PRESENTATION OF GEOGRAPHICAL DATA IN ENVIRONMENTAL INFORMATION SYSTEMS

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ABSTRACT

A model is presented to describe geographic objects in an environmental information system. The model is based on the concept of a categorical thesaurus implemented in a computer reference system.

RAISING THE PROBLEM

Information on environmental disasters currently is presented using a geographic information system (GIS). The so-called "maps of loading" approach came into general use in information systems on pollution, where pollution characteristics are given in different geographical contexts (geophysical, administrative, economical, etc.).

Most GISs are characterized by two types of data: cartographic (or spatial) and attributive. Geographical aspects of a phenomenon, including spatial relations, are presented in a spatial database. An attributive database contains quantitative and qualitative descriptors of geographical objects and their relationships. An attributive database generally does not provide geographical relations; yet, it is an attributive database that is most suitable for presentation of a conceptual model of the subject area, comprising all kinds of relations between objects, including geographical relations.

The presentation of geographical relations of objects becomes urgent for a large attributive database where these relations could comprise conditions for provisional selection of objects. The results of selection can be reflected even through a spatial database.

In this paper, a model is described that presents geographic data in an attributive database related to an environmental information system.

REALIZATION OF THE MODEL

The geographical aspect is one of the basic aspects of information-related environmental activity, since environmental data are usually related to space and time. The subject of the description includes geographical objects (GO) as components of some geoterritorial system (GTS) consisting of GO of different character. The basic type of relation for these systems is a place relation. The GTS is formed from numerous GO (which are homogeneous in a certain sense), if the place relation between them produces a qualitatively new object. For example, an unrelated set of rivers does not generally form a GTS. However, a GTS is formed if a set of rivers connect with each other by a place relation, so that they form a network of rivers flowing into each other and, finally, into a common river, forming a basin of the common river. The place relation here is interpreted as the flow of one river into another. Another example of a GTS, of a different type, is an administrative and political system of the type, "country," with provinces, regions or states being its components. If a set of GO (even homogeneous) does not form an integral unit (e.g., a set of bays of a sea does not comprise a GTS), then itmakes up a geoterritorial complex (GTC). Thus, to comprise a GTS, a set of GO must have a common system-forming property.

The possibilities for an end user in the information system (IS) are determined by the system's thesaurus, i.e., a concept-terminology database. To create a conceptual database (a classifier or thesaurus) for the problem medium (PM), "Geographical Objects and Systems," an approach is proposed based on the idea of a categorical thesaurus. The essence of the approach is that the conceptual model of the specific PM is based on common scientific categories which have their own subject interpretations.

To describe a GO, three groups of categorical facets have been identified: 1) taxonomic, 2) system-related and 3) type-related. The first group includes the following facets: Substrata (Land - L, Ocean - O); Morphology - GEM (Areal -A, Line - L, Point - P); Nature - NTR (Artificial - A, Natural -N). This group yields two classes/taxons: "Natural land lines" (e.g., rivers) — SUB=L, GEM=L, NTR=N and "Artificial land points" (e.g., settlements, observational points) — SUB=L, GEM=P, NTR=A. A taxonomic context makes up an intensional part of the conceptual model of the GO. The second group, the system-related group of facets, comprises an extensional part of the GO model. Six basic classes of GTS are implied here (Figure 1): Global, Continental, Administrative and Political, Sectoral, Production and Economical, and Geophysical. As the Figure shows, the classes of GTS are hierarchical in structure. Each of the GTS in these classes is formed by a set of GO related to one taxon. For example, "country" as a subclass of GTS is formed by the following GO of the taxon: SUB=L, GEM=A, NTR=A. The third group is represented by the type-related category that allows a subject typification of GO in terms of geosystems — rivers, lakes, etc. as natural water bodies of land hydrosystems; settlements, observational points, transport centers as artificial objects of different geosystems, etc. Each of the facets is hierarchical in structure, and this reflects the subject knowledge in the given field. The structure of the facet "Geophysical Systems," for example, represents the structure of knowledge of climatic and vegetation areas, hydrosystems of land and sea, mountainous and other geosystems.

The structure of the facet "Administrative and Political Geosystems" gives a description of the present-day administrative and political division of the countries, etc. Each GO belongs to only one taxon/class. Each GTS is formed by a set of the same class. However, any GO may be described in terms of any GTS of basic classes. For example, meteorological station Dixon (as a type of an observational point on land) can be described in the information system in several contexts: 1) global (Northern Hemisphere/former USSR); 2) continental (Asia/Siberia); 3) administrative (Russian Federation/ Taimyr National District); 4) sectoral (Russian Hydrometeorological Service/Far-East Region/Dixon Hydrometeorological Service); 5) production and economical (East-Siberian Economical Region); 6) geophysical (Arctic tundra). From now on, this object will appear in every query in the information system which has any of the above-mentioned points.

