

# **SDI 25000 and Topographic Map Production in Macedonia**

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**Key words:** Topographic maps, Macedonian 25000SDI, scale 1:25000, GIS portal, global map

## **SUMMARY**

Between 1945 and 1991 years, all cartographic data for Macedonian territory as a part of former Yugoslavia has been produced by the Military Geographic Institute (MGI) in Belgrade. Whole territory is covered with topographic maps prepared in a several periods mainly by MGI. After that, until 2004 year, official state cartographic production of Macedonia was in stagnation without any official activities in this field.

First beginnings of cartographic production in Agency for Real Estate Cadastre - AREC (former Agency for Real Estate Cadastre- AREC) as National Mapping Organization (NMO) of Macedonia after the independence of Macedonia were the study for establishing of state base maps for GIS and the Global Mapping project. Macedonian Global Map data have been published on internet as a part of Global Map on 08th March 2006 as a first official Macedonian cartographic product after its independence, and as first European country included within the global map ([www.iscgm.org](http://www.iscgm.org)).

In a period from 2004 till 2006 year, Japan International Cooperation Agency (JICA) donated funds for the project for preparing new topographic maps in scale 1:25000, i.e. topographic spatial data infrastructure 25000. Final products from the project are printed and digital topographic maps in a GIS database for 60% of territory, as well as the black and white orthophoto with 0.5m resolution, photo materials and new GPS passive network for whole territory of Macedonia. Macedonian GM data have been utilized as a background of the index map in a backside of topographic maps.

After the period of cooperation with JICA, Macedonian NMO has continued with the process for preparing of the other topographic maps with aim to cover the rest area, other 40% of territory of Macedonia. Up to date, about 90% of topographic maps are already produced and released for purchasing. The new topographic maps are available in Macedonian and English languages, which can be found on the web Portal of AREC also ([www.katastar.gov.mk](http://www.katastar.gov.mk)). The final output formats of new digital topographic data are in GeoTIFF for raster data, and ArcInfo Coverage, Shape file and DXF for vector data. The process of preparing of the other maps is ongoing, within the cartographic department of AREC, with aim to cover whole territory of Macedonia by the end of year 2011.

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## **1. PREFACE**

Preparing of topographic maps in several scales in a period between years 1945 and 1991, i.e. while Macedonia was a Republic within the Former Yugoslavia federation, has been done by the Military Geographic Institute (MGI) of Yugoslavia, with the central office in Belgrade. Other thematic and geographic maps for Macedonian territory in the same period were prepared by Geokarta, with the central office in Belgrade also. Both facts make clear that all cartographic works in former Yugoslavia were centralized in state level.

In that period, Agency for Real Estate Cadastre (AREC), former State Authority for Geodetic Works (SAGW), was the responsible institution for establishing of local geodetic networks, cadastral surveying, preparing of cadastral maps, registration of real estates and updating of the cadastral information (maps and database). After independence of Macedonia, from 1991 to 2004, it was forgotten that in new independent country there is no other responsible governmental institution to carry out for cartographic works. All ARECs capacities were oriented in to developing of new cadastral system with registered property rights, i.e. AREC did not play the role of Macedonian National Mapping Organization (NMO). That period characterized with the stagnation in all cartographic works. In official utilization, were the prepared maps by MGI with the old date of publishing and with non-updated information! AREC had only the role of map seller.

First efforts of Macedonian independent national cartographic production are the preparation works for developing of first Spatial Data Infrastructure 25000 (Study for establishing of state base maps for GIS in the Republic of Macedonia) and the Global Mapping project.

On 08<sup>th</sup> March 2006, in the web site of International Steering Committee for Global Mapping (ISCGM) was published the Macedonian GM data (Idrizi B., Biljarska N., 2007). It considers as first official Macedonian national cartographic product. Macedonia is 22<sup>nd</sup> country, as well as the first European country that has been released its data within the Global Map. Through participation in this project, i.e. the provision of base framework geographic dataset, Macedonia has contributed in the sustainable developing of globally homogenous geographic data set in scale 1:1.000.000 for vector data and 30" resolution for raster data.

During the "Study for establishing of state base maps for GIS in the Republic of Macedonia", on year 2003, in cooperation between AREC and Japan International Cooperation Agency (JICA) teams, was realized a need for urgent establishment of new topographic maps in scale 1:25.000 in printed and digital form, containing the latest geographic information suitable for use at the national level, as well as to acquire the techniques required for establishment of maps, and to disseminate geographic information at national level. As a result of the study, the implementation of projects was done in a period from March 2004 to November 2006, with in the fruitful cooperation between JICA and AREC. On November 2006, as a result of

successful implemented project, around 60% of the territory of Macedonia was covered with the new topographic maps in scale 1:25000 and developed database for the same area (with blue color in figure 1), and orthophoto with 0.5m resolution for whole territory of Macedonia (JICA, 2006). Production of the rest topographic maps is ongoing process within the AREC.

