

GIS Application in Landscape Planning

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ABSTRACT

Geographic Information Systems have become of increasing significance for environmental planning, landscape planning and environmental impact studies in recent years. The main reason for this is the need, in Environmental Planning, to compare a great number of area-related data describing the affected natural resources and their sensitivity related to the effects of impacts. because GIS can be used to couple area-related data with their attributes, and can be used to overlay these, it represents a highly efficient instrument for such planning tasks.

Environmental Impact Studies additionally need the prediction of environmental effects of impacts. Therefore Model approaches or risk analyses have to be imbedded in the GIS Technology. This paper describes some of the basic application methods by using a Geographic Information System. Project work and GIS application in connection with model-approaches are demonstrated with several examples from existing project work:

- The WÜRM VALLEY STUDY, an EIA Study for problems of increased traffic in the WürmValley, south of the City of Munich
- Impacts of the New AIRPORT MUNICH II on the region and problems of urban development and increased traffic.
- Sustainable Environmental Management in the crossborder region of the Bavarian forest Böhmerwald (Sumava) and Mühlviertel (upper Austria).

The chosen examples from landscape planning and environmental impact studies have been worked out by using GIS and environmental modelling capabilities. For every project a different issue based GIS Project Information System was created and evaluated.

1. THE WÜRM VALLEY STUDY

The Würm Valley is a recreational area southeast of Munich and one of the city's preferred residential areas. The area suffers from heavy traffic pressures because of the attractiveness of the landscape in close proximity to Munich.

Together with the Regional Planning Authority of Munich and a working group of planning offices supported by the various local municipalities, the Federal Ministry of the Environment and the Bavarian Ministry of Works have financed an integrated study of the environmental impacts associated with various traffic scenarios. In contrast to standard environmental impact studies, a whole traffic network has been under evaluation instead of just one road.

A basic GIS was created using paramters such as natural resource data:

- geology,
- soils,
- groundwater,
- elevation,
- vegetation and fauna.

Land use data such as:

- traffic network, existing and planned,
- land use types and land use planning

were also included at a scale of 1:25.000.

In order to describe the status quo, traffic counts were carried out. In addition, present land uses were interpreted from false-colour infrared aerial photographs and land use plans from the local

municipalities. As indicators of environmental conditions, environmental quality data such as degree of forest dieback and groundwater levels and quality were collected.

The main purpose of the study was to predict the impact of increased traffic levels on the environment by:

- noise calculations,
- calculation of emissions,
- calculation of immissions.

These emission and immission calculations were based on traffic scenarios. The impact of traffic on the fauna was also analysed. In addition, a risk analysis for impacts on soils, groundwater and vegetation was carried out.

For the evaluation of the database, the ARC/INFO GIS tools have been combined together with a traffic simulation model based on the local road and rail network.

Together with local planners and councillors, various traffic scenarios were developed to reduce the overall impacts on the Würm Valley. Measures considered to fulfill the study goals included proposals for bypass roads and promotion of public transport (in particular local and suburban train networks). Road speed restrictions and road closures were also considered.

The impacts of these traffic (= road and rail) scenarios were evaluated by:

- the carrying capacity of the traffic systems - road and rail,
- the noise levels expected during the day and night, overlaid with the land use data to show the residential areas affected.

For this purpose, ESRI Germany created a noise pollution programme and connected it with the GIS database to produce noise level maps for the status quo and the various scenarios.

The impacts on the natural resources have been quantified by an overlay of impacts buffers of the emissions, related to the various traffic scenarios. The main impacts are:

- those on residents and visitors from traffic noise,
- contamination of soils, groundwater and vegetation by various pollutants (eg., heavy metals),
- increased environmental hazards from selected pollutants within a buffer zone of 100 m along roads,
- vehicle emissions related to varying traffic levels during the day,
- bisection of areas by new traffic routes (roads, rail) especially related to amphibian populations, undisturbed areas, etc.,
- increased forest dieback within the region, especially along road corridors..

