United Nations E/CONF.93/BP.14

Economic and Social Council

Distr.: Limited
19 December 2000

English only

Seventh United Nations Regional Cartographic Conference for the Americas
New York, 22-26 January 2001
Item 7 (c) of the provisional agenda*
Reports on achievements in surveying, mapping and charting in addressing national, subregional, regional and global issues, including applications

Cartographic developments and challenges for dissemination of geospatial data

Submitted by the International Cartographic Association**

The ICA Mission (www.icaci.org)

The mission of the International Cartographic Association is to promote the discipline and profession of cartography in an international context.

ICA is the world authoritative body for cartography, the discipline dealing with the conception, production, dissemination and study of maps. A map is a symbolised image of geographical reality, representing selected features or characteristics, resulting from the creative effort of its author's execution of choices, and is designed for use when spatial relationships are of primary relevance.

* E/CONF.93/1.
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The International Cartographic Association exsits:

- to contribute to the understanding and solution of world-wide problems through the use of cartography in decision-making processes;
- to foster the international dissemination of environmental, economic, social and spatial information through mapping;
- to provide a global forum for discussion of the role and status of cartography;
- to facilitate the transfer of new cartographic technology and knowledge between nations, especially to the developing nations;
- to carry out or to promote multi-national cartographic research in order to solve scientific and applied problems;
- to enhance cartographic education in the broadest sense through publications, seminars and conferences;
- to promote the use of professional and technical standards in cartography.

The Association works with national and international governmental and commercial bodies and with other international scientific societies to achieve these aims.

In the context of dissemination of geospatial data it must be stressed that cartography not only deal with compilation and presentation but also the use of the information.

A Cartographic Approach to Spatial Data Infrastructures

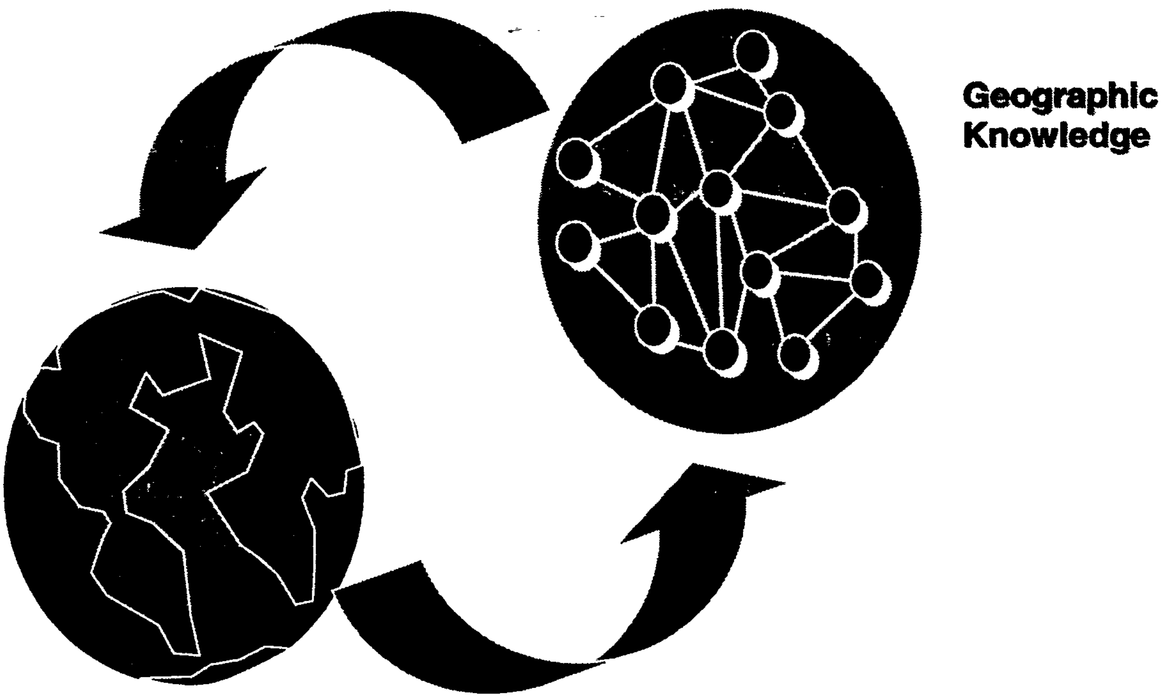
It is often stated that 80% of all data can be tied to a location. In cartography we deal with location of real world objects and of activities in the natural and cultural environment. By considering the whole life cycle of each object together with its usage and user(s) it is easy to realise that the ability to handle location has a great potential, which includes many possibilities to increase the efficiency of the cartographic displays in decision support systems.

