

DEVELOPING OF GIS DATASET FOR CONSERVATION OF THE OHRID LAKE WATERSHED AREA

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Abstract

Lake Ohrid has 87.5 km of shoreline and covers an area of 358.2 km², with the average depth of the lake 164m. It has a maximum depth of 289m. The watershed of Lake Ohrid includes steep mountains, as well as both Big and Small Prespa Lakes.

In 1980, UNESCO declared the Lake Ohrid as a "site of cultural and natural values of the global patrimony." In 1994, the World Bank, in cooperation with the Republics of Albania and Macedonia, began preparation for a Global Environment Facility (GEF) grant to fund the incremental costs of a Lake Ohrid Conservation Project.

On year 2004, during the project for preparing of topographic maps, the need for creating a new database for management and conservation of the lake Ohrid watershed area has been detected. One of the aims of project was the contribution in the next phases of Lake Ohrid Conservation Project (LOCP), i.e. to be a bridge between the current and future project phases in terms of GIS database development.

The developed GeoDatabase (EGIS_OHRID.mdb), is organized in 6 datasets, i.e. Basemaps, Drainage, Hydrography, EnvBack, EnvMonitor, and Thematic data, which contains several feature classes.

The outputs from the project are Ohrid basin environmental conservation database, Land use database, specification and new cartographic key. Due to the international mean of the database, it was developed in two languages, i.e. Macedonian language for local and English for international use were utilized.

Key words: GIS, environment, Lake Ohrid, data set, watershed area,

1. Introduction

The Agency for Real Estate Cadastre (AREC) of the Republic of Macedonia is a governmental organization which provides geospatial data to other state organizations and institutions, to the private sector and the citizens in general, in the form of topographic maps, geodetic maps, aerial photographs, numerical and graphic data.

In its history, due to hierarchy of geodetic, cartographic and cadastral works in former Yugoslavia, the main responsibilities of AREC were the works related with 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 year 1991, all AREC capacities were

oriented in to developing of new cadastral system with registered property rights. It was forgotten that in new independent country there is no other responsible governmental institution to carry out for geodetic, cartographic and cadastral works.

Year 2004, is the beginning of the official Macedonian cartographic production. AREC (on that time State Authority for Geodetic Works - SAGW) as a national mapping organization (responsible governmental institution), in cooperation with Japan International Cooperation Agency (JICA) teams, on March 2004 was started with the preoperational field works for preparing the terrain for aerial photo, with the aim to produce topographic maps in scale 1:25.000, as well as to develop a spatial data infrastructure (SDI) 25000. On November 2007,

around 60% of the territory of Macedonia was covered with the new topographic maps and developed the database for the same area, and orthophoto with 0.5m resolution for whole territory of Macedonia[4]. From year 2011, whole territory of Macedonia is covered by topographic maps in scale 1:25000 in digital form.

During the project for producing of topographic maps, the need for creating a new database for management and conservation of the lake Ohrid watershed area has been detected. The GIS (Geographic Information System) team inside the cartography department of AREC has implemented the developing of Environmental GIS database for conservation and management of the Ohrid lake watershed area, in a geodatabase format. One of the aims of project is the contribution in the next phases of Lake Ohrid Conservation Project (LOCP), i.e. to be a bridge between the current and future project phases in terms of GIS database development and capacity building [6].

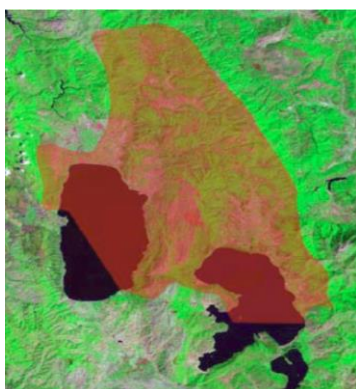


Figure 1. Lake Ohrid watershed area inside the territory of the Republic of Macedonia [3]

(Area 3556km², about 30 map sheets scale 1:25000)

2. Environmental GIS database for Lake Ohrid watershed area

In the process of studying current situation of establishment and potential needs for geographic information in Macedonia, during the mapping project it was identified that the establishment of Lake Ohrid Conservation Project (LOCP) is in need of establishing GIS database for environment management for the Lake Ohrid watershed area (figure 1) and digital land use maps in scale 1:25.000 (figure 4). Based on the above circumstances, JICA agreed to expand the coverage of production of national base maps to include the watershed area and further develop basic GIS database for its environmental management in technical cooperation with AREC [4].

