

ANNOTATION

for a dissertation for a doctoral degree
Philosophy (PhD) 6D071100 – Geodesy
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MODERNIZATION OF LOCAL GEODETIC NETWORK OF ALMATY CITY WITH USE OF SATELLITE AND GRAVITY DATA

Relevance of the topic. Modernization of the local geodetic network of Almaty is an important task for improving the accuracy of spatial positioning and ensuring the sustainability of the city's geodetic infrastructure. The rapid development of urban infrastructure, as well as the seismic and tectonic activity of the region, require regular updating and improvement of the accuracy of geodetic measurements. At present, the solution of modern problems in geodesy is associated with high requirements for the accuracy of the geodetic network. The existing urban geodetic network no longer meets the requirements of regulatory and technical documents, this is closely related to the emergence of high-precision geodetic instruments (satellite receivers, electronic tacheometers, etc.). The contradictions between the accuracy of measurements performed by new instruments and the accuracy of the existing local urban geodetic network are due to the fact that old coordinate systems were created using other equipment that are much inferior in technical characteristics (theodolites, light range finders) and measuring technologies. Given the above factors, the right solution would be to integrate modern satellite technologies and gravimetry data, which will significantly improve the accuracy of altitude and horizontal coordinates, which is necessary for various engineering projects, monitoring deformations of the earth's surface and ensuring the safety of urban structures. Also, the creation of a local geoid model is not only of scientific and practical importance, but is also considered economically feasible, since the construction of a geoid model will replace expensive, labor-intensive geometric leveling with cheaper GNSS methods.

The aim of the study is the comprehensive modernization of the local geodetic network of Almaty through the application of satellite technologies and gravimetric data to improve the accuracy of spatial coordinates. The framework includes the transformation of coordinates between the local system and the global WGS84 system, as well as the development of a high-precision local geoid model using modern methods and technologies.

Object and subject of the study. The object of the study is the local geodetic network of the city of Almaty. The subject of the study is modern methods and technologies for the comprehensive modernization of the geodetic network (calculation of transformation parameters between coordinate systems, creation of a local geoid model) using satellite and gravimetric data.

Research objectives. Adjustment of statistical satellite observation data performed at the points of the Almaty geodetic network in the universal software package GAMIT / GLOBK to improve the accuracy of spatial coordinates. Taking into account system errors for ionospheric delays, tide accounting, etc. and joint adjustment with global IGS stations will allow determining the coordinates of the points with high accuracy. Calculation of the parameters of the transition between the local coordinate system and the global WGS 84 system, taking into account the heterogeneity of networks, is achieved by using various transformation methods: the Helmert method, polynomial and conformal transformation, etc. Evaluation of the accuracy of the obtained results, selection of the most suitable method that ensures high accuracy of the transformation.

Development of a local geoid model based on ground-based gravimetric data and gravimetric modeling methods that will take into account regional features of the gravity field. Comparative analysis of the results obtained with existing global geoid models.

Scientific provisions submitted for defense.

Modernization of the horizontal geodetic network of Almaty based on advanced methods of satellite observation processing and coordinate transformation to improve the accuracy of spatial positioning.

Development of a high-precision local geoid model for Almaty using satellite and terrestrial gravimetric data.

Scientific novelty of the research.

A comprehensive approach has been developed for the modernization of the horizontal geodetic network of Almaty, including the determination of transformation parameters to the WGS84 system based on modern algorithms for satellite observation processing and coordinate transformation.

For the first time in the territory of Almaty, a high-precision local geoid model has been created through the integration of satellite and terrestrial gravimetric data.

Practical significance. The results of this study can be applied in the practical modernization and operation of the geodetic network of Almaty. The developed local geoid model and the newly determined transformation parameters between coordinate systems will be useful for improving the accuracy of spatial measurements in engineering projects, construction, deformation monitoring, and other tasks requiring high-precision data. The outcomes of the research can be utilized in various fields of activity, including the RSE "National Center of Geodesy and Spatial Information" (NCGPI), the Department of Land Relations of Almaty, as well as domestic and international research organizations working in this field. This contributes to the development of the economy and enhances the safety of national infrastructure.

Relationship with research and development and government programs. The defense of the doctoral dissertation is an expected outcome of the grant-funded project for fundamental and applied scientific research of young scientists – postdoctoral fellows under project IRN №AP19175328 “Zhas galym” for 2023–2025, supervised by A.S. Urazaliyev.

