A National Geocentric Datum and the Administration of Marine Spaces in Malaysia[2]

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Abstract

Malaysia is a country with two primary land masses, Peninsular Malaysia and East Malaysia (on the northern part of the island of Borneo). The country has a total land mass of approximately 330,000 square kilometers and 4320 kilometres of coastlines. The marine spaces within its jurisdiction are approximately 574,000 square kilometers. Approximately 30 percent of these spaces are under State jurisdiction. Administering and managing Malaysia's marine spaces across the extent of the country represents a challenge for both surveyors and administrators. A national geocentric datum was adopted in 2002 which, among others, united Peninsular Malaysia and East Malaysia under a single national mapping datum. Prior to the adoption, the country embraces two separate mapping datum. This paper will , to a certain extent, discuss the derivation and features of the national geocentric datum and attempt to outline additional challenges towards the development of an appropriate marine administration (cadastre) system for Malaysia.

1. INTRODUCTION

Malaysia is a country with two primary land masses, Peninsular Malaysia and East Malaysia (on the northern part of the island of Borneo). The country has a total land mass of approximately 330,000 square kilometers and 4320 kilometres of coastlines. These land masses support a population of 25 million. The country also enjoys the distinction of having the southern most tip of the Asian continent at Tanjung Piai, the southern most tip of Peninsular Malaysia. Malaysians refer to their homeland as "tanah-air", literally translated to mean "land and water (*or sea*)". This concept of land/water continuity exists since the country's recorded history. The need to administer and manage both land and marine spaces are thus not an alien concept. Malaysia is part of the South East Asian Region and a founding member of the Association of South East Asian Nations (ASEAN). The country has terrestrial borders with Thailand, Brunei Darussalam and Indonesia and has maritime borders with Thailand, Brunei Darussalam, Singapore, Indonesia, Vietnam and the Philippines.

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[2] *This paper does not necessary represent the position of the Ministry of Natural Resources and Environment Malaysia, the Department of Survey and Mapping Malaysia, the Land Surveyors Board Peninsular Malaysia, the Institution of Surveyors Malaysian or the Association of Authorized Land Surveyors Malaysia*

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1.1 System of Government

Malaysia's system of government is similar to that of the British, but modified because Malaysia is a Federation of 13 states and 3 Federal Territories. The government is based on a bicameral parliamentary system, headed by a Prime Minister.

The Federal Government has jurisdiction, among others, over external (foreign) affairs, defence, internal security, shipping, navigation, fisheries, ports and harbours whilst the State Government has jurisdiction, among others, *land and its administration*, agriculture, forestry and mining.

1.2 National Marine Spaces

The National Marine Spaces comprise of the following

- Territorial Seas
  the belt of seas measured 12 nautical miles seaward of the territorial sea baseline
- Contiguous Zone
  the belt of seas, contiguous to the territorial sea, measured 24 nautical miles seaward from the territorial sea baseline
- Exclusive Economic Zone
  the area beyond and adjacent to the territorial sea, measured 200 nautical miles seaward of the territorial sea baseline
- Continental Shelf
  the area beyond and adjacent to the EEZ, measured to a limit (usually 350 nautical miles from territorial sea baseline) where a physical continental shelf exists beyond the 200nm limit.

