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Implementation of Multipurpose Cadaster Model in Albania

Genc Salja[1], Marpol Koço[1]

Department of Geodesy, Faculty of Civil Engineering, Polytechnic University of Tirana, Rr. Muhamet Gjollesha, Tirana, Albania
E-mail: *salja.genc[at]gmail.com*

Department of Applied Geology, Environment and Geoinformatics, Faculty of Geology and Mine, Polytechnic University of Tirana, Rr. Elbasanit, Tirana, Albania
E-mail: *marjo_peko87[at]hotmail.com*

Abstract: ***Legally, the creation of a Cadaster and land survey in Albania has started since 1874. Cadaster developments in Albania have been several since the creation of the ALBSreP system in 2012, until 2019 where the State Cadaster Agency (ASHK) was established based on Law no. 111/2018 "On the Cadaster", as a merger of the former Immovable Property Registration Office IPRO, the former Agency for Legalization Urbanization Integration of Informal Areas and Constructions ALUIZNI and the former Agency for Inventory and Transfer of Public Property. Establishment of SPATIAL DATA INFRASTRUCTURE (NSDI) IN ALBANIA - ASIG in 2013.ASIG creatednetworks on2018-2020 that constitute the Geodetic Reference Framework of Albania (KRGJSH) with high accuracy to guarantee spatial reference according to European standards in all its components: National GNSS Network, Gravimetric Network, Levelling Network, Mareographic Network, and Magnetometric Network. These are all developmental steps towards the creation of Multipurpose Cadastral. This work illustrates the design process for multipurpose cadastral system. This research intended to provide an accessible Web GIS prototype consisting of spatial and legal information related to Cadastral Information System The final product is visualization and interactive spatial application of Land/Cadastral Information System and filed survey.***

Keywords: Engineering, Planning, Metadata, GIS, Multipurpose Cadastral Database, Urban Perspective, ASIG, ASHK, Mapping, QGIS, PostgreSQL, Python, Web GIS

1. Introduction

Multipurpose cadaster is a framework that supports continuous, readily available, and comprehensive land-related information at the parcel level (Panel on a Multipurpose Cadastre, 1980).

It is imperative that land should be properly managed because of the vital role it plays in human affairs vis-à-vis the source of most material wealth. To effectively manage land and its resources, comprehensive information about land should be recorded in an organized and robust manner, to enable quick and flexible access to land related. Land information is a prime requisite for making decisions related to land investments, development, and management (Kaufmann and Steudler, 1998).

The basic components of a multipurpose are:
1) A reference frame consisting of a geodetic network,
2) A series of current, accurate large-scale maps,
3) A cadastral overlay delineating all cadastral parcels,
4) A unique identifying number assigned to each parcel, and
5) A series of land data files.

2. Objectives

The objectives of the multifunctional cadaster are four: Urbanization, taxation, property legality, Infrastructure.

Cadastral parcels are primarily defined to ensure ownership and to make land market easier and safer.

Urban planning
This use case aims to define guidelines to help local authorities or governmental agencies (other cases) to provide urbanism documents as digital data, for the management of construction permits. The finality is to identify the rights and duties that apply to each cadastral parcel.

Cadastral parcels and attributes are required for the design/construction/management of many infrastructures project.

Taxation
Another aspect is the taxation, by having updated data we would generate in real time the taxation map. The main purpose here is to describe procedure to create the structure of multipurpose cadaster in Albania. All over the world, there were movements to establish fully digitized cadaster. It is accepted that cadastral systems will be implemented more and more in future and will be planned to assist land market along with effective administration, development, and management. After having multipurpose, will be very helpful for construction, engineering, and other projects.

Right of entry and rights to use land in rural areas is a problem of significant position when it comes to a Building Permit. Different area of property on paper and different boundaries. A field survey is needed to see the current situation.

