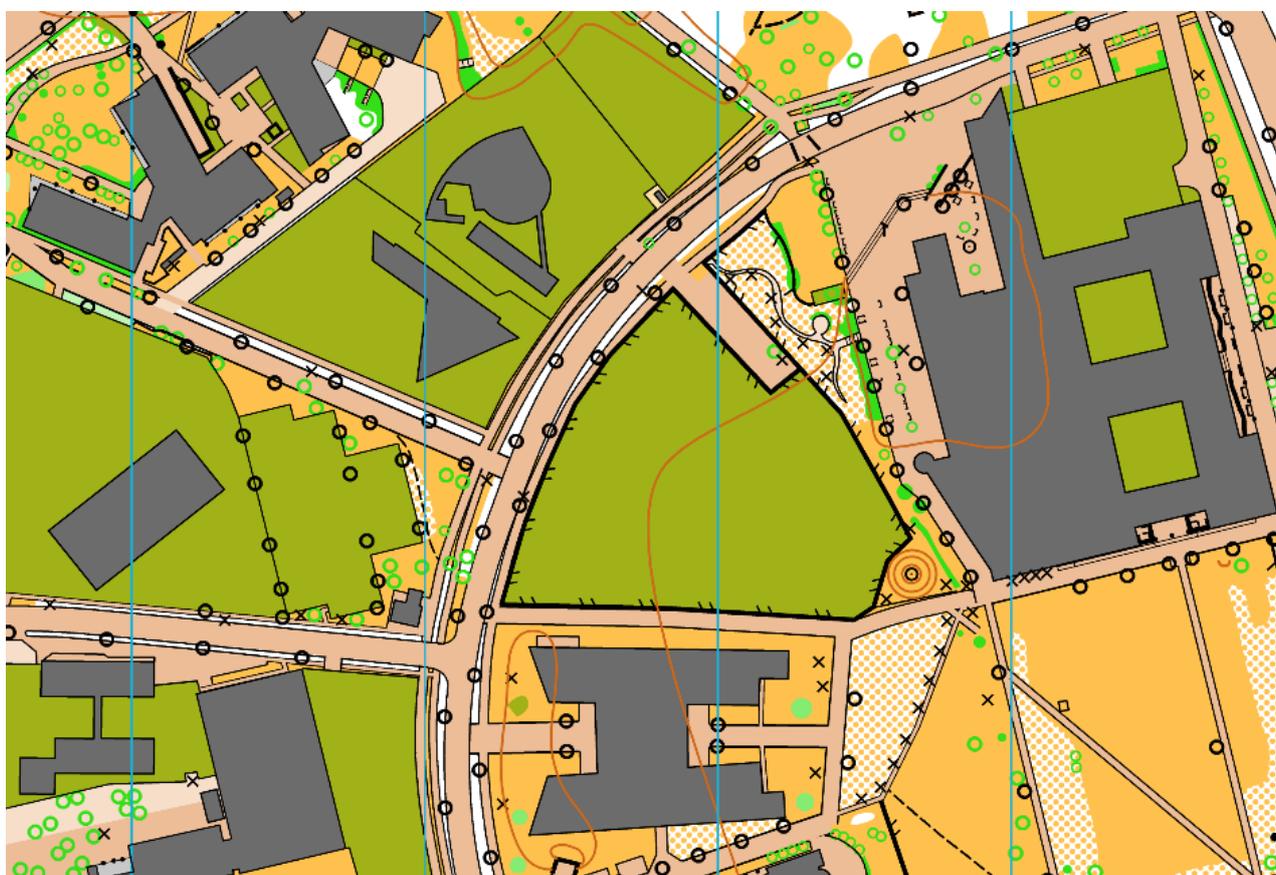


# CARTOGRAPHY IN HUNGARY 2011–2015



Prepared by the  
**Hungarian National Committee (HNC) of the ICA**  
edited by

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for the  
**16th General Assembly, Rio de Janeiro, 23-28 August 2015**

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# 1. National (government) topographic and cadastral mapping in Hungary

## National mapping (civilian): Summary of FÖMI's Activities for ICA Report (2011-2015)

### Hungarian Geodetic Control Networks

#### Uniform National Horizontal Network (EOVA)

The EOVA is based on the Hungarian Datum 1972 (HD72), where the network orientation was provided by 40 Laplace-points and the scale was maintained by 23 EDM lines.

Parameters connecting the Hungarian control network to the ETRS89 and ED-87 systems have been established and being maintained.

In order to provide a high order scale a 864 meter length Standard Baseline at Gödöllő (situated about 30 km from Budapest) has been measured in 1987 with Väisälä interferometric method and Kern Mekometer in co-operation with the Finnish Geodetic Institute. The re-measurement in 1999 proved its high stability. The baseline with 5 pillars was accredited for EDM calibrations for national and international use.

The EOVA network (Fig. 1) consists of:

- 163 sites of 1st order (146 points within Hungary and 17 points in the neighbouring countries),
- 1925 sites of 3rd order,
- 4189 sites of principal 4th order,
- 43542 sites of 4th order,

The 1st, 3rd and principal 4th order sites have 6664 orientation sites. 3666 orientation sites have co-ordinates.

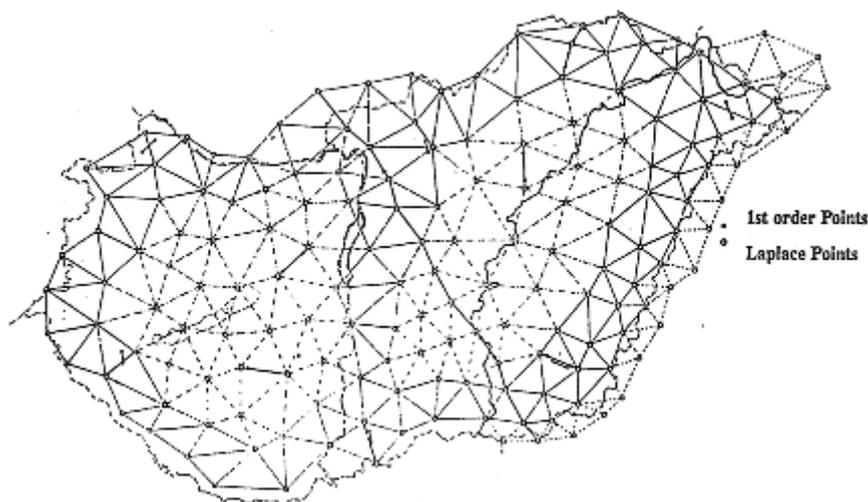


Fig. 1 Sites of the 1st order Uniform National Horizontal Network

An EOVA Database - created and operated by FÖMI - contains position and descriptive data of the horizontal control sites (1<sup>st</sup>, 3<sup>rd</sup> and 4<sup>th</sup> order) as well as their sketching. The database contains the site number, the vertical and horizontal site co-ordinates in the EOV and old projection systems, the location of the sites (county, settlement, sheet number), the sketch of approach, the date of measurement and site checking actions (Fig. 2).

The screenshot shows the EOVA Database interface. At the top, there are navigation buttons: 'VAB keresés', 'Új pont (V)', 'Módosítás (V)', 'Törlés (V)', 'MAG keresés', 'Új pont (M)', 'Módosítás (M)', and 'Törlés (M)'. Below this, there are two main panels: 'Keresés' (Search) and 'Pont adatai' (Point Data).

**Keresés (Search) Panel:**

- Pontszám: [ ]
- Megye: [Veszprém]
- Település: [ ]
- Szelvénytípus: [ ]
- Koord. int. Y1: [ ]
- x1: [ ]
- y2: [ ]
- x2: [ ]
- Rendűség: [I. rendű]
- Állapot: [ ]
- Pontvédő: [nincs]
- Állandósítás: [nincs]
- Áll. éve: [ ]
- Helyszínelés: [ ]

Buttons: 'Feltételek törlése', 'Keresés'

**Pont adatai (Point Data) Panel:**

	Y	X	<b>Pontszám:</b> 52-4001
<b>EOV:</b>	522951,030	201644,650	<b>Más azonosító:</b> Somlóhegy
<b>St_t:</b>	127067,790	36452,390	<b>Szelvénytípus:</b> 52-42
<b>HKRT:</b>	127061,420	-1302,200	<b>Megye:</b> Veszprém
<b>*EOV:</b>	522953,020	201646,850	<b>Település:</b> Doba

**Állapot:** rendben  
**Meghatározás:** 1951  
**Állandósítás:** kő  
**Állandósítás éve:** 1949  
**Pontvédő:** nincs  
**Rendűség:** I. rendű  
**Helyszínelés:** 1991, 1999

**Magasság**  
henger f.sz.: 445,36  
magassági jegy: 442,45  
kő, vasszekevény  
fedőlapja: 431,79

**Változás átvezetés:**  
2003.02.27

**Megjegyzés:** \* a jel EOV koordinátája, \* pf. 1342St., (OP db), 178, 65 (nyt.sz.)

**Search Results:** A keresés eredménye(i): 7  
43-2001/1  
43-3001  
52-4001  
52-4001/1  
53-1001

Fig. 2 Sample printout from EOVA Database

The military mapping agency is responsible for the preservation of the points of military geodetic orientation network as well as execution of the tasks related to its maintenance or accidental replacement of points.

## Uniform National Height System (EOMA)

The EOMA has normal heights referring to the Kronstadt datum point. The national datum point 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.) (Fig. 3).

EOMA consists of:

1. 41 principal fundamental benchmarks (16 established on rock, others are deep-drilled benchmarks situated in sedimentary area),
2. 819 of 1st order special benchmarks based in 3-5.5 m deep monumentation,
3. 454 of 2nd order special benchmarks based in 3-5.5 m deep monumentation,
4. 11 of 3rd order special benchmarks based in 3-5.5 m deep monumentation,
5. 4150 sites of 1st order,
6. 5744 sites of 2nd order,
7. 10083 sites of 3rd order (GPS/geoid technique for the replacement of the classical 3rd order levelling was used since 2000),
8. about 1100 points along the 1st order levelling lines with repeated measurements to study the surface height variations,
9. 6655 sites of Bendefy system which is though part of Baltic system EOMA does not have these sites,
10. 23 connecting levelling lines to the neighbouring countries.

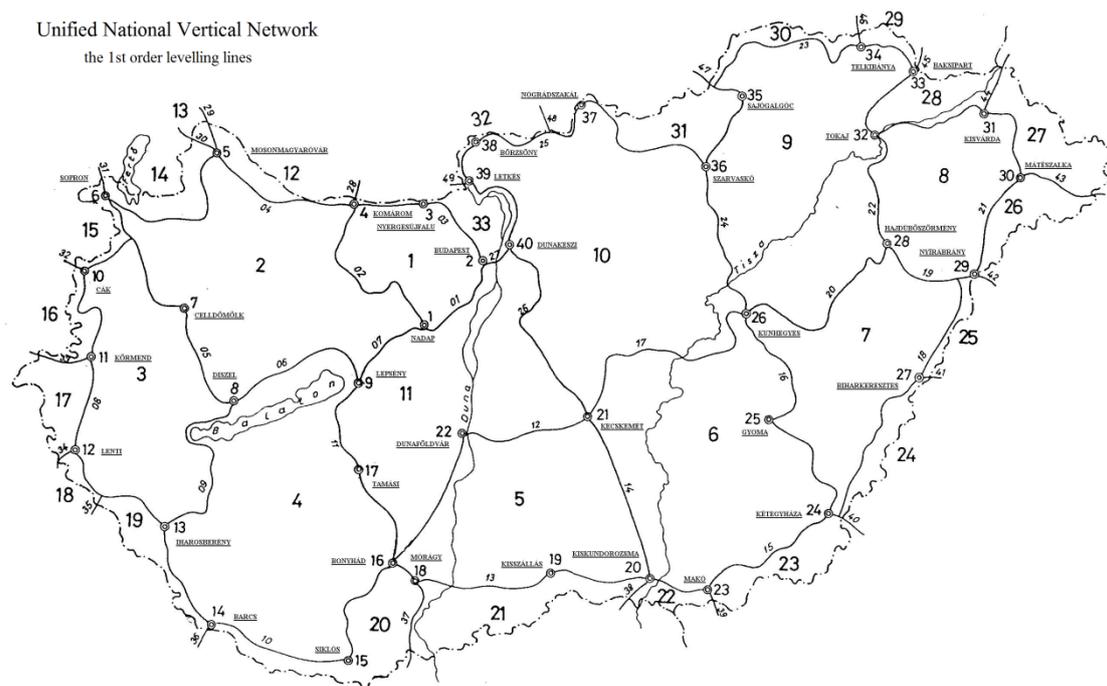


Fig. 3 Sketch map of the 1st order Unified National Vertical Network (EOMA)

Hungary joined UELN (United European Levelling Network) in 1994, submitting levelling data connecting selected primary benchmarks. The sequential adjustments of the UELN network proved that EOMA is one of the best quality national levelling network in Europe. Our fundamental levelling site, Nadap, has been proposed and selected in 2007 as one of the 13 European datum point of the newly defined EVRS2007 European height reference system. Hungary contributed to EUREF's EUVN Densification Action, measuring and submitting high quality GPS and levelling measurements at 20 selected stations.

An efficient technique has been elaborated at FÖMI for the replacement of the 3<sup>rd</sup> order levelling with GPS measurements and geoid information. This technique was successfully applied in the practice for the completion of the EOMA 3<sup>rd</sup> order network in the Transdanubian region in 2000-2005. This work is being continued to provide levelling benchmarks to all Hungarian settlements, which are not yet included into the previous EOMA realizations.

The re-levelling of the EOMA 1<sup>st</sup> order lines has been started in 2007 at the NE part of the country. The whole re-levelling is planned to complete by 2011.

Preparations for the EOMA modernization also has been started, where the vertical control network is being prepared to better serve and exploit the needs and capabilities of the modern, satellite positioning techniques. Plans for an integrated network are being elaborated, where all physical (levelling, gravimetry) and geometric (GNSS, InSAR) techniques are represented and will provide the long term means of the national geodetic control.

The EOMA database was also created and is operated by FÖMI and involves the following information (Fig. 4) about the levelling control sites (1<sup>st</sup>, 2<sup>nd</sup> and 3<sup>rd</sup> order): site number, vertical coordinates, site location (county, settlement, and sheet number), date(s) of measurement and site inspection(s), scanned site sketch and description.

VAB keresés	Új pont (M)	Módosítás (M)	Törlés (M)	MAG keresés	Új pont (M)	Módosítás (M)	Törlés (M)
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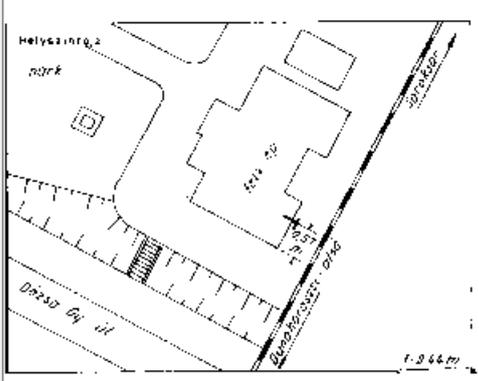
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<input type="checkbox"/> Pontszám:	<input type="text"/>																																		
<input checked="" type="checkbox"/> Megye:	Pest																																		
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<input type="checkbox"/> Vonalszám:	<input type="text"/>																																		
<input type="radio"/> Bendeffy <input type="radio"/> EOMA																																			
<input type="checkbox"/> Koord. int. y1:	<input type="text"/>																																		
x1:	<input type="text"/>																																		
y2:	<input type="text"/>																																		
x2:	<input type="text"/>																																		
<input type="checkbox"/> Rendőség:	III. r. kieg.	<b>Helyszín leírása:</b> Dunaharaszti vá.felv.ép.-nek pálya felőli falában.																																	
<input type="checkbox"/> Állapot:	nincs megjegyzés	<table border="1"> <tr> <td><b>Pontszám:</b></td> <td>1106102-1</td> </tr> <tr> <td><b>Más azonosító:</b></td> <td>0435</td> </tr> <tr> <td><b>Szelvénytípus:</b></td> <td>55-21</td> </tr> <tr> <td><b>Megye:</b></td> <td>Pest</td> </tr> <tr> <td><b>Település:</b></td> <td>Dunaharaszti</td> </tr> <tr> <td><b>Állapot:</b></td> <td>rendben</td> </tr> <tr> <td><b>Állandósítás:</b></td> <td>csap</td> </tr> <tr> <td><b>Állandósítás éve:</b></td> <td>1956</td> </tr> <tr> <td><b>Helyszínelés:</b></td> <td>1999 , 2001</td> </tr> <tr> <td colspan="2" style="text-align: center;"><b>Magasság</b></td> </tr> <tr> <td><b>EOMA:</b></td> <td>105,577</td> </tr> <tr> <td><b>Balti:</b></td> <td>B 105,591</td> </tr> <tr> <td colspan="2" style="text-align: center;"><b>EOV koordináta</b></td> </tr> <tr> <td><b>Y:</b></td> <td>653700</td> </tr> <tr> <td><b>X:</b></td> <td>223200</td> </tr> <tr> <td><b>Változás átvezetés:</b></td> <td>2002. 08. 01.</td> </tr> </table>		<b>Pontszám:</b>	1106102-1	<b>Más azonosító:</b>	0435	<b>Szelvénytípus:</b>	55-21	<b>Megye:</b>	Pest	<b>Település:</b>	Dunaharaszti	<b>Állapot:</b>	rendben	<b>Állandósítás:</b>	csap	<b>Állandósítás éve:</b>	1956	<b>Helyszínelés:</b>	1999 , 2001	<b>Magasság</b>		<b>EOMA:</b>	105,577	<b>Balti:</b>	B 105,591	<b>EOV koordináta</b>		<b>Y:</b>	653700	<b>X:</b>	223200	<b>Változás átvezetés:</b>	2002. 08. 01.
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Fig. 4 Sample printout from the EOMA Database

## National GPS Network (OGPSH)

The FÖMI Satellite Geodetic Observatory (FÖMI SGO) is responsible for all geodetic GPS developments (techniques and networks) in Hungary. The FÖMI SGO maintains and operates the Hungarian GPS Geodynamic Reference Network (HGRN), the national GPS network (OGPSH) and the Hungarian Active GNSS network.

The 'more classical, stone-monumented' OGPSH network is being built-up from the following components:

1. Hungarian part of the EUREF/ETRS89 Network: 9 sites (1991 and re-established in 2007),
2. OGPSH frame network: 23 sites (re-measured periodically)
3. the OGPSH network: 1089 sites (measured 1995-97), see (Fig. 5) and (Fig. 7)

The coordinates of the OGPSH sites are available in the ETRS89 (ETRF2000 epoch 2007.4) reference system, as well as in the EOV projection system for mapping purposes.

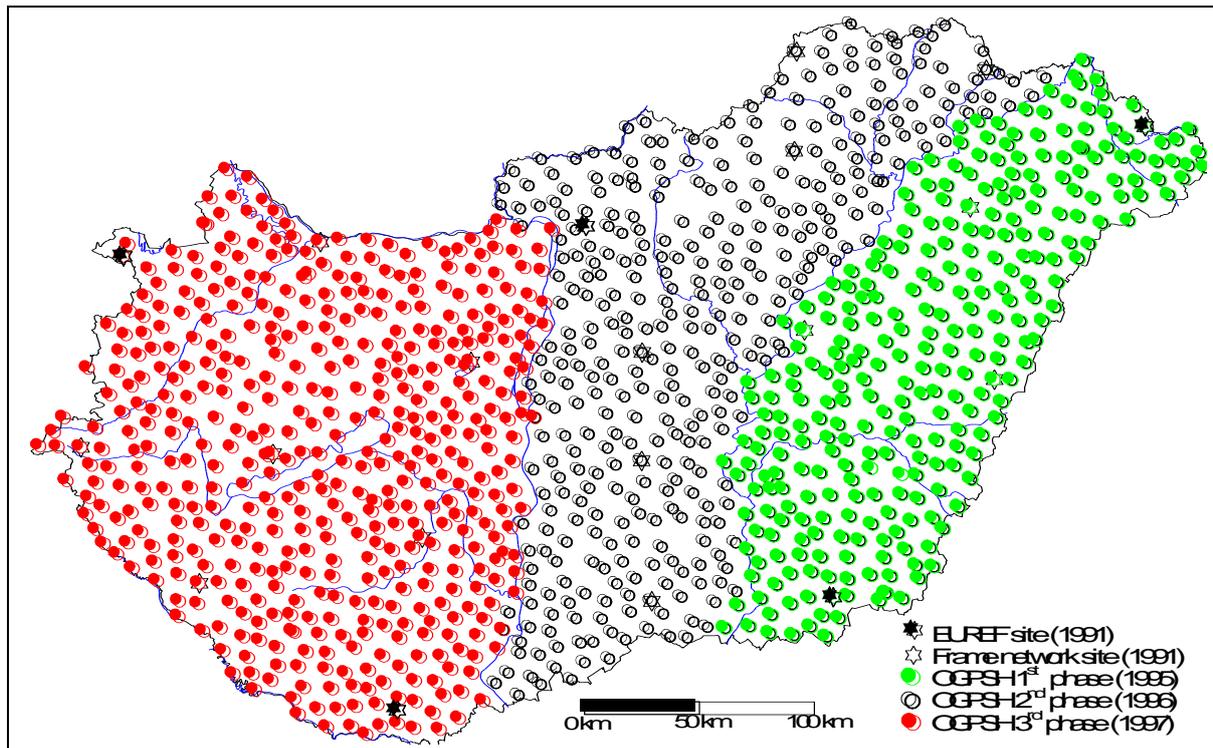
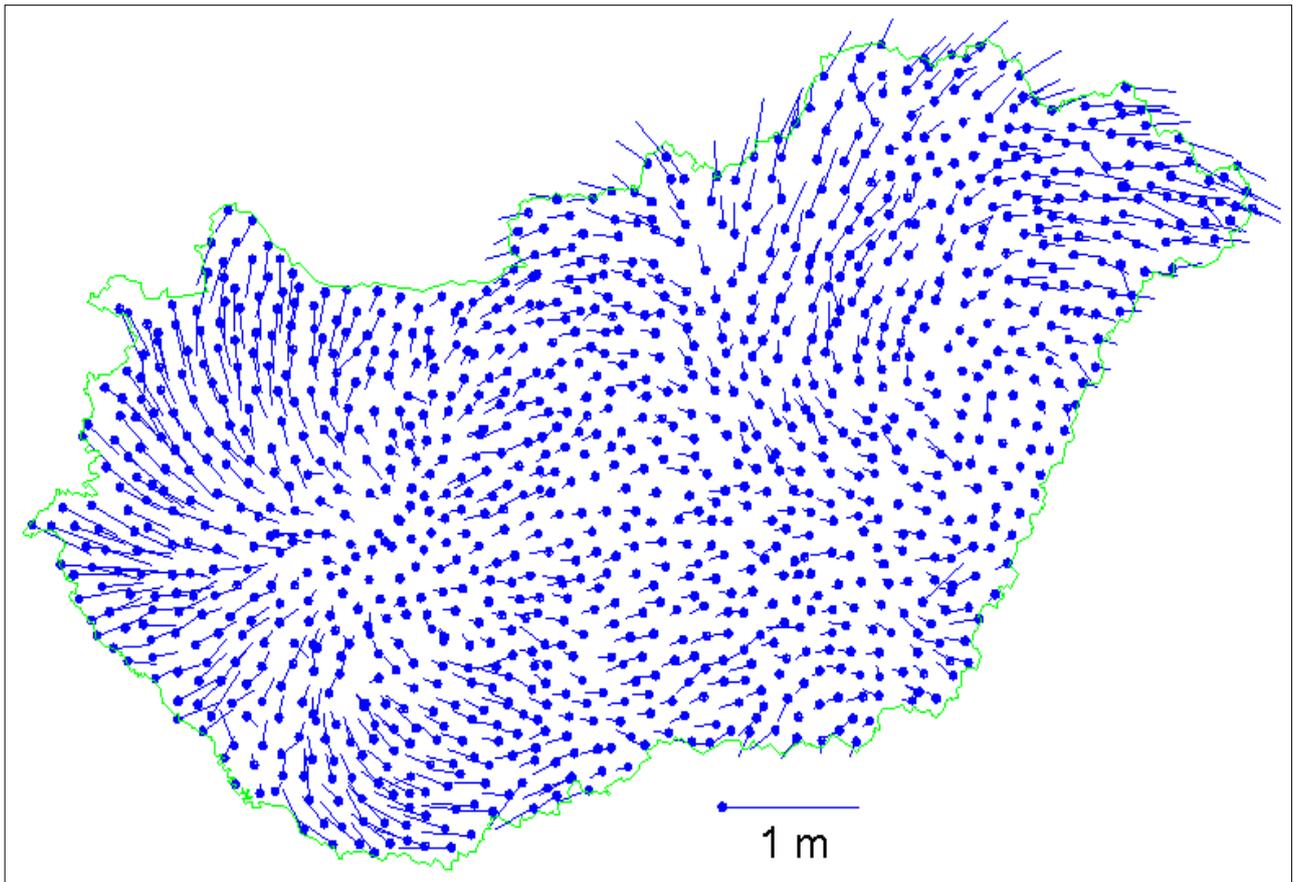


Fig. 5 Sites of the National GPS Network (OGPSH), Hungary

An OGPSH Database was created and is operated by FÖMI. The database contains the most important data of the GPS control sites as site identifier, the EUREF and the EOVS vertical and horizontal co-ordinates as well as the site location (county, settlement and sheet number), site-access description and scanned site sketch.

