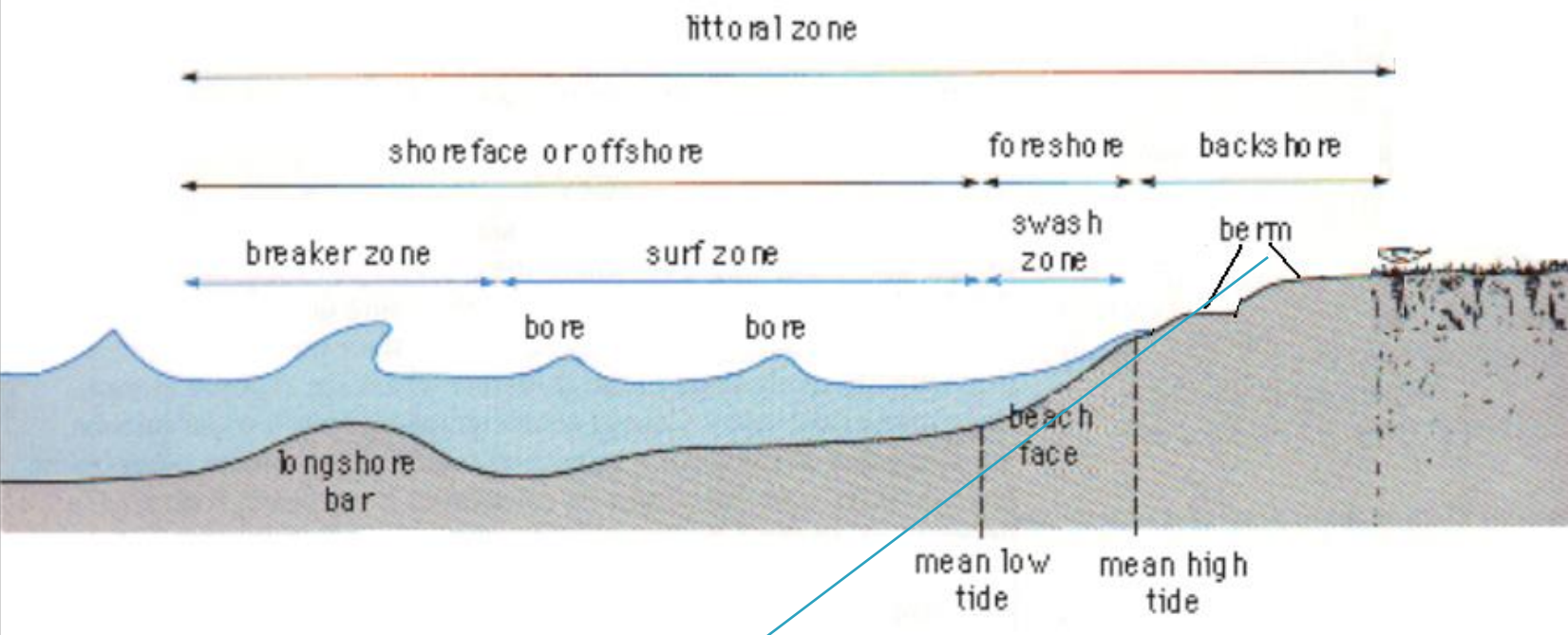
- ❖ Computer based program.
- ❖ Simulates flows, waves, sediments and ecology in rivers, lakes, estuaries, bays, coastal areas and seas in two dimensions.
- ❖ Developed by DHI (Danish Hydraulic Institute), Denmark
- ❖ Purposes:
 - Design data assessment for coastal and offshore structures
 - optimization of port layout and coastal protection measure structures
 - environmental impact assessment of marine infrastructures
 - coastal flooding and storm surge warnings

Coastal Zones



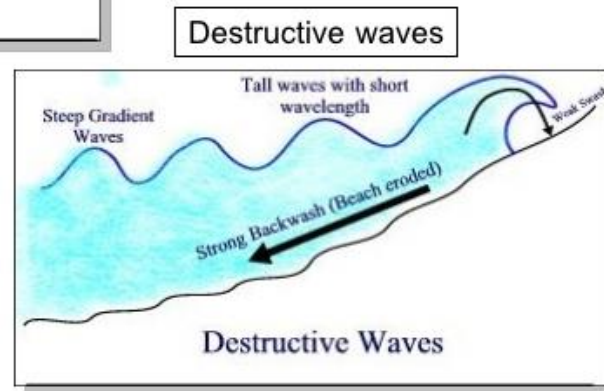
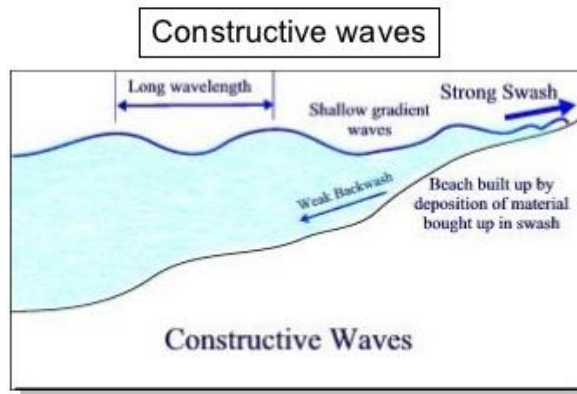
A beach is part of a coastal system, which includes several zones defined by their proximity to shore and the dominant processes that occurs within them.





Constructive & destructive waves

Constructive & destructive waves.



Coastal Zone

(Datum–Chart)

- ▶ Chart datums (CD) are used on nautical charts to reference water depths.
- ▶ Traditionally, bathymetric data has been collected relative to a survey (or sounding) datum, then translated to chart datum for storage and chart production.
- ▶ As a result, most legacy bathymetric depth data are relative to some local chart datum.
- ▶ The following is a listing of some chart datum definitions:
 - MLW Mean Low Water
 - MLLWLT Mean Lower Low Water Large Tide
 - MLLW Mean Lower Low Water
 - LNT Lowest Normal Tide
 - LLWLT Lower Low Water Large Tide
 - LAT Lowest Astronomic Tide (atmospheric and oceanographic effects minimized)

GLOSARI ISTILAH PASANG SURUT

Datum Carta, Datum Untuk Penyurutan
Pemeruman

CD

Air Surut Falak Terendah

LAT

Air Pasang Falak Tertinggi

HAT

Aras Laut Min

MSL

Air Surut Perbani Min

MLWS

Air Pasang Perbani Min

MHWS

Air Surut Anak Min

MLWN

Air Pasang Anak Min

MHWN

TIDAL GLOSSARY TERMS

*Chart Datum, Datum For
Sounding Reduction*

Lowest Astronomical Tide

Highest Astronomical Tide

Mean Sea Level

Mean Low Water Spring

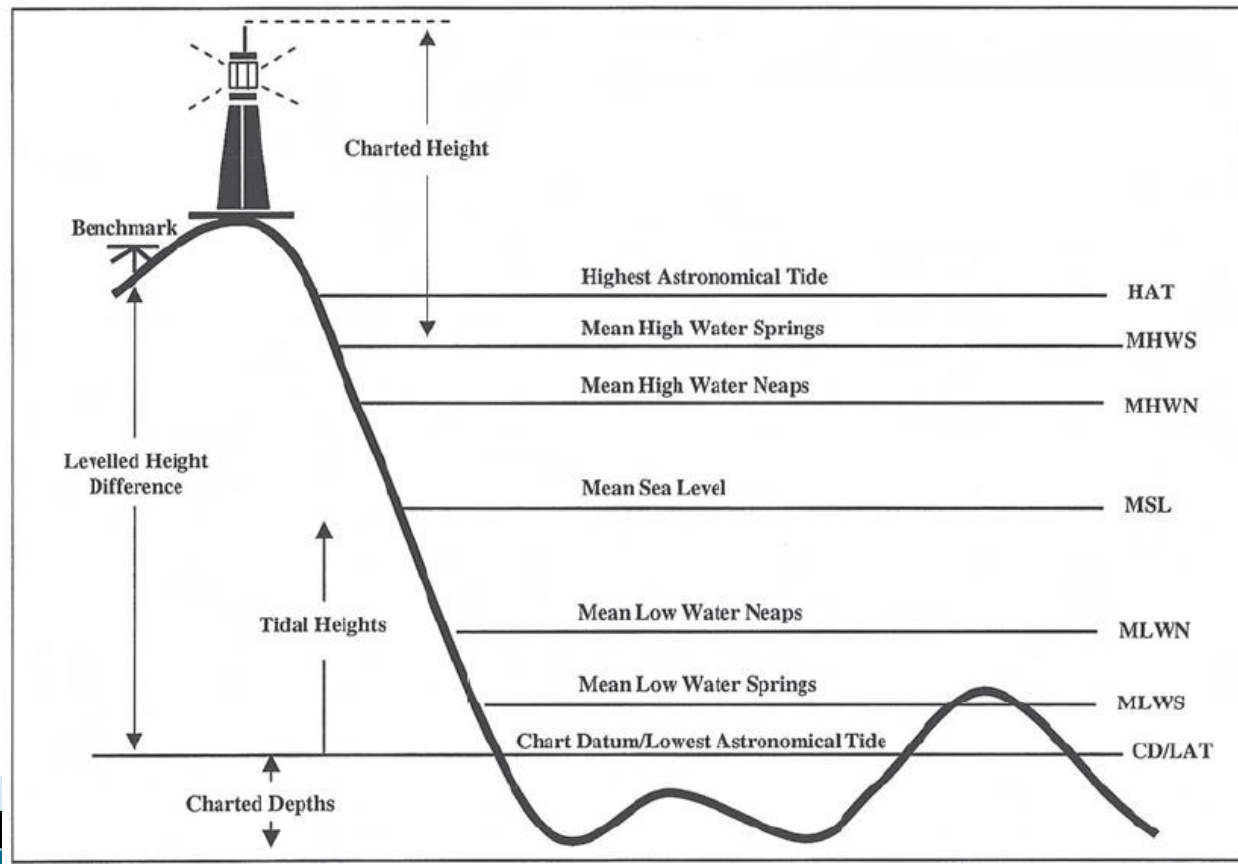
Mean High Water Spring

Mean Low Water Neaps

Mean High Water Neaps

Coastal Zone

(Higher Low Water (HLW))
(Mean Sea Level (MSL))
(Higher High Water (HHW))
Tidal Height



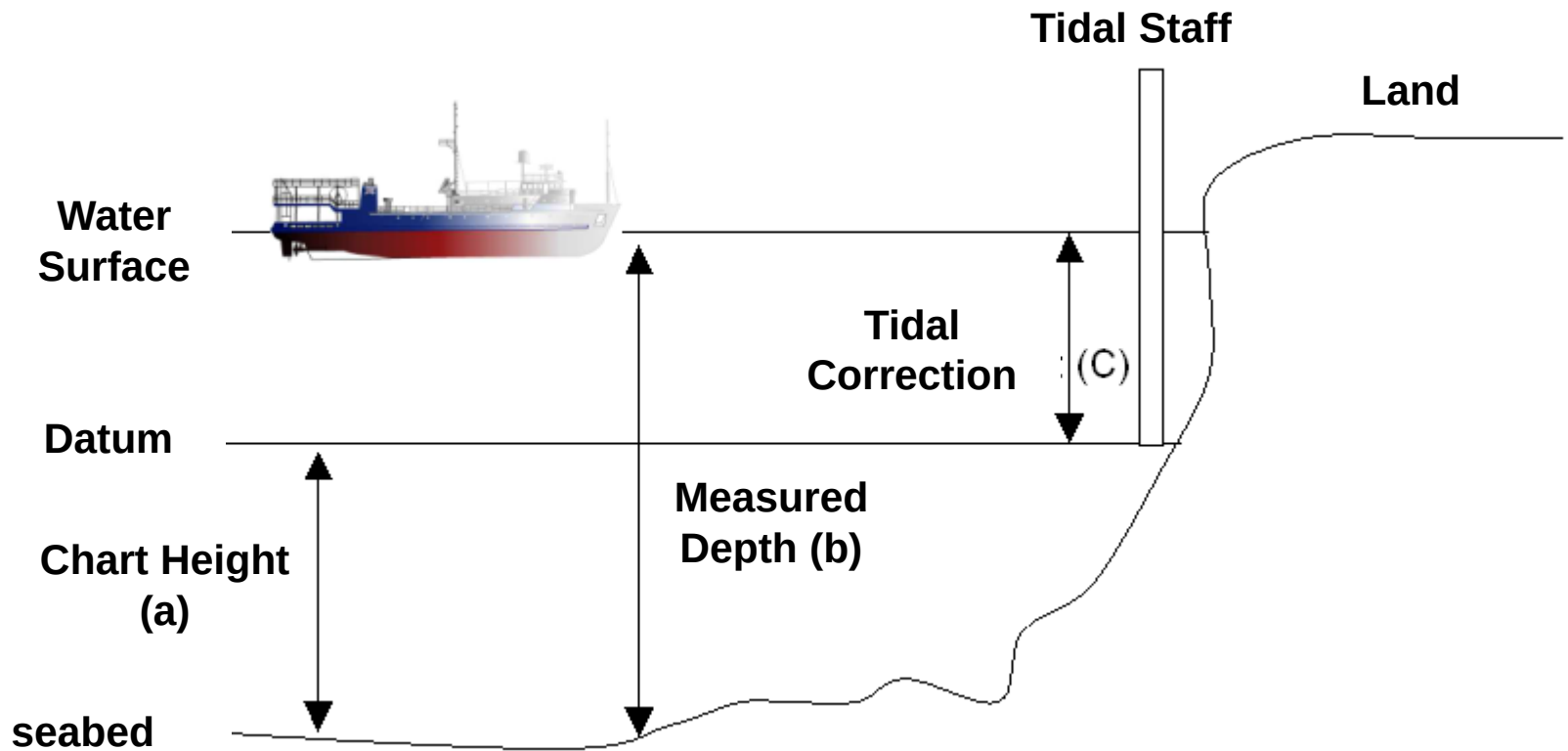


Diagram of Chart Datum

Coastal Zone (Coordinates)

- ▶ In this International Standard, a *coordinate* is one of *n* scalar values that define the position of a single point.
- ▶ In other contexts, the term *ordinate* is used for a single value and *coordinate* for multiple ordinates
- ▶ A *coordinate reference system* defines the coordinate space such that the coordinate values are unambiguous.

Coordinate

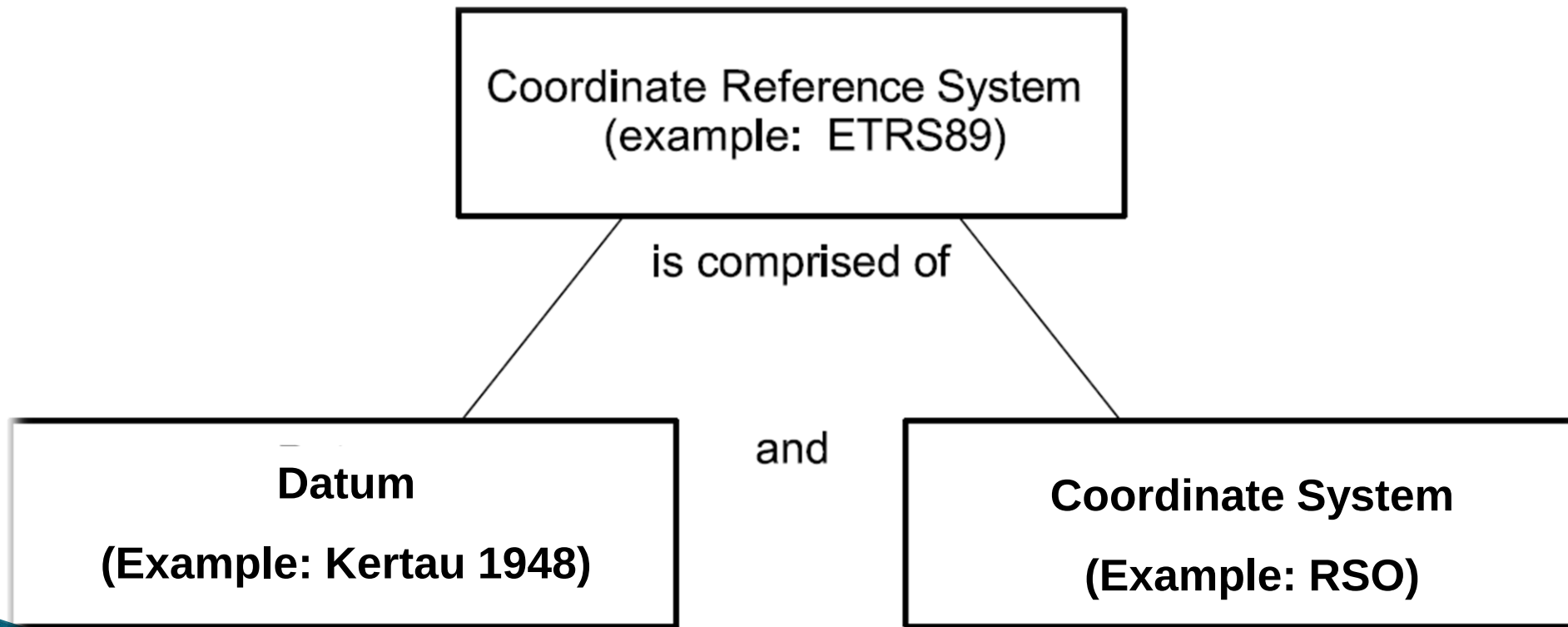


Figure 2 — Conceptual model of a coordinate reference system

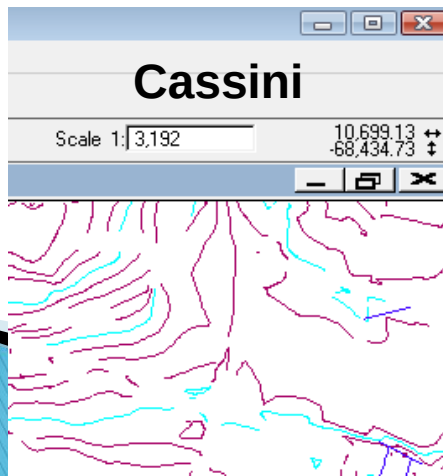


**Koordinat
Geometri
Bumi
(Lat-Long)**

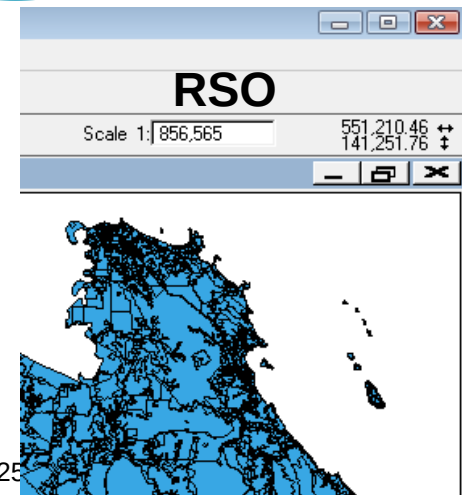
**Geocentric
Datum of
Malaysia
(GDM 2000)**

**Coordinate
System in
Malaysia**

**Rectified Skew
Orthomorphic
– RSO**

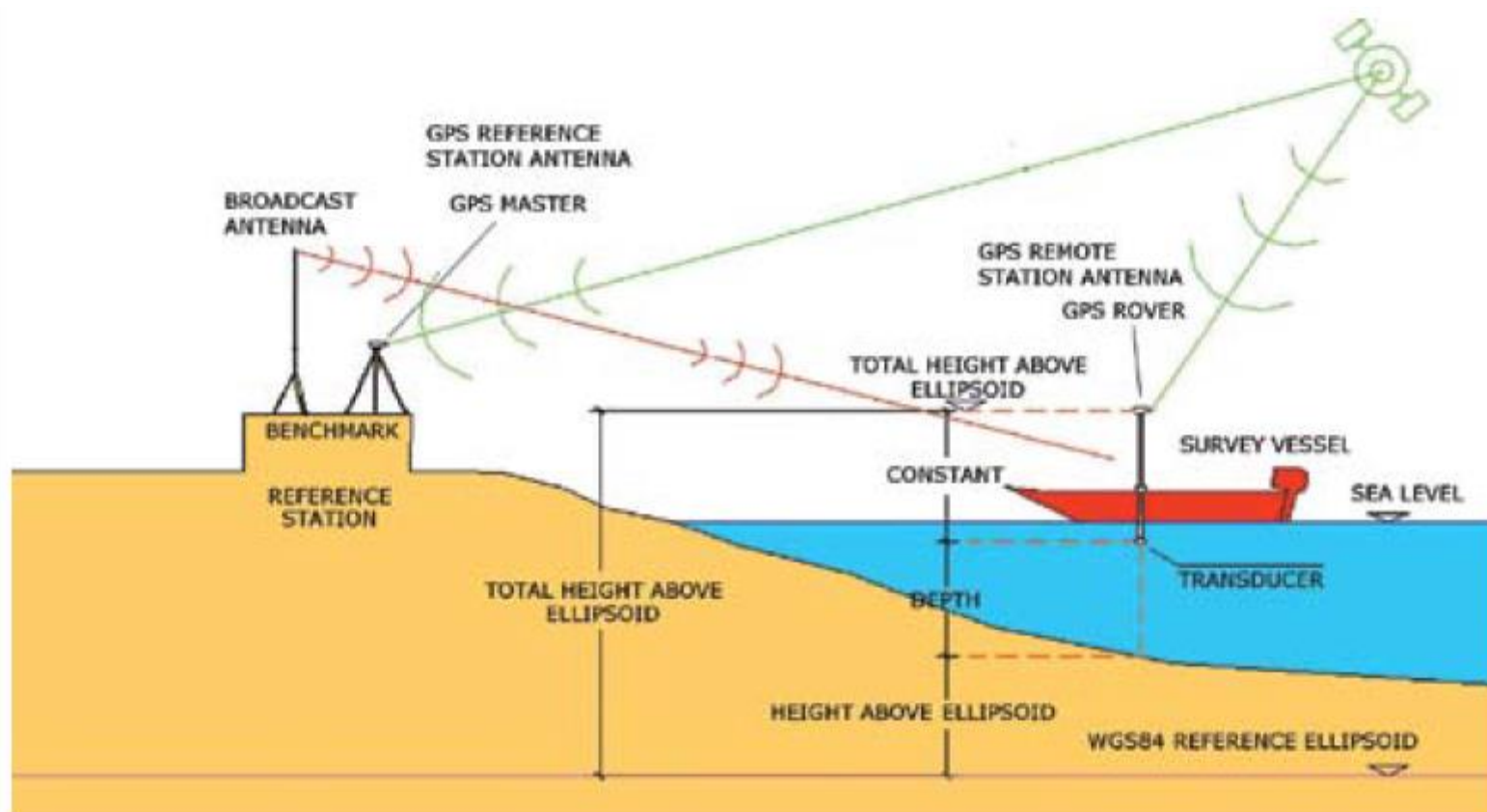


**Koordinat
Cassini-
Soldner**



Coastal Zone (WGS 1984/UTM)

- ▶ Basic technique using Differential GPS real-time for measurement the position of survey vessel



Coastal Zone

(WGS 1984/UTM)

- ▶ GPS readings of the roving antenna are given above a datum called the WGS84 (World Geodetic System 1984)

THE UNIVERSAL TRANSVERSE MERCATOR PROJECTION (UTM)

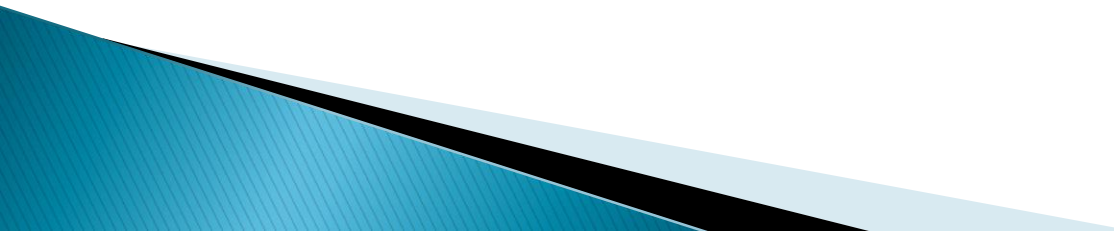
- ▶ UTM is a world-wide system of transverse Mercator projections based on the International Earth Ellipsoid 1924.
- ▶ It comprises about 60 zones, each 6° in longitude wide, with central meridian at 3°, 9°, etc. from zero meridian.
- ▶ The zones are numbered from 1 to 60, starting with 180° to 174° W as zone 1 and proceeding eastwards to zone 60.



Coastal Zone

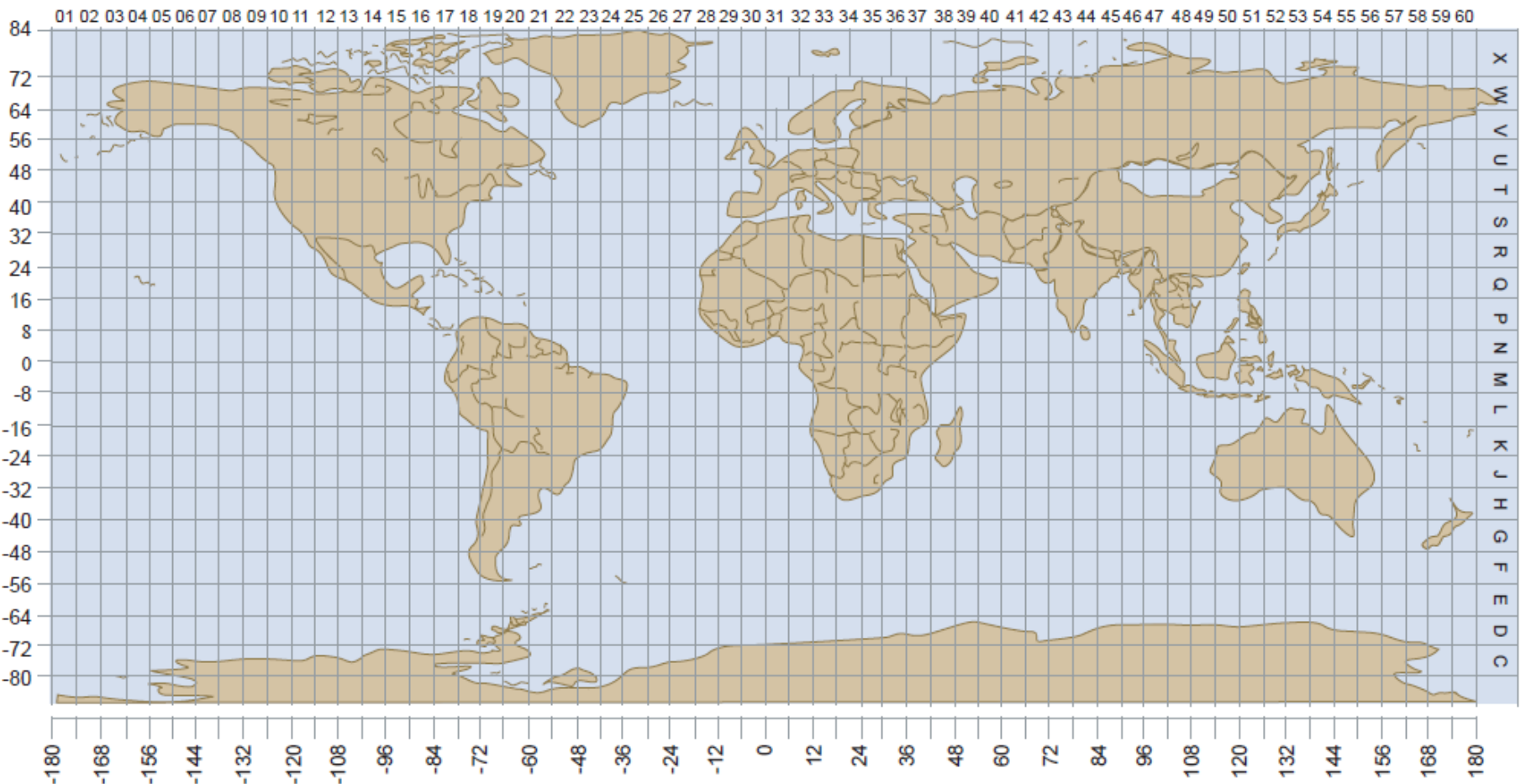
(WGS 1984/UTM)

THE UNIVERSAL TRANSVERSE MERCATOR PROJECTION (UTM)

- ▶ In latitude, the UTM system extends from 80° N to 80° S, with the polar caps covered by a polar stereographic projection.
 - ▶ The scale factor at each central meridian is 0.9996 to counteract the enlargement ratio at the edges of the strips.
 - ▶ The false origin of northings is zero at the equator for the northern hemisphere and 106 m south of the equator for the southern hemisphere.
 - ▶ The false origin for eastings is 5×10^5 m west of the zone central meridian.
 - ▶ Projection tables are available for the system and all NATO maps are based on it. However, as there is no continuity across the zones, one cannot compute between points in different zones.
- 

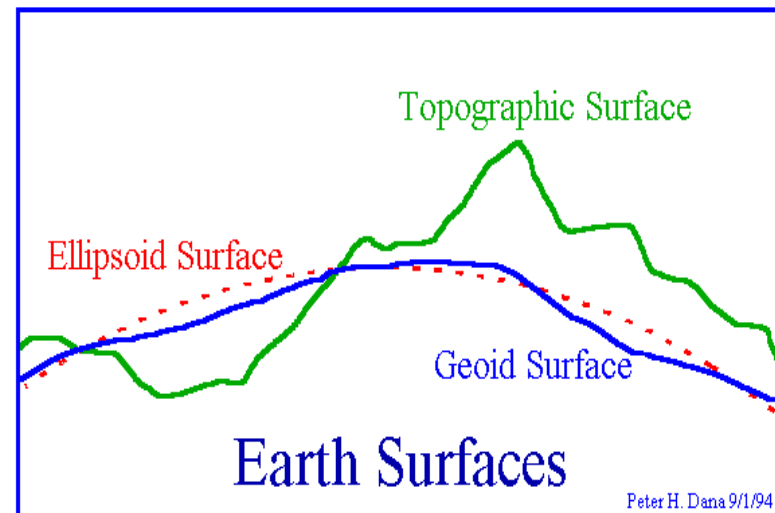
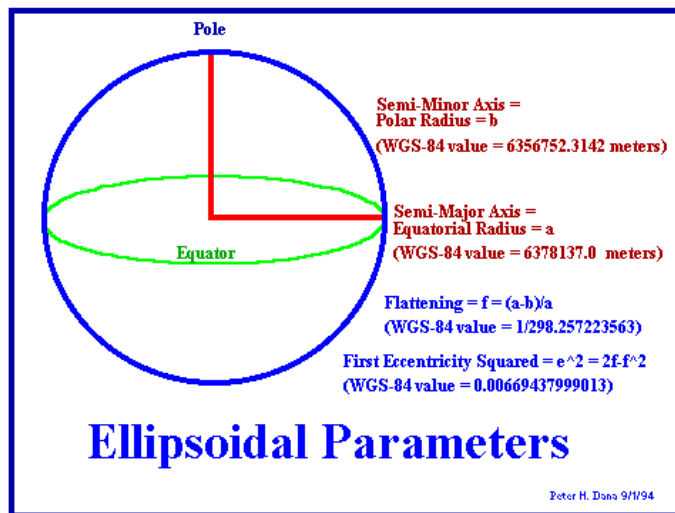
UTM Transverse Mercator (UTM) System

UTM Zone Numbers

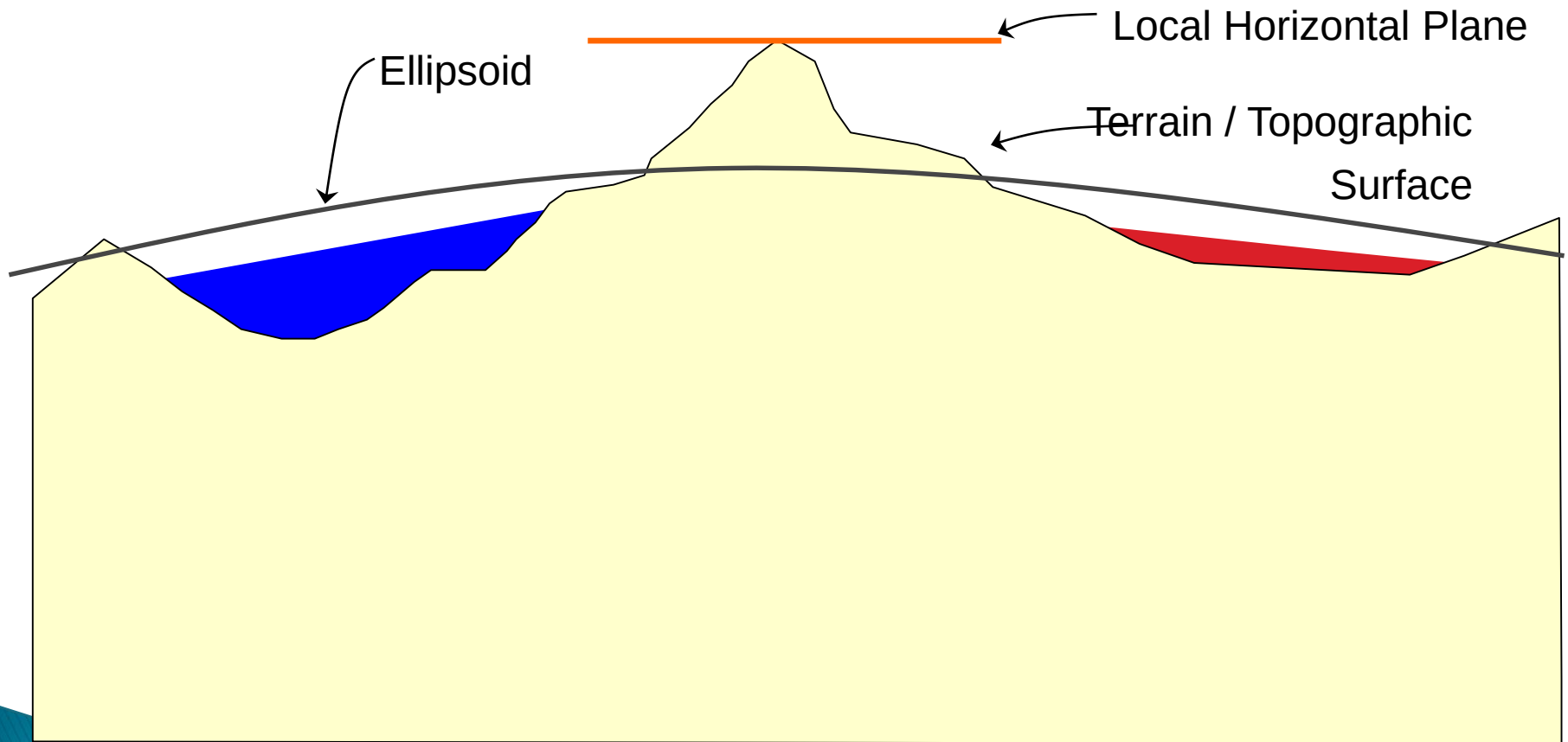


DATUM PEMETAAN

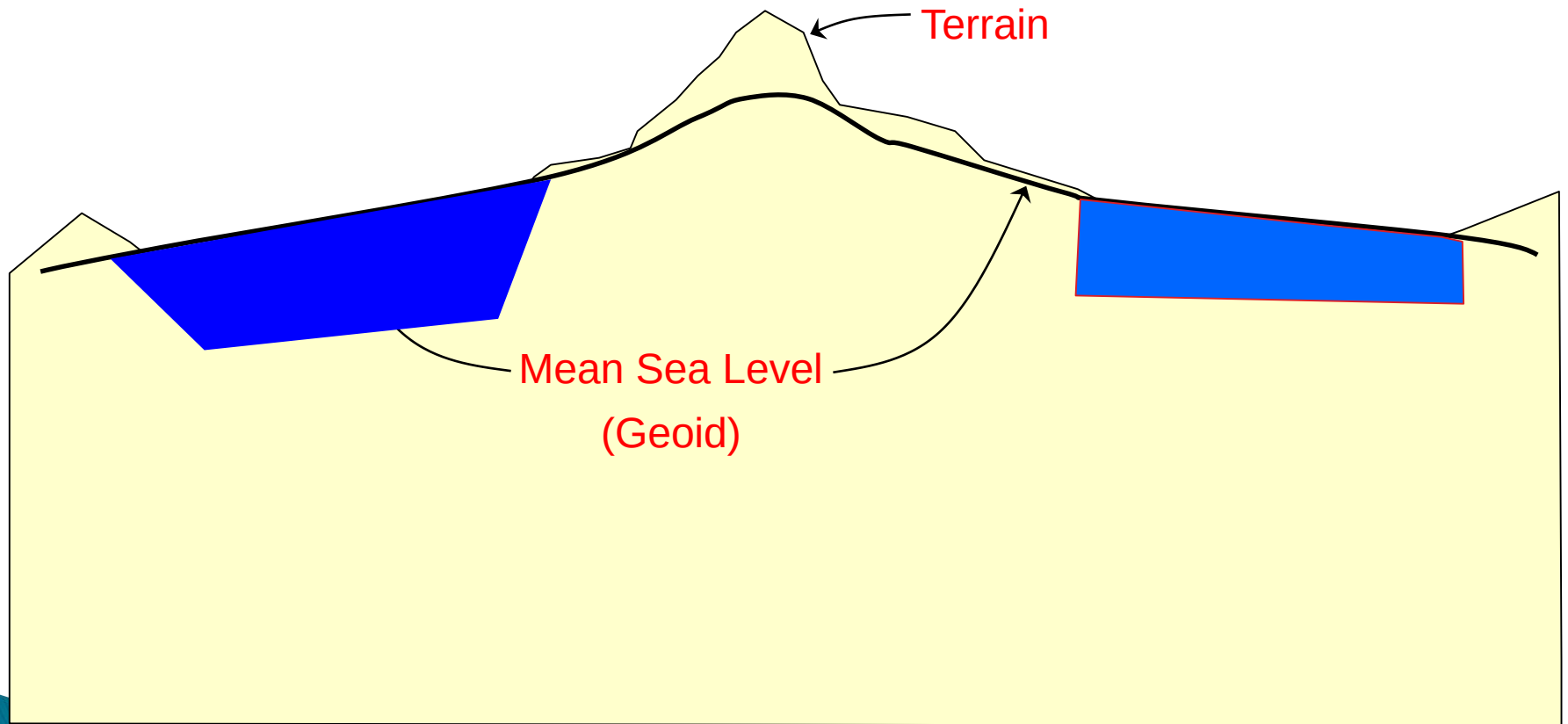
- ❑ Datum adalah sistem rujukan yang menerangkan saiz dan bentuk bumi.
- ❑ Datum telah berubah dari penggunaan sfera bumi kepada model ellipsoid terutamanya dengan adanya pengukuran dari satelit masakini.



Modeling the Earth



Modeling the Earth



Jenis-jenis Sistem Koordinat

- ❑ Bagi menentukan kedudukan sesuatu titik berbanding dengan titik-titik lain, konsep **arah** dan **jarak** biasanya digunakan.
- ❑ Ini dapat dilaksanakan dengan berbagai-bagai sistem, antaranya ialah:

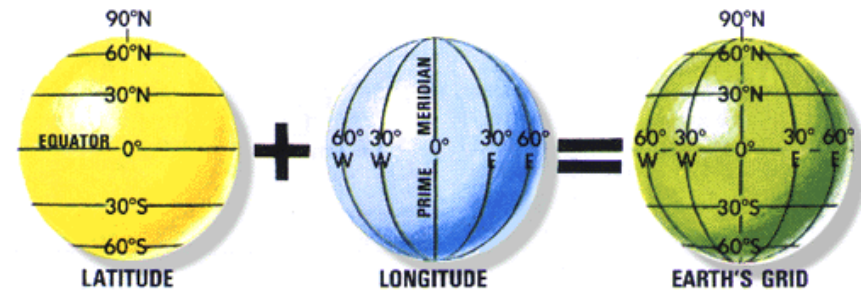
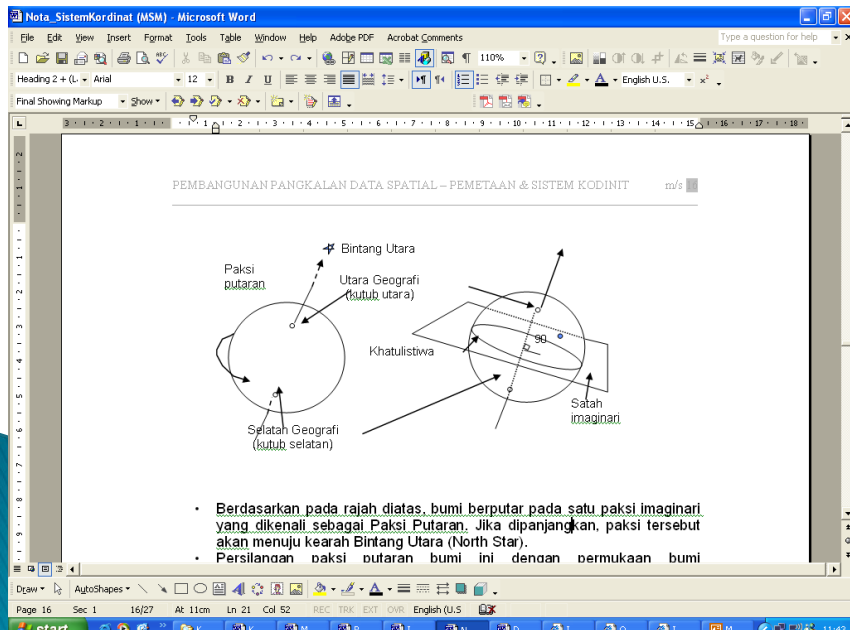
manusia primitif contohnya, menggunakan panduan pada matahari naik dan matahari jatuh, depan dan belakang, kiri dan kanan, dsb dalam menentukan arah manakala jarak pula dinyatakan seperti masa bergerak dari satu tempat ketempat yang lain.

- ❑ Walau bagaimanapun, satu sistem yang lebih universal perlu dibina dan dikaitkan dengan satu rujukan yang unik atau sebagai titik permulaan.
- ❑ Dengan yang demikian, apabila sesuatu titik diketahui kedudukannya, maka kedudukan titik-titik lain akan dapat ditentukan berdasarkan pada arah dan jarak daripada titik tersebut.

Jenis-jenis Sistem Koordinat –

1) Koordinat Geometri Bumi (Lat-Long)

- ❑ Konsepnya menyamai dengan sistem koordinat satah tetapi koordinat geometri bumi lebih kompleks kerana bentuknya adalah sfera
- ❑ Penentuan lokasi pada bumi boleh dilakukan dengan membuat ukuran sudut berdasarkan pada skala *sexagesimal* iaitu pembahagian bulatan kepada 360 darjah ; 1 darjah kepada 60 minit dan 1 minit kepada 60 saat.



Jenis-jenis Sistem Koordinat –

2) Sistem Koordinat Bentuk Benar Serong Di Tepat (*Rectified Skew Orthomorphic* - RSO)

- ❑ Sistem koordinat RSO diasaskan kepada Unjuran BBST atau RSO yang digunakan dalam pemetaan topografi negara Malaysia. Unjuran RSO ini merupakan kelas unjuran 'ellipsoidal oblique Mercator' yang dicipta oleh Martin Hotine pada tahun 1947.
- ❑ Unjuran ini bersifat *Conformal* yakni mengekalkan ciri-ciri samabentuk yang sesuai digunakan bagi negara-negara yang kedudukannya senget memanjang seperti Semenanjung Malaysia, New Zealand dan Itali.
- ❑ Hotine, Direktorat Pemetaan Koloni di Teddington, England, telah menyediakan jadual-jadual bagi unjuran BBST untuk Malaya. Jadual-jadual tersebut telah digunakan sehingga kini oleh JUPEM.
- ❑ Sistem koordinat RSO telah digunakan sebagai Grid Rujukan Kebangsaan – sistem grid asas yang digunakan untuk pemetaan Semenanjung Malaysia.

