Rujukan Kami : JUPEM 18/7/2.148 (***87***)

Tarikh : ***6*** September 2005

Semua Pengarah Ukur dan Pemetaan Negeri

Semua Pengarah Ukur Topografi

Semua Ketua Seksyen

PEKELILING KETUA PENGARAH UKUR DAN PEMETAAN

BIL. 10 TAHUN 2005

GARIS PANDUAN PENGGUNAAN MODEL GEOID MALAYSIA (MyGEOID)

1.0 TUJUAN

Pekeliling ini bertujuan untuk menyediakan garis panduan berkaitan model geoid Malaysia (MyGEOID) serta penggunaannya bagi kerja-kerja pengukuran dan pemetaan di seluruh negara.

2.0 LATARBELAKANG

Kemajuan dalam teknologi *Global Positioning System* (GPS) telah merevolusikan pengukuran bagi membolehkan penentuan maklumat kedudukan mendatar dan juga ketinggian. Dalam hal ini, teknologi GPS antara lain menyediakan kaedah alternatif bagi mendapatkan ketinggian dengan lebih mudah. Walau bagaimanapun, nilai ketinggian yang dihasilkan daripada ukuran GPS tidak seragam berbanding dengan ketinggian yang didapatkan daripada ukuran aras. Keadaan ini disebabkan ketinggian aras adalah berasaskan permukaan samaupaya (*equipotential surface*) yang dikenali sebagai geoid, sementara ketinggian GPS merujuk kepada permukaan bentuk bumi teoretikal yang dikenali sebagai elipsoid. Ketinggian GPS (dikenali juga sebagai ketinggian elipsoid) boleh ditukarkan kepada ketinggian berasaskan geoid (dikenali juga sebagai ketinggian ortometrik) dengan tepat, jika jarak pemisahan di antara geoid dan elipsoid (dikenali juga sebagai ketinggian geoid) diketahui.

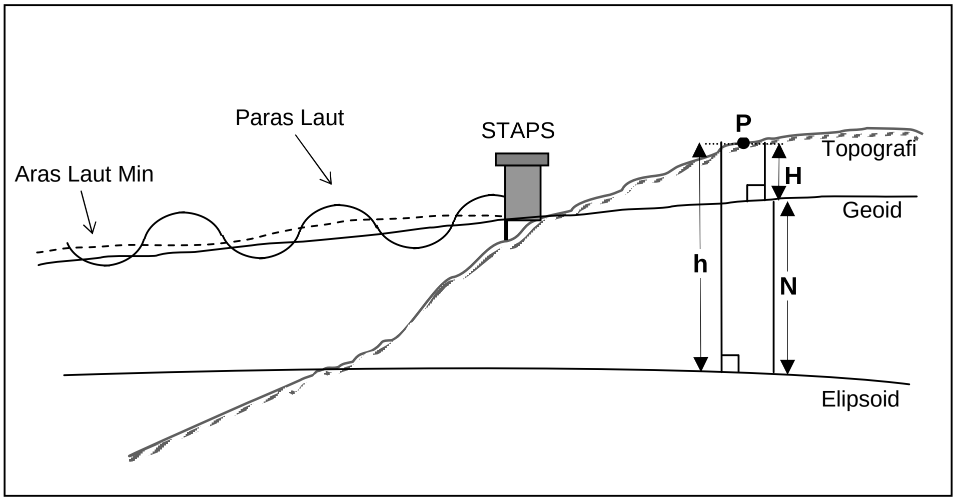
Pada tahun 2002, JUPEM telah melaksanakan projek pemetaan geoid dengan objektif utama untuk menghasilkan model geoid berkejituan tinggi dalam usaha menentukan nilai ketinggian geoid di seluruh negara. Perhitungan untuk menerbitkan model geoid tersebut memerlukan antara lainnya maklumat graviti yang padat. Dalam hubungan ini, JUPEM telah menjalankan ukuran graviti bawaan udara bagi seluruh Semenanjung serta Sabah dan Sarawak pada tahun 2002 dan 2003. Sebagai tambahan, data graviti *terrestrial*, data altimeter satelit, model geoid global dan *digital terrain model* telah turut digunakan dalam perhitungan model geoid Malaysia. Disamping itu, ukuran aras GPS di atas tanda-tanda aras telah diuruskan bagi memodelkan bias datum tegak dan selanjutnya menerbitkan geoid kesepadanan (*fitted geoid*) dengan datum tegak yang berasaskan nilai aras laut min. Usaha-usaha yang dijalankan ini telah akhirnya menghasilkan model geoid Malaysia yang pertama yang dikenali sebagai MyGEOID.

