Space Referencing Core Data for GI in Hungary

Szabolcs MIHÁLY, Hungary

Key words: Geoinformation, GI, Space referencing, GSDI, Standard, GPS, Remote sensing, Ortophoto, Digital cadastre, Cadastre, Land management, Real estate, Land cover, LPIS, Administrative boundaries, Topographic map, DEM.

SUMMARY

The Hungarian National Spatial Data Infrastructure is under establishment, harmonising with INSPIRE. In that frame the space referencing core data for GI plays basic role, as usual. Under the administration of the Hungarian National Mapping and Cadastre Agency at the Ministry of Agriculture and Rural Development the space referencing core data exist, however recently is under development for GI digital applications as well harmonisation with INSPIRE and GSDI.

The paper presents the respective developments performed in Hungary in making these core data applicable for GI, as well as the results at recent time. Details are given about the space referencing geodetic frameworks (geodetic networks, active GPS network), the space referencing base maps (topographic and cadastral maps) and remote sensing base data including the CORINE land cover database as well. The system of digital data supply is also presented, including the TAKARNET network service of land registry information for wide community of internet users. The whole Hungary-covered orthophoto and land parcel identification system digital data browser is also presented in the paper.

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1. STATUS OF SPACE REFERENCING CORE DATA IN GI

All the geographic information databases and systems need common and unified space referencing geodetic framework realized physically by geodetic control sites on the Earth surface and/or by satellite orbits in the space. The GIS need as well such space referencing base maps which contain the Earth surface objects of most commonly usage, making possible the comparative and correct forming the idea or decision on position of any of the space information. These are the space referencing core data serving as common and unified base to geographic information.
Geoinformation databases can be divided by their thematic properties and role as it follows in the status nomenclature below:

a) Core GI data
   a1. Space referencing core data (to be used commonly for all GI)
   - Space referencing geodetic framework
     - Reference and projection systems
     - Geodetic control network or/and GNSS infrastructure
   - Space referencing base maps
     - Topographic maps
     - Cadastral maps
   - Georeferenced remotely sensed data

   a2. Thematic space core data (relying on space referencing core data and often serving for operating any partial thematic data) e.g.
   - Environmental and natural conservation data
   - Transportation data
   - Water data
   - Agricultural data, rural development data.

b) Partial thematic space data of applied interest (e.g. social, technical, business, political) – theoretically of infinite multitude. They cover the main and partly final goal of GI activities.

The article discusses the space referencing core data in section a1., developed and offered for GI in Hungary.

2. INSTITUTIONAL BACKGROUND FOR SPACE REFERENCING CORE DATA

2.1. Organisations Responsible for Space Referencing Core Data

The space referencing core data, namely the geodetic control networks, production and actualisation of large scale state base maps including the cadastral maps and the 1:10 000 scale topographic mapping fall under the responsibility of the Ministry of Agriculture and Rural Development (MARD), often referred to as civil mapping tasks. State topographic mapping at scales smaller than 1:10 000 up to 1:250 000, as well as production of maps for

defence requirements including those for NATO is controlled by the Ministry of Defence (MoD), often referred to as military tasks.

Supervisory bodies are the Department of Lands and Mapping (DLM) of MARD and the Mapping Service of the Hungarian Defence Forces (MS HDF) of MoD. The above sharing of tasks is prescribed in Act No. LXXVI of 1996 on Surveying and Mapping Activities.

Supervision role of the DLM, MARD (often referred to as Lands and Mapping Administration) involves the tasks of the land registry, land use, land valuation, land protection and utilisation, too. These topics are regulated by different acts and decrees, each separately.

The civil mapping and land affair tasks for maintaining the space referencing core data in Hungary are carried out by the institutional network consisting of the Institute of Geodesy, Cartography and Remote Sensing (FÖMI) as governmental organisation with nation-wide competence, 19 County Land Offices (CLO) and the Budapest Land Office as governmental organisations with territorial competence at county level, 116 District Land Offices (DLO) and the Capital Districts Land Office as governmental organisations with territorial competence at district level, and the Office for National Cadastral Programme, as non-profit organisation.

2.2. On implementation of the NSDI

The strategy plan of the Lands and Mapping Administration at MoARD proposes the implementation of the next tasks for the years 2004-2006:

- Establishment of a country-wide GNSS service and the equipments relating to it,
- Creation of the Database of Digital Topographic Maps (DITAB),
- Programme the aerial photography of the country and creation of digital orthophotos in scale 1:10 000 in 3 year cycles,
- Modernisation of the information technology at the Lands and Mapping Administration, e-commerce, e-signature,
- Serving the agriculture subsidy of farmers in use of Land Parcel Identification System (LPIS) in the frame of Integrated Administration and Control System,
- Publication of value-added spatial data and thematic map data.
- Links and networking (domestic: with academia, NGOs, and governmental agencies, PPP) as well as co-operations with EU institutions, organisations (EuroGeographics, PPC, EUROGI etc), Member States' institutions (e.g. BEV, OS) and scientific organisations such as FIG, ICA, ISPRS and IUGG/IAG.

Recently, the Hungarian NSDI harmonisation with the European INSPIRE and with the GSDI is on the process.

