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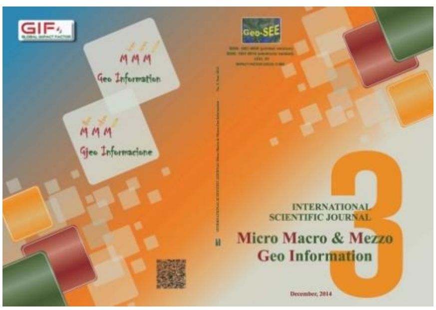

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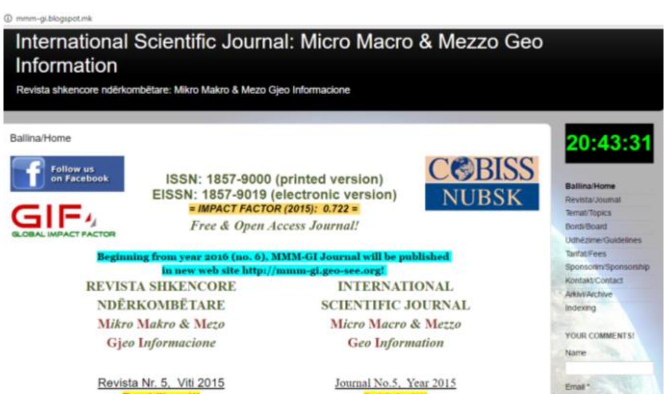

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JENGO, A PROTOTYPE MOBILE APPLICATION BASED ON CROUWDSOURCING FOR LIS

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SUMMARY

The possibility of collecting data with one's own mobile tools is very inviting and at the same time attractive, and useful. There are strong initiatives to adopt crowd-sourcing, citizens in Land Administration. In that way citizens can be provided with useful and easy-handling mobile tools for mapping, so they can give land related information with their own mobile phone (McLaren, 2011; Brabham, 2013). On the one hand in many less developed countries the people lack land rights documents and citizens without documentation often lack secure tenure over land. On the other hand the inadequate quality of cadastral maps affects the life of citizens who need means to quickly and cost-effectively settle their cadastre related issues. The first goal of paper is to identify the success factors relevant to cadastre related crowdsourcing projects. Another goal of paper is to present an adequate mobile application, according to the established factors, Jengo, for mapping 2D/3D buildings/constructions and to record attributes, including photos, and also for uploading captured data to the system of those who are asked to participate in the crowdsourcing campaign. The methodology of collection includes primary objectives which were the on-site scanning of a construction, identification and recording of their violations and graphical presentation of their expansion on the OS map.

Key words: OSM, mobile application, crowdsourcing, cadastre

1. INTRODUCTION

The crowdsourcing is an on-line, distributed problem-solving and production model which was generated by the inherent needs, and ambitions of the human society enabled by info communication revolution in the end of the twentieth century.

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Because crowdsourcing draws input and insight from individuals in on-line communities, it has the potential to be a useful digital tool to complement traditional public participation programs for governance (Brabham, 2009).
As it was described by Sharma (2010) the adequate definition of the vision and the strategy are necessary for citizen, who distribute information through crowdsourcing. There are strong initiatives to adopt crowdsourcing in Land Administration. On the one hand in many less developed countries there is a lack of documents on land rights and without documentation citizens often lack secure land tenure. On the other hand the inadequate quality of cadastral maps affects the life of citizens who need means to quickly and cost-effectively settle their cadastre related issues. The stability of the land administration affects not just some governmental sectors but the economy as a whole that is why a strong, stable land administration is an aim for each society. Likewise in some European countries/regions a significant proportion of the inhabitants live in buildings/houses, which do not have proper permits. It is of national interest to legalize the status of these constructions. The related public administration procedures heavily involve the citizens. In order to legalize illicit constructions the public authorities must have important spatial information such as positions, dimensions, information about type and characteristics of a building or construction etc.
The main aim of this paper is to present a possible solution, a tool for solving the above outlined problems. In addition it will present the mobile application, whose development was started by Compet-Terra Ltd., and development path of application, by which citizens can collect, and give land related or other information with their own mobile phone, using a simple, cost-effectively mobile application such as Jengo (http://competterra.com/index.php?jengo_en). As a possible crowdsourcing data collecting mobile tool for the editing objects, in this paper the main concepts of Jengo will be presented taking into account the critical successful factors of crowdsourcing. Within the presentation of new applications it is necessary to look back on the existing android application for supporting OSM (OpenStreetMap).

2. CONCEPTS OF JENGO

According to the study of Sharma (2010), which analyzed the critical success factors of an outsourcing initiative in the available academic and professional literature, the motive alignment of the crowd occupies a central place in the Crowdsourcing Critical Success Factor Mode. The peripheral factors are neither exclusive nor exhaustive, but the mentioned ones are the

following; vision & strategy of the crowdsourcing initiative, linkages & trust, external environment, infrastructure and human capital.
Based on the acquired experience in LIS projects and studying broad range of crowdsourcing literatures our analysis resulted that these success factors are highly relevant to cadastre related crowdsourcing projects as well. Jengo is conceptualized on this basis. The following analysis identifies principles of the Jengo mobile application.

2.1. Vision and strategy of the Jengo Supported Crowdsourcing Projects

The first of the peripheral factor of the motive alignment of crowd is the "Vision and Strategy". Clarity in 'Vision' is vital and imperative to the success of crowdsourcing initiatives (Brabham, 2009). The successful crowdsourcing initiatives enter the market with clear and well-defined objective and ideas (Sharma 2010). To convince the crowd to participate in the data collection can be done with the previous definite aspects, and it is important that the specified visions are flexible. The flexibility of vision is necessary for successful crowdsourcing not only in the term of organic changed environment in which these initiatives are realizing, but if the crowd feel it his own the vision, the enthusiasm and ambition of crowd take the initiative to the defined purpose.
The cadastre domain embraces several problems, which are relevant for adoption of the crowdsourcing model. Legalization of Illicit Building. Significant proportions of the society or important groups have build constructions out of the legal regulations. Their inevitable interest to legalize and register their land. They are highly motivated to accomplish this vision of having legally/technically checked and recorded building. Managing Informal Settlement results more secured land use rights in a dynamically changing organic system of society. The special residential areas, like Kibera in Kenya, near to city Nairobi, are dense, buildings have frequently been reconstructed and the fluctuation of inhabitants is significant. However, residents are deeply interested in their property being recorded, which provides them some sort of legal security. Crowdsourcing is a cost effective approach to map and record rights of informal settlements. Environmental problems can have impact on health and motivates crowd by morality.

2.2. Jengo's Approach to the Human capital Aspect of Crowdsourcing

To satisfy the next peripheral factor, the human capitals, in the first hand the crowd need to be convinced of the goal, to feel the vision as his own. Based on as Carmel (2003) describes, the collective characteristics, skills and abilities of the crowd is human capital, which is not limited to, language

skills, managerial skills, national orientation, traditions and level of education. Mapping parcels and building expects some understanding of geometry and topology. The crowdsourcing business model call the crowd to carry out tasks, which usually done by professionals (Reference to the definition: Howe, 2008), however the motivated crowd is not interested in mapping and can frustrated to use a GUI focused on mapping.
Bridging this gap we need to find a non-GIS approach to GUI, which is more desirable for users. The GUI should be simple, user-friendly, equipped with easy to understand symbols, and to be supported in on-line and off-line mode too. Data collection crowdsourcing projects are controlled via inputs (Podolcsák, 2014). The participant should provide input according to predefined standards.

2.3. Infrastructure

The crowdsourcing initiatives are mostly either mobile or web based. According to Donner (2009) the Crowdsourcing requires abundant, reliable and cheap telephone or mobile access for its communication needs. The critical aspect is the availability of the much needed capital sources for development of the initiative (Kleemann et al. 2008). For the crowdsourcing that-why mostly were used an open source software, which are ease accessible, reliable. Another important thing is that the developed application should be simple, user-friendly, equipped with easy understand symbols, and to be supported in on-line and off-line mode too.
In the cadastre domain the crowdsourcer calls stakeholder to provide graphical data and makes them possible to access public data and status of business processes. The infrastructure serves a client server based architecture, which can be a web based application or cloud computing infrastructure. As it was highlighted in the previous point the external business can be considerably different thus the IT requirements are various. The crowdsourcing approach can be adopted in a formal business process then the collected data need to be transferred via a more secured channel, e.g. ftps. access to Internet. The crowdsourcing initiatives are usually financed by public budget, and the sustainability is better when the software application is open source. As simpler the code is as many people can be involved in the software development society.

2.4. Serving Linkages and trust

A good relationship is essential to human-centered operating model of crowdsourcing respect. Providing that the right connections - among others - the knowledge transfer becomes easier, and also enables to ease the implementation of feasible crowdsourcing initiatives. Carmel (2003) defines the concept of linkages as “something, which emerges between individuals, between work groups, between firms or between nations due to geographic, cultural, linguistic, or ethnic connections”. In some certain problems of average weight give better knowledge of approaches under certain conditions, such as Experts estimate. Here we can think to product evaluations, to estimate effects of climate etc. In all of that, people are linked, the uploaded information is viewable for the crowd, and linkages can add a substantial trust aspect to the crowdsourcing initiative (Brabham, 2009).

Majority of the Cadastre problems relates to security and involves private information too. Users should be convinced their private data is transferred safely while their public data is mutually accessible and the whole process is transparent.

2.5. Compliance with the External Business Environment

The tasks associated with crowdsourcing must be compatible with the prevailing business practices and cultural norms. The crowd must also be able to relate the goal of the crowdsourcing initiative to their living environment. It's important that the crowd do not need to change their behavior in order to make the maximum use of the system, because it is the environment in which being the crowdsourcing realized, is not necessarily permanent, it could be ever-changing, organic. The business environment of the crowdsourcing cadastre projects is various.

Informal settlements are organic systems. Land users move in and out while the walls of the flats and the building are changing as well. An informal settlement registration can be kept informal focusing on a consensus of the users, their neighbours and the local rules in the informal settlement. These type of projects need to share information among stakeholders and support their forums to reach a mutual agreement. The users are focusing on their space of living, agreed alteration of boundaries, and entrance while geometry overlaps and gaps are less important. In these types of informal settlement projects Jengo is a mean to edit the layout of the flat, upload data to a server then visualize actual use together with background layers, e.g. orthophoto for stakeholders. The photo of the entrance is part of the record, which serves both the positioning of layout and protecting the right of the user. The exact matching of floor-plans is not a mandatory prerequisite since mismatching is in line with organic organization of informal settlements however some careful post-adjustment can be done by privileged participants of the crowd using desktop applications.

There are other problems which have more formal business environment. E.g. in some countries or regions a significant proportion of the inhabitants live in buildings which do not have proper permits. The related public administration procedures heavily involve the citizens in. In order to legalize illicit constructions the public authorities must have spatial information such as positions, dimensions, information about type and characteristics of a building or construction. In these types of cadastre related projects the crowd-sourced information relates to a formal application, which is settled according to a legally defined public administration process.
In spite of the above mentioned samples some urban cleanliness and public health focused cadastre related projects have no territorial limits and have higher frequency of data collection/process/distribution. The type of data can also be various apart from geometry and location information scanned docs and pictures could also be collected.

3. OVERVIEW OF JENGO

3.1. Use case

The Crowdsourcer and the Participants use the Jengo application (Figure 1). In order to manage the campaign the Crowdsourcers customize Jengo by setting-up some technical features of the crowdsourcing project. The participant uses Jengo to capture data of the construction; the details are indicated by the next diagram

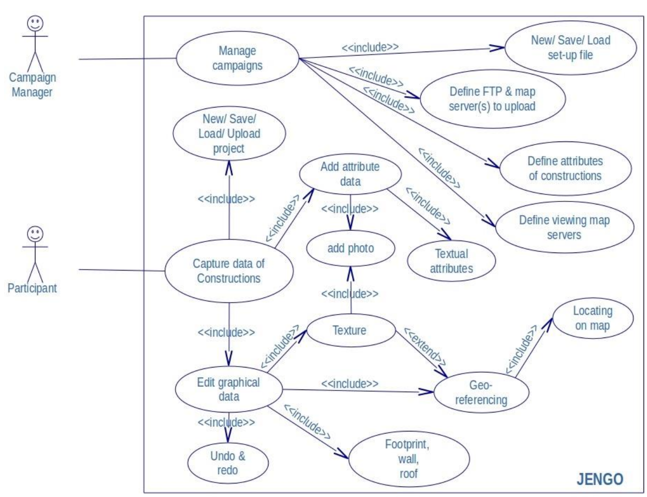


Figure 1. The participants, their leading role and available function

There is a recent request to slightly extend the above use case structure by extending the texturing to make possible to map parcels using Jengo. The planned texturing GUI allows the user to move the vertices of the polygon to their image on the picture then adjust the image to the polygon. This extension uses the same GUI but do not modify the image but alter the polygon. In this way parcels can be drafted by Jengo's edit functions then map to orthophoto using the altered texturing function.

3.2. General Workflow

Conceptual, general workflow of using Jengo for mapping constructions is shown on the Figure 2. Dimension of the object must be determined by direct measurement or copying data from existing documents. These data will be edited on Jengo's work-screen, as wire-frame, on the edges of the white vertexes. After recording attributes (such as ID, use, status, etc) the taken photo can be selected as the texture of the wire-frame. The building is defined in 3D, but before that, the optional coordinates (high of the building) must be calculated. The default value of location is based on the mobile provided coordinates and the user move/rotate the footprint to the right position. It is planned, that Jengo stores data as project file, city GML, or KML, GIF, and upload them. As the processes are finished, it is possible to share or upload data to the crowdsourcer.

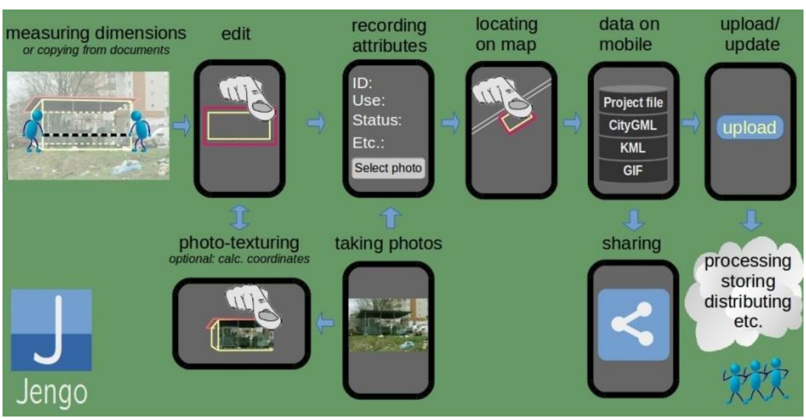


Figure 2. The work-flow of Jengo application

3.3. Infrastructure

Jengo can be used in standalone mode, editing the constructions geometry, texture, all this in offline mode. In this local mode, all the functions are available (Figure 3), and the complete file can be saved to the mobile device memory unit. Via internet connection the above -mentioned, created data can be uploaded to the server. The other two solution/mode for using Jengo, is a direct creating/editing files, with all already presented functions, to the server-cloud or to the FTP server, which include permanent internet connection (Figure 3).

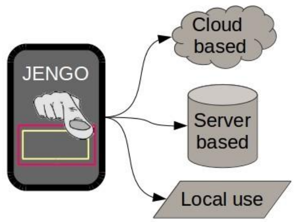


Figure 3. The schematic presentation of Jengo infrastructure

3.4. Application Architecture

Jengo uses proven open source technologies for mobile application development. The software framework is QtQuick, which is a cross-platform application development framework using the QML GUI description language, which allows the integration of JavaScript code and libraries (Figure 4). Data are stored in a SQLight database, 3D presentation adopts Three.js. The prototype uses the QtLocation library to access Open Street Maps.
Jengo uses SQLight for storing all the data of the features (constructions). SQLite is an in-process library that implements a self-contained, server-less, zero-configuration, transactional SQL database engine. SQLite is an embedded SQL database engine. Unlike most other SQL databases, SQLite does not have a separate server process. SQLite reads and writes directly to ordinary disk files. A complete SQL database with multiple tables induces, triggers, and views, is contained in a single disk file.
Jengo is based on Qt Quick, written in QML and JavaScript (Figure 4). Qt is a cross-platform application framework that is widely used for developing application software that can be run on various software and hardware platforms with little or no change in the underlying code-base, while having the power and speed of native applications. Qt provides Qt Quick that includes a declarative scripting language called QML that allows using JavaScript to provide the logic. With Qt Quick, rapid application development for mobile devices became possible, although logic can be written with native code as well to achieve the best possible performance.

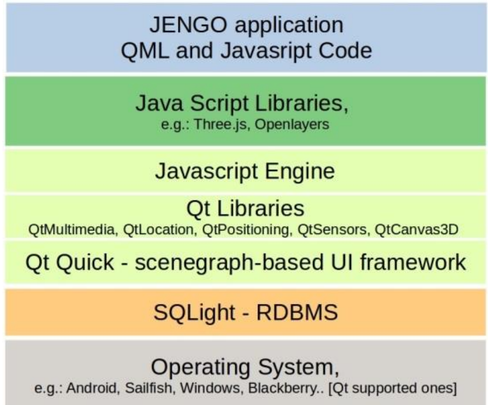


Figure 4. Jengo's architecture

For graphics, positioning and 3D Jengo uses QtMultimedia, QtLocation, QtPositioning, QtSensors and QtCanvas3D libraries. For 3 dimension display Jengo also uses three.js JavaScript library (Figure 4). The application also has a strong GIS component that is based on OpenLayers. OpenLayers are an open source JavaScript library for displaying map data in web browsers. It provides an API for building rich web-based geographic applications.

