Modelling and Dissemination of Land Survey Data

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Abstract

Standardization of methods for collecting, processing and exchange of spatial data (and data in general) is a necessary prerequisite for faster, safer, and more efficient use and dissemination of data. Currently there are number of international standards which define concepts of spatial data exchange. The Land Administration Domain Model (LADM), besides a generic model for land administration systems, provides the support for modelling of relationships between cadastral data and land survey procedures. OGC Observations and Measurements (v2.0) (O&M) specification, also published as ISO 19156, defines a conceptual schema for observations and features involved in sampling when doing observations. LADM and OGC O&M are associateed through LADM class LA_Source, i.e. its child class LA_SpatialSource. This paper analyses the data models and the legislation related to surveying and manners of processing and exchange of survey results on various use cases in Croatia, primarily through LADM and OGC O&M.

Key words: land survey, Land Administration Domain Model, OGC Observations and Measurements, data exchange

1 INTRODUCTION

Introduction of standards into data management is important for establishment of system of exchange among different users, information systems and locations. It is necessary to standardize the procedures for defining of data and methods for structuring and coding of data as well as for procedures for distribution and maintenance of data (Cetl 2003).

Identical situation is with land survey procedures and their outcomes i.e. original land survey data (angles, distances, coordinates, etc.). In case these data are stored in a well suited structure, the main prerequisite for its broader and easier usage becomes fulfilled. Possible uses of land survey data, structured in such way are:

- more efficient preparation for subsequent land surveys
- faster data processing
- exchange of land survey data between different parties
- resolving of land disputes, etc.

Many authors have dealt with the topic of storing measurement data into database and implementation of measurement based systems. Buyong et al (1991) explained conceptual model of a measurement based multipurpose cadastral systems, where only measurements are stored according to previously defined model and coordinates are calculated when needed. Goodchild (1999) and Navratil et al (2004) analysed possibilities of introducing measurement data into GIS systems.

Van Ooestrom et al (2012) focused on cadastral geodata acquisition based on field surveys in the context of the international standard ISO 19152 (LADM). They explained the opportunity for modelling of data resulting from measurements by Spatial representation sub-package of the LADM, and by functionalities included from several other ISO standards. Strong et al (2013) stress out that without internationally agreed measurement standards, it is not possible to have valid and authentic cross border comparison which would facilitate both the processes of evaluation and decision making for land administration and management.

2 MODELLING OF LAND SURVEY DATA

2.1 LAND ADMINISTRATION DOMAIN MODEL

Land administration domain model (LADM) besides its primary purpose, modelling of land administration systems, provides support for modelling of original land survey data from which spatial data related to land were created.

Class LA_SpatialSource of the LADM (Figure 1) is a subclass of the class LA_Source and its purpose is to hold information on the original land surveys.

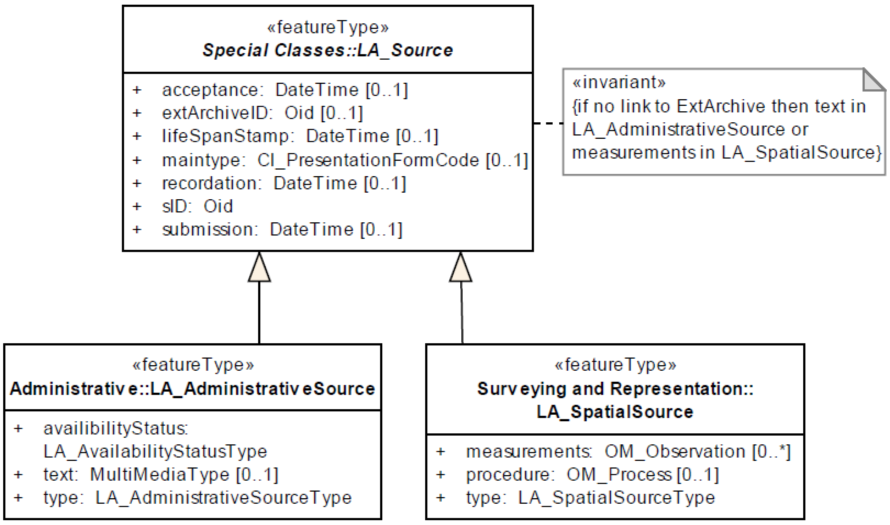

Figure 1 Class LA_Source and its subclasses (LADM)

The LA_SpatialSource class of LADM holds as attributes, measurements, procedure and type. Definition of data types for attributes measurements and procedure of the LA_SpatialSource, are defined in ISO 19156 (OGC Observations and Measurements) as OM_Observation and OM_Process. Those two classes can be further extended in order to comply with specific needs of various users, as we show in the reminder of the paper.