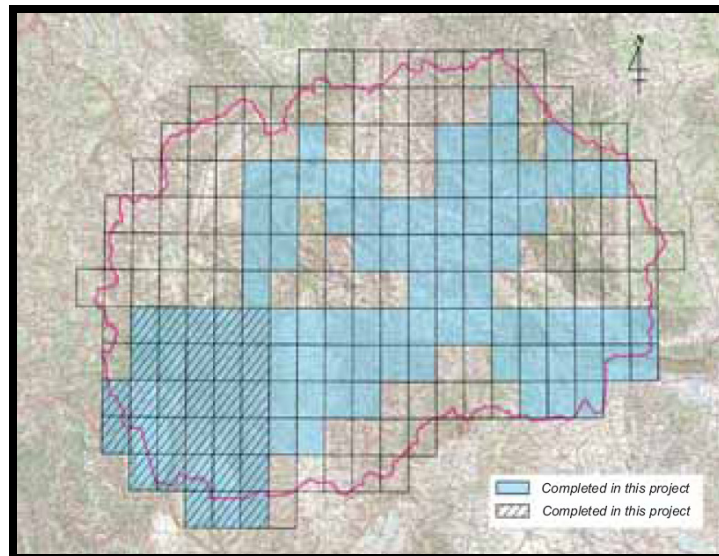


Figure 1. Covered area with new topographic maps 1:25000 prepared from 2004 till November 2006.

## 2. TOPOGRAPHIC MAPS BEFORE YEAR 2004

Topographic maps prepared by MGI up to year 1991, covered the whole territory of Macedonia as a part of former Yugoslavia. Within that period, have been published topographic maps in scales 1:25.000, 1:50.000, 1:100.000 and 200.000. All products were in analog form (paper maps), and the presented data relates to year 1972, and some of them were updated in year 1986 (Talevski J., Vuckov S., Gjorgjievski G., 2005).

At the beginning, based on aero-photogrammetrical surveying, were prepared topographic maps in scale 1:25000. Other topographic maps in rest scales (1:50000, 100000 and 200000) were prepared by generalizing of existing topographic maps 1:25000. All topographic maps had the status of military secret data, and they were not allowed for civil utilization. In total 210 map sheets were in scale 1:25000, 61 map sheets in scale 1:50000, 18 map sheets in scale 1:100000, and 6 map sheets which cover all Macedonian territory, as well as 2 map sheets which cover the eastern part of Albania in border with Macedonia in scale 1:200000. All of them are in state coordinate system of former Yugoslavia, based on Gauss-Krüger projection and ellipsoid of Bessel 1841, except one set of topographic maps in scale 1:50000 prepared in a geographic coordinate system based on Paris prime meridian.

Serbo-Croatian language with Latin alphabet as official has been used for all sets of topographic maps. Only the topographic maps in scale 1:200000 has the legend with description for most used symbols.

Those topographic maps, after year 1991 were given to AREC. Until production of first own

Macedonian topographic maps in scale 1:25000 (November, 2006), they were the only source of topographic maps for utilization in Macedonia. They have been scanned and georeferenced, and purchased to users in digital form as GeoTIFF. In that period, AREC was seller of topographic maps, without any activities for updating or producing of new ones.

### 3. NEW MACEDONIAN TOPOGRAPHIC MAPS IN SCALE 1:25000

“The study for establishing of state base maps in the Republic of Macedonia” present the beginnings of efforts for developing of Macedonian own national cartography. Due to the situation in previous period (till year 2003) in the governmental responsible institution for mapping, foreign assistance was very important and necessarily. In year 2003, Japan International Cooperation Agency (JICA) started the research on current situation with national mapping and GIS in Macedonia. After very fruitful cooperation between JICA and all governmental institutions, it was decided donation of funds for realizing a project for producing of topographic maps in scale 1:25000 followed by GIS database.

The whole project was realized in a period from March 2004 to November 2006, in which around 60% of territory was covered with new topographic maps, i.e. Macedonian 25000SDI. Up to December 2010, other ≈30% of territory was covered with new maps, in total around 90% (figure 2).

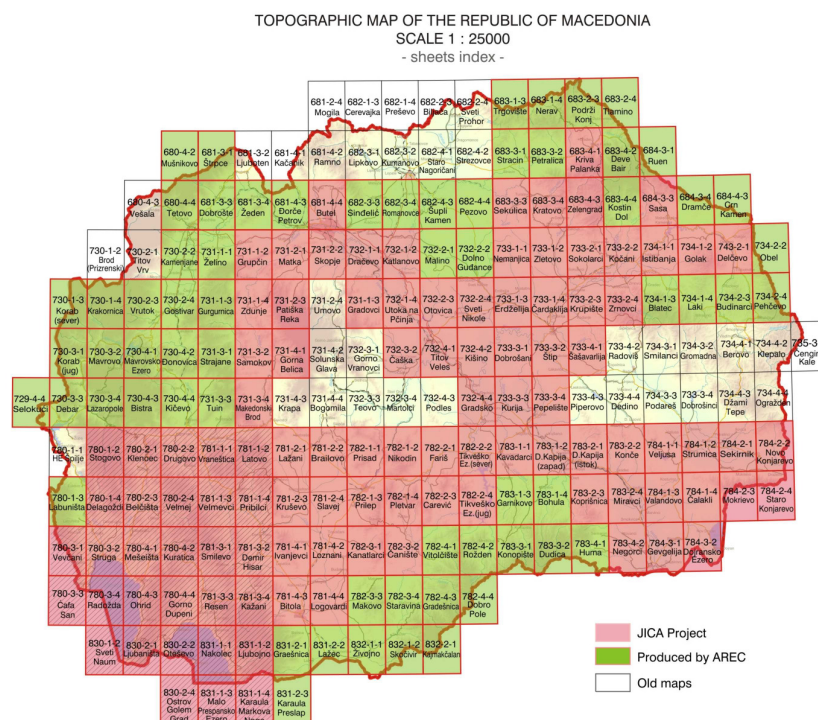


Figure 2. Coverage with new topographic maps 1:25000 ([www.katastar.gov.mk](http://www.katastar.gov.mk), February 201)