3.0 KONSEP GEOID

Geoid adalah permukaan samaupaya bagi medan graviti bumi yang boleh dianggap sepadan dengan aras laut min global. Sehubungan itu, geoid boleh digunakan sama seperti aras laut min bagi tujuan rujukan ketinggian. Nilai aras laut min pula adalah purata daripada aras tertinggi dan terendah pasang surut air yang dicerap di Stesen Tolok Air Pasang Surut (STAPS). Ianya digunakan sebagai rujukan kepada ketinggian sesuatu butiran pada, di atas atau di bawah permukaan tanah.

Secara umumnya, hubungan di antara permukaan topografi, geoid dan elipsoid boleh digambarkan seperti dalam **Rajah 1**. Ketinggian yang merujuk kepada geoid bagi titik **P** di atas permukaan topografi dikenali sebagai ketinggian ortometrik, **H** sementara ketinggian yang merujuk kepada permukaan elipsoid dikenali sebagai ketinggian elipsoid, **h**. Jarak pemisahan di antara permukaan elipsoid dan geoid pula dikenali sebagai ketinggian geoid, **N**. Ketinggian ortometrik boleh diterbitkan dari ketinggian elipsoid dan ketinggian geoid dengan menggunakan rumus berikut:

$$\mathbf{H = h - N}$$



Rajah 1: Perhubungan umum di antara permukaan Geoid dengan permukaan Topografi dan Elipsoid.

4.0 MODEL GEOID MALAYSIA - MyGEOID

MyGEOID mengandungi nilai ketinggian geoid (atau nilai N) relatif kepada permukaan rujukan elipsoid GRS80 dalam bentuk grid. Ianya terdiri dari dua model geoid iaitu WMGEOID04 bagi Semenanjung Malaysia dan EMGEOID05 bagi Sabah dan Sarawak.

Di Semenanjung Malaysia ianya meliputi kawasan di antara latitud 0° Utara hingga 8° Utara dan longitud 98° Timur hingga 107° Timur dengan saiz grid 1’ x 1’ (1.8 km x 1.8 km). Sementara bagi Sabah dan Sarawak, ianya meliputi kawasan di antara latitud 0° Utara hingga 9° Utara dan longitud 106° Timur hingga 121° Timur dengan saiz grid 2’ x 2’ (3.6 km x 3.6 km).

Julat nilai ketinggian geoid bagi MyGEOID adalah di antara -16 meter hingga 10 meter di Semenanjung Malaysia, sementara di Sabah dan Sarawak adalah di antara 28 meter hingga 60 meter. Tanda negatif dalam nilai ketinggian geoid bermaksud permukaan geoid tersebut berada di bawah permukaan elipsoid.

MyGEOID membolehkan pengguna-pengguna GPS di Malaysia memperolehi nilai ketinggian ortometrik pada tahap ketepatan 5 sentimeter di seluruh negara. Sehubungan itu, MyGEOID boleh digunakan untuk penentuan ketinggian yang memerlukan tahap ketepatan tersebut yang merangkumi antara lainnya kerja-kerja ukur topografi dan pemetaan, ukur kejuruteraan, pemantauan bangunan-bangunan tinggi dan pemendapan tanah. Selain itu MyGEOID membolehkan penubuhan kawalan ketinggian di kawasan tanah tinggi dan terpencil dilaksanakan dengan tepat dan cepat.

5.0 GARIS PANDUAN PERKHIDMATAN DAN PENGGUNAAN MyGEOID

Penerangan lanjut mengenai kaedah dan prosedur penggunaan MyGEOID adalah sepertimana yang dinyatakan dalam garis panduan seperti dikepilkan di **LAMPIRAN ‘A’.** Antara lain, maklumat yang terkandung dalam garis panduan tersebut merangkumi perkara-perkara berikut:

a. Definisi geoid, aras laut min dan ketinggian ortometrik.
b. Data yang digunakan bagi menghasilkan MyGEOID.

c. Penggunaan dan perkhidmatan yang berkaitan MyGEOID.

d. Format data yang dibekalkan serta bayaran bagi perkhidmatan MyGEOID.

e. Prosedur cerapan GPS yang disyorkan bagi mendapatkan ketinggian ortometrik.

Sekian, terima kasih.

