RESEARCH OF THE RELIABILITY OF GEOREFERENTIAL SPATIAL DATASET (GDR10LT) OF THE REPUBLIC OF LITHUANIA

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Abstract
The systemized and methodically arranged according to the principles of geographic information systems set of the most important objects of Lithuanian territory's geodetic base and topographic databases (GDR10LT) is collected and kept in data storage and covers the whole territory of Lithuania. The purpose of the georeferential base GDR10LT at the scale 1:10 000 is to collect, keep, use, renew and provide data to users. The literature analysis shows that the majority of authors presented studies about data composition and application but they did not analyse their reliability.
The aim of the research was to revise the chosen territory of the georeferential base map by the field method and to determine the discrepancies between the situation in the area and in the map as well as the reasons of such discrepancies. It was necessary to verify the data reliability and outdated map information due to changes of the situation. The field research was conducted in three different areas, and the data was processed using tools provided by www.zis.lt. Statistical data analysis was performed using Microsoft Excel software. The object of the research was information depicted in georeferential base map (GDR10LT) of the chosen territories. The following research methods were used: literature analysis, analysis of cartography material, collation of field data, statistical data processing, interviews. The conclusion can be made that GDR10LT data are reliable; two mistakes were found in the plot of 6407.5 hectares: a navigational obstacle and 800 metres of asphalt cover were not marked. Other determined discrepancies covered the territory of 17.46 hectares. The outdated map information was found. The marking of settlements generally mismatched because of many new buildings in the area that were not mapped. Therefore GDR10LT should be updated more often in accordance with ORT10LT data.
Key words: Georeferential base map, GDRLT, ORTLT, georeferential data.

Introduction

The object of georeferential base is natural and anthropogenic features of terrene, geodetic points, state boundary, names of cities, towns, villages, swamps and forests, hydrographic objects and their names etc. The spatial data set of the reference base of territory of the Republic of Lithuania at the scale 1:10 000 (abbreviated name – GDR10LT) is the state spatial data set. This spatial data set consists of the features related to water bodies, land cover, transport network, engineer communications, geodetic points, elevation values, geographic names etc. Each object has unique identification and information about its life-circle (GDR10LT..., 2014). National Land Service under the Ministry of Agriculture pursues the policies of the Republic of Lithuania in the spheres of geodesy, cartography, georeferenced public datasets of the Republic of Lithuania and infrastructure of spatial information of Lithuania. It conducts state geodetic and cartographic works, compiling of state geodetic base and public georeferential datasets, improvement and activity assurance of Lithuanian spatial information infrastructure and coordinates the use of spatial datasets (Papišienė L., 2014).
Since 1992 the state enterprise "GIS-Centras" responsible for development and administration of geographic information portal of Lithuania (www.geoportal.lt) and state georeferential base cadaster, administration of georeferenced public spatial datasets and data delivery for society is acting in Lithuania.
All legal and natural persons in Lithuania who purchase and use these data can be the users of georeferential data (Kryžanauskas A. et al. 2010). Recently data are more often applied for plot accounting of agricultural land and performing analysis of changes ((Bykovienė A. et al. 2014), (Plieninger, et al. 2013)). Lately GIS technologies and georeferential base data as the background are very widely used when accomplishing scientific research ((Abalikštienė, Aleknavičius P., 2013) (Aleknavičius A., Aleknavičius P., 2010)).
Georeferential spatial dataset at scale 1:10 000 of the Republic of Lithuania (GDR10LT) covers the territory of the whole country. GDR10LT is created and updated using digital raster orthophoto map at scale 1:10 000 of the Republic of Lithuania (ORT10LT), spatial data of Geodetic and cartographic base information system GKPIS, administrative boundaries of address register of the Republic of Lithuania, register of cultural heritage, section lines and openings of forest cadaster; also spatial data provided by pipeline (Joint stock company "Mažeikių nafta") and information given by administration

of civil aviation about high constructions. Layers of georeferential data in Lithuania were updated in 2011 and 2012 according to available ORT10LT, and a new layer of heights was created. The state enterprise "State Land Fund" constantly updates the layers of georeferential spatial base according to the observations of residents. Since July, 2013 additionally each object has unique identification, and information about its life-cycle, the reason of the last change and mean used for the change is collected (GDR10LT..., 2014).
The above mentioned facts allow stating that georeferential base data are very widely used and thus it must be accurate and updated timely. Data are collected using remote methods, performing digital and visual interpretation of orthographic maps in a cameral way. The earlier mentioned additional information is also used. The literature review showed that most of authors presented studies about data composition and their application but they did not analyse their reliability and did not perform the field research. The accuracy is analyzed only by Kryžiauskas and Motiejauskas (Kryžiauskas, Motiejauskas 2010) but only for hydrographic objects. Therefore the authors conducted the research and revised the georeferential base map of the chosen territory by the field method, i.e. it was checked if the situation presented in the map corresponded to the real situation in terrain. It was accomplished in order to find out the reliability and outdated information of GDR10LT data.