The first results of this ongoing work have shown that:

- levels of groundwater contamination are similar for all the various scenarios investigated.
- vegetation and soils show increased impacts with the increased levels of traffic. Traffic must be strictly regulated in order to prevent contamination from exceeding current levels.
- Noise calculations for road and rail traffic show high levels. Even now, noise levels exceed those of standard official recommendations.

2. THE IMPACTS OF THE NEW INTERNATIONAL AIRPORT MUNICH II ON THE SURROUNDING AREAS

Various prognostic studies have been carried out to predict the development of the region north of Munich associated with the building of the new airport. The major impacts will be:

- the creation of a substantial number of new jobs,
- related housing and industrial development for new workers setting in the area,
- noise and industrial pollution impacts on residents.

The work was conducted in contract with the Bavarian Ministry for Environment and Planning, and carried out by a working group of three planning offices for urban development, infrastructure and ecological planning. ESRI Germany was responsible for the related GIS work.

GIS has been applied to handle local and regional planning problems in an integrative study combined with traditional planning methods. The three major components of the study are:

- a) The ecological condition and carrying capacity of the region.
- b) The carrying capacity of the existing traffic system (road and rail).
- c) The planning goals for urban development (housing, production and industry).

To carry out the study, a GIS was created for a total area of 1.410 qkm at a scale of 1:25.000, covering the combined administrative areas of 44 municipalities. The GIS database includes the following basic data:

- geology,
- soils,
- groundwater,
- landscape aesthetic evaluation,
- biotope networks,
- existing land uses,
- existing planning goals,
- protected environmental areas.

An initial step was the definition of landscape ecological units with unified ecological potential and sensitivity. The forms the development would take and the associated traffic infrastructure were assessed using an environmental matrix. Four different types of residential and industrial development were defined and their impacts on the natural resources determined. A sensitivity matrix for the ecological units was developed and applied.

A restrictive method was used to define potential areas of development, using the GIS, involving:

- a selection of protected areas and sites where development should be avoided
- a definition of biotope networks
- a formulation of restrictive planning goals for protected areas
- a definition of ecologically sensitive areas related to groundwater, buffer capacity of soils, aesthetically sensitive areas, etc.

This resulted in a map of highly sensitive areas where development is to be restricted.

The second step was the selection of corridors along existing road and rail routes to select those areas which can be connected with the existing traffic system. The third and final step was an integration with the regional planning goals relating to:

- urban development,
- aesthetic landscape values and "green belt" planning,
- land use systems for sustainable development.

The results of this analytical GIS application show a spatial distribution of areas with varying potential for development. The results will be used in the formulation of a regional management plan.

The particular problems associated with the determination of noise pollution on residents from the new airport have been solved by using the GIS coupled with noise distribution calculations. These calculations served to determine the areal effects on the local municipalities, and to illustrate these statistically in the form of maps. Through the overlay of calculated noise values on the ground (from standard noise calculation procedures) with the population of the settlements within the various municipalities, it is possible to calculate quickly which areas and how many residents will be affected by sporadic or continuous disturbances. These disturbances can be further related to airport management models, aircraft types and chosen flight paths.

3. A TRILATERAL GIS FOR SUSTAINABLE ENVIRONMENTAL DEVELOPMENT AND REGIONAL LANDSCAPE PLANNING

With the recent opening of the borders between Western and Eastern Europe, formerly separated neighbours have been developing new economic and cultural contacts. The expansion of the internal European market has created new forms of cooperation and links within Europe. Bavaria, the Czech Republic and Austria are at the centre of this new development process, their borders meeting in the heart of Europe.

The Bavarian Forest, Bohemian Forest and Mühlviertel are situated at the intersection of these three countries - a ecologically, sensitive landscape of low mountains, connecting rather than dividing the three very similar regions.

Issues of environmental protection, economic development, housing and infrastructure, traffic management and general problems of regional planning and information have had to be addressed for this beautiful region containing two national parks. The formerly marginal and undisturbed region divided by the Iron Curtain became subjected to a sudden increase of traffic, tourism and development after the opening of the borders.

