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Quantitative assessment of the scope of content of selected topographic maps of Polish lands from the 19th and the first half of the 20th century*

Abstract. The author presents an overview of the scope of content of selected topographic maps of Polish lands from the 19th and the first half of the 20th century in its quantitative aspect. 19 maps were analysed and a common conceptual model linked to the Database of Topographic Objects (DBTO10k) was developed on the basis of catalogues of object types. Quantitative statistics were also prepared for the object types from maps before and after harmonization. Differences between their numbers within the same maps reflect the conceptual variety of said maps. The number of types of objects (before and after harmonization) was then juxtaposed with selected thematic layers: water network, transport network, land cover, buildings, structures, and equipment, land use complexes, localities and other objects. Such factors as scales, publication dates and topographic services which created analysed maps were also taken into consideration. Additionally, the analysed maps demonstrate uneven levels of generalization. Inclusion of objects typical for large-scale cartography on topographic and general maps is one of the distinctive features.

Keywords: old topographic maps, maps' scope of content, topographic objects, databases, Database of Topographic Objects (DBTO10k)

1. Introduction

Research focusing on old maps has very long and rich tradition. Studies resulting from the work of former cartographers have been analysed in various contexts, the most important of which are: circumstances in which maps were created, their accuracy, scope and ways of depicting geographical content, but also their reception and further fate. The subject of all the above-listed studies was the same, but the objectives differed. Some researchers focused on maps as documents reflecting the contemporary world and the possibilities of its spatial representation (S. Pietkiewicz 1960, M. Stankiewicz 2000, A. Konias 2010, and F.P. Faluszczak 2011). On the other hand, other researchers assessed the maps foremost in terms of their usefulness for further research, mostly in historical geography where old maps still remain one of the main sources of information (W. Iwańczak 2008, B. Konopska et al. 2012, and A. Czerny 2015).

The review of the scope of content of selected topographic maps of Polish lands from the 19th and the first half of the 20th century represents the second of the aforementioned trends, which is only reinforced by the fact that such studies very often include analyses which underlie geographic and historical research. Any analysis of geohistorical landscape of Polish territories involves dealing with many series of maps which were developed by topographic services of the partitioning states, which means that they were prepared on the basis of different instructions, keys to symbols, and methods of content presentation, using different degrees of content generalization and different underlying mathematical foundations. Consequently, any collection of such maps needs to be harmonized and

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integrated, not only in terms of geometry (georeferencing), but also in terms of the maps' conceptual aspects, before it can be used effectively for any analysis (J. Kuna 2014, J. Plit 2014, T. Panecki 2014, 2015).

The main focus of the article is quantitative assessment of the content of 19 old topographical maps of Polish lands developed by topographic services of three various countries, in different years and at different scales. The research consisted in comparing the number of object types included in the maps' keys to symbols, using the object types to develop a common conceptual model, and assessing the scope of content within such model. The common model was based on the contemporary Database of Topographic Objects (DBTO10k). It is a reference database for topographic and thematic maps. Its content has been organised in accordance with three levels of specificity – feature class category (9), feature class (57) and object types (286), and the main criterion used to define the content is physiognomy (*Rozporządzenie…* 2011; R. Olszewski, D. Gotlib 2013).

The model developed for this article allows for comparing the scope of content of old maps at the unified level of generalization, because the object types defined in the keys to symbols have been assigned to the corresponding types of objects from the modern database. Although the maps selected for the analysis largely differ from the DBTO10k standard in terms of their scales, it was not possible to use the Database of General Geographic Objects (DBGGO) in the research, although it was more similar to them in this respect. The DBGGO contains no data concerning buildings and – to a large extent – land use complexes which constituted elements of the content of 1: 300,000 maps.

2. Source materials

The analysis was conducted on the basis of maps from 1800−1939. The beginning of the period corresponds to the breakthrough in topographical cartography and its end is marked with the outbreak of World War II and the end of the work of the interwar Polish Military Geographical Institute (MGI). The set of the analysed maps includes German maps from the World War II period which were direct continuation of works which had been carried out since the end of the 19th century.

The most significant part of the selection process was to make sure that the maps chosen for the analysis are representative. They should be diverse in terms of their scales, elaboration dates and topographic services of countries in which they were created (table 1).

Tab. 1. Criteria used for maps selection

Scales	1:25,000–1:28,800 1:75,000–1:150,000 1:200,000–1:300,000
Date of issue	1800–1870, 1870–1939
Topographic service	Polish, German, Austrian, Russian

Firstly, it is possible to identify a succession of scales of the maps from this period and differentiate between them on the basis of this aspect. Secondly, the analysed period can be divided into two shorter periods, and the maps can be divided into two subgroups, in accordance with their elaboration dates – a group of maps created before 1870 and a group for maps created after that date (which constitutes a symbolic caesura for the modern topographic cartography). Thirdly, four topographic services could be distinguished among the maps' creators.

Ultimately, a matrix was elaborated for twenty-four maps which fulfilled the above-mentioned assumptions (table 2). It was impossible to fill it completely, and the shortcomings result from the unavailability of a sufficient number of map sheets (Russian maps), keys to symbols (Austrian and Russian maps), or simply from the lack of maps that meet the above-listed criteria (Russian and Polish maps).