2.2 OGC OBSERVATIONS AND MEASUREMENTS

OGC Observations and Measurements model (O&M) arises from work originally undertaken through OGC's Sensor Web Enablement (SWE). The O&M is a conceptual model for observations and measurements, with the goal of providing a common ontology for sensor and observation systems. The key idea is that an observation results is an estimate of the value of some property of the feature of interest, while the other observation properties provide context or metadata to support evaluation, interpretation and use of the result (Open Geospatial Consortium 2013). The feature of interest specifies the object upon which the observation was made, resulting in an estimate of the value of a feature of interest's property (Figure 2).

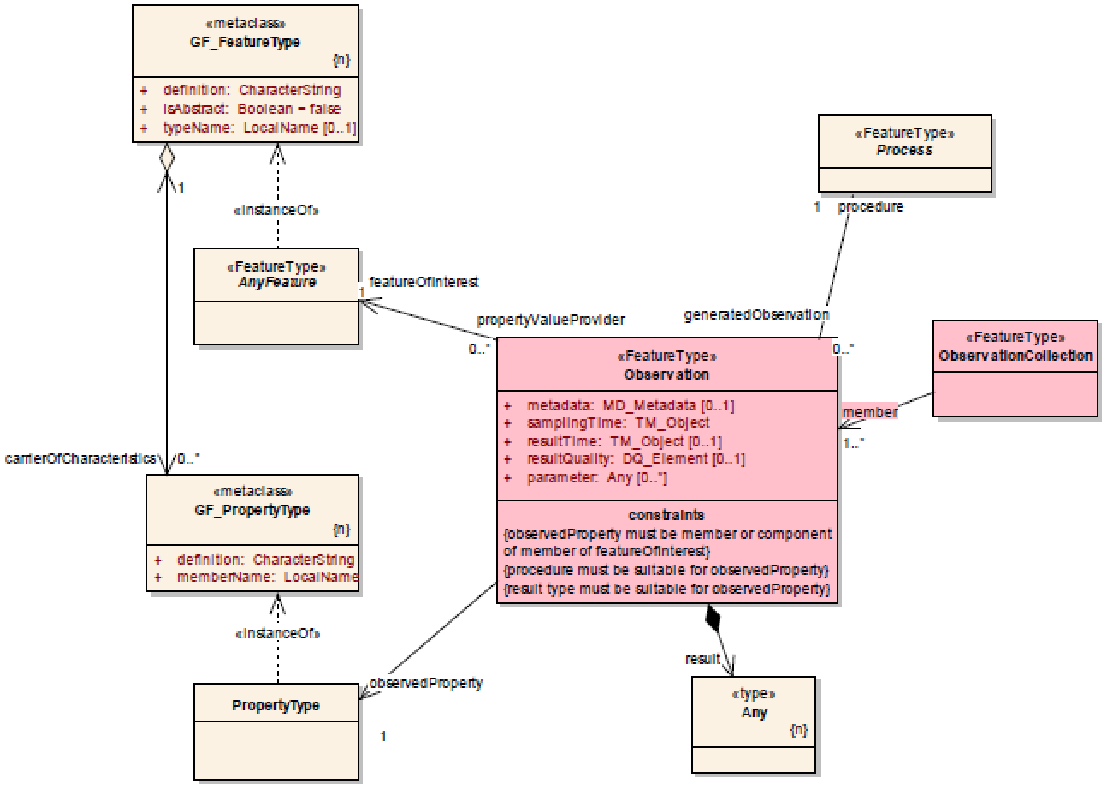

Figure 2 The basic Observation type (Open Geospatial Consortium 2013)

Some of the subclasses of the generic Observation class, relevant for geodetic surveying, are (Open Geospatial Consortium 2013):

- The class OM_Measurement refers to an observation whose result is a measure. For instance, measurement of width (property type) of a building (feature-of-interest) using measuring tape (procedure) had the result 10.32 m.
- The class OM_GeometryObservation refers to an observation whose result is of type GM_Object. For instance, determining of position (property type) of a point (feature of interest) using GNSS RTK device (procedure) had the result of type GM_Object.
- The class OM_CategoryObservation refers to an observation whose result is of type ScopedName. For instance, category observation of type of point (property type) of certain geodetic point (feature-of-interest) by field survey (procedure) had result "GNSS survey point" (set of possible values is previously defined).
- The class OM_ComplexObservation is also important because with this class we can model complex observations to the same feature of interest. For instance, feature of interest is point, and complex measurement can include horizontal and vertical angle, slope distance etc.

