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Website : <http://survey.gov.bn/>

E-mail : info@survey.gov.bn

GEOCENTRIC DATUM BRUNEI DARUSSALAM 2009 (GDBD2009) IMPLEMENTATION AND IMPLICATIONS



جائیتن اوکور

SURVEY DEPARTMENT
MINISTRY OF DEVELOPMENT

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ISO 9001 E-mail : info@survey.gov.bn

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Introduction

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- Historically, Brunei Darussalam geodetic datum has been established since 19th century using conventional surveying techniques and procedures.
- Confined to small areas of the globe, fit to limited areas and to satisfy national mapping requirements.
- Local datum is not aligned with global geocentric coordinates frames.
- Existing datum does not compatible with the wide spread use of modern positioning systems and international recommendation.
- Survey accuracy often degraded because of approximate coordinate transformation procedures.

Introduction

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- ❑ The new Geocentric Datum will provide a single standard for collecting, storing and applying spatial data at all levels – local, regional, national and international.
- ❑ The GDBD2009 will facilitate the creation of an integrated national geographic data infrastructure.
- ❑ GDBD2009 is totally compatible with satellite-based positioning/navigation system such as Global Positioning System (GPS)

Introduction

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- Development of geocentric datum will lead to practical realization of the “Whole to Part” Principle.
- The key success factors in the GDBD2009 realization;
 - Geodesy
 - Least Squares Adjustment, and
 - High Precision GPS

Geodetic Datum

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Classical Geodetic Datum

- ❑ Defined implicitly by assigning coordinates to one or more points within the region being mapped.
- ❑ Their center is not explicitly defined and could be many hundreds of meters from the geocentric.
- ❑ Directions of axes are defined according to local astronomical phenomena at the time of the definition.

Modern Geodetic Datum

- ❑ Usually geocentric systems by definition, have their center at the center of mass of the earth
- ❑ The direction of their axes are defined as ECEF system.
- ❑ The realization of coordinates within geocentric datum needs high accuracy space geodetic techniques
- ❑ Geocentric datum development is based on Global Geodetic Network Solution

Geodetic Datum

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A modern geodetic datum can be defined as:

- Three dimensional Earth Centered Earth Fixed (ECEF) Cartesian System to define the Cartesian XYZ coordinates.
- An ellipsoid of revolution to defined the geodetic coordinates (latitude, longitude and ellipsoid height).

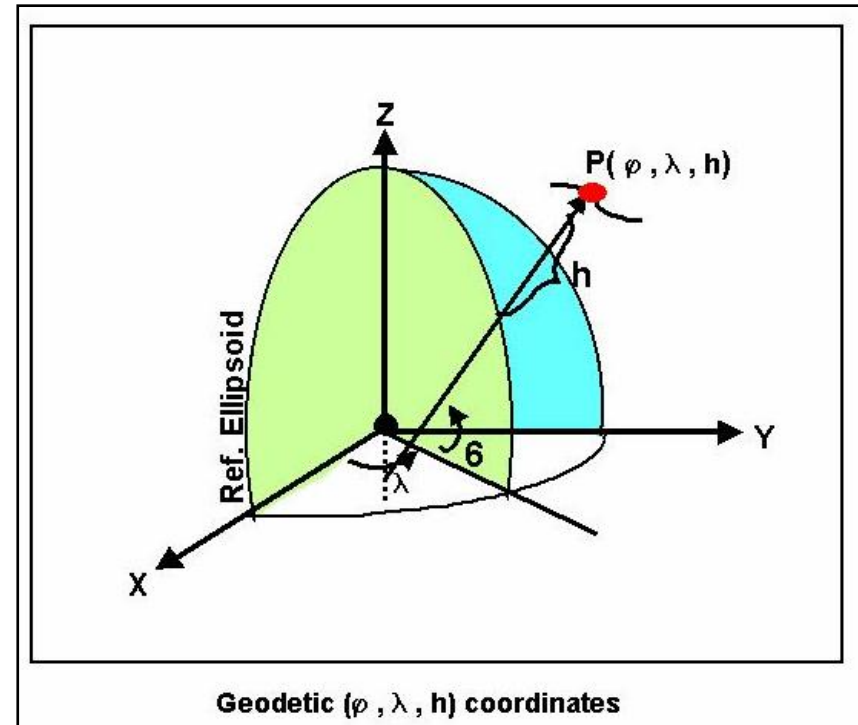
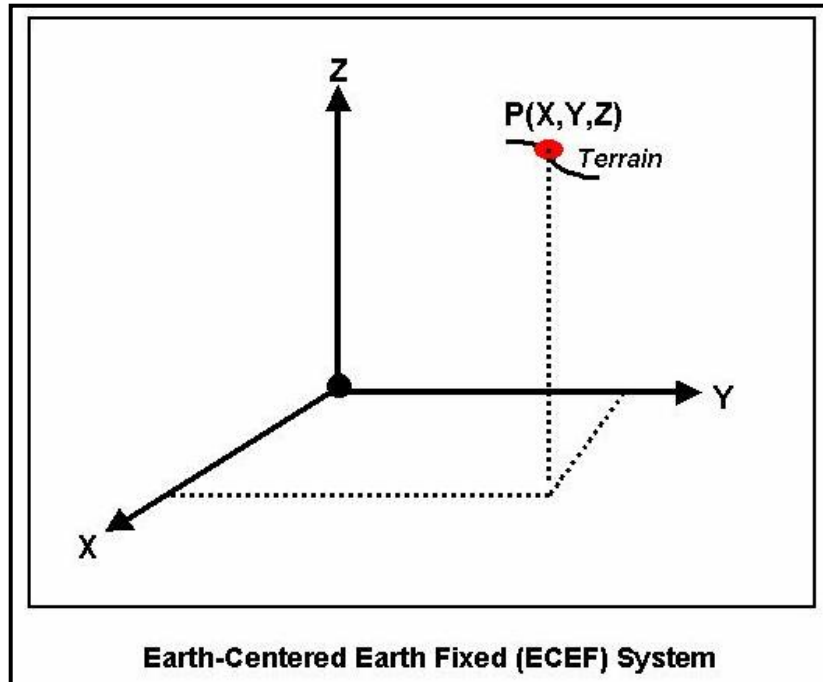


