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REMOTE SENSING IN SPACE AND IN TIME

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Abstract

The environmental information systems (EIS) will have more increasing and greater role in Hungary at present as well in the near future. The remote sensing seems to be the most important procedure for loading data into a small-scale system suitable for regional data supply. The article presents the possibilities of remote sensing for gathering information in space and in time through the EIS developed at the Department of Photogrammetry, Technical University of Budapest.

Keywords: remote sensing, environmental analysis, history.

Introduction

In the past decade the increase of the volume of information flow and information acquisition necessitated the systematization, well-arranged processing of this data. The gradual progress has established the difference, so-called geographical information systems (GIS) which are capable of meeting these requirements. Nowadays these systems undergo further specialization, e. g. in information systems helping the solution of land using, legal problems (LIS) and the so-called environmental information systems (EIS) intended to track the processes of our environment (BRASSEL, 1991).

The basic conditions for the creation of an EIS are as follows (BILL and FRITSCH, 1991):

- Treatment of spatial information on the earth and its objects (2,5D or 3D modeling)
- Storage facility for spatial, chronological and content data
- Performance of operations among the different masses of data
- Functions suitable for describing the environment
- Possibility for the simulation of environmental processes.

In respect of remote sensing, the first two conditions are most important because the environmental changes, processes do always happen in space. Therefore, loading the database of the EIS requires some spatiality

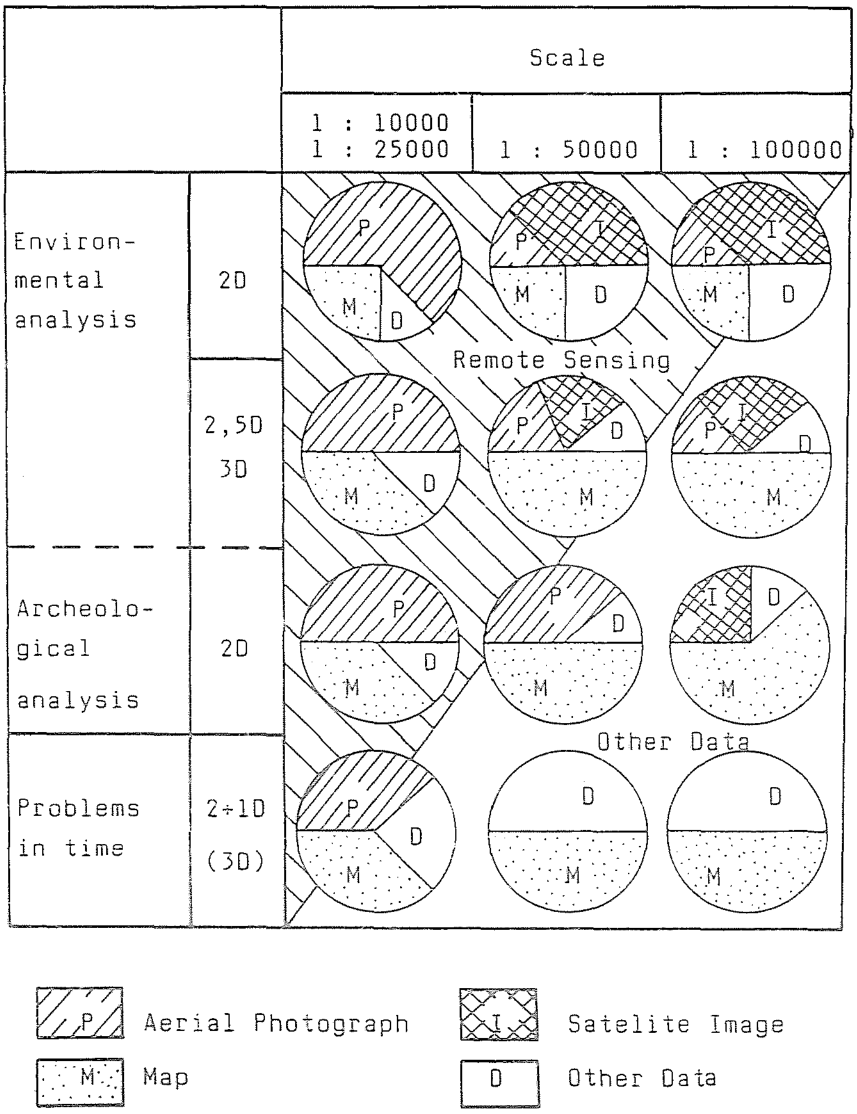

Fig. 1. Environmental applications and data acquisitions

under any circumstances. The time-dependence of these processes is also obvious. Thus, if we want to load such an information system with the help of one of the most efficient means, remote sensing, consideration has to be given to the above mentioned matters (BUCHROITNER, 1991).

