CO-420

NEW APPROACH TO CARTOGRAPHIC PRESENTATION OF GEOREFERENCE DATABASE IN POLAND

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1. INTRODUCTION

The Directive 2007/2/EC resolved on March 14, 2007 , which defines INSPIRE, the European Spatial Data Infrastructure requires that spatial data are commonly created by public institutions of the European Union countries. Every member state is obliged to establish its own legal acts, introducing the assumptions of the INSPIRE Directive. In Poland, the team of experts was established in the beginning of 2009 at the Head Office of Geodesy and Cartography; its task was to prepare the draft Decree of the Minister of the Interior and Administration (MSWiA), concerning the data base of topographic and general geographical objects, and cartographic works. It is to be one of 12 administrative decrees to the Act on spatial information infrastructure of March 4, 2010 – the legal act which implements the INSPIRE Directive resolutions in Poland.

The discussed Decree of the MSWiA specifies the method of creation, updating and distribution of the Georeference Data Base (BDG), which is based on an integrated model of topographic and general geographic data bases. That data base will allow to make general geographic maps in the entire scale series. TOPO10 component is to be the source of data for topographic maps at the scales of: 1:10 000, 1:25 000, 1:50 000 and 1:100 000 for general works, at the scales: 1:250 000, 1:500 000 and 1:1 000 000 TOPO250 component will be used, being a set of generalised spatial data, stored in a unified data structure.

The basic issue related to cartographic presentation of BDG data was to design a coherent system of symbols and the content range, graphical layout and elements of cartographic grids for maps, which would create the complete scale series of topographic and general-and-topographic maps in the history of Polish cartography. The idea concerning the range of content presented on maps, as well as graphical solutions in particular scales was based on traditions of the Polish topographic cartography, first of all on civil topographic maps produced at the scales 1:10 000 and 1:50 000 and general maps, edited from the General Geographical Data Base. However, editing assumptions of new maps also considered contemporary technological achievements of data bases, geographic information systems and map production systems.

Three important practical assumptions have been made. Firstly, the BDG was to be the only data source for all cartographic works, with the exception for the terrain relief elements, which were to be acquired from the Digital Terrain Model. The second important assumption, which influences the selection of content and form of maps was to achieve the complete automation of the possibly maximum number of tasks, performed at the stage of data generalisation and visualisation. The third factor was the intention to adapt the content and layouts of maps to the users' needs and expectations, with consideration of various applications, such as supplying the map services of the official geoportal.

2. STATUS OF TOPOGRAPHIC CARTOGRAPHY IN POLAND

The characteristic feature of the current status of topographic cartography in Poland is the lack of uniformity of maps produced at various scales; this refers to the reference system, division into map sheets, substantial and graphic concepts and the level of updating. It results from many purposes, the most important of which concerned political conditions existing before 1990, and, in particular, subordination of topographic - civil and military – cartography to limitations and restrictions related to the Polish membership in the Military Warsaw Pact. As a result of those limitations, not only military maps, but also civil maps, which were to be used for economic purposes, were not accessible for individual users, they were classified as „secret" and they could be used by authorised institutions and state offices. But, in order to allow for even such level of distribution of civil topographic maps, in the course of producing those civil maps basing on military maps, they had to be transformed from the secret „1942" co-ordinate system to specially developed co-ordinate systems, such as: „1965" (stereographic, secant projection) for maps 125 000 and 1:50 000 and the system 1980 (quasi-stereographic projection) for the maps 1:100 000. Besides, Polish military and derivative civil topographic maps published in the period 1953 – 1990 were made basing on the Soviet instructions for military map production, which were obligatory in all Warsaw Pact member states.

The highest achievement of the Polish, post-war topographic cartography was production of the detailed topographic map of Poland at the scale 1:10 000, and 1:5 000 for selected urban areas (4% of the area of Poland); that map was produced in the period 1957 – 74, both, for civil and military purposes, basing on aerial photographs and field measurements. That map, the majority of which was updated following the 10-year cycle, became the basis for development of military („1942" system) and civil („1965" and „1980" systems) topographic maps at smaller scales.

Changes of the political system in 1989 had important impacts for the further development of topographic cartography in Poland. In 1990 confidentiality of the "1942" system was cancelled and the number of restricted objects and information was highly limited; this allowed for public distribution of the existing civil topographic maps produced in "1965" and "1980" systems to the society. Cancellation of confidentiality of the "1942" system allowed for issuing and distribution of civil versions of military maps at the scales of 1:200 000 (in 1990 – 92) and 1:100 000 (in 1993 – 1999, tourist edition). At the same time, in the first half of the nineties, following the order of the Surveyor General of Poland, a concept of the new generation of topographic maps at the scales of 1:10 000 and 1:50 000 was developed. Ideas concerning those maps based on utilisation of contemporary scientific achievements, considered new, wide possibilities to apply topographic maps, as well as they terminated the uniformity of civil and military map development (Stankiewicz , Głażewski 2000).

