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A Country Report on Tidal Activities in Malaysia

Malaysia covers an area of about 329,758 square kilometers, consisting of 11 states in Peninsular Malaysia and 2 states in the Borneo (Sabah and Sarawak) and a Federal Territory. Peninsular Malaysia, covering 131,598 sq. km. has its frontiers with Thailand and Singapore while the states in Borneo covering 198,160 sq. km, borders the territory of Indonesia's Kalimantan to the South and Brunei to the North. Malaysia lies close to the equator between latitudes of 1°N and 7°N and longitudes of 100°E and 119°E. It has a multi-racial population of 22 million.

The Department of Survey and Mapping, Malaysia (DSMM) traces its origin way back in 1886. At present, its function amongst others include.

In the recent years, there have been numerous geodetic projects implemented by DSMM on a nation wide scale. Collectively, these projects were and are executed with the final aim of providing horizontal and vertical controls for the development of various infrastructures across the country.

1. Introduction

The Department of Survey and Mapping Malaysia (DSMM) is the main government agency in Malaysia responsible for the acquisition, processing, archiving, and dissemination of sea-level data. To date, there are 12 tidal stations along the coast of Peninsular Malaysia (West Malaysia) and 9 tidal stations along the coast of Sabah and Sarawak (East Malaysia).

Before DSMM took over the responsibility for the tide stations from the State Land and Survey of Sabah in 1984 and from the State Land and Survey of Sarawak in 1990, all the tide stations in the states were held under the responsibility of each State Land and Survey respectively.

This article will describe briefly the history of the tidal observations prior to the establishment of the present sea level network in Malaysia; stipulate the objectives of the network; the description of the model of the tide gauges and their date of establishment; the types of tides available in Malaysia and also the policy of the Department regarding the dissemination of tidal data.

2. Background

Since colonial times, way back from the nation's independence in 1957, there were quite a number of sites selected for tide measurements by various government agencies such as in Kuantan (1908), Port Dickson (1930), Pulau Pinang (1955 and 1958), Pulau Lakei (1950-1951 & 1955-1956) and Tawau (1918). The observation periods ranged from a month to a year. However, the records and the methods of observation were not available in the Department. There was no long term planning for sea level measurements and monitoring of sea level changes at that time. The

measurements were merely used to define local vertical reference datums for selected places to provide height essential to the development of the nation's infrastructure. Because of these measurements, a few datum had been established, namely Land Survey Datum 1912 (LSD 1912) in Peninsular Malaysia, Pulau Lakei Datum in Sarawak 1960, Kota Kinabalu Datum 1975 and Befry Datum 1918 in Sabah. These datum are currently still in use.

In 1963-1964, there were attempts to establish a tide station network along the coast of Peninsular Malaysia. The attempts did not materialize due to the lack of expertise and experience. The urge to set up a tidal observation network finally came to light again after the tidal observation project was initiated in 1981. The technical aids were provided by the Hydrographic Department, Maritime Safety Agency, Japan and funded by the Japan International Cooperation Agency (JICA) under the Colombo Plan. In a span of 6 years (1981-1986), 12 tide stations were established.

When DSMM took over the maintenance and custody of Sabah tide gauges at Kota Kinabalu, Tawau and Sandakan in 1984, the stations were not in good condition and eventually the stations were not functioning due to either break-down or other reasons (Takanori Imanishi, October 1991). The stations were later revived in 1987 for Kota Kinabalu and Tawau stations while the Sandakan station was only revived in 1993.

Same problems were encountered in Sarawak when DSMM took over the responsibility of maintaining the tide gauges from the State Land and Survey, Sarawak in 1990. Two stations, namely Bintulu and Miri, were restored in 1991.

