

# **WEB Portal for Dissemination of Spatial Data and Services for the Needs of the Agency for Real Estate Cadastre of the Republic of Macedonia (AREC)**

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**Key words:** 3D Portal, Cadastre, GIS, Visualization

## **SUMMARY**

The possibilities offered in these modern times, regarding the accessibility to information, electronic communication, IT technology, safety standards, acceptable economic elements and most importantly the good ideas are the moving forces that are carrying the society to a new advanced level. In this direction, also, tends the global idea regarding the need of implementation of the 3D cadastre.

The 3D cadastre is a global novelty. Currently it represents an idea that is being built, collects examples, makes links between countries, exchanges ideas, and it gives an impulse of energy that this idea of 3D cadastre should be implemented. AREC as part of its strategy has implemented a WEB GIS system with cutting edge technology which is a compact whole of 2D and 3D functionalities. The AREC GIS portal provides service through which you can get an overview of spatial and attribute data from cadastral-geodetic information system, including interrelated data that constitute the required information. The access to the portal is free, it represents an on-line solution which means that anyone, anywhere in the world can get the desired information. Potential investors can easily and simply choose the location for their buildings, receiving constantly updated picture of the current situation on the terrain through the AREC GIS portal.

The idea of implementing such system by AREC is a result of the need to simplify the procedures, also, shortening the time to gain the needed information and the possibility to do that for free. The functionalities that are offered by this system represent a set of features designed for both ordinary and advanced-professional users, and include insight into the cadastral maps, insight into the base of enrollment in AREC, the ability to view terrain in 3D, preview of 3D objects, the ability to draw the user geometry and many other tools.

As a conclusion to this paper, the idea and the possibilities offered by such a system regarding the access to information are a need, but also this idea for the first time includes the third dimension in the cadastre, of course, viewed from the aspect of visual representation that broadens opportunities compared to the 2D cadastre. The 3D Web GIS solution with all the advanced IT technologies in which it is implemented, is a great starting point in the process of building a fully functional solution regarding the implementation and application of 3D cadastre in the Republic of Macedonia.

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## **1. 3D CADASTRE – IDEA, NEED, PURPOSE, REALITY**

The 3D cadastre is a global novelty. We all agree that we need such a novelty that will contribute for better functioning of cadastres in the world, and certainly that will contribute for better organization and management of real estate in any possible way (social, economic, legal).

3D cadastre at the moment is an idea that is being built, it collect examples, it's building links between countries, exchanging ideas, it gives an impulse of energy that this idea should be implemented. There are many problems from a legal, institutional and technical aspect that still need to be considered and solved in order to bring the best possible solution as a model for implementation of the 3D cadastre in the world.

## **2. WHERE IS THE REPUBLIC OF MACEDONIA IN RELATION TO THIS ISSUE?**

In this regard, the Agency for Real Estate Cadastre of the Republic of Macedonia takes an active part in realizing innovative ideas of walking alongside with the other countries. The 3D cadastre is not yet fully implemented by any country in the world. Because of this condition, there are connections between those ideas whose aim is to contribute in creating something new, which can be taken as part of building a 3D cadastre. AREC has implemented the AREC GIS PORTAL enabled with 2D and 3D functionalities like an idea of building a relation between 2D and 3D cadastre in terms of technical aspect and visualization of the third dimension as part of the Real Estate Cadastre in the Republic of Macedonia.

## **3. FROM IDEA TO PRODUCT**

AREC, as an institution, whose services are intended primarily for citizens and professional users, constantly makes new steps towards bringing the information to citizens by introducing new services by making easier, faster and more efficient way for them to obtain the required information.

The possibilities offered in these modern times, regarding the accessibility to information, electronic communication, IT technology, safety standards, acceptable economic elements and most importantly the good ideas are successfully implemented by AREC in its way of working, upgrading itself through creating innovative systems with the sole purpose to make the information available to anyone who needs it.

AREC as part of its strategy has implemented a GIS system with cutting edge technology which is a compact whole of 2D and 3D functionalities. The AREC GIS portal provides service through which you can get an overview of spatial and attribute data from cadastral-geodetic information system including interrelated data that constitutes the required information.

The idea of implementing such system by the Agency for Real Estate Cadastre of Republic of Macedonia is a result of the need to simplify the procedures, also, shortening the time to gain the needed information and the possibility to do that for free.

