ISSN 2278-7763

A Comparison of National Orthometric Heights with DGPS/Leveling and ITRF00 Datum with WGS84 (EGM08) Geoid

Assist Lact. Aysar J. Abdulkadhum

Al-Qasim Green University/College of Water Resource Engineering/Iraq/Babylon

E-mail:eng_aysar@yahoo.com

Abstract

Today, the recent global Earth's gravity model, EGM08, is successfully used for different purposes in Geosciences. In this paper, EGM08-based geoid model of the Deferential Global Position System (DGPS). The national orthometric heights are compared with the (DGPS) /leveling data that is obtained from ten points in the Babylon province in the middle of Iraq. This study will show that considering the truncation bias of EGM08 will reduce the root mean square error (RMSE) of the differences between the orthometric heights and DGPS/leveling data The standard deviation (SD) by about 1.8cm., the differences of DGPS/leveling with EGM08 which indicates that EGM08 may be used for orthometric height determination with an accuracy of < 2 cm. In the middle of Iraq region and offers a reasonably good transformation platform from ellipsoid to local datum. However, local determination of Geoid is necessary for better accuracy of the orthometric height from DGPS.

This paper aims a introducing a modern technique for determining elevation, avoiding cumbersome and time consuming spirit leveling operations. Fast vertical positioning can be obtained using DGPS with geoid models. High accuracy of DGPS derived with EGM08 (geoid model currently available for the whole world)

Keywords : EGM08, geoid, ellipsoidal and orthometric heights, DGPS leveling.

1 INTRODUCTION

The Earth Gravitational Model EGM08 is the latest version of a series of geopotential models developed under the leadership of the US National Geospatial-Intelligence Agency (NGA) [1]. It incorporates harmonic coefficients derived from the GRACE satellite mission, marine gravity anomalies derived from satellite altimetry, and a comprehensive set of terrestrial gravity anomalies. Complete to degree and order 2159, with additional spherical coefficients (SHCs) extending up to degree 2190 and order 2159, EGM08 offers an unprecedented level of spatial resolution (~9 km) for the recovery of any gravitational field functional over the entire globe [2]. Since its release, EGM08 has become the standard geopotential model used for many applications including geoid modeling. It has been evaluated in a number of countries using a number of methods. The evaluation and quality assessment of the EGM08 is important for being used in various geodetic and other scientific applications at global and regional scales. The evaluation of the EGM08 is based on the comparisons with other external data. This data may include GNSS/leveling observations, airborne and surface gravity data, sea surface topography and deflections of the vertical

This paper focuses on the evaluation of EGM08 in part of the middle in Iraq using DGPS/leveling over a ten points in Babylon province.

2 The study area

The study area is shown in Figure 1, part of the middle of Iraq in Babylon province. Location coordinates are from 356425.336 to 3621461.546 North and from 440229.459 to 431730.219 east.

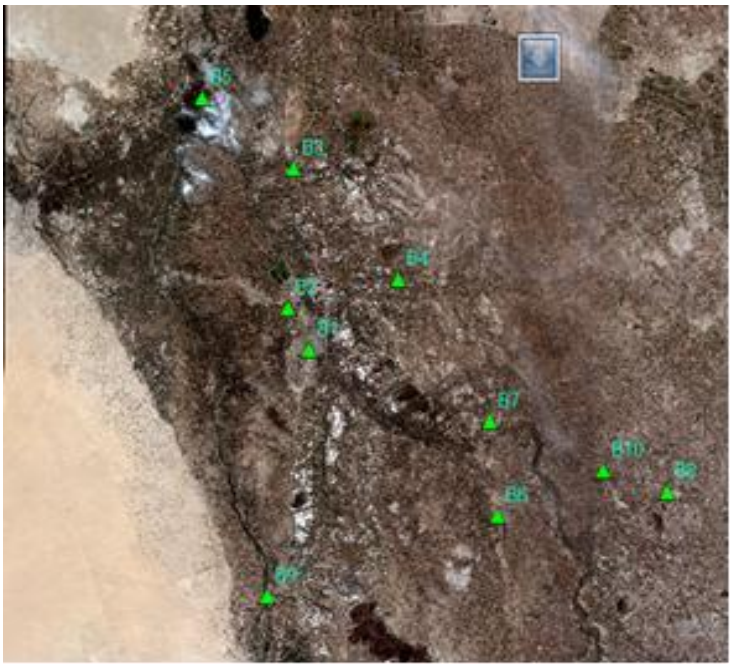

Fig 1. The study area (Babylon Province)

ISSN 2278-7763

3 DATA SETS

The orthometric heights for the ten points were obtained from the State Commission survey in Iraq. As the reference sea level for these heights was in the south of Iraq (FAW), the datum was called MSL FAW, this data shown in Table1. On the other hand, the differential global position system (DGPS) type Topcon (GR3) GNSS receivers was used static method to observed 10 points, each point observed 5 hours. The RINEX data of the points were then submitted to the AUSPOS online GPS Processing Service (http: www.ga.gov.au). The data were computed using the Bernese GPS software. All computed coordinates were based on the ITRF00 reference frame.

