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TOWARDS A NEW BODY OF KNOWLEDGE FOR GEOGRAPHIC INFORMATION SCIENCE AND TECHNOLOGY

Danny VANDENBROUCKE[1] and Glenn VANCAUWENBERGHE[2]

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SUMMARY

Geographic information (GI) and technology has rapidly expanded and evolved over the past decades resulting in an increased need for experts in this field. However, the academic, private and public sectors active in this domain often have difficulties to find well-trained and skilled employees. The geospatial workforce often appears to be inadequately prepared to the continuously evolving GI-domain. This paper presents the results of the Erasmus project 'Geographic Information – Need to Know (GI-N2K)'[3] which aimed at filling this gap by analyzing the demand for and supply of geospatial education and training, the creation of a European version of the Body of Knowledge for GI Science & Technology (BoK GI S&T), the development of a platform with tools for using the BoK and by testing and validating the results through real-world use cases during plugfests.

Key words: Body of Knowledge, Geographic Information, concept, curriculum design, hierarchy, ontology.

A DEMAND-DRIVEN EDUCATION AND TRAINING SYSTEM

The geospatial industry is a rapidly growing industry and involves high-value, high-tech jobs, innovative services and fast evolving technologies. In the European context, the need to prepare Europe's GI S&T workforce that

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is able to answer to the requirements of the European knowledge society is driven by several European strategies and policies such as the Digital Agenda for Europe, the Smart Cities initiative, the INSPIRE directive, the European Union Location Framework (EULF) and many other initiatives. The markets of geographic information and related technologies are huge and they are still growing: e.g. the European GIS market was valued at 2.06 billion € in 2012 and is expected to reach 2.96 billion € in 2016 (Technavio, 2015). Related markets such as UAV's will reach an estimated 6.28 billion € (European Union, 2015).

However, even if the markets are important, the handling and using of geographic data and information is a challenging task and requires specific skills. The demand for well-trained GI professionals is therefore high. Employers in the domain of GI often find it difficult to find well-trained and skilled employees, as geospatial workers appear to be inadequately prepared to answer to the challenges and opportunities in this field. The gap between existing knowledge and skills and the job market requirements is not a specific problem for the geospatial market as is illustrated by other studies (Vassiliou, 2014). It is also confirmed by important players in the market such as Shell and Google. The General Manager of Geomatics and Information Management of Shell Global Solutions stated in an phone interview in 2013:

> *"Our demand for new GI professionals is growing but, despite the current economic crisis, we have difficulties in finding people with the right knowledge and skills" (Vanouden, 2013).*

Other stakeholders refer to a mismatch between education and training in the domain of Geographic Information Science and Technology (GI S&T) and the actual job requirements in the labour market. This was expressed clearly by Ed Parsons, geospatial technologist of Google during another interview in 2013:

> *"A career in geospatial technology requires a combination of technical skills that are not taught as an integrated package in any meaningful way at our universities today. There are excellent postgraduate courses in GIS but these tend to be very focused on geography, which isn't a bad thing, but you don't tend to get the computer skills you need. On the other hand, there are intensive computer science courses that fail to provide the geographical knowledge needed. It is hard to get the right mix" (Parsons, 2013).*

In order to set-up a more demand-driven workforce educational and training program, there needs to be consensus about what geospatial professionals in Europe should know (knowledge requirements) and be able to do (skills requirements).

The project 'Geographic Information - Need to Know (GI-N2K)' aims to help making the geospatial workforce education and training system more demand driven and flexible by developing an agreed ontology for the GI S&T domain. GI-N2K builds upon the existing GI S&T BoK that was developed by the American University Consortium for Geographic Information Science (UCGIS), published in 2006 by the Association of American Geographers (DiBiase, 2006). The main objective of GI-N2K is to develop a dynamic GI S&T BoK which is in line with the latest technological developments and takes into account the European dimension. To achieve this objective, the following activities were and are still undertaken:

1. Analysis of the current situation with focus on the demand of private and public sector as compared to the existing academic and vocational training offer;
2. Revision of the content of the GI S&T BoK to bring it in line with technological developments, emerging new knowledge areas and the European context;
3. Development of tools and guidelines that allow to manage and use the GI S&T BoK for defining vocational and academic curricula, job profiles, etc.;
4. Testing of the GI S&T BoK, its tools and guidelines through participation of dedicated target groups from the private, public and academic sector.

In the next sections we discuss briefly the applied approach and the results for each of the activity lines.

ANALYSIS OF OFFER AND DEMAND

The first activity of GI-N2K was focusing on the analysis of the demand for geospatial education and training. In order to analyse the match between the knowledge, skills and competences that are required by employers and organizations in the field of geospatial information (demand side) and the knowledge and competences that are central in the current offer of GI S&T curricula, programmes and courses in Europe (supply side), two surveys were conducted:

1. The GI-N2K Demand Survey aimed to evaluate the current workforce demands in GI S&T and identify presumed future directions;
2. The GI-N2K Supply Survey aimed to collect information about which GI S&T courses and programmes are available in Europe and

to explore which parts of the GI S&T domain are present in today's teaching.

For both surveys the original GI S&T BoK developed by the American University Consortium for Geographic Information Science (UCGIS), was used as a starting point for the design of the questionnaires.

The aim of the GI-N2K demand survey was to assess the relevance of individual Knowledge Areas (KA) and Units of the existing GI S&T BoK and to identify additional and potentially new areas that should be included in the its new version. In total, 435 surveys were fully completed by professionals actively working in the GI S&T domain in Europe. Answers were collected from professionals working in the public sector (39%), private sector (35%), academic sector (23%) and non-profit sector (3%). Respondents were asked, among others to rate the importance of GI S&T BoK KA's in their job on a scale between 1 (not relevant) and 6 (extremely relevant).

The aim of the GI-N2K Supply survey was to describe and analyse the current supply of GI S&T education and training in Europe in terms of course size, level and content, and to collect information on the awareness and use of the GI S&T BoK. The survey was successfully completed by 234 organisations involved in GI S&T teaching and training in Europe. A total of 570 courses on GI S&T were identified, of which 427 were on offer at the time of the survey (2014), and 143 were intended to be offered in the near future. Respondents were asked to use the GI S&T BoK to specify the content of existing and intended courses, with a maximum of 3 courses per response.

The detailed results of the survey can be found in two separate reports (Wallentin et al., 2014; Rip et al., 2014a). However, some points are highlighted here. With regard to the demand side:

- The three main sectors – public administrations, private organisations and academia – evaluated the BoK Knowledge Areas congruently;
- The GI S&T community evaluated the relevance of the current GI S&T BoK KA's in their professional work differently. 'Geospatial data' and 'Cartography and Visualization' were considered as the most relevant BoK Knowledge Areas, whereas advanced 'Geocomputation' received the lowest rating.
- The gap analysis revealed several topics that are not (fully) covered in the current GI S&T BoK, including programme development, WebGIS, SDI, data acquisition and other 'hot' topics such as big data and augmented reality.

Table 1 provides an overview of terms and concepts respondents of the demand survey deemed missing in the current BoK.

Table 1: Keywords and topics mentioned in the demand survey that are missing in the existing GI S&T Body of Knowledge (based on Wallentin et al., 2014)

Demand survey		
Frontend	Semantics, Semantic web	Big Data, Mass Data
Application Programming Interface (API)	Harmonisation	Radar Remote Sensing, Sidelooking Airborne Radar (SAR)
Geojson	Geoportal	Geo-marketing
Python	ISO Standards 19107, 19109	Object Based Image Analysis (OBIA)
Plugin	Open Street Map (OSM)	2D / 3D / 4D
Java, Javascript	Unmanned Aerial Vehicle (UAV)	Building Information System (BIM)
Object Oriented Programming	Drone	Data archive
Web Application	Global Navigation Satellite System (GNSS)	Augmented Reality
HTML5	Open data	Indoor GML
RESTful	Crowdsourcing, Voluntary Geographic Information (VGI)	City GML
General Packet Radio Service (GPRS)	Geo-processing	Smartphone, mobile

With regard to the supply side several other issues could be observed:

- Most of the identified courses have a study load between 0 and 11 ECTS (European Credit Transfer System), and are given on the levels of EQF5_6 and EQF7 (European Qualifications Framework).
- The current GI S&T Knowledge Areas ‘Analytical Methods’, ‘Geospatial Data’ and ‘Cartography and Visualization’ were most often indicated as the subject of the existing courses. The most popular subjects of the intended courses were ‘Data Modelling’, ‘Geospatial Data’ and ‘Analytical Methods’.
- Web services, data acquisition technologies, point cloud analysis, programming in Python, UML, XML, Qualitative GIS, and Open source software were mentioned as subjects that are relevant for teaching although they are not covered by the BoK.

The analysis of the demand against the supply revealed a need for more teaching about the subjects “Programming” and “Mobile”. The two surveys provided valuable input for the identification of new concepts that should be included in an updated version of the GI S&T BoK. Finally, the surveys also showed that the current awareness and use of the GI S&T BoK are limited, especially at the demand side (Rip et al., 2014b).

A EUROPEAN BODY OF KNOWLEDGE FOR GI S&T

The GI S&T BoK developed in 2006 aimed at defining a framework with a description of the key concepts defining the GI field. The BoK was conceived as a traditional hierarchical structure consisting of three levels: 10 Knowledge Areas (KA), which were divided into 73 Units which in turn were divided into 330 Topics. This meant that e.g. each topic belonged to exactly one unit and that that unit belonged to one KA only. The European scientific geospatial community evaluated the existing BoK as being too static, too much geography oriented and reflecting the US perspective (e.g. at the level of reference material used). Reinhard et al. proposed also a revision of the KA’s (Reinhard et al., 2011).

Based on these findings, an ontology based approach is envisaged, meaning that the starting point would rather be the definition of a series of concepts, without necessary linking them to a particular hierarchical level. Several types of relationships are foreseen, not only hierarchical ones such as ‘sub-concept of’ and ‘super-concept of’, and ‘pre-requisite of’ and ‘post-requisite of’, but also ‘similar with’. Such a richer set of relationships would allow to build a geospatial ontology and apply linked data concepts in the development of the platform and tools (Ahearn et al., 2013).

After an extensive discussion within the GI-N2K consortium it was decided to follow a mixed approach allowing to evolve step-by-step towards a full geospatial ontology. In a workshop in Lisbon in March 2015 (see figure 1) and a follow-up workshop in Athens in September 2015 it was decide to use the old KA’s as a sort of organizational canvas complemented with a 11th KA called ‘Web-based GI’ to cover recent technological developments.

Table 2 shows the 11 working groups. Throughout the work it was decided to drop KA6, ‘Data manipulation’, and to redistribute its content under different other KA’s. Also some of the original names of KA’s were slightly altered: e.g. ‘Data modeling’ became ‘Data modeling, storage and exploitation’.

Table 2: 11 Knowledge Areas used as organizational canvas for revision of the BoK

1. Analytical methods	7. Geocomputation
2. Conceptual foundations	8. Geospatial data
3. Cartography and visualization	9. GI and Society
4. Design and Setup of Geographic Information Systems	10. Organizational and Institutional aspects
5. Data modeling, storage and exploitation	11. Web based GI
6. Data Manipulation	

Figure 1: consortium members at work during the workshop in Lisbon (2015)

The 11 working groups were then working for 12 months (from May 2015 to April 2016) in two iterations to define the concepts (topics and units) and their content. In order to do so, the working groups set-up a network of experts for their KA by contacting known experts and by selecting other experts after a public call for experts. In the first round, the existing list of topics and units were evaluated and a decision was made, either to drop, revise (minor/major) or keep them ‘as-is’. In addition, working groups could also propose new concepts. For each of the retained concepts a name and short title was defined. All the concepts were structured according to the topic or unit level (so hierarchical relationships were defined). For each concept it was analysed whether it potentially concerned a cross-KA concept, so belonging to more than one KA. As a result some blocks of topics were moved to other KA's and/or regrouped, or relationships were added. In a second round, the retained concepts were further elaborated and content was added as much as possible according to the following information scheme:

- Number
- Name/Title
- Description
- References
- Relationships

All the work was done by the working groups and uploaded in a 'simple' wiki according to the above schema. It is important to note that for technical reasons a first release of the new BoK was frozen by early May in order to allow integration in a consolidated repository which the tools developed could then work with. However, the revision itself is ongoing process. Concepts might still be added, additional relationships defined, content added, etc. This is work that will continue, even after the lifetime of the project.

A VIRTUAL PLATFORM TO USE AND EXPLOIT THE BOK

In order to exploit the revised GI S&T BoK it should be organized in a structured repository and a series of tools are needed to visualize, maintain and use the content, e.g. for designing curricula. GI-N2K looked into work that was previously done in Europe and the US (Painho et al., 2008; Ahearn et al., 2013). While the structure of the repository was decided based on the agreed the revision strategy for the BoK (including the elements to retain), the definition of precise specifications for the platform and tools was still necessary. This was done during the kick-off meeting in Leuven (2013) and a dedicated workshop in Castellon (2014). Based on these functional and non-functional requirements it was decided to test the existing tools from colleagues in the US, i.e. from the City University of New York (Ahearn) and San Diego State University (Skupin). The tests revealed that the existing tools could be a good starting point to develop additional tools on top of an improved version of them.
From summer 2014 onwards, an intensive cooperation was set-up with the two US universities and by October 2014 a mirrored and improved platform was created as a European instance in the cloud. Then an intense cycle of further testing and improving, modifying and adding of functionalities started. New RESTful services were developed by the US colleagues based

on the GI-N2K specifications to allow exposure of the content of the BoK in different ways for usage by the GI-N2K tools.

Figure 2 provides an overview of the architecture of the GI-N2K platform. It consists of:

1. An GI S&T ontology server and triple store (repository) in Linked Data format that contains the accepted concepts;
2. A GI S&T semantic wiki through which new concepts can be proposed and discussed;
3. A series of RESTful services that extract (part of) the BoK content to expose and use it with the tools;
4. A series of tools to perform specific operations such as the design of curricula, the comparison of curricula, the definition of learning paths, job profiles etc.

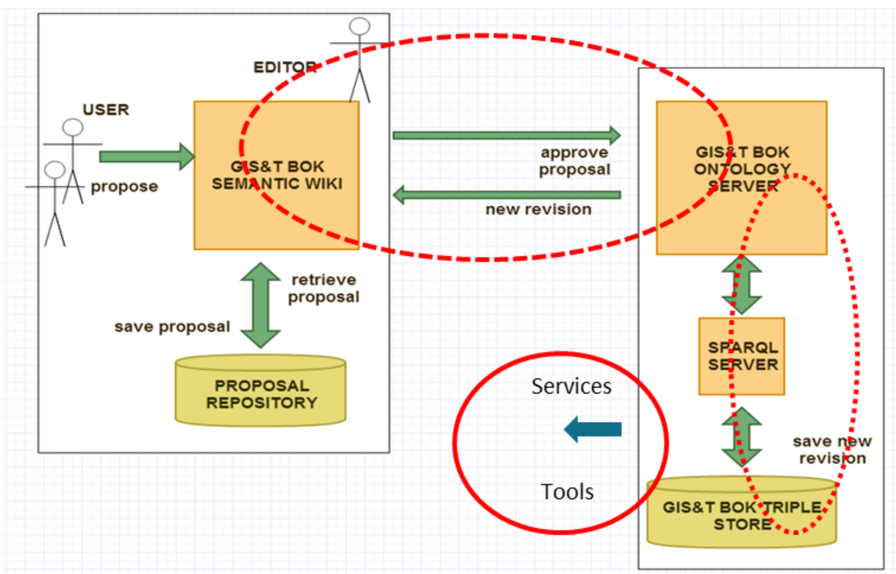

Figure 2: Overview of the architecture of the GiN2K platform (based on Ahearn at al., 2013)

The semantic wiki allows contributors to propose new concepts, changes to its content, new relationships, etc. The contributor is a regular user that can't approve and integrate the changes in the repository. That is done by the editor. In practice the editors are the KA leaders and co-leaders of the GI-N2K consortium. They evaluate/review the proposed changes and accept or reject them. However, the wiki allows also to document and discuss the proposed changes so that final decisions are based on sound arguments, proposals and contra-proposals. After all, the BoK should be the result of a collaborative approach of the geospatial community.

Figure 3 shows the GI S&T semantic wiki. It has a text and graphical interface through which the BoK can also be explored. The wiki will be accessible by the public, but contributing to the wiki is based on a controlled access mechnaims according to the above describe pre-defined roles.

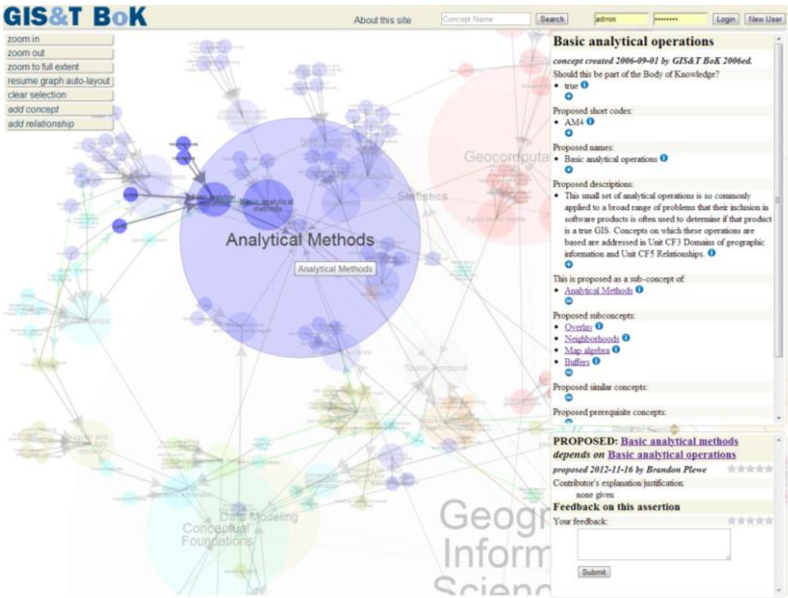

Figure 3: Graphical interface of the GI S&T semantic wiki

One of the tools developed is a curriculum design tool. The major interface is shown in figure 4.

Figure 4: Major interface of the curriculum design tool

The tool allows to design new curricula, to edit existing ones, to find and copy curricula and to compare them. The basic idea is that a curriculum can consist of up to three levels including lectures and practical works, courses and groups of courses or modules. Users can skip levels if they want so. The tool allows selecting and dragging concepts from the BoK into the defined curriculum as well as their abstracts. Abstract descriptions can be altered or extended. The curricula can of course be saved and printed.
The last activity line of the GI-N2K project is the organization of a series of workshops/plugfests to present the new BoK and the tools and to organize 'hands-on' exercises to explore the BoK and the tools and to test them according to well-defined 'real-world' use cases. One example is the design of a curriculum for vocational training on Spatial Data Infrastructures (SDI) and INSPIRE based on three job profiles (INSPIRE manager, data expert and service expert) and taking into account potential learning paths.
The workshops/plugfests started in May 2016 and will run until September 2016. They are planned in Girona (Spain), Debrecen (Hungary), Salerno (Italy), Helsinki (Finland), Salzburg (Austria), Sofia (Bulgaria), 's-Hertogenbosch (The Netherlands) and Barcelona (Spain). The workshops/plugfests are open and aim to create awareness about the BoK and to collect feedback on the BoK and the tools in order to improve them in the future.

CONCLUSIONS

The GI-N2K project was set-up to help bridging the gap between the current geospatial education and training offer and the needs of the market in this field. First two surveys on demand and supply of geospatial education and training were organised to assess the state-of-the-art and to provide input to the revision of the BoK. The latter was done with the help of a network of 150 geospatial experts: concepts were deleted, revised or added, and described in a 'simple' wiki. In parallel, a European ontology based paltform was set-up in the cloud and the revised BoK was uploaded in its triple store repository. Some RESTful services were developed on top of it to expose the content of the BoK to the GI-N2K tools. The priority tool developed is a curriculum design tool that allows defining, managing and comparing curricula. Test and validation plugfests started and will run through until September 2016.
The revision cycle which took one year followed a mixed approach, keeping the hierarchical aspects of the repvious BoK (by using units and topics), but also integrating the ontological aspects by adding and revising relationships

(e.g. similarity). It should be stressed that the revision approach chosen allows to work step-by-step and to gradually evolve twaords a full ontology-based environment. Furthermore, the revision process is a continuous process and will go on, even after the end of the project. Finally it should be stressed that GI-N2K was a highly collaborative effort involving more than 200 people. The challenge for the future is to keep this rich network up and running beyond the project life cycle.

REFERENCES

1. Ahearn S.C., Icke, I., Datta, R., DeMers, M.N., Plewe, B., Skupin, A. (2013). Re-engineering the GIS&T Body of Knowledge. International Journal of Geographical Information Science, 27:11, 2227-2245. http://dx.doi.org/10.1080/13658816.2013.802324 [accessed 15.05.2016]
2. DiBiase, D., DeMers, M., Johnson, A., Kemp, K., Luck, A. T., Plewe, B., Wentz, E., Eds. (2006). Geographic Information Science & Technology Body of Knowledge. Washington, D.C., Association of American Geographers. http://downloads2.esri.com/edcomm2007/bok/GISandT_Body_of_knowledge.pdf [accessed 15.05.2016]
3. European Union – European GNSS Agency (2015). GNSS Market Report, Issue 4, Luxembourg: Publications Office of the European Union
4. GI-N2K (2016). http://www.gi-n2k.eu
5. Painho, M. Curvelo, P. 2008: BoK e-Tool Prototype. An ontological-based approach to the exploration of Geographic Information Science & Technology Body of Knowledge. Proceedings Eugises 2008, Cirencester, UK. 8pp. http://www.eugises.eu/proceedings2008/painho.pdf [accessed 15.05.2016]
6. Rip F.I., Lammeren, R.J.A. van, Bergsma A.R. (2014a). GI-N2K Supply survey. An exploratory survey about teaching geo-information in 28 European countries. Wageningen University CGI report 2014-2. Wageningen, the Netherlands.
7. Rip, F., Wallentin, G. and van Lammeren, R. (2014b). Integrated analysis of the demand for and supply of geospatial education and training: Results of the GI-N2K Surveys. GI-N2K Consortium: Leuven, Belgium.
8. Reinhardt, W. (2011). Geoinformatics education in different disciplines - challenges - approaches and experiences. In Hubeau, M., Steenberghen, T., Van Balen, K., Van Orshoven, J., Vileikis, O. (eds.). Leuven,

Belgium: LeGIO Workshop, 18 November 2011, KU Leuven, p.21-28. https://ees.kuleuven.be/legio/ [accessed 15.05.2016]

9. Technavio (2015). GIS Market in Europe 2012-2016, Market Report
10. Vassiliou, A. (2014). Getting youth on the right path to bridge the skills gap. Speech at the launch of McKinsey Report on 'Education to Employment: Getting Europe's Youth into Work'. Brussels, January 13, 2014: http://europa.eu/rapid/press-release_SPEECH-14-10_en.htm [accessed 15.05.2016]
11. Wallentin, G., Hofer, B., Traun, C. (2014). GI-N2K. Analysis of the demand for geospatial education and training (Task 1.1), Project Deliverable 1.1.1. University of Salzburg, Interfaculty Department of Geoinformatics – Z_GIS.

ONLINE-MONITORING OF THE SUBWAY STATION ERDBERG VIENNA

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UDC: 625.42:621.398]:004.78-047.36(436)

INTRODUCTION

In modern construction and planning industry, especially renovations (restructuring measures) of old objects, objects in operation etc. the safety aspect becomes more important. A potential source for hazards and damage during renovation respectively conversion can be caused by uncontrolled deformation of directly or indirectly affected object parts. Therefore it is obvious that deformation behavior of these object parts should be investigated as precisely as possible before the rebuild and monitored at best during construction works and to determine its magnitude. Thus in this context about a technique which is not brand new but has not been used all too often – the online geomonitoring- is spoken, where online observations of such deformations using geodetic methods are possible.
Under suitable measuring arrangement nowadays even minor changes to building or plant components can be automatically detected. The Online Monitoring System used by Vermessung ANGST ZT GmbH (in combination with the software GOCA) offers on the one hand an overview of the observed object's condition of change that is retrievable via internet at any time and on the other hand, in case of exceeding the tolerance values, an automatic alert system with optical-acoustical warning for all present on the spot and alerting of those responsible by SMS or e-mail.

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By online monitoring and with responsible chosen tolerance value an exposure can be recognized in a timely manner.
The following is a report on the online- and geomonitoring and alerting in the completed project of the transport hub A4/A23 ("Node Prater").

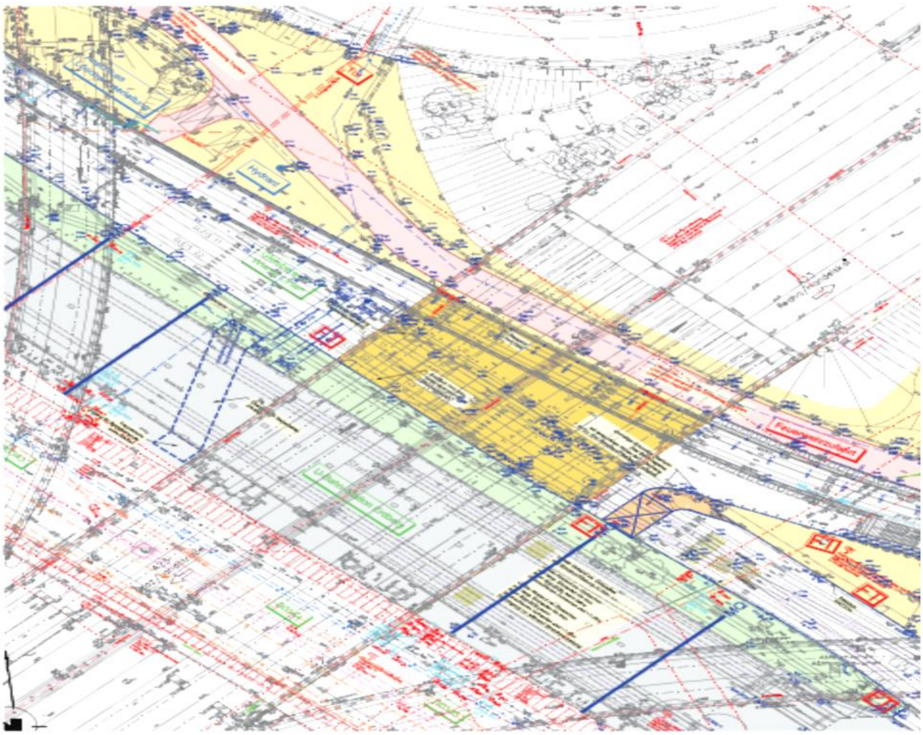


Illustration 1: Project U3-Station Erdberg

1. THE PROJECT:

In course of the renovation program of the transport hub A4/A23 ("Node Prater") by ASFINAG building work also touched areas which were influencing the area of responsibility of the Vienna Lines (subway station Erdberg). New bridges for crossing Danube Canal were build, too.
Resulting from loads caused by intermediate support as well as loads from temporarily back fillings settlements in the area of the subway were expected. Furthermore surface loads in terms of concrete loads were brought up to the temporarily back fillings.

For monitoring and as well to assess the impact of the construction measures on the affected U3- subway station 'Erdberg' (Fig. 1) a surveying monitoring was planned, which 'Vermessung ANGST ZT GmbH', Vienna, was commissioned to implement. The online geomonitoring was performed from 13.02.2014 until 28.05.2915.

2. INSTALLATION AND OPERATION OF THE ONLINE MONITORING SYSTEM

The distribution of the measuring points within the measuring sections was determined by the responsible structural engineer of Vienna Lines and portrayed in the report on determination of warning and alarm values (Site plan Ill. 1 and Table 1) ([2][3]).
In each measuring sections prism reflectors were set as planned prior to the commencement of work in the U3 subway station Erdberg, in order to enable an automatic observation with total stations. The measuring robots (TC) were mounted on consoles, which were assembled and fixed firmly to the particular wall with screws. Immediately after the online monitoring system's set up the reference measurement was performed.
Measuring interval: In order to receive the fixation of a reasonable epoch interval for the execution of the deformation measurements the measuring robots were set into 24 hours online operation for the reference measurement, the observations were evaluated, visualized and interpreted. After several variable held epoch intervals the further epochs for the execution of the monitoring program were scheduled to once per hour.
Warning values and warning levels: In case of deviations from expected behavior and according to the size of deviation a warning level is disclosed. The warning levels are divided into two levels (see Table 1):
Warning values: when warning values are reached – no compromising stability yet
Alarm values: when exceeding alarm values - compromising stability

MQ 1-4			
	Vertical deformations	Warning values [mm]	Alarm values [mm]
		+ 5 /-5	+ 10 /-10

Table 1: Warning and alarm values for the measuring section MQ 1-4 station Erdberg ([2])

In practice in case of exceeding the limit a warning is automatically carried out at the construction side via an optical or acoustical signal (see Ill. 8). At once the persons responsible (Employees of Vermessung Angst GmbH and subsequently the construction management) are informed of a warning state via SMS or e-mail. The automatic transmission of an alarm message – this criticality has never been reached in practice – would have caused the personnel to evacuate of the hazardous area and the station master to immediate close the line.

Control cross-section and measuring points: In the subway station 4 control cross-sections with 6 measuring points each (with these measuring points in each case the 3D wall support movements are captured) had to be processed (see also Illustration 14 and 15 in Annex). A control cross-section is consisting of 6 measuring points (X.1 – X.6), 2 points on top and 4 points at the bottom whose spatial location needs to be captured ([1]).

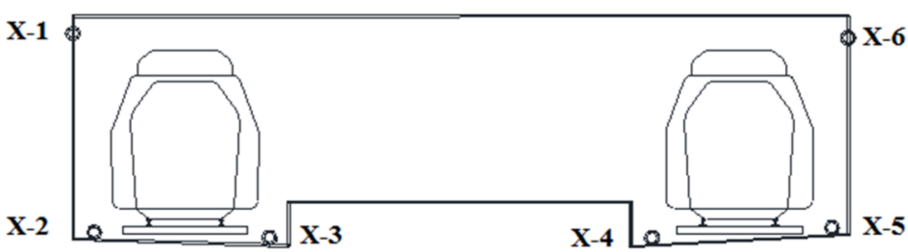


Illustration 2: Measuring point position in the measurement planes in the area of the subway station Erdberg

2.1 Measuring point stabilization and network

To conduct the measurements at the measurement object resp. subway stations the measurement object was provided with a certain amount of measuring points. All measuring points (network and object points) were defined by reflectors, which were firmly attached to the building structure with dowels, precisely defines and ensuring observation possibility for several years. In particular attitude changes of the reflectors based on vibrations caused by subway operation must be avoided.

In order to determine changes to the construction geometry in a result of he construction works, measurement data of the reference and object points were evaluated by means of geodetic network measurements and network adjustment and epoch wise an analysis of the stability behavior via statistically sound deformation analysis was performed. The network was composed of interlaced traverses with 5 reference points each, of which 4 were arranged outside the deformation area (see Ill. 3).

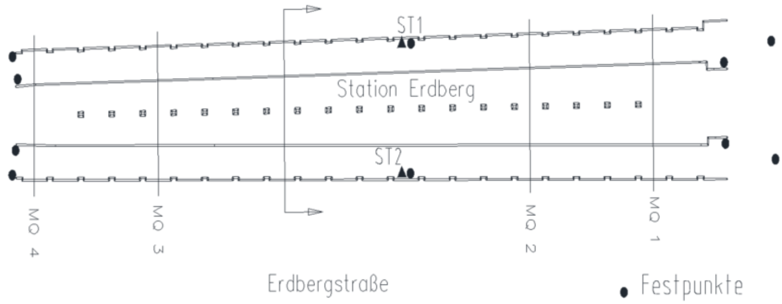


Illustration 3: Fixed point position and measurement plane in the area of subway station Erdberg

3. GEODETIC ONLINE GEOMONITORING SYSTEM GOCA

For the online geomonitoring of the project 'Subway station Erdberg' the application of a monitoring measuring system (MMS) with two total stations was necessary, which were connected to the MMS via a geosensor network. The MMS is to meet the requirements of a geodetic 3D-online monitoring system:

- Online measurements for selected deformation points (see Ill. 7) within determined intervals
- Immediate warning respectively alerting the persons responsible in case of exceeding predefined threshold values (optical, acoustical, telecommunication (Ill. 8))
- Collecting all measurement data in a central database and archiving the data for preservation of evidence and later inspection and re-evaluation

The breakdown of the particular monitoring task ensues interdisciplinary into the components data collection, modeling, reporting and reaction (implementation of an alarm plan) [5]. Central state variable of the above mentioned modeling components in geodetic monitoring is the three-dimensional displacement of object points as position and height changes within a uniform coordinate system.
By means of the mentioned basis components for the used project the data collection and analysis of the data were carried out by the network adjustment-based geomonitoring program GOCA, which has been developed

under the project leadership of Prof. Dr. Reiner Jäger at the Institute of Applied Research (IAF) at Karlsruhe University of Applied Sciences.
The different automatable modules of the GOCA geomonitoring chain (see Ill. 4) replace as complete system the old manual geodetic monitoring methods ([4] [7]).

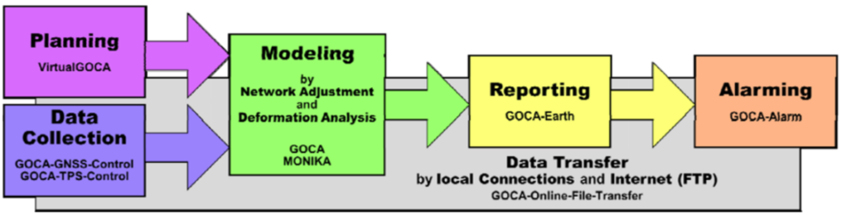


Illustration 4: Components of the geodetic geomonitoring chain using the example of GOCA system ([4] [5])

3.1 Used hardware and software

An online monitoring system for automatic monitoring of construction movements consists of the following basis components:

- Measuring sensor (motorized precision total station with automatic target recognition to prism, see Ill. 7)
- Communication box with computer and GOCA-TPS-Control to control the measuring sensor inclusive automatic measurement data collection (geomonitoring component 1, Ill. 4)
- GOCA-Software and GOCA-Alarm for network adjustment based deformation state estimation, visualization and alarming (geomonitoring component 2,3 and 4, Ill. 4)

In addition to the efficiency of the precision total station especially the service spectrum of the analysis software (geomonitoring component 2, 3 and 4, ill. 4) is a central criterion for the complete system ([4] [5]).

