Some aspects of the edge matching method of digital topographic maps in the scale of 1:50 000 for creation the main state topographic map

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SUMMARY

The article proposes the research of some aspects of the edge matching method of digital topographic maps in the scale of 1:50 000 for creation single seamless Topographic Database of the Main State Topographic Map in Ukraine within the framework of the Ukrainian-Norwegian project. The single seamless Topographic Database of the Main State Topographic Map (hereinafter – Topographic Database) is being created for the first time in Ukraine for the creation and development of the National Spatial Data Infrastructure which requires relevant, reliable and high-quality Core Reference Datasets which based on digital topographic maps. This research considers the edge matching of the updated digital topographic maps before the uploading into Topographic Database. Compliance with the proposed requirements for the edge matching of the updated digital topographic maps will raise the quality of the edge matched updated digital topographic maps in the scale of 1:50 000 for creation the seamless Topographic Database of the Main State Topographic Map. During researching of the edge matching method of the updated digital topographic maps in the scale 1:50 000 was defined that the transformation of coordinates from one zone of the Gauss-Krueger projection to another executes with insufficient accuracy for the usage of analytical methods in ArcGIS.
Introduction

The creation and development the national level of the National Spatial Data Infrastructure requires relevant, reliable and high-quality Core Reference Datasets which based on digital topographic maps of the scales: 1:10 000, 1:50 000 and 1: 100 000. The single seamless Topographic Database of the Main State Topographic Map (hereinafter – Topographic Database) is being created for the first time in Ukraine within the framework of the Ukrainian-Norwegian project, the input data of which are the updated digital topographic maps of the scale 1:50 000.

The research is related to the implementation of the Ukrainian-Norwegian project “Maps for good land governance” (hereinafter – project) which started after the signing the Agreement between the State Service of Ukraine for geodesy, cartography and cadastre and Statens Kartverket – the Norwegian Mapping Authority on 28 of February 2018.

The Technical Manual “Creation Topographic Database “Main State Topographic Map”. Creation (updating) digital topographic maps” (hereinafter – Technical Manual) was created for ensuring the requirements for the creation of the single seamless Topographic Database of the Main State Topographic Map. Technical Manual has the details and principles of contemporary geoinformation approach to the production of digital topographic maps (Karpinskyi & Lazorenko-Hevel, 2020). The creation of the single seamless Topographic Database as continuous coverage of geospatial data for the whole territory of Ukraine has its technical peculiarities for the edge matching updated digital topographic maps.

The purpose of the article is to research some aspects of the edge matching method of digital topographic maps in the scale of 1:50 000 for creation single seamless Topographic Database of the Main State Topographic Map.

Method and Theory

Digital topographic maps of the project are created (updated) by vectorization method in the State Geodetic Reference Coordinate System of USC-2000 in the Gauss-Kruger projection in the corresponding 6-degree zone (EPSG: 5562, EPSG: 5563, EPSG: 5564, EPSG: 5565) in the adopted state map of topographic maps in the scale of 1:50 000 in the software ArcGIS for Desktop 10.5.

There is one of the peculiarities of the created digital topographic maps of the scale 1:50 000 that they are hybrid because the update of features with clear contours (networks of roads, streets, driveways, blocks and houses, power lines (voltage over 35 kV)) is performed with detail and accuracy of the scale 1:10 000 (root mean square error – 3 m), and update all other features – with an accuracy of 1:50 000 (root mean square error – 25 m).

The vector models of the edge matched digital topographic maps in the scale of 1:50 000 are the input data for the creation seamless Topographic Database of the Main State Topographic Map. The edge matching of the updated digital topographic maps in the scale of 1:50 000 is performed on all frames with adjacent updated map sheets. There is the question: at what stage to perform the edge matching of the updated digital topographic maps: to perform manually or automatically edge matching in the ArcGIS during vectorization of the digital topographic maps or after uploading updated digital topographic maps into Topographic Database of the Main State Topographic Map. The requirement of the Technical Requirements of the project is performing edge matching before the uploading edge matched updated digital topographic maps into Topographic Database, so this research considers the first variant which has not been studied in detail in the literature.