According to the discussed concept, 5110 map sheets of the 1:10 000 map were issued by 2003; they covered 31% of Poland (first of all urban areas). Since that time it was substituted by the topographic map at the TBD (Topographic Data Base) standard. By 2009 about 1200 map sheets were issued (2300 data base modules). The topographic map at 1:50 000 scale, made according to the new concept, was issued in the period 1995 – 2002; in total, 589 map sheets were issued (60% of the area of Poland). Both maps used the new co-ordinate system „1992" (Gauss-Krüger projection in a wide, 12° zone for Poland). After discontinuation of publishing the 1:50 000 map in the „1992" system, attempts were made to continue covering Poland with a map at that scale and 134 map sheets in the „WGS-84" system (corresponding to 268 map sheets in the „1992" system) were issued, mainly in co-operation between the Head Office of Geodesy and Cartography and the General Staff of the Polish Army.

As a result of those changes the current coverage of Poland by topographic maps is as follows:

- 1:10 000 scale: 5110 map sheets in „1992" system, up-to-dateness mainly for the nineties; about 1200 map sheets in the TBD standard, up-to-dateness for the years 2002–2009,
- 1:25 000 scale: coverage: 82% of Poland, up-to-dateness: the second half of the seventies and the eighties,
- 1:50 000 scale: 650 map sheets in the „1965" system (coverage: 100% of Poland), up-to-dateness: the seventies; 589 map sheets on „1942" and „1992" systems (coverage: 59% of Poland)), up-to-dateness the nineties; 134 map sheets in the „WGS-84" system (coverage: 25% of Poland), up-to-dateness: the first half of the past decade,
- 1:100 000 scale: 151 map sheets in the „1942" system (tourist edition, coverage: 100% of Poland), up-to-dateness: the second half of the nineties,
- 1:200 000: 76 map sheets in the „1942" system (coverage: 100 % of Poland), up-to-dateness the second half of the eighties.

3. CHARACTERISTCS OF THE GEOREFERENCE DATA BASE

Three reference data bases has been functioning in Poland: the Topographic Data Base (TBD), the VMap Level2 data base and the General Geographic Data Base (BDO) (Gotlib, Iwaniak, Olszewski, 2007). Each of them is characterised by a different scale level (between 1:10 000 and 1:250 000), they are not mutually related, they were developed basing on various data sources, with respect to diversified applications and they were developed in various organisational and technological conditions. Only the TBD may be considered as a product which meets the criteria of separation of spatial data bases and cartographic products (TOPO and NMT components – compliant with the topographic model and KARTO component compliant with the cartographic model). The VMap L2 (first edition) data base, developed in the period 2000–2005, is a hybrid product, without distinct separation of DLM and DCM model features.

Due to military specifics of the VMap L2 data base the most important was to combine two civil, reference data bases, TBD and BDO, although the different conceptual models, up-to-dateness and geometric accuracy of data files. The objective of the authors was to integrate the resources of TBD and BDO data bases, by development of such a data model, which would allow for acquisition of topographic data, as well as generalised spatial data in one, multi-resolution data bases, for the needs of analysis and general applications. Such a model should guarantee:

- A complete description of the terrain at the specified level of details,

- Separation of objects of the continuous land cover, using the physionomic criterion (land cover complexes),

- Identification of land use objects with respect to their functions (land use complexes),

- Simultaneous occurrence of detailed and aggregated classes of objects (e.g. buildings and built-up areas, roadways, roads, etc.) required for appropriate presentation of data of various base scales,

- Recording tables of hierarchic dictionaries, in which utilisation of a particular value depends on the level of details of reference data.

The administrative decree to the act on spatial information infrastructure, which is currently prepared, considers the, so-called, conceptual assumptions. The BDG, developed basing on that decree, will be constructed as the MRDB type data base, consisting of two logical components: TOPO10 and TOPO250 and cartographic components: KARTO10, KARTO25, etc. (fig. 1).

