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THE VALIDITY OF THE BDOT10k DATABASE ON THE EXAMPLE OF THE TOWN OF TARNOBRZEG

Up to date issue of cartographic studies is a complex problem. The content of the BDOT10k database is particularly important from the user's point of view, which should be updated on a current basis. The authors carry out an analysis of the database's validity along with the assessment of changes in spatial topography based on available non-standard topographical studies and an orthophotomap. The research was carried out in the town of Tarnobrzeg, which due to its specificity (a town with high dynamics of development) allows for a clear picture of the essence of the problem.

Keywords: Tarnobrzeg, BDOT10k, topographic maps, urban structure, development of the city

1. Introduction

Since the 1990s, in Poland, official topographic maps have been made in digital technologies, until 2003 the main tools for their implementation were CAD. In 1999, experimental and pilot works in the field of building a modern topographic database began at the Head Office of Geodesy and Cartography. Test projects "Dunajec and Wisła" in 1999, and "Kujawy" in 2000 became the basis for the development of "Technical guidelines of the TBD topographic database". Initially, the database was called the "topographic database", before the publication of guidelines it was changed to the "topographic database", leaving the TBD abbreviation [1].

The guidelines were issued by the Head Office of Geodesy and Cartography in 2003. In 2008, their updated version was marked with the number 2.0. In the guidelines, the topographical database (TBD) is defined as "uniform in terms of

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the conceptual model, an official nationwide system for collecting and sharing topographic data, which besides data consists of an appropriate financing system, organization, IT tool and necessary technical guidelines and instructions". The guidelines set out the rules for the organization of the TBD system, the development of a 1:10,000 topographic map, specification of the basic resource and TBD data exchange standards [2]. The legal basis for the creation of the topographic database was the Geodetic and Cartographic Law [3] and the Regulation of the Minister of Regional Development on detailed rules and procedures for establishing and maintaining the national system of information on land [4].

In the Regulation of the Minister of Internal Affairs and Administration regarding the database of topographic objects and databases of general geographic objects, as well as standard cartographic studies, the names "topographical database" (TBD) and "general geographic database" (BDO) were replaced by the names "database of topographic objects"(BDOT10k) and "general geographic objects database"(BDOO) [5].

2. Database of Topographic Objects – BDOT10k

2.1. Objective of development and legal basis of BDOT10k

The database of topographic objects, BDOT10k, is a spatial database of a reference nature corresponding to the detailed topographical map in scale 1:10,000. The basic task of its creation is to collect and share data for use in various information systems created by public and private institutions. The creation of BDOT10k is intended to prevent unnecessary repeated collection of the same data by various institutions.

The need to create a database of topographic objects for the whole country with details ensuring the creation of standard cartographic analyzes at scales 1:10,000 – 1:100,000, was written in the Spatial Data Infrastructure Act [6]. Guidelines for the creation of BDOT10k were included in the Regulation of the Minister of Interior and Administration [5]. The ordinance together with attachments defines the scope of data collected in BDOT10k and BDOO databases, organization, mode, creation standards, updates and sharing of both databases, also contains information on the joint objects catalog for BDOT10k and BDOO, three-level object classification, UML application scheme and GML scheme for both databases, guidelines for entering objects into databases, technical standards for creating standard mapping surveys are defined on scales from 1:10,000 to 1:1,000,000 [5].

2.2. Structure of BDOT10k

BDOT10k collects information about topographic objects, which include the spatial location of objects, their characteristics, cartographic codes and object metadata. Objects are grouped on three levels: on the first there are categories of object classes, on the second – object classes and on the third, most detailed one there are objects themselves.

The BDOT10k database is created and updated on the basis of data from various sources. The basic materials are public data registers constituting the State Geodetic and Cartographic Resource (PZGiK):

- land and building register – EGiB – is a source of information about the location, geometry, function, purpose of land and buildings,
- geodetic record of the utilities network – GESUT – it collects data on cables, their housings, technical devices related to networks,
- state register of boundaries and areas of territorial division units of the country – PRG – this database contains information on the borders of the state and territorial division units of the country, the boundaries of the coastal belt, the maritime coastline, surface areas of the divisions of the country and sea areas,
- the state register of geographical names – PRNG – is a source of information on the names of towns and physiographic objects,
- register of towns, streets and addresses – EMUiA,
- orthophotomap, aerial and satellite imaging – are a source of information about the most-real condition of coverage and land development,
- numerical terrain model – is a source of geometric data of watercourses and reservoirs, as well as the main data source for BUZM object classes (excavation, flood embankment, dam), OIPR (rock, boulders, rock threshold, etc.).