"BERKHIDMAT UNTUK NEGARA"

(DATO' HAMID BIN ALI)
Ketua Pengarah Ukur dan Pemetaan
Malaysia

<u>Salinan kepada</u>:

Timbalan Ketua Pengarah Ukur dan Pemetaan

Pengarah Ukur Bahagian (Pemetaan)

Pengarah Ukur Bahagian (Kadaster)

Setiausaha Bahagian (Tanah, Ukur dan Pemetaan)
Kementerian Sumber Asli dan Alam Sekitar

Pengarah,
Institut Tanah dan Ukur Negara (INSTUN),
Kementerian Sumber Asli dan Alam Sekitar

Pengarah,
Pusat Infrastuktur Data Geospatial Negara (MaCGDI)
Kementerian Sumber Asli dan Alam Sekitar

Ketua Penolong Pengarah,
Unit Ukur Tanah, Cawangan Pengkalan Udara dan Maritim,
Ibu Pejabat Jabatan Kerja Raya Malaysia

Penolong Pengarah,
Unit Ukur Tanah, Bahagian Kejuruteraan Awam,
Ibu Pejabat Jabatan Perumahan Negara

Setiausaha,
Lembaga Juruukur Tanah Semenanjung Malaysia

Setiausaha,
Lembaga Juruukur Tanah Sabah

Setiausaha,
Lembaga Juruukur Tanah Sarawak

LAMPIRAN 'A'

MALAYSIA GEOID MODEL (MyGEOID)
GUIDELINE

JABATAN UKUR DAN PEMETAAN MALAYSIA

2005

CONTENTS

1.	INTRODUCTION		1
2.	BACKGROUND		1
	2.1	The Geoid and Mean Sea Level	1
	2.2.	Orthometric Height or Elevation	2
	2.3	Determination of the Geoid Model	2
	2.4	Use of the Geoid Model	3
	2.5	The Geoid-Ellipsoid *S*eparation	4
3.	MyGEOID		5
4.	MyGEOID DATA		9
	4.1	Data Format	9
	4.2	Data Supply	9
	4.3	Charges	10
5.	MyGEOID RELATED SERVICES		11
6.	RECOMMENDED PROCEDURES FOR GPS DERIVED ORTHOMETRIC HEIGHT		11
7.	EXCLUSION OF LIABILITY		14
8.	CONDITIONS FOR DATA USE		14
	GLOSSARY		15

1. INTRODUCTION

1.1. The Department of Survey and Mapping Malaysia (JUPEM) has undertaken various projects that involved tide gauge observations, precise levelling, terrestrial gravity measurements, establishment of permanent Global Positioning System (GPS) stations and GPS network observations with the objective of setting up a geodetic infrastructure for various precise applications.

1.2. Even though the use of GPS has gained popularity amongst Malaysian Surveyors, the accuracy in GPS heighting is currently overshadowed by conventional levelling. In order to obtain highly accurate vertical height values (orthometric height) from GPS measurements, a geoid separation model has to be utilised. MyGEOID which is the Malaysian version of the geoid separation model is meant to complement and strengthen the existing geodetic infrastructure for Malaysia, consequently enabling the extended use of services rendered by GPS.

1.3. This guideline is intended to present the concept of the geoid, the realization of the geoid model for Malaysia and the available services that are being rendered to users. The recommended procedures in obtaining and making use of the services are also described.

2. BACKGROUND

2.1. The Geoid and Mean Sea Level

There have been many definitions of the geoid . Nevertheless, it can be deemed as the equipotential surface of the Earth's gravity field which best fits, in a least square sense, the global mean sea level. For all intents and purposes, the geoid can be taken to be the same as the mean sea level.

The mean sea level on the other hand is the average level of the ocean surface halfway between the highest and lowest levels recorded by tide gauges at specified locations. It is utilised as a plane upon which heights of features on, above or below the ground can be referenced.

2.2. Orthometric Height or Elevation

The height of a feature above mean sea level is called an orthometric height or an elevation. Elevation of features has been used in everyday lives, for example to build roads and in most types of major construction. Elevations are measured by one of two methods, i.e. either by using levelling or by using GPS derived height.

Levelling has been used to determine elevations for hundreds of years. It can be very accurate, but takes a long time and needs several people to do the work. Poor weather and rough terrain could cause more problems and these factors consequently made levelling expensive. However, until recently, it was the only truly reliable method.

With the advancement of technology, GPS can now be used to quickly and easily determine not only very accurate positions, but also elevations. In the latter case, there is no need to consider the distance from the last point where elevation data is obtained, the type of terrain or whether or not the weather is bad.

2.3. Determination of the Geoid Model

The geoid can be considered as the mean sea level plus its natural continuation under the landmass, as in **Figure 1**. This extension must be determined mathematically or modelled. The geoid model is actually based on gravity data collected, be it acquired through ground, airborne or space gravity surveys. Once the geoid is determined, the difference between the two surfaces, the ellipsoid and the geoid can then be computed anywhere in the country.