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Geodetic Datum

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Classical Geodetic Infrastructure

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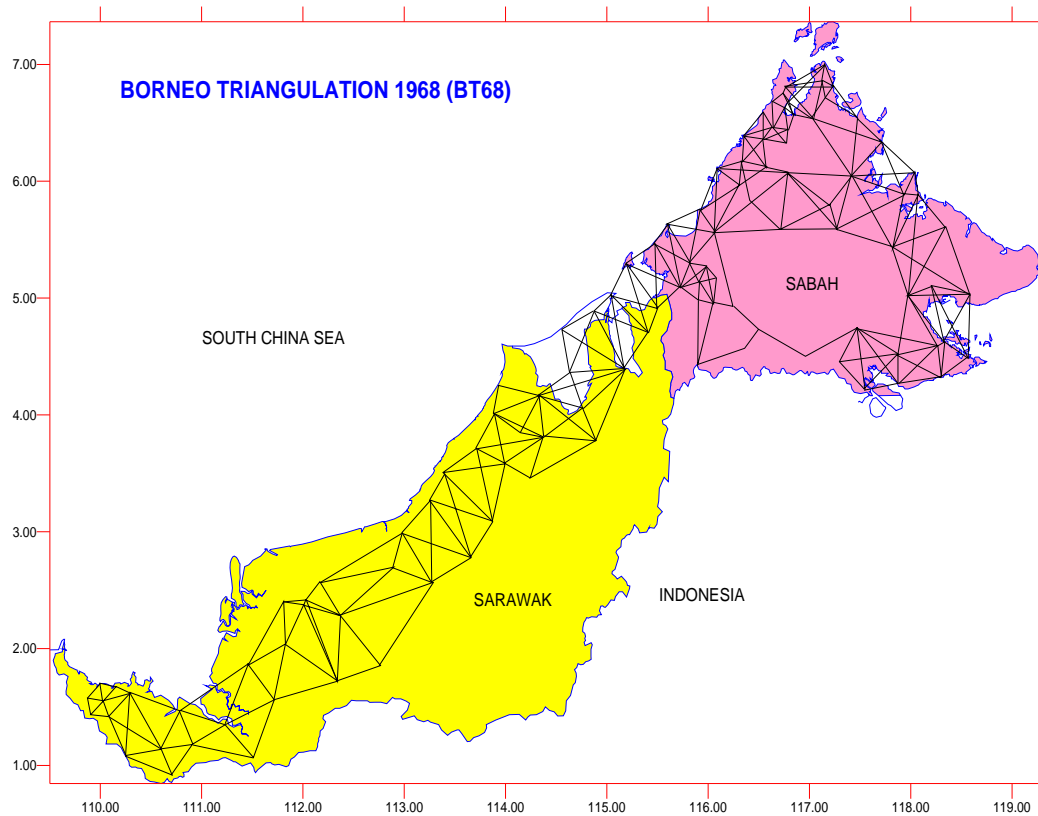
The Present Existing Geodetic Reference System for Brunei Darussalam

- Borneo Triangulation System 1948 (BT48) for Brunei Darussalam
- Still being used for geodetic, mapping and cadastral surveying
- Datum :
 - Origin : Timbalai
 - Reference Ellipsoid : Modified Everest.

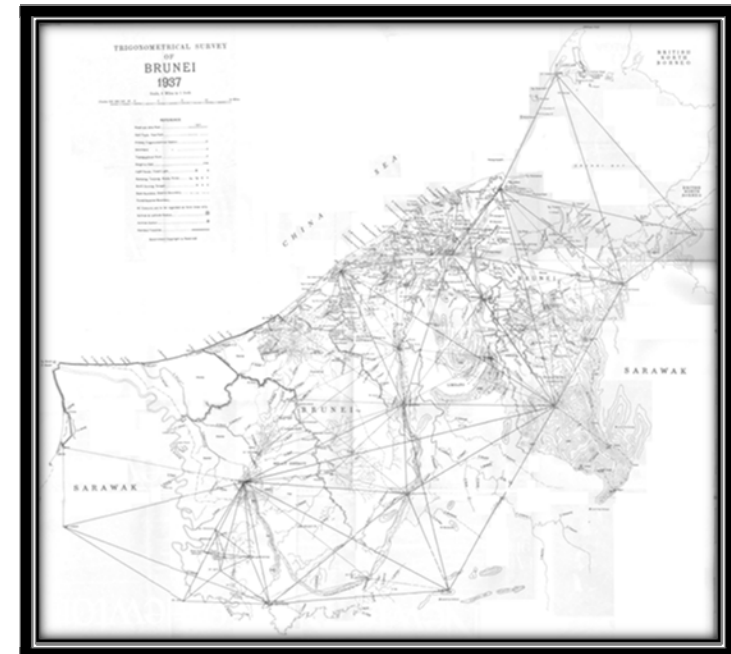
Classical Geodetic Infrastructure

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Borneo Triangulation 1968 (BT68)



