# EXTENDED LPIS DOMAIN MODEL FOR SERBIA

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***Abstract:*** *A land-parcel identification system (LPIS) is a system to identify land use for a given country. The goal of LPIS is to get a clear picture of how the land is used for agricultural production, regardless of the crop that is grown on them. Such a regulated and transparent system is a prerequisite for obtaining EU subsidies for agricultural production. LPIS core conceptual model defines entities in agriculture like agricultural parcels and blocks. ISO 19152 defines a reference Land Administration Domain Model (LADM) covering basic information-related components of land administration including parties (people and organizations), basic administrative units, rights, responsibilities, and restrictions (ownership rights), spatial units (parcels, and the legal space of buildings and utility networks), spatial sources(surveying) and spatial representations (geometry and topology). This paper describes the possibilities of integration of these two models for Serbia. Cadastral data for Serbia are given in country domain profile based on LADM. Extended LPIS domain model for Serbia based on collaboration with LADM is proposed together with case study example. The proposal has been given for the implementation of LPIS based on open-source GIS solutions. Data on the cadastral parcel and agricultural parcel are under the jurisdiction of two different organizations. Both models are based on the same key abstraction - the parcel, which raises the possibility of the occurrence of redundant data. By integrating the two models, the connection of one model with another can be provided. The introduction of the service architecture will enable that the data in both systems are up to date, which would reduce redundancy.*

***Key words:*** *LPIS, LADM, domain model*

## INTRODUCTION

The term "parcel" in LPIS refers to the area unit declared by the farmer. Generally, the three types of possible terms are in use for this concept: cadastral parcel, agricultural parcel and block (Figure 1). Based on this, three types of systems are defined:

1. system based on cadaster,
2. system based on agricultural parcel,
3. system based on block.


Figure 1 – a) agricultural block, b) agricultural parcel, c) cadastral parcel

Cadastral parcels are based on the property, while the land (agricultural) parcels and blocks are based on the types of land cover (Table 1).

*Table 1.*

Reference parcel in LPIS

| | Agricultural parcel | Farmer block | Physical block | Cadastre parcel |
|---|---|---|---|---|
| Land use in according to subvention | One type of crop | One or more types of crops | One or more types of crops | No match |
| applicant | Farmer | Farmer | One or more farmers | One or more farmers |

Reference parcel used in LPIS is the basic unit that is used by a single user. It is also the parent class of cadastral parcels, agricultural parcels and agricultural and physical blocks. Agricultural parcel contains only one type of crops and belongs to one user. Agricultural block is a unit which contains single grown crops, which belongs to a single user or multiple users and may or may not be divided by stable boundaries (roads, rivers, streams ...). The cadastral parcel is the basic unit of land which defines the right of property owners and can be arable and non-arable.

If the cadastral parcels are used as a reference for the LPIS, it may be the case that data registered in the cadastre differ from the reality, e.g. registered and real area do not match. If farmers declare used area it could reduce the risk of false declarations. Subsidies are paid to farmers for the "net" surface of a parcel i.e. the area that can be used as arable land. Non-arable land inside the parcel (buildings, trees, fallows etc.) is not taken into account. Data on net surface should be regularly updated.

Many countries were historically mostly focused on the parcels, especially with regard to agricultural use. In Serbia, the real estate cadaster was developed following the land cadaster which was only concerned with ownership over land (primary used for agricultural production and tax calculation based on cadastral income). It is estimated that about 80% of the agricultural parcels can be viewed through the boundaries of cadastral parcels, but, since it is not a universal rule, in other cases the cadastral parcels must be regarded as a unit of division within the system.

Advantages of such system based on cadastral parcels is that if the cadastral offices regularly update their data, the user can always get the actual situation on the ground, in line with the situation in the cadastre - surface geometry, topology and other attributes of the parcels, and data about the owners (which is considered as a well-kept cadastre). All these data are official, and official management of cadastre in practice should provide a unique identification system (parcel registry with identification numbers) which is required at the level of identification of parcels.

On the other hand, the system based on agricultural parcels is the system according to which every agricultural holding will each year carry out the application that gives information about the farms that are in its possession. The applicants have to draw the boundaries of each parcel to be reported and submit them along with other data.

