Development of regions with an integrated GIS environment in northeast Hungary

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Abstract

The Hungarian law 1996/XXI. of spatial development and planning has facilitated the formation of regional organisations and set up new requirements as well. The Regional Development Council of the County, which is responsible for the co-ordination of the regional rural development, the Association of Agglomeration Councils in Debrecen for Settlement Development and the professionals of the County Chamber of Agriculture decided to use Geographical Information Systems.

Information systems of the region usually serve design. Regional planning is a procedure which focuses on a certain area and predetermines changes in it. The governing principles of the Ministry of Environment Protection and Regional Development issued in 1997 must have been taken as a guide during the formation of the concept of GIS regional development.

Debrecen Agricultural University has leading role in this field. Our GIS development projects help the education, research and regional developments. Among the GIS applications the development of the "Regional agricultural business and extension information system" based on Internet/Intranet technologies will have GIS extension.

1. Introduction

The law 1996/XXI. of spatial development and planning has facilitated the formation of regional organisations and set up new requirements as well (GRASELLI, 1997). Both the possible ways of improving undeveloped areas -financed from structural funds during the accession process to the EU- and the Common Agricultural Policy (CAP) referring to these areas presuppose the existence of a regional development plan.

Respecting the situation above, the Spatial Development Council of the County, which is responsible for the co-ordination of the regional rural development, the Association of Agglomeration Councils in Debrecen for Settlement Development and the professionals of the County Chamber of Agriculture decided to use Geographical Information Systems as spatial decision supporting (SDSS) tools and methods for regional planning.

Information systems of the region usually serve design. Regional planning is a procedure which focuses on a certain area and predetermines changes in it. The aim is to create better and more balanced structure and conditions. (KERTÉSZ, 1997). The governing principles of the Ministry of Environment Protection and Spatial Development issued in 1997 must have been taken as a guide during the formation of the concept of GIS regional development.

Main role is assigned to the spatial decisions related to local problems and a GIS based solution will be presented below.

2. Materials and methods

2.1 Spatial decision supporting systems

The aim of the system is to help decision-makers to solve complex spatial problems, therefore to contribute in:

- Monitoring the situation and changes in certain areas and settlements
- Ensuring information exchange on the one hand for the preparation of decisions and for the decisions itself in the field of regional development and planning, on the other hand between the organisations that are needed for the duties of regional development and planning performed by the governments and other authorities.

Following Densham (SPRAGUE, 1980) the created system also complied with the followings: capability for analytical modelling, applicability for database management systems, suitable for graphical visualisation, listing and expert system.

2.2 Technical background

The information technology background of development and utilisation has already been set up at Debrecen Agricultural University, Faculty of Agronomy, and it is intended to be improved and updated. As a result of the GIS and information technology developments at the Centre for Informatics and at the Department of Water and Environmental Management the present state can be characterised as follows:

- Fiber optic local back bone network
- Internet connection for every computers
- ISDN telephone center with video conferencing facilities
- GIS training laboratory
- GIS laboratory for researchers and developers
- Virtual GIS local network
- Up to date GIS software products, for example :

    - *ARC/INFO for UNIX (SUN-SOLARIS) 7. 1.2 Floating*
    - *ARC/INFO for WINDOWS NT 7.1.2 Floating*
    - *ArcView 3.0*
    - *ERDAS IMAGINE 8. 3 for UNIX (SUN-SOLARIS)*
    - *ERDAS IMAGINE 8.3 for Windows NT*
    - *MAPINFO*
    - *MapInfo for Windows Professional 4.1*
    - *AutoCAD R13*
    - *Idrisi for Windows*
    - *Civil engineering software products*

2.3 Structure of the regional information system

The basic layers in the database of the system were compiled thematically from the most significant parameters in planning based on the followings.

- Maps of infrastructure networks, most significant data and indicators of the state of supply
- Characteristic data of land use
- Maps of environmental conditions and characteristic data of the state of environment
- Metadata of regional information systems
- Metadata of regional and local concepts, plans, programs

Data were collected for the database of the regional information system using the following methods:

- GPS Technology (PATHFINDER-II.)
- Manual digitising of maps and other graphical items.
- Scanning maps. This procedure includes scanning, namely automatic digitising, (linefollow) followed by vectoring.
- Improving existing data sets (DTA-50 CORINE land cover) airphotos

Each thematic set got into a separate logical group , called layer, during data input. An important part of data input is error handling. Through the visualisation of the error list, both the operator and the controller (recipient) can and should ascertain that the obtained digital map is free of errors. Errors appear as predefined codes on the screen. Naturally one layer can contain only one kind of object-type, therefore the error lists of different layers are different. The name of the error is also presented in the list beside the visual reference.