Borneo Triangulation 1948 (BT48)



Realization of GDBD2009

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GDBD2009 is being realized through :

- A set of Stations Coordinates (and velocity) defined in the precise ECEF reference system i.e. International Terrestrial Reference System (ITRS).
- Coordinates of 8 Zero Order Stations in Global Geocentric Coordinate System
 - ITRF Frame : ITRF 2005
 - Epoch of Reference : 1st June 2009
- The adoption Reference Ellipsoid is GRS80

Realization of GDBD2009

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Realization of GDBD2009 has undergone several tasks:

- GPS Data Collection at 8 Zero Order Network connected to IGS stations
- Observation Period : 17th May – 2nd June, 2009
- GPS Data Collection at 13 Primary and 5 Secondary stations of BT48, connected to Zero Order Network and IGS stations
- Observation Length: 48 hour per Station
- Campaign Period : February – March 2009

Realization of GDBD2009

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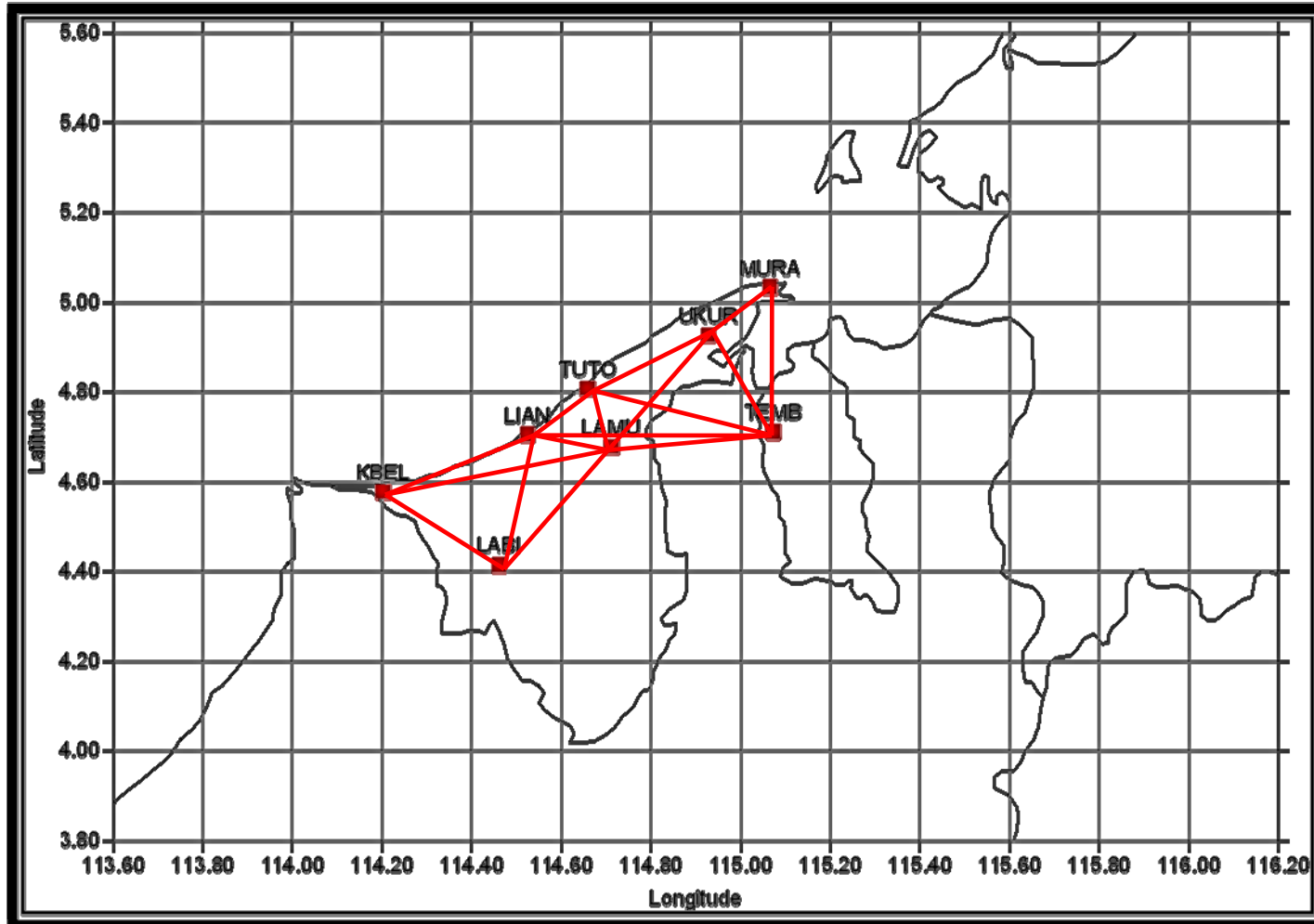
- The data processing and adjustment of the GDBD2009 Network
 - Software : BERNESE VERSION 5.0
- Computation of Transformation Parameters;
 - GDBD2009 to BT48 and Reverse
 - GDBD2009 to WGS84 and Reverse
- Development of GDBD2009 Transformation Software