Sometimes, when the content is useful, other registers are used, such as:

- road data bank – BBD – relational database of the General Directorate for National Roads and Motorways, containing information on geometry, numbering, classes, road technical parameters, lane management, engineering facilities,
- data of the General Directorate for Environmental Protection – to the extent of protected areas,
- data of the National Heritage Institute – to the extent of immovable monuments,
- data of the National Water Management Authority and the Institute of Meteorology and Water Management – to the extent of water network,
- the national official register of the territorial division – TERYT – kept by the Central Statistical Office – is the source of information on the identifiers and names of the territorial division units of the country,
- data from town and community councils – to the extent of institution registered offices.

Field inspections complement and verify data from registers [5].

3. General functional and spatial characteristic of the research area – city of Tarnobrzeg

The city was founded in 1593, with visible development of buildings in the 1770s. Initially, the city developed concentrically around the centrally located market. With time, the center of gravity of the system has been moved south. Even in the mid-19th century, the building structure was mainly single-family residential buildings, free-standing or creating frontages, and several service facilities: the town hall, the monastery of Dominicans and small basic services.

After Poland regained its independence, the city accelerated its development. First, under the Four Year Plan, Tarnobrzeg was included in the Central Industrial District project, choosing Mokrzyce (currently a district of the city) as the place for development of metallurgical plants with a refinery, foundry and copper forge which was to become a driving force for the growth of the urban tissue [7].

The most important event affecting the dynamics of Tarnobrzeg's development was the discovery, in 1953, of rich deposits of native sulfur (it was defined as one of the largest deposits of native sulfur in the world). The new industrial unit – Sulfur Mine of Tarnobrzeg became the reason for the increase in the number of inhabitants, which led to the dynamic development of the city's residential structure, with particular emphasis on the multi-family block building [8]. Similarly to other units of the region, the urban tissue of Tarnobrzeg, based on the location of the main industrial plant, is largely residential and service structural units of multi-family housing and basic public utilities. As a result of the administrative reform of Tarnobrzeg, in 1975, it became a province and this state lasted until 1998. It was a time of dynamic development and investments. The period after the loss of the provincial city's status coincided with technological changes that made sulfur mining unprofitable and the mine was put into a state of liquidation, which significantly contributed to limiting and weakening the construction movement.

4. Current state of BDOT10k along with an analysis of the degree and type of investment in the area of the city of Tarnobrzeg

4.1. Method of analysis

The research method is a comparative analysis of basic cartographic studies, a digital orthophotomap and the BDOT10k database. The analyses were performed using the QGIS program. It is a free and open software, which tools are commonly used to carry out spatial structure analysis [9;10]. Materials for research were collected data from the Regional Center for Geodetic and Cartographic Documentation in Rzeszów. The database of BDOT10k topographic objects and topographic maps in scale 1:10,000 in 1965 and 1992

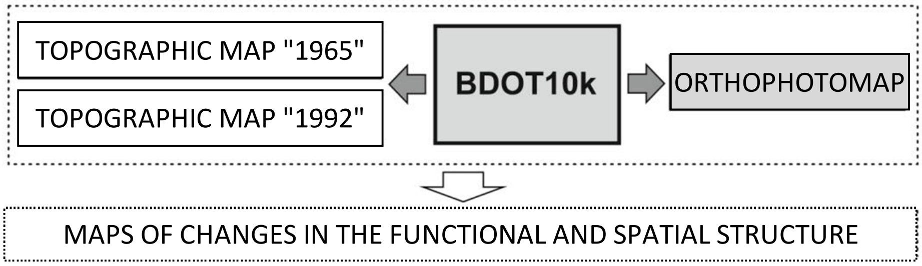

Fig. 1. Diagram of the structure of the comparative analysis (own study)

layouts were used, with maps in the 1965 layout from 1989 and 1999 in the 1992 layout. Orthophotomap (current status in 2017) was downloaded from the Geoportal (geoportal.gov.pl) thanks to the WMTS service (Fig. 1.).

The main analysis is a comparison of the BDOT10k database contents with a digital orthophotomap, which will allow determine the approximate current status of the database. Secondary analysis includes comparison of the database with the topographic map scans. A summary of the results will enable a graphical presentation of maps of functional and spatial changes in the city.