Diversity of aspects can be taken into concern as requirements, to implement a digital cadastral database (Ali et al. 2010). Land Information System (LIS) in Albania is a mix it contains maps in Digital format around 10% of the property parcel the rest in plots, maps, and records on

hardcopy. having no cartographic elements or scale at all with outdated attributes. Traditional maps of Albania have damaged reference grid, not in scale. But these traditional maps could be as a good reference basis in generating new maps, no matter if based on any high resolution Orthophoto from ASIG, record of ancient aerial photographs, or via ground surveys.

3. Method and Material

All the materials used for creating and maintain the multipurpose cadaster are manpower, GPS Total Station, Computer Machines and Software.

The conceptual model of MPC development consists of seven main phases is shown in Table 1.

Table 1: Conceptual model of MPC

Database ALBSReP	Refinement and enhancement of existing ALBSReP. will provide a base data
2. Large Scale Geospatial Data Acquisition	Mobile laser scanning, Drone Image
3. Large Scale GIS Base Map	Municipality Local Geospatial Data Centre dataset that consists of large-scale topographic map and other GIS layer. ASIG Data
4.MPC Module	Application modules for integration of multiple data sources, importing data from Licensed surveyors, topology checks, validation and updating new Cadastral Map.
5. 3D-SDI	Applying data fusion method to generate 3D city model and 3D SDI using available large scale MPC database from Building Permits-Setting standards for new Permits.
6. MPC Database	Land Administration Domain Model (ISO19152), INSPIRE, ASIG
7.Online Web Access	MPC will provide a mechanism for access to spatial data as well as mapping and spatial analysis over the Internet.

4. Database Design

A geo-spatial database for all the layerswas designed and developed. Every layers have its attribute information), and appropriate relationships between the layers were identified and created. Based on the unique ID all the Layers are Joined in the database.

Table 2: Spatial database layers

	Table	Type of Geometry	Fields	Type	Description
1	Parcel	Polygon	ID_Parcele	Text	Kodi Unik i Parcelës
			ID_Zone Kadastrale	Number	Kodi Unik i Zonës Kadastrale
			Nr Parcelës	Text	
			Sip_faktike	Number	Sip e matur
			Sip_juridike	Number	Sip Sipasdok hipotekor
			ID_Pronësie	Number	Kodi Unik i Pronësisë
			Perimetër	Number	Perimetri ne metra
			Centroidi Perëndimor	Text	Perëndimi i qendrës se parcelës
			Centroidi Verior	Text	Veriu i qendrës se parcelës
			Tipi i pronësisë	Text	Pronar i VetëmoseBashkëpronar
			Data e kryerjes se Matjeve	Date	Date
			Konflikte	Text	Po/Jo
			Nr Protokolli	Text	
			Posedues	Text	EmriPoseduesit
			Emri i FirmesTopografike	Text	Emri i Firmësqe ka kryermatjet
			Origjina Parcelës	Text	Legalizim, Komision i Kthimit te pronave, Privatizim, etj
2	Cadastral Zone	Polygon	ID_Zone Kadastrale	Number	Kodi Unik
			Sipërfaqja	Number	
			Perimetri	Number	
			Centroidi Perëndimor	Text	
			Centroidi Verior	Text	
			Numri_Parceleva	Text	
3	Boundary Points	Point	ID_Pike	Number	
			Nr Pikës	Text	
			EmërFoto	Text	
			Data e kryerjes se Matjeve	Date	
			X(Koordinata)	Number	
			Y(Koordinata)	Number	
			Z(Koordinata)	Number	
4	Boundary Parcel	Line	ID_Parcele	Text	
			Lloji	Text	
			Tipi	Text	
			ID_Pronësie	Text	
			Data e kryerjes se Matjeve	Date	
			Data e Aplikimit	Date	