Here below, through an EIS data loading developed at the Department of Photogrammetry, Technical University of Budapest, we present the possibilities of the remote sensing applications for the analysis of the environment, as well as the data loading methods of the areas researched by us (*Fig. 1*).

Remote Sensing in Space

We started developing our system in autumn of 1989. Upon the formation of the layers of EIS, the natural spatial arrangement was primarily taken into account. Practically in the basic concept, plane layers situated one below the other in space were developed. This time the loading of the determined layers also began (*Fig. 2a*). The creation of these layers was fundamentally influenced by the remote sensing data supply, since our starting condition was the operative utilization of remote sensing.

In the meantime, with the progress of the works it has turned out that this structure consisting of discrete spatial planes had to be compacted for better modeling of the environmental processes (*Fig. 2b*). From the spring of 1991, the required remote sensing data collection was accordingly carried out. In this way the new structure increasingly approaches the real 3D concepts. Drawing closer to the 3D data supply, we had to find the methods of remote sensing which complied with this (EHLERS, 1987; KRAUS, 1988). Obviously, much depends on the conditions. A $100 \times 100\,\mathrm{m}^2$ resolution (pixel size) is already self-evident today for the information deduced from satellite images. If, however, this is extended to the 3rd dimension (KRAUS, 1991), a voxel of $100 \times 100\,\mathrm{m}^2$ is unusable in the case of EIS, since mainly near the earth the height resolution of 100 m is not sufficient. Based on this, the requirements of the resolution have been modified to a voxel of $100 \times 100 \times 25\,\mathrm{m}^3$.

This requirement can be met by remote sensing data recovery (interpretation), taking into consideration the area generalization of $100 \times 100\,\mathrm{m}^2$. *Fig. 3* shows the sources of the height interpretation of the different environmental objects and phenomena as well as their possibilities under the analysis conducted by us (WINKLER, 1991).

Remote Sensing in Time

In the foregoing the spatial aspects of interpretation were discussed. If, however, we wish to get a real picture of the status of our environment, with the knowledge of the momentary situation, the chronological changes

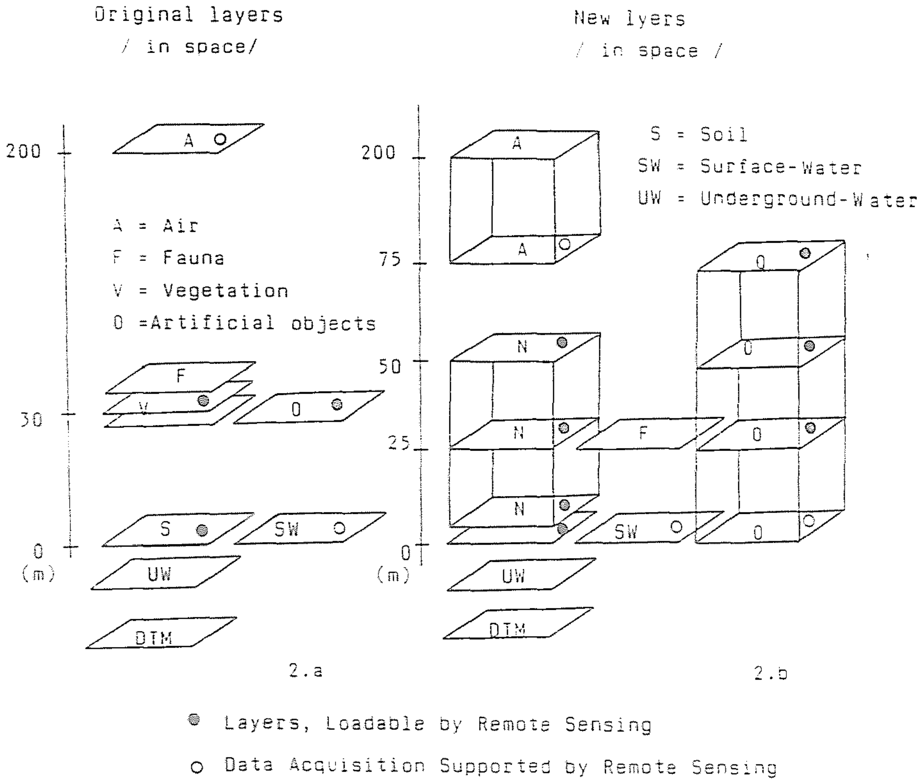

Fig. 2. Layers of EIS

of the condition of the different objects have also to be considered. In addition, phenomena can occur for which the examination in the deeper time interval constitutes the purpose itself. In these cases the 3rd dimension of an EIS can be the time in main function or as a component.