General

At the general level we see that geospatial data will be available and used in many kinds of applications. Almost all countries are in the process of establishing a National Spatial Data

Infrastructure as exemplified in other papers to this conference. Furthermore, the infrastructure for telecommunication will facilitate the accessibility not only to office use but also for use in mobile units. The vision by ESRI, the Environmental Systems Research Institute, visualised in the graph below will be a reality in many countries within a few years.

Vision by ESRI



Geographic Knowledge Will Be Available To Anyone, Anywhere, Anytime!

The graph shows the vision by ESRI, Redlands, California, USA (http://www.esri.com).

There is, however, also a great need of standardisation and development of methods to describe the spatial objects we are dealing with. The technical committee number 211 of the International Standardisation Organisation (ISO/TC211) is currently developing standards for geospatial data. Since a general description of all kinds of geographical features is complicated in a talking language it is even more complicated to achieve a description to be understood by a computer. The full standard will comprise a set of sub-standards and in addition be based on other IT standards. According to the latest time-table the first standards will be released during 2001. The importance of the ability to deal with data from different sources with relevance to sustainable development is exemplified as follows (Haagenrud et.al., 2000):

Global

Since the Rio Summit in 1992 when the Agenda 21 was formulated environmental concerns at the global level have been in focus. The today debated but in general acknowledged Green House effect and spectacular weather phenomena like El Nino, severe flooding or draught events in parts of the world have in later years underlined the importance of these issues. GIS based simulation models visualised by animated maps are since long in operation and part of the common set of tools in studies of the effects of such phenomena can be of great importance in exploring the possible consequences of climatic change.

Another area where GIS modelling and simulation plays an increased role is mapping and modelling of air pollution (Haagenrud, 1997). UN Global Environment Monitoring System (GEMS/AIR 1973-1992) is an urban air pollution monitoring and assessment programme, which evolved from a World Health Organisation (WHO) urban air quality monitoring pilot project that started in 1973. Since 1975, WHO and the United Nations Environment Programme (UNEP) have jointly operated the programme as a component of the United Nations systemwide Global Environment Monitoring System (GEMS). GEMS is a component of the UN Earthwatch system.

GIS modelling and simulation is also of paramount importance in the studies and mapping of the long-range transboundary air pollutants (Kucera et.al., 1998).

This subject has been the focus of a UN ECE Convention since a number of years and international research programmes support economic evaluation of air pollution abatement and the resulting effects on corrosion damage to buildings and cultural heritage.

Regional

The building and construction sector is the main consumer of materials, energy and other resources. In the industrialised world building is estimated to answer to some 40% of societies total energy consumption and construction itself produces approximately 40% of all the manmade waste. These facts are today receiving high attention. Techniques and methodologies for reuse and recycling of materials are being developed and there exists good examples, regionally and locally, of growing markets for reuse of materials and products.

Cartographic modelling of the distribution and flow of materials in the built environment is, in this perspective, a good example of a priority area. Seeing the materials in the existing building stock as a presumptive resource for new and re- construction is well in line with the sustainable development approach. A number of studies have been performed, on both smaller and lager scales and on various aspects of spatial distribution of building materials, that can be used as basis for concerted and directed R&D to develop and refine appropriate cartographic modelling techniques.