4.2. Updating of the BDOT10k database

The update was started by checking the changes that occurred in the studied area, by comparing the BDOT10 data with the orthophotomap. Thanks to the WMTS service, the orthophotomap was loaded, then vector layers were applied to it. Due to the content of a large number of layers and information in the BDOT10k database, we tried to give the layers appropriate styles, so that they are legible. Database layers often come in contact or overlap, so it is important to have a clear picture of each layer, because the introduced changes could cause topological errors. The city area was analyzed by searching for places where the vector layers did not coincide with the orthophotomap view. An appropriate update of the object classes in these areas has been made. During the analyzes, layers containing new building objects were created. 95 new buildings were created (Fig. 2.), they were mainly single-family residential buildings with accompanying buildings (garages, outbuildings) (in Figure 3 marked as A). Locations where the office buildings (company headquarters) and the health care facility were demolished were also located (in Figure 3 marked as B.).

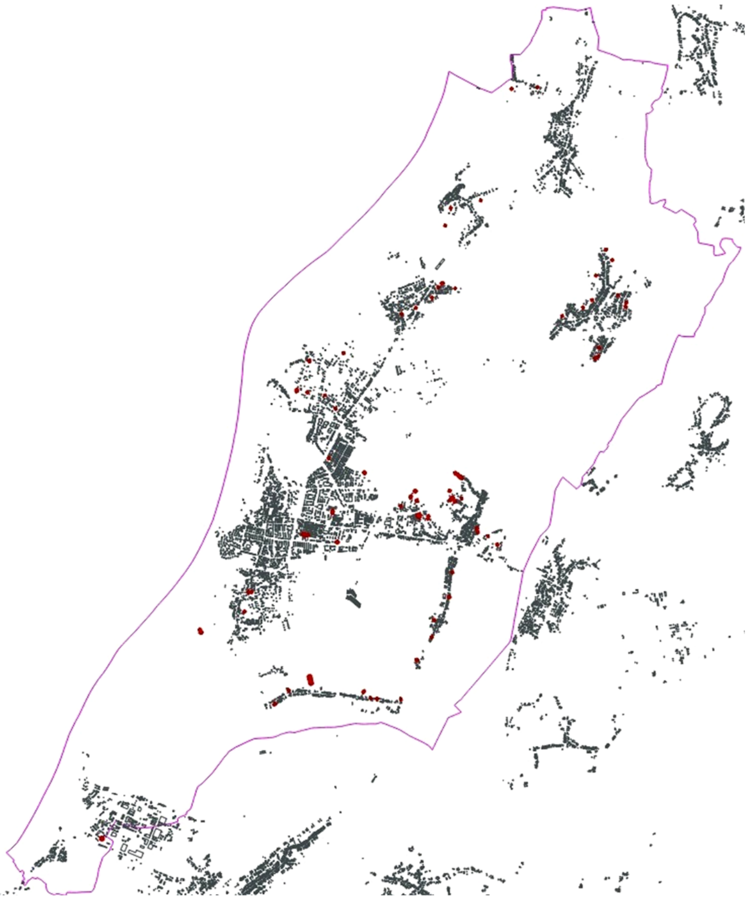

Fig. 2. BDOT10k update. The red color indicates the buildings entered into the base as part of the update based on the orthophotomap (own study)

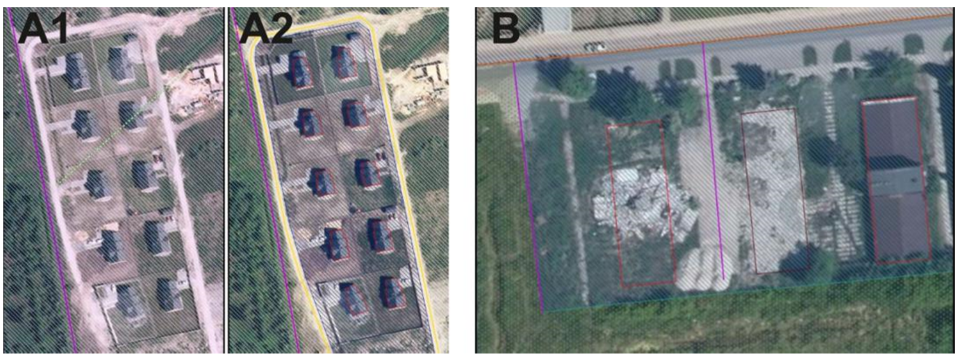

Fig. 3. BDOT10k update. A – introduction of new buildings, improvement of the existing road and introduction of a new one (A1 – view before the update, A2 – after the update), B – demolished buildings visible on the orthophotomap (own study)