Jenis-jenis Sistem Koordinat - Sistem Koordinat Bentuk Benar Serong Di Tepat (*Rectified Skew Orthomorphic* - RSO) - samb

Parameter Datum RSO

Ellipsoid = Modified everest

semi-major – $a = 6377304.063\text{m}$

pejakan – $f = 1/300.8017$

Origin = Kertau, Pahang **latitud $3^{\circ} 27' 54''.18 \text{ U}$,
Long $102^{\circ} 37' 13''.63 \text{ T}$**

Had unjuran :

Utara - Latitud 8° U

Timur - Meridian $104^{\circ} 30' \text{ T}$

Selatan- Latitud 1° U

Barat - Meridian $99^{\circ} 30' \text{ T}$

Parameter Unjuran

Unit pengukuran : Rantai 1 rantai = 20.11678249 meter

Koordinat ambilan unjuran : 40,000 rantai T, 0 rantai U

Garis awal unjuran : melalui origin pada azimut $323^{\circ} 01' 32''.8458$

Faktor skala di origin (kawasan garis awal) = 0.99984



Jenis-jenis Sistem Koordinat –

3) Koordinat Cassini-Soldner

- ❑ Pemetaan Kadaster pula meliputi semua aktiviti pengukuran bagi penghasilan Pelan-Pelan Akui atau Certified Plan (CP) ataupun Syit Piawai (Standard Sheet) bagi tujuan pentadbiran dan pengurusan hakmilik tanah di Malaysia.
- ❑ Unjuran yang digunakan bagi pemetaan kadaster ini ialah Unjuran Cassini-Soldner.
- ❑ Unjuran Cassini-Soldner adalah bersifat jarak-sama atau *equidistance projection*. Umumnya, unjuran ini mengekalkan jarak pada satu arah sahaja (biasanya arah Timur-Barat) manakala arah Utara-Selatan akan mengalami herotan apabila berjauhan dari origin.

Jenis-jenis Sistem Koordinat - Koordinat Cassini-Soldner - *samb*

- ❑ Di Semenanjung Malaysia, terdapat sepuluh (10) sistem koordinat Cassini Soldner yang dapat di bahagikan kepada tiga sistem yang berbeza.
- ❑ Setiap sistem ini mempunyai origin yang berbeza serta terpisah antara satu dengan yang lain. Tiga sistem ini ialah :
 1. Sistem Malayan Revised Triangulation (MRT): bagi negeri-negeri Kelantan, Trengganu dan sebahagian dari Perak.
 2. Sistem ASA : bagi negeri-negeri Johor, Negeri Sembilan, Melaka, Pahang dan Selangor.
 3. Sistem PERAK : bagi negeri-negeri Pulau Pinang, Kedah, Perlis dan Perak Utara.

Jenis-jenis Sistem Koordinat –

4) GEOCENTRIC DATUM OF MALAYSIA (GDM 2000)

- ❑ Sejak tahun 1879. sistem koordinat negara telah melalui beberapa peringkat pembaharuan.
- ❑ Bermula dengan sistem Perak dan Sistem Asa, rangkaian ukur yang dikenali sebagai *Malayan Revised Triangulation* (MRT) di Semenanjung Malaysia dan *Borneo Triangulation* 1968 (BT 68) di Sabah dan Sarawak, telah diwujudkan hasil daripada pelarasan semula ke atas *Repsold Triangulation*.
- ❑ Walau bagaimanapun, sistem koordinat tersebut masih menggunakan datum lama yang berasaskan kepada *Elipsoid Modified Everest* dengan titik asalan (origin) di Kertau bagi Semenanjung Malaysia dan Timbalai bagi Sabah dan Sarawak.
- ❑ Datum MRT dan BT 68 adalah bersifat tempatan dan tidak selari dengan moden global yang digunakan pada masa kini.

Jenis-jenis Sistem Koordinat - GEOCENTRIC DATUM OF MALAYSIA (GDM 2000)

- ☐ Kerbanyakan negara maju pada masa ini menggunakan WGS84 sebagai datum bagi memudahkan integrasi data spatial.
- ☐ Pada masa ini, data ukuran GPS (koordinat) di padang perlu melalui proses transformasi sebelum dapat digabungkan dengan data spatial sedia ada.
- ☐ Bagi mengatasi permasalahan ini, pada Ogos 2003, JUPEM telah memperkenalkan datum baru bagi Malaysia yang dikenali sebagai *Geocentric Datum of Malaysia* atau GDM2000.
- ☐ Datum ini adalah berasaskan datum WGS84 yang mempunyai origin di pusat bumi dan bersifat global.
- ☐ Ini akan menjadi asas rujukan kepada data spatial dan sistem koordinat bagi pemetaan negara Malaysia pada masa hadapan.

Jenis-jenis Sistem Koordinat – GEOCENTRIC DATUM OF MALAYSIA (GDM 2000)

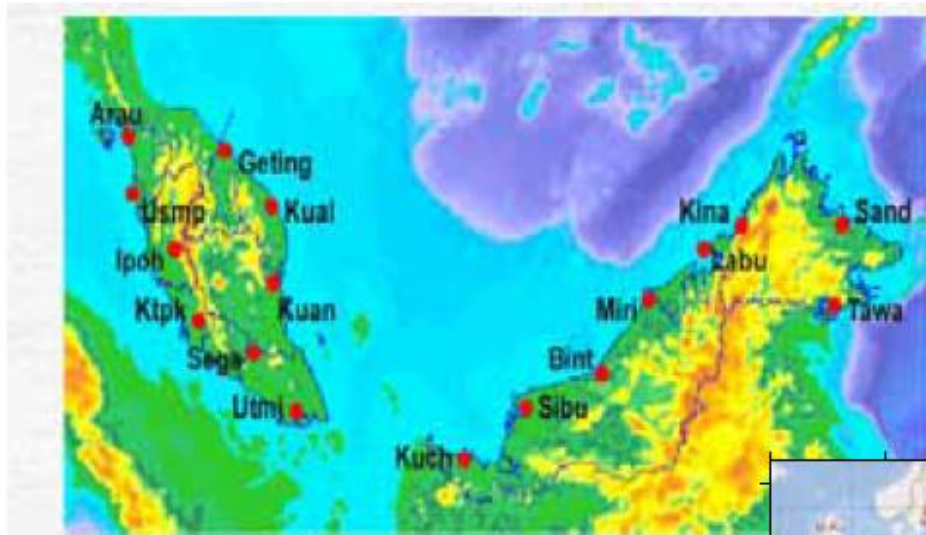
Mengapa Geocentric Datum ?

- ❑ Penggunaan sistem penentu kedudukan menggunakan satelit yang meluas
- ❑ Datum sedia ada tidak seragam
- ❑ Datum sedia ada melebihi daripada satu (RSO dan Cassini)
- ❑ Sesuai dengan penggunaan dan cadangan di peringkat international (global)
- ❑ Secara definisinya, *Geocentric datum* adalah satu sistem yang mempunyai origin (0,0,0) yang bertemu dan bersepadan (coincide) dengan pusat bumi.

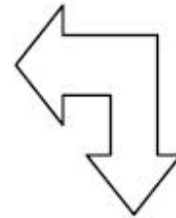
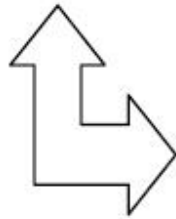
Features of GDM 2000

- ▶ GDM 2000 is defined by the coordinates of the seventeen (17) MASS stations. They are
 - referred to the following parameters for the GRS 80 ellipsoid and within ITRF 2000 at
 - epoch 2nd January 2000. The salient features of the National Geocentric Datum (GDM
 - 2000) are:
 - Defined by the coordinates of seventeen (17) MASS stations.
 - Referred to the following parameters:
 - $a = 6,378,137$ meters
 - $1/f = 298.257222101$

► Permanent GPS Stations Utilised in the Derivation of GDM 2000



MASS Stations



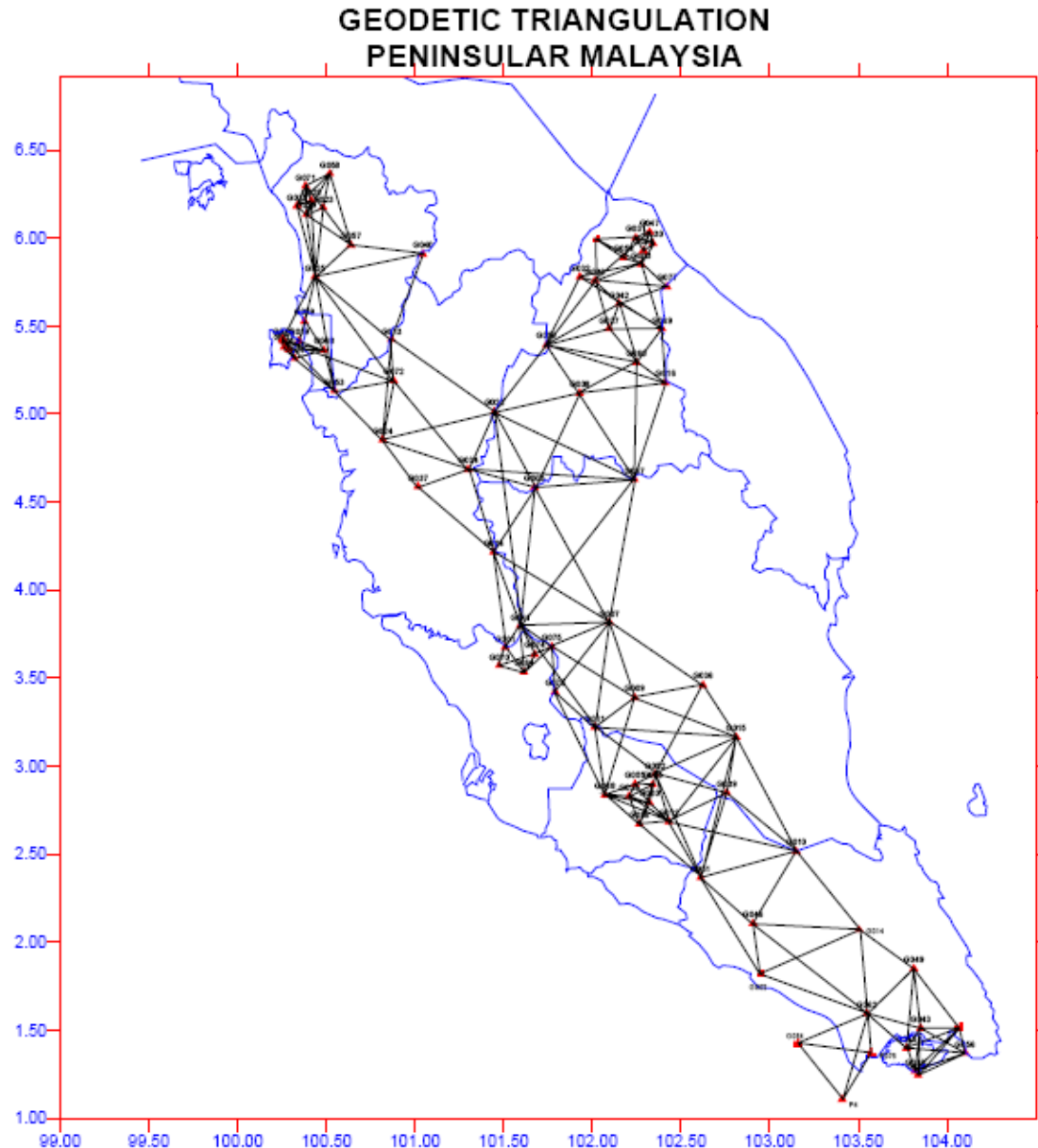
IGS Stations

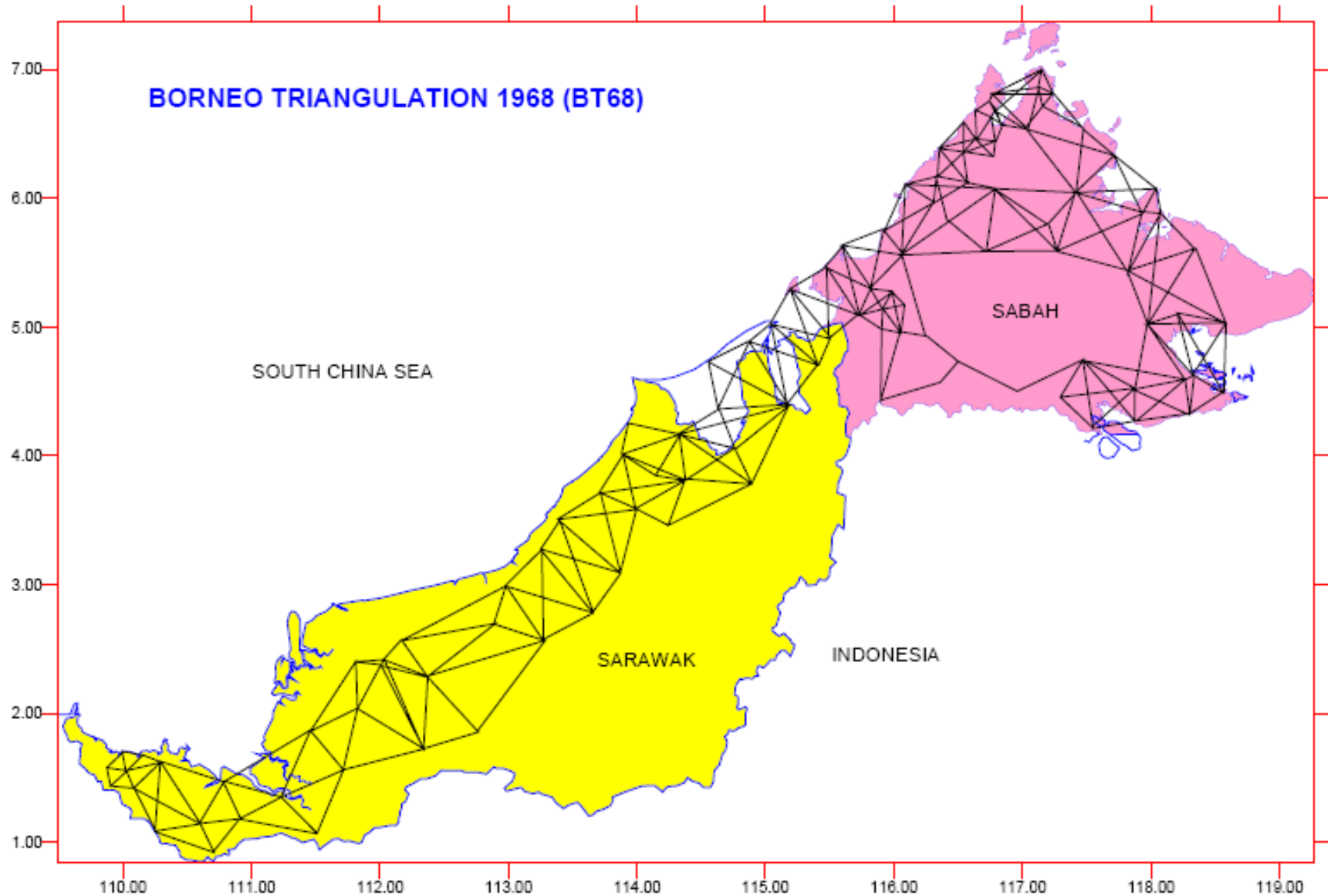


Malaysia Active GPS Stations (MASS)



► Triangulation Networks: Peninsular Malaysia





KURSUS PEMODELAN HIDRAULIK BAGI PROJEK PEMBANGUNAN DI PANTAI DAN LUAR PANTAI

Parameter Utama Hidraulik

Sr. Dr. Khairul Nizam Abdul Maulud
Department of Civil & Structural Engineering/
Earth Observation Center (EOC)
Universiti Kebangsaan Malaysia

Numerical Model (Model Berangka)

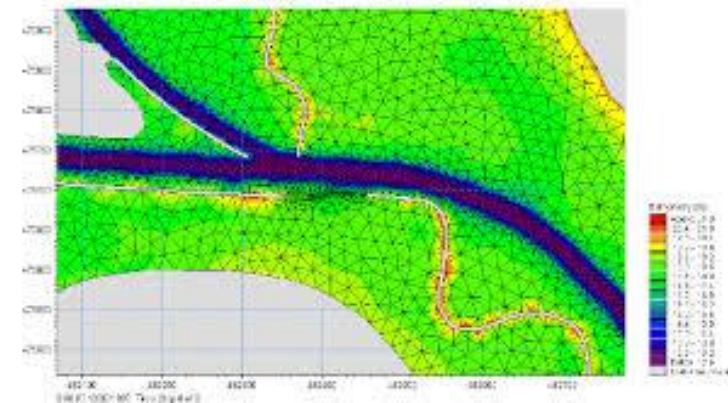
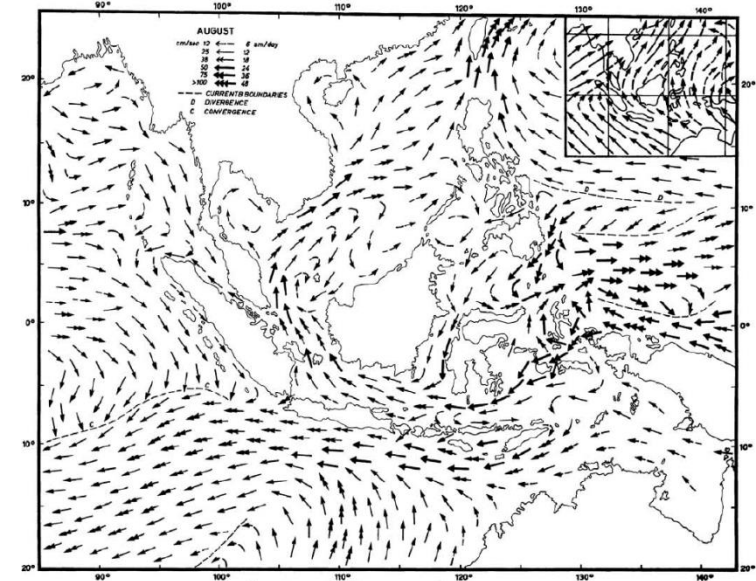
- ▶ Pemerhatian & Pencerapan perlu dijalankan untuk menyiasat keadaan sedia ada di satu-satu kawasan.
- ▶ Tujuan model berangka adalah untuk **mengkaji dan menganalisis ciri-ciri hidrodinamik** dan juga untuk menghasilkan **peta banjir**.
- ▶ Pembangunan pesat boleh menukar jumlah sedimen yang dihantar ke kawasan pantai, menghasilkan hakisan, dan menghapuskan tanah lembap.
- ▶ Oleh sebab itu, pengumpulan data marin perlu mengenalpasti parameter hidrodinamik yang terdiri daripada **BATIMETRI, PASANG SURUT, ANGIN, OMBAK, ARUS** dan **SEDIMEN (kualiti air)**.
- ▶ Semua data yang diperolehi digunakan untuk tujuan pemodelan hidrodinamik dengan menggunakan perisian hidrodinamik seperti MIKE 21 yang dibangunkan oleh DHI.
- ▶ Terdapat beberapa model yang berbeza boleh dijalankan seperti Model hidrodinamik (HD), Model spektrum gelombang (SW).

Tujuan permodelan hidrodinamik

- ▶ Tujuan penilaian hidrodinamik adalah untuk **mensimulasikan daya hidrodinamik** di pinggir pantai dan kawasan-kawasan luar pesisir untuk melihat senario semasa dan masa depan dengan mengambil kira peningkatan paras laut , bagi tujuan menilai kesan kenaikan aras laut.
- ▶ Terdapat pelbagai perisian komersial yang terdapat untuk menjalankan simulasi hidrodinamik pantai seperti Delft 3D (Model Belanda), Telemac (Model British), MIKE 21 (Model Denmark).
- ▶ Perisian MIKE 21 dibangunkan oleh Danish Hydraulic Institute Inc. (DHI) digunakan untuk menjalankan simulasi transformasi hidrodinamik dan gelombang.
- ▶ MIKE 21 adalah kejuruteraan pakej perisian profesional yang mempunyai sistem model yang komprehensif untuk dua dimensi (2D) bagi aliran bebas permukaan.

PARAMETER HIDRAULIK

1. Batimetri
2. Paras air & Pasang Surut
3. Angin
4. Ombak
5. Arus
6. Sedimen

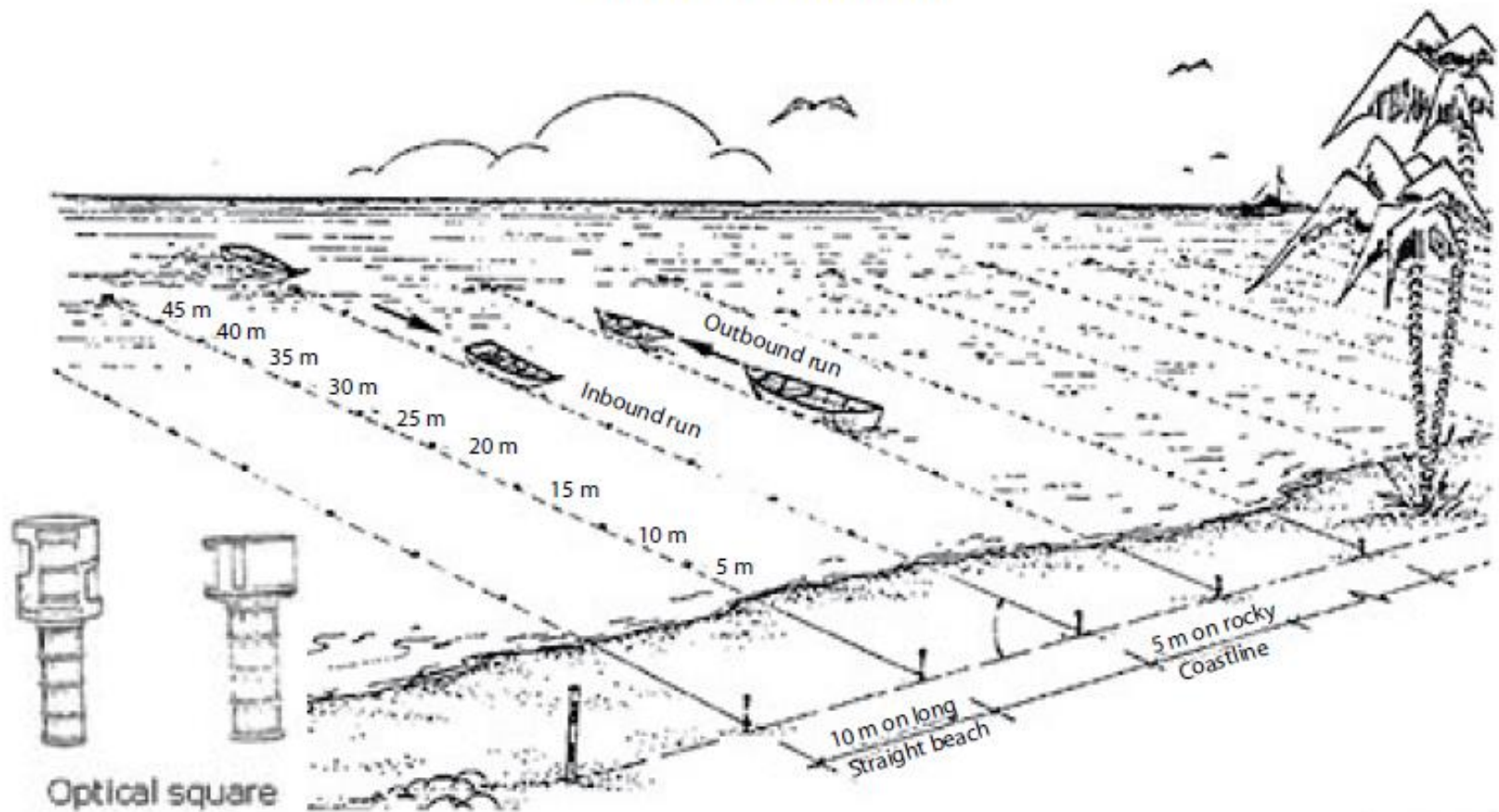


1) Batimetri

- ▶ Ukur hidrografi, juga dikenali sebagai kajian batimetri.
- ▶ Penting apabila wujud pembangunan yang dirancang di atas laut atau air.
- ▶ Pemantauan paras laut dan pengukuran dijalankan oleh tiga agensi utama di Malaysia iaitu;
 - Malaysian Meteorological Department (MET),
 - Department of Survey and Mapping Malaysia (JUPEM) and
 - Pusat Hidrografi Nasional (PHN).

Kaedah Konvensional

FIGURE 4
Parallel line method



Kelas Pengukuran Batimetri

IHO STANDARDS FOR HYDROGRAPHIC SURVEYS (S-44)
5th Edition February 2008

TABLE 1
Minimum Standards for Hydrographic Surveys
(To be read in conjunction with the full text set out in this document.)

Reference	Order	Special	1a	1b	2
Chapter 1	Description of areas.	Areas where under-keel clearance is critical	Areas shallower than 100 metres where under-keel clearance is less critical but features of concern to surface shipping may exist.	Areas shallower than 100 metres where under-keel clearance is not considered to be an issue for the type of surface shipping expected to transit the area.	Areas generally deeper than 100 metres where a general description of the sea floor is considered adequate.
Chapter 2	Maximum allowable THU 95% Confidence level	2 metres	5 metres + 5% of depth	5 metres + 5% of depth	20 metres + 10% of depth
Para 3.2 and note 1	Maximum allowable TVU 95% Confidence level	a = 0.25 metre b = 0.0075	a = 0.5 metre b = 0.013	a = 0.5 metre b = 0.013	a = 1.0 metre b = 0.023
Glossary and note 2	Full Sea floor Search	Required	Required	Not required	Not required
Para 2.1 Para 3.4 Para 3.5 and note 3	Feature Detection	Cubic features > 1 metre	Cubic features > 2 metres, in depths up to 40 metres; 10% of depth beyond 40 metres	Not Applicable	Not Applicable
Para 3.6 and note 4	Recommended maximum Line Spacing	Not defined as full sea floor search is required	Not defined as full sea floor search is required	3 x average depth or 25 metres, whichever is greater For bathymetric lidar a spot spacing of 5 x 5 metres	4 x average depth
Chapter 2 and note 5	Positioning of fixed aids to navigation and topography significant to navigation. (95% Confidence level)	2 metres	2 metres	2 metres	5 metres
Chapter 2 and note 5	Positioning of the Coastline and topography less significant to navigation (95% Confidence level)	10 metres	20 metres	20 metres	20 metres
Chapter 2 and note 5	Mean position of floating aids to navigation (95% Confidence level)	10 metres	10 metres	10 metres	20 metres

Contoh tolerance kerja ukur hidrografi

Order/Depth	5m	6m	7m	8m	9m
Special	0.252797	0.254018	0.255453	0.257099	0.258952
1 a	0.504207	0.506047	0.508214	0.510701	0.513507

TOR – MBES SURVEY (AQVASPACE)

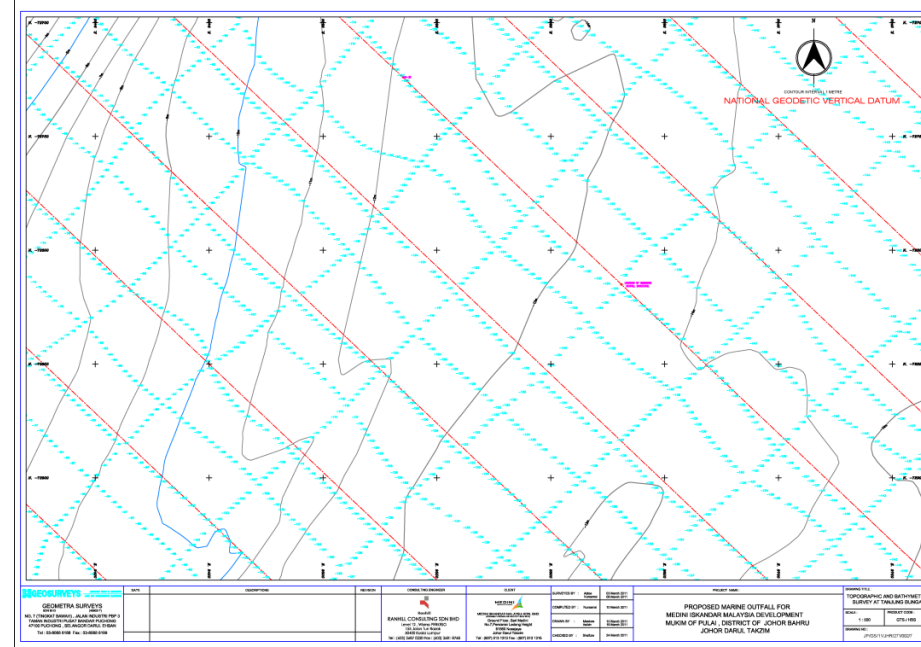
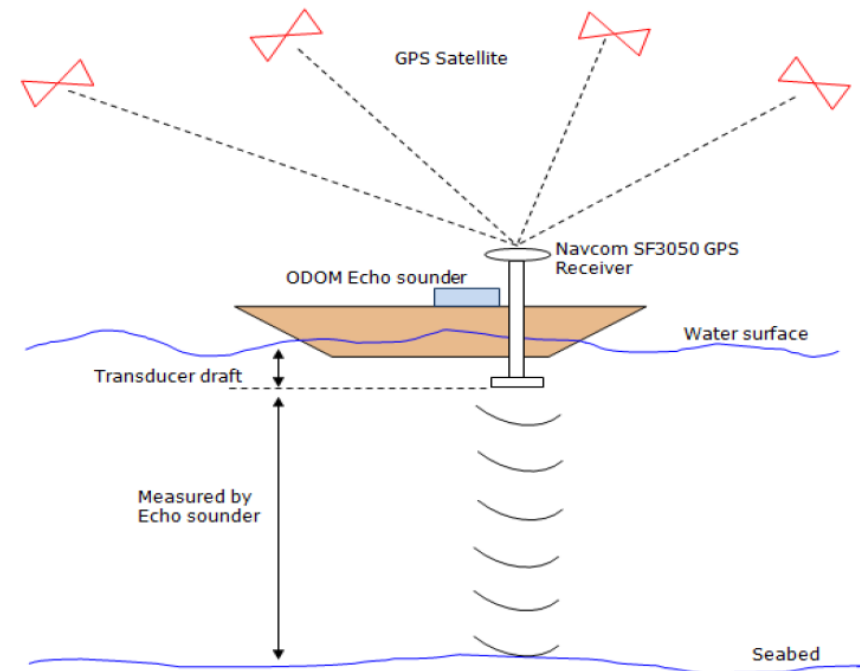
- [viii] All hydrographic works shall comply with the International Hydrographic Organization (IHO) standard and meet the minimum standard for hydrographic survey in accordance with *IHO Standard for Hydrographic Surveys SP 44 5th Edition, February 2008, Order 1a.*

Secara amnya perbezaan data batimetri adalah di antara 10-40 cm, ia berada di dalam tolerance Spesifikasi yang ditetapkan - Order 1a

Pengukuran Batimetri

1) Single beam Batimetri

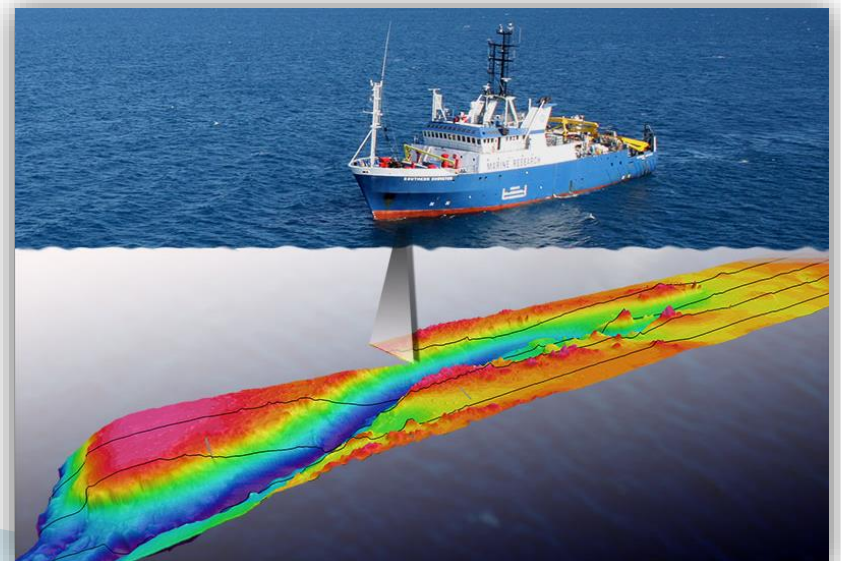
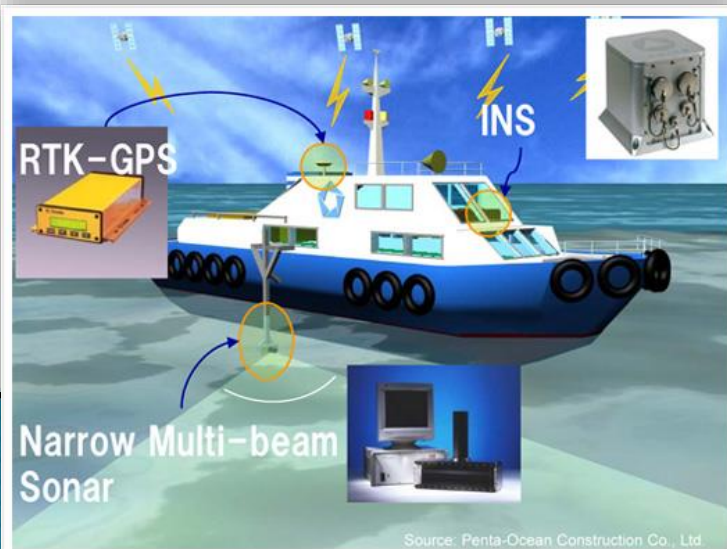
- ▶ Single-beam merupakan kerja ukur kedalaman air yang menggunakan pancaran tunggal sebagai pengirim dan pengiriman signal gelombang suara.
- ▶ Single-beam mengukur jarak dengan cara mencatatkan beza masa penghantaran gelombang ke dasar laut dan masa penerimaan semula setelah mengalami proses pembalikan
- ▶ Julat frekuensi single-beam relatif mudah untuk digunakan, tetapi hanya menyediakan informasi kedalam sepanjang garis trak yang dilalui oleh kapal.



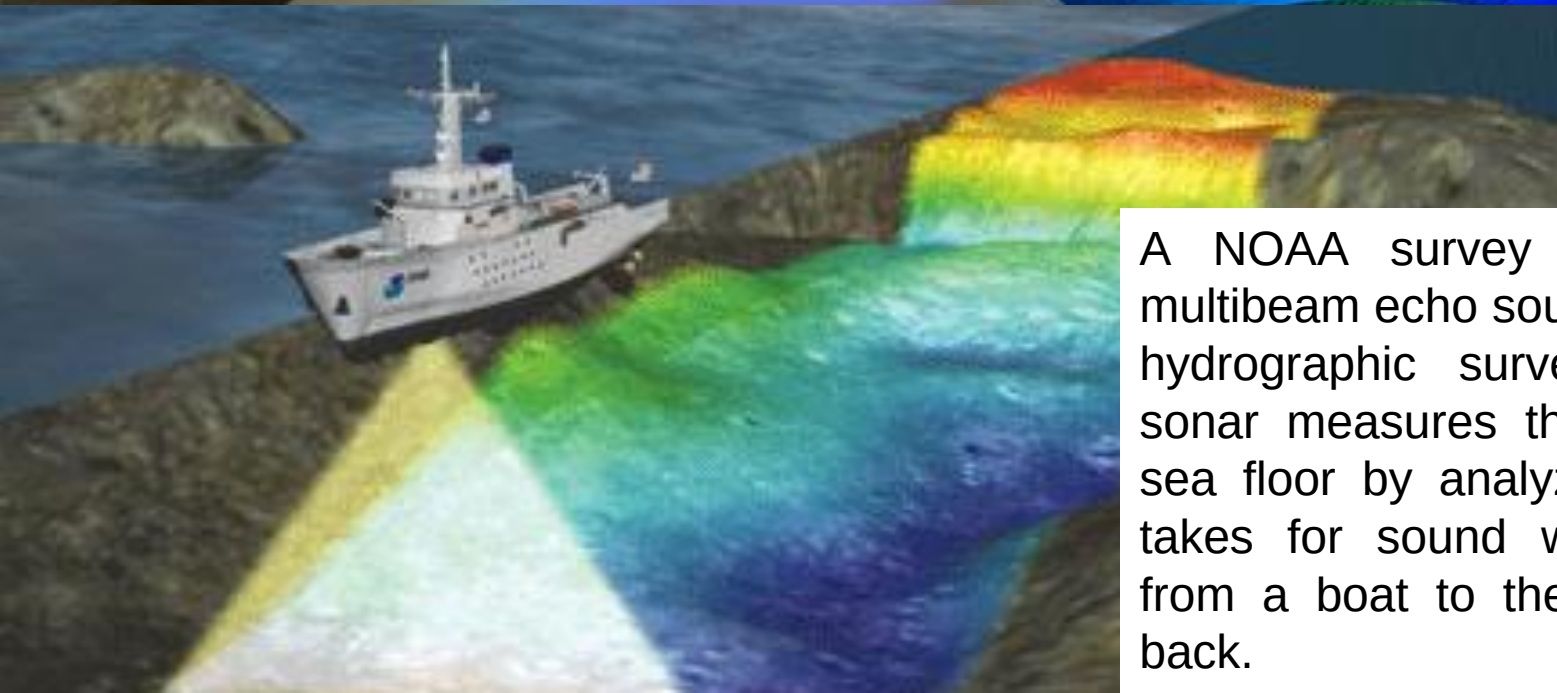
Pengukuran Batimetri

2) Multibeam Batimetri

- ▶ Multi-Beam merupakan pengukuran menentukan kedalaman air di kawasan yang luas.
- ▶ Prinsip operasi alat ini secara umum adalah berdasar pada pancaran denyutan yang dipancarkan secara langsung ke arah dasar laut dan kuasa akustik dipantulkan kembali dari dasar laut (sea bed).
- ▶ Multibeam batimetri dapat menghasilkan data batimetri dengan resolusi tinggi (0.1 m vertikal dan kurang dari 1 m horizontal)

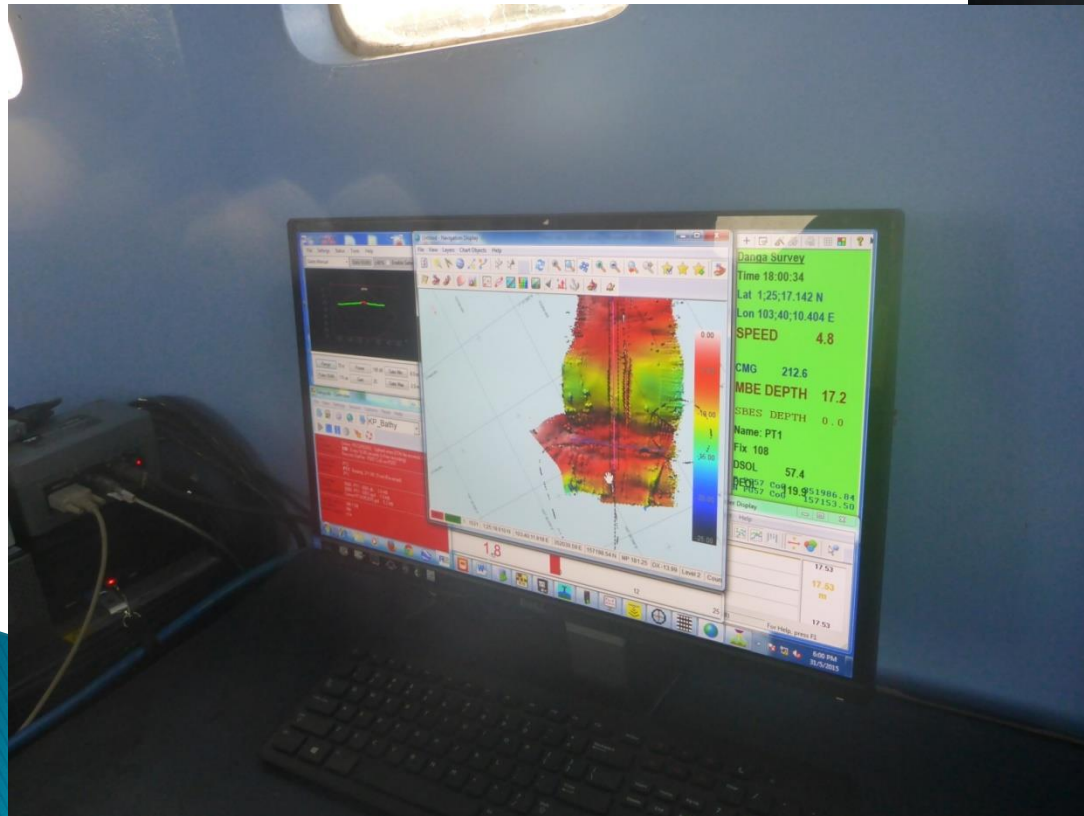
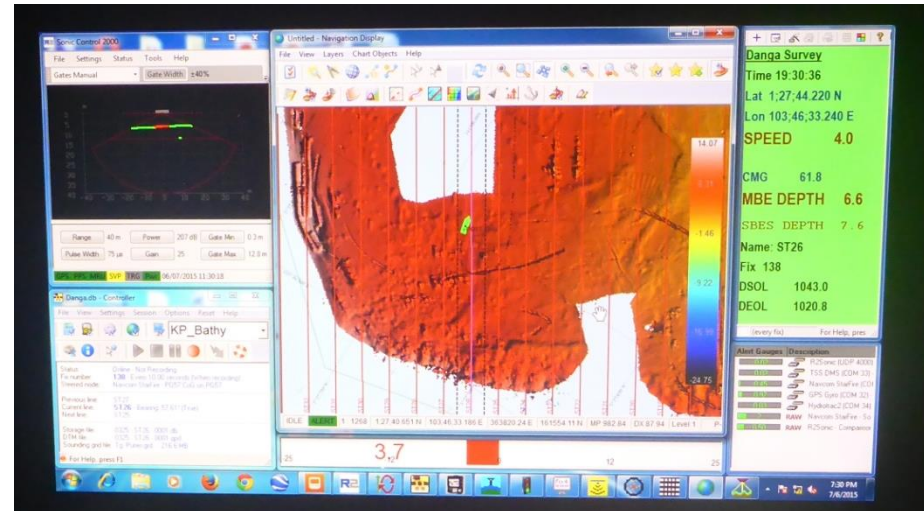


Multibeam Survey/Bathymetry

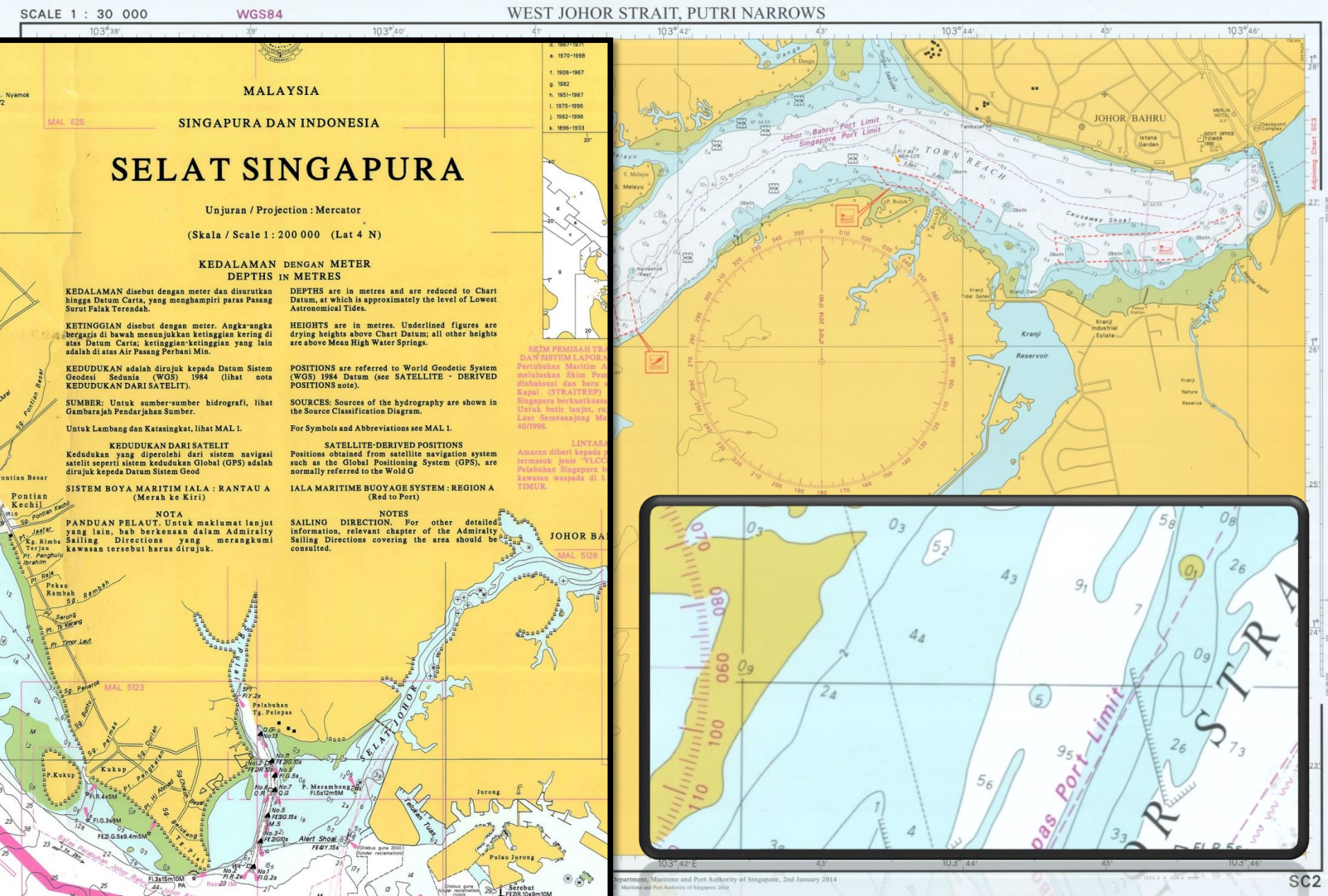


A NOAA survey ship uses its multibeam echo sounder to conduct hydrographic surveys. Multibeam sonar measures the depth of the sea floor by analyzing the time it takes for sound waves to travel from a boat to the sea floor and back.