Figure 1: Peninsular and East Malaysia

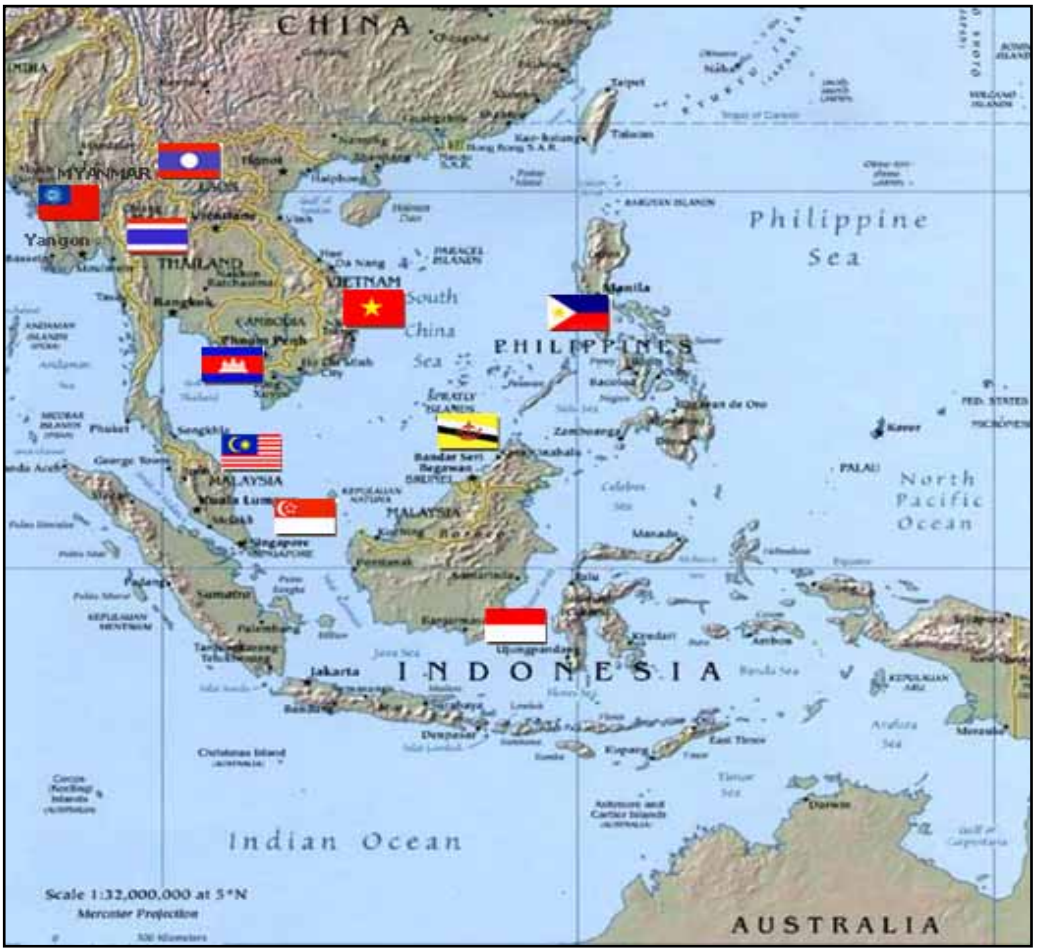

Figure 2: Malaysia and its South East Asian Neighbours

1.3 Administrative Constraints

Jurisdiction over marine spaces and management responsibilities are split between the State and Federal Governments. The marine spaces within Malaysia's jurisdiction are approximately 574,000 square kilometers. Within this space are more than 600 islands, few have yet to be named.

The State effectively control up to 3 nautical miles from the low water mark whilst the Federal Government has jurisdiction and management from that point to the outer edge of the EEZ and the Continental Shelf.

As a result, the eventual areas of jurisdiction that would fall under the State and Federal Governments are respectively as follows:

State Jurisdiction (Coastal Waters - 3nm offshore)
- Peninsular Malaysia 17950 sq km
- East Malaysia 20250 sq km

Federal Jurisdiction (Territorial Waters - *12nm offshore*)
- Peninsular Malaysia 38800 sq km
- East Malaysia 20300 sq km

These areas (only territorial seas) already represent approximately 30% of Malaysia's land mass.