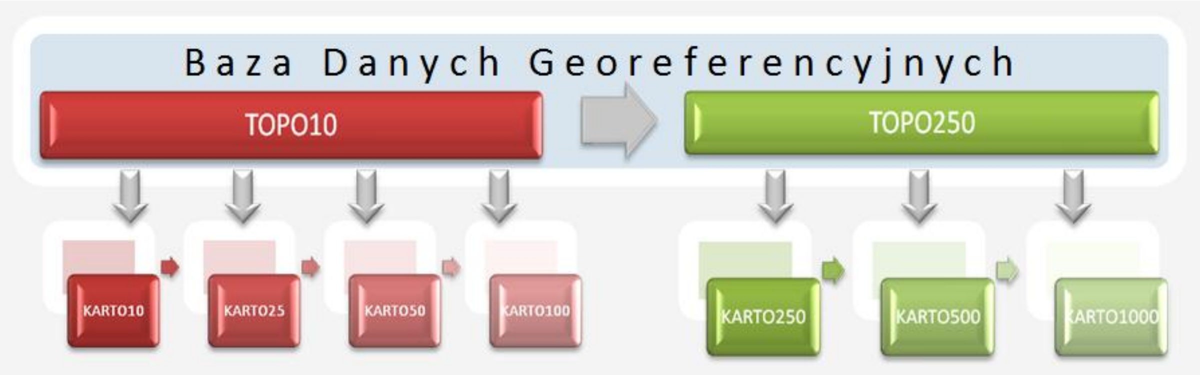

Fig. 1. Components of the Georeference Data Base

The BDG model is generally based on the TBD model, but it has been considerably developed for those classes of objects, which geometric representation, as well as attributes, differ from the topographic model for presentations in general scales. This concerns, in particular, transportation networks; besides axes of carriageways the data bases of such networks must contain axes of roads and road junctions – objects which represent the road network in TOPO250. Other specific case in the topographic data base is point representation of localities. Modification of geometric representation allowed for population of the TOPO250 component with the TOPO10 data. It also enabled to apply the idea of spatial invariants, which, among others, play an important role in data generalisation.

The TOPO10 component of the BDG data base is created basing on vectorisation of a digital orthophotomap, direct surveys, utilisation of large-scale cartographic products (the base map) and data included in other registers maintained by public institutions. It is assumed that data from TOPO10 will be the only source of data for the TOPO250 component, providing that determination of appropriate generalisation processes is of key importance.

As a result of performed investigations the general methodology of automatic population of the TOPO250 component with the TOPO10 data has been specified. A prototype computer system has been developed, which allows for implementation and testing that process. It has been assumed for the purpose of testing, that the existing functionality of GIS software, available on the market (GeoMedia and ArcGIS packages, extended by dedicated, generalisation functions) should be utilised, to the maximum possible level, as a base for developing that system. The final implementation of the system functionality will be directly developed in the Oracle Spatial 10g tool environment. Maintenance of the, so-called, topological model of data, and, first of all, the possibility to maintain topological relations between particular objects in the process of generalisation, was the most important criterion of evaluation of the software usefulness.

4. CONCEPT OF A SCALE SERIES OF TOPOGRAPHIC MAPS IN BDG STANDARD

The following three basic issues should be resolved, first of all, in the process of developing the idea of maps in the BDG standard.

1. Determination of the map content range in particular scales and unification of conceptual models and their correlation for maps at scales 1:10 000 – 1:100 000 with the TOPO10 component, and for maps at scales 1:250 000 – 1:1 000 000 with the TOPO250 component of the BDG.

2. Determination of rules of generalisation of objects for particular categories with the possibly highest utilisation of automation possibilities.

3. Assigning a possibly uniform graphical for to particular symbols on maps of a scale series.

The following factors were considered in the process of selection of the map content elements:

- Functions and methods of map utilisation,

- Graphical capacity specified, first of all, by the map scale, technology of reproduction and methods of its utilisation,

- Conventionally assumed content range of Polish topographic maps, with necessary consideration of new demands and conditions.

Three basic methods of utilisation of maps of the designed scale series may be distinguished: (Grygorenko 1980, Hake 1983, Ostrowski 2008):

1. Wide utilisation of maps, for official and economic purposes, as the basis for making decisions by various offices and institutions,

2. Background and the basic information source (apart from spatial data bases of various types) for thematic map making (e.g. geological, hydrographic maps) and derivative maps (such as city plans, maps of roads, tourist maps),

3. Basis for recognition of geographic space of own country or regions (tourist, didactic, social functions).

Topographic maps produced in large scales (1:10 000, 1:25 000) are made, first of all as presentation of urban areas (all streets may be placed on such maps) and their documenting and reference functions play an important role. Medium-scale maps are mainly used outside urban areas, where topographic maps – besides their reference function – are often used for orientation in the terrain. Functions of general scales maps result from visualisation of various spatial systems for bigger areas.