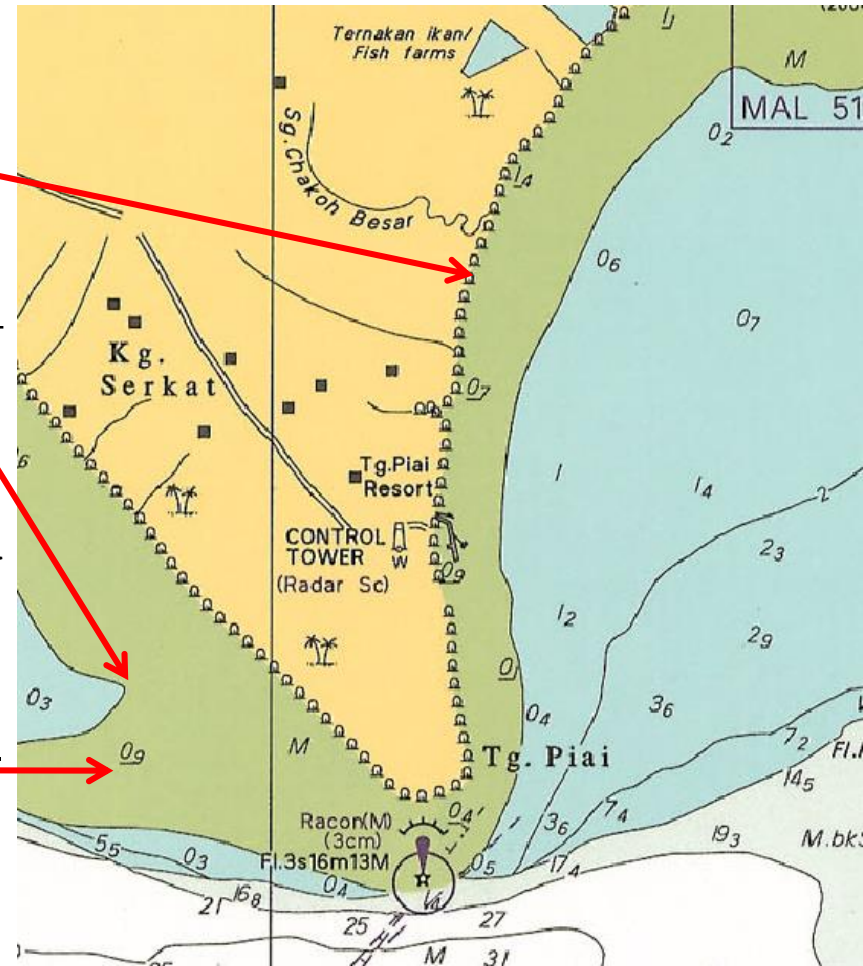
Monitoring station in the ship



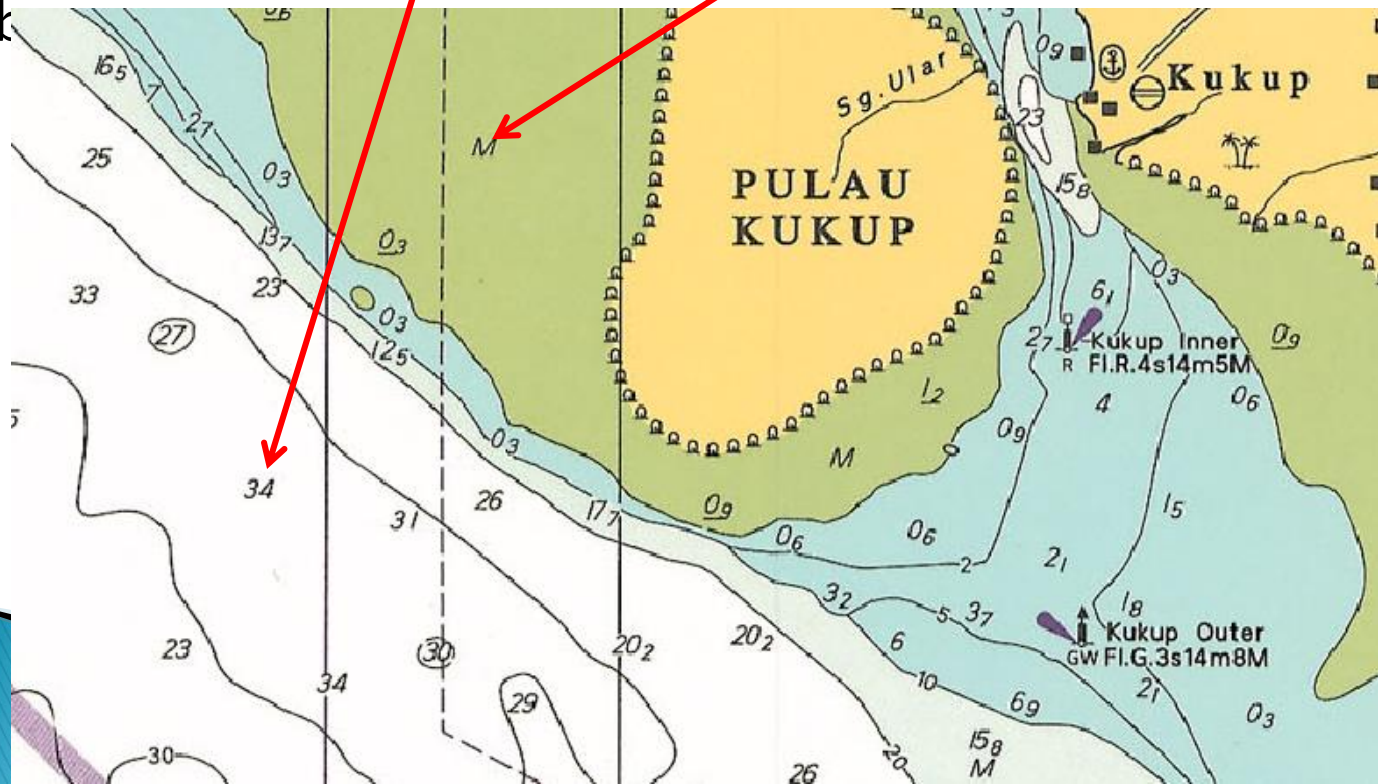
Output Pengukuran Batimetri-Carta



- **Garisan pantai (shoreline)** – sempadan daratan dan air. Paras Air Tertinggi biasanya digunakan.
- **Depan pantai dan kawasan kering (foreshore and drying area)** – sempadan garis pantai dengan ketinggian datum carta. Ia bergantung kepada pasang-surut, kelihatan semasa surut dan tenggelam semasa pasang.
- **Kedalaman dan ketinggian kering** – ketinggian kawasan pantai dan kawasan kering berasaskan datum carta.

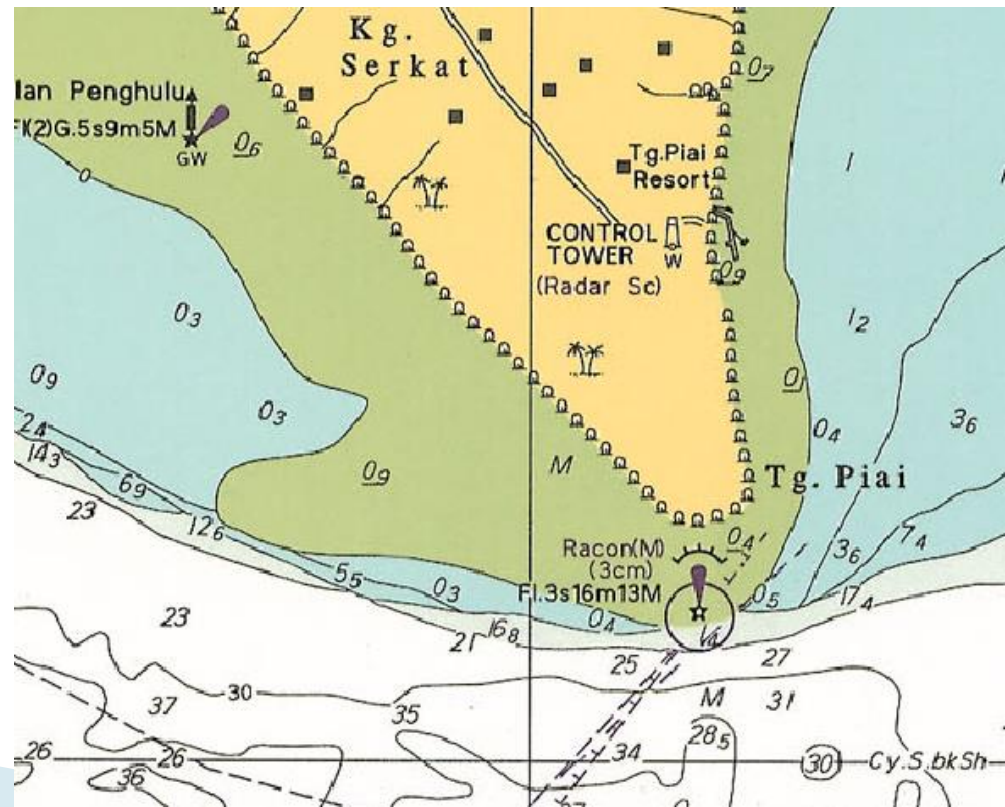


- Kontor kedalaman – garisan yang mempunyai kedalaman yang sama.
- Kualiti dasar laut – tanda nama yang menggambarkan jenis dasar laut, misalnya L- lumpur, B –batu, M- Mangrove dsb.
- Bantuan pelayaran – menunjukkan kawasan bahaya (batu karang, kapal karam, dsb), rumah api, boya keselamatan, laluan selamat dsb

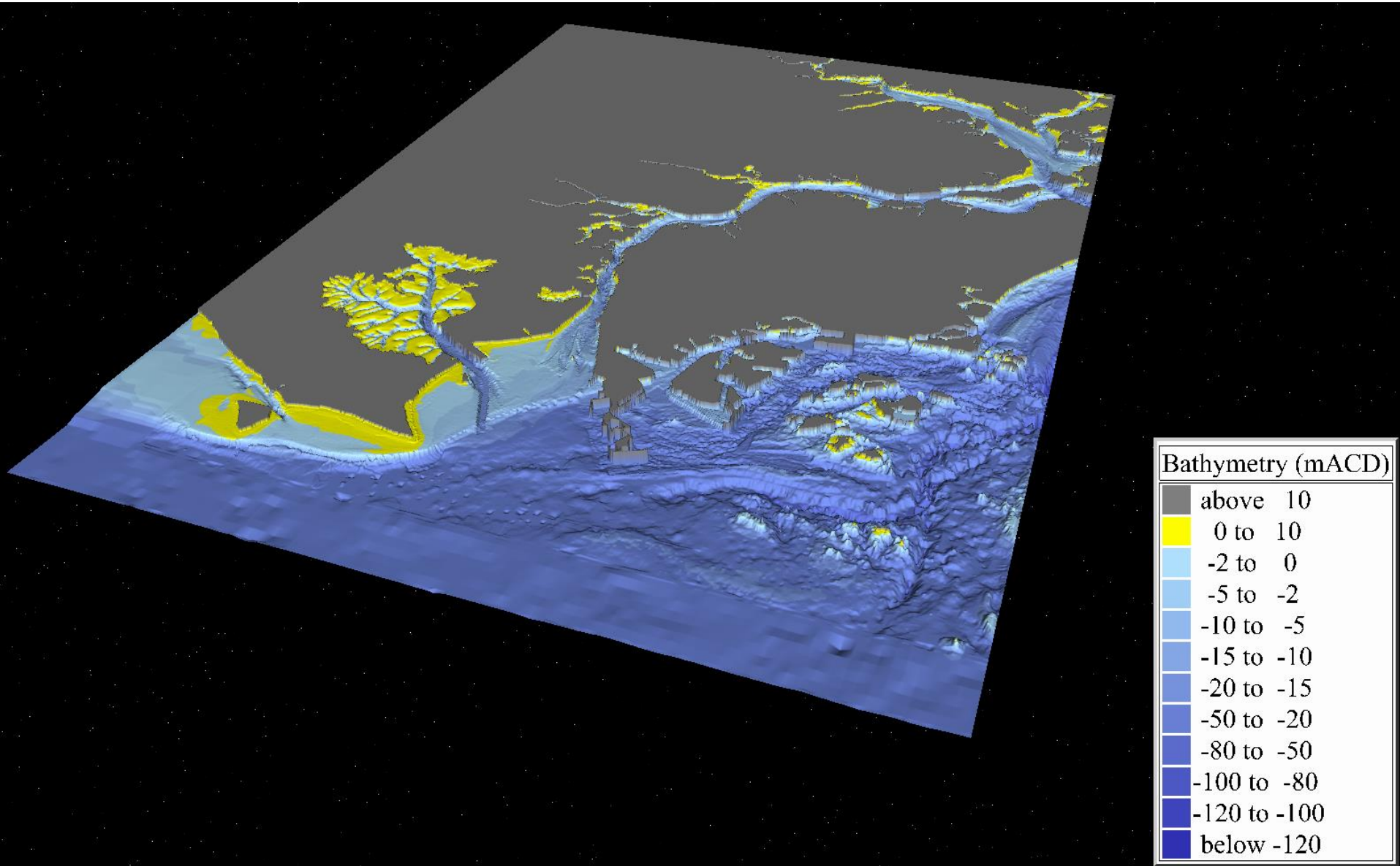


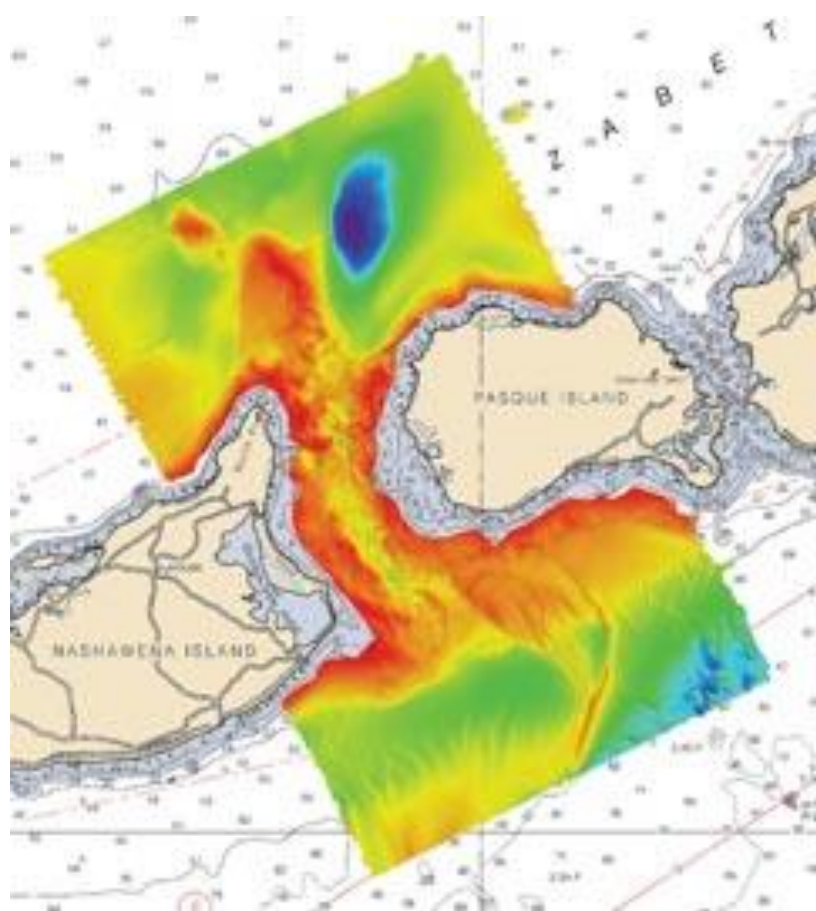
- Mercutanda (landmarks) – tanda semulajadi atau buatan yang boleh kelihatan dari pantai.
- Butiran maritim – butiran buatan manusia yang penting atau berguna untuk pelayaran seperti jeti, pelabuhan, breakwaters, jambatan, kabel dasar laut, dsb.

- Topografi pantai dan daratan – butir-butiran semulajadi atau buatan manusia, garis kontor, ketinggian dsb. Maklumat tidaklah sebanyak maklumat hidrografi.



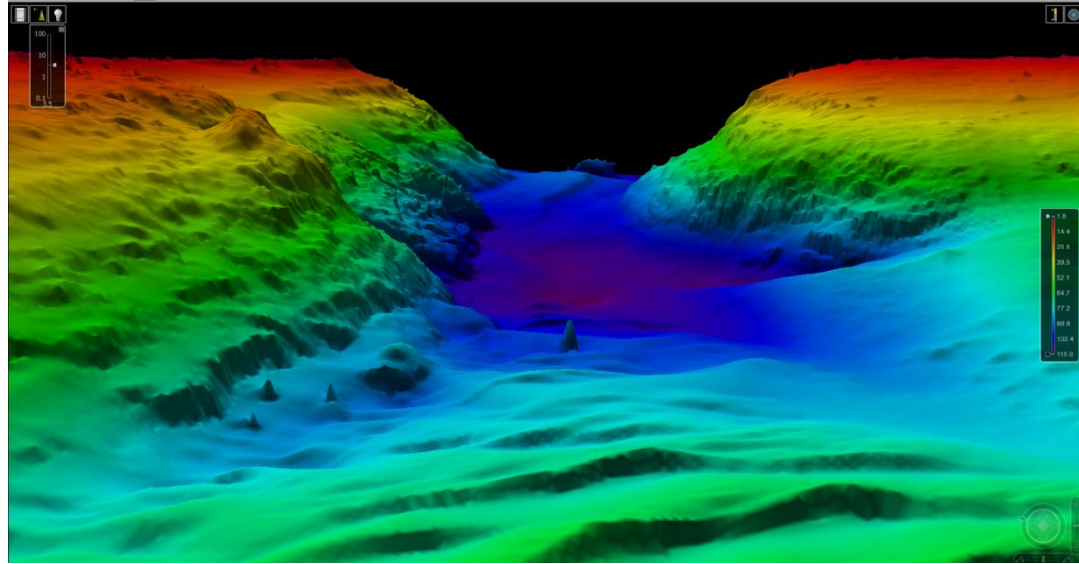
Batimetri



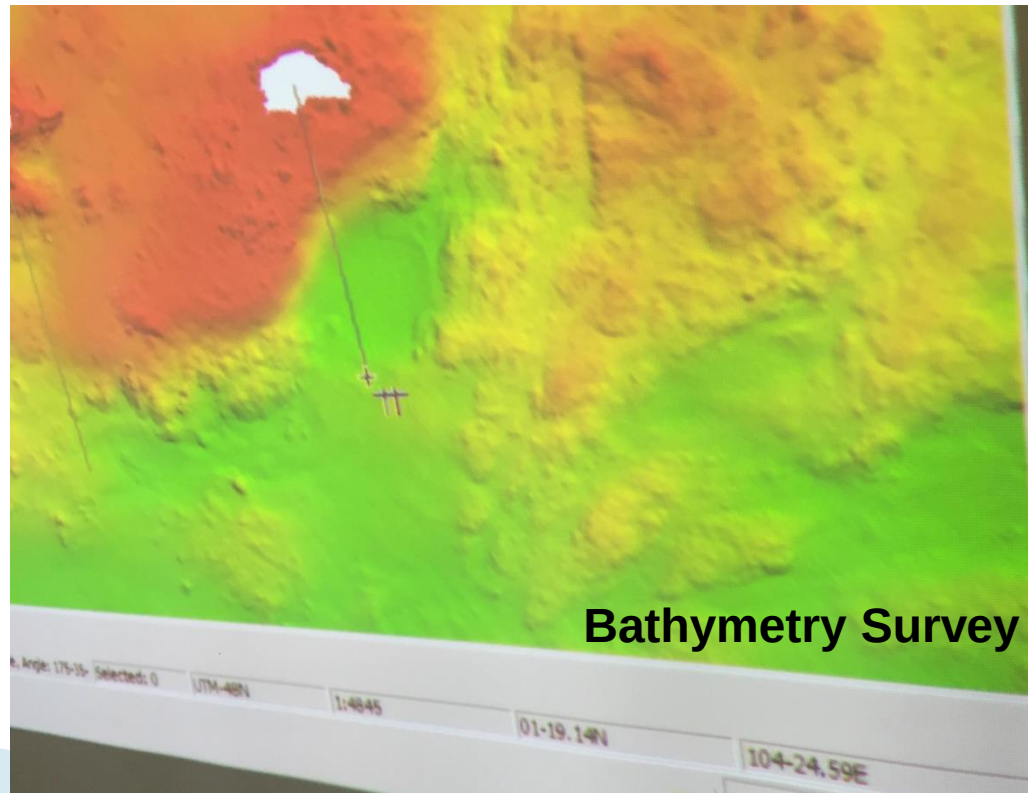


DTM - Digital Terrain Model

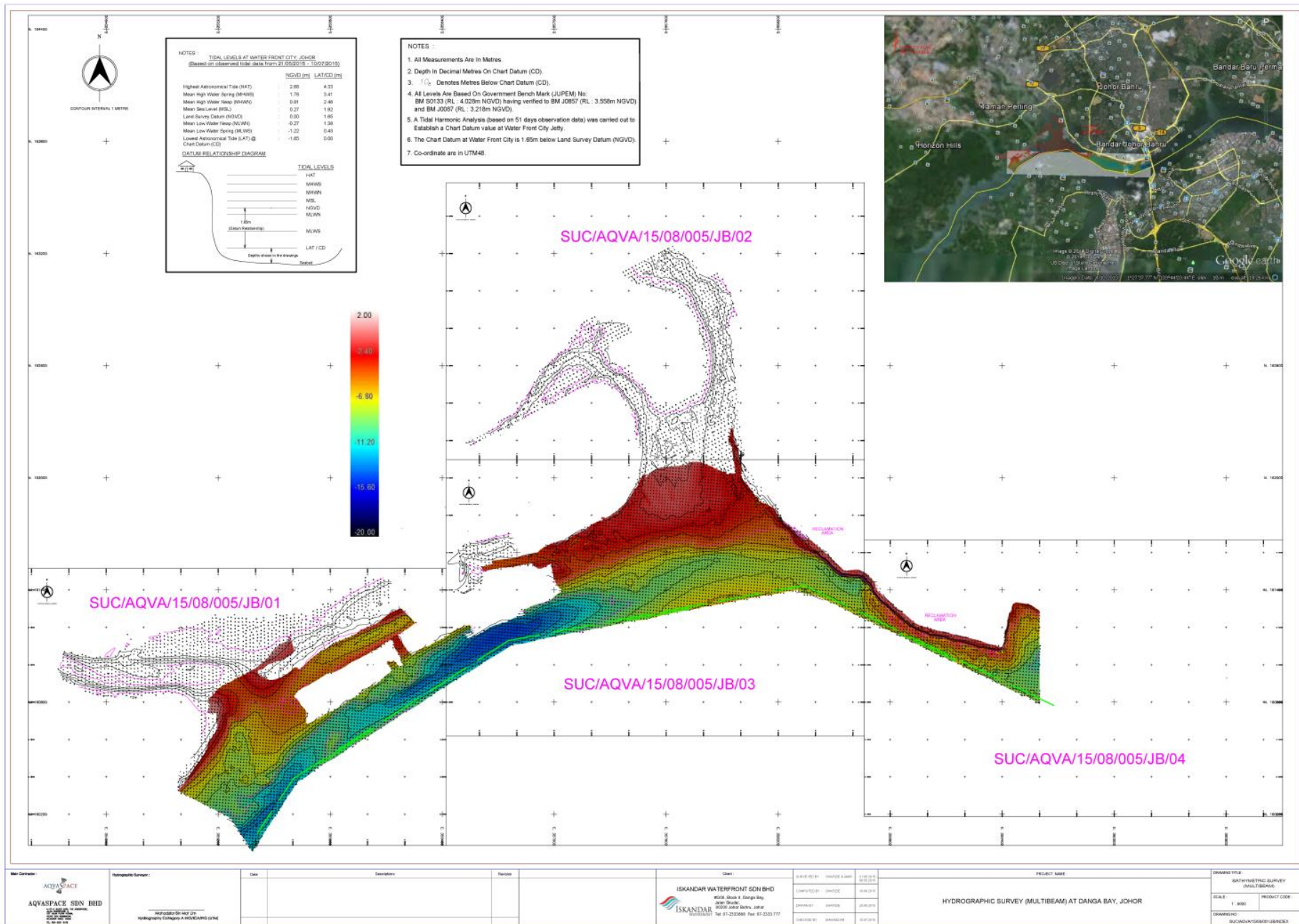
Hasil dari Ukur Batimetri



Bathymetry Survey

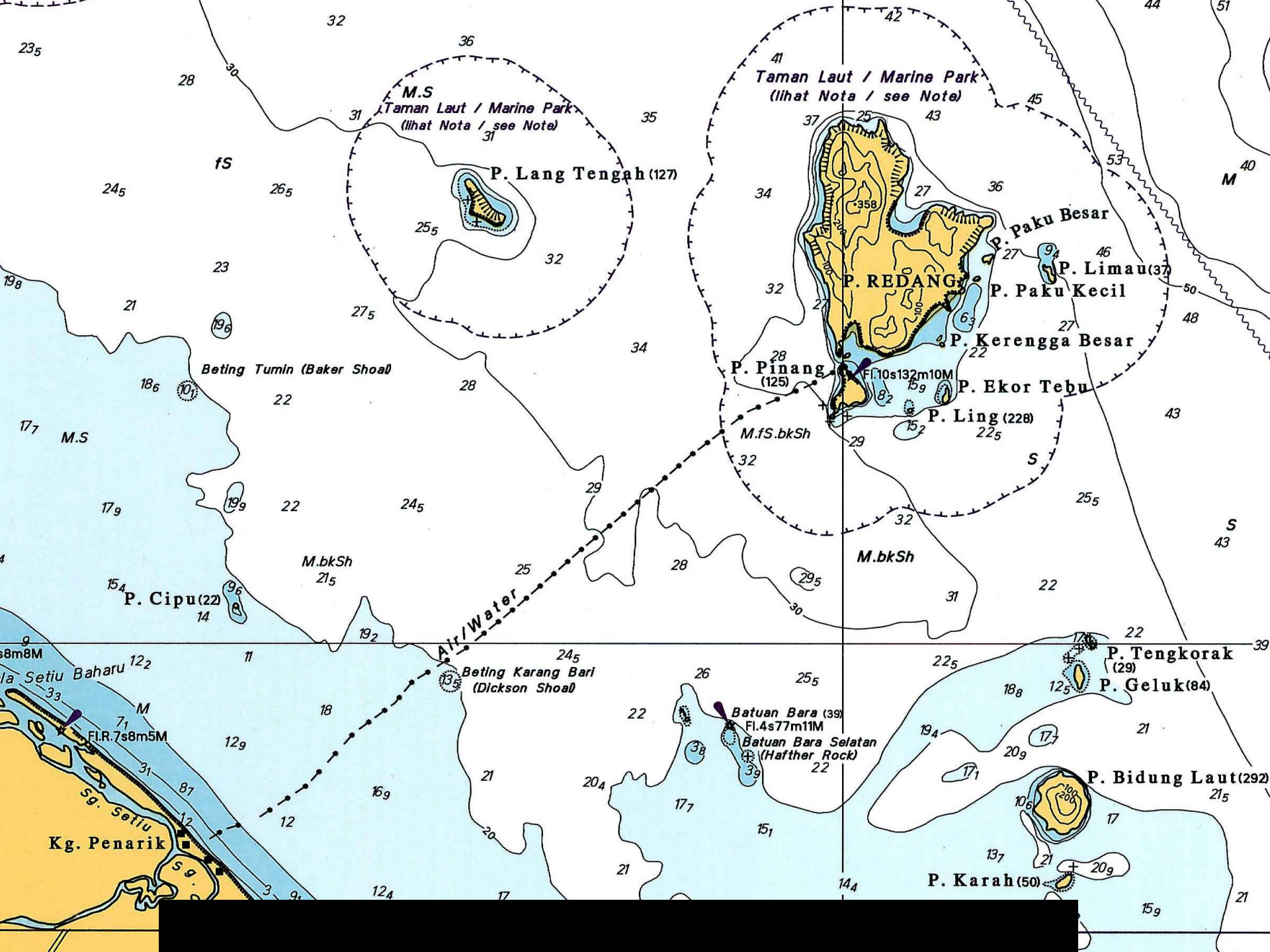


Bathymetry Survey







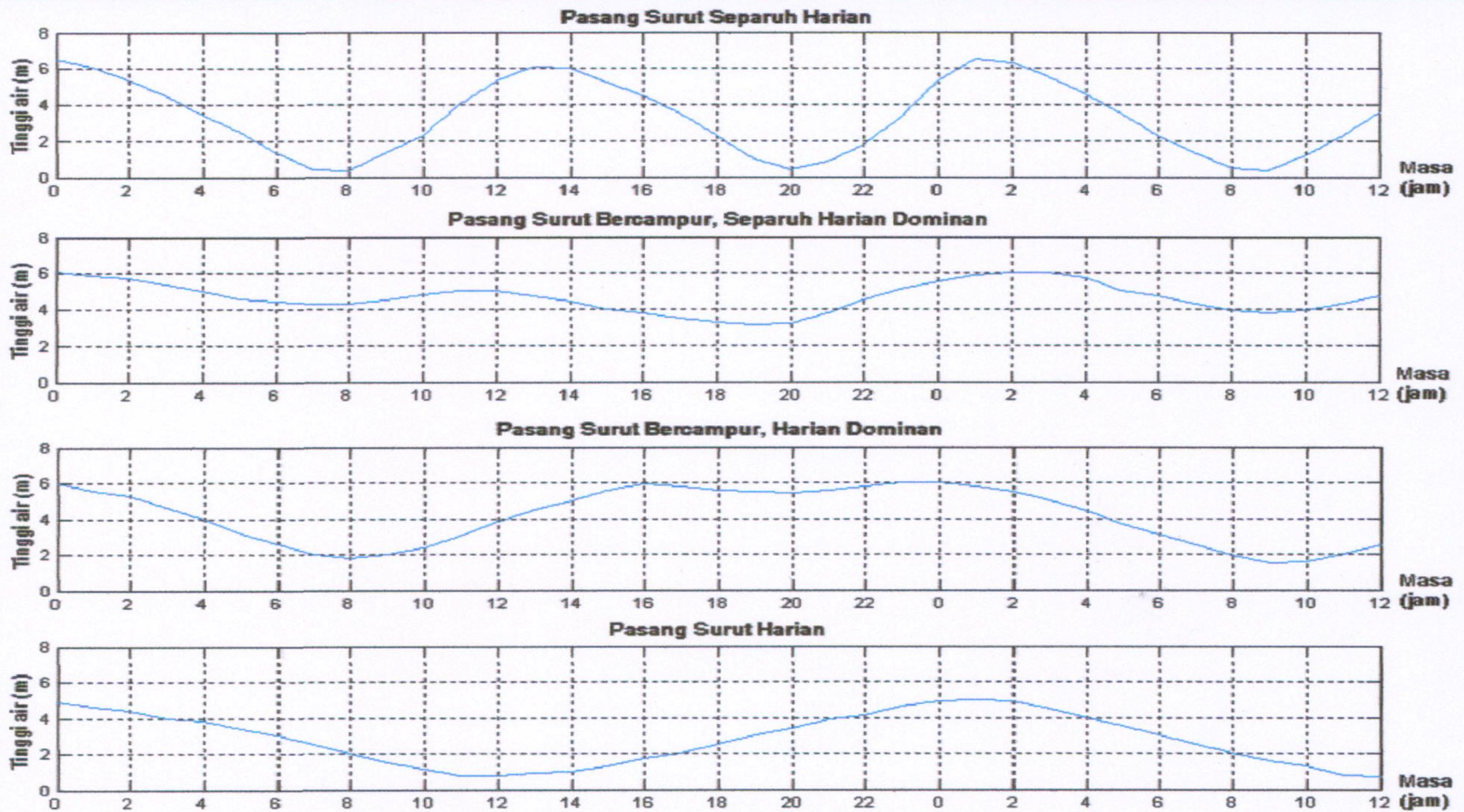


2) Paras Air & Pasang Surut

- ▶ Pasang-surut adalah perubahan berkala naik dan turun paras permukaan air disebabkan perbezaan daya tarikan daripada pelbagai badan cakerawala, terutama bulan dan matahari ke atas permukaan bumi.

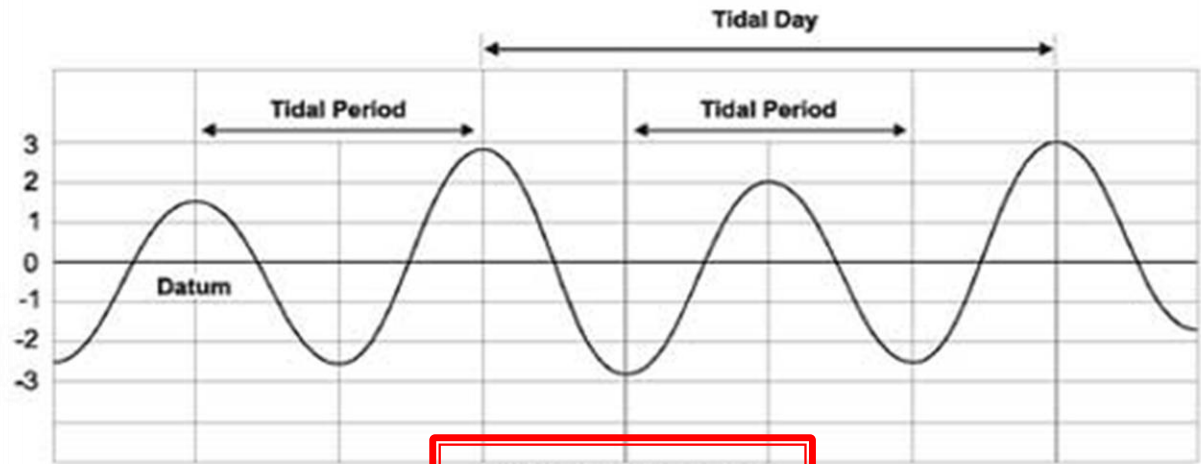
JENIS-JENIS PASANG-SURUT

- ▶ Pasang surut harian sekiranya. Mempunyai tempoh pasang surut selama 1 hari. Kawasan pasang surut berlaku sekali air pasang dan sekali air surut dalam masa sehari. Antara kawasan pasang surut harian adalah di Mexico, Laut Jawa dan Vietnam-China.
- ▶ Pasang surut separuh harian sekiranya. Tempoh pasang surut adalah selama 12 jam 25 minit. Kawasan yang terlibat berlaku 2 kali pasang dan 2 kali surut sehari dengan hanya perbezaan kecil pada paras tertinggi dan terendah.
- ▶ Pasang surut bercampur (pasang surut harian dominan). Paras air pasang dan surut mempunyai perbezaan yang ketara. Kebiasaannya sekali pasang dan sekali surut dalam sehari.
- ▶ Pasang surut bercampur (pasang surut separuh harian dominan). Pada waktu-waktu tertentu ia akan mengalami sekali pasang dan sekali surut dalam sehari.

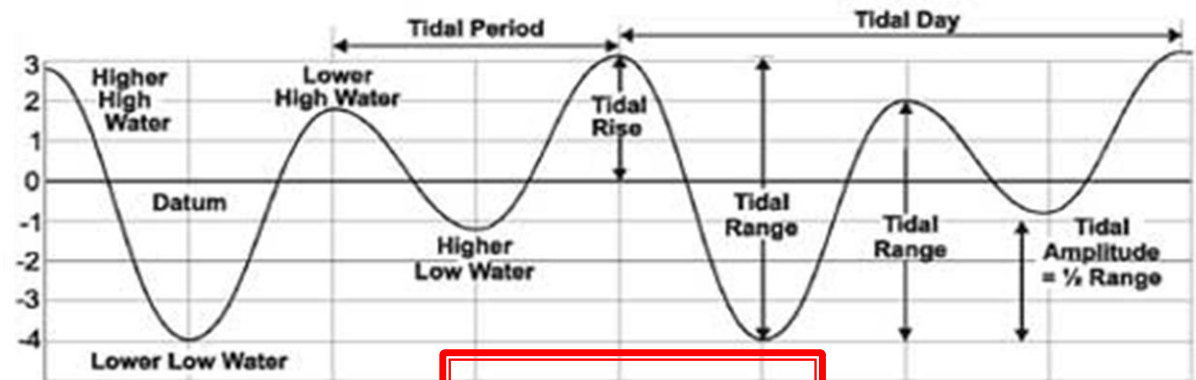


Sifat pasang surut

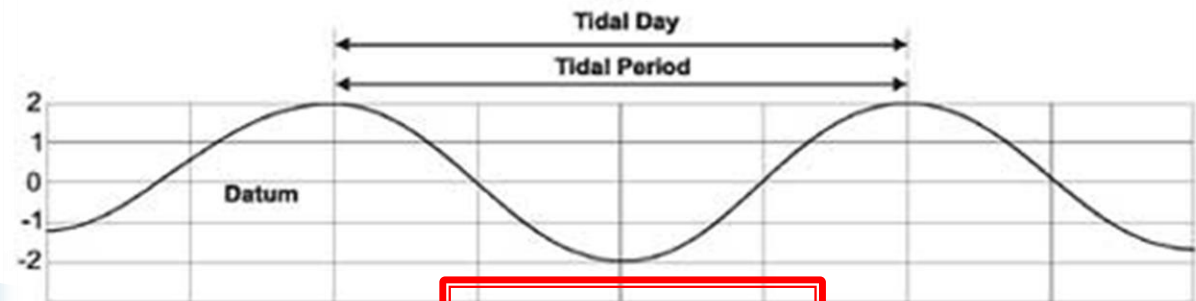
Jenis pasang surut di Malaysia



SEMIDIURNAL TIDE



MIXED TIDE



DIURNAL TIDE

Tides Station – JUPEM

- ▶ JUPEM menerbitkan maklumat mengenai air pasang surut untuk 12 lokasi di Semenanjung Malaysia, 6 lokasi di Sabah dan 4 lokasi di Sarawak.
 - ▶ Data ini boleh diperolehi dalam bentuk cetakan atau digital dalam format PDF.
 - ▶ Buku Rekod Cerapan Air Pasang Surut diterbitkan secara tahunan yang mengandungi maklumat mengenai lokasi stesen-stesen, aras air pasang surut, aras laut min dan pemalar harmonik.
 - ▶ Selain itu, terdapat juga maklumat terperinci mengenai setiap stesen tolok air pasang surut, data aras dan marigram perubahan aras laut.
 - ▶ Buku Jadual Ramalan Air Pasang Surut tahunan dihasilkan daripada data cerapan melalui hitungan analisis harmonik.
- 

Tides Station – JUPEM

- ▶ Aras Datum yang digunakan untuk ramalan air pasang surut berdasarkan Air Surut Perbani Indian (ISLW).
- ▶ Jadual ramalan air pasang surut tersebut mengandungi maklumat berikut :
 - Pemalar Harmonik
 - Jadual ketinggian setiap jam
 - Jadual masa air tertinggi dan terendah
 - Marigram ketinggian air pasang surut