After the quantitative update, the dates of introducing the objects to the database were checked. In the attribute tables, all layers contain information about the date of creating the object (x_dataUtworzenia) and information about the date of the geometry of the object (x_aktualność). For all facilities in the city area, the date of the geometry of the object is 15/10/2012, while the date of creating the object is 15 November 2012, the date of creating the database. The attribute of the buildings was also analyzed and the buildings that had the value "Bud" were selected, which means that at the end of 2012 they were buildings under construction, which were not being used. 242 of such buildings were selected

4.3. Comparison of BDOT10k content and available non-standard cartographic studies

Additional, somehow side-by-side analyzes are the comparison of BDOT10k with topographic maps in the "1965" (from 1989) and "1992" (from 1999) systems. Thanks to the raster map in the "1965" layout, we managed to create a new layer in the base, containing buildings visible on the rasters, due to which you can determine the time of construction of buildings before 1989. Number of such buildings identified is 6,874. The last analysis was made by comparing objects from BDOT10k with topographic maps in the "1992" layout. The analysis did not take into account the previously selected buildings. 3,435 buildings have been identified (Fig. 4.).

In the separate analyzed time intervals, it can be seen that the largest number of single-family residential buildings and farm buildings were built (including, garages). In the years 1989–1999 there were 1,203 single-family buildings built, i.e. 39.5% of all constructed buildings at that time, and 1,501 utility buildings, i.e. 49.5% of all buildings constructed in that period. In the next time interval (1999–2013) the construction pace in Tarnobrzeg decreased, however, the most numerous building groups among the newly-created were single-family residential buildings – 312 and utility buildings – 219, which was respectively 52.5% and 37% share in new buildings in this period. During the construction of the base, 280 buildings were under construction, 86.5% of which were single-family houses (242 buildings).

Apart from the number of buildings, the analysis also covered the building area. Based on data from BDOT10k, it was established that from 1989 to 2013, the area of Tarnobrzeg development increased from 1,069,591 m^2 to 1,658,410 m^2, i.e. it increased by 55% (buildings under construction were included in the calculations). The fastest growth in building space is in the years 1989–1999, it was 43%. The Table 1. shows the detailed distribution of surfaces depending on the function.