Class Observation together with all of its subclasses can be used to model data acquired in the field, which are related to spatial units within a cadastral database. Relation between measured features of interest in the field (OGC O&M) and spatial units in cadastral database

(LADM) is the class LA_SpatialSource which holds informations about original land survey data.

3 LAND SURVEY IN CROATIA

3.1 BACKGROUND

Land survey in Croatia is regulated with Law on state survey and real estate cadastre (Gazzete 2007a), with number of rule books and technical specifications. The regulations (Gazzete 2007b, Gazzete 2008, Gazzete 2009) define how survey should be done, which precision has to be satisfied and which additional metadata about observed objects should be acquired in the field in order to collect precise measurements which can be repeatable and controllable. The Law on state survey and real estate cadastre also defines that all geodetic projects, which are the basis for changes in land books, should be archived in cadastre. Currently, these archives are collection of papers and CD-s which contain spatial data in formats specific for every surveying company individually.

3.2 DEFINITION OF A MODEL FOR GNSS MEASUREMENTS

Based on previous discussion and motivations, we define the model of a simple GNSS measurement. By using OGC O&M conceptual model, land survey data can be modelled in a generic way in order to fulfil the need for easier and faster usage and exchange of land survey data (Figure).

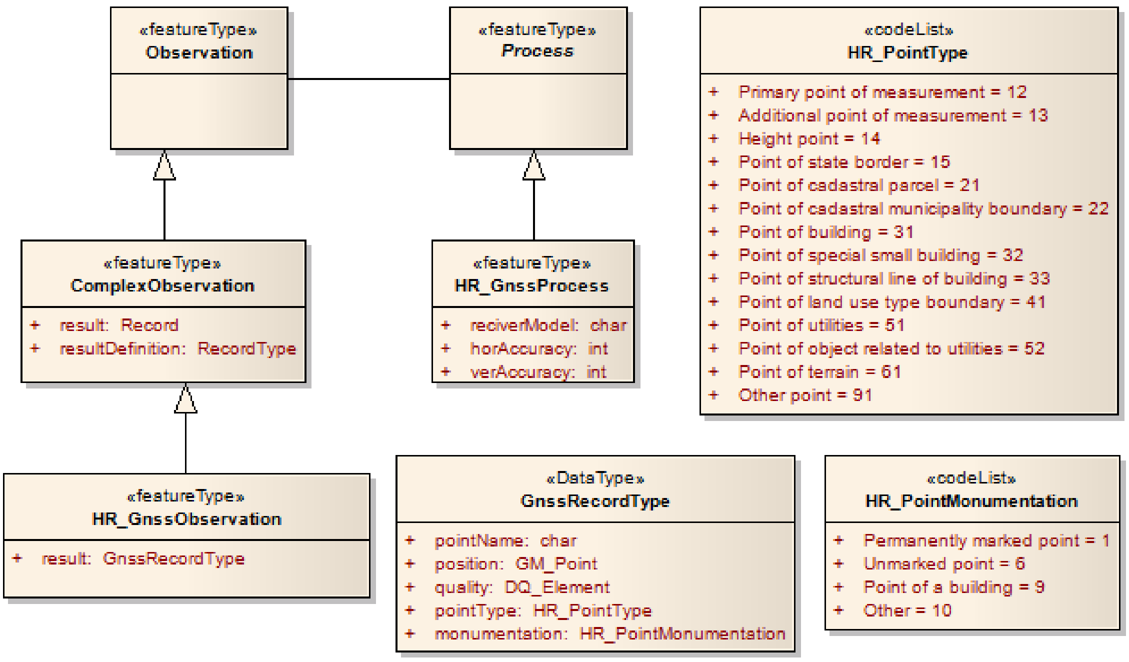

Figure 3 Basic GNSS survey model

We extended the class ComplexObservation with a new class HR_GnssObservation and defined a new data type (GnssRecordType). Prefix HR represents ISO Alpha-2 code for Croatia and indicates that extended classes are specific for the situation in Croatia. Class HR_GnssObservation is used for modelling of all GNSS measurements and defines which attributes should be acquired besides point position. The attribute quality is of type DQ_Element (from ISO 19115) so it can hold elements like horizontal and vertical precision, number of satellites in the moment of measurement, etc. The attributes point type and monumentation are code lists domains of which are defined within the previously mentioned Croatian regulations. We introduced the data type GnssRecordType in order to define a fixed structure of a complex observation, thereby avoiding for instance that various companies define various sets of attributes to be collected.