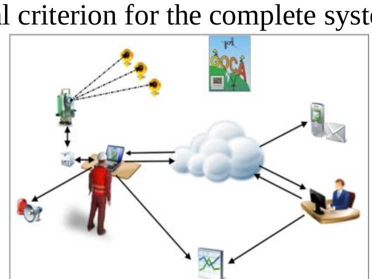


Illustration 5: General overview of the measuring system ([from 6, S. 61])

3.2 Geo-sensor networks

The superordinate term 'sensor networks' refers to a bundling of several sensors to a network, in order to determine common or specific condition information. The term geo-sensor networks includes sensor types for monitoring tasks in geoscience disciplines (Meteorology, hydrology, geodesy, geology, geophysics, etc.), which comprise different sensor types (geodetic sensors, geotechnical sensors, meteo sensors etc.) depending on complexity resp. the interdisciplinary character of the state estimation. The accuracy of georeferencing the sensors is problem- and sensor specific of varying importance. In classical geodetic deformation analysis – as a task of permanent monitoring of displacement states (PELZER, 1971, 1976) in a geodetic sensor's network – the continuous sensor georeferencing in terms of high-precision sensor positioning is assumed respectively base state variable for additional state estimations at the same time (Ill. 2) ([7]).

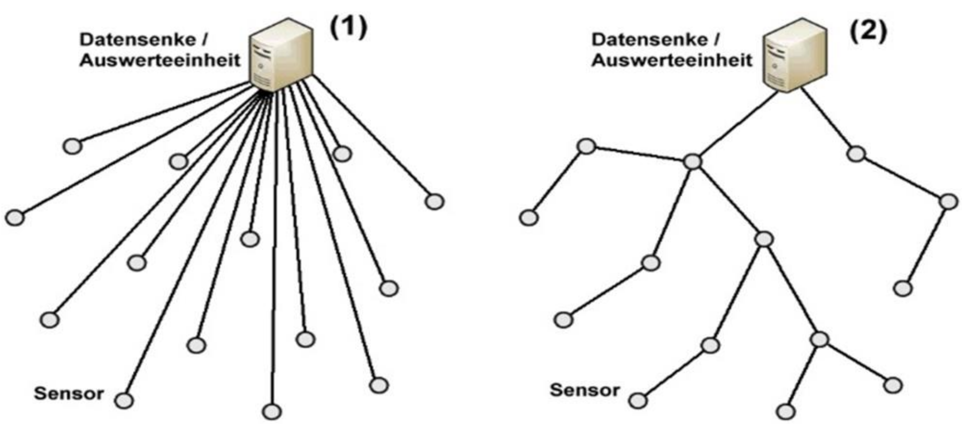


Illustration 6: (1) Direct data link [7], (2) manually configured data network [7]

Common name	Range (Ø / max.)	Extensibilit y / to	Data medium (Cable / Radio)	Comments
LAN / Ethernet	100 m / 80 km	yes / ∞	Data cable / fiber optic cable	

Table 2: Approximate ranges for direct data connections (table excerpt from [7, S.97])

The data transfer from the sensors to the data sink/evaluation unit in geo-sensor networks can result from direct connections on the one hand (star topology, see ill. 6 (1)). According to scheme illustration 6 (1) (Direct data link) the two instruments (Topcon IS 301) used in the area of the subway station were directly linked. Besides these instruments further sensors e.g. meteorological sensors were considered.

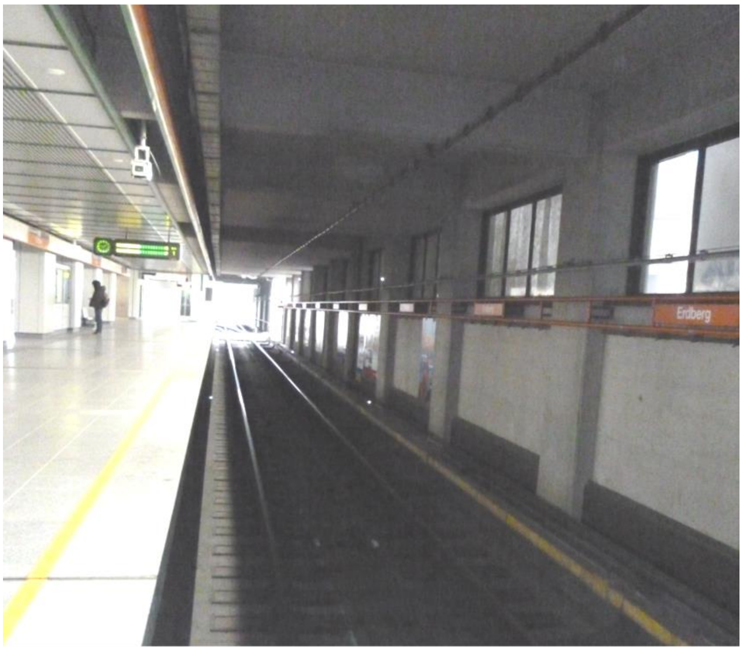


Illustration 7: Measuring station ans measuring section example - subway station Erdberg

Illustration 8: Box for central computer and control system inclusive alarm system (optical and acoustical)

In this way the two Topcon instruments could get put into operation, driven and controlled continuously from one of the central computers via the internet (e.g from the office). The central computer system also has exceeding time and cost-saving affects compared to former installations.

3.3 Topcon instruments and course of measurements

For position and height measurements two precision total stations (Topcon IS 301) were used. By means of Automatic Target Recognition (ATR) and TPS Control programs the three components (horizontal angle (Hz), zenith angel (V) and distance (D)) were simultaneously determined and registered in online mode. These instruments show a certificated distance accuracy of $\sigma s = \pm 0{,}3$ mm + 1 ppm, the certificated horizontal and zenith angel accuracies are $\sigma Hz = \pm\ 0{,}06$ mgon respectively $\sigma V = \pm 0{,}10$ mgon.
The Topcon total stations generally possess really good performance specifications. Working with Topcon IS-series instruments is extremely beneficial due to structured menus and very short recording time (Change in targeting points and measurements in both faces). The existing robotic mode (Online mode) enables a very rapid provision of the individual measurement cycles of the measurement program given by the customer in connection with the remote control of the TPS-control program (Prof. Jäger, HS Karlsruhe).
In order to fulfill all special requirements regarding the monitoring the automatically operating Online-MMS “GOCA” was installed. The Online monitoring is taking place with two high-precise Topcon total stations. In each measurement run the prisms were measured in given measurement cycles in two faces and forwarded to the following analysis.
The GOCA software enables the computation of absolute displacements in the form of online displacement estimations referring to a common coordinate system of the fixed points (reference point coordinate system) in the submillimetre range.
Employees of Vermessung Angst GmbH observed online from their office the behavior of the object and provided the construction management with relevant measurement results (information about the object's behavior), whereat also a daily measurement report (Reporting part in the above shown geomonitoring chain, see Ill. 4) is sent via email. The result were visualized in real time on the server of Vermessung Angst ZT GmbH. The access was made available for all corresponding participants via log-in and password. The customers were able to retrieve actual changes in position of the object during construction works at any time or place. During visualization a focus

was set on the quick and clear detection of deformations (marking tolerance values in striking color) of the individual object points on the start page.
All measurement values, the computed coordinates and additional information were archived in a database. Thereby consistency and plausibility can be checked as required.

4. DEFORMATION ANALYSIS, MODELING AND ANALYZING MEASUREMENT DATA

4.1 Basics

The concept of geodetic geomonitoring – the following treated state estimation instances based on data from linked sensors (see Ill. 6) single- or multistage geodetic network adjustment- has remained unchanged since the basic setting and technical definition of the mathematical modeling of deformation analysis [9] more than forty years ago, see also [8], [4], [5], [6], [7], [10], [13] and [14]. The technical innovations in the age of IT allow for from now on three decades in different stages of deployment a continuous automation respectively real-time capability of the geomonitoring chain (Ill. 4) and thereby a local staff-free, permanent real-time geodetic geomonitoring system such as GOCA [5] for civil protection and as early-warning system in building industry.
In network adjustment based deformation analysis the sensor points which are regarded as stable reference points $\mathbf{x}_R$ form the uniform 3D coordinate system for computation and modeling of the object point positions $\mathbf{x}_O$ in one or several associated figuline object areas (ill. 7). The stability and congruency of the reference points $\mathbf{x}_R$ can also be statistically analyzed and proved [10].
In the network adjustment based concept of GOCA GNSS and LPS sensor data are processed online or near-online (for epochal measurements also post-processed) in a 3 stepped adjustment concept ([4],[6],[7],[10],[13]) as least squares estimations as well as robust M-Estimator ([11], [12]). The initialization step 1 serves as determination of the 3D reference point frame $\mathbf{x}_R$ and its covariance matrix $\mathbf{C}_{X,R}$. Step 2 includes – in regards to the presented (2D/1D) concept in this report (1a-e) – the continuous adjustment of the GNSS calculations (spatial vectors) and LPS data (slope distance, directions, zenith distances and leveled height differences) mapped to appropriate position and height components. Thereby the 3D georeferencing of the object points $\mathbf{x}_O(t)$ with covariance matrix $\mathbf{C}_O(t)$ is carried out in the reference point datum $\mathbf{x}_R$. Central state variable of the modeling component, but also for reporting and alarming within the geodetic

geomonitoring chain (Ill. 4), is the 3D displacement vector $\mathbf{u}$ of the object points $\mathbf{x}_O(t)$ (see Ill. 9) derived from the sensor data as well as its velocity and acceleration component $\dot{\mathbf{u}}$ and $\ddot{\mathbf{u}}$. The georeferencing of the object point time series $\mathbf{x}_O(t)$ and the object state variable $\mathbf{y}(t) = [\mathbf{u}(t), \dot{\mathbf{u}}(t), \ddot{\mathbf{u}}(t)]^T$ takes place in a consistent reference point coordinate system $\mathbf{x}_R$.

4.2 GOCA network adjustment concept and adjustment steps 1 and 2

The functional model of the position and height adjustment in the GOCA adjustment steps 1 and 2 is based on the following correction equations:

GNSS position baselines: $$\begin{bmatrix} \Delta x_{ij} \\ \Delta y_{ij} \end{bmatrix}_{GNSS} + \begin{bmatrix} v_{\Delta x,ij} \\ v_{\Delta y,ij} \end{bmatrix}_{GNSS} = \begin{bmatrix} \Delta \hat{x}_{ij} \\ \Delta \hat{y}_{ij} \end{bmatrix} \quad (1a)$$

Horizontal distances: $$s_{ij} + v_{s,ij} = s \cdot \sqrt{\Delta \hat{x}_{ij}^2 + \Delta \hat{y}_{ij}^2} \quad (1b)$$

Directions: $$r_{ij} + v_{r,ij} = \arctan\left(\frac{\Delta y_{ij}}{\Delta x_{ij}}\right) - o_i \quad (1c)$$

GNSS height baselines: $$\Delta h_{GNSS,ij} + v_{\Delta h,_{ij}} = \Delta \hat{h}_{ij} \quad (1d)$$

Terrestrial height differences:

$$\Delta H_{terr,ij} + v_{\Delta H,ij} = \Delta s_h^m \cdot \Delta \hat{h}_{ij} + (\hat{a}_{00} + \hat{a}_{10} \cdot x_j + \hat{a}_{01} \cdot y_j)^m - (\hat{a}_{00} + \hat{a}_{10} \cdot x_i + \hat{a}_{01} \cdot y_i)^m$$

… (1e)

'm' in (1e) is referring to the area index and with Δs_h^m resp. a_{ik}^m the scale difference resp. the area polynomial coefficients for modeling the local height reference surface in the area m. Concerning GNSS, the GOCA software component GOCA-GNSS-Control (see Ill. 4) can work in RTK and in near online mode (RINEX data). As a result of chain link 1 (see Ill. 4) regarding GNSS the 3D baselines (1a, e) - besides the terrestrial sensor data (LPS) - are passed on in so-called GKA format [5] for continuous network adjustment and deformation state to the GOCA deformation analysis software (chain link 2, Ill. 4). The 3D baselines are converted to 2D/1D baselines and processed according to (1a, e).

4.3 GOCA Adjustment step 3 and deformation state estimation

The deformation analysis in GOCA adjustment step 3 is based on the simultaneously from online GOCA network adjustment step 2 arising object point time series and their covariance matrices:

$$\mathbf{x}_O(t) \text{ and } \mathbf{C}_O(t) \qquad (2a, b)$$

Illustration 9 shows the object point time series $\mathbf{x}_O(t)$ (2a), the result of network adjustment in GOCA step 2 by the example subway station Erdberg, Vienna.

Illustration 9: Visualization of raw object point time series $x_O(t)$ (2a) on a daily base by the example of one object point of the geomonitoring network U3 station Erdberg, Vienna

The expected movements/deformations are about a quasi even process (except the last measurements), so that the chosen sample rate of respectively in measuring epochs 1/day was sufficiently.

In GOCA step 3 – based on the results $\mathbf{x}_O(t)$ and $\mathbf{C}_O(t)$ (2a, b) from GOCA step 2 and individual settings for critical values and statistical parameters for object points $\mathbf{x}_O$- the following online estimations for deformation analysis of the object area as least squares and robust Huber ans L1 estimation are possible:
- moving average in position and height
- online displacement estimation at different epoch definitions (see Ill. 3)
- Kalman filtering for displacement, velocity and acceleration [12]

The functional model of the above mentioned displacement estimation (see Ill. 10) between two epochs and periods t_0 and t_i reads as follows:

$$\begin{bmatrix} \mathbf{l}_{t_0} \\ \mathbf{l}_{t_i} \end{bmatrix} + \begin{bmatrix} \mathbf{v}_{t_0} \\ \mathbf{v}_{t_i} \end{bmatrix} = \begin{bmatrix} \mathbf{E}_1 & \mathbf{0} \\ \mathbf{E}_2 & \mathbf{E}_2 \end{bmatrix} \cdot \begin{bmatrix} \hat{\mathbf{x}}_0 \\ \hat{\mathbf{u}}(t_0, t_i) \end{bmatrix} = \mathbf{A} \cdot \hat{\mathbf{y}}$$

with $\hat{\mathbf{y}} = [\hat{\mathbf{x}}_0(t_0), \hat{\mathbf{u}}(t_0, t_i)]^T$ (3a,b)

Each epoch time t_0 and t_i marks the middle of a discrete epoch interval in each case (e.g. 1 hour or 1 day, ill. 10) and both observation groups $\mathbf{l}_{t_0}$ and $\mathbf{l}_{t_i}$ are derived directly from the object time series $\mathbf{x}_O(t)$ from GOCA adjustment step 2 (2a, b). The observation corrections are referred to as v, furthermore $\hat{\mathbf{x}}_0(t_0)$ and $\hat{\mathbf{u}}(t_0, t_i)$ are referred to as the object point position at starting point t_0 respectively the occurred displacement at time t_i as part of the parameter vector to be estimated.

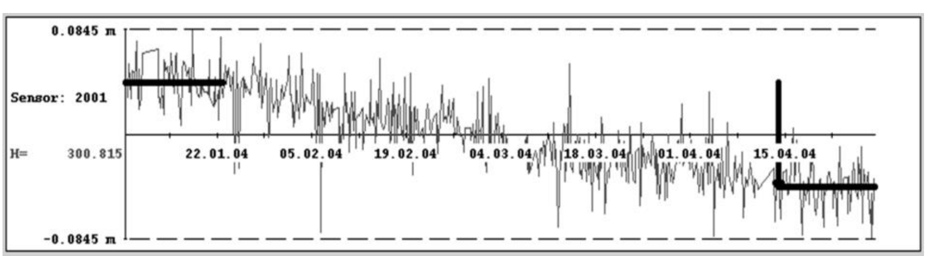
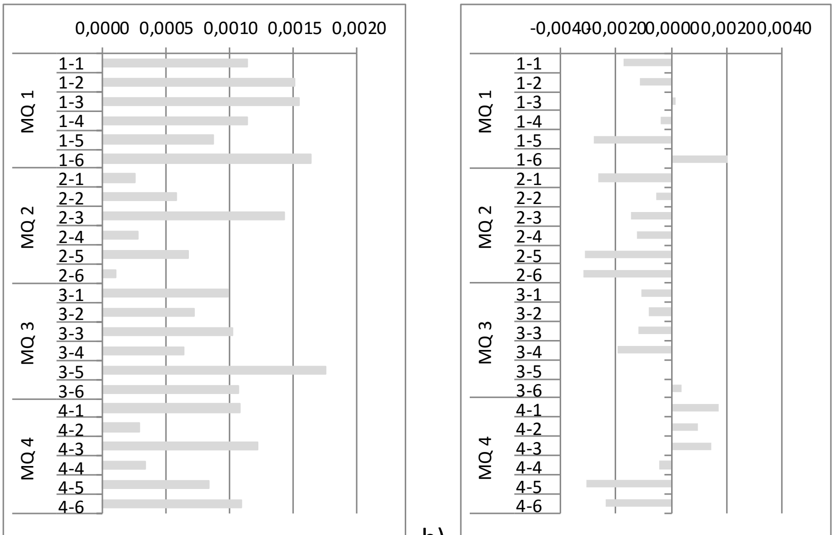


Illustration 10: GOCA visualization of time series $x_O(t)$ of an object point (adjustment step 2) and displacement estimation (adjustment step 3) by the example of a subsidence



a) b)

Illustration 11: Graphics displacement horizontal [m] a) and determined height displacement resp. settlement absolute vertical [m] b)

The GOCA Kalman filtering ([12], [14]) – as additional component of the state estimation in GOCA step 3 in chain link 2 (Ill. 4) – is based on the following state transition matrix $\mathbf{T}(t)$ for the state vector **y**(t). For its transition from previous $t-\Delta t$ to present time the following applies:

$$\mathbf{y}(t) = \mathbf{T}(t)\cdot\mathbf{y}(t-\Delta t) \qquad (4a)$$

with

$$\begin{bmatrix}\mathbf{u}(t)\\ \dot{\mathbf{u}}(t)\\ \ddot{\mathbf{u}}(t)\end{bmatrix} = \begin{bmatrix}\mathbf{I} & [\Delta t] & \left[\frac{1}{2}\Delta t^2\right]\\ \mathbf{0} & \mathbf{I} & [\Delta t]\\ \mathbf{0} & \mathbf{0} & \mathbf{I}\end{bmatrix}\cdot\begin{bmatrix}\mathbf{u}(t-\Delta t)\\ \dot{\mathbf{u}}(t-\Delta t)\\ \ddot{\mathbf{u}}(t-\Delta t)\end{bmatrix} \qquad (4b)$$

and

$$\mathbf{y}(t) = [\mathbf{u}(t), \dot{\mathbf{u}}(t), \ddot{\mathbf{u}}(t)]^{\mathrm{T}}. \qquad (4c)$$

The state vector comprises in the parameters **y**(t) (4c) the 3D displacement $\mathbf{u}(t)$, the 3D velocity $\dot{\mathbf{u}}(t)$ and the 3D acceleration $\ddot{\mathbf{u}}(t)$ of the object points $\mathbf{x}_O(t)$ in between two sequenced time intervals Δt. The state transition model (4a, b) implied a Taylor expansion truncated after second term of the unknown displacement function $\mathbf{u}(t)$ and thus the assumption of a constant acceleration $\ddot{\mathbf{u}}(t)$ within a short filter time interval Δt. This assumption is – by appropriate high sampling rate or naturally slowly moved (static) processes – almost always feasible resp. given in geodetic geomonitoring for many objects (construction, dams, landslides, mines etc.). The covariance matrix $\mathbf{C}_y$ of the prediction $\mathbf{y}(t)$ (4b) – as stochastic Gauß-Markov-Model [11] component of the actual estimation at time t – is calculated according to the law of error propagation applied to (4b) on the basis of the covariance matrix from the previous estimation of the state vector $\mathbf{y}(t-\Delta t)$. As observation component **l**(t) for the Kalman filter predictions **y**(t) (4c) come up the GOCA based displacements $\mathbf{u}(t)$ within the interval Δt, referring to the same state vector **y**(t) (4c), with appropriate covariance matrix. This observation component **l**(t) at time t and the stochastic model $\mathbf{C}_l$ are as follows:

$$\mathbf{l}(t) = \mathbf{l}(\mathbf{y}(t)) =: \mathbf{u}(t) = \mathbf{x}_0(t) - \mathbf{x}_0(t_0) \quad (4d1)$$

with

$$\mathbf{C}_l = \mathbf{C}_{x_0}(t) + \mathbf{C}_{x_0}(t_0)\,. \quad (4d2)$$

The observations $\mathbf{l}(t)$ (4d1) are the differences between the present object point position $\mathbf{x}_0(t)$ (2a, b) from GOCA adjustment step 2 (FIN files) minus the position $\mathbf{x}_0(t_0)$ to the reference date for the displacement of the Kalman filtering. The Kalman filter estimation ([4], [10], [12], [14]) itself is equivalent to the Gauß-Markov-Model [11] of a common adjustment on prediction $\mathbf{y}(t)$ (4a, b, c) and observation component (4d1,2) at time t.
The above results of adjustment step 2 and 3 are provided both numerical and visualized in a graphics window (Ill. 9 and 10). They are also available as general output interface, e.g. for virtual sensor modeling or 'integrated deformation analysis' (also 'system analysis' or structural health monitoring') ([4], [14]). An alerting (acoustical, SMS, email etc.) can result from direct comparison of the estimated numerical values of the deformation parameters (such as e.g. $\hat{\mathbf{u}}(t_0, t_i)$ (3b)) with the appropriate critical state variable (see Tab. 1), from statistical significance of the deformation parameters as well as logical AND resp. OR operation of both cases.

4.4 Robust M-Estimation

Sensor data errors and systematical error (e.g incorrect ambiguity resolution for GNSS) would involve defective results in the above deformation analysis for a fully automated GOCA real time adjustment step 2 and 3. False alarm or a high risk to erroneously suppressed alarm situations in a critical state would be the consequences. In order to eliminate this risk or keep it as small as possible the parameter estimation in GOCA deformation analysis in the adjustment steps 2 and 3 are based on the concept of robust M-Estimations ([11], [14]).

4.5 Current development of the GOCA system

The current development in the GOCA system included the implementation of a quasi-integrated 3D network adjustment ([14], [15]) in geometry and gravity space in 2015. The 2D/1D modeling (1a-e) persists unchanged, e.g. in order to cover 1D leveling networks further on. The quasi as well as the fully integrated 3D model in contrast to the 1D/2D model and so-called 'geometrical' 3D models can parametrize all available geoinformation and sensor data, i.e. gravity field models (e.g EGM 2008), gravimetry, GNSS total stations (TPS), leveling, laser scanners, radar sensors, geotechnical sensors up to photogrammetric data from modern video tachymeters – for geomonitoring geodynamical, natural and structural processes resp. objects. That is why both above mentioned integrated 3D models have a key role in actual and prospective research and development.

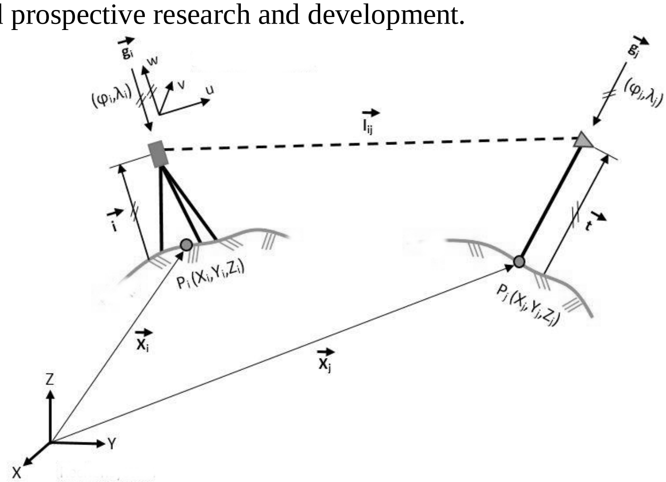


Illustration 12: Vector summary for quasi-integrated 3D modeling for total station observations (TPS) with skewed gravity directions in standpoint and target point system

Illustration 12 shows the gravity filed integrated 3D modeling by the example of total station observations (TPS). For skewed gravity directions (φ_i, λ_i) resp. (φ_j, λ_j) in standpoint system (instrument height i) resp. in target point system (reflector height t) the vector summary adds up to:

$$\mathbf{x}_i + \mathbf{i} + \mathbf{l}_{ij} - \mathbf{t} - \mathbf{x}_j = \vec{\mathbf{0}} \tag{5a}$$

Based on (5a) the significant observation vector $\mathbf{l}_{ij}^{i}$ for TPS observations (directions, zenith distance and slope distance) in the standpoint system (I) is as follows:

$$\mathbf{l}_{ij}^{i} = \begin{bmatrix} \Delta u \\ \Delta w \\ \Delta w \end{bmatrix}_{ij}^{i} = \mathbf{R}_e^i(\varphi_i, \lambda_i) \cdot \begin{bmatrix} \Delta x \\ \Delta y \\ \Delta z \end{bmatrix}_{ij} - \begin{bmatrix} 0 \\ 0 \\ i \end{bmatrix}^{i} + \mathbf{R}_e^i(\varphi_i, \lambda_i) \cdot \mathbf{R}_j^e(\varphi_j, \lambda_j) \cdot \begin{bmatrix} 0 \\ 0 \\ t \end{bmatrix}^{j} \tag{5b}$$

The vector components ($\Delta u_{ij}^{i}, \Delta v_{ij}^{i}, \Delta w_{ij}^{i}$) from $\mathbf{l}_{ij}^{i}$ enable an easy parametrization for the above mentioned TPS observations and with (5b, right part) a transformation in an earth-fixed (e) geocentric Cartesian calculation system (x, y, z) [15]. The GNSS baselines are directly parametrized as coordinate differences within the uniform earth-fixed geocentric Cartesian calculation system (x, y, z). Already this example shows the superiority of the integrated 3D model compared to the 2D/1D approach and other 'geometrical' 3D models, because for combined GNSS terrestrial networks only a linked sensor network (ill. 7) is provided. The demand for additional 'identical' points for GNSS and terrestrial sensor nodes and components expires for the integrated 3D models. In the quasi-integrated 3D model (GOCA Software version 5.3) the parameters of the vertical directions (φ_i, λ_i) resp. (φ_j, λ_j) (5b) are pairwise introduced as unknowns and -via the integrated gravity field model – as direct observations at the same time. In a fully integrated 3D model the parametrization of the gravity filed and also the parameters of the vertical directions (φ_j, λ_j) (5b) of the individual network points result from regional spherical cap harmonics.

The 3D modeling, integrated as additional option in the GOCA software, affects only step 1 and 2 within the GOCA concept of stepwise adjustment (chapter 4.2 and 4.3). The deformation state estimation stays unaffected.

In 2016 in cooperation with TOPCON the photogrammetric component of the geomonitoring system GOCA is continued with the above mentioned quasi-integrated 3D adjustment model implementation. With regard to encoded measure marks and their modeling via image processing a recourse to developments within precise navigation (www.navka.de) is possible. The integration of image data received from TOPCON video tachymeters in the GOCA system implies a multi-sensory supported bundle block adjustment I the 3D adjustment.

SUMMARY

The presented project 'Subway station Erdberg' in Vienna clearly demonstrates, that a fully automated operation of a geomonitoring system by means of the geomonitoring system and the software GOCA is possible. The geomonitoring serves primarily for estimating the probability of damage occurring. The results are available in real time and – enabled by the internet – available at any locations.

Determining geometric changes resp. 3D deformations in form of settling and position displacement and their chronological sequence were of particular interest, on the one hand for ensuring the employees safety at the building site and to guarantee a safe and from the building site unaffected run of the subway lines.

Particularly worth mentioning is the extremely high profitability of the measuring system, especially the low effort for capturing many measuring cycles with little temporal and staff assignment. This enables the metrological online monitoring of construction works during current operations of ÖBB trains and subway lines.

On that basis the fully automation of epoch measurements as step 1 of the geomonitoring chain (see Ill. 4) in case of tachymeter sensors (TPS) by the usage of several simultaneously monitoring ATR tachymeters with precision prisms and WLAN data transmission to the GOCA software components responsible for steps 2, 3 and 4 can be achieved.

The continued deformation process modeling and the alarm management building upon that shall guarantee that the construction-related additional occurring displacements remain within safe limits, resp. a timely evacuation of the inhabited housing complex is ensured during construction works.

The use of observation measurements, GOCA software and communication systems were really important for this project, because the high-precision measurements provided the requested information for the state of the tunnel and subway station based on the construction work fully automated. The risk is minimized not only for the tunnel and the subway station, but also for the involved people and public safety. Without the high standards of measuring technologies with high precision instruments and the reliable software

GOCA which enables an automated deformation monitoring, this project would not have been feasible.

Attention should be paid to the fact that applying such automated observation software can not replace geodesists as experts but can be used there to support his performance.

Literature

[1] Geotechnischer Sicherheitsmanagementplan, Bericht: BGG Consult, Wien

[2] Überschüttung Startschacht und Tübbingtunnel U2/5 - Ermittlung von Warn- und Alarmwerten für die Setzungen, 20.03.2013, IC Consulenten ZT GmbH Wien

[3] Projekt: Asfinag - A4/A23 - Knoten Prater Warn- und Alarmwerte- Tecton Consult Engineering ZT GesmbH

[4] R. Jäger (2014): GNSS/GPS based Online Control and Alarm System (GOCA) - Weiterentwicklungen zum Integrierten Geomonitoring mit LowCost GNSS und inertialen MEMS-Sensoren. Proceedings IX. Mittweidaer Talsperrentag 2014. Mittweida, 14.-15. Mai 2014. Wissenschaftliche Zeitschrift der Hochschule Mittweida. R. 1 2014. ISSN 1437-7624. S. 21-33.

[5] JÄGER, R. & S. KÄLBER (1999-2015): www.goca.info. GOCA-Website. URL: www.goca.info.

[6] KABASHI, I., RAGOSSNIG-ANGST, M. UND R. JÄGER (2011): Geodätisches Online-Monitoring von alten Bauwerken in gefährdungskritischem Zustand im Zuge von Sanierungen. 16. Internationale Geodätische Woche Obergurgl 2011.Grimm-Pitzinger, A.; Weinold, T. (Hrsg.) Wichmann Verlag, Heidelberg. ISBN 978-3-87907-505-8.S. 53-65.

[7] KABASHI, I., ANGST, J., RAGOSSNIG-ANGST, M., JÄGER, R. UND P. SPOHN (2013): Automatisiertes geodätisches Monitoring an den Staudämmen Jablanica, Grabovica und Salakovac. (In: Hanke, K.; Weinold, T. Hrsg.). 17. Internationale Geodätische Woche Obergurgl 2013. Wichmann. ISBN 978-3-87907-526-3.

[8] PELZER, H. (1976): Zur Analyse von permanent registrierten Deformationen. Proceedings VII Course on Engineering Survey with High Precision. Darmstadt. S. 781-796.

[9] PELZER, H. (1971): Zur Analyse geodätischer Deformationsmessungen, DGK, Reihe C, Heft 164, München.

[10] Kälber, S. and R. Jäger (2000): Realization of a GPS-based Online Control and Alarm System (GOCA) and Preview on Appropriate System Analysis Models for an Online Monitoring. Proceedings 9th FIG-Symposium on Deformation Measurement and Analysis. Sept. 1999, Olsztyn, Poland. p. 98 -117.
[11] Jäger, R., Müller, T., Saler, H. und R. Schwäble (2005): Klassische und robuste Ausgleichungsverfahren - Ein Leitfaden für Ausbildung und Praxis von Geodäten und Geoinformatikern. Wichmann-Verlag, Heidelberg. ISBN 3-87907-370-8.
[12] Jäger, R. and F. Gonzalez (2005): GNSS/GPS/LPS based Online Control and Alarm System (GOCA) - Mathematical Models and Technical Realisation of a System for Natural and Geotechnical Deformation Monitoring and Hazard Prevention. ISGDM IAG-Symposium 2005. University of Escuela Politécnica Superior de Jaén. Spain. (F. Sanso and A. J. Gil (Eds.): Geodetic Deformation Monitoring: From Geophysical to Engineering Roles. IAG Series on Geodesy Symposia. Springer Heidelberg and New York. ISBN 3-540-38595-9. S. 293 – 304.
[13] R. Jäger (2014): Modelbildung und Realisierung eines Systems zum Geomonitoring in Bauwesen, Geotechnik und Naturkatastrophenschutz. Proceedings 9. Kolloquium Bauen in Boden und Fels. Technische Akademie Esslingen (TAE). Januar 2014. ISBN 978-3-943563-08-05, Registered at http://dnb.dnb.de. S. 359-368.
[14] R. Jäger (2015): Geometry & Gravity Space related 3D Integrated Geomonitoring – Feasibility, Advantages and Implementation into the GOCA-System. Extended Abstract. Proceedings 2nd International Workshop Integration of Point-and Area-wise Geodetic Monitoring for Structures and Natural Objects. Stuttgart, 23.-24. March 2015. Siberian State University of Geosystems and Technologies (SSGA), Novosibirsk, Russian Federation and Institute of Engineering Geodesy, University of Stutttgart, Germany (Eds.). ISBN 978-00-049116-0. Page 19.
[15] Heck, B., Illner, M. und R. Jäger (1995): Deformationsanalyse zum Testnetz Karlsruhe auf der Basis der terrestrischen Messungen und aktueller GPS-Messungen. Festschrift Draheim-Kuntz-Mälzer. Universität Karlsruhe.