Results

The recent research of the edge matching process of the digital topographic maps shows the importance of automated edge matching of the digital topographic maps for their further stitching, the
creation of topologically consistent networks of the linear features (for example, road network and hydrography) and coverage of the polygonal features (settlements, vegetation and soils, etc.) (INSPIRE, 2007; Geoscience Australia, 2012; Xin Chang Zhang, 1998; MD. Mosharaf Hossain, 2008).

The authors of this research suggest some aspects of edge matching methods of the updated digital topographic maps of the scale 1:50 000 in ArcGIS for creation the Main State Topographic Map:
1) the digital topographic maps are created according to the topological relationships between geospatial features;
2) the updated digital topographic maps are edge matched if they have similar geometric and attributive characteristics and the distance between them does not exceed the maximum root mean square error of the position of features;
3) the value of the maximum distance between geospatial features must be determined as an edge matching function; the root mean square error of the position of features is 28 m for the scale 1:50 000 and 5.6 m – for the scale 1:10 000;
4) the nodes are created during the edge matching process on the common frame of the digital topographic maps;
5) edge matching functions should be able to handle small gaps in data, slight discrepancies, overshoots and missed and double lines;
6) the updated digital topographic maps of 1:50 000 scale are edge matched on all frames with adjacent map sheets (Fig. 1).

![Image](image_url)

**Figure 1** The example of the edge matched map sheet frame М-34-83-B with adjacent map sheets frames in the ArcGIS project

The initial data for the edge matching of the updated digital topographic maps of the scale 1:50 000 are from one to four adjacent map sheets as updated geodatabase *.gdb, which have passed quality control and accepted (especially for the edge matching of the updated digital topographic maps of the scale 1:50 000 which were updated by different executors). Examples for the edge matching of the linear and polygonal features are shown 2 – 4.

During the edge matching process of the updated digital topographic maps in ArcGIS were founded the differences (gaps) between the frames of the map sheets at the boundaries of the Gauss-Krueger zones projections, which is 1 – 8 mm on the ground. The reasons of these gaps are that standard tools of the ArcGIS execute incorrect geodetic and cartometric operations: the transformation of
coordinates from one zone of the Gauss-Krueger projection to another with insufficient accuracy for the usage of analytical methods (Karpinskyi & Kin, 2020).

It was created reference frame of the digital topographic maps of the scale 1:50 000 for solving these problems. This reference frame was calculated by the analytic methods of determination the coordinates of geospatial features in the Gauss-Krueger projection in the corresponding 6-degree zones.

Figure 2 The example of the edge matched adjacent updated digital topographic maps

Figure 3 The example of the edge matching the linear feature (contour line) of the adjacent updated digital topographic maps

Figure 4 The example of the edge matching the polygonal feature (the forest and the settlement) of the adjacent updated digital topographic maps

Figure 5 The gaps between the frames of the map sheets in the 4th and 5th zones of the Gauss-Krueger projection
Recommendations and conclusions

Some aspects of the edge matching method of the updated digital topographic maps in the scale 1:50 000 was proposed and used for edge matching of adjacent map sheets which has its technical peculiarities.

Compliance with the proposed requirements for the edge matching of the updated digital topographic maps will raise the quality of the edge matched updated digital topographic maps in the scale of 1:50 000 for creation the seamless Topographic Database of the Main State Topographic Map.

During researching of the edge matching method of the updated digital topographic maps in the scale 1:50 000 was defined that the transformation of coordinates from one zone of the Gauss-Krueger projection to another executes with insufficient accuracy for the usage of analytical methods in ArcGIS.

The authors of this research offer to develop the software complex in the GIS to solve this issue. This software complex allows executing geodetic and cartometric operations with rigorous analytical methods.

Acknowledgements

This research was conducted by scientists from Kyiv National University of Construction and Architecture together with scientists from State Enterprise “Research Institute Geodesy and Cartography” and the Norwegian Mapping Authority (Statens Kartverk).

References