The facet and categorical basis is presented in the computer thesaurus as a database whose elements consist of the following structure: 1) semantic index (SI) determining the position of the given element in the system of categories; 2) term-notion appropriate to the SI; 3) encyclopedic entry (including subject references); 4) coordinates block. The first two elements of the thesaurus are shown in Figure 2 as an example of the base/meteorological station fragment; the last two elements are shown in Figure 3 using, as an example, the Baltic Sea description in the database.

Semantic effectiveness of the computer thesaurus, developed on the categorical basis, is shown by the fact that the conceptual models of different geographical objects can be created from the basic set of conceptual blocks. In technical terms, the effectiveness is shown by the fact that the thesaurus presented can at the same time serve as an off-line computer manual and a source of notion and term databases to be used in different environmental information systems. These databases are easy to include in any information system, comprising (through SI) the whole complex of knowledge of geographical objects contained in the thesaurus. To this end, an external text (ASCII) file, whose structure is similar to that in Figure 2, is selected and produced in the computer thesaurus. The computer thesaurus was developed as an application in RIHMI-WDC of the Russian Hydrometeorological Service (Roshidromet) in the FoxPro 2.0 medium on the PC AT.

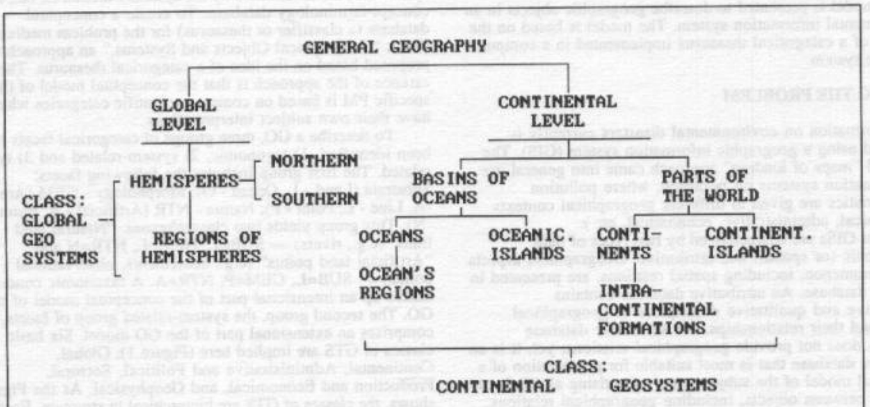

FIGURE 1. HIERARCHIAL STRUCTURES OF TERRITORIAL GEOSYSTEMS

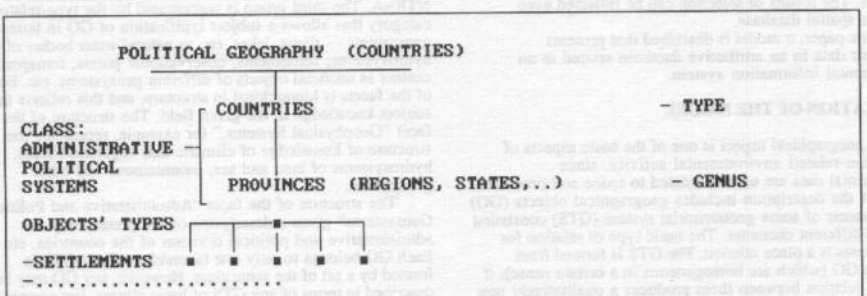

FIGURE 1. (TO BE CONTINUED)

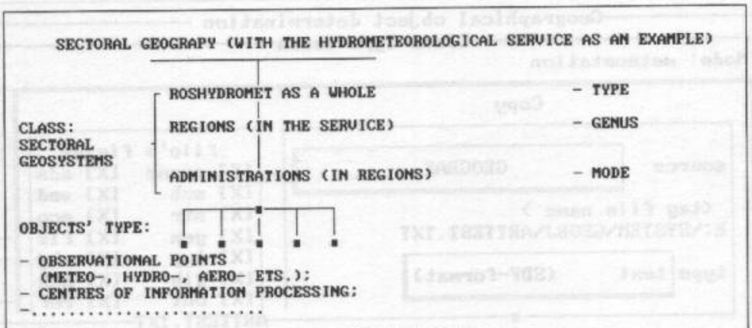

FIGURE 1. (TO BE CONTINUED)