3.5. Software Development Framework Jengo and the Licenses

During the selection of software development framework, the following principles were taken into account;

1. It was necessary that the software can be easily transferred to various mobile platforms, to be a cross platform application.
2. Also, it was important to be supported on web technology, to be ease of use inspired by OGS standards.
3. And lest but not last the chosen program must have simplicity of software development

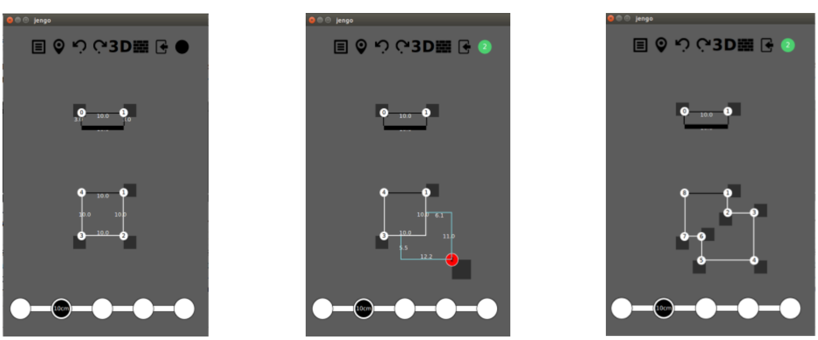
Qt was selected because it can be loaded with features and functionality for all application developments. It can run on various software and hardware platforms, having the power and speed of native applications. Qt Open Source is available under the GNU Lesser General Public License (LGPL).
Qt is frequently used for developing application software with graphical user interfaces (GUIs); however, programs without a GUI can be developed as well, such as command-line tools and consoles for servers. GUI programs created with Qt can have a native-looking interface, in which cases Qt is classified as a widget tool-kit.

Qt Quick includes a declarative scripting language called QML that allows using JavaScript to provide the logic. With Qt Quick, rapid application development for mobile devices became possible, although logic can be written with native code as well to achieve the best possible performance. Qt can be used in several other programming languages via language bindings. It runs on the major desktop platforms and some of the mobile platforms. It has extensive internationalization support.
QML is a user interface mark-up language. It is a JavaScript-based, declarative language for designing user interface–centric applications. QML is mainly used for mobile applications where touch input, fluid animations. QML elements shipped with Qt are a sophisticated set of building blocks, graphical (e.g., rectangle, image) and has tools (e.g., state, transition, animation). These elements can be combined to build components ranging in complexity from simple buttons and sliders, to complete internet-enabled programs. QML elements can be augmented by standard JavaScript both in-line and via included .js files. Elements can also be seamlessly integrated and extended by C++ components using the Qt framework.
As it mentioned, QML is using JavaScript to provide the logic. JavaScript is a high level, dynamic, untyped, and interpreted programming language it is prototype-based with first-class functions, making it a multi-paradigm language, supporting object-oriented and functional programming styles. It has an API for working with text, arrays, dates and regular expressions.
Jengo development is using Open Source software development tools. Taking into account their licenses it is possible to issue JENGO with Open Source license.

4. JENGO – EXISTING VERSION

Based on the concepts a prototype version have been developed, which has some basic functions of the planned Jengo application. The emphasis was on the user-friendliness. The functionality of Jengo allows users to map 2D/3D buildings/constructions, upload KML, it can be downloaded from: http://competterra.com/index.php?jengo_en.
The existing version, which will be presented, has passed several iterations so graphical editing based on users' experience has been significantly improved. The Jengo assumes that each building is composed of rectangular polygons which sides are parallel either with X or Y axis. The default value of each angles are exactly 90 or 270 degrees, however the user can modify it. In accordance to that, running the Jengo application user can see a pre-made geometry and topology, a square and its cross-section on the centre of screen (Figure 5/a). The existing version is available only in English, with which

users rarely encounter. On the top of the screen is a menu with eight icons, namely menu, displaying on the map, undo and redo, 3D view, editing wall, exporting KML file, and the last icon is the "selecting – activating indicator", which shows the possibility of editing an element. On the lower part of the screen the grid is located, which used to determine the resolution of editing.
The graphical user interface of Jengo is designed to take the user, and he/she can start editing, without reading the instructions, because editing is straightforward and does not require any knowledge, neither GIS basics. The undo/redo option is encouraging too. A grid selector is situated at the bottom of the GUI that controls the size of grids from 5 cm to 1 meter. Jengo provides a default footprint shape, which is a 10x10 meter rectangle that the user can immediately tap and alter. While user is editing shape Jengo indicates dimensions, however tapping on grid selector does it as well. Above the footprint the selected or active wall is shown and can be edited as well. (Having set-up function completed indication of the wall can be switched on/off)
Shaping the topology of desired object follows logic of simple gestures having the same results in any context. Edit the object, although the pre-made geometry suggests, it is possible with displacement of the vertexes or edges (dots of square). To move the vertex, touch it until the activity indicator becomes green, in the same time the vertex becomes red, and it is ready to move along the X and Y axes (Figure 5/b). Meanwhile on the neighbouring edges of active vertex can be seen the length, in order to precisely editing. The topological correctness is checked by the application thus it is impossible to create an incorrect shape (Figure 5/c).

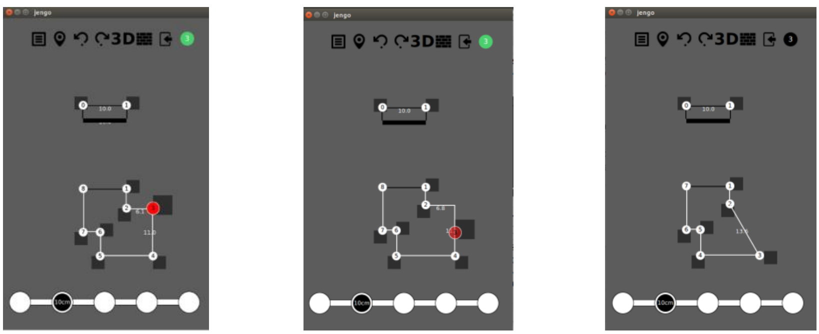


a. b. c.

Figure 5. Running Jengo mobile application: a) the start screen of Jengo application, b) displacement of the vertex, with displayed length of edges, c) the excepted wire frame shape, after checked topological correctness.

Displacement is a different operation then the modification of shapes but both need to select a vertex or edge. There is a need for a simple gesture,

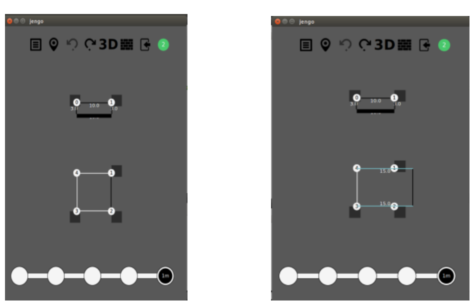
which differentiates these two functions. So after having select a geometry element the user lifts up his/her finger then taps the already selected element and moves it (Figure 6/a). Jengo allows displacing a vertex along one of the two connected edges. An edge is displaced parallel at a right angle to its direction (Figure 6/b). These rules make possible the way user can fully control the geometry characteristics of the resulted polygon.
The system automatically deletes edges which have zero length. In this way vertexes can be deleted pulling them on the neighbourly vertex (Figure 6/b, 6/c), as well as with this gesture can be managed the corner truncate too (Figure 6/c).



a. b. c.

Figure 6. Altering the wire-frame shape: a) activate the edge, b) displacement a vertex along the neighbourhood edges, c) delete a point – truncate the corner

Dimensioning the edges can be done in two steps; first activate the edge with touching it, and when it becomes black, it's ready to move, in a direction perpendicular to itself. Jengo supports data acquiring using on-site measured or collected data, therefore during a displacement of the wall, the user can monitor the sizes of the adjacent walls, in that way it is possible to dimension the object precisely (Figure 7/a, 7/b).

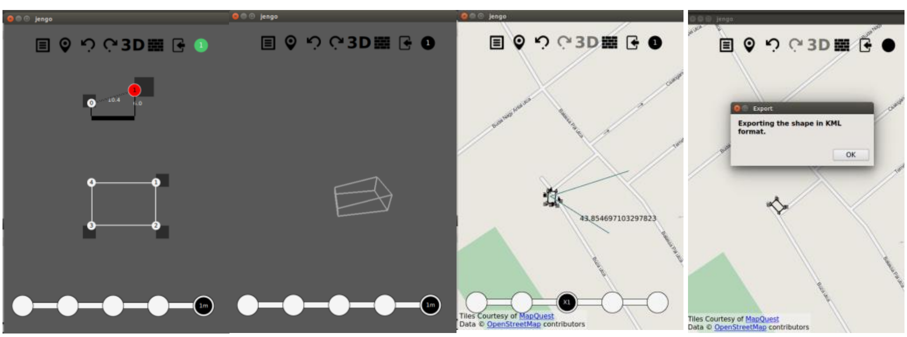


a. b.

Figure 7. Dimensioning the edges: a) activation of selected edge, b) displacement the wall/edge perpendicular to itself

The height of edges is given as default 3m, the user can give the height of each vertexes on the cross-section picture above the footprint (Figure 8/a), one by one, simply with selecting other edge. When the user finished editing a wire-frame object, editing a footprint and wall height, has a possibility to see the constructed object in 3D (Figure 8/b). During 3D display, the object rotates around its own centroid, thus ensuring that to can be viewed in its entirety.

The Jengo application gets the location from the built in positioning of the mobile phone. After having accessed Open Street Map via Internet the user can move and rotate the footprint to the right location (Figure 8/c, 8/d). There is a multi-position switch on the bottom of the GUI to adjust the sensitivity of the rotation. The export to KML function creates a simple and valid kml file named „out.kml" in the devices standard Documents folder (Figure 8/d). The file is created using the location data gathered and set during the editing and mapping of the shape. The KML file represents the nodes of the shapes with coordinate points of a Linear Ring, and allows the exported data to be imported to an Earth browser such as Google Earth, Google Maps, and Google Maps for mobile.



a. b. c. d.

Figure 8. 3D visualisation and displaying on the map: a) setting the edges height, b) 3D visualisation of wire frame object, c) rotation of the object, d) place on the right position and export KML data.

5. DEVELOPMENT PATH OF JENGO

Based on the development path, with the present version of Jengo software the footprint and the wall can be presented. For editing the wire-frame is simple, the user can use existing function as undo/redo. The location of the edited construction can be received from the GPS of the mobile device, and the exported KML file can be presented on the OpenStreet map.

In the next, improved version of Jengo the user have a possibility to construct not only the footprint and the wall of the building, but the roof too. The position and the data will be uploaded to the FTP server as layers, namely as raster and vector files, also there is an opportunity to upload 2D wfs file to the server without changing the server content. In this version it is already possible to use Jengo to support campaign, for e.g. in the framework of environmental campaign it's possible to map and edit a container and collect all information into the pre-designed and pre-defined database and map.
In the planned final version of Jengo software the users can give a textual characteristic of the walls and roof. Beside that the export to KML function creates a simple and valid kml file named „out.kml" in the devices standard Documents folder. The file is created using the location data gathered and set during the editing and mapping of the shape. The KML file represents the nodes of the shapes with coordinate points of a Linear Ring, and allows the exported data to be imported to an Earth browser such as Google Earth, Google Maps, and Google Maps for mobile. In this version the edited construction can be uploaded to server as wfs vectorised file. Options for the snapping photos with GPS positions, and options for detailed design of objects will be also implemented.
In the expected final version of Jengo software the users can give a textural characteristic of the walls and roof. It can be realised by textual characteristic or by added the captured photos.

6. CONCLUSION AN FUTURE WORKS

Compet-Terra, consulting company in the LIS arena, has identified crowdsourcing as one of the most important trends in the LIS field. Compet-Terra has been running a related in-house research. Having analyzed business and management aspects of crowdsourcing, available technologies initial finding and conclusions were drown then various prototyping was started. Jengo is one of them. The development started in March and the research objective is to test and adjust or proof the concept and gain experience in technical issues of the software development.
This version of Jengo has been tested by some Land Administration professionals and based on this initial feedback modifications were identified and some of them have already been implemented. The embraces only a part of the conceptional functions which has been implemented, e.g. the implementation of the set-up, which customizes the application to projects is still ongoing and some difficulties caused by reported bugs of the development still needs some workaround to be elaborated in the code.

It is too early to make grounded conclusion regarding the concept, however some preliminary observations can be made. The adoption of the user-friendliness related principles seems to be promising. Keeping the code open is welcomed. Staying inside a simple use of Qt Quick. Using QML and JavaScript and not embracing heavy C++ code resulted some performance issues and needed several workaround of the shortages of this environment, however it seems developers always find a solution.

7. REFERENCES

1. Brabham, D.C.: Crowdsourcing as a model for problem solving: An introduction and cases. Convergence: The International Journal of Research into New Media Technologies, 2008. 14(1), 75–90.
2. Brabham, D.C.: Crowdsourcing the public participation process for planning projects. Planning Theory, 2009. 8(3), 242–262
3. Brabham, D.C.: Using Crowdsourcing In Government. Annenberg School for Communication and Journalism, University of Southern California. IBM Center for The Buisness of Government, 2013.
4. Carmel, E.: The New Software exporting Nations: Success Factors. The Electronic Journal on Information Systems in Developing Countries 2003. 13,(4):1-12
5. Donner, J.: Mobile-based livelihood services in Africa: pilots and early deployments. Communication technologies in Latin America and Africa: A multidisciplinary perspective, 2009. pp. 37-58
6. Howe, J. 2008: Crowdsourcing: Why the Power of the Crowd is Driving the Future of Business, Crown Publishing Group, New York, NY, USA
7. Kleemann, F., Vob, G. G., Rieder, K.: Un(der)paid Innovators: The Commericial Utilization of Consumer Work through Crowdsourcing. Science, Technology and Innovation Studies, 2008, pp. 5-26.
8. McLaren, R.: Crowdsourcing Support of Land Administration a New, Collaborative Partnership Between Citizens and Land Professionals. A report for Royal Institution of Chartered Surveyors commissioned by RICS Land Group (RICS), Parliament Square, London SW1P 3AD, United Kingdom, 2011
9. Podolcsák, Á.: Crowdsourcing-related business consulting (Crowdsourcing vonatkozású üzleti tanácsadás) Metropolian University of Applied Sciences - Thesis, 2014
10. Sharma, A.: Crowdsourcing Critical Success Factor Model Strategies to harness the collective intelligence of the crowd. http://irevolution.net/2010/05/05/towards-a-model-for-successful-crowdsourcing/ 2010

11. Willett, W., Heer, J., Agrawala, M.: Strategies for Crowdsourcing Social Data Analysis. ACM Human Factors in Computing Systems (CHI), 2012, pp. 227-236
12. http://doc.qt.io/ - Last viewed: aug. 2016
13. http://threejs.org/docs/ - Last viewed: aug. 2016

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CONTEMPORARY GIS-BASED METHODOLOGICAL APPROACH FOR ASSESSMENT OF OPTIMAL LOCATIONS FOR EXPLOATATION OF SOLAR-ENERGY POTENTIALS

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SUMMARY

Generally the country has huge solar potential as a renewable energy source, but they are still exploited in a very small extent. The renewable energy resources, that are easily accessible in rural areas are mostly unused. The harnessing of the sun as an inexhaustible source of energy mostly depends of the duration of the intensity of the solar radiation, which in Republic of Macedonia is around 3,8 kWh/m^2 and it is about 30% greater than the average value in many European countries. The goal of this paper is, to describe some GIS-based contemporary methodological approaches of geospatial analysis of some key topographic surface parameters for assessment and evaluation of optimal locations for construction of solar power plants. Main focus of interest in the analyses is set to some most important topographic land surface parameters such as: slope (gradient of the surface), aspect direction of slope, as well as the shading analysys of the land surface. Main accent at the analysis is set at the rural areas. The methodology approach is developed on a few case study areas in the south-west part of Republic of Macedonia (in the north part of the Prespa like region). As input digital data have been used few digitized maps in scale 1:25000 with many vector data layers(grid pint map, map with contour lines and others). Using various interpolation methods , taking as input data the grid point map and contour map in vector format it is obtained a digital elevation model- DEM od the land surface in raster format with spatial resolution 20x20m. Using different spatial analyses with a set of GIS tools in an efficient way are obtained several raster maps with values of slopes(gradients, inclinations) of the land surfaces , raster maps with aspect-direction values as well as raster maps with shadow analysis of

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the surface and others. Using values of slopes and aspects directions are preliminary determined suitable locations at the surface for exploatation of solar potentials. Results of performed analysis show, that the analyzed areas have considerable potential for use of solar energy. With proper placement and construction of solar photovoltaic power plants can be significantly improved the energy efficiency and supplying of electricity of nearby villages. Beside that, the proposed methodological approach for analysis of suitable locations can be applied to any other spatial location. The proposed GIS-based analysis serves as an efficient tool for identification and quantification of land surface parameters that have a key impact in decision making regarding exploatation of the solar energy potentials. With similar methodological GIS-based approach also can be determined some other land surface parameters necessary for analyzing of suitable locations for other renewable energy sources such as: wind-power potentials, small hydropower potentials and others.