The class Process (from OGC O&M) is an abstract class, so for practical use we extended it with the class HR_Process. This class holds several attributes among which two very important ones are horizontal and vertical accuracy. This is the accuracy of a receiver as declared by the manufacturer. These attributes can be used for calculation of the precision of measurements.

In order to additionally clarify the concept, we created a simple instance level model with the attributes which are collected during GNSS survey of a certain boundary point of a parcel (Figure 4)

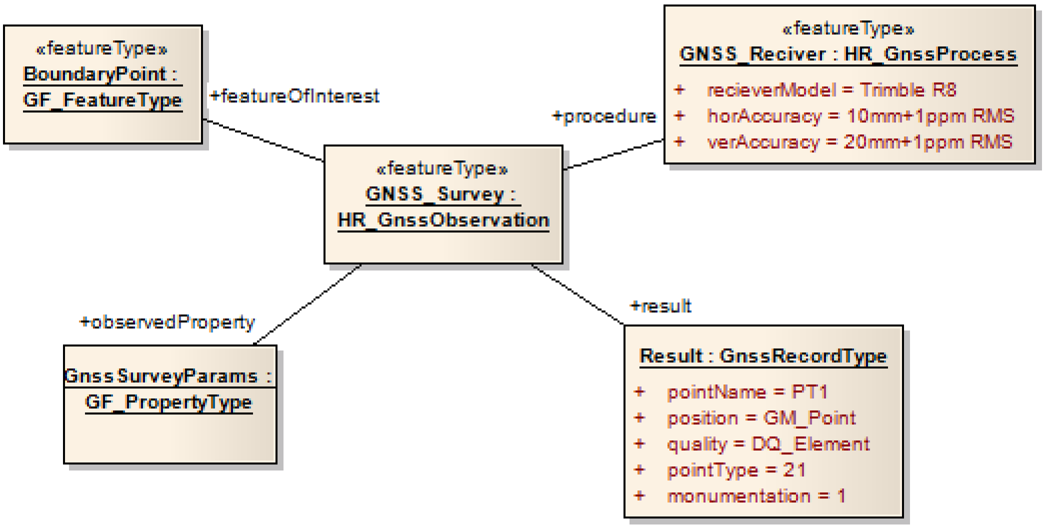

Figure 4 Instance level diagram of GNSS survey

Survey results stored according to this model can be physically stored in either GML or LandXML file since these formats support object encoding in textual files. A more advanced application of such a model could involve importing into a spatial database using a predefined workflow. Once the measurements are stored in a database, various analyses, transformations and translations of these data can be done.

In cadastral databases surveyed points are usually transformed or adjusted whereby their coordinates are changed, whilst the original location of a surveyed point is never changed. LADM allows such an option through class LA_Point which enables storaging of information about the original location and the transformation applied to the point, coupled with the resulting coordinates.

By using the described approach it is possible to compare originally measured values to those official on the digital cadastral map. This can especially prove valuable in case of land disputes.

4 CONCLUSION

In this paper we discussed the relevance of defining a model for storing of land survey data and presented a conceptual model for land survey data which we explained on a use case from Croatia.

Management of land survey data by the appropriately modelled structures brings multiple benefits:

- easier usage, exchange and integration of measurements
- increased level of quality, consistency and integrity of data
- more efficient error checking

These benefits would bear even more impact if a model for storage and management of land survey data would be introduced on international level in a form of international standard, like it is a case with instrument calibration (ISO 17123 prescribes how survey instruments must be tested and calibrated).

In Croatia, there are laws, rule books and specifications which define the framework for unique land survey procedure. The next step could be defining of the data format for exchange of land survey data in a digital form.

Furthermore, in Croatian cadastre, land survey data are archived in a paper form is not appropriate for fast and wider usage.

Further research will be focused on developing of a more detailed data model for land survey data and exploration of possibilities for integration of these data with cadastral systems based on LADM.

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