3. HUNGARIAN ELEMENTS OF SPACE REFERENCING CORE DATA

3.1. Space Referencing Geodetic Framework

3.1.1. The Reference System

A reference system called Hungarian Datum 1972 (HD-72) was introduced in 1972 based on independent adjustment of Hungary's astrogeodetic network. Its reference ellipsoid is the IUGG Geodetic Reference System 1967 (GRS67). The HD-72 is located and oriented relatively at the terrestrial geodetic site Szőlőhegy. Based on HD-72, in Hungary established the Uniform National Horizontal System (in Hungarian called: EOVA), the Uniform National Height System (in Hungarian called: EOMA), the Uniform National Mapping System (in Hungarian called: EOTR) are in use (in brackets the Hungarian abbreviations are given).

3.1.2. The Projection System

A projection system called in Hungarian EOV (Uniform National Projection system) was introduced in 1972. The reference ellipsoid of EOV is the IUGG GRS67. Type of the projection: oblique-axis reduced (secant) cylindrical projection. The whole territory of the country is represented on one strip of cylindrical projection. To meet the requirements of the domestic and international professional communities, a Description Directory of Hungarian Reference and Projection Systems has been issued in 1995 by FÖMI. The Description gives an overview on the EOV parameters, the HD-72 definition, the Hungarian vertical system and the relation of HD-72 to the WGS-84 and its European realisation ETRS'89 systems. A revised version of the transformation parameters has been computed, harmonised in the frame of the EUREF WG of EuroGeographics and IAG, as well as disseminated for GI use in 2000. This version became part of the Hungarian GI standard.

Military maps and digital mapping databases of small scales are using Universal Transverse Mercator (UTM) and Lambert Conformal Conical map projections on the WGS-84 reference ellipsoid.

3.1.3. The Uniform National Horizontal Network

The EOVA orientation is provided by 40 Laplace-points and the scale is maintained by 23 EDM lines. Based on that 150 geodetic control sites serve as a base for the Hungarian EOTR. Later on, for high order scaling, a 864-m long Standard Baseline at Gödöllő town (about 30 km from Budapest) has been measured with Väisälä interferometric method in co-operation with Finnish Geodetic Institute in 1987 and re-measured in 1999. This very stable baseline with 5 pillars is accredited for EDM calibrations for national and international use. Parameters connecting the Hungarian control network to the European EUREF-89 and ED-87 systems have already been measured, computed and finalised.

The EOVA consists of: 163 sites of 1st order 1974 sites of 3rd order, 4307 sites of principal 4th order, 43780 sites of 4th order. An EOVA Database (VIZAB) is maintained and operated by

FÖMI, containing the positional and descriptive data of horizontal control sites as well as their sketching. It contains: the number of the sites, the vertical and horizontal co-ordinates of the sites in the EOV and old projection systems, the location of the sites (county, settlement, sheet number), the date of determination and checking actions, sketch of approach. Its on-line data supply on internet is provided.

3.1.4. Uniform National Height System

The EOMA has normal heights with Baltic Sea level. The reference site is Nadap with height in the EOMA system H=173,1638 above Baltic Sea level (H= 173,8385 above the Adriatic Sea level, in which the height system of Hungary was given earlier). EOMA consists of 41 principal fundamental benchmarks, 800 of 1st order special benchmarks based in 3-5.5 m deep, 5981 sites of 1st order, 5096 sites of 2nd order, 13 417 sites of 3rd order. Hungary has a kinematic network containing about 1100 points along the 1st order levelling lines to study the recent crustal movements, and 23 connecting levelling lines to the neighbouring countries. Upon the 1994 call of IAG/EUREF sub-commission, the Hungarian EOMA is connected to the European vertical network and height system.

A Database of EOMA (MAGAB) containing the data of height control sites (1st, 2nd and 3rd order) maintained and is operated by FÖMI. These data are number of the sites, vertical co-ordinates, location of the sites (county, settlement, sheet number), date of determination, measurement and control of the sites, textual and scanned description of the surroundings. The EOMA on-line data supply on internet is provided.

3.1.5. National GPS Network

The Satellite Geodetic Observatory of FÖMI is the centre for the Hungarian GPS Network (OGPSH) activities of handling the 9 sites determined in EUREF Network, the 24 sites of the OGPSH framework and the 1153 sites of OGPSH measured all over the country. The coordinates of the OGPSH sites are available in the 3D spatial ETRS89 reference system as well as determined in the EOV projection system for mapping purposes. The superior accuracy of the OGPSH allowed the analysis of the traditional EOVA network. A comparison and analysis have been performed using a simplified 7-parameter Helmert transformation. The horizontal residuals after transformation are about or less than 0.5 meters at the edge of the network. An OGPSH Database maintained and is operated by FÖMI. The database contains the most important data of the GPS control sites as site identifier, the EUREF and the EOV vertical and horizontal co-ordinates as well as the site location (county, settlement and sheet number), textual description and scanned site sketch. This database is available on line by internet.

