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BASICS OF USING GEODETIC REFERENCE COORDINATE SYSTEM UCS-2000 TO ENSURE MAINTENANCE OF THE STATE LAND CADASTRE

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Introduction. Mechanism of State geodetic reference coordinate system UCS – 2000 use for the State Land Cadastre requires legal regulation.

Analysis of recent research and publications. In designing and implementing the State geodetic reference coordinate system UCS-2000, significant work, related to theoretical research, development of scientific and technological activities as well as practical observations were performed. The largest contribution to the resolution of this problem was introduced by the Research Institute of Geodesy and Cartography (RIGC) and enterprises of the Main Department of Geodesy, Cartography and Cadastre - Ukrheodezkartohrafiyi. The significant role is also played by Lviv Polytechnic National University and other structures.

The first step was the adoption in 1998 of the Scientific and Technical Program of the geodetic reference national system creation. In accordance with industry custom of Ukrheodezkartohrafiyi RIGC together with Lviv Polytechnic the research on reference geodetic coordinate systems was performed. The result of this study was scientific - technical report, which analyzed existing European and global geodetic reference system and proposed the scientific and technical program of a national system of reference creation. This system should have become compatible with the most common European and global geodetic reference systems. Than there was the Decree of Cabinet of Ministers of Ukraine dated on 16 January 2003 № 37 "On approval of the State Scientific and Technical Program on the development of topographic and geodetic activities as well as national mapping for 2003 - 2010". It included the establishment of a national reference system and the network development of permanent stations of satellite radio navigation observations. It should be noted that even a year earlier " Plan - measures on reference coordinate system were developed, part of the national reference system of Ukraine", which regulated the procedure of reference coordinate system implementation with terms specifying and works value. An important step towards creating a national reference frame was the organization of comprehensive work on the design and definition of parameters of referentce coordinate system for the territory of Ukraine. Modelling of reference geodetic coordinate system was implemented in 2003 by RIGC and Lviv Polytechnic, taking into conideration recommendations of the General Assembly EuroGeographics of European Union. Results discussion of simulation parameters was carried out with the participation of such representatives: Main Department of Geodesy, Cartography and Cadastre (Ukrgeodezkartohrafiya, National Academy of Sciences, Ministry of Defense, Ministry of Education, Ministry of Transport and the National Space Agency of Ukraine. In the same year, "Technical-economic report on the implementation of reference geodetic coordinate system" was designed. It provided the scientific and technical grounding of reference geodetic coordinate system implementation with the necessary technical and economic calculations.

In parallel with the establishment of the theoretical foundations of national geodetic reference coordinate system - there were works with legal and regulatory support for its implementation. It is, first of all, the development of the "Procedure of using satellite navigation systems equipment during topographic surveying, cartography, aerial, design, research works and cadastral surveying" (Resolution of Cabinet of Ministers of Ukraine dated on 13.07.1998 , № 1075) . Accordingly, survey work using GPS equipment, and the results processing of observations is allowed to businesses and individuals on the basis of a license issued by the competent authority, adherence of certain conditions set by the authority and rules for such activities. Then terms of implementation and use of World geodetic coordinate system WGS-84 in Ukraine were developed (Decree of Cabinet of Ministers of Ukraine dated on 22.12.1999, № 2359) . This Regulation has been changed by ammendments several times, including the amended Decree dated on 23.12.2009, № 1413, according to which the State Committee for Land Resources is

responsible for the implementation and use of reference coordinate system WGS-84 in Ukraine, which is the coordinate basis of global navigation satellite systems (GNSS) operation. Also the "Regulations on the state monitoring network of global navigation satellite systems and Program of the functioning and development of state monitoring network of global navigation satellite systems providing for the period until 2010" (Decree of Cabinet of Ministers of Ukraine dated on 14.04.2004 , № 470) in response to a proposal of National Space Agency and the National Academy of Sciences concerning the establishment of the state monitoring network of global navigation satellite systems. As the main objectives of that network is the collection, processing and information presentation of global navigation satellite systems to specialized State

Services of Ukraine during their work from the base coordinate-time support of the state, as well as meeting the needs of other users of these systems in improving the accuracy of the location, it means that greatly stimulated the activities aimed at implementing a national reference system.