Mapping area was expanded for the state base maps for GIS project with 16 more map sheets (about 2,145km²).

This expansion enabled the construction of a GIS database for the Lake Ohrid watershed area and will contribute to the ongoing Lake Ohrid Conservation Project supported by the World Bank [5].

The objectives of this project are:

- 1) Identifying the need of GIS database through the discussions with LOCP
- 2) Designing the GIS database for environment management for the watershed
- 3) Collecting necessary information and establish the GIS database for the watershed
- 4) Establishing the digital topographic map for the watershed, and
- 5) Establishing the land use map for the watershed [6].

In view of the World Bank future assistance, this project established the data specification and provide minimum required GIS database for environmental management for the Lake Ohrid watershed. It is hoped that this project will be a bridge between the current and future project phase of LOCP in terms of GIS database development and capacity building[6].

2.1. Data Sources

In order to construct Environmental GIS for conservation and management of the Lake Ohrid watershed area, opinions, suggestions and source information were collected from diverse institutions and organizations who have kindly offered full cooperation and assistance to AREC.

Considering the complexity and multipurpose character of the GIS database, very wide number of data sources has been utilized [2]:

- old topographic maps in scale 1: 25000,
- extraction of some layers of SDI (Spatial Data Infrastructure) 25000, database of new topographic maps in scale 1:25000,
- orthophoto maps of year 2004,
- CAD data from the CIS Department AREC,
- geological maps in scale 1:100.000,
- climatic, pedological map and geological map of the national parks Galicica in scale 1:100,000,
- fitochetonomical map of Galicica in scale 1: 50,000,
- borders, dendroflora, hydrography, distribution facilities, forest communities, zoning and geomorphologic maps of Pelister in scale 1:25000,
- CORINE (GRID with 100 and 200 spatial resolution)

- population data, cultural monuments, tourist facilities, and water quality.

contents of database were translated in English language [5].

2.2. Technical details of Geodatabase

Due to new topographic maps standards were prepared in Macedonian and English languages, EGIS geodatabase has been developed in both languages also. All printed paper maps are in both versions (Macedonian and English) also. In Macedonian version, Cyrillic alphabet as official has been used for all contents, and in the English version,

During the project, with the aim to present a EGIS_Ohrid data as a cartographic product, was created special cartographic key for all types of data within the EGIS_Ohrid geodatabase (in 25 sheets), as well as the special data specification in 105 sheets in total [5].

Because of the Law for real estate cadastre of Macedonia, where the state coordinate system is defined with all its parameters, developing of EGIS database was realized based on the parameters of state coordinate system of Macedonia, which are shown in next table 1.

Table 1. Parameters of state coordinate system of Macedonia [4]

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

2.3. Overview on the process of preparing of new topographic maps-database

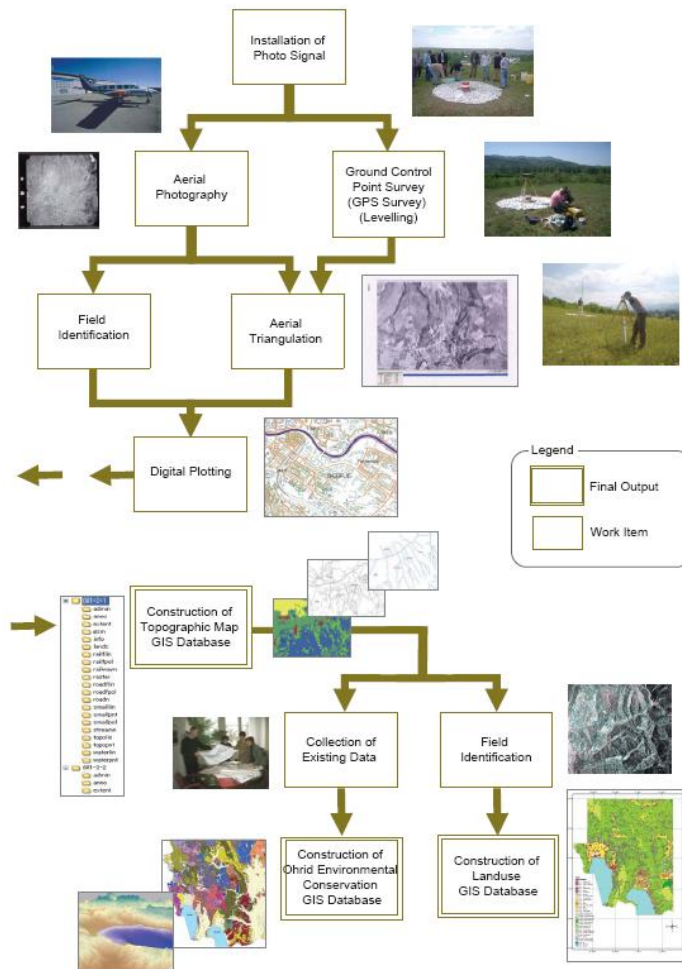
Over the period of the project implementation, numerous work items have been carried out by the AREC and the JICA study team with assistance of the related organizations for producing of SDI25000 and EGIS Ohrid. The process was started by defining of new specification for E-GIS Ohrid, and creating new cartographic key.