Key words: Geospatial analysis, solar power, GIS , Multicriteria decision making, photovoltaics.

I. INTRODUCTION

Renewable Energy Systems use resources that are constantly replaced in nature and are usually less polluting. The all-time needed energy in our lives has been provided by energy resources. These resources can be divided into two categories as renewable and nonrenewable. It can be said the renewable energy sources have almost endless power and they don't pose any danger to the environment (*Mutlu S., Çabuk A.,Güney Y, 2011)*. These renewable energy sources are: Solar, Wind, Geothermal, Biomass, Hydroelectric, Wave and Hydrogen. The most popular of these resources is solar power, the basis of life. Solar energy is a renewable energy source nearly inexhaustible and pollution free.

In order to tap the potential of Renewable Energy sources, there is a need to assess the availability of resources spatially. There are more technological approaches for exploatation of the solar radiation. At some of them, the solar energy mainly is used for heating and direct illumination, but on the other side some technologies use the solar energy for direct geneating of electricity(Zakšek K., Marsetič A., Kokalj Z., 2007).

The analysis of topographical land surface parameters using conventional methods often is a very tedious work task and demands lot of time for performing of needed analyses.

Solar Parks would include all required facilities for generation of solar power, which may include evacuation and transmission infrastructure, solar radiation monitoring station, water availability, access roads to the park, interior roads in the park, telecommunication facility, fire station, green belt and security (Sanjeevi Prasad.S, Dineshkumar.K, and Madha Suresh.V,2014)

The researches in this paper mainly are focused on applying of some contemporary GIS tools for determination of some basic topographical parameters of land surface which are most importand for the possibility of exploatation of the solar energy potentials. The solar energy potential at a given location in a large extent depends on values for altitudinal gradient on the land surfaces as well as on values for compas aspect direction of slopes. Having on disposal the necessary data about the quantity of the solar radiation at any given location wether at annual or daily level (http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php), the other factors that mostly have a great influence on the assessment of suitable locations for exploatation of the solar energy depend on some other topological parameters of land surface.

Employing GIS-based methodological approaches, on the basis of digital maps in vector format with grid points and contour lines , it can be easily obtain a Digital Elevation Model-DEM of the land surface which is analysed.

Applying the geospatial analyses and techniques for modeling with GIS tools, now it is possible efficient displaying of land surface with Digital Elevation Models, TIN models , and shading relief models . GIS-based multi-criteria analysis involves two types of evaluation methods: Boolean overlay operations and WLC-Weighted linear combinations (Hott R., Santini R., and Brownson J., 2011). Solving the complex phenomena in GIS environment with use of s.c. Multicriteria analysis of problems can be a very useful tool (Alekhya D. and Karakoti I., 2010). After all the proposed geospatial analysis of the solar energy potentials is an efficient tool for preliminary screening of suitable locations also for constructing of PV-Photovoltaic solar plants.

Innovations in solar radiation mapping are now contributing to the rapid growth of solar energy market in many countries. The developed solar radiation maps benefit everyone from homeowners and solarpanel installers to the developers and financiers of large-scale power projects, industry experts, and governments (Gastli and Charabi,2009).

II. METHODOLOGY APPROACH

II.1. Study area and its properties

The study area encompases the north part of the Prespa lake(fig.1). More exactly the area comrised of the town of Resen, Resen field area and some

villages located in the south and south-west part of the town as well as part of the massif of the mountain Baba.
In the lower flat area the surfaces are planted with apple orchards , there are also meadow areas and some smaller low shrubby areas . The mountain part of the study area is mostly covered with deciduous forests and some part is covered with conifer forests.
The geographic extent of the study area encompasses the area between 20^0 45’- 21^0 in east-west direction and 41^{0} - 41^0 07’ 30’’ in south-nord direction. The elevation differences in the study area are in interval from 851 m.a.s.l. to 1776 m.a.s.l.

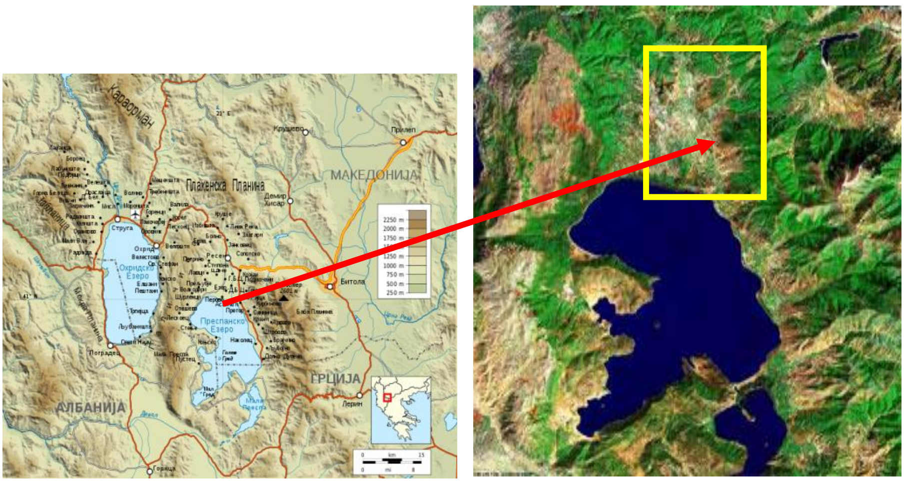

Fig.1. Cartographic and satelite display of the location of study area (Wikipedia)

II.2. Source data

As initial input data are used topographic maps with different layers of data in vector format in scale 1:25000. Each map covers an area of about 140 km^2. For the purpose of study were used the data layers of point grid, contours, digitized road network , digitized stream network map, digitized map with polygons of all populated places(villages and towns) land cover and land use vector dataset as well as some other layers. All of the data in these maps are projected using the state coordinate system (Bessel) based on the Gauss-Krueger projection.
Beside the maps with spatial data are also used some numerical data which are related to the solar irradiation in the study area at annual, monthly and daily level.

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II.3. Solar energy and its potentials

Republic of Macedonia extends largely in the solar belt between 40 and 42 degrees north latitude. The annual average solar radiation at optimal slope parameters of the land surface is around 1699 kWh/m2 (Table 1) with a daily solar radiation of 4,6 kWh/m2 .

TABLE 1 Values of global solar radiation for the study area

Annual global solar radiation (kWh/m2)			
	Horizontal surface	Vertical surface	Land surface at the optimal slopes
Minimum	1495	1086	1695
Average value	1500	1089	1699
Maximum	1509	1093	1708

Beside that , the Prespa valley is characterized by prolonged solar radiation, which during the year may be variable from 1400 to a maximum of 2600 hours per year. This amount of solar radiation offers excellent opportunities for the exploitation of solar energy potentials.

II.3. Principle of operation of photovoltaic cells and panels, solar farms

Today more commonly the modern manufactured solar cells are called photovoltaics. They are made of semiconductor material (typically silicon and germanium). When sunlight falls on the surface of these photo-voltaic panels they absorb it through the photons . The absorbed energy from the photons hits the electrons in the silicon allowing them to move. By adding other impurities into silicon (boron, phosphorus, etc.) can be established an electric field (Fig. 2).

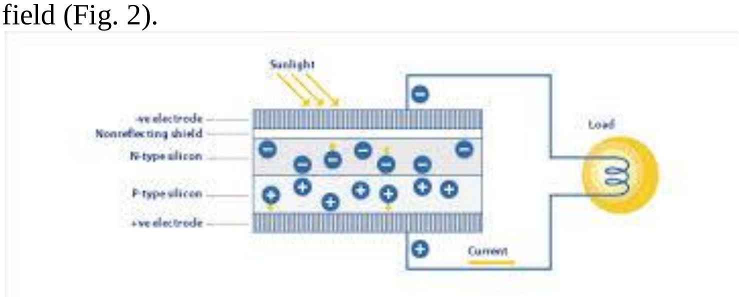


Fig.2. Principle of operation of photovoltaic cells

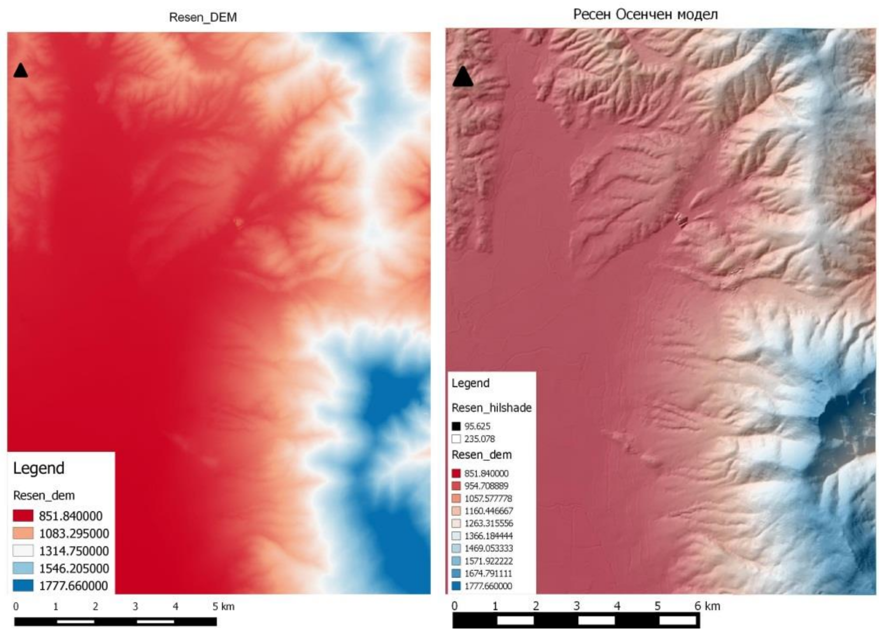
The established electric field acts as a diode because it allows flowing of the electrons only in one direction. As a consequence of that it appears an electric current of electrons or current. In fact the photovoltaic conversion is an direct conversion of the sunlight into electric current or electricity.
In practical meaning the photovoltaic pannels as relativelly simple for design and performance, and beside that they can be maintained with minimal efforts.
Today more and more in the focus of interest are so called photo-voltaic solar farms , whre the solar light is directly converted into electrical energy which is accumulated and used according to the needs (Fig.3).

Fig.3. Display of a photovoltaic solar farm

II.4. Digital Elevation Model-DEM of the lnd surface and analysis of main land surface parameters in GIS platform

For analysis of main topological parameters of land surface the creation of DEM- Digital elevation model is essentialy important and is main input dataset for further analyses of the land surface. In this case study, the DEM for the study area can be obtained with different interpolation methods. Spatial interpolation is the process of using points or contours with known values to estimate values at other points **(Chang K.T. (2012).** In such way can be estimated elevation value at an unknown elevation points using known elevation readings at nearby points or cuntours. Usually in GIS applications spatial interpolation is applied to estimate values for all cells in a raster map. In this way using the interpolation tool Topo-to-raster in ArcgIS is used a combination of two input data in vector format: One is the point grid file and the other is the shape file with contours (Fig.4).

The obtained DEM raster map is with resolution of 20m. Using the obtained DEM raster map, with further geospatial analyses in GIS platform are determined additional land surface parameters which are important for site suitability analysis such as: Slope map, Aspect map, Hillshade map and others.



a) b)

Fig.4. DEM model of the study area a.) and Hillshade relief model b.)

For furter analyses is used the DEM raster map of the land surface. Employing different tools for raster and vector analysis of the GIS open source software package QGIS in an efficient way can be obtained also different kinds of vector and raster maps. using these maps can be determined the most important land surface parameters.

With this approach, using the DEM raster map of land surface is determined a raster map with slope values of the surface. The slope tool in QGIS calculates the maximum rate of change from a cell to its eight neighbouring cells, which is typically used for representing of the stepness of the terrain surface. For each cell,Slope tool calculates the maximum rate of change in value from that cell to its neighbors. The maximum change in elevation over the distance between the cell and its eight neighbors identifies the steepest downhill descent from the cell. The obtained map is in raster format with pixel resolution od 20m, whrereas in each pixel of the map is stored the slope value which is expressed in percents(%) (Fig.6.).

Again, using as input data the DEM raster map it is determined also the aspect raster map in same pixel resolution with values of the compas directions of the slopes. In fact the Aspect tool in QGIS calculates the direction in which the plane fitted to the slope faces for each raster cell. Aspect tool identifies the downslope direction of the maximum rate of change in value from each cell to its neighbors. It can be thought of as the slope direction. The values of each cell in output raster indicate the compass direction that the surface faces at that location. It is measured clockwise in degrees from 0(north) 90(east) 180(south) 270(west) to 360(north). Each compas side is coded with code number (Fig. 5).

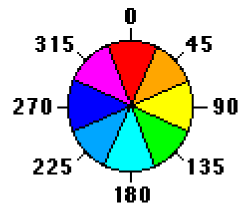
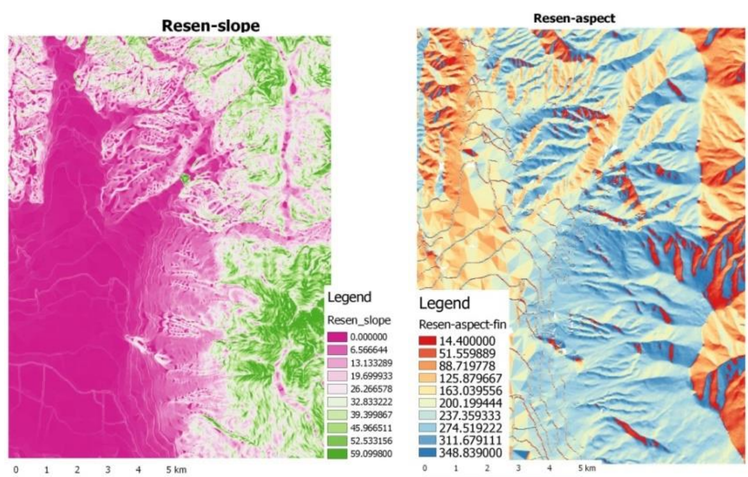


Fig.5. Aspect directions with coded numbers

In this case the north side is marked with 0 or 360^0 (whole circle), the east side has value of 90^0, the south side has value of 180^0 and the west side 270^0 (Fig. 5).The obtained map is in raster format with pixel resolution od 20m, whrereas in each pixel of the map is stored value of the aspect direction of the slope which is expressed in degrees (^{0}) (Fig.6.).



a.) b)

Fig.6. Raster map with slope values in % a) and raster map with values of compas direction of the slopes b.)

III. KEY LAND SURFACE PARAMETERS FOR OPTIMAL EXPLOATATION OF THE SOLAR ENERGY POTENTIALS

III.1. Determining of the suitable slopes and compas directions of the slopes at the land surface

As it was mentioned above, as a basis for determination of suitable locations for exploatation of solar energy potential using GIS tools was used the DEM model of the land surface in study area. Employing the raster DEM map they were obtained raster maps with values of slopes and aspect direction of slopes at pixel level (Fig.6).

In raster analyses in GIS platform very often is used so called Multictriteria analysis-MCA. The main goal of this type of analysis is to simplify the more complex issues using multiplicatice criteria in order to bi found some optimal alternative solutions concerning the finding and screening of appropriate locations at some part of the land surface area which is of our interess.

Principally GIS based multicriteria analysis involves two types of evaluation methods: 1. Method with boulean operators of overlaping and 2. Linear combinations with use of s.c. factors of influence and importance for particular datasets.

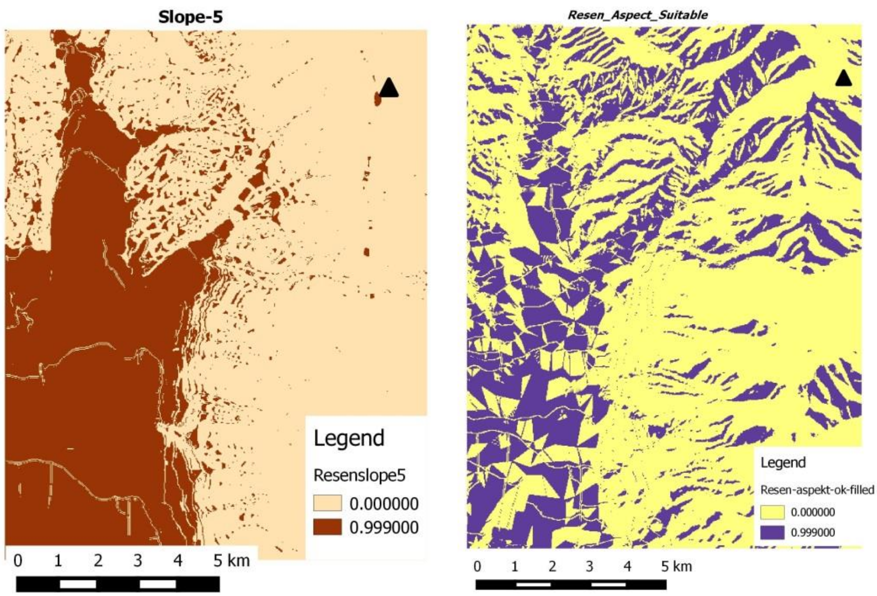
In this research is applied the first method with boulean operators. At the first stage the main criteria for assessment of optimal locations should be determined. It is done with setting of a treshold value of raster cells in a given raster map. Setting the treshold value allows to be obtained different raster maps or so called Boulean digital maps. In boulean maps all raster cells are coloured with two colors. One color represents the suitable raster cells in the map whereas the other colour represents the unsuitable raster cells. All siitable cells in the map have value of 1 and the others have valie of 0.