The most important step towards the implementation of the State reference geodetic coordinate system was carrying the satellite observations. The first such observations were performed in 1995. Enterprises of Main Department of Geodesy, Cartography and Cadastre (Ukrheodezkartohrafiyi) with technical support from the Institute of Applied Geodesy (IfAG) of the Federal Service of Geodesy and Cartography of Germany – organized 5-day observations at 16 specially-built stations, the average distances between which were 200 - 300 km. As a result of the observations processing, coordinates of these stations are obtained in the system ETRS89, ITRS/ITRF1997 and WGS-84.

In 2000 satellite geodetic observations were held at periodically existing GNSS stations and 43 stations of Geodetic Control Network (GCN) of the 1 class. The observations were made in the period from 3 to 30 September 2000 by the Ukrainian State Air-Geodetic Enterprise (UkrSAGE), Lviv Polytechnic National University, State Enterprise "Poliskgeodezkartohrafiya", Main Astronomical Observatory of NAS of Ukraine. According to results of study, which was conducted in RIGC, the coordinates of 43 stations in the GCN system ETRS89, ITRS/ITRF1997, ITRS/ITRF2000, WGS-84 were obtained, which were then used as output in modeling and determining the parameters of reference coordinate system for the territory of Ukraine. A few years after similar satellite observations were done at 815 control points of GCN of the 1 class. These items were later accepted as output when aligning GCN of Ukraine. In 2006-2007 satellite observations were made at another 481 points of GCN of the 2, 3, 4 classes. These additional observations were made specifically just for those points there errors with the equalization of linear-angular constructions of GCN exceeded 0.10 meters. In the framework of geodetic works providing on the delimitation and demarcation of the state border of Ukraine, satellite observations were done at 600 points of planned network (in the area of Ukrainian-Russian border).

Towards a general equalization of the GCN there was a process of creating a bank of geodetic data. Bank of geodetic data included systematic information on points of geodetic surveying, leveling, gravity and geodetic networks of geodetic networks condensation within the territory of Ukraine; also made measurements on them and the results of their study.

Adjustment of GCN of the 1, 2, 3 and 4 classes was performed by parametric method, taking into account errors of initial data by the method of the smallest squares in the coordinate system UCS-2000 (in spatial coordinates XYZ). It was carried out using established bank of geodetic data and programming software GeoLab. It is proved that the mean square error of the defining of geodetic points coordinates on the adjustment does not exceed 0.05 cm throughout Ukraine.

Works were performed in frames of the project "Cataloguing coordinates and elevation of surveying points" (2008) on collecting information about the types of centers, external characters and their situation, giving proper names to Ukrainian geodesy points; fixing the collected and processed information in the bank of geodetic data; cataloging coordinates organization and elevation points according to trapezoid scale 1:200 000 and forming schemes of geodetic network for each catalogue.

The final step towards the formation of a new reference coordinate system was the developing of transformational digital field - based on finite element method. To do this, we used 23357 combined points of geodetic network in Ukraine, the coordinates of which are defined in system SC-42 and UCS-2000.

To establish the connection of local coordinate systems with State geodetic reference coordinate system USC-2000 in the last four years - there were works of local coordinate systems with UCS-2000.

Statement of the task. The article deals with the principles of the use of State geodetic reference coordinate system UCS-2000 for the organization providing of the State Land Cadastre.