The above mentioned ideas of civil topographic maps at scales of 1:10 000 and 1:50 000, as well as maps at scales of 1:10 000 in the TBD standard, developed in the nineties, became the important basis for specification of the map content range for the designed series of scales. It was assumed that new maps should refer, to the possible extent, to conceptual models and graphical solutions, applied on those maps. However, on the other hand, it was necessary to introduce a series of significant changes. They resulted from many purposes, the most important of which include:

- New technologies of map making and reproduction,

- Experiences and critical remarks related to utilisation of previously made topographic and general maps,

- Significant extension of possibilities to utilise new graphical solutions, in particular, in with respect to utilisation of colours,

- The necessity to unify the entire scale series, both, with respect to the content and graphical form.

In the proposed scale series of new maps, produced in the BDG standard, the number of presented content categories is gradually, but clearly decreased, following the decrease of scales. While 176 categories are distinguished on a 1:10 000 map, the number of categories distinguished on a 1:1 000 000 scale reaches 46 only, i.e. it is four times smaller (fig. 2). Such reduction of the number of content categories in successive scales results from various generalisation and editing processes, which lead to elimination of certain categories, as well as to generation of new ones (fig. 3). Generation of new categories of objects in smaller scales results, first of all, from substitution of separate symbols with a common symbols (e.g. built-up areas instead of buildings, symbols of localities instead of built-up areas) (W. Ostrowski et. al. 2010).

As it turns out from (fig. 3) reduction of the number of map content categories in successive, smaller scales, occurs almost evenly (only for the map at the scale of 1:1 000 000 it is more radical and reaches about 40 %). However, fig. 3 clearly presents that the highest changes of the map content appear on the map at the scale of 1:250 000 comparing to the 1:100 000 scale map. The highest numbers of new, as well as eliminated content categories occur in this case. This results from the fact that many, relatively small objects, characteristic for topographic maps (buildings, stadiums) are not presented at that scale, and, on the other hand, the highest number of new categories appears on that maps, what is the result of, first of all, the introduction of symbolised marking of localities (diversified by the number of inhabitants) and industrial plants.

All of those operations should have the positive impacts on the usefulness of maps of the new edition.