The superior accuracy of the OGPSH allows 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 shown in (Fig. 6). The maximal residuals are about 0.5 meters at the edge of the network.

In order to better serve the surveyors and avoid misuse or misinterpretation of the ETRS89/EOV transformation software tools were made available to perform the cm-accuracy transformation. The free EHT software uses local 7-parameter transformation and may be used for post-processing. A new version of the software has been prepared and may be downloaded from the GNSSNET server ([www.gnssnet.hu/downloads/EHT4.1\\_Setup.exe](http://www.gnssnet.hu/downloads/EHT4.1_Setup.exe)), where the latest geoid has been built in resulting improved reliability for the transformed height component. The VITEL solution is designed for real-time applications and available for a nominal fee. The software and the integrated database may be built in the rover GNSS receivers and provide cm-accuracy transformed coordinates in our national EOVS system.



*Fig. 6 Horizontal transformation residuals at the OGPSH sites*

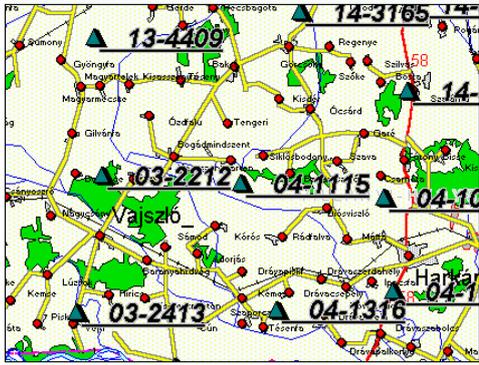
<p align="center"><b>OGPSH PONTLEÍRÁS 2007</b></p> <p align="center"><b>A hálózat pontosított elhelyezésével az ETRS89/ETRF00 vonatkozási rendszerben</b></p> <p align="center"><b>GPS SITE DESCRIPTION FORM 2007</b></p> <p align="center"><b>Updated ETRS89/ETRF00 reference frame realization</b></p>			
<p><b>A pont EOVSzáma:</b> 04-1115</p> <p><b>EOV identifier:</b></p>		<p><b>Település:</b> Hegyszentmárton</p> <p><b>Settlement:</b></p>	
<p>Kiválasztotta: Paulik Sándor, 1997</p> <p>Selected by:</p>		<p>A pont jellege: HP</p> <p>Type of the site:</p>	
<p>Pontvédelem:</p> <p>Safety construction:</p>		<p>Special information:</p>	
ETRF00(R05)	X= 42300079,291	Y= 2381675,815	Z= 4556995,642
ETRF00(R05) WGS84	46-53-28.4104	10-6-2.3514	h= 215,899
EOV	y= 555501,39	x= 22270,24	H <sub>GPS</sub> = 171,24
<p align="center"><b>Megközelítési leírás (Approach description)</b></p> <p>Hegyszentmárton templomától a temető felé DK irányba haladva, 2.3 km után található a pont, az út mellett 7 méterre, a 47-es számú villanyoszlop közelében.</p>			
<p align="center"><b>Megközelítési térkép</b></p> <p align="center"><b>1 : 200 000</b></p> <p align="center"><b>scale map for approach</b></p>		<p align="center"><b>Helyszínrajz</b></p> <p align="center"><b>Site sketch</b></p>	
			

Fig. 7 Sample description form of the OGPSH network sites

## The Hungarian Active GNSS Network (GNSSnet.hu)

The Hungarian GNSS reference station infrastructure and services have been established by the GNSS Service Centre (GSC) of the Institute of Geodesy, Cartography and Remote Sensing (FÖMI). The network consists of 35 Hungarian GNSS stations. In addition to these, observation data of 19 stations from the neighbouring countries is collected and processed in real time to provide nationwide homogeneous coverage with cm-accuracy services. The average inter-station distance is less than 60 km, enabling accurate modelling of distance-dependent errors like ionosphere, troposphere and orbits. All of the Hungarian stations and most of the integrated external sites are equipped with state-of-the-art GPS+GLONASS hybrid sensors and individually calibrated choke-ring antennas. Seven units are also Galileo ready.

The GNSS Service Centre uses the GNSMART network RTK software package (Geo++ GmbH) to provide reference data for both real-time and postprocessing applications.

Real-time data is provided via the Ntrip protocol in various formats:

1. single station DGNSS data in RTCM 2.1 and RTCM 3.0 formats,
2. single station RTK data in RTCM 2.3, RTCM 3.0 and CMR formats,
3. network RTK data in RTCM 2.3, RTCM 3.1 and CMR formats.

All major network RTK concepts (PRS, FKP and MAC) are supported.

RINEX and virtual RINEX data is provided for post-processing via the GSC website in RINEX version 2.11 format.

Since January 2013 we are running a new service (autopostGNSS) supporting users who want to run the post-processing of their own field measurements in our dedicated server using the SSRPOST module of GNSMART.

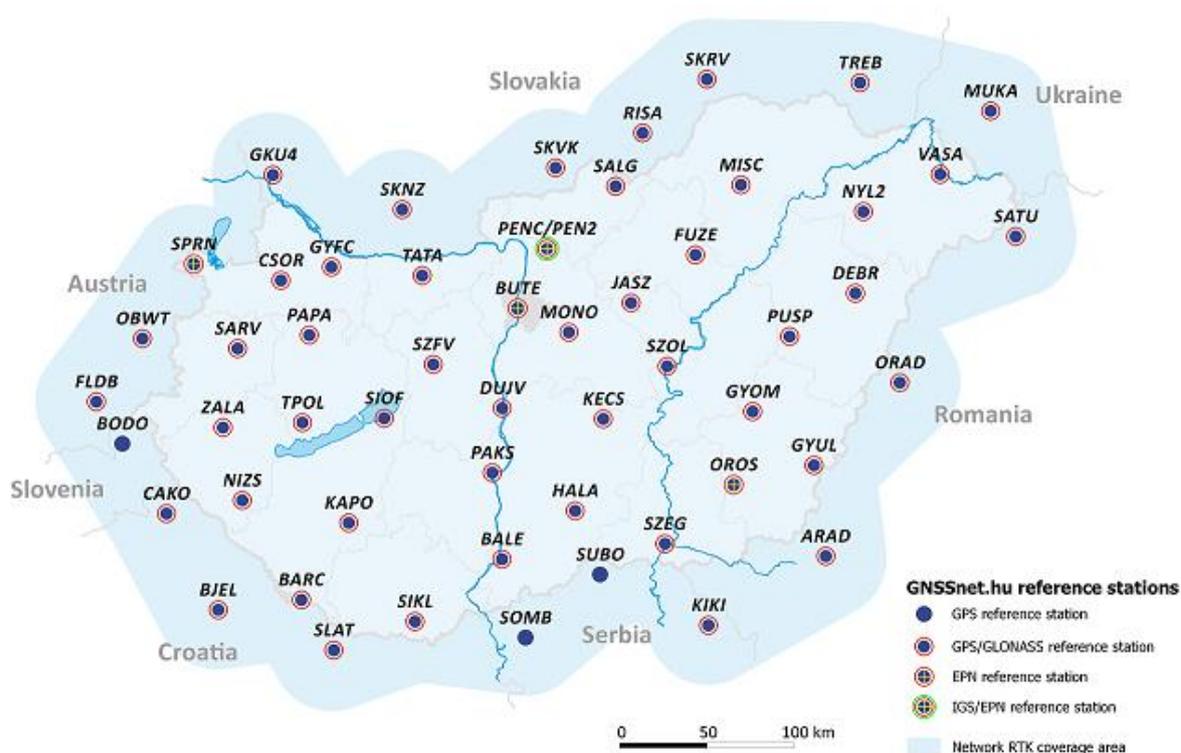


Fig 8 The Hungarian Active GNSS Network – GNSSnet.hu

GNSSnet.hu reference station coordinates are determined in ETRF2000 reference frame. Transformation to the Hungarian local grid (EOV) is supported in both real-time and post-processing mode. A new online transformation service (EHT) is provided at the GSC website and a significantly improved real-time version (VITEL) is available for most receiver brands as an extension of the RTK rover receivers' controller software. The transmission of transformation information via RTCM messages is also supported.

The GSC concentrates its efforts on service quality improvements. Besides the automatic quality control of the GNSMART software the GSC developed a number of real-time and post-processing quality monitoring tools for both internal use and information dissemination to the clients. The current status of the service can be monitored online via the GSC website: <http://www.gnssnet.hu>. A special monitoring tool has been developed for mobile phones. This enables users working on field to judge whether the system performs according to expectations.

### **Integrated Geodetic Network (INGA)**

In 2008 FÖMI, in agreement with the academic institutions initiated the realization of the Integrated Geodetic Network, called INGA. At the INGA benchmarks GPS, levelling and gravimetric measurements are performed and their coordinates are expressed in all geodetic reference frames available in Hungary (EOV, ETRS89, EOMA). The points are primarily selected from levelling benchmarks, where undisturbed GNSS measurement is possible. The MGGA (National GPS Geodynamic Network) sites are part of INGA by default and also the suitable markers of the Hungarian Gravity Base Network are incorporated. New markers are only installed where the network geometry could be guaranteed from existing sites. The INGA site separation is about 15-20 km, the country will be covered by some 1000 benchmarks. The INGA sites will have enhanced physical and legal protection to ensure the long term existence of the network and the represented reference frames. This work was started in 2007 at the NE part of Hungary and by 2014 the network establishment had been completed east from river Danube. Further continuation of the network realization is pending.

The GPS/levelling information at the INGA sites is used to create the Hungarian Height Reference Surface (HRS), which is the reference of the heights measured by GNSS. This HRS is embedded into the RTK GNSS receivers and provides direct access to physical heights through field GNSS measurements. Additionally an online transformation tool (EHT) is made available for the users to transform the ETRS89 3D coordinates into the national physical height system, EOV.

### **State Boundary Surveys**

The total length of Hungary's boundary lines with seven neighbouring countries is over 2200 km. On these lines more than 50 000 corner points can be found, which are recorded in different coordinate and map systems (4 types) that were valid at the time of the peace treaties. The state boundary survey is performed by the Division of State Boundary Survey of FÖMI. The roles of the Division are the followings:

1. tasks of surveying, updating and maintaining the state borders coordinated by the Police (Ministry for Home Affairs),
2. production of detailed technical summaries in boundary documents for jobs accomplished with the experts of the neighbouring countries and approved by competent authorities,

3. tasks concerning the obligations of the owners of the border markers.

The accurate technical border documentation edited by the Division, verified by international agreements and kept at FÖMI, contains the co-ordinates of the corner points and their descriptions. Thus, these serve as a technical (surveying) basis of any international contract related to the state boundaries.

Besides the daily routine, the Division is responsible for a unified co-ordinate and map system covering the whole Hungarian state border and for regulations, which will meet the current demands and will be compatible with future surveying jobs in Hungary.



*Fig. 9 Hungarian-Slovakian-Ukrainian triplex state boundary mark*

## **Remote Sensing Activity in Hungary – Scientific, Activities, Results and Applications**

### **The maintenance and updating of Hungarian Land Parcel Identification System (LPIS-Hu)**

Past decades justified the significance and advantages of a continuously evolving scientific and technological background of using remote sensing methods for agricultural purposes. The Land Parcel Identification System (LPIS-Hu) and Control with Remote Sensing (CwRS) play an important role in the system of the agricultural area-based payments in the EU Member States. The preceding R+D phase and the operational years of the National Crop Monitoring and Production Forecast program (NCMPF, 1997-2003) that had been carried out by FÖMI provided a good basis for the establishment of LPIS-Hu and CwRS.

The LPIS-Hu ('MePAR' in Hungarian) is one of the main ongoing activities of FÖMI Directorate of Agriculture and Rural Development (DARD) and its predecessors since 2002. After the establishment of the ortho-photo background and the GIS database of LPIS-Hu, the system was integrated into the Integrated Administration and Control System (IACS) as one of its main components, and it has been the basis of area-based agricultural subsidies since 2004. As a pillar of IACS, it provides geospatial and administrative support for the farmers during the

procedure of area-based subsidy applications, and for the IACS institutes during the administration and different control procedures.

### Basic data and thematic layers

The system is based on physical blocks with natural boundaries (Fig.10), which was found to fit the most appropriately the country's agricultural utilization characteristics. In 2015, the entire territory of Hungary is covered by approximately 412 000 physical blocks, with an average size of 22.5 ha. The base and background of the vector data are ortho-photos. Satellite images are also used during the updating process. About 180 000 farmers participate in the Single Area Payment Scheme (SAPS). In this framework, farmers indicate the agricultural parcels they use.

The Community's agricultural policy puts an emphasis on efficient agro-environmental and rural development actions for sustainable development. Within these actions, farmers are compensated by subsidies if they obey certain restrictions and follow some technological instructions to protect environment. Beyond basic data, LPIS contains thematic layers contributing to the management of agri-environmental and rural development subsidies. These layers were established following the legal requirements and the needs of newly introduced subsidy schemes. Some of them are the Vulnerable Water Bases (since 2006), layers of various landscape features (since 2010), water protection buffer strips (since 2012).

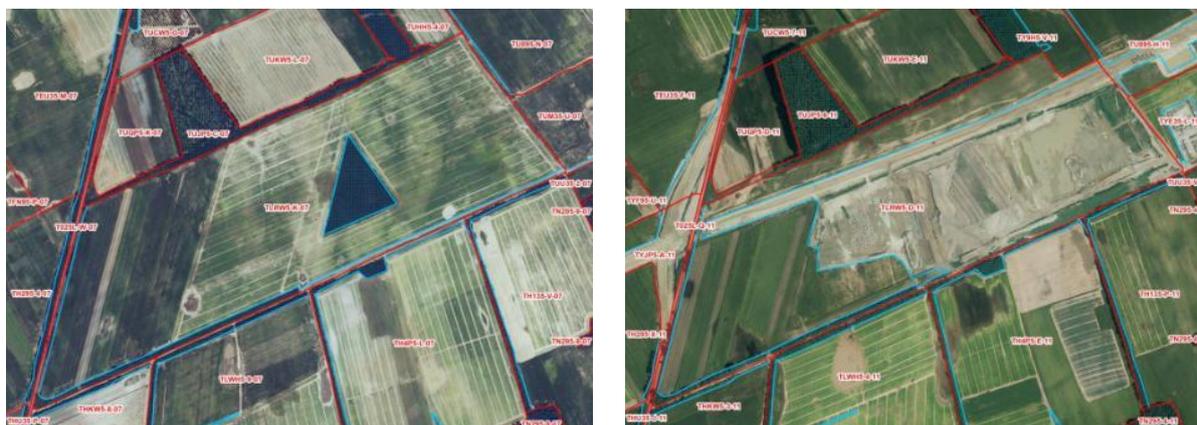


Fig 10 Illustration of the LPIS-Hu (MePAR) GIS database with orthophoto background (red – block boundaries, cyan – boundaries of ineligible areas)

### Systematic LPIS update, change management and quality assurance

LPIS must be up-to-date as much as possible to efficiently support application and control process, which is achieved by three procedures. In the framework of four-year updating cycles, about one fourth to one third of the country is systematically updated every year. Clients (farmers) make requests for modification in case they notice difference between LPIS data and actual cultivation structure. Some modifications (called 'block reviews ex officio') are made during processes carried out by the Paying Agency or by FÖMI – for example, classical field checks or remote sensing controls. These review procedures are mainly carried out using ortho-photos (see Fig.11), but high and very high resolution satellite images as well as field inspections also support decisions.

Failure of the LPIS in unambiguous localisation of each agricultural parcel induces risks of double declaration of land, whilst inadequate quantification of eligible area renders the cross-checks ineffective in the identification of over-declarations by farmers, both involving financial risks for the EU Funds. Therefore the European Commission introduced a quality assurance framework, a series of tests assessing compliance with specified quality requirements. From 2010, execution of the LPIS test is compulsory for every Member State.



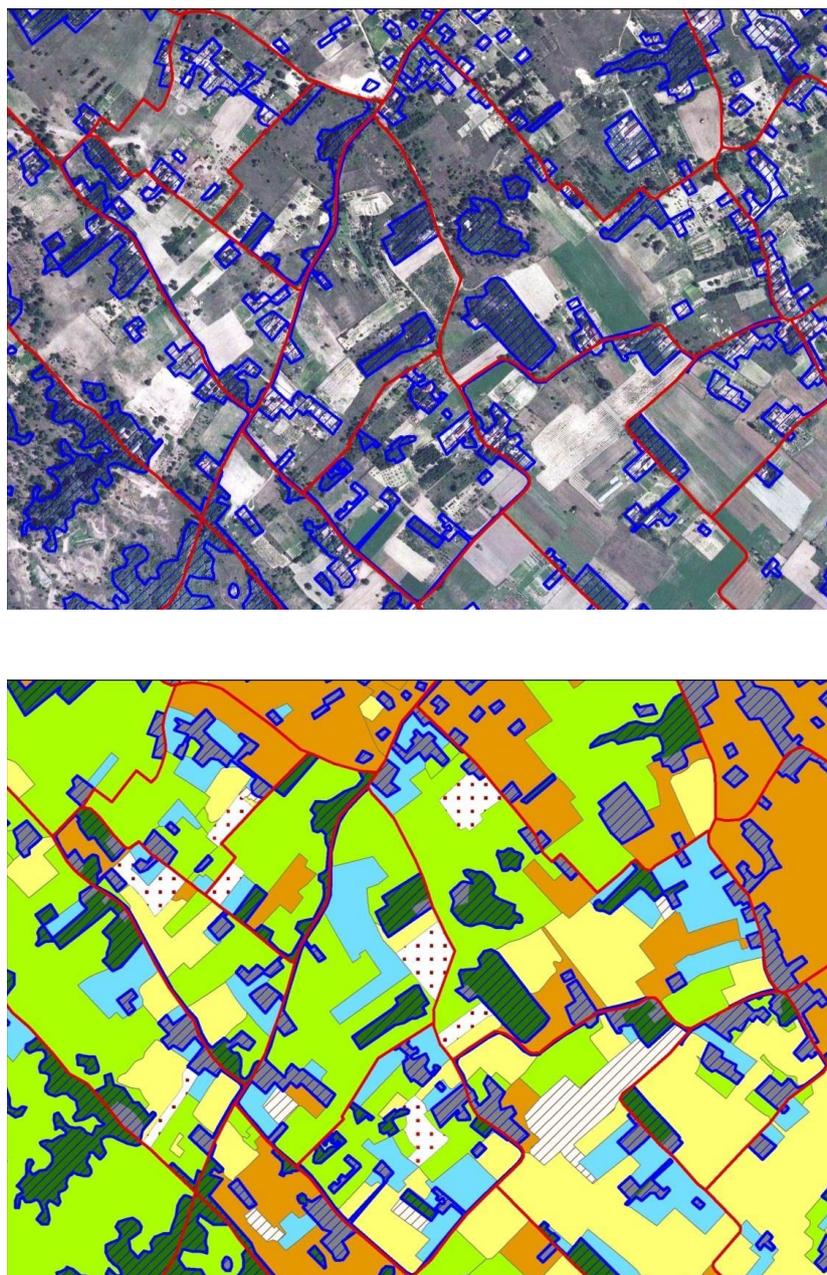
*Fig. 11 It is an example of review and change management of physical blocks. In the left hand side image the MePAR state of year 2010 (delineated on the basis of year 2007 ortho-photos), while on the right hand side image that of 2012 (delineated on 2011 ortho-photos) is seen. The reduction of eligible area is caused by road construction.*

## Recent developments of LPIS

FÖMI developed a workflow-driven GIS software that integrates ortho-photos, satellite images and vector data. This software supports the individual review of LPIS physical blocks and also the recording of changes. The most recent developments regarding the system cover the version update of the underlying PostgreSQL database and ESRI ArcGIS software and the distribution of spatial database into several repositories in order to improve performance.

MePAR regularly undergoes important improvements following the regulatory changes and the findings of audits. The most spectacular development in the past years was the introduction of so-called MePAR Land Cover. It is a part of MePAR, uses its methodology and basic logic, and it was established using visual interpretation, but its thematic accuracy is much deeper, resulting in more detailed geographical delimitation (Fig. 12). In Hungary there is no other system with this resolution, accuracy and frequent update period, using visual interpretation and raster data as data source. MePAR Land Cover system primarily contains agricultural areas, subdivided by different land use (e.g. arable land, pastures and plantations). The categories even at the topmost level of hierarchy are defined on the basis of eligibility, and the category system is more detailed within eligible areas. The main purposes of MePAR Land Cover are to improve the efficiency of control of area-based subsidies, to provide statistical data for developing new agrarian strategies, to help the creation of new thematic layers and to help tracing agricultural changes.

Currently the most active development of MePAR is connected to the reform of Common Agricultural Policy. It entered into force in the beginning of 2015, and it determines the trends of agricultural subsidies until 2020. It has been a hard work since 2014 to prepare all the necessary additional thematic layers that support the claim submission and the control process in the new framework. Beyond visual interpretation, automatic digital image processing methods – including Object-based Image Analysis (OBIA) – are incorporated.