### 3.1. Technical details of new topographic maps of Macedonia in scale 1:25000

New topographic maps were prepared in parallel in Macedonian and English languages (figure 3). In Macedonian version, Cyrillic alphabet as official has been used for all contents. In the other maps in English language, the rules of translation are not the same for all contents in map. Only the legend of most used symbols was translated in English, and other text contents were transformed in Latino alphabet by transliteration method.

These maps are in the same coordinate system (table 1) and tiling system with old maps, i.e. in state coordinate system of Macedonia. There are new information's as legend, details for mathematical elements, data policy, and important dates from the process of map preparing. They are open for utilization by all type of users, without any limitation.

New topographic key with 208 symbols has been defined also. In comparing with older one (328), around 30% less symbols has new maps. Unfortunately, reducing the number of symbols has direct influence on decreasing the quantity, as well as in decreasing of the quality of data presented in new maps.

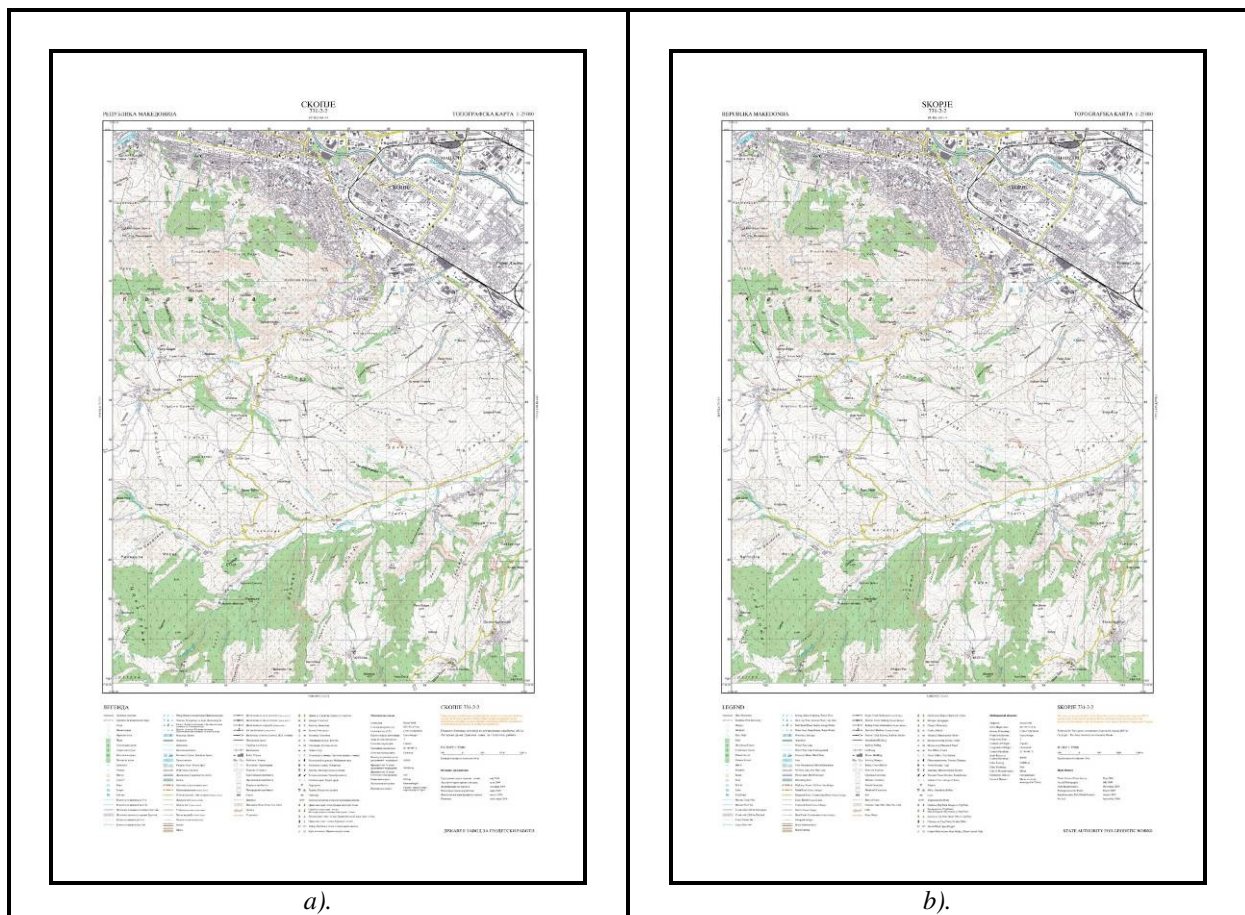


Figure 3. Example of new topographic maps 1:25000 in Macedonian (a) and English (b) language