Under contract of the Bavarian Ministry for Regional and Environmental Affairs, the Czech Ministry of Economic Affairs and the Office of the Upper Austrian Provincial Government, a trilateral concept has been created by an international expert group of ecologists, regional planners and GIS specialists, using a central GIS for collection of different data from the various information sources of the respective countries.

The GIS played a central role as an integration tool and as an issue-based Information System to deliver basic information and strategic concepts for the decision makers in the region, as well as those in the state governments.

The tremendous effort involved in creating a trilateral GIS and its successful application for strategic management and policy led the UNESCO to recognize the development concept as an International MAB (MAB and the Biosphere) Pilot Project.

The project was subsidized by 50 % European Economic Community funding as part of the INTERREG Programme.

3.1 Strategic Problems and Development Issues

Open exchange of information and experience between the three countries proved indispensable for the preparation of the trilateral development concept. For a sustainable development of the 9.000 qkm

study region, the following themes were emphasized by a round table of the experts together with the decision makers of the region:

- Proposals for the safeguarding, conservation and management of the basic natural resources and landscape in a way which meets the needs of the Bavarian Forest and Sumava National Parks and which is consistent with the interests of agriculture as well as those of tourism and local recreational needs.
- Future prospects and proposals for agriculture and forestry, taking into account non-agricultural income possibilities particularly in connection with the specific recreational value of the area. To this end, the possibility of directing future agriculture toward predominantly resource-conserving forms of land cultivation was examined.
- Development opportunities, particularly in the areas of tourism and local recreational use, associated with the Bavarian Forest and Sumava National Parks. The opportunities for environmentally and socially appropriate forms of tourism were given particular consideration.
- Traffic measures necessary for the creation and improvement of border crossings, both for road and railway crossings as well as footpaths. The use of environmentally-friendly local passenger transport systems, in suitable areas was investigated.
- Proposals were made for environmentally-friendly practices in the commercial sector, supply and waste-disposal areas (technical infrastructure), and housing construction.

The study is based on the assessment of extensive information. In addition, surveys were carried out by institutions active in the region, organized by the mayors, chief administrative officers of the districts, and district leaders. Through this extremely productive cooperative effort, a number of very detailed proposals were worked out and examined in terms of their compatibility with the aims of the development plan and their suitability as projects for the development of the study region. In addition, expert study groups were formed to deal with specific topic areas (e.g. agriculture) and, working in close cooperation with one another, to work out aims and proposed measures.

3.2 GIS Creation and Integration of Data from Three Countries

The aim of the trilateral GIS creation was to connect data from the various sources of the three countries to gain relevant planning data and to develop evaluation possibilities. This was necessary to produce thematic maps such as development potentials of functional spatial units, the status of nature conservation including ecologically sensitive areas, socio-economic data of the residential population and tourists as well as data on land use, land use potential and environmentally relevant data of traffic, transportation, emissions, water quality and species diversity.

The geographic database was designed to cover the following aspects in particular:

- topographic information,
- land use and land cover,
- water resources and their protection,
- traffic and transportation,
- tourist infrastructure,
- administration and statistical data.

The database was created using ESRI's ARC/INFO GIS software applied in the three countries, with different thematic layers. These were connected to statistical information gained from various sources of the partners' administrations.

The main reason for the success of the international and interdisciplinary project was ultimately the good personal collaboration and relationship between the scientists, planners and GIS experts in the trilateral planning group in selecting, evaluating and integrating the basic information.

3.3 Results and Application

The results of the study are published in summarized reports with maps in all three languages. For each country, detailed projects were defined as pilot projects for the solution of typical problems of the region such as species protection, safeguarding of nature resources, soil protection and water purification.

Models for alternative land use strategies in agriculture, forestry, housing, traffic and tourism were developed and have been partly implemented.

The project proposals to implement solutions for the region have been published in three individual national reports based on the fundamental GIS information. Some of the projects now have been initiated with the financial assistance of the European Economic Community.

4. REFERENCES

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