*Fig. 12 It is an illustration of the difference in the thematic accuracy between the 'base MePAR' and the MePAR Land Cover. In the upper image ineligible areas are shaded with blue. In the lower image many different categories can be seen, for example: yellow – arable land, light green – pastures and meadows, red dots – fruit plantations, brown lines – vineyards, dark green – forests and groups of trees, grey – built infrastructure.*

## Area-based Subsidy Control with Remote Sensing (CwRS)

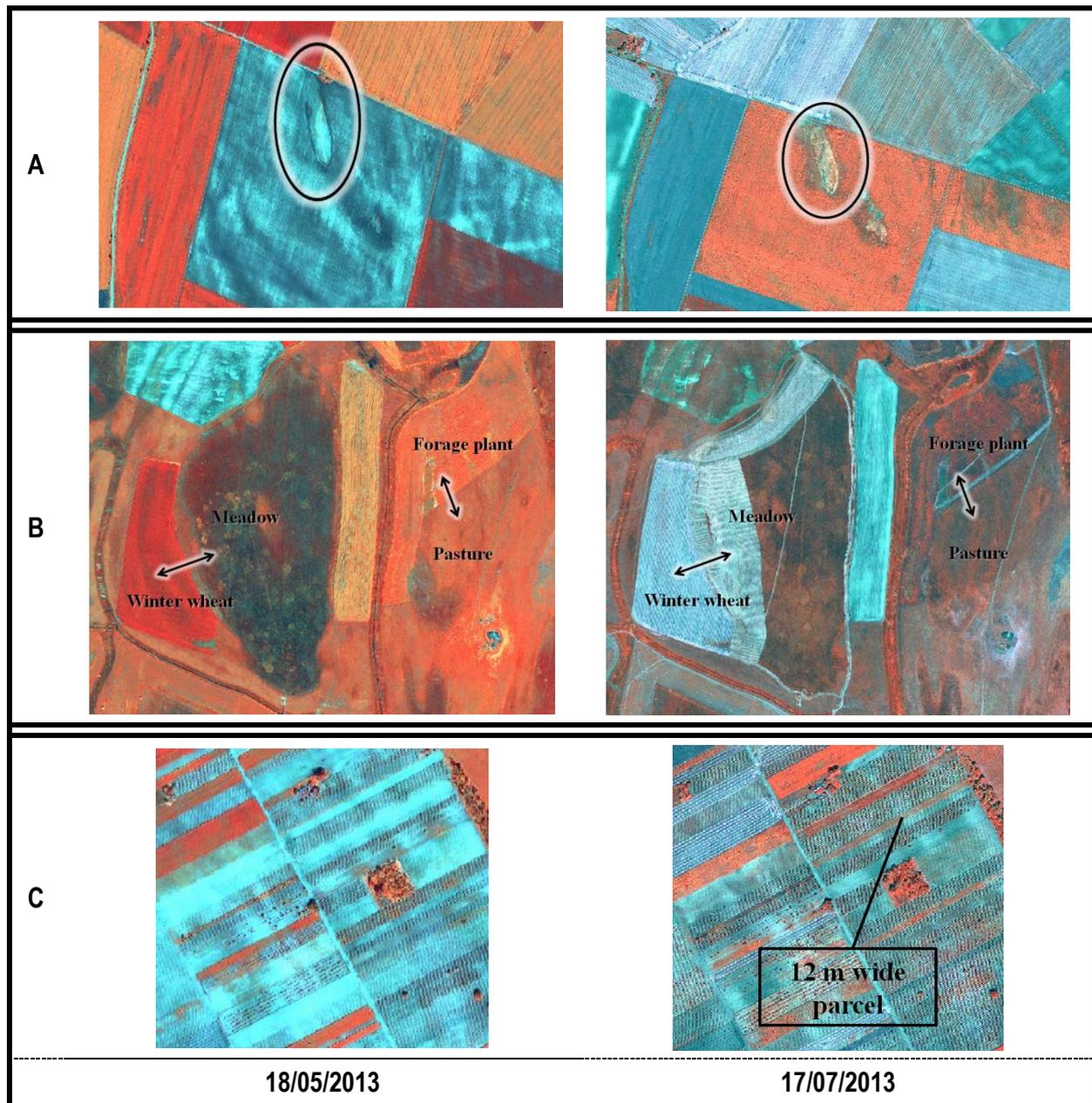
The methodology and technology of the NCMPF can be used not only for information extraction at county and regional level, but also on agricultural parcel level to control agricultural subsidy claims with the use of satellite images.

Since 2004, the EU accession, the Agricultural and Rural Development Agency (ARDA) is responsible for the administration and control of applications of area-based subsidies. Remote sensing control ran on the basis of Land Parcel Identification System (LPIS-Hu). The applications for area-based agricultural subsidies consist of alphanumeric and vector data. Since 2008, subsidy claims can be submitted only electronically, via an Internet application.

The control of selected claims is the role of FÖMI. The core task is actual remote sensing control using satellite images, called Computer-Assisted Photo-Interpretation (CAPI). The aim of CAPI is to answer three questions for every declared parcel: whether the declared crop can be observed in the parcel, whether the declared area is correct and whether the parcel complies with the standards of Good Agricultural and Environmental Conditions (GAEC). High resolution (HR) image time series are used to determine crops, while exact area measurement is done using current very high resolution (VHR) images (Fig. 13). Since 2013 two relating methodological improvements help CAPI. Firstly, using two VHR's is very helpful in territories having variant crops with different growing seasons (Fig. 14). Secondly, stereo VHR provides altitudinal data. With the help of significantly different viewing angle the obstruction of clouds can be avoided and the nadir of high elements can be determined more precisely.



*Fig.13 It is an example of time series used in Computer-Assisted Photo Interpretation*



*Fig.14 Benefits of using two VHR images in one zone*

*A: for GAEC check (weed on formerly inland water patch),  
 B: if we cannot determine the strict border of parcels using only one image, and  
 C: at narrow parcels where HR images cannot help at crop determination.*

In Hungary, most area-based subsidies consist of two parts: SAPS (Single Area Payment Scheme) and Top-Up (Complementary National Direct Payments) with somewhat different conditions. The definition of agricultural parcel and GAEC regulation has changed over years; in 2014 twelve standards were monitored.

CAPI is carried out on several (18-30) graphic workstations, with a central database and automatic task distribution. The results of control are delivered to ARDA in digital form, containing tabular and geographical data. Since 2013 both the claim database and the result

database of remote sensing control are delivered using a newly developed interface between ARDA and FÖMI. ARDA carries out follow-up checks based on the control results before the final decision on the acceptance or rejection of a claim. The format and structure of control documents – i.e. electronic database and vectors in GIS – have also been improved to allow the most effective implementation of follow-up checks. The overview of the control procedure is shown in Fig. 15.

In the EU system, the total number of submitted claims in Hungary are between 175 000 and 200 000. Out of these, about 9 000 - 12 000 is controlled with remote sensing every year. This can be considered as a rather big sample as compared to other member states. The only feasible solution to carry out successful control of this amount of dossiers (4–6%), within a very short period of time, is the use of remote sensing and GIS techniques for the majority of the claims.

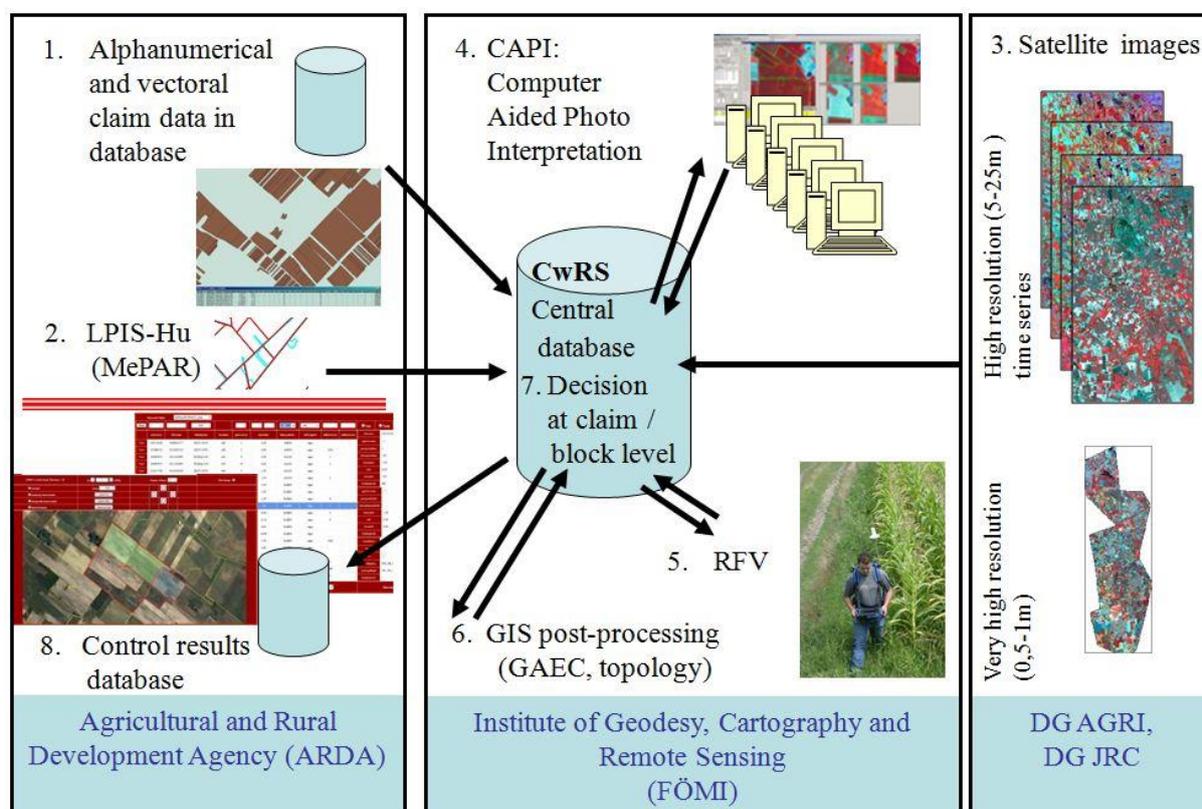
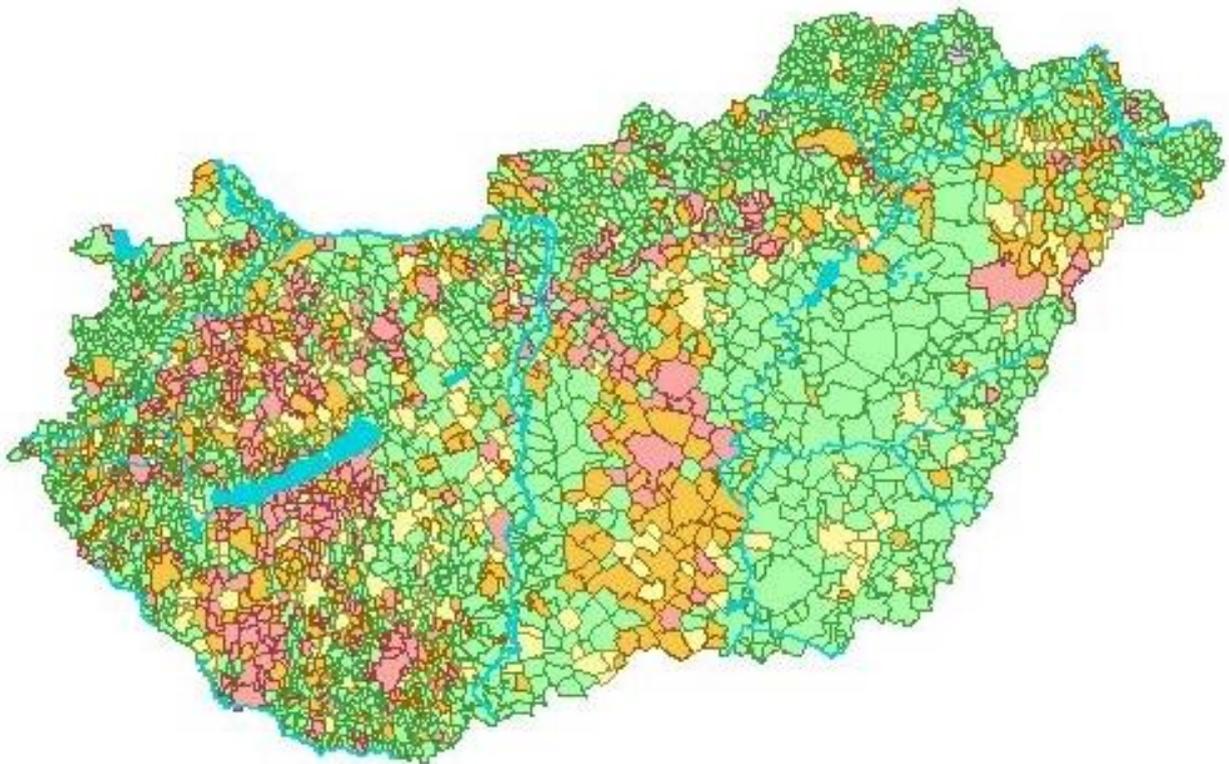


Fig.15 Basic elements of Area-based Subsidy Control with Remote Sensing

## Remote Sensing Applications Supporting the National Ragweed Control Program

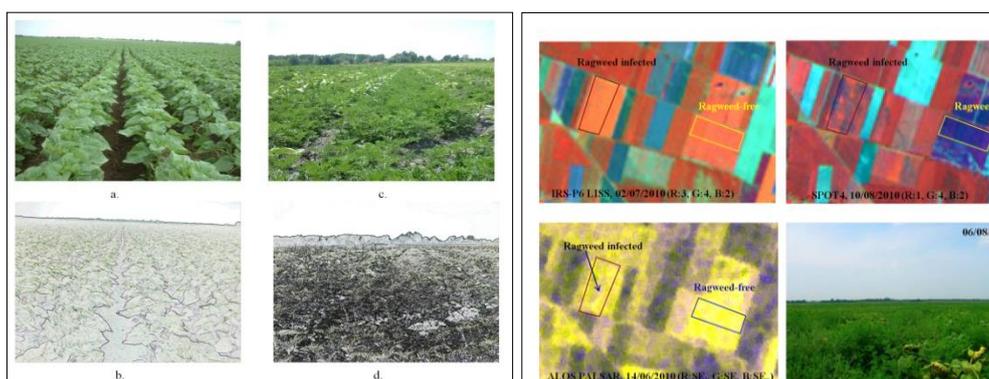
Ragweed pollen-induced allergy has gradually become an important issue in Hungary. The number of people suffering from pollen allergy had been increasing so that there was an imperative need for a National Ragweed Control Program.

The Ragweed Control Program has been operational since 2005. The introduction of four high-tech components (RS+GPS+GIS+web) was inevitable to basically improve the traditional ground-based ragweed control system in Hungary. The remote sensing assessment covers the whole arable land and helps in the optimization of in situ measurements and their documentation. (Fig.16)



*Fig.16 Ragweed-infection in 2011*

**Polarimetric radar and optical satellite data were used to identify ragweed infection in sunflower.** Geometrical changes can be well identified by using polarimetric radar images (RADARSAT2, ALOS PALSAR) with different wavelengths (C-, L-band) and different polarizations (quad, dual). (Fig.17)



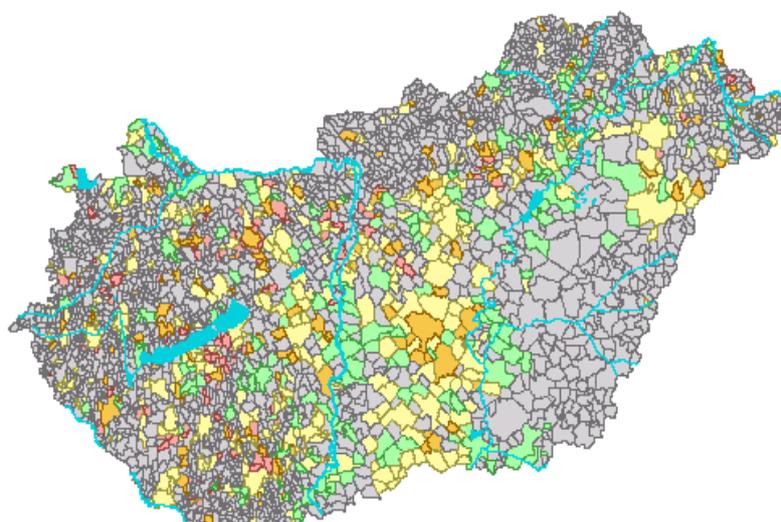
*Fig. 17 Ragweed-infected and ragweed-free sunflower parcels on optical and radar polarimetric images compared to photos taken on the spot*

FÖMI analysed agricultural damages in different croplands which result in structural changes. To develop and extend the present method is worthwhile as ragweed infection identification system is expeditious, objective and economical. The development of the system creates the possibility to identify the spread of ragweed infection in sunflower fields on larger areas and to forecast the following year's infection.

## Central Ragweed Information Server

The Central Ragweed Information Server (CRIS) was developed in order to synchronize tasks among different authorities. The CRIS has been supporting the operative work from 2006. The ragweed risk maps produced by FÖMI are published in CRIS as input data for on-the-spot checks, which are exported to the dedicated integrated hand-held GIS-GPS equipment. The Server synchronizes 400-500 people's work in the most critical period of July-September.

The Ragweed Control Program primarily builds on the co-operation of land users. Spatial statistics of ragweed infection are available for the public in the form of electronic maps, via the web sites of FÖMI and MRD. The server provides multi-day trainings for users, and has undergone further major improvements, which were driven by the needs arising at different institutions participating in the program. (Fig. 18)



*Fig. 18 Eradication of ragweed and activities about ragweed infected parcels executed by different authorities in 2012*

## Development of Agricultural Risk Management System (MKR project)

The objective of the MKR project is to support the setup of an information development which should meet all the requirements of a damage liability system entirely. Its accentuated aim is to level up services provided for stakeholders (individuals, enterprises, companies), to support administrative liabilities of contributors involved.

According to its role in the project - in case of drought, waterlogs and floods - FÖMI is supposed to provide thematic maps of assessments of damages generated by remote sensing processes by using satellite data.

These maps provide more detailed information about the areas damaged or affected. These analyses - as in most cases they are applicable to substitute on-the-spot checking - provide significant support in reconsideration of damage-relief applications. (Fig. 19)



*Fig. 19 On the spot checking of waterlog, 2013*

## Drought monitoring

The provision of quick, objective, reliable and homogenous information about development and impact of these kind of disasters is very imperative at local and regional scale. Remote sensing is an excellent tool for this purpose.

After the waterlog descending at the beginning of year 2011, we had to face up to lack of precipitation (0.4 per cent of the average for that period of the year) – in comparison to the annual yearly statistics. Monitoring of drought in August and November had been carried out by remote sensing (Fig. 20).

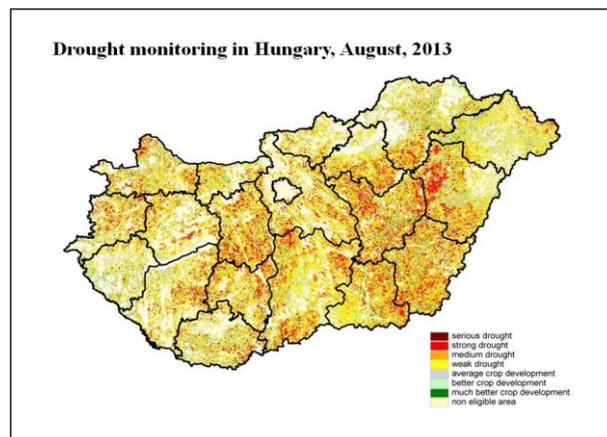
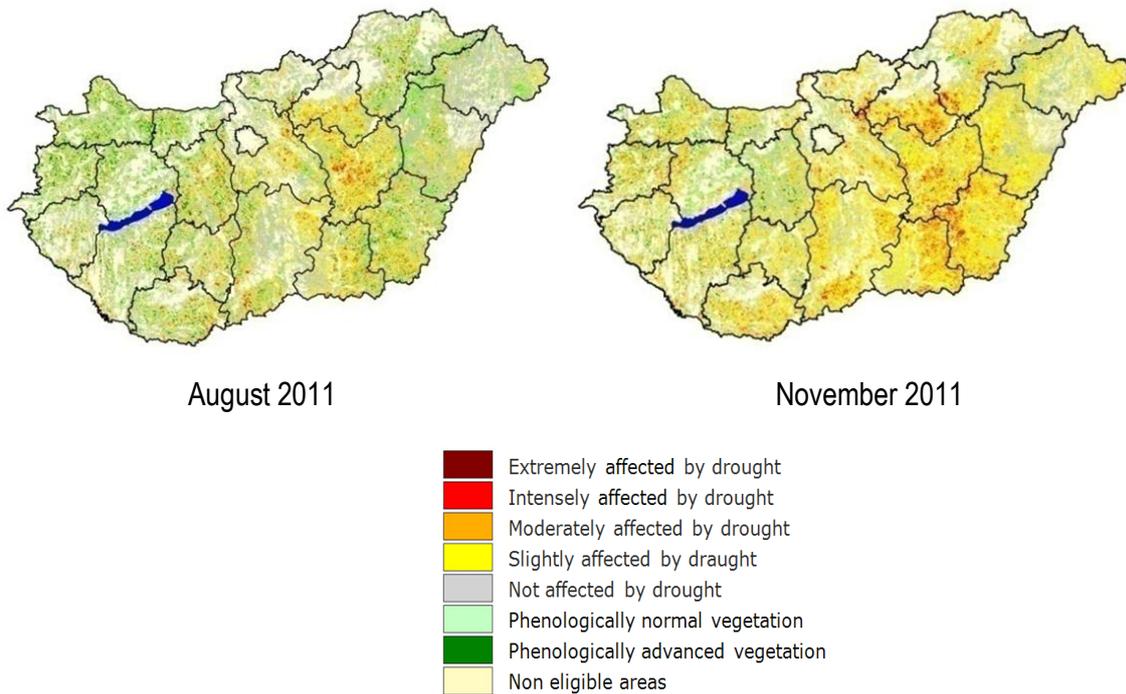


Fig. 20 Amount of drought

## Waterlog monitoring

Hungary experienced extreme amount of precipitation recently, affected mainly the croplands of the Great Hungarian Plain. According to the data received from OVF waterlog coverage reached its peak in April, 2013 and foreshown the eventuality of further damages in agricultural production.

In the frame of MKR project (Development of Agricultural Risk Management System) FOMI started surveying waterlog by remote sensing. Evaluation of HR satellite images (IRS-Resourcesat2 LISS, SPOT5, Landsat TM7 and ETM8) has been carried out, classified the affected areas according to the categories below:

open waterlog / flooded area      204 322 ha

soil seriously affected by waterlog      26 096 ha

soil moderately affected by waterlog 10 3384 ha  
soil slightly affected by waterlog 21 7540 ha  
vegetation in water 170 548 ha

Waterlog maps are constantly forwarded to other institutes involved in MKR project. (MVH, NÉBIH, OVF, OMSZ, AKI). (Fig.21)

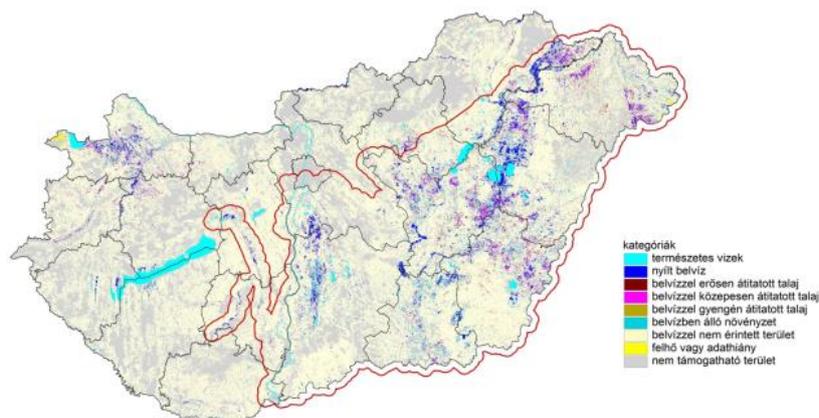


Fig.21 Waterlog map generated by evaluation of SPOT5, IRS LISS/AWiFS, Landsat TM7/8 optical satellite images acquired between 9/4/2013 - 1/5/2013

## Hungarian GIS Register of Vineyards (VINGIS)

### The Hungarian National Vineyard GIS

In 2001 – to fulfil EU and national professional requirements – the Hungarian Ministry of Agriculture entrusted the Remote Sensing Centre of the Institute of Cartography Geodesy and Remote Sensing (FÖMI TK) with the development and maintenance of the Geographic Information System (GIS) supported Hungarian National Vineyard Register (VINGIS).

