

ON THE PROBLEM OF UNIFICATION OF LANGUAGE OF TOPOGRAPHIC MAPS AND
CREATION OF MULTI-PURPOSE GIS

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Abstract. This report is intended to discuss the problem of international unification of topographic maps constituting the data base and the base of knowledge for geographic information systems (GIS). The main attention is paid to the contents of these maps. Theoretical basis and a project of the system and structure of the contents of topographic maps are developed and examined, the modern classifications adopted by the Sciences of the Earth being used.

Historically established, the class of topographic maps is notable for its authentic representation of geographic reality, which is attained by the field measurements and by the integral presentation of the Earth's surface.

In the majority of countries these maps serve as the principal source of versatile time-space information based upon the system of coordinate enabling to position this information geographically. Topographic maps contain remotely sensed data as well as different indices and information concerning natural and socioeconomic objects. These maps assure a reliable base for theoretical generalization, for the detection of relations and interdependencies between the objects and phenomena.

High precision of these maps on the plane and in altitude assure an opportunity for the evaluation of objects and phenomena with the use of numerous indices, and namely, localization (coordinates), dimensions (length, area, volume, height, depth), orientation (exposition, angles of inclination and slope), form (general configuration, extent, sinuosity, curvature), density (thickness, concentration), roughness (general, vertical, horizontal). For different objectives, the studies carried out with the use of maps enable to obtain derivative characteristics, e.g. morphometric ones, percentage of area occupied by forests, arable land or by marshes, an extent of spreading of Karst; to trace diverse profiles taking into account the aim of the studies, the level of necessary minuteness and territorial coverage.

Topographic maps represent a good base for theoretical research at different levels, for revelation of ties and relations between objects and phenomena.

Thus, the topographic maps constitute an universal data base of the Earth. This base is notable for its high precision, very rich contents and multi-purpose character.

In the majority of countries the trends and modern perspectives of the development of cartographic science and production are determined by the creation of geodetic and cartographic funds, by compilation of electronic and digital maps, by the establishment of cadastral and geoinformatic centers.

International cooperation in the domain of exchange of information, in developing global net of GIS, as well as the cooperation between different countries in utilization of maps for economic and ecological objectives, especially at the global and inter-regional levels, become very urgent.

Topographic maps, thanks to their merits already mentioned, constitute the informational kernel of GIS. However, topographic

maps produced now by appropriate services of different countries, can not assure a base for compatibility of different GIS.

The structure and level of development of national cartographic services are quite different; There is a great diversity of national particularities of contents, mathematical base, precision, periodicity of revision and updating of topographic maps. There is no common approach to the use of dimension of ellipsoid representing the Earth, 12 ellipsoids being employed (Krasovsky 1940, Hayford 1909, Clark 1880, 1886, Bessel 1841, et cetera). Many countries have their own coordinate system, different projections being used there. The level of topographic knowledge of the globe is quite region-dependant. The reappraisal of importance of maps of various scales takes place these days. The maps and plans of large scales are becoming more and more important for national economies of developed countries, while for the developing countries the maps of 1:50,000 scale constitute the base for the projects of economic development and for rational use of natural resources. A general trend for the acceleration of pace of cartographic work increases the importance of photomaps containing minimum of hatched elements.

An international unification of topographic maps is not yet sufficiently developed. The attempts in this direction concerning the maps of 1:1,000,000 scale have been undertaken in 1891 (The Fifth Congress of International Geographic Union, Bern) and in 1962 (The UN Technical Conference, Bonn). Nevertheless, the technical conditions for the maps of this scale adopted by these international assemblies, did not enable to assure the desired unification. It could be noted that there are some unified systems of maps in certain countries, which were developed to assure a harmony of national maps. These countries dispose of very advanced technology for cartographic and polygraphic work. IN more general sense such unification embraces the scales and projections and in a less extent the content and design of maps. The most obvious are

the differences in representing following elements on maps: sea and ocean coastlines (different systems of reference), hydrography, contour interval, degree of minuteness and principles of displaying types of vegetation. There is no coordination, nor consistency in representation of similar elements on topographic maps of dry land and on navigational maps, which are often used together for studies of littoral zones. This contrast becomes especially evident when analyzing integrality of contents of maps produced in different countries. One could observe a tendency of impoverishment of contents connected with application of automated methods which are not always capable to assure a desired representation of differentiation of natural areas.

In almost all countries the designation systems used for topographic maps are reduced to systems of conventional signs which were established empirically, supplemented or revised periodically without any scientific substantiation, nor theoretic generalization.

The use topographic maps as an informational base for the development of automated data banks and for that of GIS, requires the elaboration of classifiers of objects to be mapped and forwards a whole series of strict conditions to be satisfied and, namely:

- systematic approach to the representation and description of the totality of objects in the form of classes and subclasses in accordance with their properties and essential attributes;
- inclusion of all the objects known at actual level of knowledge;
- hierarchic order of objects (harmonized organization);
- openness to the expansion of information.

According to these requirements we elaborated general system and structure of contents of topographic maps for their international unification.

An optimization of contents of topographic maps at the international level is supposed to be realized on the basis of

systematic approach, the essence of which consists in examination of phenomena in their integrity, versatility, correlations and evolution. It is also envisaged to coordinate topographic maps of dry land, littoral zones and navigational maps.

The contents of topographic maps is defined as "an integral system, having an hierarchic order and containing the data on objects and phenomena of natural and artificial origin, observed on the Earth, their properties, connections, relations, which are represented with the help of conventional signs in strict conformity with classification of objects to be mapped.

A model of classification of objects of topographic mapping exposed below, consists of two large categories of objects: 1) socioeconomic and 2) natural and natural-anthropogenic (including content of maps of dry land and of water areas).