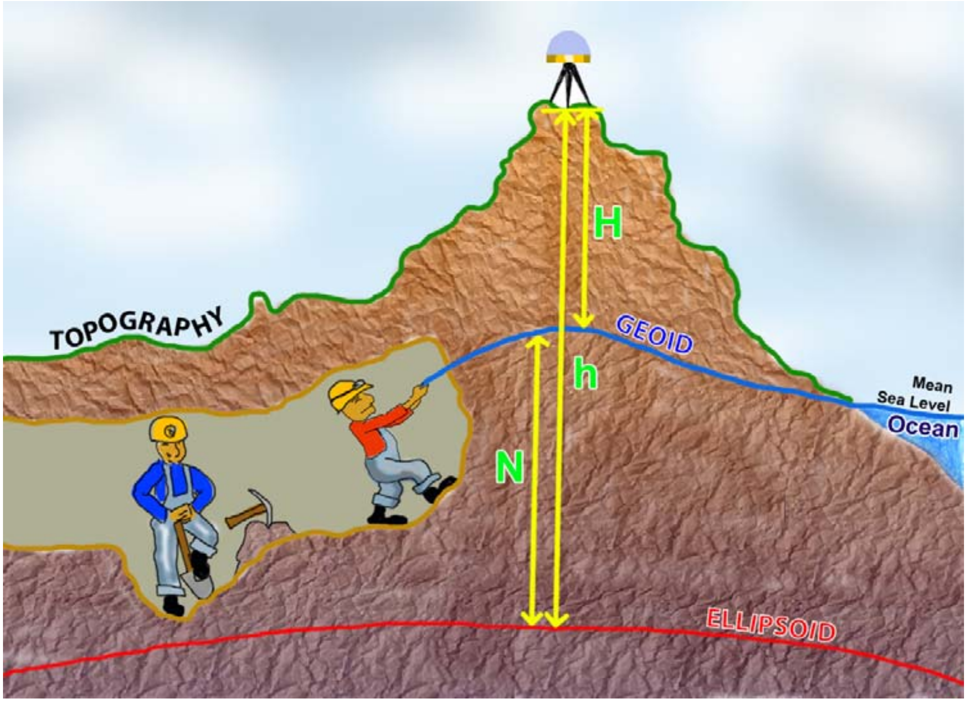


FIGURE 1: The topography, geoid and ellipsoid.

2.4. Use of the Geoid Model

The Geoid model contributes to the vertical component of the reference system so that ellipsoidal GPS heights can be converted to orthometric elevations for practical uses.

The real challenge lies in knowing the relationship between the ellipsoid and the geoid. Once the difference between these two surfaces, called the "geoid-ellipsoid separation" or "geoidal height", at a given point is determined, then application of the geoidal height to the GPS height measurement can be made to obtain the mean sea level elevation as in **Figure 2**.

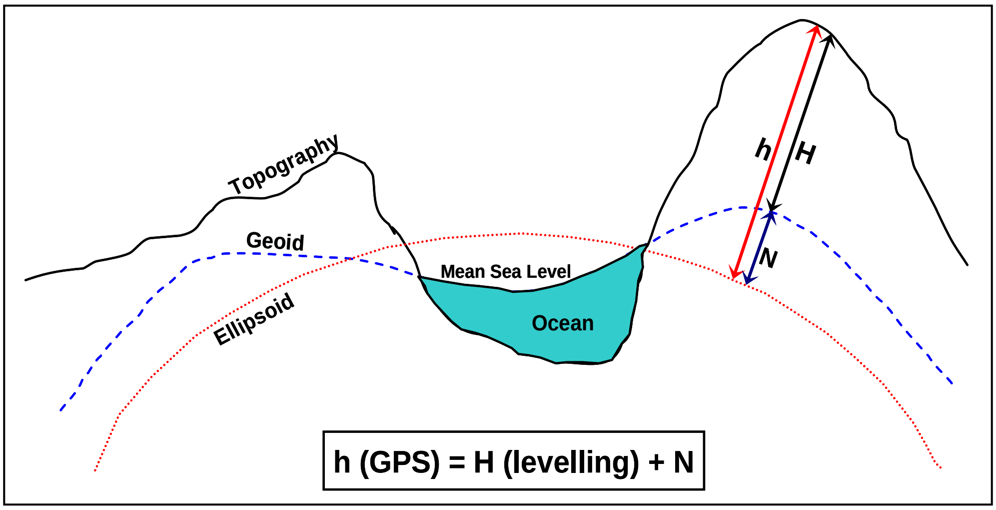


FIGURE 2: Relationship between Topography, Geoid and Ellipsoid

The three key main elements to consider when examining the geoid are, thus:

- Topography - The surface of the Earth.
- Ellipsoid - GPS heights are referenced to this mathematical surface.
- Geoid - The natural surface extension of mean sea level.