The aim of the research: to revise the chosen territory of the georeferential base map by the field method and to determine the discrepancies between the situation in the area and in the map as well as the reasons of such discrepancies. It was necessary to verify the data reliability and outdated map information due to changes of the situation.

Methodology of research and materials
The available literature on the problem was analysed. The detailed analysis of cartographic material in work place was performed. During the analysis, ORT10LT data, used as additional means, allowed getting acquainted with the specific aspects of the terrain's data interpretation and to prepare for the field research. The highest labour costs included the revision of cartographic material by the field method. Statistical data processing was applied for data accounting and generalization. The interview method was used in order to find out whether there was a mistake in the map or just deterioration. Data were processed using tools provided by the website www.zis.lt. Statistical data analysis was performed using Microsoft Excel software.

The object of the research - information of land objects depicted in the georeferential base map (GDR10LT) of the chosen territories.

Results and discussion
During the research three areas were chosen for the revision using the field method. The first territory (I) was chosen in Šakiai town and suburbs. It was selected because Šakiai is a compact Lithuanian town, and thus the field research did not require high labour costs. The next area was chosen in Kaunas and its suburbs (II) because it is one of Lithuania's biggest cities with characteristic development. The third territory was chosen in the rural area, i.e. Žasliai cadastral area. Three localities of different situations were chosen: a rural area, a small town and a part of the city. Such a choice of various situations allowed a versatile research which helped to determine the reliability of GDR10LT in both urban and rural areas.
The research was performed in the spring and summer of 2014. The authors present a brief discussion of the main discrepancies between the map and the real situation in each of three areas before summarizing the data.
Settlements dominated in the first research zone (equal to 453.50 hectares) and therefore the major part of discrepancies were new buildings that are not mapped yet and newly formed homesteads. Another considerable part of discrepancies referred to newly dug out ponds that were not included in the map as well. Not a single significant mistake was found because all detected discrepancies showed outdated map information therefore it can be said that the map is reliable and no mistakes were determined.
The size of the second research object is equal to 530.0 hectares. It includes both the area in the city and in the suburbs. This makes the object quite similar to the first one, but it is also expected as the area is located in the city. The change of buildings' density (more buildings are present in this area) is also estimated in this zone. The extent of new buildings has considerably increased; the entire

neighbourhood of new buildings and roads to these areas are not marked in the map. The extent of the change is significantly larger compared to the first area. It is worth mentioning that the mistake of cameral interpretation was found in this territory (Fig. 1).

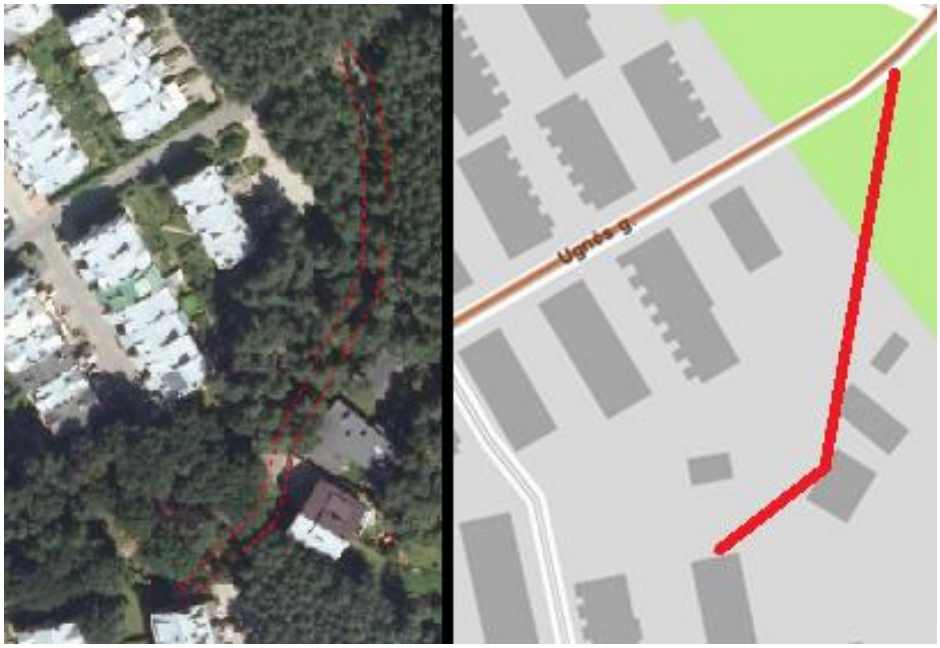

Fig. 1. Unmarked road section in ORT10LT and the approximate location in GDR10LT

A discrepancy found during the research can be considered as a mistake because asphalt road (street) is depicted in the orthographic map of 2012, and the plan of this road was aproved in Kaunas city municipality in 2007. The street is paved in the forested territory and thus it is hardly distinguished in the orthographic map according to interpretation method. This mistake can be considered as significant because the asphalt road is an important element of the terrain. The roads marked in georeferential base are often used for the base of other thematic and special maps, and such a mistake can be automatically repeated in other maps.