Table 1. Coordinate system of topographic maps

<b>Datum</b>	Hermannskögel
<b>Ellipsoid</b>	Bessel (1841)
<b>Map projection</b>	Gauss-Krüger (3° zones)
<b>Central meridian</b>	21° E
<b>Zone of projection</b>	7
<b>Prime meridian</b>	Greenwich
<b>Prime parallel</b>	Equator
<b>Scale factor</b>	0.9999
<b>False easting</b>	500000m
<b>False northing</b>	0m
<b>Elevation origin</b>	Mean sea level – Molo Sartorio, Trieste, Italy.
<b>Units</b>	Meter (m)

### 3.2 Background of new topographic maps of Macedonia in scale 1:25000

With aim to make more simple finding out the tile number and name of needed map, in a back site of all paper topographic maps is given the “sheets index” map for whole territory of Macedonia, based on tiling system of Macedonian topographic maps in scale 1:25000 (figure 4). The “sheets index” map has two categories of data, i.e. special and background. Special data represent the tiling system, and the background is obtained from the Macedonian GM data with the role to make more visible and clear which places in which topographic map can be found. Background is composed by four Macedonian GM layers, three vector layers and elevation data from raster layers. Vector layers have been used in total, except the boundary layer. From the boundary layer, only the national boundary has been used as a part of background of “sheets index” map (Idrizi B., 2008a).

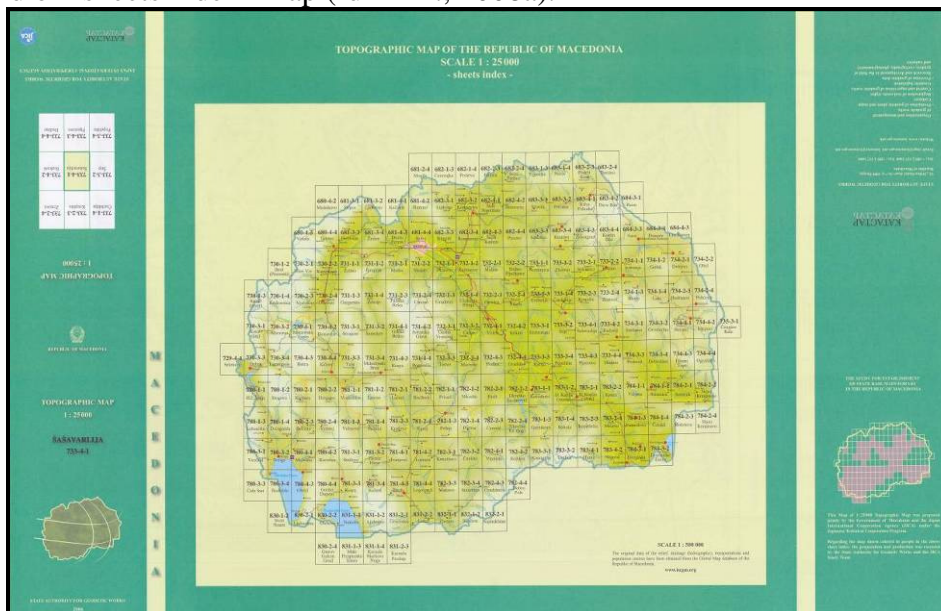


Figure 4. Back site of paper topographic maps

### 3.3 Macedonia 25000 SDI

The thorough consideration during “The study for establishing of state base maps in the Republic of Macedonia” has been paid through the entire process to adopt technical specifications that meet user needs, Macedonian geography, and to establish the Spatial Data Infrastructure (Macedonian 25000SDI) that can be widely used. Based on this rules, data structure of Macedonian 25000SDI comprises the fundamentals of information infrastructure in Macedonia. It contents 10 layers, i.e railways, roads, land classification, administrative areas, spatial scheme, reference raster, annotations, topographic feature, small objects and water spaces. Some of them are not shown in paper topographic maps, but they can be found in database. In next figure (5), can be seen the logical view of Macedonian 25000SDI and the example of single dataset consists of 1workspace and 12 coverage’s as 1 map sheet except raster components (AREC, JICA, 2006).

