# THE CONCEPTION OF A SPACE RELATED INFORMATION SYSTEM FOR HUNGARY

F. SÁRKÖZY

Department of Surveying,
Technical University H-1521, Budapest

Received July 3, 1989

## Abstract

Since the 19th century the cadastral survey of Hungary has been performed. The maps have been compiled in different scales, projections, grids and contents.

In 1975 a new map system, the Unified Nation-wide Map System was established.

Two kinds of maps created by direct surveying exist in the system: the first is the cadastral basic map in scales 1 : 1000, 1 : 2000, 1 : 4000 for cities, towns and villages, land without settlements, respectively. The second is the topographic map in scale 1 : 10 000.

In the end of the decade a pilot project has been started to compile digital maps for the city and some districts of the capital Budapest on the basis of the cadastral basic map.

Since the mid 80s we can observe the mushroomlike proliferation of position related digitized data for several purposes.

A subcommission of the Academy of Sciences decided to have a unified conception worked out for position related digitized data systems meeting different demands.

The conception worked out in March of 1988 among others is dealing with:

– the data systems in this country operating or under development;
– the meaning of the unified identifier (geocode) and its role in the development of space related informatics;
– the technical contents of a nation-wide spatial information system and the tasks in developing the system;
– the anticipated circumstances of maintenance of the system.

The paper contains the most definitive statements in consideration of the topics listed above.

## Introduction

In Hungary the cadastral surveying has very deep roots. This fact may be explained by two motives:

– in the times of Austro-Hungarian Monarchy (till 1918) all geodetic, topographic, cartographic activities (except the cadastre) were performed by the Austrian (most by the Military Geographic Institute) [1];
– the underdevelopment of industry emphasized the meaning of agricultural production. As the cadastre was built up for the determination of land taxes it became a most important tool for providing income for the state budget.

Although after the multiple economic reforms of 1947, 1957, 1968 the meaning of land taxes for budget became practically insignificant, the importance of cadastre for the state surveying and mapping administration did not decrease at all. This inertness was the reason why, by the introduction of the new mapping system in 1975 [2], the emphasis was placed on the so called surveying basic map which, strictly speaking, was nothing else than a slightly modernized cadastral map.

The creation of a new mapping system had real grounds because of the large variety of projections (stereographic, four kinds of cylindric etc.), scales, contents, accuracy and timeliness of data of the large scale maps that existed by that time. The most urgent demand on the new unified map system was claimed from the side of urban utilities. It was initiated by a decree of the Ministry for Building which prescribed the new survey of all utilities of the 90 largest towns of Hungary in the period from 1968 by 1990.

After the introduction of the new mapping system in 1975, instead of solving the existing problems, new ones arose. At first, according to a new directive of the state surveying and mapping administration, all the performed utility surveys had to be transformed into the projection and griding of the unified mapping system. Secondly, the contents and the scale of the so called utility basic map did not coincide with those of the new surveying basic map. The only way of solving these (and other) problems was the digital large scale mapping [3].

Other branches of customers demanded other kinds of digital data. For example in 1975 the Hungarian Post completed a country-wide digital elevation model with 200 m $\times$ 200 m mesh, aiming the design of the microwave communication network [4], or since the early 80s a regional planning institute has begun the compilation of a database for linear engineering establishments (roads, railways, pipelines, cables etc.) with a resolution corresponding to the 1 : 100 000 scale map [5].

Several planning offices for civil engineering, in connection with switching over to the CAD methods, have begun performing extensive digitizing works without any coordination regarding the accuracy, contents, structures, format etc.

Special role has been played in the formation of new demands on space related informatics by the nation-wide project of computerization of state administration, particularly the operations of city municipalities. In the capital Budapest and in two other cities (Győr and Miskolc) independently of each other system projects were worked out on the position related information systems of these cities.