3.1.6. Development of the GNSS Infrastructure in Hungary

The GPS technique (also known as GNSS – Global Navigation Satellite System) is the most efficient GIS data collector and a highly important tool for navigation and surveying. Unfortunately the satellite positioning has a relevant drawback, its accuracy, when a single equipment is used insufficient for applications with higher accuracy demands. In order to improve the accuracy, reliability and integrity additional terrestrial infrastructure elements

should be established. Those systems, relying on the network of permanently operating GPS stations are estimating and real-time distributing the actual position error budget of the satellites that way improving the accuracy of the field measurements. The FÖMI has designed a network of 12 permanent GPS stations to serve all cm-accuracy positioning applications based on post-processing. Building-up of the network has been started only in 2002 and planned to be completed by 2006. Up to now 75 % of the stations are operational. Installing the operational stations we established National Service Centre, where through a website (GPSNET.HU) the GPS data obtained at the permanent reference sites are accessible for any GPS user. All network sites, using the NTRIP internet-based protocol are able to disseminate nationwide sub-meter accuracy real-time DGPS corrections. Cm-accuracy RTK corrections are also broadcasted but the only valid for the close vicinity of the individual reference stations. The network is shown on *Fig.1*. Our task now is to further densify the 12-station network up to 20-25 stations.

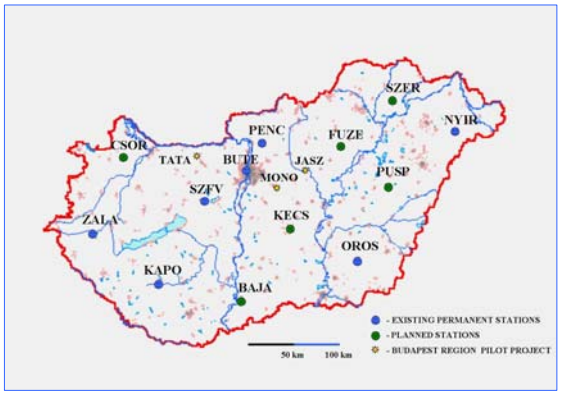

Fig.1. The Hungarian Active GNSS Network – GPSNET.HU

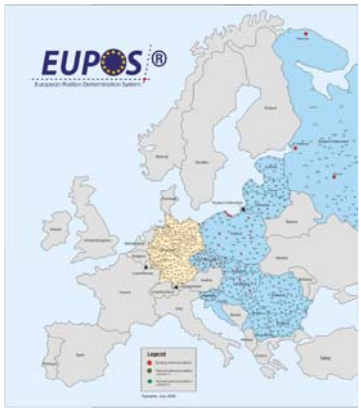

Fig.2. EUPOS – a European regional GNSS service initiative

For regional or continental across border networking and data exchange as well as for application of unified compulsory and optional standards in differential corrections and in data transmissions Hungary joined the German initiative to operate a European regional GNSS service EUPOS (see *Fig.2.*).

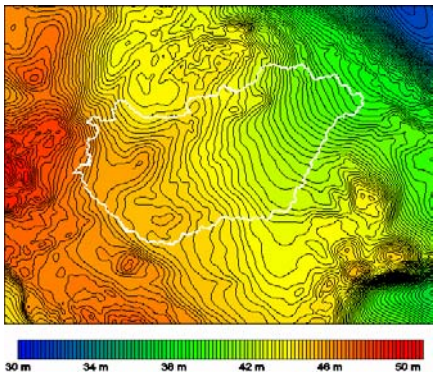

Fig.3. The HGEO2000 gravimetric quasigeoid solution Contour interval: 0.1 m

3.1.7. The Geoid Undulation

The latest gravimetric quasigeoid solution for the area of Hungary (*Fig.3.*) was computed by FÖMI in 2000. It was derived from more than 380 000 gravimetric measurements and the GPM98CR (n=720) geopotential model. The solution refers to the GRS80 geocentric ellipsoid. Its estimated relative accuracy is better than 0.5 ppm. The HGEO2000 geoid solution is available in digital form on a 1.5' by 1.5' grid. This solution represents a major improvement both in accuracy and spatial resolution comparing to the previous versions.

For supporting the GPS heighting activities the gravimetric quasigeoid has been combined with levelling and GPS data. The combined HGGG2000 GPS-gravimetric solution is already used in Hungary for the 3rd order densification of the vertical control network.

3.2. Space referencing base maps

3.2.1. Cadastral system

The cadastral system in Hungary represents an object oriented unified registration including the geometric description (cadastral maps) and the legal property description (registration sheets) of all land parcels and other real estates.

There had been land book, land registration and cadastral maps operating in Hungary for over 150 years. These records were unified in 1972 by the Act on Real Estate Registration and later on by the Act CXLI (1997) on Real Estate Registration. The cadastre system (often called unified real estate registration) consists of:

- Real estate registration map, which is identical to the cadastral map and serves also for land surveying purposes.
- The parcels each having a unique parcel number and legal property description recorded on the 'Property Sheets'. Property sheet consists of three pages:
  - Page 1. with descriptive data (parcel number, address, parcel area, features of cultivation, soil quality, etc.),
  - Page 2. with titles i.e. data relating to the ownership (name, birth, address, etc.),
  - Page 3. with all the other titles and deeds (mortgages, restrictions, easements, etc.).