Zero Order Network GDBD2009

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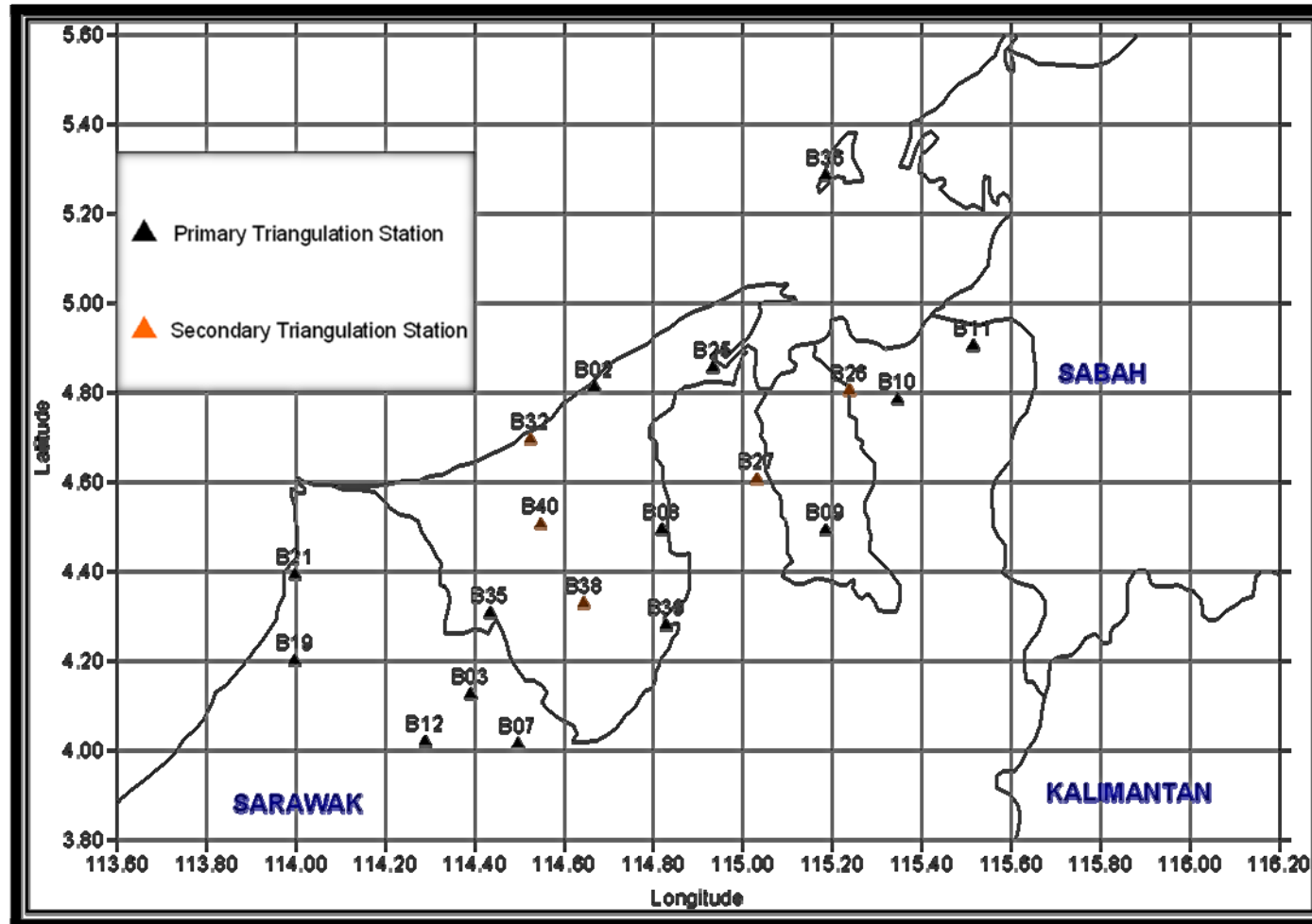