3. Objectives Of The Tidal Observation Network

The objectives of the network are:

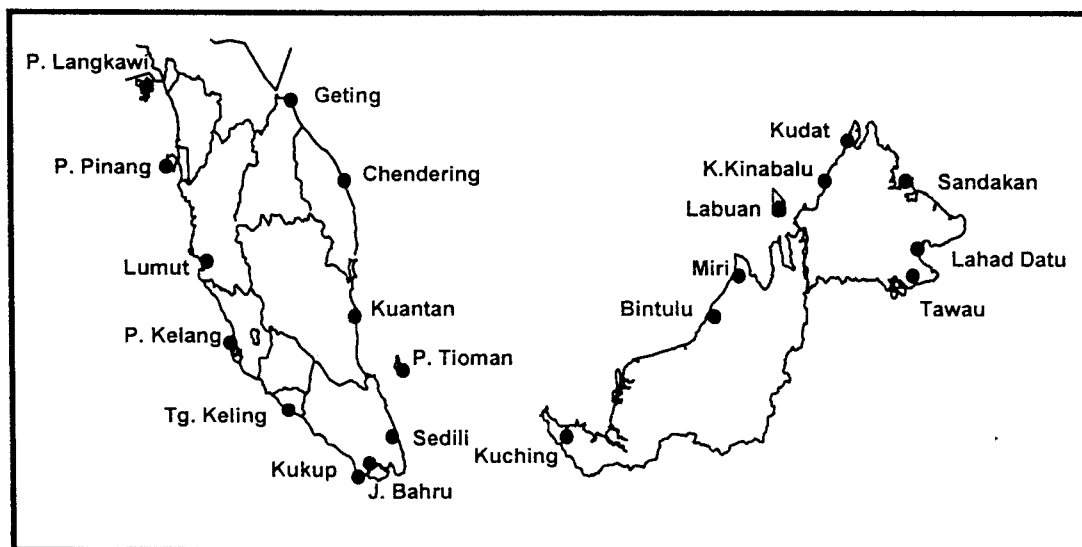
- a) To carry out continuous tide observations at these locations for at least 19 years to complete a cycle of the regression of the moon's nodes.
- b) To process the observed tidal data and to obtain the mean sea level values at the selected tide stations.
- c) To analyze the observed tidal data and obtain the Harmonic Constants for tidal prediction.
- d) To publish records of Tidal Observation and Tide Prediction Tables annually.
- e) To study the tidal characteristics along the coast of West and East Malaysia.

4. Malaysian Tidal Network

There are 21 tidal stations in Malaysia. 12 are in West Malaysia and 9 are in East Malaysia. Table 1 below shows the location, date of establishment and type of tide gauge used at all the tidal stations.

Station	Established	Type	Type / Date Replaced
<i>Pen. Malaysia</i>			
1. Pulau Langkawi	Nov. 1985	LTT-3AD	DFT-1 / April 1998
2. Pulau Pinang	Nov. 1984	LTT-3AD	DFT-1 / April 1998
3. Lumut	Nov. 1984	LTT-3AD	DFT-1 / April 1998
4. P. Kelang	Dec. 1983	LTT-3AD	DFT-1 / Oct 1993
5. Tanjung Keling	Nov. 1984	LTT-3AD	DFT-1 / May 1998
6. Kukup	Nov. 1985	LTT-3AD	DFT-1 / May 1998
7. Johor Bahru	Dec. 1983	LTT-3AD	DFT-1 / May 1998
8. Tanjung Sedili	Oct. 1986	LTT-3AD	DFT-1 / May 1998
9. Pulau Tioman	Nov. 1985	LTT-3AD	DFT-1 / May 1998
10. Tg. Gelang	Dec. 1983	LTT-3AD	DFT-1 / April 1998
11. Cendering	Oct. 1984	LTT-3AD	DFT-1 / April 1998
12. Geting	Oct. 1986	LTT-3AD	DFT-1 / April 1998
<i>Sarawak/Sabah</i>			
13. Kuching	Feb 1996	LTT-3AD	DFT-1 / June 1998
14. Bintulu	Aug 1992	LTT-3AD	DFT-1 / Sept. 1993
15. Miri	Jan 1993	LTT-3AD	damage since Dec. 1998
16. Labuan	Dec 1995	DFT-1	
17. Kota Kinabalu	June 1987	LTT-3AD	DFT-1 / June 1998
18. Kudat	Oct 1995	DFT-1	
19. Sandakan	Aug. 1993	DFT-1	
20. Lahad Datu	Oct 1995	DFT-1	
21. Tawau	June 1987	LTT-3AD	DFT-1 / Aug. 1993

Location of tidal stations throughout Malaysia.