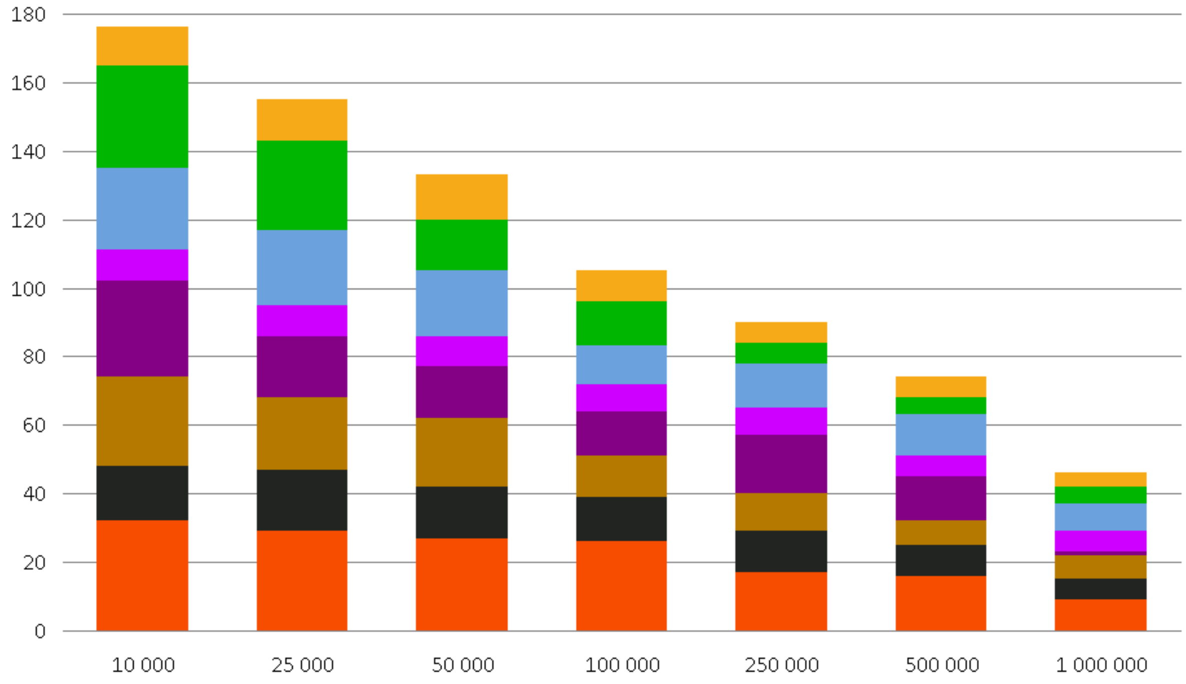

Fig. 2. Number of presented content categories distinguished on maps: terrain relief (yellow), vegetation (green), hydrography (blue), borders (light violet), industry (dark violet),.built-up areas (brown), railways (black), roads (red)

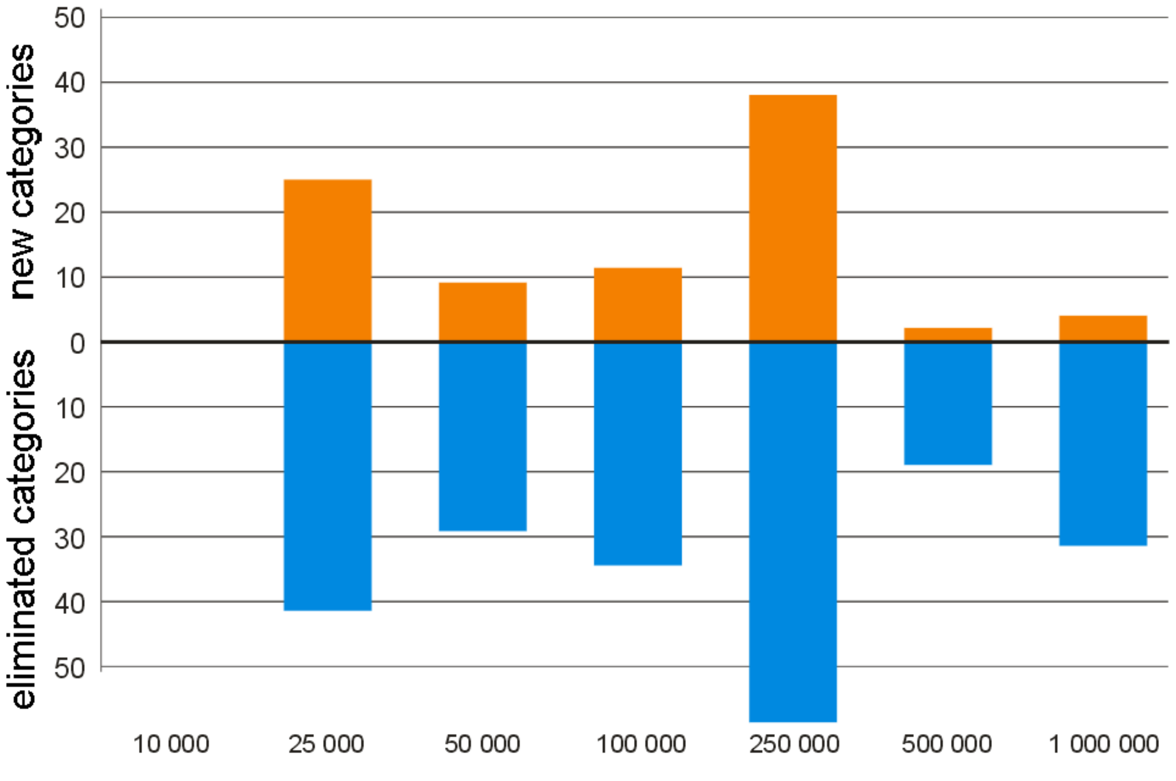

Fig. 3. The number of new and eliminated content categories in successive scales

5. UTILISATION OF THE CARTOGRAPHIC SYMBOLISATION RULE

The rules, which point to directions of correct modelling of cartographic symbols systems, and which are particularly important for topographic maps, include:

- Explicitness and separation of symbols, ensured, among others, by inclusion of all cartographic symbols, used for topographic (and general) maps in the entire scale series, in one, consistent system.

- Associativity and readability, ensured by constructing cartographic symbols with consideration of high geometric precision, subordinated to human perceptual abilities.
- Consistency and graphical arrangement, which cannot be achieved without correct (separated and consistent) classification of separations. (Głażewski, 2004)
- The following rules may help in selection of such values of graphical variables, which will guarantee the visual balance between all details presented on a map:
- Utilisation of sober colours of similar intensities for surface symbols (if this does not result in relation of subordination),
- Enrichment of colour filling of surface symbols with symbol patterns,
- Minimisation of the number of symbols reproduced in black, as well as surfaces filled in black (for large scales – elimination of surfaces filled in black),
- Presentation of edges of (topographic) objects using grey or brown colours, elimination of contours presented in darker colours for many surface symbols.