The selected set of maps included also maps created as a result of plate table surveys: Austrian Second Military Survey, German *Urmesstischblätter* (UMTB), *Messtischblätter* (MTB), as well as a detailed MGI map. At the point of their elaboration, they were most detailed topographic maps available and they were used as the basis for elaboration of smaller-scale maps, such as 1:75,000−1:150,000 maps: the Austrian *Spezialkarte der Osterreichisch-Ungarischen Monarchie*, which is exceptionally rich in content, the German *Karte des Deutchen*

Tab. 2. Matrix of maps fulfilling given criteria. Maps' short names which are used further are given in square brackets

		Austria	Germany	Russia	Poland
1:21,000 – 1:28,800	before 1870	Second Military Survey	Urmesstischblätter [UMTB]	X	X
	after 1870	X	Messtischblätter [MTB]	X	MGI detailed map
1:75,000 – 1:150,000	before 1870	Kummersberg map	Gilly map	Three-verst map	Quatermaster's map
	after 1870	Spezialkarte der Őesterreichisch- -Ungarischen Monarchie	Karte des Deutches Reiches [KdDR]; Karte des westlichen Russlands [KdWR]	Two-verst map	MGI tactical map
1:200,000 – 1:300,000	before 1870	Liesganig map	Reymann map	X	Chrzanowski map
	after 1870	Generalkarte von Mitteleuropa [GKME]	Übersichtskarte von Mitteleuropa [UKvME]	X	MGI operational map

Tab. 3. List of maps

ID	Map name, scale, date of issue	Source of information for topographic feature types
	Austrian maps	
1	Second Military Survey, 1:28,800, 1807–1869	specimen sheet (1834)
2	*Spezialkarte…*, 1:75,000, 1875–1915	specimen sheet (1904)
3	Kummersberg map, 1:115,200, 1855	map sheet (06, 1855)
4	GKME, 1:200,000, 1872–1918	list of symbols (J. Libiński 1912)
5	Liesganig map, 1:288,000, 1824	map sheet (Tab. XIX, 1824)
	German maps	
6	UMTB, 1:25,000, 1820–1876	specimen sheet (1818)
7	MTB, 1:25,000, 1875–1945	map sheet (3661, 1940)
8	KdDR, 1:100,000, 1875–1945	specimen sheet (1887) and map sheet (67, 1944)
9	KdWR, 1:100,000, 1914–1921	specimen sheet (1911)
10	Gilly map, 1:150,000, 1802–1803	map sheet (C1, 1803)
11	Reymann map, 1:200,000, 1806–1908	specimen sheet (1838)
12	UKvME, 1:300,000, 1893–1945	map sheet (R52, 1913 and R50, 1943)
	Russian maps	
13	Two-verst map, 1:84,000, 1883–1935	list of symbols (J. Lewakowski 1920)
14	Three-verst map, 1:126,000, 1846–1918	list of symbols (J. Lewakowski 1920)
	Polish maps	
15	Quatermaster's map, 1:126,000, 1839–1843	map sheet (Kol. II, Sek. VIII, 1839)
16	Chrzanowski map, 1:300,000, 1859	map sheet (05, 1859)
17	MGI detailed map, 1:25,000, 1919–1939	list of symbols (WIG, 1937)
18	MGI tactical map, 1:100,000, 1919–1939	list of symbols (WIG, 1937)
19	MGI operational map, 1:300,000, 1919–1939	list of symbols (WIG, 1937)

Reiches (KdDR) map, Russian verst maps, and the MGI tactical map. An especially unique map of this kind is the German 1:100 000 map of Western Russia (*Karte des westlichen Russlands* − KdWR) which was created using only the Russian map of similar scale as its basis. Some of the older maps of this type include Gilly map of Prussia, the Austrian Kummersberg map and the Topographic Map of the Polish Kingdom developed by Polish topographers – all of them were developed as a result of generalization of precise (for the time) topographic surveys. The analysis covers also topographic-and-general-scale maps, such as Reymann 1:200,000 map which showcases a very rich catalogue of objects (especially economic facilities), an Austrian map of the same scale and German and Polish 1:300,000 maps (table 3).

Map selection was not the only significant factor influencing the study – indication of a reliable list of object types presented on the maps was equally important. Three types of keys to symbols were used: specimen sheets (mainly for German maps), lists of symbols from the inter-war period (Russian maps, *Generalkarte von Mitteleuropa* – GKME, and MGI maps), and map legends on the map sheets (German maps). Two versions of the keys to symbols – an older and a newer version – were used for two maps: KdDR and *Übersichtskarte von Mitteleuropa* (UKvME).

3. Methodology

In the opinion of the author of this article, the variety of the scope of maps' content can be only analysed on the basis of a uniform conceptual model. In such a model, the object types identified on the old maps are assigned to common conceptual categories, which allows for their classification. The common conceptual categories used in this analysis were the DBTO10k object types to which the object types presented on the maps were assigned. The object types from the old maps were identified foremost with those types from the DBTO10k model which corresponded to them conceptually, which allowed for development of a coherent classification of topographic objects shown on old maps.

The starting point of harmonization of the content of the maps was development of the database containing lists of object types specified in the keys to symbols (fig. 1). A symbol representing a given terrain object was usually chosen as the object type. However, there were also some exceptions – in some cases one symbol in a map legend corresponded to two objects (e.g. a symbol indicating "wood with

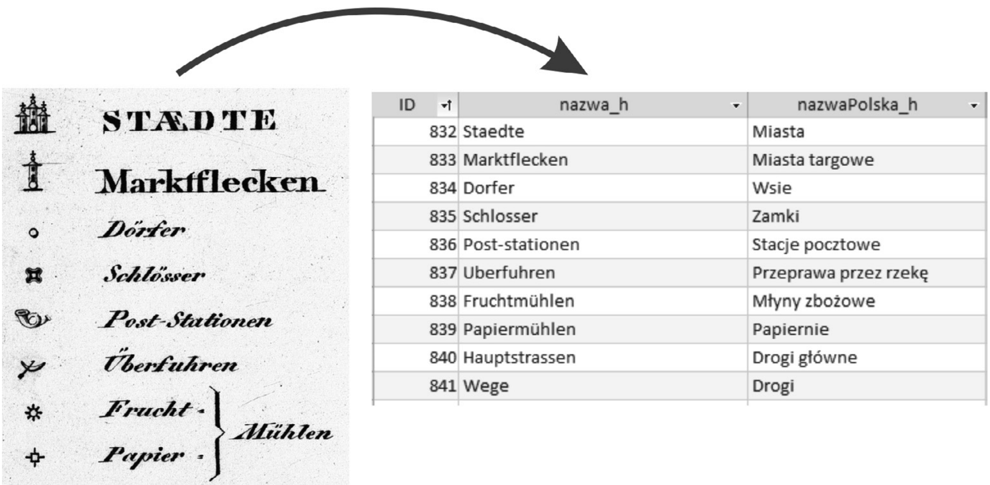

Fig. 1. Key to symbols of the Liesganig map (1:288,000, 1824). While transforming map legend to the database format, names of topographic feature types were considered both in original notation (i.e. German) and Polish translation

