MANAGEMENT INFORMATION SYSTEMS: EMERGING TOOLS FOR INTEGRATED FOREST PLANNING

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Abstract

Reliable information is necessary for effective management planning. To some extent a data base management system (DBMS) often provides the underlying structure of a management information system (MIS). Many computerized systems can be grouped under the MIS umbrella. This is the case of GIS (geographic information system) that is optimized to store, retrieve and update geographic information. Such developing technologies that are being used more and more for the planning, monitoring and evaluation of management activities at different levels must take into account requirements of the forest managers and technical implications.

In this paper terminology and theoretical concepts are reviewed and discussed.

An example of a regional plot-based forest inventory integrated in a GIS is also briefly presented.

Introduction

Nowdays a lot of forest managers are concerned with electronic data processing. The usefulness of a management information system is already well known and is becoming an increasing part of forest management activities. The widespread application of this technology is due to the decreasing cost of computer systems and to improved softwares.

In our opinion, emerging new technologies such as MIS (management information system) or GIS (geographic information system) remain concepts which are not always sufficiently defined before being used. They must be regarded more as a tool than as a "solution" for the manager. It is really surprising to hear more and more people speaking about GIS as a must for their activities without really knowing how to proceed.

Forest inventory and forest management activities are among the best designed fields for applying the MIS concept. Any forest survey makes use of a great volume of detailed and up-

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to-date information that requires data base management as well as spatially referenced data (CLINCH, 1989; SHEFFIELD and ROYER, 1989).

Management information system : what does it mean?

Due to the obvious confusion over the various existing concepts there is no general agreement on what is really meant by a management information system (KEMPF and LOUIS, 1988). However it can be considered as a fully integrated and organization-wide computerized system that provides vital information for strategic planning and decision-making. However a more pragmatic concept deals with an assembly of subsystems each meeting specific management information needs (SHRADER, 1979). In pratice, such an approach is more successfully achieved.

A data base management system (DBMS) that operates with a data base often constitutes a component or the elementary structure of an MIS when it satisfies the main following objectives :

- to provide information support for decision-making and planning activities at top management level (useful for a forest service);
- to provide information support for all levels of management, in planning and management control (useful for a forester);
- to deliver information in a required time frame (when the manager needs it).

The principal implications of such objectives are based on the ability to :

- include selective retrieval, updating and computations;
- incorporate complex data analyses, simulations and optimizations;
- store, process and maintain a great quantity of data;
- operate in an automated and interactive mode;
- provide ready access to the data necessary to develop models;
- present data outputs in one or more formats (e.g. : tabulations, video displays, computer maps).

The main expected benefits can be summarized as follows :

- development of minimum data sets (collection of variables able to provide an answer to a question either directly or indirectly) and standardized procedures,
- establishment of uniform standards for measurements,
- coordination of research to save both time and energy,
- efficiency of exchange and transfer of research information.

An information system must begin by defining the necessary and sufficient conditions for the data (ROSE, 1989). Some important needs are to :

- define completely and concisely the information required,
- identify what and how to measure to provide this,
- identify the accuracy required,
- ensure suitable computer support (hardware, software),
- make full use of existing and checked information.

Geographic information system: what does it mean?

In forestry, the geographic information system (GIS) is assuming a more and more important role. However this computerized system must not be seen as simply an expensive cartographic tool. It should rather be considered as an MIS with a geographical level because it is optimized to store, retrieve and update spatial information for specific purposes. It can also process this information in a format suited to user's application and should contain an up-to-date model of the user's area. The system can integrate various types of geographic data and maps which are of great interest for the forest managers in order to obtain information such as : kind of species occurring on such or such a type of soil, identification of optimum extraction routes through the comparison of topographic and inventory data, delineation of zones of equal productivity.

Such a system is far more than an image analysis system (IAS), the objective of which is to provide a satellite classification map. For several image analysis systems, GIS functions have been added to the software in order to alter and combine images in a geographic way but such functions don't necessarily optimize the system and so it should be referred to more accurately as geographic analysis system (GAS).

Above all the basic concept of a GIS is to maintain a set of spatially registered data layers stored in either raster or vector mode.

In the case of a GIS the following general requirements should be satisfied :

- ability to handle multilayered, heterogeneous data bases of spatially-indexed data,
- ability to query the data bases about the location and properties of a range of spatial objects,
- efficiency in managing such queries in an interactive mode,
- ability not only to retrieve but also to create new information,
- flexibility in configuring the system in order to accommodate a variety of specific applications.

GIS is sometimes perceived by many as the answer to all questions related to geographical analysis. More often GIS are adopted and used with little attention paid to the differences between real GIS approaches and traditional methods :

- failure to appreciate the different structures of time and cost scheduling associated with GIS,
- skill of users,
- lack of quality data (out-dated and inaccurate source maps, poor quality drawings, ...),
- disparity between input effort and sufficient output.