2.5. The Geoid-Ellipsoid Separation

The reference surface for heights in Malaysia is traditionally taken as the Mean Sea Level (MSL). As indicated earlier, the geoid is a surface of equal gravity potential which closely approximates the mean sea level. However, heights derived from GPS are relative to the GPS reference ellipsoid. As afore-mentioned, the separation between the geoid and ellipsoid is known as the geoid-ellipsoid separation (or N value). Considering that N value is relative to a specific ellipsoid, extreme care must be taken to ensure that the N value used refers to the correct ellipsoid.

In the examples below, both the N value and the ellipsoidal height refer to the same ellipsoid (usually WGS84 when working with GPS-derived ellipsoidal heights or GRS80 ellipsoid; note that WGS84 is taken as being the same as GRS80 ellipsoid):

Example 1

In an absolute sense, N is used as follows:

$\mathbf{H = h - N}$

If $\mathbf{h}$ = 62m and $\mathbf{N}$ = -12m

$\mathbf{H}$ = 62 - (-12) = **74m.**

Example 2

In a relative (baseline) sense where the change in N is used:

$\mathbf{(H_2 - H_1) = (h_2 - h_1) - (N_2 - N_1)}$

i.e. $\Delta\mathbf{H} = \Delta\mathbf{h} - \Delta\mathbf{N}$

$\mathbf{H_2} = \mathbf{H_1} + \Delta\mathbf{H}$

If $\mathbf{H_1}$ = 636.5m (known); $\mathbf{h_1}$ = 623m; $\mathbf{h_2}$ =581m; $\mathbf{N_2}$ = -17m; $\mathbf{N_1}$ = -15m

$\Delta\mathbf{h}$ = 581 - 623 = - 42m
$\Delta\mathbf{N}$ = -17 - (-15) = - 2m
$\Delta\mathbf{H}$ = (- 42) - (- 2) = - 40m

$\mathbf{H_2}$ = 636.5 + (- 40) = 596.5 m

3. MyGEOID

3.1. The Malaysian geoid models or in short, MyGEOID consist of the following:

- Peninsular Malaysia – WMGEOID04
- Sarawak and Sabah – EMGEOID05

The geoid models are hybrid ones, combining the gravimetric geoids with datum transformations and GPS ellipsoid heights on levelled bench marks. **Table 1** shows the specifications of the geoid models.