In addition, research related to the development of the geoid model has been carried out within the framework of the Program-Targeted Funding (PTF) of the state order for the implementation of a scientific and/or scientific-technical project under budget program 217 “Development of Science”, under the priority “Information, Communication, and Space Technologies”, IRN №BR21882366 “Development of the Geoid Model of the Republic of Kazakhstan as the Basis of a Unified State Coordinate and Height System” for 2023–2025, supervised by K-K. Kassymkanova.

The author's personal contribution consists of setting the goal and objectives of the research, preparing the information base, the calculation part, analysis and interpretation of the results obtained, primary processing of satellite observations and their adjustment, recalculation of the parameters of the transition between the local coordinate system and WGS84, creation of a geoid model, writing articles and a doctoral dissertation.

Publications. 8 scientific works have been published on the topic of the dissertation, including: 1 article in a journal, which is included in the Scopus database (Percentile - 36), 1 article was published in an international conference, which is included in the WoS and Scopus databases, 6 articles in journals recommended by the Committee for Quality Assurance in Science and Higher Education of the Ministry of Science and Higher Education of the Republic of Kazakhstan.

1. A. S. Urazaliyev, D. A. Shoganbekova, R. Shults, M. S. Kozhakhmetov, G. M. Iskaliyeva. Investigation of LSMSA approach in local geoid modeling//News of the National Academy of Sciences of the Republic of Kazakhstan, Series of Geology and Technical Sciences. – 2024. – T. 4. – P. 261-273. (Percentile - 36)

2. Shults, R., Urazaliyev, A., Annenkov, A., Nesterenko, O., Kucherenko, O., Kim, K. Different Approaches to Coordinate Transformation Parameters Determination of Nonhomogeneous Coordinate Systems//Environmental Engineering. Proceedings of the International Conference on Environmental Engineering. ICEE. – Vilnius Gediminas Technical University, Department of Construction Economics & Property, 2020. – Vol. 11. – pp. 1-7.

3. Urazaliyev AS, Kyrgyzbayeva GM, Nurakynov SN TRANSFORMATION OF COORDINATES OF GEODETIC NETWORK WITH USE OF SATELLITE TECHNOLOGIES ON THE EXAMPLE THE TERRITORY ATTACHED TO THE CITY OF ALMATY // News of the NAS RK. Series physical and mathematical . – 2020. – No. 3. – P. 160-168.

4. Zhantayev , ZS, Kaldybayev , AA, Nurakynov , SM, Urazaliyev , AS, & Kairanbayeva , AB SCIENTIFIC AND METHODOLOGICAL BASES OF GPS MONITORING OF INTENSIVE MOVEMENTS OF THE EARTH'S CRUST IN THE EARTHQUAKE-PRONE REGIONS OF KAZAKHSTAN// Bulletin of the NAS RK. Physical-mathematical series. – 2020. – No. 3. – P. 177-182.

5. A.S. Urazaliyev , G.M. Kyrgyzbaeva . METHOD OF DETERMINING THE PARAMETERS OF THE TRANSITION TO THE LOCAL COORDINATE SYSTEM OF THE CITY OF ALMATY BY SATELLITE TECHNOLOGIES // BULLETIN " KazNITU ", No. 2 (138), 2020, 274-278 pp., ISSN 2709-4758

6. Shoganbekova D. A., Urazaliyev , A. S., Kasymkanova , Kh. K., Kozhakhmetov , M. S. ASSESSMENT OF THE EFFECTIVENESS OF GLOBAL GEOPOTENTIAL MODELS FOR THE TURKESTAN REGION// Aues Bulletin . – 2024. – Vol. 2. – No. 65.

7. Shoganbekova , DA, Urazaliyev , AS, Kassymkanova , K., Kozhakhmetov , MS , Kydyrkozhakzy , S. EVALUATION OF GLOBAL GEOPOTENTIAL MODELS IN KAZAKHSTAN BASED ON GEOID HEIGHTS AND GRAVITY ANOMALIES // Bulletin KazGASA . – 2024. – T. 2. – No. 92. – pp. 194-209.

8. Zemtsova A.V., Urazaliyev A.S. COORDINATE SYSTEMS IN MODERN GEODESY//Bulletin of KazGASU . – 2017. – V. 4. – No. 66. – P. 133-138.

Structure and volume of the dissertation. The dissertation work consists of an introduction, literature review, description of the object and methods of research, results and their discussion, conclusion and a list of references from 112 sources.