Anyway it is always preferable to begin with a small limited but functioning GIS than a large one which never works !

Figure 1 deals with the general concept of an MIS and linkages between constitutive elements.

Trends in application of GIS

Since production of GIS has become available, applications are growing rapidly (CRAIN, 1989).

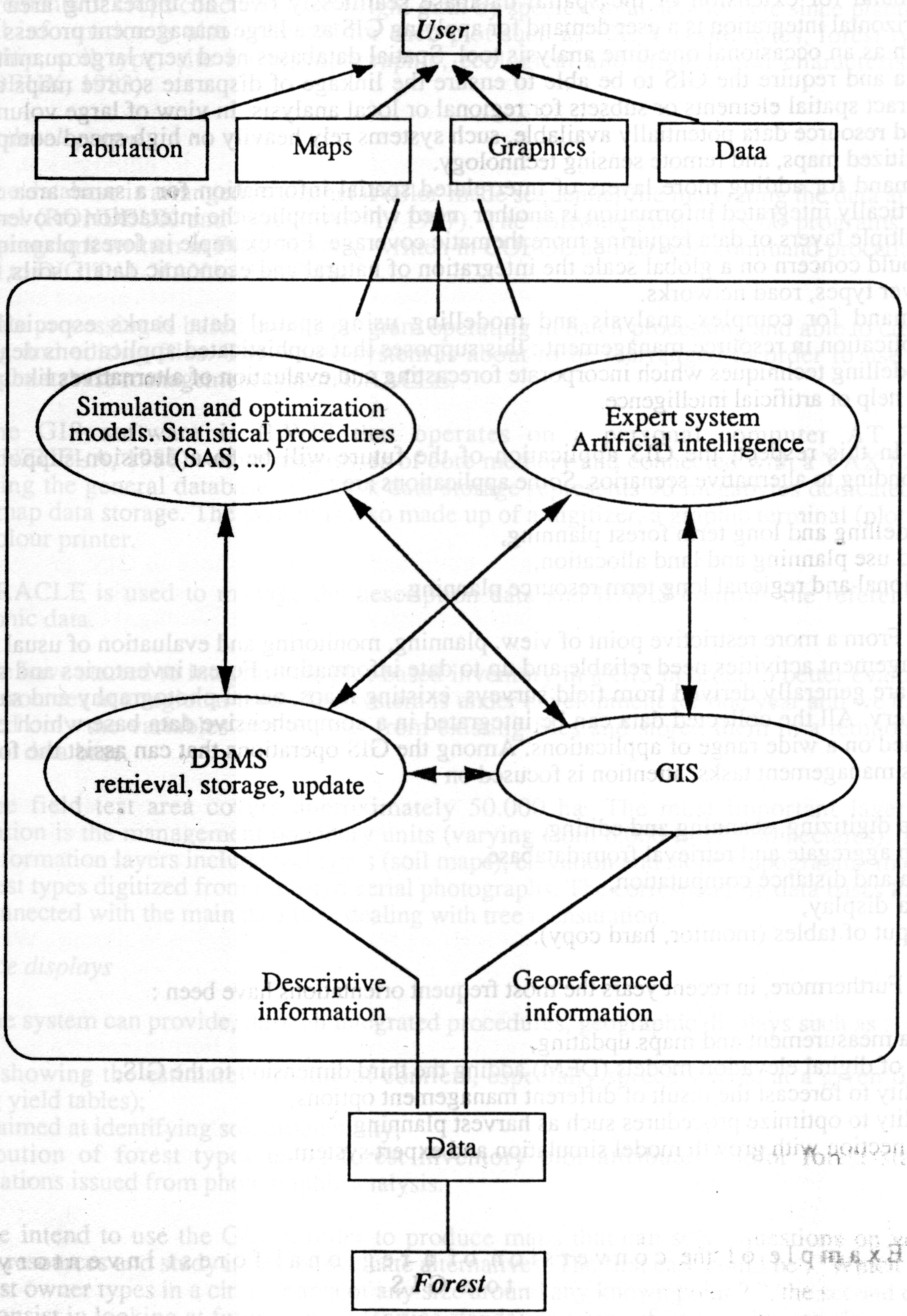

Figure 1 : Example of a general representation of an MIS in forest management

From a general point of view the main options can be referred to as follows :

- demand for extension of the spatial database seamlessly over an increasing area : this horizontal integration is a user demand for applying GIS as a large management process rather than as an occasional one-time analysis tool. Spatial databases need very large quantities of data and require the GIS to be able to ensure the linkage of disparate source maps and to extract spatial elements or subsets for regional or local analysis. In view of large volumes of land resource data potentially available, such systems rely heavily on high speed computers, digitized maps, and remote sensing technology.
- demand for adding more layers of interrelated spatial information for a same area : such vertically integrated information is another need which implies the interaction or overlay of multiple layers of data requiring more thematic coverage. For example in forest planning this should concern on a global scale the integration of natural and economic data : soils, forest cover types, road networks.
- demand for complex analysis and modelling using spatial data banks especially for application in resource management : this supposes that sophisticated applications deal with modelling techniques which incorporate forecasting and evaluation of alternatives likely with the help of artificial intelligence.