VINGIS supports vineyard registration and serves as the basis for checking and supervising subsidy distribution of vineyard uprooting, planting and restructuring as well as allocating the subsidy paid on vineyard-basis. It has significant role in improving the quality production and market competitiveness, it assures the protection of the designated origin and takes action against adulteration of wine.

Since 2005 for each restructuring claim and since 2006 for each uprooting claim individual ortho-photo based maps were printed using VINGIS. Beside cartographic information other technical data supporting the control were added to these documents. The experience of field inspectors show that without these individual VINGIS maps the accuracy of the on spot checks, and the identification of the target area could not be satisfactory.

Since 2006 the <http://www.vingis.hu> website is available (Fig. 22).

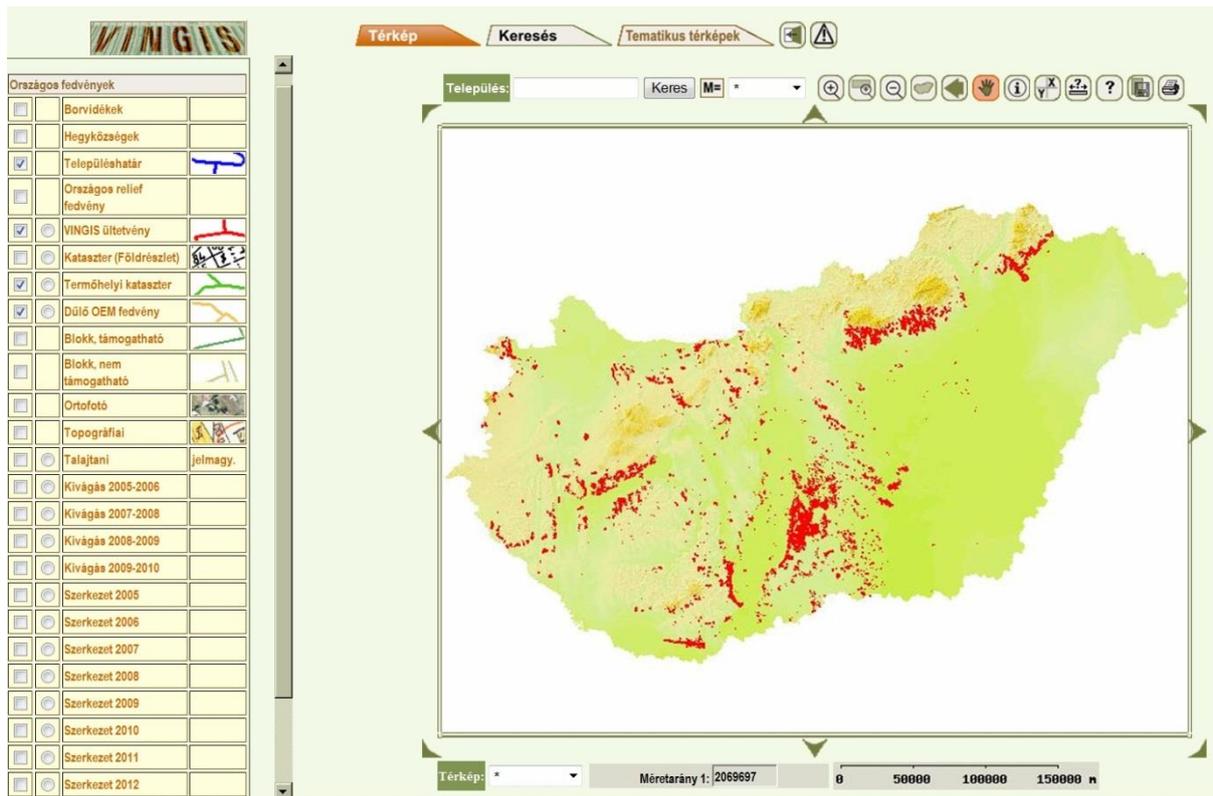


Fig. 22 Vineyards on VINGIS web server

The VINGIS web server provides opportunity for the controlling authorities to pre-filter incoming claims and to check specific key information related to subsidy claims. Currently VINGIS has about 450 personal users from the professional authorities and organizations such as Ministry of Agriculture, Agricultural and Rural Development Agency, Central Agricultural Office, Research Institute for Viticulture and Oenology, Land Offices, National Council of Wine Communities and all Wine Communities themselves.

## The eco-potential maps for vine-growing

The analogue maps of eco-potential for wine-growing (the area suitability for wine production) – see Fig. 23 – were developed and maintained by the Research Institute for Viticulture and Oenology (SZBKI). The goal of mapping the suitability of wine-growing fields is to appoint the best areas for wine production.



*Fig. 23 A map on ortho-photo background showing the classification of the areas for their suitability of wine-growing*

The digital integration of these maps into the VINGIS system was very useful for the administrators of vineyard communities in their daily work to draw the certificate of new plantation. It is also a requirement, because according to the law, subsidies can be paid for vineyards only if they are planted on areas suitable for wine production.

This map shows the ecotops (basic units of wine-growing areas characterized with equal ecological marks – i.e. essential descriptive data) contoured by polygons and appraised with numerical values. The maps linked to the attribute tables of the detailed features show the difference between the areas with different numerical values. The system ensures to define clearly the vineyards which ecotop they belong in. The corrected area of wine (registered ecotops) is one of the basic data of the submitted product descriptions' map insets. After the additions of previous years, currently 9 753 ecotops (440 368 ha) are included and published in the eco-potential layer of the VINGIS.

## **Designations of origin and geographical indications**

VINGIS has also become part of the system of protecting wines with designated origin and geographical indications. Regulations introduced a universal frame concerning different wine-growing regions. This sort of classification uses product specification which consists of the name to be protected and the demarcation of the geographical area concerned (including lot numbers) documented by VINGIS. In the whole country wine with protected origin can be produced only from designated locations.

The delimitation of the vineyard sites is important to evaluate the quality and the price of the wine. Displaying any kind of information on label concerning geographical origin is allowed if this information is validated by VINGIS. Each professional state and trade organisation is

VINGIS user therefore monitoring and supervising the wine market has become a real possibility.

There are 5 wine-growing regions in Hungary having fully completed designations of origin and from 22 wine-growing regions geographical indication regulations were achieved. The drafting of product descriptions, which was the tasks of all member states, directed the attention to several problems the solution of which cannot be postponed, yet the whole wine-viticulture sector would benefit from the expected favourable results.

The 40 year old suitability eco-potential maps receive a new form. As the result of the cartographic correction (the border of cadastre is corrected to ortho-photographs), it could be defined from each plantation if it is included in an area suitable for wine-growing. In some cases producers have a couple of years to initiate the inclusion of their plots to a wine-growing area and till this time these plantations are ranked provisionally at class II.

The process of the deposition and the judgment of requests for community protection of the designation or geographic origin denomination of a wine are regulated by EU and national legislation. According to this, a VINGIS map must be attached to the request for product description. The law of wine defines that VINGIS is the suitable geoinformation system in conformity with the community regulation of the wine sector cadastre, which is the base of the payment of subsidies for vineyard uprooting, planting and restructuring, as well as of the cartographic control of the geographic delimitation of the wine production sites marked with geographic denomination under protection or protected designation of origin.

One layer of the VINGIS map is called 'the smaller geographic unit' or 'vineyard site' which is approved to be marked. Its name should be written as it is defined in VINGIS. The map production process is regulated by the policy elaborated by FÖMI and HNT (National Council of Wine Communities).

An electronic version of the map is deposited at the Ministry on a DVD to which the product description refers, together with the documentation containing its proclamation. In the document it is unambiguously defined which plantations belong to certain vineyard sites. The protected vineyard sites are also registered in the vineyard site maps of VINGIS (Fig. 24).

Based on the orders FÖMI has delimited 1482 vineyard sites. Moreover it accomplished the overview maps and vineyard site maps of 37 product descriptions which were submitted to the Ministry of Rural Development. 30 of 36 pertain to 'protected denomination of origin' product category and 7 of 37 have 'protected geographical indication' product category. The new product descriptions were sent to the European Commission by the end of year 2011. From 2012 the modification claims of these product descriptions are being processed.

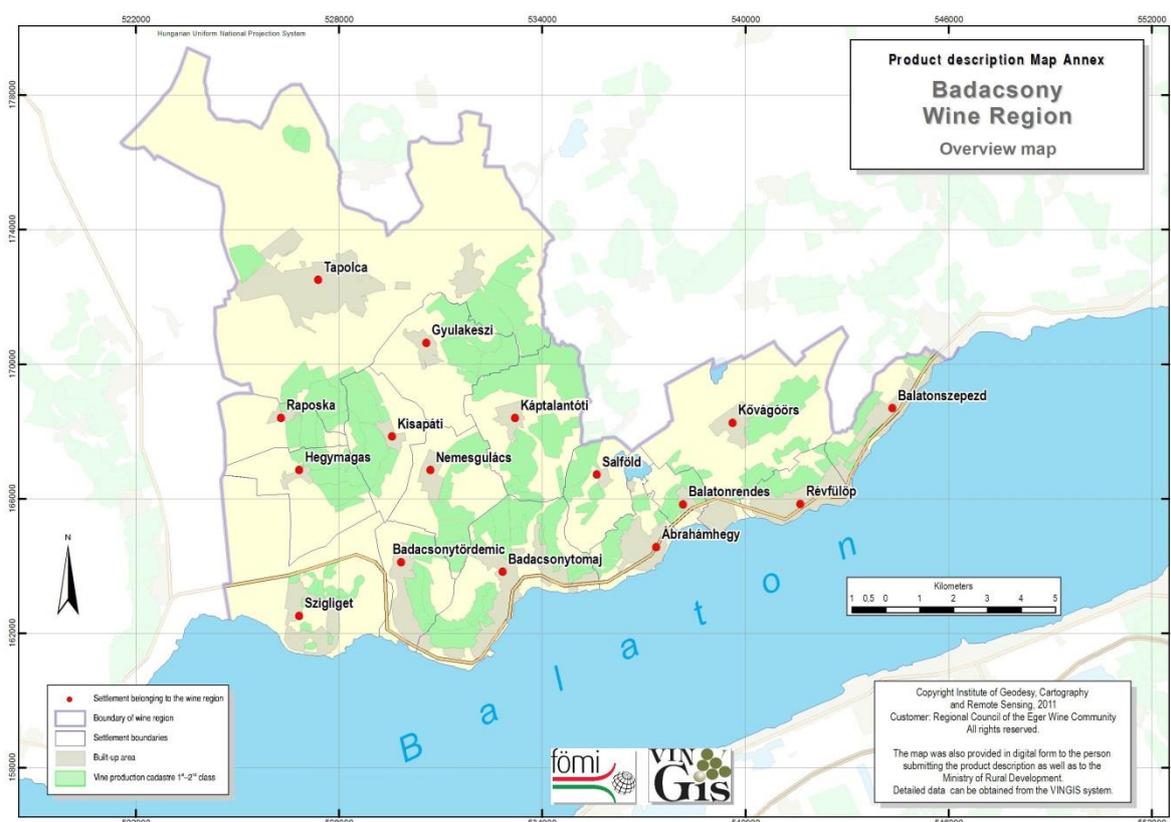


Fig. 24 The overview map inset of the Badacsony product description

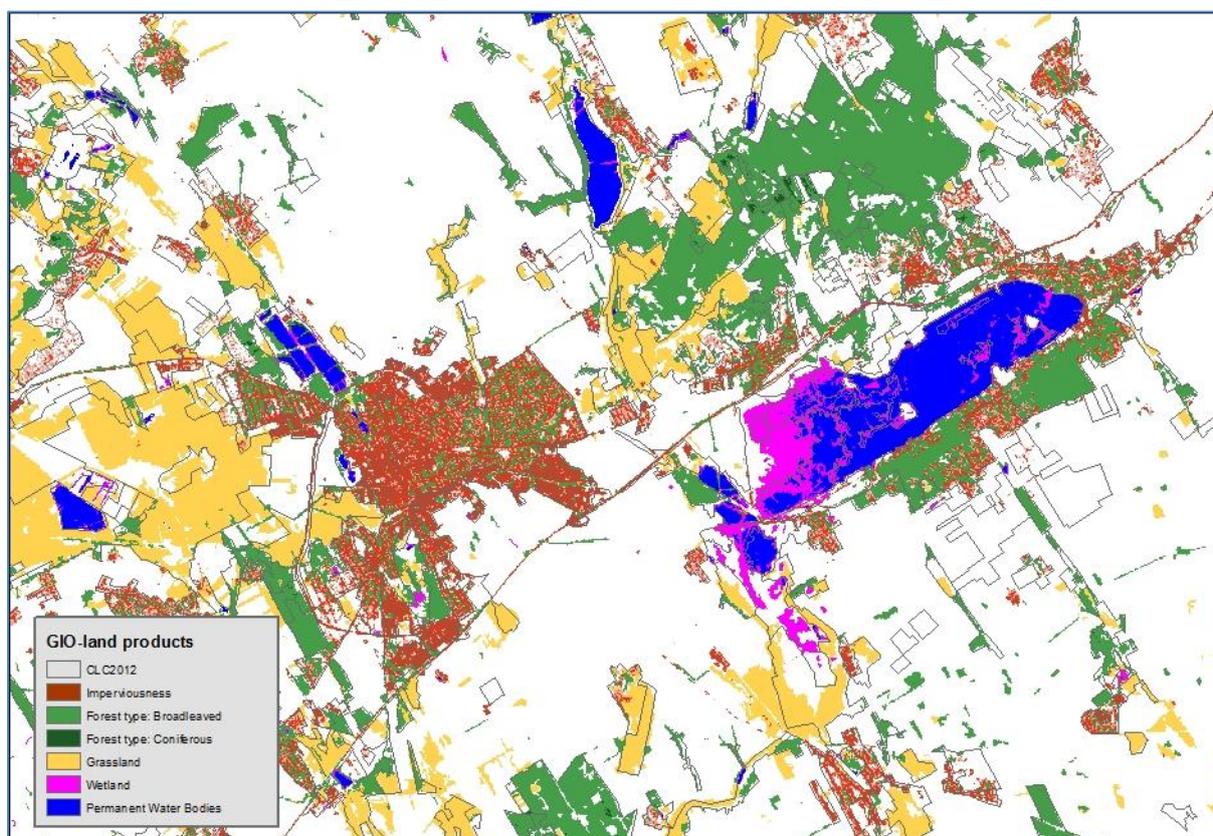
## Environmental Land Monitoring

Since 2001 FÖMI experts have continuously participated in activities of the land cover - related European Topic Centres, which form part of the background institutions of European Environment Agency (EEA):

1. 2001-2006: European Topic Centre - Terrestrial Environment (ETC-TE)
2. 2006-2010: European Topic Centre - Land Use and Spatial Information (ETC-LUSI)
3. 2011-2014: European Topic Centre - Spatial Information and Analysis (ETC-SIA)
4. 2015-: European Topic Centre – Urban, land and soil systems (ETC-ULS)

Experts of FÖMI, as core member of the consortium forming the Topic Centres, have played key role in coordinating the preparation and the quality control (verification) of the pan-European land cover databases (CLC2000, CLC2006, CLC2012, GIO High Resolution Layers), as well as in training the experts of the participating 39 countries. Additional connected tasks include methodological development, testing, evaluation and assessment of applications and indicators; furthermore participation in the elaboration of the INSPIRE Data Specification on Land Cover. From 2015, our work in the European Topic Centre continues within the confines of ETC - Urban, Land and Soil Systems (ETC-ULS).

In the framework of European COPERNICUS Programme, the GIO-land project was accomplished in 2014. Major tasks of the project were the production of CORINE land cover database for 2012 (CLC2012) and mapping of CLC changes between 2006 and 2012. As a new component, 5 High Resolution Layers (GIO-HRLs) covering all Europe were produced.



*Fig 25 Results of GIO-land Hungary projects around the city of Székesfehérvár - CLC2012 polygons and the GIO high resolution land cover layers*

FÖMI experts participated in the GIO land program in two ways:

1. National activities
  1. As an EEA member state, Hungary has produced the CLC2012 and CLC-Change (2006-2012) databases within the frames of GIO-Hungary project . These datasets will be integrated into the common pan-European CLC databases. Furthermore, verification and enhancement of the GIO-HRLs for Hungary were carried out. The final products are disseminated at national level by FÖMI.
  2. Related to CLC mapping, a research project was carried out to develop methodology for automatic detection of significant portion of the CLC changes, funded by the Hungarian "Kutatási és Technológiai Innovációs Alap" (application number URKUT\_10-1-2011-0022),
3. Pan-European activities
  1. As member of the European Topic Centre - Spatial Information and Analysis (ETC-SIA) FÖMI was involved in the preparation, technical coordination and quality control/assurance of the CLC mapping project in the 39 participating European countries. This included among others methodological development (including creation of the CLC2012 Support Package software), training and verification.
  2. FÖMI took part in the validation of other GIO-land products (e.g. Urban Atlas).
  3. FÖMI participated in analyses based on the above-mentioned databases (testing of the Urban sprawl and High Nature Value indicators; development of Imperviousness change indicator).

Besides the above mentioned projects, we actively participate in long-term strategic development and planning of land monitoring in Europe, within the scope of FP7 HELM project (2011- 2013) and the EAGLE (Eionet Action Group on Land Monitoring in Europe) working group.

### **Participation in projects related to land monitoring**

#### **FP7 Geoland2 project (2010-2012)**

The FP7 project GEOLAND2 aimed to work out robust specifications and methodology for the operational production of the five HR layers, together with the update of the CORINE land cover database for Europe. The project was carried out in the context of GMES, a initiative of the European Commission, which aims to build up a European capacity for Global Monitoring of Environment and Security. The European Land Monitoring Service (EUROLAND) addresses the local (i.e. the Urban Atlas) and the continental component (i.e. high spatial resolution, wall-to-wall land cover parameters and land cover change) of the Land Monitoring Core Service (LMCS).

1. Local Component: The Urban Atlas generates VHR geo-information on land use for important European urban agglomerations. Its main objective is to support the Urban Audit of DG Regional Policy.
2. Continental Component: EUROLAND developed 5 High Resolution Layers and HR change layer at pixel based level with information on impervious areas, forests, grasslands, wetlands and small water bodies. The continental component is complemented by statistical area frame sampling (SATChMO) using VHR imagery. It is aimed to better understand the reasons for change across European regions and to support the validation of continental monitoring approaches in Europe and Africa.

FÖMI experts participated in methodology development and validation activities for the validation of 5 GMES High Resolution layers, Urban Atlas and Satchmo products.

#### **Harmonised European Land Monitoring (FP7 HELM) (2011- 2013)**

The aim of the FP7 HELM project (2011- 2013) was the improvement of the European land monitoring concept. FP7-HELM project realizes a network of authorities concerned with land monitoring across Europe. Its aim is to initiate a move to increase the maturity of European land monitoring along five sequential steps: (1) mutual interest in achieving reciprocal knowledge, (2) shared visions and planning for the future, (3) joint activities by taking on tasks collectively, (4) alignment of national systems involving the mutual adaptation of data interpretation methods and of the timing of data gathering, (5) lasting integration and combining data across all administrative levels.

FÖMI was part of the core team of the consortium, participated in six workshops, and were responsible for the tasks of collecting information about operational commonalities and differences of European land monitoring systems, defining ways to improve the synchronisation of data gathering and collection of criteria for a common European land cover data model.

#### **EAGLE (Eionet Action Group on Land Monitoring in Europe) Working Group (2010 - today)**

The EAGLE group (Eionet Action Group on Land monitoring in Europe) was set up in 2009 by members of EIONET NRCs on land cover as a response to the growing need to discuss

solutions for a better integration and harmonization of national mapping activities with European land monitoring initiatives (i.e. CLC) at technical level, independently from any political or industry preferences, following the concept of a bottom-up approach. EAGLE's objective is to elaborate a future-oriented conceptual solution that supports a European information capacity for land monitoring built on existing or future national data sources. By 2013, the group has worked out the EAGLE matrix, a tool for semantic decomposition and comparison of nomenclatures and the EAGLE UML model for collection of land monitoring data on voluntarily basis. Proof of concept testing of the elaborated concept is being carried out starting from 2014, within the frame of EEA's GIO funds. FÖMI experts have played a key role in matrix development, the presentation of the concept on several forums and in the ongoing testing.

### **GMES (COPERNICUS) Land Monitoring Core Service Implementation Group**

This group, including 7 permanent experts (EEA, DGs and the member states) had the main task to supervise and validate the implementation of the GMES (Global Monitoring for Environment and Security). The main activity in 2010 was the preparation for GMES Initial Operations (GIO, 2011-13). Two current projects with high importance - Urban Atlas and geoland2 - were also closely monitored by the Group. The Group had regular meetings in Brussels. A FÖMI expert participated in the work of the group, which has closed its operation in December 2010.

### **INSPIRE Initiative**

A FÖMI expert, nominated as EEA-EIONET representative participated in the work of "TWG "Land Cover", which was one of the 19 new Thematic Working Groups to discuss INSPIRE Annex II & III themes. Three meetings and several teleconferences were organized in 2011 - 2012. The FÖMI expert contributed to data quality and metadata chapters and issues relating to the work of the European Environment Agency (EEA).

### **GMES in-situ coordination (FP7 GISC)**

GMES in-situ coordination (GISC), a FP7 funded project, started in the European Environment Agency in January 2010 and ended on 31 October 2013. Aims of the project were to develop innovative and sustainable frames and an adequate management system for in-situ data access. Main task of FÖMI was to provide comments on in-situ data and infrastructure requirements.