			Nr Protokolli	Number	
			EmërSubjekti	Text	
5	Road_Line	Line	ID_Rruge	Numer	
			Emërrrugë	Text	
			Vendodhja e Rrugës Liveli	Text	
			Njësia_ Administrative	Text	
			Gjendja e rrugës	Text	E shtruar, e pa shtruar, e keqe, Me kalldrëm
			Lloji	Text	Kryesore, Dytësorë, Fundore, Këmbësore, Trotuar, Kunete, Pandus, Kanal
6	Road	Polygon	ID_Rruge	Numer	
			Vendodhja e Rrugës Liveli	Text	
			Emer_rruge	Text	
			Njësia_ Administrative	Text	
			Gjendja e rruges	Text	E shtruar, e pa shtruar, e keqe, Me kalldrëm
			Lloji	Text	Kryesore, Dytësorë, Fundore, Këmbësore, Trotuar, Kunete, Pandus, Kanal
7	Building	Polygon	ID_Ndertese	Numer	Kodi Unik
			ID_Parcele	Numer	
			Funksioni	Text	Banese, Biznes, Magazine, Zyre, Depo Uji, Mix, KabineElektrike, etj
			Nr_kati	Numer	0,1,2
			Popullsia e Ndërtesës	Numer	
			Gjendja e Ndërtesës	Text	Amortizuar, ne gjendje te mire ...etj.)
			Sipërfaqja	Numer	
8	Manhole	Line	Lloji	Text	Shiu, Kanalizime, Ujera te bardha, Ndriçimi, Telefonie
			Tipi		Beton, Hekuri, Plastike
9	Parking	Polygon	Tipi	Text	Privat, Publik
10	Topography		ID_Izoipse	Number	
		Pike	Kuota	Number	
		Line	Izoipse	Number	
			ID_Linje		
11	Electricity	Line	Lloji		Kuote, Shtylle,Shkalle, Peme, rrugore etj
			Kuota	Number	
			Lloji	Text	Izohipse, Mure, Porte, Konsol, Rrethim, Gardh, Skarpate, Shkalle, Bordure,Lulishte, Korsi Biçikletash, StacionAutobusësh etj
12	Tree	Pike	Id_Peme	Number	
			Lloji	Text	
13	Canal		ID_Kanali		
			LLoji		
15	Ownership	Table data	ID_Pronësie	Number	
			Data e Lindjes	Date	
			Shtetësia	Text	
			Pasaporta	Text	
			Punësimi	Text	
			Shtetësia	Text	

5. Infrastructure System

In this chapter, it will be described which software products are used for the implementation of theapplication components of the Web-GIS System

5.1 Software infrastructure AND *Data Layer*

Proposed solution for the system is structured on the above-described client-server model, where all components of the multitier architecture are developed on ***open-source technology***, which core iscomposed by very stable and reliable existing back-end software, licensed free of charge, constantlyupdated by a worldwide user community.

Geoportal and the other system applications, will be specifically developed for this project based onthese engine applications and customized with all required tools, presenting look and feel.

Characteristics such as layout, colors, fonts, logos, etc. defined in agreement with Client. Data Layer is based on 2 main components: Database Management System (DBMS) and File System.

5.2 Database Management Server: PostgreSQL/ PostGIS

The management of the *System Database* is carried out by the open-source server application called.

PostgreSQL with ***PostGIS*** for the spatial components. PostgreSQL, (or simply *Postgres*) is a database management system (DBMS) that emphasizes scalability. And compliance with standards.

Its main functions are:

- Store data.
- Management of backup and recovery procedures.
- Retrieve data as requested by other software applications.
- Ensure the correctness and consistency of the data.
- Management of the transaction log.
- Provision of roll-back operations, to recover the previous state to one or more transactions in the database.
- Replication of the database itself for security and scalability.

Postgres is used with the extension **PostGIS**, which adds support for geospatial data, vector, and raster, allowing operations on geometry, measurements, spatial queries, etc. following SQL specification from the OGC.

5.3 Data Back-Up and Disaster Recovery plan

Being a crucial part of the system, data must be protected.

For this reason, it is important to foresee the implementation of data backup and recovery plan for theSystem database, to be executed automatically and regularly by tools provided by the DBMS.