Recently, for registration of land parcels and other real estates (e.g. buildings), a full cadastre system is in force in Hungary, identical with the concept recommended by FIG in his document "Cadastre 2014" It is a unified, multipurpose legal system, integration of the cadastral maps and the registration records including the earlier land records (Grundbuch). The Hungarian Cadastre System is operated by the District Land Offices of the counties and the Capital Districts Land Office of Budapest of the Civil Lands and Mapping Administration.

Hungary has an area of 93 029 km^2 and 10.2 million inhabitants. In the middle of the 90's there were over 7 million property records and 61 000 cadastral maps of different scales (1:1000, 1:2000, 1:4000) for built-in area and rural area. During the political and economical changes in the 90's, a land compensation programme has been enacted whereby land areas are redistributed to former owners or other compensation claimants. So, an effective 2.1 million new land parcels have been created on more than 5 million hectares. All these have been managed, auctioned, divided, set out, and the results assimilated into the Cadastre System. This situation required prompt activities, modernisation and computerisation of Land Offices network in the last decade.

Recently, all the 116 District Land offices are handling and maintaining the land ownership records using a unique database handling software called TAKAROS (116 TAKAROS

databases) and the land use information using a unique handling software called FÖNYIR (116 FÖNYIR databases), all supervised by FÖMI. These databases are connected together by a nation-wide intranet called TAKARNET, operated by FÖMI (see *Fig.4.*) The user community is provided by land registry data services using that TAKARNET. The 116 District, the 20 County Land Offices, the DLM of MoAR and the FÖMI are networked for management purposes using a META information system.

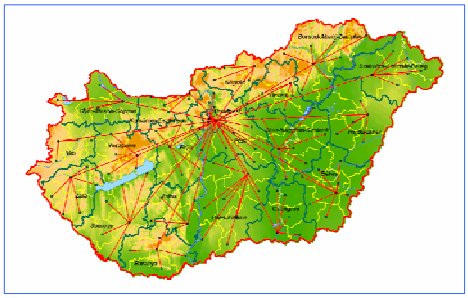

Fig.4. The physical contexture of the TAKARNET

3.2.2. National Cadastre Programme

A nation-wide map renewal (data capture) programme was worked out to realise the unification and updating the existing systems within the framework of the National Cadastral Programme. New professional standards and rules prepared by FÖMI were issued for digital mapping: the Hungarian standard on the Conceptual Model of the Digital base maps, and Guidelines for it.

A National Cadastral Programme Non-profit Public Benefit Company (NCP Public Benefit Co.) draws the credit and organises the map production. It supervises the implementation, gets – in co-operation with the Land Offices – the new maps and sells it directly or indirectly to the users. The latter forms the basis for the redemption of the credit. The tendering is according to the Hungarian Public Procurement Act. The main aim of the Programme is to produce digital cadastral maps throughout the country. From professional aspects, the implementation of the programme is directed by the DLM of the MoARD. Professionals and surveying and mapping companies are contracted by the NCP Public Benefit Co. to carry out the digital cadastral survey in standardised form and the digitisation for rural areas.

At the 1st phase, digital cadastral survey in MSZ 7772-1:1997 standardised form has been carried out on appr. 10 % of the area of Hungary. The results of large amount of digital cadastral maps of standardised object oriented relational database form are expected to be integrated with land registry data in the database of the Land Office IT-systems called TAKAROS to make the cadastral system alive in computerised form.

In a 2nd phase DLM has drawn up the proposal for the continuation and acceleration of the National Cadastral Programme. The main aim of the 2nd phase NCP is to produce digital cadastral maps by vectorisation of existing paper maps throughout the country:

– The first measure is to vectirise the existing analogue maps for the rural areas in 2004-2005.
– The second measure is to vectorise the existing analogue map for the urban area starting in 2004 and finalising till the end of 2007.

The MSZ7772-1:1997 standard defined digital base map actualisation and perfection with needs of longer time and high budget will be continued from 2008.

3.2.3. Administrative Boundaries Database of Hungary

Based on the cadastre data and the state boundary surveys, the Institute of Geodesy, Cartography and Remote Sensing in 1998 compiled and recently maintains the Hungarian Administrative Boundary Database (MKH). The continuous update is provided in the co-operation between FÖMI and Land Offices. Co-operating also with Hungarian Statistical Office in MKH the boundaries of NUTS levels and the boundaries between the urban and rural areas of the settlements are treated and provided for the users. The source of the database is the national cadastre, the directly measured co-ordinates of those boundary points, which represent at the same time administrative boundaries too. The output products are databases of different resolutions gained by generalisation. The list of standard products of the administrative boundaries and their characteristics are shown in the following table:

Resolution	Approximate scale	Precision of co-ordinates
1 m	1 : 5 000	1 m
2 m	1 : 10 000	1 m
5 m	1 : 25 000	1 m
10 m	1 : 50 000	1 m
20 m	1 : 100 000	10 m
50 m	1 : 250 000	10 m
70 m	1 : 350 000	10 m
100 m	1 : 500 000	10 m
200 m	1 : 1 000 000	100 m
500 m	1 : 2 500 000	100 m

3.2.4. Topographic Maps

The Hungarian Act on Surveying and Mapping and the respective Decree to it coming into force on 1st March, 1997 distinguish the topographic maps produced till 1997 in EOTR and the state topographic maps. Respectively, the responsibility for topographic maps is divided between the DLM of MoARD and MS HDF of MoD as follows:

- Topographic maps produced till 1996 in EOTR – FÖMI of DLM of MoARD,
- State topographic maps of large scales (equal to or larger than 1:10 000) – FÖMI of DLM of MoARD,
- State topographic maps of medium and small scales (smaller than 1:10 000 and up to 1:250 000) – MS of HDF of MoD.