In the course of graphical forming of symbols, the overriding was assumed, which was also assumed in the map content classification, which concerns division of map content elements into thematic categories, following the canon known from the previous edition of maps. However, the novelty is to subordinate of clear colour distinguishing of symbols to particular categories, i.e. utilisation of hues of leading colours for presentation of those categories:

a) built-up areas – brown (1 in fig. 5)
b) roads - brown (+ colour diversification of inner lines) (1)
c) railways – black (2)
d) hydrography – blue (3)
e) vegetation – green (4)
f) protected areas – green (4)
g) borders – light violet (5)
h) industry – dark violet (6)
i) terrain relief – light brown (7)

Fig. 4. Colour hues of basic categories of elements of topographic and general map (explanations in the text above)

For the designed maps, presentation of built-up areas, settlement networks, roads and borders was highly modernised.

Several generalisation thresholds may be distinguished in classification of built-up areas. The first threshold concerns different approaches between the scales of 1:25 000 and 1:50 000, where, in the case of residential houses, individual buildings are substituted by images of built-up areas of various types and various density. The next and the most radical threshold of generalisation occurs between the maps made at scales of 1:250 000 and 1:500 000. All categories of residential houses, including municipal buildings, are presented by one symbol of residential or commercial-and-service areas. On general maps (from 1:250 000) all localities are presented by symbols diversified by the number of inhabitants and the nature of built-up areas – if the scale permits – are diversified into housing-and-service or industrial-and-storage areas.

Functional diversification of built-up areas was made using variable colours, assuming that housing districts will be filled in light brown and for residential houses various tints of orange will be used.

Municipal buildings (with the exception of the smallest scales, 1:100 000 and 1:250 000) are presented as dark brown. Buildings used for economic purposes are presented in grey, and industrial buildings, as well as other industrial objects, are presented in violet (fig. 5).