MODELING THE RESPONSE OF THE MEDITERRANEAN SEA LEVEL TO GLOBAL AND REGIONAL CLIMATIC PHENOMENA

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SUMMARY

Fluctuations of the sea level pose an issue of emerging importance, especially after scientific research revealed a clear rising trend. Since the early 80's, a new technique, satellite altimetry, resulted in an abundance of sea surface height measurements and these data are crucial to both oceanographic and geodetic applications. This work presents the results of a correlation study of the Sea Level Anomaly (SLA) with global and regional climatic phenomena that influence the ocean state as well. For this reason, three correlation indexes have been examined. The first one is the well-known Southern Oscillation Index (SOI) corresponding to the ocean response to El Niño/La Niña-Southern Oscillation (ENSO) events. The next index is the North Atlantic Oscillation (NAO) index, which corresponds to the fluctuations in the difference of atmospheric pressure at sea level between the Icelandic low and the Azores high. The last index is the Mediterranean Oscillation Index (MOI), which refers to the fluctuations in the difference of atmospheric pressure at sea level between Algiers and Cairo. The raw data used were SLA values from Jason-1 and Jason-2 satellite altimetry missions for a period of thirteen years (2002-2014) within the entire Mediterranean Basin. Regional multiple regression

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and correlation analyses between sea level anomalies and these indexes were carried out in order to detect and model correlations between the Mediterranean sea level and the aforementioned global and regional climatic phenomena.

Key words: Sea level, altimetry, regression analysis, PCA, Mediterranean Sea.

1. INTRODUCTION

The study of sea level rise and sea level variations is a topic of major importance for geodetic, oceanographic, environmental and other applications. In these applications, the modeling of the steric and non-steric part of the variations is a critical task as these variations are influenced by many factors. For example, some of the factors that affect the temporal and long-term variations of the sea level, are changes in sea temperature, salinity, total water volume and mass (EPA, 2011).
Satellite altimetry has changed the traditional measurement of sea level with tide-gauge stations located in coastal areas around the globe and resulted in the availability of sea surface height measurements with global coverage, homogeneous accuracy and resolution (Chelton et al., 2001; Garcia et al., 2007; Vergos et al., 2012). Since the early 80's repeated satellite altimetry data span nowadays over a period of about 35 years and the record of observations for the sea level offer new opportunities for the estimation of sea level variations and its proper modeling with global and regional climatic phenomena. A crucial point in studying the variations of the sea surface is the correlation of Sea Level Anomaly (SLA) with global and regional climatic phenomena that influence the ocean state as well, usually represented in oscillation indexes. This is also the main objective of this study.
Three oscillation indexes were selected to be examined. The first one is the well-known Southern Oscillation Index (SOI) corresponding to the ocean response to El Niño/La Niña-Southern Oscillation (ENSO) events (http://www.bom.gov.au). The next index investigated is the North Atlantic Oscillation (NAO) index, which corresponds to the fluctuations in the difference of atmospheric pressure at sea level between the Icelandic low and the Azores high (Perry, 2000). The last index investigated is the Mediterranean Oscillation Index (MOI), which refers to the fluctuations in the difference of atmospheric pressure at sea level between Algiers and Cairo (Corte-Real et al., 1998). These three indexes were used in regression and correlation analyses along with satellite altimetry derived SLA data. The raw SLA data were obtained from Jason-1 and Jason-2 satellite altimetry

missions for a period of thirteen years (2002-2014) within the entire Mediterranean Basin.

2. AREA UNDER STUDY, AVAILABLE DATA AND PRE-PROCESSING

The area under study spans the entire Mediterranean Sea bounded between $30^o \leq \varphi \leq 50^o$ and $-10^o \leq \lambda \leq 40^o$. The data employed in the present work are those of the Jason-1 and Jason-2 satellite missions. For Jason-1, data during the period from 15/1/2002 (cycle 1) to 07/12/2008 (cycle 255) have been used resulting in a total number of 670703 observations while for Jason-2, data from 4/7/2008 (cycle 0) to 31/12/2014 (cycle 239), have been used with a total number of 882197 observations (see Figure 1 for the Jason ground track pattern over the area under study). Each Jason cycle consists of 254 passes with almost 20% of those having available observations in the Mediterranean Sea within the satellite's period of ~10 days. The mesh of values is not as dense as those from other satellites (e.g., ENVISAT and CRYOSAT2) and its cross track spacing at the equator is approximately 300 km. The data used have been downloaded from the Radar Altimeter Database System (RADS) operated by the Delft Institute for Earth-Oriented Space research (DEOS) (RADS 2015). RADS presents a collection of almost all past and current satellite altimetry and is DEOS' effort in establishing a harmonized, validated and cross-calibrated sea level data base from satellite altimeter data.

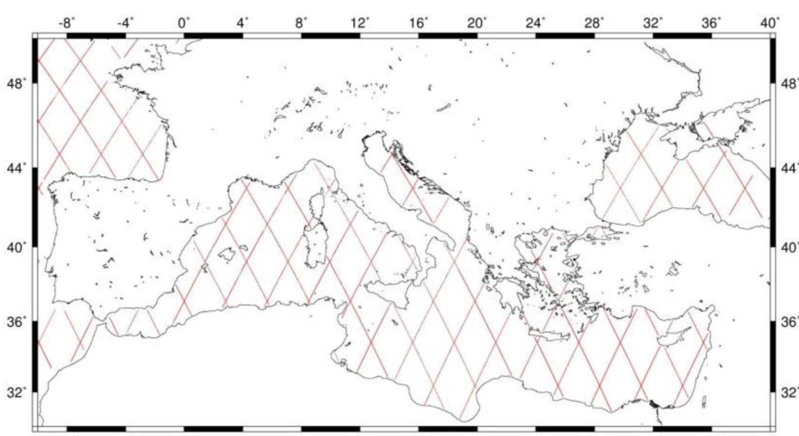

Figure 1: Jason data distribution over the Mediterranean Sea

The altimetric data are available in the form of SLAs referenced to a "mean-sea-surface" that depends on user selection within the RADS system. Therefore, it was decided to refer the data to the EGM2008 geoid (Pavlis et al., 2012). It should be noted that a zero-tide (ZT) geoid model was adopted in order to be in-line with the tide-conventions used in altimetric data processing. As far as the selection of the geophysical corrections and models used, those were a) ECMWF for the dry tropospheric correction, b) MWR(NN) for the wet tropospheric correction, c) the smoothed dual-frequency model for the ionospheric correction, d) tidal effects due to Solid Earth, Ocean, Load and Pole from the Solid Earth tide, GOT ocean tide and GOT load tide (the latest models for each satellite) and pole tide models respectively, and e) the CLS Sea State Bias (SSB) model for the SSB effect (Naeije et al., 2008) and the references herein should be advised for more details on the models used. All geophysical corrections mentioned previously have been applied to the Jason-1 and the Jason-2 raw observations, in order to construct corrected geophysical data records, i.e., corrected SLAs referenced to the EGM2008 ZT geoid (AVISO, 2015, and 2016).

Table 1: Statistics of JASON data Unit: [m].

	nr. values	min	max	mean	std
Jason-1	670073	-1.817	0.880	0.009	±0.150
Jason-2	882197	-0.783	1.169	0.041	±0.153

Tables 1 summarizes the statistics of the JASON 1/2 SLAs values for both satellites where the maximum and minimum values shown are clearly due to blunders in the available SLA data. These blunders are all located close to the coastline. Both datasets have small mean values and an agreement in the standard deviation is noticed

3. OSCILATION INDEXES

In order to investigate any possible correlation between SLA and global or regional climatic phenomena that influence the ocean state three indexes have been examined. SOI corresponds to the ocean response to El Niño/La Niña-Southern Oscillation (ENSO) events and gives an indication of the development and intensity of El Niño or La Niña events in the Pacific Ocean. It is calculated using the pressure differences between Tahiti and Darwin. Negative values of the SOI often indicate El Niño episodes, i.e., warmer waters in the eastern Tropics, while positive values of the SOI are typical of a La Niña episode, i.e., cooler waters in the eastern Tropics (Allan et al., 1991; Können, 1998; Ropelewski et al., 1987). The next index investigated is NAO. It controls winter climate variability in the North Atlantic from central North America to Europe. Positive values of NAO result in warm and wet winters in Europe, dry winters in Mediterranean and in cold and dry winters in northern Canada and Greenland, while negative values of the NAO bring moist air into the Mediterranean and cold air to northern Europe (Tsimplis amd Josey, 2001; Osborn, 2006 and 2011; Wakelin et al., 2003; Woolf et al., 2003). The last index investigated is the Mediterranean Oscillation Index (MOI), which refers to the fluctuations in the difference of atmospheric pressure at sea level between Algieres and Cairo. It is an indicator of climate variability in the Mediterranean, since positive values of MOI are related to dry weather throughout the Mediterranean, except from the south-eastern part. On the contrary, negative values of MOI are related to cyclogenesis in west Mediterranean and abnormally wet weather, except from the south-eastern part (Palutikof, 2003; Tsimplis and Shaw, 2006; Supic et al., 2004; Sušelj and Bergant, 2006; Vergos and Natsiopoulos, 2012). For this study all data for oscilation indexes have been accessed from the Climate Research Unit of the University of East Anglia (http://www.cru.uea.ac.uk/). Tables 2-4 below summarizes the values of each index for the period of study.

4. REGRESSION AND CORRELATION ANALYSIS

A regional multiple regression analysis between SLA variance values (Co) of Jason-1 and Jason-2 and SOI, MOI and NAO indexes is carried out to model the response of the Mediterranean to these global and regional climatic phenomena. Assuming that the observations are given in discrete points in the area,the computation of the covariance function is carried out by numerical integration (Tcherning and Rapp, 1974). If each observation y_i represent a small area A_i and y_j represents an area A_j then the empirical covariance is given by the following equation:

$$C(\psi) = \frac{\sum A_i A_j y_i y_j}{\sum A_i A_j}, \qquad (1)$$

with $\psi_{k-1} < \psi_{ij} < \psi_k$ where ψ is the spherical distance. If the area is subdivided into small cells holding one observation each and A_i and A_j are assumed to be equal then Eq. (1) reduces to

Table 2: MOI values for period under study

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	-0.20	-0.12	0.42	-0.30	0.40	0.35	0.75	0.61	0.32	-0.63	-0.56	-0.15
2004	0.21	-0.25	-0.23	-0.38	-0.12	0.33	0.68	0.39	0.40	-0.45	-0.05	-0.66
2005	0.84	-0.22	-0.32	-0.28	0.00	0.32	0.50	0.65	0.30	-0.12	-0.56	-0.08
2006	-0.26	-0.30	-0.33	-0.22	-0.14	0.19	0.72	0.47	0.08	-0.05	0.09	0.10
2007	0.14	0.14	-0.09	-0.29	0.24	0.27	0.82	0.38	0.31	-0.27	-0.41	0.23
2008	0.33	0.13	-0.19	-0.29	-0.63	0.41	0.65	0.62	0.10	-0.34	-0.58	-0.52
2009	-0.98	-0.36	-0.49	-0.22	0.00	0.27	0.71	0.38	0.13	0.12	-0.18	-0.99
2010	-0.91	-1.18	-0.30	-0.16	-0.08	0.12	0.60	0.68	0.14	-0.51	-1.04	-0.73
2011	-0.18	0.29	-0.60	-0.10	0.07	0.44	0.41	0.48	0.48	0.06	-0.70	0.27
2012	0.54	0.25	0.23	-0.81	0.15	0.36	0.86	0.61	0.12	-0.50	-0.73	0.18
2013	-0.18	-0.59	-1.18	-0.50	-0.06	0.57	0.73	0.60	0.21	-0.20	-0.11	0.31
2014	-0.79	-0.45	0.02	-0.27	-0.05	0.13	0.30	0.39	-0.07	-0.12	-1.26	0.07

Table 3: SOI values for period under study

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	-0.30	-0.90	-0.91	-0.48	-0.85	-1.75	0.26	-0.35	-0.18	-0.26	-0.32	0.92
2004	-1.31	0.77	-0.11	-1.91	1.22	-1.91	-0.72	-0.90	-0.31	-0.42	-1.05	-0.94
2005	0.20	-2.99	-0.26	-1.22	-1.46	0.11	0.06	-0.97	0.34	1.12	-0.42	0.01
2006	1.29	-0.26	1.93	1.17	-0.96	-0.98	-0.90	-1.75	-0.60	-1.52	0.05	-0.39
2007	-0.83	-0.38	-0.30	-0.35	-0.30	0.14	-0.44	0.01	0.12	0.44	0.82	1.49
2008	1.54	2.05	1.04	0.56	-0.25	0.34	0.20	0.64	1.26	1.52	1.64	1.43
2009	0.85	1.37	-0.21	1.06	-0.86	-0.45	0.18	-0.59	0.35	-1.66	-0.67	-0.95
2010	-1.13	-1.59	-1.40	1.88	0.85	0.24	1.95	1.77	2.44	1.80	1.62	2.90
2011	2.01	2.12	2.09	3.02	0.46	-0.04	1.11	0.07	0.96	0.91	1.41	2.45
2012	0.90	0.22	0.20	-0.65	-0.38	-1.51	-0.15	-0.74	0.22	0.17	0.33	-0.77
2013	-0.10	-0.47	1.06	0.01	0.90	1.45	0.76	-0.23	0.41	-0.34	0.75	-0.05
2014	1.24	-0.28	-1.64	0.98	0.69	-0.37	-0.26	-1.42	-0.78	-0.92	-1.08	-0.72

Table 4: NAO values for period under study

YEAR	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	0.15	1.34	1.08	-1.74	1.17	-0.86	0.09	-0.99	0.35	-3.68	0.31	-0.85
2004	0.2	-1.23	1.07	1.08	-0.67	-0.38	-0.3	-0.76	2.51	-2.18	-0.55	1.27
2005	1.82	-2.25	-1.29	0.71	-0.13	-1	-0.08	0.94	0.5	-0.45	-1.01	-0.81
2006	-0.1	-1.24	-1.12	0.57	-0.22	-0.41	0.83	-2.47	-1.02	-1.97	1.7	3.08
2007	1.77	0.42	2.03	-0.1	0.62	-3.34	-1.05	-3.41	-1.18	-0.02	-1.67	1.42
2008	1.87	1.81	0.37	-2.02	-3.26	-2.05	-1.38	-0.21	-2.07	0.01	-1.3	-0.58
2009	0.61	-1.43	0.15	1.74	1.52	-3.05	-0.92	1.07	-0.63	-2	1.68	-3.72
2010	-2.38	-3.25	-0.8	-1.03	-1.66	-2.4	0.06	-2.01	-2.38	-2.41	-3.34	-4.62
2011	-1.38	2.79	-0.44	2.39	1.08	-1.58	-3.39	-0.18	2.97	1.45	0.74	3.2
2012	2.05	1.28	1.78	-2.36	-0.83	-2.58	-1.31	-0.44	-1.44	-3.21	-1.11	0.6
2013	1.08	-0.26	-3.75	0.03	1.23	1.4	2.52	2.16	-0.57	-0.36	0.04	3.54
2014	0.71	2.32	1.64	0.84	-0.08	-1.98	0.91	1.14	-2.1	0.31	-2.17	1.89

$$C_k = \frac{\sum y_i y_j}{N_k}, \tag{2}$$

where N_k is the number of products $y_i\, y_j$ in the k^{th} interval (Knudsen 1988). From Eq. (2), C_o may be computed by the following formula

$$C_0 = \frac{\sum y_i y_i}{N}. \tag{3}$$

Regarding the oscillation index values, these were normalized using the minimum and maximum values of NAO, in order to obtain values coherent to each other. More specifically, all indexes values were first normalized to [0,1] as follows:

$$x' = \frac{X - X_{min}}{X_{max} - X_{min}}, \tag{4}$$

and then rescaled to [-1,1] by applying the following formula:

$$x' = x' * 2 - 1. \tag{5}$$

The monthly values for C_o and the normalised monthly value of each index were then used in order to estimate the three regression coefficients. The computed values of each coefficient are provided in Table 5. The b_1 coefficient corresponds to MOI, b_2 to SOI and b_3 to NAO.
During all years, MOI should be the most proper measure of climatic forcing contribution to sea level variations in the Mediterranean. The large values of the MOI coefficient (b_1) indicate a strong correlation with the SLA. The SOI coefficient values are smaller than the ones of MOI, while during the years that the ENSO events are strong (2011, 2013) b_2 is larger than b_1. Given that El Niño and La Niña may not be representative for the Mediterranean Sea, due to their distance and the characteristics of the latter as a closed sea area, NAO should be more appropriate to indicate any correlation between atmospheric forcing and SLA variations. The absolute values of the NAO coefficient (b_3) are close to 1 signaling that atmospheric conditions in the North Atlantic are not the dominant contributing factor for the Mediterranean Sea, while the large value of 2010 can be attributed to the small value of SOI. This is in-line with the findings of previous researchers (see, e.g., Tsimplis and Shaw, 2008), and signals that atmospheric forcing is not the contributing factor to the steric sea level variations in the Mediterranean.

Table 5: Regression coefficients for JASON satellites:

Satellite	Year	b_1	b_2	b_3
JASON1	**2002**	6.198	-3.055	1.128
	2003	6.839	0.365	0.285
	2004	8.564	1.182	1.586
	2005	11.102	-1.335	-1.708
	2006	9.144	2.031	0.298
	2007	5.808	1.844	0.952
	2008	2.882	2.508	-1.371
JASON2	**2009**	5.234	3.032	0.209
	2010	6.143	0.666	3.407
	2011	2.464	3.362	-0.692
	2012	5.436	2.224	-0.958
	2013	-5.598	7.767	2.347
	2014	6.741	1.622	0.918

A correlation analysis was also carried out to model any seasonal correlation between SLA and these indexes. Four periods with a duration of 3 years each (2002-2004, 2005-2007, 2008-2010, 2011-2013) have been checked. The correlation ($\rho_{X,Y}$) between two variables (X, Y) is estimated by:

$$\rho_{X,Y} = \frac{cov(X,Y)}{\sigma_X \sigma_Y}, \tag{6}$$

where cov is the covariance function and σ_X, σ_X are the standard deviations of X and Y, respectively. The covariance functions is defined as

$$cov(X,Y) = E[(X - \mu_X)(Y - \mu_Y)], \tag{7}$$

where μ_X is the mean of X and E is the expectation. Then Eq. (6) becomes:

$$\rho_{X,Y} = \frac{E[(X-\mu_X)-(Y-\mu_Y)]}{\sigma_X \sigma_Y}\ . \tag{8}$$

In this study X is the average of seasons for each year of the period under study, μ_X the average of all seasons and σ_X, σ_X the corresponding standard deviations.

Figure 2 depicts the correlation between seasons and indexes for a period of three years. The results presented in Figure 2 are similar to those found in the regression analysis, i.e., the correlation is similar to the values of the computed regression coefficients (see Table 5). Although a seasonal effect is not obvious, due to the fact that periods of three years are tested, it can be noticed that MOI and NAO are strongly correlated with SLA during the winter months of each year. This is in line with the fact that NAO and MOI are well correlated and follow each other, especially during winter. On the other hand, the seasonal correlation between SOI and SLA depends on the strength of ENSO events and it is presented with a lag of 4-8 months.

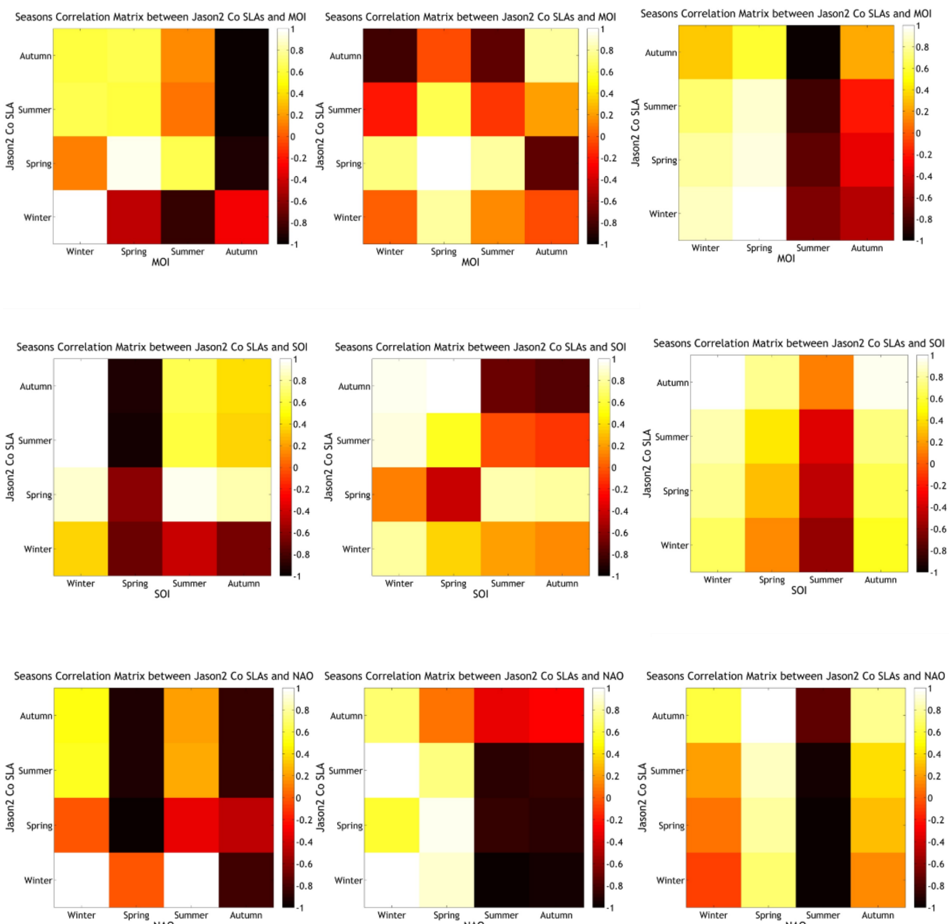

Figure 2: Correlation between Seasons and MOI (top), SOI (center) and NAO (bottom) for periods (2002-2004, 2005-2007, 2011-2013).

CONCLUSIONS

In this paper, an analytical outline of the use of satellite altimetry for modeling the correlation between global and regional climatic phenomena, was presented. Jason-1 and Jason-2 satellite altimetry derived sea level anomalies for a period of thirteen consecutive years (2002-2014) and for the entire Mediterranean basin were used for conducting regional multiple regression and correlation analyses with the SOI, MOI and NAO indexes. These analyses aimed in detecting and modeling correlations between the Mediterranean sea level and global and regional climatic phenomena. From the regional multiple regression analysis, it was concluded that the response of the Mediterranean Sea is more predominant with the MOI. During years with strong ENSO events the regression coefficient for the SOI index has the largest values. From the correlation analysis carried out, it was found that some correlation between ENSO events and SLA variations can be seen while NAO is strongly correlated with MOI and SLA for winter months. The weak response of the SLA in the Mediterranean Sea level during Summer implies that atmospheric forcing is not a contributing factor to the steric sea level variations in the Mediterranean during that period.

REFERENCES

1. Allan, R.J., Nicholls, N., Jones, P.D. & Butterworth, I.J. (1991). A further extension of the Tahiti-Darwin SOI, early SOI results and Darwin pressure. J. Climate 4, 743-749.
2. AVISO (2015). OSTM/Jason-2 Products handbook SALP-MU-M-OP-15815-CN, edition 1.9, May.
3. AVISO (2016). Jason-1 Products Handbook SMM-MU-M5-OP-13184-CN, edition 5.1, April 2016
4. Chelton, D.B., Ries, J.C., Haines, B.J., Fu, L.-L. & Callahan, P.S. (2001). Satellite altimetry. In International Geophysics Series “Satellite Altimetry and Earth Sciences: A Handbook of Techniques and Applications” (Eds. L.-L. Fu & A. Cazenave), Academic Press, San Diego 69:4-131.
5. Corte-Real, J., Qian, B. & Xu, H. (1998). Regional climate change in Portugal: precipitation variability associated with large-scale atmospheric circulation. International Journal of Climatology 18: 619–635.
6. Garcia, D., Ramillien, G., Lombard, A. & Cazenave, A. (2007). Steric sea-level variations inferred from combined Topex/Poseidon altimetry and GRACE gradiometry. Pure Appl. Geophys. 164:721-731.

7. EPA - USA Environmental Protection Agency (2011). Sea Level - Climate change in the United States. https://www3.epa.gov/climatechange/science/indicators/oceans/sea-level.html. Accessed May 1, 2015.
8. Können, G.P., Jones, P.D., Kaltofen, M.H., & Allan, R.J. (1998). Pre-1866 extensions of the Southern Oscillation Index using early Indonesian and Tahitian meteorological readings. J. Climate 11, 2325-2339.
9. Naeije M., Scharroo R., Doornbos E., & Schrama E. (2008). GLobal Altimetry Sea-level Service: GLASS. Final Report. NIVR/DEOS publ., NUSP-2 report GO 52320 DEO, 107pp, December 2008.
10. Osborn, T.J. (2006). Recent variations in the winter North Atlantic Oscillation. Weather 61, 353-355.
11. Osborn, T.J. (2011). Winter 2009/2010 temperatures and a record-breaking North Atlantic Oscillation index. Weather 66, 19-21.
12. Palutikof, J.P. (2003) Analysis of Mediterranean climate data: measured and modelled. In: Bolle, H.J. (ed): Mediterranean climate: Variability and trends. Springer-Verlag, Berlin.
13. Pavlis N., Holmes S., Kenyon S., & Factor J. (2012). The Development and Evaluation of the Earth Gravitational Model 2008 (EGM2008). Journal of Geophysical Research, Volume 117.
14. Perry, A.H. (2000). The North Atlantic Oscillation: an enigmatic see-saw. Progress in Physical Geography 24, 289–94
15. RADS-DEOS (2015). Radar Altimeter Database System. http://rads.tudelft.nl. Accessed January 2015.
16. Ropelewski, C.F., & Jones, P.D. (1987). An extension of the Tahiti-Darwin Southern Oscillation Index. Monthly Weather Review 115, 2161-2165.
17. Supic, M., Grbec, B., Vilibic, I., & Ivancic, I. (2004). Long-term changes in hydrodynamical conditions in Northern Adriatic and its relationship to hydrological and atmospheric processes Ann. Geophys., 22 (3) (2004), pp. 733–745
18. Sušelj, K., & Bergant, K. (2006). Mediterranean Oscillation Index Geophys. Res. Abstr., 8 (2006), p. 02145 European Geosciences Union.
19. Tsimplis, M.N., & Josey, S.A. (2001). Forcing of the Mediterranean Sea by atmospheric oscillations over the North Atlantic Geophysical Research Letters 28 (5): 803-806.
20. Tsimplis, M.N., & Shaw, A.G.P. (2008). The forcing of mean sea level variability around Europe, Global and Planetary Change, Volume 63, Issues 2–3, September 2008, Pages 196-202, ISSN 0921-8181, doi: 10.1016/j.gloplacha.2007.08.018

21. Wakelin, S. L., Woodworth, P.L., Flather, R.A., & Williams, J.A. (2003). Sea-level dependence on the NAO over the NW European Continental Shelf. Geophysical Research Letters, 30(7), Art. No. 1403.
22. Woolf, D.K., Shaw, A.G.P., & Tsimplis, M.N. (2003). The influence of the North Atlantic Oscillation on Sea Level Variability in the North Atlantic Region. The Global Atmosphere and Ocean System. 9(4): 145-167.
23. Vergos, G.S., & Natsiopoulos, D.A. (2012). Ocean remote sensing altimetric satellites in support of sea level anomalies and mean sea surface modeling. Presented at the 32nd European Association of Remote Sensing Laboratories (EARSel) Symposium "Advances in Geosciences", May 21-24, Myconos, Greece.

ESTIMATING BLOCK VOLUMETRIC PROPORTION OF BIM ROCK IN MOGLICE HPP TUNNEL ALIGNMENT

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ABSTRACT

For Moglica-Grabova tunnel, which is part of Devoll Hydropower Project in Albania, two techniques of tunneling are planned: TBM for the Flysch series starting in Moglicë and Drill & Blast for the Ophiolite section, starting in Grabova. Between Grabova and Moglica there is a section of the tunnel which will pass through a heterogeneous rock mass composed of blocks of different lithology and a fine matrix. For the characterization of this section of the tunnel and for the selection of the appropriate method, the block volumetric proportions need to be assessed. The purpose of this paper is to present three methods used for estimation block volumetric proportions in this area the results obtained and their interpretation.

Key words: BiM Rock, Volumetric Proportion, Linear Proportion, Scan Line.

1. INTRODUCTION

1.1 DESCROPTION OF THE PROJECT AND ENCOUNTERED PROBLEMS

The Moglica Hydroelectric Project is part of a Hydropower cascade planed on Devoll River which will utilize a head of 300m along an about 22 km long stretch of the River between 650 m a.s.l. and 350 m a.s.l.. The intake is situated upstream the 140 m high rock fill dam planned at Moglica. The powerhouse is located in an underground cavern on the east bank of Devoll River and has two Francis units with total capacity of 165 MW. Transmission voltage is 220 kV and estimated average annual energy production is 452 GWh. The tailrace outlet is at the upper end of the reservoir created by a 50 m high dam planned at Kokël. Approximately 11.7

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km of tunnels with a diameter of 5.4m will be excavated in different rock masses and approximately 700m of which will pass throw BiM rocks and mélanges. Block-in-matrix rocks (BiM rocks) are mixtures of hard blocks embedded in weaker and finer matrix that are very difficult to characterize. Estimating Block Volumetric Proportions in these rock types is one of the most important properties for their characterization and the evaluation of the behavior of the overall rock mass.

2. VOLUMETRIC BLOCK PROPORTION AND SELF SIMILARITY

The proportion between block and matrix is a very important index for the characterization of heterogeneous rock masses because based on the value it is possible to judge on the mechanical behavior of the overall massive. (Uanderwood, 1970) For more information this properties can be correlated with other parameters such as uniaxial compressive strength and block size distribution. A relatively small block and matrix proportion indicates that very large blocks are isolated within the rock mass which is mostly composed of matrix and a large number of very small blocks. The overall rock mass in this case will behave like the matrix. An average value of the proportion, practically less than 43 % indicates that the blocks of massive tend to be supported by the matrix and have no contact with each other. In cases where this proportion is higher than 50 % but less than 67 %, blocks tend to contact each other. In cases where the proportion is greater than 75% the overall behavior of the rock mass will be similar to the one of the blocks. Anyhow the boundary percentage where blocks are considered to 'contact' each other depends on the shape and the size distribution of the blocks (Laznicka, 1988).

Most of the times Mélanges and Block in Matrix rocks are considered heterogeneous, but several scientific works have shown and proved that many chaotic geological processes have self-similarity in different scales (Lindquist, 1991). These discoveries have a great practical impact because by having comprehensive data in a smaller scale it is possible to predict an overall rock mass behavior (Medley, Goodman 1994). These discoveries have crucial practical applications.

Three set of data have been used in this paper for the evaluation of the true volumetric proportion of the blocks which include surface scan lines, linear drill core from the boreholes and surface mapping.

2.1 Linear Block Proportions from Core Drillings

Both measurements from geological drilling as well as from scanning lines on the map are intended for the calculation of the linear block proportion. Linear portions of blocks for each line or geological drilling are calculated as the total length of scan lines intersected blocks divided by the total geological drilling length or model scan line.
Linear block proportions are calculated for the drillings located in the area of the block in matrix massive as well as modeled scan lines on the superficial map. The requirement for the data to be considered sufficient is that the scan line length should be at least 10 times the maximum diameter of the encountered block.
The volumetric portions calculating procedure initially is carried out in the cores of Shemsit geological drilling, which is considered the most representative drilling in the area because it is located in the center of the block and matrix massive. The total drilling length is 93m and the maximum size of the encountered block in this drilling is about 3 meters.

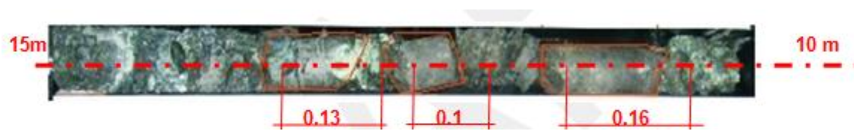

Figure 1.Shemsit Drilling Block length measurement for linear proportion calculation (Devoll HPP, 2011)

The scan line crosses through the axis of the drilling and the lengths of line interrupting each individual block are measured as shown in Figure.1. In this geological drilling the calculated linear portion of blocks is about 36%, a value which makes the block proportion geotechnically important for the overall massive see Table 1.

Table 1. Summarized data for calculating linear proportions from Shemsit drilling (Rusi M., 2016)

Drill Hole	Shemsit
Total Drilling length (m)	93
Total number of measured blocks	114
Total length of blocks (m)	33.518
Maximum block size (m)	2.977
Minimum block size (m)	0.06
Mean block size (m)	0.29
Linear Block Proportion (%)	36

2.2 Linear Block Proportions from Scanlines

The procedure of calculating the volumetric portions from scan lines is performed on the superficial map with the identified blocks from the field inventory. Measurements were conducted on 5 scan lines which include a total length of 4000m as shown in Figure 2. Scan lines are selected parallel to each other with a distance of almost 300-400meters. The largest identified Block on site has a maximum dimension of about 450 m.

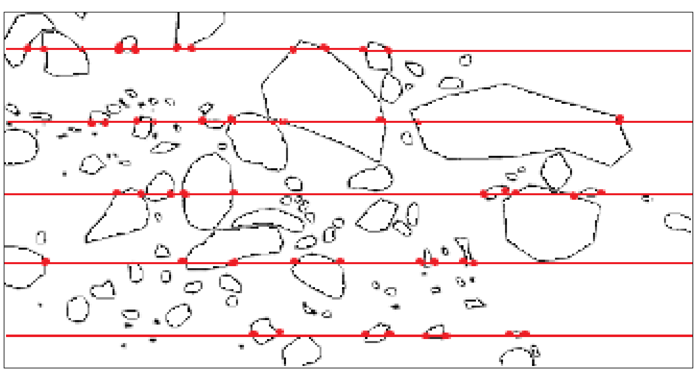

Figure 2. Scan lines in the surface map for calculating linear block proportion (Rusi M., 2016)

In order to satisfy the requirement that the scan lines should include a length of minimum 10 times the maximum diameter of the block, we selected 5 scan lines each with a fixed length of 800m. From calculations carried out on the intersection lengths of blocks with the total length of each line we have obtained linear portions of the blocks ranging from 14% to 26% as shown in Table 2. The estimated average proportion from 4000 meters of scan lines resulted about 20%.