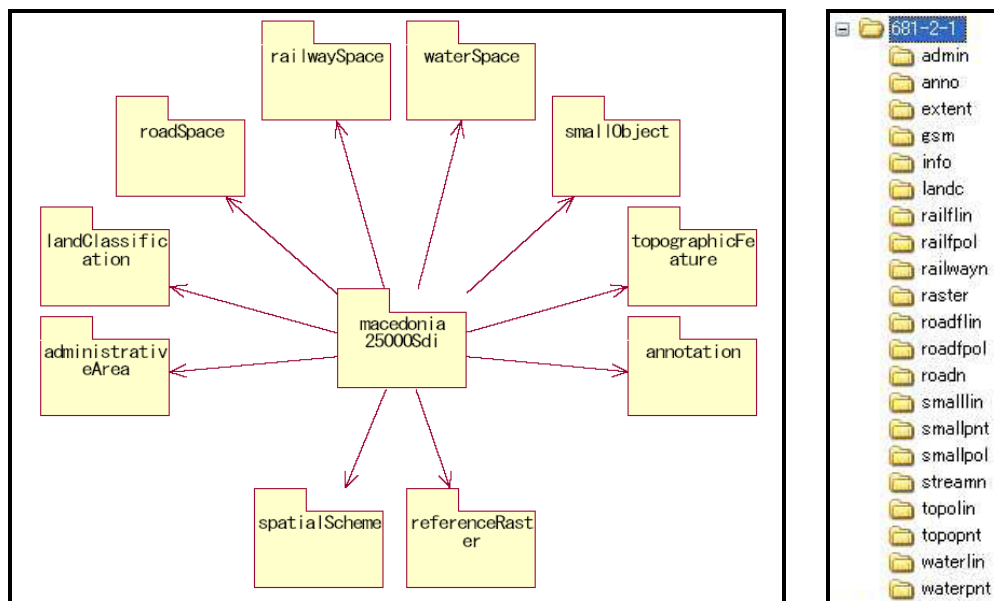


Figure 5. Macedonian 25000 SDI and ArcInfo Coverage structure of single dataset

From Macedonian 25000SDI, several datasets such as Topographic Map GIS Database, Land use GIS Database and Ohrid Environmental Conservation GIS Database were generated as the final product. The digital Printing Data and the Printed Maps were prepared for the extensive use by various users (figure 6) also.

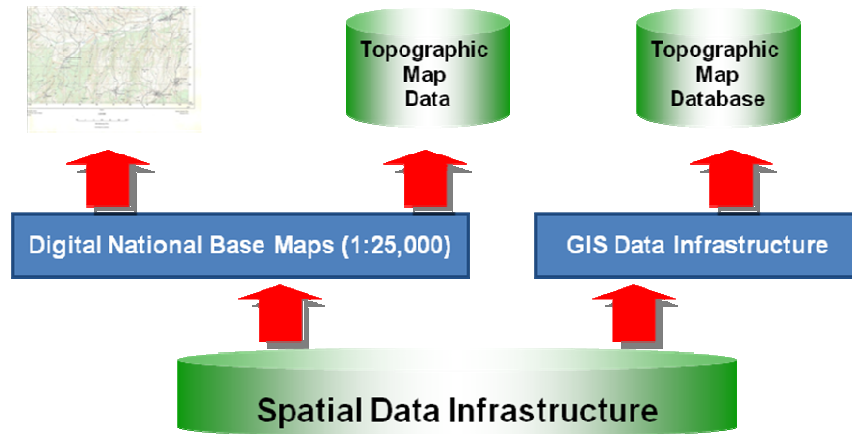


Figure 6. Outputs from Macedonia 25000SDI

### 3.4 Overview on the process of preparing of new topographic maps-database

Over the period of the project implementation (March 2004 – November 2006) and after that (November 2006 – December 2010), numerous work items have been carried out by the AREC and the JICA study team with assistance of the related organizations for producing of national topographic maps in scale 1:25000. The process was started by defining of new specification for Spatial Data Infrastructure, and field works on reconnaissance of ground control points and installation of aerial photo signals.

Shooting of aerial photographs was realized on May 2004, followed by field works for surveying of ground control point and field identification of aerial photographs. After finished field works, the process was continued by office digital photogrammetrical works (aerial triangulation, digital plotting and compilation). With aim to eliminate accidentally errors, supplementary field identification and digital compilation were done. At the end of process, preparations of data for printing have been done in Adobe Illustrator and ArcInfo Coverages in ArcGIS. Below is the summary of work items completed in this project (figure 7).



