COMPARISON OF GEIOD UNDULATION BETWEEN REAL TIME KINEMATICS NETWORK AND NATIONAL GEODETIC VERTICAL DATUM DERIVED FROM GEOMETRIC GEIOD AGAAINST MALAYSIAN GEIOD

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ABSTRACT

GPS measurement technology nowadays have increasingly and have a place in high attention no matter in whatever fields. It is used to get the value of a coordinate (latitude, longitude, height) is an important thing, especially in the field of survey profession. However, the observation of the GPS height is not given in the actual altitude (orthometric height) it is because GPS itself refers to a complex mathematical surface that is ellipsoidal surface. To get the actual height, one additional reference surface known as the Geoid surface or equipotential surfaces (MSL) should be used. In this fast-paced era, a measurement work mainly in the field of cadastre and mapping require fast access coordinate values, therefore the use of GPS observations are very helpful for this situation. A survey is conducted to determine the equivalence of the geoid, which is the Geoid model were published by the Department of Survey and Mapping Malaysia. With the geoids separation to be derived from GPS observations at different monuments barrel benchmark in the study area, namely in Klang Valley. The N_{gps} contour will be created by this evaluation. The difference observed value can also help the Department of Survey and Mapping Malaysia for the validation of the Geoid during which the first study was conducted earlier in 2005 for the state of Pahang and Johor.

INTRODUCTION

Global Positioning System (GPS) is become commonly use and universal technology for everyone. It can be used for various fields of works even now we also can find this technology has been implementing in our favourite movies. Basically, the Global Positioning System (GPS) was designed for military applied. Its primary purpose was to allow soldiers to keep track of their position and to assist in guiding weapons to their targets. The satellites were built by Rockwell International and were launched by the U.S. Air Force. The entire system is funded by the U.S. government and controlled by the U.S. Department of Defence. The GPS constellation of satellites consists of at least 24 satellites – 21 primary satellites and 3 orbiting spares. They orbit the earth at an altitude of 17,500 KM (10,900 miles) at a speed of 1.9 miles per second between 60°N and 60°S latitude. Each satellite weighs 1900 lbs and is 17 feet (5.81 meters) wide with solar panels extended. The satellites orbit the earth twice a day. This guarantees that signals from six of the satellites can be received from any point on earth at almost any time. In Geodesy, GPS is a realization of determine the dynamic of the earth. Geodesy is the discipline that deals with the measurement and representation (geometry, physics, and temporal variations) of the Earth and other celestial bodies (Moon and other Planets). Geoids it is an *equipotential* surface. Due to variations in the earths mass distribution (oceans and land), the Geoids has an irregular shape that is described as "undulating". This means that potential gravity is the same at every point on its surface. GPS were now a day are used to obtain the height of certain point on the earth, due to retrieved the correct height by usiAng GPS technique the geoid model come in to make this height will be useful.

In Malaysia scenario, the GPS are used for cadastral reference, as a horizontal control datum as go as for mapping and engineering field of activities, with the establishment of network control which is Malaysian Active GPS System (MASS) and the most recent is Geocentric Datum of Malaysia.

In the field of work that require height value, using GPS itself have a restricted where the GPS height was determine by one of mathematical surface so called ellipsoid. There for to obtain height at certain point levelling technique are commonly used where the value of height was carried out from the benchmark which is been derived from mean sea level (MSL) where the height is referred to geoid or orthometric height.

1.0 Problem Statement

In determine height in some area, Orthometric height have carried out by levelling which is the value were obtain by the benchmark (BM), now the orthometric height can be easily obtain by GPS observation and yet still needed the Geoid height which is N value from Survey Department. But now a day, the GPS height could be too subjective things or sometime peoples have doubted with the value, it's could be of the accuracy of the GPS itself or maybe by the area of the observation were taken place.

1.1 Objective of Study

1.1.1 To explore the development of Malaysian Geoid (MyGeoid) by Malaysian Survey and Mapping Department, (JUPEM).

1.1.2 To evaluate and compare Geoid undulations derived from GPS and MSL with the N value of MyGeoid.

1.2 Scope of Study

The research study area were conducted in Selangor area coordinated covered at Latitude 3° 09' 56.1"N, 101° 25' 21.6"E Longitude to Latitude 3° 03'03.8"N, and Longitude 101° 35' 32.9"E as figure 1. The research study was focused in GPS height observation on Bench Mark (BM) which was founded on research study area.