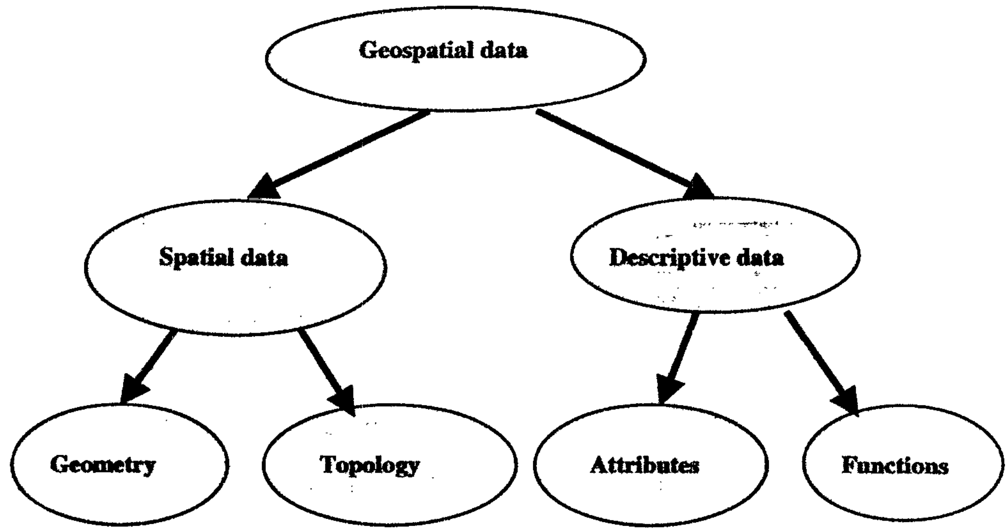
Local

Characterising and controlling the micro-environmental exposure conditions are one of the main challenges for the surveillance and maintenance of our environment To day multi-sampling instruments with automatic data capturing tools are available for temperature, wetness and UV, and passive samplers for gases and particles also exist. Available dispersion models for roads and street canyons can also model the air quality and exposure of buildings. Traffic planners are often in need of practical tools for studying the effect of abatement strategies on air quality in streets where people are exposed. Here again cartography offers powerful tools to visualise the invisible.

