

Statement

on PhD thesis submitted to St Ivan Rilski University of Mining and Geology, Sofia,
Bulgaria

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Title: Geodetic Earth Observations Combination for Vertical Reference System Definition – A Case Study for the Kingdom of Saudi Arabia Vertical Datum and Vertical Reference Frame

About the author

Mr Othman Al-Kherayef holds a BSc degree in Geodesy from King Saud University in Riyadh, Saudi Arabia, 1992, and a MSc degree from School of Military Survey in Hermitage, Berkshire, Great Britain, 1995. Fifteen years of his career he spent with Saudi Military Survey, where he had been assigned to various positions and was involved in significant nation-wide surveying and mapping projects. Then he moved to the newly established General Commission for Survey, where since 2015 he is General Director for the General Directorate of Geodesy. In 2018 he began his doctoral studies and work on his PhD thesis at St Ivan Rilski University of Mining and Geology, Sofia, Bulgaria.

Description of the thesis

The submitted thesis presents investigations on possible solutions of a very significant and important problem such as defining and implementing a vertical datum and reference frame for the Kingdom of Saudi Arabia using all available technologies, both classical and modern.

The dissertation comprises 211 pages including 3 annexes and follows the classical structure of a PhD thesis. It begins with an introduction to the subject (Chapter I) which directly leads to a list of research aims and objectives, focused at significant improvement of the existing vertical geodetic datum in the Kingdom of Saudi Arabia (KSA) and developing a state-of-art methodology for combining all available geodetic Earth observations for tide-gauge benchmarks geopotential numbers and orthometric heights estimation.

In Chapter II are given geometric and physical fundamentals related to the PhD research topic. Attention is drawn to the basics of the height systems and vertical datums definitions, as well as the observation methodologies related to vertical reference frame definition.

In Chapter III the boundary value problem approach is presented along with global geopotential modelling technique using spherical harmonic functions and possible contribution of the latest satellite gravity missions data. Another topic investigated here is how to achieve higher accuracy from classical leveling due to enhancement of atmosphere refraction models using air temperature measurements. Next come the basics and processing methodology of the sea-level records analysis in the specific KSA environment, and also a review of satellite altimetry and its possible contribution for determination of sea surface topography in tide-gauge areas. The chapter concludes with a definition of the multiple-vertical datum problem, which is proposed to be solved following three different strategies.

Chapters IV and V are especially devoted to a numerical experiment which is substantial part of the doctoral research. In the first one the available sources of empirical data are presented,

including GNSS, vertical and gravity networks, satellite altimetry and tide-gauge data. Currently existing vertical datum solutions are also mentioned. The analysis in Chapter V includes solutions of manifold problems beginning with refraction coefficient determination, followed by combining tide-gauge and satellite altimetry data where dynamic ocean / sea surface topography determination problem is stressed upon. The final part deals with possible solutions of the multiple-vertical datum problem, achieved using the three strategies defined before. After a brief description of the workflow, experiment data combination results are comprehensively analyzed in each scenario and summarized in final conclusions for Chapter V.

The submitted PhD thesis is finalized with conclusions, recommendations and contributions, separated in the last Chapter VI. Obvious is that the research aim and objectives set in Chapter I are successfully achieved. Most impressive amongst all results is perhaps the new value of the difference between the levels of Red Sea and the Arabian Gulf, as per Jedda and Ras Tanura tide-gauges respectively. Reducing drastically the 0.790 m height difference, assumed previously, to -0.136 m only, is a real proof of the importance of the correct application of the orthometric corrections to the leveling results.

The most significant part of the results obtained in the doctoral research are presented in four publications, all of them papers submitted to international scientific events.

Specific comments

The submitted doctoral research covers a lot of specific topics each of which may be subject to individual study. The thesis could be successfully completed even if focused only at the multiple-vertical datum problem solution, without getting into specific details. In this regard, the author had put more efforts than usually needed for getting a positive assessment of his job.

The contributions outlined in the conclusive part of the dissertation are presented too extensively which does not facilitate assessment of the research achievements.

Final evaluation statement

This thesis represents a great deal of work. The results are well presented and their interpretation is at high scientific level compatible with the international standards. The thesis is ready for public examination and certainly meets the requirements for awarding its author, Mr Othman Al-Kherayef the PhD degree.

Sofia, 29.02.2020

Momchil Minchev

ЗАПИЗЕНИ ДАННИ СЪГЛАСНО
СЛ. 2 ОТ ЗЗЛД