Different algorithm is used for the correction of each potential error and reuce error propagation risk. Proper debugging algorithm can be assigned to all error types by the help of the reference or its name.

The resulted database, which was consistent both logically and physically, was an ArcView SHAPE file. The SHAPE file perfectly fits into the planned system since this converted file is in the standard file form of the ArcView software that is the frame utility for the potential decision support.

The agricultural regional information system that is currently under development can be a source of various attribute data during improvements in the future. This system is subject to amplification and completion with GIS applications. The development, which is supported by the National Technical Development Committee and by the Ministry of Agriculture and Food, is co-ordinated by the consortium of the Agricultural University and 3 County Chambers of Agriculture.

Faculty of Agronomy at Debrecen Agricultural University formed a consortium and prepared a successful application for the invitation Information and Communication Technology Applications (IKTA) of the National Technical Development Committee (OMFB) in April 1997. The aim of the project was to encourage the development of content-trade and information market in Hungary. It also aimed at the improvement, introduction and

wide spreading of applications and services for public use.

The aim of the project is to form a regional agricultural business and advisory information system for three counties, which counts on the co-operation between various members of agriculture. In the system chambers of agriculture, public companies, business companies and small producers, which have direct daily contact, form the consortium and the domain of users whose interest is the formation of an information service that functions smoothly. This system could help members of the economy to retrieve data about national and international market and to inform their partners.

The following services shall be obtained from the project:

- Regional and distributed agricultural information database containing producers' and cost price, marketing, technology and finance information.
- Internet service based on the regional agricultural information database.
- Extension service based on the farmer notary system and on the information technology background.

Benefits of the realisation of the project:

- Decrease of the lack of information in the agricultural sector.
- Creation of the regional information databases that are needed for the effective operation of the advisory system.
- Improvement of international relations and of the chances to get into the Electronic Business and traditional market.
- Introduction of modern communication and information technology into agricultural economy.

3. Results and evaluation

3.1 The agricultural regional information system as attribute data source

The system has been developed from Web servers, relational database servers and FTP servers to support the handling, automatic transfer and publication of information of both textural and relational databases.

A descriptive database was assigned to each relational database, which contains the information about its content, therefore allows for a uniform treatment of data and for the exchange between different systems.

The maintenance of databases uses Web interface or - by using the definitions in the descriptive databases - batch mode through e-mail, ftp or http protocol. Data exchange between chambers and DAU is provided through the replication function of the applied relational data structure management system.

Enquiry of data is offered on a Web interface from the publications of predefined tables and charts that follow the changes in the database automatically and by the ad-hoc queries of the users through the Web interface.

The availability of data is expanded by a data-ordering and posting function that sends data via e-mail to the user periodically or in case of need.

Textural information and documents are handled by the combination of relational descriptive database and FTP and Web servers. Two basic aspects were taken into consideration during the formation of the document handling system. One aspect is the simplification of document handling and publication. Therefore the sub-components of the system (FTP server, Web server, database server) are "hidden" at the user side of the interface. For the user it is like working with a common directory structure. The user interface is composed partly from the Web browser and partly from a client program that looks alike and has similar functions to the Explorer of Windows 95. Some own-developed Microsoft Office add-ons are also provided. By the help of them it is possible to publish documents without leaving the working process, directly from the application. The transfer - replication, publication or archiving - of the documents can be performed without the user through the server, which allows for the automatic transfer of documents available on local or remote network.

Optional tree structures can be formed from the documents in the system and these are stored in a database. Depending on the authority of the user, the document structures can be expanded, parts can be moved, copied and deleted but the reference information is kept. Documents are stored in a directory structure that is alike to the structure described in the database. This structure is handled via the ftp protocol irrespective of the file structure. The segmental database of the document handling system contains descriptive data of the texts (e.g. title, writers, keywords etc.), the structure of storage, references, information needed for transfers and access limitations.

Document structures that are formed independently can be shared or replicated, thereby allowing for publication into document structures located at different local or remote networks. It also allows for the storage of local copies of documents that are in other structures.

The publication system automatically places the documents onto the Web server and maintains structures and connections based on the information stored in the database. In the present state one document structure can be assigned to one virtual Web directory. In the system that is under development, parts of the structure can be assigned to more than one virtual directory, thereby allowing for publications simultaneously to more than one server.