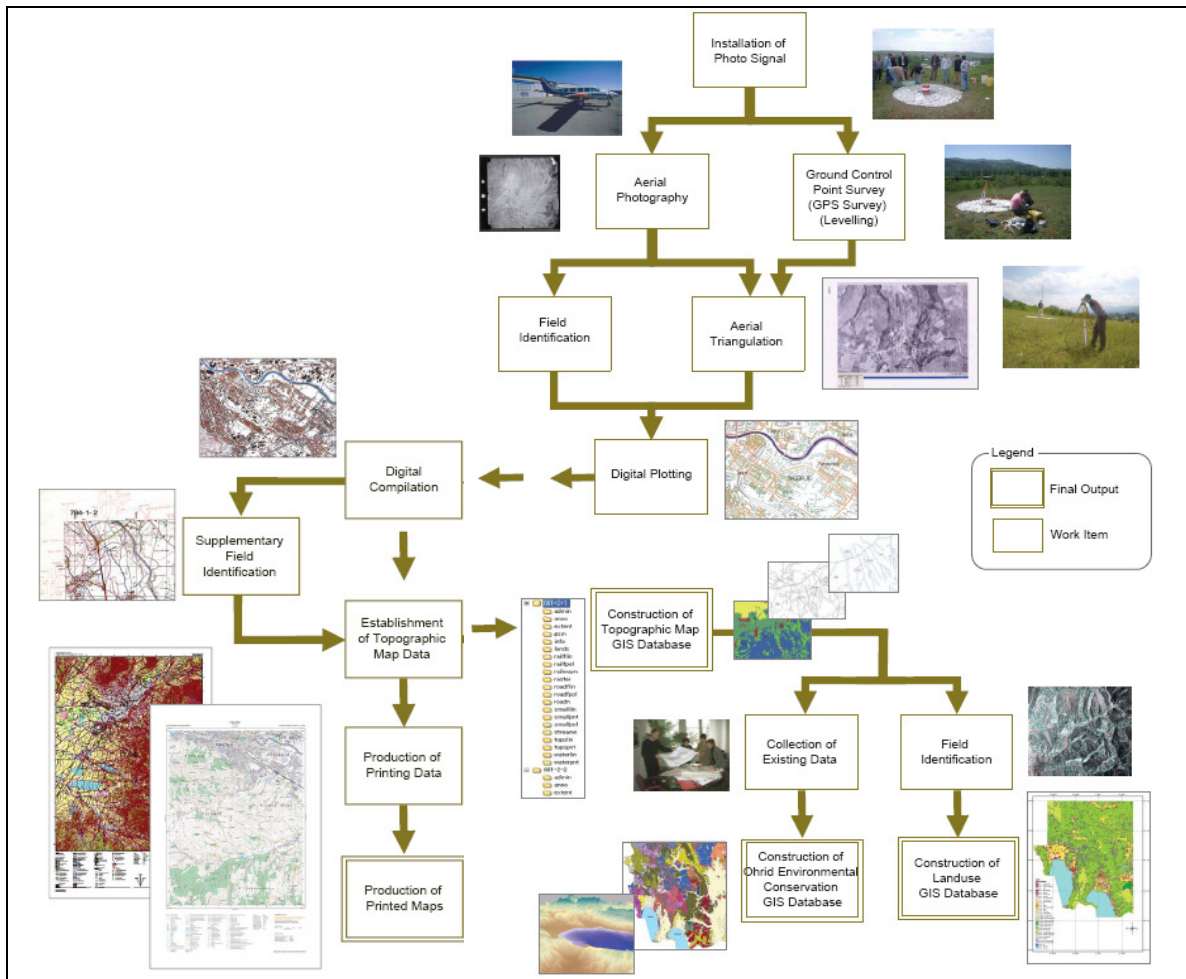


Figure 7. Work items during the project

### 3.5 Outputs from the project

As can be shown on above figure with works items, during the project have been develop Environmental GIS database of the lake Ohrid watershed area and digital land use maps in scale 1:25.000 for the same area also. The objectives of this extended part of project were to: identify the need of GIS database through the discussions with Lake Ohrid Conservation Project, design the GIS database for environment management for the watershed area, collect necessary information and establish the GIS database for the watershed area, establish the digital topographic map for the watershed area, and establish the land use map for the watershed area (30 map sheets). The personal GeoDatabase (EGIS\_OHRID.mdb) is organized in 6 datasets, i.e. Basemap, Drainage, Hydrography, EnvBack, EnvMonitor, and Thematic data. The whole extended part of project was done in ArcGIS also.

As a result of up to date done job in Macedonian independent topographic mapping, the products listed below were produced. They are the outcome of the successful technical transfer trainings and through cooperation of AREC with the other respective governmental

organizations and national universities.

**1) Aerial Photographs**

Scale: 1:40,000

Area: whole territory of Macedonia

Format: Negative Films / Contact Prints / Digital Image File

**2) Topographic Maps & Spatial Data Infrastructure**

Scale 1:25,000

Area: about 90%

Format: Printed Maps / Digital Map Data (Adobe Illustrator) / DXF /

GIS Database (ESRI ArcInfo Coverage files)

Language: English and Macedonian

**3) Orthophoto**

Resolution 50cm

Area: whole territory of Macedonia

Format: JFIF (JPEG)

Color: B/W

**4) GPS passive network**

Number of GPS points: 59

Area: whole territory of Macedonia)

**5) Digital Terrain Model (DTM)**

Model: grid of points in 20m

Area: whole territory of Macedonia

Format: GIS Database (ESRI ArcInfo Coverage file)

**6) Digital Elevation Model (DEM)**

Resolution: 5m

Area: whole territory of Macedonia

Format: raster dataset – esri grid

**7) Topographic key**

Number of symbols: 208

Format: ArcGIS style file, \*.style

Language: English and Macedonian

**8) Specification for topographic maps/database**

Number of paper sheets: 84

Format: printed in paper / DOC / PDF

Language: English and Macedonian

Following the trend of publishing geospatial data on the World Wide Web, the AREC web portal was created and putted online, making its data (topographic maps also) viewable to the customers and wide public through a web browser. ArcGIS software was used in the process and it all started with creation of the AREC GIS database to hold the data that will be published online. Prior to creating the web portal, available data for viewing are:

- Global Map data in vector format 1:1.000.000 scale consisted of National Boundary, Municipalities, Digital Elevation Model (DEM), Population centers, Rivers, Roads, Airports, and Lakes.
- Topographic maps in raster format in scales 1:200.000, 1:100.000, 1:50.000 and 1:25.000 (both new and old maps).
- Index maps in scale 1:200.000, 1:100.000, 1:50.000, 1:25.000, 1:5.000, 1:2.500, and 1:1.000.

- Orthophoto with 0.5m resolution black and white raster for the entire territory of Macedonia, and 1:1.000 color orthophoto for Skopje and Prilep

This geospatial database is driven by ArcSDE and its role is to hold and effectively retrieve data according to a user query. By using ArcCatalog software and geo-processing tools data was imported in the database. ArcIMS was used to create a web service from the map layout capable of publishing the map on the internet (figure 9). This web service is responsible for receiving a user requests and sending it to the inner GIS database layer and then forwarding the data received by the GIS database layer back to the user (Idrizi B., Biljarska N., 2008).

