AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Public Works Department

Applications of International Terrestrial Reference Frame in Geometric and Dynamic Geodesy

A Thesis submitted in partial fulfillment of the requirements of

a M.Sc. degree in Civil Engineering (Surveying)

Prepared by

Tarek Walid Saad El-Deen Hassan

B.Sc. in Civil Engineering

Faculty of Engineering, Ain Shams University, 2014

Supervised by

Prof. Dr. Mohamed El-Tokhey

Prof. Dr. Tamer Fathy Fath-Allah

Dr. Ahmed Emad Ragheb

Public Works Dept., Faculty of Engineering, Ain Shams University

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Submitted by: **Tarek Walid Saad El-Deen Hassan**

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Examiners' Committee:

Prof. Dr. Mostafa Rabah
Benha University, ...
Faculty of Engineering,
Civil Engineering Dept.

Prof. Dr. Ibrahim Shaker
Ain Shams University, ...
Faculty of Engineering,
Public Works Dept.

Prof. Dr. Mohamed El-Tokhey
Ain Shams University, ...
Faculty of Engineering,
Public Works Dept.

Statement

This thesis is submitted as a partial fulfillment of Master of Science in Civil Engineering, Faculty of Engineering, Ain shams University. The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

Tarek Walid Saad El-Deen Hassan

Signature

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Date: / /2018

Researcher Data

Name: Tarek Walid Saad El-Deen Hassan

Date of Birth: 10/11/1992

Place of Birth: Cairo, Egypt

Last academic degree: Bachelor of Science

Field of specialization: Civil Engineering

University issued the degree : Ain Shams University

Date of issued degree : 2014

Current job : Demonstrator, Public Works Dept., Faculty of Engineering, Ain Shams University

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Abstract

In this work, two critical geodetic issues in Egypt were discussed. Firstly, the dynamic nature of International Terrestrial Reference Frame (ITRF) as a geodetic datum, while the main Global Positioning System (GPS) network in Egypt is tied to a static datum is considered a critical geodetic issue. Tying any derived ITRF coordinates to the Egyptian network cannot be directly applied due to the effect of the tectonic plate motion, in addition to the datum definition change from one ITRF realization to another. The simplest solution is neglecting the effect of the datum definition change and using a Plate Motion Model (PMM) for the backward propagation of coordinates until the specified epoch of the static datum. However, the most opportune solution is applying the 14-parameter datum transformation. In this study, a new set of 14 parameters was derived to describe the transformation process of the African plate in a better way. Assessment the quality of both solutions based on recent Global Navigation Satellite System (GNSS) observations, for 4 stations from the Egyptian network, was presented. In addition, 5 different PMM(s) were used to assess the compatibility of the recent PMM(s) with the

actual plate motion in Egypt. This study showed that using the derived parameters in the 14-parameter model gives the best results. In addition, using APKIM2005D or ITRF2008-PMM as the adopted PMM gives the best results, while using NNR-MORVEL56 gives the worst results. For the horizontal component differences, the 14-parameter model with the derived parameters approach can reach 1.3cm with Root Mean Square (RMS) 3.1cm in case of using APKIM2005D and 1cm with RMS 2.3cm in case of using ITRF2008-PMM. On the other hand, for the vertical component differences, they ranged from 0.8cm to 10.9cm with RMS 8.6cm. Generally, using the derived parameters in the 14-parameter transformation model adopting APKIM2005D or ITRF2008-PMM as the used PMM can be applied to any recently derived coordinates, tied to the latest ITRF realization, to tie them to the Egyptian static datum.

Secondly, in another context, an approach of tying new stations to the Egyptian Continuous Operating Reference Stations (CORS) network using International GNSS Service (IGS) stations and PMM(s) was assessed. A new continuous operating station at Faculty of Engineering, Ain Shams University was used in this study. Tying this station to the Egyptian CORS network was performed using GNSS observations for five stations from the Egyptian CORS network, obtained from the Egyptian Survey Authority (ESA), and the resulted solutions were used as the reference in the assessment process. Four days in June 2017 were used. In addition, 24 hours observation periods and 4 hours ob-

servation periods (day and night) were evaluated. The quality of using this approach was assessed using 5 different PMM(s). The results showed that all PMM(s) give, almost, the same horizontal component accuracy with differences within few millimeters and only NNR-MORVEL56 deviates away from the other models by almost 1cm. Considering the 4 PMM(s) that give almost the same results, the resulted mean horizontal differences ranged from 1.9cm to 2.3cm, from 2.4cm to 3.1cm and from 2cm to 2.1cm in case of using 24h, 4h (day hours) and 4h (night hours) observation periods, respectively. Regarding the vertical component differences, the mean differences were 5cm, 5.4cm and 7.4cm in case of using 24h, 4h (day hours) and 4h (night hours) observation periods, respectively. Generally, using this approach in tying new stations to the Egyptian CORS network can achieve very promising results and help to avoid many administrative restrictions and additional costs. Also, the 4 hours observation periods can achieve promising results which make it applicable to the different surveying works performed in Egypt.

Keywords: CORS, Datum Transformation, Dynamic Datums, GNSS, ITRF, Plate Motion Models, Static Datums.

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