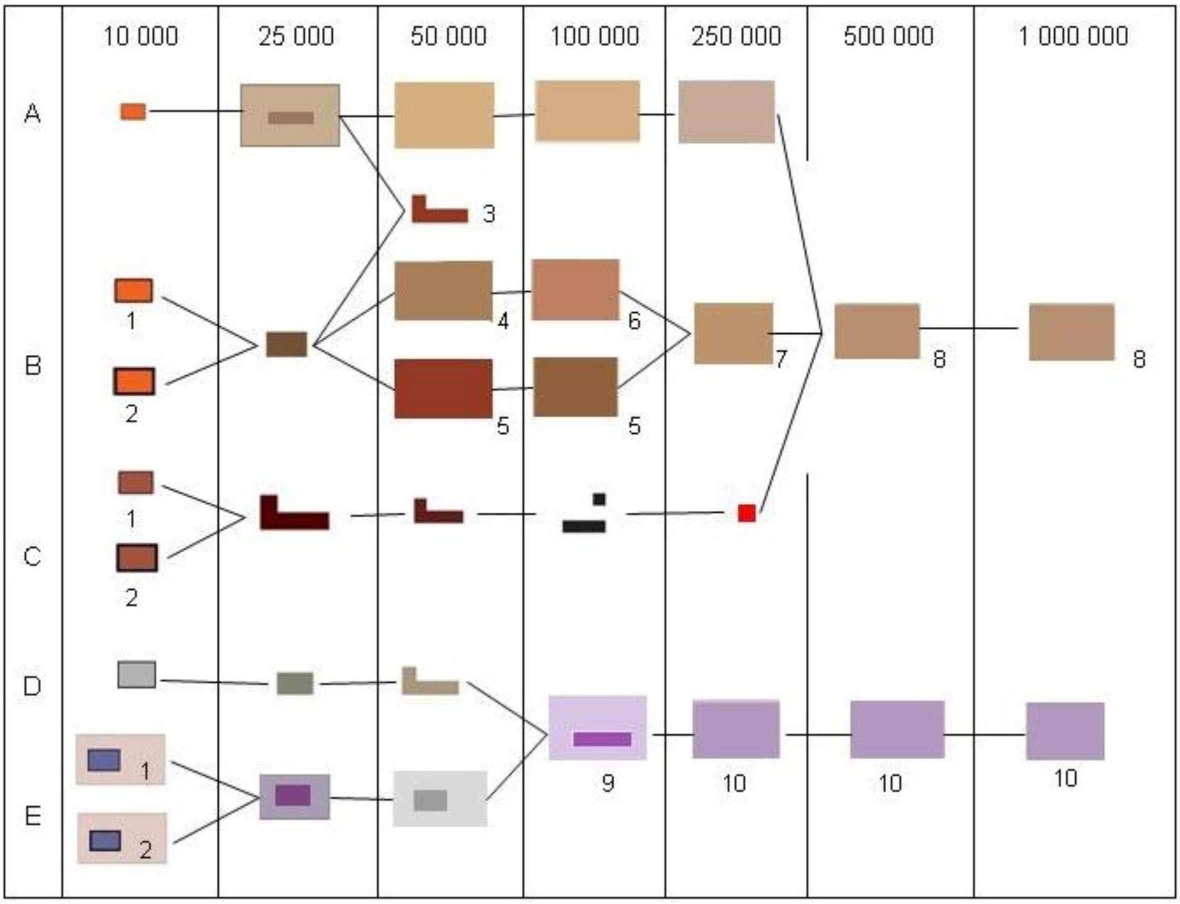

Fig. 5. Proposal of presentation for built-up areas. Distinguished categories: A- single-family buildings and areas; B – multi-family buildings and areas; C – municipal buildings; D – buildings used for economic purposes; E – industrial buildings and areas; 1 – low building, 2 – high building, 3 – residential house (single- or multi-family), 4 – densely built-up areas (multi-family), 5 – compact built-up areas, 6 – dense or scattered built-up areas, 7 – apartment buildings or commercial-and-service areas, 8 – residential or commercial-and-trade areas, 9 – industrial buildings, 10 – industrial-and-storage areas.

In presentation of roads on topographic images, clear separation between roads with hard pavements and remaining roads was made and the basic object classification criterion was changed. The technical attribute ROAD CLASS was assumed instead of previously utilised, inexplicit functional-and-technical separations. The value of that attribute is assigned by the road administrator, but criteria of the road membership in particular class are highly explicit and they consider, first of all, the constructional and technical parameters of roads. Six categories of roads of hard pavements were separated on topographic maps: highways, express ways or roads with higher speed of traffic, main roads, collective roads, local roads, other roads and 3 categories of remaining roads: roads with hardened pavements, local unsurfaced roads, other unsurfaced roads. Two categories of roads for pedestrians were also distinguished: a) parkways, b) footpaths.

Fig. 6. Roads on topographic maps

On general maps the attribute ROAD CLASS was used, as the classification criterion, only for the two highest categories; besides, the principal classification criteria is CATEGORY OF ADMINISTRATION, i.e. specification of the entity, which is the road administration (National, provincial roads).

The presentation of roads, obtained with the use of the above discussed symbols, is consistent and it explicitly distinguishes particular categories of objects, allowing for creation of a consistent presentation of the entire network of roads. (fig. 7)