of process, preparations of data for printing have been realized in Adobe Illustrator and ArcGIS.

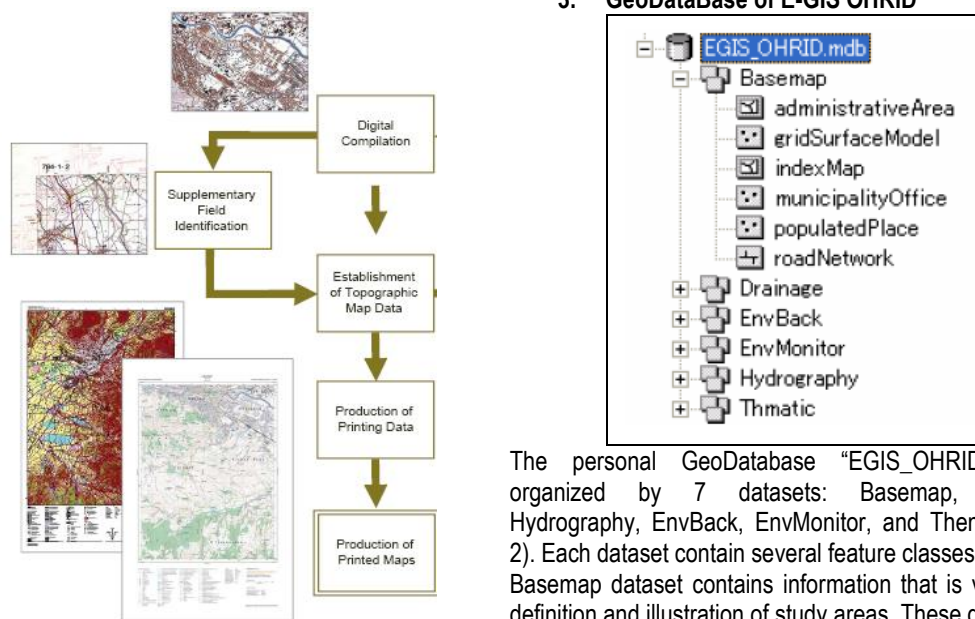
From this map data, several datasets such as Topographic Map GIS Database, Land use GIS Database and Ohrid Environmental Conservation GIS Database were generated as the final product of the project. Also, the digital Printing Data and the Printed Maps were prepared for the extensive use by various users [4].

Whole project with JICA has been started with shooting of aerial photographs, 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 accidently errors, supplementary field identification and digital compilation were done. At the end

Developing of EGIS Ohrid database was realized by using the process of digitalization of existing paper maps, extracting needed layers from new topographic maps 1:25000, and additional field identification works. Below is the general summary of work items completed in project for state topographic maps, in which one part of activities are aimed for creating EGIS Ohrid database, which can be seen in down-right corner of next figure 2.



3. GeoDataBase of E-GIS OHRID



The personal GeoDatabase “EGIS_OHRID.mdb”, is organized by 7 datasets: Basemap, Drainage, Hydrography, EnvBack, EnvMonitor, and Thematic (table 2). Each dataset contain several feature classes. Basemap dataset contains information that is vital for the definition and illustration of study areas. These data include administrative boundaries, major road networks, populated places, municipality offices, grid surface model, orthophotos, and index map corresponding to 1:25.000 topographic map sheets.

Figure 2. Work items during the project [1]

Drainage dataset contains information that is vital for hydrological analysis. These data include drainage area (subdivided into catchment, watershed, and basin), drainage line, and drainage point. They are systematically calculated and generated based on Digital Elevation Model (DEM) of 107101. To supplement DEM, post-processed Shuttle Radar Topography Mission (SRTM) data provided in 3-arc second (90m) DEM data for the globe was used. The original SRTM data was processed and released by NASA and the USGS in 2003 which is downloadable from USGS ftp site (<ftp://edcscgs9.cr.usgs.gov/pub/data/srtm/>). The Consortium for Spatial Information (CGIAR-CSI) of the Consultative Group for International Agricultural Research (CGIAR) is offering continuous elevational surfaces after applying a hole-filling algorithm which is also downloadable (<http://srtm.csi.cgiar.org/>). In this project, post-processed SRTM data is used to supplement DEM data for the area outside of Macedonia (Albanian side) yet needed to be included in watershed analysis.