Primary Geodetic Network

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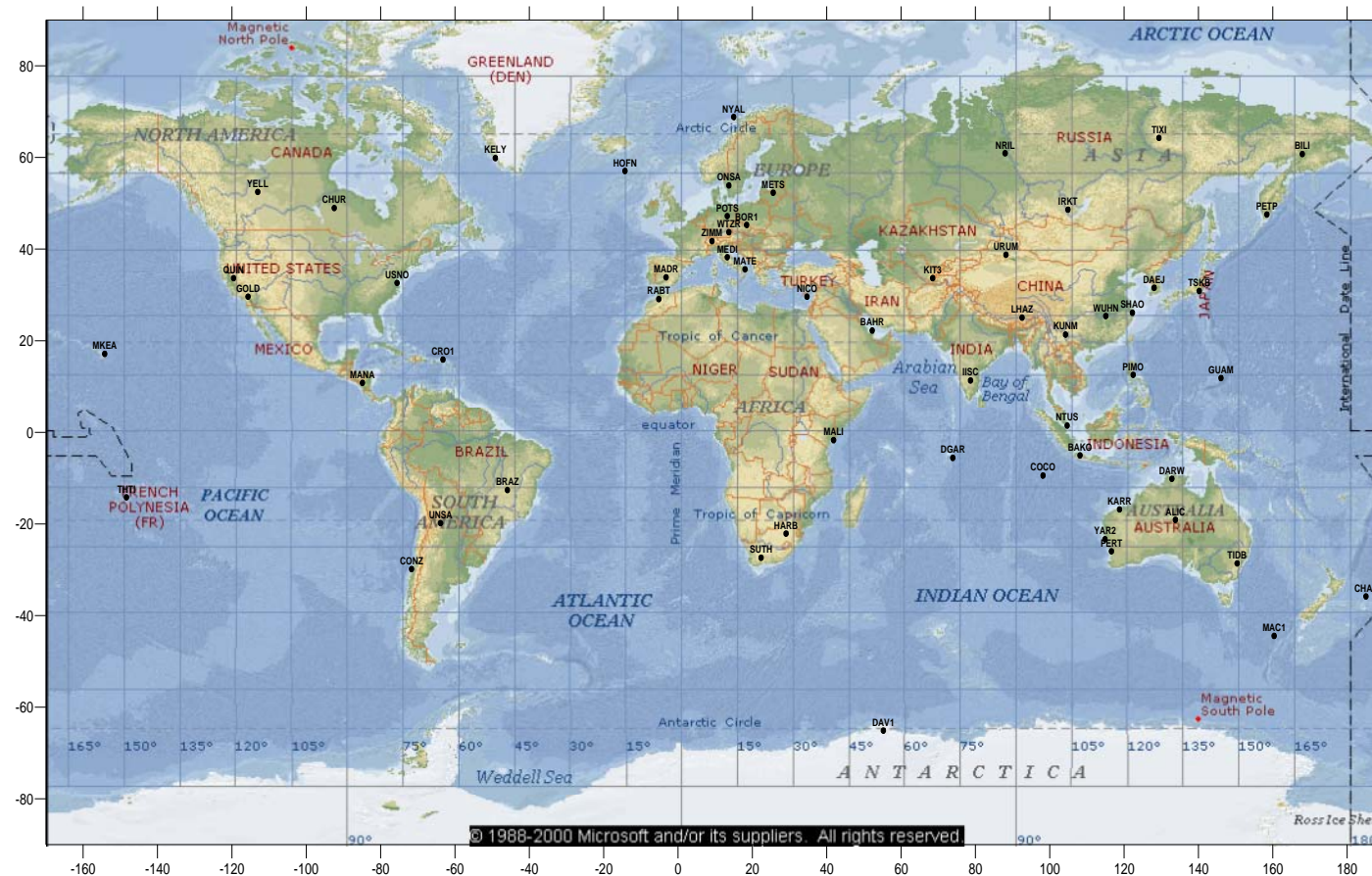


Realization of GDBD2009

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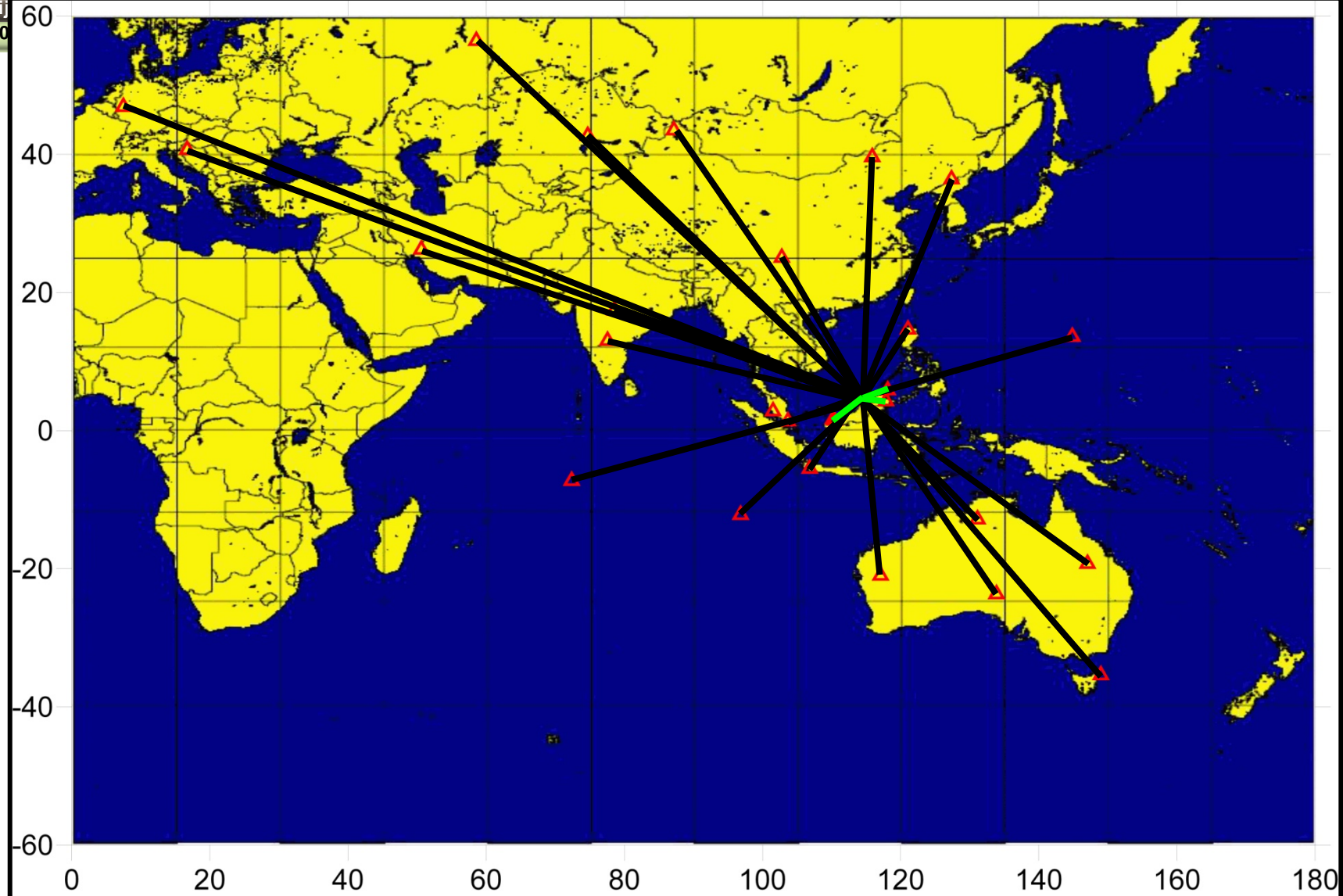
More than 50 IGS stations