With the goal of saving time and money, ensuring the compatibility, reliability and high technical standard of the new systems, the Geodetic Scientific Commission of the Hungarian Academy of Sciences took in 1985 a decision about the necessity of standardization for space related information systems and as a first step recommended to the appropriate authorities to have a system conception worked out for those. The recommendation was accepted by the Central Office of Statistics and the State Land and Mapping Office, which entrusted us (Department of Surveying, Technical University

Budapest) to elaborate the study. The work was ready and accepted by July this year (1988).

This paper is dealing with the most intrinsic statements of the study [6].

## The recent situation

The investigation was performed by two assistants of the Department, so it is possible that some small systems are missing in the scope.

The information systems having importance from our point of view can be classified into the following types:

1. computerized information systems;
2. traditional registers;

a) systems with
b) and without positional data.

The most important operating information system is the *Unified Register of Real Estates.* It is a 1. b) type system with cover all over the country. Its link to the population register is realized by the "personal numbers".

It is planned to complete the system with "geocodes" (see later) for links to the digital surveying maps.

There is a growing interest in some cities for computerization of the main municipality registers although there are other cities which do not show efforts in this field. As mentioned above in Győr, Budapest and partly in Miskolc studies and system projects were worked out in the years 1986–1987, aiming the computerization of main municipality registers. The study in Győr showed that there are 270 registers in the city from which the computerization of 62 would be advisable. Of these, 39 need position related data. Several state authorities endorsed a document expressing a support of municipality objectives. At first a pilot-project has been started: by 1st January 1989 the subsystems of a district should be filled up. In the capital Budapest the situation is a bit different. Although a system project for the capital was worked out too, the magnitude of the task claims another approach. Till the hardware, software and organization conditions are not solved, the efforts are concentrated on the compilation of digital basic surveying (cadastral) maps of the city's subsequent districts. At first the digital mapping of the 13th district was finished.

As a different fact the existence of some 1. b) type registers in the capital's municipality should be mentioned. Among these we can find the register of the Real Estate Regulation Office, the Register of State Flats, the Register of Public Charges.

The second 1. a) type system is now under development by the Sewerage Enterprises of the capital.

We can observe a totaly different situation in the case of city Szeged. Although the first pilot-project of establishing the digital surveying basic map was started here in 1976, and the local system was completed a few years ago, the system has not operated with the required efficiency till now. The reason is in the lack of systems approach in the municipality's efforts to computerize the several registers using the data of the digital basic map.

The most interesting regional information system is that of the linear establishments. The former 2. a) system compiled on the 1 : 100 000 scale maps is now in the state of computerization (it is becoming an 1. a) system). In the future the system will be transformed into a larger resolution (scale 1 : 10 000).

An object oriented complex database system was established at the Office for Highway and Railway Planning. The 1. a) type system consists of surveying, geotechnical, geological, hydrological, meliorational and mining layers. They serve as input data for the CAD of civil engineering objects.

A multipurpose 1. b) type database for water resource research is under construction at the Research Institute for Hydrology and Hydraulics. The system is contemplated with a country-wide cover.

A highly developed 1. a) soil information system is in the state of filling up [7]. Its aim is to provide for all the country precise soil information for the purposes of agricultural production and research. The resolution is based on topographic maps in scale 1 : 25 000. Till now the filling up has been finished in the largest county of Hungary (Pest county).

The digital elevation model of the Hungarian Post contains country-wide elevations in 200 ×200 m grids. The stored elevation is the highest one in the grid. Some other attributive information (for example roads, population, conductivity of soils) are also stored.

The Central Meteorological Office decided to build up a data base for storing the meteorological data of 120 observation stations spread over the country. The latitude, longitude and height of the stations will be also stored, so the position dependence of the data can be utilized.

This scope is not complete at all. But the main tendencies are shown in it quite clearly:

a) The needs of different technologies, those of administration and research require position based information systems with a wide variety of resolution and position dependence.

b) In consequence of these demands in the last years a mushroom-like proliferation of such systems can be observed.

c) The required possibility of multipurpose utilization demands the standardization of the most characteristic types of systems.