## **Photogrammetry**

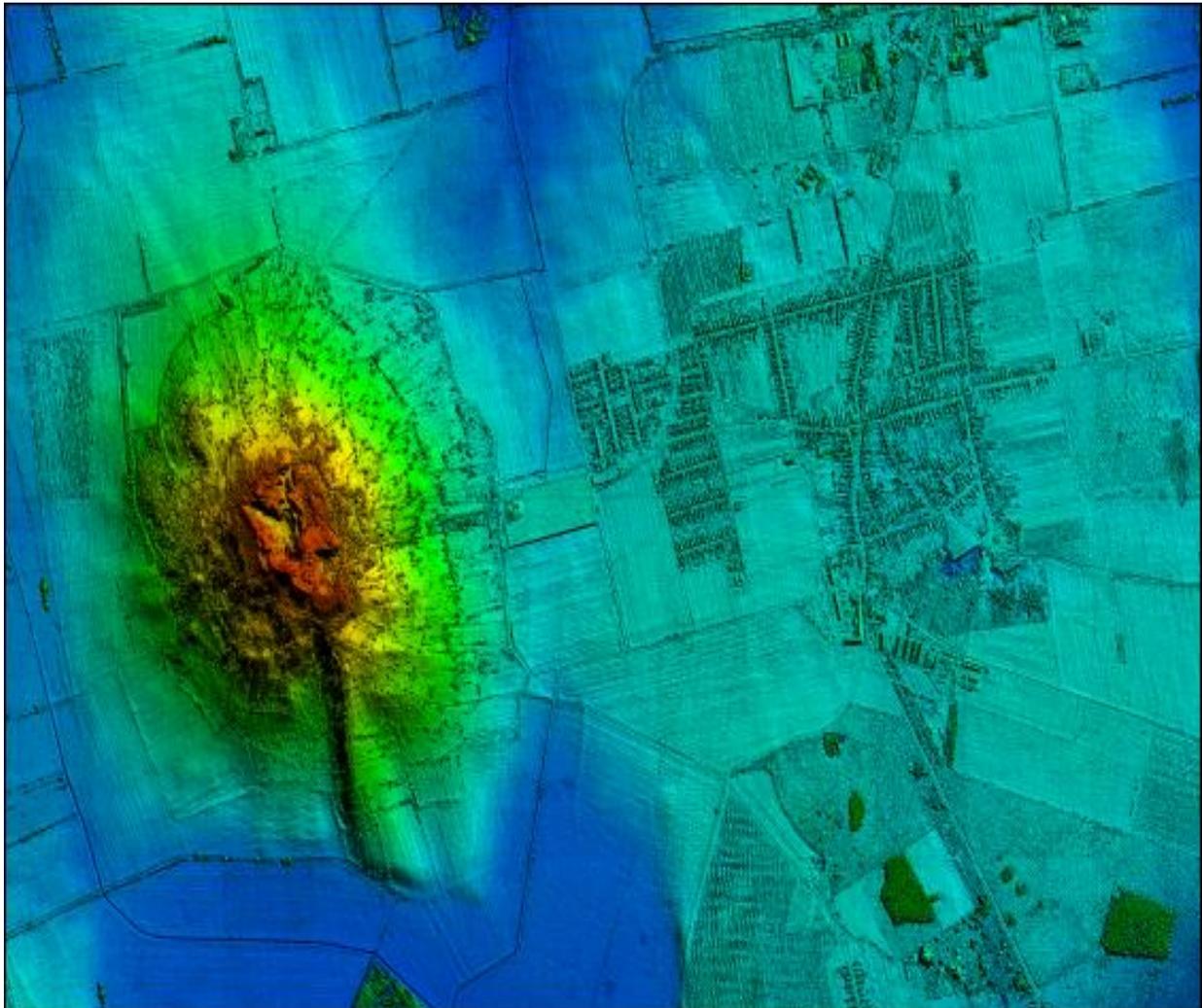
FÖMI started its operation as a smaller photogrammetry working group within the framework of the Building Monitoring System project in 2013. The five member group was a reorganization and reunion of the facilities (e.g. human resources, hardware and software) that had already existed for several decades in FÖMI.

FÖMI is able to perform any kind of task pertaining to aerial remote sensing, such as generating digital relief data (digital terrain models, digital surface models) by automatic, semi-automatic or manual stereo photogrammetric processes, manual stereo editing, 3D technical analysis, digital raster data processing and ortophoto production.

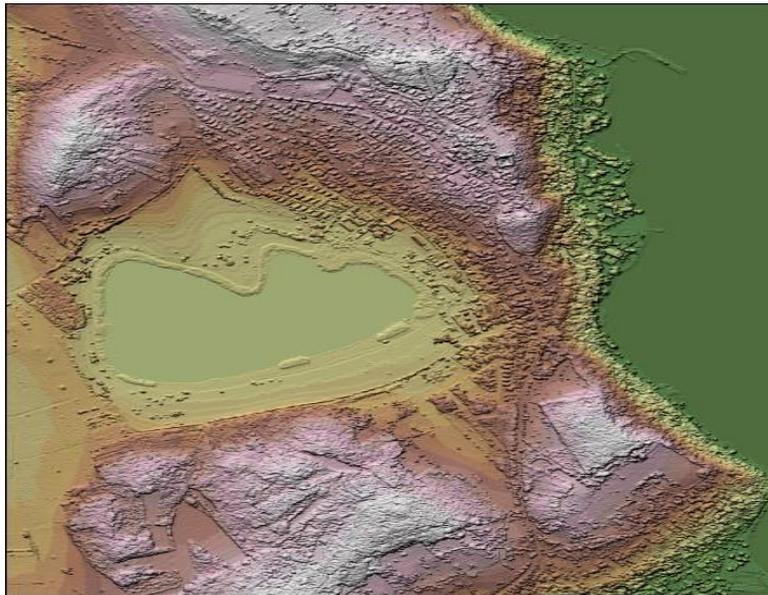
## Building Monitoring System project

FÖMI took part in creating the project on building monitoring (accepted by the Electronic Public Administration Operational Programme and financed by the European Regional Development Fund and by the national central budget), which includes automatic classification of buildings from remote sensed data in cooperation with other (e.g. height) data. The goal of the project was to support the authorities by remote sensing data to sort out the results of illegal construction activities or buildings that are out of the building permits.

In this project the photogrammetric tasks were the generation of digital surface model (DSM) for the whole country in EOTR M=1:10 000 scale, using digital frame aerial photos made in the last four years, the production of the so called DSM orthophoto coverage and the difference model (normalized DSM) by using the DSM and the existing digital terrain model (DTM). The results were used for object-based image analysis (OBIA) executed on orthophotos. On the basis of the cadastral data, the orthophotos and the building coverage differences authorities can take appropriate actions.



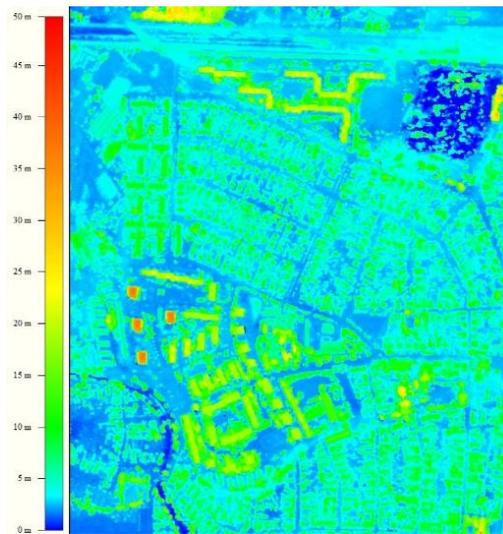
*Fig. 26 Digital surface model (DSM), shaded and colorized relief*



*Fig. 27 Digital surface model (DSM), shaded and colorized relief*



*Fig. 28 Digital surface model (DSM), Colorized point-cloud*

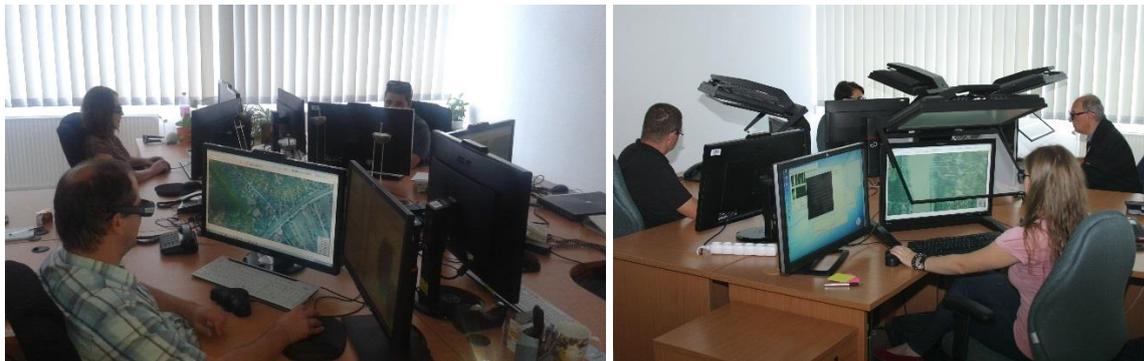


*Fig. 29 Difference-model*

## The CAP reform

Since 2014, FÖMI has been involved in the CAP reform. The main project is the production of the CAP-DTM by manual stereo editing, by using stereo-photogrammetric workstations and oriented digital aerial photos. It is necessary to assure that the digital orthophotos for the yearly update of LPIS should meet the M=1: 5000 topographic scale precision criteria as prescribed by the JRC for 2015.

Additionally, FÖMI provides the photogrammetric support of CAP. Greening that means the generation of the new digital surface models and the production of the difference-models in accordance with the aims of the CAP reform.



*Fig.30 Stereo-photogrammetric workstations (active and passive systems)*

## Bundle block adjustment and transformation of stereo satellite imagery

According to our proposal to investigate the applicability of stereo satellite imagery, the Joint Research Centre (JRC) ordered stereo satellite imagery covering one site and provided to us.



In the recent years airborne digital sensor systems were used (Vexcel Ultracam D, Ultracam X, Ultracam XP) for aerial mapping tasks and the NIR band was also recorded. Flight dates are chosen according to the LPIS campaigns in each year, which provides a full coverage of the country in a four year cycle. From 2012 digital aerial images were archived in a 16 bit per channel format also which could be beneficial for sophisticated analytical algorithms. Flying heights varies according to the terrain relief. The image processing workflow is carried out in digital photogrammetric software environments. For the production of the orthophotos we applied the experiences of the technology of MADOP 2000 and 2005. The orthophotos were created on the base of orientation elements resulted from the aerial triangulation and on the base of HUN-DEM.

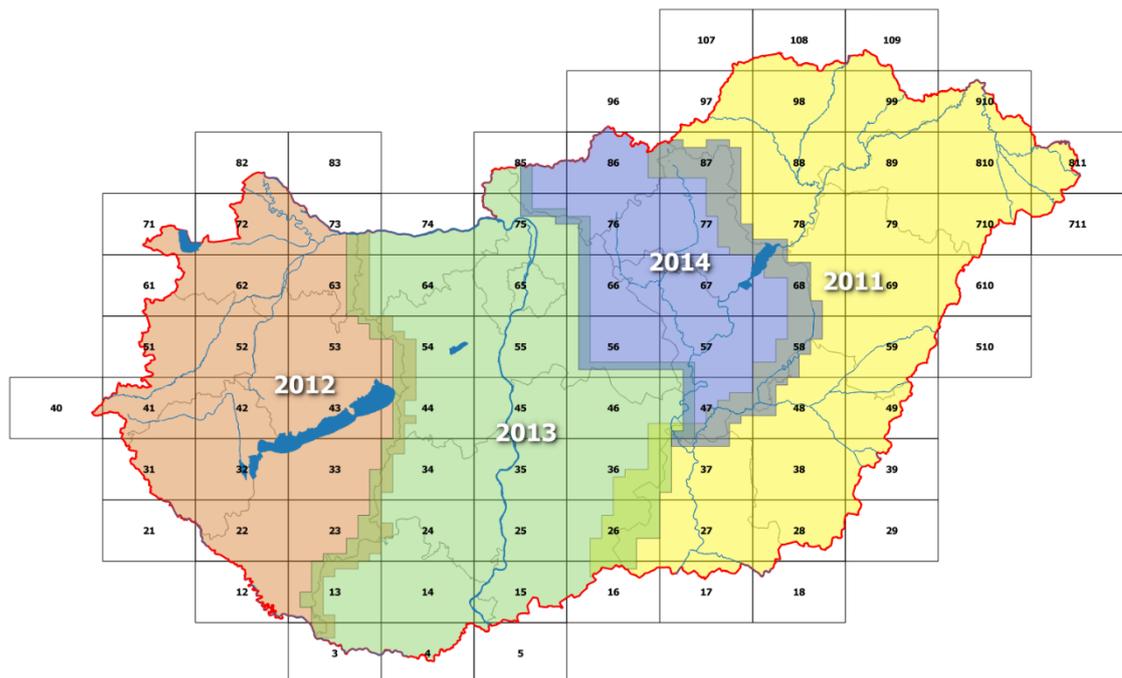


Fig. 32 Orthophoto coverage for the years 2011-2014

The time periods of aerial data acquisition of the years 2011-2014 (see Fig.32):

1. 11th August – 19th October 2011;
2. 19th August – 25th August 2012;
3. 13th June – 4th July 2013.
4. 21st May – 10th June 2014

The orthophotos are geo-referenced with high accuracy in the Unified National Projection System of Hungary, the GSD is 0.4 m, RGB and CIR orthophoto tiles are available as 8 bit per channel data.

The frames of aerial photos, the orientation elements of the frames, the high resolution and quality checked orthophotos were archived and are available for end-users of several professions. The orthophotos can serve as common spatial reference for the Hungarian GIS and RS systems.

The digital orthophotos are suitable for several applications, such as

1. Creation Hungarian Land Parcel Identification System,

2. Topographic mapping,
3. Recording of statement of several agricultural plants,
4. Establishing of land use categories,
5. Delineation of wastelands,
6. Surveying of soil map contents,
7. Delineation of soil erosion areas,
8. Mapping of inland waters,
9. Regional planning,
10. Archaeology,
11. Forest inventory, management etc.

### **Additional tasks and support**

Based on existing imagery, individual checking task, it is also possible to support officials or authorities. Stereo measurements and technical inspections can easily reveal the conditions existed at the time of image acquisition and can provide relevant support. Several in-house tasks were supported by stereo measurements where traditional orthoimagery inspections were not enough.

## **Development of Supplying Online Data 2011-2015**

### **Geoshop.hu, the geoportal service of FÖMI**

Geoshop.hu is the geoportal service of FÖMI's map databases that was launched in early 2011, after the project had been executed by the support of Central Hungarian Operative Programme of New Hungary Development Plan.

Geoshop.hu meets the requirements of data servicing of the structure and content indicated in the Directive No. 2007/2/EC (INSPIRE) on the implementation of spatial data infrastructure. FÖMI operates this service through online webshop, providing access to available spatial data for public administration, the economic sphere and also for the wide public through internet in a round-the-clock (0-24h) service.

Between 2011-2013 geoshop.hu supplied map data only from the Central Hungarian Region (Budapest and Pest County), but since February 2013 this service (except one item) has been expanded to the complete territory of Hungary.

Registration is required to submit an order; the payment is possible by bank transfer or by online credit card transaction. In the latter case the request is processed immediately and the data becomes available for download as soon as possible.



Fig. 33 Number of visitors and income value through the geoportal

Geoshop.hu is ready to provide the following databases covering the whole territory of Hungary:

1. Aerial photo
2. Administrative boundary
3. Cadastral Map with Land parcel and building (only from Budapest and Pest County)
4. Contour line
5. Elevation (Relief model)
6. Geodetic control point
7. Hungarian Gazetteer
8. National Land Cover CLC50
9. Ortophoto
10. Topographic map (raster, vectorised)

### Digital aerial photo archive online service

FÖMI has successfully completed the Digital Aerial Photograph Archive project founded by EU, on 30th June 2014. The project had been executed by the support of EKOP 2.A.2. In accordance with the Hungarian law the goal was to digitize the archive analogous films and organize them into a database. Additionally to allow their online access to public administration, authorities as well as to civil customers.

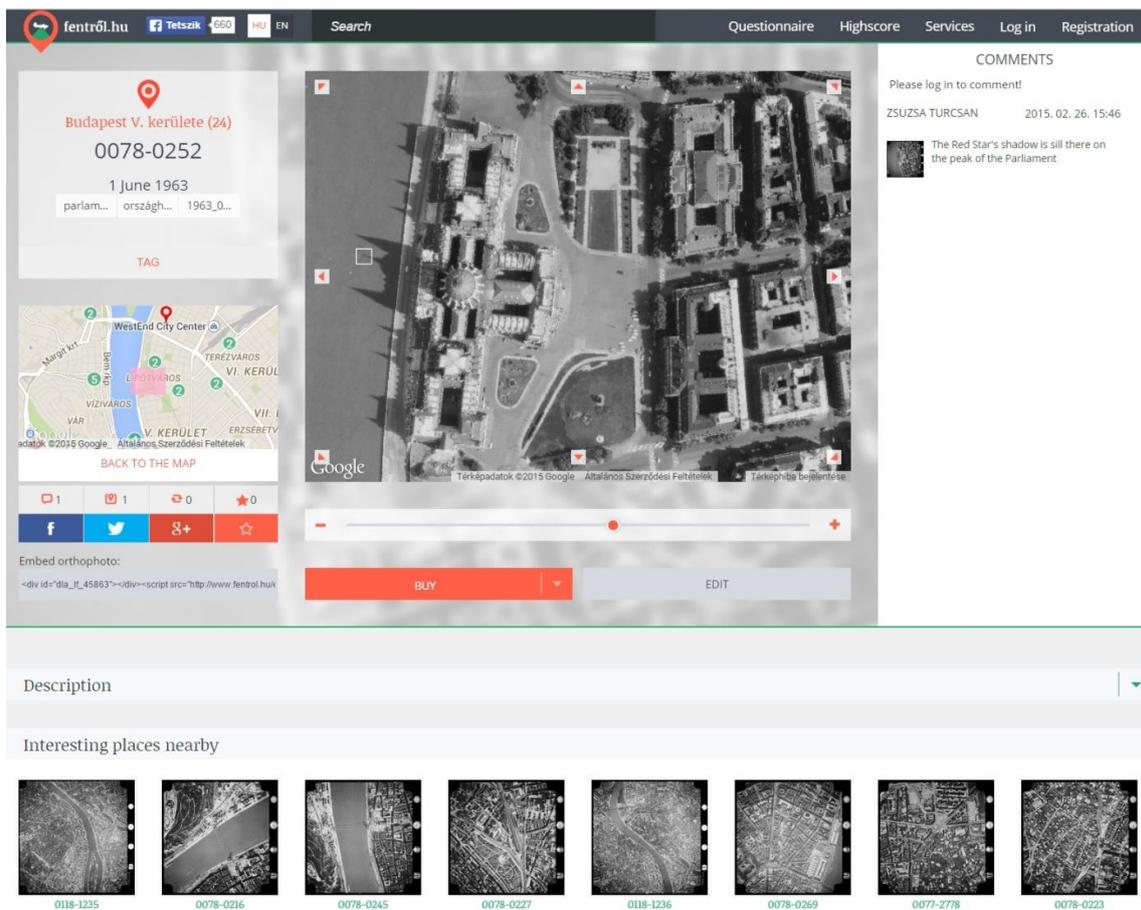


Fig. 34 Screenshot of 'fentrol.hu' website

By the end of the project, FÖMI had finished scanning 15% of the aerial images of the aerial photo archive, considering their condition (the worst ones had priority), mainly from the period of 1959-1966. The metadata were recorded from the logbooks of the flights; then the photographic frame centres were digitized. To clean and scan the films, preparatory pressurized rooms were established. The scanning was performed with two Leica DSW 700 aerial film scanners.



*Fig. 35 Georeferencing the archive analogues films manually*

The digitized aerial images can be freely browsed online at the ‘fentrol.hu’ website, where registered users can tag or comment a photo. The original photographs can be bought online (including georeference data also), or downloaded in reduced resolution for free of charge. Clients have the possibility to edit the location of the aerial photographs, for which points can be earned depending on the uncertainty of the definition of the aerial image place. The ‘fentrol.hu’ website allows searching aerial photographs by location, by attributes or by tags also.



*Fig. 36 Analogous film before and after cleaning*

Since the project have been finished, FÖMI continued to digitize the archives. By the end of February 2015, further 9.885 archive images were scanned and uploaded to ‘fentrol.hu’ website so currently there are 78.114 aerial photos available online for the public.

## National mapping (defence): National (government) topographic and cadastral mapping in Hungary

### Characteristics of the Hungarian topographic map series

Characteristics	Military topographic map series	Civilian topographic map series
Datum	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	Universal Transverse Mercator (UTM)	'Egységes Országos Vetületi Rendszer' (Unified National Projection System), EOVS
Prime meridian	Greenwich	Gellért-hegy, Budapest, Hungary
Spherical longitude of centre point of the projection	0° (Equator)	E47°06' (Gellért-hegy, Budapest, Hungary)
Type of projection; Projection zones	Equatorial (transverse), Secant, conformal, cylindrical. Sixty 6° 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 6° for every ellipsoidal bi-angle	'Double projection' i.e. from IUGG67 through Gauss sphere to the plan
Projection co-ordinate system	Portray of the Equator: N: Y = 0; S: Y = 10 000 000 m X = Parallel to the portray of the central meridian and 500 km West thereto	Y = 0; 200 km South to the centre point of the projection X = 0; 650 km South to the centre point of the projection
Height datum	Baltic (Kronstadt)	Baltic (Kronstadt)
Geodetic Datum	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' 1:200,000 / 1° x 40' 1:250,000 / (2° x 1°)	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

## **Defence Mapping Activities in Hungary**

Defence mapping activities, including all state mapping operations at scales smaller than 1:10,000, are carried out by two military organisations in Hungary; the Geoinformation Service of the Hungarian Defence Forces (GEOS HDF) is responsible for the management and technical supervision while the MoD Zrínyi Mapping and Communication Servicing Non-profit Limited Company (MoD Zrínyi Non-profit Company) is in charge for the actual map making. Nevertheless, carrying out some geo-related (however, not merely mapping) tasks, such as the EuroRegionalMap (ERM) project or the creation of military geographic products, falls within the responsibility of GEOS HDF, too.

## **Topographic and Thematic Mapping Activities**

### **Analogue Topographic Maps**

Hungary has been producing standard military topographic map series according to NATO STANAGs, i.e. in UTM projection, on WGS 84 datum and with a Hungarian-English bilingual marginalia, since 2004. One of them is the 1:50,000 scale map series, a mandatory scale in NATO, the base of which is the DTA<sup>TM</sup>-50 Digital Mapping Database. A civilian version of the above map series supplemented with EOV Hungarian (civilian) national standard grid is also available.