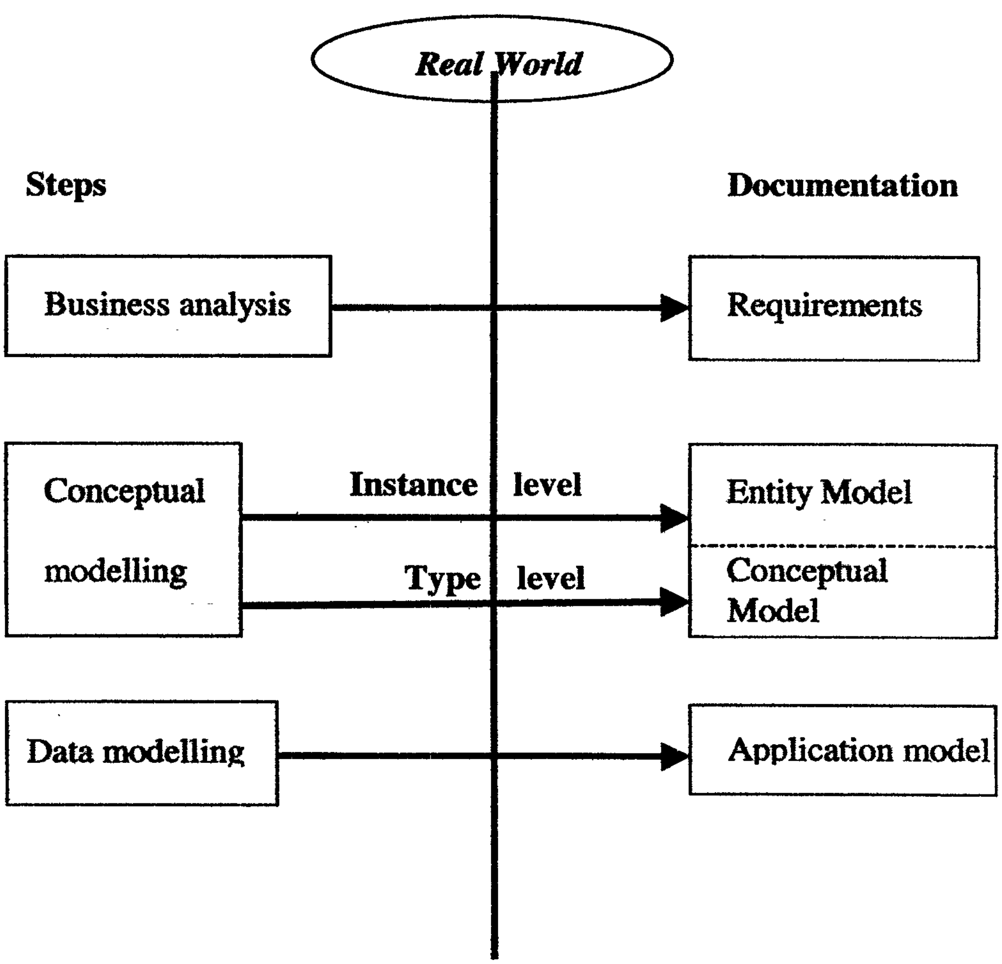
Creating the Geospatial Database

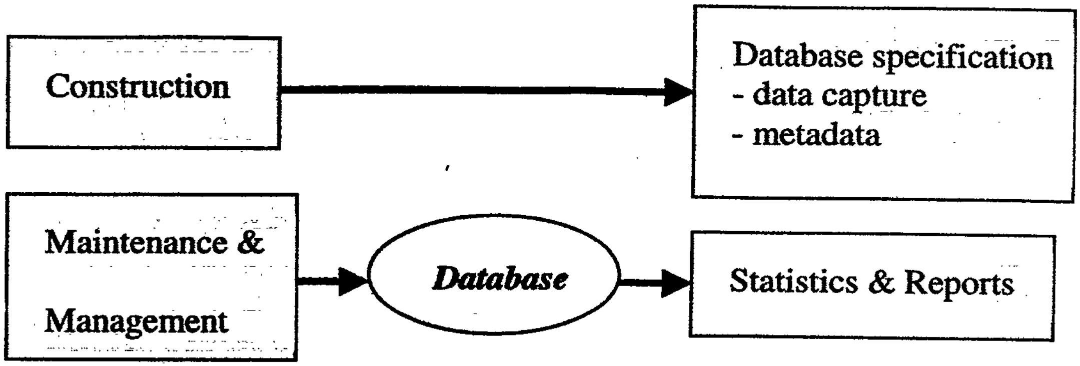
The terminology

Geographic data include *spatial data* and *descriptive data. Spatial data* deal with location and shape (geometry) and relationships (topology) among geographical features. *Descriptive data* or *attribute data* deal with other characteristics of the features than geometry and topology. *Geographic Information* concerns phenomena associated with a location relative to the Earth or knowledge obtained as a result of processing geographic data. Geographic can be replaced by *geospatial* giving the alternatives *geospatial data* and *geospatial information.* Geographers prefer geographic and land surveyors may prefer geospatial.



The figure shows the classification of geospatial data.



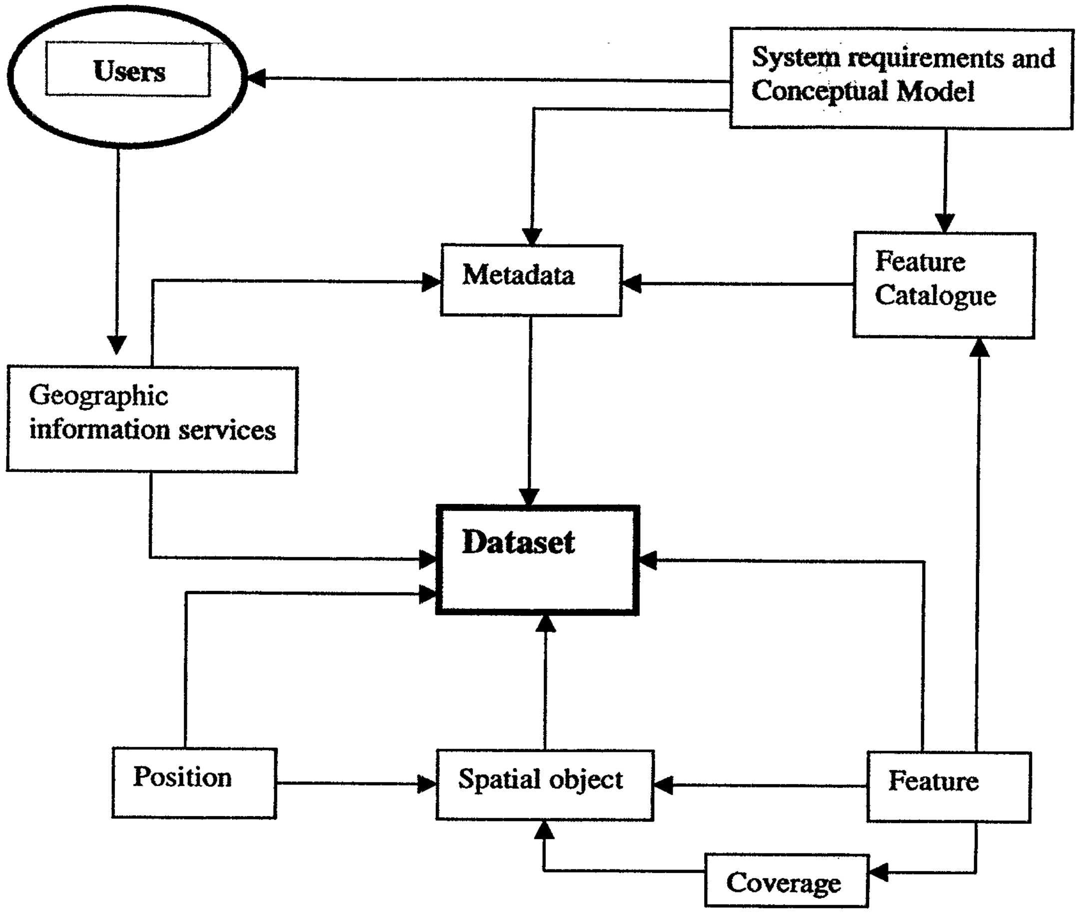


The graph shows the working process for data base construction.