1.4 Value of Marine Spaces

Within this Marine Spaces are many and at times, competing, uses and these uses include:

- Sources of food from animals, plants and fishes
- Means of transportation and communication
- Areas for development
- Areas for recreation
- Areas for dumping of waste
- Areas for scientific research
- Areas for mineral and hydrocarbon extraction

Figure 3: Aquaculture

Figure 4: Coastal Communities

Figure 5: Typical Coastal Marine Ecosystem

Figure 6: Recreational Spaces

Figure 7: Coastal Built Environment

2. CHALLENGES

In the administration of these marine spaces in Malaysia, the construction of a system to administer marine spaces should incorporate a “seamless onshore-offshore” objective. The importance of spatial and textual continuity traversing land-water interface is to obtain coherence of, among others - the register of interests, the unique parcel identifiers, the cadastral survey system, and the cadastral map, based on common national (sometimes international) coordinate system. [*Hoogsteden and Robertson, 1998, 1999*]

To promote continuity of land/water (sea) interface, it is argued that the technical components of marine and land administration system should be similar or at the very least, closely linked. This poses certain challenges, among others:

- *Geodetic Reference Framework*
  - different state and local geodetic systems
  - definition of vertical datum (the use of chart datum has always been a source of much confusion)
  - not possible to place monuments in marine space
- *Determination of base points*
  - Determination of base points and baselines in accordance to UNCLOS 1982 and consequently the various maritime zones
- *Scale of Base Maps*
  - Maps are the primary medium for the location of parcels. There are issues of data sources, data contents and data accuracy.
- *Records of Interest*
  - Recording interest within a water column (3D) with a temporal (t) component

It has been recognised that a consistent spatial data infrastructure is necessary whereby the rights, restrictions and responsibilities are administered and managed effectively within the marine spaces, similar to that which has been carried out within the landed environment.

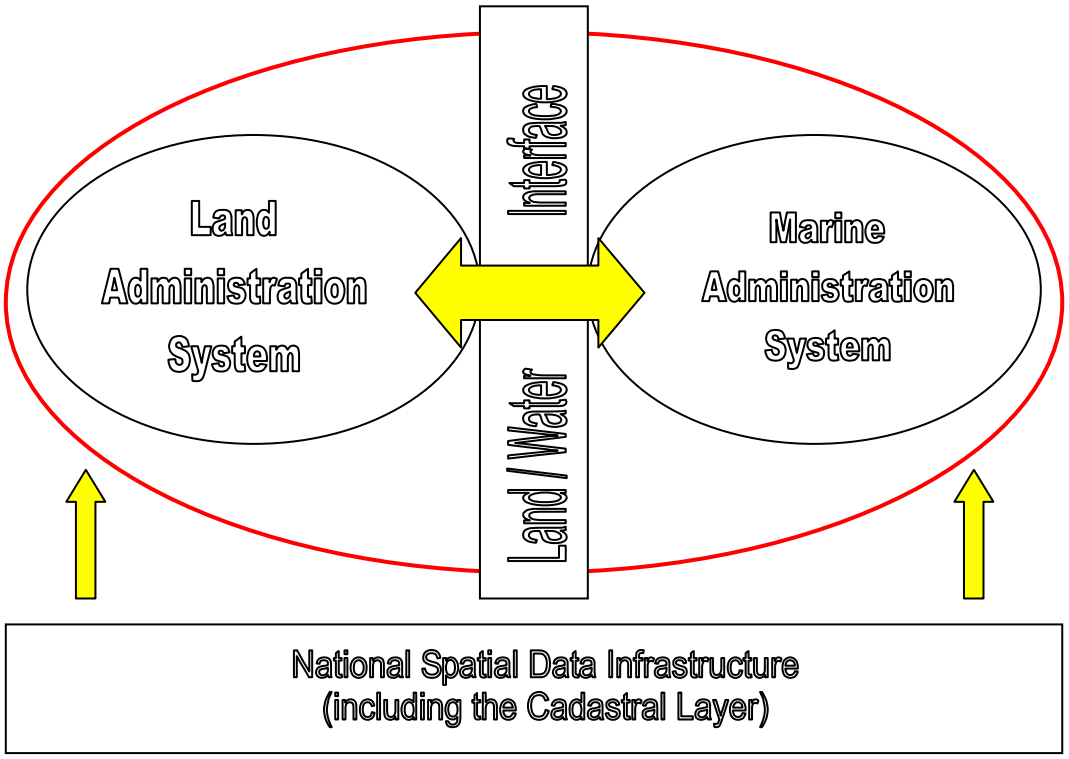

Figure 9: Land and Sea Interface[5]