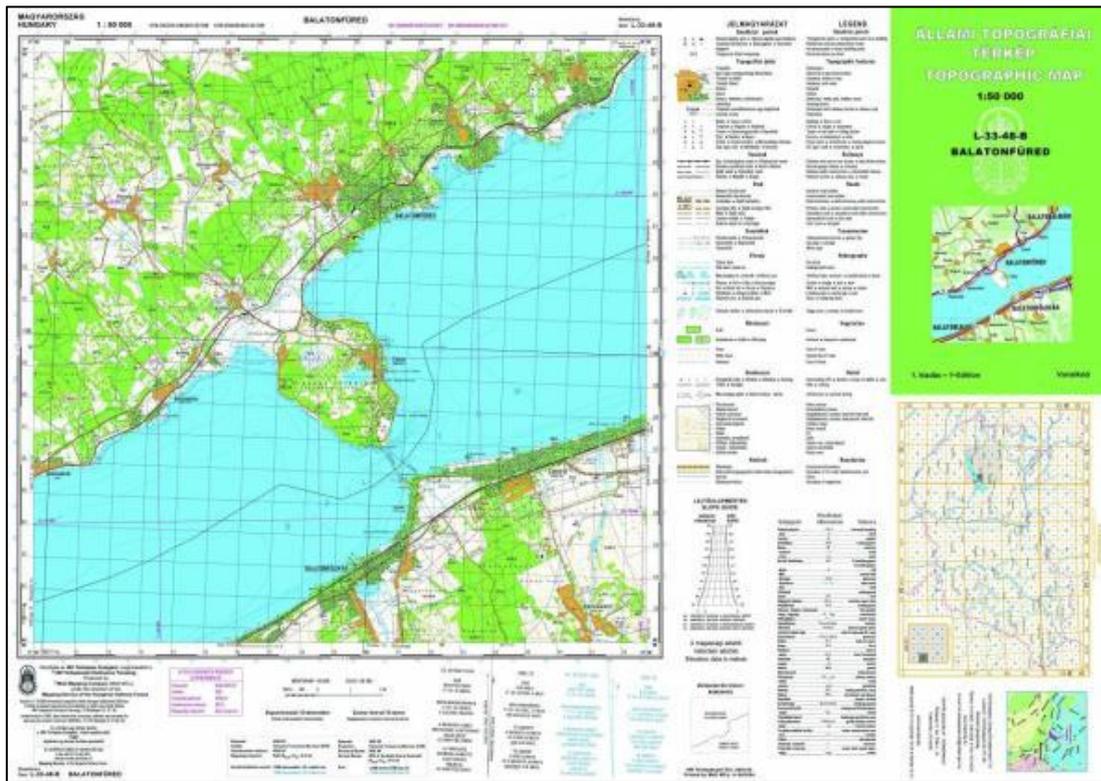


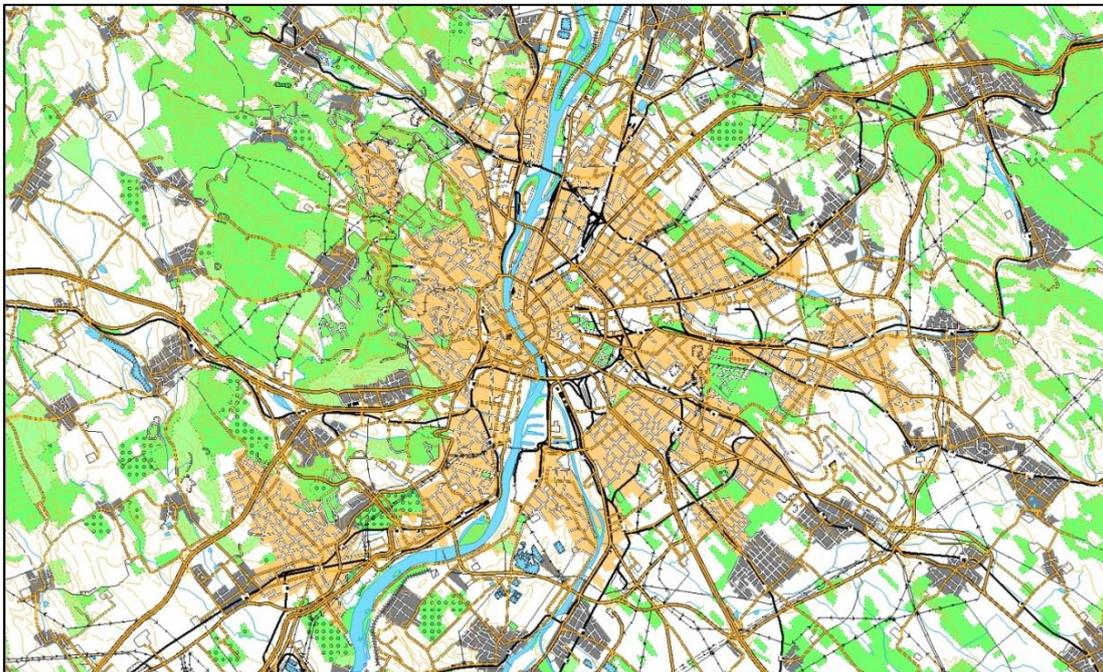
Fig. 37 1:50,000 scale topographic map (civilian version) in UTM projection enhanced with EOV grid

## Digital Databases

The legal ancestor of the GEOS HDF started establishing digital databases in the early 1980's. As a result of this activity, a number of databases and elevation models have been produced and made available for the users in various sectors, e.g. governmental, defence and public, by now.

### DTA<sup>TM</sup>-200 - Digital Mapping Database

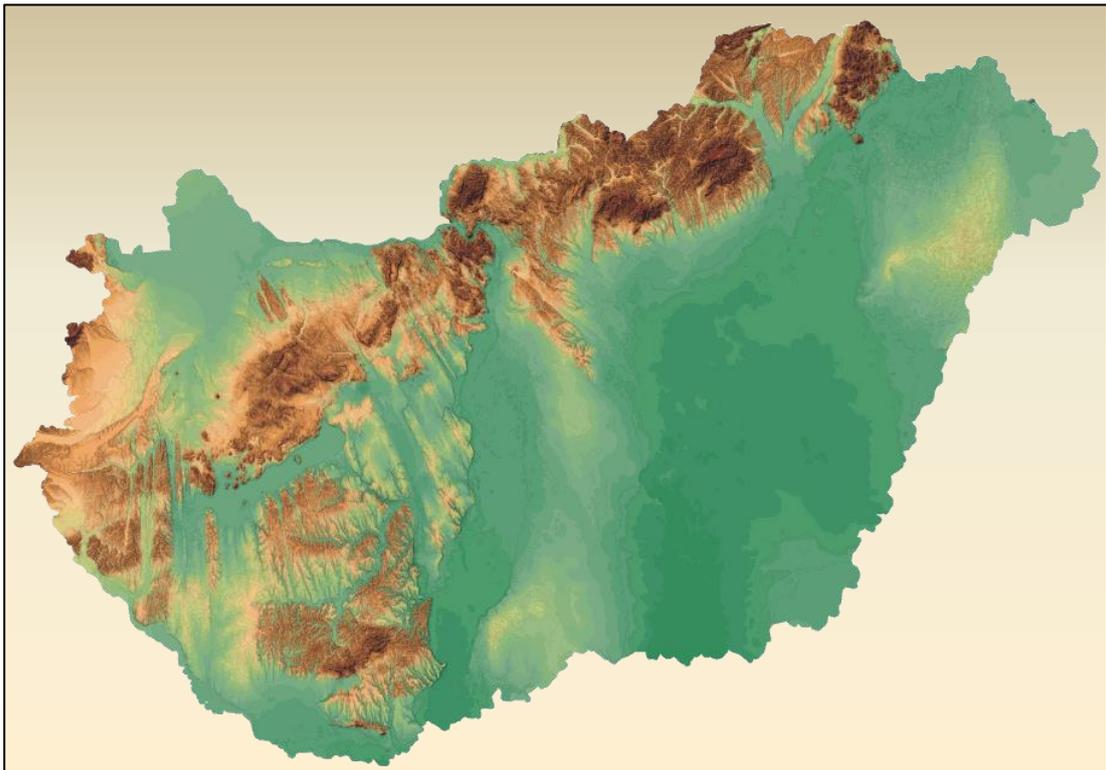
Creation of the DTA<sup>TM</sup>-200 database with a data content equivalent to the 1:200,000 scale topographic maps commenced in 1988. Since that time DTA<sup>TM</sup>-200 has been used by several institutions as grounds for their individual thematic databases. The updating of the content of the database is carried out constantly.



*Fig. 38 Extract from DTA<sup>TM</sup>-200 database, latest version*

### DDM-10 and DDM-50 - Digital Elevation Models

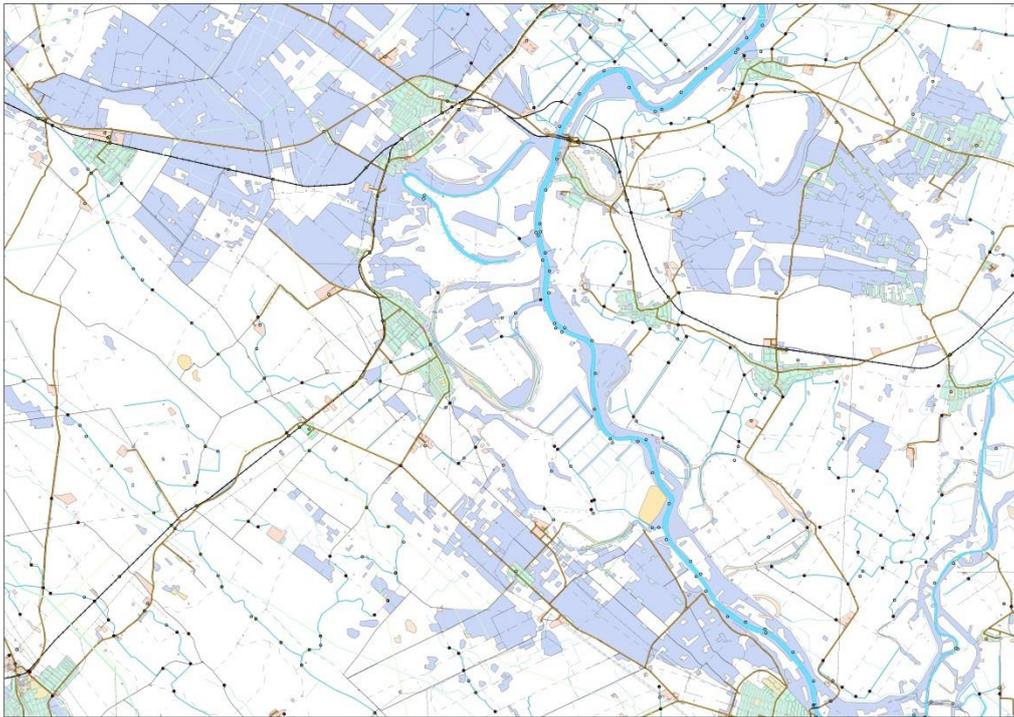
DDM-10 and DDM-50 Digital Elevation Models hold elevation data for the territory of Hungary in grid format with 10×10 m and 50×50 m density, respectively. The total size of the data file is 2.5 GBytes for DDM-10 and 100 MBytes for DDM-50. The database is available in NATO standard DTED Level 1 and Level 2 formats as well.



*Fig. 39 Representation of the Digital Elevation Model*

### **DTA™-50 - Digital Mapping Database**

‘Digitális Térképészeti Adatbázis’ (Digital Mapping Database, DTA™-50), considered the most significant digital military mapping database in Hungary, was created on the strength of the 1:50,000 scale military topographic map series. As a general skeleton map, containing some 38 feature classes in ten categories, it renders possible the automatic processing of topographic maps on one hand and can become a base of future GIS applications on the other. The database can serve as foundation for the representation of planimetry and legend of topographic maps, too.



*Fig. 40 Extract from DTA™ v. 2.0, Digital Mapping Database*

The aim of the updated and enhanced version (V2.0) of DTA™-50 database was to provide grounds for the new 1:50,000 scale military topographic map series by which a full harmony in content between analogue maps and digital mapping databases can be reached. The updating of the database is carried out continuously.

### **DITAB-50 Database**

The preparatory works of the ‘Digitális Topográfiai Adatbázis’ (Digital Topographic Database, DITAB), project, the aim of which was the creation of a new topographic database with a data content answering to the 1:50,000 scale maps but with an accuracy corresponding to the 1:25,000 scale maps in geometry, was completed in 2013 with the commencement of the actual works in 2014. The database is designed in a way that it is suitable for creating a cartographic output. Depending on the availability of future financial sources DITAB can be enhanced to have a data density of the 1:25,000 scale maps. The planned date of the completion of the work is 31 December 2018.

### **DTA™-500 and DTA™-1000 Digital Mapping Databases**

DTA™-500 and DTA™-1000 vector databases, depicting Hungary and its environments, equivalent in content to the 1:500,000 and 1:1,000,000 scale maps, respectively, have also been completed.

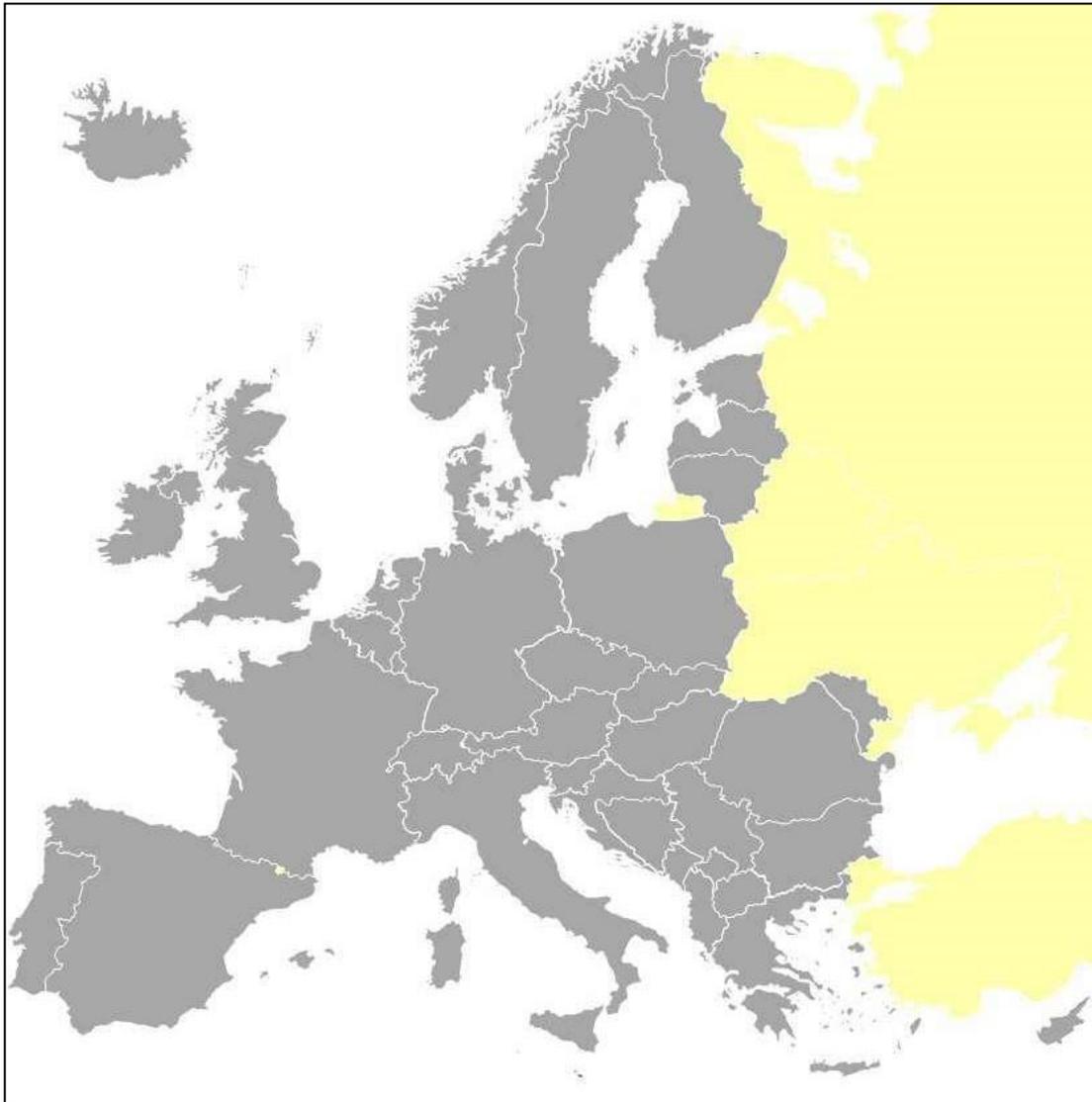
### **Multinational Geospatial Co-production Programme (MGCP)**

The MGCP was called into existence on the initiation by the USA National Geospatial-Intelligence Agency (NGA) in 2003. The aim of the program was the creation of an up-to-date, modern, digital database to satisfy the emerging national and international needs, the fight against terrorism and other global tasks, built up by 1×1 degree cells of geographic coordinates at scales

1:50,000 and 1:100,000. As a result, a GIS database, unified in content and accuracy requirements, will be at the participating governments' disposal in proportion of their participation for nearly the whole territory of the world.

### **EuroRegionalMap (ERM)**

EuroRegional Map was initiated to produce a common GIS database at a scale of 1:250,000 for Europe in 2001. Hungary joined the programme as an active member in 2008, however, has taken an active role since 2004. The ERM specification issued by EuroGeographics was adopted and a Hungarian ERM technical specification was prepared. In harmony with it, six layers are compiled. The latest version of the ERM, v7.1, was approved in April 2014.



*Fig. 41 ERM Member countries (shown in grey)*

### **Digital Raster Maps**

For defence and other law enforcement purposes, 1:50,000 and 1:250,000 scale military topographic maps are available in raster format, too. For non-governmental users a number of raster format maps can be obtained of which the civilian version of the 1:50,000 scale

topographic map series and some pre-NATO topographic maps at scales 1:25,000; 1:100,000 and 1:200,000 (called RTA) can be mentioned.

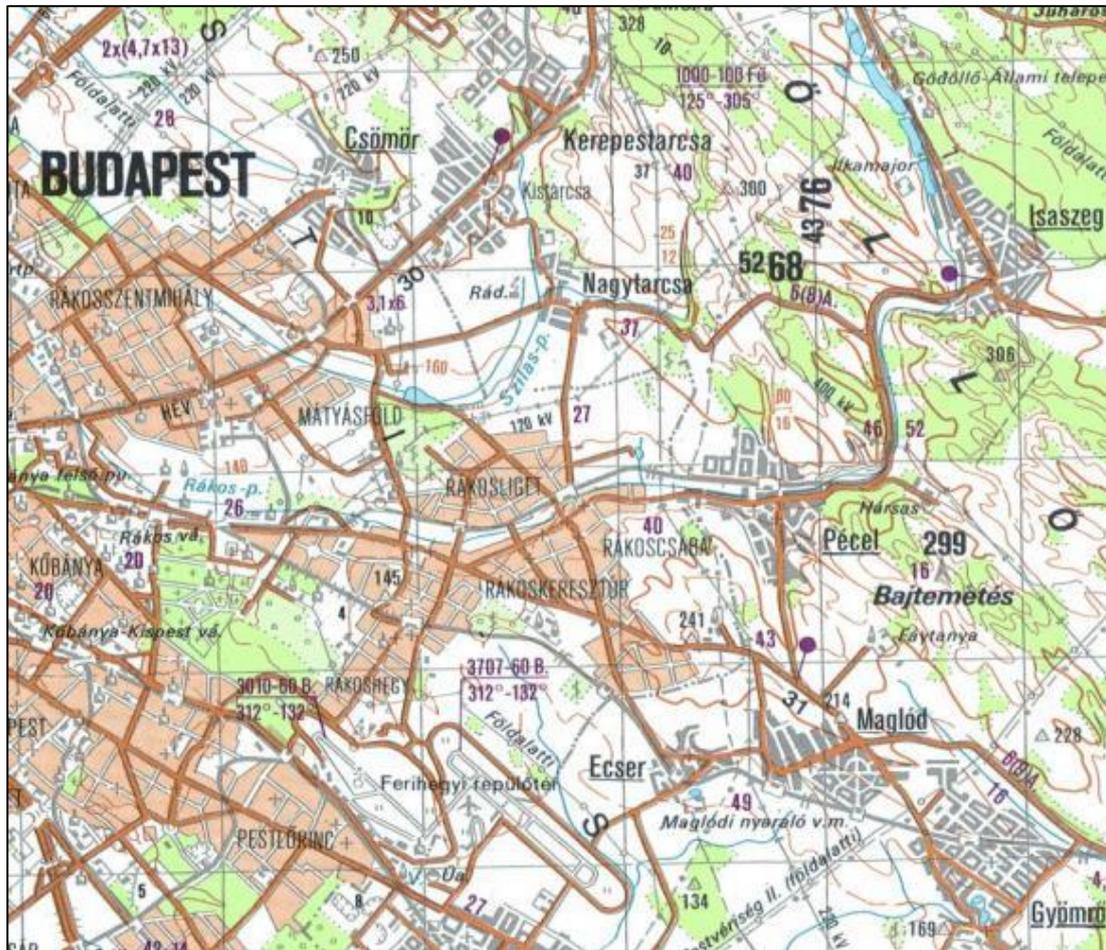


Fig. 42 Extract from RTA 200

## Thematic Maps

In addition to topographic maps a number of thematic maps and charts, military and civilian ones, are produced every year. NATO standard products such as Low Flying Charts (LFC), Transit Flying Chart (TFC) and Joint Operation Graphic (JOG), both air and ground version, are published regularly. Other products include military city maps, photomaps and charts and various maps and map series designated for special purposes like maps for training areas/shooting ranges in Hungary or etc. A non-NATO product is the 1:200,000 scale helicopter navigational chart, especially designed to the needs of Hungarian helicopter pilots. Among non-military products the ICAO aeronautical chart of Hungary can be mentioned.



## Maps for the public and other products

Hungarian defence mapping has long standing traditions in providing the public with various maps and charts. As a continuation of this practice a variety of tourist maps and road atlases of Budapest and Hungary are maintained.

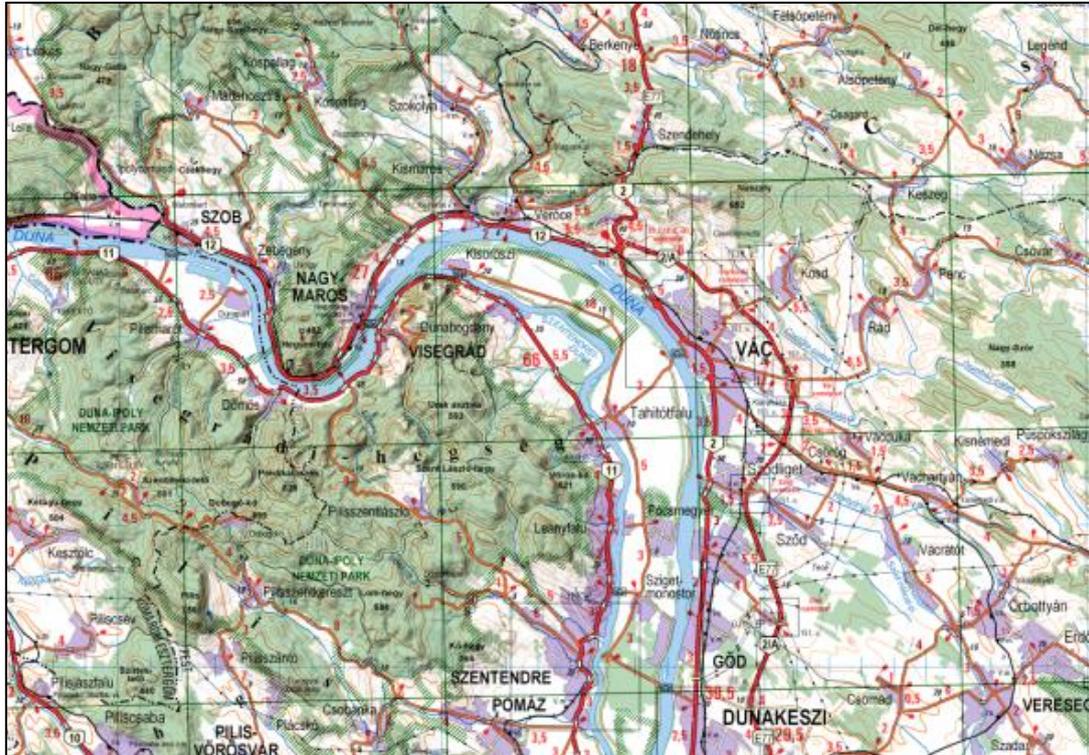


Fig. 44 Extract from the 1:200,000 scale road map

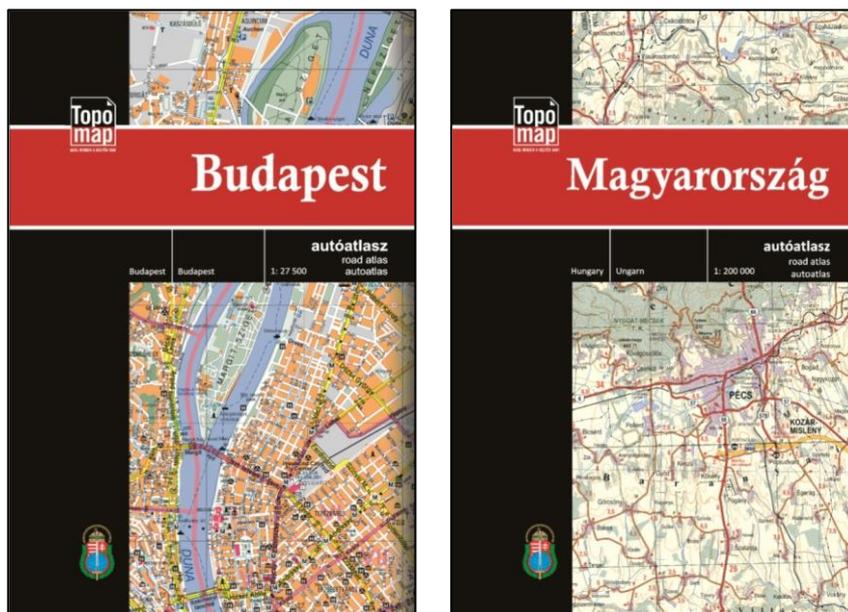


Fig. 45 Road atlases

## Other products

Other products include wall maps, relief maps, facsimile maps and calendars etc., having been in production for decades.