Such determined boulean raster maps in the further analysis can be easily combined with the well known Boulean operators such AND , OR , NOR, XOR and others.

Two criteria concerning the topological parameters of land surface are of main influence in the preliminary screening of suitable locations for solar power exploatation:

1. Locations with small slope valies
2. Locations whose aspect direction of the slope is in interval from south-east to south-west

In context of the above mentioned, as appropriate locations regarding the slope values are taken only these parts of the land surface which have small slope values (mainly flat surfaces). For this purpose, using as input dataset the slope raster map it is set a treshold value of slope of 5% . In such a way is obtained a boulean raster map with filtered values of slopes at pixel level with resolution of 20m (Fig.7). In the figure 7.a. below the suitable raster cells in the map are shown in brown colour, whereas the unsuitable raster cells are shown with light cream colour.



a.) b)

Fig.7. Raster map with slope values smaller than 5 % a) and raster map with aspect values in the interval between 135 and 225(south-east and south-west) b.)

The appropriate values in the raster map of slopes (Fig. 7.a.) have value of 1 whereas the unappropriate values have value of 0.

In similar way, using the input raster map with values of aspect compas directions of slopes (Fig.6.b) can be efficiently derived and filtered the values of aspect directions which are most appropriate for exploatation of solar energy potentials. Because the study area is located in the north hemisphere of the earth, as appropriate aspect directions of slope are taken into consideration the directions: south-east , south and south-west. The coded values for these directions are in range from 135(south-east) 180(south direction) to 225 (south-west) direction.

Following this approach, the most suitable direction of slopes in the study area should be in the interval from 135^0 to 225^0 that is to say along the line which is in direction toward the south-east until the line which is directed toward the south-west direction.

Using the raster map with aspect direction values (Fig.6.b.) with setting of treshold values in the interval from 135^0 to 225^0 can be easily obtained a new raster boulean map with filtered values of optimal compas directions at pixel level. In the figure 7.b. below the suitable raster cells for aspect values in the map are shown in dark blue colour, whereas the unsuitable raster cells of aspect values are shown with yellow colour. Again here, the appropriate values in the raster map of aspect direction of slopes (Fig. 7.b.) have value of 1 whereas the unappropriate values have value of 0.

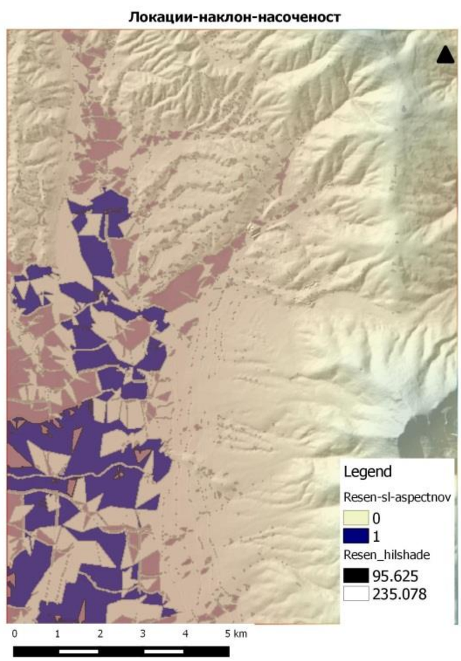


Fig.8. Raster map with suitable values of slopes and direction of slopes

Now with combination of both raster maps(Fig.7. a &b.) with filtered suitable values of slope and aspect direction, using the Raster calculator tool in QGIS in an efficient way ccan be determined a digital raster map with appropriate values for both, the slope and aspect directions (fig.8). As cabn be seen in the above raster map , the suitable location are with blue colour whereas unsuitable locations are with light cream colour. This map satisfyes both mentioned topographic criteria concerning the suitable locations for exploatation of solar power potentials.

The final obtained raster map with filtered cells can be furtermore easyly converted to a digital map in vector format. The overlaying of the final vector map above the hillsahade map gives much bether visualisation of the terrain surface.

IV. EVALUATION OF SUITABLE LOCATIONS FOR EXPLOATATION OF THE SOLAR POTENTIALS. РЕЗУЛТАТИ И ДИСКУСИЈА

In the process of making a quality geospatial analysis of suitable location for construction of solar energy farms should be taken into consideration more factors which have influence at the choice of location. These factors can be divided into several groups: Techno engineering, ecological , economic factors and others. Of course here one of the most important group of impact factors are techno-engineering factors and ecological factors. Therefore a main accent in the research was set right on the analysis of these groups of factors. In the previous chapter was explained, in which way with combination of the raster map with suitable slope values and raster map with suitable values of aspect direction can be obtained a new digital map in raster and vector format with suitable locations for construction of photovoltaic solar farms. In this case were taken into account the slope values and aspoect direction values as two factors that have most powerful impact in the selection of suitable locations from the technological and engineering point of view.

Regarding the other factors of ecological nature which have highest influence at the choice of suitable locations, in this paper were made analysis of several factors with greater influence, such as: road network infrastructure, stream network, watershed surface areas, land cover, land use as well as locations of settlement areas (towns, vilages etc) in the study area. For this purpose were used several already prepared digital maps in vector format. In fact here it is going for different vector layers of datasets of the same map in the study area. In this way was used the digital map vit vector layer of road network, hydrography network, polygonal layer of settlements as well as polygonal layers for land cover and land use types of the land surface in the study area. In the map with vector dataset of land cover are taken into consideration only those polygons with land cover that are suitable for construction of solar energy farms, so that at the same time the land cover must satisfy the criteria not to destroy the ecological balance of the environment in the study area.

All digital maps with different vector layers were overlaped, so that with such overlaping of several vector layers in an efficient way is obtained a digital map in vector format on which are presented the road network and stream network with lines as well as polygonal layers of settlements and polygonal surfaces with appropriate land cover of land surface which allow construction of farms for exploatation of solar energy potentials.

All vector layers are cummulative displayed in one vector map (Fig.9). Here as suitable locations for solar farms are taken into consideration those surfaces that are covered mainly with low shrubby areas and meadows which are shown on the map with dark blue and yellow colour of polygons (Fig.9.).

At the vector layers for road network infrastructure and stream network is also performed a buffer proximity analysis. With this analysis are set buffer zones along the streams and roads, so that all areas that are in proximity bends to rivers and roads are excluded from the selection of suitable locations for solar energy farm construction.

In the analysis of suitable poligonal areas of land cover and land use was also set a treshold value for a minimal acceptible area for solar farm construction. It was also set a polygonal buffer zone at settlement polygons, so that the proximity zones of towns and villages were also excluded in the analysis of optimal locations.

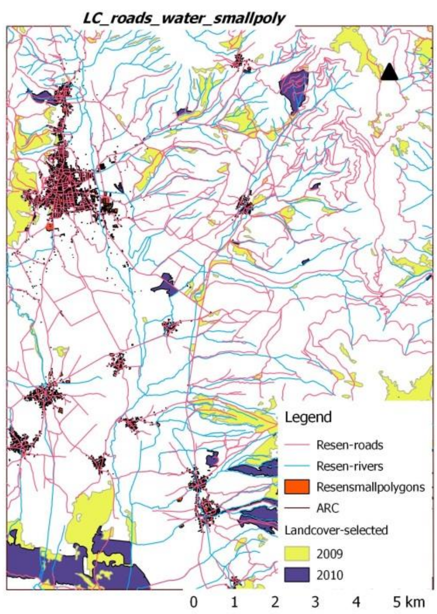


Fig.9. Map with a cumulative display of road network, river streams, settlements and land cover in vector format

Using a combined geospatial analysis of the vectorized digital map of Figure 8. with the digital map of Figure 9. in an efficient way is determined a final digital map in vector format for determined polygonal areas that satisfy the technological engineering and ecological criteria for selection of suitable areas for solar enegy potential development (Fig.10).

In the final digital map, the optimal locations for construction of solar photovoltaic farms are shown with green colour . The final map with suitable areas is in vector format and is overlaed on the raster hillshade map , with wich is ensured a bether visualisation of the land surface area. The small suitable polygons(in green) are excluded from selection due to their very small area for construction of farm for exploatation of solar power. This is done with settin of an empirical treshold values for the area of suitable polygons.

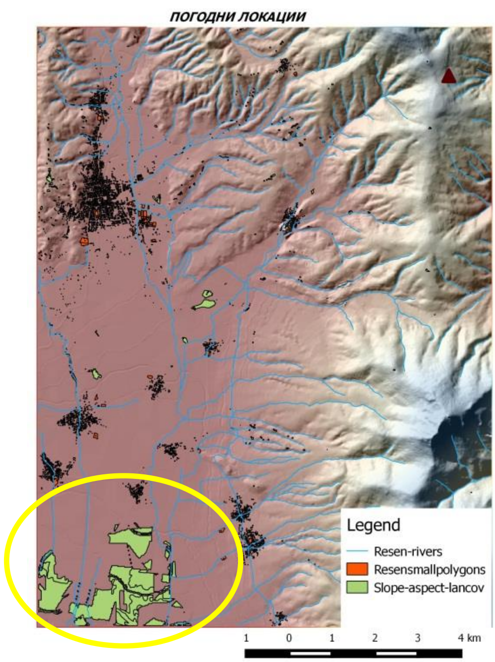


Fig.10. Map with final display of the optimal locations for exploatation of solar power potentials

V. RESULTS AND DISCUSSION

As a final result of the performed research and analysis on Fig. 10 can be seen , that almost all suitable location surfaces are located in the flat area in the south-west part of the study area arround 10 km in the south direction of the town of Resen and several kilometers in the south direction of the village Carev Dvor.

As was mentioned above, it should be emhasized that only these surface area should be taken into consideration wich are sufficiently large , where it can be foreseen a construction of farm for exploatation of solar power potentials with sufficient solar power capacity.
It should be also pointed out, that the exploatation of the solar energy potentials at the selected optimal surfaces in a great extent can also depends on the season of the year. For example, the setting of solar pannels during the summer season at lower slope values in degrees allows greater exploatation of solar radiation. On the other side, during the winter season the pathway of movement of the sun from east side toward the west side is much lower toward the south horizont. In this case greater values of the slopes of panels allow greater exploatation capacity of the solar radiation.
Taking into consideration the above constatations, it should be take into account some possibility for authomatic controlling of movement of solar panels not only from east to west direction but also from lower to greater slope in degrees depends of the season in the year. The optimal slope angles of solar panels are shown in Table 2. below.

TABLE 2 Optimal slope values of photo voltaic panels in the study area

Optimal slope angle of Photovoltaic solar panels (in degrees)	
	ANGLE
Minimal	32^0
Average	33^0
Maximal	33^0

The proposed methodologial approach in GIS platform mainly is used for preliminary screening of optimal location for solar power exploatation. In the process of making final decisions for construction of solar photovoltaic farms certainly should be performed also some additional analyses for every potential location separatelly, in order the obtained results to be compared to those which were obtained with geospatial analysis in GIS platform. The comparation analysis at the end stage will contribute toward the final right decision making concerning the exploatation of solar power potentials.

VI. CONCLUSIONS

In the paper it is presented a GIS-based methodology with spec ial approach and application of MCA(Multicriteria Analysis) evaluation of suitable sites for expolatation of solar power potentials.

The combination of GIS with the MCA evaluation is very useful software tool for right decision making concerning the location and modeling of potential locations for building of photovoltaic solar power plants. The research is practically proved with obtained results at astudy area of 140km^2 .

It should be pointed out that the proposed methodology for preliminary screening of suitable locations can be easilly applied at any other geographical area. In this paper has been done analysis of the suitability of locations taking into consideration the most important technological, engineering and environmental criteria of impact factors. In order to find suitable sites for exploatation of solar power potentials it has been done slope analysis, aspect analysis, buffer analysis of stream network and road network infrastructure, as well as analysis of the land cover classes of the land surface in the study area.

With GIS-based geospatial analysis of a combination of many digital maps with land surface parameters has been performed a final assessment of suitable locations for optimal use of solar power potentials.

REFERENCES

Chang K.T. (2012): INTRODUCTION TO GEOGRAPHIC INFORMATION SYSTEMS, 6th edition Mc Graw Hill.

Datta A. and Karakoti I. (2010): "Solar Resource Assessment using GIS & Remote Sensing techniques", *11th ESRI India User Conference 2010.*

Gastli, A.and Charabi, Y. (2010) "Solar electricity prospects in Oman using GIS-based solar radiation maps," *Renewable and Sustainable Energy Reviews*, Vol 14, pp 790–797.

Hott R., Santini R. and Brownson J. (2011): "GIS-BASED SPATIAL ANALYSIS FOR LARGE-SCALE SOLAR POWER AND TRANSMISSION LINE ISSUES: CASE STUDY OF WYOMING, U.S."

Mutly S., Cabuk A., Guney Y.(2011): "GIS based site determination model for productive Solar pharm: A case study in Eskisehir"- Proceedings of 21-st International Offshore and Polar Engineering conference, Maui, Hawaii, USA.

Photovoltaic Geographical Information System-Interactive map: http://re.jrc.ec.europa.eu/pvgis/apps4/pvest.php, acessed October,2016

Prasad S., Dineshkumar.K., Suresh M.(2014): "LOCATION OF SOLAR POWER PARK- GEO-INFORMATICS APPROACH-A CASE STUDY OF MADURAI DISTRICT, TAMIL NADU, INDIA". African Journal of Geo-Sciences Research.

Zakšek K., Marsetič A., Kokalj Z. (2007): " IZKORIŠČANJE SONČNE ENERGIJE NA KRASU", Geodetski vestnik 51-2007.1, Ljubljana, Slovenija

http://www.qgis.org/en/docs/index.html (acessed September&October 2016).

ON THE ACCURACY OF THE GIS MAPPING BASE OF VLORA

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SUMMARY

Maps in general, and those topographic in specific, serve as GIS data source, and are also its products. The maps, as tools destined to collect information with a certain purpose, should be trustworthy, not only for their thematic information, but also for their geometric accuracy with which each geographic object is identified.
Despite the care and the methods chosen, these maps contain several errors that influence the accuracy of the GIS database. These errors are multiplied due to data entry errors: during scanning, Geo-referencing, digitization etc. so, because of the conceptual and technical limitations, the geographic positioning attributes, described within spatial data contain errors and uncertainty.
This article develops the theoretical concepts on the accuracy of GIS database, and especially the mapping base of GIS, and assesses the geometric accuracy of the topographic map of Vlora at the scale of 1:50000, published by the Military Geographic Institute of the Albanian Ministry of Defense in cooperation with the US and NATO Defense Departments.

Key words: mapping, GIS, errors, qualitative attributes, accuracy, test, topology, accurate assessment.

1. INTRODUCTION

In order to have accurate interpretations and have the right decisions made, it is necessary that the data used should meet an acceptable level of quality. However, the spatial data are prone to a range of errors and uncertainties during data collection and processing.

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The quality of spatial data includes the accuracy, precision, reliability and validity, where each represents a special attribute of the database.
Until recently, the GIS usage and development experts were very careful to these errors, inaccuracies and lack of precision of spatial data. Of course, a general awareness had prevailed on the errors of all data available, with regard to inaccuracies and lack of precision, but the magnitude of the problem and its GIS solutions were not entirely on the focus. This situation has changed considerably during the last years. It is nowadays well-accepted that the error, inaccuracy and lack of precision can lead many GIS projects to fail.

2. THE SPATIAL DATA QUALITY AND ITS ATTRIBUTES

The data quality is an important factor in the process of conveying the information accurately and efficiently. It can vary from person to person, from organization to organization or application to application. It is the responsibility of the user to decide whether a data network complies with quality requirements or not; the standards varying depending on the application or use. A certain data quality could be satisfactory for one project but not necessarily for another.
The accuracy is the first consideration when data is assessed and analyzed. The accuracy, precision and the degree of error have their own meaning and importance. The degree of error is the difference between the real and estimated values. The accuracy, as relates to the error, is the degree on which an estimated value approximates a real one. The precision is the distribution of the estimated values as compared to the real ones. It is assessed based on the values of the standard deviation of all observations to the mean. The precision also refers to the ability for displaying values up to a certain value after the decimal point. The high precision or reliability does not equal high accuracy, and neither does high accuracy equal high reliability. Sometimes the two terms are used interchangeably in a wrong way.
The error is ubiquitous during each phase: on the conceptual one (perception), in the field (collection of false data due to the limitations of the theodolite, GPS satellites etc), and in measuring the attributes (due to changes in the environment, observer bias, poor data handling and manipulation, misinterpretation of the obtained data etc).
The spatial data transfer standard lists 5 components deemed adequate to assess the utility of the obtained data:

- data origin
- positioning accuracy
- attributive accuracy

- logical sustainability
- completeness

all these elements provide qualitative information in relation to the data network.