Figure 1: Showed research study area, source by google map.

1.3 Significance of Study

This study is important and gives several contributions, which are: -

1.3.1 Facilitate the users to find information about the Orthometric height/true height for their need of fields by using GPS

1.3.2 Facilitate users to update any new information of Geoid Network (Shah Alam area)

1.3.3 Can be used as quick reference in any changes off base points or coordinates due to natural disasters, such as tsunami, earthquake, coastal erosion, and the changes of Benchmark level.

2.0 GPS Height

GPS height can be derived from the ellipsoidal heights by using the following formula:

H = h – N accurate to ±5cm

Where: H = Orthometric / MSL height derived from GPS/MyGeoid

h = Ellipsoidal (GPS) height

N = Geoid height (based on MyGeoid)

Geoids it is an *equipotential* surface (figure 4). Due to variations in the earth's mass distribution (oceans and land), the Geoids has an irregular shape that is described as "undulating". This means that potential gravity is the same at every point on its surface. Nowadays, Geoids Networks is not only used for profit in organizations for business, but it has been widely used by thousands of government agencies and private companies, even though for the research by the students.

In determination of Geoids Networks, the geographical conditions of the areas are very important. Geographical conditions such as Building, roads, rivers, and also the subject of multipath error likes, transmission line, lake and also the urban area.

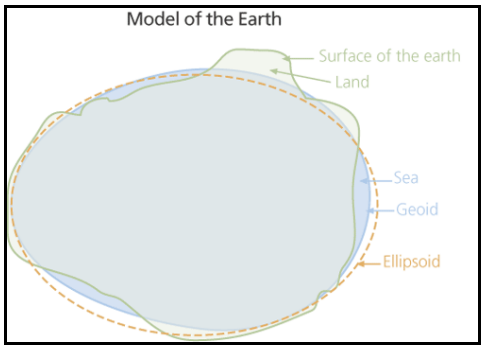

Figure 4 showed model of the earth Geoid as equipotential surface: source Witold Fraczek, Esri Applications

2.4 Malaysian Geiod (MyGeoid)

MyGEOID contain geoid height value (or values N) relative to the reference ellipsoid GRS80 surface in the form of a grid. It consists of two geoid model that is WMGEOID04 EMGEOID05 for Peninsular Malaysia and Sabah and Sarawak.

In Peninsular Malaysia, it covers an area between 0 ° North latitude and 8 ° North and longitude 98 ° East to 107 ° East with a grid size of 1 'x 1' (1.8 km x 1.8 km). While for Sabah and Sarawak, it covers the area between latitude 0 ° North to 9 ° North and longitude 106 ° East to 121 ° East with a grid size 2 'x 2' (3.6 km x 3.6 km).

Geoid height value range for MyGEOID is between -16 meters to 10 meters in Peninsular Malaysia, while in Sabah and Sarawak is between 28 meters to 60 meters. The negative sign in the height of the geoid surface means it is below the surface of the ellipsoid.

MyGEOID allows users of GPS in Malaysia acquired the orthometric heights at the level of 5-centimeter accuracy throughout the country. Accordingly, MyGEOID can be used to determine the height that requires a level of accuracy that include, among other works, topographic surveying and mapping, engineering surveying, monitoring of high-rise buildings and soil deposition. In addition, the establishment MyGEOID height control in the highlands and remote implemented accurately and quickly.

The geoid can be considered as the mean sea level plus its natural continuation under the landmass, as in Figure 5. This extension must be determined or modelled mathematically. 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. *Pekeliling Ketua Pengarah Ukur dan Pemetaan Bil. 10/2005*

Figure 5 showed the topography, geoid and ellipsoid: Source DSMM

MyGeoid: 2003 Reference Ellipsoid: GRS80 Accuracy: ±5 cm

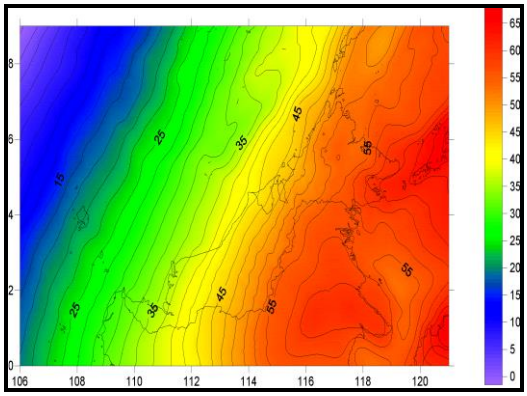

Figure 10 Final gravimetric geoid for Sabah - Sarawak region Contour Interval = 2meter