Before this Act, the topographic maps were produced for civil and military use separately. Characteristics of the Hungarian topographic map series are presented in the table.

Characteristics	Old military topographic map series	New military topographic map series	Civilian topographic map series
Datum	Krassowsky a = 6 378 245 m b = 6 356 863 m	WGS-84 (EUREF-89) a = 6 378 137 m b = 6 356 752 m	IUGG67 a = 6 378 160 m b = 6 356 774 m
Projection	Gauss–Kruger	Universal Transverse Mercator (UTM)	Unified National
Prime meridian	Greenwich	Greenwich	St. Gellért-hill, Budapest
Spherical longitude of centre point of the projection	0º (Equator)	0º (Equator)	47º06' (St. Gellért-hill, Budapest)
Type of projection; Projection zones	Equatorial (transverse), Tangential, conformal, cylindrical. Sixty 6º ellipsoidal bi-angles, each of which forms an independent co-ordinate system	Equatorial (transverse), Tangential, conformal, cylindrical. Sixty 6º ellipsoidal bi-angles, each of which forms an independent co-ordinate system	Oblique, secant, conformal, cylindrical. One co-ordinate system for the whole territory of Hungary
Way of projection	At each 6º for every ellipsoidal bi-angle	At each 6º for every ellipsoidal bi-angle	'Double projection' i.e. from IUGG67 through Gauss sphere to the plan
Projection co-ordinate system	Y = Portray of the Equator X = Parallel to the portray of the central meridian and 500 kms West thereto	Portray of the Equator: N: Y = 0; S: Y = 10 000 000 m X = Parallel to the portray of the central meridian and 500 kms West thereto	Y = 0; 200 kms South to the centre point of the projection X = 0; 650 kms South to the centre point of the projection
Height datum	Baltic (Kronstadt)	Baltic (Kronstadt)	Baltic (Kronstadt)
Geodetic base	Unified Astrogeodetic Network – common network of the former Warsaw Pact countries	Unified Geodetic Network ED-50 or WGS-84 – EUREF-89	Hungarian Datum (HD-72); independent, relative
Sheet size	1:25 000 / 7'30" x 5' 1:50 000 / 15' x 10' 1:100 000 / 30' x 20' 1:200 000 / 1º x 40'	1:25 000 / 7'30" x 5' 1:50 000 / 15' x 10' 1:100 000 / 30' x 20' 1:200 000 / 1º x 40' 1:250 000 / (2º x 1º)	1:10 000 / 6 x 4 km 1:25 000 / 12 x 8 km 1:100 000 / 48 x 32 km 1:200 000 / 96 x 64 km
Number of sheets covering the territory of Hungary	1:25 000 1166 sheets 1:100 000 92 sheets 1:200 000 28 sheets	1:50 000 319 sheets 1:250 000 9 sheets	1:10 000 4079 sheets (1:25 000 1066 sheets) (1:100 000 84 sheets) (1:200 000 23 sheets)

Digital version of the civilian topographic maps are ready in the form as you can see below:

a) Digital Topographic Map series of EOTR in scale 1:10 000
- DRTA-10: raster data of contour lines, 4098 sheets (100%), planimetry, 4098 sheets (100%), hydrography, 4098 sheets (100%), colour prints, 4098 sheets (100%),
- DVTA-10: vector data of contour lines, 4098 sheets (100%),
- DEM-10: digital elevation model, 4098 sheets (100%) (with 5m grid interval).

b) Digital Topographic Map series of EOTR in scale 1:100 000
- DRTA-100: raster data of contour lines, 84 sheets (100%), planimetry, 84 sheets (100%), hydrography, 84 sheets (100%), colour prints, 84 sheets (100%),
- DVTA-100: vector data of contour lines, 84 sheets (100%), planimetry, 84 sheets hydrography, 84 sheets (100%),
- DEM-100: digital elevation model of Hungary (with 100m x 100m grid interval) 100%.

c) Digital Topographic Map series of EOTR in scale 1:200 000: DRTA-200: raster data of colour prints, 23 sheets (100%).

Digital Products Produced by Military Mapping Organisation are as follows:
a) DTA-200 - Digital Topographic Database of 1:200 000 topographic map.
b) DDM-10 and DM-50 - Digital Elevation Models from 1:50 000 scale topographic maps
c) DTA-50 - Digital Topographic Database of 1:50 000 topographic map

For global and regional GI space referencing Hungary joined
- the Euro Global Map in 1:1000 000 resolution derived from the civilian 1:100 000 scale digital map of civil type,
- the Euro Regional Map derived from the military 1:200 000 scale map.