Contoh Stesen Pasang Surut



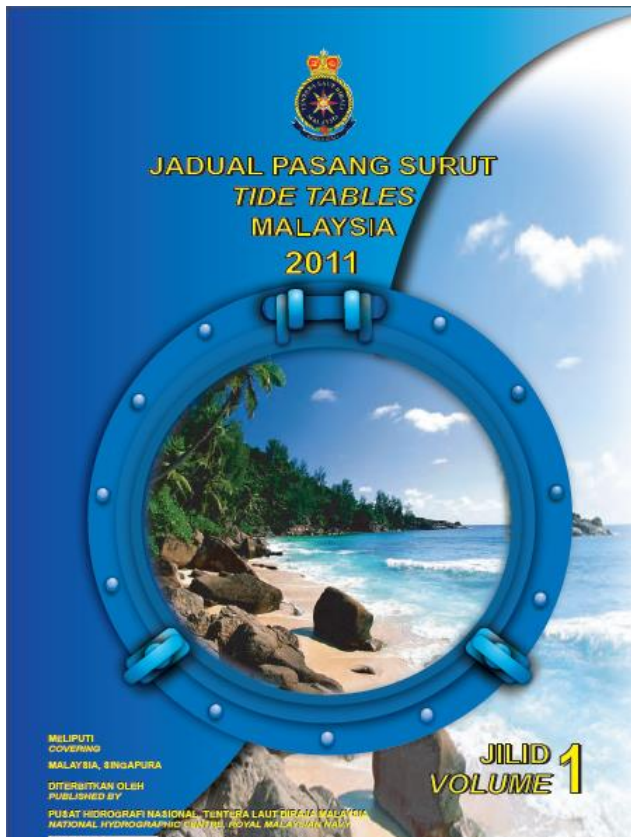
JUPEM Tidal Station

TIDAL DATA 2015

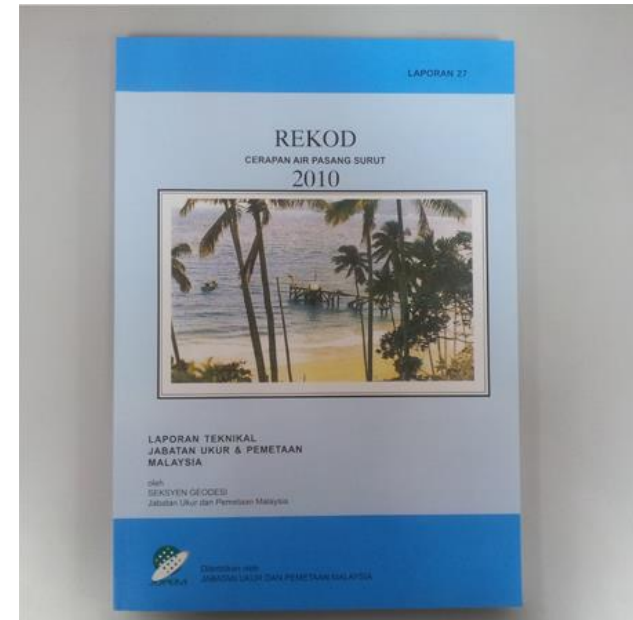


Jadual Pasang Surut

Jabatan Ukur dan Pemetaan Malaysia



Pusat Hidrografi Nasional



Water Level dan Tides

GLOSARI ISTILAH PASANG SURUT

Datum Carta, Datum Untuk Penyurutan Pemeruman

Air Surut Falak Terendah

Air Pasang Falak Tertinggi

Aras Laut Min

Air Surut Perbani Min

Air Pasang Perbani Min

Air Surut Anak Min

Air Pasang Anak Min

CD

LAT

HAT

MSL

MLWS

MHWS

MLWN

MHWN

TIDAL GLOSSARY TERMS

Chart Datum, Datum For Sounding Reduction

Lowest Astronomical Tide

Highest Astronomical Tide

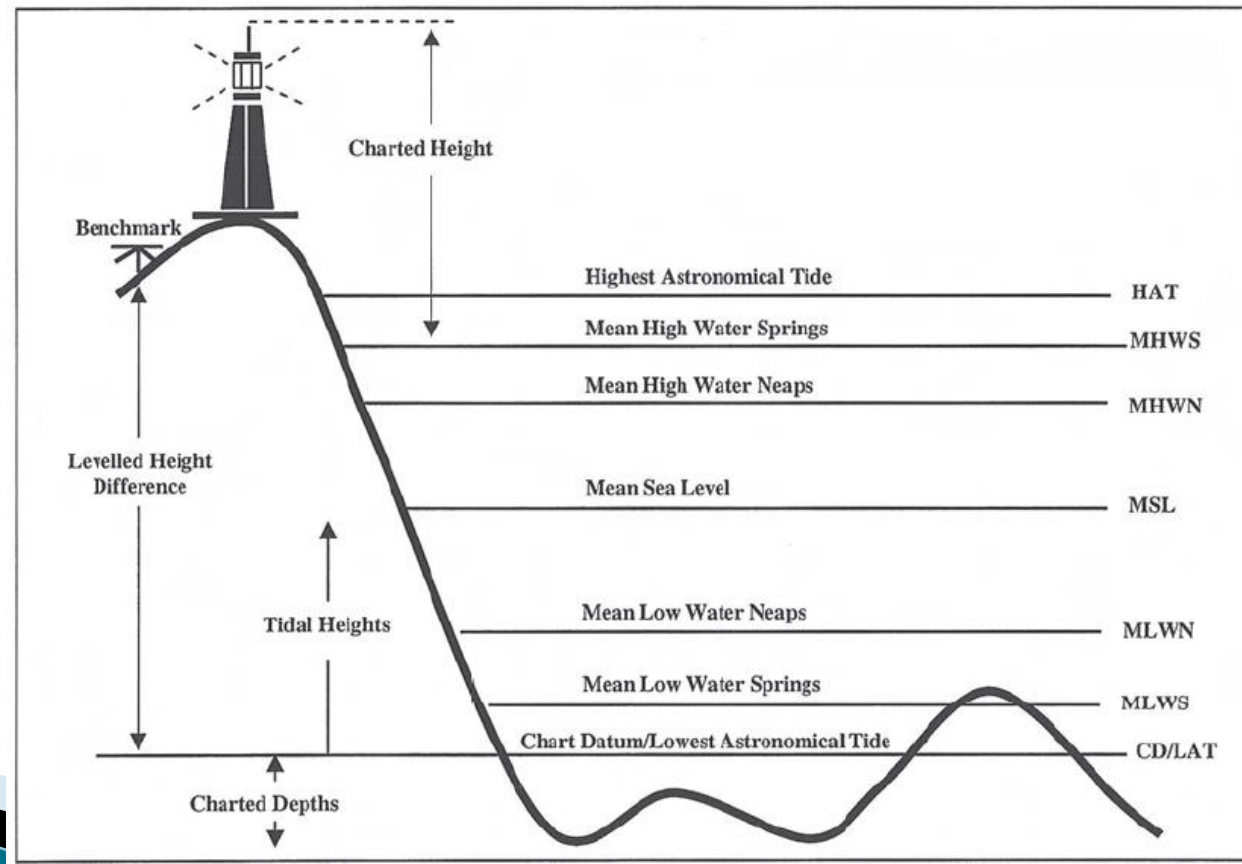
Mean Sea Level

Mean Low Water Spring

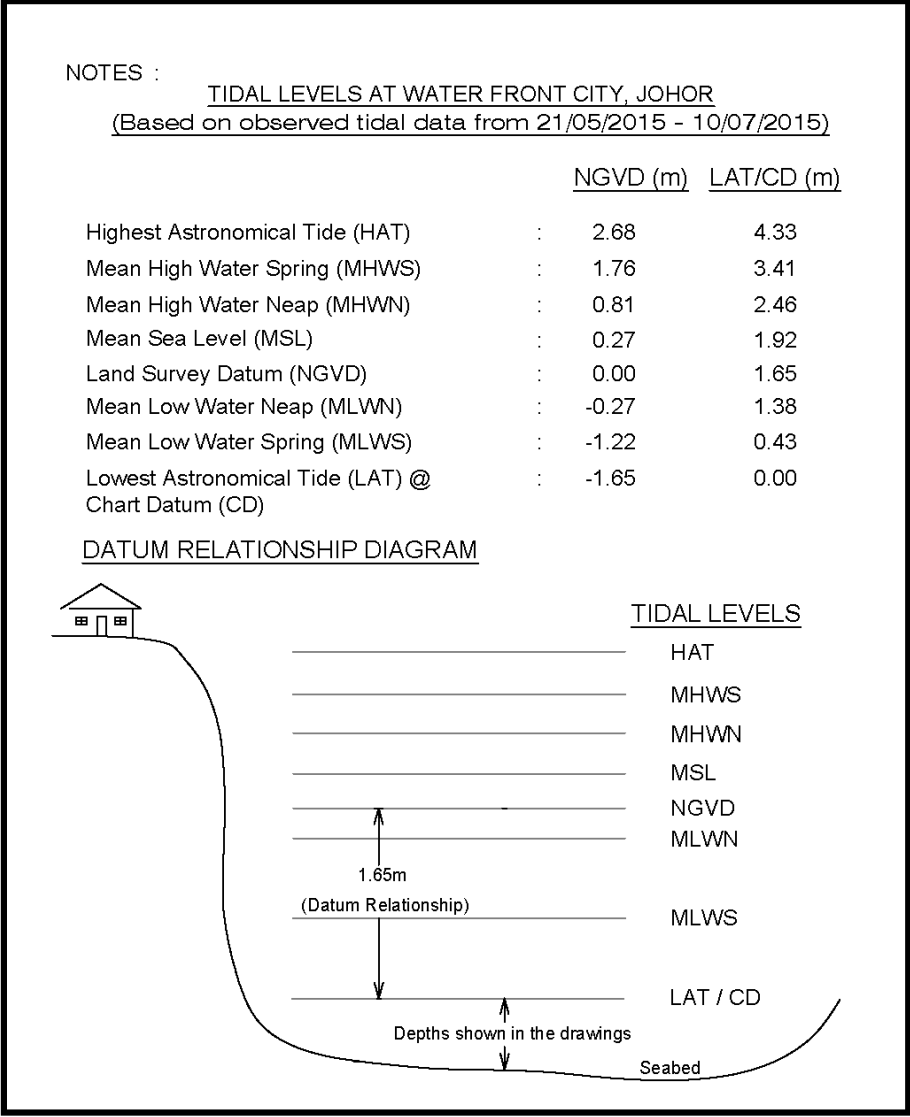
Mean High Water Spring

Mean Low Water Neaps

Mean High Water Neaps



- Air Terendah/Tertinggi Astronomi (LAT)** - Paras terendah/tertinggi yang boleh diramal dalam keadaan normal dengan mengambil kira semua faktor astronomi. Ia diperolehi dengan membuat kajian pasang-surut sekurang-kurangnya 18.6 tahun.
- Purata air pasang dan surut Purnama (MHWS, MLWS)** - purata bagi 2 kali air pasang dan 2 kali air surut berturutan dalam sehari bagi sepanjang tahun. Ia berlaku semasa bulan berada pada fasa penuh atau baru, iaitu sekali dalam setiap 2 minggu.
- Purata air pasang dan surut anak (MHWN, MLWN)** - purata 2 air pasang dan 2 air surut berturutan dalam tempoh 24 jam. Berlaku ketika bulan berada pada sukuan pertama dan akhir.



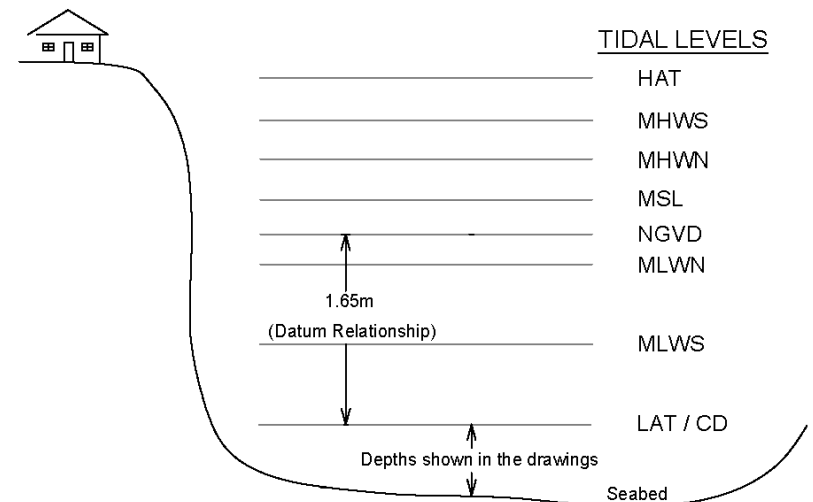
- ❑ **Aras Laut Min (MSL)** - paras purata yang dicapai air laut dalam tempoh masa tertentu. Perubahan paras laut boleh berlaku kerana kesan jangka pendek seperti pencairan ais di kutub, meteorologi (hujan, angin & tekanan), ombak, dsb.
- ❑ **Paras Purata Pasang-Surut (MTL)** - purata bagi ketinggian air pasang-surut bagi tempoh yang singkat.
- ❑ **Purata pasang dan surut tinggi (MHHW, MLLW)** - purata paras air tahunan tertinggi dan terendah dalam sesuatu tempoh (tahunan).
- ❑ **Datum Carta (CD) @ LAT** – merupakan aras di mana kedalaman di atas kebanyakan carta nautika dilaraskan. Disebabkan Lat sukar untuk ditentukan, biasanya aras untuk datum carta di definisikan sebagai satu aras di mana nilai ramalan pasang surut tidak akan jatuh di bawah CD melebihi 1 meter.

NOTES :

TIDAL LEVELS AT WATER FRONT CITY, JOHOR
 (Based on observed tidal data from 21/05/2015 - 10/07/2015)

	NGVD (m)	LAT/CD (m)
Highest Astronomical Tide (HAT)	: 2.68	4.33
Mean High Water Spring (MHWS)	: 1.76	3.41
Mean High Water Neap (MHWN)	: 0.81	2.46
Mean Sea Level (MSL)	: 0.27	1.92
Land Survey Datum (NGVD)	: 0.00	1.65
Mean Low Water Neap (MLWN)	: -0.27	1.38
Mean Low Water Spring (MLWS)	: -1.22	0.43
Lowest Astronomical Tide (LAT) @ Chart Datum (CD)	: -1.65	0.00

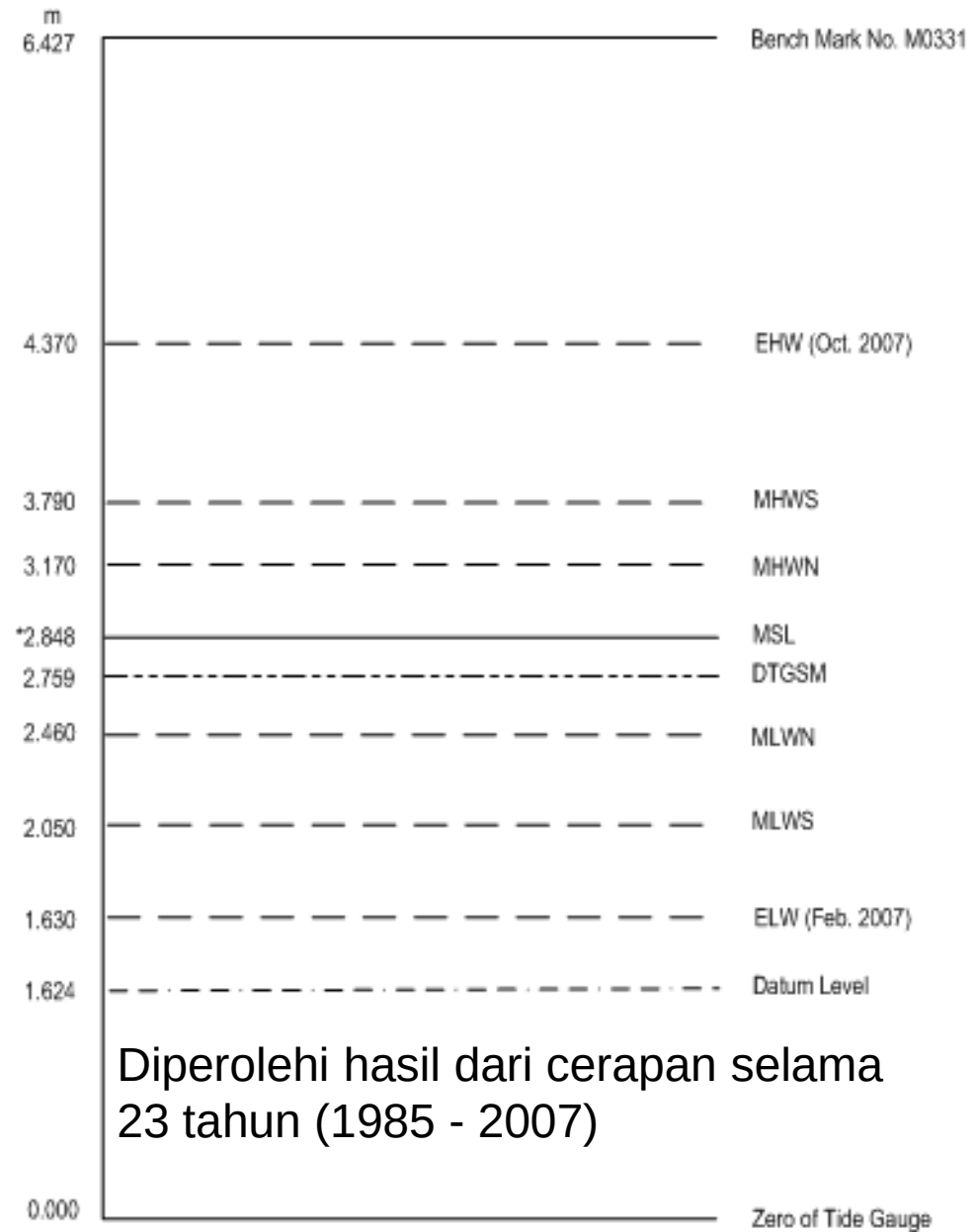
DATUM RELATIONSHIP DIAGRAM



TANJUNG KELING

Aras Pasang Surut

Tidal Levels



Diperolehi hasil dari cerapan selama
23 tahun (1985 - 2007)

TIDAL CONSTITUENTS AND TIDAL LEVELS

A. TIDAL CONSTITUENTS

Location : **WATER FRONT CITY, JOHOR BAHRU**
Position : Lat 01° 27' 10.6" N Long 103° 45' 36.6" E
Equipment : Tide Gauge RBR
Time zone : -0800
Observation period : 21 May to 10 July 2015
Nos of days : 51 days
Linear-Correlation Coefficient : 0.9996
Standard Devn of Residuals : 0.0668
Mean sea level : 1.92 m above LAT
0.27 m above NGVD

Number	Name	Sigma	H (m)	G
<u>Given Constituents</u>				
1	Sa	0.0410686	0.134	261.03
2	Ssa	0.0821373	0.041	119.89
<u>Related Constituents</u>				
15	P1 :K1	14.9589314	0.090	158.20
16	S1 :K1	15.0000000	0.008	266.51
27	MEU2 :N2	27.9682084	0.007	149.73
29	NEU2 :N2	28.5125831	0.041	290.35
33	LAMDA2 :L2	29.4556253	0.026	13.24

B. TIDAL LEVELS (WATER FRONT CITY, JOHOR BAHRU)

Type of Tide : **SEMIDIURNAL**

Reference:
LAT

Reference:
NGVD

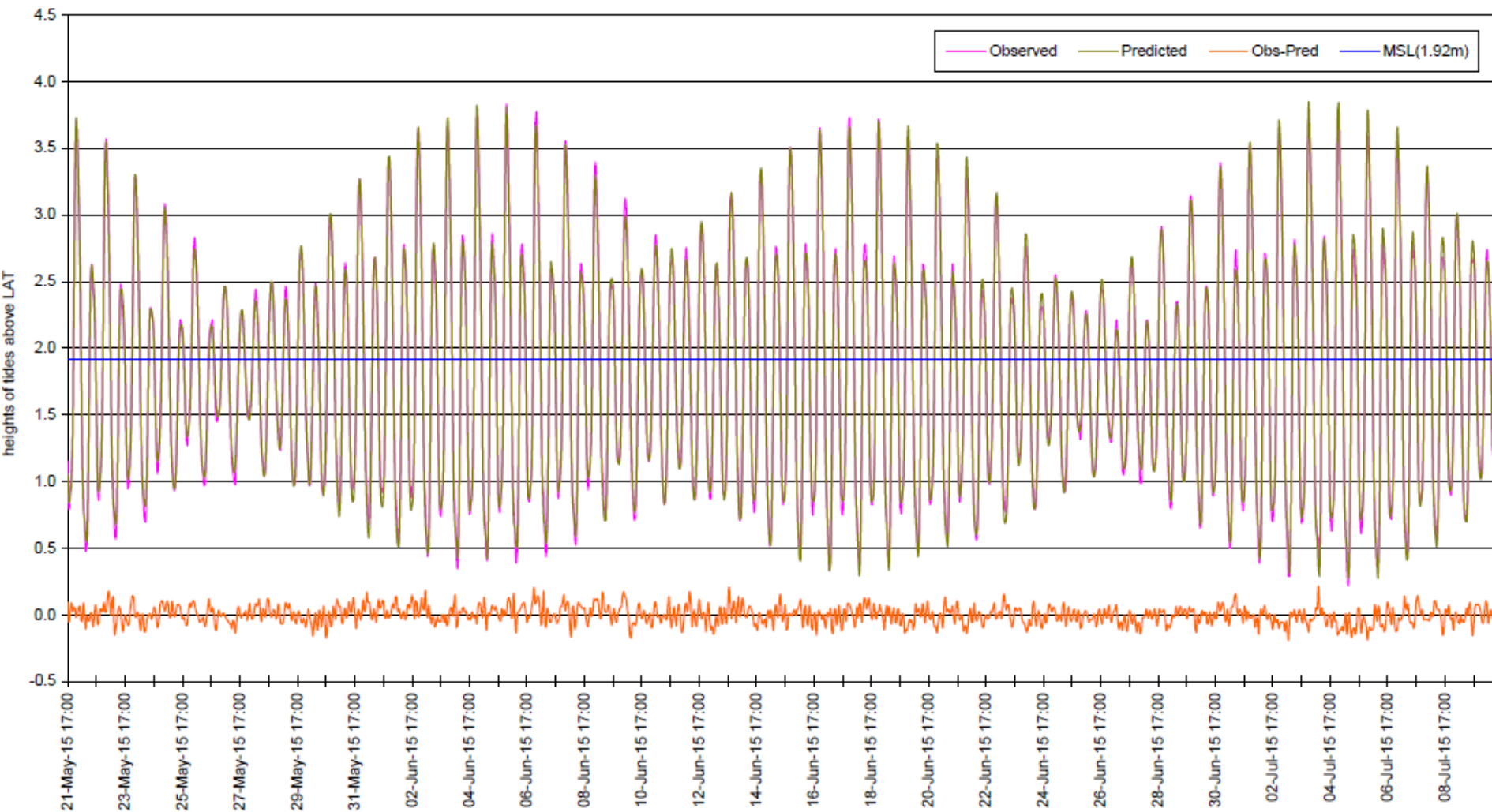
Highest Astronomical Tide	:	4.33 m	2.68 m
Mean High Water Spring	:	3.41	1.76
Mean High Water Neap	:	2.46	0.81
Mean Sea Level (MSL)	:	1.92	0.27
National Geodetic Vertical Datum (NGVD)	:	1.65	0.00
Mean Low Water Neap	:	1.38	-0.27
Mean Low Water Spring	:	0.43	-1.22
Lowest Astronomical Tide	:	0.00	-1.65

TIME SERIES PLOT OF OBSERVED, PREDICTED AND OBSERVED-PREDICTED TIDES 2015

WATER FRONT CITY, JOHOR BAHRU

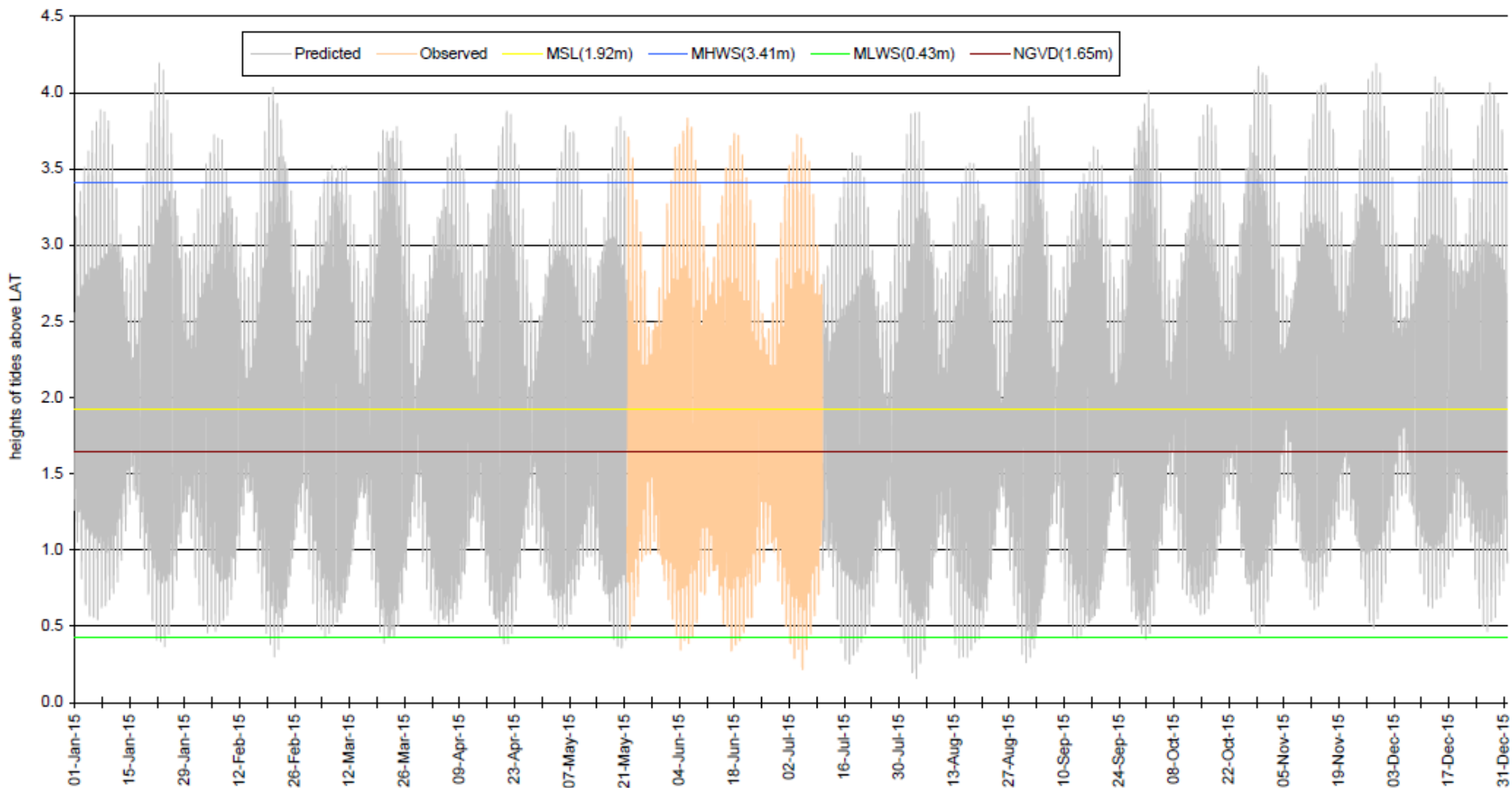
(LAT 01° 27' 10.6" N LONG 103° 45' 36.6" E)

TIME SERIES PLOT OF OBSERVED, PREDICTED AND OBSERVED-PREDICTED TIDES



TIME SERIES PLOT OF OBSERVED AND PREDICTED TIDES 2015

WATER FRONT CITY, JOHOR BAHRU
(LAT 01° 27' 10.6" N LONG 103° 45' 36.6" E)
TIME SERIES PLOT OF OBSERVED AND PREDICTED TIDES 2015



Example of Tidal Data by JUPEM

TIDAL DATA

Choose Station

Station: Tanjung Keling, Melaka

Date: October 1, 2015

HOUR	HEIGHT (CM)	
3:46	32	0.32 m
9:30	247	2.47 m
16:48	34	0.34 m
22:8	207	2.07 m

Date: October 2, 2015

HOUR	HEIGHT (CM)	
4:23	35	
10:15	233	
17:26	48	
22:50	194	

TANJUNG KELING, MELAKA

Lat 02 13 N Long 102 10 E

TIME ZONE -0800

TIMES AND HEIGHTS OF HIGH AND LOW WATERS

2011

SEPTEMBER

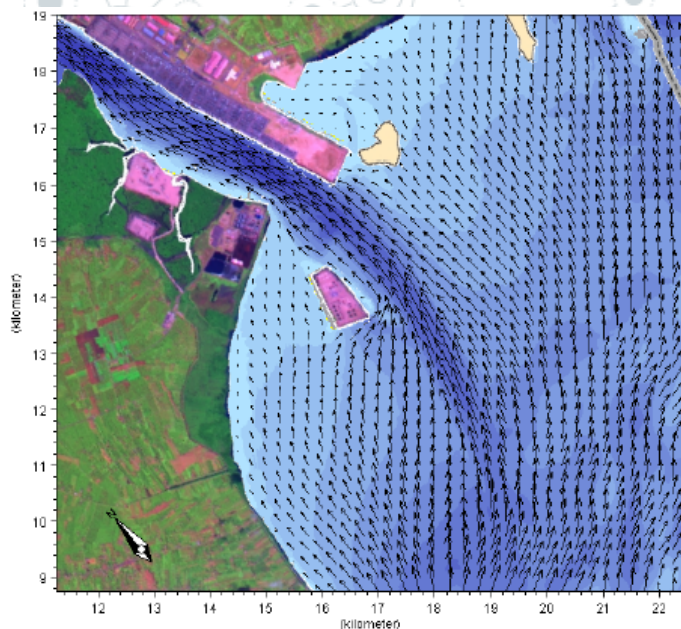
OCTOBER

NOVEMBER

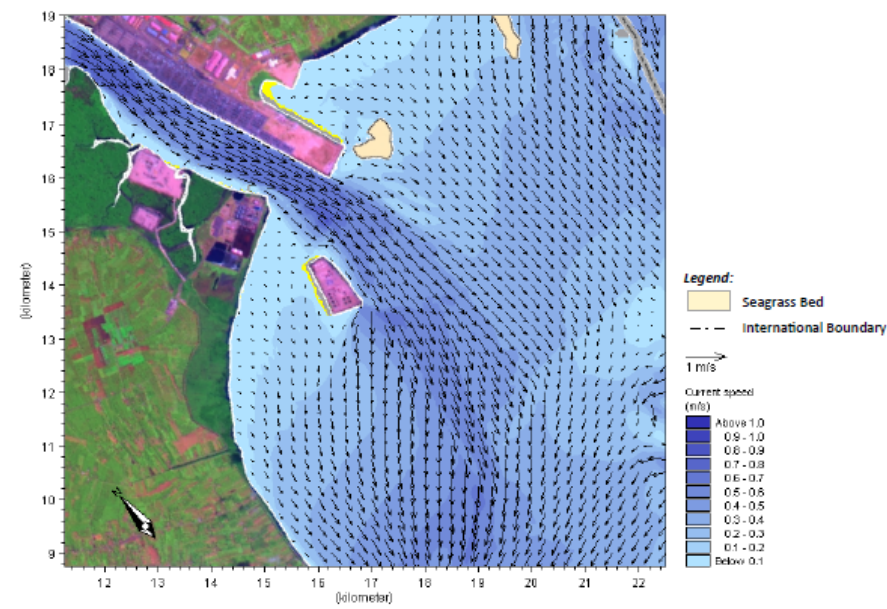
DECEMBER

Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m	Time	m
1 0341 0.3		16 0346 0.4		1 0400 0.2		16 0358 0.3		1 0509 0.4		16 0448 0.4		1 0538 0.5		16 0523 0.4	
Th 0936 2.4		F 0930 2.1		Sa 0954 2.4		Su 0931 2.1		1 1117 2.0		16 1034 2.1		1 1153 1.9		16 1111 2.0	
1701 0.2		F 1617 0.4		Sa 1734 0.5		Su 1614 0.6		T 1850 0.9		W 1659 0.8		Th 1853 0.9		F 1733 0.7	
2157 2.0		2150 1.9		2216 1.9		2158 1.8		2320 1.7		2259 1.8		2353 1.7		2337 1.9	
2 0415 0.3		17 0415 0.3		2 0439 0.2		17 0425 0.4		2 0554 0.5		17 0528 0.5		2 0628 0.6		17 0613 0.5	
F 1015 2.3		17 0956 2.1		2 1038 2.2		M 1001 2.1		2 1227 1.8		17 1123 1.9		2 1253 1.7		17 1200 1.8	
F 1740 0.4		Sa 1635 0.5		Su 1808 0.7		M 1621 0.7		W 1944 1.1		Th 1741 0.9		F 1926 0.9		Sa 1813 0.7	
2235 1.9		2216 1.8		2253 1.8		2228 1.8				2344 1.7					
3 0452 0.3		18 0439 0.4		3 0520 0.3		18 0453 0.4		3 0008 1.6		18 0621 0.5		3 0054 1.7		18 0032 1.9	
1057 2.2		18 1024 2.0		3 1128 2.0		18 1039 2.0		3 0653 0.6		18 1226 1.8		3 0743 0.7		18 0718 0.6	
Sa 1814 0.6		Su 1651 0.6		M 1839 0.9		T 1643 0.9		Th 1355 1.6		F 1848 0.9		Sa 1404 1.5		Su 1259 1.6	
2313 1.7		2243 1.7		2331 1.6		2301 1.7		2059 1.1				2024 0.9		1908 0.7	
4 0532 0.3		19 0505 0.4		4 0608 0.5		19 0531 0.5		4 0140 1.5		19 0049 1.7		4 0218 1.7		19 0145 1.9	
1146 2.0		19 1100 1.8		4 1245 1.7		19 1132 1.8		4 0840 0.7		19 0734 0.6		4 0927 0.8		19 0840 0.7	
Su 1852 0.8		M 1710 0.8		T 2002 1.1		W 1729 1.0		F 1536 1.5		Sa 1353 1.6		Su 1529 1.4		M 1414 1.5	
2352 1.6		2312 1.6				2344 1.6		2210 1.1		2014 0.9		2129 0.9		2019 0.6	

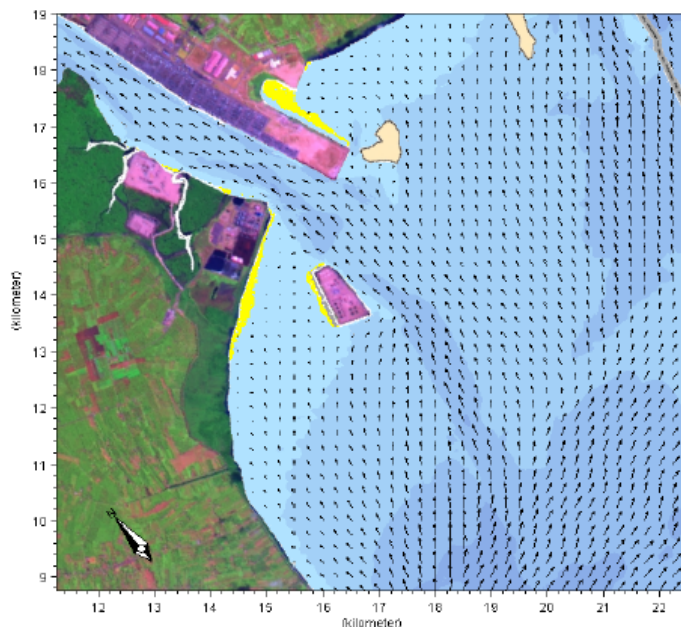
Flow Pattern During Spring and Neap Periods for Existing Condition: Pure Tide Condition



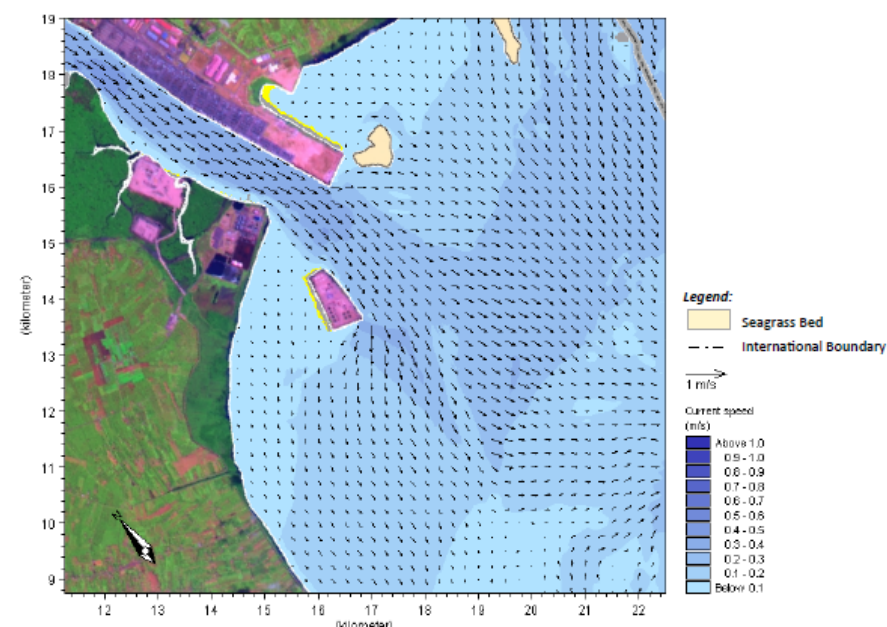
(a) Spring Period: Flood Flow



(b) Spring Period: Ebb Flow

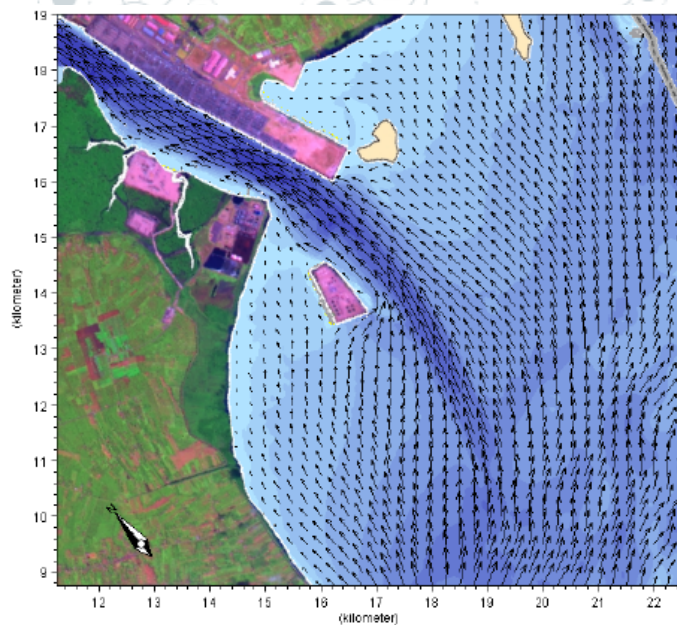


(c) Neap Period: Flood Flow

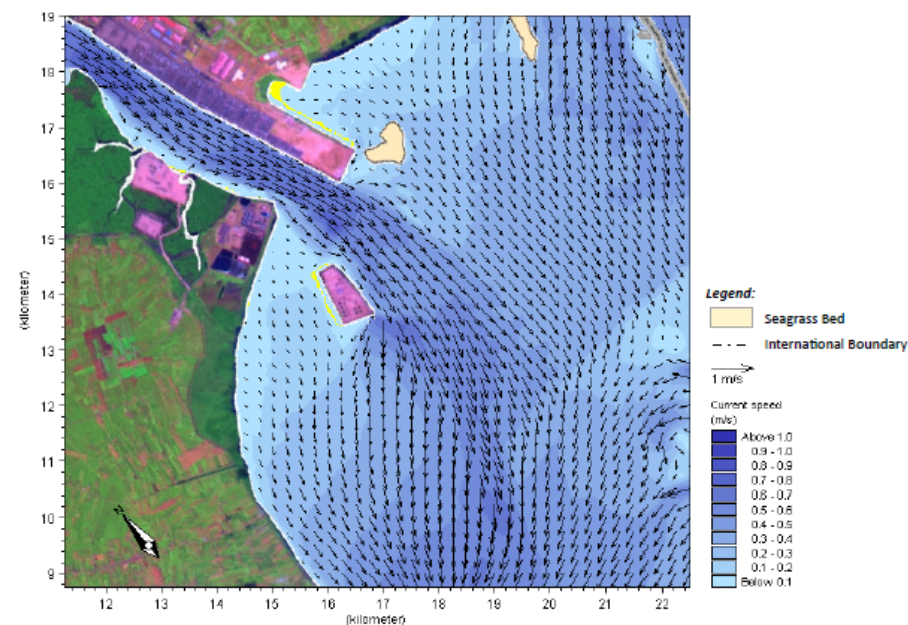


(d) Neap Period: Ebb Flow

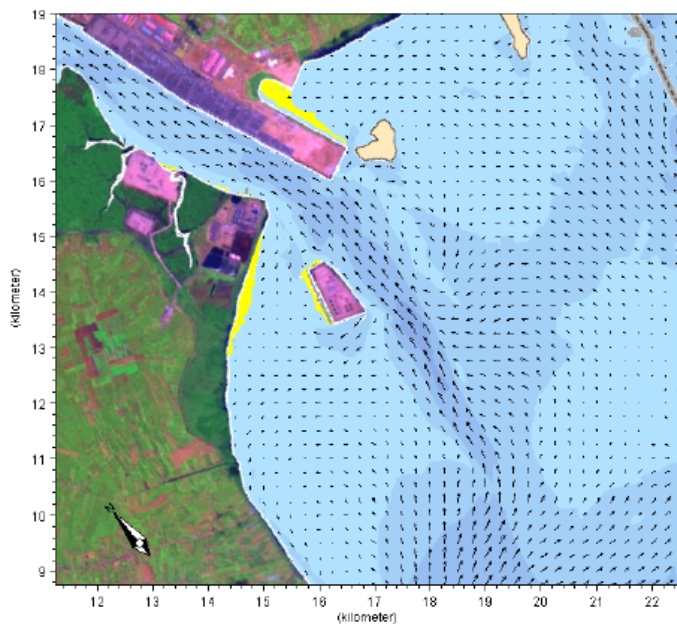
Flow Pattern During Spring and Neap Periods for Existing Condition: Northeast Monsoon Condition



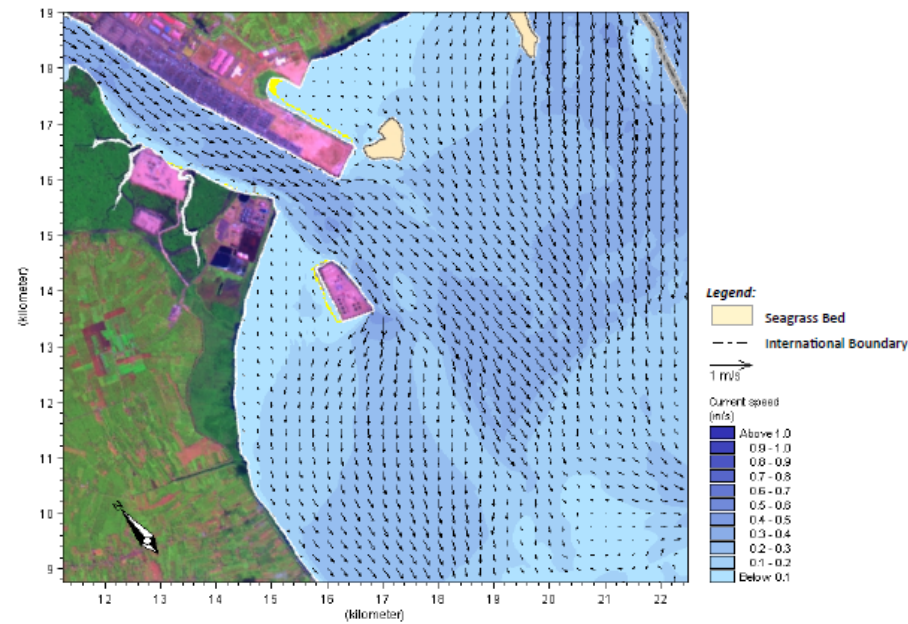
(a) Spring Period: Flood Flow



(b) Spring Period: Ebb Flow

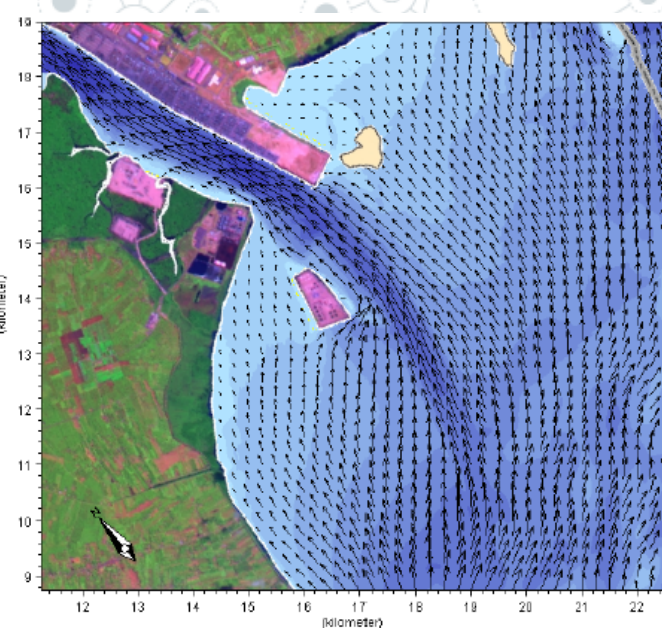


(c) Neap Period: Flood Flow

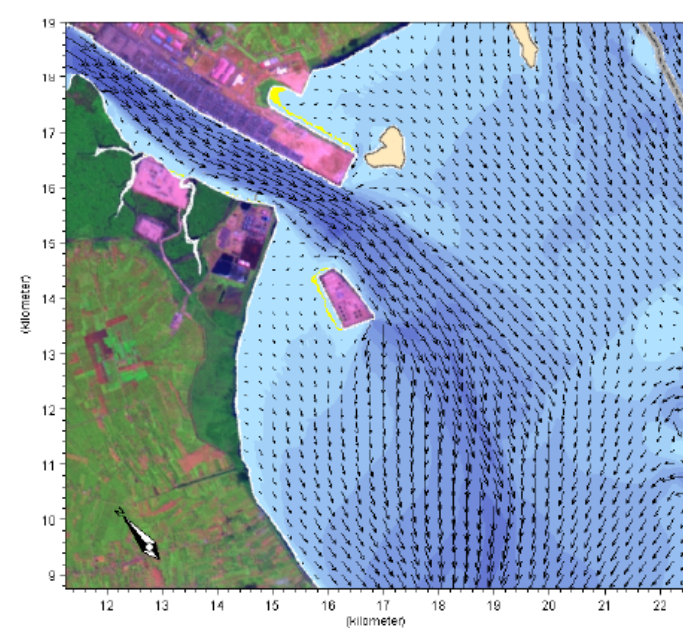


(d) Neap Period: Ebb Flow

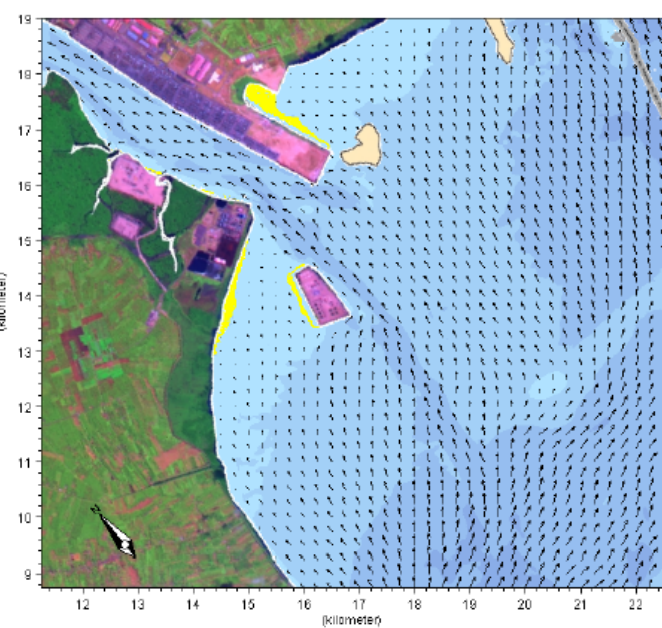
Flow Pattern During Spring and Neap Periods for Existing Condition: Southwest Monsoon Condition



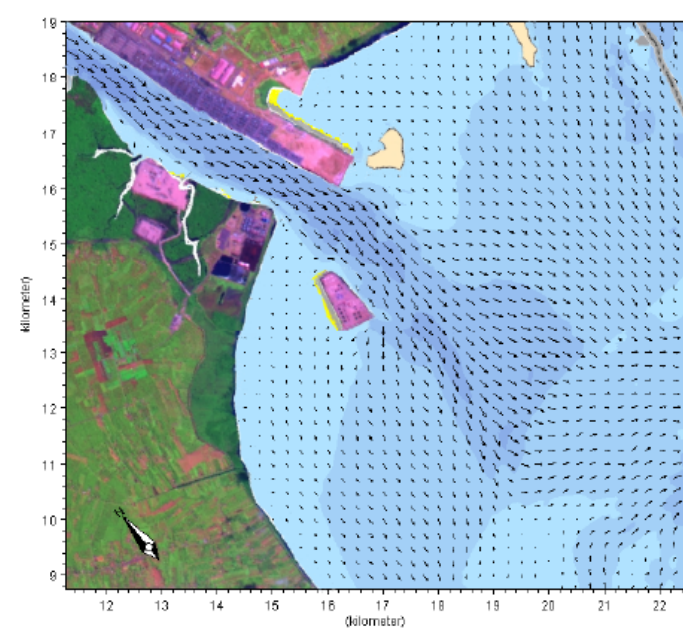
05/01/2017 7:23:00:00
(a) Spring Period: Flood Flow



05/01/2017 16:00:00
(b) Spring Period: Ebb Flow



05/01/2017 16:00:00
(c) Neap Period: Flood Flow



05/01/2017 08:00:00
(d) Neap Period: Ebb Flow

**Contoh: Mengira tinggi air pasang surut di Pelabuhan
Piawai pada 20 Januari jam 1300.**

Daripada ramalan Pelabuhan Piawai:

air pasang	1152	3.2 m.
air surut	1853	0.0 m.