2.1 Geometric accuracy (or positioning or spatial accuracy)

The geometric accuracy determines the deviation from the values of actual positions between the GIS and the nominal terrain (Servigne, Lesage and Libourel, 2010). The nominal terrain is in principle an abstract of the real world. The position accuracy can be divided in absolute or relative accuracy. It can also be sub-divided into horizontal or vertical accuracy. The assessment methods are generally based on the assessment of the sources, as compared to standards of higher accuracy or in the empirical assessments. The accuracy variations can be reported as quality covers or of the additional attributes (Vereign, 1999).
One should be careful on the risks of false accuracy and precision, for all information that is received beyond the the level of accuracy and precision of the map. This is a potential mistake for computer systems that allow the user to move or magnify the map into larger scales. The accuracy and the precision is linked to the original scale of the map and do not change is the use magnifies the map. Zooming in or out however can be misleading to the user in leading them to believe that the accuracy and precision has increased.
The position and the accuracy, as they represent the trustworthiness, the belief and the danger, define the way that the geographic database can eventually be used. The spatial analysis required sustainable accuracy within each geographic strata (Ries 1993).
Spatial error is an important concern in GIS as the error might influence several attributes of the information saved in a database. The standards and the specifications are crucial for facilitating the development and exchange of the data and geospatial products.

2.2 Semantic accuracy (or the non-spatial attributes accuracy)

The accuracy attributes or thematic one is defined as the accuracy of data attributes. If, for example, in a rice field, is marked on a map as a wheat field, the result is a thematic or attributes error. The attributes tests or thematic ones can result from deductive assessments or with samples independent from the polygon coverage. The quantitative data could be collected by using the accuracy of the data collection tool. The attributive quantitative accuracy is missing, for example, when in a region with an average of rainfall of 100 cm the measurements are collected using an instrument that collects accurately at 0.1 cm, meaning the measurement error is 0.1 cm. For the qualitative or categorical errors, the resolution is determined in the aspect of the cleanliness of the categorical definition. For example, a pine tree region is marked as a maple tree region is an example of an attributive qualitative error. One must differentiate between the original and obtained attributes.

2.3 Completeness

The completeness describes the relationship between the objects in a group of data and the relationship of the same group of objects with the real world. The completeness of the data is useful in detecting commission errors (additional erroneous characteristics) and the inactivity of certain objects (lost characteristics). In a spatial model, the model completeness, expresses the adequacy of representation in relation to user requirements (Servigne, Lesage dhe Libourel, 2010). It can also include such information as selection criteria, definition and other mapping rules that are used to create the database etc, (Veregin, 1999).

2.4 Origins

The origins provides the necessary information for rebuilding the history of a database so that it can be analyzed eventually. The origin provide the information as follows: data source, including information on the organization that provides it; coordination system, projection systems, and related corrections; data collection methods, data computing or derivation; conversion methods during digitization or vectorization of raster data; transformations (i.e. transformation of coordinates, re-classification etc (Servigne, Lesage dhe Libourel 2010).
It is important to be aware of the data source as many of the errors result from the mistakes made in this phase. To validate the previous results it is necessary to create a group of control points on data collection or description. These should be documented at such detail to allow for the improvement of data accuracy. Also, all the transformation process should be properly documented so that confusion is avoided and so is the approximation error in later stages.

2.5 Logical sustainability

The logical sustainability aims to explain the accuracy or fidelity of relationship coded in the database structure in relation to the limitations imposed by the specifications of the inputed data (Servigne, Lesage dhe

Libourel, 2010). A data network is considered sustainable is it meets the structural attributes of the object it represents. For example, a contour must be closed, construction buildings should be closed polygons, roadway nodes should be connected etc. This includes the tests on the validity of attribute values, and the description of the topology mismatches based on graphic tests or topology specifications (Veregin , 1999).
Lack of logical sustainability or the mismatch stems also from the incorrect determination of the GIS process. All of the process, from the conceptual phase, to data collection, data analysis, data manipulation and interpretation, should be standardized and accompanied with a detailed description.

2.6 Temporal accuracy

The temporal accuracy relates to the temporal attributes of the data as the time of data collection, type and frequency of data collection, as well as the period for which the data are valid (Servigne, Lesage dhe Libourel, 2010). There are 3 temporal concepts: the actual time, that is the exact time when the event took place, i.e. the date of areal photography, time of observation and time of the transaction, time of data entry etc. The temporal accuracy is defined as the part of the data error that stems from the temporary nature of the data.

2.7 Semantic sustainability

It describes the importance of the meaning of the objects in relation to the model chosen; it describes the number of objects, relationships, and correctly coded attributes in compliance to the universe of rules and specifications (Servigne, Lesage dhe Libourel, 2010). The semantic sustainability is linked to the quality of the description of the geographic objects. For example, is someone has created a hospital database, should the clinics be included in this database? Solutions to such issues require profound geographic and consolidated reasoning.

2.8 Time-Frames

Time-frames provide information on how recent are the data, which consists of a starting and ending date (Servigne, Lesage dhe Libourel, 2010). Even though some studies considers this to be a parameter on its own, Harding (2010) suggests that usage can be considered as a form of the semantic accuracy, and that the completeness and the semantic sustainability could be included under the semantic sustainability.

Due to errors linked to the data during data collection or transformation, inaccuracies (deviations from the true value) in increased and leads to data quality deterioration. Even though the errors are always found in GIS data, special care should be taken during each of the steps, so that data errors are minimized and the data quality is preserved at the highest standard. To minimize data errors, we should analyze the origin and characteristics of data errors. There are 3 kinds of errors in GIS:

1. Source errors, which are present at data sources. They take place before GIS implementation and are linked to errors of instruments, human errors, changes of objects and events on which data is being collected on.
2. Data processing errors, that are errors that happen during GIS implementation. These are errors happening during data entry (digitization – human errors, the width of a line, turns, nodes, attribute entries; solitary nodes, pseudo-nodes, entry of erroneous projections etc); data manipulation (interpolation of point data in lines and areas; overlapping of layers digitized separately – i.e. land and vegetations; mixing the effects of processing and the analysis of multi layers, i.e. if each of the layers has an accuracy of 90% , the resulting layer accuracy will be 81% and the observations density), and
3. Errors linked to results generated (scale change – the graphical and numerical scale; color templates – using the wrong colors on monitor and in print etc).

In addition to the above, other errors linked to data transfer and conversion can take place. These errors can lead to data loss. The idea that GIS data are of high quality is erroneous. The quality of GIS information depends on the quality of the data used as input.

3. ASSESSING THE DATA QUALITY FOR THE TOPOGRAPHIC MAP (SCALE 1:50000) OF VLORA PREPARED IN COMPLIANCE WITH NATO STANDARDS

The basis for making decisions in spatial projecting and planning is the spatial data, and first of all the mapping data, such as cadastral, topographic and thematic maps, and later all statistical and other available documentation. During the last decade of the 20th century, the spatial data were adapted to the digital format, revolutionizing their use. The advances in the information technology, and the revolution of the GIS data collection technology (GPS, digital photogrametry, laser scanning etc), played a leading role in the management of spatial databases.

The quality of classic topographic maps includes the geographic accuracy as well as the thematic loyalty of the map content. The positioning accuracy of the geographic information is an important quantitative element of data quality, no matter whether they are in analog or digital form. For this data analysis we took under consideration the topographic map of Vlora (scale 1:50000, sheet 2975 I and 2975 IV) developed by Albanian Military Geographic Institute, in compliance with NATO standards.

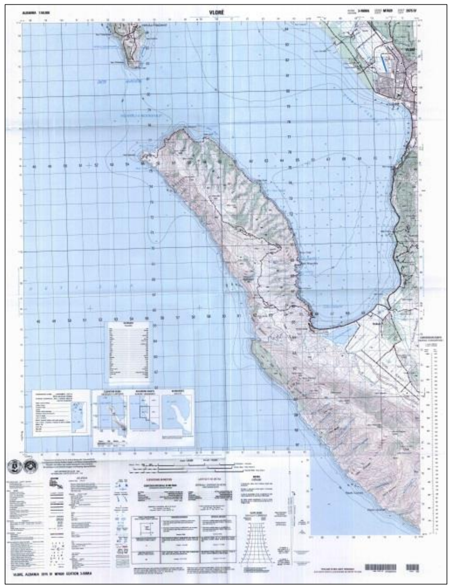

Fig. 1. The topographic map of Vlora (sheet 2975 IV)

The quality control for this map consists in establishing a series of GPS control points, clearly identified in the field and on the map (geodesic points, buildings, line intercepts, vertices etc). For these points, terrain coordinates were identified via GPS and on the map via GIS. Its is important to state that both types of coordinates were transformed on the same system, UTM evaluated for the Albanian territory. By calculating the differences in the two types of coordinates on the 'field' and 'map' we developed an index that was analyzed statistically.

The errors of digitization of current maps includes errors in the collection and processing of current data (field measurement and mapping errors) and transformation errors (scanning, geo-referencing and vectorization).

The accuracy of source maps used as input is defined by the Gauss mean quadratic error and the maximal acceptable error (twice the value of the mean quadratic error). The expression of the Gauss mean quadratic error is:

$$\sigma = \sqrt{\frac{1}{n}} \sum \Delta^2$$

where:
σ – standard deviation (Gauss mean quadratic error) of the data source;
Δ – deviation from the real values;
n – the number of observations

The statistical analysis of the above data shows that the standard deviation of the geodesic control points is σ = ± 3.2 m. The standard deviation of the detail points is less than ± 10 m.
Hydrography is better represented and more accurate as compared to other elements of the topographic maps.
The thematic accuracy includes includes the fidelity of the data of topographic maps. It is impossible to identify a mathematical expression to express thematic accuracy. In the environment displayed in the above mentioned maps there is a multitude of changes due to human intervention (buildings, trenches etc) and the influence of nature factors (landslides, erosion etc). In addition, essential differences are identified is specific methods of surveying and topography are applied (topographic and photogrametric surveys, basic height, generalization of types of terrain etc).
There are visible differences on land cover, with the most visible ones near human households. Populated areas and new infrastructure developed recently makes up most of these differences. New households are identified and old ones that have been changes their appearance. All these differences have an impact on the fidelity of old maps. Big differences are also notices on transportation network, dwelling and geographic names. The thematic accuracy for maps of 1:50000 scale, constructed in compliance to NATO standards (1994-1995), especially in their content, is higher than that of maps constructed through direct field measurements or through photogrametry. For all the other kinds of maps taken into consideration from other mapping sources, the quality is poorer due to the low accuracy of thematic content and neglect of mapping sources.
The conversion of data from analog to digital, involves other errors, but their magnitude does not pass the maximal permitted error for analog data sources. Therefore, the accuracy of digital data after processing may be estimated as a function of the maximal error of source data (m_{mb}) and the maximal error of data processing ($m_{përp}$) through this formula:

$$m^2_{max} = m^2_{mb} + m^2_{përp}$$

where: m_{max} – digital data error, m_{mb} = σ (standard deviation of source data)

If we accept that $m_{mb} = m_{përp}$, then:

$m^2_{max} = m^2_{mb} + m^2_{përp} = 2\ m^2_{mb}$, while:

$m_{max} = \pm\ 1.4\ m_{mb}$

Based on the expressions above, the mean quadtratic error was calculatedand the quality of digital data for the geodesic base points was estimated: $m_{max} = 1.4\ m_{mb} = \pm\ 1.4 * 3.2\ m = \pm\ 4.48\ m$.
The accuracy of the mathematical base (map projection, reference points and geodesic points) of topographic digital maps is listed in the following table:

Base mathematical elements	*Mean quadratic error at map scale*
Map projection (lines)	± 0.10
Reference points (marked)	± 0.10
Geodesic points	± 0.18

Tab. 1

Forest areas and/or mountains or sand hills, objects are 1.5 times less frequent with a maximal error of 0.75 mm. Where the symbols of topographic maps are not deviated, the absolute value of horizontal line errors identified strictly in relation to the nearest control point or network does not exceed 0.5 mm.
The errors due to deforming of map paper by scanning at large can be minimized, but only under certain conditions.

CONCLUSIONS

Being aware of the quality and accuracy of data, especially those in mapping, is one of the key aspects in GIS implementation. Preliminary assessment of topographic maps of Vlora at scale 1:50000 is based on the analysis of the accuracy of its plan and content. The mean quadratic error of the geodesic control points is ± 3.2 m. Positioning accuracy of the other points of the topographic content is within the map graphic accuracy. The mean quadratic error of detail points is less then ± 10 m.
The accuracy of digital data for the geodesic points obtained from topographic maps mentioned above is around ± 4.48 m, which speaks in favor of a very good quality of the spatial data of such maps.
The initial thematic data at the time maps were constructed were very reliable. However, the the quality of the general information has deteriorated

through time, and it is necessary to update the content of these thematic maps periodically.

REFERENCES

1. Harding, J. 2010. Vector Data Quality: A Data Provider's Perspective in Fundamentals of spatial data quality edited by Devillers R. and Jeansoulin R. London, UK: Wiley.
2. M.F. Goodchild (1995) Attribute accuracy. In Elements of Spatial Data Quality, edited by S.C. Guptill and J.L. Morrison. New York: Elsevier
3. Menezes, L.P.M., Miscel, B.M., Godoy, V.F., 2011, Quality Evaluation Criterium of Historical Maps, CO-363, ICC, Germania, Dresden.
4. Ries, T., "Design Requirements for Location as a Foundation for Transportation Information Systems," GIS-T '93 Geographic Information Systems for Transportation Symposium, Albuquerque, New Mexico, pp.48, March 29-31, 1993.
5. Servigne S., Lesage, N., Libourel, T. 2010. Quality components, standards, and metadata in Fundamentals of spatial data quality edited by Devillers R. and Jeansoulin R. London, UK: Wiley.
6. Veregin, H. 1999. Data quality parameters. In Geographical information systems, 2nd Ed edited by Longley P.A.,. Goodchild M. F, Maguire D.J., and Rhind D.Ë., eds., Vol. 1, Chapter 12. New York, NY: Wiley.

THE USAGE OF GNSS FOR DETERMINATION OF 2D GEODYNAMIC CHANGES OF SKOPJE VALLEY

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ABSTRACT

This paper shows the results of the determination of the geodynamic occurrences present in the territory of the Skopje Valley in the period of 2008-2012, with helpful implementation of modern geodetic methods and technology.

This paper displays the geodetic activities taken over the territory of the Skopje Valley, in order to demonstrate the proper use of modern measuring technology for satellite positioning and optimal coverage of fault structures on this territory.

The paper analyzes the results of two series of GNSS measurements on the geodynamic network of the Skopje Valley made in 2008 and 2012. The comparison of these series of measurements results in certain conclusions about horizontal shifts for the same period.

Key words: Skopje Valley, GNSS, geodynamics.

ESTABLISHING OF GNSS NETWORK FOR 2D GEODYNAMIC DETERMINATION OF SKOPJE VALLEY

Taking into account all geotectonic and geomorphological information about the territory of the Skopje epicenter area and Skopje Valley as part of it, it is concluded that the establishment of a network of points that will determine the coordinates in different time periods and define the movements of this region depending of geodynamic events is more than necessary (Bogdanovski Z., 2008).

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In view of modern technical and technological achievements in measurement technology, global positioning system is the best choice to perform the measurements for determining the coordinates of points for geodynamic occurrences. While establishing the basis for GNSS measurements in order to determine the geodynamic shifts, it is more than necessary for the points on which the measurements will be performed to be stabilized and properly founded on stable ground (Fig. 1). The pillars of Skopje trigonometric network are appropriate and logical choice for this purpose (Bogdanovski Z., Srbinoski Z. 2009). Namely, the city trigonometric network (CTN) has other important characteristics from the aspect of utilization of it as a geodynamic base, or a base for determining geodynamic shifts. One of these important characteristics is the distribution of this network in the area of the Skopje Valley and mountain ranges around it. This provides a possibility to choose the points for establishing the base for the geodynamic monitoring.