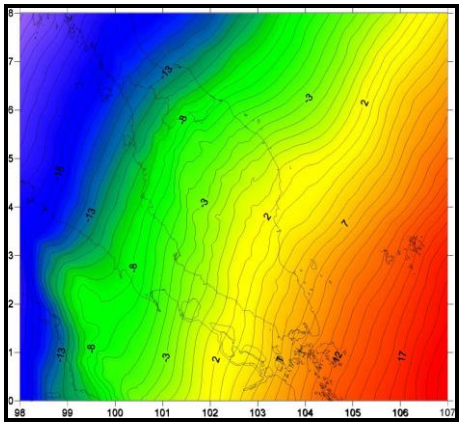

Figure 11 Final gravimetric geoid for Peninsular Malaysia region Contour Interval = 0.2 meter

3.0 Research Methodology

Method that are used for this research is using Real Time Kinematic (RTK) observation with Virtual Reference Station (VRS) and Master Auxiliary Concept (MAC) services which were provided by Department Survey and Mapping Malaysia, (DSMM) which this service was obtained from 24 hour operational from Malaysian Real Time Kinematics Network (MyRTKnet) see figure 2. Data collection was conducted by observed on BM with two services were provided.

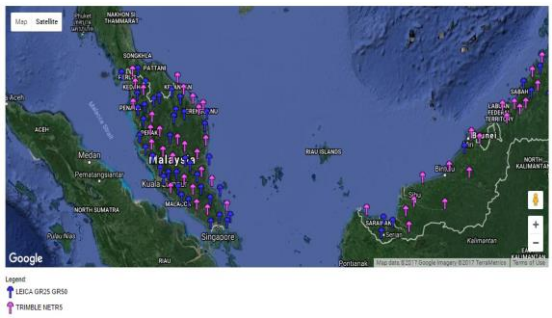

Figure 2: Show Distribution of MyRTKnet.

3.1 Software and application

Trimble Survey Manager version 2.85 (see figure) and Trimble Access version 2016.10 (see figure)

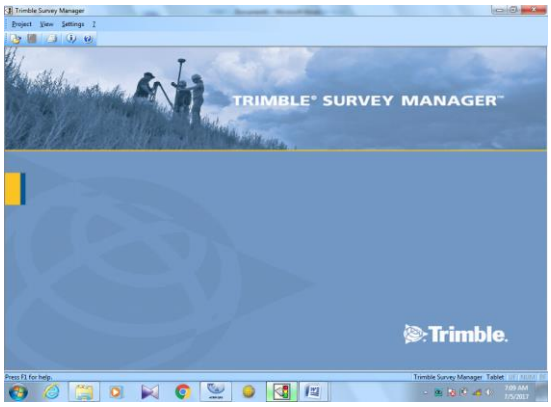

Figure 19: Trimble Survey Manager version 2.85

Figure 20: Trimble Access version 2016.10

4.0 Results

In this chapter will be discuss how the result for the research thesis proposal will be done by the end of the process. This is including how the geoid undulates derived from GPS and MSL contour will be design and the existing MyGeoid contour designed as shown in the figure *

The result also will determine whether the study area have a large error by evaluated results, this will be done by throughout with GPS observation and the existing data that will be obtained at DSMM for study area and what is the factors that occurs for these errors.

4.1 Thesis Analysis

5.1 Conclusion

Base on the research study founded that GPS technology can be used as one of the methods to obtained height accordingly use of the purposed the observation have taken part. Using RTK technique with 1 cm accuracy give advantages to engineering survey or monitoring survey for BM and it's also could be for new establishment BM route or existing route. This technique is very suitable for hilly route which is conventional levelling to determine height could take long time to get the height value.

5.2 Recommendation

From the research study, there is several things that could be done for make GPS is one of the methods that people can be used to determine height. Below is some of recommendation that could be useful for obtained good value in used GPS as tools to determine height.

i. Distribution of BM should be all over around Malaysia and should be in good condition. The distribution must in interval 1-2 kilometre.

ii. In the future may be others services could be used which provided by DSMM such Near Base (NB), iMAX, FKP and may be DSMM could have other option where is nowadays one of research have been made for RTK that been upgraded to RTX.

iii. If observation taken along road using Bipod could prevent the movement with height 2m.

iv. GPS receiver must done calibration before certain project.

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