THE CORINE LAND COVER - HUNGARY PROJECT

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The CORINE (Coordination of Information on the Environment) programme of the Commission of the European Communities has started in 1985 as "an experimental project for gathering, coordinating and ensuring the consistency of information on the state of the environment and natural resources in the Community". The Land Cover project is part of the CORINE programme. Its aim is to provide up to date information on land cover at scale 1:100.000 for the whole Europe. The nomenclature is organised into a three level hierarchy comprising 44 categories on the third level. Classification is done by computer assisted visual interpretation using precisely rectified satellite image hard copies. The project have already been completed for the bulk of EU countries by 1993.

In 1991, it was decided to extend three main CORINE inventories (Biotopes, Corinair and Land Cover) to the Central and Eastern European countries. These projects has started in Hungary and in the five other C&EE countries in 1993, as part of the PHARE Regional Environmental Programme. Project coordination is made by the Central CORINE team of the European Environmental Agency.

In Hungary, FÖMI Remote Sensing Centre is responsible for the implementation of the CORINE Land Cover project, along with the coordination of the Ministry of Environment and Regional Policy. Expected deadline of the project is mid-1995. Ministries and other public organisations will have access to the database free of charge.

In addition to the standard 1:100.000 scale Land Cover data base, derived from Landsat TM imagery for the entire country, more detailed maps (1:50.000) will also be produced for about 25% of Hungary, using SPOT satellite imagery.

The paper will give an overview of the whole project, with special attention to the following questions:

- production of satellite image maps for photointerpretation;
- problems of the land-cover nomenclature at scale 1:100.000;
- extension of the nomenclature to scale 1:50.000;
- methodological problems of photointerpretation;
- geometric and thematic validation;
- utilisation of the end product.

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In the context of multiple representation databases, it is the different conceptual resolution levels that are here referred to, not the scales as discussed in [19]. We thus emphasize the utilization of geodata bases for a variety of applications, not only for those defined beforehand for certain specific scales. The different data representations stored in the database, as well as the representations that can be deduced from existing ones, are included in the concept of multiple representation.

An important issue in multiple representation is the development of multiresolution data structures [7,8] in seeking to achieve effective data maintenance. The term multiresolution databases is also used as an alternative for multiple representation databases.

1.2 Why we need Multiple Representation Databases

The lack of automated methods for generalization as one of the reasons for multiple representation databases has been discussed by several authors [8, 15, 19]. The need for geographical data for various applications results in the need for different kinds of representations, since probably in the near future there will be no capabilities to deduce automatically all the representations needed from only one base level of the geodata base.

The potential of multiple representation databases lies above all in the updating: changes to mappings of the geographical world need only be made at the base level of the database; the other levels can be updated automatically [20,21]. At the same time the multiple representation structure provides a good control mechanism for updating [17] and consistency checking.

The resolution requirements of data collection or display systems have also been mentioned as a possible reason for a multiple representation structure [8, 12, 30]. The complex needs of different user groups require different degrees of resolution for the view of their objects. According to Bruegger and Frank [8], additional topological datastructures are needed for the implementation of multipurpose geographical information systems. To overcome the problems of insufficient topological datastructures, they proposed a formal, dimension-independent approach for building multiple, hierarchically related representations of spatial objects.

One reason for the need for multiple representation is that the concept is very natural from a human point of view. As discussed by Bruegger and Muller in [9] efficient human and machine reasoning involves multiple levels of abstraction in order to address problems in an orderly fashion without getting lost in details: the further away you are, the less you see. The need for maps at different scales and with different thematic contents demonstrates this fact for human reasoning; machine reasoning examples are the quad trees and image pyramids used in digital photogrammetry.

2 Requirements for a multiple representation database

2.1 General

The closing NCGIA report on multiple representations, initiative 3, [3], states that the main areas in multiple representation research requiring further study are a) database issues, especially the need to organize multiple topological and metrical versions for efficient access and the implementation of linkages between multiple representations; and b) generalization issues, such as flexible definitions of resolution for data sets, formalization of digital feature description and categorization models, and rules for map generalization.