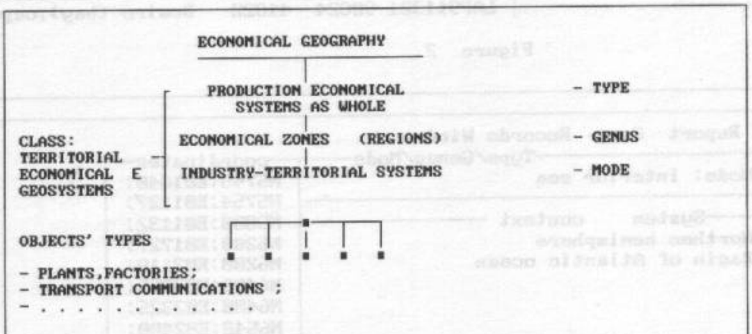

FIGURE 1. (TO BE CONTINUED)

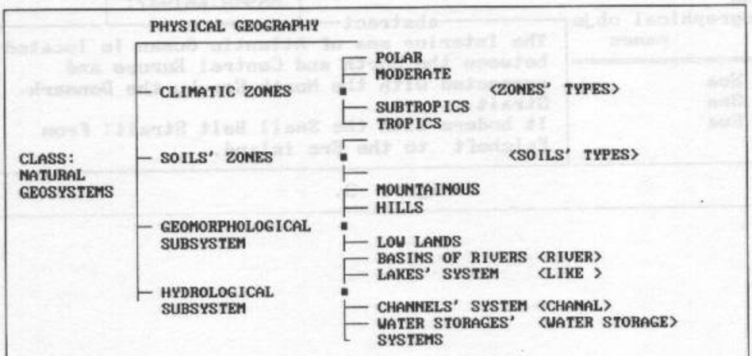

FIGURE 1. (TO BE CONTINUED)

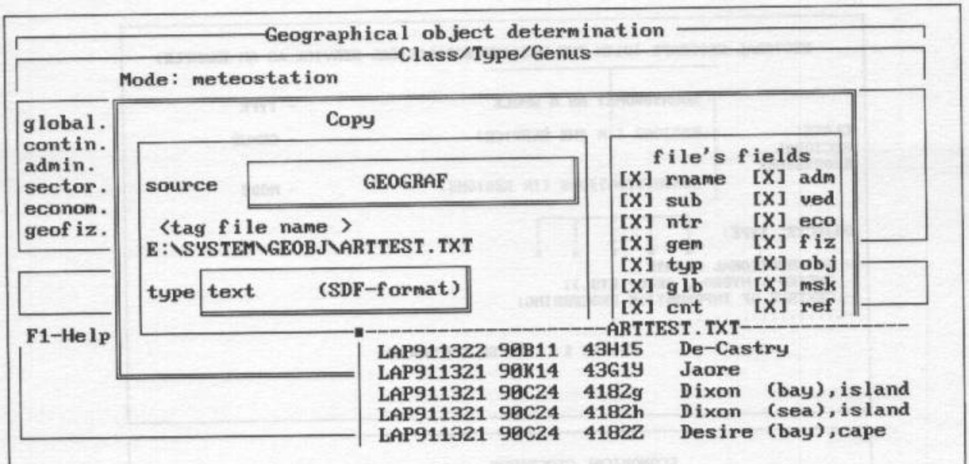

Figure 2.

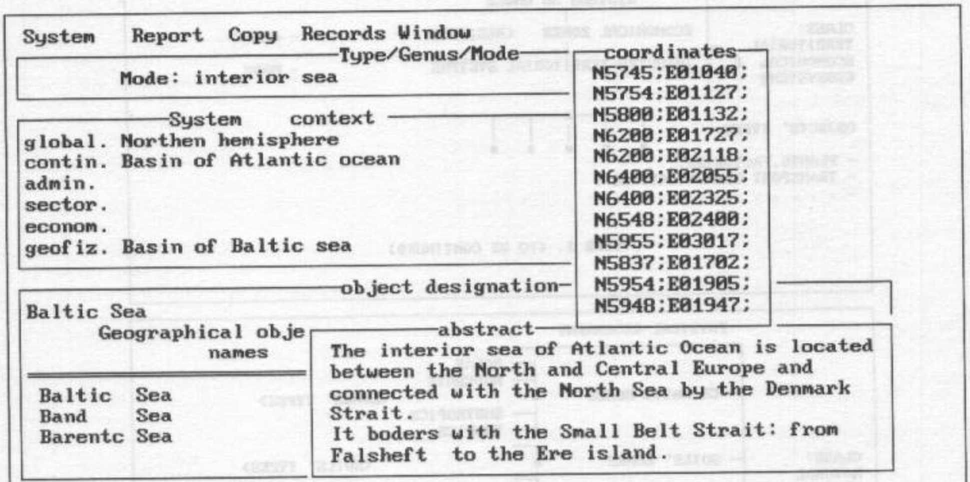

Figure 3.