Table 2. Summarized data for calculating linear proportions from Surface Scan lines (Rusi M, 2016)

Scan Line nr	Scan Line length (m)	Nr of Blocks	Maximum size (m)	Minimum size (m)	Measn size (m)	Total length of intersections (m)	Linear Proportions (%)
Line 1	800	21	20.8	1.1	5.2	108.1	14
Line 2	800	18	35	2.2	11.4	204.5	25.6
Line 3	800	12	35.1	4.6	12.9	155.3	19.4
Line 4	800	4	52.1	8.6	34.1	136.5	17
Line 5	800	3	149	2.6	55.5	166.5	21

This value is smaller than the value obtained from the linear proportions calculated from geological drilling but this small change can be explained by the difficulty of identification in the field some block due to the difficult topography and dense vegetation.

2.3 Surface Block Proportion From Superficial Mapping

Surface proportions can be calculated if the image or superficial map has a sufficient number and total length of scan lines. There are some suggestions as for the necessary lengths of scan lines to compute surface proportions of blocks. The more appropriate suggestion is that which recommends that the total length of scan lines used for calculations should be about 100 times larger than the average size of the blocks in the scanned area.
A more practical way is to calculate the surface of all the recorded blocks and to divide the sum value by the total surface of the heterogeneous rock mass. After performing the necessary calculations it is noted that the values for the surface proportions of the blocks are at the minimal range of values obtained from linear proportions of scan lines.
The surface of 101identified blocks is measured in AutoCAD, together with the total surface and the surface proportion of the blocks was calculated approximately 14%, results are summarized in Table 3.

Table 3. Summarized data for calculating surface proportions from surface measurements (Rusi, 2016)

Total surface (m²)	Number of Blocks	Maximum Surface (m²)	Minimum Surface (m²)	Mean Surface (m²)	Total surface of Blocks (m²)	Surface Proportions (%)
1006921	101	98402	2	1396.2574	141022	14

3. BLOCK VOLUMETRIC PROPORTION

As mentioned above the volumetric proportions of blocks in chaotic blocks must necessarily be defined because it helps in predicting the geo mechanical behavior of the mass. Volumetric proportions are defined by the principle self-similarity with the surface and linear proportions calculated above from geological drilling and scan lines on the surface.

Given that the blocks in this rock mass don't have a uniform shape and distribution, the linear and surface proportions do not fully comply with the volumetric proportions, but there will be a value of ambiguity and error. Especially for the surface data where the technical conditions affect the collection of information. This error depends on the total linear measurement length and the linear proportion of the block itself.

The real volumetric proportion of blocks is within the range defined by the limits of ratios adjusted to the maximum and minimum volumetric blocks.

These volumetric proportions adjustment should be seen in two aspects. The first aspect is the connection of this parameter with the strength of the overall rock mass and in this aspect is discrete and conservative to apply a reducing safety factor that modifies and adjusts the volumetric proportion calculation (Medley, 1997). On the other hand, in terms of results to economic consequences of underestimating the volumetric proportions especially in the field of tunneling, it is discrete and conservative to use a magnifying factor in the calculated value.

Practically to obtain the volumetric proportions of blocks from the above calculated linear proportions, initially some adjustments should be made in the value of proportion through a linear graph. Firstly the N value should be calculated (N d max). As explained above d max is the maximum size of the block which is identified 3mfor the geological drilling and149m for scan lines. The maximum length for Shemsit drilling is 93m, while for the scan lines are4000m. To calculate the N value we divided the value of total length with the total length of the intersected blocks. For Shemsit drilling we obtained an N value of 31 see Table 4 while for the scan lines we obtained an N value of 26.

Table 4. Summarized data for calculating N value (Rusi M., 2016)

Linear Proportions (%)	Total Length (m)	Maximum Block (m)	N-value	Linear Proportion of Blocks
Drillings	93	3	31	36
Scan lines	4000	149	26	20

In order to obtain the real range of values for the volumetric proportions it is necessary to multiply the value of the calculated linear proportions by the factor of uncertainty corresponding to the N value taken from the chart in fig 3 and the product is subtracted from the original value of linear proportions for the lower limit while the product is added to the initial value of the linear proportions to determine the upper limit (De Hoff, 1986).

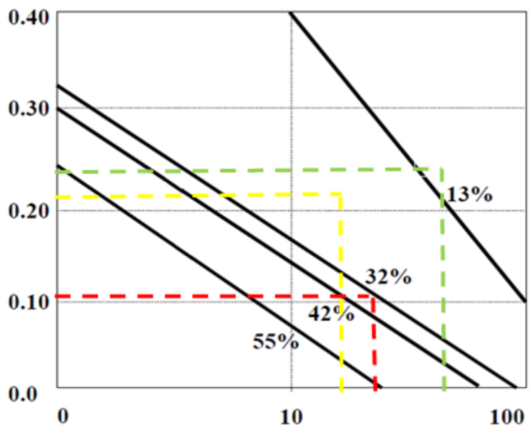

Figure 3. Uncertainty factor calculation from linear measurements and N value (Medley, 2002)

The red line in fig 3 shows the use of the chart for the uncertainty factor values obtained from geological drilling of Shemsit while the yellow line shows the values obtained by the scan lines on the surface map, the green line correspond to the surface proportion data. The obtained values of the safety factor are used to calculate the ranges of volumetric proportion summarized in the table below. True volumetric proportions will include an intermediate value of these limits defined and summarized in Table 5.

Table 5. Summarized results and the upper and lower limits of block volumetric proportions (Rusi M, 2016)

Linear Proportions (%)	N-value	Proportion of Blocks	Uncertainity Factor	Linear Proportion x Uncertainity Factor	Upper Limit of Volumetric Proportion	Lower Limit of Volumetric Proportion
Drillings	31	36	0.11	3.96	39.9	32.04
Scan lines	26	20	0.22	4.4	24.4	15.6
Surface	70	14	0.24	3.36	17.36	10.64

4. CONCLUSIONS

The block volumetric proportions of the Block and Matrix rock mass in Shemsit area have been defined on the basis of three direct calculations, surface scanning lines, geological drillings and surface mapping. Through these techniques it has been possible to measure the maximum observed size of blocks and the total length of scan line/ drill core or total surface area of mapping and thus linear and surface proportions are calculated for each case. Based on the principles of stereology for self-similarity volumetric proportions have been calculated and corrections were performed in order to get real results. The volumetric proportion of the studied area ranged from 11 % to 40 %, which means that the block volumetric proportion ratio has a geotechnical importance and massive does not behave like the matrix neither like the blocks. Previous studies have proved that a volumetric proportion of less than 25% will result in an overall rock mass behavior similar to that of the matrix, while a proportion of more than 75% will result in a behavior similar to that of the blocks. In this case the rock mass behavior is very complex and should be considered in accordance with other criteria such as 3D block size distribution, mechanical contrast between rock and matrix etc.

REFERENCES

1. DeHoff, R.T.. Problem Solving Using Quantitative Stereology. Ch7. Applied Metallography. 1986
2. 06_EST - 000 839 Site investigations and factual report Annexes - Annex D core photos, Devoll Hydropower 2011.
3. Lindquist; E., Fractals –Fractures and Franciscan. Term Paper for Rock Mechanics. Berkley; California; 1991
4. Laznicka, P., Breccias and Coarse Fragmentites: Petrology, Environments, Associations, Ores, 25 of Developments in Economic Geology: New York, 1988
5. Medley, E.; Goodman, R. Estimating the block volumetric proportions of melanges and smilar block in matrix rocks (bim rocks). Rock mechanics, Nelson &Luabach Balkema, Rotterdam. (eds)1994
6. Medley, E.W.: Uncertainty in estimates of block volumetric proportion in mélange bim rocks: Proceedings of the International Symposium of International Association of Engineering Geologists, Athens, Greece, A.A. Balkema (Rotterdam, Amsterdam), p. 267-272; 1997
7. Medley, E. W. melange and fault rocks exposed in and around abandoned quarry at the schmidt lane recycling center, El Cerrito, California. Field trip guidebook. 2002.
8. Uanderwood, E.E., Quantitative Stereology. 1970.

FIRST CONTINGENT VALUATION OF LAKE OHRID BIODIVERSITY

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SUMMARY

This study is first of its kind for the region in question. It focuses on contingent valuation method evaluation of the biodiversity of Lake Ohrid. The most spectacular quality of this ecosystem is the high biodiversity and extremely high degree of endemism, with an adjusted rate for endemism of 36%. A questionnaire with total of 18 questions, divided into five sections has been distributed in the largest towns in the area, i.e. Pogradec and Ohrid in order to elicit the willingness to pay (WTP) for the protection of the biodiversity of the residents in these areas. The research has been conducted in February 2016 and comprised people with different educational levels, professions and annual incomes. The findings of the valuation indicate that the majority of the residents are willing to pay for protection of the biodiversity. It has been discovered that WTP is positively correlated to the educational level and annual income level of the respondents, but there are no correlations to the gender and mode of payment. Likewise, the mean WTP in Albania has been estimated at 19,87 EUR per year, per household, while in Macedonia it has been 29,31 EUR. The total economic value (TEV) of the biodiversity has been determined for the entire region, i.e. for the population living near Lake Ohrid in both Albania and Macedonia and it has been estimated at 890.010,46 EUR per anum.

Key words: ecosystem services, contingent valuation, total economic value, willingness to pay, biodiversity, Lake Ohrid

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1. INTRODUCTION

It was in 1992, in Brazil when the Convention of Biological Diversity of the United Nations has been established. The main rational behind the establishment of this convention has been promotion of the conservation and protection of biodiversity, the sustainable use of the biodiversity components and equal distribution of the benefits generated by the application of genetic resources. Both Albania and Macedonia have been signing parties of this Convention, and by signing the treaty the two countries agreed to establish national biodiversity strategies and action plans for reducing the losses in biological diversity. Macedonia`s assembly ratified the Convention in 1997 while Albania`s in 1996. Following the ratification of the Convention both countries developed their own National Biodiversity Strategies in which the commitment to biodiversity had been reflected. In addition, Macedonia and Albania as candidate countries for EU Membership abide by the European Communities Biodiversity Strategy and Action Plans that are in relation to the Convention.

Despite their small sizes both countries are known for their vast biodiversity, in aquatic and land ecosystems. Especially interesting and valuable is the transboundary Lake Ohrid, which is shared between the two countries and it is known as an ecosystem with extremely high degree of endemism and high biodiversity. Moreover, the lake as an ecosystem generates different ecosystem services which are beneficial for the populations on both sides of the border.

The ecosystem services (ESs) is a field that is developing and becoming rather useful and interesting providing a linkage between the ecology and economy. In other words, lately the ESs is increasingly used and applied in order to facilitate policy and decision-making regarding ecosystem functionality, protection and utilization of different benefits which are provided by an ecosystem. However, the ecosystem functionality recently have been negatively affected by an increased anthropogenic influence and diverse damages and natural disasters which in turn affect the respective ecosystems and yield ecological and economical distresses. These past experiences paved the way for people`s active participation in conservation and protection of ecosystems, since they are becoming more aware of the importance of the environment and biodiversity. That is why there are a lot of people who are willing to pay in order to protect the biodiversity loss, thus ensuring brighter environmental future for the next generations.

The paper focuses on the economical valuation of the biodiversity (and its protection) for the people living in the major towns on Lake Ohrid, i.e. Ohrid in Macedonia and Pogradec in Albania. In other words, the investigations undertaken during February 2016 comprised a contingent valuation of the biodiversity of Lake Ohrid and they reflect the willingness to pay by the people in this region for protection of further biodiversity loss. As mentioned above, this research has been the first of its kind undertaken in this area (Zdraveski et.al., 2015).

2. LAKE OHRID`S BIODIVERSITY AS AN ECOSYSTEM SERVICE

Lake Ohrid is situated in the mountainous region between Macedonia and Albania. It is one of the Europe`s deepest and oldest lakes (Wagner et al., 2014). The lake is one of the three natural lakes in Macedonia and it is used by the citizens of both countries for recreation, flood and pollution control services and food source (Zdraveski et al., 2015). The importance of the lake has been also emphasized when it was declared a World Heritage Site by UNESCO in 1979. In 2014, the Ohrid-Prespa Transboundary Reserve between Albania and Macedonia was added to the UNESCO`s Network of World Biosphere Reserves. The largest towns on the coast of the lake are Pogradec in Albania and Ohrid and Struga in Macedonia. Likewise, the lake is also surrounded by smaller settlements in both countries.
Besides these specialties of Lake Ohrid, the most spectacular quality of this ecosystem is the high biodiversity and extremely high degree of endemism (Hoffmann et.al., 2010; Budzakoska-Gjoreska, Trajanovski and Trajanovska, 2014; Albrecht and Wilke, 2008; Kostoski et al., 2010; Trajanovski et al., 2015; Loshkoska, 2015). Moreover, the biodiversity and endemism have been both greatly studied during the past decades. Nevertheless, despite the fact that some biotic groups have been understudied or not analyzed at all, yet it is recognized that approximately 1.200 native species are known from the lake, including 586 animals and at least 212 endemic species, 182 of which are animals (Trajanovski et al., 2015). According to the same author, the adjusted rate of endemism is estimated at 36% for all taxa and at 34% for animals. Moreover, by taking into consideration the size (358 km^2) and the number of endemic species, Lake Ohrid is presumably the most diverse lake worldwide. Similar to other ancient lakes, such as Baikal and Tanganyika, Lake Ohrid hosts diverse endemic species from the entire food chain, including phytoplankton and algae, plants, zooplankton, cyprinid and predatory fish, as well as an extremely endemic macrozoobenthos (Hoffmann et.al., 2010; Budzakoska-Gjoreska et al., 2014; Albrecht and Wilke, 2008; Kostoski et al., 2010; Trajanovski et al., 2015; Trajanovska et al., 2014). According to Föller et al. (2015), ancient lakes are essential ecosystems for endemic freshwater species and this high endemic

biodiversity has been proven to be mainly as a result of intra-lacustrine diversification. Furthermore, according to Albrecht and Wilke (2008) there has been listed 72 gastropod species, 56 of which (78%) are endemic to the lake. Strong et al. (2008) noted 72 gastropod species, 55 of which are endemic while Budzakoska-Gjoreska (2012) registered 50 gastropod species, 8 of which were cosmopolitan and 42 endemic for the Macedonian part of Lake Ohrid and its watershed.

Despite the exceptionally high level of endemism in Lake Ohrid (1/3 of 21 native fish species and almost 80% of its 72 mollusc), there are non-endemic species found in Lake Ohrid, too. The lakeshore reed beds and wetlands provide an excellent habitat for numerous wintering water birds, such as the Dalmatian pelican, ferruginous duck, swan, spotted eagle and eastern imperial eagle (Velevski et al., 2010).

Although it is not immune to anthropogenic influence, Lake Ohrid is still considered as an oligotrophic lake, with high dissolved oxygen levels in its deep waters (Matzinger et.al., 2007). The eutrophication process of this lake is driven by the four biggest threats, i.e. fishing, housing, impact of tourism, invasive and non-native species (Trajanovski et al., 2015).

Although there has been a moratorium enacted for fishing for almost two decades, this has been done only on the Macedonian side of the lake and not in Albania. Today, fishing is legally allowed, but monitoring and control measures are required in order to forecast its sustainability. The increased construction along the shoreline has a negative impact on the disturbances of the littoral habitats. The summer touristic activities that are practiced along the shoreline also negatively affect the shallow part of the lake. Next, the organic pollution that occurs as a result of increased touristic activities is endangering the endemic flora and fauna of the lake. The introduction of non-native and often invasive species, such as the rainbow trout or silver carp has numerous negative and even dangerous impacts on the biodiversity of the lake (Iucnredlist.org, 2016; Trajanovski et al., 2015).

Besides these existing threats on the biodiversity of the lake, there are also some potential threats. Occasional forest fires are altering the forested habitats and thus affect the lake, too. Also, the disturbance of the aquatic fauna and pollution associated with the motorboats are decreasing the habitat and water quality. The planned building of a road along the mountain Galichica will cut off the mountain and the lake. Also, the wetland Studenchishta is about to be urbanized, which will have a tremendous negative effect on the lake`s quality due to the loosing of its natural filter while the negative effect of the road rehabilitation in Albania is already felt by the lake, which has been affected by the building of huge concrete walls inside that are used to support the built roads. Finally the collector systems are not always operating effectively and surplus of sewage water is purred into the lake (Iucnredlist.org, 2016).

3. SURVEY LAYOUT AND METHODOLOGY

In order to research how much are people willing to pay for protection of the biodiversity of Lake Ohrid, a questionnaire has been developed and tested. It has been decided that in order to establish as accurate values as possible, the survey should be conducted in person, i.e. people were approached and asked to fill-in the questionnaire by an enumerator. The survey comprised total of 18 questions classified into five sections. The first section of the questionnaire provided respondents with some background information on biodiversity, its importance and the places where it can be found in the area which has been subject of interest. The second section provided information about the importance of the biodiversity for different aspects of the everyday lives and the ways in which an individual can contribute for the protection of the environment, thus decreasing the biodiversity loss as well. The third section asked the respondents about their familiarity to biodiversity and some specific endemic species which are known to live in the Lake Ohrid, while the fourth section tried to draw values through willingness-to-pay (WTP) questions. The last portion of the survey asked respondents questions about their socio-economic status such as gender, age, educational level and annual income.

Although there are numerous techniques that can be applied in the valuation of an asset (Zdraveski, 2015), the non-market values are rather specific in terms of valuation. The biodiversity as an ES has a large non-use or non-market component and in the total economic value of the conservation and protection of the biodiversity, the contingent valuation method (CVM) is one of the more attainable and acceptable methods (Carson, 2000; Carson et al., 1998; Pearce and Turner, 1990). During the application of this method, survey questions are used in order to determine an individual`s willingness to pay for a certain change in the supply of an environmental service. In this case, the changes of the biodiversity`s levels of Lake Ohrid were subject of interest of the valuation.

Since every person has their own willingness to pay values for different goods and services, the best way to determine these values is by direct questioning of the respective individuals. For public goods valuation this process is usually conducted in a form of a referendum CVM survey (Hanemann, 1994; Arrow et al., 1993; Carson et al., 2000; and Champ et al., 2003), hence the questioning for this work has been conducted in that manner, too.

The questionnaire used in the process of determination of the WTP of the inhabitants of the Lake Ohrid region were self-explanatory and educational and the questions defined the current condition regarding the biodiversity, its importance, ways in which it can be protected on a global and local (personal) level and so on. The WTP questions were posted as follows:

- *Financially speaking, would you consider paying a fee for prevention of the biodiversity in the Ohrid area?*
- *What kind of payment would you prefer if you answered "yes" to the previous question?*
- *If you answered "yes" to question No. 12, which amount are you willing to pay for prevention of the Ohrid area biodiversity per year?*

In the end of the first question regarding the willingness to pay, the respondents were given the two possible answers, i.e. Yes and No. If the respondent answered with yes, than the following questions were to be answered and if the answer was negative, the following questions were not replayed. The next question was related to the kind of payment that would be preferred by the individual, providing him/her with three options: additional fee on the utilities bills, public tax collected by the national tax office, and public tax collected by the local (municipal) tax office. Finally, the respondent was asked how much is he/she willing to pay for the protection of the biodiversity in the Lake Ohrid area. The possible replays included three options classified into brackets: less than 50 EUR per year, between 50 and 100 EUR per year and more than 100 EUR per year. In all three cases, the respondent was asked to specify his unique amount within the bracket. In fact, the idea of these questions was to establish an open-ended mechanism for WTP surveying. However, according to Bateman et al. (1995) the open-ended elicitation mechanism is problematic and usually gives more conservative WTP amounts than other formats. That is why, there has been used a modified open-ended elicitation mechanism, which means that respondents were given the chance to choose a constrain first and then specify the exact amount that they are willing to pay, thus eliminating the anchoring bias and simultaneously give rather informative replays for the maximum WTP of each individual (Kealy and Turner, 1993; Balisteri et al., 2001; Halvorsen and Sœlensminde, 1998).
Since this is first valuation of the biodiversity in this region, there is no chance to compare our findings with past statistics. However, the study provides the pioneer and first CVM valuation of the biodiversity in this region of the world and encourages further research in the field.
In order to get an adequate number of respondents the survey has been completed in Ohrid and Pogradec. In both towns the survey has been conducted in different sites, such as public administration offices, bars,

supermarkets, banks, private organizations and alike. The selection of survey sites ensured that different profiles of people will participate, i.e. individuals with different educational and income levels.
The survey has been completed during February 2016. No incentives were given to the respondents. In total, 500 people were asked to participate in the survey with 400 people agreeing to take participation and fill a questionnaire, thus yielding a response rate of 75%. From the 400 questionnaires, 350 were usable. Furthermore, protest zeros were also eliminated, therefore leaving 300.

4. RESULTS

Out of the 300 usable surveys, 150 were from Albania and 150 from Macedonia. From the total number of respondents 42,33% or 127 were male and 57,67% or 173 were female. In Albania 77 (51,33%) and 73 (48,67%) of the respondents were male and female, respectively, while in Macedonia there were surveyed 50 (33,33%) males and 100 (66,67%) female respondents.
The majority of the respondents were in the second age group, i.e. 26-35 years old - 99 people. The rest were as follows: 52 respondents were 16-25 years old, 69 respondents were 36-45 years old, 50 - 46-55 years old and 30 were older than 56.
In Macedonia, out of the surveyed respondents, the majority were with a high-school diploma as their highest education, i.e. 70 or 46,67%. Furthermore, 67 (44,67%) of the Macedonian respondents were with bachelor degree, 9 (6%) with master degree, 3 (2%) with PhD degree and 1 (0.67%) with elementary school diploma as their highest education degree. In Albania, the majority of the respondents or 89 people (59,33%) were with bachelor as their highest education, 1 (0,67%) were with elementary school and 54 (36%) were with a high-school diploma as their highest education degree. For six respondents in Albania there was no information given for their educational level. The combined results show that the majority of the respondents in this survey in both countries were with bachelor degree as their highest education degree, i.e. 52% or 152 people.
The results obtained through the WTP questions showed that people in the region are generally willing to pay for protection of the biodiversity of the area. The modes of such payments differ and include payment of additional fee on the utilities` bills, payment of tax to the public tax office (nationally) and payment of tax to the public tax office locally (to the municipal branch of the tax office). In fact, out of the 300 respondents, 202 (67,33%) answered positively to the question of whether they are willing to pay for the

protection of the biodiversity in the area and the rest of 98 (32,67%) answered negatively.

The mean amount of payment per year for the protection of the biodiversity has been estimated at 24,59 EUR per household. By splitting the surveys by country, it can be seen that Macedonians are willing to pay more for the protection of the biodiversity, i.e. 29,31 EUR per year, per household while the Albanians are willing to pay 19,87 EUR per year, per household for the same cause.

Table 1. Willingness to pay for biodiversity protection vs. country

	Macedonia	Albania
Mean	29.30753333	19.86521739
Standard Deviation	45.87028475	20.79300793

The mode of payment is also a parameter which has been analyzed during the study. As it has been mentioned above, there were three modes of payment provided for the respondents, i.e. a) additional monthly fee to the utility`s bill; b) annual tax collected by the national public tax office; c) annual local tax collected by the local tax office. The table bellow depicts the obtained results for the three options for all respondents to the survey on contingent valuation of the biodiversity in the Ohrid area.

Table 2. Willingness to pay for biodiversity protection vs. payment mode

	Option A	Option B	Option C
Mean	40.1612001	42.06235254	32.21738673
Standard Deviation	36.12880285	54.74094002	31.49610484

The amount that an individual would pay for the protection of the biodiversity may be linked to the highest educational degree of the person in question. The following table represents the mean WTP of individuals classified according to their education. As it can be seen from the table, these two parameters are positively correlated, which means that with the increase of educational level the WTP also increases and vice versa. Therefore, the respondents with lowest education have a WTP of 18,12 EUR while the ones with PhD degrees have a WTP estimated at 33,33 EUR.

Table 3. Willingness to pay for biodiversity protection vs. educational level

	Elementary	High school	Bachelor	Masters	PhD
Mean	18.11594203	15.1441094	31.48643348	33.88888889	33.33333333
Standard Deviation	25.61981091	19.59675313	43.76041381	47.02245327	15.27525232

The respondents in the survey provided information about their annual income levels. There were three groups developed for this indicator, where Annual Income 1 comprise people with low income, Annual Income 2 - average income and Annual Income 3 group - high income. The table below represents the WTP of people with different annual incomes. As it can be seen the annual income is positively correlated to the willingness to pay for protection of the biodiversity.

Table 4. Willingness to pay for biodiversity protection vs. annual income

	Annual Income 1	Annual Income 2	Annual Income 3
Mean	14.16687371	18.71287006	48.81119663
Standard Deviation	17.05735831	25.33094997	54.7765079

Finally, the WTP may differ depending on the gender of the respondent. The obtained results indicate that the male population is willing to pay slightly more than the female population for the protection of the biodiversity in the region.

Table 5. Willingness to pay for biodiversity protection vs. gender

	Male	Female
Mean	26.84138486	22.95343745
Standard Deviation	39.05280929	33.3894753

Given the mean willingness to pay for both countries, there can be calculated the total value of the biodiversity as an ecosystem services for the two countries and in general for the people who live in the area of interest. According to the Statistical Office of Albania, in the town of Pogradec there are total of 8.869 housing units (Instat.gov.al, 2016) and according to the State Statistical Office of Macedonia there are total of 27.325 housing units in Ohrid (Stat.gov.mk, 2016). Having in mind that the survey asked respondents how much are they willing to pay per year, per household for the protection of the biodiversity in Lake Ohrid area, than by multiplication of the total number of housing units and the obtained WTP, one may derive the total value of the protection of the biodiversity as an ecosystem service generated by the lake. The next table shows the values for Macedonia, Albania, as well as for the entire population living in the area.

Table 6. Willingness to pay, housing units and total economic value in Macedonia and Albania

	Housing Units	WTP	Total Value
Macedonia	27325	29.31	800,895.75 €
Albania	8869	19.87	176,227.03 €
Macedonia and Albania	36194	24.59	890,010.46 €

As it can be seen from the table above, the total economic value of the biodiversity for Macedonia, i.e. the municipality of Ohrid has been estimated at 800.895,75 EUR per year, while for Albania, i.e. the town of Pogradec at 176.227,03 EUR per year. The total economic value of the biodiversity for the population living near the Lake Ohrid in both Albania and Macedonia has been estimated at 890.010,46 EUR per year.

5. CONCLUSIONS

Lake Ohrid and its surrounding is famous for its natural beauty, the high biodiversity and endemism worldwide. However, due to an increased anthropogenic impact on the lake and its watershed, the eutrophication of the lake is increasing while simultaneously the pollution of its surroundings is raising as well. This is the first alarm that should be noted by decision-makers, encouraging them to take actions in order to protect the environment, to protect the biodiversity and to ensure lasting quality of this amazing place on Earth. All of this can be attained in cooperation with the people who live in this area.

The goal of this study has been to estimate the total economic value of the biodiversity as an ecosystem service for the population that lives near the lake in both countries. During the determination of the total economic value of the biodiversity a contingent valuation method has been undertaken during February 2016, whereby 300 participants were directly asked about their willingness to pay for the protection of the biodiversity. Surprisingly it has been discovered that the majority of the respondents were willing to pay for this cause, i.e. 202 out of the 300 respondents. Overall, the mean willingness to pay has been estimated at 24,59 EUR per year, per household for both Macedonians and Albanians. However, it has been found out that the willingness to pay for protection of the biodiversity is higher in Macedonia, where it has been estimated at 29,31 EUR while in Albania it has been 19,87 EUR. This may be due to the fact that Lake Ohrid is the largest and most famous tourist place in Macedonia, while in Albania there are other places which generate ecosystem services that might be considered as more valuable by the population.

The gender and mode of payment did not affect the willingness to pay significantly, but the educational level and income level played a significant role in the determination of the WTP. In fact, the educational level, income level and WTP have been in positive correlation.

Having in mind the high interest for paying for protection of the biodiversity in the region, it can be concluded that an introduction of local annual tax that will be collected by the local (municipal) tax office may be implemented by the authorities, hence generating funds for the protection of the biodiversity loss in the region.

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7. REFERENCES

Albrecht, C. & Wilke, T. (2008). Ancient Lake Ohrid:biodiversity and evolution. Hydrobiologia, 615:103-140.

Arrow, K., R. Solow, P. Portney, E. Leamer, R. Radner, and H. Schuman., (1993). Report of the NOAA Panel on Contingent Valuation. Federal Register 58. pp. 4601-4614.

Balistreri, E., McClelland, G., Poe, G., Schulze, W., 2001. Can Hypothetical Questions Reveal True Values? A Laboratory Comparison of Dichotomous Choice and Open-Ended Contingent Values with Auction Values. Environmental and Resource Economics, 18: 275–292.

Bateman, I.J., Langford, I.J., Turner, R.K., Willis, K.F. and Garrod, G.D., (1995). Elicitation and Truncation Effects in Contingent Valuation Studies, Ecological Economics, 12:161-79.

Budzakoskaa-Gjoreska, B., (2012). Gastropoda from Lake Ohrid and its watershed as a aobject of developing GIS monitoring according to EU Water Framework Directive. Doctoral dissertation. Sts.Cyril and Methodius University, Faculty of Natural Sciences and Mathematics. Institute of biology, Skopje, Macedonia.

Budzakoska-Gjoreska, B., Trajanovski, S. and Trajanovska, S. (2014). Comparative biocenological analysis of Gastropoda on the Macedonian part of Lake Ohrid and its watershed. Biologia, 69(8).

Carson, R. T., Flores, N.E., Hanemann, W.M., (1998). Sequencing and valuing public goods. Journal of Environmental Economics and Management, 36: 314-323.

Carson, Richard. (2000). Contingent Valuation: A User's Guide. Environmental Science and Technology. 34(8): 1413-1418.

Champ, P.A., K.J. Boyle, and T.C. Brown, editors. (2003). A Primer on Non-market Valuation. Kluwer Academic Publishers, The Netherlands. 576 pps.

Föller, K., Stelbrink, B., Hauffe, T., Albrecht, C. & Wilke, T. (2015). Constant diversification rates of endemic gastropods in ancient Lake Ohrid: ecosystem resilience likely buffers environmental fluctuations. Biogeosciences Discuss., 12, 14271-14302.

Halvorsen, B. and Sœlensminde K., (1998). Differences between WTP estimates from Open-ended and Discrete Choice CV methods: The Effects of Heteroskedasticity. Land Economics, 74(2): 262-82.

Hanemann, W.M. (1994). Valuing the Environment through Contingent Valuation. The Journal of Economic Perspectives. 8(4):19-43.

Hoffmann, N., Reicherter, K., Fernández-Steeger, T. and Grützner, C. (2010). Evolution of ancient Lake Ohrid: a tectonic perspective. Biogeosciences, 7(10), pp.3377-3386.

Instat.gov.al. (2016). Kreu - INSTAT. [online] Available at: http://www.instat.gov.al/al/home.aspx [Accessed 27 Apr. 2016].

Iucnredlist.org. (2016). Gocea ohridana. [online] Available at: http://www.iucnredlist.org/details/155653/0 [Accessed 27 Apr. 2016].

Kealy, M. J., Turner, R. W., (1993). A Test of the Equality of Closed-Ended and Open-Ended Contingent Valuations. American Journal of Agricultural Economics, 75 (2): 321-331.

Kostoski, G., Albrecht, C., Trajanovski, S. and Wilke, T. (2010). A freshwater biodiversity hotspot under pressure – assessing threats and identifying conservation needs for ancient Lake Ohrid. Biogeosciences, 7(12), pp.3999-4015.

Loshkoska, T. (2015). Benthic diatoms as a tool for assessment of the trophic status of Lake Ohrid and its watershed. *MSc* Thesis. PSI Hydrobiological Institute - Ohrid, University "St. Kliment Ohridski", Bitola, 131 p.

Matzinger, A., Schmid, M., Veljanoska-Sarafiloska, E., Patceva, S., Guseska, D., Wagner, B., Müller, B., Sturm, M. and Wüest, A. (2007). Eutrophication of ancient Lake Ohrid: Global warming amplifies

detrimental effects of increased nutrient inputs. Limnol. Oceangr., 52(1), pp.338-353.
Pearce, D.W., and R.K. Turner. (1990). Economics of Natural Resources and the Environment. Essex: Pearson Education Limited. 378p.
Stat.gov.mk. (2016). State Statistical Office of the Republic of Macedonia. [online] Available at: http://www.stat.gov.mk/Default_en.aspx [Accessed 27 Apr. 2016].
Strong, E. E., Gargominy, O., Ponder. F. W. & Bouchet, P. (2008). Global diversity of gastropods (Gastropoda: Mollusca) in freshwater. Hydrobiologia 595: 149-166.
Trajanovska, S., Talevska, M., Imeri, A. and Schneider, S. (2014). Assessment of littoral eutrophication in Lake Ohrid by submerged macrophytes. Biologia, 69(6).
Trajanovski, S., Budzakoska-Gjoreska, B., Trajanovska, S. and Zdraveski, K. (2015). HABITAT CHANGE-DRIVING FORCE FOR ENDEMIC/COSMOPOLITAN RATIO PERTURBATION IN THE BENTHIC FAUNA OF ANCIENT LAKE OHRID AND ITS WATERSHED. Review, 43(1), pp.113-127.
Velevski, M., Hallmann, B., Grubač, B., Lisičanec, T., Stoynov, E., Lisičanec, E., Avukatov, V., Božič, L. and Stumberger, B. (2010). Important Bird Areas in Macedonia: Sites of Global and European Importance. Acrocephalus, 31(147).
Wagner, B., Wilke, T., Krastel, S., Zanchetta, G., Sulpizio, R., Reicherter, K., Leng, M., Grazhdani, A., Trajanovski, S., Francke, A., Lindhorst, K., Levkov, Z., Cvetkoska, A., Reed, J., Zhang, X., Lacey, J., Wonik, T., Baumgarten, H. and Vogel, H. (2014). The SCOPSCO drilling project recovers more than 1.2 million years of history from Lake Ohrid. Scientific Drilling, 17, pp.19-29.
Zdraveski, K. (2015). Relative Valuation of Companies: Analysis of the Beverage Industry in Macedonia. MSc. European University - Republic of Macedonia.
Zdraveski, K., Trajanovski, S., Budzakoska-Gjoreska, B. and Trajanovska, S. (2015). THE NATURE OF ECOSYSTEM SERVICES VALUATION: LAKE OHRID - THEORY VS. REALITY. Review, 43(1), pp.147-157.