Pasang surut sebelumnya	1152	3.2 m.
Pasang surut selepasnya	1853	0.0 m.

Tempoh dan julat	0701	3.2 m.
------------------	------	--------

Waktu di mana tinggi dikehendaki	1300
Waktu air surut (pasang) terhampir	1853 (1152)

Selang	0553 (0108)
--------	-------------

Daripada Jadual 1, dengan menentudalam tempoh, julat dan selang, nilai pembetulan yang diperolehi bagi air surut (pasang) ialah 3.0 (0.2) m.

Tinggi air surut (pasang)	0.0	(3.2) m.
---------------------------	-----	----------

Pembetulan	+3.0	(- 0.2) m.
------------	------	------------

Tinggi air pada jam 1300	3.0	(3.0) m.
--------------------------	-----	----------

JADUAL MENGIRA TINGGI AIR PASANG SURUT PADA WAKTU DI ANTARA AIR PASANG DAN SURUT

JADUAL 1-AM

Tempoh pasang atau surut <i>Duration of rise or fall</i>	SELANG DARI AIR SURUT (PASANG) TERHAMPIR INTERVAL FROM NEAREST LOW WATER (HIGH WATER)																				Tempoh pasang atau surut <i>Duration of rise or fall</i>
0330	0145	0150	0155	0201	0206	0211	0216	0222	0227	0232	0237	0243	0248	0253	0258	0304	0309	0314	0319	0325	0330
40	0150	0155	0201	0206	0212	0217	0223	0228	0234	0239	0245	0250	0256	0301	0307	0312	0318	0323	0329	0334	40
0350	0155	0201	0206	0212	0218	0224	0229	0235	0241	0247	0252	0258	0304	0310	0315	0321	0327	0333	0338	0344	0350
0400	0200	0206	0212	0218	0224	0230	0236	0242	0248	0254	0300	0306	0312	0318	0324	0330	0336	0342	0348	0354	0400
10	0205	0211	0217	0224	0230	0236	0242	0249	0255	0301	0307	0314	0320	0326	0332	0339	0345	0351	0357	0404	10
20	0210	0216	0223	0229	0236	0242	0249	0255	0302	0308	0315	0321	0328	0334	0341	0347	0354	0400	0407	0413	20
30	0215	0222	0228	0235	0242	0249	0255	0302	0309	0316	0322	0329	0336	0343	0349	0356	0403	0410	0416	0423	30
40	0220	0227	0234	0241	0248	0255	0302	0309	0316	0323	0330	0337	0344	0351	0358	0405	0412	0419	0426	0433	40
0450	0225	0232	0239	0247	0254	0301	0308	0316	0323	0330	0337	0345	0352	0359	0406	0414	0421	0428	0435	0443	0450
0500	0230	0237	0245	0252	0300	0307	0315	0322	0330	0337	0345	0352	0400	0407	0415	0422	0430	0437	0445	0452	0500
10	0235	0243	0250	0258	0306	0314	0321	0329	0337	0345	0352	0400	0408	0416	0423	0431	0439	0447	0454	0502	10
20	0240	0248	0256	0304	0312	0320	0328	0336	0344	0352	0400	0408	0416	0424	0432	0440	0448	0456	0504	0512	20
30	0245	0253	0301	0310	0318	0326	0334	0343	0351	0359	0407	0416	0424	0432	0440	0449	0457	0505	0513	0522	30
40	0250	0258	0307	0315	0324	0332	0341	0349	0358	0406	0415	0423	0432	0440	0449	0457	0506	0514	0523	0531	40
0550	0255	0304	0312	0321	0330	0339	0347	0356	0405	0414	0422	0431	0440	0449	0457	0506	0515	0524	0532	0541	0550
0600	0300	0309	0318	0327	0336	0345	0354	0403	0412	0421	0430	0439	0448	0457	0506	0515	0524	0533	0542	0551	0600
10	0305	0314	0323	0333	0342	0351	0400	0410	0419	0428	0437	0447	0456	0505	0514	0524	0533	0542	0551	0601	10
20	0310	0319	0329	0338	0348	0357	0407	0416	0426	0435	0445	0454	0504	0513	0523	0532	0542	0551	0601	0610	20
30	0315	0325	0334	0344	0354	0404	0413	0423	0433	0443	0452	0502	0512	0522	0531	0541	0551	0601	0610	0620	30
40	0320	0330	0340	0350	0400	0410	0420	0430	0440	0450	0500	0510	0520	0530	0540	0550	0600	0610	0620	0630	40
0650	0325	0335	0345	0356	0406	0416	0426	0437	0447	0457	0507	0518	0528	0538	0548	0559	0609	0619	0629	0640	0650
0700	0330	0340	0351	0401	0412	0422	0433	0443	0454	0504	0515	0525	0536	0546	0557	0607	0618	0628	0639	0649	0700
10	0335	0346	0356	0407	0418	0429	0439	0450	0501	0512	0522	0533	0544	0555	0605	0616	0627	0638	0648	0659	10
20	0340	0351	0402	0413	0424	0435	0446	0457	0508	0519	0530	0541	0552	0603	0614	0625	0636	0647	0658	0709	20
30	0345	0356	0407	0419	0430	0441	0452	0504	0515	0526	0537	0549	0600	0611	0622	0634	0645	0656	0707	0719	30
40	0350	0401	0413	0424	0436	0447	0459	0510	0522	0533	0545	0556	0608	0619	0631	0632	0654	0705	0717	0728	40
0750	0355	0407	0418	0430	0442	0454	0505	0517	0529	0541	0552	0604	0616	0628	0639	0651	0703	0715	0726	0738	0750
0800	0400	0412	0424	0436	0448	0500	0512	0524	0536	0548	0600	0612	0624	0636	0648	0700	0712	0724	0736	0748	0800

Julat	PEMBETULAN TINGGI AIR SURUT (PASANG) CORRECTION TO HEIGHT OF LOW WATER (HIGH WATER)																Julat
Range																	Range
5	2.5	2.7	2.9	3.1	3.3	3.5	3.6	3.8	4.0	4.1	4.3	4.4	4.5	4.6	4.7	4.8	5
6	3.0	3.3	3.5	3.7	3.9	4.1	4.4	4.6	4.8	4.9	5.1	5.3	5.4	5.6	5.7	5.8	6
7	3.5	3.8	4.0	4.3	4.6	4.8	5.1	5.3	5.6	5.8	6.0	6.2	6.3	6.5	6.6	6.7	7
8	4.0	4.3	4.6	4.9	5.2	5.5	5.8	6.1	6.4	6.6	6.8	7.0	7.2	7.4	7.6	7.7	8
9	4.5	4.9	5.2	5.6	5.9	6.2	6.5	6.9	7.1	7.4	7.7	7.9	8.1	8.3	8.5	8.7	9
10	5.0	5.4	5.8	6.2	6.5	6.9	7.3	7.6	7.9	8.2	8.5	8.8	9.0	9.3	9.5	9.6	10
11	5.5	6.0	6.4	6.8	7.2	7.6	8.0	8.4	8.7	9.1	9.4	9.7	9.9	10.2	10.4	10.6	11
12	6.0	6.5	6.9	7.4	7.9	8.3	8.7	9.1	9.5	9.9	10.2	10.6	10.9	11.1	11.3	11.5	12
13	6.5	7.0	7.5	8.0	8.5	9.0	9.5	9.9	10.2	10.6	11.1	11.4	11.8	12.0	12.3	12.5	13
14	7.0	7.6	8.1	8.6	9.2	9.7	10.2	10.6	11.1	11.4	11.8	12.3	12.7	13.0	13.2	13.5	14
15	7.5	8.1	8.7	9.3	9.8	10.4	10.9	11.4	11.8	12.3	12.7	13.2	13.6	13.9	14.2	14.4	15
16	8.0	8.7	9.3	9.9	10.5	11.1	11.6	12.1	12.5	13.0	13.5	14.0	14.5	14.8	15.1	15.4	16
17	8.5	9.2	9.8	10.0	11.1	11.8	12.4	12.9	13.4	13.9	14.4	14.9	15.4	15.7	16.1	16.4	17
18	9.0	9.7	10.4	11.1	11.8	12.4	13.0	13.5	14.0	14.5	15.0	15.5	16.3	16.7	17.0	17.3	18
19	9.5	10.3	11.0	11.7	12.4	13.1	13.8	14.5	15.1	15.8	16.5	17.2	17.2	17.6	18.0	18.3	19
20	10.0	10.8	11.6	12.3	13.1	13.8	14.5	15.2	15.8	16.5	17.2	17.9	18.1	18.5	18.9	19.2	20
21	10.5	11.3	12.1	13.0	13.7	14.5	15.3	16.0	16.7	17.5	18.1	18.8	19.0	19.5	19.9	20.2	21
22	11.0	11.9	12.7	13.6	14.4	15.2	16.0	16.7	17.5	18.1	18.8	19.4	19.9	20.4	20.8	21.2	22
23	11.5	12.4	13.3	14.2	15.1	15.9	16.7	17.5	18.3	19.0	19.7	20.5	20.8	21.3	21.7	22.1	23
24	12.0	13.0	13.9	14.8	15.7	16.6	17.4	18.3	19.1	19.8	20.5	21.3	21.7	22.2	22.7	23.1	24
25	12.5	13.5	14.5	15.4	16.4	17.3	18.2	19.0	19.8	20.6	21.3	22.1	22.6	23.3	23.6	24.0	25
26	13.0	14.0	15.0	16.0	17.0	18.0	18.9	19.8	20.6	21.4	22.2	22.9	23.5	24.1	24.6	25.0	26
27	13.5	14.6	15.6	16.7	17.7	18.7	19.6	20.6	21.4	22.3	23.0	23.8	24.4	25.0	25.5	26.0	27
28	14.0	15.1	16.2	17.3	18.3	19.4	20.4	21.3	22.1	23.1	23.9	24.6	24.8	25.9	26.5	26.9	28
29	14.5	15.7	16.8	17.9	19.0	20.0	21.1	22.1	23.0	23.9	24.8	25.5	26.2	26.9	27.4	27.9	29
30	15.0	16.2	17.3	18.5	19.6	20.7	21.8	22.8	23.8	24.7	25.6	26.4	27.1	27.8	28.4	28.9	30
31	15.5	16.7	17.9	19.1	20.3	21.4	22.5	23.6	24.6	25.6	26.5	27.3	28.0	28.7	29.3	29.8	31
32	16.0	17.3	18.5	19.7	21.0	22.1	23.3	24.4	25.4	26.4	27.3	28.2	28.9	29.6	30.3	30.8	32
33	16.5	17.8	19.1	20.4	21.6	22.8	24.0	25.1	26.2	27.2	28.2	29.0	29.8	30.6	31.2	31.7	33
34	17.0	18.4	19.7	21.0	22.3	23.5	24.7	25.9	27.0	28.0	29.0	29.9	30.8	31.5	32.1	32.7	34
35	17.5	18.9	20.2	21.6	22.9	24.2	25.4	26.6	27.8	28.9	29.9	30.8	31.7	32.4	33.1	33.7	35
36	18.0	19.4	20.8	22.2	23.6	24.9	26.2	27.4	28.6	29.7	30.7	31.7	32.6	33.3	34.0	34.6	36
37	18.5	20.0	21.4	22.8	24.2	25.6	26.9	28.2	29.4	30.5	31.6	32.6	33.5	34.3	35.0	35.6	37
38	19.0	20.5	22.0	23.4	24.9	26.3	27.6	28.9	30.2	31.3	32.4	33.4	34.4	35.2	35.9	36.6	38
39	19.5	21.1	22.6	24.1	25.5	27.0	28.4	29.7	31.0	32.2	33.3	34.3	35.3	36.1	36.9	37.5	39
40	20.0	21.6	23.1	24.7	26.2	27.7	29.1	30.4	31.8	33.0	34.1	35.2	36.2	37.1	37.8	38.5	40
41	20.5	22.1	23.7	25.3	26.8	28.3	29.8	31.2	32.5	33.8	35.0	36.1	37.1	38.0	38.8	39.4	41
42	21.0	22.6	24.3	25.9	27.5	29.0	30.5	32.0	33.3	34.6	35.8	37.0	38.0	38.9	39.7	40.4	42
43	21.5	23.2	24.9	26.5	28.1	29.7	31.3	32.7	34.1	35.5	36.7	37.8	38.9	39.8	40.7	41.4	43
44	22.0	23.7	25.4	27.1	28.8	30.4	32.0	33.5	34.9	36.3	37.6	38.7	39.8	40.8	41.6	42.3	44
45	22.5	24.3	26.0	27.8	29.5	31.1	32.7	34.3	35.7	37.1	38.4	39.6	40.7	41.7	42.5	43.3	45
46	23.0	24.8	26.6	28.4	30.1	31.8	33.4	35.0	36.5	37.9	39.3	40.5	41.6	42.6	43.5	44.2	46
47	23.5	25.3	27.2	29.0	30.8	32.5	34.2	35.8	37.3	38.8	40.1	41.4	42.5	43.5	44.4	45.2	47
48	24.0	25.9	27.8	29.6	31.4	33.2	34.9	36.5	38.1	39.6	41.0	42.2	43.4	44.5	45.4	46.2	48
49	24.5	26.4	28.3	30.2	32.1	33.9	35.6	37.3	38.9	40.4	41.8	43.1	44.3	45.4	46.3	47.1	49
50	25.0	27.0	28.9	30.8	32.7	34.6	36.3	38.1	39.7	41.2	42.7	44.0	45.2	46.3	47.3	48.1	50

30.3 @
3.03m @
3m

Tempoh
pasang
atau surut
(Duration
of rise or fall)

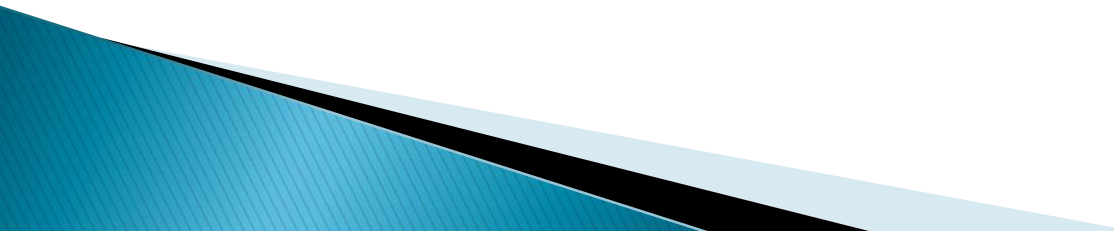
SELANG DARI AIR SURUT (PASANG) TERHAMPIR
INTERVAL FROM NEAREST LOW WATER (HIGH WATER)

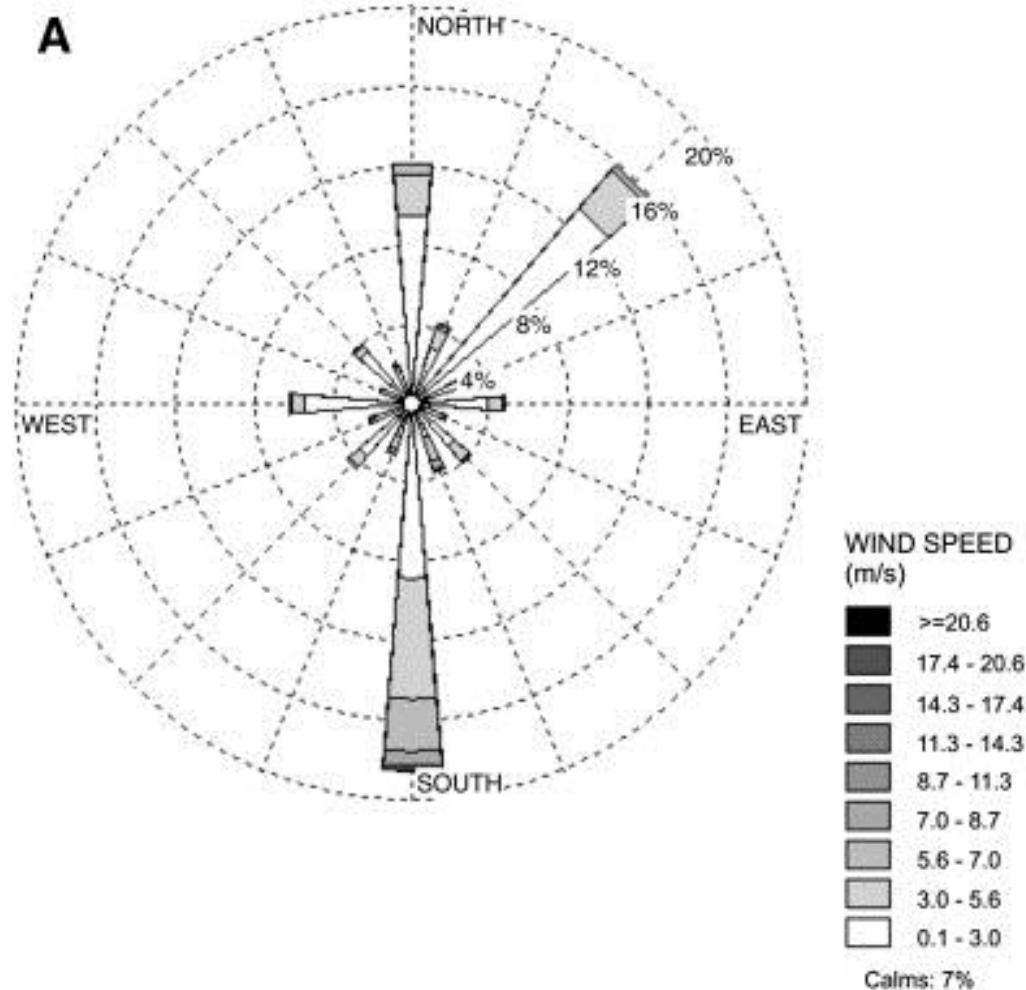
0330	0005	0011	0016	0021	0026	0032	0037	0042	0047	0053	0058	0103	0108	0114	0119	0124	0129	0135	0140
40	0006	0011	0017	0022	0028	0033	0039	0044	0050	0055	0101	0106	0112	0117	0123	0128	0134	0139	0145
0350	0006	0012	0017	0023	0029	0035	0040	0046	0052	0058	0103	0109	0115	0121	0126	0132	0138	0144	0149
0400	0006	0012	0018	0024	0030	0036	0042	0048	0054	0100	0106	0112	0118	0124	0130	0136	0142	0148	0154
10	0006	0013	0019	0025	0031	0038	0044	0050	0056	0103	0109	0115	0121	0128	0134	0140	0146	0153	0159
20	0007	0013	0020	0026	0033	0039	0046	0052	0059	0105	0112	0118	0125	0131	0138	0144	0151	0157	0204
30	0007	0014	0020	0027	0034	0041	0047	0054	0101	0108	0114	0121	0128	0135	0141	0148	0155	0202	0208
40	0007	0014	0021	0028	0035	0042	0046	0056	0103	0110	0117	0124	0131	0138	0145	0152	0159	0206	0213
0450	0007	0015	0022	0029	0036	0044	0051	0058	0105	0113	0120	0127	0134	0142	0149	0156	0203	0211	0218
0500	0008	0015	0023	0030	0038	0045	0053	0100	0108	0115	0123	0130	0138	0145	0153	0200	0208	0215	0223
10	0008	0016	0023	0026	0039	0047	0054	0102	0110	0118	0125	0133	0141	0149	0156	0204	0212	0220	0227
20	0008	0016	0024	0032	0040	0048	0056	0104	0112	0120	0128	0136	0144	0152	0200	0208	0216	0224	0232
30	0008	0017	0025	0033	0041	0050	0058	0106	0114	0123	0131	0139	0147	0156	0204	0212	0220	0229	0237
40	0009	0017	0026	0034	0043	0051	0100	0108	0117	0125	0134	0142	0151	0159	0208	0216	0225	0233	0242
0550	0009	0018	0026	0035	0044	0053	0101	0110	0119	0128	0138	0145	0154	0203	0211	0220	0229	0238	0246
0600	0009	0018	0027	0036	0045	0054	0103	0112	0121	0130	0139	0148	0157	0206	0215	0224	0233	0242	0251
10	0009	0019	0028	0037	0046	0056	0105	0114	0123	0133	0142	0151	0200	0210	0219	0228	0237	0247	0256
20	0010	0019	0029	0038	0048	0057	0107	0116	0126	0135	0145	0154	0204	0213	0223	0232	0242	0251	0301
30	0010	0020	0029	0039	0049	0059	0108	0118	0128	0138	0147	0157	0207	0217	0226	0236	0246	0256	0305
40	0010	0020	0030	0040	0050	0100	0110	0120	0130	0140	0150	0200	0210	0220	0230	0240	0250	0300	0310
0650	0010	0021	0031	0041	0051	0102	0112	0122	0132	0143	0153	0203	0213	0224	0234	0244	0254	0305	0315
0700	0011	0021	0032	0042	0053	0103	0114	0124	0135	0145	0156	0206	0217	0227	0238	0248	0259	0309	0320
10	0011	0022	0032	0043	0054	0105	0115	0126	0137	0148	0158	0209	0220	0231	0241	0252	0303	0314	0324
20	0011	0022	0033	0044	0055	0106	0117	0128	0139	0150	0201	0212	0223	0234	0245	0256	0307	0318	0329
30	0011	0023	0034	0045	0056	0108	0119	0130	0141	0153	0204	0215	0226	0238	0249	0300	0311	0323	0334
40	0012	0023	0035	0046	0058	0109	0121	0132	0144	0155	0207	0218	0230	0241	0253	0304	0316	0327	0339
0750	0012	0024	0035	0047	0059	0111	0122	0134	0146	0158	0209	0221	0233	0245	0256	0308	0320	0332	0343
0800	0012	0024	0036	0048	0100	0112	0124	0136	0148	0200	0212	0224	0236	0248	0300	0312	0324	0336	0348

Julat (Range)	PEMBETULAN TINGGI AIR SURUT (PASANG) CORRECTIONS TO HEIGHT OF LOW WATER (HIGH WATER)																		
5	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.5	0.6	0.7	0.9	1.0	1.2	1.4	1.5	1.7	1.9	2.1	2.3
6	0.0	0.0	0.1	0.1	0.2	0.3	0.4	0.6	0.7	0.9	1.1	1.2	1.4	1.6	1.9	2.1	2.3	2.5	2.7
7	0.0	0.0	0.1	0.2	0.3	0.4	0.5	0.7	0.8	1.0	1.2	1.4	1.7	1.9	2.2	2.4	2.7	3.0	3.2
8	0.0	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.0	1.2	1.4	1.6	1.9	2.2	2.5	2.8	3.1	3.4	3.7
9	0.0	0.1	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.3	1.6	1.9	2.1	2.5	2.8	3.1	3.4	3.8	4.1
10	0.0	0.1	0.1	0.2	0.4	0.5	0.7	1.0	1.2	1.5	1.8	2.1	2.4	2.7	3.1	3.5	3.8	4.2	4.6
11	0.0	0.1	0.2	0.3	0.4	0.6	0.8	1.1	1.3	1.6	1.9	2.3	2.6	3.0	3.4	3.8	4.2	4.6	5.0
12	0.0	0.1	0.2	0.3	0.5	0.7	0.9	1.1	1.4	1.8	2.1	2.5	2.9	3.3	3.7	4.1	4.6	5.1	5.5
13	0.0	0.1	0.2	0.3	0.5	0.7	1.0	1.2	1.6	1.9	2.3	2.7	3.1	3.5	4.0	4.5	5.0	5.5	6.0
14	0.0	0.1	0.2	0.3	0.5	0.8	1.0	1.3	1.7	2.1	2.5	2.9	3.3	3.8	4.3	4.8	5.4	5.9	6.4
15	0.0	0.1	0.2	0.4	0.6	0.8	1.1	1.4	1.8	2.2	2.6	3.1	3.6	4.1	4.6	5.2	5.7	6.3	6.9
16	0.0	0.1	0.2	0.4	0.6	0.9	1.2	1.5	1.9	2.3	2.8	3.3	3.8	4.4	4.9	5.5	6.1	6.7	7.3
17	0.0	0.1	0.2	0.4	0.6	0.9	1.3	1.6	2.0	2.5	3.0	3.5	4.1	4.6	5.2	5.9	6.5	7.2	7.8
18	0.0	0.1	0.2	0.4	0.7	1.0	1.3	1.7	2.2	2.6	3.2	3.7	4.3	4.9	5.6	6.2	6.9	7.6	8.3
19	0.0	0.1	0.3	0.5	0.7	1.0	1.4	1.8	2.3	2.8	3.3	3.9	4.5	5.2	5.9	6.6	7.3	8.0	8.7
20	0.0	0.1	0.3	0.5	0.8	1.1	1.5	1.9	2.4	2.9	3.5	4.1	4.8	5.5	6.2	6.9	7.7	8.4	9.2
21	0.0	0.1	0.3	0.5	0.8	1.1	1.5	2.0	2.5	3.1	3.7	4.3	5.0	5.7	6.5	7.3	8.0	8.9	9.7
22	0.0	0.1	0.3	0.5	0.8	1.2	1.6	2.1	2.6	3.2	3.9	4.5	5.3	6.0	6.8	7.6	8.4	9.3	10.1
23	0.0	0.1	0.3	0.6	0.9	1.3	1.7	2.2	2.8	3.4	4.1	4.7	5.5	6.3	7.1	7.9	8.8	9.7	10.6
24	0.0	0.1	0.3	0.6	0.9	1.3	1.8	2.3	2.9	3.5	4.2	4.8	5.6	6.4	7.4	8.3	9.2	10.1	11.0
25	0.0	0.2	0.3	0.6	1.0	1.4	1.8	2.4	3.0	3.7	4.4	5.0	5.8	6.6	7.7	8.6	9.6	10.5	11.5
26	0.0	0.2	0.4	0.6	1.0	1.4	1.9	2.5	3.1	3.8	4.5	5.1	5.9	6.7	8.0	9.0	10.0	11.0	12.0
27	0.0	0.2	0.4	0.7	1.0	1.5	2.0	2.6	3.2	4.0	4.7	5.3	6.1	6.9	8.3	9.3	10.3	11.4	12.4
28	0.0	0.2	0.4	0.7	1.1	1.5	2.1	2.7	3.4	4.2	4.9	5.5	6.3	7.6	8.6	9.7	10.7	11.8	12.9
29	0.0	0.2	0.4	0.7	1.1	1.6	2.1	2.8	3.5	4.2	5.1	6.0	6.9	7.9	9.0	10.0	11.1	12.3	13.3
30	0.0	0.2	0.4	0.7	1.1	1.6	2.2	2.9	3.6	4.4	5.3	6.2	7.2	8.2	9.3	10.4	11.5	12.7	13.8
31	0.0	0.2	0.4	0.8	1.2	1.7	2.3	3.0	3.7	4.5	5.4	6.4	7.4	8.5	9.6	10.7	11.9	13.1	14.3
32	0.0	0.2	0.4	0.8	1.2	1.7	2.4	3.1	3.8	4.7	5.6	6.6	7.6	8.7	9.9	11.0	12.3	13.5	14.7
33	0.1	0.2	0.5	0.8	1.3	1.8	2.4	3.2	4.0	4.8	5.8	6.8	7.9	9.0	10.2	11.4	12.6	13.9	15.2
34	0.1	0.2	0.5	0.8	1.3	1.9	2.5	3.2	4.1	5.0	6.0	7.0	8.1	9.3	10.5	11.7	13.0	14.3	15.6
35	0.1	0.2	0.5	0.9	1.3	1.9	2.6	3.3	4.2	5.1	6.1	7.2	8.4	9.6	10.8	12.1	13.4	14.8	16.1
36	0.1	0.2	0.5	0.9	1.4	2.0	2.7	3.4	4.3	5.3	6.3	7.4	8.6	9.8	11.1	12.4	13.8	15.2	16.6
37	0.1	0.2	0.5	0.9	1.4	2.0	2.7	3.5	4.4	5.4	6.5	7.6	8.8	10.1	11.4	12.8	14.2	15.6	17.0
38	0.1	0.2	0.5	0.9	1.4	2.1	2.8	3.6	4.6	5.6	6.7	7.8	9.1	10.4	11.7	13.1	14.6	16.0	17.5

1.7 @
0.17m @
0.2m

3) Angin

- ▶ Angin merupakan salah satu komponen di dalam pembentukan ombak kerana angin bertindak sebagai daya yang menjana ombak.
 - ▶ Arah tiupan angin dapat dihubungkan dengan arah pergerakan ombak.
 - ▶ Keadaan angin dipengaruhi oleh musim monsun.
 - ▶ Terdapat dua musim monsun iaitu Musim Angin Monsun Timur Laut dan Musim Angin Monsun Barat Daya.
 - ▶ Musim Monsun Timur Laut bermula pada bulan November hingga bulan Mac.
 - ▶ Manakala Musim Monsun Barat Daya bermula pada bulan Mei hingga bulan September.
- 

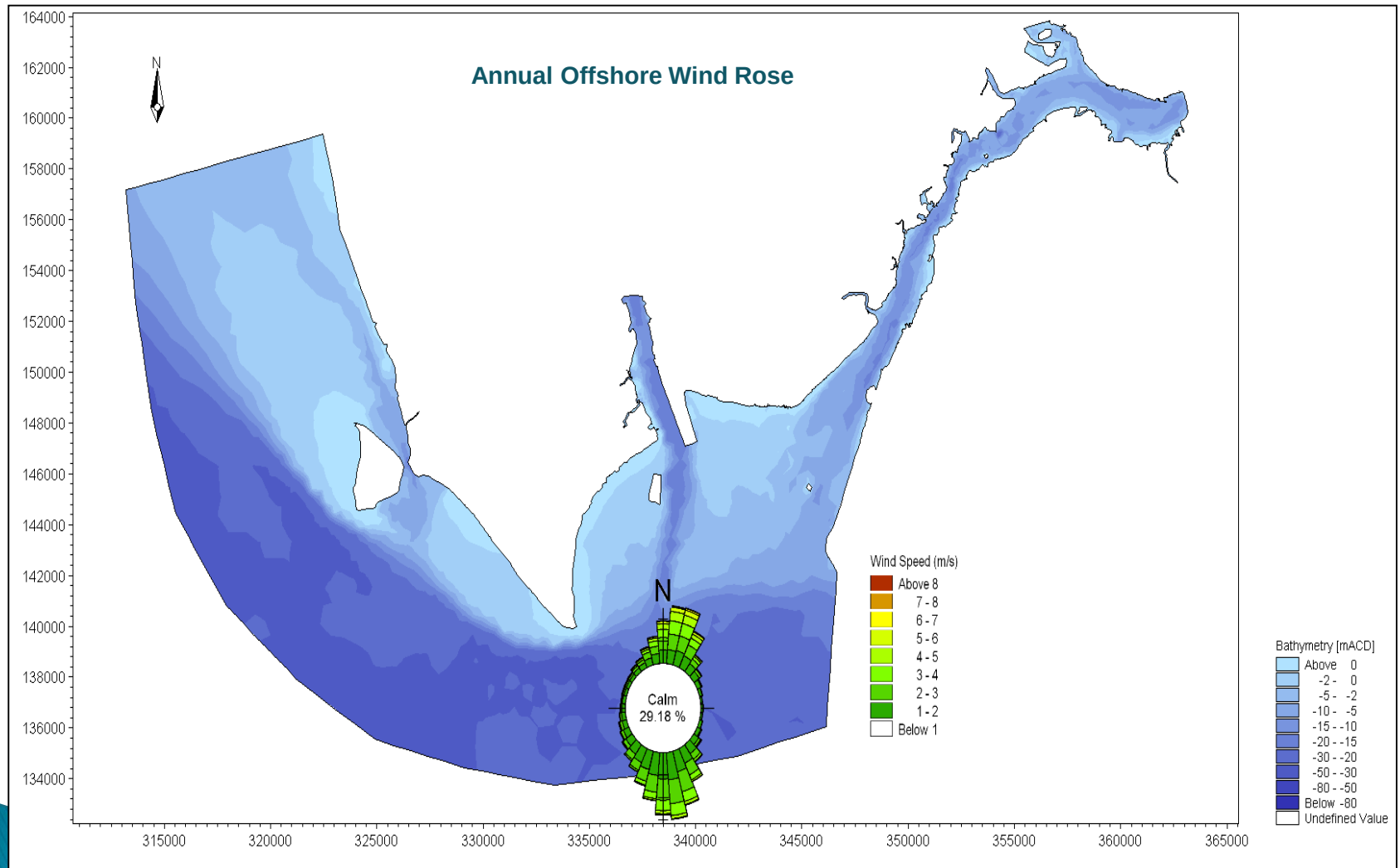


- Bacaan tiupan angin di rekod oleh Jabatan Meteorologi Malaysia (JMM).
- Data angin ditunjukkan dalam bentuk arah dan kelajuan angin dalam meter per saat.
- Data ini kemudiannya diproses untuk mendapatkan ringkasan tiupan angin (*wind roses*)

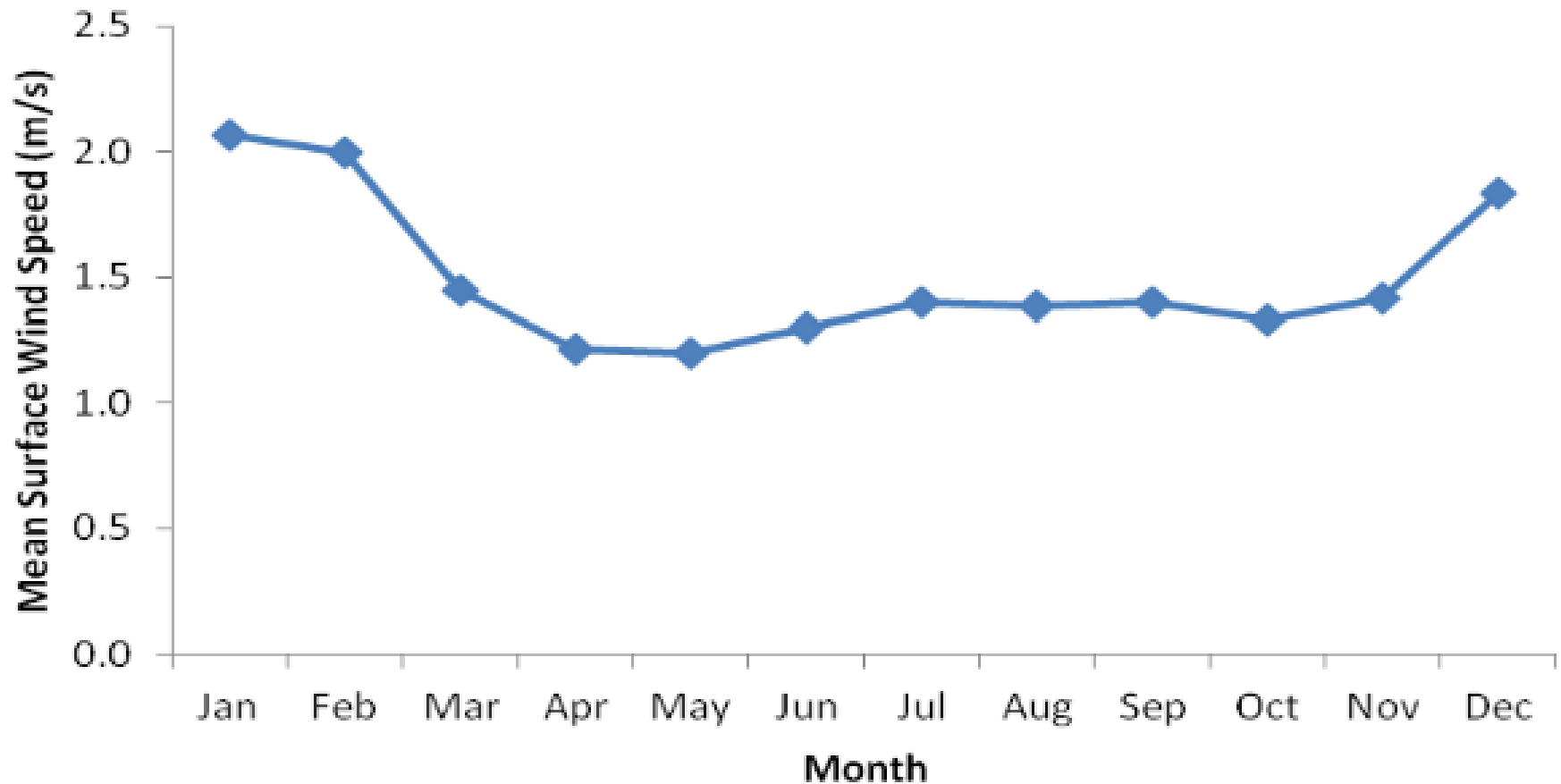
Data Angin daripada JMM

1	Malaysian Meteorological Department							
2	Period : 2008							
3	Range : Latitude 0.0 - 8.0 N Longitude 99.0 - 121.0 E							
4								
5	Note:							
6	1. The directions indicate where the wind , wave or swell is COMING from.							
7	2. The number 990 in the direction column indicate variable direction .							
8	3. Add 8 hours to the UTC time to get the local time.							
9								
10	Year	Month	Day	ObsTime [UTC]	Latitude [degree]	Longitude [degree]	WindDirection [degree]	WindSpeed [knots]
11	2008	01	01	00	3.5	104.3	240	30.0
12	2008	01	01	00	4.3	107.1	030	32.0
13	2008	01	01	00	4.4	110.9	310	13.0
14	2008	01	01	00	6.1	107.4	030	25.0
15	2008	01	01	06	1.2	103.9	010	33.0
16	2008	01	01	06	2.3	101.8	050	15.5
17	2008	01	01	06	3.4	109.1	360	21.0
18	2008	01	01	06	5.6	108.6	020	25.0
19	2008	01	01	06	7.2	108.1	040	46.0
20	2008	01	01	12	2.6	101.2	160	7.0
21	2008	01	01	12	2.7	107.4	010	21.0
22	2008	01	01	12	3.7	105.8	010	12.0
23	2008	01	01	12	6.9	109.8	010	34.0
24	2008	01	01	18	1.2	103.9	010	33.0
25	2008	01	01	18	1.5	102.9	030	11.0
26	2008	01	01	18	2.0	105.8	340	16.0
27	2008	01	01	00	2.8	107.8	330	22.0

Annual Offshore Wind Rose



Annual Wind Pattern



Source: JBIA Meteorological Station

Figure 6.24 Annual Mean Velocity Wind Pattern 2006-2011

Seasonal offshore Wind Roses for Eastern Straits of Johor

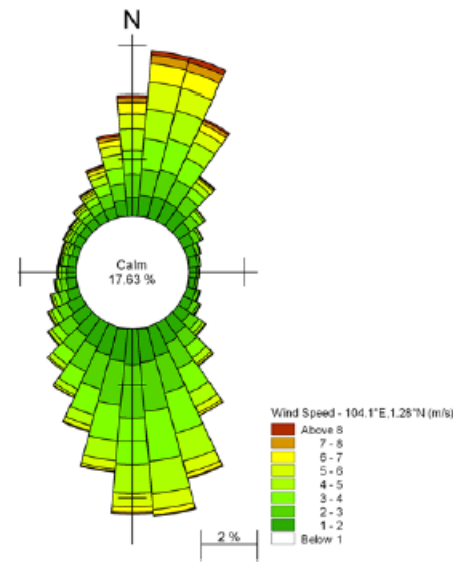
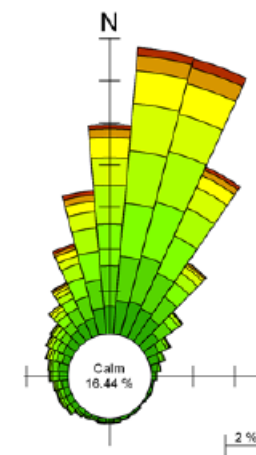
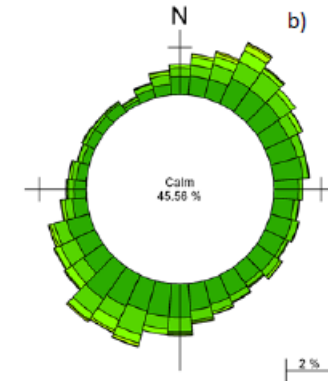


Figure 4.1
Annual Offshore Wind Rose for Eastern Straits of Johor

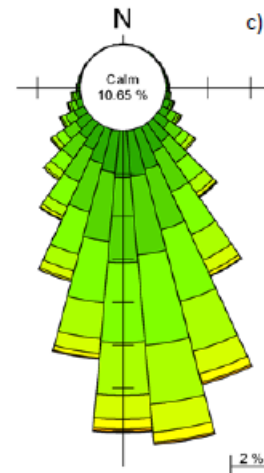
a) Northeast Monsoon



b) Inter-monsoon (April)



c) Southwest Monsoon



d) Inter-monsoon (October)