When developing our information system we reckoned with a study period of 10 years. Obviously, for such a short-term analysis (by which the solution of the overwhelming part of the environmental problems can be promoted) the most various tools and means of remote sensing are available. Meanwhile questions have arisen where auxiliary layers of 40 years have to be created. Based on the possible information density, on the analogy of the spatial 3D system, we have established the voxel of $100 \times 100\,\mathrm{m}^2 \times 10$ years. In environmental analysis this works in principle for a duration of 100 years, not only with remote sensing basic information. Of course, in our case the pixel size of $100 \times 100\,\mathrm{m}^2$ has a great significance due to the data density of

	Objects		Remote Sensing: Sat. Image TM	Remote Sensing: Sat. Image SPOT	Remote Sensing: Air photo 1:500	Remote Sensing: Air photo 2000	Remote Sensing: Terr. photo	Map: Topogr	Map: Old
Height	Air/ 200m/		/	/	/	○	◐	/	/
	Air/0 - 100m/		○	/	◐	◐	●	/	/
200 ↑	Tower, Chimney		/	○	●	◐	●	◐	/
	Settlement		◐	◐	●	●	◐	◐	○
	Forest		◐	○	●	◐	○	○	○
	Industry		○	○	●	○	●	○	○
0	Low veget.		◐	○	●	●	○	●	/
0	Veget.	0 year	●	◐	●	●	/	◐	◐
	Settl.		●	◐	◐	●	/	●	●
	Water		○	/	○	○	/	◐	/
↓	Veget.	100 year	/	/	/	/	○	●	◐
1000	Settl.		○	◐	●	●	/	●	●
Time	Water	1000 year	◐	◐	◐	◐	/	●	◐
	Archeol. obj.		○	◐	●	●	/	●	●

● Good possitibilites in interpretation

◐ Midle possibilities in interpretation

○ Bad possibilities in interpretation

Fig. 3. Possibilities of data acquisition for EIS

the available basic information. The time density is comparatively large, so it allows the real and continuous modeling in time and, expectably, the establishment of the 3D space-time system.

With the other kind of research we can establish new information from the summary of the layers, produced in large time deep. Such case can happen for example when analysing of archaeological objects. The act of the remote presents auxiliary data for the objects. *Fig. 3* shows the application of the remote sensing method for the time-dependent researches.