clearings" constitutes in fact two different topographic objects) and in others, one object type could be represented twice (e.g. as a symbol of a farmstead and as an explanatory abbreviation in the list of symbols). Symbols which did not constitute topographic objects, e.g. markings indicating the direction of the river or road exits, were also included in the map legends. Different types of topographic objects understood as graphic representations of terrain objects were taken into account when converting keys to symbols into the database (M. Stankiewicz 2005). 2766 object types were recorded in the database on the basis of the analysis of 19 topographic maps.

Three methods of integration of object types from the old maps and DBTO10k were used to develop a common data model:

1. Semantic assignment consisted in searching for equivalents of the types of objects identified on the old maps among the object types distinguished by the DBTO10k. The assigned objects are similar to each other, e.g. in terms of their physiognomy or function, but this does not mean that they are semantically conform.

2. Extending the scope of the content of DBTO10k took place when no significant equivalents of object types from the old maps could be found in the modern database. These were such objects as, for example: gallows, signposts, border stones or wrecks [of ships]. In such cases, the informative scope of the contemporary database was expanded. As DBTO10k has a three-level structure, all object types had to be not only identified within the database as object types (third level of the structure), but also assigned to an appropriate class and class category of objects (respectively: second and third level of classification).

3. The metalegend has a form of a universal classification of object types constituting conceptual generalisation of objects identified on the analysed maps (I. Gołębiowska et al. 2012, T. Panecki 2014). Individual object types are assigned to more general conceptual categories, identified on the basis of a criterion which is as uniform as possible. In this case, the objects were not identified with their equivalents from DBTO10k, but more general types were developed on the basis of both these groups. This approach was used for the road network and localities.

It was then used as a basis for development of a data model for historical topographic objects, based on the DBTO10k structure. Just like the contemporary database, it assumes a three-level hierarchy and a division into: object class categories (9), object classes (43 out of 57 in DBTO10k) and object types (137 out of 286 in DBTO10k). Of these, 26 object types are distinguished only on the old maps and not included in the modern database. They are primarily landmarks and natural objects whose depiction on the maps used to be necessary, whereas nowadays they do not fulfil any significant role in cartography (e.g. gallows, hedges or road signs).

Two types of data were analysed for a quantitative comparison of the content of the maps:

• the number of object types before the harmonization corresponding to the number of object types identified in the maps' keys to symbols,

• the number of object types after harmonization obtained as a result of integration of the content of the old maps into a common data model based on DBTO10k.

The quantitative difference between the number of object types before and after harmonization is important in the analysis. It can be interpreted as differentiation of objects in terms of additional characteristics (attributes). For example, there were 22 types of bridges indicated on the Austrian *Spezialkarte* which were varied in terms of the material used in the bridges' structures, their supports and forms of transportation they were meant to serve. All these 22 object types were classified as one object ("bridge"), with relevant attributes, in a harmonized model.

It can be therefore said that the difference (the decrease of the number of object types after harmonization) reflects the degree of conceptual differentiation of maps, as the "bridge" (as the "primary object") and its attributes are distinguished separately. Considering bridges for one more example – all of their various types (object types in the key to symbols) were the basis of arriving at the "number of object types before the harmonization", while the single object type "bridge" (and similar ones, on the basis of conceptual harmonization from DBTO10k) was the basis for the "number of object types after harmonization".

4. The scope of content of the maps in their quantitative aspect

Further parts of the article focus on the content of the maps analysed in relation to their general quantitative aspects, which takes into consideration also their division into individual object class categories (thematic layers) and the three criteria used for the selection of representative maps: scale and publication date, as well as the topographic service of the state responsible for creation of each map.

4.1. General approach

The above-mentioned values (numbers of object types before and after harmonization) were compared for each analysed map and the percentage decrease was calculated in each case (table 4). On average, the decrease for the entire set of maps amounted to 62.7%. It means that slightly less than a half of the scope of content of old maps consists of so-called basic objects, that is, object types harmonized to a common data model. The remaining part of the scope of their content consist of attributes (in the meaning of contemporary criteria of modelling topographic objects). It can be also stated that the lower the decrease of the number of object types after harmonization, the less detailed the map (in the sense of the differentiation of the same objects in relation to certain characteristics) or the higher the number of homogeneous and internally non-diverse object types in its scope of content.

Tab. 4. Relation between topographic feature types before and after data harmonization. Maps were arranged according to the percentage decrease of feature types after harmonization. Colors correspond to the topographic services developing the maps (green − Austrian, blue − German, red − Russian, orange − Polish)