The third chosen area (III) is the largest and different from the first two as it is a rural territory with the abundance of agricultural land. It is Žasliai cadastral area in Kaišiadorys district. Minor map discrepancies were found in this area compared to the terrain situation but their amount was the least. It should be emphasized that three communication towers are located in Žasliai cadastre locality. Two of them are present in the northwest part of cadastre; their approximate coordinates are as follows: (1: X 538026, Y 6079502 and 2: X 538023, Y 6079620). The coordinates of the third tower are: X 538958, Y 6079553. All the mentioned towers are seen in the orthographic map; they can be interpreted according to the contrasting colour and shadow falling on the farming land. During the field research it was determined that one tower (X 538958, Y 6079553) was not marked in GDR10LT (Fig. 2).

Fig. 2. Unmarked navigational obstacle in ORT10LT and approximate location in GDR10LT

The communication tower interpreted in the orthographic map is seen on the left side of Fig. 2, while it is not marked in GDR10LT on the right side of the figure. In case of doubt whether it was a mistake in the map or the change of the situation, ORT10LT data was revised and the object was found. In addition, local residents were interviewed and they stated that the tower was built approximately five years ago. Thus this case can be considered as a mistake.
The table of variation of georeferential data was composed after performing the revision of georeferential data of the whole area by field interpretation method and generalizing the received data.

Table 1

Variation of georeferential data

Amount / Land	Plot or amount of objects before the revision			Plot or amount of objects after the revision			The change of plot (ha) or amount (units)		
	I	**II**	**III**	**I**	**II**	**III**	**I**	**II**	**III**
Hydrography (ha)	8.96	3.04	172.35	9.06	3.04	172.35	+0.1	-	-
Swamps (ha)	-	-	26.52	-	-	26.52	-	-	-
Settlements (ha)	327.59	165.62	254.34	329.06	180.04	254.44	+1.47	+14.42	+0.1
Forests, gardens (ha)	11.22	132.03	1180.72	11.22	131.91	1180.74	-	-0.12	+0.02
Meadows, farming and other land (ha)	65.08	176.95	3699.28	63.11	161.75		-1.97	-15.20	-0.17
Roads, streets (ha)	40.50	37. 70	90.79	40.9	38.67	40.55	+0.4	+0.9	+0.05
Unused land (ha)	0.67	14.66	-	0.67	14.66	-	-	-	-
Towers, navigational obstacles (units)	-	3	2	-	3	3	-	-	1
Total plot (ha)	453.50	530.0	5424.0	453.50	530.0	5424.0			

After the statistical analysis of georeferential data of land surface objects, it can be said that the most of discrepancies were determined in marking of settlements, and this discrepancy is the most frequent. According to the field interpretation data 15.77 hectares of additional settlements should be marked. A part of newly paved roads, composing 1.35 hectares, was not marked as well. Territories, where these objects should have been marked, generally are marked as farming land in the map.

The majority of discrepancies are determined in the second area chosen for the investigation, i.e. the part of Kaunas and its suburbs. Although this area of the research is the smallest, many discrepancies were found. It can be concluded that GDR10LT data of big cities and their suburbs should be updated more often because a large part of these objects are already pictured in ORT10LT but are not drawn in GDR10LT. It was determined that a part of objects were not depicted in ORT10LT, and therefore could not be remotely interpreted and drawn in GDR10LT. They create almost 50 percent of all discrepancies.

The smallest amount of discrepancies were estimated in the third area although this territory is the largest. It should be noted that this territory is in the rural locality 5 – 8 km away from the district centre where farming land dominates and the situation has changed insignificantly.

The research findings show that georeferential base data is quite accurate as only two mistakes were found in the plot of 6407.5 hectares. This number is small; in order to avoid such mistakes, the method of ORT10LT data field interpretation should be used but it would greatly increase labour costs.

Conclusions

1. The majority of discrepancies, i.e. 15.99 hectares, were estimated in marking of newly built houses. This discrepancy was found in most cases, and therefore georeferential data in suburbs of the cities should be updated more often.
2. Almost 50 percent of discrepancies are because of outdated ORT10LT data, and the rest – due to not updated GDR10LT information.
3. Two mistakes were found in the map: the street paved in 2007 and an aeronavigational obstacle built in 2010 were not marked. Most likely, these mistakes were made due to the lack of the skills or cameral interpretation of the data.
4. Georeferential base data are quite accurate because only two mistakes were found in the plot of 6407.5 hectares. This number insignificant; in order to avoid such mistakes, the method of ORT10LT data field interpretation should be used but it would greatly increase labour costs.

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