The first category is composed by classes of following objects¹:

- geodetic nets (order, type);
- international frontiers and administrative boundaries (political and administrative segmentation);
- dwellings, buildings, constructions and their parts (type of settlement, population, political and administrative importance, character and type of buildings, historical and cultural value);
- objects of economics and local landmarks in dwelling zones and outside of them (economics significance, orienting properties, specialization, ecological importance);
- transport, road network, structures on land and in sea (type of transport, roads classes, their covering, technical arrangement, exploitation extent, installations for aerial, land and water transport);

¹ The brackets contain the grounds of classification and grouping of objects inside a class.

- objects of water supply and hydrotechnical facilities (their type, exploitation periods and debit, quality of water, function and type of hydrotechnical installation)

The category of natural and anthropogenic objects consists of following classes:

- hydrography, oceans and seas (types and dimensions of hydrographic objects, their properties, dynamics and water regime, their utilization and protection);
- relief of dry land and that of the shelf, anthropogenic forms being included (their type, genesis, morphology, dynamics indices and morphometric characteristics);
- snow, ice and permafrost formations (their type, genesis, dynamics, morphology);
- vegetation - natural and cultivated (natural forms of vegetation, natural and anthropogenic mutations, agricultural and technical crops, cultures and plantations);
- fauna and flora of grounds (mode of life, indications of species, constancy of residence);
- soil, ground sediments, artificial covering (types of soils, granulometric composition, stability, extent of degradation, practicability);
- swamps, salines (practicability).

In the integral system composed of interconnected elements of content of topographic maps, each class is presented as a system of inferior rang, which is characterized by the multitude of its objects with their own properties, signs, parameters.

Further hierarchic detailing is established inside the classes according to above exposed principles of subdivision and using modern scientific classifications, already existing or developed for topographic maps.

There are also included, proposals concerning contemporary urgent tendencies in improvement of maps' quality. New objects and indices

are proposed as well. For instance, there have been developed a subdivision of content intended for use while solving ecological problems with the help of maps.

Taking into account the importance of cadastral mapping, as well as that of ecological problems, urgency of planning nature-preserving measures with the use of maps, the systematization of content elements was carried out at the details level. The degree of minuteness in representation of objects and their characteristics in by-component classifications, corresponds to maps of large scale(1:5,000). Thanks to strict and logical orderliness of its divisions, a transition from isolated objects and their characteristics to generalized indices, compositions and superior groups, becomes more easy, i.e. generalization for maps of smaller scales.

An example of by-component system (vegetation) is given in the Appendix.

It seems that these days we have all the prerequisites for the realization of the project of international unification of topographic maps on the base of theoretical development and through using computerized technologies. At the first stage it might be reasonable to select the most important scales. The development of unified systems of topographic maps could become a part of national cartographic programs. This may demand an intensification of studies and cooperation between different countries which should be supported by the International Geographic Union and by International Cartographic Association. Unified topographic base of knowledge will serve as a base for compiling international thematic maps, will give an incentive to the development of fundamental sciences and to the elaboration of diverse international projects; and, what is the most important - to the extension of international cooperation in numerous directions of compilation and application of maps.

Appendix

VEGETATION

(Natural, changed and cultivated)

ARBOREAL. *Forests*: leaf-bearing, coniferous and mixed

* Borders: well defined, with edges of a forest, with gradual transition

* Characteristics of forests:

Prevailing and valuable species (up to three per area)

Age (young, mature, over-mature)

Percentage of species and that of species of upper and lower layers

Height, diameter of trunk, distance between the trees

Forestry indices (openings, numeration of quadrants)

* *Native (primary) and slightly changed forests*

(represented by thickening sign and indication of species, above mentioned characteristics being shown)

Non-native forests (secondary)

(characterized by above indices, but its sign and indication of species are not thickened)

Forests disturbed by natural reasons

Wind-fallen wood; burned wood and shoots on it;

* Dead wood; traces of avalanches

Forests disturbed by human activity

Glades, shoots (species and heights indicated)

* Dying forests

Swampy and submerged in zones of storage lakes

Glades on steep slopes (unrecoverable)

Affected by diseases and pollution

Arboreal vegetation in various conditions of existence

Sparse Forests

Crooked forests; dwarf forests

* Creeping woods (coniferous and leaf-bearing, species and heights)

* Saxaul (black and white with drought-resistant shrubs)

* Areas of rare and valuable species (growing naturally)

Narrow belts of forests, separate groves, isolated

trees

Forests on landslips, on Karst sinks

Palm groves, bamboo thickets, mangrove thickets

SHRUBS

Continuous bush thickets, groups, narrow belts of shrubs, isolated shrubs

Characteristics of shrubs: species, heights

Thorny bushes; creeping shrubs

HERBACEOUS VEGETATION, SEMI-SHRUBS, SMALL BUSHES

* Meadows

Hydrophilic (flood-land grass, weeds of lake hollows and marshes)

Alpine grass

Weeds of dry valleys and arid lands

High grass: hydrophilic, steppe weeds (feather-grass, etc)

Reed, cane

Sedge

Steppe grass

Dry steppe and semi-desert vegetation (weeds and semi-bushes)

* Ephemeras

* Halophytes

Small bushes, belts of small bushes

* Vegetation on depressions of relief, non-expressible at the scale of a map (designated by a sign without outline)

MOSSES AND LICHENS

Moss cover - compact and discontinuous

Lichens (Iceland moss, etc)

CULTIVATED VEGETATION

Arable lands used for cultures of crops rotation.

Kitchen-gardens

Arboreta, young forest-plantations.

Park type plantations, lawns

Orchards, vineyards, berry plantations

Rice plantations, plantations of technical crops