ID	Number of feature types before harmonization	Number of feature types after harmonization	Percentage decrease of feature types after harmonization	Map name
1	39	27	30.8	UKvME, 1:300,000, 1893−1945 (sheet R52, 1913)
2	29	17	41.4	Chrzanowski map, 1:300,000, 1859
3	119	68	42.9	KdDR, 1:100,000, 1875−1945 (sheet 67, 1944)
4	67	36	46.3	Kummersberg map 1:115,200, 1855
5	151	76	49.7	MTB, 1:25,000, 1875−1945
6	52	26	50.0	Gilly map, 1:150,000, 1802−1803
7	37	18	51.4	Liesganig map, 1:288,000, 1824
8	113	54	52.2	UKvME, 1:300,000, 1893−1945 (sheet R50,1943)
9	38	18	52.6	GKME, 1:200,000, 1872−1918
10	131	62	52.7	KdDR, 1:100,000, 1875−1945 (reference sheet 1887)
11	265	116	56.2	MGI detailed map, 1:25,000, 1919−1939
12	242	105	56.6	MGI tactic map, 1:100,000, 1919−1939
13	117	50	57.3	Two-verst map, 1:84,000, 1883−1935
14	80	34	57.5	Quatermaster’s map, 1:126,000, 1839−1843
15	168	69	58.9	MGI operational map, 1:300,000, 1919−1939
16	124	49	60.5	Reymann map, 1:200,000, 1806−1908
17	130	50	61.5	UMTB, 1:25,000, 1820−1876
18	180	68	62.2	KdWR, 1:100,000, 1914−1921
19	147	52	64.6	Three-verst map, 1:126,000, 1846−1918
20	200	70	65.0	Second Military Survey, 1:28,800, 1807−1869
21	255	84	67.1	Spezialkarte…, 1:75,000, 1875−1915

The first on the list is a German 1:300,000 map whose content has been reduced to the smallest extent (30.8%) after its harmonization to the database form. This means that the map depicted mostly general object types which were at the same time largely consistent with the common data model, and that about ⅓ of the map's scope of content constitutes additional characteristics of the objects. The Austrian maps (scales 1:28,800 and 1:75,000) have the most diverse content – the number of depicted object types decreased for them by about 65%. It is a result of great diversity of buildings (mainly sacral buildings), infrastructures (bridges) and economic facilities (production plants).

4.2. Thematic layers

The quantitative analysis of the scope of content of old maps was also carried out within selected object class categories from DBTO10k: water network, transport network, land cover, structures, buildings and equipment, land use complexes, localities and other objects. The analysis does not include utility infrastructure and protected areas, as such elements of the layers were indicated only on a few maps.

An overview of the number of types of objects of water network, including rivers, canals and drainage ditches, shows that the highest numbers of such object types were indicated on the Austrian maps at the scales of 1:28,800 and 1:75,000, and that they were also showcased there in the most diverse way. There was a 75% and 73.5% drop, respectively, in the number of object types for these two maps, whereas the average for all maps was 37.7% (fig. 2). The Austrian 1:28,800 map has separate symbols for rivers flowing through clay, intermittent rivers and muddy rivers, all of which were classified as "rivers" in the final model. Some of the maps differentiate between rivers and channels, navigable and non-navigable ones, which influences the conceptual diversity. Drainage ditches are also an element of this layer, and they can be divided into dry and wet

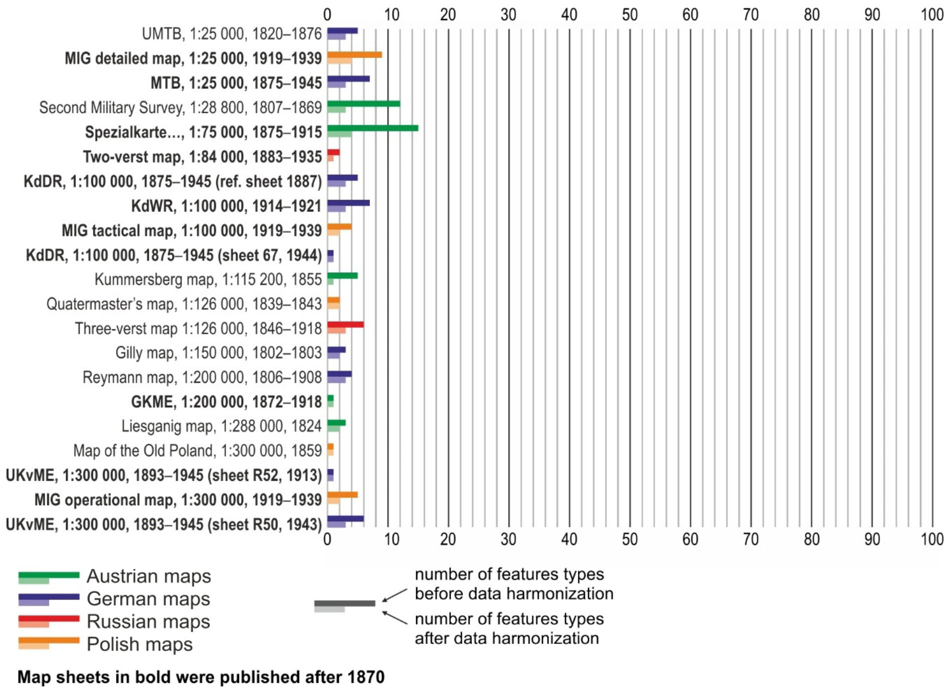

Fig. 2. Number of feature types on different maps' key to symbols among "water network" feature class category (before and after harmonization)

ditches on the basis of many maps. It is worth noting that the modern database does not include such an attribute.

The transport network is the most diverse thematic layer, and the average drop in the number of object types after conceptual harmonization of data is about 66.7%. This is mainly due to the methods of classifying roads on maps and applying different criteria even within one map. Most commonly, distinctions between various roads were made on the basis of their surface material ("chaussee", "gravel", and "fascine" roads, and even "roads made of boards" on the Austrian Second Military Survey map). Other criteria included: function ("utility", "post", "military", "rural", and "connecting" roads), importance ("main", "side", and "local" roads) and condition ("well-maintained" and "unmaintained" roads). This last criterion was often reflected in the graphic design of the symbols (M. Niedźwiecka 2016).

Due to the above-mentioned diversity of road classification criteria, their harmonisation did not consist in assigning types from old maps to the types form a modern classification, but in developing a separate metalegend (based on historical and contemporary road categories). Individual road types were assigned to the specially created 5 relatively general categories: "highway or expressway", "main road", "secondary road", "local road", and "special road". The roads which on the old maps were indicated as "winter roads" were foremost assigned to the last of the above-mentioned categories (T. Panecki 2014).