3.2.5. The Gazetteer of Hungary

The gazetteer-database under responsibility of FÖMI contains 39 types of geographical names including the names of settlements, parts of the settlement, the landscape, large units of the land, woods, nature conservation areas, relief and hydrography, names of remarked points (ruin, look out tower etc.) as well as the names of the most important objects of traffic. This is a Database of Geographical Names (FNT – Földrajzinév-tár).

The database has two versions. The first one (FNT1) corresponds in quantity of names approximately to a topographic map in scale 1:50 000. This database was produced by using of 300 sources (maps, geographical literature, economical, statistical sources), and each municipality had the chance to complete, modify the database reflecting the local use of name. FNT1 covers the whole territory of Hungary, and changes are continuously updated.

The second version (FNT2) corresponds in quantity and in the types of names used roughly to the topographic map scale 1:10 000, with a readiness of 40%. It covers the names of the database FNT1 with addition names collecting directly on the field, taken from large-scale topographic maps, cadastral maps, and other sources. The two parts of the database comprise about 200 000 records.

3.3. Georeferenced remotely sensed core data

3.3.1. Digital Orthophoto Programme of Hungary

In the frame of European Harmonisation Programme of the MoARD three nationwide connected projects were launched by FÖMI in 2000 to be carried out during 3 years, called MADOP (Hungarian Digital Ortophoto Program, Magyar Digitiális Ortofoto Program). These are: “Wall to wall aerial photography of Hungary”, Creation of 5 m x 5 m resolution DEM of the country, Set up of full digital orthophoto coverage of Hungary.

The project “Aerial photography of Hungary 2000” was finished successfully. Now in the archives of FÖMI about 7000 aerial photos at scale 1: 30 000 are available in analogue and digital forms.

The vectorised contour lines from 1:10 000 topomaps served as the basis for creation of 5 m raster size and 0.7 m accurate in Z DEM for the whole country. The 5 m x 5 m DEM of Hungary (about 4 billion points) archived now according to map grid of 1:10 000 and is available for the user community.

3.3.2. National Crop Monitoring and Production Forecast Programme

In the framework of the Hungarian Agricultural Remote Sensing Programme (HARSP 1980-) supported by the National Committee for Technological Development (NCTD) and Ministry of Agriculture and Rural Development (MoARD, earlier MoA), 300 man years R+D was invested by FÖMI Remote Sensing Centre (FÖMI RSC). The original final objective of the programme was to introduce remote sensing applications to the operational agro-information system in Hungary. The R+D phase (1980-96) of HARSP was fundamental to the operational CROPMON (from 1997-). After the successful implementation of the CROPMON in Hungary in 1997, the program gradually extended by covering a characteristic sub sample (6 in 1998 and 9 in 1999-2001 out of 19) of the counties to monitor the entire area of Hungary directly from 2002. In the CROPMON Programme that was operational for the 7th years in 2003, FÖMI RSC provided country and county (19) level crop production forecast data based on remote sensing, measuring the areas and expected yields of the 8 main crops. These crops together represent the 78-82% of the Hungarian cropland. The area and yield data are reported to the MoARD by a strict calendar 4 times in a season, synchronised to the existing traditional production forecast system of MoARD.

THE CROP AREA ASSESSMENT in CROPMON is based on the quantitative analysis of multitemporal high-resolution images (Landsat TM and IRS-1C/1D LISS-III.) providing precise crop area estimation at different levels: locally, on county level and for the entire country. The technology is calibrated and being operationally checked at agricultural parcel level. The actual standard crop maps were also provided to MoARD.

THE CROP YIELD FORECAST is accomplished by the application of the model developed by FÖMI RSC which combines high-resolution satellite (Landsat TM and IRS-1C/1D LISS-III. or SPOT) data and NOAA AVHRR time series. A HRPT receiving station had been installed and operated in FÖMI RSC from May, 1998 to provide secure and real time NOAA AVHRR data access for the models. The innovative crop yield forecast methodology that combines high resolution images + NOAA AVHRR data time series, performed well for the major crops at county level. Another novel robust method that utilizes land use information and built on NOAA AVHRR time series for yield prediction is also introduced. Based on the method applied, yield spatial distribution maps could also be reported for the major crops. The operational CROPMON knowledge basis and system coupled with continuous improvement in the applied technology led to a number of additional applications. The basic elements of CROPMON and the applications supported by CROPMON are shown on *Fig.5*.