Example of a Tide Station

DSMM was also involved in the ASEAN-Australia Tides and Tidal Phenomena Project (AATTP) which was implemented in 1985 for the purpose of improving regional cooperation in marine science. The project aimed to obtain simultaneous observations of sea level time series in the ASEAN region and to centralize all modern sea level data into a certified database. Furthermore, the tidal stations at Lumut and Cendering were included in the network of Global Sea Level Observing System (GLOSS) coordinated by the Intergovernmental Oceanographic Commission (IOC). Data were also sent to the TOGA Sea Level Centre at the University of Hawaii, USA on a regular basis. In addition, data from all the 21 stations were also sent to the Permanent Service for Mean Sea Level (PSMSL) in the United Kingdom and the Joint Archive for Sea Level based at the University of Hawaii, USA.

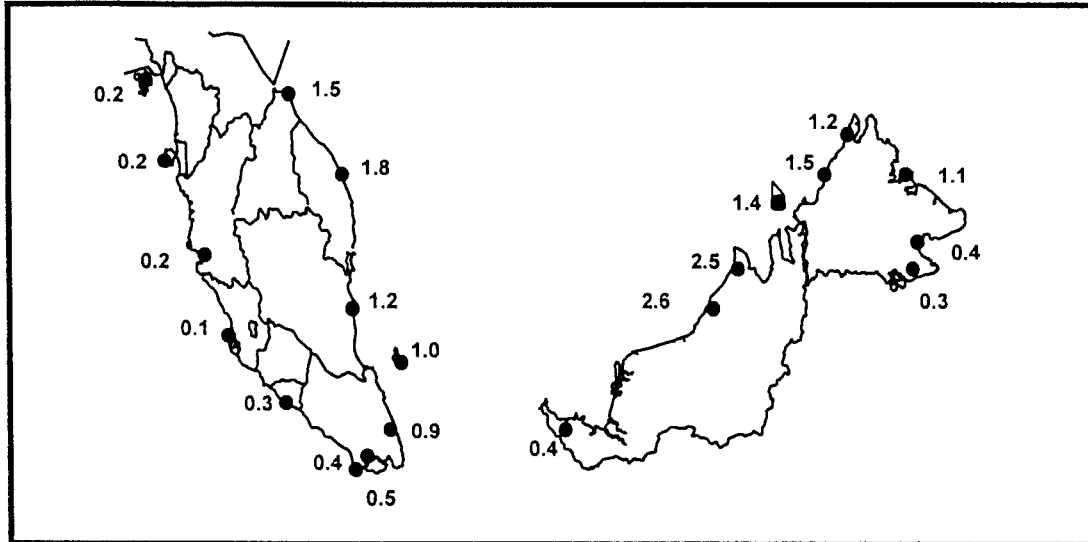
5. Types of Tides

The classifications of tides are based on the value of the ratio (F) of the sum of the amplitudes of the two main diurnal components (K1 and O1) to the sum of the amplitudes of the two main semi-diurnal components (M2 and S2).