Other elements of this layer are also very varied. The old maps distinguished between many types of crossings, differentiating between them on the basis of their function (meant to be used by people, horses or carts) and sources of power (ferries with peddles, steam ferries, motorised ferries). There were also numerous paths, also divided into various subgroups, such as paths for pedestrians and riders, as well as "partially disappearing paths" (Austrian *Spezialkarte*).

The number of object types related to the transport network was the greatest in the case of *Spezialkarte*, MGI maps, and KdWR, and smallest on the maps of Chrzanowski, Kummbersberg, and Liesganig, as well as on the Topographic Map of the Polish Kingdom (fig. 3). There is no direct link between the number of object types and the scale of the map, it can be nevertheless stated that cartographers tended to use more diverse classification criteria (especially in relation to roads) after 1870.

Out of all the analysed thematic layers, the land cover was the most homogeneous conceptual category, and the objects belonging to

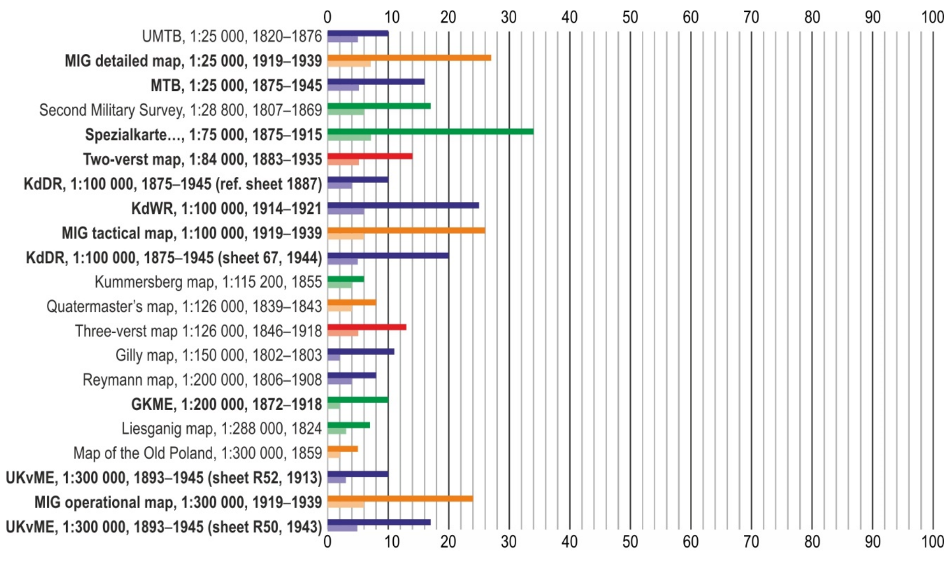

Fig. 3. Number of feature types on different maps' key to symbols among "communication network" feature class category (before and after harmonization)

this layer were usually not distinguished by any additional characteristics. The decrease in the number of object types after harmonization was small and amounted on average to 26.5% The maps with most varied content are the Austrian 1:28,800 map (a drop of 54.8%) and the German maps: UMTB and KdDR (in each case, a decrease by 50%). 5 object types were classified on the Austrian map as the "surface water": among them such elements as "partially drained" and "boggy" ponds. On the other hand, the German maps distinguish between several different types of meadows: wet, dry and overgrown, which also influenced the conceptual diversity of these maps.

The decrease in the number of object types was below 50% in the case of other maps, and in the case of 5 of them, there was no decrease at all – only one object type from BDOT10k was identified for each type of land cover from the old maps (fig. 4). These were 3 Austrian maps (Kummersberg map, Liesganing map and GKME), German maps (Gilly map and UKvME in its older version) and the *Karta Dawnej Polski* (Map of Former Poland). Given the above-mentioned values, it is possible to come to an erroneous conclusion that the symbols indicating the land cover on the old maps had quiet high conceptual homogeneity in relation to contemporary criteria. However, despite similar names used to distinguish individual elements of land cover (in the past and today), we are not able to determine what the concept of forest or built-up area meant in the past and what were the detailed criteria for generalization – if they were even set at all, especially for older maps.

The most numerous group of objects are buildings, structures and installations (fig. 5). The highest number of object types can be found on the MGI 1:25,000 and 1:100,000 maps: (respectively, 97 and 96) and Austrian maps at the scale of 1:75,000 (87) and 1:28,800 (68). The dependence of the number of object types on the scale of the map is clearly visible: the lowest number of object types was distinguished on Liesganig map (4), the Map of Former Poland (6) and UKvME in its older version (8). Most important buildings (from topographic point of view), main churches, and on the German map also mills and windmills, are all depicted on these maps. The MGI operational map depicts as many as 50 objects, but most of them (31) are presented in the key to symbols in the form of explanatory abbreviations. It is difficult to say how many of them were really presented on the map.

Out of all the analysed maps, the Russia three-verst map and the Austrian *Spezialkarte* had the biggest drops in the number of object