The system can be divided into two subsystems: the Internet service provided by DAU for public use and the Intranet systems of the participants (chambers, DAU and other organisation that wish to join the system).

This breaking up of the system is only a logical one, since Internet and Intranet systems have identical structures and can be optionally modified and organised into open and protected subsystems. The Intranet of the chambers can be divided further more into regional subsystems according to the structure of the chambers and also the organisations that wish to join and the members of the chambers can create their own subsystems.

Each Intranet system is composed of a database management system, an FTP and a Web server, document maintainer and publisher system. The connection between the systems is provided by the replicate functions of the applied database management system together

with the publisher server. The administration is segmented, however it is possible to maintain certain subsystems from remote locations.

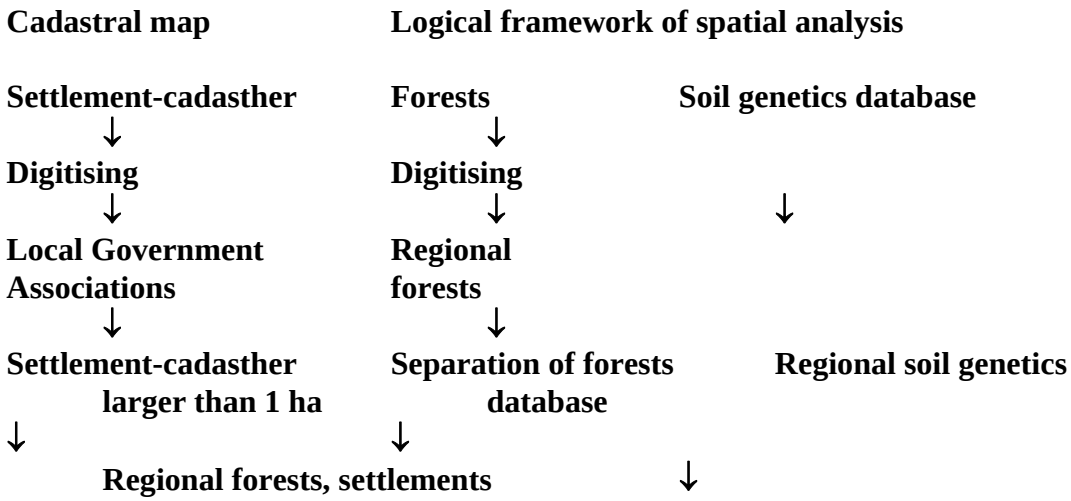
3.2 Spatial analyses

There are quite a lot of national and international examples of application of regional planning systems for infrastructure improvement.
Below follows some analyses made at the University:

- Site selection of the now power station system Debrecen to decrease carbon-dioxide load. (Fig. 2.).
- Drinking-water aquifer vulnerability analysis for point and non-point pollution sources. (10).
- Nitrate load analysis of surface water in the Bihar-Pain. (9).
- Coop yield forecasting in the region based on remote sensing data and crop models.
- The sewage sludge application based on the soil. Vulnerability Analysis (8).
- Assignment of new fruit-production areas.
- Ecological assessment of wheat-bearing areas.
- Environmental Impact Assessment of regional waste disposal dumping site. (Fig. 3.).

Areas that can be suitable for environmental resource management related forest-plantations in the research area were assigned during the present study. The basis of the solution is the applicability of geographical information systems to simultaneously handle and analyse the spatial and alphanumeric information of databases and the proper tools allow for effective analysis and visual interpretation of solution alternatives.

The main objective of the decision supporting method is to create a new layer – namely to create information that is new and that is needed for decisions, area limitations, regional statistics etc. – from one or more existing layers. The Boolean matrixes resulted from overlaying or re-coding are the logical bases of the layers, which allow for an indefinite number of overlays. (TAMÁS, 1997). The logical framework of the analysis is presented in Figure 1.



↓→ **Soil genetic maps of areas outside settlements and existing forests →**

Separation of strong acid and weak acid soils →

Separation of sand-drift and humus sand →

Separation of soils with bad and extremely bad water management

Separation of With less than 50t/ha organic matter content →

Separation of areas larger than 1 ha from the remaining area

↓

Areas potentially suitable or forest plantations

The layer resulting from the analyses contains all the regional information that has been set as criteria for queries. The resulted layer is presented in Figure 4.

Figure 2.