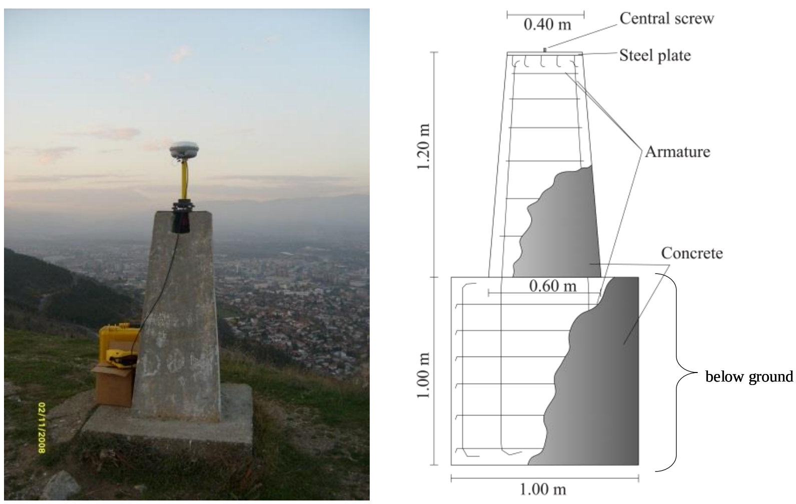

Fig 1. ***Point from Skopje trigonometric network and way of stabilization.***

The selection of points from CTN which form the base for the geodynamic determination of Skopje Valley was based on several conditions. A basic condition set in the designing of the network was the position of the points and their arrangement in relation to Skopje Valley as well as the mountains Skopska Crna Gora and Vodno. In addition, there was a condition from geometric aspect to design a rational geometric shape so that the network will satisfy the standards for the design of geodetic networks. In order to satisfy the requirement of accessibility of points, points which are easily accessible (by car) were chosen. Accordingly, the choice fell on the following six trigonometric points:

- Trigonometric point -TP 2003, located on the southern slopes of the mountain Skopska Crna Gora, nearby the village of Mirkovci. This point is the most northern point of the CTN;
- TP 2017, located on the southeastern slopes of the mountain Skopska Crna Gora, nearby the village of Bulachani;
- TP 2009 which is located in the central part of the Skopje Valley, more precisely in the settlement of Butel;
- TP 2079, located on the central part of the mountain Vodno, in the area Markovo Kale;
- TP 2059, located on the southeastern slopes of the mountain Vodno, nearby the village of Batinci, and
- Trigonometric point 2070, located on the southwestern slopes of the mountain Vodno, nearby the village of Govrlevo (Bogdanovski Z., 2013).

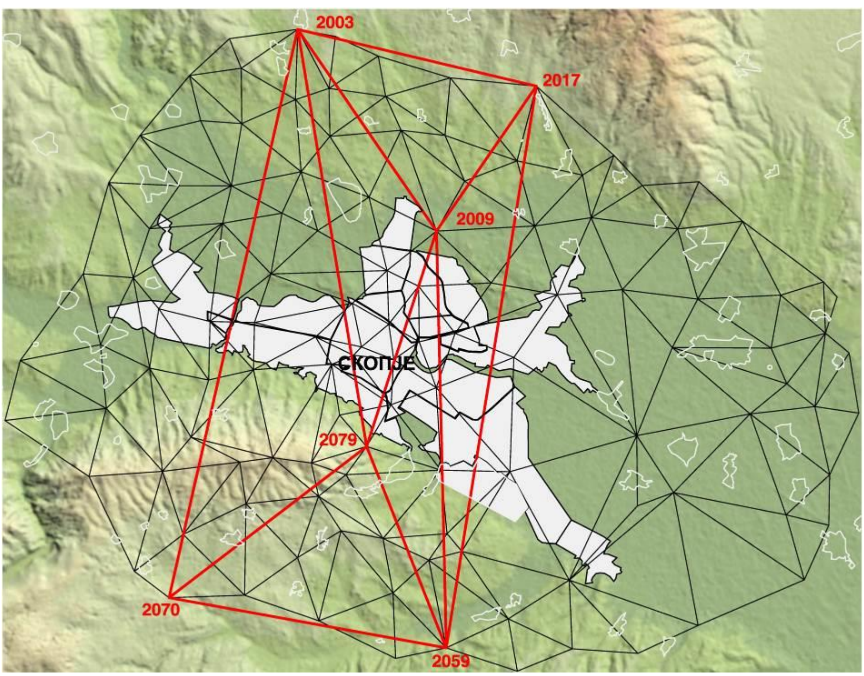

Fig 2. ***The geodynamic base in relation with CTN of Skopje.***

The main characteristics of such establish network of 6 points are:

- The points represent concrete pillars which are properly founded with shape of cut four-pyramids;
- The network formed by these points is with direction from northeast to southwest and practically connects the mountains Skopska Crna Gora and Vodno.
- The maximal distance of 20.7 km in the network is between points 2003 and 2059;
- The minimal distance of 5.7 km in the network is between points 2017 and 2009.

INSTRUMENTS AND SOFTWARE USED FOR PERFORMING AND PROCESSING GNSS MEASURMENTS FOR SERIES 2008 AND 2012

The measurements in the Global positioning system are carried out with appropriate measuring technology and adequate equipment. The instruments with which the measurements for geodynamic purposes are carried out should possess certain characteristics and meet certain standards, which will lead to the desired accuracy of the measured base vectors. Nowadays there are a lot of reputable manufacturers of instruments and equipment for global positioning.

In the measurement campaigns carried out to establish the geodynamic base for Skopje Valley 4 instruments from the renowned Swiss company Leica Geosystems and 2 receivers from a reputable U.S. company Trimble were used.

From Leica Geosystems were used – 2 *Leica GX1230* and 2 *Leica ATX1230*. The two *Trimble R6* receivers which were used to perform the GPS measurements belong to the group of dual-frequency receivers with integrated antennas (Fig 3).

Fig 3. ***Trimble R6 receiver.***

Data processing was carried out with *Leica Geo Office Combined* (v 4.0) software and *Trimble Business Center* (v 2.0).
This software is a modern tool for processing GNSS measurements, based on Windows environment.
To get the coordinates of the points with an accuracy which is needed to define their position, it is necessary to perform the processing of measurements with known precise satellite ephemerides at the time of measuring. For that purpose the *Leica Geo Office Combined* software offers input of precise ephemerides already downloaded from the Internet. This software works with the following extensions of precise ephemerides: **.sp3;*.sp3c;*.pre*.
The subroutine *MOVE3* is an integrated part of this software; this subroutine can make network adjustment by the least squares method.
The second software, *Trimble Business Center v 2.0,* is also software that works on a *Windows* platform.
In this software there is an option for type choosing of data processing according to measurements taken with Trimble receivers or receivers from other manufacturer. This is very important because phase corrections depending on satellite azimuth and satellite elevation relative of GPS antenna type are not a default option in the basic style of calculation in this software.
Adjustment of the network of GPS points should be performed after the processing of data and getting the needed base lines. The adjustment of the network should be in accordance with the standards for adjustment of networks for monitoring of geodynamic processes (Srbinoski Z. at al. 2013).

RESULTS OF GNSS MEASURMENTS PERFOMED IN TIME SERIES 2008 AND 2012

The analysis of geodynamic phenomena can be performed from different aspects and it represents multidisciplinary area of research. In this part of the research, the task of geodesy comes down to determining the horizontal and vertical movements of the Earth’s crust, within geodynamic bases that cover a certain territory. For the determination of Earth's crust movements it is necessary to perform several series of measurements, and then to compare their results.
The results of the GNSS measurements on the geodynamic base of the Skopje Valley are analyzed in this paper. The comparison of two or more series of GNSS measurements can result in conclusions about the horizontal movements of the Earth's crust, while for the determination of vertical

deformations, it is necessary to perform extensive leveling measurements or combination of GNSS measurements and InSAR measurements.

Two series of measurements that were performed on this basis are with next characteristics:

- The first series was performed in October 2008,
- The second series was performed in September 2012.

Both series of measurements were performed according to standard parameters that are used for geodynamic needs:

- The measurements are performed using dual-frequency GNSS receivers;
- Minimum length of observation session on each of the measuring points was 8 hours;
- The registration of GNSS data was with observable logging rate of 15";
- In the process of calculation were used precise ephemerides.

The two series of measurements are processed using Leica Geo Office Combined, and controls of those calculations were made with software Trimble Business Center.

From the results of the adjustment of base lines and calculation of points coordinates from the geodynamic base in the first and second series it can be concluded that the points from the geodynamic network are determined with high positional precision ranging between ± 1-2 mm.

The Cartesian coordinates of the points and their positional accuracy in the first series are shown in Table 1. The Cartesian coordinates of the points from the second series of measurements and their positional accuracy are shown in Table 2.

Table 1. ***Cartesian coordinates of points in first series (2008)***

Point	Coordinates (WGS 84)			Accuracy	
	X	Y	Z	m_p	m_D
2003 Mirkovci	4413633.8708	1730176.2492	4253435.9154	0.0012	0.0022
2009 Butel	4415994.0400	1735923.9510	4248434.4742	0.0011	0.0020
2017 Bulachani	4412038.3425	1737888.5576	4252091.9738	0.0010	0.0019
2059 Batinci	4424433.4789	1739503.3525	4238416.9017	0.0011	0.0020
2070 Govrlevo	4426812.5409	1730750.6561	4239793.4217	0.0012	0.0022
2079 Markovo K.	4421374.3783	1735554.9321	4243399.5917	0.0008	0.0015

Table 2. ***Cartesian coordinates of points in second series (2012)***

Point	***Coordinates (WGS 84)***			***Accuracy***	
	X	***Y***	***Z***	m_p	m_D
2003 Mirkovci	4413631.8634	1730175.9734	4253434.8726	0.0020	0.0038
2009 Butel	4415992.0008	1735923.6636	4248433.3820	0.0018	0.0035
2017 Bulachani	4412036.3520	1737888.2920	4252090.9418	0.0018	0.0035
2059 Batinci	4424431.4916	1739503.0819	4238415.8632	0.0020	0.0039
2070 Govrlevo	4426810.5567	1730750.3876	4239792.3850	0.0019	0.0038
2079 Markovo K.	4421372.3615	1735554.6535	4243398.5235	0.0014	0.0027

Because of the nature of the GNSS measurements, the results of free networks adjustment (as is our case) are not directly comparable. Therefore it is necessary to transform the measurements from the two series in the same geodetic datum. One of the ways for such transformation, which is used in the area of geodynamics, is the adoption of common coordinates for a point of the network in both systems (series). In our case, the point 2070_Govrlevo was used. For this point the coordinates from the first series are used and all other points of the second series are moved in relation to it.
As we already mentioned earlier, there are many ways of analyzing the measured values, and an analysis of surface deformation obtained and based on two series of measurements will be carried out in this paper. This analysis is based on the comparison of adjusted base vectors, and for this aim it is necessary for the ellipsoidal coordinates of points to be transformed into grid coordinates in one of the known cartographic projections.
To increase the accuracy of the calculation, a special cartographic projection was made, based on the characteristics of the state cartographic projection (Srbinoski Z., 2009). It is a transverse cylindrical conformal cartographic projection with central meridian defined with geodetic longitude on geographic center of geodynamic network:

$$L = 21^{o}\ 25'\ 36''$$

In this way, the deformations of cartographic projection are within the accuracy of measurement and do not affect the results of the measurements and their application in the analysis of geodynamic shifts.
The grid coordinates from the points of the geodynamic base in the first series are shown in Table 3, while the grid coordinates of the points in the second series are shown in Table 4.

Table 3. ***Grid coordinates from first series (2008)***

Points	***Coordinates***	
	Y	***X***
2003 Mirkovci	498251.8742	4661711.1838
2009 Butel	502739.8363	4655119.9332
2017 Bulachani	506013.2963	4659821.1125
2059 Batinci	502988.7711	4641544.6331
2070 Govrlevo	493972.7656	4643225.3418
2079 Markovo K.	500430.9441	4648117.7000

Table 4. ***Grid coordinates from first series (2012)***

Points	***Coordinates***	
	Y	***X***
2003 Mirkovci	498251.8758	4661711.1955
2009 Butel	502739.8387	4655119.9308
2017 Bulachani	506013.3012	4659821.1192
2059 Batinci	502988.7702	4641544.6343
2070 Govrlevo	493972.7656	4643225.3418
2079 Markovo K.	500430.9465	4648117.6993

The final values of the base vectors in the two series are calculated based on the grid coordinates of the points and then these vectors are compared. (Gospodinov S., 2011). The results of the analysis are shown in Table 5 and Figure 4.

Similar results, but with lower intensity are registered at point 2017_Bulachani. The deformations of base vectors to this point are with intensity from 6.4 mm to 8.9 mm; it also indicates significant displacement of this point.

The movements of the points 2003 and 2017 indicate possible active fault that passes between them and the other points, as well as the fault between points 2003 and 2017, which confirms the data from the Neotectonic map (Bogdanovski Z., 2013).

Table 4. **Comparisons between base vectors in two series**

Base vector	Values		differences (mm)
	2008	2012	2012-2008
2070 - 2003	18974.6443	18974.6560	*11.7*
2070 - 2079	8102.0515	8102.0530	*1.5*
2070 - 2059	9171.3214	9171.3203	*-1.1*
2059 - 2079	7053.2041	7053.2011	*-3.0*
2059 - 2017	18525.0493	18525.0557	*6.4*
2079 - 2003	13767.0312	13767.0435	*12.3*
2079 - 2009	7373.0762	7373.0746	*-1.6*
2079 - 2017	12966.5925	12966.6002	*7.7*
2009 - 2003	7974.1074	7974.1195	*12.1*
2009 - 2017	5728.5799	5728.5888	*8.9*
2003 - 2017	7988.2440	7988.2484	*4.4*

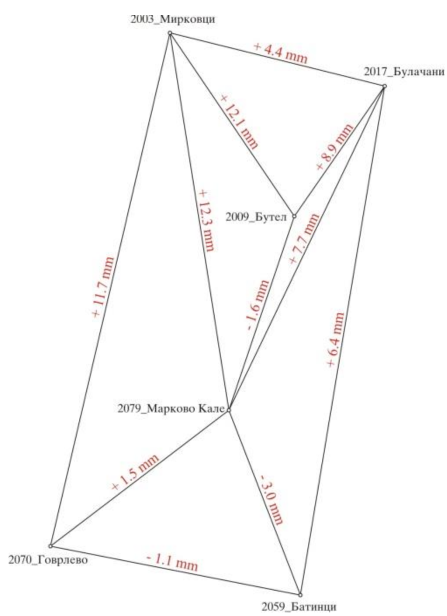

Fig 4. **Comparison of base vectors from two series.**

On the other hand, there are no significant differences at the other base vectors, which lead us to note that there is no displacement of other points from the geodynamic base. Namely, the results in the table indicate that the deformations are within the accuracy of measurement, from which we can reach the conclusion that the points in the central and southern part of the network are relatively stable.

In further research, these data can be a basis for many analyzes, including basics of tensors mathematics. These analyzes can result in the definition of angled and surface deformations for the geometric centers of the figures, their trends and movements, and some other data which are interesting for geodynamical research.

CONCLUSIONS

The determination of the local geodynamic phenomena in Skopje Valley was performed on the basis of GNSS measurements within the framework of a specially designed geodynamic network (base) for that aim. The geodynamic base consists of 6 points from the trigonometric city network of Skopje, which are carefully selected in consultation with geologists and seismologists.

In this paper, processed data from two series of 8-hour measurements in the network performed in 2008 and 2012 are used to define the local movements of the Earth's crust. The processing of data was performed with the *Leica Geo Office Combined* and *Trimble Business Center* software. From the data in this paper it can be concluded that the points in the geodynamic network are determined with high positional precision which is around ± 1 mm.

For the purpose of data analysis, calculation is made with grid coordinates of the points in a special cartographic projection. This projection is a transverse cylindrical conformal cartographic projection with central meridian defined with geodetic longitude on the geographic center of the geodynamic network. In that way, the deformations on the cartographic projection become insignificant, and the accuracy of the processed base vectors is maximal.

The analysis of the results of calculations is performed by *comparing the base vectors* between the measurement points. The analyses indicate that the maximum difference of base vectors appears to point 2003_Mirkovci and are in range between 11.7 mm and 12.3 mm, and suggests that this point is significantly moved. The same results but with smaller intensity are present at point 2017_Bulachani. The deformations of base vectors to this point are with intensity from 6.4 mm to 8.9 mm; it also indicates significant displacement of this point.

On the other hand, there are no significant differences at the other base vectors, which lead us to note that there is no displacement of other points from the geodynamic base. Namely, the results in the table indicate that the deformations are within the accuracy of measurement, from which we can reach the conclusion that the points on the central and southern part of the network are relatively stable. The above mentioned analyzes of the geodynamics of the Skopje Valley result in the following general conclusions:

- The time difference of about 4 years between these two series of GNSS measurements provides an opportunity to get quality and significant results for the deformations of the Earth's crust in the area of Skopje Valley.
- In order to determine possible trends in the Earth's crust deformations, it is more than necessary to perform more series of GNSS measurements, whose results would be compared with the results of the zero series.

For more comprehensive analysis of geodynamic phenomena in the region of Skopje Valley it is more than necessary to expand the geodynamic network with more pillars from the city microtrigonometric network of Skopje.

REFERENCES

1. Bogdanovski Z.: Establishing of GNSS frame for geodynamics determination of Skopje Valley, master thesis, Faculty of civil engineering, Skopje, 2008.
2. Bogdanovski Z., Srbinoski Z.: Establishing of GNSS frame for geodynamics determination of Skopje Valley, BALGEOS meeting, Sarajevo, Bosnia & Herzegovina, 2009.
3. Bogdanovski Z.: Determination of geodynamics of Skopje Valley based on geodetic measurements, PhD thesis, Faculty of civil engineering, Skopje, 2013.
4. Gospodinov S.: Determination of block defined plain crustal deformation by measured spatial vectors, Military-geographic service, Sofia, 2011.
5. Hofmann-Wellenhof B., Lichtenegger H., Wasle E.: GNSS – Global Navigation Satellite System. GPS, GLONASS, Galileo, and more, SpringerWien-NewYork, 1st edn, 2008.
6. Srbinoski Z.: State-of-art of geodesy in the Republic of Macedonia, BALGEOS meeting, Vienna, Austria, 2008.
7. Srbinoski Z.: Mathematical cartography, Faculty of civil engineering, Skopje, 2009.