[5] International Workshop for Administering the Marine Environment, Kuala Lumpur, April 2004

3. NATIONAL GEOCENTRIC DATUM (GDM 2000)

3.1 Background

National Geodetic Framework supports national development, the national economy and security of tenure within the land market. The drive for a modern, digital era friendly geodetic framework in Malaysia arises from, amongst others, the -

- Increasing use of GPS for various applications has revealed shortcomings in the existing Malaysian local datums
- Unified coordinate system referenced to a universally adopted datum is needed to accommodate needs of efficient acquisition and use of digital spatial data
- Homogeneous geodetic infrastructure would provide appropriate framework for the integration of spatial data for decision making
- The realization of the value of a homogeneous national spatial data infrastructure and the growing prominence of spatial sciences industry.

Historically, Malaysian geodetic datums has been established since 19th century using conventional surveying techniques and procedures and -

- Local datums are not aligned with global geocentric coordinates frames.
- Existing datum is not compatible with the wide spread use of modern positioning systems and international recommendations.
- Survey accuracy often degraded because of approximate coordinate transformation procedures.

The geodetic reference frame to define the Malaysian geocentric datum was realized through a set of permanent GPS stations termed the Malaysian Active GPS Stations (MASS) defined in the International Terrestrial Reference Frame (ITRF). For that purpose, long baseline connections between the MASS stations to IGS stations in the region were made. In deriving the National Geocentric Datum,

- Malaysia operated and still operating 17 MASS stations continuously (since 1998); 10 in Peninsular Malaysia and the rest in Sabah and Sarawak (East Malaysia).
- In establishing connections to IGS stations, 11 of the IGS have been used.
- GPS data from all those stations have been processed together to determine MASS station coordinates in the ITRS reference frame.
- 4 years of GPS data from all MASS stations have been utilized in the processing.
- Eventually, a highly accurate and consistent 3-D geocentric coordinates for the 17 MASS stations have been able to be determined and they define the Malaysian geocentric datum.
- Those coordinates are based in the ITRF 2000 at epoch 2nd January 2000 and accuracy of the coordinates is at 1 cm level.