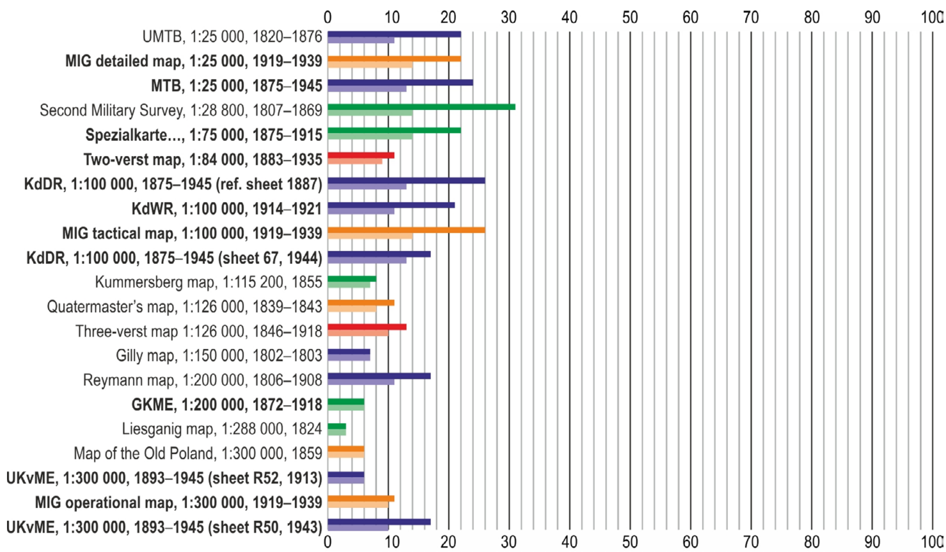

Fig. 4. Number of feature types on different maps' key to symbols among "land cover" feature class category (before and after harmonization)

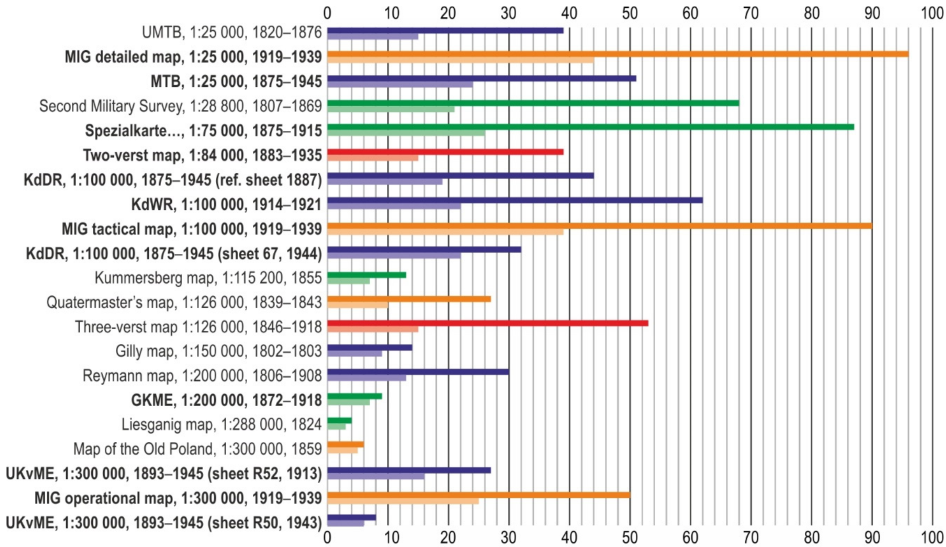

Fig. 5. Number of feature types on different maps' key to symbols among "buildings, structures and installations" feature class category (before and after harmonization)

types (respectively, 71.7% and 70.1%), and therefore also the highest degree of variety. In the case of the Russian map, it is a result of the great variety of building types (most have separate symbols for wooden and brick buildings), whereas in the case of the Austrian map, bridges are the main source of the map's varied character, as the map distinguishes between different types of bridges on the basis of their construction materials (bridge deck and pillars) and the transportation type. There was even a separate symbol for "railway bridges which can be crossed by compact infantry units".

The second, most frequently represented layer is composed of land use complexes and includes objects representing areas which are homogeneous in terms of their functions (fig. 6). The greatest number of them was identified on the MGI maps at the scales of 1:25,000 and 1:100,000 (respectively 49 and 48) as well as on Reymann map (45) and the MGI 1:300,000 map (43). It is a consequence of a rich catalogue of explanatory abbreviations which constitute an element of the maps' keys to symbols. Most of them describe areas constituting land use complexes, foremost economic facilities. There is only one such object identified on the Map of Former Poland (a manor house) and the Austrian GKME (a railway station). The German 1:25,000 map from the first half of the 19th century is definitely most varied (a drop of 82.4%). It is a consequence of the diversity of mines (11 types of extracted raw materials), as well as economic and industrial complexes (13 types).

In contrast to the previously discussed thematic layers, it is difficult to distinguish the types of localities on topographic maps in any unambiguously clear manner. Only a few out of all the analysed maps have a legend for markings distinguishing between various settlement units, and these often turn out to be insufficient, because the same typeface was used to indicate, for example, parts of villages, farmsteads and hamlets. It is possible to attempt to define the fullest possible catalogue of topographic objects which meet the definition of a locality on the basis of the on-line draught and the key to symbols[1]. Not only cities, towns and villages were considered to be localities in the designed model, but also a number of other topographic objects, which may be localities, for example

[1] The following definition was adopted after DBTO10k: "Locality is a settlement unit or other built-up area having different name than other localities, and in case of the same name – belonging to a different type" (*Rozporządzenie…* 2011, p. 12).