With the implementation of the AREC GIS portal and the few simple steps to get information, all the paperwork, counters and lost time disappear, providing anybody, from anywhere, at work, home or anywhere in the world at any time, to have available up-to-date information from cadastral-geodetic information system for a few seconds.

#### **4. FEATURES (PERFORMANCES) AND FUNCTIONALITIES**

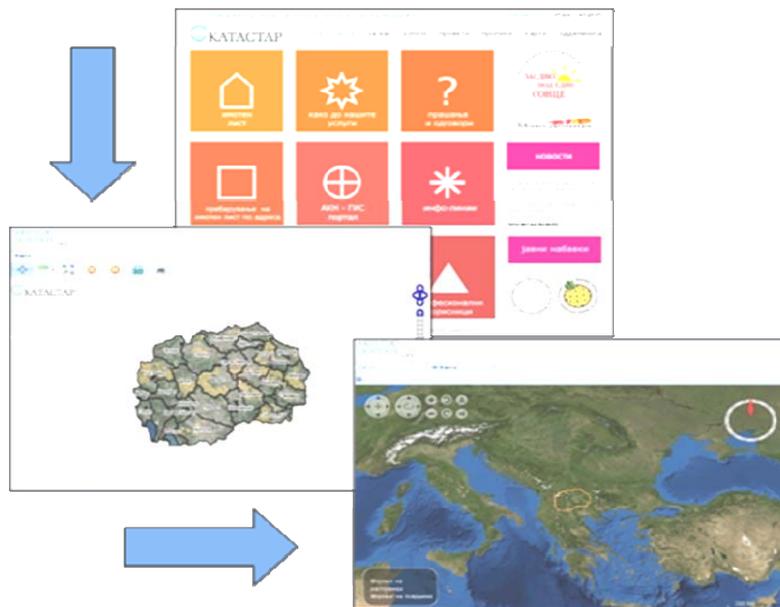
AREC in the 3D GIS PORTAL enabled by the object and the purpose of this service provides a simple user interface with a choice of certain functionalities. The user interface is based on the selection of certain components presented in the user environment through the 2D and 3D functionality of the system (Figure 1).

The user's environment of the 3D GIS PORTAL is presented through the central panel, the navigation panel, the menu selection, the layers and the functionalities. To access the 3D environment of the system, the 2D user environment needs to be activated which means that these two options are closely related.

The features and functionalities of the system can be divided into two modes: mode - system administrator and functionality of the whole structure, managing the system from aspect of its upgrade, update and user administration and mode - user which means utilization of the possibilities of this system and what this system offers to the regular (registered) and professional users.

The 3D GIS portal by AREC consists of a 3D user space for map preview (plans, model terrain, etc.) Scrolling along the user space is possible through standard controls by which the user can manipulate through the map space using tools as pan, zoom, tilt, rotate, stop, reset heading, reset all. In the space provided for map overview, there are functions for measuring

length (actual length and air along the ground) and surface (2D and 3D) display of geographic coordinates and altitude in wgs84 coordinate system in the current cursor position.



**Figure 1. AREC's web site – 2D GIS Portal – 3D GIS portal**

The functions are selected by the default menu. The menu functions on the principle of selection from drop-down list of features where more options and possibilities can be found. The ability to search the cadastral parcel is a feature that offers display of that parcel specified in 3D, through a selection of cadastre county, cadastral municipality and the number of requested cadastral parcel. This option is only available if it's a digital cadastral municipality, otherwise you must use a combination of 2D and 3D functionality to search by raster maps (archive or work maps) and then display the requested cadastral parcel in the 3D user space. After selecting the desired parcel you can get and preview insight into the cadastral database of the cadastral-geodetic information system, respectively to the registration of rights in the AREC of RM.

Using the choice of layers we choose what we want to be shown in the user space of the map. Optionally, the core layer is a display of orthophotos who are presented in color, then there is the ability to display digital cadastral parcels and 3D objects, and tags or labels of the names of towns, settlements and number of cadastral parcels. The option these layers to be turned on and off gives us the possibility of choice, so we can get the information we need without burdening the user environment with those layers that we do not need at that point.

The ability to display the vertical representation of the terrain through contour lines gives a special feeling of the visual representation of the terrain, which gives us clearer and more accurate information about the model. The more you zoom into the pointed place, the denser and more precise view of the contour lines we receive. The option of adding custom contour lines is very useful when we want to get even more accurate and clearer picture of the terrain.