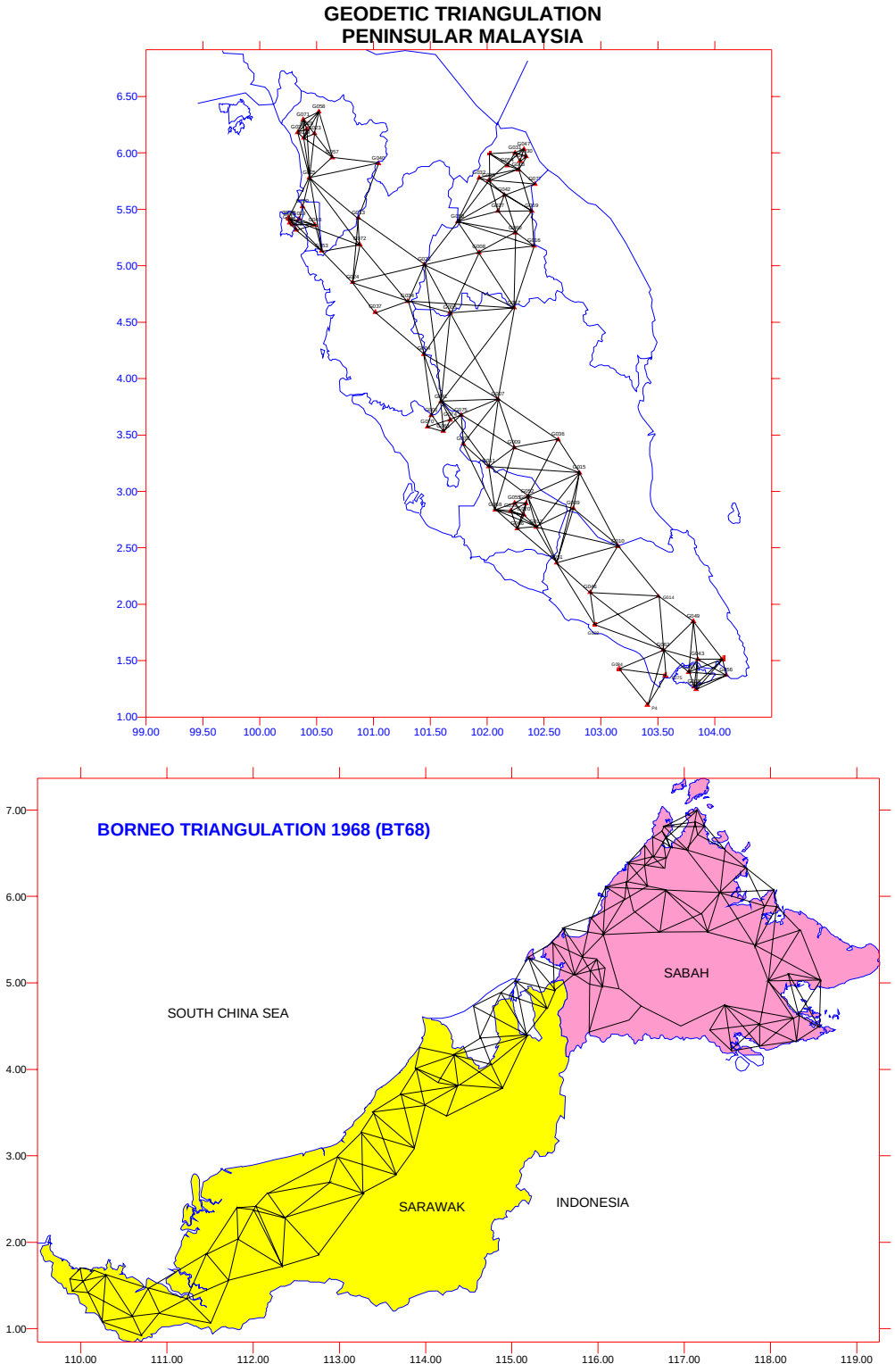

Figure 10: Triangulation Networks: Peninsular Malaysia and East Malaysia[6]