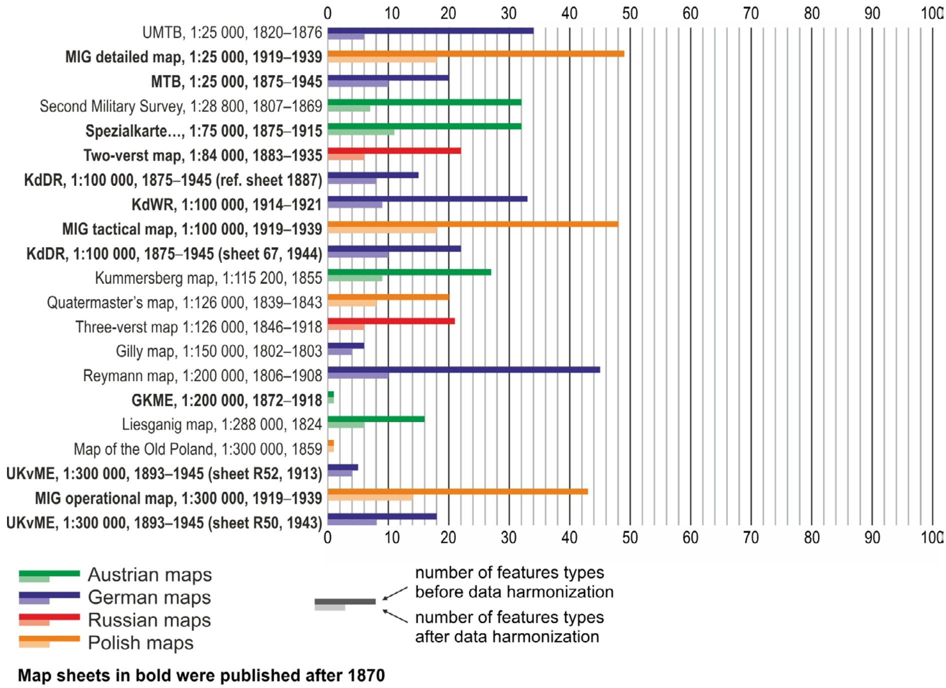

Fig. 6. Number of feature types on different maps' key to symbols among "land use" feature class category (before and after harmonization)

farmsteads, manor houses, mills, taverns or forester's lodges, as long as they meet the definition of a locality, primarily in terms of their spatial and naming distinctiveness.

The conducted study shows that the biggest number of types of localities have been distinguished on the MGI 1:300,000 map and the KdWR 1:100,000 map (20), which is a result of the existence of an extensive system of qualitative symbols (MGI map) and writings (German map) (fig. 7). There was definitely a lower number of types of localities distinguished on the keys to symbols of the maps to which the administrative criterion was applied, dividing the localities into cities, towns and villages (e.g. Gilly map, Liesganig map and the Topographic Map of the Polish Kingdom).

The maps used different criteria for differentiating between the types of localities. For cities, the main criterion was their administrative function – e.g. district cities, poviat cities, as well their population sizes (it first appeared on the Austrian map – *Spezialkarte*). On the other hand, villages were usually divided into villages with churches and villages without churches, which is a consequence of the fact that the topographic maps were meant to be used for military purposes. Qualitative criteria (number of inhabitants, number of houses) were introduced later. Some maps divided villages on the basis of their morphogenetic qualities – compact and dispersed development.

The last analysed layer consisted of "other objects" (fig. 8). It is a rather broad layer, conceptually speaking, which (just as the reference model, DBTO10k) contains objects that are not classified into other categories (including objects related to transportation, landmarks and natural objects). The largest number of objects of this type can be found on the Austrian *Spezialkarte* (46), and the smallest number is distinguished on Gilly map (2) and Chrzanowski map (1). This is the layer which contains the largest number of objects which were not included in the modern database, primarily natural objects and objects significant in their roles as landmarks. Such objects include for example signposts (Russian maps and older German maps) or border stones and milestones (older maps), as well as shipwrecks (MGI maps), light-

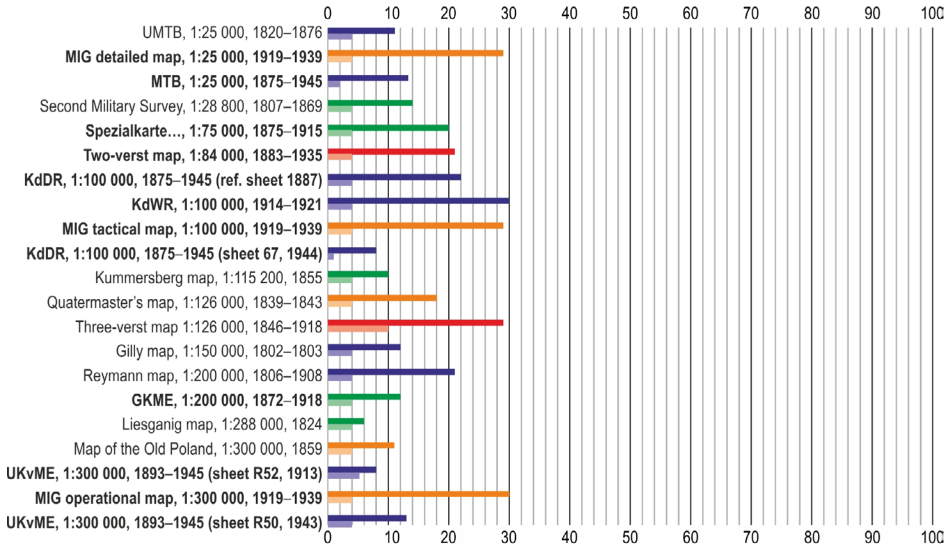

Fig. 7. Number of feature types on different maps' key to symbols among "administrative units" feature class category (before and after harmonization)

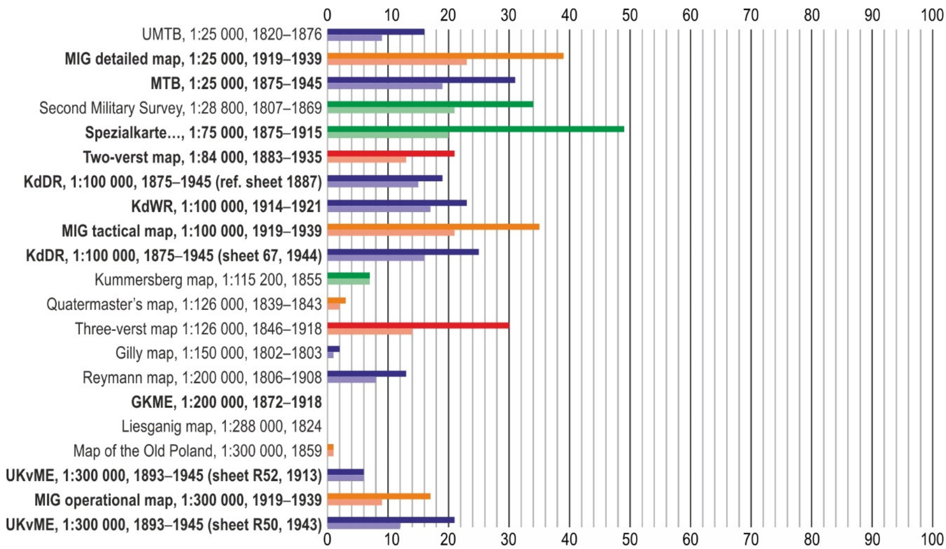

Fig. 8. Number of feature types on different maps' key to symbols among "other features" feature class category (before and after harmonization)