Materials and methods. Also the Decree of Cabinet of Ministers dated on 22.09.2004 , № 1259 "Some questions on geodetic coordinate system use" claims that fulfilling geodetic and cartography works from January 1,

2007 is carried out using the State geodetic reference coordinate system UCS-2000. This Resolution had some practical implementation in Geodesy and Cartography, however, in other areas, particularly in the land cadastre the classical coordinate systems as SC-63 were used. Only in 2008 Decree № 485 dated on October 6, 2008, of State Land Committee " On the determination of areas and submitting proposals for the implementation of the State geodetic reference coordinate system of UCS–2000". This envisaged, for the first time, the creation of a working group, which was instructed to study the issue and make suggestions on possible ways of UCS-2000 implementing in the field of land issues.

Subsequently, issue consideration and discussion on the state and prospects of UCS–2000 implementation was proposed for discussion of extended meetings of the Interagency Working Group on Coordination of activities aimed at improving the coordinates and time providing, scientific and technical sections in Geodesy, Cartography and Cadastre of Ministry of Environment and Science - Technology Council of the State Committee for Land Resources .

Decree of Main Department of Geodesy, Cartography and Cadastre - Ukrheodezkartohrafiyi № 23 dated on 14 April 2011 "On regulation use of State geodetic coordinate system UCS-2000" was published in 2011. It regulates the use of UCS-2000 in compiling the index cadastral maps (plans), cadastral maps (plans) cadastral plans of land areas and planning documentation.

Although even in 2012 during the inventory of land or organization of state land cadastre it was regulated that topographic – geodetic works were carried out in a single state system of coordinates or derivative one to determine or clarify the boundaries of land and that the geodetic framework of the State Land Cadastre coordinates are points coordinates of State geodetic network in a single state system of coordinates but real transition to a broad introduction of UCS-2000 has not happened yet.

Decree of Main Department of Geodesy, Cartography and Cadastre of Ukraine № 468 dated on September 27, 2012 "On the issues of the application of the State geodetic reference coordinate system UCS-2000 in the software of the State Land Cadastre" became an important one. Decree requires the use dated on 01.01.2013 system of UCS-2000 in the creation and maintenance of software of the State Land Cadastre and approves plan activities for the transition to UCS-2000.

Results and discussion. The most important issue of transition to UCS-2000 is a mechanism development for application of the State geodetic reference coordinate system UCS -2000 for the State Land Cadastre and it is necessary for management of entities of survey and cartography activities in the field of land issues. It is important to observe the following principles using State geodetic reference coordinate system UCS-2000:

- Compliance with international standards;
- Use of international experience of geodetic reference coordinate systems;
- The use of rigorous mathematical methods for providing of coordinate transformation operations and coordinates transformation from classic to modern systems of coordinates;
- Taking into account the existing administrative-territorial structure of Ukraine;
- The use of existing regulatory - technical and software infrastructure of State land cadastre organization;
- Performing all topographic-geodetic, cartography and land operations in the system of coordinates UCS-2000 or local coordinate systems, clearly related to the coordinate system UCS-2000;
- Systematic transition to the coordinate system UCS – 2000 of the existing topographic-geodetic, cartography, land management materials that are designed in coordinate systems SC-42, SC-63 and local coordinate systems formed from them;
- Surveying of cadastre objects on the ground is carried out using satellite geodetic GNSS receivers and electronic total stations using all available modern technology measurements;
- Establishment of uniform requirements for execution of geodetic satellite observations;
- Using GNSS equipment during topographic surveying, cartography and cadastral survey should be governed by regulatory and organizational principles.

Conclusions. The implementation of the basic principles of the State geodetic reference coordinate system UCS–2000 use - will provide harmonization of legal acts into conformity with the norms of law and establish basic provisions applying geodetic reference coordinate system UCS-2000 for the State Land Cadastre.

Basics of using geodetic reference coordinate system UCS-2000 to ensure maintenance of the state land cadastre

I. Zayets

The article deals with approaches and the peculiarities of use of geodetic coordinate reference system UCS-2000 for the State Land Cadastre organization.