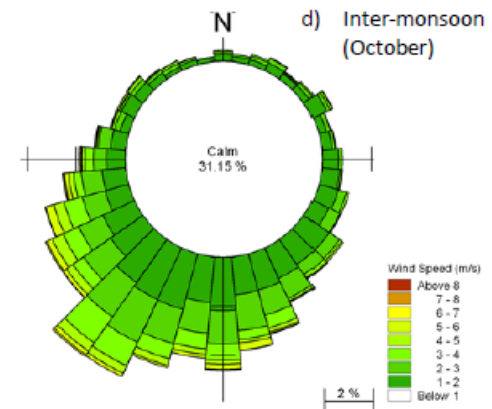


Figure 4.2 *Seasonal Offshore Wind Roses for Eastern Straits of Johor*

Seasonal offshore Wind Roses for Western Straits of Johor

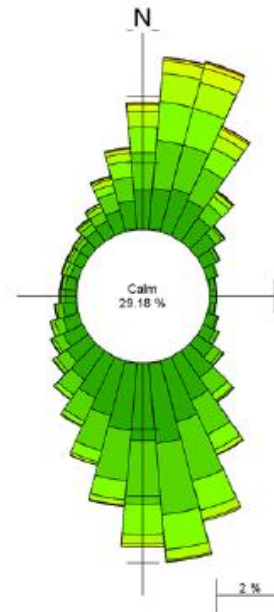
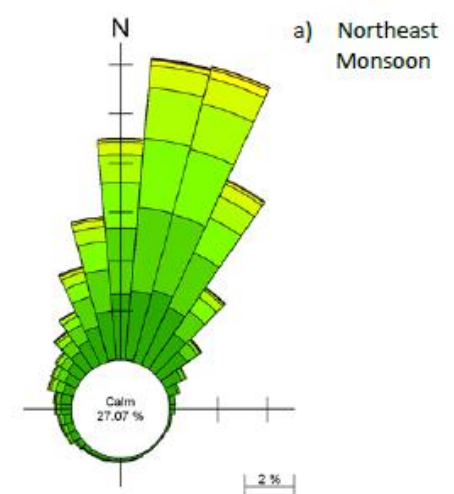
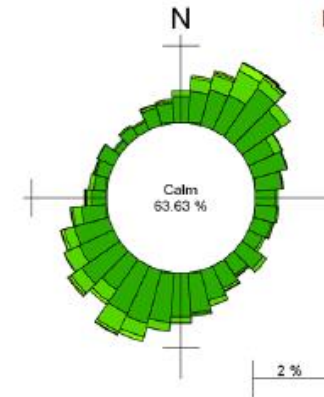


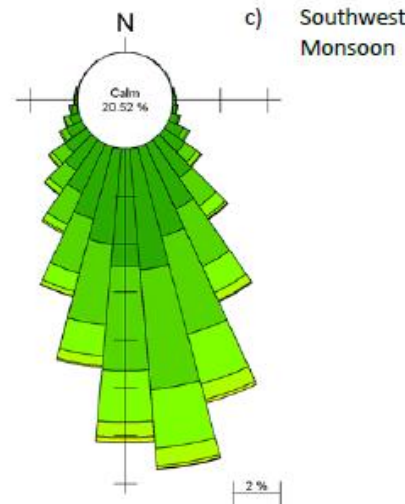
Figure 4.3
Annual Offshore Wind Rose for Western Straits of Johor



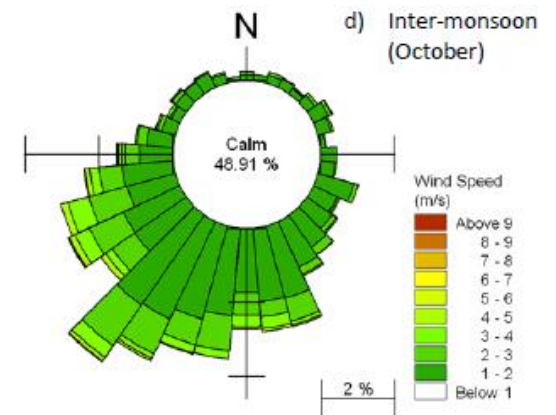
a) Northeast Monsoon



b) Inter-monsoon (April)



c) Southwest Monsoon



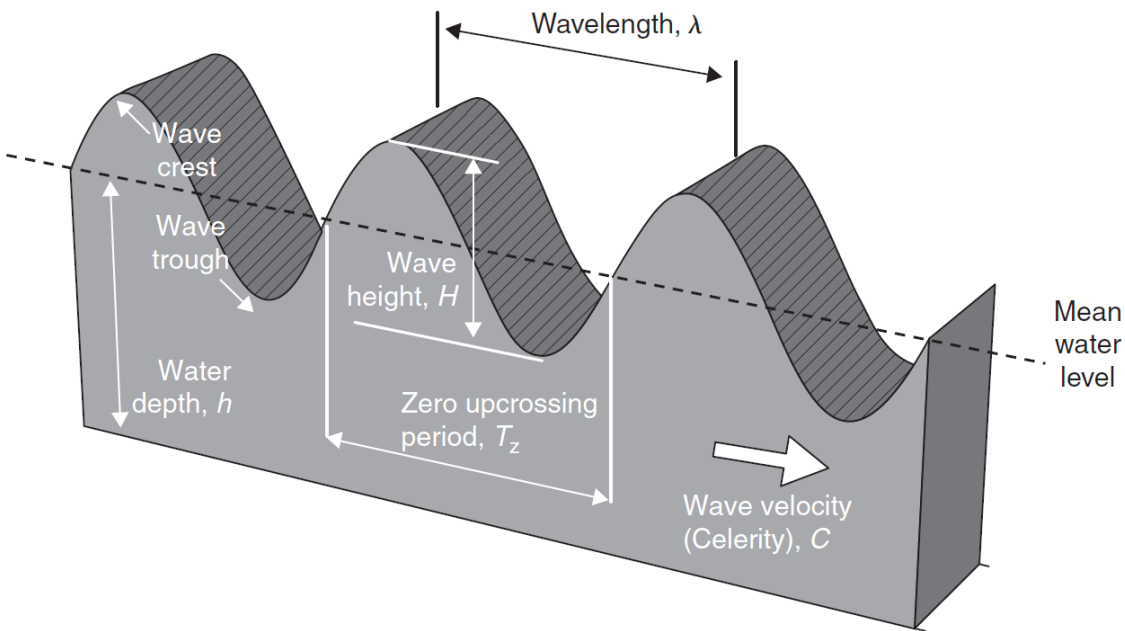
d) Inter-monsoon (October)

4) Ombak

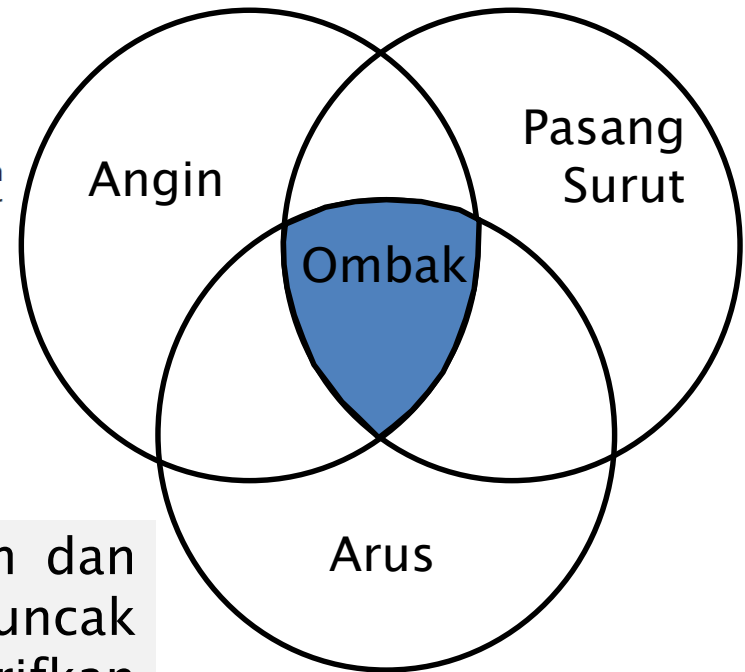
- ▶ Ombak merupakan kejadian fenomena yang biasa dan salah satu daripada daya hidrodinamik yang bertindak ke atas pantai.
- ▶ Ombak terjadi apabila pergerakan berkala air dalam keadaan tertentu sama ada depan ke belakang atau atas ke bawah.
- ▶ Ombak lautan terjadi akibat daripada tiupan angin yang meniup permukaan laut dan seterusnya membentuk ombak.
- ▶ Terdapat juga ombak yang terhasil daripada tarikan astronomi seperti pasang surut, pergerakan dasar laut (*tsunamis*) atau apabila berlaku perubahan pada tekanan atmosfera di permukaan air tenang (*seiches*).

Ciri-ciri dan pembentukan *kejadian ombak*

- ▶ *Air mempunyai kedalaman yang tetap, d dan panjang gelombang, L (atau tempoh, T).*
- ▶ *Pergerakan ombak adalah di dalam bentuk 2 dimensi, yang membawa kepada puncak ombak yang tinggi dengan ketinggian malar di sepanjang puncak.*
- ▶ *Ombak adalah tetap iaitu tidak berubah mengikut masa.*
- ▶ *Bendalir (air) adalah tidak boleh mampat.*
- ▶ *Kesan kelikatan, gelora, dan ketegangan permukaan mempunyai kaitan di antara satu sama lain.*
- ▶ *Ketinggian ombak, H adalah kecil berbanding dengan panjang gelombang, L dan kedalaman air, d (iaitu $H / L \ll 1$ dan $H / d \ll 1$).*



Komponen kejadian ombak

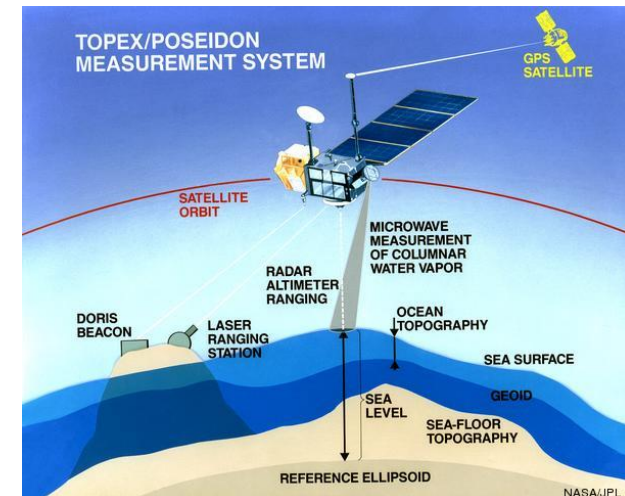


- Semua gelombang mempunyai ketinggian dan panjang yang sama dan masa di antara puncak gelombang juga berterusan dan ditakrifkan sebagai tempoh gelombang.
- Dalam gelombang monokromatik, tenaga adalah berkadar dengan kuasa dua ketinggian ombak dan tempoh gelombang.
- Gerakan gelombang adalah set tenaga yang bergerak dan zarah air tidak bergerak bersama-sama dengan gelombang.
- Tenaga yang dihasilkan akan berkurangan apabila ia mula sampai ke laut cetek dan pantai.

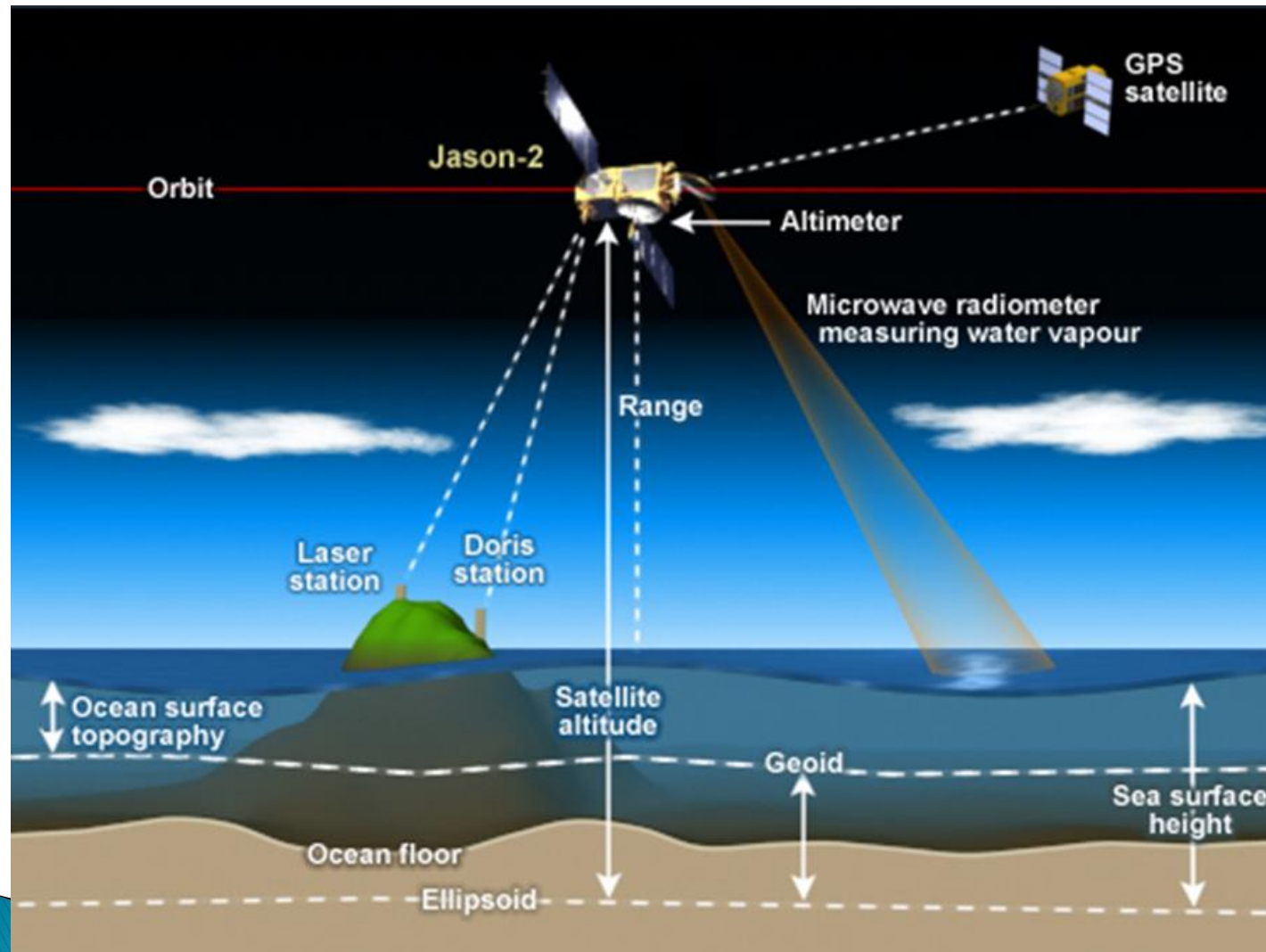


Satellite Altimeter

- ▶ Use of satellite radar altimeters to measure global **sea surface height (SSH)** has come a long way since the brief Seasat mission of 1978.
- ▶ Early missions measured SSH with an accuracy of tens of metres.
- ▶ More recent high quality satellite altimeter missions such as TOPEX/Poseidon (launched August 1992) and Jason-1 (launched December 2001) measure SSH to an accuracy of a few centimetres.
- ▶ These satellites were specifically designed to measure SSH to the highest possible accuracy.

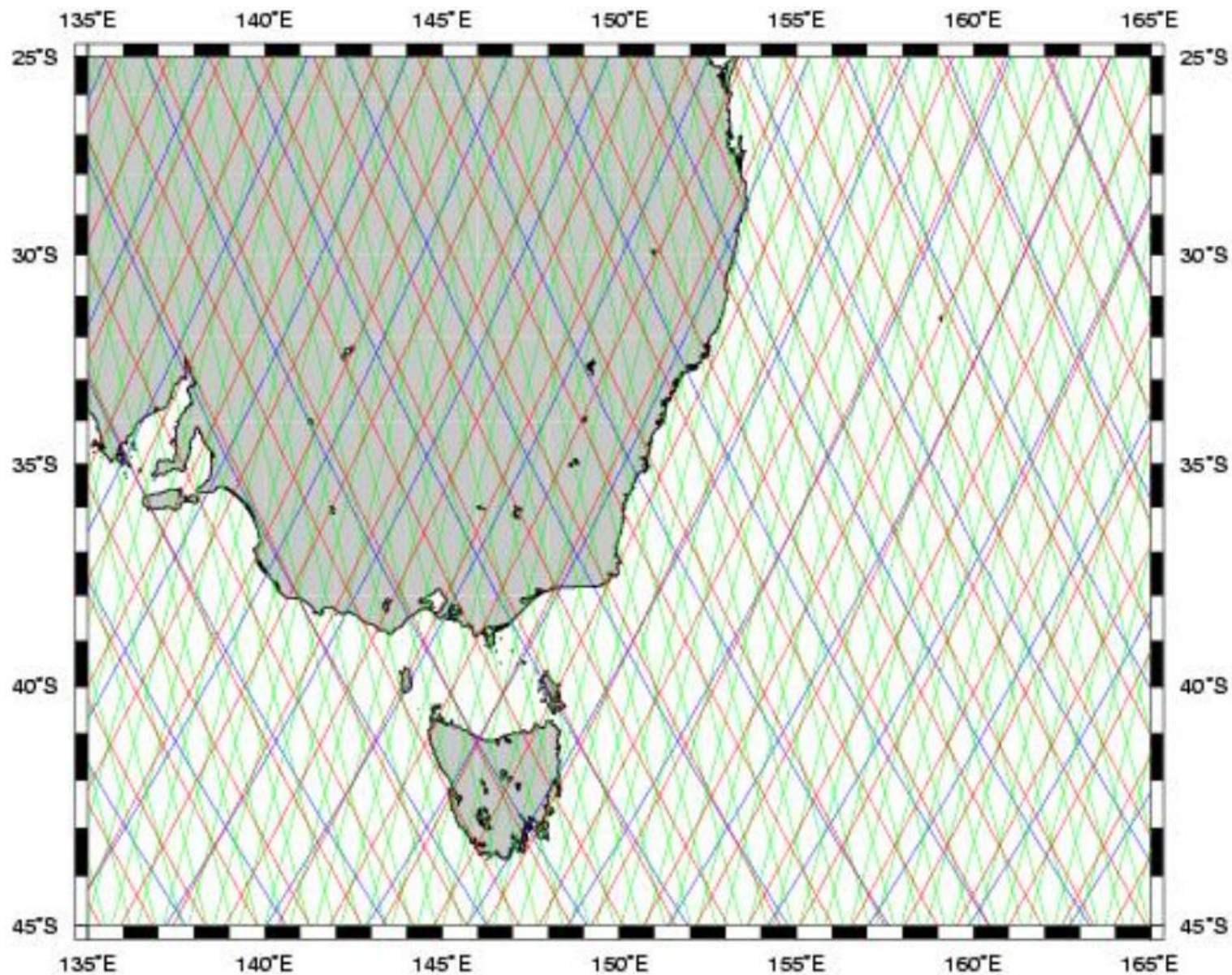


Satellite Altimeter



Satellite altimeter missions

Name	When	Orbit characteristics	Comments
Skylab	1973		Experimental
Geos-3	1975-78		Mainly geodetic
Seasat	1978 (3 months)	800km, 3-day repeat, inclination=78°, retrograde	Oceanographic
GEOSAT Geodetic Mission	1985-1986 (18 months)	800km, non-repeating	Geodetic
GEOSAT ERM (Exact Repeat Mission)	1986-1990	800km, 17-day repeat, inclination=78°, retrograde (included Seasat orbit)	Oceanographic
ERS-1 other phases	various, 1991 on	Various modes, including a brief geodetic phase	
ERS-1 phases C & G	1992-1993 and 1995-1996	800km, 35-day repeat, inclination=81°, retrograde, sun-synchronous	Oceanographic
TOPEX/Poseidon	1992-2005	1340km, 10-day repeat, inclination=66°, prograde	First truly high quality oceanographic altimeter
ERS-2	1995-2003	As for ERS-1 phases C&G	
GFO (GEOSAT Follow On)	2000-2008	As for GEOSAT	Follow-on of GEOSAT ERM
Jason-1	2001-present	As for TOPEX/Poseidon	Follow-on of TOPEX/Poseidon mission
Envisat	2002-present	As for ERS-2	
Jason-2	June 2008 - present	As for Jason-1	Follow-on of TOPEX/Poseidon and Jason-1



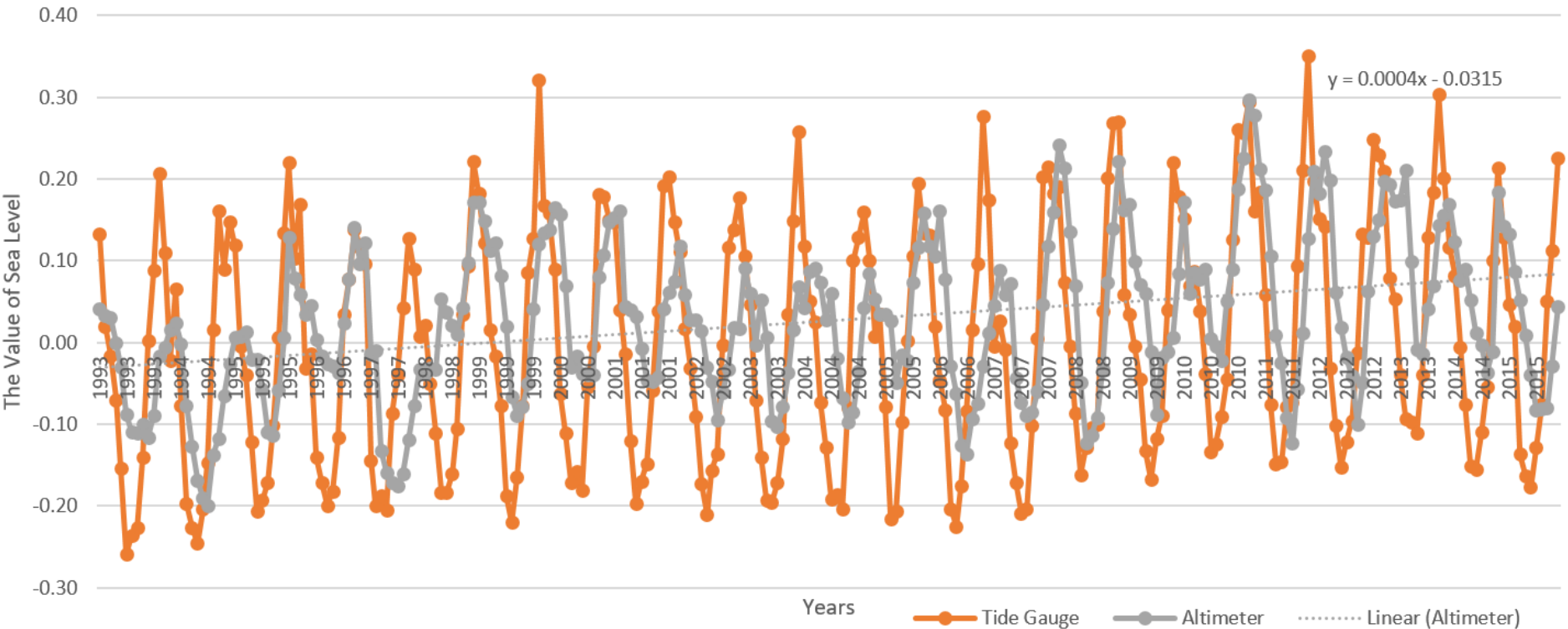
**TOPEX/Poseidon
& Jason-1
(10 days)**

**ERS-1/2
& Envisat
(35 days)**

**GEOSAT
& GFO
(17 days)**

Satellite Altimeter

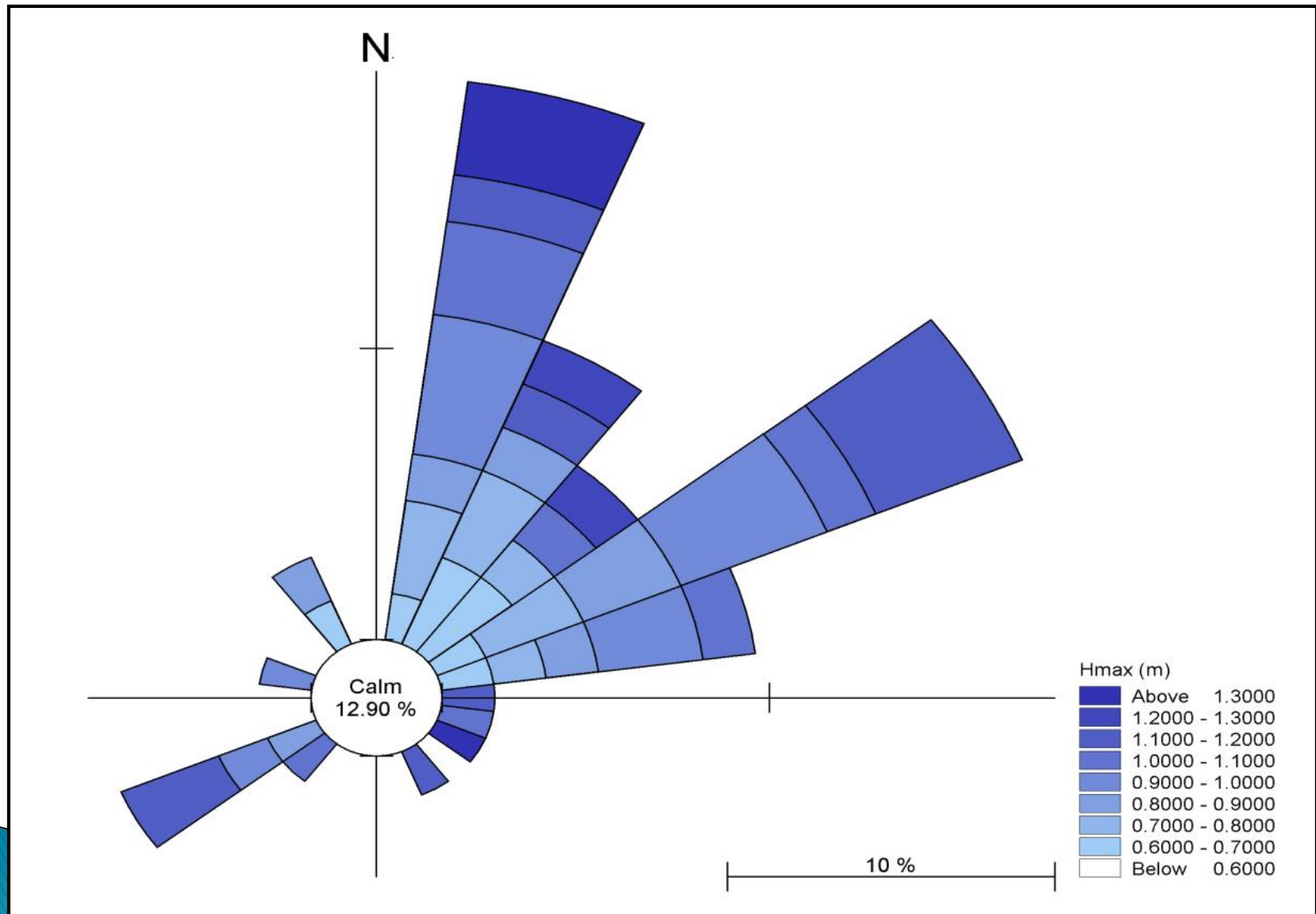
Sea Level trends between altimeter satellite and tide gauge at Tanjung Gelang (Year 1993 - 2015)



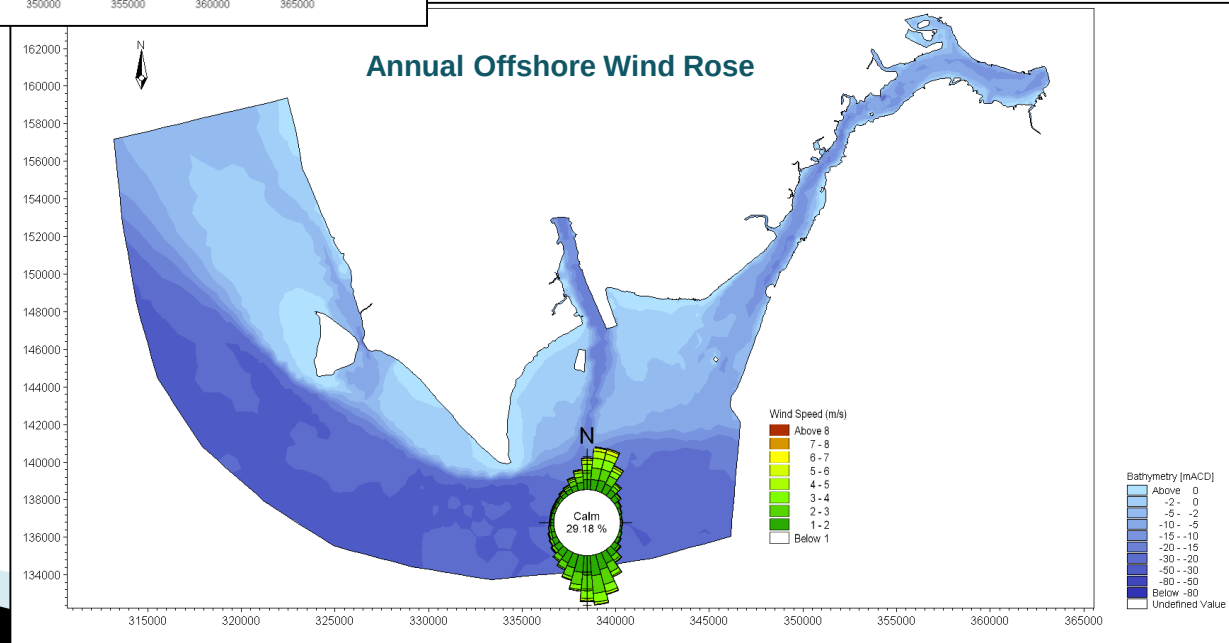
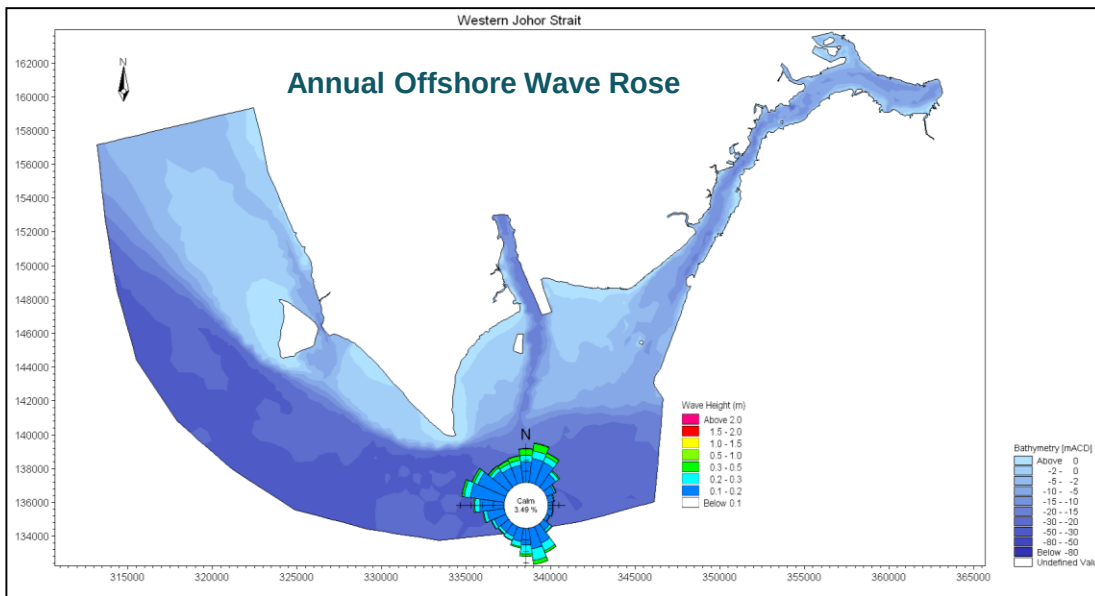
The background features a complex network diagram with various nodes (some solid, some hollow) connected by lines. A blue and black diagonal wave pattern is visible in the bottom-left corner.

WAVE ROSE

Wave height and direction

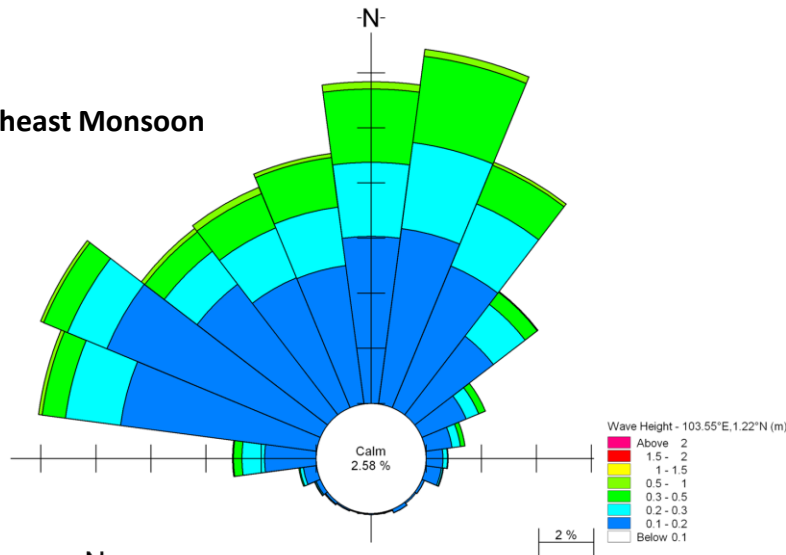


Annual Offshore Wave & Wind Roses: Western Johor Strait

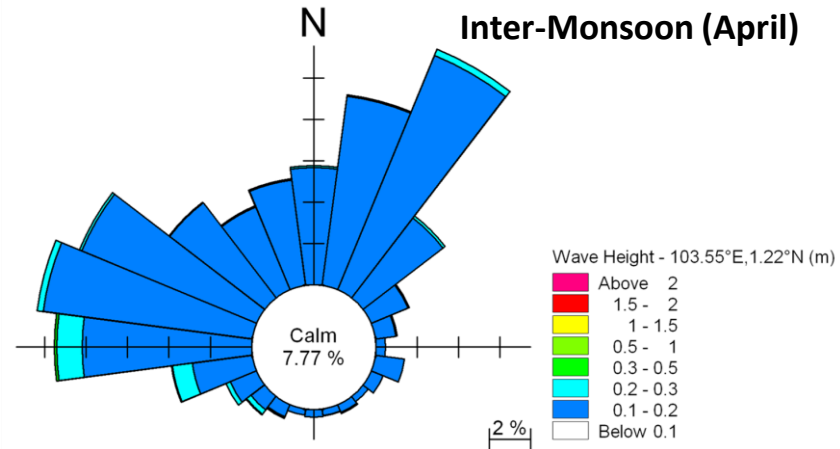


Seasonal Offshore Wave Roses: Western Johor Strait

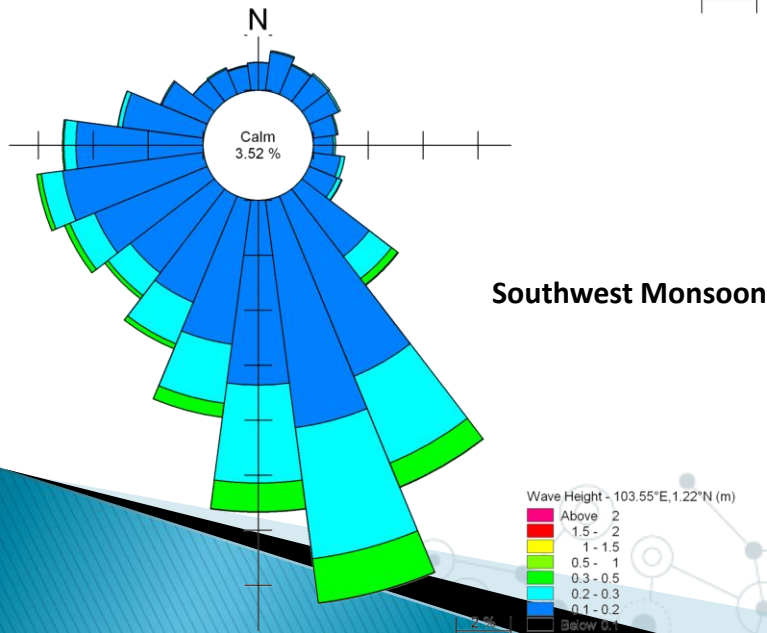
Northeast Monsoon



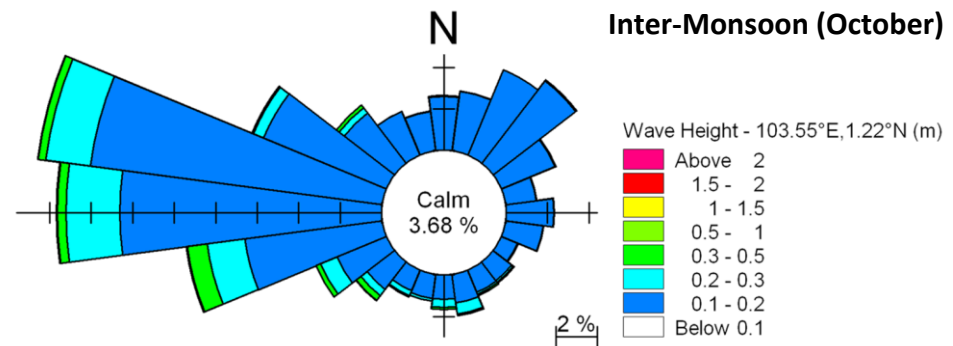
Inter-Monsoon (April)



Southwest Monsoon

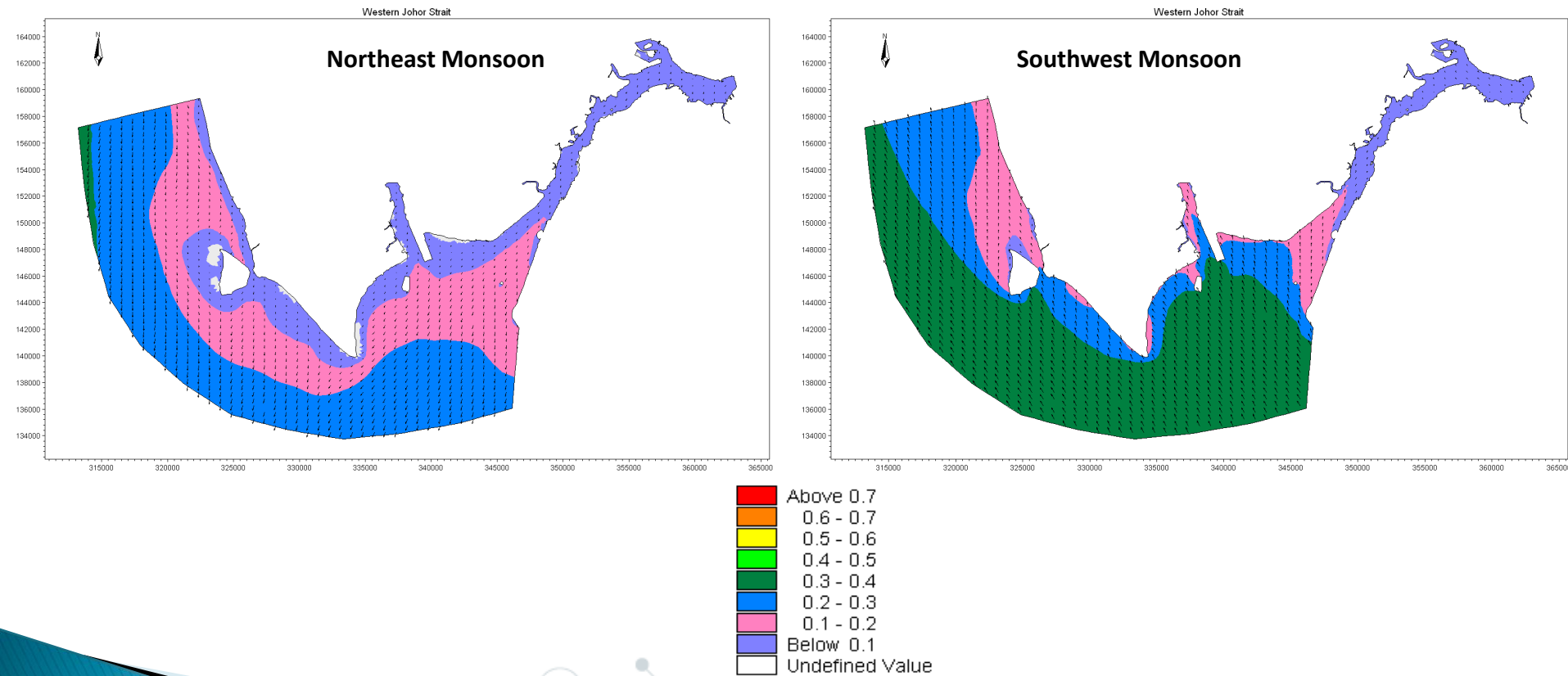


Inter-Monsoon (October)