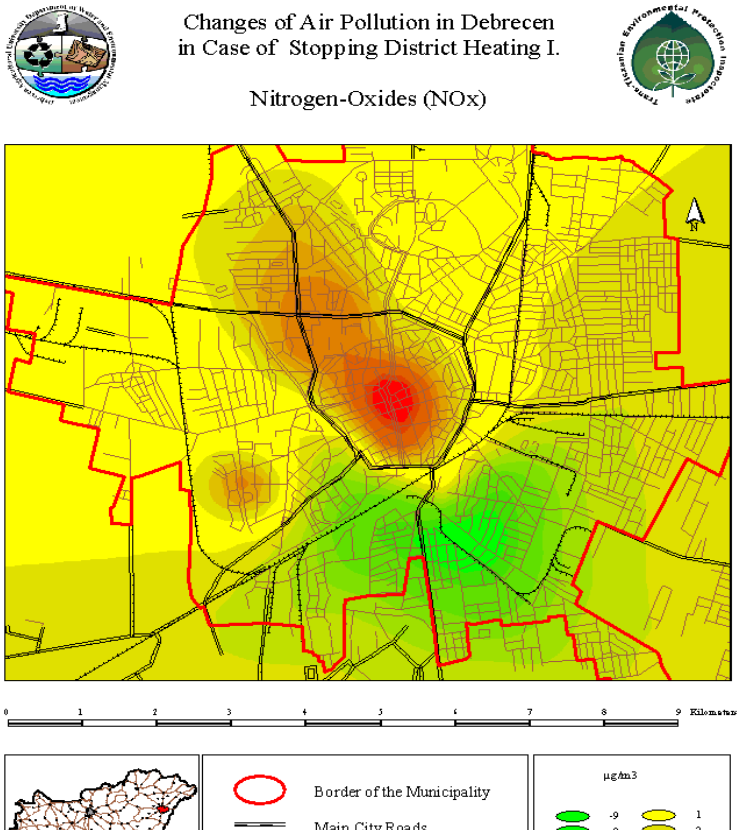


Figure 3.

Figure 4.