In this respect, the GIS application of the future will be in a decision-support role responding to alternative scenarios. Some applications are :

- modelling and long term forest planning,
- land use planning and land allocation,
- national and regional long term resource planning.

From a more restrictive point of view, planning, monitoring and evaluation of usual forest management activities need reliable and up to date information. Forest inventories and spatial data are generally derived from field surveys, existing maps, aerial photography and satellite imagery. All the collected data can be integrated in a comprehensive data base which can be queried on a wide range of applications. Among the GIS operations that can assist the forester in his management tasks, attention is focused on :

- map digitizing, scanning and editing,
- map aggregate and retrieval from database,
- area and distance computation,
- data display,
- output of tables (monitor, hard copy).

Furthermore, in recent years the most frequent orientations have been :

- area measurement and maps updating,
- use of digital elevation models (DEM) adding the third dimension to the GIS,
- ability to forecast the result of different management options,
- ability to optimize procedures such as harvest planning,
- connection with growth model simulation and expert system.

Example of the conversion of a regional forest inventory to a GIS

The regional inventory

The survey is based on 11.000 circular sample plots related to 550.000 ha of productive forest set on a systematic 1.000 x 500 m grid of the national coordinates. Each sample plot represents an area of fifty hectares. The position of every tree has been recorded through its distance from the plot center and its azimuth. Since 1989, in order to provide information about resource planning, a new approach based upon a multiphase sampling has been studied. Measurements of crops concern breast height girth by species, total heights, age since planting. General information is also collected for each plot such as : X, Y coordinates, forest type, ownership, soil type, site index, topographic, ecological and silvicultural characteristics (RONDEUX, 1983).

System development

The database is arranged in a general tailor-made sequential file integrating the data at the plot level (RONDEUX and TOUSSAINT, 1987). The software comprises 60 programs (35 source programs written in FORTRAN, 5 written in COBOL and 20 with command procedures adapted to DIGITAL VAX under VMS).

Data processing is based upon a program operating in batch processing and able to create working and editing files. The whole system is about to be rearranged in order to use the relational database management system ORACLE.

The GIS software is ILWIS that operates on a personal computer AT 386 (VALENZUELA, 1988) with 6 megabytes of core memory and connected with a VAX 8250 containing the general database. The disk data storage represents 90 megabytes dedicated to digital map data storage. The system is also made up of a digitizer, a graphic terminal (plotter) and a colour printer.

ORACLE is used to manage the description data and ILWIS controls the referenced geographic data.

We have started to integrate the plot-based inventory in a GIS in order to better evaluate forest resources at a regional level. The system is under development for one year and we have extracted only the variables and records from existing files and stored them in a temporary relational data base.

The field test area covers approximately 50.000 ha. The most important layer of information is the management boundary units (varying from 6.000 to 12.000 hectares). The other information layers include soil types (soil maps), elevation and slope (topographic maps) and forest types digitized from infra-red aerial photographs. The corresponding data bases have been connected with the main data base dealing with tree mensuration.

Resource displays

The system can provide, through integrated procedures, geographic displays such as :

- maps showing the estimated volume of conifers, especially spruce stands, at a given time (using yield tables);
- maps aimed at identifying soil productivity;
- distribution of forest types using forest inventory plot attributes and/or forest stand delineations issued from photographic analysis.

We intend to use the GIS in order to produce maps that can solve questions on very specific resources and study issues or evaluate alternatives. The first case could be : "Which are the forest owner types in a circular area of any size around any known point ? ", the second one could consist in looking at future forests (spruce stands), in terms of volume by age classes, in the event of several thinnings weights and revolutions.

Sample plots being accurately located within the region studied, the next interesting step would be to relate resource conditions to geographic features (cities, roads, wood-using industries). In such a way one, could be modified, through an iterative process, the distance from plot to roads or other features and the change in forest resources evaluated.

Conclusions

As the decision - making and strategic planning activities seem to be an objective of MIS, the more sophisticated the system, the more data quality, data access and availability, useful output, cost benefit analysis and personnel training have to be considered. One of the constraints to coherent and efficient application of MIS and GIS technologies in forest management in the next years will probably lie in a shortage of skilled and integrated teams and in a lack of quality data. Nevertheless at a time when land surveys are always in progress the implementation of MIS is a powerful and adequate tool for the forest manager provided his objectives are very clearly defined and sufficient resources are available. We cannot forget that there is a need for a concerted effort for the building of small, decentralized, simple and cheap solutions as well as of large and full-integrated systems. This need calls for increased efforts to ensure compatibility in order to facilitate and to promote wider use of available systems. It also includes the permanent evaluation of existing information systems for use around the world.

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