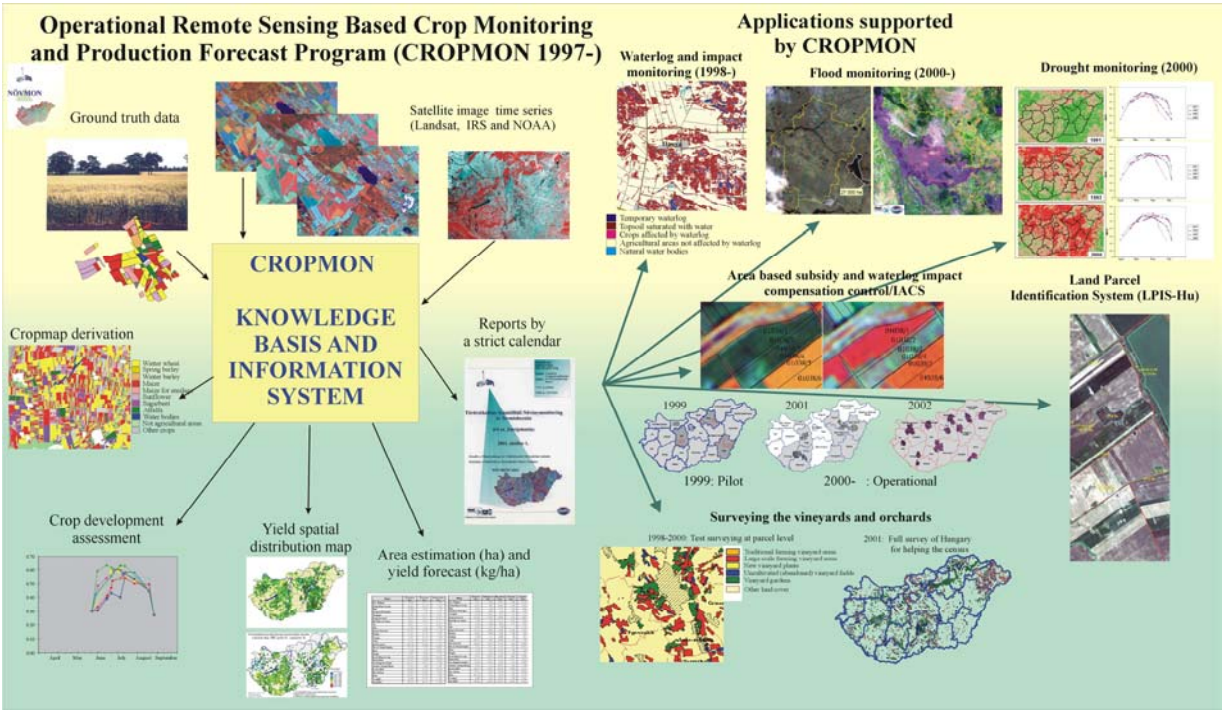

Fig.5.

3.3.3. Physical block based Hungarian Land Parcel Identification System

Building up the Integrated Administrative and Control System (IACS) is a key issue in EU member states. One of the main components of the IACS should be used from 2004, is the Land Parcel Identification System (LPIS-Hu) (called MePAR in Hungarian). Hungary started to build the LPIS-Hu in 2002, after the experience of a pilot project called ProMePAR.

The LPIS-Hu is based on physical blocks with natural boundaries, which was found to fit the best to the country's agricultural utilization characteristics. The source data used in LPIS building were digital ortho-photo coverage of Hungary, 1:10 000 scale topographic maps and high resolution satellite image data series between 2000 and 2003. Approximately 300 000 physical blocks cover the entire area of Hungary. The average size of the blocks is 32 ha, including all land use categories and the whole area of Hungary. The LPIS-Hu project also includes the development of the geographical information system (GIS) of physical blocks, and the integration of different area based information for managing rural development schemes and training for the institutional participants, clients of the IACS.

The LPIS-Hu GIS database contains for each physical blocks: the unique alphanumerical identifier, the boundaries of the physical blocks (red lines), the boundaries of the ineligible parts of the blocks, bigger than 0,1 ha or wider than 5 meters separated by land use (cyan lines); areas, land use categories and eligibility categories of the above defined polygons, dominant land use category, sum of geographical (gross) and the eligible (net) area, categories of Environmental Sensitive Areas and Less Favoured Areas, year of ortho-photo or

VHR satellite image background, date of last modification. Although the cadastral coverage does not constitute the base data of LPIS, a partially scanned or vectorised layer from 2003 is overlaid on the unique block maps to help the orientation of the farmers during the transition to the new reference system.

For supporting the advisory activities of the institutional IACS participants an internet application, called MePAR Browser has been operated with dedicated access for the members of the National Administration and consultants (NGOs) helping the farmers to provide correct data to the farmer-block database.

3.3.4. CORINE Land Cover Databases

Based on 1990 epoch data a CORINE Land Cover database of 1:100 000 resolution has been elaborated also in Hungary as harmonized with European initialisation. Later on here some details will be given when discussing its update.

a) CORINE Land Cover 1:50 000

As part of fulfilment of the government resolution on the "Development of environmental information systems", the implementation of the CORINE Land Cover database at scale 1:50 000 (CLC-50) has finished using financial resources from the Ministry of Agriculture and Rural Development and the Ministry of Environment and Water in the period between 1998 and 2003). The database supports Hungary's accession to the EU in various fields, such as the planning of sustainable agriculture, rural development, agri-environmental planning and nature conservation. The CLC-50 project has direct links to the standard European CORINE Land Cover project, however most elements of the methodology were upgraded according to the present level of technology in geo-data processing. The national CLC-50 nomenclature has been developed from the standard (level-3) European nomenclature and includes 79 level-4 and level-5 classes, which have been adapted to Hungarian conditions. Orthorectified SPOT-4 satellite images taken in 1998-99 and computer-assisted photointerpretation allow for high positional accuracy of delineation. The 0.04 km^2 size minimum mapping unit (0.01 km^2 for lakes) provides enhanced geometric detail. A rigorous internal supervision and an external quality control (performed by the National Park Directorates and the counties' Plant Health and Soil Protection Services) are other key elements of producing a high quality database. In the table below, main parameters of the standard European CORINE project (CLC-100) and that of the CLC50 project are compared.