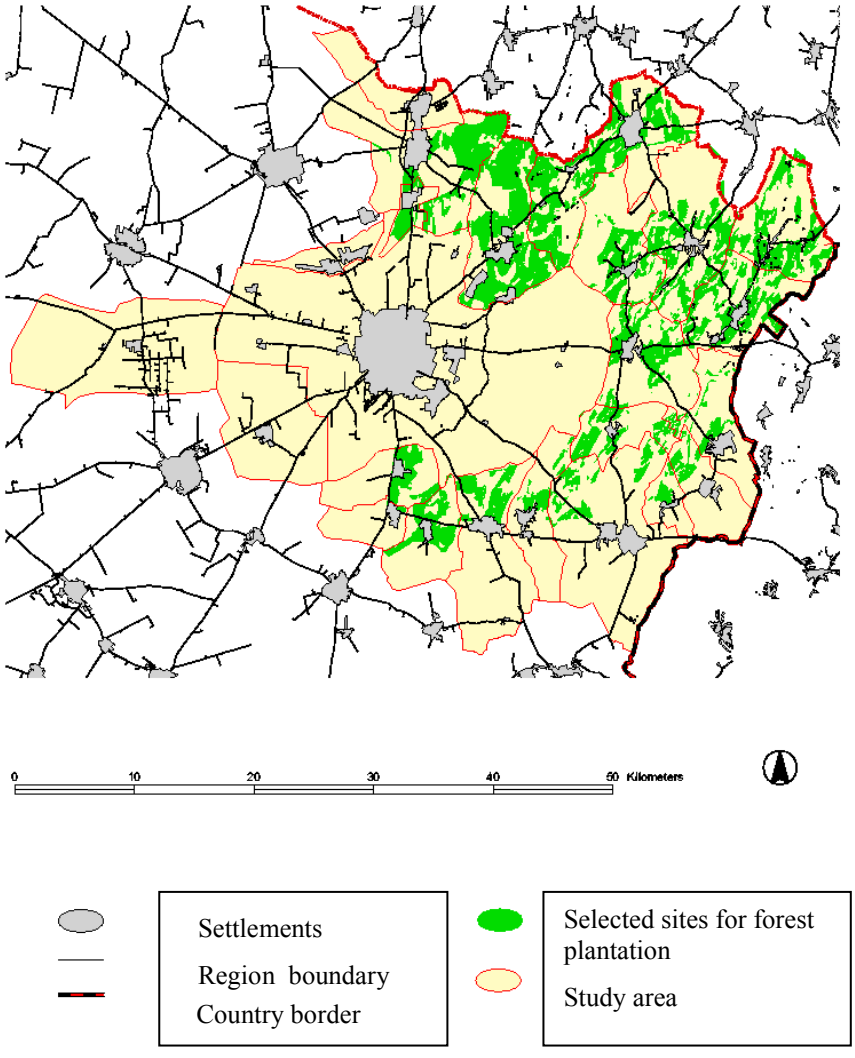
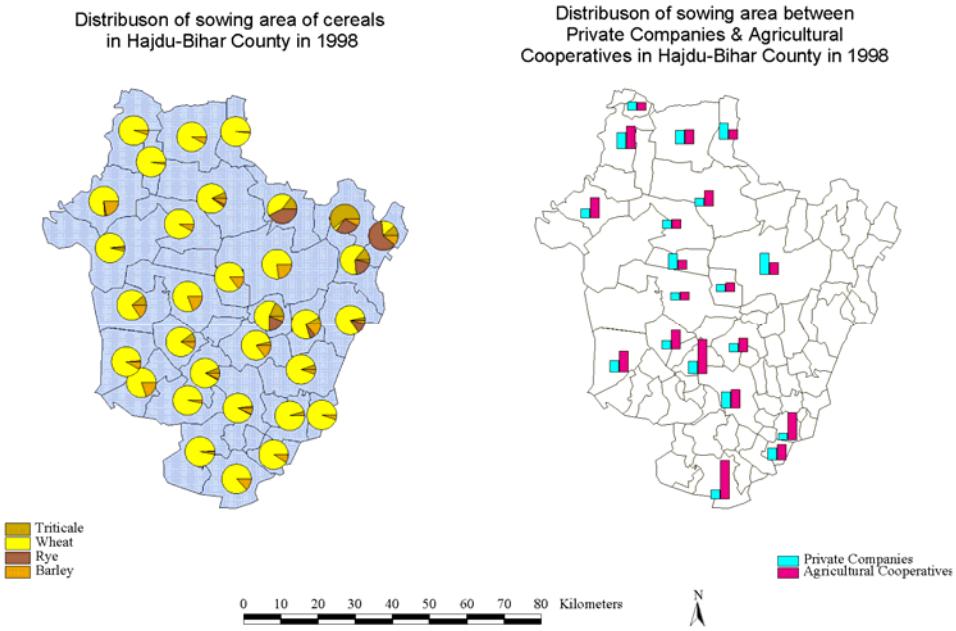

0
10
20
30
40
60 Kilometers
Settlements
Region boundary
Country border
Selected sites for forest plantation
Study area

Figure 5.



3.3 Outline of the possible techniques of regional Spatial Decision Supporting Systems

The last step in setting up an information system is to connect it to the network, thus to return information and analysis results to the participants, to provide feedback. Presently known mean of GIS database-access is to use so called Internet Map Server. Map data can be accessed in two ways: one is through the static view (HTML pages, "quick access"), the other is dynamic GIS access through Internet Map Server. The later is an integrated software of the WEB server, which allows graphical databases to be published on Internet/Intranet. At the user's side GIS operations can be performed on existing databases by a Java application ("MapCafe") that is downloaded from the WWW server and run by the browser. Supported functions are- among others-: zoom of the maps at will, query of information from the active map layers, alteration of the map layers to be visualised, separation and selection according to certain query criteria, printing maps, visualisation of map co-ordinates, etc. By the help of the above mentioned possibilities not only spatial analyses can be regarded as the "added value" of regional information centres, but also the means of access, which quicken and make the job of the information system participants and the operation of the whole system more efficient.

4. Conclusion

Spatial problems and spatial decisions have determining role in regional development. A system that is capable of acquiring, analysing and handling spatial data is needed for solution. The nature of the concept of spatial decision supporting systems (SDSSS) must be taken account of during the formation of GIS. The aim of the system is to help decision-makers to solve complex spatial problems.

The database that has been created in a GIS must be a both logically and physically consistent database or data set, which can be achieved through proper error searching and handling during the set-up process. The main objective of the system used for decision support is to create new layer – namely to provide information that is needed for optimal decisions – from one or more already existing layers.

The last step in setting up an information system is to connect it to the network. One possible way to access the alphanumeric database for the client is to use HTTP protocol to run the application and presently known mean of GIS database-access is to use so called Internet Map Servers.

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