In a number of countries (European and non-European) the identification based on the mapping of agricultural blocks is adopted. The block represents a continuous area of agricultural land that is limited by natural boundaries, within which farmers define their parcels. Systems based on blocks recognize the fact that it may not be possible to delineate individual agricultural parcels on cartographic documents, because for example they are too small in many cases. It also takes into account that every year there are approximately 20% of changes in the boundaries of agricultural parcels, so recording of these changes each year may be impractical.

Blocks can be formed as:

- Physical blocks - surface limited by natural boundaries of the field - such as boundaries, roads, asphalt, streams, rivers, permanent crops, etc.
- Agricultural blocks - formed as sets of parcels of one owner.

EU recommends using blocks for simplicity and lower cost of maintenance, unambiguous determination of blocks and the exactness of the surface that corresponds to actual situation. This is due to the fact that cadastral and agricultural data are under the jurisdiction of different organizations and may not always be up-to-date. This situation may be overcome using integrated data model described in the remainder of the paper.

## MATERIAL AND METHODS

The methodology used is Object Oriented Methodology (OOM) which is a system development approach encouraging and facilitating re-use of software components. The diagrams are developed using the Unified Modeling Language (UML) that is a general-purpose modeling language in the field of software engineering, which is designed to provide a standard way to visualize the design of a system.

## RESULTS AND DISCUSSIONS

ISO 19152 is an international standard from the ISO 19100 series of standards which defines the domain model for land administration (Land Administration Domain Model-LADM)**Error! Reference source not found.**. Within the standard, land administration refers to the administration part which focuses on properties and the geometric representation of spatial components. LADM covers all the mutual concepts of land administration across the world, it incorporates the rules and guidelines given by the publication Cadastre 2014 and is based on the ISO standards from the 19100 series. Apart from this, LADM has to be simple in order to be used. The use of this model in a certain country assumes adding additional attributes, operations and associations.

Modelling is the main way to simplify the development of certain systems and it offers the base for significant communication between (parts of) the systems. The basic domain model proposed by this standard is shown in Figure 1. LA_SpatialUnit class serves to model spatial units. The LA_Party class represents people or organizations that have certain rights, restrictions or responsibilities in relation to the spatial units with certain shares (LA_RRR class). The LA_BAunit class incorporates all the rights, restrictions and responsibilities of one or more person in relation to a certain number of spatial units, so that the share amount in the ownership equals 1. This set of classes is sufficient enough to cover the basic structure of land administration data.

The profile of the domain model for the cadastral records in Serbia was created by extending the basic LADM (Figure 2). With the extension of the LA_SpatialUnit class which represents land objects, new classes were formed that refer to cadastral parcels (RS_Parcel). This class also represents buildings and part of buildings. In this paper LADM is observed from angle of parcels so in the future text only parcels will be analyzed. The RS_Party class is derived from the LA_Party class and it represents people or organizations that have certain rights, restrictions or responsibilities in relation to spatial units with certain shares. Rights, restrictions and responsibilities are represented with the LA_RRR class and the derived classes that match the needs of the cadastral records in Serbia (RS_RRR and RS_Restrictions). All the rights, restrictions and responsibilities of one or more owners of one parcel are stored in a special document which is in Serbia called the real-estate document. LADM provides this structure with the LA_BAunit class. With the extension of this class a new one is formed, called RS_RealestateFolio which is used to model the real estate document.

Every new class in domain model receives attributes and links in order to comply with national legislation. For example, the land use, date of construction, number of floors, rooms etc. are only some of those attributes. The resulting model represents the profile of the domain model for Serbia and as such, enables the cadastral records to be interoperable and to easily fit into European framework. The author's previous paper on the creation of the profile of the domain model can be found in [2] and [3].