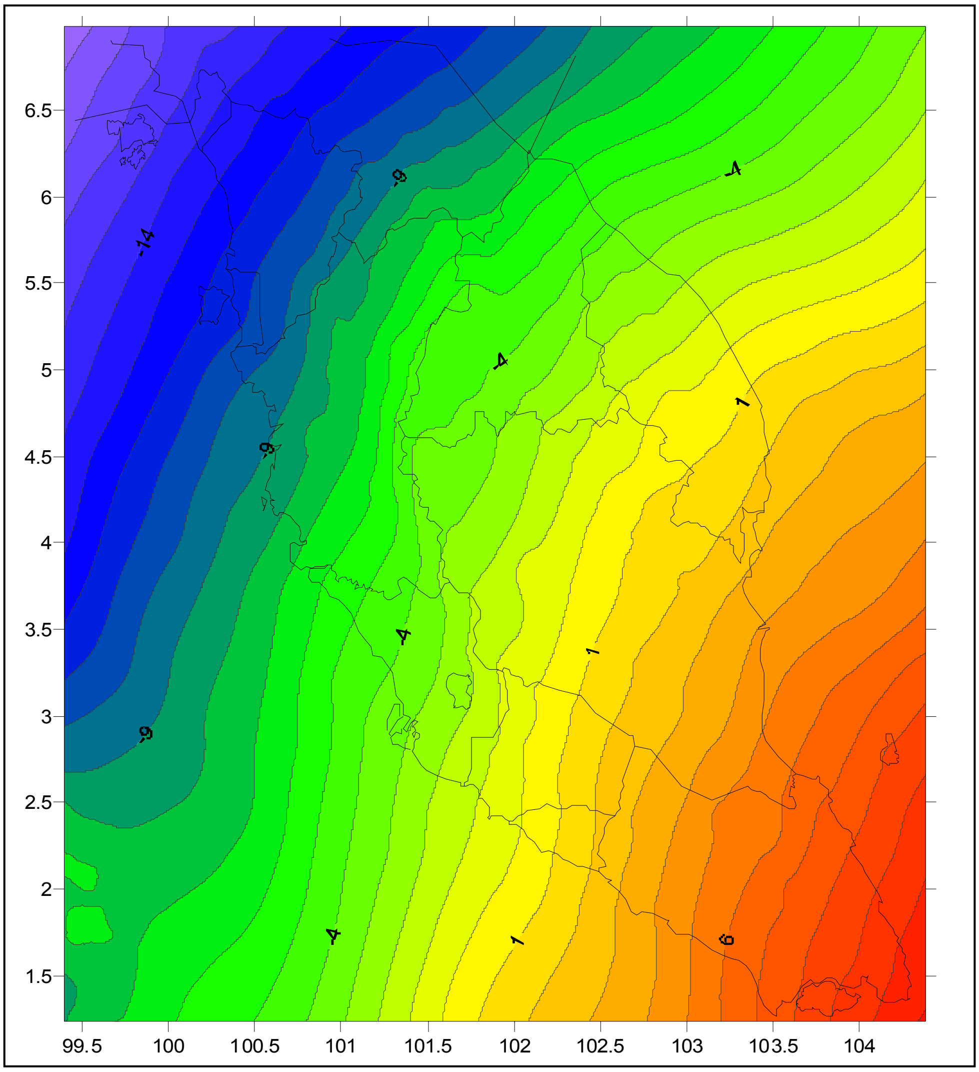


FIGURE 3: Peninsular Malaysia Geoid 2004 (WMGEOID04)

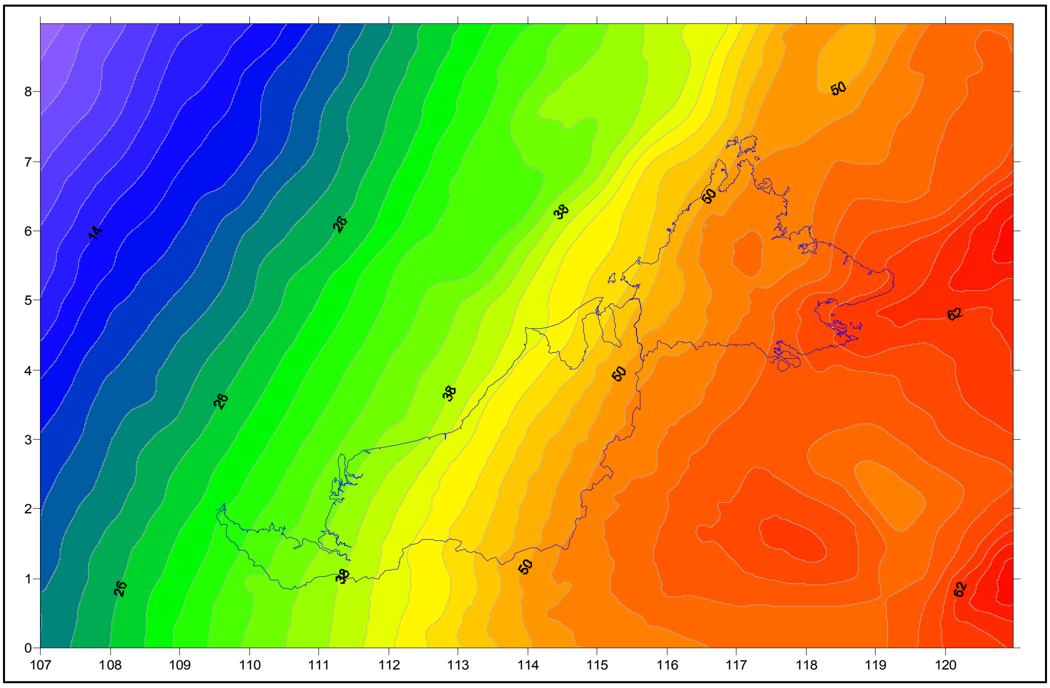


FIGURE 4: Sabah & Sarawak Geoid 2005 (EMGEOID05)

3.2. Absolute comparison of gravimetric geoid-ellipsoid separation with the geometric (GPS minus benchmark heights) equivalent revealed existence of datum bias, or datum ambiguity. Therefore, the final geoid model was computed by fitting the GPS-levelling and the gravimetric geoid to produce Malaysia's first ever geoid model – MyGEOID, which fits the local Mean Sea Level of Peninsular Malaysia as well as that of Sabah and Sarawak.

3.3. It should be stressed that this final geoid inherits the possible systematic errors of GPS levelling, and thus could no longer be an equipotential surface. However, the geoid will match the vertical datum of Malaysia, and thus permits users to convert GPS heights in ITRF to level heights in the said datum.