This working process has been developed over a rather long time and origins from Donna Peuguet (1984). Methods for systems development have also been developed during several decades. The innovations in object orientation in combination with methods proven as successful have resulted in the Unified Modelling Language (UML), which now can be considered as a standard for modelling (Booch, Rumbaugh and Jacobson, 1999). The standardisation work conducted by ISO/TC 211 and the Open GIS Consortium (OGC) is now in a final phase for releasing the first standards for geospatial information.

Framework for standardisation of topographic information

This section gives an overview of an approach to standardisation of topographic information in a rather general form that can be adopted to similar applications. It is based on the ISO standardisation of geographic information (ISO 19100, Reference model). It is envisaged that this approach will be compliant with the forthcoming ISO standard. The following diagram shows a possible implementation of the different parts and their relationships:



The contents of this diagram may be described as follows:

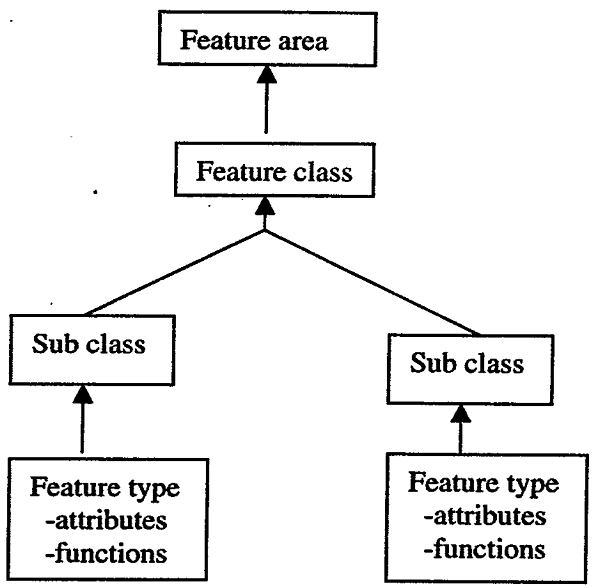
The *dataset* contains instances of the features (spatial objects) described in the feature catalogue, including attributes, relationships, and functions (defined mathematical operations for computing information about feature classes) in accordance with object oriented techniques.

A coverage is a complex data structure that associate values of attributes to individual positions within a defined space or geographic area. A rasterised image and a an elevation model in grid form are examples of coverages.

The *metadata* allows users to search for, evaluate, compare and order geographic data. It describes the contents in the dataset in such way that it is possible for a client to evaluate the fitness for use (quality) of the data. The structure of the *metadata dataset* is standardised by ISO 19100-15.

Geographic information services, comprise a set of software with purpose to correctly perform retrieval operations as well as manipulation operations such as transformation and interpolation.

The *feature catalogue* shall present the abstraction of reality represented in one or more sets of geographic data as a defined classification of phenomena. The feature catalogue gives a collective classification and description of the feature types. In order to get a good structure of the catalogue we organise the feature types into feature classes and feature areas in the following way:



With feature area we understand the part of the universe as it is described in the application schema, which is sub-divided into feature classes. Examples are communication, elevation and waters. A feature class can be divided into subclasses.

The Topographic Base Map Feature Catalogue

Feature Classes and Feature Types

The feature classes and feature types for a digital topographic base map might be:

Administrative boundaries

Sub classes are administrative boundaries and natural reserves. Administrative boundary feature types are national boundaries, provincial boundaries, district boundaries, urban district boundaries, local government areas and perhaps also tribal land. Natural reserves feature types are forest boundaries, national parks, game management areas.

Infrastructure

Sub classes are roads, railways, power lines, pipe lines and telecom. The feature types are segments, nodes (crossings), road signs etc.

Settlements

Sub classes are urban settlements and rural settlements.

Land use

Sub classes are cultivation and plantation, forest and natural vegetation.

Hydrology

Sub classes are lakes, rivers, dams, wetlands and springs.

Relief

Sub classes are contour lines, spot heights and geodetic points.

Geographical names

Sub classes in accordance with the above feature classes.

Conclusions

Geospatial data will play an important role in many different applications in the future. Many users will have problems to integrate data from different sources. Data providers, like National Mapping Organisations, have to adopt standards and well proven techniques to build and provide data to the users. This paper has shown that there is a machinery available.

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