Realization of GDBD2009

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GDBD2009

Main Deliverables

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Main Deliverables of the development GDBD2009 ;

- Brunei Darussalam Zero Order Network
 - Accurate Station Coordinates of Zero Order Network in ITRF2005, Epoch 1st June 2009.
- Transformation Parameters between BT48 and GDBD2009
- New Equations for both Cadastral and Topographic Mapping
 - Small Scale Topographic Map
 - Large Scale Cadastral Map
- GDTSB Software
- GDBD2009 Technical Manual

Implication of Adopting GDBD2009

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- Implication on Surveying and Mapping Practices;
 - Integrated 3D GPS Positioning
 - Map Migrations
 - Topographical Mapping
 - Cadastral Database
 - GIS Users
- Socio-economic Implications
- Navigation and Scientific Implications

Surveying and Mapping Practices

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Integrated 3D GPS Positioning and Surveying

- Position determination using various GPS techniques have been increasingly practiced for various survey related applications
 - Development Height Modernization for Brunei Darussalam
 - This will encourage the use of GPS as an effective positioning tool without going through the lengthy process of conversion to the old local datum of BT48
 - The new GDBD2009 will also support the function of Real Time Kinematic (RTK) GPS Network in the country
- .

Height Modernization for Brunei Darussalam

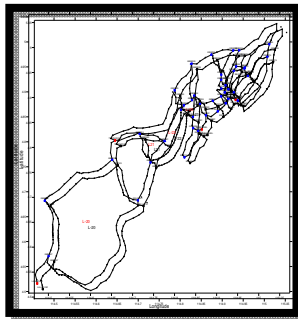
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- ❑ Height Modernization is defined as the establishment of accurate and reliable heights using GNSS technology
- ❑ GNSS permanent network in Brunei is the latest venture of Survey .Based on these information and the needs to support modern height system, the implementation of Height Modernization System (HMS) in Brunei Darussalam were realized.
- ❑ The main objective of the Height Modernization Project is to develop cm accuracy Fitted Geoid over the Brunei Darussalam area.

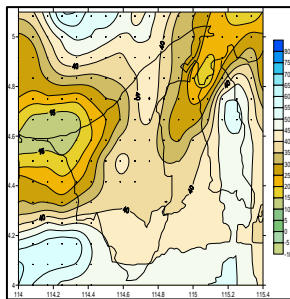
Height Modernization for Brunei Darussalam

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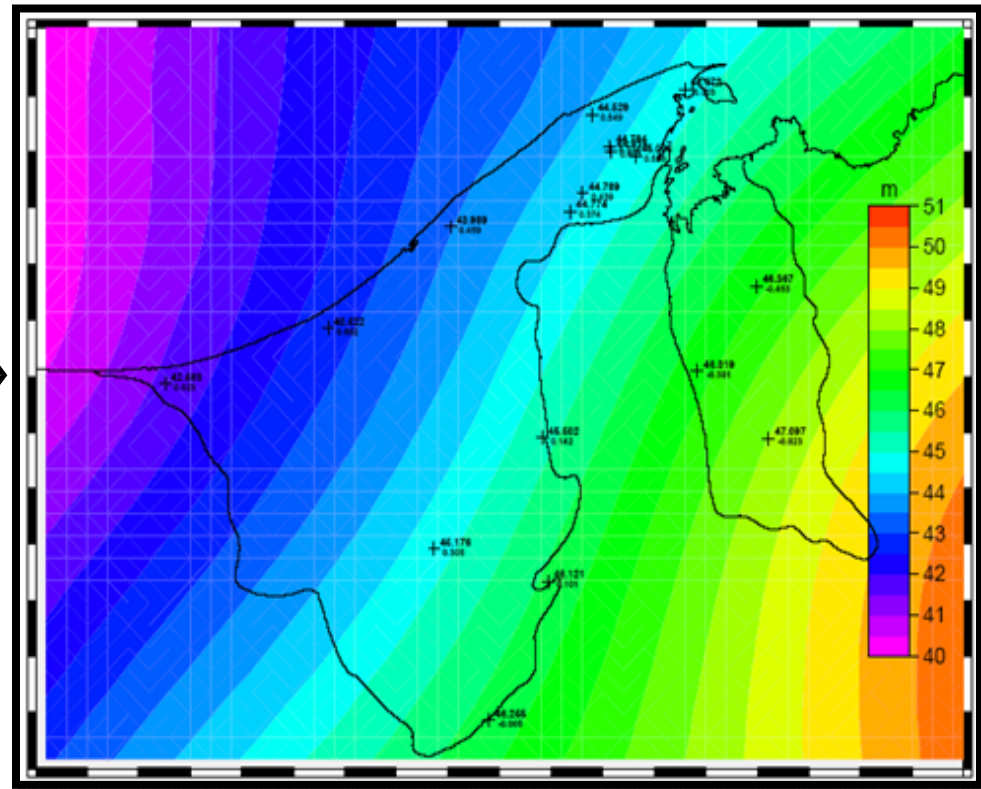
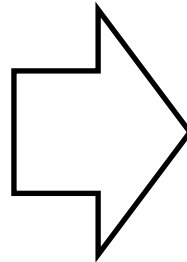
Precise Leveling