This option provides us the ability to get a contour line with the desired value that we will be able to determine – enroll.

The choice of the 3D settings applies to the selection of quality that will be used to show the 3D visualization of terrain and buildings. The 3D quality as an option refers to the ability to define the distance where the 3D objects will begin to appear. The lower the value is, the higher should be the display so the 3D objects can be presented. The ratio of heights is a function through which you can exaggerate differences of upland terrain. Number 1 is taken as a standard value of the coefficient which represents the real picture of the terrain. The option for selection of level for darkness i.e. transparency is used to change the clarity of 3D objects so the maximum value means that the objects are not transparent at all, while the minimum value means full transparency of 3D objects. As available options, there is also the relationship between 2D and 3D GIS functionalities from the AREC GIS portal, and the possibility to switch from 3D to 2D user space in the same position which is shown in both user spaces. Several representations of the AREC GIS portal's user interface are shown on Figure 2.

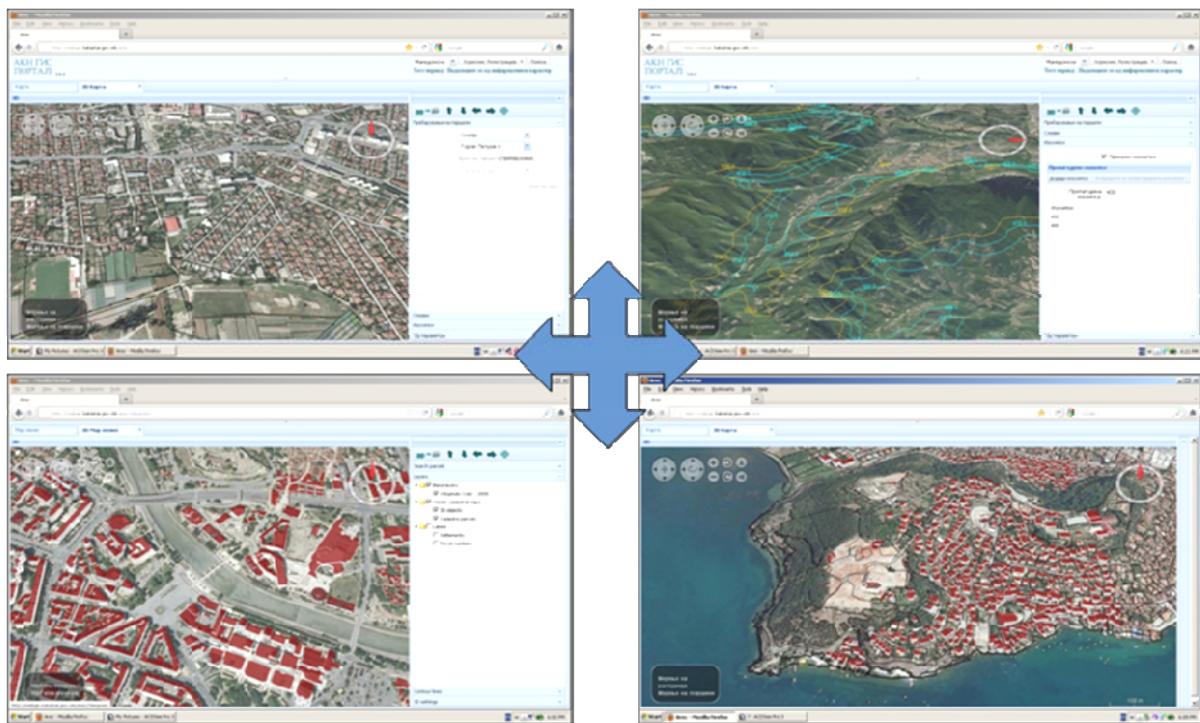


Figure 2. Several representation of the AREC GIS PORTAL's user interface

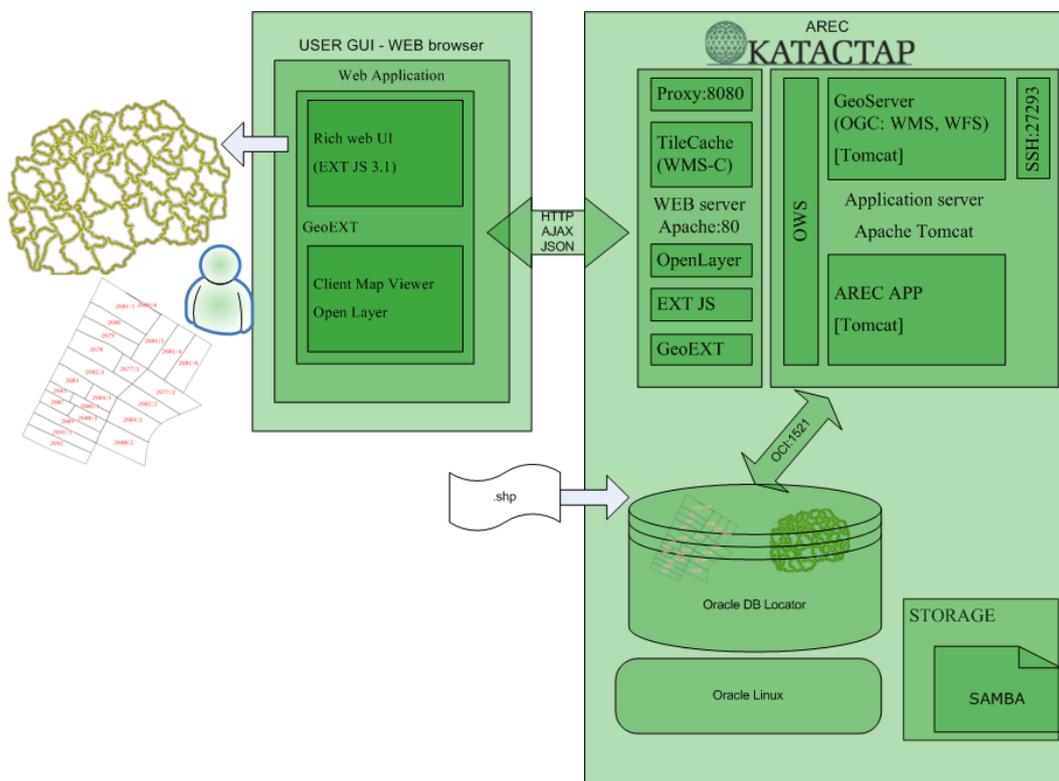
## 5. THE AREC GIS PORTAL ARCHITECTURE

The main IT architecture principles that are the basis for creation of the AREC GIS portal are:

- **Interoperability** - the architecture ensures efficient system integration with relevant external systems

- **Security** - the architecture provides a sufficient level and design of security and authorization
- **Openness** - the architecture is open for integration due to the fact that it is based on open standards
- **Flexibility** - the architecture ensures the degree of flexibility which is required to handle possible changes of the business process model
- **Scalability** - the architecture ensures that the system implementation can be scaled efficiently in relation to possible scenarios on growth in transactions, volume of data and number of concurrent users, etc.