## The concept of the geocode and geocode-like identifiers

As the decree No 21/1986/XII. 28./Min. Agr. orders, in all computerized datafiles and registers containing data of space related objects the unified and valid geodetic identifiers have to be used [8].

With the help of geocodes it is possible to link different registers, on the other hand, the task of identification inside a given system can be performed. At the same time for a lot of weekly position depending applications the only geocodes identifying the objects allow to consider spatial relations (e.g. weather forecast, regional planning etc.).

As mentioned above, in the Hungarian surveying the cadastral approach of surveying tasks is still very dominant. That is the reason why the system of geocodes is worked out unanimously for the lots and comprehensive units, consisting of lots or sets of lots, only.

The geocode is a string composed of two characters (the code of type), six figures for Y and six for X coordinates, and may be supplemented by four characters for the heights (relative or absolute).

The first character of the type code shows the shape and spacing of the object (0 = point-like, 1 = linear, 2 = area lying on the surface, 3 = object in the space, 4 = comprehensive linear object ect.).

The second character refers to the object (A = basic object, B = first order comprehensive object etc.).

It should be mentioned that the decree allows the code to be completed with a few elements.

The coordinates denote one point within or on the boundary of the object. This statement is in the author's opinion the most disputable one in the concept. It means that all geocodes must be physically determined (digitized) and drafted on the maps. I think it would be much more expedient if the situation of the geocode were determined by a mathematical law (e.g. the point of gravity or in the case the point of gravity is out of the object its projection on it).

The basic object of the system is the lot. Therefore, the identification of objects not related directly to the lots or the hierarchies built up from lots needs special coding, not worked out yet.

Another problem arises in the coding of technical objects situated inside a lot. Two possibilities are recommended:

The first one is the so called geocode-like identification. Its essence is that the geocode of the lot in the end is supplemented by a type code of the object (e.g. a building has two type codes, one in the beginning for the lot and the other in the end for the building. The coordinates are the same as those for the lot).

The second one is the independent coding of the object linked to the independent code of the lot.

It means that in this case all the buildings should have two full codes.

The operation of the system is planned heterogeneously: the codes regarding the lot built up hierarchy must be determined or verified, stored, updated and delivered for other data bases by the so called land offices, resident in the county centres, the codes related to the technical establishments, environmental zones etc. have to be produced and managed by the organizations interested most of all in the given topic. They have only to report to the land offices the completing of the codes. Who are these organizations is, however a question not cleared up yet.

Nevertheless, it seems to me that in a short time the geocode system will be able to solve the weakly position dependent tasks of several data bases, in some cases, with a country-wide cover.

## The conception of the National Space Related Information System NSRIS

In the early 70s, when the idea of digital mapping arose, the surveyors' and cartographers' opinion was that the task was as simple as to digitize the existing maps of largest scale. From these input data they hoped to get output in any kind of resolution using the algorithms of automated generalization procedures. However, not long after the beginning of the first practical projects it became clear that the task was not as simple as it was assumed. The weakness of the former conception is caused by two facts:

The digitization of large scale maps is a very slow work. The completion of a nation-wide cover may take several decades if not a century. That means that if we want to produce small resolution GIS-s from the data of the large scale maps, the community for a very long time has to suffer the lack of those.

On the other hand, the creation of perfect algorithms of automated generalization has not been solved till now. To avoid the above shortcomings we design the NSRIS consisting of subsystems as follows:

*Surveying Data Base* (SDB) the digital version of the surveying basic (cadastral) map, joined with the alphanumeric database of the Unified Register of Real Estates.

*Space Related Technical Data Bases* (SRTDB), which are planned to be compiled for cities, towns (may be in the next century with growth of the infrastructure for some villages too).

The basic map of the system should be the copy of the SDB, structured at least in layers of lots, buildings, blocks, public areas.

Its most important thematic layers are those of traffic network with engineering establishments, public utilities with establishments (water, gas, sewerage, electricity, post, heating, cable TV etc.).