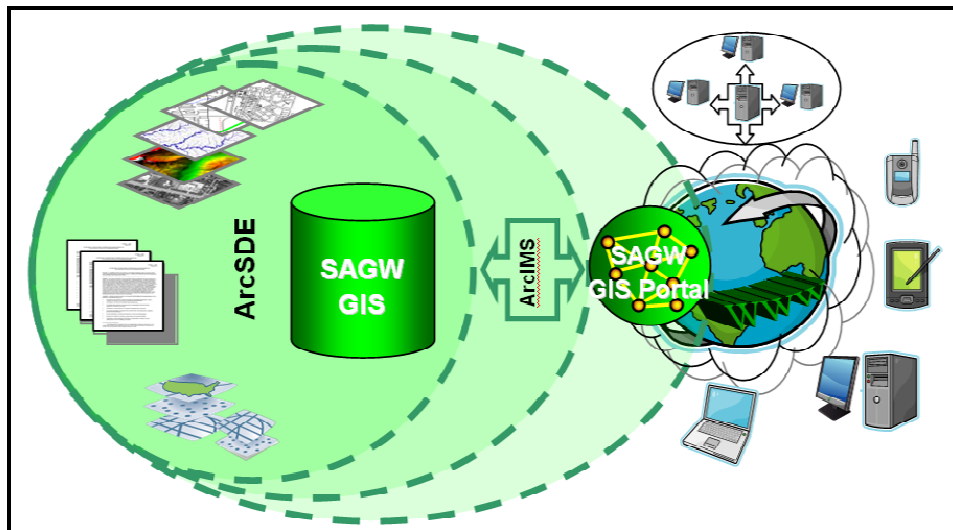


Figure 9: Underlying technology of web portal

#### 4 ONGOING ACTIVITIES ON TOPOGRAPHIC MAPPING IN MACEDONIA

The process of preparing the rest 10% topographic maps in scale 1:25000 to cover of whole territory with new topographic maps is ongoing process within the AREC as a Macedonian NMO. Based on the results in past six years, with the existing capacities of Macedonian NMO, optimal period for completing of the rest topographic maps is the end of year 2010/11. Orientation of capacities for the period after 2011 is very important, because preparing of topographic maps in scale 1:25000 does not present all topographic mapping. New topographic maps in scales 1:50000, 1:100000 and 1:200000 are very important for completing of first set with own Macedonian topographic maps. Due to date of existing aerial photographs (May, 2004), updating of new topographic maps is very significant process also. In other way, Macedonian NMO needs to assist on preparing of topographic maps in scale 1:50000 with NATO standards to Ministry of defense also.

## 5 CONCLUSIONS

In a period from 1991 to 2004, Agency for Real Estate Cadastre has been playing the role of map seller of cartographic products prepared by Military Geographic Institute from Belgrade before year 1991. During that period, there are not any activities related to national map production in Macedonia.

From the above four chapters, can be summarized that official national cartography in Macedonia is so young, i.e. in its beginnings. Up to date, Macedonian Global Map data and around 90% of new topographic maps in scale 1:25000 were completed in total. New topographic maps have the data based on the aerial photographs of year 2004, which means that the last produced maps have not the latest information (around 5 years old). Preparing of the rest 10% of topographic maps 1:25000 is ongoing process within the AREC.

New topographic maps are available in Macedonian and English language, and they are open for all categories of users.

Old maps in scale 1:25000 of uncovered area with new maps are still in official utilization. Together with topographic maps in other scales (1:50000, 100000 and 200000), they are almost available for purchasing as a paper maps and in digital form as georeferenced raster data in GeoTIFF format.

The differences between new and old topographic maps 1:25000 are essential. New maps represent the latest information, they are in digital and paper format, GIS database has been created, they have legend of most used symbols, in back site they have map of Macedonia in scale 1:500.000 based on Macedonian GM data and the index sheets map with the information for tile and name of topographic maps. Older ones have the historical largeness.

*Table 2. Differences between topographic maps prepared by MGI before 1991 year and AREC with JICA after 2004 year (Idrizi B., 2008b)*

<b>Changed categories</b>	<b>Old maps</b>	<b>New maps</b>
Year of production	1970-1990	2004-2010
Covered area	100%	90%
Data format	Paper	Paper and digital (ArcInfo Coverage, GeoTIFF, Ai, DXF)
Language	Serbo-Croatian	Macedonian and English
Prime meridian	Greenwich or Paris	Greenwich
Alphabet	Latino	Cyrillic and Latino
Way of delivery of paper maps	Not folded	Folded and not folded
Information outside the margins	Scale line, coordinates	Map legend, scale line, Mathematical elements, preparation, Survey method, coordinates, legend
Background	Don't have	Sheets index map, tiling, information for AREC
Data policy	State secret	Open for all type of users
Price of one sheet paper map	130euro	3.3euro
Symbols	328	208

During realizing of project in a period May 2004 - November 2006 from JICA study team, close to preparing around 60% of topographic maps 1:25000, technology transfer and training of several teams were realized. As a result of technology transfer, AREC has the departments for digital photogrammetry, digital cartography, GIS and surveying, and as a result of trainings, today AREC have very high quality trained human capacities in those departments. The technology which is in using and the human capacities, gives the guaranty that the topographic mapping has a good future in Macedonia.