- a) Semi-diurnal typeRatio(F) < 0.25
- b) Mixed (Dominant semi-diurnal) 0.25 < Ratio (F) < 1.5
- c) Mixed (Dominant diurnal) 1.5 < Ratio (F) < 3.00
- d) Diurnal type Ratio (F) > 3.00

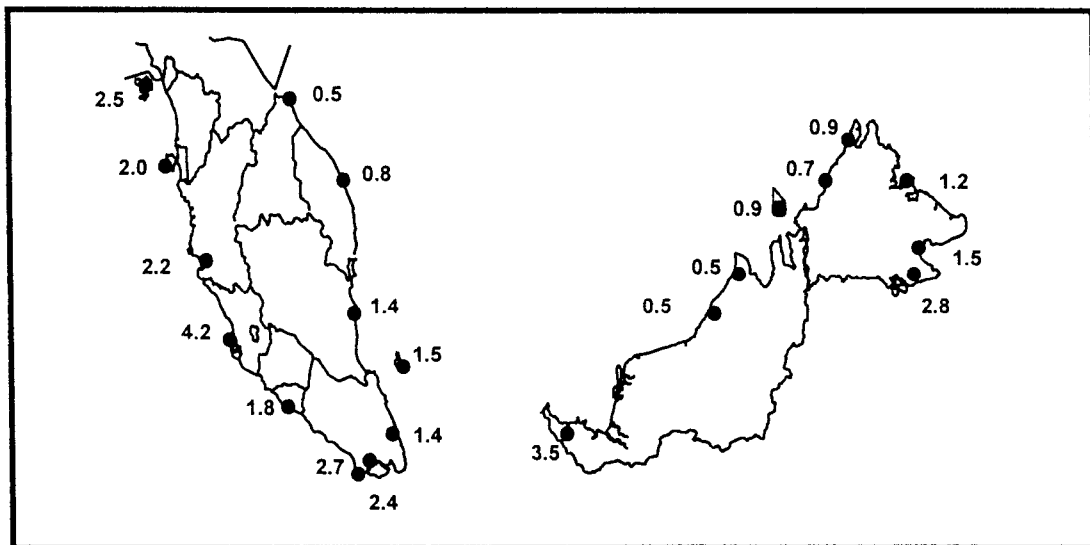
The ratio (F) of the tide found in Malaysia.

In Peninsular Malaysia, it is dominated by semi-diurnal and mixed (Dominant semi-diurnal) tide except Cendering station which has a mixed (Dominant Diurnal) tide. On the other hand, the tide in East Malaysia is either dominated by mixed (Dominant semi diurnal) tide or mixed (Dominant diurnal) tide. There is no diurnal tide available in Malaysia.



$$(H' + H_o) / (H_m + H_s)$$

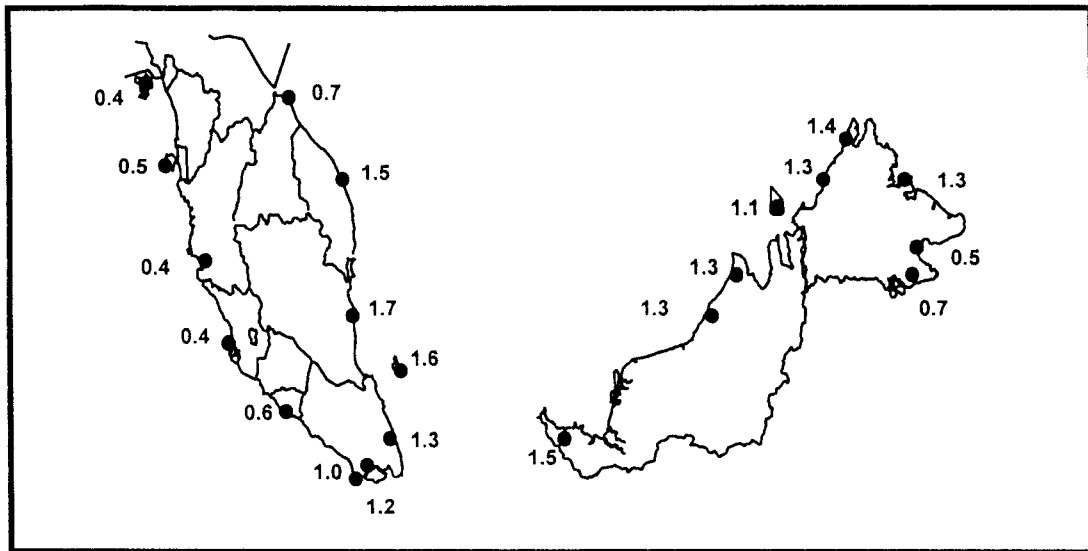
Tidal (Spring Range)