*Space Related Agricultural Technical Data Bases* (SRATDB) should be developed step by step in block structure fot territories outside the settlements, prospective for intensive agricultural use.

As basic map of the system the corresponding SDB data are considered in a layer structure, allowing separation of the lots, buildings and administrative boundaries. As special layers those of the communication, hydrography, over- and underground lines, elevations, soil parameters are suggested.

*Nation-wide Geographical Information System* (NGIS). The system is, excluding the common coordinate system, independent of the SDB, its basic map should be compiled as a union of separable layers of road network, railway network, hydrography, settlements, administrative boundaries, geographical names. The proposed complementing layers are those of wires, tubes and pipelines, digital elevation model, land use, soil parameters, mineral resources, data of environmental protection, reference data for remote sensing.

## Accuracy requirements to the data filling up the NSRIS [9]

The heterogeneity of data, in accuracy sense, captured from different sources (digitization, field survey, photogrammetry) is discussed. The problems arise in connection with the SDB, where the possibility of compilation of a graphic standard basic map from the data base is demanded. If we capture the data from an existing standard basic map by digitizing, the obtained data base will be of lower precision than that needed for the compilation of a standard basic map. Therefore, the adequate selection of graphic materials for digitizing, which coincide in sense of accuracy with the other data sources, is recommended.

Some of our accuracy recommendations in figures (mean square errors of coordinates, heights or distances) are as follows:

*For the SDB*

- the corner points of lots and technical establishments in towns ±10 cm.
- the same in villages ±15 cm.
- the same outside of settlements ±25 cm.

*For the SRTDB layers*

- corner points of buildings and deflection points of road axes ±10 cm
- poles of aerial cables, horizontal projection of points of deflection of underground utility lines ±10 cm
- the relative heights of the points above ±15 cm

*For the NGIS*

— points of deflection of roads, railways, these of main street networks of settlements $\pm$ 1.0 m
— points of deflection of administrative boundaries $\pm$30.0 m
— absolute heights of the 15 ×15 m mesh points $\pm$ 2.0 m
— the relative height of points on a distance $L$ $\pm\sqrt{L:200}$ m
— point of deflection of aerial and underground lines in horizontal sense $\pm$1.5 m
— absolute heights of the same points $\pm$2.5 m
— relative (to the ground) heights of aerial lines $\pm$1.0 m
— the same for underground lines $\pm$0.5 m
— points of gravity of buildings $\pm$1.0 m
— framing measures of buildings $\pm$0.5 m
— stream line deflection points by mean water $\pm(5+L:\ 100)$ m
— the width of the river $L$ at the profiles through the points of deflection $\pm$3.0 m
— points of deflection at boundaries of land use, not matched with the roads $\pm$20 m
— points of deflection at boundaries of graduated soil types $\pm$50 m

*For the SRATDB*

The main task of this subsystem is to meet the demands of CAE in meliorational, agricultural design works. In correspondence with these aims
— points of deflection of road and railway axes $\pm$ 0.5 m
— points of deflection of administrative boundaries $\pm$15 m
— the absolute heights of points in a 10 ×10 m mesh $\pm$ 0.7 m
— the relative heights on a distance $L$ $\pm\sqrt{L:300}$ m

## Data model of the system

It should be chosen from the vector type ones. We are recommending the hypergraph data model concept, which gives a good opportunity to link the coordinate type data to the attributive type ones.

## The territorial allocation of the subsystems

Because of being an organic part of the SRTDB and SRATDB subsystems, the SDB has to be located at the same places.

As a collection of urban systems the SRTDB has to be organized at the county land offices. The part of the system related to the county centre must be organically linked to the computer aided city administration. Taking into account that the county centres have priority in establishing their systems, we can assume a rather long time till the first systems for other towns can be developed. Hopefully for this time the speed of on-line data communication will grow up at least to 9000 bit/s, which allows to use these remote data in the same ways as if they were dislocated in the very town. On the other hand, the majority of planning offices is located in the county centres, so they can use the data efficiently, independently of the development of the telecommunication network.