Backup operations allow to copy all information in files, which can be archived in a data storage in asecure location. Using backup files, the complete structure of System Database, including data, tables,stored procedures, constraints, etc. can be recreated at any time.

Backup plan for System database foresees the implementation of automatic operations to be executedregularly:

- Local dump of the database, in a specific format agreed with Client.
- Creation of a compressed file.
- Transfer of the compressed backup file in a data storage in Client Intranet, located in another place, to be identified with Client. In this way, it is possible to have 2 copies of the same backup file.
- Delete of backup files

It must be planned to implement different types of backup: Complete backup (i.e., every day at midnight; Differential backup (i.e., at midday); Backup of log files (i.e., every hour)
Backup files are stored for a specific period (i.e., 7 days)

The final version of schedule will be agreed with system administrator.

In this way, in case of disaster events, the whole system and saved data can be recovered or restored.from a backup system when needed.

The manual for the implementation of backup and disaster recovery procedures is provided, with step-by-step sequence of SQL commands, configuration parameters and any other relevant information.The system should be configured to automatically save information be made periodically on a schedule.

5.4 File System

File system, for storing documentation and media files, will be located on a shared SAN, accessible.from the three main core servers.

5.5 GIS Server application: GeoServer

GIS Server application is specifically dedicated to the execution of GIS functionalities and the publication of spatial data as map services, compliant with OGC standard protocols (WMS, WFS, WFST,etc.)

GIS Server for proposed solution is ***GeoServer*** an open-source application written in Java.

Designed for interoperability, GeoServer publishes layers and maps, as collection of layers, from anymajor spatial data source using open standards, representing an easy method of connecting existinginformation and reference implementation of the OGC standard protocols, using service specifications.such as WMS, WFS, WCS and Web Processing Service specifications.

Through GeoServer, authorized users can publish spatial data as map services, whether from internal*System* database, or from external sources, such as *OpenStreetMap*, *Google Maps*, *Bing Maps*, etc. To ease the operations, GeoServer provides an easy-to-use interface.

Once published, users can consume these layers as Web GIS services.

GeoServer will be used as e tool to create Maps by creating a direct connection to Postgres SQL Database

GeoWebCache will be used to create Static Maps, this is part of GeoServer.

5.6 GeoNetwork

GeoNetwork is a catalog application to manage spatially referenced resources. It provides powerful metadata editing and search functions as well as an interactive web map viewer. It is currently used in numerous Spatial Data Infrastructure initiatives across the world.

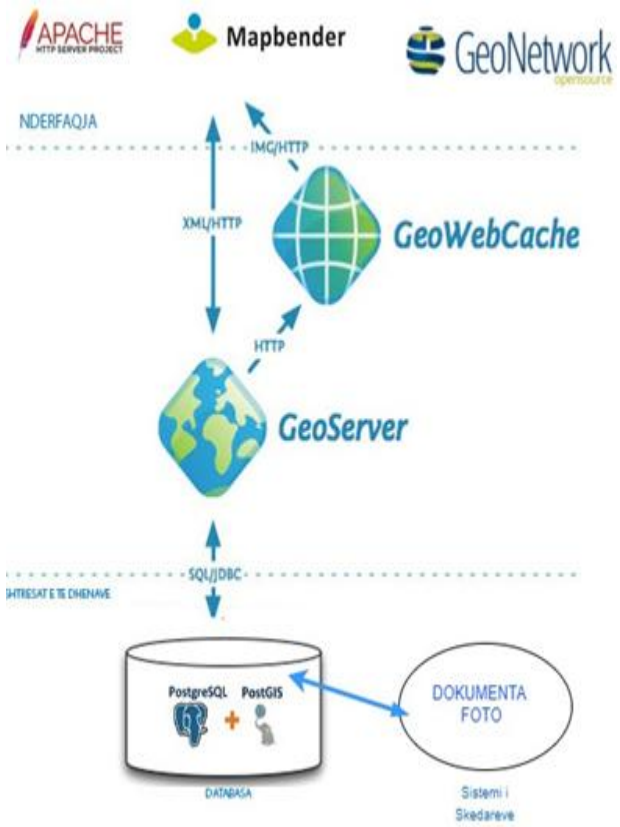

Figure 1: Architecture Schema of the MPC

6. Data Visualization in Web GIS

For data bing accesible by public, local authorites , Agencies and other parties Mapbender is used.