8. Srbinoski Z., Jovanov J., Bogdanovski Z., Gjorgjiev Gj., Dimeski S.: Use of GNSS reference station networks to provide close to real time atmospheric models for weather forecast and monitoring of tectonic movements, University Sts. Cyril and Methodius, Skopje 2013.
9. Westerhaus M., Becker M., Demoulin A., Hwang C., Shen W. B., Wright T.: Integrating geodetic and geological studies of active crustal deformation, EGU, Wien 2012.

DEVELOPING OF THE ALBANIAN GLOBAL MAP DATASET; CASE STUDY: VECTOR LAYERS

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UDC: 528.9:004.9(496.5)

SUMMARY

International Steering Committee for Global Mapping (ISCGM) is an organization located at Authority for geospatial information of Japan in Tsukuba, established in year 1996, composed by representatives of geospatial information authorities of respective countries and by the experts in this field, in order to promote the Global Mapping Project, as well to develop global geospatial information needed to solve global-scale issues, to provide them widely, and to promote the use of global information in cooperation with the respective countries (iscgm.org, September 2016).

Being the whole world is divided into different continents and countries that follows various institutions, which develops the geospatial data with the same or different standards; it is thought that the global geospatial data to have same standards, so they can be used to be exchanged in order to reach the analysis of a problem; more easily and at a low cost.

The main purpose of this project is global data collection of geospatial data from all states and interested organizations to develop and to have easy access to digital geographic information at global level of scale 1:1.000.000 for vector, as well 30" spatial resolution for raster data. This is useful to equip the implementation of international/global agreements and conventions for environment protection, for supervision of major phenomena of the environment and encourage economic growth. Global Map also contributes in development of spatial data in global level (GSDI-Global Spatial Data Infrastructure).

The Republic of Albania, within the project for the compilation of the global map dataset is represented by the State Authority for Geospatial Information (ASIG), as the responsible institution for Albanian cartography at the national level. Preparation of Albanian GM dataset has been proceed in academic level within the geodesy department of the Polytechnic University of Tirana, with aim to support, help and improve the Albanian cartography. Existing topographic maps in scale 1:25.000,

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ortho photo images from year 2007, satellite data, as well as the official data from governmental institutions has been utilized as source data.
In this paper, in details is shown the whole process of data compilation, quality and outputs of Albanian Global Map vector dataset.

Key words: Global mapping, Albania, ISCGM, Global Map, vector data, transportations, population centers, boundaries, drainage.

1. INTRODUCTION

Global Map is a set of digital maps that accurately cover the whole globe to express the status of global environment. It is developed through the cooperation of National Geospatial Information Authorities (NGIAs) in the world. An initiative to develop Global Map under international cooperation, the Global Mapping Project, was advocated in 1992 by the Ministry of Construction, Japan.
Non-contemporary standards of International World Map in a scale of 1:1,000,000 dating from 1891, the development of digital technology, the need for recognition of global geospatial data, and using updated datasets, in 1992 in Rio de Janeiro in Brazil was proposal for establishing of Global Map (GM) in scale 1:1,000,000. (Maruyama H., 2005)
GM database contains four vector layers (population centers, transportations, drainage and boundaries) at scale 1:1.000.000 and four raster layers (land cover, land use, vegetation and elevation) with spatial resolution of 30" (arc seconds of longitude and latitude).
State Authority for Geospatial Information (ASIG) and geodesy department of the Polytechnic University of Tirana, through the PhD thesis of Milot Lubishtani supervised by prof.dr. Bashkim Idrizi, has developed the vector and raster datasets for Albanian GM version 2, which have been released on 14th of July 2016 in www.iscgm.org.

2. GLOBAL MAPPING

Global Map is an international project, which states, namely the state agencies dealing with geospatial-qualified data to apply for membership on a voluntary basis, by applying established standards for membership.
Global mapping project is an International collaborative initiative, through the voluntary participation of national mapping organizations of the world, aiming to globally develop a homogeneous geographic data set at the ground resolution of 1km for raster data and vector data in scale 1:1.000.000, and to establish concrete partnership among governments, private sectors, data

providers and users to share information and knowledge for a sound decision-making.

The primary objective of Global Mapping project is to contribute to the sustainable development through the provision of base framework geographic dataset, which is necessary to understand the current situation and changes of environment of the world.

The purpose of the Global Map is; to accurately describe the present status of the global environment in international cooperation of respective National Mapping Organizations (NMOs) of the world, aimed for:

- Monitoring and early warning systems for natural disasters;
- Developing ecosystem, drainage basins framework for environmental assessment;
- Monitoring and management of natural resources;
- Quantifying the Trans boundary issues;
- Assessment of the trends of environment changes;
- Rapid response capability/early warning;
- Local, national and multinational physical development planning;
- Environmental priority setting, analytical studies over large areas and
- Informed for decision-making of policy makers with a strategic database (Idrizi B., et all, 2010).

Increasing demands and the needs to be qualified data geospatial and their use for achieving a result set and necessary and cost as little as possible, many European countries and the Balkans have handed over the data as geospatial on the global map with a scale of 1 1.000.000 and as such as Macedonia in 2006, Romania in 2009, Bulgaria in 2009, Kosovo in 2011 and Albania in 2016.

Despite the maps prepared in local/national standards, GM dataset enable (Idrizi, 2006):

- All data of the Earth to be in one place;
- With the same data structure;
- In the same format;
- In the same coordinate system;
- In the same scale; and
- With similar accuracy.

The main objective of this global project is to bring all nations and concerned organizations together to collaboratively develop and provide easy and open access to worldwide geographic information at a global scale. The use of these dataset:

– will facilitate the implementation of global agreements and conventions for environmental protections;

- will support the monitoring of major environmental phenomena; and
- will encourage economic growth within the context of sustainable development.

Joining the world community of surveying and mapping organizations will facilitate the acquisition of the latest information and knowledge of digital geographic data development and service; it would also facilitate to raise the status of the organization by active participation in international activities and the contribution to sustainable development which is the final goal of Global Mapping Project (figure 1).

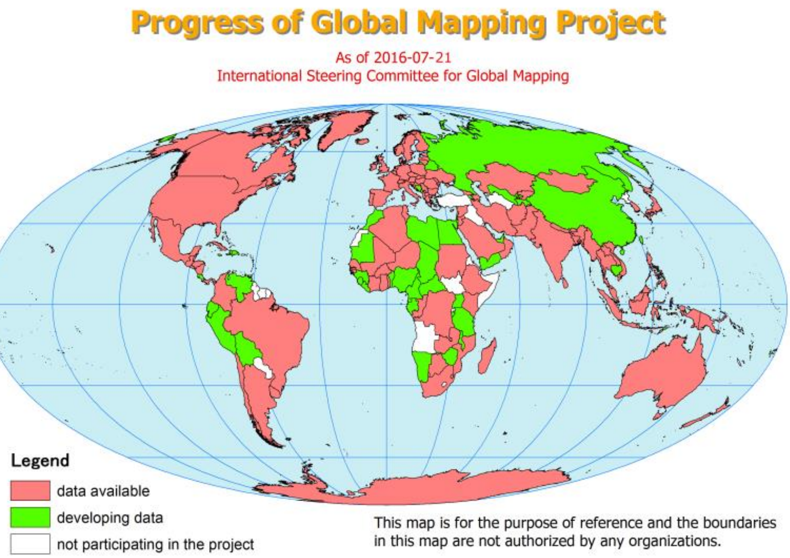


Figure 1. Progress of Global Mapping project (21.07.2016, www.iscgm.org)

Global Map is fundamental digital geospatial information being developed to cover the whole land of the globe. It is an effort central to the Global Mapping Project. Global Map data have been developed under the cooperation of National Geospatial Information Authorities (NGIAs) of respective countries and regions (Kishimoto N.,2010).

The ISCGM takes the central role in conducting the Global Mapping Project to develop and provide Global Map data set with the following characteristics (Idrizi B., et All, 2011):

- Geospatial information developed and authorized by NGIAs of respective countries and regions around the world;
- Fundamental geospatial information covering the whole land of the globe;
- Data are updated in every five years as a target cycle;

- Freely available for download, and in case of non-commercial purposes, in principle, anyone can use the data freely; and
- Digital geospatial information composed of eight layers being developed with consistent specifications.

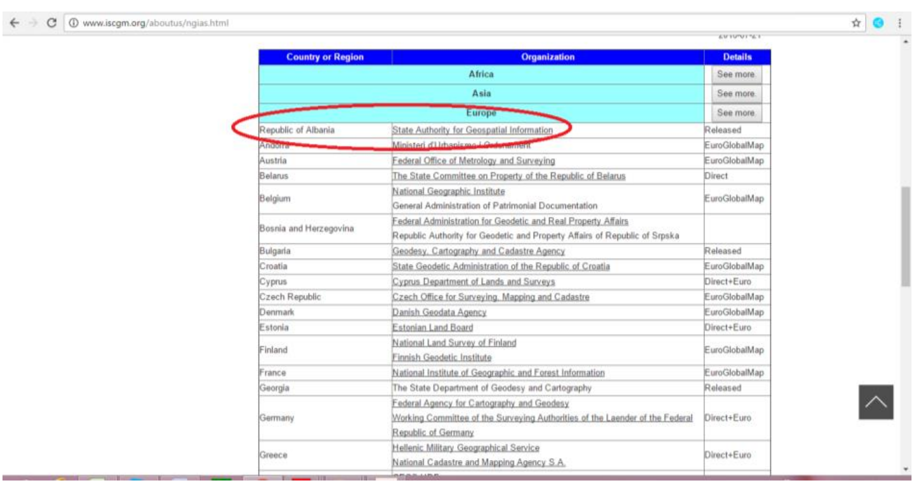
3. GLOBAL MAP DATA OF ALBANIA

The Global Mapping project is for noncommercial purposes, while the participation in it is voluntary. Eligible for participation are only the national mapping organizations, which are the governmental responsible institutions for mapping and spatial data developing on national level.

Involvement by an organization in the project in generally is categorized in three levels, i.e. as Level A, B and C.

Level A means that institution will prepare the data set of own country and other countries, the *Level B* mean that institution will prepare the data set of own country, and the *Level C* mean that institution will give all necessary data, preparation will be done by ISCGM.

The Republic of Albania participates in global mapping project since 30.06.2016 in *Level B*, through State Authority for Geospatial Information (ASIG) as national mapping and spatial data infrastructure organization (figure 2). Republic of Albania is last country that has participated in GM project, before the dissolution of ISCGM and the termination of the Global Mapping Project on August 2016!



www.iscgm.org/aboutus/ngias.html

Country or Region	Organization	Details
Africa		See more
Asia		See more
Europe		See more
Republic of Albania	State Authority for Geospatial Information	Released
Andorra	Ministeri d'Urbanisme i Ordenament	EuroGlobalMap
Austria	Federal Office of Metrology and Surveying	EuroGlobalMap
Belarus	The State Committee on Property of the Republic of Belarus	Direct
Belgium	National Geographic Institute General Administration of Patrimonial Documentation	EuroGlobalMap
Bosnia and Herzegovina	Federal Administration for Geodetic and Real Property Affairs Republic Authority for Geodetic and Property Affairs of Republic of Srpska	
Bulgaria	Geodesy, Cartography and Cadastre Agency	Released
Croatia	State Geodetic Administration of the Republic of Croatia	EuroGlobalMap
Cyprus	Cyprus Department of Lands and Surveys	Direct+Euro
Czech Republic	Czech Office for Surveying, Mapping and Cadastre	EuroGlobalMap
Denmark	Danish Geodata Agency	EuroGlobalMap
Estonia	Estonian Land Board	Direct+Euro
Finland	National Land Survey of Finland Finnish Geodetic Institute	EuroGlobalMap
France	National Institute of Geographic and Forest Information	EuroGlobalMap
Georgia	The State Department of Geodesy and Cartography	Released
Germany	Federal Agency for Cartography and Geodesy Working Committee of the Surveying Authorities of the Laender of the Federal Republic of Germany	Direct+Euro
Greece	Hellenic Military Geographical Service National Cadastre and Mapping Agency S.A.	Direct+Euro

Figure 2. List of participants in GM project (www.iscgm.org, 30.06.2016)

Developing of Albanian GM dataset has been conducted in a closed cooperation between the State Authority for Geospatial Information (ASIG) and geodesy department of the Polytechnic University of Tirana, through the PhD thesis of Milot Lubishtani in a field of establishing Albanian GSDI with case study on developing of Albanian Global Map dataset. Working team of ASIG has been leaded by Milot Lubishtani from the university site (as PhD candidate) and supervised by Prof.Dr. Bashkim Idrizi (from the university site also), together with mapping and GIS experts of ASIG, and direct technical support from the team of experts from ISCGM-Japan.
Albanian Global Map V2, consists both, the vector and raster layers, totally 8 layers, which have been released on 14th of July 2016 in www.iscgm.org, as free downloadable for non-commercial use.

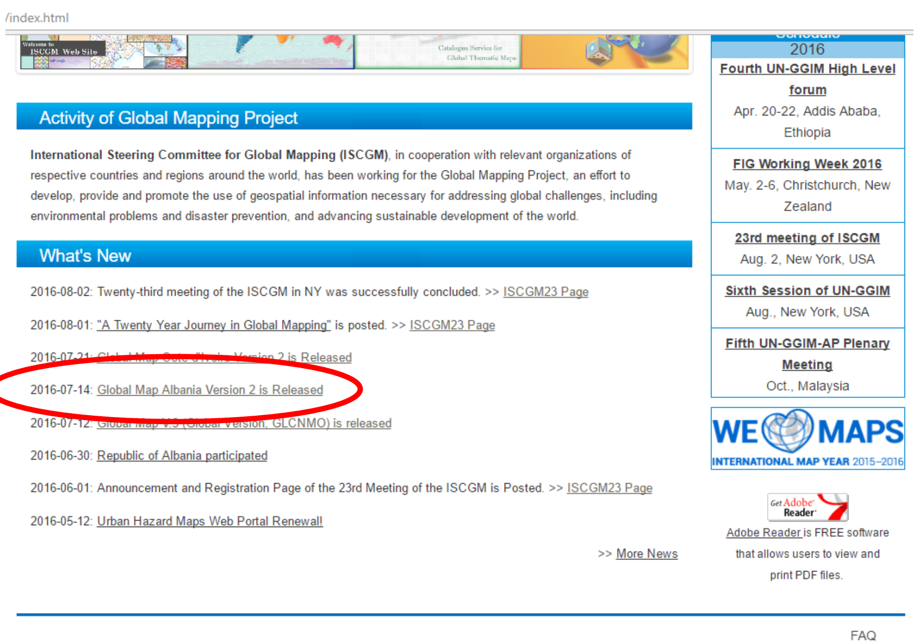


Figure 3. Extract of ISCGM web site (www.iscgm.org, 30.06.2016)

3.1. Data source for Global Map of Albania

Official data from responsible governmental institutions for supplying the current and updated data sets that have been used:

- State Authority for Geospatial Information (ASIG);
- Institute of transportation;
- Albanian Institute of Statistics (INSTAT);

- Military Geographical Institute of Albania;
- Ministry of the Urban Development.

In order to harmonize the input data with the GM V2.2 specification, all received data have been transformed, converted, harmonized and generalized, as well reprocessed in a cases of satellite images. In a next table and figure, the list of developed layers and the directory structure of Albanian GM dataset according to GM V2.2 specification for national/regional version are given.

Vector Layers	Raster Layers
Boundaries	Land Cover
Drainage	Land Use
Trasportation	Elevation
Population Centers	Vegetation

Table 1. Global Map V1/V2 data set layers - national/regional version

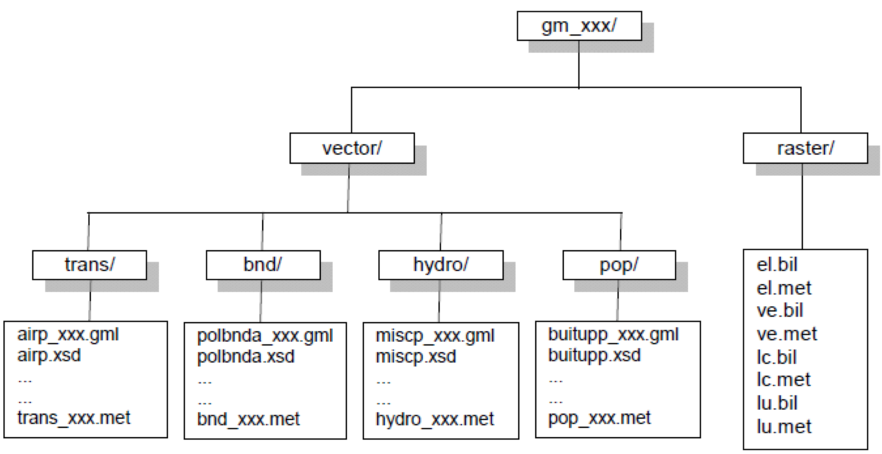


Figure 4. Directory Structure (Global Map Specifications Version 2.2)

3.2. Global Map vector data of Albania

The features of the vector data are represented by the three basic spatial objects: points, edges (lines) and faces (polygons), allocated a category number for linking the geometrical with attribute data. Next table (2) shows the list of developed vector layers, feature names, geometrical types, inclusion (optional or mandatory) and abbreviation of layers names.