The arguments above in rough lines are valid for the dislocation of SRATDB too.

For the NGIS we recommend a central dislocation in the capital of Hungary Budapest, with an on line data access capability for the project offices and administrative centres, spread over the country.

## Scheduling filling up the NSRIS

From the large scale based subsystems, at first, the establishment of urban systems (SRTDB) seems to be necessary. It must be performed continously: for an approximately four year period no more than three urban systems should be completed parallelly.

The middle scale related NGIS can be filled up parallel with the urban systems. The users' demands show that at first the digital elevation model of the system should be filled up. In cases where supplementary resources are available, the simultaneous filling up of several layers is desirable.

## Conclusions

Realization of the project needs urgent measures stated below.

— One of the central administrative state institutions has to take charge of the compilation, functioning and maintenance of NSRIS. (In my opinion it should be the Office of Land and Mapping of the Ministry of Agriculture and Food).

— The detailed technical specifications of the subsystems have to be worked out, with respect to the basic data contents, data accuracy, updating cycles, unified format of data transfer.

— The legal conditions of data capture, verification and delivery have to be set up.

— The scheduling of creation of subsystems and within those that of the different layers has to be established. In my opinion, as mentioned above, the most urgent task is the compilation of the NGIS and within that the digital elevation model. On the other hand, the urban systems for *Budapest* and *Győr* have to be continued.

— A very important task is the technical, legal and psychical preparation of the receptive media. The use of digital, space related information in most cases results in a crucial change of working processes. This rebuilding needs great financial and intellectual resources. The expenditures can be recovered only if the data delivery and data acceptance are coincided. Therefore a special technical consulting group has to be set up, which can help the co-operation of the data delivering and data accepting bodies.

My last remarks are concerned with the question of profitability of such systems. I am sure that the real profit of operating the systems is an indirect one, which is hidden in improvements of countless details of public services, project designs, environmental protection, etc. Considering the direct profits it can be assessed that the recovering of system investments begins to work two or three years after the first not experimental application systems started their operation.

## References

1. RÉDEY, I.: History of Geodesy. (In Hungarian). Printed lecture notes. Tankönyvkiadó, Budapest. 1966.
2. JOÓ, I.: The Hungarian Large-Scale Mapping for the Purpose of Land Management. Proceedings of the XVIII International Congress of Surveyors. 1986 Toronto, Canada. Commission *7*. pp. 298—315.
3. SÁRKÖZY, F.: Experiment for Establishing the Automatic LIS (Land Information System) in Budapest. Proceedings of the XVIII International Congress of Surveyors. 1986 Toronto, Canada. Commission *3*. (Summary only) pp. 333—334.
4. DIVÉNYI, P.: A National Digital Terrain Model and its Revision. Proceedings of Second International Symposium on Digital Topographic Cartography. Plovdiv 1986. pp. 82—90.
5. KRIZSÁN, M.—LAKY, I.: Territorial Information System of Linear Establishments Located Outside of settlements. (In Hungarian) Geodézia és Kartográfia. Vol. *38*. No 6/1986. Budapest. pp. 417—420.
6. SÁRKÖZY, F. (Ed.): Development of Space Related Information Systems. (In Hungarian) Central Office of Statistics. Budapest, 1988.
7. Computerized Information System of Soils. (In Hungarian) Hungarian National Committee of CODATA. Budapest, 1985.
8. BALOGH, Gy. DEME, Gy.: The Geocode Method as New Approach in the Methodology of the Storing and Utilization of Cadastre and Land Management Data. Proceedings of the XVIII International Congress of Surveyors. 1986. Toronto, Canada. Commission *7*. pp. 523—531.
9. SÁRKÖZY, F.: Geodetic Bases of Information Systems. Proceedings Euro-Carto VI. Brno 1987. pp. 90—104.

Prof. Dr. Ferenc SÁRKÖZY H-1521, Budapest