IS THE MERGER AND ACQUISITION THE APPLICABLE ENTRY-MODEL IN THE CASE OF MACEDONIA?

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SUMMARY

Merger and acquisition is a well-known entry market model, which enables companies to strengthen its position. This paper aims to research the applicability of this model within the context of Macedonia. The paper theoretically reviews the concept of M&A, as well as illustrates concrete cases when companies enter and/or strengthen its position in the Macedonia's market. The paper concludes that M&A is used in several cases mainly from big companies and not for small ones.

Key words: Merger, acquisition, company, strategy.

INTRODUCTION

Most of the global companies start as national companies and expand through internationalizing their operations. They may have many motives of doing so. It can depend on advantages they hope to gain and requirements of their particular industry. The decision to locate in a particular country is guided by the existence of local and regional markets. This can result in that global companies acquire local companies to speed up the process of entering new markets (Morrisson J, 2002). Organizations spend millions on their identities (*Melewar & Saunders, 2000*). They build showrooms, produce packaging, design products, launch advertising campaigns, buy vehicles, train staff, and even replace doorknobs. If these activities are effectively coordinated, they present a clear, strong message that positions the organization as a whole.

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Merger and Acquisition, is becoming a significant strategy for big companies when entering foreign markets (Melewar, 2001). Many of multinational firms have after acquisitions and restructuring, have been forced to find new ways of identifying themselves in an effort to project their new circumstances. Therefore the need to put an even greater emphasis towards projecting consistent global corporate identity is of particular importance for further positioning.

THEORY

Theories of Mergers and Acquisition (M&A) are not mutually exclusive. A firm could, for example, seek to gain market power and at the same time be building an empire and believe that it can more efficiently manage the business of a firm or plant it has targeted as a potential acquisition. A merger refers to the combination of two companies. This entails that a new organization structure appears from the two combined companies. On the other hand, an acquisition is one company buying another (Bruner, 2004)
United States Department of Agriculture Economic Research Service elaborates two leading M&A efficiency theories. These are the disciplinary and synergistic merger motives which impact M&A.

a)**Disciplinary mergers** theory suggests that M&As discipline target firms' managers who pursue objectives other than profit maximization. Managers who do not maximize profits presumably would focus attention on goals other than profitability. Since this difference in focus can come at the expense of operating efficiency, a firm's performance may suffer. Poor performance does not go unnoticed, however. Opportunistic buyers may observe the poor performance accompanied by good assets and discipline the poorly performing plant by acquiring it. Thus, the disciplinary theory suggests that acquiring firms merge with poorly performing targets and improve their performance as new management realizes the full potential of a target's assets.

b)**Synergistic mergers** theory holds that firm managers achieve efficiency gains by combining an efficient target with their business and then improving the target's performance. Buyers recognize specific complementarities between their business and that of the target. Thus, even though the target is already performing well, it should perform even better when it is combined with its complementary counterpart, the buyer firm. The synergistic theory implies that target firms (or plants) perform well both before and after mergers.

After an acquisition, employees' behaviour of the acquired firm can act through four elements. They can work hard to support the organisation after the acquisition (loyalty), they can quietly continue to do their job as before (compliance), they can express their opposition, working to change things (voice) or they can reduce their effort and use working time for personal business (neglect) (Bourantas & Nicandrou, 1998).

ANALYSIS

Thomson Reuters Legal Solution emphasizes the main corporate entities commonly involved in private acquisitions in Macedonia are limited liability companies (LLC) and joint stock companies (JSC). An LLC must have a minimum share capital of Euro 5,000 and can have from one to 50 shareholders. The number of shareholders in a JSC is not limited and its minimum share capital depends on whether there is an initial public offering (IPO) for the subscription of shares on incorporation. The minimum share capital is Euro 25,000 if the JSC is incorporated without an IPO, and Euro 50,000 if an IPO is intended. JSCs that are not listed on the Macedonian Stock Exchange, that either made an IPO for a subscription of shares or have a nominal share capital of at least Euro1 million and more than 50 shareholders, are considered as JSCs with special reporting obligations. Parties that intend to acquire 25% or more shares issued by a listed JSC or a JSC with special reporting obligations, must make a public bid for a takeover under applicable rules.There are several cases of mix international and local companies, which have used the M&A to broaden its activities in the Macedonian market. Following are presented the most significant M&A in Macedonia which occurred during 2014 and beginning of 2015 (Jovanovic J. and Dragan I, 2015).

a)Telecom Austria Group/Blizoo Macedonia

Telecom Austria Group on July 2014 announced hat it was finalizing its 100 % acquisition of triple-play cable Blizoo Macedonia, from Swedish private equity house EQT, the price was undisclosed. Austrian telecom stated that the acquisition of Blizoo Macedonia, represents a significant step in the execution of Telecom Austria Group's convergence strategy, and will allow VIP Operator (its telecom operator in Macedonia) to buddle fixed-line and mobile services in the future. With the takeover of one of the leading cable operators in Macedonia, Telecom Austria Group gained 63000 new customers in the Macedonian market. Synergies in terms of resources, experience and processes are expected to open up new opportunities for further development, was claimed by Telecom Austria.

b)Telecom Austria Group/Telecom Slovenija Group

Telecom Austria Group entered into another merger with Telecom Slovenija Group, as they have agreed to merge their subsidiaries in Macedonia, VIP Operator (Telecom Austria Group) and ONE (Telecom Slovenija Group) both operating in the Republic of Macedonia. According to public information delivered by both companies, Telecom Austria Group aims to own 55% and have sole control over the newly created entity. ONE is the third largest mobile operator in Macedonia with a market share of 23.6 % and a customer base of about 562,000 at year half 2014. Telecom Austria has been offering mobile services in Macedonia via its subsidiary VIP Operator since 2007. Having a market share of 28.1 % and approximately 630,000 customers at half 2014, it is the second-largest operator in the country.

c)Phillip Morris International Management SA/Tutunski Kombinat Prilep AD

Phillip Morris International Management SA and the tobacco company Tutunski Kombinat Prilep, merged and through a joint venture, established the company Philip Morris-Tutunski Kombinat Prilep LTD in 2014. The capital of the newly founded company is controlled by Phillip Morris International Management SA with 51 % (also with voting rights) and Tutunski Kombinat Prilep with 49% respectively. This merger appeared as a result of a strategic partnership agreement signed by the two companies in May 2014. The newly founded joint-venture company has been fully operational since September 2014 and its main aim is the production of cigarettes under the Philip Morris brand in Macedonia.

d)Visteon Corporation / Johnson Controls LTD Macedonia

In April 2014 Visteon Corporation gained control and become the sole owner of the Johnson Controls LTD Macedonia, a company owned 100% by Johnson Controls Holding Company Inc. USA. The sale agreement between Visteon Corporation and Johnson Controls Company Inc. USA worth US $ 265 m, was officially signed on January 12-th 2014. With the agreement, Visteon Corporation acquired Johnson Controls Holding Company's daughter companies in Macedonia, USA, Brazil, Slovakia, Tunisia, Bulgaria and Germany.

e)Eurostandard Banka AD Skopje/ Postenska Banka AD Skopje

In April 2014, Eurostandard Banka AD Skopje gained 100 control over Postenska Banka AD Skopje . Eurostandard Banka AD Skopje previously owned 2/3 of the capital of Postenska Banka AD Skopje and bought the remaining stocks worth Euro 4.4 m. by the Republic of Macedonia. With this transaction Postenska Banka AD Skopje merged into Eurostandard Banka AD Skopje and ceased to exist as a separate legal entity. As the only merger or acquisition in the field of banking services in Macedonia in 2014, this merger set the example for the expected trend of mergers between banking and financial service institutions to take place in the coming years.

f)Mid Europa Partners / Danube Foods Group

Mid Europa Partners, a leading investment fund and the largest private equity firm focused on Central Europe and Turkey, at the beginning of 2015 announced that it was aiming to acquire a controlling interest in Danube Foods Group. Since its foundation in 1999, Mid Europa Partners has been managing capital totaling Euro 4.2 bn. With revenues of more than Euro 400 m in 2014, Danube Food Group is a regional leader in the field of milk and dairy products, confectionery, mineral water and energy drinks.

CONCLUSIONS

In the case of Macedonia M&A is an applicable model, used mainly from big companies and no so much from smaller ones. The analysis of this paper conclude that entering through M&A strengthen the position of the acquirer company and in some cases (such as Telecom Austria Group) the company incrieses the market portion with new custimers. The M&A happens mainly to already estabklished companies, which have its market segments and perspectives are ahead for the acquirer company. The paper also concludes that the M&A is not limited to one or few industries, instead it is widely streched, hereby only during 2014 in Macedonia industries such as banking, tobacco, cable-tel and telecommunication, food and beverages, were subject of M&A practices. The strategy of M&A is not limited to foreign companies, but it includes also local companies. It means there are cases when foreign companies acquires a local company, as well as when a local company acquires another local company.

REFERENCES

1. RISTEV, L. NOVESKA, L. QOKU, V. (2014). Private mergers and acquisitions in Macedonia: overview, Thomson Reuters Legal Solution, enabled by http://uk.practicallaw.com/5-537-8344 ; accessed on 12.09.2015 ;

2. JOVANOVIKJ, J, DAMESKI, D. (2015) . Macedonia Mergers and Acquisition; Gllobal Legal Insights, enabled by http://www.globallegalinsights.com/ ; accessed on 12.09.2015 ;
3. MELEWAR, T.C (2001). Measuring visual identity: a multi-construct study, Corporate communications: An international journal, Vol. 6, No. 1
4. MELEWAR, T.C. & SAUNDERS, J. (2000). Global corporate identity systems: using an extended marketing mix, *European journal of marketing,* Vol. 34, No. 5/6
5. MORRISON, J. (2002). *The international business environment: diversity and the global economy*. Houndmills, Basingstoke, Hampshire, Palgrave
6. BRUNER, R. (2004). Applied Mergers and Acquisitions, *Volume 172 of Wiley Finance*, New Jersy, USA
7. United States Department of Agriculture Economic Research Service, Mergers and Acquisition Theories , enabled by http://www.ers.usda.gov ; accesed on 15.09.2015;

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SOCIO-URBAN DEVELOPMENTS IN KOSOVO: STUDY CASE PRISTINA

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SUMMARY

At the beginning of the XXI century, the life started to be very dynamic in Kosovo with emphasis on large urban centers. Ruined houses started to be reconstructed, new houses were built, and small and medium enterprises were established, as well as new institutions. Thus, the emigration of rural population simultaneously occurred from small urban centers and other urban centers, focused in Pristina. The growth of urban population in Pristina has happened for many reasons, which are mention the most important ones such as: Establishment of the entire central administration, public/private universities and health institutions, as well as international headquarters, the concentration of economic business, which created the best opportunities for education, employment, health, better infrastructure in general and better condition for life in Pristina then in other places. Given such a whole urban population in Pristina, many institutions were unprepared - without urban conditions to cope with the influx of population. As a result of the immigration of people in Pristina, and the lack of development and implementation of new policies and strategies for urban areas, happened a really urban chaos, where in some neighborhoods of Pristina has lack of adequate infrastructure and thus cannot have the development of a comfortable life for society.

Having such a situation, through using adequate methods and theory, this study aims to research demographic and urban growth in Pristina and causes that have pushed to immigrate in Pristina.

Key words: population, migration, unplanned development.

INTRODUCTION

Many researchers and experts have been focused on urbanism studies including: sociologists, urban ecologists, urban planners, architects, geographers and professionals from other fields. Such interest to study urbanization is due to the fact that the process of urbanization is affected by a

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number of social, economic, ecological, political, and other factors, which has implications in everyday urban life and beyond. Urbanization is a very complex process which include population size, expansion of the city, culture of urban life, socio - economic structures of the general urban population, the city functions (administrative, education zone etc.), technical - technological advancements and others indicators.
One of the theorists of urbanization, Harvey points out that urbanization is an aspect of the environment created and caused by the spread of industrial capitalism. In traditional societies, city had significant differences from the village. In the modern world, industry reduces the division between city and countryside. The agriculture is mechanized and run simply on the basis of the price and profit principle. As work in the industry so this process reduces the differences of lifestyle among the people living in town and village. The same as Harvey, Castells points out that the spatial form of a society is closely linked to the overall mechanism of its development (Giddens, 2002, pg. 537).
The growth of urban population in developed countries rapidly increased after the industrial classic revolution in Western Europe in the second half of the XVIII and XIX century, as a result of the process of industrialization and deagrarization, while after World War II, concentration of population in cities and the expansion of urban settlements included all countries of the world, particularly developing countries ("Third World") (Islami, 2008, pg. 385).
In 1950, the number of people living in urban areas was 750 million. In the year 2000, that figure is estimated to have been 2.86 billion, 47 percent of humanity. The fifty percent mark will be crossed in 2007, when for the first time more people will be living in urban centers as compared to rural areas. By 2030, nearly 5 billion people will live in cities, 61 percent of the world's population (United Nations, 2004). Humanity's future is definitely urban, and the trend of urbanization irreversible.
Urban population growth is expected to be particularly rapid in the urban areas of less developed regions, averaging 2.3 per cent per year during 2000-2030. The worrying aspect of this growth is that it brings in its wake the 'urbanization of poverty.' About one third of the world's urban population – nearly one billion people – lives in slums. Asia has about 60% of the world's slum dwellers, Africa 20%, and Latin America about 14% (UN-HABITAT, 2003). Local and national governments have limited capacity to cope with the ever-increasing demand for housing, infrastructure and services, and the issues of governance too are left unaddressed (Shipra Narang and Lars Reutersward, 2006).
Urbanization and development of urban life in Kosovo with all his pace and dimensions is new, even though some cities have relatively long history and

tradition. Until World War II, about 10 % of the total population of Kosovo was urbanized. Thereafter, the life had an intense dynamic in all its dimensions and urban population had continuously increased. The number of cities increased from 5 cities (1948) to 30 cities by the end of the 80-s, and among them had even mixed cities – towns, neither town nor village.

The impact of urbanization is not completely negative. Cities often perform the role of motors, driving national economies. They are dynamic spaces, and provide important economic, social and cultural opportunities for urban populations as well as the hinter-land. If properly managed, urbanization can actually help reduce poverty by increasing productivity and providing communities access to services, infrastructure, lively-hoods and security (Shipra Narang and Lars Reutersward, 2006). Lack of urban management has made in Kosovo and particularly in Pristina not have a positive effect in reducing unemployment and poverty.

On the other hand, a particular phenomenon that has accompanied the development of most municipalities is the lack of design of general urban planning of last century in most cases about 1,400 rural settlements were left out of spatial planning process. However, the expansion of settlements generally had the character of concentration throughout the last century. This situation changed after 1999, because both urban and rural settlements began to take the shape of dispersed settlements, especially along the roads and agricultural land. This deteriorated situation continues, because despite of the rapid growth of urban population, Kosovo municipalities (most) were without municipal and urban development plans. Until '90s, has existed only urban plan (city plan) and in some cases regional plan. After 2000, Kosovo started with a new system of spatial planning, where, has two level of planning (local and national level). At local level has three plans (detail plan, urban plan and municipal development plan). Although some of the Kosovo municipalities have drafted urban planet, unfortunately, they are not applied. Reasons for not implementing the plans are numerous and varied but, the main reasons were political interference and corruption. In this case, Pristina has urban development plan but it has not a municipal development plan (until July 2013), which cover all territory of Pristina. The challenge for Pristina is the lack of implementation of the urban development plan as well as other ones associated (plans) with it. Problems like this, has lidding to urban and sub urban chaos of Pristina territory. After the last War in Kosovo ('99), migration from villages of Pristina and from other less urbanized (developed) urban centers and periphery of Kosovo moved to Pristina, thus creating a real density of population, increasing of requirements for housing, increasing of rent for flats and so on. Lack of enforcement of existing urban plans, lack of detailed urban development plan for the new neighborhoods

and the lack of municipal development plan has caused expansion of the city in an uncontrolled manner.
Having such a situation, the paper aims to reflect urban demographic trends, physical expansion and urban challenges in order to have a clearer picture of trends of urbanization in Pristina and challenges facing the city today.

THE DATA, METHODS AND SCOPE OF THE STUDY

Basic data used in this study are those from censuses, orthophotos and topographic maps by years and various studies and reports. Through analysis with GIS on the orthophotos and the maps, it has become possible to measure urban - physical growth of Pristina. Analytical historical, statistical and comparative methods have taken place which deserve in this study.
The study aims to recognition demographics and spatial increase of Pristina and the developments that have challenged it in different time periods, with emphasis after 1999. The study builds upon three research questions: a) does the growing urban population in Pristina after '99? b) Does growing horizontal (physical - urban expansion) city of Pristina and in which time period? And, c) What kind of challenges had the city of Pristina during transitive period?.

A BRIEF HISTORY OF URBANIZATION

Urbanization and urban life in Kosovo is relatively new, even though some Kosovo towns have inherited old urban tradition and culture. The education level of socio-demographic structures was low until the late '80s of the last century, economic activities in the city did not differ significantly from those in rural areas, the exception does the trade, and developed agrarian life in most Kosovo cities, which makes, the life in the city to have a very small difference from life in the countryside. Kosovo was much undeveloped until the second half of the last century (XX). Later penetration of capitalist economic elements, lack of economic development in its territory, the country's colonial position, concentration in the agrarian sector, etc., have led to a specific urbanization. Such a situation began to change in the second half of the last century (XX), including late industrialization, economic development, advancement in education and health system, as well as other social - economic and political advancements. During that time, with the expansion of the municipal system began demographic trends in large cities (Prizren, Peja, Gjilan, Ferizaj, Mitrovica, Gjakova), especially in the capital of Kosovo, Pristina. After the establishment of the first public university in

Pristina (1970) and other important institutions, it began to become more attractive to people from rural areas and small urban centers throughout Kosovo, but also from East Kosovo and other regions inhabited by Albanians.

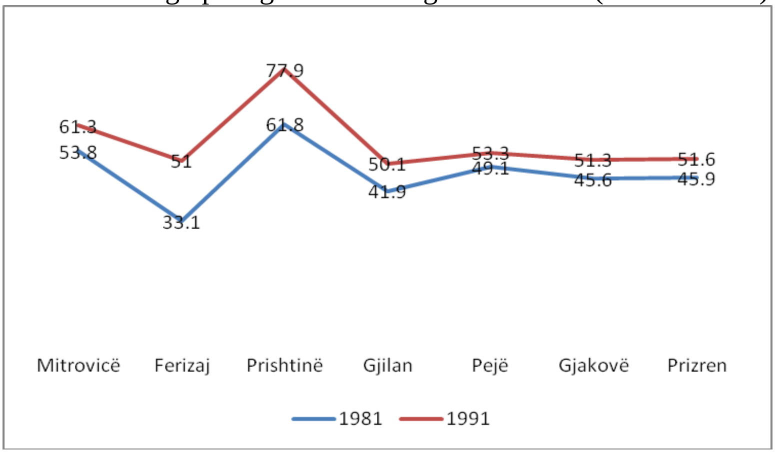
The development of urbanization in Kosovo dates from ‘70s onwards, where besides the large urban centers began to extend to smaller urban centers which were previously rural areas with a central position, but later became municipal centers. Significant developments in the demographic growth of cities occurred until the end of ‘80s - up to 1990 and 1991 where a stagnation of development was caused due to a bad political situation in the country. All public institutions with few exceptions were closed, and the Albanian workers had been violently fired from their jobs. Educational and health institutions had also been closed. During these years the public life had stagnated. Another phenomenon that happened in most cities in Kosovo and especially in Pristina was the process of colonization of the territory by the ethnic Serbian, Montenegrin, Bosnian, etc., with the aim and political background (increasing numbers of non-Albanian community). But even this process of colonization by Serbian chauvinist policies did not work. Despite the great migration of the Albanian population throughout the 90s and before, and unfavorable situation (survival) were strong indicators such as the connection with the family and homeland, as well as high fertility and solidarity between Albanians have made stronger as a community until the liberation ('99) and the country's independence (2008).

The urban population in Kosovo constituted 15.5 % in 1953, 32.4 % in 1981 and about 36 % in 1991 (estimate) in the overall population. The number of urban population was about 71.000 in 1948, it increased to approximately 730.000 inhabitants in 1991. In the period 1953-1981 the urban population increased to 388.300 inhabitants or 306.9%, while in the period 1953-1991 around 600.000 inhabitants, or about 480% (Islami, 2008, pg. 386). It is estimated that currently between 45-50 % of Kosovo's population lives in the city.

The rate of urbanization in seven regional centers according to the census of 1981 and estimate which is done in 1991[2] has no significant differences, except of Pristina, which leaves behind the other urban centers. Hence, it is worth mention that during the period of 10 years, all regional centers of Kosovo have marked an urban demographic increase about 10% - 20%. See the chart;

[2] For political reasons, the Albanian population did not participate in the census (1991) organized by the Serbian political backdrop circles and as such is only an estimate.

Fig. 1: Urban demographic growth at 7 regional centers (1981 to 1991).



Source: For the year's 1981 official census of population, 1991 (estimate), SAK, (Islami, 2008).

The life started to be very dynamic in the post war Kosovo. Ruined houses started to be reconstructed, new houses were built, and administrative, educational, cultural institutions, as well as new businesses were established. During this period, life began to take its right meaning but also accompanied by many challenges. Transitional period (after '99), in which the country is going through in general, especially the capital of Kosovo, Pristina, is accompanied by many challenges in the field of urbanization. Migration from rural areas - remote rural, small urban centers, but also from large urban centers - regional centers and other areas inhabited by Albanians especially from East Kosovo have led to an increase in population and expansion of the city and urban suburbs, associated by major irregularities in the field of urbanization. Usurpation of public - private property, unplanned construction, traffic jam, lack of parking's, lack of public spaces, clash of rural - urban cultures, became part of life in the capital - Pristina.

Currently, according to the results of the census, households and dwellings in Kosovo (April 2011), Pristina has about 200.000 residents and this number could be many times larger if we add the number of non-resident persons and daily migrations and if registered all of citizens. From the census conducted in 2011, it became clear that a large number of citizens who live in Pristina, they did not change their permanent residence address. Actually, there are many citizens who live in Pristina however, their address of residence are in their place of origin. And, as a result of this, Pristina has a small number of population living in it. Based on different population estimates indicate that Pristina could have over 300,000 inhabitants. If we add daily and weekly migration also, the number of population can be higher. Considering a poor urban aspect of Pristina with the lack of infrastructure, traffic jam, degraded urban environment, lack of housing and high cost of living, became the most discussed issues and problems faced during recent years by the citizens visiting Pristina and especially Pristina citizens.

DEMOGRAPHIC AND URBAN GROWTH

Demographic growth of cities throughout Kosovo had been during all second half of the last century. As we mentioned above, there was a demographic increase mainly in 7 largest regional centers including Prizren, Peja, Mitrovica, Gjilan, Gjakova, Ferizaj, and especially Pristina. Demographic growth of urban centers was caused by both natural components and mechanical components such as migration of population.

Pristina Municipality has 43 settlements, organized in 16 counties (local communities). In those settlements living 40.528 households while only in rural area living 6.420 households (ASK, 2015, pg. 185). In some villages, especially those belonging to Malsia e Gollakut (Gallap), is noticed a great movement of the population (especially young people) towards urban areas (Pristina). Thus, some villages that have been populated, have lost a considerable number of residents, such as Nishec, Radashec, Kukaj, Hajkobilla, Gllogovica etc. (K.K. Pristina, 2008, pg. 25). Migrations of population from rural areas and others part of Kosovo caused the constant demographic growth of Pristina. See table;

Table 1: Movement of Pristina population in the period 1948-1999

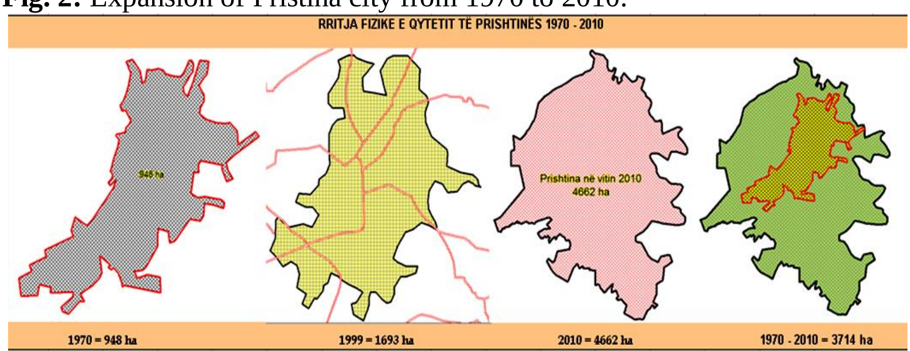
Year	Number of population	Year	Grow in % in period
1948	19.631	1948 - '53	22.7
1953	24.081	1953 - '61	61.5
1961	38.893	1961 - '71	78.7
1971	69.514	1971 - '81	55.5
1981	108.083	1981 - '91	43.9
1991	155.499	1991 - '99	25.4
1999	195.000	1948 - '99	893.3
2011	198,897	1999 - '11	2.0
2013	207.477	2011 - '13	4.3

Source: For the years 1948-1981 official census of population 1991-1999 (until the end of March) estimate (Islami, 2008, pg. 398). For year 2011, refer to census of population (2011) and 2013 estimate by ASK. Analyzed by the author.

Demographic data show that the largest urban growth in Pristina has occurred between '60s – '70s, where urban growth reached up to 80%, then to continue with a gradual decrease to '90s. Whereas, from '50s to '90s, urban demographic growth had reached 900%.

The residential and other non - residential area (commercial buildings, roads, kindergartens, etc.) had a constant increase both in urban and rural areas.
Since '99, Pristina has marked a rapid increase of both inter urban and suburban areas, which led to a confusion on distinction of the cadastral boundary of its urban space. Pristina city has already joined with Fushë Kosova town almost even with that of Lipjan, Graqanica and Obiliq.
The expansion of business activities along the national road from Pristina to Peja and cheaper price of living (lower prices of land and housing/flat) has led the developments to focus on this part of the urban area. On the other hand, alongside the national road Pristina – Skopje are also concentrated commercial buildings, creating thus closer connection between Pristina and Lipjan. Given such a large urban growth and constructions expanded along the roads (Pristina - Ferizaj), makes us believe that, for nearly one decade Pristina will be connected to Ferizaj.
Pristina City and its suburbs, for just one decade (the last decade) was expanded (built) about 200%, including entire neighborhoods with individual and collective housing, commercial buildings, etc. Urban and suburban developments with such a rapid growth were almost totally unplanned where all rude developments caused a "rural area" of certain neighborhoods which have multidimensional and long term consequences. See the map;

Fig. 2: Expansion of Pristina city from 1970 to 2010.



Sources: Topographic maps ('70, '99), NIMA (National Imagery and Mapping Agency) and Orthophoto 2010, KCA (Kosovo Cadastral Agency), converted in picture by author.

Based on the analysis done with GIS (Geographical Information Systems) through using orthophoto and topographic maps to 1970 – 2010 about growing urban space, the urban spaces was built in 1970 about 948 hectares, in 1999 was about 1693 hectares (expanded), in 2010 marked a record increase (expansion of the city) around 4662 hectares. Expressed in percentage from 1970 to 1999 marked an increase of 78.59%, while, from 1999 to 2010 the city was expanded of 175.37%. On the basis of this analysis for 30 years (1970-1999) Pristina has not been expanded in physical-urban aspect as it is increased only in the last decade (1999-2010).

Currently, in Pristina the quality of housing construction is (mostly) of high standards, but one thing which makes life hard in such modern apartments is unplanned construction. Today, in the center and suburbs of Pristina as well, the life has become very hard, due to the rude construction with the lack of natural lighting, lack of physical infrastructure (roads, car - parking, sidewalks, etc.) and social one (kindergartens, schools, health centers).

Another increasing phenomenon in Pristina and beyond is, known as “Urban Disintegration” from the majority world – urban area, is the creation of separate inter-sub urban districts independently urbanized, constructed and administered by individual private companies. This form of new districts creates social groupings – deep social urban differences as well as territorial disintegration, though such concepts are unacceptable to developed countries.

In such neighborhoods can live only people with very high income! But the concern is that the establishment of such suburbs is like “prisons” surrounded by high walls and separated from the majority urban – world. The clash of different cultures within the community that lives in such neighborhood, and other urban culture surrounding neighborhood, causes individual and collective dissatisfaction, stress, and social division. It is another concern the fact that such districts are constructed in the most qualities agricultural land. See fig.

Fig. 3: Constructions of neighborhoods in Pristina.

Source: Photo by internet.

After 1999, the needs for residential and commercial buildings increased substantially. Lack of urban plans, the unwillingness of decision-makers and policy-makers to design and implement plans and urban standards, and corruption are some of the causes that have led to Kosovo expand settlements completely unplanned manner. One of the cities that suffer the most because of the large influx of people is Pristina. In Pristina new neighborhoods were built spontaneity way without implement urban criteria, urban constructions, and constructions occurred in public and private property by disabling a normal life for citizens. Since 2013, look like a small progress where the local government of Pristina, have made a positive trend in the context of detention of illegal constructions. The current government has emerged at the forefront of illegal builders, although there are numerous strains of the latter, however, so far the situation of illegal construction is under government control and it gives a wisp of hope for the citizens of Pristina.

CAUSES OF DEMOGRAPHIC AND SPATAL GROWTH

During ‘60s - 70s of the last century and especially in the first decade of the XXI century, major changes of demographic concentrations and spatial expansion took place in urban and suburban areas. Migrations were at a slower pace, but after 1999 onward, considering the latest stage of migrations, and the most important one, which caused the rapid growth of cities and especially of Pristina.

At this time, migrations from village - city, from small towns to bigger towns and from other Albanian territories were a routine of time, and everyone had the chance to use it. But the target of young people (students) was particularly Pristina. Pristina became a generator of population concentration and social-economic development as well as hopeful for the population, because the opportunity to have a better life (education, job, etc.), was greater than elsewhere (Gollopeni, 2012, pg. 6). The urban growth reasons are divided into two groups: demographic and spatial (urban) growth reasons.

Causes of demographic – urban growth

There are a variety of pushes and pull factors; individual and social that have made the Pristina have such a demographic and urban growth, such as:

- ***Pristina as a University center*** - until '99, Pristina was the only university center in Kosovo. Large number of young people came to study not only from Kosovo but, also from Macedonia, Montenegro and East Kosovo (Albanian nationality). After graduation, a number of youth lived in Pristina, where they began a new life, thus gradually turning from an immigrant into a citizen of Pristina;

- ***Establishment of central administration and other institutions*** (economic, business, cultural, international residencies, etc.), created new jobs very much needed by the society;

- ***Destruction of houses and businesses*** - during the war ('99) especially in rural settlements caused the migration of population from rural to urban areas. After the war, a large part of the rural society began investment in larger urban centers in the country, especially in Pristina, hoping to have a greater, faster and more safe market;

- Concentration of economic investment in greater in capital city – with numbers than in all other centers, led especially youth population towards Pristina;

- Better quality infrastructure of Pristina than elsewhere - Infrastructure in general was incomparably better in Pristina that in other urban centers, and particularly in rural areas;

- Public and private property usurpation - a part of the population in the absence of their houses (which were destroyed during the war by Serbian police and army) led them to come in the city and usurp flats, business premises and public / private property (temporarily) thus using the lack of legal institutions. Hence, benefiting materially from such actions, and thus slowly becoming permanent residents of Pristina;

- Better living conditions – better opportunities for education, health, employment, cultural activities and attitude were better public services;

- Lack of development of urban development plans and the implementation of existing ones (by decision makers and policymakers) - enabled physical growth - urban uncontrollably. This situation is very much also contributed clan connections, nepotism and corruption.

- Lack of strategy and residential policies in the country - not knowing housing requirements to the appropriate extent and defining urban construction standards, urban growth expanded in an unplanned manner, taking the whole area of agricultural land and causing inadequate access to infrastructure, and - Increasing number of unplanned businesses along the roads;

These are the main and the most important reasons that have led to such demographic growth and expansion of Pristina city, but never end up with that, there are other especially individual reasons which require certain analysis and studies.

CONCLUSIONS

The urban population had increase trend until the early ‘90s in all cities of Kosovo in particularly was increase in Pristina. Thereafter, growth of urban population stagnated by mechanical components due to political reasons. During this period, public institutions including universities, schools, factories, etc. have been closed and the majority of Albanians have been fired of their jobs. The emigration of Albanians intensely occurred during ‘90s, when many families migrated in order to provide their own living (Europe and wider).

Until the second half of the last century, only regional centers such as Pristina, Prizren, Gjilan, Gjakova, Mitrovica, Ferizaj, and Peja were urbanized, but through later expansion of the municipal system, more central position settlements received city status. Thus, until the late ‘80s, the number of towns increased to around 30 ones including mixed towns (neither town nor village). The overall urban population of Kosovo was about 10% in the

'50s, but it marked an increase until the end of the XX century of about 35% urban population.
Pristina was the city that had mostly immigration of population marking an urban increase. The highest number of urban population has been in the period 1960 - 1970; to continue with slower increase until 1990. Thus, according to 1991 (estimate), Pristina had about 75% of urban population and in 2011, 81% urban population (KAS, 2011).
Large population immigration or “Demographic boom” known as demographic concept took place in Pristina in 1999 and onwards, for reasons mentioned above. At this time, public institutions were not prepared to design adequate plans and urbanism strategies as well as good management of urban spaces. In terms of institutional gap and other reasons, people built houses, business premises and other facilities without respecting the construction standards, thus bringing Pristina to an urban collapse. In just a decade urban territory expanded rapidly with about 200%. Even though most of the buildings were built of a hard (solid) material, the problem is that they have (mostly) been constructed without permission urban (plans), but they were imposed and unplanned.
Tend to migrate has the new generation, well qualified and with sustainable economic status. The trend of rural-urban migration, causes depopulation of rural areas and overcrowded urban areas.
Among the main reasons of the fast demographic - urban growth is certainly immigration, because the main country’s institutions were located in Pristina, such as public and private universities, public administration, major business centers, international headquarters and other, all these elements created favorable conditions and new jobs, and certainly better life conditions, which enabled Pristina to be very attractive place of working and living.
Challenges faced by citizens and urban areas of Pristina are numerous including illegal constructions which day by day makes urban life harder, traffic jam, lack of green spaces, lack of parking’s, noise, environmental pollution from vehicles, lack of adequate infrastructure and so on.
If the institutions of the country does not establish rural development policy in the near future, many rural areas can even depopulation, the number of pupils in primary education decreases, which prevents a qualitative development of education in rural areas and therefore, in the absence of pupils many schools can be closed. Also come into consideration demographic changes, especially those under age where the older generation (65 years old) increases.
Finally, to stop the urban chaos, Kosovo institutions needs to have rural development strategy and Pristina needs to have a special status (law) and a special budget, start the implementation of urban and municipal development plan, design and implement regulatory plans for specific neighborhoods;

announce international competition on the design and planning (neighborhoods, streets, squares, parking etc.), establish an Urban Planning Institute which among others will deal with monitoring of implementation of such plans etc., otherwise everything will be too late.