In the following, the requirements for a multiple representation database are listed as reported in the literature; for such, the references are given, but also the author's own ideas are included. The requirements for a multiple representation database seem to concentrate on two main areas: data abstraction models and data maintenance problems.

Datamodel and structures

The same object is represented at different levels in the multiple representation database in different degrees of detail [8]. At the base level, spatial objects are available in maximal resolution and detail. Different representations have distinct inherent properties such as positional error [23]. The set of conflicting objects must be defined [1,20, 21] in the multiple representation database. Available spatial operators must be defined. Digital feature description models must accommodate the complexity of compound and hierarchical objects [3]. Specialized data structures are needed for storage of complex objects. Multiresolution data structures should provide rapid access to generalized versions [17].

Object directory

An object directory in which the contents of the database are defined; the presence of stored objects, their application-specific classes and the features of their representations, like dimension, locational accuracy and spatial data model [18].

Interconnected levels

The levels are interconnected by hierarchical relations. Topological relations between the different representations are explicitly modelled in the data structure [8]. This provides a control mechanism for database integrity. Topological relations have to be maintained [19].

Representation levels

Decisions about the levels and their complexity, the resolution levels of application dependent data, are needed [19]. The appropriate level of detail for different purposes has to be selected and a decision made about the generalization operators needed for the modification. Muller [26] calls these the catastrophical changes occuring between the scales.

Indexing mechanisms

Indexing mechanisms of multiple scale representations have to be developed since a multi-scale database may be very large. The concept of a single spatial index and a single list or index of objects becomes rather monolithic, so direct access into an appropriate level should be provided [17].

Decision processing

Software capable of making decisions about updates and retrievals is required as is a mechanism to control the changes to the contents of the database and retrievals from it [17].

User interface

User queries of multiple scale representations have to be developed: a candidate representation for output is selected, or an appropriate representation derived [17].

2.2 Data model for multiple representation databases

By a data model we mean here definition of the following:

- data: objects with their properties and relationships
- integrity rules : consistency must be preserved at each level and between levels
- operators: at one level and between different levels.

3 Updating in the multiple representation databases

Figure 3 shows the different update propagations in a geodata database. In case A, Figure 3, we have an ordinary geodata base with no defined connectivities between levels. The updates have to be made to the base level and to all the generalized versions separately. Each time an update is made it must be repeated for each of the generalized versions. In case B, Figure 3, we have a multiple representation