GNSS Data



Gravity data



Geoid Database Over The Brunei Darussalam

Geoid Computation – Computation of Geoid for determination N value (Geoid height) are based on combination of precise levelling data, GNSS and Gravity data.

Surveying and Mapping Practices

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Map Migrations

- The RSO is an oblique Mercator projection used for cadastral and topographical mapping application in Brunei Darussalam.
- The RSO provide an optimum solution in the sense of minimizing distortion whilst remaining conformal.
- This projection system has been used in Brunei Darussalam (called Borneo RSO/ Timbalai RSO) for topographical mapping and cadastral surveying based on the local BT48 datum.
- The new Geocentric RSO projection Parameters for Brunei Darussalam is being established.

Implication on Practice

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Topographical Mapping and Cadastral Survey

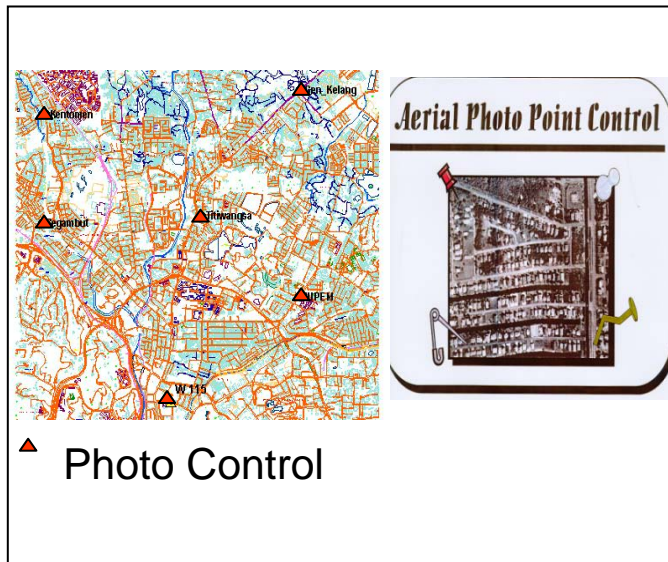
- ❑ The existing map projection used for topographical mapping and cadastral survey in Brunei Darussalam is the RSO based on BT48 system (BRSO coordinates).
- ❑ $BT48 \rightarrow (E,N)BRSO$
- ❑ The procedure of converting WGS84 coordinates to their corresponding values in local RSO system involves several transformation steps such as the following:
 - ❑ $\phi, \lambda_{WGS84} \rightarrow BT48 \rightarrow (E,N)BRSO$
- ❑ The introduction of GDB2009 will have a significant effect on the topographical mapping and cadastral products (reduce transformation errors)
 - ❑ $\phi, \lambda_{GDBD2009} \rightarrow (E,N) BRSO_{GDBD2009}$

Topographical Mapping/Cadastral Survey

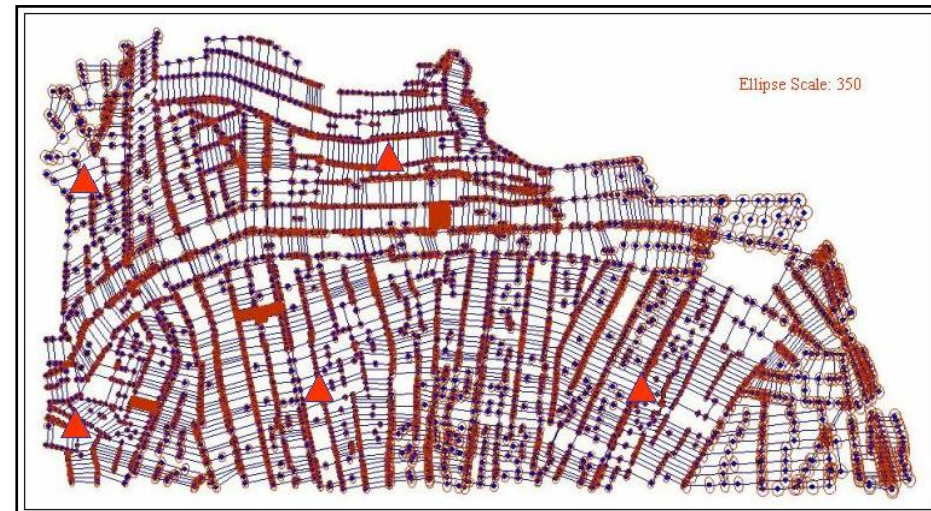
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Digital Mapping System