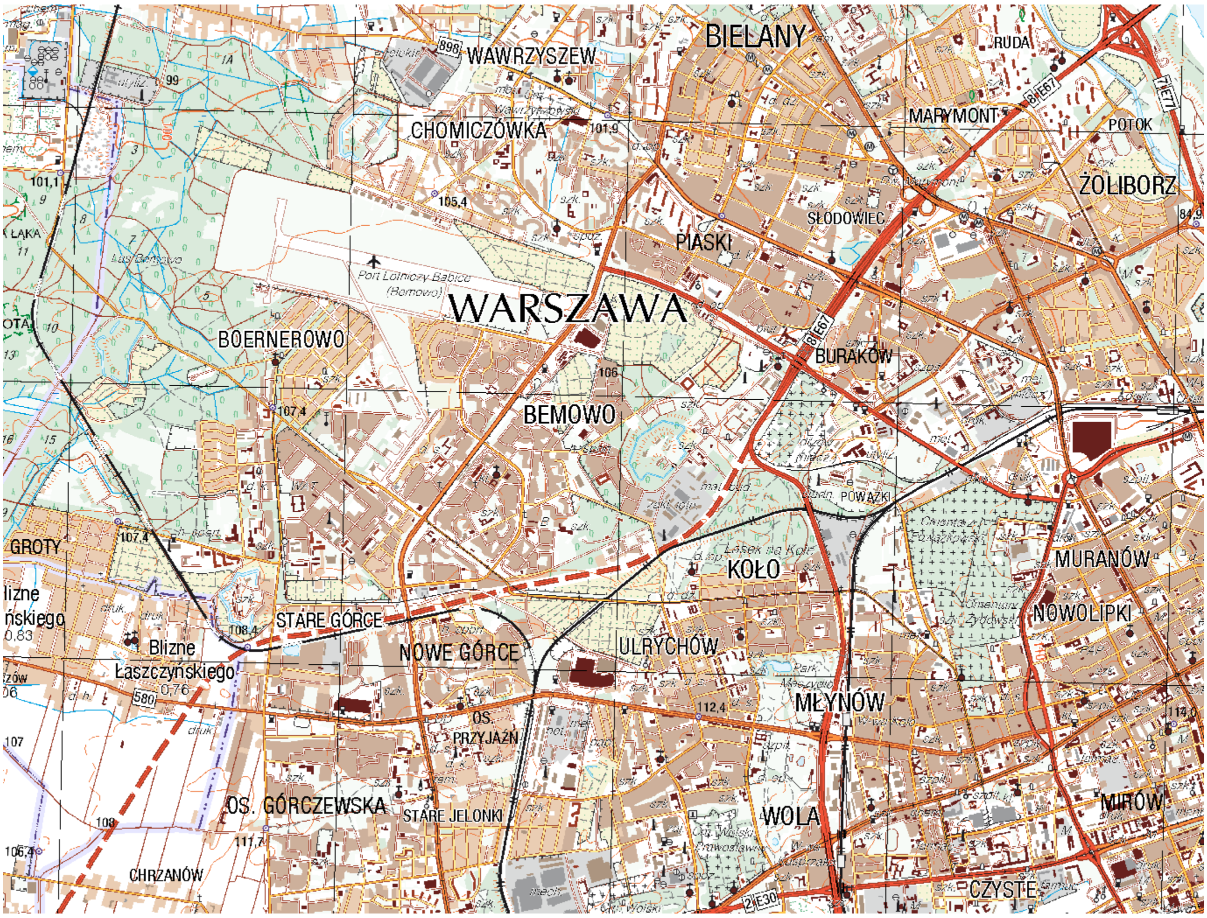

Fig. 7. 1:50 000 topographic map in the new graphical layout (fragment of a map sheet):Borders of landscape parks as well as borders of firing grounds were also introduced. Other important changes include the substitution of a kilometre grid with the geographical grid and elimination of geodetic control points from maps.

6. FINAL REMARKS

In the era of intensive development of the information society, updated and detailed spatial information and geo-information services, which are used for transforming selected data into useful information, have become particularly important. Therefore it is also important that a reference data set, which could be the basis for various analyses and background for derivative works, could be widely accessible for the entire country. Following the resolved legal act on Spatial Data Infrastructure, the multiresolution Georeference Data Base (BDG) will be the basic resource of reference data in Poland.

Benefits resulting from implementation of the multiresolution data base (allowing for storing representation of real geographical objects at various generalisation levels) are significant, and they include:

- Increase of effectiveness of updating the basic TOPO10 resources,
- Possibility to automatically generalise objects at the second level of TOPO250,
- Possibility to perform multi-scale analysis of spatial data,
- Automation of a process of supplying spatial data at topographic and general scales to map production systems,
- Simplification of population of sectoral (customised) spatial data resources and derivative thematic works (environmental, military, planning sectors etc.).

Besides implementation of a system of harmonised spatial data, the essence of modernisation of openly available information also includes modernisation of map products – consistency of presentations for the entire series of scales and adaptation of symbols to various forms of data presentation (e.g. visualisation in Internet services) of not only conventional, paper map sheets. The key changes of symbolisation of Polish topographic and topographic-and-general maps concern built-up areas, settlement networks, roads and borders. Among others, classification criteria of roads were made, using the road class (topographic maps) or the road administration (general maps) as the principal criterion. Basing on functional and physionomic criteria, classification of buildings was enriched and presentation of built-up areas was extended. On general maps all localities are presented by symbols diversified according to the number of inhabitants. Borders of landscape parks and borders of firing grounds were also introduced. Other important changes concern, among others, substitution of kilometre networks with geographic networks, discontinuation of presentation of control points on maps. All those modifications should have their positive impacts on the readability and usefulness of the new map edition. Completion of the first stage of practical testing and publication of test map sheets is planned by the end of this year.

Three basic assumptions, concerning the establishment of the data base structure, automation of technological processes and consistent graphical concept of maps, are influenced by legal, economic and organisational aspects, but the future benefits experienced by each user of spatial information will be the most important. And this will be the final user, who will practically verify the usefulness of presented solutions and the quality of products.

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