Step forward is the creation of the web portal for the purpose of informing stakeholders, customers and clients for cartographic/GIS products of AREC, i.e. topographic maps through the internet. This step demonstrates the Macedonian NMO efforts to make itself an open institution by placing geospatial information it possess online available to the world for viewing 24/7. In future this should be developed to become an order and purchase site.

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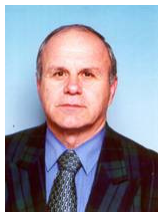
[www.iscgm.org](http://www.iscgm.org) (February, 2011)



## BIOGRAPHICAL NOTES



**Bashkim IDRIZI**, was born on 14.07.1974 in Skopje, Macedonia. He graduated in geodesy department of the Polytechnic University of Tirana-Albania in 1999 year. In 2004, he got the degree of master of sciences (MSc) in Ss.Cyril and Methodius University-Skopje. In 2005 he had a specialization for Global Mapping in Geographical-Survey Institute (GSI) of Japan in Tsukuba-Japan. On year 2007, he held the degree of Doctor of sciences (PhD) in Geodesy department of Ss.Cyril and Methodius University-Skopje. He worked in Agency for Real Estate Cadastre from May 1999 until January 2008. During those period, in 2004 he appointed for head of cartography department, i.e. geodetic works. From October 2003 up to January 2008, he worked as a outsourcing lecturer in State University of Tetova. From February 2008, he works as a cartography and GIS Professor at the State University of Tetova-Tetova. He continues with working as outsourcing lecturer in geodesy department of the University of Prishtina-Kosova. He is the author of three cartography university books, and more than 60 papers published and presented in national and international scientific conferences related to geodesy, cartography, GIS and remote sensing. From March 2010, he is appointed as president of Geo-SEE (South-European Research Association on Geo Sciences).



**Risto RIBAROVSKI**, was born on 09.05.1943 in Bucharest, Romania. He graduated in geodesy department of the University of Belgrade-Yugoslavia in 1967 year. His first work experience was started on year 1969 as assistant for geodesy within the geodesy department at the Civil engineering faculty in Skopje. At year 1979 he got the assistant professor degree, 1984 associate professor and at year 1990 he got the professor title. He is the author of seven geodesy university books, many manuscripts for students and papers published in national/international geodesy and cartography conferences. At the moment he is professor in retiring and very active in geodetic chamber of Macedonia, scientific projects and organizing the conferences.



**Subija Izeirovski**, was born on 05.09.1964 in Struga, Republic of Macedonia. He graduated at the Faculty of electrical engineering & computer sciences at the University in Ljubljana, Slovenia in 1990. From 1990 to 1993 worked in Ljubljana in a company specialized for measurements of electric supply and projecting of alarm systems and sensors. Since 1995 possess his own agency for translating from Slovenian, German & English language into Macedonian language and viceversa. In 2008 he received degree of master of sciences (MSc) at „St.Kliment Ohridski,, University in Bitola. His master thesis was „Raster web based integrated Remote Sensing/GIS system for managing of real estate,,. Since the beginning of 2008 is employed in the public enterprise „Makedonija pat,, section in Struga as a leader engineer for technical and investment tasks. He is author of two papers presented in national scientific meetings, and during the year 2009 has also made two applications for scientific projects (one between Macedonia and Slovenia, and the other IPA project Macedonia-Albania). Currently he is a Ph.D candidate at „St.Kliment Ohridski,, University in Bitola.



**Sali Zhaku** was born on 18.01.1971 in Struga, Macedonia. He graduated at the Faculty of History-Geography at the University “A.Xhuvani” in Elbasan-Albania in 1998 year. In 2003-2006 he got the degree of master of sciences (Msc) in Geography department of University Tirana-Tirana Albania. On year 2009 he held the degree of Doctor of sciences (PhD) in Geography department of University Tirana-Tirana Albania. His first experience was started on year 2004, as professor at the gymnasium “Niko Nestor” in Struga. From 2005-2006 year, he worked as a teacher in primary school “Naim Frasheri” in Struga. From 2006-2008 he worked as assistant Professor (Msc) in department of Geography at the State University of Tetova, part time. From September 2010 he works as Professor Dr.sc in the department of Tourism&Ecology at the State University of Tetova. He is the author of seven papers published and presented in international scientific conferences related to GIS and Geography. From 2010 he is member of Geo-SEE (South-European Research Association on Geo Sciences).



**Nikola Ribarowski** was born on 15.10.1984 in Skopje, Republic of Macedonia. He graduated in Skopje’s University St. Kiril and Metodij, geodesy department of the Civil Engineering Faculty in 2008 year. As a student, he had a first work experience. From 2006 to 2008, he worked in 2 authorized surveyors and trade companies for geodetic works, when he prepared a lot of geodetic-cadastral files. In 2009, he started with a master studies, and now, he is finishing his master thesis. From November 2009 to February 2011, he worked at the Macedonia’s distribution agency of Sto, global brand for facade insulation systems. Also, in 2011, he was selected, as an associate, at the “Goce Delcev” University in Stip. At the moment, he is working as a consultant for quality control, on the World Bank-Real Estate Cadastre and Registration Project.

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