Fig. 46 Facsimile Relief Map

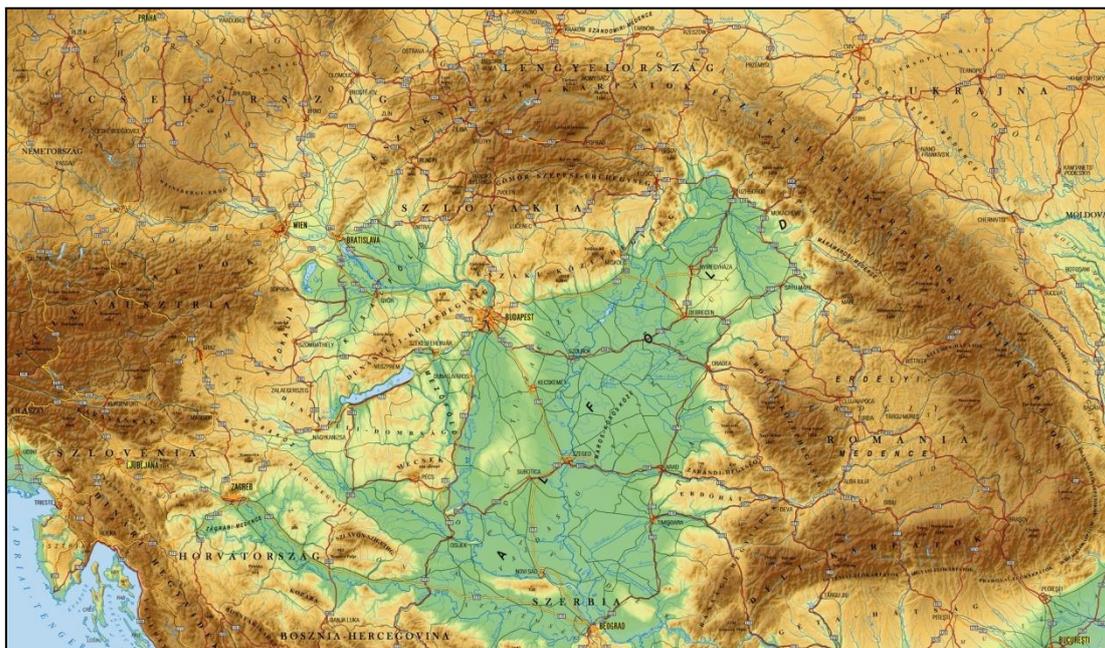


Fig. 47 Wall map of the Carpathian Basin

## Military geographic products

The production of military geographic information in analogue and digital formats has a two folded goal: first, to train Hungarian soldiers and officers in preparation of their future military career and second, to give them actual and up-to-date support in peace keeping missions. A variety of publications, including 48 country descriptions mostly for the crisis areas, were produced by the end of 2014.



Fig. 48 Military Geographic Atlases

## Bilateral agreements

Hungary maintains extensive relationships not only with its most important strategic partners but also with other NATO and PfP nations. As a consequence, Hungary has concluded bilateral geospatial agreements with 22 countries so far (with another two in finalization) and continues to make efforts to widen its international relationships with other countries, too. We are maintaining relations with governmental (military and civilian) organizations in more than 30 countries throughout the world.

## 2. Activities of the Hungarian Society of Surveying, Mapping and Remote Sensing, ICA Hungarian National Board

### Chronology of activities developed by Hungary in the ICA in the period 2011-2015

#### 1. Joint ICA Symposium on “Maps for the Future: Children, Education and Internet”

Event organized at the University of Orléans previously to the 25<sup>th</sup> International Cartographic Conference, on 30 June and 1 July 2011. Four ICA commissions and a working group participated in the event:

- Cartography and Children,
- Education and Training,
- Maps and the Internet,
- Planetary Cartography
- Cartography for Early Warning and Crisis Management

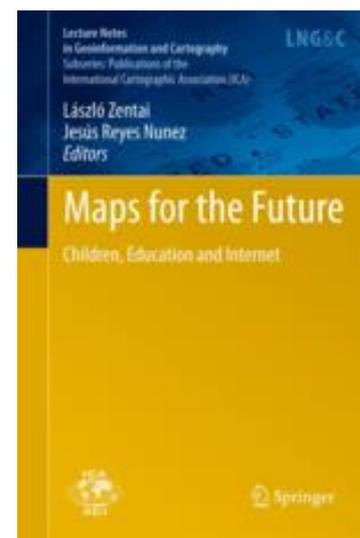


The Laboratory CEDETE of the university was the responsible entity for the local organization of the symposium, headed by the PhD student of ELTE university Vanda Turczi, who was staying in Orléans as Erasmus student at that time.

The Scientific Committee was led by José Jesús Reyes Nuñez, Assoc. Prof at ELTE Dept. of Cartography and Geoinformatics and Chair-person of the ICA Commission on Cartography and Children.

Hungary was represented with seven oral presentations and two posters:

- Eszter Simonné Dombóvári (ELTE Dept. of Cartography and Geoinformatics): Teaching Cartographical Skills in Different Educational Systems of EU
- László Zentai (ELTE Dept. of Cartography and Geoinformatics): The Role of Output Devices in the Higher Education of Cartography



- José Jesús Reyes Nuñez, Csaba Szabó (ELTE Dept. of Cartography and Geoinformatics): Updating a Hungarian Website about Maps for Children
- Gáspár Albert, Gábor Csillag, László Fodor, László Zentai (Geological and Geophysical Institute, ELTE Dept. of Cartography and Geoinformatics): Visualisation of Geological Observations on Web 2.0 Based Maps
- István Elek, Gábor Gericsák (ELTE Dept. of Cartography and Geoinformatics): Developing Map Databases: Problems and Solutions
- Henrik Hargitai, P.G. Vizi (ELTE Institute for Art Theory and Media Studies): Cartographic elements in Children's Drawings as a response to the „Red Sludge” Industrial Disaster
- Henrik Hargitai (ELTE Institute for Art Theory and Media Studies): Interpretation of Surface Features of Mars as a Function of the Language of Placenames
- Eszter Simonné Dombóvári, José Jesús Reyes Nuñez (Vienna Technical University – ELTE Dept. of Cartography and Geoinformatics): Survey on Chernoff Faces in Hungary and Austria – Further Research and Experiments (poster)
- Henrik Hargitai, P.G. Vizi (ELTE Institute for Art Theory and Media Studies): An Exhibition of Children's Drawing of the Red Sludge Disaster: Cartography, Art and a Shocking Experience

Two Hungarian colleagues (Jesús Reyes and László Zentai) were Chair-persons of two sessions. They also edited first the Digital Proceedings of the Symposium (on CD) and later the hard-copy version, which was a volume entitled “Maps for the Future: Children, Education and Internet”, containing selection of presented papers. This book was published by Springer-Verlag on January 2012.

## 2. Participation in the 25<sup>th</sup> International Cartographic Conference (Paris, 3-8 July 2011)

Hungary was represented by 14 delegates in this conference:

- László Zentai, Mátyás Gede, Gábor Gericsák, José Jesús Reyes Nuñez, Zsolt Török, János Mészáros, Zsuzsanna Ungvári (ELTE Dept. of Cartography and Geoinformatics)
- Henrik Hargitai (ELTE Institute for Art Theory and Media Studies)
- Andrea Pődör (NYME Dept. of Geoinformatics)
- Anita Rohonczi (Cartographia Publishing House)
- Eszter Simonné Dombóvári (ELTE PhD student, Vienna Technical University)
- Vanda Turczy (ELTE PhD student, Univeristy of Orléans)
- Katalin Tóth (European Commission Joint Research Centre)
- Gizella Bassa (GiziMap Ltd., exhibitor)



László Zentai (ELTE) and José Jesús Reyes Nuñez (ELTE) represented the country in the 15<sup>th</sup> General Assembly, where László Zentai was elected ICA Secretary General, José Jesús Reyes Nuñez Chair-person of the Commission on



Cartography and Children and Henrik Hargitai Chair-person of the Commission on Planetary Cartography for the period 2011-2015.

Hungarian colleagues presented a total of 12 papers and 4 posters, four of them developed in international collaboration with specialists from Australia, Argentina, Austria and Russia:

- David Fraser, László Zentai, Maria Cecília Bonato Brandalize: The Changing Face of Cartographic Education and Training
- Mátyás Gede: Optimising the Distortions of Sinusoidal-Ellipsoidal Composite Projections
- Henrik Hargitai, Kira Shingareva: Planetary Nomenclature: A Representation of Human Culture and Alien Landscapes
- Jesús Reyes Nuñez, Anita Rohonczi, Cristina E. Juliarena de Moretti, Ana María Garra, Carmen Alicia Rey, María V. Alves de Castro, Teresa A. Saint Pierre, Mariana A. Campos: Updating Research on Chernoff Faces for School Cartography
- János Mészáros: The Danube Map of Béla Vályi and its Georeferencing Method
- Andrea Pódör: The Methodological Advantages of using Webserver in Teaching GIS
- Anita Rohonczi: Cartographic Research for Blind and Partially-Sighted People applied in Practice
- Eszter Simonné Dombóvári, Mátyás Gede: New Possibilities of Mute Map Games on Virtual Globes
- Katalin Tóth: Quality of Geographic Information - Simple Concept Made Complex by the Context
- Zsolt Török: Crossing Borders: Cartographic and Military Operations and the International Borders in the Lybian Desert before WWII
- Vanda Turczi: Public-oriented, Map-based Communications in Various Scientific Areas, particularly Water Related Themes
- László Zentai: Legibility of Orienteering Maps: Evolution and Influences
- Mátyás Márton, Gábor Gercsák: The Present State of Reconstructing a 150 Year Old Globe (poster)
- Mátyás Márton, Katalin Plihál, Zsuzsanna Ungvári: Restoring Blau's Globes by Modern Methods (poster)
- János Mészáros: 3D Modelling of Rock Faces using Microsoft Photosynth and Meshlab Softwares (poster)
- Eszter Simonné Dombóvári, Georg Gartner, Manuela Schmidt, Jesús Reyes Nuñez, István Klinghammer, Anita Rohonczi: Further Research on Chernoff Faces – A Survey in Hungary and Austria (poster)

László Zentai, Henrik Hargitai and José Jesús Reyes Nuñez were Session Chairs. José Jesús Reyes Nuñez, as member of the Judging Commission, participated in the evaluation of entries sent to the Barbara Petchenik Competition that were presented in the International Exhibition.

### **3. Meeting of the ICA National Committee at ELTE Dept. of Cartography and Geoinformatics**

The meeting was held on 29 September 2011 and members of the National Committee and ICA Commission members were elected for the period 2011-2015.

### **4. Meeting of the ICA Executive Committee and Commission Chairs at the Vienna University of Technology**

Meeting held on 24 and 25 September 2011. Hungary was represented by László Zentai (ICA Secretary General), José Jesús Reyes Nuñez (Chair of the ICA Commission on Cartography and Children) and Henrik Hargitai (Chair of the ICA Commission on Planetary Cartography).

### **5. Sukendra Martha's (ICA Vice-President) visit to the ELTE Dept. of Cartography and Geoinformatics**

On the last week of September 2011 Sukendra Martha (ICA Vice-President & President of the Cartographic Society of Indonesia) accepted the invitation of the Dept. of Cartography and Geoinformatics at ELTE and presented a lecture entitled “Indonesian Cartography and Geospatial Data and Information Management” on 28 September.



### **6. Sara Irina Fabrikant's visit to the ELTE Dept. of Cartography and Geoinformatics**

Prof. Dr. Sara Irina Fabrikant (Dept. of Geography at University of Zurich), Chair-person of ICA Commission on Cognitive Visualization, visited the ELTE Dept. of Cartography and Geoinformatics on September 12-14, giving a presentation entitled “Creating Effective and Efficient Geovisualizations”



## 7. Cartography on three continents workshop (Budapest, 27 June 2012)

A special event organized by the Department of Cartography and Geoinformatics at Eötvös Loránd University (ELTE), in the frame of the 4th International Symposium on the History of Cartography of the International Cartographic Association (ICA). Three presentations were offered by three distinguished invited professionals from Europe, Africa and America:

- *Current Issues on Geographical Names: UNGEGN report to ICA*  
**Ferjan Ormeling** (The Netherlands), ICA Secretary General 1999-2007, President of the Netherlands Cartographic Society, Convenor of the United Nations Group of Experts on Geographical Names (UNGEGN), Cartography Section of the Faculty of Geographical Sciences, Utrecht University
- *South Africa's contribution to 20th century Cartography*  
**Elri Liebenberg** (South Africa), Chair of ICA Commission on History of Cartography, Professor Emeritus of Geography, University of South Africa
- *Infrastructure of Spatial Data in Brazil*  
**Paulo Menezes** (Brazil), ICA Vice-President, Vice-President of the Brazilian Society of Cartography, Head of GEOCART Labor, Department of Geography, Federal University of Rio de Janeiro

Photos made during the workshop here: <http://lazarus.elte.hu/hun/tantort/2012/2012-06-27-3kontinens/thumb.html>



## 8. 4<sup>th</sup> International Symposium of the ICA Commission on the History of Cartography: Exploration, Discovery, Cartography

The ELTE Dept. of Cartography and Geoinformatics organized this event on 28-29 June, 2012. The Hungarian colleagues presented four papers and four posters:

- Török, Zsolt-Hillier, Domonkos: Exploring and Mapping the Danube between Buda and Pest: László Vörös' hydrographic and topographic map (1833)
- Zentai, László: Discovery of forested areas in topographic maps: development of orienteering maps
- Nemerkenyi, Zsombor – Bartos-Elekes, Zsombor (Hungary/Romania): Explorers of Congo and Zambezi in the 19th Century and the Comparative Analysis of their Cartographical Works
- Deák, Antal András: The Mystery of a Mine Map
- *Gercsák, Gábor-Márton, Mátyás: Digital virtual restoration and reconstruction of a 150-year-old Hungarian globe (poster)*
- *Jeney, János György: Comparison of the overall presentation of ethnic maps of Hungary made by German and Hungarian mapmakers between 1867 and 1920 (poster)*
- *Jesus Reyes: The first National Atlas of Cuba: Rediscovering the early 20th century country (poster)*
- *Síkhegyi, Ferenc (Hungary): Geological Mapping in Central Europe in the 18th and early 19th century (poster)*

Website of event: [http://lazarus.elte.hu/~zoltorok/2012\\_Budapest/index.html](http://lazarus.elte.hu/~zoltorok/2012_Budapest/index.html)

## 9. Meeting of the ICA Commission on Planetary Cartography

The ELTE Dept. of Cartography and Geoinformatics was represented on this event by our student Zsófia Merk, who presented her paper entitled “Map of Io”. The meeting was organized this event at Moscow State University of Geodesy and Cartography (MIIGAiK) on 9-13 July, 2012. Henrik Hargitai (Chair-person) also participated representing Hungary.

## 10. ELTE Doctor et Professor Honoris Causa: Ferjan Ormeling



The Rector of Eötvös Loránd University accepted the proposal presented by the Dept. of Cartography and Geoinformatics to give Prof. Ferjan Ormeling (The Netherlands, ICA Ex-Secretary General) the title of Doctor et Professor Honoris Causa of our university. The Ceremony was held on 10 May 2013 and a day before Prof. Ferjan Ormeling participated in the activities programmed for the Pázmány Day at ELTE, having a presentation entitled “Cartography as intentional distortion”.

## 11. Joint ICA Symposium on Sharing Knowledge (Dresden, 23 August 2013)

Event organized within the activities before the 26th International Cartographic Conference of the International Cartographic Association (ICA) in Dresden. Organizers of the event were José Jesús Reyes Nunez, Katalin Zsoldi and János Jeney, Assoc. Professor and PhD students of the ELTE Department of Cartography and Geoinformatics. The event was organized at the Dresden University of Technology and it counted with the participation of the ICA Commissions on:

- Cartography and Children,
- Education and Training,
- Maps and Graphics for Blind and Partially Sighted People and
- Planetary Cartography

Four colleagues participated in the event representing Hungary: Andrea Pődör, Henrik Hargitai, László Zentai and José Jesús Reyes Nunez. The three last colleagues also chaired sessions during the event. The Digital Proceedings of the Symposium were edited by José Jesús Reyes Nunez.

Website of the event: <http://lazarus.elte.hu/jointsymposium2013/index.html>



## 12. Participation in other symposia

Hungary was also represented in other events previous to ICC 2013:

- **Workshop on Historical Maps, Atlases and Toponymy** (Leipzig, 22-23 July). Event organized by the ICA Commissions on History of Cartography and on Atlases. The ELTE Dept. of Cartography and Geoinformatics was represented by János Jeney (PhD student) with the paper entitled “Relation of toponymy and minorities living in the Vojvodina Region in the beginning of the 20th century”.
- **Workshop on Generalisation and Map Production** (Dresden, 23-24 July). Event organized by two ICA Commissions (Generalisation and Multiple Representation, Map Production and Geo-Business). The ELTE Dept. of Cartography and Geoinformatics was represented by Zsuzsanna Ungvári, PhD student (Zs. Ungvári-N. Agárdi-L. Zentai: A comparison of methods for automatic generalization of contour lines generated from digital elevation models).
- **Workshop on Eye Tracking: Why, When, and How?** (Dresden, 23-24 July). Dreždában az ICA Geovizualizációs, illetve a Felhasználók bizottság szervezésében. Event organized by two ICA Commissions (Geovisualization and Map Users). Ádám Bérces and Zsolt Török (ELTE Dept. of Cartography and Geoinformatics) presented their paper entitled “A home-made, 10 bucks eye tracking system”.

## 13. Participation in the 26<sup>th</sup> International Cartographic Conference (Dresden, 25-30 August 2013)

Hungary was represented by 14 delegates in this conference:

- László Zentai (ELTE Dept. of Cartography and Geoinformatics)
- Pokoly Béla (VM)
- Mátyás Gede, János Jeney, José Jesús Reyes Nunez, Zsolt Török, Zsuzsanna Ungvári, Katalin Zsoldi (ELTE Dept. of Cartography and Geoinformatics)
- Henrik Hargitai (ELTE Institute for Art Theory and Media Studies)
- Andrea Pódör (NYME Dept. of Geoinformatics)
- László Grimm, Gyula Iván, Balla Csilla Kovátsné, Zsuzsanna Turcsánné Tóth, Felicián Varga, Zoltán Zboray (FÖMI)
- László Orosz, Benedek Simó, Gábor Turczi, Zsuzsa Vikor (MFGI)
- Gizella Bassa, Tamás Scikely (GiziMap)
- Eszter Gálicz (Universität der Bundeswehr München)

Hungarian colleagues presented a total of 15 papers and 10 posters, four of them developed in international collaboration with specialists from Germany and Austria:



- José Jesús Reyes Nunez: Smartphone-based school atlases?
- Zsolt Török: Visualizing in historical context: the study of the Dresden map of Hungary from the 1570s
- László Zentai: Implementation of Cartographic and Digital Techniques in Orienteering Maps
- B. Kádár–Mátyás Gede: Where Do Tourists Go? Visualizing and Analyzing the Spatial Distribution of Geotagged Photography
- Mátyás Gede–Zsuzsa Ungvári–László Zentai: Virtual Globes Museum 2.0 – Adding the Power of Community
- Mátyás Gede–H. Hargitai–E. Simonné-Dombóvári: “Blind Mouse” on Mars and Moon – a Map Game for Disseminating Planetary Topographic Knowledge
- László Zentai–Béla Kovács: Cartography in higher education: changes in the last decades
- Mátyás Gede–János Mészáros: Digital Archiving and On-line Publishing of Old Relief Models
- Katalin Zsoldi: Budapest 3D underground map
- Mátyás Gede–C. Petters–G. Nagy–A. Nagy–János Mészáros–Béla Kovács–C. Egri: Laser Scanning Survey in the Pál-völgy Cave, Budapest
- László Zentai: A less known topographic survey: a 1: 50 000 Scale Military Survey of Hungary (1940-1944)



- Gáspár Albert–Zsuzsanna Ungvári: Cave Volumetric Studies Based on Archive Maps of the Pál-völgy Cave (Hungary)
- Eszter Gálicz, Md. I. Hossain, W. Reinhardt: Geo Web Services for transport crisis management in alpine region
- Lucia Morper-Busch, László Orosz, Benedek Simó, Christian Bialas, David Bertermann: ThermoMap – An Open Source Web Mapping Solution for Displaying Superficial Geothermic Resources
- Andrea Pődör, Márta Kiszely: Analyses of Visualization Methods of the Earthquake Catalog Mapping for Educational Purposes
- Katalin Zsoldi: Budapest 3D underground map
  
- *Buchroithner Manfred, János Jeney: Finding the sources of data used for making ethnic maps (poster)*
- *Henrik Hargitai, Mátyás Gede, Zsófia Merk: Geobrowsers vs. Cartographic Artworks: Virtual Planetary Globes Designed for K–12 Education (poster)*
- *János Jeney, Manfred Buchroithner: The use of OpenSource technologies for distributing historic maps and creating search engines for searching through the catalogues (poster)*
- *János Jeney, Manfred Buchroithner: Ethnic maps of the Hungarian settlement areas from around the world (poster)*
- *Krisztián Kerkovits, János Györffy, Mátyás Gede: Renewing Cabill's Equal-Area Butterfly Projection (poster)*
- *Vera Maigut, Zsuzsanna Viktor, Gábor Turczi: Transenergy – surface geological map and 3D model horizons (poster)*
- *Simonné, Reyes, Gartner, Schmidt, Robonczy: Austrian-Hungarian Survey on Chernoff Faces: An Alternative Method of Representation in School Cartography (poster)*
- *Bence Toronyi, Gyula Iván: Support of Disaster management by SDI and Cartography (poster)*
- *Zsolt Török, Domonkos Hillier: Visualizations of the river Danube based on László Vörös' 1833 hydrographic map (poster)*
- *Zsuzsanna Ungvári, Renáta Szabó: Some aspects of the generalization of small-scale digital elevation models (poster)*
- *Zsuzsanna Ungvári, Tibor Tokai: The interactive gazetteer of a 150-year-old globe (poster)*



László Zentai, Henrik Hargitai and José Jesús Reyes Nuñez were Session Chairs. José Jesús Reyes Nuñez, as member of the Judging Commission, participated in the evaluation of entries sent to the Barbara Petchenik Competition that were presented in the International Exhibition.