Category	WMGEOID04 (Peninsular Malaysia)	EMGEOID05 (Sabah and Sarawak)
Year	2004	2005
Gravimetric Base Model	WMG03A	EMG03C
Gravity Measurements	Terrestrial = 5,634 points Airborne = 24,855 points	Terrestrial = 691 points Airborne = 37,109 points
Altimetry Data	KMS02	KMS02
DEM	DTED/SRTM	DTED/SRTM
Terrain Corrections (Resolution)	DTED = 3” SRTM = 30”	DTED = 3” SRTM = 30”
Terrain Corrections (Method)	2-D FFT	2-D FFT
Global Geopotential Model	GGM01C	GGM01C
Geocentric Reference Frame	ITRF2000 (GDM2000)	ITRF2000 (GDM2000)
Horizontal Resolution	1.5’	3’
NGVD bias estimate	1.317 meter	1.252 meter
GPS on Benchmark	37 points	60 points
Accuracy (1 Sigma) w.r.t. GPS/ Benchmark	4.2 cm	4.1 cm

TABLE 1: WMGEOID04 and EMGEOID05 Geoid Models of Malaysia

3.4. The WMGEOID04 geoid model is fitted to the NGVD in Peninsular Malaysia, which is based on 10 years observation of the Mean Sea Level at Port Klang (1984-1993).

3.5. The EMGEOID05 geoid model for Sabah and Sarawak is fitted to the Sabah Datum 1997 which is based on 10 years of Mean Sea Level observation at Kota Kinabalu Tide Gauge Station (1988-1997). Since all geoid height values refer to this datum, concerned areas are subject to the following offsets:

No.	Vertical Datum	Offset (m)
Sabah		
1.	Sabah 97	0.00
Sarawak		
1.	Sabah (Lawas)	-0.16
2.	Merapok (Lawas)	-0.16
3.	STAPS Jabatan Laut (Limbang)	-0.32
4.	Original (Miri)	-0.14
5.	Bintulu (Bintulu)	-0.36
6.	Pulau Lakei	-0.35

4. MyGEOID DATA

4.1. Data Format

The data file format has a header for every file showing the geoid-ellipsoid separation to 3 decimal places. MyGEOID consists of a 1' by 1' grid (approximately 1.8 km) of geoid-ellipsoid separations (N Values) relative to the GRS80 ellipsoid, which is also used for the Geocentric Datum of Malaysia (GDM2000).

4.2. Data Supply

Data can be obtained from the Geodesy Section by formal application through letter, fax or e-mail and will be supplied as required by user, either in hardcopy or softcopy form. Data can be supplied in binary or ASCII grid format as well as in either point data or block data. For point data, the following input information are required:

i. Id, lat, long (degrees); or
ii. Id, lat, long (deg, min, sec); or
iii. Id, X, Y, Z (meter) ; or
iv. Id, N, E, (general UTM, meter).

Where: Id = point identification
lat = latitude
long = longitude
deg = degree
min = minute
sec = second
X, Y, Z = Cartesian coordinate in meter
N, E = Grid coordinate in meter
UTM = Universal Transverse Mercator

For block data, the coordinates defining the block for which geoid separation data is required have to be provided.

4.3. Charges

As indicated earlier, geoid separation data available are in the the form of 1' x 1' (1.8 km x 1.8 km) grid over the whole country. They could be purchased in the forms and with payment of charges, as follows:

Geoid Data	**RM / Unit**
Point	15.00
Geoid Map Sheet (L7030 / T738 Series): 30 km x 30 km	1,000.00
Peninsular Malaysia	20,000.00
Sabah	10,000.00
Sarawak	10,000.00

5. MyGEOID RELATED SERVICES

In addition, JUPEM also provides the following related services:

a. Computation of the following information:
   i. Geoid heights interpolation
   ii. Ellipsoidal to orthometric heights
   iii. Orthometric heights to ellipsoidal
   iv. Deflection of vertical (arc sec)

b. Generation of geoid map (as requested) in the form of grid block.

In providing the aforesaid services, the charges as mentioned in Para 4 will apply.

6. RECOMMENDED PROCEDURES FOR GPS DERIVED ORTHOMETRIC HEIGHT

In order to achieve orthometric height of 5 cm or better accuracy, at least the same level of accuracy must be obtained in GPS derived ellipsoidal heights. Therefore, it is important to ensure that all components of GPS observation meet the following requirements:

- Dual-frequency GPS receivers with full-wavelength are required for all observations of base lines greater than 10 km.
- Geodetic antennas with ground planes or multipath mitigation capability are required.
- All antennas used during a project should be identical; otherwise corrections must be made for antenna phase patterns.
- Height of antennae must follow manufacturer’s specification.