Parameter	CLC-100, Hungary	CLC-50
Nomenclature	standard EU level-3	standard EU, extended to level-4/5 according to natural conditions in Hungary
Methodology	hardcopy photointerpretation	softcopy (computer assisted) photointerpretation
Area resolution	0.25 km^2 for all categories	0.04 km^2; 0.01 km^2 for lakes
Linear resolution	100 m	50 m
No. of classes	27 (out of 44)	79
No. of polygons	24 000	175 000
Positional accuracy	<100 m (RMS)	<20 m (RMS)
Thematic reliability	>85%	>90%
Supervision	not documented: direct corrections on plastic overlays	documented: remarks on polygon level (instructions for corrections)
External quality control	no	yes
Final product	topologically structured ArcInfo database	

Fig 6.

b) CORINE Land Cover 1:100 000 update (CLC2000 project)

The basic aim of the European CORINE Land Cover (CLC) project is to provide an inventory of the Earth surface features for managing the environment. CLC is consistent and comparable across the continent.

A new project called IMAGE&CLC2000 is undertaken to update the standard CLC database (referred to as CLC1990) giving a "snap shot" of Europe (EU25, Bulgaria, Croatia, Liechtenstein and Romania) for the year 2000. The project is jointly managed by the Joint Research Centre (JRC) and European Environment Agency (EEA). The updated CLC database is called CLC2000. Additional products are: refined (corrected) first CLC inventory (CLC90) and the land cover change database between the 1990 and 2000: CLC-Changes.

The re-produced (backdated) CLC1990 database was generated as a GIS using the CLC2000 and the CLC-Changes databases. The consequences and benefits of the application of this method are:

- The national CLC-50 and CLC2000 is compatible as much as possible;
- CLC2000 is a high quality database in terms of geometry and thematic content;
- There was no need to correct the original CLC1990 database (which includes several geometric and thematic errors due to simpler technology of the 90's). The reproduced CLC1990 also has high thematic and geometric accuracy.

3.4. National Map Standards and Regulations

The introduction of digital technology for the management of map requires GI-oriented standards. Appropriate standards and instructions are created in Hungary for the definition of map content, their acceptance and quality control, and the digital exchange of this information, harmonised with the respective CEN TC 287 and ISO TC 211 geoinformation standards. These map standards and regulations issued in Hungary are the following:

- National Standard MSZ 7772-1:1997 On Digital Base Map, Conceptual Model, often referred as DAT standard (DAT = Digitális AlapTérkép – Digital Base Map) has been prepared by FÖMI and issued by the GIS Standardisation Committee (MB818) of the Hungarian Body of Standards and with support of DLM of MoARD. This standardises the digital cadastral maps.
- Derived from the MSZ 7772-1:1997 standard, a series of technical instructions (often referred as DAT instructions) has been issued by DLM of MoARD in 1997. They prescribe the certification and quality acceptance of cadastral maps, as well as the regulation for planning, creating and renewing maps, database content and structure, data exchange format, quality control and certifying of DAT.
- National Standard MSZ 7772-2:2002 On Definition of Digital Topographic Database has been prepared by FÖMI and MS HDF and issued by the GIS Standardisation Committee (MB818) of the Hungarian Body of Standards.

BIOGRAPHICAL NOTES

Academic experience: Dipl. Photogrammeter-Surveyor (Institute of Geodesy, Ariel Survey and Cartography, Moscow, 1967), Doctor Tech. (Budapest Technical University, 1982), Candidate of Technical Sciences (Hungarian Academy of Sciences, 1981), Ph.D. degree (Budapest Technical University, 1995). Practical experience: Satellite geodetic techniques and GPS. Elaboration of satellite geodetic adjustment software systems. Elaboration and nationwide harmonisation of the Hungarian „Digital base map" standard and „Digital topographic map database" standard. Coordination and successful realization of numerous national and international R+D projects. Database modelling. National Spatial Data Infrastructure. Coordinate system transformation. Teaching: Periodical lecturing at the Budapest Technical University from 1981 as honorary associate professor (satellite geodesy, GPS, Land Information System). Lecturing at College of Geoinformatics, The University of West Hungary from 1989 as associate professor (satellite geodesy, GPS, GIS, digital photogrammetry). Professional awards: „Lázár Deák Medal" of the Hungarian Professional Society (1982), „Fashing Antal Medal" of the Agricultural Ministry (1996), Academy Prize by the HAS (1993). Publications: lecture notes, monographs, more than 170 papers published in proceedings and registered journals, similar amount of internal reports, a big part of it on GIS and digital cadastre. Recent membership: Consulting member of Geoscience Department of HAS, Geodetic Scientific Committee of HAS (deputy chairman of the Committee), Chairman of GI Standard's WG of Hungarian Office of Standars, Representative to Eurogeographics, Hungarian representative to FIG Commission 3. Recent position: Full time position: Director General, Institute of Geodesy, Cartography and Remote Sensing, Hungary. Half time position: Associate Professor of Department Geoinformation Technologies, College of Geoinformatics, The University of West Hungary.

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