vessels[2] or light buoys (newer German maps). Natural objects included such noteworthy elements as hedges, reefs and underwater rocks as well as rushes and reed beds. All these types of objects were important in the past, as they could limit military activities, hence the need to depict them on maps. Interestingly, the biggest number of object types which are not included in DBTO10k was found on relatively modern, yet detailed maps: the German 1:25,000 map

[2] A ship which performs the function of a lighthouse.

from the end of the 19th century and the MGI 1:25,000 map from the inter-war period.

4.3. Scales, issue dates, creators

The decrease in the number of object types after harmonization was also analysed in a more generalized way, i.e. divided in accordance with the succession of scales, the issue dates of the maps, as well as the maps' contractors (topographical services of individual countries) (table 5).

The smaller the scale, the more conceptually diverse the map, except for the object types related to the transportation network and localities, as roads and settlements constitute a backbone of any topographic map and the degree of variety of this layer is similar regardless of the scale of the map in question. The biggest percentage decrease concerns land cover elements (a decrease of about 49.1% on the maps at scales of 1:25,000−1:28,800 to a drop of about 12.2% on the maps at scales between 1:200,000 and 1:300,000). Generalisation consisted mainly of establishing conceptual links between various types of vegetation and grouping them into more general categories.

The variety in terms of the map producers, that is, the topographic services, is the biggest in the "buildings, structures and installations" category in which Russian maps (a decrease of about 66.6%) differ significantly from other maps (a drop of about 46%), as the key to symbols of the Russian three-verst map contains two variants (wooden and brick) for almost all types of buildings. The transportation network was by far the least varied category, and roads were presented with the same degree of detail on the old topographic maps of all countries.

The maps' elaboration dates have the greatest influence on the number of elements in the transportation network. The newer the map, the more detail the presentation of the road network, which is directly linked to the on-going technological progress. The differences concerning the land use complexes are relatively minor, and mostly concern commercial facilities. Their diversity is greater on maps created before 1870, even though it is the second half of the 19th century that is associated with progressive industrialization.

The analysis of table 5 allows to answer the following question: which of these variables has the most impact on the amount of details and conceptual generalization (decrease in

Tab. 5. Percentage decrease of feature types after harmonization for individual feature class categoies, broken down into different maps in terms of: scale, topographic service and date of issue

Feature class category	Scales			Topographic service				Date of issue	
	1:25,000 – 1:28,800	1:75,000 – 1:150,000	1:200,000 – 1:300,000	Austrian	German	Russian	Polish	before 1870	after 1870
water network	58.0	42.3	24.0	52.3	33.6	50.0	32.0	35.8	41.3
communication network	64.4	65.8	66.1	62.9	66.9	62.9	67.2	55.8	71.6
land cover	49.1	28.0	12.2	18.5	34.9	20.6	23.4	22.6	29.5
buildings, structures and installations	59.5	55.8	32.0	44.6	47.2	66.6	48.1	49.6	49.9
land use	68.5	60.1	40.6	54.5	54.4	72.0	51.6	58.3	53.7
administrative divisions	62.0	89.5	85.0	83.6	74.3	89.0	91.4	83.1	81.8
other	41.2	36.0	24.3	33.3	30.4	48.5	32.2	28.3	37.3
overall	57.5	53.9	40.6	50.0	48.8	58.5	49.4	47.6	52.2

the number of object types) of the analysed layers. For each of the following layers, the most significant variable (or variables) is/are:

• water network – foremost the scale of the map and the topographic service,

• transportation network – elaboration date,

• land cover – scale, to a smaller extent, the topographic service,

• buildings, structures and equipment – scale,

• land use complex – scale and elaboration date,

• administrative division – it is difficult to indicate the variable which determines the level of detail of this category (it varies within individual maps),

• other objects – scale.

5. Conclusions

There is no doubt that the set of maps analysed in this article is very diverse, both in terms of quantity and quality. The old topographic maps differ in terms of the number and types of topographic objects they include, as well as their generalization and classification methods. Of course, the old maps follow some of the general trends known from contemporary general geography – for example the number of object types (and the detail of their representation) decreases with the reduction of the map's scale. However, there are also some tendencies which are characteristic specifically for maps from the 19th and the first half of the 20th century.

The general and topographical scale maps – Reymann map (1:200,000) and Polish and German 1:300,000 maps – are good examples of such characteristics. Their scope of content is less diverse than that of larger-scale maps, but they include some object characteristic for large-scale maps, such as various buildings (churches, mills, taverns), economic facilities (various types of production plants), and even landmarks used for orientation (roadside crosses). These objects cannot be found on contemporary maps of that scale, including DBGGO. The road network is subject to only a minor conceptual generalization as well. Paths are still included even in the keys to symbols of smaller-scale maps, although without the specific distinction between paths "for pedestrians" and "for riders".

Considering the results presented in the article in the context of the period they concern leads to a realisation that said results testify to the emerging concept of a topographical map as a carrier of general geographic information. It would be worthwhile to conduct similar analyses for twentieth-century and contemporary maps to assess whether they are more consistent and homogeneous in terms of their conceptual differentiation.

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