Layer	Feature Name	Feature Type	Inclusion	Abbreviation
Transportation	Airport	point	optional	airp
	Railroad Station	point	optional	rstatp
	Port	point	optional	portp
	Railroad	edge	mandatory	raill
	Road	edge	mandatory	roadl
	Trails and Tracks Line	edge	mandatory	traill
	Ferry route	edge	optional	ferryl
Boundaries	Political Boundary	point	mandatory	polbndp
	Coast Line	edge	mandatory	coastl
	Political Boundary Line	edge	mandatory	polbndl
	Political Boundary Area	face	mandatory	polbnda
Drainage (Hydrography)	Miscellaneous (Dam/Weir/Island/Spring /Water-Hole)	point	optional	miscp
	Miscellaneous (Dam/Weir)	edge	optional	miscl
	Aqueduct/Canal/Flume/ Penstock	edge	optional	aquel
	Water Course	edge	mandatory	riverl
	Inland Water	face	mandatory	inwatera
Population Centres	Built-up area	point	optional	builtupp
	Built-up area	face	optional	builtupa

Table 2. Feature class, name, type and inclusion of vector layers

3.2.1. Transportation layer of Albanian Global Map

There are seven national developed Global Map layers of Albanian dataset:
- *Airports,* which include digital cartographic data with attributes for the airports of the Albania, represented as points;
- *Ports,* which include digital cartographic data with attributes for the airports of the Albania, represented as points;
- *Ferry Routes,* which includes digital cartographic data with attributes for the ferries of the Albania, represented as lines;
- *Railroad,* which stations include digital cartographic data with attributes for the railroad stations of the Albania, represented as points;
- *Railroads,* which include digital cartographic data with attributes for the railroads of the Albania, represented as lines;
- *Trails and tracks line,* which includes digital cartographic data with attributes for the railroads of the Albania, represented as lines;
- *Roads*, which include digital cartographic data with attributes for the roads of the Albania, represented as lines.

Based on results, derived from the analyses and processing of transportation network in Albania; all highways, railroads, roads of first and second order, some local roads and Tirana airport, have been included within the transportations layer of Albania's GM. In total have been included 302km Highway, 421km Primary route, 3362km Secondary route, 11583km others and 483km Rail road's, as shown in figure 5.

3.2.2. Population centers layer of Albanian Global Map

There are two national developed Global Map layers of Albanian dataset:
- *Build up areas*, which include digital cartographic data with attributes for the main cities of Albania, represented as polygons;
- *Build up areas*, which include digital cartographic data with attributes for the smaller cities and main settlements of Albania, represented as pints.

Based on results, derived from analyses and processing population centers data in Albania within the layer of population centers of Albanian GM, in total have been included 208 population centers, i.e.61 cities and 147 settlements, shown in figure 6.

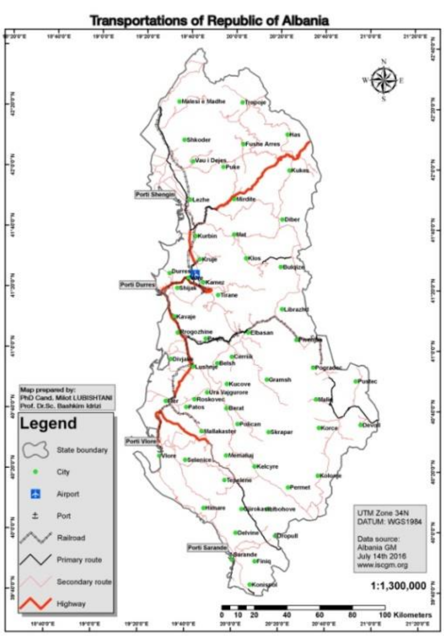


Figure 5. Transportation layer

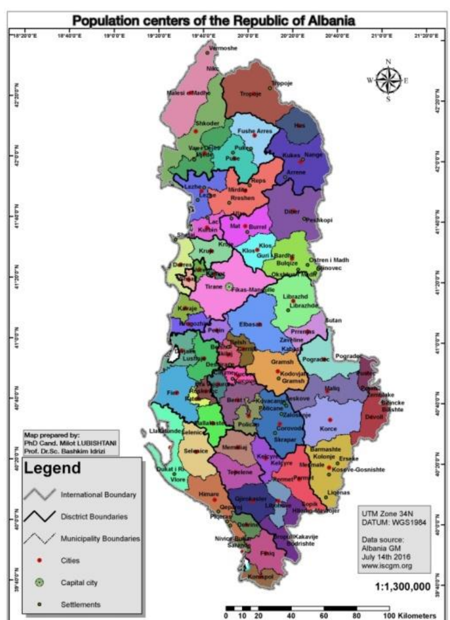


Figure 6. Population centers layer

3.2.3. Drainage (hydrographic) layer of Albanian Global Map

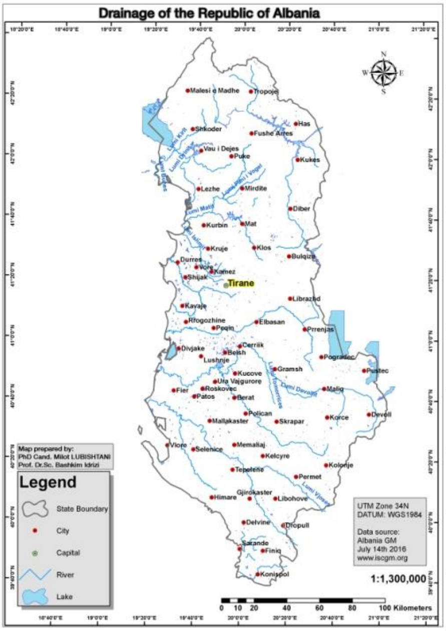
There are four national developed Global Map layers of Albanian dataset:
- *Miscellaneous,* which includes the digital cartographic data with attributes for the dams, weirs, islands, springs, and water-holes of the Albania, represented as points;
- *Aquels,* which include digital cartographic data with attributes for the aqueducts, canals, flumes, and penstocks of the Albania, represented as lines;
- *Rivers,* which includes digital cartographic data with attributes for the watercourse of the Albania, represented as lines;
- *Inland water,* which stations include digital cartographic data with attributes for the lakes of the Albania, represented as polygon.

Within the drainage (hydrographic) layer of Albania's GM data, based on results derived from analyses of hydrography of Albania, 41 rivers, 477 lakes and 896 reservoir have been include, which can be shown in figure 7.

3.2.4. Boundaries layer of Albanian Global Map

There are three national developed Global Map layers of Albanian dataset:
- *Coast line,* which includes digital cartographic data with attributes for the coast line of the Albanian seas, represented as lines;
- *Political boundary line,* which includes the digital cartographic data with attributes for the national and administrative boundaries (in two levels, as district and municipality) of the Albania, represented as lines;
- *Political boundary area,* which include digital cartographic data with attributes for the areas (polygons) of districts and municipalities (based on current legislation) of the Albania, represented as polygons;

Finally, based on results emerging from analyses of boundaries of Albania in national and local level, within the boundary layer have been added national boundary line, district boundaries and all municipality boundaries, shown in figure 8.
These map layers are part of our collection of fundamental digital cartographic data in vector format at scale 1:1,000,000. In terms of vector geometry, the lines, points, and polygons in these map layers are identical to National Map boundaries map layers. The difference is in the attributes assigned to boundaries features. The Global Map edition includes just the data fields and attribute values in the Global Map Specifications Version 2.2. Whole dataset is downloadable through www.iscgm.org/gmd (figure 9).



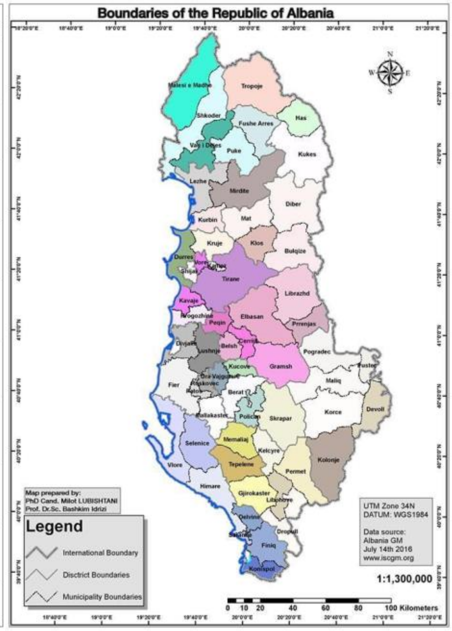


Figure 7. Drainage layer

Figure 8. Boundaries layer

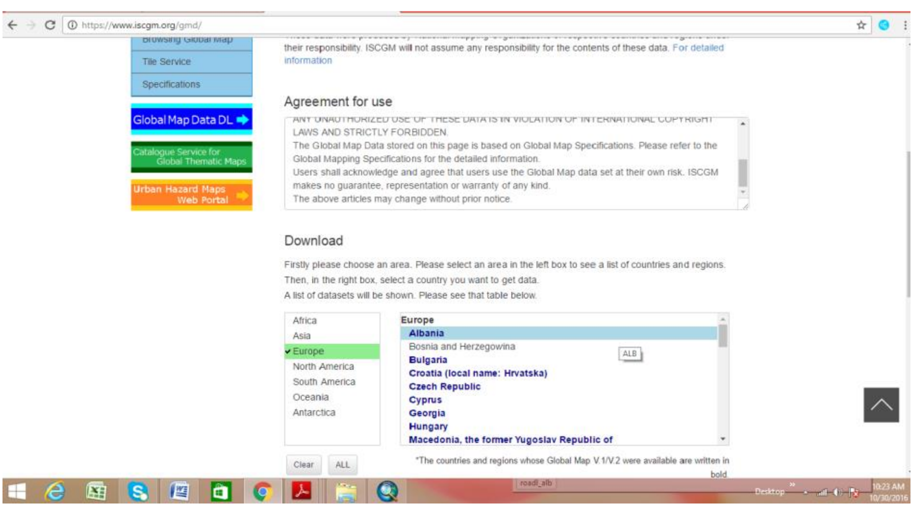


Figure 9. Web page for free download (https://www.iscgm.org/gmd)

3.3. Metadata of Global Map vector data of Albania

Metadata is "data that provides information about other data". Three distinct types of metadata exist:

- Structural metadata;
- Descriptive metadata and
- Administrative metadata.

Metadata is data about the quality, condition, contents and other characteristics of the data, which also describes the lineage, process and accuracy of the data set.
Global Map Metadata Profile is based on ISO 19115 core metadata elements and other profiles to provide information about Global Map data.
Metadata package is a subset of metadata that define the related metadata entities and elements. In next table, extract from Albanian Global Map metadata is given:

	Boundary	**Drainage**	**Population Center**	**Transportation**
Country	Albania	Albania	Albania	Albania
Version	2.2	2.2	2.2	2.2
Metadata	Boundary	Drainage	Population Center	Transportation
Organisation Name	ASIG (State Authority for Geospatial Information)	ASIG (State Authority for Geospatial Information)	ASIG (State Authority for Geospatial Information)	ASIG (State Authority for Geospatial Information)
Voice	+355672138519	+355672138519	+355672138519	+355672138519
Delivery Point	Str."Papa Gjon Pali Ⅱ",Godina e Inovacionit, kati Ⅲ- te	Str."Papa Gjon Pali Ⅱ",Godina e Inovacionit, kati Ⅲ- te	Str."Papa Gjon Pali Ⅱ",Godina e Inovacionit, kati Ⅲ- te	Str."Papa Gjon Pali Ⅱ",Godina e Inovacionit, kati Ⅲ- te
City	Tirana	Tirana	Tirana	Tirana
Administrative Area	Tirana	Tirana	Tirana	Tirana
Country	Albania	Albania	Albania	Albania
Electronic Mail Address	dcm@bnetd.ci	dcm@bnetd.ci	dcm@bnetd.ci	dcm@bnetd.ci
Online	www.bnetd.ci	www.bnetd.ci	www.bnetd.ci	www.bnetd.ci

Resource				
Date Type	001	001	001	001
Abstract	Global Map Albania - Boundary is one of the layers of Global Map Albania. It consists of Political Boundary Line, Political Boundary Area features and Coast line.	Global Map Albania - Drainage is one of the layers of Global Map Albania. It consists of Water Course, Inland Water features, Miscellaneous and Aquaduct.	Global Map Albania - Population Center is one of the layers of Global Map Albania. It consists of Built-up Point and Built-up Area feature.	Global Map Albania - Transportation is one of the layers of Global Map Albania. It consists of Airport, Port, Railroad, Railstation and Road features.
Purpose	The Global Map is a basic framework database designed to support Geographic Information Systems applications, especially for examination of global environmental issues.	The Global Map is a basic framework database designed to support Geographic Information Systems applications, especially for examination of global environmental issues.	The Global Map is a basic framework database designed to support Geographic Information Systems applications, especially for examination of global environmental issues.	The Global Map is a basic framework database designed to support Geographic Information Systems applications, especially for examination of global environmental issues.
Credit	©ASIG	©ASIG	©ASIG	©ASIG
Use Limitation	Refer to data policy	Refer to data policy	Refer to data policy	Refer to data policy
Statement	The Global Map Albania version 2 Boundary layer was developed based on Global Map Specifications	The Global Map Albania version 2 Drainage layer was developed based on Global Map Specifications	The Global Map Albania version 2 Population Center layer was developed based on Global Map	The Global Map Albania version 2 Transportation layer was developed based on Global Map Specifications

	version 2.2. The data source was a Digital Map 1:25000 and Orthophoto, topographic map made in 1985 and orthophoto made in 2008.	version 2.2. The data source was a 1Digital Map 1:25000 and Orthophoto, topographic map made in 1985 and orthophoto made in 2008.	Specifications version 2.2. The data source was Digital Map 1:25000 and Orthophoto, topographic map made in 1985 and orthophoto made in 2008.	version 2.2. The data source was a Digital Map 1:25000 and Orthophoto, topographic map made in 1985 and orthophoto made in 2008.

Table 3. Extract from Albanian GM METADATA V2.2.

4. CONCLUSIONS

By its' efforts, ISCGM has managed to implicate Global Map as part of the "Implementation Plan" of the World Summit on Sustainable Development (World Summit on Sustainable Development - WSSD) held in Johannesburg (August-September, 2002). At that meeting it was decided that the project's compilation of Global Map completed by the end of 2007, as well as GM's data be updated each five years.

All European countries have joined the GM except countries like Montenegro, Belarus and Bosnia and Herzegovina. Albania is the last country participated to the project, as well last European country has been released its GM dataset. Releasing the Albanian GM dataset, will fill a big gap of Balkan Peninsula, due to non-participating of two countries!

Climate change is a process by which facing the world in these days, and automatically create a need that we geospatial data global of which can manage a various emergencies such as natural disasters, floods, earthquakes, mudslides, volcanoes etc. As more states to be part of GM, as more geospatial data we have, the easier it will be the management of emergencies. By including Albanian GM dataset in Global Map, direct contribution on regional environmental analyses will be enabled.

With the Global Map dataset being in digital form, it lends itself to various data manipulation and for modeling real life situations. Global Map dataset may have limited uses at national and local scales, however Global Map dataset is needed to address global, regional, and trans-boundary and in many cases national concerns. Therefore, the Albanian GM dataset as latest updated data set will support all type of spatial analyses.

Albanian Global Map data set can be downloaded from the web site www.iscgm.org, intended for non-commercial use (research, academia, students etc.). In a case of need for usage for commercial purposes, interested institution must obtain permission from the ASIG, otherwise, each unauthorized use for commercial purposes is in conflict with the law on copyright and related rights which is prohibited and punishable.

From September 2016, based on the letter of approval from ASIG, the Albanian GM data set has been migrated to the United Nations Geospatial Information Section (UNGIS), due to decision for transfer of GM data to UNGIS database, which has been formalized on August 2016, at New York, during the final (23rd) meeting of ISCGM.

5. REFERENCES

1. Maruyama H., Sasaki H., and Okatani T. (2005): Global Mapping – Global Geo-information for Sustainable Development. GSI. Tsukuba, Japan.
2. Kishimoto N. (2005): Global Map specifications; handout; Geographical Survey Institute; Tsukuba – Japan.
3. Idrizi B. (2006): Developing of globaly homogeneous geographic dataset through the global mapping project. Kartografija i geoinformacije; Zagreb; Croatia.
4. Idrizi B., Nikolli P., Hyseni D. (2010): Kosova in Global Map; 3rd ICCGIS conference - Proceedings; Bulgaria.
5. Idrizi B. , Meha M., Nikolli P. Kabashi I. (2011): Data quality of Global Map and some possibilities/limitations for its wide utilization for global issues; FIG COM 3. www.fig.net
6. ISCGM (2012): Global map specification 2.2. www.iscgm.org
7. http://www.iscgm.org (September 2016)

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