$$2(H_m + H_s)$$

Spring range – large at Port Kelang and Kuching

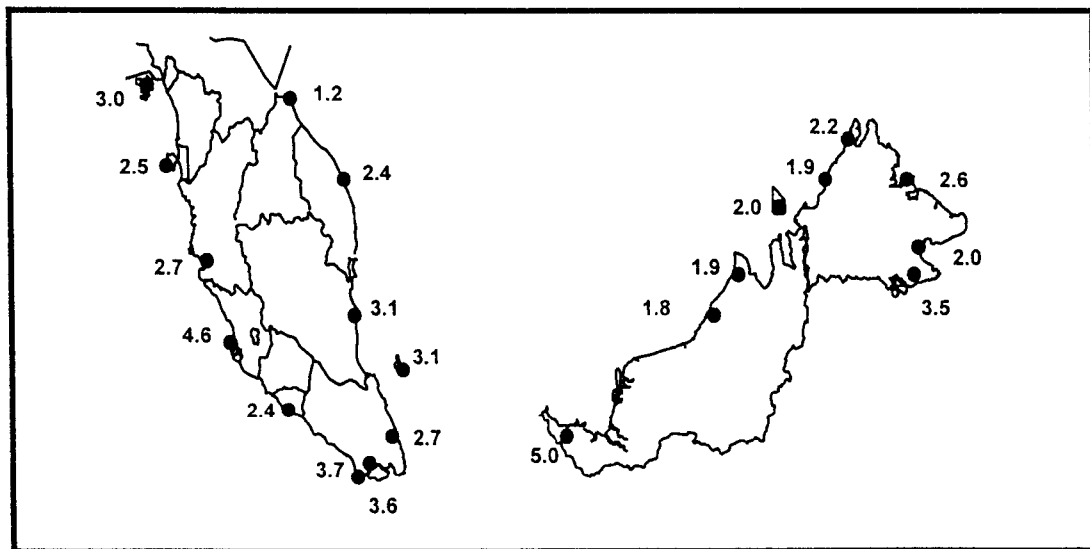
Tidal (Diurnal Range)



$2 (H' + H_0)$

Large Diurnal Range at stations facing South China Sea

Tidal (Spring and Diurnal Range)



$2 (H_m + H_s + H' + H_0)$

The maximum tidal range

6. Dissemination of Tidal Information

The Department of Survey and Mapping Malaysia produces two publications annually. They are

- (a) Record of Tidal Observation and
- (b) Tide Prediction Tables

The tidal predictions of all the stations are based on a set of 60 harmonic constituents, analysed from the yearly observation. The final predicted tide values that would be adopted for *Tide Prediction Tables* are the mean of the past 5 years of good observations.

7. Conclusions

With the newly installed tide gauges at Kudat, Lahat Datu, Pulau Labuan and Kuching in the late 1995 and early 1996, the tidal observation network in Malaysia can be considered as adequate and evenly distributed along the Malaysian coast. However the department may consider from time to time to increase the number of tide stations when the need arises.

Until the end of 1995, almost all the tide stations in the West Malaysia have collected at least 9 years of tidal data. On the other hand, only Kota Kinabalu and Tawau in Sabah have collected 8 years of tidal data, the rest of the stations in the East Malaysia are still very new.

So far, there is still no comprehensive and long term investigation into the tidal phenomena and mean sea variation for the whole of Malaysia. However, the tidal phenomena and mean sea level variation around Peninsular Malaysia had been carried out by Mr. Shigeru Toyoshima based on 6-9 years of tidal data from all the 12 tidal stations. A paper entitled *Tidal Phenomena and mean sea level variations around Peninsular Malaysia* was presented in a seminar *Tide and Tidal Phenomena* in 1994 in Kuala Lumpur.