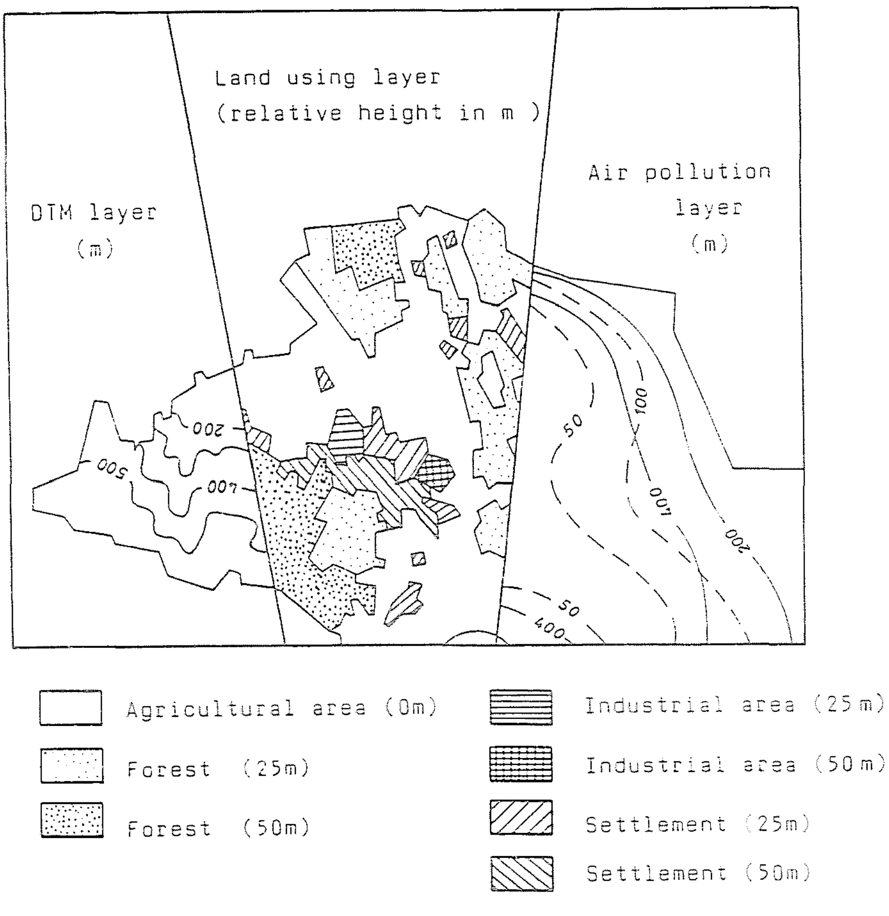

Fig. 4. Three (with height-information) layers of EIS

Results and Conclusions

The following results have been achieved in the development of the environmental analysis system and of its data loading:

– We have established a model area in Győr–Sopron–Moson county.

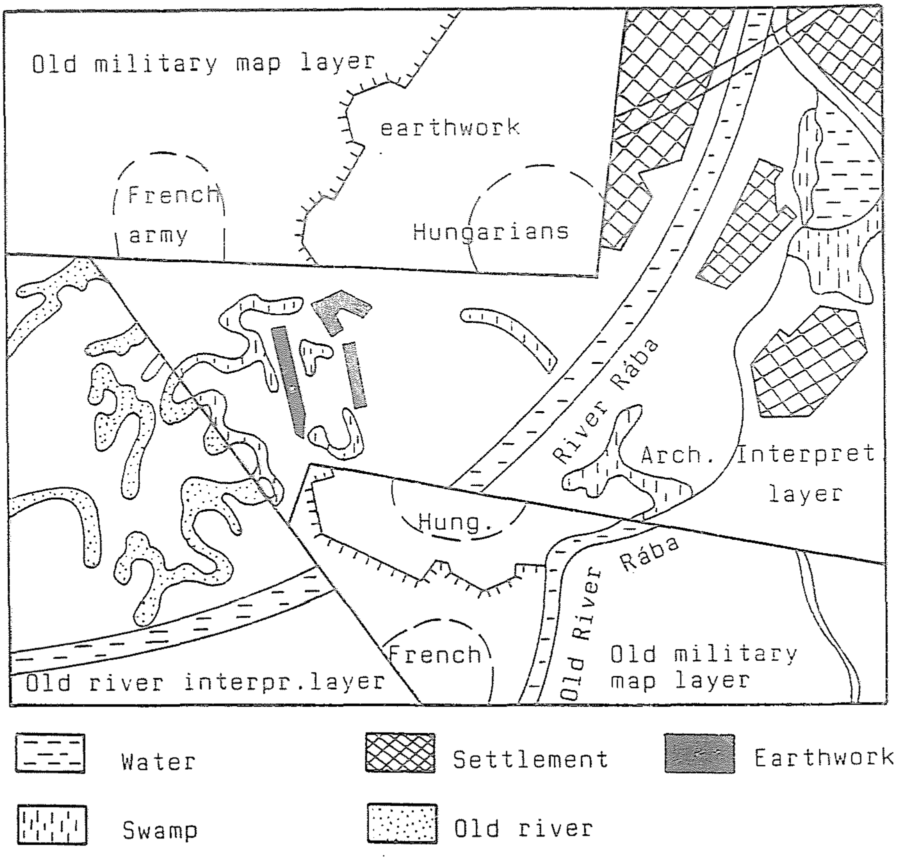

Fig. 5. Three war-historical layers of EIS

– We have tried out the remote sensing methods of data collection in space and in time. It has turned out of analysis that the height relations of the surface objects and phenomena (for regional research, in smaller scales) can be determined with great reliability by interpretation methods.

– In the case of in-time studies for the environmental analysis tasks we could cover a time depth of approx. 40 years with remote sensing. The data density for this was appropriate in the scale relations mentioned in the foregoing, we managed to make a full use of this. In the case of data collection of larger time depth for archaeological purposes we could integrate the remote sensing auxiliary data into the scope of the EIS.

Figs. 4 and *5* illustrate the above. *Fig. 4* presents the details, copied into one of the three layer senses (DTM, Land using, Air) of the EIS established. The quantities between brackets show the average relative height of the blocks evaluated. The system is able to assign these values to the DTM and to create a so-called absolute height model important in environmental analysis.

Fig. 5 is an example for applying remote sensing in the solution of problems in great time depth. Three layers of the EIS (military scheme from the last century, archaeological interpretation of aerial photograph, interpretation of old river beds) are shown like the preceding. The joint analysis of the layers helps to explain certain military moves (the attack against the fortification camp not having made) of the Battle of Győr (1809).

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