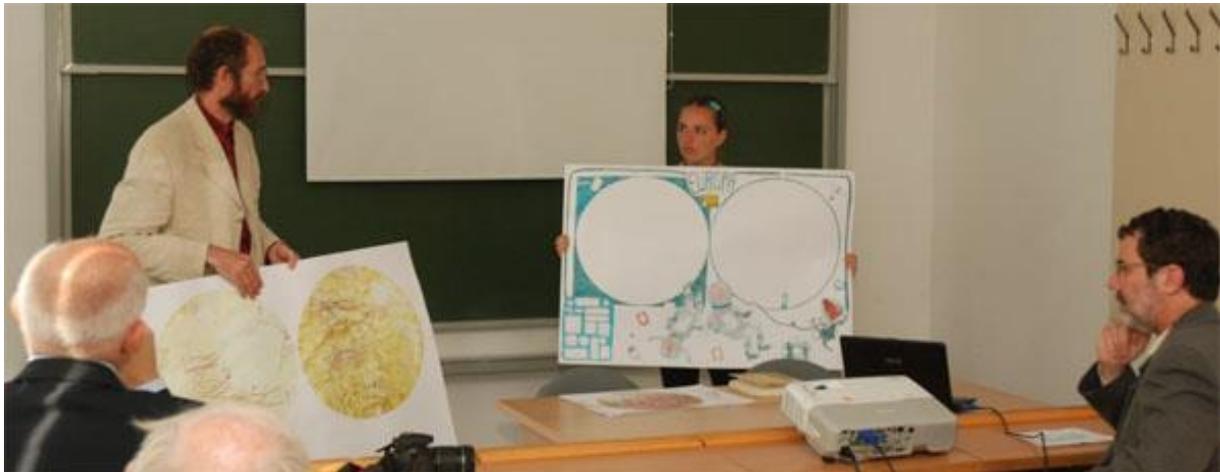
## **14. Participation in the Digital Technologies to Cartographic Heritage workshop (Rome, 19-20 September 2013)**

Hungary was represented by Krisztina Irás, János Jeney, Timár Gábor, Csilla Galambos and László Zentai, as well as with the following papers:

- Krisztina Irás, István Elek: Digital Map Collection and Map Database of the Eötvös Loránd University
- László Zentai: The way to Cartography 2.0: The implementation of the Digital Technologies in Cartographic Heritage in Cartography and in the ICA

## **15. Joint ICA Commission meeting (Budapest, 3 September 2014)**

Two ICA Commissions and a Working Group organized their joint meeting at ELTE Dept. of Cartography and Geoinformatics: Commission on Cartography and Children, Commission on Planetary Cartography and Working Group on the International Map Year. The meeting was organized as one for the previous activities related to the 9th International Workshop on Digital Approaches to Cartographic Heritage, counting with the participation of delegates interested on the activities of these commissions and working group. José Jesús Reyes Nunez (Hungary) presented the activities developed by the Commission on Cartography and Children in the previous year, Bengt Rystedt (Sweden) reported on the activities developed and planned for the International Map Year and Henrik Hargitai (Hungary) presented (together with the other authors) the newest products of a collection of maps of planets and moons for children.



## **16. Organization of the 9th International Workshop on Digital Approaches to Cartographic Heritage (Budapest, 4-5 September 2014)**

The event was organized by the ELTE Dept. of Cartography and Geoinformatics and the National Széchényi Library (venue of the workshop), as well as counted with the scientific coordination of the ICA Commission on Digital Technologies in Cartographic Heritage. 33 Hungarian colleagues participated in the workshop, presenting the following papers:

- L. Zentai: Revisiting the Preservation of Modern Cartographic Products
- E. Kiss, Zs. Ungvári, P. Fulajtár: Digital Map Collection Project at the National Széchényi Library
- E. Biszak, H. Kulovich, S. Biszak, G. Timár, G. Molnár, B. Székely, A. Jankó, I. Kenyeres, Cartographic Heritage of the Habsburg Empire on the Web: the MAPIRE Initiative
- L. Tóth, Contribution of the Hungarian Military Mapping to the Cartographic Heritage
- C. Galambos, Topographic Basis and Projection of Early Geological Maps About Hungary
- K. Irás, B. T. Nguyen: Geolocating System of Old Maps – Without Georeferencing
- G. Timár, J. Mészáros, G. Molnár: A Simple Solution for Georeferencing the Cassini Map Series of France
- G. Timár, Zs. Bartos-Elekes, G. Molnár, Z. Imecs, Zs. Magyar-Sáska, Improvement of Horizontal Georeferencing Accuracy of the 1864 Map of South Romania by Correction Grid (GSB) in GIS and Web Publishing Environment
- G. Molnár, G. Timár, E. Biszak, Can the First Military Survey Maps of the Habsburg Empire (1763-1790) be Georeferenced by an Accuracy of 200 Meters?
- J. Jeney: The Use of Digital Technology in International Archival Map Research
- Á. Hegedüs, G. Gercsák, Life and Works of Sándor Radó
- Pődör, Experiment of Involving Students in Preserving Geographical Names Appearing on Historical Maps
- T. Kiss: Digital Processing of the Map Collection of the Environmental and Hydrological Archives
- M. Gede: Novel Globe Publishing Techniques Using WebGL
- R. Szabó: Virtual Visualization of a Celestial Globe
- Zs. Ungvári: A Method to Create Interactive Gazetteer to Old Globes
- G. Albert: What Does an Archive Map Tell the Contemporary Map Readers? Information Transmissivity Analysis on the Survey Maps of the Josephinische Landesaufnahme (1763–1787)
- Á. Hegedüs, G. Gercsák: Life and Works of Sándor Radó
- The following Hungarian colleagues chaired various sessions during the event: Gáspár Albert, Mátyás Gede, Gábor Gercsák, Krisztina Irás and Gábor Timár.



### **17. Meeting of the ICA National Committee and ICA President's visit at ELTE Dept. of Cartography and Geoinformatics**

The meeting was held on 22 January 2015. One of the main topics of this meeting was information about the Hungarian participation in the next International Cartographic Conference in Rio de Janeiro, discussing themes as the Hungarian participation in the International Exhibition, number of papers and posters sent to the organizers, etc. During the morning of this day Georg Gartner, ICA President visited the Dept. of Cartography and Geoinformatics and had a work session with the Head, Prof. László Zentai.



### **18. Organization of the Hungarian edition of the Barbara Petchenik International Competition**

The Barbara Petchenik national competition was organized in Hungary from October 2014. The organizer institutions were the ELTE Dept. of Cartography and Geoinformatics and the Hungarian Geographical Society and the competition was sponsored by Esri Hungary Ltd. and Dimap Ltd. The deadline given to the schools and interested people to send the entries was 15

March 2015 and the Jury selected three drawings to represent the country in the International Competition:



1. Zsófia Katalin Albert (8 years): The map of my World. Budavári Elementary School, Budapest.
2. Laura Eliza Mázás, Petra Panna Mehn, Piros Anna Szabó (10 years): World tree on our world (Our place is the whole world). Rákospalotai Meixner Elementary and Basic Art School, Budapest.
3. Valentina Sturcz (14 years): Let the music for everyone. Fazekas Mihály Elementary and Secondary School, Budapest.

Hungary also received an entry from Bucharest, to represent Romania in the competition:

1. Ada Maria Ciontu (11 years): Building bridges of peace across the world.

The ceremony to give the prizes for the winners was held at Eötvös Loránd University, Lágymányosi Campus, during the celebrations in occasion of the Neumann Day (7 May 2015).



### **19. Participation in the 11th Conference on Cartography and Geoinformatics in Buzet, Croatia (9-11 May 2015)**

László Zentai and Béla Kovács participated in this event.

### **19. David Fairbairn, former General Secretary of the ICA, teacher of the University of Newcastle visited Hungary.**

David Fairbairn presented a paper at Eötvös Loránd University, Department of Cartography and Geoinformatics: *Can VGI be integrated with official map data?*



## **20. 10th International Workshop on Digital Approaches to Cartographic Heritage, Corfu Island, Greece (27-29 May 2015)**

Presented papers from the department:

- Zentai L., Cartactual, something special to preserve (and make publicly available) as a Cartographic Heritage: from paper maps to Cartography 2.0;
- Gede M., Barancsik Á, Determining the projection of small scale maps based on grid line shapes.

Gede Mátyás chaired the Aerial Photography session.



## 3. Cartographic training and research at institutions of higher education

### Activities of the Department of Cartography and Geoinformatics, Eötvös Loránd University (ELTE), Budapest

The status of the Department was changed last time in 2003: the Department of Cartography was named Department of Cartography and Geoinformatics and moved to the newly formed Faculty of Informatics. The three basic duties of the Department are as follows:

- training of cartographers at BSc, MSc and PhD levels,
- teaching cartography to future teachers of geography, to geography students, to Computer Science MSc students, and to students of environmental sciences and programmers,
- supplying of maps, digital images, webmaps and professional advice for educational and scientific activities of the university's faculties.

The staff of the Department (full time and lecturers on contract) numbers 16. Subjects of the cartography syllabus that require other professional qualification than the Department staff has are taught by noted Hungarian and foreign scholars (giving a full course, an optional course, or just a few lectures). Altogether 25 foreign experts and visitors contributed to the training of cartography undergraduates and graduates between 2011 and 2015. The training activities of the Department were expanded within the Doctoral School of Earth Sciences, Cartography Sub-programme: 3 candidates got the PhD in cartography in the last 4-year period. Within the past four years, the Department received 20 students and sent 15 students on mostly Erasmus mobility.

László Zentai, the head of the department is serving as a Vice-Dean of the faculty from 2012, and János Györffy was also serving as a Vice-Dean till 2012.

The website of the department (<http://lazarus.elte.hu>) was opened in 1995. For long this was the starting point of the Hungarian cartography.

### Training

The first independent university department of cartography was established in 1953. The first training syllabus was prepared in 1955, and it formed the basis of the training of Hungarian cartography students until the early 1970s.

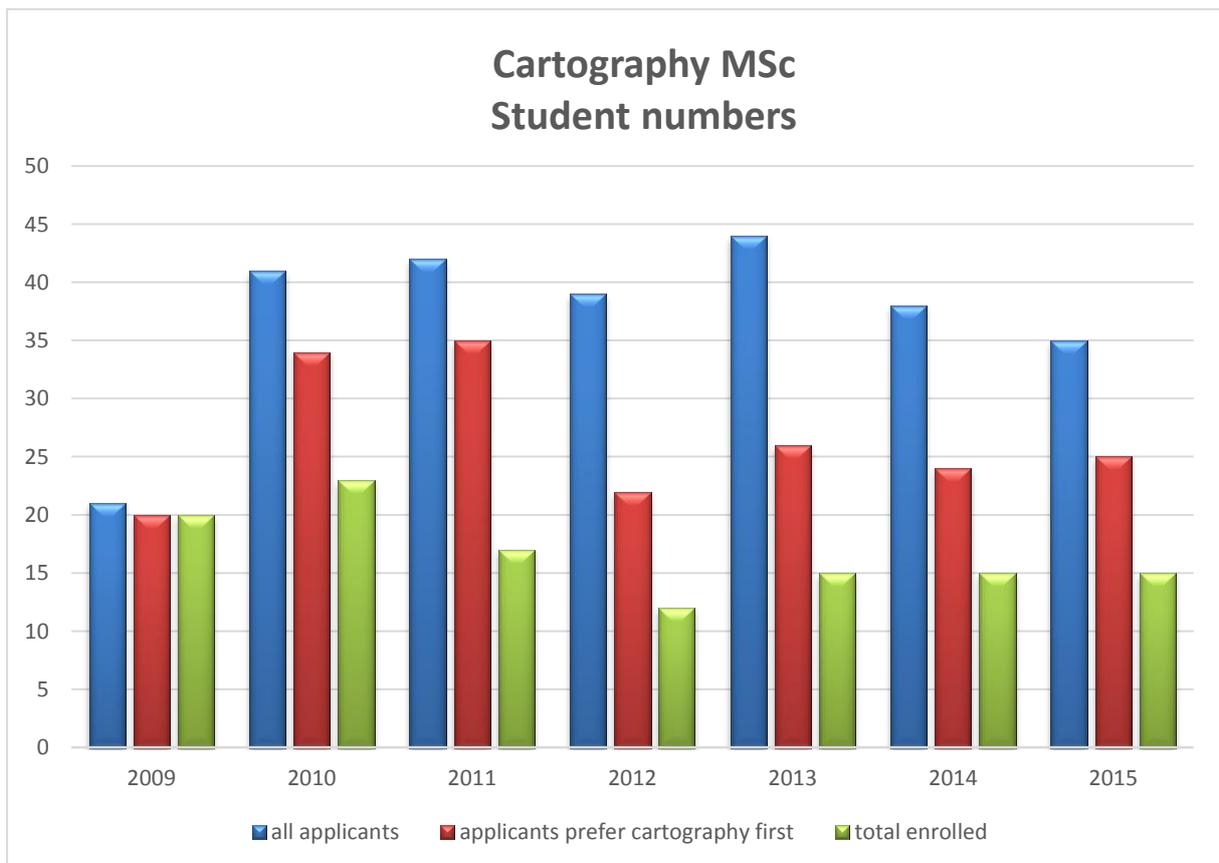
In 1973, cartography training was changed as part of the general reform of university training. Cartography training continued to be a 3-year programme.

The Hungarian Act on Education of 1986 made it possible that cartography training became a 5-year programme. The first 10-semester programme was launched in the 1988–1989 academic year. The Department continuously modernized its curriculum after 1990 to introduce digital cartography. A new curriculum was formed in 2001.

The multi-cycle system according to the Bologna model started in all fields of studies in Hungary as of 1 September 2006. This process was not consistently linked to the establishment of the programmes of the second cycle (master level). The specialization in cartography (starting after the second semester) is available in the Earth Sciences BSc programme; the whole BSc programme is of 6 semesters. Based on the bachelor degree, the students can apply for several MSc programmes by ranking them, including cartography (4 semesters), which is unique in Hungary.

The teaching of the processes and methods of computer-assisted cartography (automated surveying methods, computer graphics, computer-controlled technologies) are supported by a range of technical acquisitions of the Department (GPS receivers and base station, scanners, output devices, computer software).

The MSc system for cartographers was introduced in 2009 after a short preparation period. After five years, a reformed structure was accepted as of September 2014 to follow the world trend of computerizing, to meet the changing demands of the labour market, to harmonize the system with the international practice, to change the rate of credit/contact hour, and to require more individual research work. Old and new courses were put into a basic (mandatory) and four flexible (three mandatory) modules, which can be taken according to the students' professional interest. Some courses are offered also in English. The best students are involved in the research projects of the department, the professional profile of which is also modernized by employing new teachers who represent the professional interest in geoinformatics.



## Sub-programme for Cartography of the Doctoral School of ELTE

Cartography is traditionally related to several disciplines. Historical events, social or economic changes, geological formations, meteorological phenomena, and ocean currents are all chances for communication of cartographic information.

If you visit the homepage of the Department of Cartography and Geoinformatics, you can get a sample of this variety by taking a view of the degree theses and their themes chosen by the PhD students.

The Department does not plan a radical change in the practice of training doctoral students, but it is susceptible to any new tendency arising. The purpose is to go before the prevailing challenges and guide the way to those who work in practical cartography. Indeed, most of the students, including the majority of PhD students, will find employment in the field of cartography (or in fields related to it, e.g. informatics, environmental conservation, public administration); some of them had even worked in these fields prior to being a student at the Department.

Most of the staff of the Department – researchers, professors, and teacher-engineers – participates actively in education, research and practical cartography. In the publication lists, beside traditional maps, you can find electronic atlases and multimedia cartographical publications financed by domestic or foreign superiors (companies, funds, offices). Their preparation includes theoretical and practical work of the staff of the Department.

Modern education, especially doctoral schools and workshops surpassing even the higher education, needs the intensive development of technical resources. This is the only way to keep pace with the development of the general level of techniques. This is why one of the recent fundamental tasks of professors, PhD students and undergraduate students is to compete.

## Research

The Department has undertaken research in the following fields of subjects:

- Aspects of representation in thematic cartography (digital maps - electronic atlases)
- Map projections
- History of cartography
- Toponymy
- GIS, webGIS
- Virtual Globes Museum
- Managing a special sub-project in the National Research University Project (TÁMOP): Large cartographic databases and informatics in thematic cartography (2010-2012).
- Participation in editing the new National Atlas of Hungary (2012-)

## Other universities

Two major universities offer MSc degrees in professional areas related to cartography. The Budapest University of Technology and Economics has a three-semester programme of Land Surveying and Geographical Information Systems Engineering, and Óbuda University (in Székesfehérvár) offers a two-year programme of Land Management Engineering. Until last years, the latter training belonged to the University of West Hungary.

There are several other institutions in Hungary that have various PhD programmes available for those students who have an MSc degree in our profession, including earth sciences, environmental sciences and even forestry. They are as follows: Budapest University of Technology and Economics, University of Debrecen, University of Miskolc, University of West Hungary, University of Pécs, University of Szeged, and Szent István University in Gödöllő.

## 4. Map collections

### Map Room of the National Széchényi Library

The past couple of years were very rich again in conferences and exhibitions organized in Hungary in the themes relating to map history.

The National Széchényi Library organized the following exhibitions, or actively participated in organizing them:

In 2011.

- Specialities of a cosmographic atlas. Treasures of founder's collection of the National Library

In 2012:

- Specialities of a cosmographic atlas. Treasures of founder's collection of the National Library: navigational charts
- Reconstruction of the old and new Perczel globes

In 2013:

- Specialities of a cosmographic atlas. Treasures of founder's collection of the National Library: Hungarica maps

In 2014:

- Specialities of a cosmographic atlas. Treasures of founder's collection of the National Library: War history maps
- Commission on Digital Technologies in Cartographic Heritage 9<sup>th</sup> international workshop

In 2015:

- Specialities of a cosmographic atlas. Treasures of founder's collection of the National Library: city maps
- 

Publications:

- Pászti László: Kiegészítés Schedius Lajos és Blaschnek Sámuel Magyarország-térképének kiadástor-ténetéhez. In: Geodézia és kartográfia 2012/1-2. (9-12. o.)
- Plihál Katalin: A Tabula Hungariae... Ingolstadt, 1528. Térkép és utóélete az eddigi és a jelenlegi kutatások tükrében. - Budapest : OSZK : Kossuth, 2013, ISBN 978-963-200-613-0
- Kiss Eszter–Pászti László: A tér digitális ábrázolásának szerepe a nemzeti emlékezet megőrzésében. In: Tér(v)iszonyok és térkép(zet)ek. Budapest, 2014. 246-262. old.
- Danku György: Áttekintés a Tabula Hungariae-kutatások állásáról. In: Könyvtári Figyelő, 2015/1

Although it is not exactly an event of map history, in this place it is worth mentioning that for many years the National Széchényi Library and the Lazarus Cartographic Foundation have been organizing every spring an exhibition and competition for the most beautiful printed and digital maps produced in Hungary during the previous calendar year.

*László Pászti, Keeper of the Map Room*

## **War History Institute and Museum, War History Map Room**

### **National Progress Report 2011-2014**

#### **Activities of the Maproom:**

The main task of the Maproom is promoting researchers with different pieces of cartographical materials /ancient maps, series maps, aero-photographs,.../. The most studied items are the first, second and third military survey maps of Hungary and the aerophotos of Hungary (1950-1990). The number of researchers is about 390-400 persons per year.

#### **Education in the Maproom:**

Study visits of different groups from universities, colleges and even groups from abroad, 10-14 groups per year. The objectives of these visits are historical cartography, introduction to military surveys. Courses has been regularly held to the students of Military Academies.

#### **Automation of map-catalogues, digitising projects and internet::**

The catalogue of the individual maps of the Maproom has been processed – 30.000 pieces. For the elaboration Folio Views program was used. The total catalogue can only be used locally in the Maproom. The maps of Hungary, Europa, the Balkans, Russia and the maps from the First World War are scanned and linked to the text (about 36 000 map sheets). The maps of Hungary (from the fifteens century to 1918, about 6500 map sheets) and the maps from the First World War (about 8000 map sheets) are available on the internet ([hungaricana.hu](http://hungaricana.hu)). The maps of the first, second and third military survey maps of Hungary and the Habsburg Empire are too on the internet (Mapire).

#### **Collection development:**

We have an increase cca. 2000-2500 maps per year (military maps, colour copies, other maps).

#### **Conservation, restoration:**

10-20 maps per year are under professional restoration, scanning of maps for security reasons.

#### **Exhibitions:**

„The Renaissance Cartographer Man – Colonel Tóth Ágoston” - exhibition for the 200th anniversary of the birth. It was in the War History Museum in November of 2012.

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## Virtual Globes Museum

The Virtual Globes Museum web page was opened in 2007 with only five virtual globe models. Since then, the number of globes was raised over one hundred. The amount and heterogeneity of data made it necessary to rethink the underlying database structure. The new version of the web site introduces several new functions such as the possibility of adding multiple descriptions to globes in various languages and creating collections from a subset of globes. The most important improvement, however, is the crowd sourcing of the site: registered users can add or update descriptions and collections, which can fasten the growth of the database. Another novelty is the replacement of the old VRML plug-in used for displaying the globe models to a new WebGL or Flash-based visualization.

Naturally, new content is not published uncontrolled. First of all, user registration is not automatic but done upon e-mail requests. This is mainly to keep away robots and trolls from the site. Then, registered users can have different permissions. All new or modified content is subject of a reviewing process, and only materials reaching a certain quality are classified as “public”. Non-public materials are visible only to their owners. The right of “giving publicity” is initially restricted to the developers of the site, but later any user can achieve this right after generating a certain amount of high-quality content. In contrary to the previous version of the site, globe and collection pages have unique URLs, so not only the museum’s website itself but any specific content can be referenced, shared in social network community sites etc. While users proudly present the latest content they added, at the same time they popularize the museum itself, making it more widely known and visited.

The introduced changes solved most of the problems of the old system. The changes of the technical background added even more possibilities to the future development, and made the use of the VGM website easier.

The application of Web 2.0 principles brought a kind of cartographic communication to the site: it helps to collect further interesting information about the globes and share it with the public. Furthermore, thanks to the possibility of user-created collections, the museum can serve much better the priorities in cartographic education with special thematic collections such as an illustrated history of globes, or a collection following the changes of geographical names etc.

Currently, new globes can be added only by the system administrators. The most important development plan is to add an online globe georeferencer. The georeferencer will be able to deal with uploaded gore scans and globe photographs, letting users create their own virtual globes. Naturally, a detailed user manual and photographing guide will supplement the new system, and quality checking will be even more important on user-created virtual globes than on descriptions or collections.

## VGM 2.0 - Virtual Globes Museum

What's new? - Information - Globes - Collections - Interactive gazetteer
English - Magyar
User: 
Password: 
login



**Date:** 1878  
**Diameter:** 10.5 cm  
**Scale 1 :** 120 000 000  
**Uploaded by:**  
**Detailed information:** [magyar](#) [English](#)

**10.5 cm German political and physical earth globe - 1 : 120 000 000**

<b>General description</b>	Physical-political globe. The virtual globe is based on unmounted gore set.
<b>Date</b>	1878
<b>Publisher</b>	Kartographische Institut, Berlin
<b>Place of publication</b>	Berlin, Germany
<b>Author</b>	D. Reimer (E. Vohsen)
<b>Technology</b>	The globe was probably made by mounting the paper prints of the spherical segments the north and south – are completed by 2 polar caps of 20°. The material of the support were ever mounted on a globe. The virtual globe was prepared by the high resolution sc globe and then by georeferencing of the polar caps.
<b>Support</b>	unknown
<b>Virtual instance's origin</b>	Map print of an unknown (not indicated) edition of the globe. Maproom of the Department of Cartography and Geoinformatics. Eötvös Loránd Univer