REFERENCES

1. ASK, (2015). Vjetari statistikor 2015, ASK, Prishtinë.
2. Giddens, A. (2002). Sociology, Tirana: SOROS.
3. Gollopeni, B. (2008). Spatial Planning Process, Year I. no. 1, Magazine Environment, Pristina: MESP, fq.17.
4. Gollopeni, B. (2012). Urbanization and urban planning challenges in Kosovo, European Magazine, no. 6. Pristina: SOROS, pg. 6-8.
5. Gollopeni, B. (2013). Shortcomings of spatial/urban planning in Suhareka, Readings in Population, Environment and Spatial Planning, Edited by: K.D. Sharma, H.S. Mangat and K. Surijit Singh, ISPER, Panchkula / INDI, pg. 355-364.
6. Islami, H., (2008). Demographic Studies, 100 years of demographic development of Kosovo, Pristina: ASAK.
7. Mulla, Gj. (2000). Urban sociology, Pristina: University of Pristina.
8. Municipal Assemble of Pristina, (2008). Medium-term development strategy of Pristina, 2008 -2011, Pristina: MAP.
9. Shipra Narang and Lars Reutersward. Improved governance and sustainable urban development Strategic planning holds the key, European Journal of Spatial Development, 2006. http://www.nordregio.se/EJSD/
10. United Nations (2004). World Urbanization Prospects: The 2003 Revision. New York.
11. Urbanization and Socio-Urban Developments in Pristina in Post-Conflict period, Proceedings of the 2nd Annual International Conference on Business, Technology and Innovation, Edited by: E. Hajrizi, UBT, Durres – Albania, 1 & 2 November 2013.
12. KAS, Census Atlas of Kosovo 2011, KAS, 2013.

DEVELOPING OF LAND INFORMATION SYSTEM FOR SUPPORTING AND MANAGING OF AGRICULTURAL SECTOR IN VITI MUNICIPALITY

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ABSTRACT

The purpose of this paper is to present: the role of LIS technology and its application in agriculture, the presentation of data and farming information through LIS, land management and their use by using **LIS** technology, the use of LIS applications to achieve the objectives, the use of GIS applications for creating maps of cultures of land, classes of land, the use of land and the land cover also we are going to design and construction a geographical database.
In this paper we have created database with GIS with existing data in the context of benefit of maps for cultures, classes, suitability. Aim of the paper is seen as such base to helps agriculture.

Keywords: LIS, GIS,Agriculture,Viti Municipality, ArcGIS, farmers,land, map.

1. INTRODUCTION

Soil survey data and Geographical Information Systems (GIS) are important tools in land use planning [Coleman, A. and Galbraith, J., 2000]. The soil based-GIS made the decision-making process more accurate, automated, and efficient. It is a dynamic product that serves to convert verbal communication into visual communication while preventing information overload [Kukaj, Y. et al., 2014]. Traditional land-use planning involved many different sources of printed information such as soil survey manuals, topographic maps, aerial photographs, vegetation surveys, flood maps,

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hydrology maps, and property surveys to name a few [Coleman, A. and Galbraith, J., 2000].

GIS has a significant role to play in agriculture at several scales from local to global [Coleman, A. and Galbraith, J., 2000]. The development of several new digital databases at regional and larger scales, the advent of new continuous data collection and remote sensing techniques at the farm scale, and the continued migration of GIS to more and more powerful desktop computers have caused an explosive growth in the number and variety of agricultural applications during the past few years [Willson, J.]. One of the misconceptions about GIS is that it is only a map-making tool [Maliqi, E. et al., 2015]. The most important applications are probably those connected with precision or site specific farming, which aims to direct the application of seed, fertilizer, pesticide, and water within fields in ways that optimize farm returns and minimize chemical inputs and environmental hazards [Willson, J.]. The establishment of this GIS will integrate diverse geospatial data, such as topographic, hydro graphic, land and soil suitability, street network, vegetation cover, land use and others in GIS database and their joint analysis, increases the quantity as well as quality of derived information [Dushaj, L. et al., 2009]. The use of technologies such as GIS will also enable us the analysis of trends, such as trends in overgrazing, land degradation, land use change, and urbanization of agriculture land. This will be a powerful tool to get solution of problems and building a land use planning in commune level [Dushaj, L. et al., 2009].

A Land Information System (**LIS**) is a Geographic Information System for cadastral and land-use mapping, typically consisting of an accurate, current and reliable land record cadastre and associated attributes. A LIS comprises spatial data that represent the legal boundaries of land tenure and provides a vital base layer for integration into other spatial information systems or as a standalone solution that permits users to retrieve, create, update, store, view, analyze and publish land information [www.compass.ie].

Map-based Land Information Systems deliver real benefits to a range of organizations [www.compass.ie]:

- for land owners – including estate managers, agro business cooperatives, and government authorities,
- for natural resource use companies – including forestry, extraction and wind energy companies,
- for local and central government requiring accurate land and building use inventories.

A good LIS system is it system which supports the resolution to the following additional questions:

- Agricultural monitoring,
- Disaster monitoring,

- Water resources monitoring,
- Modelling data from many sources,
- Share data between stakeholders.

2. CASE OF STUDY

Territory of Vita municiplaty consists of 43 settlements, spread in a surface area of 297 km^2. Viti municipality lies in the southeastern part of Kosovo, crossed by the river "Morava Binçës" between the triangle Gjilan northeast, on south Kacanik and Ferizaj on west. Land area of Viti Municipality is 29,700 ha [Ferati, B., 2014]. From all agricultural area out of 17,962 is farmed agricultural land, where 13,190 ha are private and 250 ha are State owned. From all this area in general, only 175 ha are fallow. Area of arable land per capita is estimated to be around 0.25 ha, while the size of land per family on average is estimated around 1.8 ha, per family. Below is the graph that shows the value of the property expressed in hectares [Ferati, B., 2014].

Figure 1. Geography position of Viti

3. METHODOLOGY

3.1. Geodatabase

A database is collection of data organized in a structured way, so that; information can be retrieved quickly and reliably [Ullah, K., 2014]. The invention ofInformation Technology has led the database to be used in a management system, which is called Database Management System

(DBMS) [Ullah, K., 2014]. DBMS is a set of programs, in other words software systems that enables following actions to be performed in a database - stores and extracts information from a database, Modification of database by adding, editing, deleting and sorting of data [Ullah, K., 2014]. Modern GIS uses Spatial Database to integrate the geometry or features data with other types of data, spatial database facilitates storing and querying data that is related to objects in space, including points, lines and polygons [Ullah, K., 2014]. The collection of data that have common features and attributes are placed within a separate group [Ferati, B., 2014]. Depending on the geometry of data the sub organization is divided into: polygon, line and point. Attributes of the data in each group of data have three different areas: automatic software attributes, attributes for data connection with key and attributes that describe the object [Ferati, B., 2014]. At ArcGIS 10.1 software as we define the coordinate system (KOSOVAREF01) we have called the initial data and then we create the database by using the possibilities of this software in order to benefit graphical data (maps) for: culture, class, cover and suitability of land.
We created the graphical data in ArcGIS within a geodatabase with intention that this geodatabase to content graphical data for: the cultures of lands, classes of lands, following agricultural objects, network communications, hydrography, settlements, public buildings, educational facilities, religious buildings, land suitability, and borders. All these layers are represented by a geodatabase followed with "Feature Class". Paste is calculated based on scale of mapping on the dimensions of the map and the territory that is developed where most appropriate value reduction factor for mapping emerged: Scale 1: 80000. In the end we have created some maps and they have view as Figure 2 and maps content: the coordinate system, the legend, symbols, title, north direction, etc. These maps can be used for various agricultural needs for the territory that is presented. Elements that will be presented in maps this paper will be: cultures, classes, agricultural accompanying facilities, network communications, hydrography, settlements, religious facilities, suitability and borders. The mathematical model for maps is the model in follow table:

Table 1. Mathematical model of maps.

Coordinative system	Datum	Projection	Scale
KosovaRef01	ETRS 89	Transverse Mercator	1:80000

3.2. Source data

Basic data of achieving this paper are obtained from the relevant institutions of Republic of Kosovo. The table below shows data obtained, type of data, format of data and source data.

Table 2. Source data

Data	Format	Source data
Ortophoto	Ecw	Kosovo Cadastral Agency
Cadastral maps	Tiff	Viti Municipality
Roads	Vector	Viti Municipality
Boundary of Cadastral zones and parcels	Vector and Raster	Viti Municipality
The data for cultures, classes,use and coverage of land	Text and Image	Kosovo Satistical Agency
The data for hydrography, settlements and traffic	Text and Image	Viti Municipality

3.3. The methodology used in the research

In order to achieve desire results we have inserted in ArcGIS different data as needed.Creation of graphical presentation – mapshas been divided into several layersas you can see in Chapter 4. Graphical data aredividend into different layers which are included within the maps in Chapter 4. ArcGIS options makes possible the achieving outcomes. In this paperare used many options of ArcGIS for managing spatial dataincluding using the spatial analysis options or the creation of buffer zones.
The following figures show visually passing of these data through the various processes requiredand thematic layers that have appeared with GIS.

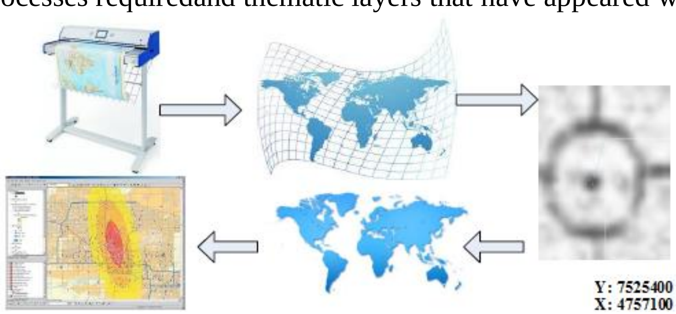

Figure 2. From analog to digital format

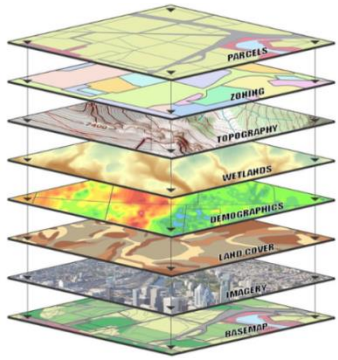

Figure 3. Presentation of data in layers.

4. RESULTS AND DISCUSSIONS

Based in the research we can say that overall about 60% of the population in Viti municipality work in agriculture from the total area of about 61% is agricultural land while the rest is used for other purposes.
Based on the analysis know Viti municipality has considerable fund of agricultural land, forest and pastures that represent significant economic potential the municipality the figure below.

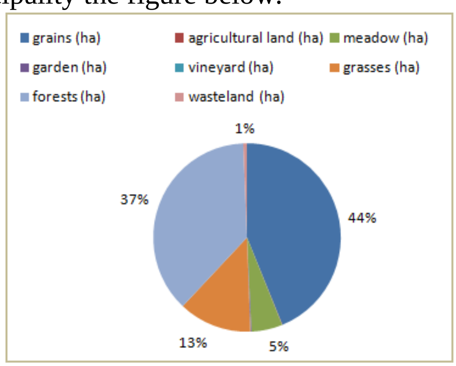

Figure 4. Agricultural crops by areas (ha)

The entire territory of Viti municipalitycategorized according to the degree of fertility expressed on the surface ranging as we see in Figure 3.

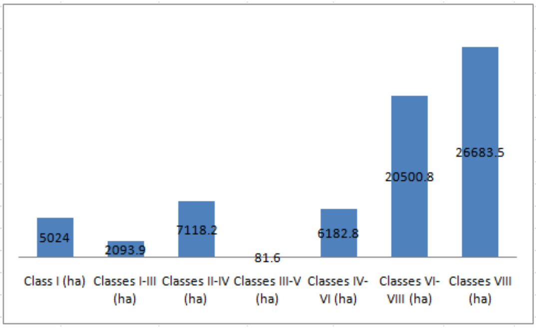

Figure 5. The area of land by fertility classes (ha)

It should be mentioned that in 1982 Viti land consolidation is applied (regulation and collection of land) in some villages of the municipality generally ten cadastral zones and unlike other towns in Kosovo only in Viti municipality was developed consolidation without irrigation system and also in areas that is applied has all remaining without registering Immovable Property Right Register (IPRR) and it is worth mentioning that a considerable part of the municipality has remained free land consolidation completed. The map below shows the land consolidation in Viti municipality and most of the municipality is out mass land consolidation.
Analysis of data is done for a relatively long time initially did the data analysis of the data after digitization, these data we processed in the ArcGIS software and then we won the paper maps that are seen in Figure 6-10.

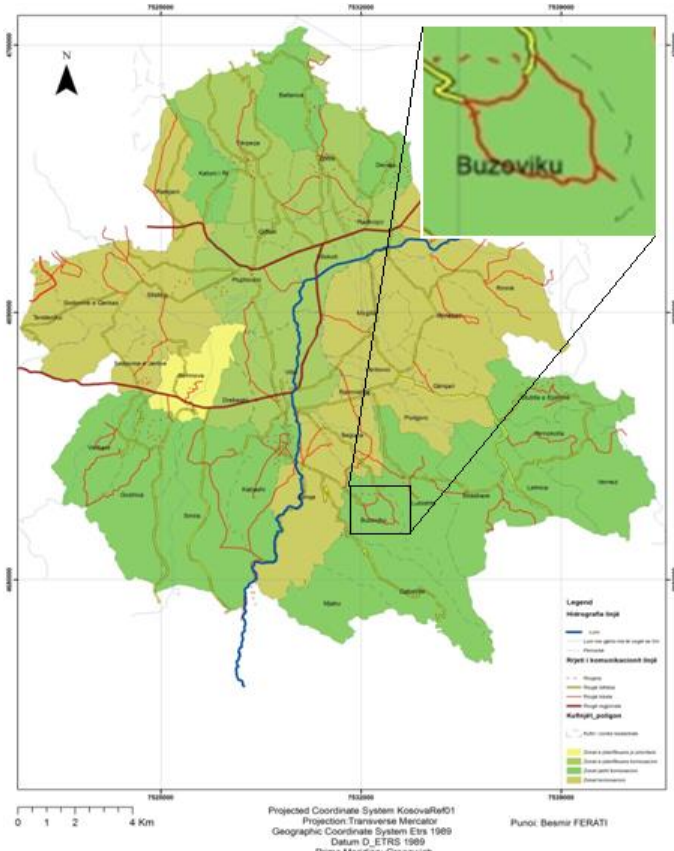

Figure 6. Map of land consolidation

By analyses and the followed methodology, in Figure 6 we have showed map of Viti municipality according cultures and in this map we can see that appeared some layers as boundary of cadastral zone, all categories of roads, all water sources also are appeared possible cultures like: farming, grain, grass, arboriculture, forests and construction land. From the map we can see that the biggest area of municipality is covered with grains.

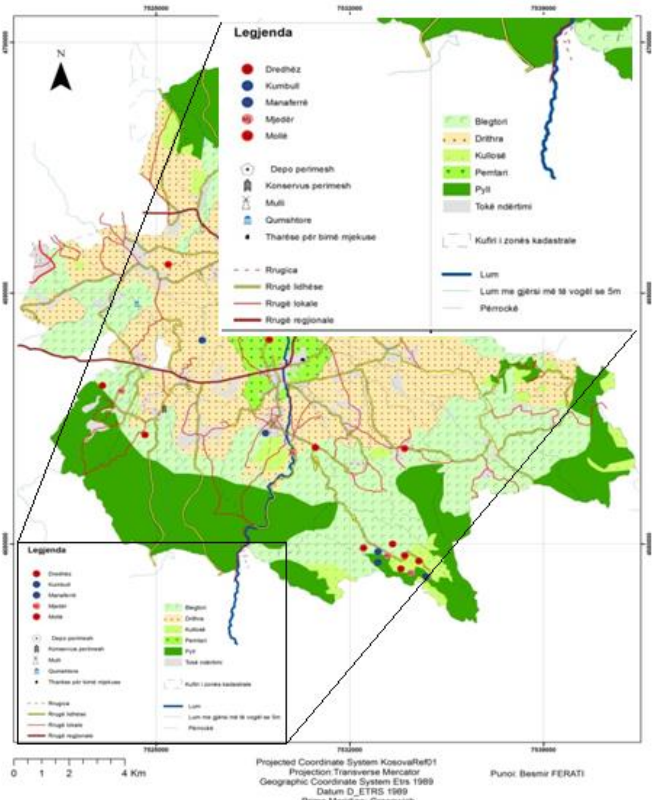

Figure 7. Map of culture

In Figure 7 are appeared classes of land for Viti municipality, from 1 to 7 class, also are appeared road and water sources for Viti municipality. So whole area of Viti municipality is appeared according data that we have used and followed methodology of the paper.

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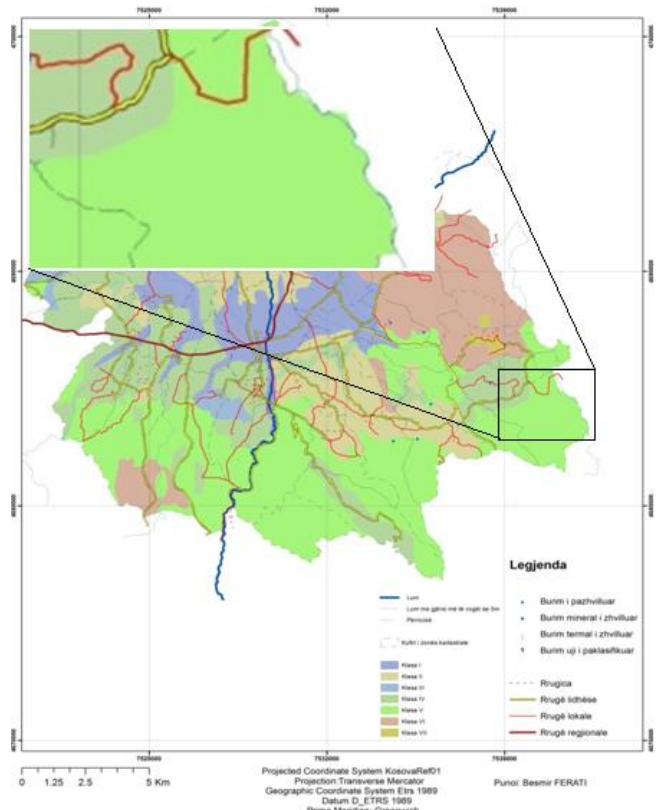

Figure 8. Map of classes

Also in Figure 8 we have created some layers that includes: roads, water sources and land cover and if we look carefully it seems that the biggest areas of Viti municipality is agricultural zone.

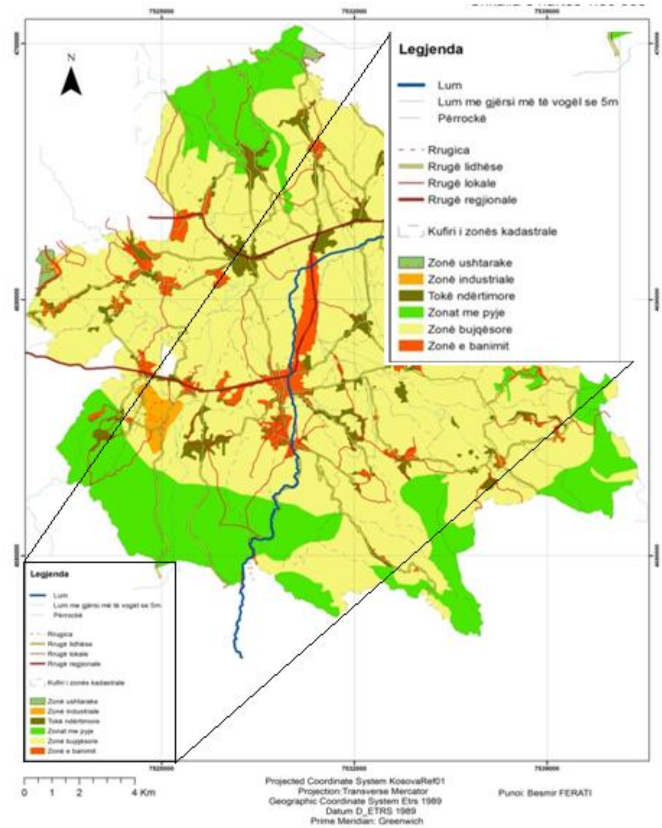

Figure 9. Coverages map

In Figure 9 is appeared suitability of land and from this map we may conclude that area of municipality according suitability is the biggest percentage with land "very good" and "average", and we can say the land of Viti is suitable for agricultural activities. Creation of coverage map for Viti municipality is important for urban planning because it represents the clear state of the municipality.

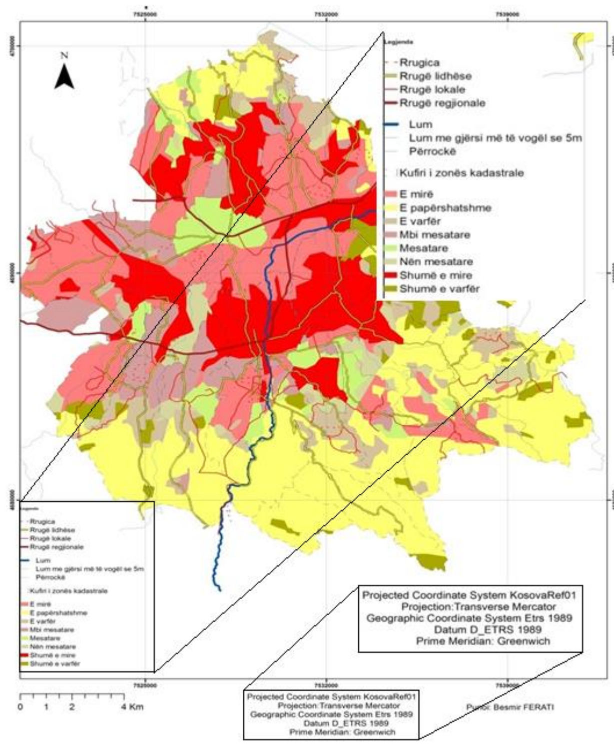

Figure 10. Suitability map

The farmers with the help of LIS, they use and analyze all the data that have been gathered in the pre-planting phase and receive results that have to do more with the control of the land, if it is risked from any bacteria or other harmful risks that can affect the production. Then for harvesting, farmers use a special technique called "monitor the production" used to analyze the overall data. From that it is understood if the agricultural seasonal plan was functioning. These data are then entered into the LIS by helping farmers to reach the desired maps and information.
One such example is shown in the figure below (Figure 11).

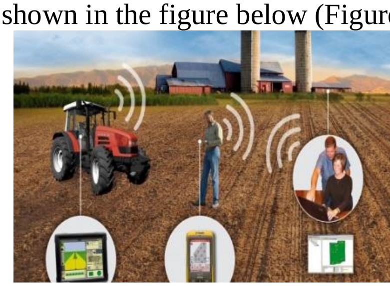

Figure 11. LIS and its role in agriculture

In Figure 11 see a farmer who conducts field according to a plan of action coordinated with a database and graphical part to prepare the land, it is resulting in productive agricultural crops.
We are illustrate an example It will be served to farmers this paper of ours with graphical and textual data that have Farmers can manage their work in the field in this way, example if at different times irrigate agricultural crops they have the opportunity with the data referred in order to know which areas are irrigated and which are not for example if you want to know for certain surface what kind of culture that comprises and also create different maps after you presented to stakeholders.

5. CONCLUSIONS

LIS is important in the management of land and this technology is important in agriculture.
During the discussion on this topic we have seen how much important the system of land management is and the significance of what else this system can do in Agriculture. Seeing the importance of this, we have created several maps; as the map of cultures of land, map of classes of land, map of land use and map of land cover and with the help of these maps enabled us a rational, economical and a right way of use of land.
The importance of this system is not only that what information we may have, this system today is spreading its relevance also as much rational and economical use of land. Implementation of this system has made it possible nowadays that all data about property to be digitized, and this theme is carried out in this way where firstly the data are analyzed than processed and finally digitized and today we have agricultural spatial data for municipality of Viti.
The decisions were made with a more accurate knowledge base and were more efficient thanks to the power of the LIS.
In this paper explained Geographic Information System (GIS), it is application in agriculture, the importance of this system, data analysis, ta processing, and finally reached the permission result of this application. By establishing a database for this municipality we have managed to see quite clearly all agricultural land in this municipality as cultures, classes, compatibility, usability, etc.
Through LIS technology, we see all agriculture of the territory of the municipality a form which we will define us what we want to see and GIS technology enables us to have only a few clicks. Opportunity to enriched LIS

for the municipality of Viti is undisputed because we already we createda sustainable basis.
Opportunity management of agricultural lands in Viti is simple since in we created various data which are easily manipulated form and these data have settled down in database and different layers through GIS.
Developing of the geo data of Viti Municipality in this form is a sustainable resource for investors to have a clear picture on the lands of municipality knowing the different data for different cultures, classes, suitability, land consolidation, irrigation systems, roads, etc.
We see an ugly phenomenon as is conversion of some agricultural land into construction land, and this is destructive phenomenon.
Finally municipality of Viti urgently need to take precautions against this destructive phenomenon.

Acknowledgement
The authors are grateful to the Kosovo's institutionsfor permition of using data in this paper.

6. REFERENCES

1. Kukaj, Y., Ahmeti, P., Ajvazi, B., Murseli, S. (2014). "Application of GIS in water supply management network". Paper published. Skopje .
2. Ferati, B. (2014). "Aplikimi i GIS-it në bujqësi në komunën e Vitisë" – Punim diplome. Prishtinë
3. Maliqi, E., Hyseni, D., Maliqi,G., (2015). ”Application of GIS in the special zone of interest "Gumnishtë" – Kosovo". Paper published. Skopje .
4. www.esri.com, " Network analyst – tutorial" .
5. Willson, J. " Local, national and global applications of GIS in agriculture. Paper published.
6. Coleman, A., Galbraith, J., (2000). "Using GIS as an agricultural land – use planning tool". Paper published. Virginia.
7. Dushaj, L., Salillari, I.,Suljoti, V., Cenameri, M., Sallaku, F., (2009). "Application on gis for land use planning: a case study in central part of Albania". Paper published.
8. Ullah, M., K., (2014). "Urban land-use planning using geographical information system and analytical hierarchy process: case study dhaka city. Phd Research. Land University. Sweden
9. www.compass.ie

IBI INDEX APPLICATION IN ASSESSMENT OF THE ECOLOGICAL STATUS OF LAKE OHRID TRIBUTARIES

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SUMMARY

The importance of Lake Ohrid tributaries is in the fact that they contribute with approximately 50% in the overall water balance of this aquatic ecosystem. Likewise, they represent important habitats, hence positively affecting the maintenance of the general biodiversity of the lake`s watershed, especially the macroinvertebrates biodiversity.

The subject of this research was to assess whether these water bodies, bearing their importance in mind, have already been affected by the anthropogenic influence and in which manner these changes have been reflected in the macrozoobenthos community structure. Thus, by implementation of the results obtained for the Irish Biotic Index (IBI), an assessment of the ecological status of the tributaries, according to the EU Water Framework Directive, has been done for the first time. The results indicated to a lower ecological status in most of the sampling sites than the required "good" ecological status by the WFD. In fact, the inflows of the rivers have been assessed with moderate to bad ecological status (in fall) for River Sateska and bad for rivers Koselska and Cherava in both fall and spring.

Key Words: tributaries, Lake Ohrid, ecological status, benthic fauna.

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1. INTRODUCTION

The use of community structure of freshwater organisms for bio-monitoring can be traced back to the pioneering work of two German scientists, R. Kolkwitz and M. Marsson, in the early 1900s. Their publication on saprobity (degree of pollution) led to the development of indicator organisms. Today, indicators are much sought after as magic bullets to summarize a wide variety of states – from biological health to economics.

There are compelling reasons for the apparent popularity of freshwater macroinvertebrates in current bio-monitoring practice (Rosenberg et al., 1997): they are ubiquitous; they are species rich so the large number of species produce a range of responses; they are relatively sedentary; they are long-lived, which allows temporal changes in abundance and age structure to be followed, and they integrate conditions temporally, so like any biotic group, they provide evidence of conditions over long periods of time.

The use of benthic macroinvertebrates as environmental indicators is based on their ability to respond to a variety of environmental variables such as sediment quality, water quality, hydrological conditions, shading and biological factors (Armitage et al., 1983; Rosenberg & Resh 1993; Chessman 1995; Bonada et al. 2006). Furthermore, benthic invertebrates play an essential role in key processes within aquatic ecosystems (food chain dynamics, productivity, nutrient cycling and decomposition: Reice & Wohlenberg 1993 creating an important link between primary producers, detrital deposits and higher trophic levels in aquatic food webs (Brinkhurst 1974, Stoffels et al 2005). Consequently, benthic macroinvertebrates have become the most commonly used biological indicators in freshwater ecosystems (Resh & Jackson 1993).

The Water Framework Directive (2000/60/EC) (WFD) requires establishment of bio-monitoring programmes and reaching good ecological status for European aquatic ecosystems. It is based on more holistic approach of functioning and structure of aquatic ecosystems taking into consideration 5 biological quality elements: fish, phytoplankton, macrophytes, phytobenthos and benthic macroinvertebrates (Irvine et al. 2002; Heiskanen et al. 2004).

Assessing the ecological status of the water bodies in the watershed of Lake Ohrid, based on the WFD requirements have only recently started. The research has been limited to the littoral region of the Lake Ohrid (Loshkoska, 2015; Schneider et al., 2014; Trajanovska et al., 2014). Unlike the lake, very little attention has been given to the community structure inhabiting the Lake watershed, i.e. tributaries in general. Thus, until this research, the ecological status of the tributaries has never been a subject of research.

The primary goal in this study was to assess the ecological status of the tributaries as important contributors in the water balance for the Lake and habitats for the benthic fauna. In that context, some attributes of the benthic communities structure such as density and diversity and their seasonal and spatial variations as well as the impacting factors have been investigated.

2. MATERIAL AND METHODS

The research has been completed within one-year period duration, in 2014. Following the natural laws and life cycle of macrozoobenthos, the sampling dynamics was twice during the year: in spring and in autumn.
The sampling sites selection have been done taking into consideration the differences in the level of anthropogenic pressure and the bottom heterogeneity.
The samples from River Sateska have been collected from three sites along the river: Upper Course, in the upper flow; Middle Course in the middle flow and Inflow close to the inflow into the Lake. Only one site, the inflow of the rivers into the Lake, has been sampled for the rivers Koselska and Cherava (Fig. 1.).

Figure 1. The sampling sites

Kick and sweep method (ISO: EN 27828:1994 AQEM/STAR-lakes: Cheshmedjiev et al. 2011) was used during the sampling on the tributaries on sandy, gravely and mixed bottom covered by macrophytic vegetation. The kick net was D-shaped, with a metal frame holding a mesh bag of 400-

mm size (Fig. 2.). The standard kicking time interval was 5 minutes. In order to calculate the qualitative composition of the sampled area, a metal rectangular square (1m^2 square) was set on the bottom where the sampling was taking part. This sampling type has been used on all sampling sites. The depth point was varying between 0.3-0.6 m. The samples have been sieved, preserved with 70% ethanol and transported to the Laboratory for further examination.

Figure 2. Kick and sweep-D-shaped net

Next, the determination has been done using the following keys: Lukin 1976, Sapkarev 1964, Radoman 1983; 1985, Kerovec 1986, Polinski (1929), Snegarova (1954), Radoman (1959), Hubendick (1960, 1970), Hadzisce (1974), Krstanovski (1994) etc.

Finally, the Irish Biotic Index-IBI (modified Biotic Index) was used to assess the ecological status of the sampling sites. The Biotic Index was developed by EPA using QRS (Q-value) based scheme and successfully applied in the river monitoring programs under WFD. The Q-value of a sampling site is assigned to one of five ecological classes from 5-1, indicating class status ranged from bad to high (Waterstatusireland.irish-surge-forecast.ie, 2016)

3. RESULTS AND DISCUSSION

Table 1 shows the benthic community structure, i.e. density and diversity of the macrozoobenthos from the sampling localities in the tributaries of Lake Ohrid. 51 species have been registered in both seasons from 6 systematic groups: Oligochaeta, Hirudina, Gastropoda, Isopoda, Amphipoda and Insecta. 72 % of the total diversity belongs to the group of Insecta. The diversity of the other 5 classes, with an exclusion of Isopoda, is almost evenly distributed and ranges within the boundaries from 6-8% (Fig. 3.). This high portion of Insecta diversity of the macrozoobenthos in the rivers distorts the common patterns about the diversity in the Lake where Insecta are insignificant little present, but Gastropoda apparently predominates.