Mapbender is a web-based geoportal framework to publish, register, view, navigate, monitor, and grant secure access to spatial data infrastructure services.

High user-friendliness

- Modern web-based interfaces for user and administrators
- Delivery with preconfigured applications for displaying, navigating, and querying maps (OGC Services)
- Administration of OGC Services in a Service repository. Individual configuration of Services in every application
- Customization of applications to individualrequirements via the web interface with a collection of customizable elements
- The adaption of the designs can be done via customizable templates and CSS.
- Based on the integrated user management, individual applications, single functionality, and services can be assigned to specific users or groups
- Copy, import and export of applications.

Feature

- Mapbender has its own template for mobile applications, which has been optimized for use onsmartphones and tablets.
- Digitalization: Mapbender makes it possible to create, retrieve and change geometry objects in the web browser. Complex forms for data input can be generated. All is configured via the administration Data source is SQL.
- Search: Configurable modules for creating searches via SQL
- Web-based printing with customizable print templates and image export
- WMC creation and handling
- GPS positioning
- And more nice features to discover.

The proposed method is robust, less time intensive and less vulnerable, flexible, and easy to use.

Th Pilot Web-Gis created contain WMS Layers from the Municipality of Tirana, Base Layers like Orthophoto, Administrative Units etc. from S**tate Authority for Geospatial Information (ASIG),** Multipurpose Cadastral group Layer's data are data we have measured in the field by Drones and GPS.

In the portal created we can Query the layers by different attribute, export data in another format.

WMS Services are created so other agencies can have access in the data.

Figure 2: MPCWeb GIS portal on Mapbender

7. Conclusion

The project was able to design some standards and implementation technique.

The model specified considers several layers not only the parcel and the building layers in considers border parcels, roads, electricity, topography etc.

The development of a multi-purpose cadaster system is closely linked to the development and consolidation of ownership. This is a first step to collect generic information not only about cadastral and land administration data There are many more aspects that are not mentioned in this paper – such as the cadastral processes of land transfer, subdivision the main entities of the cadaster, that would deserve further investigation.

We have many benefits from building such a system:

- Updated and detailed Cadastral Map.
- Identification and inventory of public and private land.
- Application of GIS processing system for building Queries or various applications for property and objects related to property.
- Unification of data in a single coordinate system.
- Land regulation in favor of planned or forced development.
- Related territorial data.
- Effective urban planning.
- Eliminate overlaps between development plans.
- Updated land value map.
- Updated and accurate data for infrastructure projects, expropriations, etc.; based on direct field measurement.
- Transparency with the public.

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Author Profile

Phd.Cand. **Eng. Genc SALJA**: Born in Shkodra, 1989.Lives in Tirana. Completed studies as Geodetic Engineering in 2012. He started PhD studies on 2014. His work experience includes Geodetic engineer in the private sector, GIS Expertise for EU Project, Freelancer for TomTom; Guest Lecturer at the Polytechnic University of Tirana; Specialist in the GIS/Cadaster Sector in Tirana Municipality.
Expert in real estate valuation

Phd.Cand.Eng. Marpol KOÇO, Born in Tirana, 1987. Finished study as Mining Survey Engineer on 2011. He started PhD studies on 2012. His work experience includes Geodetic engineer in private sector; External Lecture at University; Specialist in the Directorate of Policies and Mining Development; Head of Sector in Cadastral Directorate in Tirana Municipality. Expert real estate valuation.