- **Portability** - the hardware and the software are open to several platforms considering hardware architecture and operating systems.

The application is developed as three tier application in which the presentation, the application processing, and the data management are logically separate processes (Figure 3).



**Figure 3. The AREC GIS portal system architecture**

There is storage for raster data, .shp files, .jpeg documents for geodetic points, user documents, etc. The database server operates on Oracle Linux. The Oracle database is extended with the option Oracle Locator, which provides geospatial data storage, viewing and editing.

The application tier is processing user requests and separates the business logic from other modules, such as the data access layer and the user interface. Application tier is represented by a Tomcat application server which is run on Ubuntu Linux. It consists of a Geoserver, for geospatial data viewing and editing and the AREC application, built with JAVA programming language. The Geoserver connects to the Oracle database and to the Storage and all the layers are defined in it. The application tier has a built-in security module based on SpringSecurity protecting unauthorized users from the administrative part of the portal.

The presentation layer is the topmost level of the application and it's responsible for the delivery and formatting of information to the application layer for further processing or display. Presentation tier is made of pure javascript and html code, enabling cross browser display. The Apache web server consists of tilecache, which contains everything that is once produced by the Geoserver, then proxy, OpenLayer library for displaying map data in web browsers, Ext JS library for attribute data, GeoExt library for bringing the functionalities of OpenLayer and Ext JS together in a single user interface for web mapping and attribute data search and display. Apache is a far more robust and quicker HTTP server than Tomcat and that is considered in the creation of the system architecture. That's the reason the web server is Apache, and the application server is Tomcat.