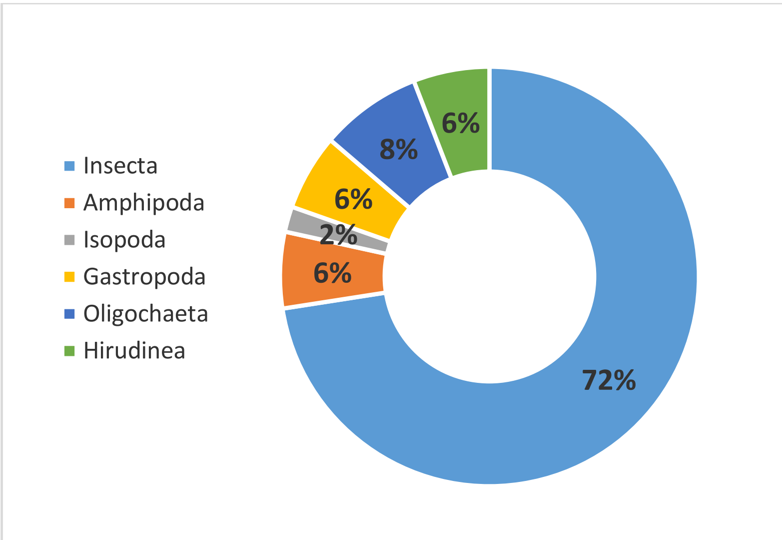

Figure 2. Classes contribution in the general diversity

Table 1. Density and diversity of the macrozoobenthos in the tributaries of Lake Ohrid

Species	R.Sateska Upper		R.Sateska Middle		R. Sateska Inflow		R.Koselska		R.Cerava	
	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall	Spring	Fall
Aeshna grandis Linnaeus, 1758									1	
Ancylus fluviatilis O.F. Muller, 1774	1	2		1						
Aphelocherius aestivalis Fabricius, 1794			2		1					
Asellus aquaticus Linnaeus, 1758								1		
Atheryx sp.	3		3							
Baetis vernus Curtis, 1834	32	39	4	30			8			4
Baetis rhodani Curtis, 1834				3				3		
Baetis scambus Curtis, 1834				7						
Bezzia sp.	1									
Caenis macrura Stephens, 1835							1			
Chironomus sp.	1		24						64	
Chironomus plumosus Linnaeus, 1758		13		3		4	10	18		
Coenagrion sp.									1	
Corixa sp.						1				
Criodrilus lacuum Hoffmeister, 1845		1								
Dytiscus sp.				1						
Ecdyonurus venosus Bürmeister, 1839	4	5		14	3					
Epeorus sp.	4	8								
Ephemera danica Müller, 1764	17	33		94	38	29	1			7
Ephemerella sp.	6									
Erpobdella octoculata Linnaeus, 1758			4	4	3		2	3		
Gammarus balcanicus Schäferna, 1922	36	47		27						
Gammarus roeseli Gervais, 1835			64	170	83	375				7
Gammarus ochridensis Schäferna, 1926										8
Glossiphonia complanata Linnaeus, 1758	1				1					
Goera sp.				2		1				
Gomphus vulgatissimus Linnaeus, 1758			2		1	2				
Haemopis sanguisuga Linnaeus, 1758									2	
Hermetia sp.							1			
Hydrophilus sp.									2	
Hydropsyche sp.	1									
Isoperla sp.	1	3		3						
Leptocerus sp.	49	49		111	12	1				
Leptophlebia sp.						6				
Leuctra sp.				2	1					
Limnephilus sp.			4	2	3					
Limnius sp.			4	1	1					
Limnodrilus hoffmeisteri Claparède, 1862							1			
Lymnaea stagnalis Linnaeus, 1758								3		
Ormosia sp.				1			1			
Perla marginata Panzer, 1799	14	21								
Platanbus sp.									2	
Potamothrix hammoniensis Michaelsen, 1901		1		1				8		
Rhithrogena sp.	23									
Rhyacophila sp.		16								
Sericostoma sp.	6			16	1	3		1		5
Silo sp.	3									
Stylodrilus sp.							7			
Tabanus sp.	1		1	4						
Theodoxus fluviatilis Linnaeus, 1758			3							
Tipula sp.		4							2	

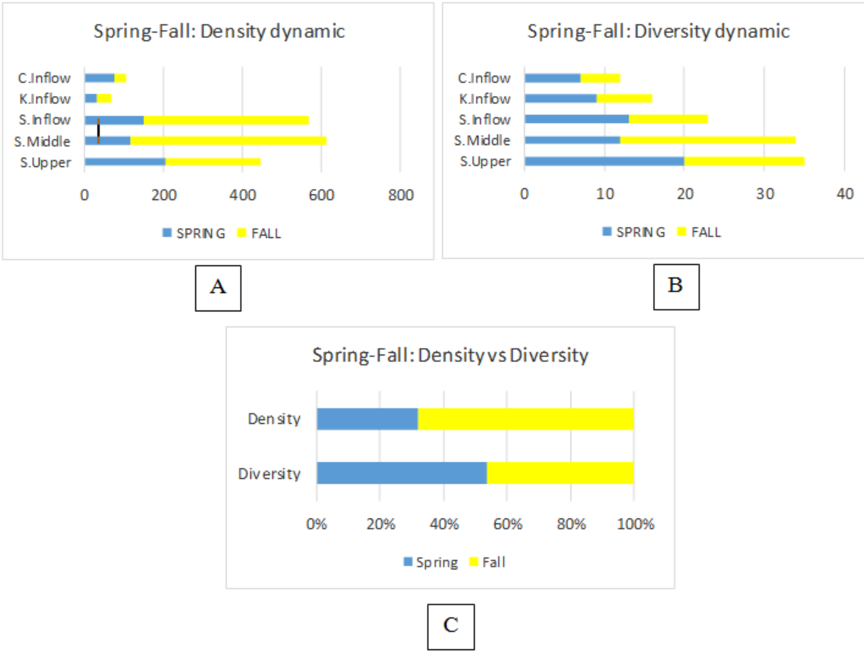

Figure 4 (A-C): Density and diversity variations in spring and fall: A-density dynamic; B-diversity dynamic; C-Density vs. Diversity dynamic

Figure 4 depicts the variation in the density and diversity of the general macrozoobenthos in spring and fall season. Thus, the diversity, with an exclusion in the sampling site Sateska Middle (S.Middle) is higher in spring than in fall. But if we analyze the density trend in both seasons, it is obvious that the density significantly increases during the fall period. Seasonal variability of the benthic community structure and productivity is high because many species of the benthic macro invertebrates have annual (or shorter) life cycles, which culminate in an adult phase during the open water period. Having in mind that over 70 % of the species are from the class of Insecta, diversity decreasing is expected phenomenon. In fact, during the late spring and early summer period, most of the aquatic species develop from larvae to imagoes leaving the water environment. This enable the immature ones, or the ones producing second generation, developing under "optimal" conditions: higher food availability as a result of the increased level of organic sedimentation and lowered competition for food.
Both density and diversity besides the seasonal dynamics are even more prone to changes resulting from sediments characteristics (spatial distribution) and anthropogenic impact or due to synergy of both of them. This is best evidenced along the river course of River Sateska, where the

samples have been taken from three different sampling points with different sediment traits and level of anthropogenic impact. In fact, as it can be seen from the Figure 5, the density and diversity have an irregular trend, whereby they are highest in the upper course (S.Upper-Spring) then they decrease in the middle and again increases in the inflow. The highest density and diversity which coincide with the upper course is due to the absence of any visible anthropogenic influence, i.e. this site could be considered as a reference site.

The decrease in the density and diversity in the middle course is due to the increased anthropogenic impact represented by agricultural activities and the alteration of the natural meandering river bad into straightforward canal. This river in 1962 was diverted into the Lake (Jordanoski et al., 2007) and ever since it flows through both agricultural and urban areas and carries a very high load of waste water, sewage waste, nutrients such as phosphorous and nitrogen, but most of all it loads the Lake with huge sediment amount. The load of phosphorus coming from the River Sateska might be about the same as that coming from the sewerage of Pogradec (Watzin et al., 2002). Finally, the increasing of the density in the inflow in comparison with the upper course, especially in the fall period is due to the faunal exchange between the Lake and the river.

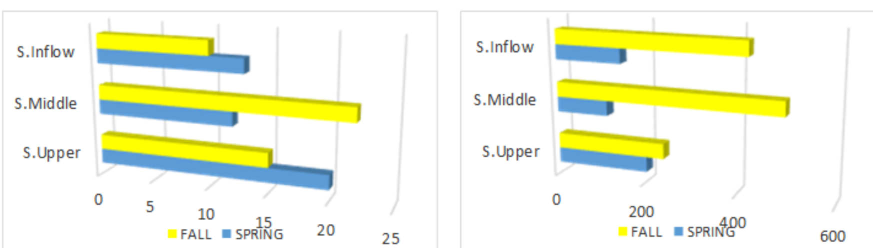

Figure 5 (A-B): Diversity and Density variations along river Sateska: A-diversity dynamic; B-density dynamic.

In fact, many benthic faunal elements from the littoral of the Lake penetrate into the lower course of the river thus increasing the overall density of the macrozoobenthos (Trajanovski et al., 2015). This is not a case with the diversity, which is significantly lower than the upper and middle course especially in the fall, as a result of absence of many Insecta representatives as it has already been explained above: most of the Insecta larvae have become imagoes and left the water environment.

In fall, the conditions in regards to the density differs concerning the middle course, where the highest densities have been recorded. The explanation behind this phenomenon is in the decreased water level and turbulence

altogether with higher input of organic load from the aquatic and neighboring terrestrial vegetation. These enabled conditions for optimal development of the population of the *Gammarus roeselii*, as a representative of the scrapers/shredders functional feeding group (Mayer et al., 2009). This species comprises 34 % of the total community density.
In the two other rivers, the variations of the density and diversity are also prone to seasonal changes but the community structure is very poor, i.e. both the diversity and the density are significantly lower than the sampling sites in River Sateska. This could be explained by an increased anthropogenic impact which has been reflected in the deteriorated trophic state of the water and habitat change (Matzinger et al, 2006; Veljanoska Sarafiloska, 2002; Trajanovski et al., 2015).
Furthermore, the community structure, i.e. metrics has been used in assessment of the ecological status of the tributaries of Lake Ohrid. IBI index values from 1-5 have been extrapolated in the scale referring the ecological status within the boundaries from high to very bad status.
The term ‘ecological status’ is defined in the WFD as: ”…*an expression of the quality of the structure and functioning of aquatic ecosystems associated with surface waters, classified in accordance with Annex V*” (WFD 2000-Article 2.21, 2000). This implies that classification systems should reflect changes taking place in the structure of the biological communities and in the overall ecosystem functioning as response to anthropogenic pressures.
Table 2 shows the IBI values and their interpretations about the ecological status of all researched sites by assigning one of the five ecological classes ranging from high to bed.

Table 2. Seasonal variations in the ecological status of the sampling sites

	S.Upper	S.Middle	S.Inflow	K.Inflow	C.Inflow
SPRING	5	3	3	2	2
FALL	5	3	2	2	2

As it can be seen and already been explained by the community structure, the ecological status of the tributaries varies in the boundaries high to bad. High ecological status has been registered in the upper course in river Sateska, in both seasons, where no visible changes or any anthropogenic influence has been observed. That is why this site could be considered as reference site.
Going down the course of the River Sateska, the anthropogenic influence increases, which results in decreasing of the ecological status. Hence, in the middle course in both seasons the ecological status has been assessed as moderate. During the spring seasons, the ecological status of the Inflow is

also moderate, but in fall, due to the lower water level and increased agricultural activities, the water quality deteriorate which is reflected on the ecological status, i.e. the ecological status changes from moderate to bad. In the two other rivers, the ecological status stayed unchanged throughout both seasons, i.e. it has been assessed as bad ecological status. Both rivers have been known as major contributors for pollution of the littoral of the Lake, loading it with sediments, organic waste, phosphorous and nitrogen (Veljanoska Sarafiloska et al., 2008). More precisely, River Koselska from the village of Kosel to its inflow passes through populated areas and represents recipient of the waste domestic waters from the households and sediments from the agricultural areas which contribute to deterioration of the River’s water quality. Similarly, the River Cherava which rises in Albania, on the way beside accepting the domestic waste and sewage waters, due to the erosive character of the ground, it becomes one of the main donors of erosive material into the Lake.

4. CONCLUSIONS

As represented above, the ecological status of the sampling sites varies in the boundaries from high to bad based on the values of IBI index. The high ecological status was record in the upper course of River Sateska in both seasons. Unlike, the ecological status deteriorates going down the river course, first to moderate than to bad, which is in correlation to the level of the anthropogenic impact: changes of the river bed, altered habitats and season as shown in the Inflow of River Sateska.

The macrozoobenthos community structure in the sampling sites seemed affected by the seasonal changes of the factors in the water medium (either physical or chemical), but more to the spatial changes as result of the anthropogenic factor. As shown above, the seasonal changes affect and “promote” the lower density and diversity of the benthic communities.

5. REFERENCES

AQEM. 2002. Manual for the application of the AQEM method. A comprehensive method to assess uropean streams using benthic macroinvertebrates, developed for the purpose of the Water Framework Directive. Version 1.0, February 2002, 1-89.

Armitage, P., Moss, D., Wright, J. and Furse, M. (1983). The performance of a new biological water quality score system based on macroinvertebrates over a wide range of unpolluted running-water sites. *Water Research*, 17(3), pp.333-347.

Bonada, N., Prat, N., Resh, V. and Statzner, B. (2006). DEVELOPMENTS IN AQUATIC INSECT BIOMONITORING: A Comparative Analysis of Recent Approaches. *Annual Review of Entomology*, 51(1), pp.495-523.

Brinkhurst, R.O. (1974). The benthos of lakes. McMillan Press Ltd. London. 190 pp

Cheshmedjiev S., R. Soufi, Y. Vidinova, V. Tyufekchieva, I. Yaneva, Y. Uzunov, E. Varadinova (2011). Multi-habitat sampling method for benthic macroinvertebrate communities in different river types in Bulgaria. - *Water Research and Management*, 1 (3), 55-58

Chessman, B.C. (1995). Rapid assessment of rivers using macroinvertebrates: a procedure based on habitat-specific sampling, family-level identification and a biotic index. *Australian Journal of Ecology* 20, 122-9

Hadzisce S. (1974): The fauna of the snails in Lake Ohrid as an animal group rich with endemic forms and its spread in the separate zones of bental region. Congress for problem of the regulation of Lake Ohrid. Skopje, pp. 260-271.

Heiskanen, A.-S., W. Van de Bund, A.C. Cardoso & P. Nõges (2004): Towards good ecological status of surface waters in Europe – Interpretation and harmonisation of the concept". *Water Science and Technology* 49 (7), 169-177.

Hubendick B. (1960). Faunistic review of the Ancylidae of Lake Ohrid. – Arch. Sc. Biol/. Beograd, (3–4): 89–97.

Hubendick B. (1970). Studies on Ancylidae. The Paleartic and Oriental species and formgroups. Acta Regiae Societatis Scientiarum et Litterarum Gothoburgensis (Zool) 5: 4-52

Irvine, R., Kerridge, I., McPhee, J. & Freeman, S. (2002). Interprofessionalism and ethics: consensus or clash of cultures? *Jnl of Interprofessional Care*, 16:3, 199-210.

Jordanoski M., Velkova-Jordanoska L., Veljanoska-Sarafiloska E. (2007): Ecological effects of River Sateska and its tributaries on ancient Lake Ohrid: *Natura Montenegrina*, Podgorica, 7(2): 541-547.

Krstanovski, Z. (1994). Taxonomy and ecology of Planaria from Lakes Ohrid, Prespa and Dojran and Adjacent Water-bodies. PhD thesis, Sts. Cyril and Methodius University, Skopje.

Loshkoska, T. (2015). Benthic diatoms as a tool for assessment of the trophic status of Lake Ohrid and its watershed. *MSc* Thesis. PSI Hydrobiological Institute - Ohrid, University "St. Kliment Ohridski", Bitola, 131 p.

Lukin, E. I. (1976). Fauna SSSR: Leeches (First part). Scientific Academy, Institute for Zoology,published by “Nauka” Leningrad.

Matzinger A., Jordanoski M., Veljanoska-Sarafiloska E., Sturm M., Muller B. and Wuest A. (2006). Is Lake Prespa Jeoparadizing the Ecosystem of Ancient Lake Ohrid? *Hydrobiologia* **553**: 89-109.

Mayer, G., Maier, G., Waloszek, D. and Maas, A. (2009). Mouthpart Morphology of Gammarus Roeselii Compared to a Successful Invader, Dikerogammarus Villosus (Amphipoda). *Journal of Crustacean Biology*, 29(2), pp.161-174.

Polinski W. (1929). Limnological investigation of Balcan Peninsula. Relict Gastropod fauna of Lake Ohrid. Glas Srp. akad. nauka, Beograd, 173(65): 131–178.

Radoman, P. (1985). Hydrobioidea a superfamily of Prosobranchia (Gastropoda), II. Origin, Zoogeography, Evolution in the Balkans and Asia Minor. Monographs, Inst. zool. Prir. Mat. Fak., Beograd, 1/1: 1-173.

Radoman, P., (1983). Hydrobioidea, a superfamily of Prosobranchia (Gastropoda). I. Systematics. Monographs, Serb. Acad. Sci., Belgrade, str. 1-256.

Reice, S. R., and M. Wohlenberg. (1993). Monitoring freshwater benthic macroinvertebrates and benthic processes: measures for assessment of ecosystem health. Pp. 287–305 in D. M. Rosenberg, and V. H. Resh, eds. Freshwater bio-monitoring and benthic macroinvertebrates. Chapman and Hall, New York, NY.

Resh, V.H. & Jackson J.K. 1993. Rapid assessment approaches to bio-monitoring using benthic macroinvertebrates. In: Rosenberg, D.M. & Resh, V.H. (eds.) Freshwater bio-monitoring and benthic macroinvertebrates. Chapman and Hall, London. p.95-233

Rosenberg, D. M. & Resh, V.H. (1993). Freshwater Biomonitoring and Benthic Macroinvertebrates. Chapman & Hall, New York. ISBN: 0-412-02251-6x. 488 pp

Rosenberg, D.M., Davies, D.G.Cobb, and Wiens, A.P. (1997). Protocols for Measuring Biodiversity: Benthic Macroinvertebrates in Fresh Waters. Dept. of Fisheries & Oceans, Freshwater Institute, Winnipeg, Manitoba. 53, Appendices

Sapkarev, J., (1964). Fauna of Oligochaeta from Lake Ohrid. Godsen zbornik na Prirodno-matematickiot fakultet na Univerzitetot vo Skopje 15: 5-98.

Schneider, S., Cara, M., Eriksen, T., Budzakoska Goreska, B., Imeri, A., Kupe, L., Lokoska, T., Patceva, S., Trajanovska, S., Trajanovski, S., Talevska, M. and Veljanoska Sarafiloska, E. (2014). Eutrophication impacts littoral biota in Lake Ohrid while water phosphorus concentrations are low. *Limnologica - Ecology and Management of Inland Waters*, 44, pp.90-97.

Snegarova Lj. (1954). Fauna of Gastropods on the Lake Ohrid. Acta. Published by Museum for Natural Sciences, Skopje. pp. 55–85.

Stoffels, R., Clarke, K. and Closs, G. (2005). Spatial scale and benthic community organisation in the littoral zones of large oligotrophic lakes: potential for cross-scale interactions. *Freshwater Biology*, 50(7), pp.1131-1145.

Trajanovska, S., Talevska, M., Imeri, A. and Schneider, S. (2014). Assessment of littoral eutrophication in Lake Ohrid by submerged macrophytes. *Biologia*, 69(6).

Trajanovski, S., Budzakoska-Gjoreska, B., Trajanovska, S. and Zdraveski, K. (2015). Habitat change - driving force for endemic/cosmopolitan ratio perturbation in the benthic fauna of ancient Lake Ohrid and its watershed. *Review*, 43(1), pp.113-127.

Veljanoska-Sarafiloska E. (2002). Nitrogen and phosphorus loading in Lake Ohrid influenced by Rivers Velgoska and Koselska. Master thesis. University “St.Kiril and Metodij”, Skopje, Macedonia. (in Macedonian).

Veljanoska-Sarafiloska E., Jordanoski M. and Semo M. (2008). Water quality at the littoral zone of the Macedonian part of Lake Ohrid. Review. *PSI Hydrobiological Institute-Ohrid* **41**, 70-78.

Waterstatusireland.irish-surge-forecast.ie. (2016). WELCOME TO HIGH STATUS IRELAND. [online] Available at: http://www.waterstatusireland.irish-surge-forecast.ie/services.html [Accessed 6 May 2016].

Watzin, M, Puka, V, Naumoski, T (eds) (2002). "Lake Ohrid and its watershed, State of the environment report" (Lake Ohrid Conservation Project. Tirana, Albania and Ohrid, Macedonia).

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THE CARTOGRAPHIC PROJECTIONS USED IN ALBANIAN MAPS

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SUMMARY

Map projections and coordinate transformations are the basis of achieving a common frame of reference for geographic information. The requirement of a common ellipsoid, datum, map projection, and finally plane coordinate systems make it possible to use plane geometry for all types of spatial overlay and analysis. Projection of geographic data from the ellipsoidal Earth to a plane coordinate system always results in distortion in area, shape, distance, and other properties. With appropriate selection of a projection, the user can preserve desired characteristics at the expense of others.

For the production of Albanian maps are used different cartographic projections. This is explained with the fact that most of these maps are created from foreign persons and geographic institutions, keeping safe their cartographic traditions.

The cartographic projections used as mathematical base of topographic and thematic maps of Albania are:

- Polar conic projection in the new edition of Ptolemy maps;
- Gauss-Krüger projection in Bessel ellipsoid, with origin the intersection of the Equator by the meridian of Ferro with λ_{Ferros} = 17° 39' 46.5'' in the maps, scale 1:75000 and 1:50000, published by Military Geographic Institute of Wien (1868-98, 1913-18);
- Polyconic equivalent Projection of Bonn in Clark ellipsoid with origin the intersection of the Equator by the central meridian $\Lambda_0 = 18^0$ 39' 09", in the maps of scales 1:50000, published by Military Geographic Institute of Florence (MGIF) (1922-25);
- Bonne pseudo-conic equivalent projection in Bessel ellipsoid with origin the intersection of parallel Φ_0 = 41° 20' 12''.809 by the central meridian Λ_0 = 19°

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45’ 45”.285, in the maps of scales 1:50000, published by Military Geographic Institute of Florence (MGIF), Italy (1927-1934);

- Gauss - Boaga projection in Bessel ellipsoid with origin the intersection of the Equator by the central meridian $\Lambda_0 = 20^0$, in the maps of scales greater than 1:50000 and topographical plans of residential areas at 1:5000 scale, published by Military Geographic Institute of Florence (MGIF) (1939 - 1948);
- Gauss-Krüger projection in Krassowsky ellipsoid with origin the intersection of the Equator by the central meridian $L_0=21^o$ in the maps, scale 1:25000 and 1:10000, published by Military Geographic Institute of Albania (1950 - 1955, 1970 - 1992)[4]. During the period 1946-1996 are also created a series of cadastral maps (which covered approximately 56.27% of the Albania’s territory) in scale 1: 500; 1: 1000; 1: 2000; 1: 5000; 1: 10000 and 1: 50000. Cadastral maps created during the years 1946 - 1960, are in 1: 2500 and 1: 5000 scale and based on the Bessel ellipsoid, Gauss-Kruger projection and the central meridian Lo = 20º 00'. Almost all cadastral maps created after 1960 were constructed in the state coordinate system: the Krasowsky ellipsoid, Gauss-Kruger projection and central meridian Lo = 21^0 00’.
- UTM projection in WGS 84 ellipsoid with origin the intersection of the Equator by the central meridian $\Lambda_0 = 21^0$, in the maps of scales 1:50000 and 1:25000, published by Military Geographic Institute of Albania (MGIA) (after 1994);
- Version of the pseudoconic projection, developed by prof. dr. Agim Shehu (Polytechnic University of Tirana, Albania) in the Earth sphere, was used for the first time at the “The geographical atlas of Albania” 1968, in the scales 1:2000000 and smaller ones. In the 1980 year this projection was used for the creation of the maps of Albania in the scale 1:200000, as geological, hidrogeological and fitogeographical maps, etc. also it is used for all (127) the maps of “Climatic atlas of Albania”, 1986, in the scale 1:800000 and for all (256) the maps of “Agricultural geographical atlas of Tirana district” in the scales 1:100000.

Keywords: *cartography, map, mapping, map projections, mathematical cartography, Albania*

1. INTRODUCTION

New methods of acquiring spatial data and the advent of geographic information systems (GIS) for handling and manipulating data mean that we no longer must rely on paper maps from a single source, but can acquire,

[4] The central meridian, $\Lambda_0 = 21^\circ$, is located at easternmost extreme of Albania, leaving on his west over 99.7% of the territory. The area with the greatest distortions of the projection is the coastal zone. The distortions in this area reduce accuracy of topographical plans of large scales, which are necessary for development of tourist infrastructure, economic and cadastral system.

combine, and customize spatial data as needed. To ensure quality results, however, one must fully understand the diverse coordinate frameworks upon which the data are based. Datums and Map Projections provides clear, accessible explanations of the terminology, relationships, transformations, and computations involved in combining data from different sources.

The concept of cartography as science was presented for the first time under the title geography in the second century in the famous Ptolemy's work Introduction into Geography. In the middle Ages, the regional direction in geography that was built on Ptolemy's ideas, found its expression in the most important geographic works of that time, in big atlases from the 16th and 17th centuries that were collections of maps and comprehensive texts. The synonym for cartography was cosmography, and some cartographers of that time were called cosmographers.

Theory of map projections is a branch of cartography studying the ways of projecting the curved surface of the earth and other heavenly bodies into the plane, and it is often called mathematical cartography[5]. Map projections have been developing parallel with the development of map production and cartography in general.

The subject of map projections, either generally or specifically, has been discussed in thousands of papers and books dating at least from the time of the Greek astronomer Claudius Ptolemy (about A.D.150), and projections are known to have been in use some three centuries earlier.

Mapmakers have developed hundreds of map projections, over several thousand years. Three large families of map projection, plus several smaller ones, are generally acknowledged. These are based on the types of geometric shapes that are used to transfer features from a sphere or spheroid to a plane. Map projections are based on *developable surfaces,* and the three traditional families consist of cylinders, cones, and planes. They are used to classify the majority of projections, including some that are not analytically (geometrically) constructed. Which developable surface to use for a projection depends on what region is to be mapped, its geographical extent, and the geometric properties that areas, boundaries, and routes need to have, given the purpose of the map.

During last six centuries are used different cartographic projections for the production of Albanian maps. This is explained with the fact that most of these maps are created from foreign persons and geographic institutions,

[5] The object of study of the mathematical cartography it is on the one hand representation of Earth’s curved surface on a flat surface (map), on the other hand how to use the maps in various scientific and practical purposes. Plan representation of a portion of the land area is done by choosing an appropriate projection system purpose and destination topographic map or plan which is to be drawn.

keeping safe their cartographic traditions. For a small country as Albania, number of the projections used must be tightly related with criteria well determined.

Albania always has profited by the wide cartographic experience of the other countries with a great economic and scientific potential. Our cartographers have followed with much attention and interest the progress in theory, technique and technology of cartography. A lot of this progress is reflected in the practice of Albanian mathematical cartography particularly in the theory of cartographic projections.

In our article, we analyzed, except some of the usual cartographic projections, some projections processed theoretically and practically by prof. Agim Shehu, which are used in the compilation of several thematic atlases in Albania.

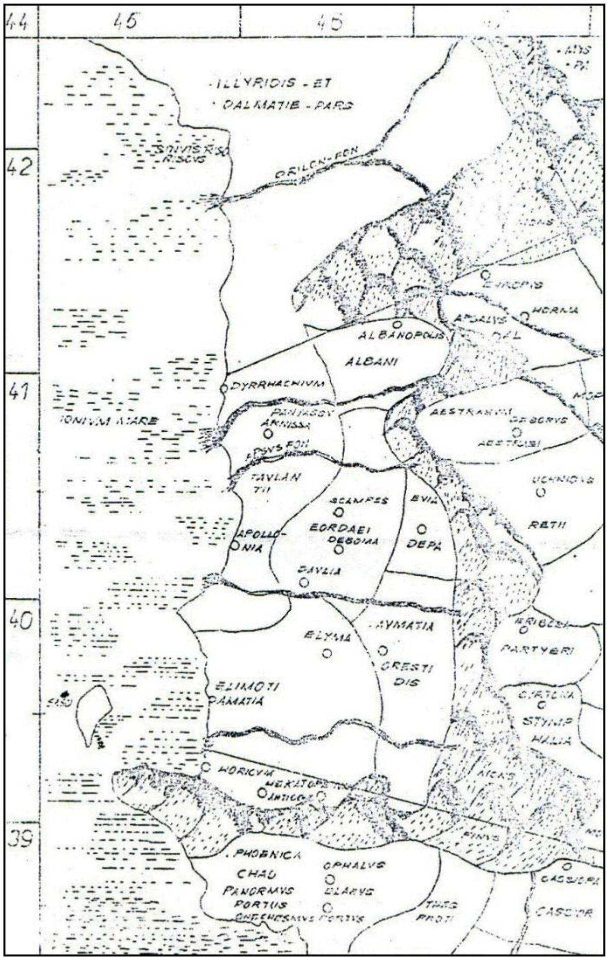
2. A BRIEF HISTORY OF ALBANIA MAPPING

Albania is one of the oldest nations in the European Continent. Some of the cities as Berat (antique name is Antipatra), Durres (Durrahcium), Apollonia (Apoloni), Lezha (Lissus), Butrint (Buthranton), etc., are founded since the fifth and fourth centuries before Christ. Some of these cities are reflected also in the small scale maps of Hecate, Eratosten, Strabon, etc.

Albania is presented detailed in the maps of Ptolemy[6] (map 1), in the Roman maps of Peutinger, in the Albanian maps and portulanes ones. In the 16-th century, after the discovery of the new continent, at the time when the world economical center has moved from Italy at Netherland, at the time when the

[6] In cartography, Ptolemy is best known for three map projections: the first projection employed straight meridians that converged at the poles and curved parallels—qualities of a simple conic projection; the second projection would be classified today as a pseudoconic projection (it has curved evenly-spaced parallels and curved meridians that converge at the poles); his third projection would be classified today as an azimuthal projection. One of the most surprising features of Ptolemy's world map (ca. 150 AD) is its excessive distortion along the east-west direction. This is because the excessive distortion of Ptolemy's maps is a natural result of the erroneous value he adopted for the Earth's circumference in combination with Ptolemy’s attempt to preserve the latitudes of some locations gained through astronomical observations. Another consequence is the instability of the position of Ptolemy’s Prime Meridian in the geographical coordinate system, mutual rotation of the local maps and the displacement of positions given with respect to a reference point lying approximately on the same meridian along the north-south axis. It resembled a modified perspective view of the earth, but there is little, if any, evidence that he actually used it.

flow of Europeans going towards America has began, it was seemed a great fall of cartography in many countries of Europe. The contrary has happened in Albania, where it was a great increase in the mapping of its land.



Map 1. *Ptolemy's map of Albanian territory. Claudius Ptolemy "Geographia" is a fundamental geographic and cartographic work of the 2nd century A.D. which influenced European cartography of the Renaissance. Ptolemy can be considered as one of the first who gave a "concrete" cartographic evidence to the region of central Europe a part of which is covered by today's territory of the Albania.*

We can mention through the numerous portulane maps in the 16-th century the maps of Comotio (1571), which are considered the first topographical maps of our land; the maps of Reis (1529), Gastald (1560), Mercator (1585), etc., present rather detailed all the territory (Shehu & Dragovoja, 1984),

In the 17th century were considered valuable the maps of Canteli (1689), Coronelli (1691) and Tchelebi (1635). They have personally carried out itineraries in different areas of Albania. The maps of the above mentioned authors have served as a base for the creation of the new maps, in the 18th century.

Hartenthum (Hartenthum, 1903) has given a completed table for the maps produced in the 19th century: among them we can mention the maps of Palma, Lapie, Weis, Hahn, Kiepert, Gubernatis, Military Geographic Institute of Wien, etc.

At the beginning of the 20th century were created new accurate and rich maps for all territory of Albania from Baldacci (Baldacci, 1917) and Nopcsa (Nopcsa, 1929). These maps were based on the results of the itineraries carried out by authors.

During the First World War, the Military Geographic Institute of Wien has carries out the topographical surveying of Northern and Central Albania, in the scale 1:75000, while the Military Geodesic Services of Italy and France have surveyed a part of Southern Albania in the scale 1:50000. After the First World War, Herbert Louis (Louis, 1928) has surveyed in the scale 1:100000 the areas unfinished by the above mentioned military services and has published in 1928 the new map of Albania in the scale 1:200000.

From 1927 until 1939 the Military Geographic Institute of Firenze was involved in the creation of new topographical maps, in the scale 1:50000 for all the territory of Albania. Because of the beginning of the Second World War the works was interrupted, making impossible surveying of a small part of southern Albania.

Until this period of 20 – the century are produced a lot of thematic maps, also by Albanian authors inside and outside Albania. During centuries the Albanian administration and specialists have contributed in a decisive way to provide a complete and accurate content of the maps, continuing of the surveys, itineraries, etc. In the places where their presence has missed there are a lot of mistakes. Those who have read Armao (Armao, 1937), Ginzel (Ginzel, 1918) and Traversi (Traversi, 1965), have understood the necessity of the presence of Albanian administration and topographers.

After the Second World War were founded in the new state of Albania different topographical and cartographical services giving their precious contribution in this field (Shehu & Dragovoja, 1984).

3. THE MAIN CARTOGRAPHIC PROJECTIONS USED IN TOPOGRAPHIC AND THEMATIC MAPS AND IN GEOGRAPHICAL ATLASES

Mapmakers have a general rule that small-scale maps can be projected from a sphere, but large-scale maps always must be projected from an ellipsoidal surface such as e.g. the WGS 84 ellipsoid etc. In the above mentioned maps are used different cartographic projections:

- The new edition of Ptolemy maps are based in his polar conic projection,
- Military Geographic Institute of Wien and H. Louis have used Gauss – Kruger projection;
- Military Geographic Institute of Firenze has used Bonn pseudoconic projection;
- Most of the above mentioned authors of maps have used polar conic projections;
- Military Geographic Institute of Albania and Albanian geodesical Services have used Gauss – Kruger projection;
- The cartographic services has used polar conic, Gauss – Kruger and the versions of pseudoconic projections prepared by prof. Agim Shehu for the creation of thematic maps.
- Actually, the Military Geographic Institute of Albania is using the UTM projection for preparation of topographical maps in scale 1:50000 and 1:25000.