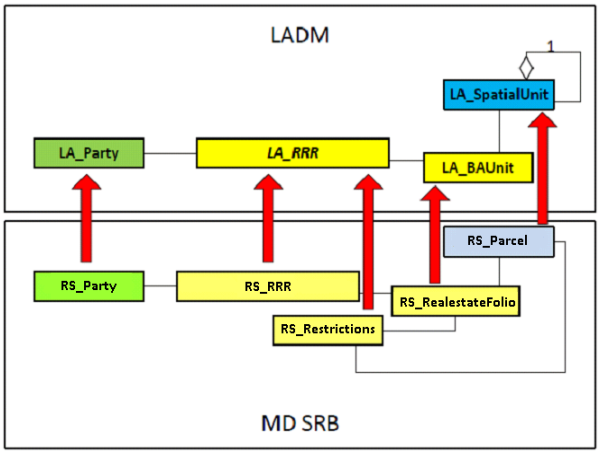


Figure 2 – LADM core classes and profile for Serbia

Land is the primary factor in agricultural production and the provision of food for a population. Thus, land is one of the main resources for investment, and it provides the basis for obtaining loans from financial institutions such as banks and other lenders. Land Parcel Identification System (Land Parcel Identification System - LPIS) is a system that establishes a database that records the actual use of agricultural land. The aim of the LPIS is to get a clear picture of how the land is used for agricultural production, regardless of the crop that is grown. Such a regulated and transparent system is a prerequisite for obtaining EU subsidies for agricultural production. European union member states have established Integrated Administration and Control Systems (IACS), including Land Parcel Identification Systems (LPIS) as the geospatial component.

Declared agricultural parcel which is subject of the payment calculation can be unstable over time and space (crop rotation, out of use, aggregation or subdivision of fields) so the reference parcel is used as basic unit for LPIS (Figure 3). Reference parcels can be either cadastral parcels (CadastreParcel) or production blocks (FarmerBlock, PhysicalBlock). Some member states built their system on the definition of spatila agricultural parcels (SpatialAgriculturalParcel).

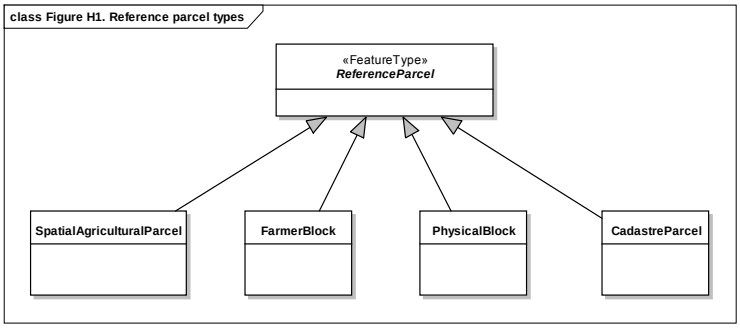


Figure 3 – Reference parcel in LPIS

The main difficulties of the cadastral parcel as reference for subsidies application are that it contains non-agricultural land, so the area eligible for payment cannot be directly determined. Also, boundaries of agricultural activity are out of the scope of land administration, and their maintenance via the cadastral update cycle is very complicated. Therefore, the concept of SubParcel is introduced in Annex H of LADM standard. SubParcel plays the role of a reference parcel as a glue between LADM and LPIS. Figure 4 shows the core model of LPIS which can be extended to fit particular need of national implementations.

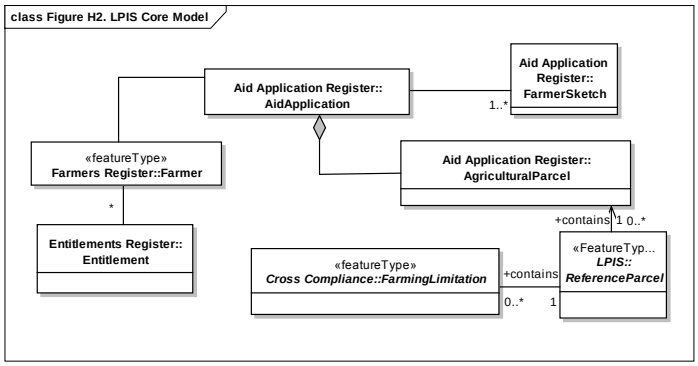


Figure 4 – Core classes for LPIS

For a meaningful, comparable and standardized classification of land, at least for the case of cadastral parcels in Serbia as agricultural reference parcel, SubParcel class is designed as a part of cadastral parcels in the model. SubParcel has composition association to RS_Parcel (Figure 5).