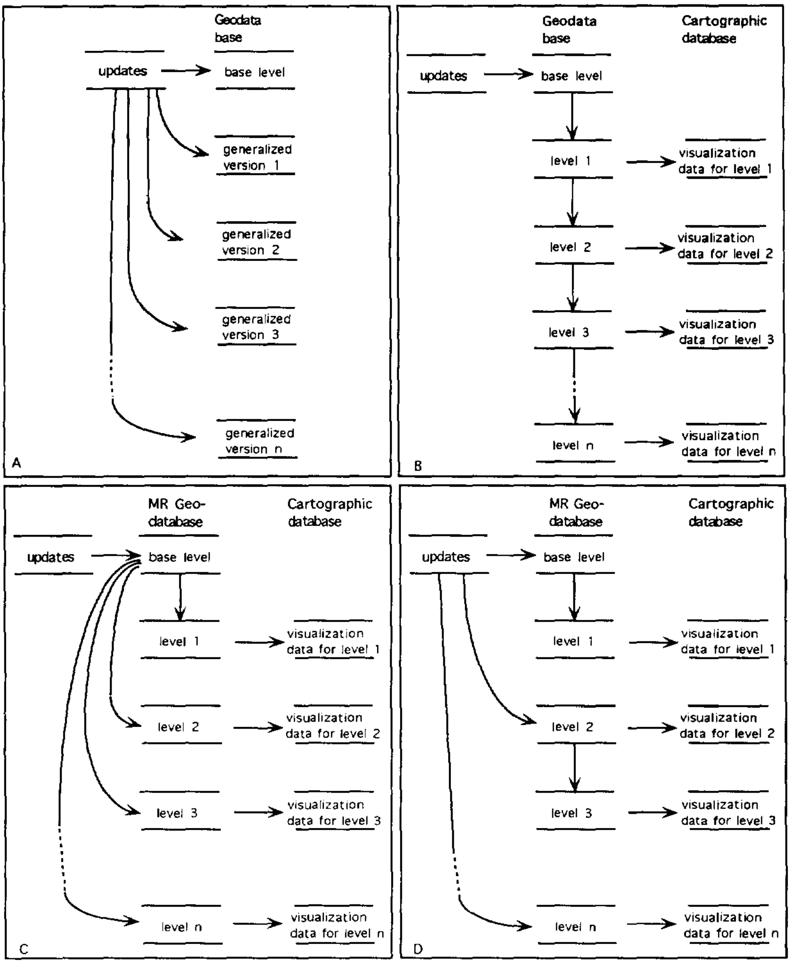

Figure 3. Updating geodata base (A) and (MR) multiple representation database (B,C,D).
→ data flow and ═ data store.

database with defined connectivities between the different representation levels. The database consists of two parts: the model generalization database, and the cartographic database. Updates are made at the base level and then propagated from level to level. In case C, Figure 3, the updates are made to the base level and then deduced from the base level to each of the other levels. In case D, Figure 3, updates are made to the base level. Propagation can partly be deduced from one level to another when there are defined connectivities between the levels. It is not always possible to deduce the representation level from the more detailed levels: these must be updated directly. We emphasize that in cases B, C and D the task of generalization is facilitated by separating the visualization part from the database where the conceptual generalization operators can be used, for example the aggregation operator. The cartographic database in

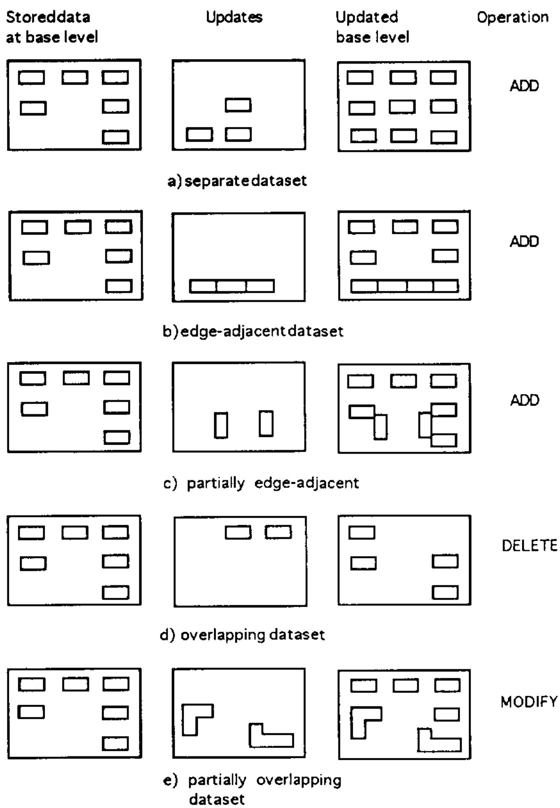

Figure 4. Examples of update situations for incremental generalization.
▭ a building.

4 Conclusions

We have discussed the importance of multiple representation databases, and especially their role in simplification of updating processes. We have demonstrated that the area of multiple representation is a very large one when seen as a whole. To a certain extent, it can already be utilized today, but we are still far from full utilization in a fully automatic environment. There are still a number of important issues to be solved, such as formal definition of the connectivities between the levels. The research done in this subject at Finnish Geodetic Institute has mainly involved studying and defining the basic concepts in multiple representation databases. One important outcome of our work is the concept of incremental generalization. The emphasis of futher research should be on construction of a prototype system.

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