Table 1: Final geodetic, IGRS coordinates (ITRF00 DATUM) ellipsoid and orthometric heights.

Points	Latitude (DMS)	Longitude (DMS)	Ellipsoidal Height (M)	Orthometric Height (m.s.l. Faw) (M)
B1	32 28 16.51064	44 25 18.18714	25.565	28.318435
B2	32 30 49.60980	44 23 28.97446	24.941	27.530455
B3	32 39 28.83220	44 23 54.91233	28.546	31.031135
B4	32 32 39.21685	44 32 41.96034	24.062	27.22567
B5	32 43 43.82660	44 16 17.08606	31.441	33.40214
B6	32 18 08.82660	44 40 56.90886	20.384	24.2103
B7	32 23 54.11206	44 40 18.05645	22.061	25.75015
B8	32 19 37.38784	44 54 59.50758	17.600	22.25379
B9	32 13 03.14962	44 21 56.56295	21.729	24.448655
B10	32 20 56.66761	44 49 45.79156	20.697	25.01696

4 COMPARISON PROCEDURE

The basic relationship between geoid, ellipsoidal and orthometric heights is given by the following simple equation

$$h = H + N \quad (1)$$

Where h, H and N are ellipsoidal, orthometric and geoid heights respectively. Based on the known heights and computed ellipsoidal heights, geoid heights were computed at the 10 GNSS/leveling points by re-arranging equation 1 in

$$N^{GPS} = h - H \quad (2)$$

The above values provided the dataset upon which the evaluation tests were performed. For EGM08, the geoid height values of the 10 GNSS/leveling points with respect to WGS84 were determined using the FORTRAN harmonic synthesis program, hsynth_WGS84.f together with the EGM2008 Tide Free Spherical Harmonic Coefficients and its associated Correction Model [3]. To run this program an input file with the Latitudes and longitudes of the 10 points must be stored in the same folder as the executable file of the program. After running the program, an output file containing the geoid height values for all the points is automatically stored in the same folder as the program. The output file can then be opened using Notepad or Excel.

5 RESULTS

In this section the compare the differences of geoid heights derived from EGM08 versus the geoid heights from GNSS/leveling. Table 2 shows the geoid heights difference for the 10 points and Table 3 the summary of statistics. The results show that the EGM08 provides the most consistent agreement with the GNSS/leveling data over the points and the differences with the orthometric heights ranged (0.0173-0.0703) meter.

Table 2: EGM08 geoid height values and N^{GPS} values for the 10 GNSS/leveling.

Points	N (EGM08)	$N^{GPS} = h - H$	$N^{GPS} - N^{EGM08}$
B1	- 2.7819	- 2.7534	0.0285
B2	- 2.6379	- 2.5794	0.0585
B3	- 2.5372	- 2.4851	0.0521
B4	- 3.1881	- 3.1636	0.0245
B5	- 1.9847	- 1.9611	0.0236
B6	- 3.8915	- 3.8263	0.0652
B7	- 3.7594	- 3.6891	0.0703
B8	- 4.6963	-4.6537	0.0426
B9	- 2.7369	-2.7196	0.0173
B10	- 4.3621	-4.3199	0.0422

TABLE 3: STATISTICS OF THE DIFFERENCES $N^{GPS} - N^{EGM08}$ AT THE 10 POINTS (UNITS IN METER)

	MINIMUM	MAXIMUM	MEAN	STANDARD DEVIATION (SD)	RMS
EGM08	0.0173	0.0703	0.0429	0.0183	0.006

6 CONCLUSION

Small differences indicated by the study between national orthometric heights and orthometric heights with EGM08 geoid (DGPS/leveling) give an indication, this geoid (The Earth Gravitational Model EGM08) very good and very close to reality and in the various projects so that acceptable accuracy

REFERENCES

[1] Pavlis, N.K., Holmes, S.A., Kenyon, S.C., Factor, J.K., 2008, An Earth Gravitational Model to degree 2160: EGM2008. Presented at the 2008 General Assembly of the European Geosciences Union, Vienna, Austria, April 13-18, 2

[2] Kotsakis, C., and Katsambalos, K.,2010. Quality analysis of Global Geopotential Models at 1542 GNSS/leveling Benchmarks over the Hellenic Mainland, Survey Review,42,318pp. 327-344 (October 2010).

[3] EGM08-WGS84version,software and data, http://earth- info.nga.mil/GandG/wgs84/gravitymod/egm2008/egm08_wgs84.html