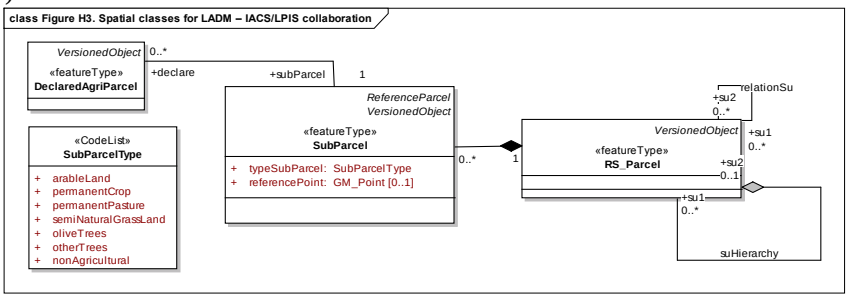


Figure 5 – Integration LADM and LPIS through SubParcel

RS_Party, Farmer, Right/Restriction/Responsibility (RS_RRR), YearlyAidApplication, YearlyFarmerSketch, DeclaredAgriParcel are the basic classes designed to manage administrative data in the model (Figure 6). LPIS class Farmer is specialization of LADM class RS_Party. It contains attributes specific to farmer. Farmers may apply for agricultural subsidies every year. To handle the application information of farmers, YearlyAidApplication class is designed. Every aid application must be accompanied by farmer declarations which describe each piece of land used by farmer for agricultural activities and farmers' sketch. Therefore, there are two classes (DeclaredAgriParcel and YearlyFarmerSketch) that together compose data from YearlyAidApplication. To represent their entitlement rights, PaymentEntitlement class is introduced in the model.

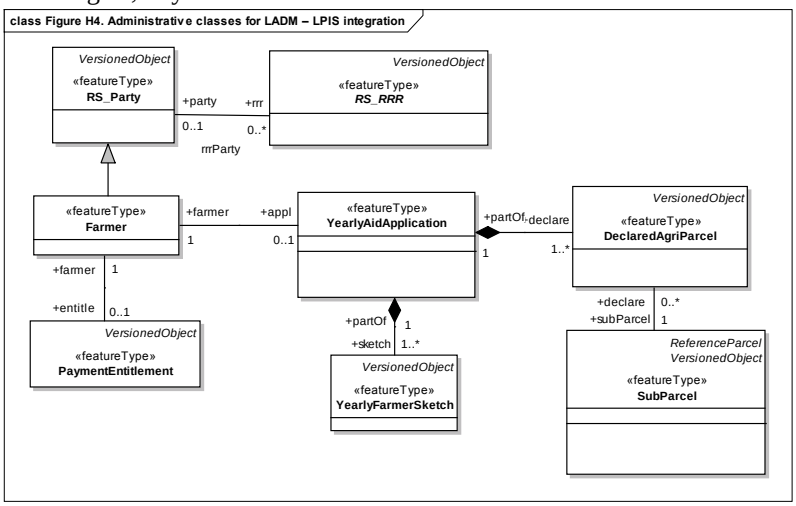


Figure 6 – Integration LADM and LPIS - Farmer

LPIS deals with farmers (users of land) and the cadastre deals with owners and they may not be the same person. However, cadastral system deal with a wide range of information related to land including ownership, rights (right holders of registered properties), farming rights, restrictions, responsibilities etc. It is a fact that cadastral systems are currently not always capable of administering all kinds of land related rights. Therefore, registration of farmers and farming rights in an cadastral system has been regarded as an obstacle when compared with LPIS. In fact, a farmer is a person who does some kind of agricultural activity on some piece of land. Farmers may own some land for their activities. They may lease and/or get some kind of consent from others for another piece of land. For this example farming rights can be designed as part of an cadastral system with a few extensions in code lists (RS_RightType and RS_AdministrativeSourceType) with attribute values for attributes of some LADM classes. The idea is that this will enable the application of an integrated solution for the management of land use rights both for cadastral system and LPIS applications.

## CONCLUSIONS

This paper describes the possibilities of integration of LADM and LPIS models for Serbia. Cadastral data for Serbia are given in country domain profile based on LADM. Extended LPIS domain model for Serbia based on collaboration with LADM is proposed. The proposal has been given for the implementation of LPIS based on open-source GIS solutions. Data on the cadastral parcel and agricultural parcel are under the jurisdiction of two different

organizations. Both models are based on the same key abstraction - the parcel, which raises the possibility of the occurrence of redundant data. By integrating the two models, the connection of one model with another can be provided. Future work will include development of the Web services and geo-services for publishing data on the Web.

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