3.1. Polar Conic Projection of Ptolemy

Conic map projections are appropriate for mapping regions at medium and large scales with east–west extents at intermediate latitudes. Conic projections are appropriate for these cases because they show the mapped area with less distortion than other projections. In order to minimize the distortion of the mapped area, the two standard parallels of conic projections need to be selected carefully.

The new edition of Ptolemy maps are based in his polar conic projection[7]**.** Ptolemy C. ACE 130 revolutionized the depiction of the spherical earth on a map, and suggested precise methods for fixing the position of geographic features on its surface using a coordinate system with parallels of latitude and meridians of longitude. Ptolemy's eight-volume atlas Geographia

[7] The simple conical projection, from Ptolemy, Cosmographia. Ulm: Lienhart Holle, 1482

(Geography) is a prototype of modern mapping. It included an index of place-names, with the latitude and longitude of each place to guide the search, scale, conventional signs with legends, and the practice of orienting maps so that north is at the top and east to the right of the map—a universal custom today. In this work, he used information first presented by the Greeks, and was the first to come up with what are known as projections. Ptolemy approved the use of the projection for maps of smaller areas, however, with spacing of meridians to provide correct scale along the central parallel. Although Ptolemy's maps were incredible for the time, his maps were very inaccurate.

To determinate the geographical coordinates of the objects, it is necessary to know the dimensions and characteristics of the geometrical figure, which approximately coincides with the true form of earth. For that purpose, Ptolemy was based on the dimensions of the sphere, calculated by Poseidon, in which the length of the meridians and equator is 37800 km (Codazzi, 1959), i.e. about 2200 km less than the length calculated earlier by Eratosthenes. So, the radius of the Poseidon's sphere: R = 6016.057 km and the longest semi axis (a) of the Krasowsky's ellipsoid is a= 63778.245 km. Then, the difference a – R = 362.188 km.

The projection of Ptolemy is a conical, polar and equidistant, in which the length of the meridians (m) and that of standard parallel (P_0) aren't distorted. The standard parallel has the latitude $F_0 = 41^0 00'$.

3.2. The Transverse Mercator (TM) projection;

The Transverse Mercator (TM) projection in its various forms is the most widely used projected coordinate system for world topographical and offshore mapping. All *versions* (e.g. Gauss-Kruger, Gauss Boaga, and UTM) have the same basic characteristics and formulas. The differences which distinguish the different forms of the projection which are applied in different countries arise from variations in the choice of values for the coordinate conversion parameters, namely the *latitude* of the natural origin, the *longitude* of the natural origin (central meridian), the *scale factor* at the natural origin (on the central meridian), and the values of *False Easting* and *False Northing*. Additionally there are variations in the width of the longitudinal zones for the projections used in different territories.

3.2.1. Gauss-Kruger Projection, 1868-98, 1913-18, 1950 - 1951 and 1970 - 1985

Austro-Hungarian Empire for its interests in the Balkans[8], from the second half of the century 19-th and early the century 20-th through the Military Geographical Institute of Vienna (MGIW), built in the north of Albania, a reference coordinate to support mapping of this part of the territory of Albania, in scale 1:75000 and 1:50000. Geodetic co-ordinates of the points of triangulation were calculated on Bessel ellipsoid - 1841, Gauss-Krüger projection[9], with origin the intersection of the Equator by the meridian of Ferro with λ_{Ferros} = 17° 39' 46.5'', in the year 1918. False Northing origin 0.000 m and false Easting origin 0.000 m. Central meridian, each meridian go from central meridian, and the Equator are straight lines. Other meridians and parallels are complex curves, concave toward the central meridian and the nearest pole, respectively.

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[8] In support of military operations during the First World War, the southern part of Albania was surveyed by Geodetic Services of the Italian Army (for Vlora's district) and the French Army (for Kortcha's district) at 1:50000 scale. These maps were used by MGIW, to produce maps at 1:75000 scale. The 1:75000 scale maps covered approximately 75% of Albania's territory.

[9] In Europe this projection is called the Gauss-Kruger, in honor of the mathematicians Carl Gauss and Johann Kruger who later worked out formulas describing its geometric distortion and equations for making it on the ellipsoid. The Gauss-Kruger projection, also known as the Gauss Conformal, is the one conformal projection of the earth ellipsoid, in which the central meridian of the projection is held to have the same length and scale as the meridian arc of the ellipsoid. The central meridian, also known as the "principal meridian", is the central axis of the projection. In its standard form, the central meridian is taken to be at longitude 0 degrees. The central scale factor set at 1.0000, coordinate units in meters, for Northing's Xn and Easting's Ye. Xn is negative for latitudes south of equator. For a conformal projection, the source image and its projection must consist of complex coordinates with isometric properties.

The conversation, of geodetic coordinates (φ, λ) into Gauss – Gruger plane grid coordinates (N, E) is accomplished in three stages:

- To convert geodetic latitude φ into isometric latitude q (a Mercator variable). The transformation of (φ, λ) into (q, λ) creates a mapping of geodetic coordinates into Mercator variables, isometric coordinates pairs (q is known as the "isometric latitude".
- To transform complex isometric latitude ψ = q + i λ into the "complex intermediate latitude": w = u + iv, by the inverse Lambertian eGud (ψ, w).
- To evaluate the integral E_3 on w, to find the unitary coordinates: z = x + iy, and convert these to Gauss – Kruger metric coordinates N and E.

In the years 1950 -1955, the specialists of Military Topographic Group of Albania (MTGA) carried out the reconstruction and the densification of the MGI Net in order to grant the request for mapping in 1:25000 scales. At the same time, the first–order network was transformed from the MGI reference system (1934) into the 1942 co-ordinate system, which was based on Krassovsky ellipsoid, Gauss-Krüger projection[10] with central meridian $L_0=21^o$.

The New Albanian Net, constituted from Triangulation and Leveling Networks, was designed, rebuilt, measured and calculated from the Military Topographic Institute of Albania (MTI) during the years 1970-1985. The triangulation was designed to fulfill the requirements of mapping till at 1:10000 scale (on account of accuracy) and for perspective maps at 1:5000 scale (on account of density).

The geodetic horizontal datum [coordinate reference of Albania (ALB86)] is based on: the ellipsoid of Krasowsky 1940; North ellipsoid origin, $\Phi_0 = 0^0$; East ellipsoid origin, $\Lambda_0 = 21^0$; Gauss-Krüger (TM) projection; *False Northing* rectangular origin, 0,000 m; *False Easting* rectangular origin, 4500000 m, and coefficient of deformation in central Meridian, $K_0 = 1$.

In this geodetic horizontal datum is based topographic map of the Albania territory at scale 1: 25000 created by former MTIA (today IGU) in the period 1959 - 1985. Figure 1 shows the number of first and second editions, by years (Shehu, 1994).

[10] The Gauss-Krüger projection is a conformal mapping of a reference ellipsoid of the earth onto a plane where the equator and central meridian remain as straight lines and the scale along the central meridian is constant; all other meridians and parallels being complex curves. The Gauss-Krüger projection is the result of a triple-mapping in two parts (Bugayevskiy & Snyder 1995).

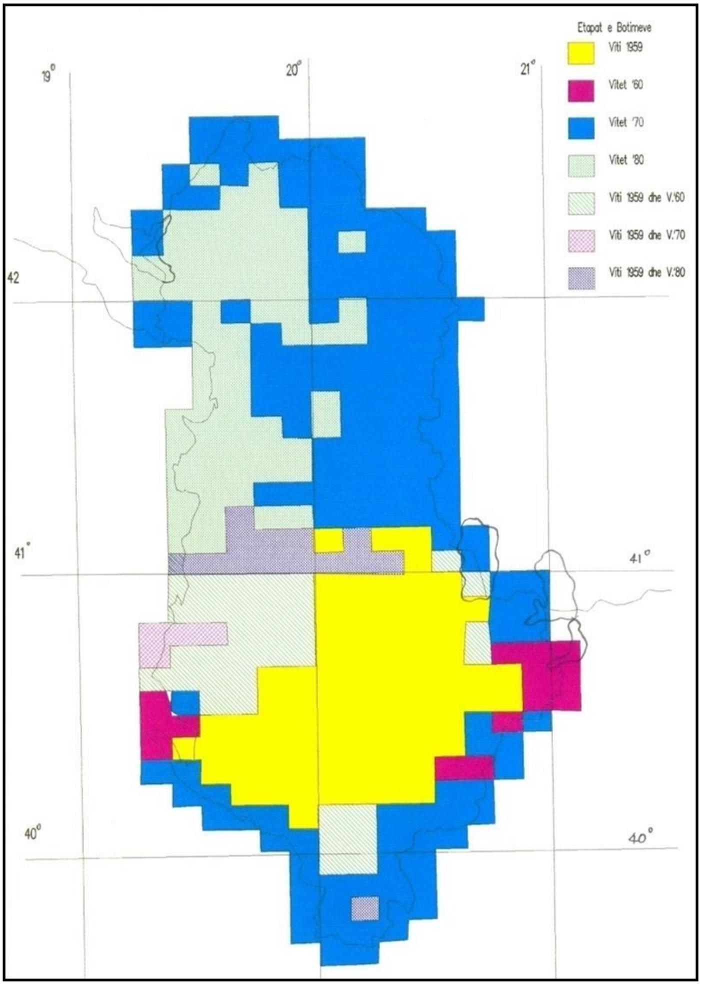

Fig. 1. The publication of the map at 1: 25000 scale by former – MTI, today MGI (1959 – 1985); (Source: Shehu, A. 1994)

Map series at scale 1: 25,000, published by the Military Cartographic Geodetic Institute of Moscow, which has MGI covers all Albanian territory, with the exception of the territory for which there are maps of this scale, published in 1959. This series of maps is published in 1962 year as a result of increasing of topographic maps in scale 1: 50000, published by the Military Cartographic Geodetic Institute of Moscow in 1952 year. The content of these maps, in most of them, corresponds to the content of the Italian maps, published in the years 1928 - 1939, scale 1: 50000, but transformed into Krasowsky ellipsoid and Gauss - Kruger projection. In the

Krasowsky ellipsoid and Gauss - Kruger projection also supported all of Albania topographic maps in scale 1: 50000 and smaller published by the former - MTI today MGI, in the period of 1976 – 1992 (fig. 2). The topographic maps of these scales are the result of works in the office, using for this purpose the source materials as: the existing topographic maps in scale 1: 25,000, published by MGI; existing topographic maps in scale 1: 50000, published by MGI and partly from foreign institutions; new aero topographic surveying and partial topographic surveys.

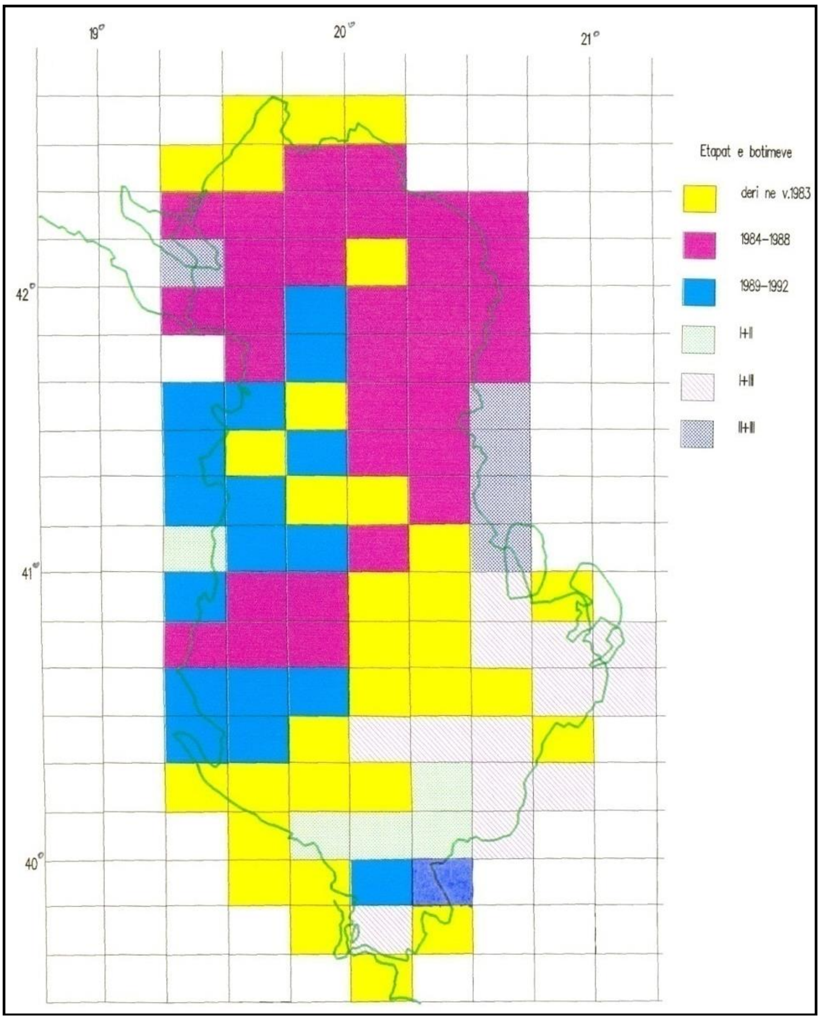

Fig. 2. The publication of the map at 1: 50000 scale by former – MTI, today MGI (1976 – 1992); (Source: Shehu, A. 1995)

During the period 1946-1996 are also created a series of cadastral maps (which covered approximately 56.27% of the Albania's territory) in scale 1: 500; 1: 1000; 1: 2000; 1: 5000; 1: 10000 and 1: 50000. Maps created during the years 1946 - 1960, are in 1: 2500 and 1: 5000 scale and based on the Bessel ellipsoid, Gauss-Kruger projection and the central meridian Lo = 20º 00'. Almost all cadastral maps created after 1960 were constructed in the state coordinate system: the Krasowsky ellipsoid, Gauss-Kruger projection and central meridian Lo = 21^0 00' (Shehu & Nikolli, 2001).
The central meridian, $\Lambda_0 = 21^\circ$, is located at easternmost extreme of Albania, leaving on his west over 99.7% of the territory. The area with the greatest distortions of the projection is the coastal zone. The distortions in this area reduce accuracy of topographical plans of large scales, which are necessary for development of tourist infrastructure, economic and cadastral system. Remember that Italians selected as the projection central meridian $\lambda_0 = 20^0$ for Albanian territory to support the mapping of the country at large scale (1: 5000, 1: 2000, 1: 1000).

3.2.2. Gauss Boaga projection

After 1939 year, for topographic maps of scales greater than 1:50000 and topographical plans of residential areas at 1:5000 scale, the Military Geographic Institute of Florence (MGIF) passed to another coordinate reference. The geodetic datum of this reference was: Bessel (1841) ellipsoid; the North ellipsoidal reference origin, $\Phi_0 = 0^0$; the East ellipsoidal reference origin, $\Lambda_0 = 20^0$; the Gauss- Boaga projection[11]; false Northing origin, 0.000 m; false Easting origin, 0.000 m.
At 1948, the horizontal coordinative base transformed from Moskva's CNIGA-IK Institute into Krassowsky ellipsoid (4-th zone 6°) with central meridian $\lambda_0 = 21°$ to support the territory mapping at 1:25 000 scale.

3.2.3. UTM Projection

The UTM and Gauss–Krüger coordinate systems are based on the Transverse Mercator projection. The most familiar and commonly used

[11] The Gauss–Boaga projection is a map projection used in Italy that uses a Hayford ellipsoid. The projection is named after Carl Friedrich Gauss and Giovanni Boaga. It was created by Giovanni Boaga in the 1940s who was at that time the head of the Istituto Geografico Militare. The projection method is a slight variant of the Gauss–Krüger series development for the ellipsoidal transverse Mercator projection. Like the closely related UTM, the Gauss–Boaga scales the projection down so that the central meridian has a scale factor of 0.9996 rather than 1.0.

Transverse Mercator in the topographical mapping is the *Universal Transverse Mercator* (UTM).

The Universal Transverse Mercator (UTM) projection and grid were adopted by the U.S. Army in 1947 for designating rectangular coordinates on large-scale military maps of the entire world. The UTM is the ellipsoidal Transverse Mercator to which specific parameters, such as central meridians, have been applied. The Earth, between lats. 84° N. and 80° S., is divided into 60 zones each generally 6° wide in longitude. Bounding meridians are evenly divisible by 6°, and zones are numbered from 1 to 60 proceeding east from the 180th meridian from Greenwich with minor exceptions.

Each geographic location in the UTM projection is given *x* and *y* coordinates in meters, according to the Transverse Mercator projection, using the meridian halfway between the two bounding meridians as the central meridian, and reducing its scale to 0.9996 of true scale (a 1:2,500 reduction). The lines of true scale are approximately parallel to and approximately 180 km east and west of the central meridian. Between them, the scale is too small; beyond them, it is too great. In the Northern Hemisphere, the Equator at the central meridian is considered the origin, with an *x* coordinate of 500,000 m and a *y* of 0.

The Military Geographic Institute of Albania has distributed hard-copy maps in 1:50,000 scales produced in collaboration with the USA agency NIMA (National Image and Mapping Agency – now called NGA: National Geospatial-Intelligence Agency). These products are spatially referenced in the UTM (WGS84) coordinate system.

Reference parameters of the Coordinative Reference established by Military Geographic Institute of Albania after 1994 year are: ellipsoid name - WGS 84[12]; ellipsoid origin of North - Earthy Equator ($\varphi = 0^0$); Ellipsoid origin of East - Central Meridian $\lambda_0 = 21^0$ E; map projection name - UTM zone 34 N; false northing, in grid units - 0.000 m; false easting, in grid units - 500 000.000 m, in west of meridian $\lambda_0 = 21^0$; scale factor at natural origin in central meridian ($\lambda_0 = 21^0$): k_0=0.9996; Magnitude of projection zone - 6^0 and projection Zone – 34.

[12] The WGS84 ellipsoid was established by satellite positioning techniques. It is referenced to the centre mass of the Earth (*i.e.*, geocentric) and provide a reasonable fit to the entire Earth. The WGS84 datum provides the basis of coordinates collected from the GPS, although modern receivers transform the coordinates into almost any user selected reference datum.

3.3. Polyconic equivalent Projection of Bonn, 1922-25.

During years 1922-25, the Military Geographic Institute of Florence (MGIF), constructed the triangulation network of I, II, III-orders to support the border mapping [734 km (length) x 2 km (width)] in scale 1: 50000. The geodetic datum of this reference was: Clark Ellipsoid; the North ellipsoidal reference origin, $\Phi_0 = 0^0$; the East ellipsoidal reference origin, $\Lambda_0 = 18^0$ 39’ 09”; the projection, Bonn's equivalent Polyconic; false Northing origin, 0.000 m and false Easting origin, 0.000 m.
Polyconic projection is a modified form of conical projection in which cutting point of all parallels to the central meridian is true to scale. The distances between the meridians along each parallel are also true to scale. Near the central meridian both area and shape are approximately correct, but away from it both are wrong. Properties of this projection are:

- Parallels are arcs, having different centre,
- Except the central meridian, all other meridians are regular curves. The central meridian is a straight line,
- All parallels are standard parallels,
- East west distances are correctly represented along the particular parallels and north south distances are correctly shown only along the central meridians,
- The projection is neither equal area nor orthomorphic.

This projection is suitable for representing small areas. Areas with a large latitudinal and limited longitudinal extent in the middle latitudes can be represented on this projection.

3.4. Bonne pseudo-conic equivalent projection

In 1927-1934 period Military Geographic Institute of Florence (MGIF), Italy carried out the geodetic base in four orders to support the territory mapping at 1:50000 scale. The geodetic datum of this reference was: Bessel (1841) ellipsoid; the north ellipsoidal reference origin, $\Phi_0 = 41°$ 20’ 12’’.809; the east ellipsoidal reference origin $\Lambda = 19°$ 46’ 45”.285; the projection, Bonn's Pseudo - conic Equivalent; central meridian $\Lambda_0 = 20°$ (Shehu, 1995); false northing origin, 300 000 m; false easting origin, 100 000 m. Maps of scale 1: 50000 were published by MGIF in the years 1928-1939 (fig. 3).

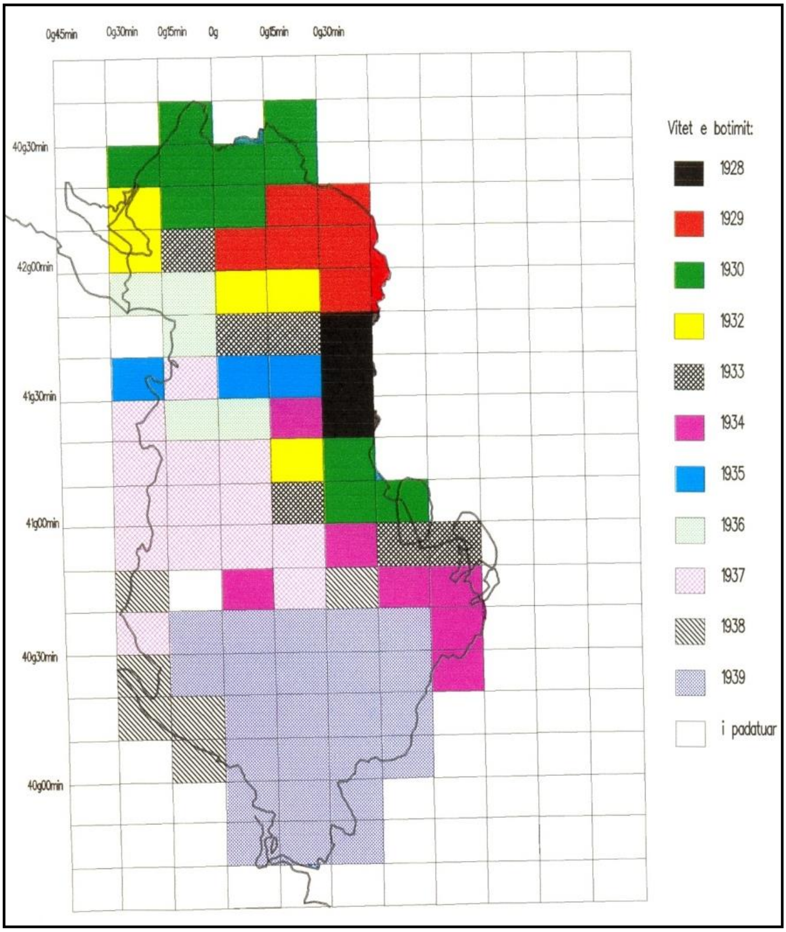

Fig. 3. The publication of the map at 1: 50000 scale, by Military Geographic Institute of Florence (MGIF) (1928– 1939) (Source: Shehu, A. 1995)

In the Bonn's Projection[13] a central meridian and a standard parallel are assumed with a cone tangent along the standard parallel. The central

[13] A Bonne projection is a pseudoconical equal-area map projection, sometimes called a dépôt de la guerre or a Sylvanus projection. Although named after Rigobert Bonne (1727–1795), the projection was in use prior to his birth, in 1511 by Sylvano, Honter in 1561, De l'Isle before 1700 and Coronelli in 1696. The Bonne projection can be seen as an intermediate projection in the unwinding of a Werner projection into a Sinusoidal projection; an alternative intermediate would be a Bottomley projection

meridian is developed along that element of the cone which is tangent to it and the cone developed on a plane.
Bonn's Projection is modified conical projection in which exaggerations of scale are removed along the parallels in the sense that all parallels are true to scale. The central meridian is straight, while the others are drawn by joining the intervals along the parallels by smooth curves. The parallels are concentric circles. It is an equal area projection. It is easy to draw with reasonable shapes around the central meridian.

Properties of this projection are:

- All the parallels are true to scale and are concentric curves,
- Central meridian is a straight line and other meridians are smooth curves,
- The scale is correct only along the central meridian; along the other meridians there is exaggeration which is increases away from the central meridian. Due to that the shape becomes increasingly distorted away from the central meridian, and
- It is an equal area projection.

3.5. Version of the pseudoconic projection, developed by prof. dr. Agim Shehu (Polytechnic University of Tirana, Albania)

The state of Albania is situated between latitude $\boldsymbol{\varphi}_s = 39^0\ 38'$ and $\boldsymbol{\varphi}_N = 42^0\ 39'$ ($\Delta\ \boldsymbol{\varphi} = 3^0\ 01'$), and longitude $\lambda_w = 19^0\ 16'$ and $\lambda_E = 21^0\ 04'$ ($\Delta\lambda_{max} = 1^0\ 48'$, $\Delta\lambda_{min} = 0^0\ 49'$) and extends over an area of 28.748 km^2 (land 27.398 km^2, water 1.350 km^2). The terrain is mostly mountainous (highest point 2753 m) and hills with small plains along coast.

The proportions:

$K_1 = \Delta\ \boldsymbol{\varphi} / \Delta\lambda_{max} = 3^0\ 01'/1^0\ 48' = 1.67$

$K_2 = \Delta\ \boldsymbol{\varphi} / \Delta\lambda_{min} = 3^0\ 01'/0^0\ 49' = 3.75$

show the meridional extension of Albania.

Applying the well known formulas of the above mentioned projections, it is noticed that for the scale 1:1000000, $\lambda_0 = 20^0\ 00'$, $\Delta\ \boldsymbol{\varphi} = \Delta\lambda = 0^0\ 30'$, in the most disfavorable points (λ_w, λ_E):

- the differences between coordinates (x, y) in the same points of the cartographic network and for all versions (tangential, secant) are very small ($\Delta x_{max,\ \Delta\lambda min} = 0.13$ mm);

- the differences of the abscissa values in the same parallel are also small ($\Delta x_{max,\ \Delta\lambda max} = 1.12$ mm);

- small differences are noticed in the values of deformations in the same meridian (m), parallel (p), surfaces (s) and angles (ω), where: $p_{max} = 1.001599$ and $\omega = 0^0\ 02'\ 47''$ at central perspective projections;

- in the group of polar cylindrical projections, the maximal longitude deformations reach the value 36.52% (for the tangential case) and the value 2.97% (for the secant case: $\varphi_0 = 41^0\ 00'$), while angle deformation is $\omega_{max} = 35^0\ 06'\ 34''$ (for the tangential case) and $3^0\ 11'\ 22''$ (for the secant case) (Shehu, 1977).

Based in the above mentioned observations prof. Agim Shehu (Shehu, 1977) has elaborated versions of pseudoconic projection, having these demands:

1. The meridians must be straight lines, going out from pole P;
2. The parallels must be straight lines parallel to coordinate axis E;
3. The length of the central meridian must not be deformed ($m_0 = 1$);

The studied versions are not conform ($\omega \neq 0$) and $m \neq p$, but one version can be equivalent if it is completed the condition that the length of all parallels is not deformed ($p = s = 1$). Then fixing the tangential versions ($\varphi_0 = 41^0\ 00'$), secants $p_N = p_S = 1$; $p_N \neq p_S \neq 1$ and the equivalent one, Shehu 1977 has calculated the values of coordinates (x, y) and deformations (m, p, s, ω), from which he has arrived in these conclusions:

1. For the extreme points of the cartographic network ($\Delta\lambda = \pm\ 1^0\ 30'$) coordinates (x, y) and the values of deformation, change very little between them and the values of the classic projections;
2. Also in the equivalent case meridians are straight lines;
3. The deformation of the meridians is smaller than the deformation of parallels;
4. Isocolls of deformation for meridians and angles correspond with the orientation of meridians, for this reason these projections are suitable for use for Albanian territory, because it has a meridional orientation;
5. The maximal deformations of the angles are $0^0\ 19'\ 44''$, $0^0\ 39'\ 24''$ and $0^0\ 59'\ 09''$, respectively for the points with a longitude from the central meridian $\Delta\lambda_1 = \pm 0^0\ 30'$, $\Delta\lambda_2 = \pm 1^0\ 00'$ and $\Delta\lambda_{3\ (max)} = \pm 1^0\ 30'$.

The tangential version of the projection above mentioned was used for the first time at the “The geographical atlas of Albania” 1968, in the scales 1:2000000 and smaller ones. In the 1980 year this projection was used for the creation of the maps of Albania in the scale 1:200000, as geological, hydro geological and fit geographical maps, etc. also it is used for all (127) the maps of “Climatic atlas of Albania”, 1986, in the scale 1:800000 and for all (256) the maps of “Agricultural geographical atlas of Tirana district” in the scales 1:100000.

4. CONCLUSIONS

Map projections have a wide use. They have been widely used to solve some geometric problems of spherical geometry, astronomy, crystallography, geology, etc., in graphical form. Today, topographical and geographical maps are very important for every GIS; therefore map projections are especially important in creating geoinformation systems. Knowledge of cartographic projections of topographic and thematic maps has a great importance in creation of a geographic database suitable for studies and different geographic analyzes etc.
Map projections have their largest and most frequent application in producing maps showing a smaller or bigger part of the Earth's surface. Theory of map projections is a branch of cartography studying the ways of projecting the curved surface of the earth and other heavenly bodies into the plane, and it is often called mathematical cartography. Map projections have been developing parallel with the development of map production and cartography in general.
The cartographers working on map projections have made great achievements in both the study of theory of map projections and the exploring of new types of projections, as well as their application and development of new directions in map projections. Mapmakers have a general rule that small-scale maps can be projected from a sphere, but large-scale maps always must be projected from an ellipsoidal surface such as the WGS 84 ellipsoid.
In the Albanian maps and atlases are used different cartographic projections as:

- Polar conic projection in the new edition of Ptolemy maps;
- Gauss-Krüger projection in Bessel ellipsoid, with origin the intersection of the Equator by the meridian of Ferro with λ_{Ferros} = 17° 39’ 46.5’’ in the maps, scale 1:75000 and 1:50000, published by Military Geographic Institute of Wien (1868-98, 1913-18);
- Polyconic equivalent Projection of Bonn in Clark ellipsoid with origin the intersection of the Equator by the central meridian $\Lambda_0 = 18^0$ 39’ 09”, in the maps of scales 1:50000, published by Military Geographic Institute of Florence (MGIF) (1922-25);
- Bonne pseudo-conic equivalent projection in Bessel ellipsoid with origin the intersection of parallel Φ_0 = 41° 20’ 12’’.809 by the central meridian Λ_0 = 19° 45’ 45”.285, in the maps of scales 1:50000, published by Military Geographic Institute of Florence (MGIF), Italy (1927-1934);
- Gauss- Boaga projection in Bessel ellipsoid with origin the intersection of the Equator by the central meridian $\Lambda_0 = 20^0$, in the maps of scales greater

than 1:50000 and topographical plans of residential areas at 1:5000 scale, published by Military Geographic Institute of Florence (MGIF) (1939 - 1948);

- Gauss-Krüger projection in Krassovsky ellipsoid with origin the intersection of the Equator by the central meridian $L_0=21^o$ in the maps, scale 1:25000 and 1:10000, published by Military Topographic Institute of Albania (1950 -1955, 1970-1992)[14];
- UTM projection in WGS 84 ellipsoid with origin the intersection of the Equator by the central meridian $\Lambda_0 = 21^0$ in the maps of scales 1:50000 and 1:25000, published by Military Geographic Institute of Albania (MGIA) (after 1994);
- Version of the pseudoconic projection, developed by prof. dr. Agim Shehu (Polytechnic University of Tirana, Albania) in the Earth Sphere, was used for the first time at the "The geographical atlas of Albania" 1968, in the scales 1:2000000 and smaller ones. In the 1980 year this projection was used for the creation of the maps of Albania in the scale 1:200000, as geological, hydro geological and fit geographical maps, etc. also it is used for all (127) the maps of "Climatic atlas of Albania", 1986, in the scale 1:800000 and for all (256) the maps of "Agricultural geographical atlas of Tirana district" in the scales 1:100000.

REFERENCES

1. Almagia R. (1928) La nuove carte dell'Albanie. Roma
2. Armao E. (1937) Localita, chiese, fiumi, monti, toponimi varii di una antica carta dell'Albania Settentrionale. Roma.
3. Baldacci A. (1917) Intinerari Albanesi. Roma.
4. Bugayevskiy, L.M. and Snyder, J.P., (1995), *Map Projections: A Reference Manual*, Taylor & Francis, London.
5. Cerabregu, M. (1977) Kosova në hartat e vjetra, Prishtinë
6. Codazzi, A. (1959) Storia della carte geografiche. Milano
7. Coronelli P. M. (1697) Memoire Istoriographiche. Venecie
8. Ginzel H. (1918) Aufgaben und Tatigteit der krigsmappierung auf der Balkan halbinsel. Wien
9. Hahn J. (1854) Albanische studien. Jena
10. Hartenthum H. (1903) Die cartographie der Balkan halbinsel. Wien
11. Loui H. (1928) Die neue carte von Albanian. Berlin

[14] The central meridian, $\Lambda_0 = 21^{\circ}$, is located at easternmost extreme of Albania, leaving on his west over 99.7% of the territory. The area with the greatest distortions of the projection is the coastal zone. The distortions in this area reduce accuracy of topographical plans of large scales, which are necessary for development of tourist infrastructure, economic and cadastral system.

12. Pal Nikolli, Bashkim Idrizi & Ferim Gashi. (2012) Zhvillime të hartografisë shqiptare: 1912-2012. "Studime Albanologjike", IV, 2012/4, Tiranë.
13. Ptoleme C. (1613) La Geografia. Venezia.
14. Shehu, A. & Dragovoja, M. (1984) Shqipëria në hartat e paraçlirimit. Tiranë
15. Shehu, A. & Nikolli, P. (2001) Historia e hartografisë shqiptare. ShB. Julvin 2. Tiranë
16. Shehu, A. (1967) Një variant i projeksionit pseudokonik. Buletini i Universitetit Shtetëror të Tiranës. Seria "Shkencat e Natyrës". Nr. 3. Tiranë
17. Shehu, A. (1977) Projeksione hartografike të përshtatëshme për hartat tona tematike. Bul. Shkencave Teknike. Nr. 3. Tiranë
18. Shehu, A. (1994) Buletin i informacionit "Shkenca dhe Mjedisi", nr. 1, Tirana
19. Shehu, A. (1995) Buletin i informacionit "Shkenca dhe Mjedisi", nr. 2, Tirana
20. Traversi C. (1965) Storia della Cartografia italiana della isole Egee e dell' Albania. Firenze
21. Zulfequar Ahmad Khan. (1998) Text Book of Practical Geography. Concept publishing company, New Delhi, 110059.

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