6 Provided by the Department of Survey and Mapping Malaysia

3.2 Derivation of GDM 2000

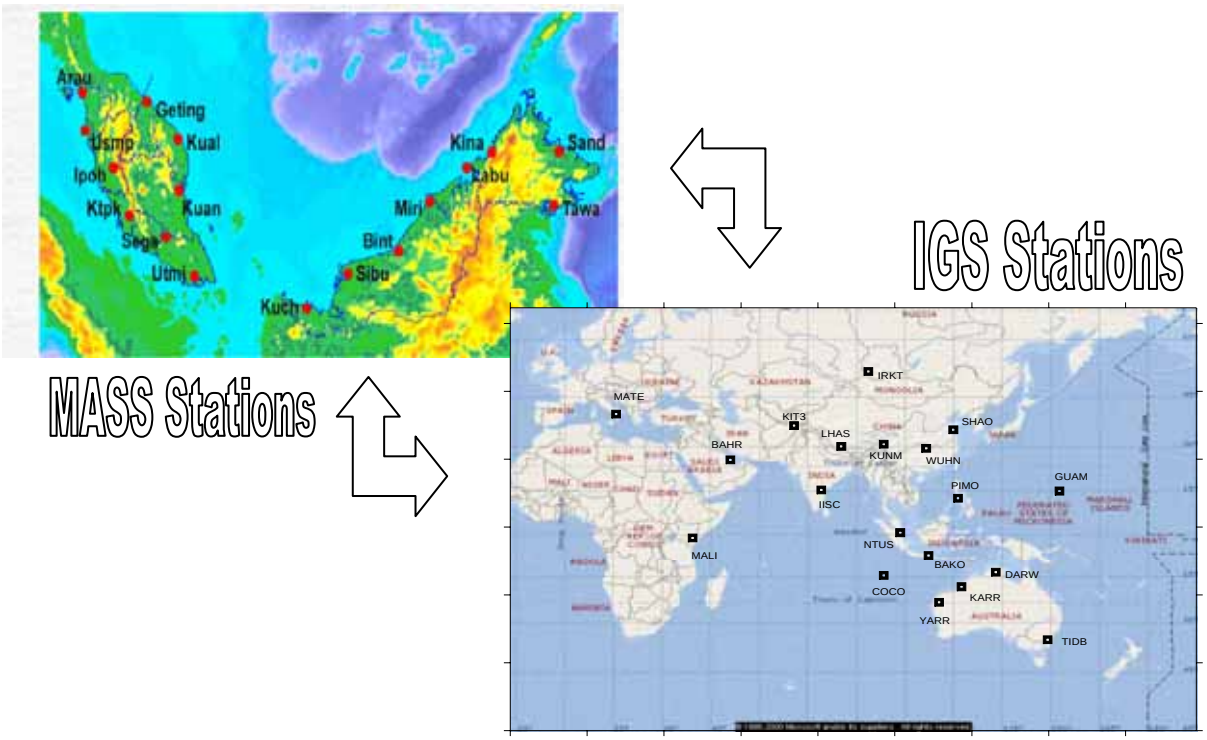

Figure 11: Permanent GPS Stations Utilised in the Derivation of GDM 2000

3.3 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

Figure 12: Malaysia Active GPS Stations (MASS)

The Geocentric Datum of Malaysia (GDM 2000) will provide a single standard for collecting, storing and applying spatial data at all levels – local, regional, national and international. It will facilitate the creation of an integrated national spatial data infrastructure for Malaysia considering that the country has two primary land masses and approximately 600 islands.

4. SIGNIFICANCE OF GDM 2000

The National Geocentric Datum (GDM 2000) is able to unify the various geodetic datums that were in use with reference to a geocentric reference frame defined in the ITRF system. Adoption of geocentric datum made datum unification between East and West Malaysia a reality. GDM 2000 forms the backbone for the national adjustment of all existing GPS control stations to bring all coordinates into the ITRF system.

It also herald a new era where a high accuracy, homogeneous and up-to-date datum is available for the nation, realizing that the geodetic reference frame supports a myriad of national agenda including national security, security of land tenure and security and sustainability of the land market and the built environment. GDM 2000 also provides for Malaysia an internationally compatible system for all spatial data.

The significance of GDM 2000 is not lost within the realm Marine Spaces Administration as it allows common geo-referencing of spatial data, promotes homogeneity in spatial data and will facilitate data integration and spatial analyses for decision making.

5. CONCLUSION

Most countries have a land administration system that operated as separate entities from their marine administration system. This causes management gaps at the coastal zone. The idea of having a seamless spatial data administration system that includes the marine and terrestrial environments has been well accepted.7

This is evident at the conclusion of the International Workshop for Administering the Marine Environment held in Kuala Lumpur in April 2004 which recommended that a marine dimension be added to all coastal countries national SDI in the Asia Pacific region. The development of an appropriate seamless SDI would certainly help in the integration of the two systems. Consequently, the development of a seamless SDI that includes data from land, coast and marine environments will enable the access and sharing of data between those environments to be improved.

While the country's administrators look into how best to effectively administer her marine spaces, some of the technical (spatial) challenges have been overcome by the adoption of the National Geocentric Datum (GDM 2000) introduced by the Department of Survey and Mapping Malaysia in 2002.

[7] International Workshop for Administering the Marine Environment, Kuala Lumpur, April 2004