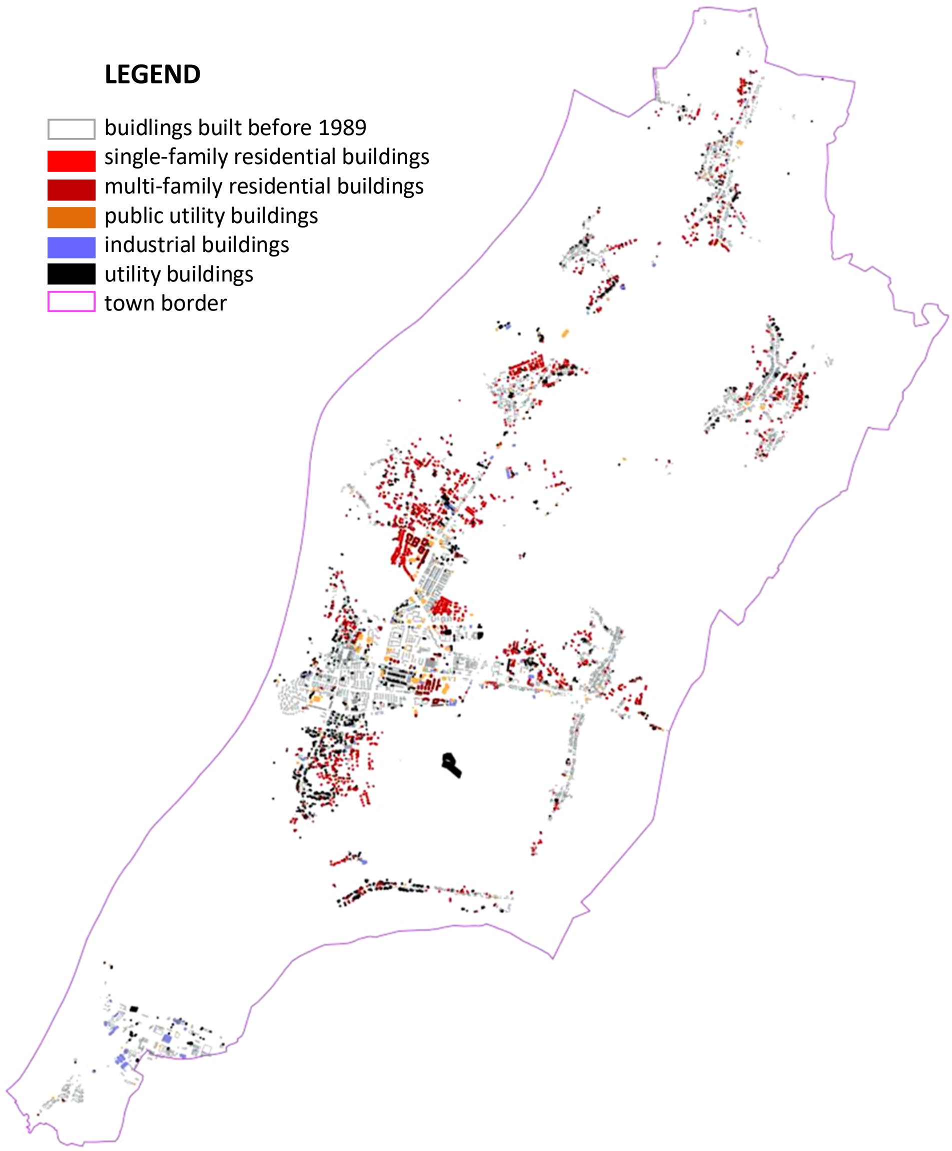

Fig. 4. Analysis of spatial and functional changes in 1989–2013 (own study)

Table 1. Change of building area in the analyzed time intervals (own study)

Buildings / Years	Single-family	Multi-family	Residential buildings in total	Utility buildings	Public utility buidling	Industrial	Σ
	[m²]						
to 1989	296,135	155,784	451,919	251,880	187,088	178,704	1,069,591
1989–1999	140,775	33,913	174,688	174,908	66,029	47,259	462,884
1999–2013	39,479	2,057	41,536	20,159	10,783	10,361	80,786
under construction	31,310	1,786	33,096	2,053	5,450	4,550	45,149
Σ	507,699	193,540	701,239	446,947	269,350	240,874	1,658,410

5. Conclusions

As part of the research, the Database of Topographic Objects (BDOT10k) was compared with other sources of data, an orthophotomap and topographic maps from the late 1980s and 1990s. In the research area - the city of Tarnobrzeg, after the update based on the orthophotomap, discrepancies were found and 95 new buildings were added to the database. The estimated time of creation of 9,699 objects from the BUBD layer was also determined. The area of development in the city of Tarnobrzeg increased by 55%, i.e. 0.25 km^2, with the increase of 0.19 km^2 by 1999. Conducted analyses show that that the city was developing most dynamically until 1999, when a reform was introduced changing the administrative division of the country and the unit lost the status of the province.

On the basis of the performed research, it can be argued that the amount of data contained in BDOT10k is sufficient to carry out spatial and statistical analyses, both by using the functions and creating spatial queries in the database, as well as by performing analyses on the layers themselves or between them, and by comparing vector data with raster data. Comparing vector layers with raster layers of topographic maps is much simpler and more transparent than comparing rasters of topographic maps. Furthermore, BDOT10k has a wider range of information about objects than traditional topographical maps. In the database, we can search for information, including about the data source, category of existence, general and detailed function of the object, cartographic codes for the appropriate scales of topographic and general geographic maps, number of storeys, we can also obtain information about geometry (e.g. surface, dimension) due to GIS program functions. The Database of Topographic Objects contains information that did not appear on topographic maps because it would affect their legibility.

Despite the functionality and many attributes that BDOT10k has, the drawback is its out-of-date status. The database that has been used since its inception on 15 November 2012 is not valid, although the Regulation of the Minister of Interior and Administration of 17 November 2011 regarding the database of topographic objects and databases of general geographic objects, as well as standard cartographic studies (Journal of Laws of 2011 No. 279 item 1,642, as amended) says that "updating of data contained in BDOT10k takes place immediately after obtaining new data".

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