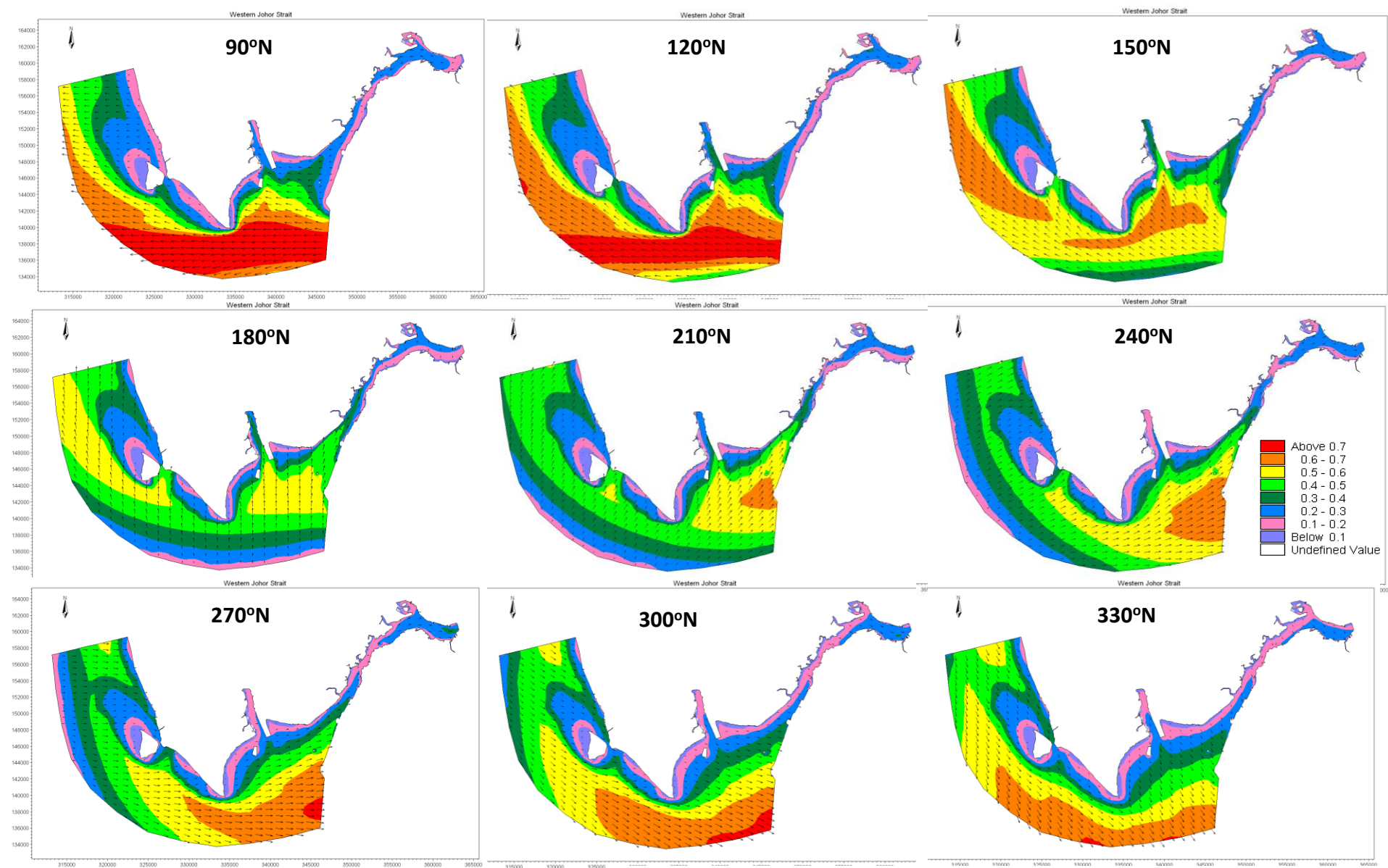


Causes of Erosion: Offshore Waves

Wave Simulations for Typical Offshore Condition: Western Johor Strait

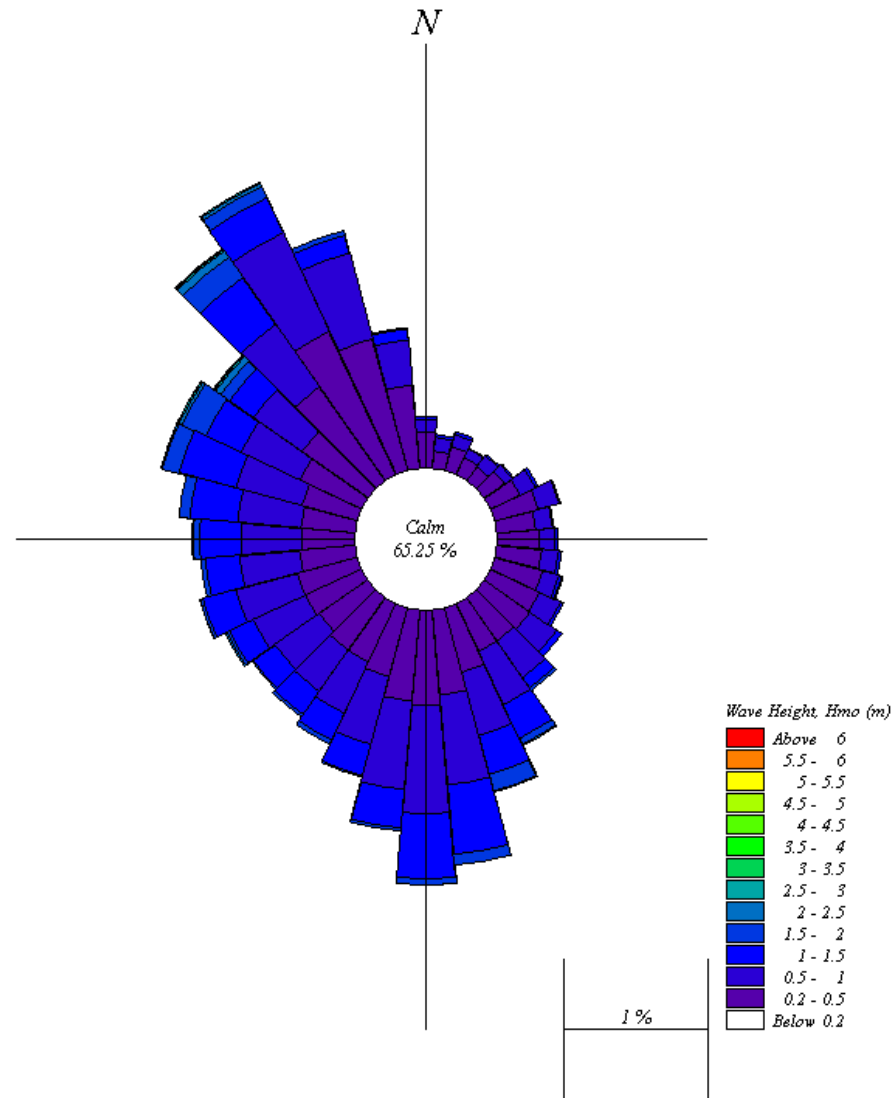


Wind Generated Waves

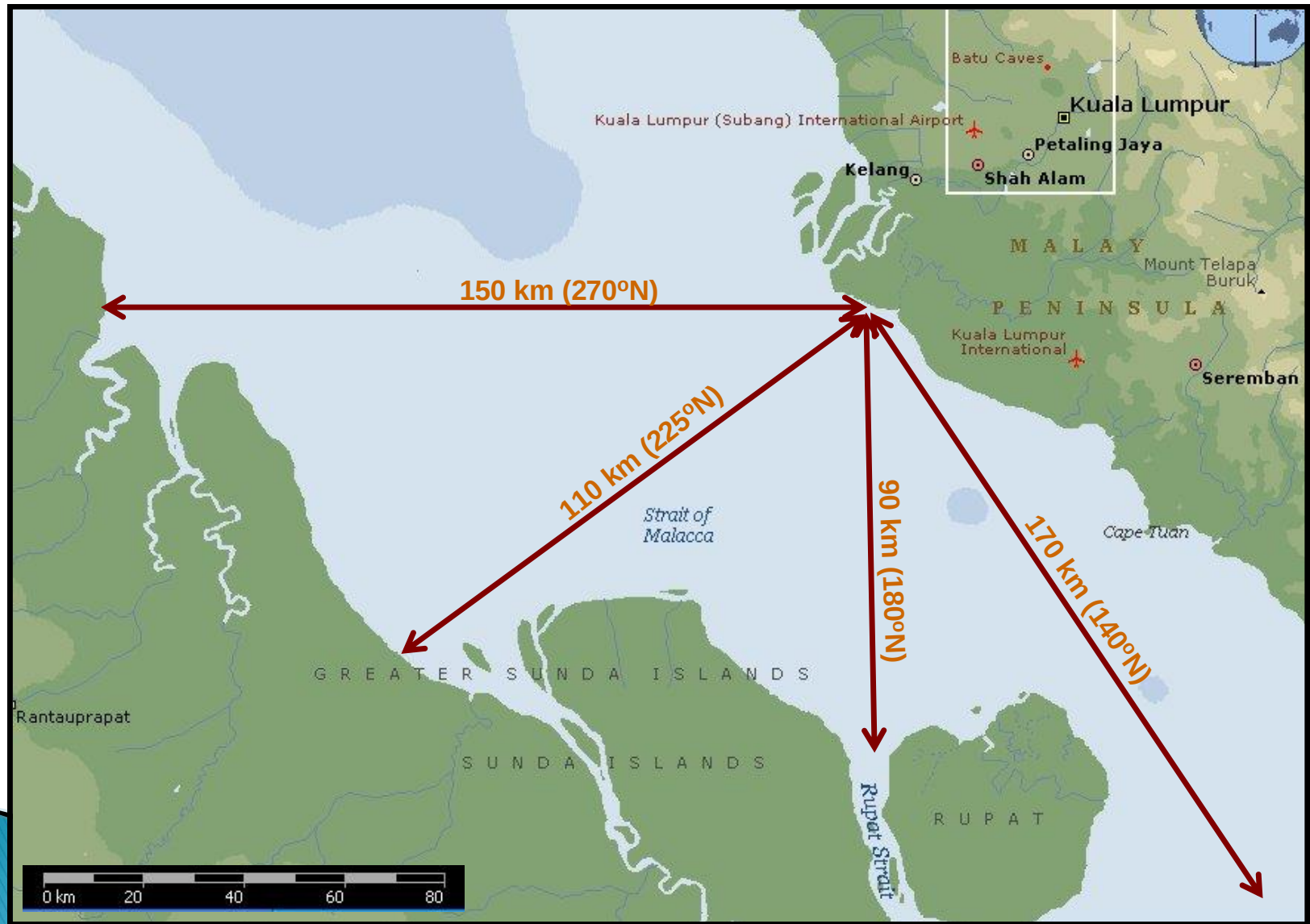


Wave Simulations for 12 m/s Wind: Western Johor Strait

Explaining erosion: Annual Wave Rose for Port Klang Based On 21 Years of Wave Hind cast

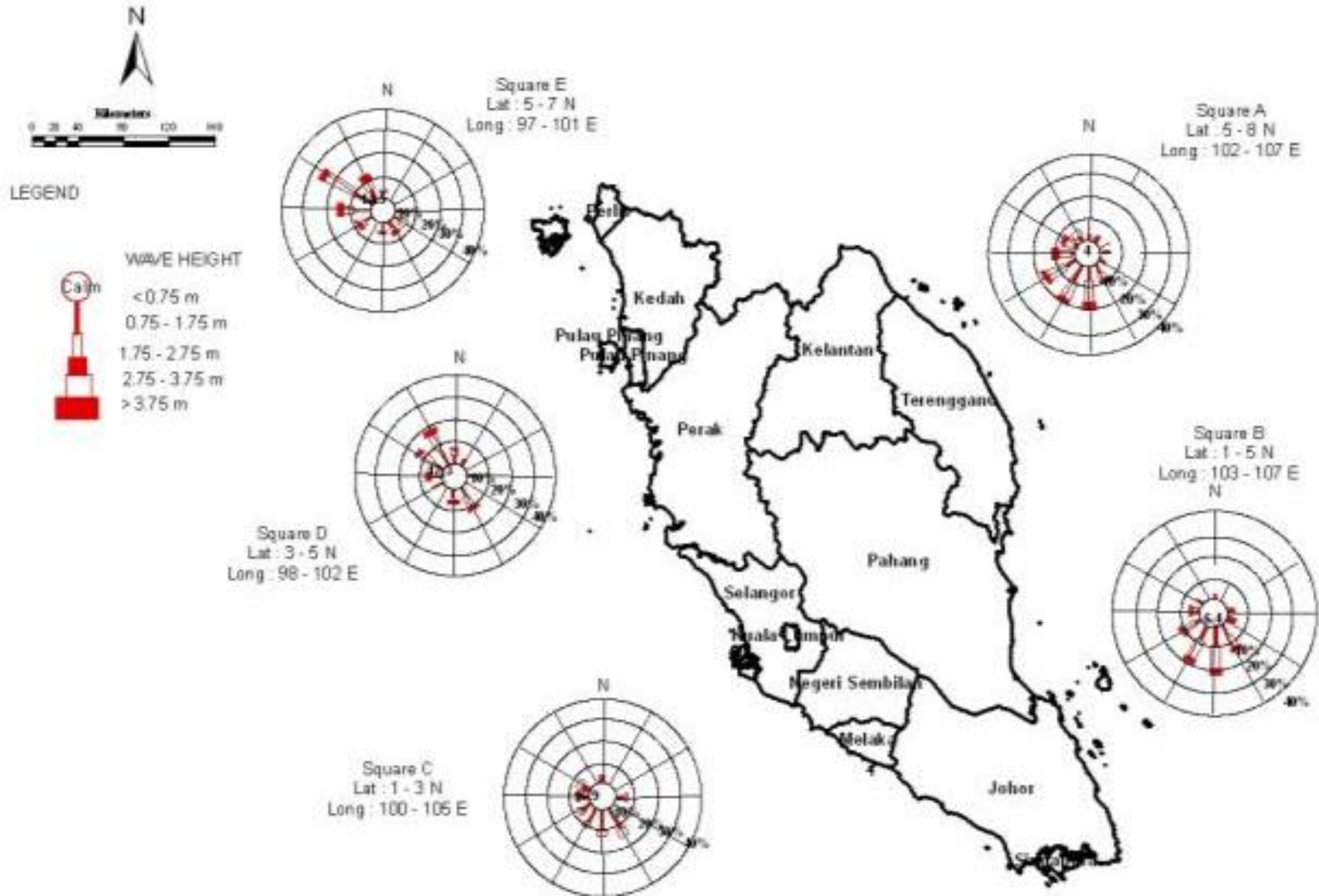


Wave Exposures at Carey Island

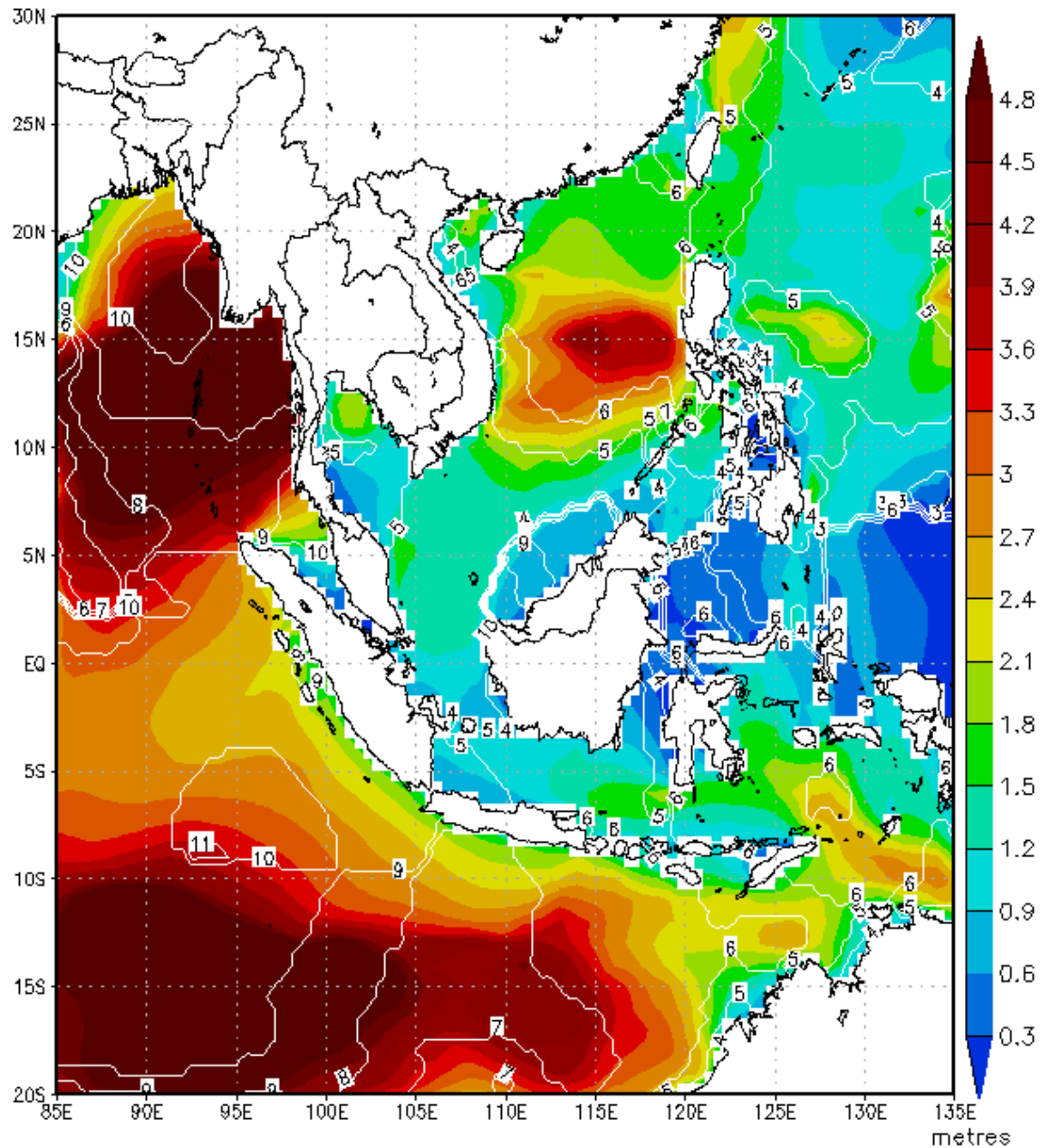


Wave height during Northeast Monsoon in Malaysia

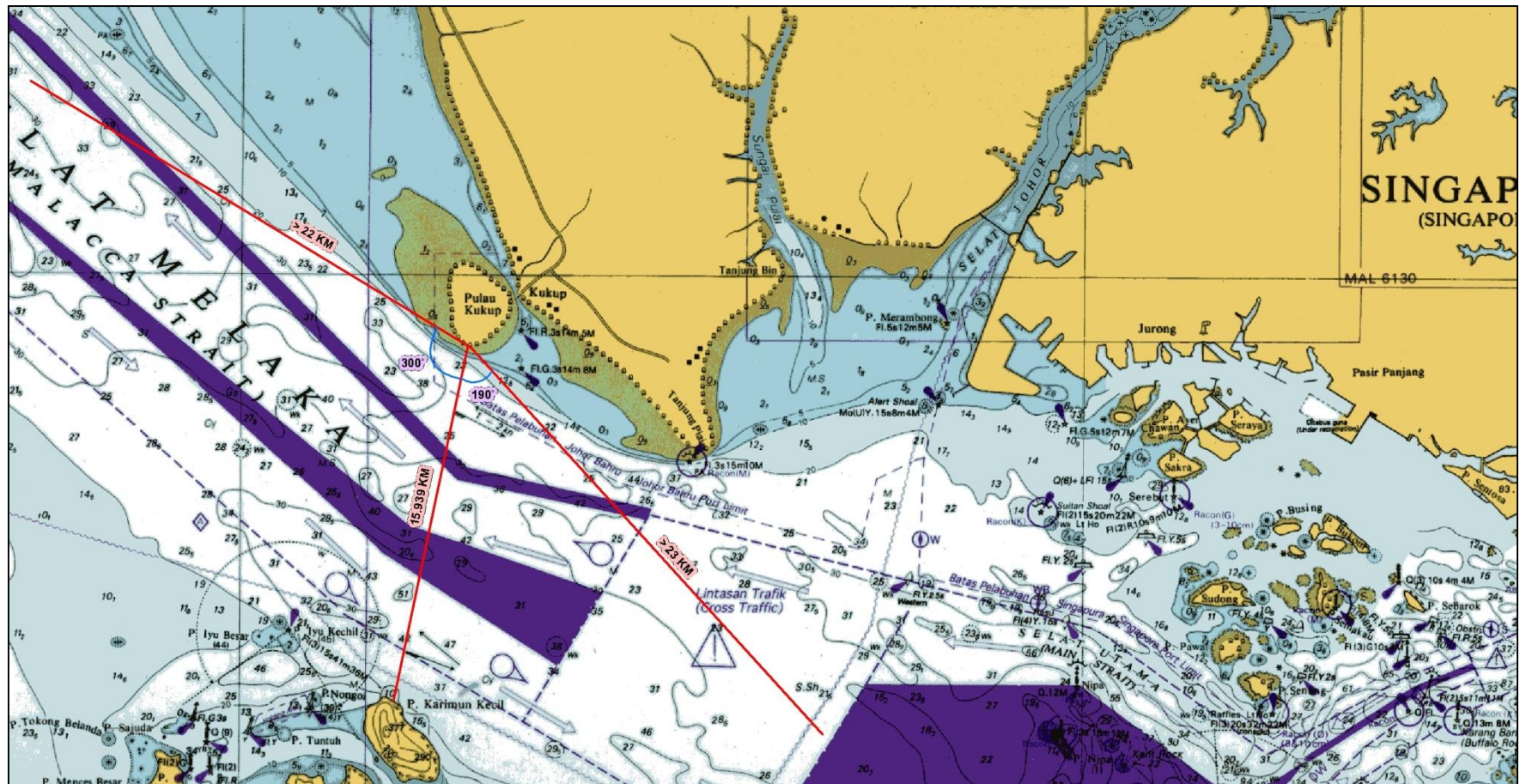
(U.S Climatic Data Centre, Shipboard Observations)



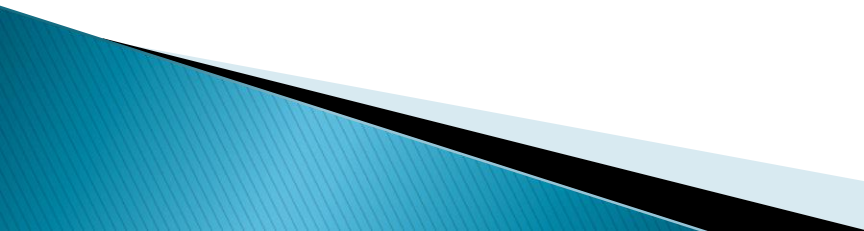
MMD-WAM Maximum Wave Heights(metres,shaded contours),
peak wave period(seconds, white lines),
Valid Time Mon 2000LT17JUN2013



Wave Fetch: PULAU KUKUP, JOHOR



5) Arus

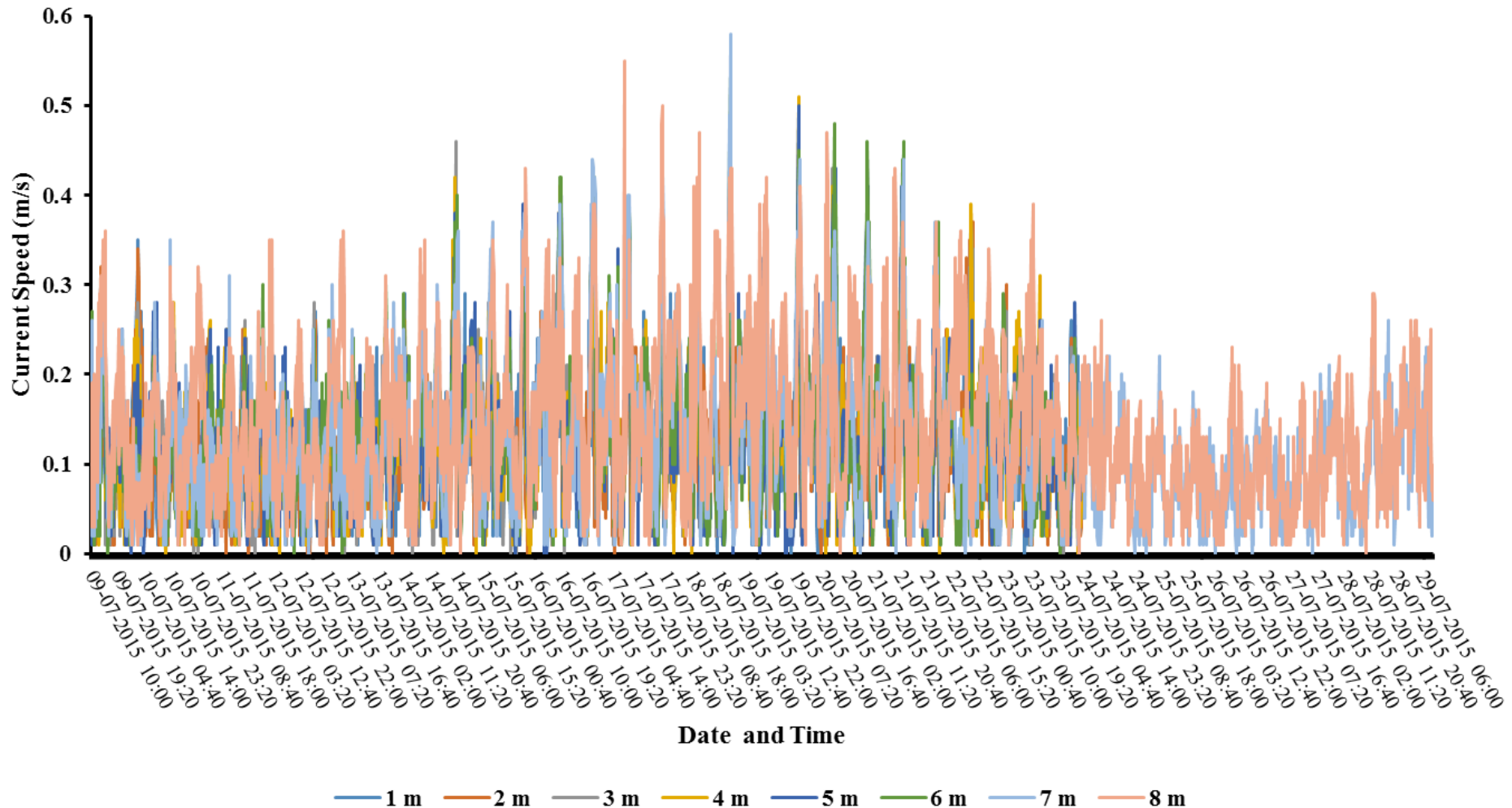
- ▶ ADCP (Acoustic Doppler Current Profiler)
 - ▶ ADCP menggunakan gelombang akustik untuk mengukur profil halaju semasa, sama ada dalam sungai, muara dan lautan.
 - ▶ Ia digunakan secara meluas oleh pelaut untuk mengukur arus dalam persekitaran laut dalam.
 - ▶ ADCP menggunakan denyutan bunyi frekuensi tinggi dan gema untuk mengukur kelajuan air dan arah.
 - ▶ ADCP menghantar isyarat akustik ke dalam ruang air, dan kekerapan isyarat dihantar, seterusnya dibandingkan dengan frekuensi isyarat berselerak yang terpantul dari zarah di dalam air.
- 



5) Arus

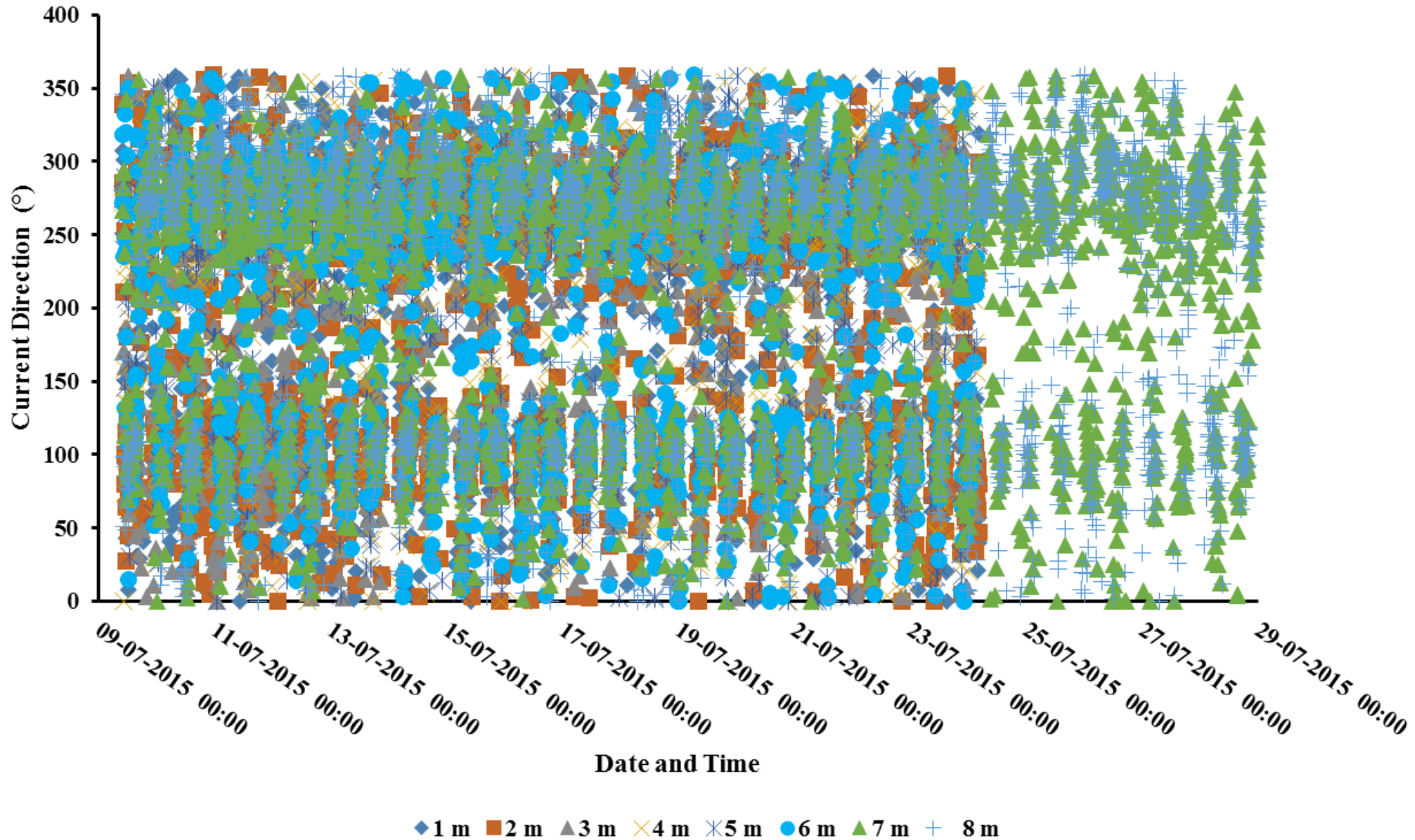
- The current speed - between 0.00 m/s and 0.58 m/s.
- The highest current speed was recorded at 0.58 m/s
- The lowest is recorded as 0.00 m/s.
- The dominant of the current direction shows variations during the flood and ebb tide.

CURRENT SPEED AT STATION 1, JOHOR BAHRU



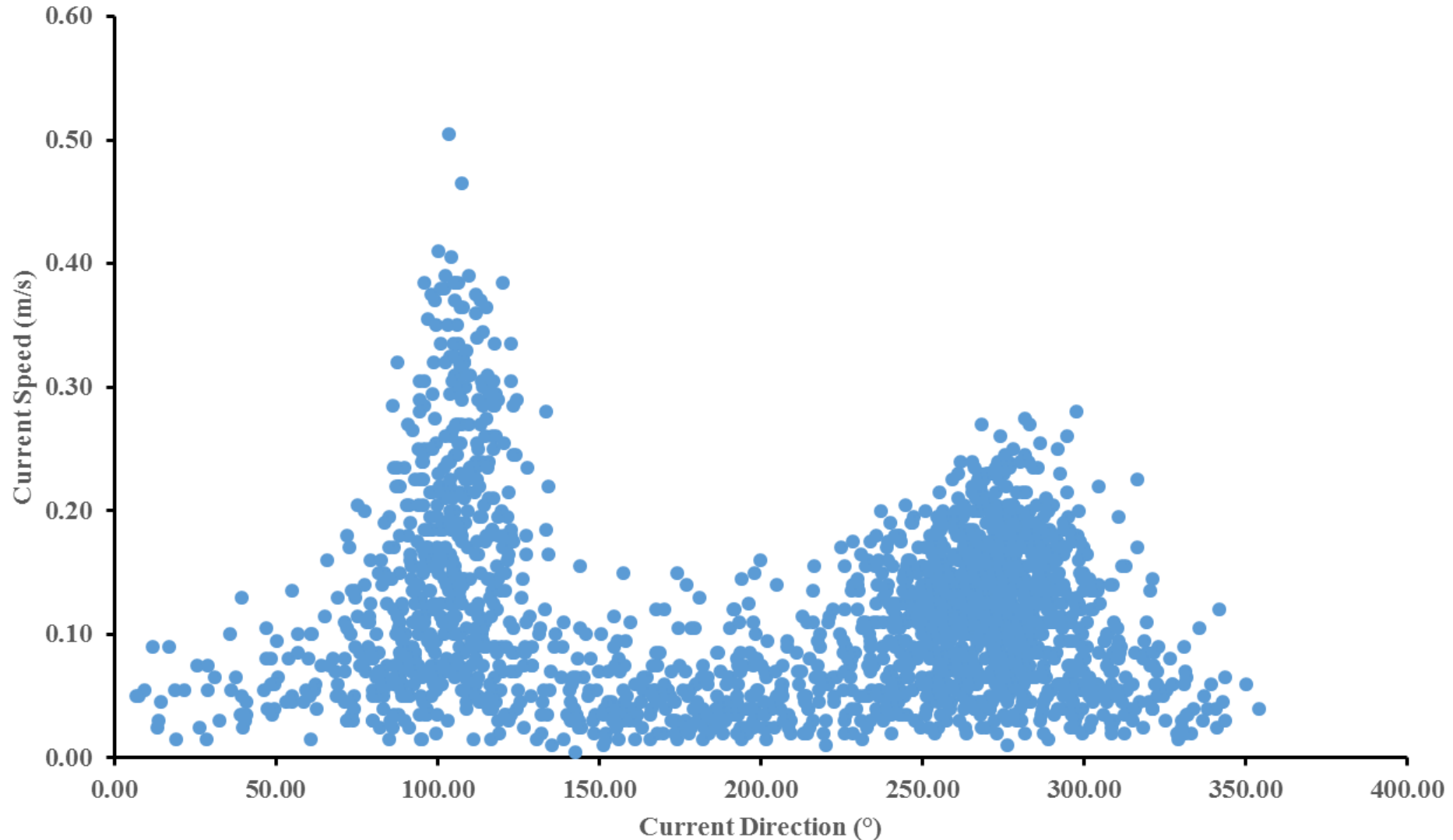
Current Direction

CURRENT DIRECTION AT STATION 1, JOHOR BAHRU



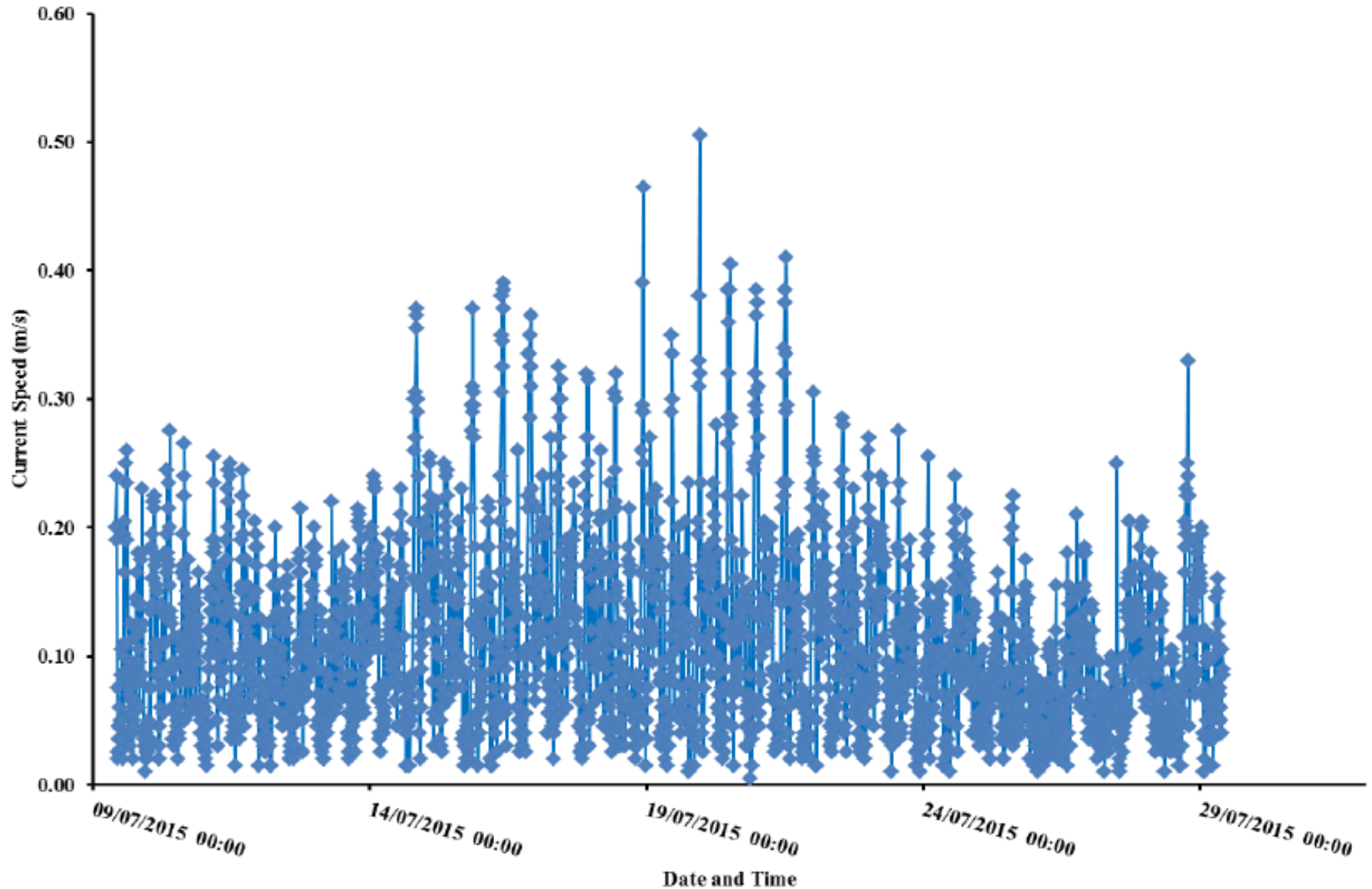
Average Current Speed Vs Direction

CURRENT AVERAGE AT STATION 1, JOHOR BAHRU



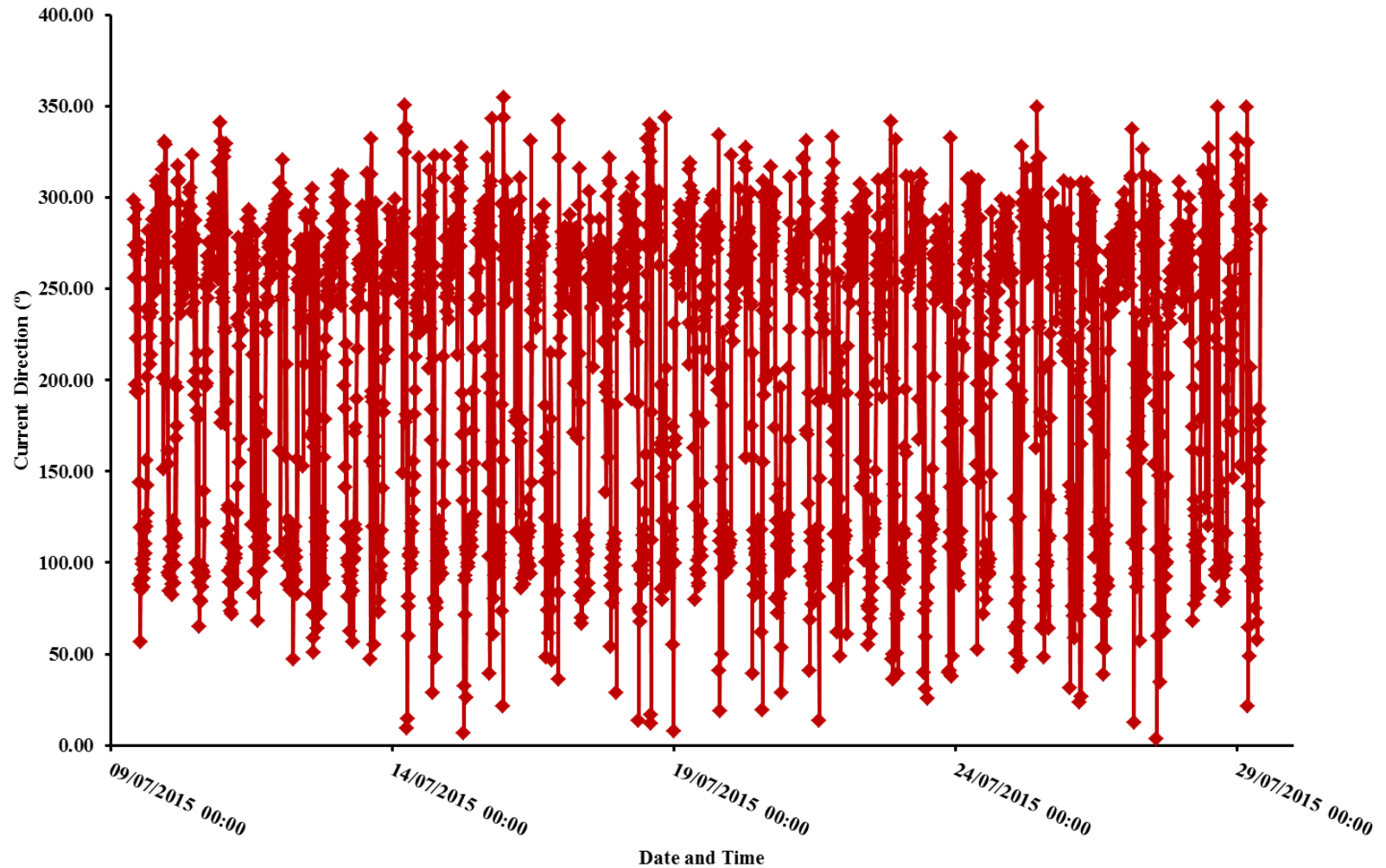
Average Current Speed

CURRENT SPEED AVERAGE AT STATION 1, JOHOR BAHRU

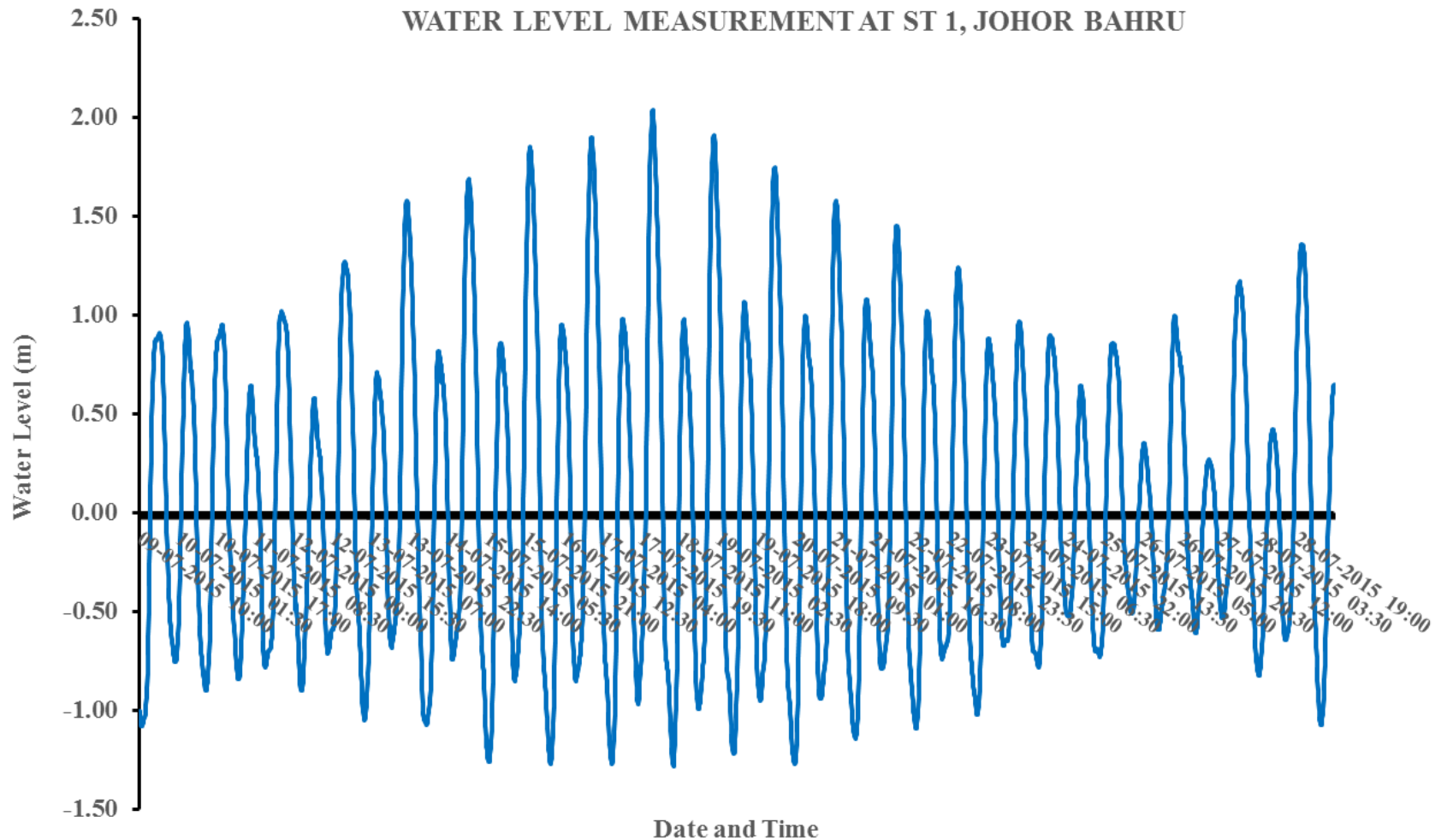


Average Current Direction

CURRENT DIRECTION AVERAGE AT STATION 1, JOHOR BAHRU

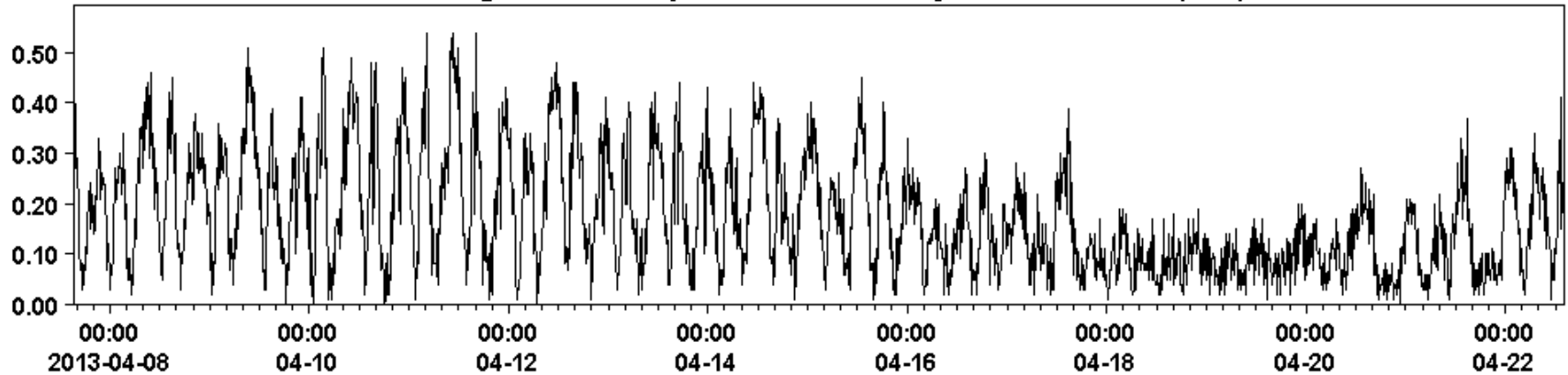


Water Level Variations

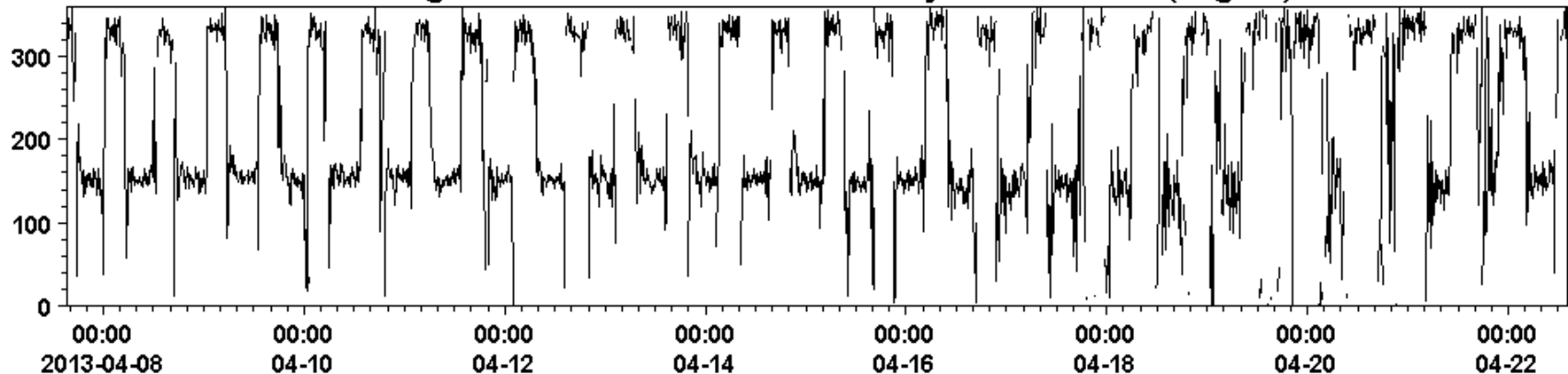


- Average current speed and direction at this station varies based on tidal factors.
- The maximum current speed up to 0.55 m/s during Spring Tide
- The maximum current speed up to 0.2m/s during Neap
- The dominant current direction measured was around 140°-170° and 320°-360° which coming from Southeast and North direction.