Hydrography dataset contains information of hydrographic features. These data include stream lines, hydro lines, hydro areas, and hydro points. The difference between Drainage dataset and Hydrography dataset is that

Drainage dataset is generated from DEM on the other hand Hydrography dataset is produced by extracting hydrographic features from SDI.

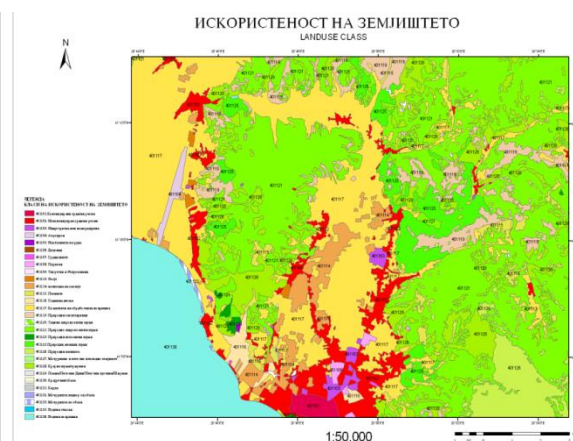
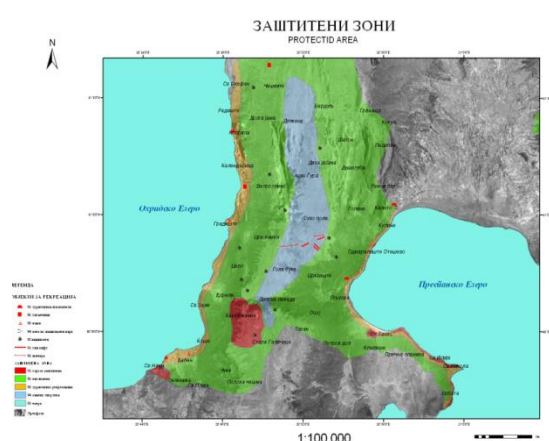
EnvBack dataset contains information that is vital to exploration of ecological stability but is not directly related to hydrography of the system. These data include land use, depth contour, depth point, depth surface, littoral zone, climate zone, fitocenology zone, dendraflora zone, znational park boundary, protected area, and CORINE data.

EnvMonitor dataset contains information that is collected by various environmental monitoring activities which is vital for lake conservation but is not directly related to hydrography of the system. These data include microbiology, water quality, and red list (endengared spices).

Thematic dataset contains information that is collected from various sources which is related to natural and socio-economic aspect of the region but is not directly related to hydrography of the system. These data include geology, population census, tourist accommodation, tourist census, recreation facility, cultural heritage, and geomorphology [4].

Table 2. Layers of EGIS Ohrid Geodatabase

Basemap Data Set - Administrative Area - Road Network - Municipality Office - Digital Elevation Model (DEM) - Ortho Photo - Index Map Drainage Data Set - Catchment - Watershed Environmental Monitoring Data Set - Microbiology - Water Quality - Red List	Environmental Background Data Set - Land Use - Depth Contour - Depth Point - Depth Surface - Littoral Zone - Climate Zone - Fitocenology Zone - Dendraflora Zone - National Park Boundary - Protected Area - CORINE Land Cover Data (100m) - CORINE Land Cover Data (250m) - Forest Type (Area) - Forest Type (Point)	Hydrography Data Set - Stream Line - Water-related Facilities (line) - Water Area - Water-related Facilities (point) Thematic Data Set - Geology - Population Census - Tourist Accommodations - Tourist Census - Recreation Facility - Recreation Facility (Point) - Cultural Heritage - Geomorphology
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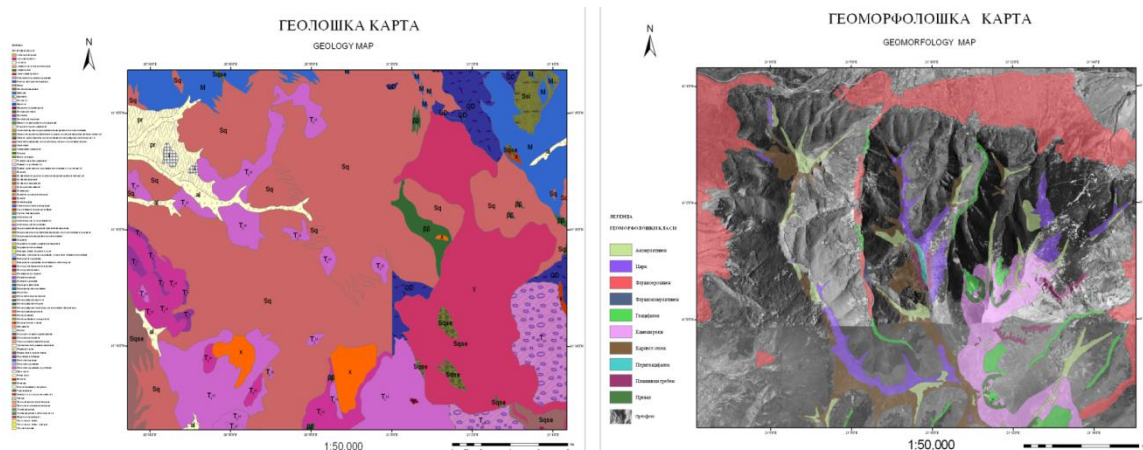