Digital Cadastral Database

Implication on Practice

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GIS Users

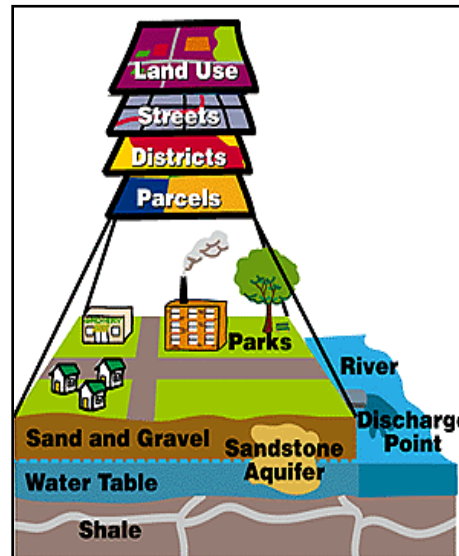
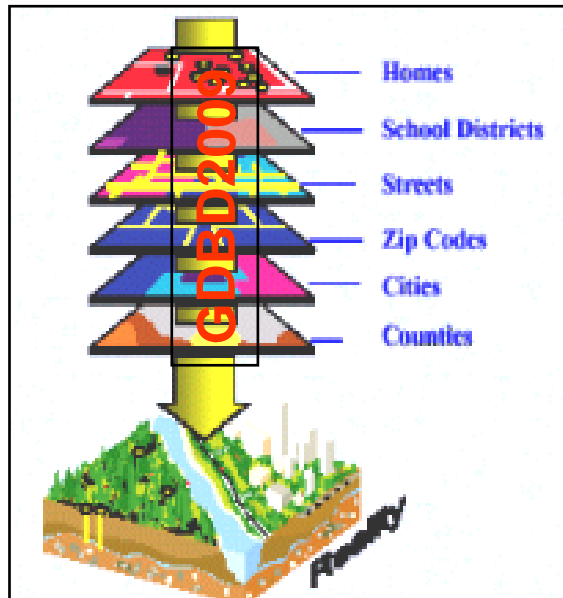
- The GDBD2009 provides coordinates that are appropriate for applications at all levels and allows the easy integration with other information technologies such as GIS.
- The development of Brunei Darussalam Spatial Data Infrastructure will be provide consistent national datasets to users on the same coordinate system.
- The BSDI will be based on the GDBD2009 and all datasets will be supplied to users in GDBD2009 coordinates.
- The use of GDBD2009 will minimize confusion for all users and provide maximum accuracy where precise spatial information is required.

GIS Users

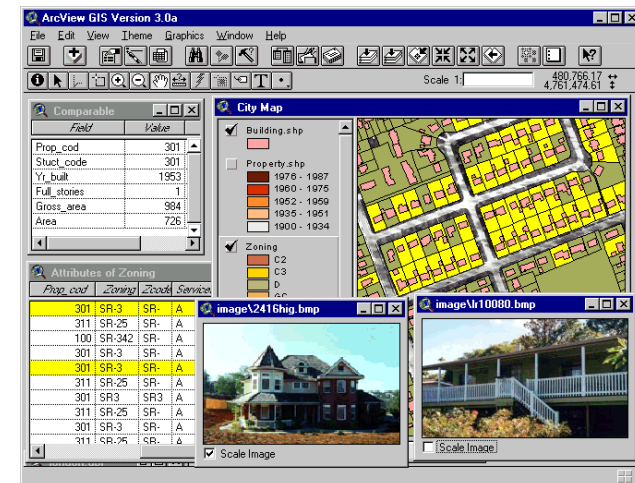
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GIS is not merely a beautiful digital map



Socio Economic Implications

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- The user segment of GDBD2009 will be:
 - Government Department Agencies – Survey Department, Land Departments, Planning Department, Local Governments and Municipalities.
 - Non-Government Organization- private surveyors
 - Public and private users.
- Government agencies and the private surveyors will be most affected since they directly involve in cadastral survey practice and the main user of the topographical and cadastral mapping products .

Socio Economic Implications

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- Private and public organizations will need to assess both the impact and benefits of adopting GDBD2009 in terms of their current and future operational requirements, financial, administrative and managerial issues.
- The adoption of GDBD2009 will accommodate the integration of spatial datasets and consequently will provide better data sharing, handling and management of the related datasets.
- The new datum will also encourage consistent or uniform spatial data standard across the country

Conclusions

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- ❑ The new Geocentric Datum for Brunei Darussalam (GDBD2009) is being established by the DSB using GPS space geodetic technology based on International Terrestrial Reference Frame (ITRF2005) and Geodetic Reference System 1980 (GRS80) reference ellipsoid.
- ❑ Accuracy estimate for the stations in the network that define GDBD2009 is found to be in the better than 1 cm in all components.
- ❑ In the process of implementing GDBD2009, matters related to datum transformations, map projections, implication on surveying and mapping practices and socio-economic have been addressed.

Conclusions

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- Implementation of GDBD2009 will further encourage the use of GPS positioning technology by various mapping related agencies in this country.
- The new datum will also encourage consistent or uniform spatial data standard across the country



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