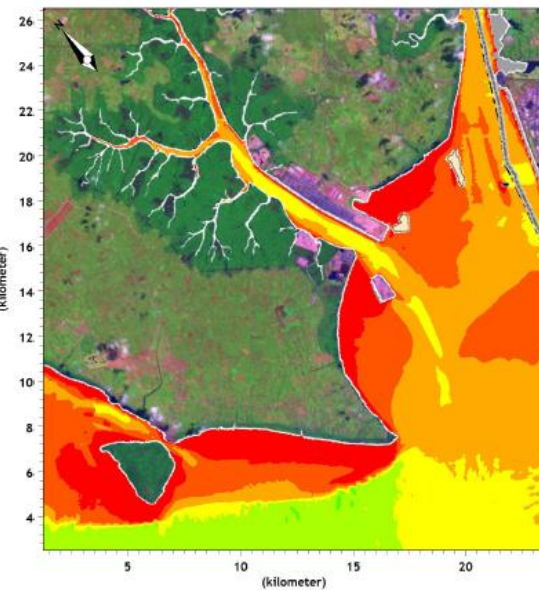
Average Current Speed Measured by ADCP Kuah A (m/s)



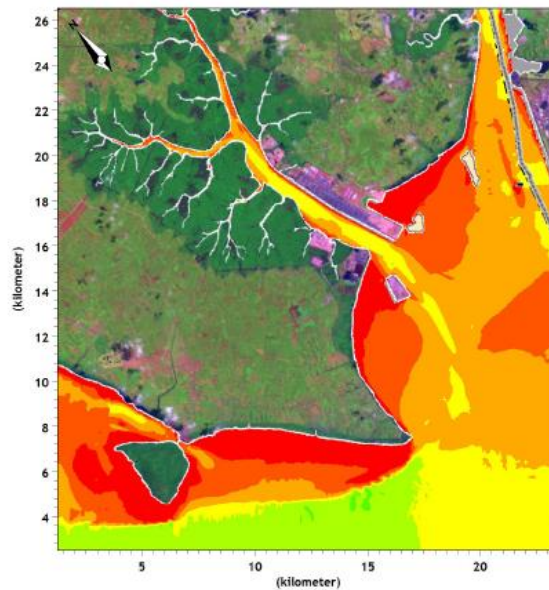
Average Current Direction Measured by ADCP Kuah A (degree)



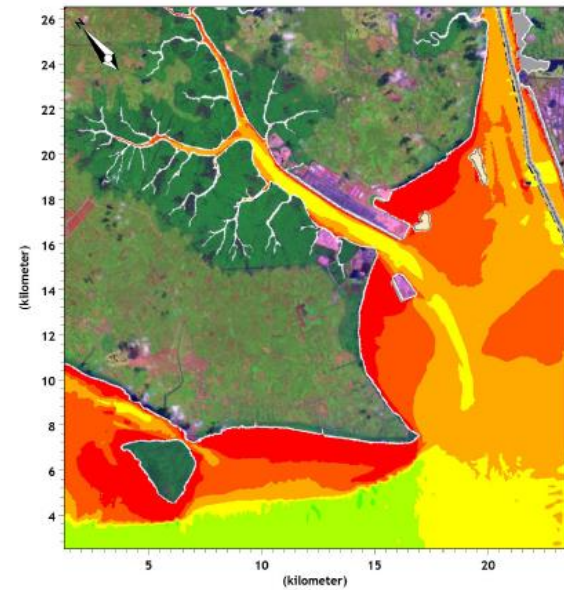
Mean and maximum current speed plots for existing condition



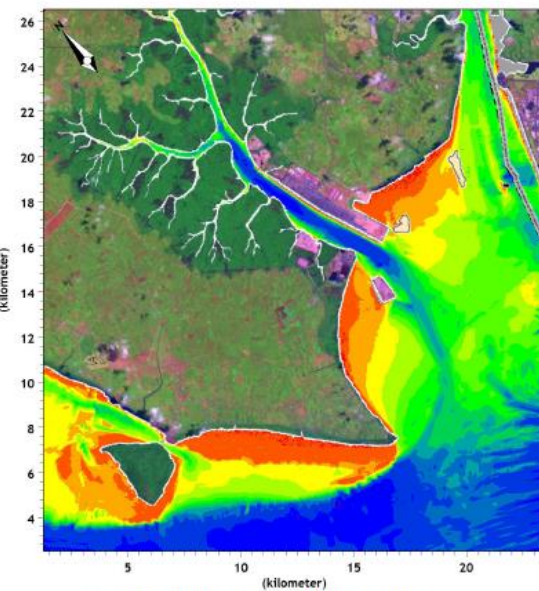
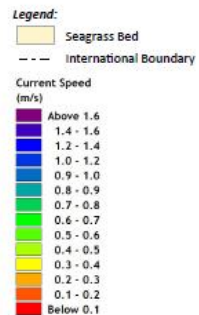
(a) Pure Tide Condition (Mean Speed)



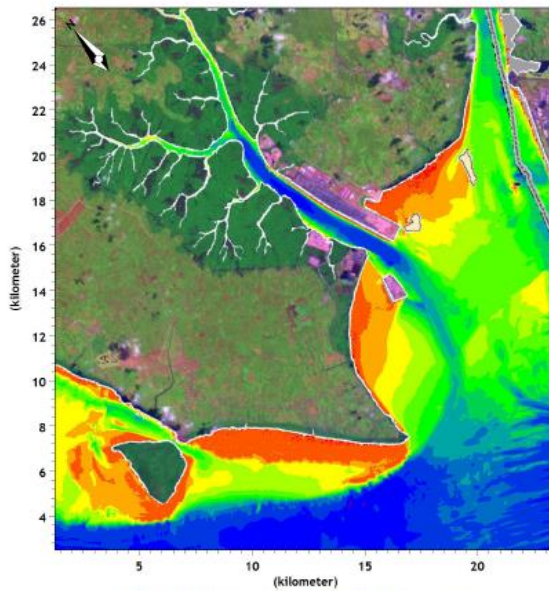
(b) Northeast Monsoon Condition (Maximum Speed)



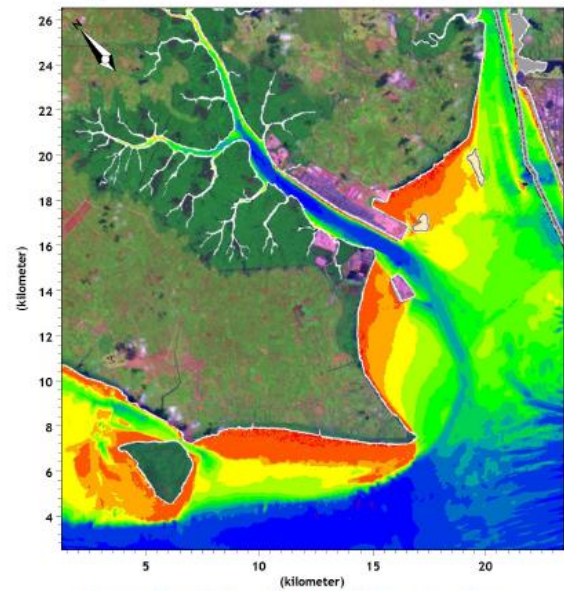
(c) Southwest Monsoon Condition (Mean Speed)



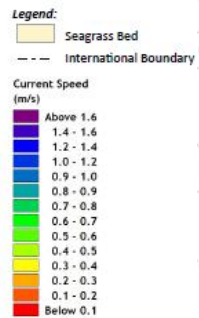
(d) Pure Tide Condition (Maximum Speed)

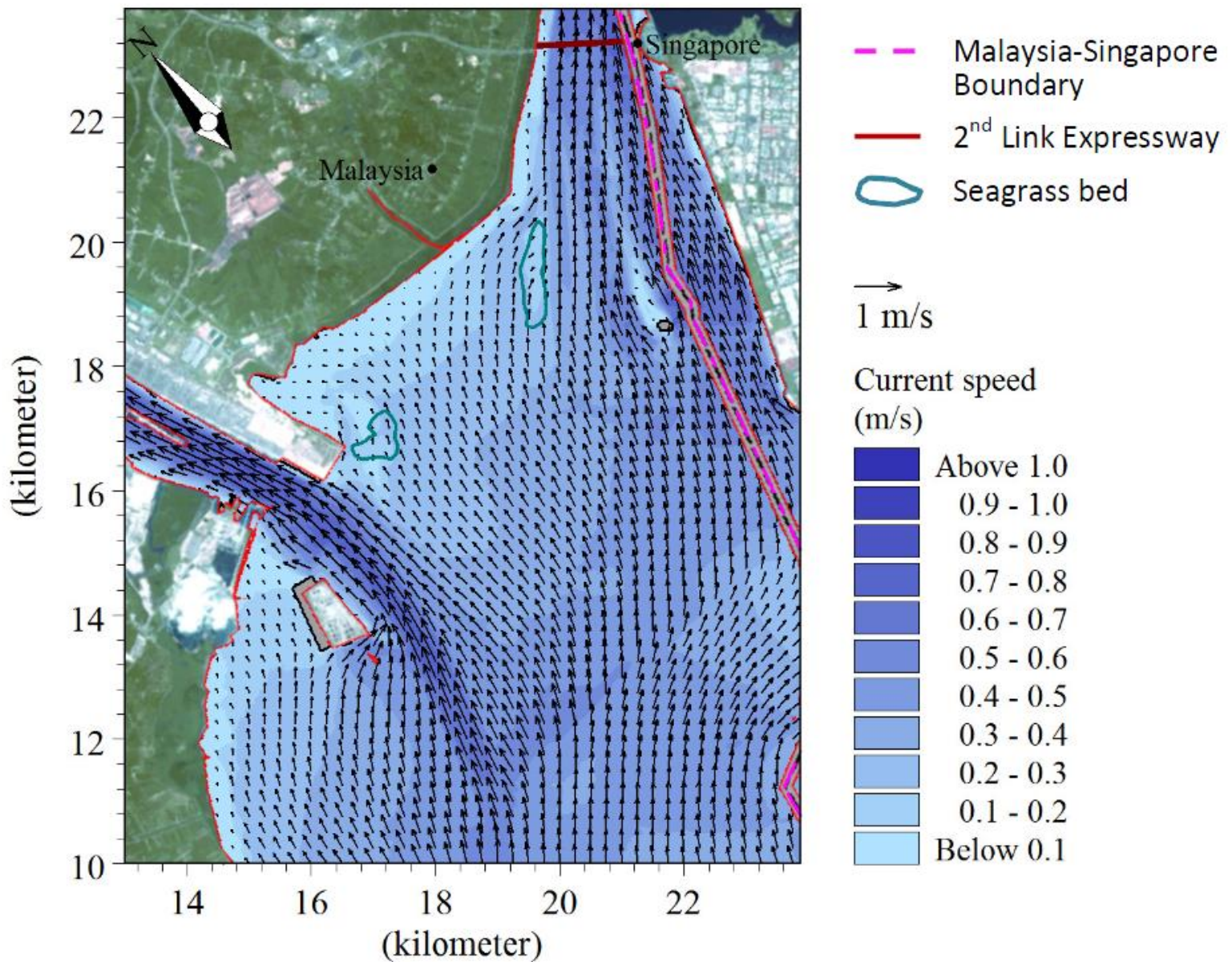


(e) Northeast Monsoon Condition (Mean Speed)



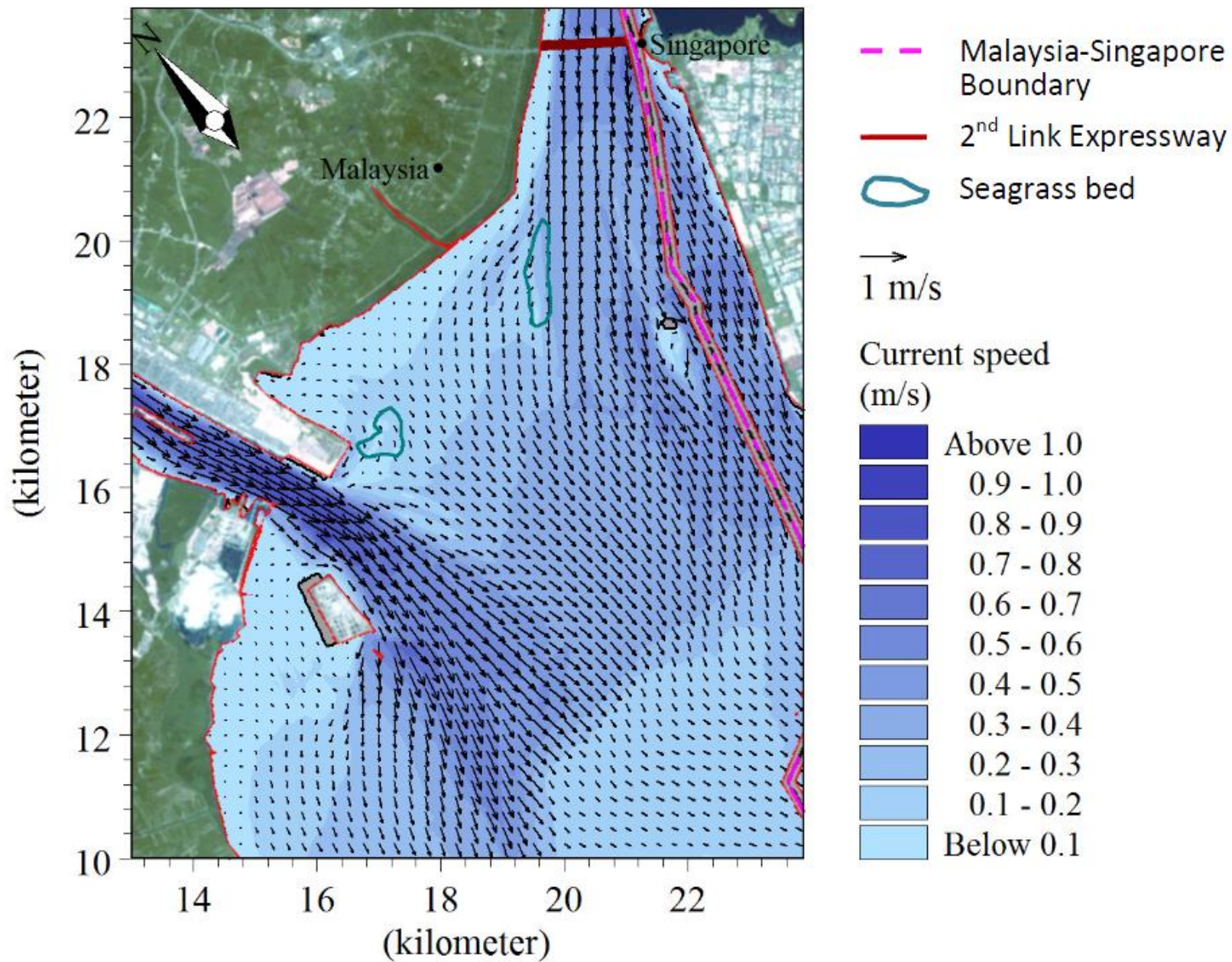
(f) Southwest Monsoon Condition (Maximum Speed)





29-Jun-14 11:00:00 PM

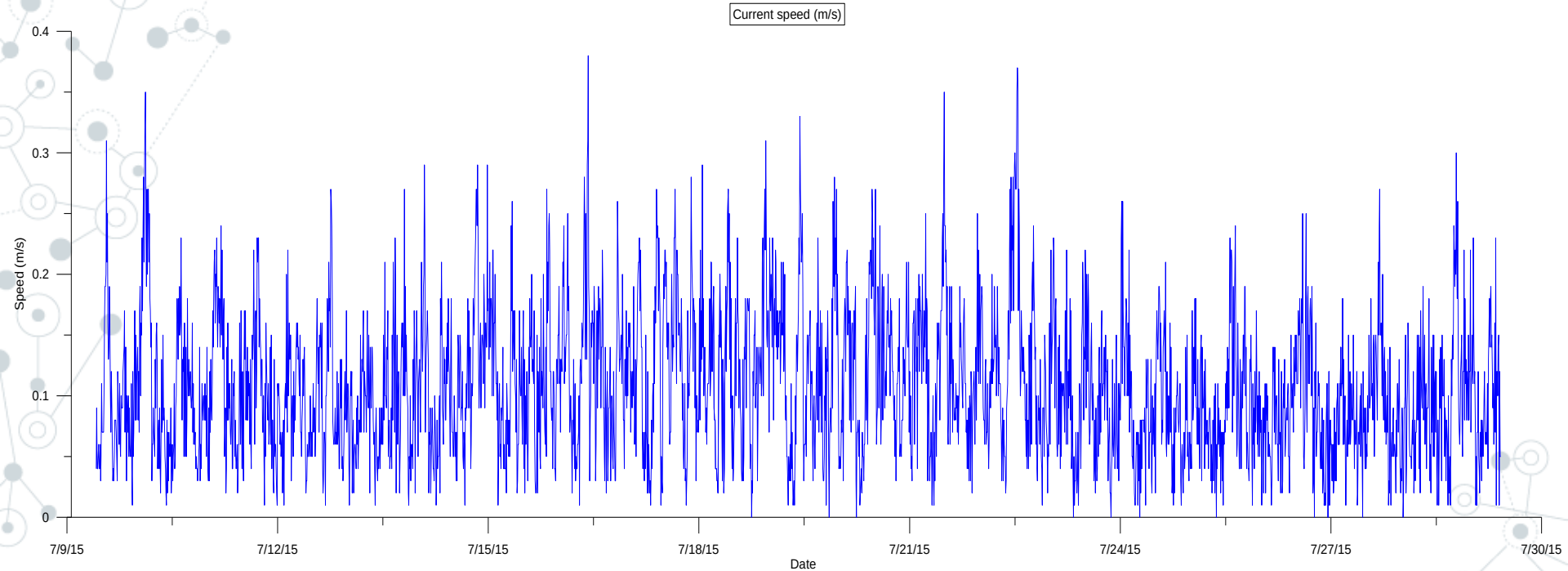
a) Spring period: Flood flow



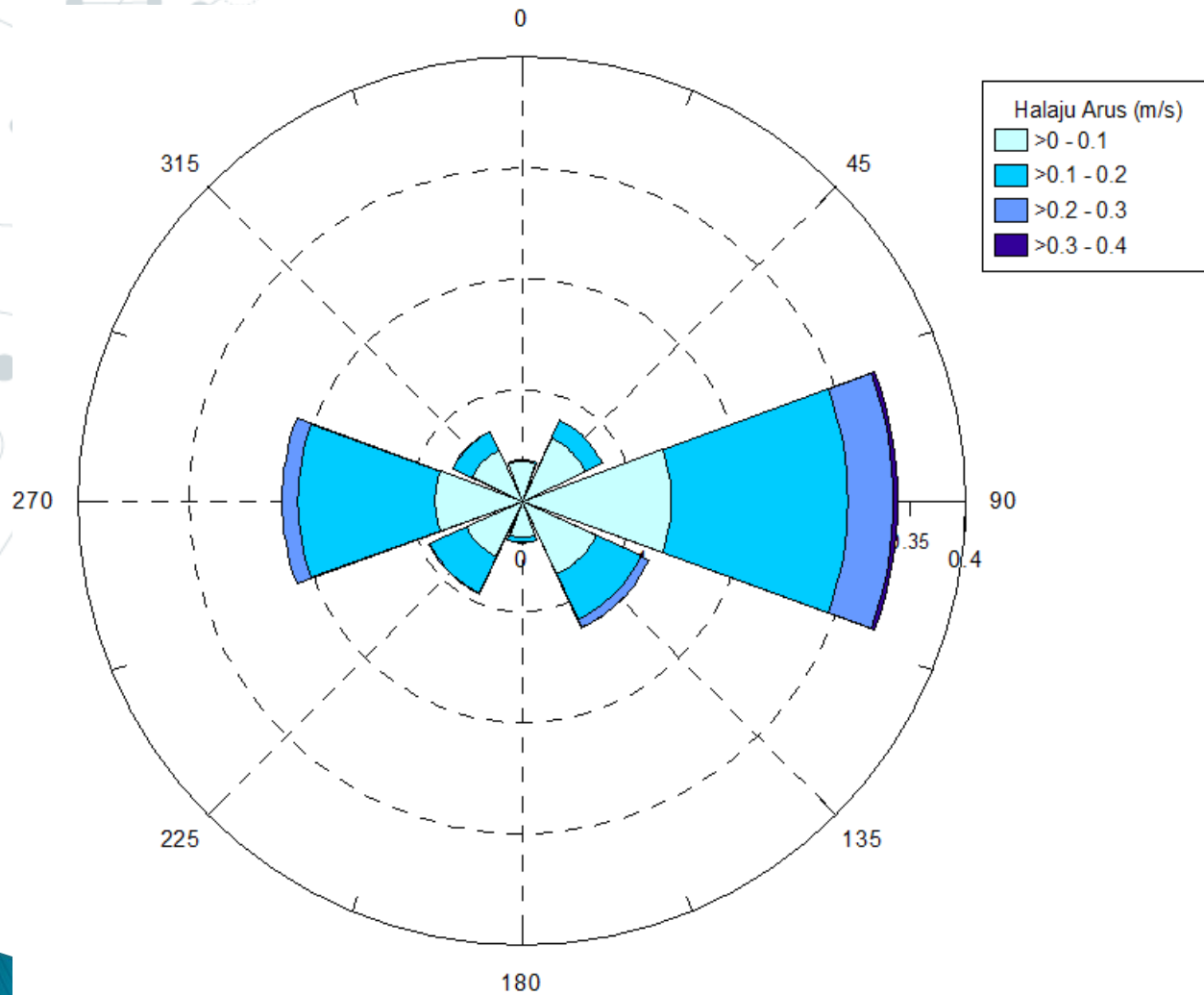
30-Jun-14 3:00:00 AM

b) Spring period: Ebb flow

ADCP: Current Speed



ADCP: Current Direction

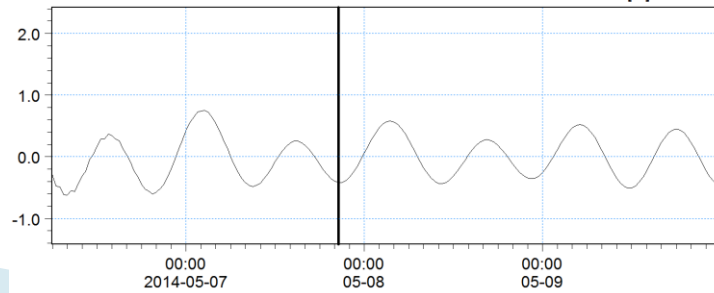
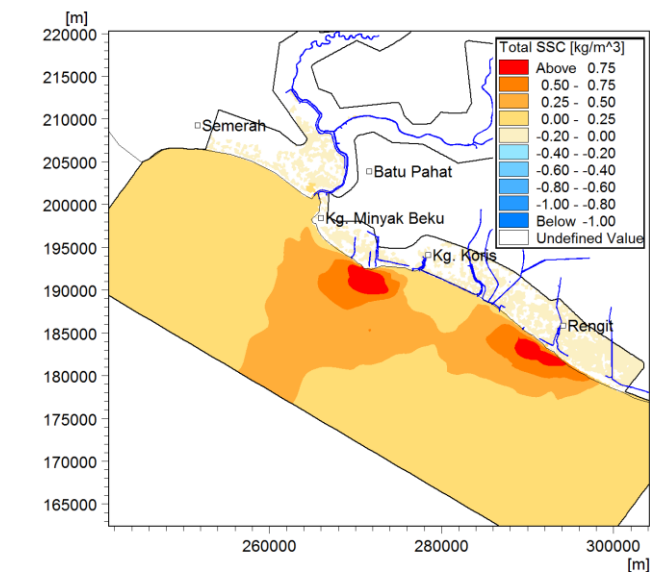
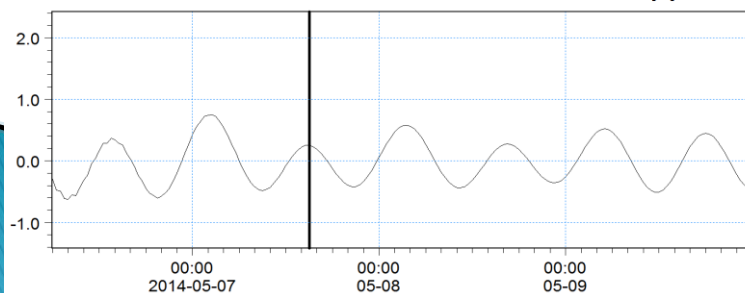
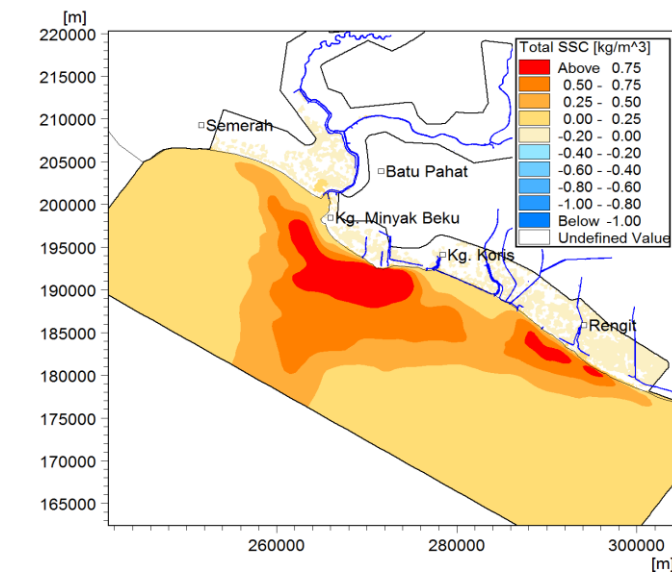


ADCP DATA

DATE & TIME	CELL SIZE															
	1 m		2 m		3 m		4 m		5 m		6 m		7 m		8 m	
	CURRENT SPEED	CURRENT DIRECTION	CURRENT SPEED	CURRENT DIRECTION	CURRENT SPEED	CURRENT DIRECTION	CURRENT SPEED	CURRENT DIRECTION	CURRENT SPEED	CURRENT DIRECTION	CURRENT SPEED	CURRENT DIRECTION	CURRENT SPEED	CURRENT DIRECTION	CURRENT SPEED	CURRENT DIRECTION
09/07/2015 10:00	0.04	307.75	0.05	338.59	0.08	274.18	0.21	271.94	0.19	277.96	0.12	318.68	0.17	292.54	0.16	280.05
09/07/2015 10:10	0.09	251.18	0.05	285.46	0.13	286.49	0.24	276.98	0.24	274.72	0.27	272.33	0.26	266.26	0.03	164.58
09/07/2015 10:20	0.04	301.18	0.12	275.24	0.24	284.78	0.24	267.81	0.14	240	0.16	271.05	0.14	282.57	0.17	50.86
09/07/2015 10:30	0.04	273.18	0.08	210.72	0.04	170.54	0.03	0	0.01	340.02	0.05	235.1	0.02	294.23	0.19	97.75
09/07/2015 10:40	0.05	150.26	0.02	252.65	0.09	284.04	0.01	74.05	0.04	289.29	0.06	247.83	0.04	252.55	0.19	98.72
09/07/2015 10:50	0.06	93.69	0.1	79.89	0.02	160.02	0.03	220.6	0.12	263.66	0.04	131.63	0.03	237.53	0.18	104.11
09/07/2015 11:00	0.04	108.85	0.05	100.08	0.08	186.58	0.04	158.5	0.05	145.71	0.03	332.45	0.06	112.54	0.18	91.59
09/07/2015 11:10	0.04	77.47	0.11	27.04	0.08	120.61	0.05	95.39	0.04	125.84	0.06	319.94	0.02	135	0.03	98.88
09/07/2015 11:20	0.06	43.11	0.07	114.38	0.03	90	0.03	135	0.04	205.97	0.01	180	0.1	343.07	0.2	48.84
09/07/2015 11:30	0.03	345.53	0.09	64.01	0.03	70.91	0.05	228.27	0.04	271.51	0.04	238.78	0.03	126.16	0.12	78.21
09/07/2015 11:40	0.05	111.8	0.01	180	0.08	186.58	0.05	265.24	0.07	283.63	0.04	304.59	0.07	90.81	0.13	81.74
09/07/2015 11:50	0.11	79.84	0.08	88.51	0.07	149.86	0.02	270	0.03	264.96	0.05	123.07	0.04	138.81	0.19	84.86
09/07/2015 12:00	0.07	93.92	0.03	123.69	0.04	88.6	0.03	116.57	0.07	278.49	0.1	263.22	0.05	214.7	0.1	63.43
09/07/2015 12:10	0.07	129.05	0.03	353.29	0.02	164.74	0.04	106.14	0.03	200.32	0.02	350.13	0.05	85.76	0.08	56.73
09/07/2015 12:20	0.07	7.43	0.03	45	0.04	358.57	0.1	233.71	0.11	181.07	0.12	107.1	0.17	90	0.23	83.13
09/07/2015 12:30	0.07	42.11	0.07	74.81	0.04	85.36	0.02	135	0.05	161.18	0.04	14.74	0.08	68.96	0.15	76.34
09/07/2015 12:40	0.1	73.14	0.14	62.19	0.1	88.23	0.11	56.02	0.06	30.65	0.04	82.69	0.17	95.78	0.18	90
09/07/2015 12:50	0.16	75.18	0.15	75.96	0.11	59.93	0.01	194.04	0.03	128.93	0.06	109.65	0.11	90.51	0.28	76.76
09/07/2015 13:00	0.19	122.29	0.09	90.62	0.08	98.13	0.06	114.44	0.04	92.6	0.02	90	0.14	101.07	0.25	96.67
09/07/2015 13:10	0.19	80.98	0.23	97.22	0.18	94.5	0.1	113.34	0.1	112.53	0.04	67.48	0.08	92.17	0.23	95.84
09/07/2015 13:20	0.2	121.61	0.22	111.28	0.21	93.91	0.2	94.62	0.19	96.2	0.12	73.92	0.15	99.9	0.29	96.03
09/07/2015 13:30	0.31	97.92	0.32	96.92	0.19	113.01	0.13	90	0.09	117.43	0.08	86.24	0.14	101.55	0.22	100.1
09/07/2015 13:40	0.21	86.76	0.21	81.95	0.17	102.12	0.19	98.34	0.14	101.15	0.13	97.28	0.2	108.79	0.31	102.08
09/07/2015 13:50	0.25	84.15	0.2	91.76	0.2	101.31	0.2	121.16	0.18	113.65	0.22	90.26	0.29	92.75	0.29	102.27
09/07/2015 14:00	0.16	96.67	0.15	80.29	0.2	109.67	0.19	104.47	0.22	93.69	0.26	88.48	0.26	103.98	0.26	114.91
09/07/2015 14:10	0.13	105.48	0.17	82.3	0.2	113.24	0.23	104.16	0.24	92.83	0.3	80.47	0.26	94.65	0.35	113.46
09/07/2015 14:20	0.14	121.58	0.11	91.02	0.2	111.91	0.18	113.5	0.32	92.34	0.24	99.7	0.25	109.73	0.32	115.52
09/07/2015 14:30	0.19	93.71	0.2	103.12	0.23	115.09	0.27	108.03	0.25	108.21	0.19	125.78	0.3	119.05	0.35	110.67
09/07/2015 14:40	0.16	77.01	0.13	86.07	0.13	110.76	0.25	102.98	0.22	117.97	0.26	102.05	0.27	105.74	0.34	105.39
09/07/2015 14:50	0.1	98.47	0.13	84.84	0.14	120.28	0.2	105.6	0.18	98.72	0.17	111.23	0.2	118.52	0.27	101.52
09/07/2015 15:00	0.07	119.36	0.09	138.21	0.18	116.13	0.11	108.94	0.11	131.63	0.23	112.85	0.32	102.11	0.22	107.37

5) Sedimen

- ▶ Juga dikenali sebagai endapan atau enapan
- ▶ Bahan yang tenggelam ke dasar laut/sungai
- ▶ Bahan yang didepositkan oleh air, angin, ombak dll



Jenis-jenis Sedimen

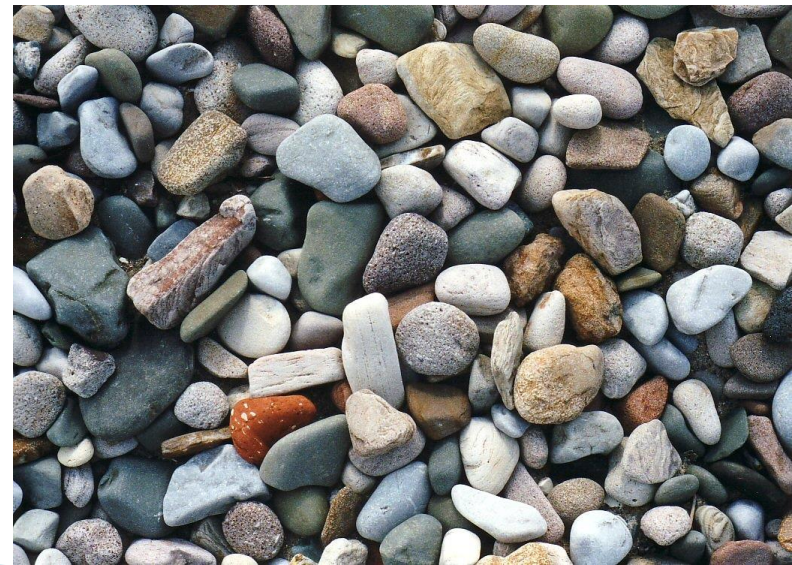
Enapan Campuran
Sediment mixtures



Sedimen halus



Sedimen kasar



Riverine sediment

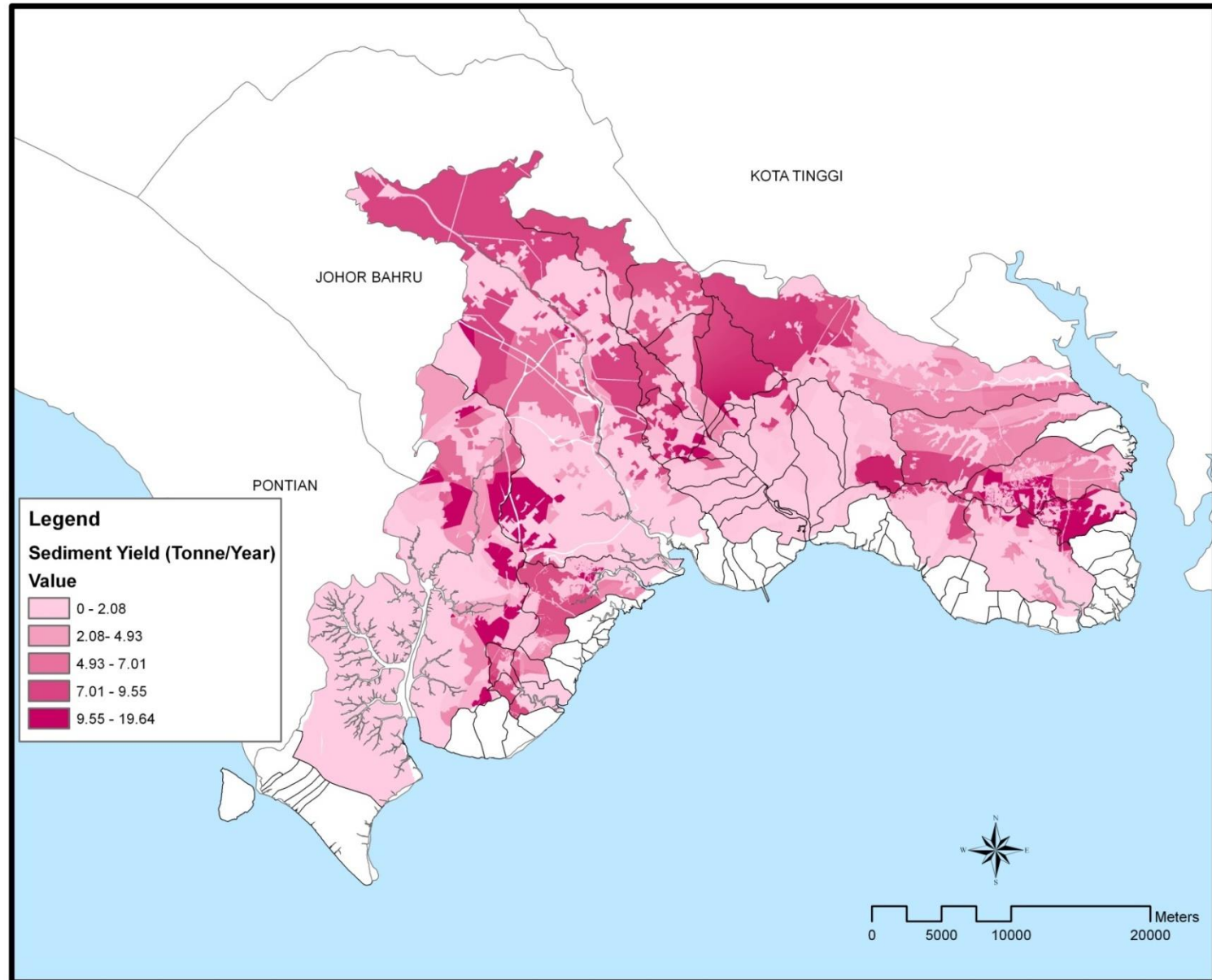


Marine sediment

Sedimen yang disebabkan oleh
aliran sungai yang menghala ke laut



River Sedimentation Analysis – Estimated Sediment Yield



Percentage of exceedance of suspended sediment concentration above 5mg/l

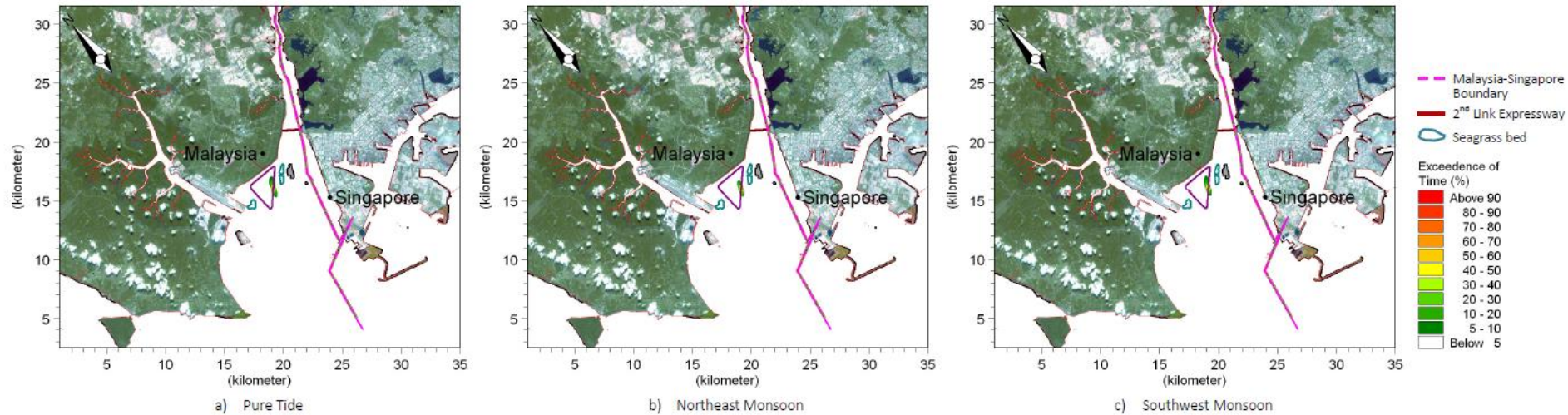


Figure 12.59

Percentage of Exceedance of Suspended Sediment Concentration above 1 mg/L due to Reclamation Works for Scenario 1: Uncontained Condition

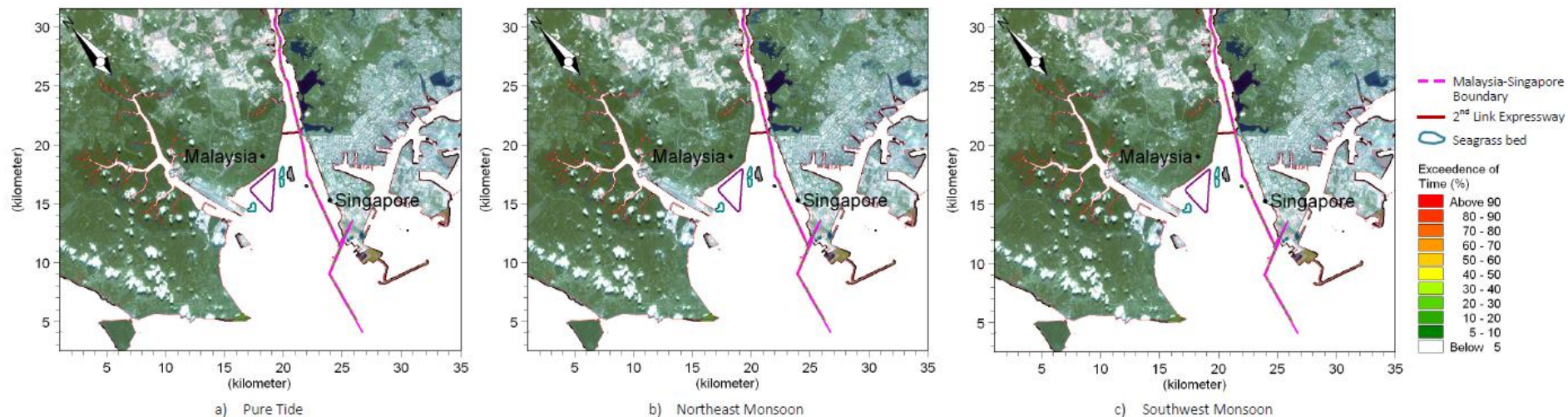


Figure 12.60

Percentage of Exceedance of Suspended Sediment Concentration above 5 mg/L due to Reclamation Works for Scenario 1: Uncontained Condition

TERIMA KASIH