Figure 3. Layouts from EGIS Ohrid geodatabase (protected area, landuse class, geological areas, and geomorphological data) [3]

As a special part of the project, from the data obtained from the field identification and new topographic maps in scale 1:25.000, the land use maps in scale 1:25.000 (Figure 4) for the entire area of the watershed has been published in digital and paper format [4].

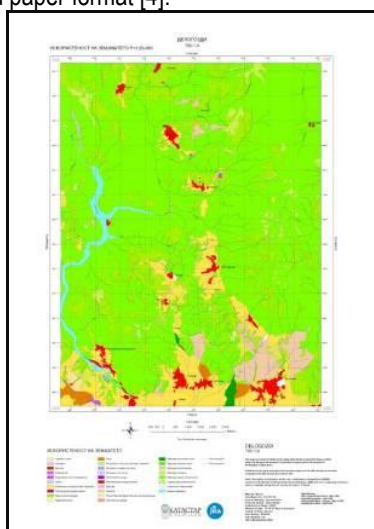


Figure 4. Example of Land use map in scale 1:25.000 [5]

In a next list, the final outputs from the project with all details are given [4]:

1) Ohrid Basin Environmental Conservation Database

Scale 1:25,000

Area: 3,556km² (Red in figure 5)

Number of map sheets: 30 sheets

Format: Printed Maps / Digital Map Document (*.mxd)

GIS Database (ESRI ArcGIS Geodatabase file)

Language: English and Macedonian

2) Land use Database

Scale 1:25.000

Area: 3,556km² (Red in figure 5)

Number of map sheets: 30 sheets

Format: Printed Maps / Digital Map Document (*.mxd)

GIS Database (ESRI ArcGIS Geodatabase file)

Language: English and Macedonian

3) Cartographic key

Format: ArcGIS style file, *.style

Language: English and Macedonian

4) Specification for land use maps

Number of paper sheets: 30

Format: printed in paper / DOC / PDF

Language: English and Macedonian

4. Conclusions

Environmental GIS for Lake Ohrid watershed area has been developed as part of mapping project, powered in cooperation by the Agency for Real Estate Cadastre as national mapping organization of Macedonia and the Japan International Cooperation Agency. It is the first GIS project realized within the institution, and one the first environmental GIS projects in Macedonia, which contain 38 feature classes recorded in 8 data sets.

Negative aspects of the data set are coordinate system and accessibility. Due to fact that the area is in border area with two countries, i.e. Albania and Greece, database is not fully compatible with the data from the other site of border. This is because of coordinate system which was used for developing of the geo database. In this kind of projects, especially for projects with international importance,

coordinate system should be adopted by the international standards, such as datum's WGS84 or ETRS89, and UTM as map projection.

Problems which comes from the limited accessibility to developed EGIS Ohrid geodatabase, makes it not applicable and with very wide range of utilization. It is not included in any GeoPortal, and it is not well known from the geo community in Macedonia and neighboring countries as direct stakeholders.

Beside lack of some technical issues of the geodatabase and spatial data infrastructure of EGIS Ohrid, it represents one of the greatest reached environmental databases in Macedonian history, as a bridge between the current and future project phases of LOCP in terms of GIS database development and capacity building.

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