The protocols used in the creation of the AREC GIS PORTAL are: AJAX, Oracle ODBC, SQL, CQL, JSON, XML, GML and the standard OGC protocols: WMS, WFS, WCS, SLD.

### **5.1 The database**

The AREC GIS PORTAL database is consisted of tables which hold data for the cadastral parcels and buildings, objects used for visualization of 3D models, Spatial Unit Register data for the cadastral departments, cadastral municipalities, political municipalities, census and statistical circles, then Global Map data for the Macedonian state border, the boundaries of political municipalities, water coverage, roads and railways, major cities and urban areas, geodetic point data. The table structure is based on the shape files that are obtained for data entry, with the addition of columns required for the functioning of the application and the entity - relationship model setup. The database also contains data about the documents, custom codes and also administrator data for the users, their rights, translations and other application parameters.

## **6. FROM DATA TO INFORMATION!**

The 3D AREC GIS portal is based on Open Source principles. To operate all its features, a complex system of relations is made, where different types of technologies are used, software and ways of functioning that are compatible with each other and function as a whole. All these relations are reduced to how to deliver the data to the system and how to process that data and present it to the final users. After all, it comes down to data that compose the system, because that's where the answer to our question comes from.

In the AREC 3D GIS portal, is used a set of graphic and attribute data that are pertaining to several technologies which are mutually compatible. The basic data that are part of the functioning of this system are:

NASA WORLD WIND – an Open Source platform, developed in JAVA SDK programming environment. NWW represent a virtual globe with a set of multiple layers shown as a one whole. NWW is representing layers of Blue Marble - images of the Earth, satellite images of LandSat7, SRTM (Shuttle Radar Topography Mission), a representation of terrain height (DTM), boundaries of countries, names of countries, cities and others... and all is driven by the 3D Engine which allows movement (levitation), zooming to and from a certain point.

Open GL (Open Graphics Library) - a standard specification defining a cross-language, cross-platform API for writing applications that produce 2D and 3D computer graphics

Digital Orthophotos (maps) made in color in 2009 with air photogrametry, made by using digital methods, developed in the Macedonian National Coordinate System (Bessel ellipsoid/Gauss–Krüger projection) developed for the whole territory of RM in .jpg/.jgw and .tif/.tfw format.

Digital elevation terrain model (DEM), developed in the Macedonian elevation system (ortometric heights, with elevation date bench mark in Trieste) for the whole territory of the Republic of Macedonia in ESRI grid,. shp,. dxf formats with resolution of 20m x 20m and scales according to the division of lists of the basic national topographic map of the Republic of Macedonia in a scale of 1:25000. DEM is transformed into WGS84 and written in .tif format and converted into a format suitable for NWW.

Cadastral counties (units) - representing boundaries of cadastral units - vector data in .shp/.shx/.dbf format.

Cadastral municipalities - representing boundaries of cadastral municipalities – vector data in .shp/.shx/.dbf format

Cadastral parcels - representing boundaries of cadastral parcels – vector data in .shp/.shx/.dbf format

3D objects - objects in 3D view, elaborated in ORACLE (transformation of coordinates, classification by tiles, correction of the amount of points) and converted into a format suitable for setting NWW (.json-format) - vector data in .shp/.shx/.dbf/.shp.xml/.sbn/.sbx format.

3D labels - represent text data like names of settlements and numbers of cadastral parcels.

## 7. CONCLUSION – CURRENT AND FUTURE SITUATION

All opportunities offered by such a system is needed regarding the availability of information but also as an idea where for the first time the third dimension is included in the Cadastre of the Republic of Macedonia, of course viewed from the aspect of visual representation that extends the possibilities in terms of 2D cadastre. The 3D Web GIS solution and implementation of technology is an opportunity that the system is using with the possibility of upgrading to a fully functional solution in terms of implementation and application of 3D cadastre in the Republic of Macedonia. The future of this system one day will be a perfect solution for the realization of numerous problems and solutions in the field of cadastre services and beyond. The openness of this system is the most significant part of the whole idea. That means, the upgrade and its application will only go in upward run, hoping that one day would be included as an important part of the 3D cadastre system solution.

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