Recommended guidelines for field and office procedures are as listed in **Table 2** and **Table 3** below:

Field Procedure		
No.	**Items**	**Parameter**
1.	Observation Technique	Static positioning
2.	GPS Control	At least 3 stations
3.	Observation Sessions	At least 2 independent sessions
4.	Station Connections	At least 3 independent baselines
5.	VDOP	Less than 6 (90% of the observation session)
6.	Elevation Angle	Above 10
7.	Satellite Tracking	At least 5 satellites with GDOP of less than 6
8.	Equipment Calibration	As in KPUP 6/1999
9.	MyRTKnet Usage	As in KPUP 9/2005

TABLE 2: Guidelines for Field Procedures

Office Processing Procedures		
No.	**Items**	**Parameter**
1.	General Procedure	Prescribed procedures as provided in manufacturer's manual must be followed.
2.	Datum	GDM2000
3.	Ephemerides	• Short baselines of less than 30 km: broadcast. • Long baselines: precise.
4.	Baseline Processing Quality	• RMS less than 2 cm. • Maximum data rejection - less than 10 %. • Ambiguity fixed solution. • Aposteriori variance factor is unity.
5.	Adjustment	• Only independent baselines (n-1) should be included in the adjustment. • Least square adjustment should be used.
6.	Minimally Constrained Adjustment	1 control station fixed in GDM2000 coordinates.
7.	Quality Indicator	• Must pass Chi-squares test at 95% confident region. • All baselines must pass the local test.
8.	Test on Control Stations	Relative precision must be less than 2 ppm (2D) and 3 ppm on the vertical component.
9.	Over-constrained Adjustment	At least 2 control stations must be fixed in the final adjustment.

TABLE 3: Guidelines for Office Procedures

7. EXCLUSION OF LIABILITY

JUPEM has made every endeavour to ensure that the information contained in MyGEOID data made available to the public is free from errors and omissions. However, JUPEM does not warrant that the supplied information is free from errors or omissions. JUPEM shall not be in any way be liable for any direct or indirect loss, damage or injury suffered by the use of this data.

8. CONDITIONS FOR DATA USE

The data is the sole property of the Director General of Survey and Mapping. They are supplied to approved users, and is non transferable. The data must not be sold, given away, traded, let, hired or otherwise dealt with. Users are permitted to use the data in demonstrations and displays, provided a statement acknowledging supply by JUPEM is displayed with the data or any derived product.

Department of Survey and Mapping Malaysia
September 2005

GLOSSARY

Ambiguity

The unknown integer number of cycles of the reconstructed carrier phase contained in an unbroken set of measurements from a single satellite pass at a single receiver.

Vertical Datum Bias

The difference in vertical reference between gravimetric geoid and the local mean sea level.

Deflections of Vertical

The angle between the plumb line (line perpendicular to the geoid) and the line normal to the ellipsoid. This angle has both a magnitude and a direction and usually resolved into two components, one in the meridian and the other perpendicular to it in the prime vertical.

Ellipsoid

A smooth mathematical surface used to describe the shape of the earth for geodetic computations. The figure is formed by rotating an ellipse about its minor (shorter) axis and is typically described by dimensions for the semimajor axis (a) together with the semiminor axis (b) or flattening, (f) = (a-b)/a.

Ellipsoid height

The distance from a point to the reference ellipsoid along a line normal to the ellipsoid.

GDOP

Geometric Dilution of Precision. GDOP represents the uncertainty expected in the three positional coordinates plus the clock offset from a particular configuration of the satellites. High GDOP means low accuracy.

Geocentric Datum of Malaysia (GDM2000)

A geocentric coordinate system for positioning in Malaysia, whose origin coincides with the centre of the mass of the earth which fits into International Terrestrial Reference Frame.

Geoid

An equipotential surface (a surface of equal gravity potential) which most closely matches mean sea level. An equipotential surface is normal to the gravity vector at every point.

Gravimetric Geoids

Geoid model computed based on gravity data.

GRS80 Ellipsoid

Geodetic Reference System 1980. The reference ellipsoid of GDM2000.

Mean Sea Level

The average height of the sea for all stages of the tide over a period (often used as a reference for general leveling operations).

NGVD

A network of reference adopted as a standard geodetic datum for elevation in the country.

Orthometric Height

The distance from the geoid to a point, measured along a line normal to the geoid.

Static GPS

GPS carrier phase differencing technique where the GPS observations are carried out using one or more stationary receivers and where the integer ambiguities are resolved from an extended observation period through a change in satellite geometry.

VDOP

Vertical Dilution of Precision. A value expressing the confidence factor in the accuracy of the vertical component of a position solution based on current satellite geometry. The lower the value the greater the confidence in the solution.