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The harmonised data model for assessing Land Parcel Identification Systems compliance with requirements of direct aid and agri-environmental schemes of the CAP

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ABSTRACT

The EU Common Agricultural Policy (CAP) subsidies to farmers are administered through dedicated information systems, a part of which is the GIS-based Land Parcel Identification System (LPIS). The requirement to map and record land eligible for payments has led to a situation where the agricultural administrations have acquired a large amount of geographic data. As the geospatial community of data producers, custodians and users has grown during the last decades, so has the need to assess the quality and consistency of the LPIS towards the EU regulations on the CAP as well as for cross compliance with environmental legislation. In view of this, a LPIS Conceptual Model (LCM) is presented in this paper in order to address harmonisation and data quality needs. The ISO 19100 series standards on geoinformatics were used for LCM development, including an UML modelling approach and the handling of the quality of geographical information. This paper describes the core elements of the LCM and their integration with data supporting management of agri-environment schemes. Later, the paper shows how the LCM is used for conformity and quality checks of the member states' LPIS system; an Abstract Test Suite (ATS) for mapping the LCM model against existing system implementations was developed and tested in collaboration with several member states.

1. Introduction

In the last two decades, the CAP has been reformed several times, with the aim of better targeting new challenges and controlling expenditure. The most radical change was introduced in 1992, and from then on the CAP focused on direct income support to farmers based on cultivated area instead of production, as well as on integration of environmental concerns. After the CAP reform in 2003, in order to distribute the EU subsidies, each member state established an Integrated Administration and Control System (IACS), including an identification system for agricultural parcels, known as the Land Parcel Identification System (LPIS) as the spatial component. The main functions of the LPIS are localisation, identification and quantification of agricultural land via very detailed geospatial data. In order to receive EU support farmers have to adhere to environmentally friendly land management requirements, commonly known as cross-compliance (CC) principles. Furthermore, farmers can carry out additional actions to reduce agricultural pressure on the environment or to improve the countryside biodiversity. These are known as agri-environmental measures (AEM) and incur additional monetary support. Management of information on environmentally compliant land use and agri-environmental measures is the second most important function of IACS/LPIS. As a result, nowadays there is a considerable amount of geographic data, which is used for the management of the EU agricultural policy and of the European-wide geospatial community of data providers and custodians (MARS, 2007; MARS, 2008; MARS, 2009).

Although the regulatory requirements are uniform across the sector, the particular implementations were subject to member states subsidiarity. Some of the member states used their cadastral data as the starting point for the creation of their new LPIS registers, while others made use of a dedicated production block (farmer's block, physical block) system (Milenov and Kay, 2006; Sagris et al., 2008). Therefore, different LPIS vary over common concepts,

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models of representation and spatial identification of the agricultural land use unit (Sagris et al., 2008). These days the main concern of the geospatial community and the European Commission is how well established systems are 'fit-for-purpose', raising questions about the conformity of the systems with the EU regulations and the quality of the datasets themselves. The spatial datasets for cross-compliance are, for the most part, collected and maintained by environmental authorities outside the LPIS in its strict sense, and therefore the different systems need to be interoperable. The majority of the spatial data in question is subject to the process of pan-European standardisation and harmonisation, triggered by the INSPIRE Directive (Directive, 2007/2/EC).

Therefore, there is a need to assess the quality and consistency of the LPIS as well as to ensure systems interoperability. The LPIS Conceptual Model (LCM) was developed in the Joint Research Centre (JRC) of the European Commission as part of the LPIS Quality Assurance framework (Devos, 2010) and is a cornerstone for these efforts. The second section of this paper describes the state-of-the-art of the database quality assessment and conformance testing issues. The third section is dedicated to the LCM, describing its development process and the most recent version. The *universe of discourse* or in other words the scope of the model was extended from land registration context as published in Inan et al. (2010) to include cross-compliance and AEM issues and some elements of the previous version were refined. The following chapter reviews how the LCM can be used for the conformance and quality checks by means of the developed Abstract Test Suite. In the conclusion, we discuss our experience in the model and test suite development and further possible applications of the LCM and the ATS.

2. Methodology for testing conformance – state of the art

Information about the quality of available geographic datasets is vital to the managing of agricultural subsidies and proper handling of the distribution of funds. Paying agencies confront situations requiring extremely accurate data in order to justify their decisions to the farmer and the auditing authority. Therefore, paying agencies need instruments to assess and demonstrate how well their datasets are aligned with the legislative requirements. The standardised description of the quality of geographic data may facilitate this need.

In order to describe and measure quality International Standards for geographic information provide the framework which consists of *quality principles* (ISO 19113) and concepts of *conformance and testing* (ISO 19105). The cornerstones of quality principles are *quality elements*, which describe different aspects of data quality. There are *data quality overview* elements (purpose, usage, lineage) and *quality elements* (completeness, logical consistency, positional temporal and thematic accuracy). Each quality element can be tested for conformance by means of *quality procedures*, *quality measures* and *quality tests*. Standards define conformance for geographic data as the fulfilment of specific requirements (ISO 19105) and conformance quality level as a threshold value or set of threshold values for data quality results used to determine how well a dataset meets the criteria set forth in its product specification or user requirements (ISO 19113). In this article, we also use '*conformity*' as a synonym to the term '*conformance*' used by the ISO.

Therefore, the objective for conformance testing in the agricultural domain is the testing of a candidate product or system for specific characteristics required by the CAP regulation. ISO 19105 provides two steps of conformance testing as illustrated by Fig. 3. The first step, called the Abstract Test Suite (ATS), identifies the *logical consistency* of dataset(s) with the requirements in order to ensure that the basic concepts of the universe of discourse are represented in an appropriate way by analysing the data specification. The second step (Executable Test Suite, ETS) examines the datasets themselves for completeness, positional, temporal and thematic accuracy against elements of the universe of discourse (e.g. correct land cover type recording, its extent and precise delineation by dataset objects) as well as against their own specifications, tested in step 1 (e.g. only attribute values allowed by specification are used). In this article, we concentrate on the ATS and testing of logical consistency quality element, which implies examination of database structure, attribute domain values, format and topological consistency. In other words, we test if the database setup is designed correctly to reflect important elements of the universe of discourse.

However, geospatial data cannot be directly tested with respect to legislative text. An additional step, a 'translation' of the basic concepts into a common conceptual model, is necessary. Conceptual models can be expressed in a formal modelling language such as UML. In addition, a XML/GML schema can be produced based on the model, also known as a conceptual schema or geospatial community data specification. The structure of the real geographical database can be described by application models and application schemas. In order to evaluate the conformity of the implemented database, the application schema should be *mapped* against a conceptual schema. In cases when different datasets of different organisations and institutions need to be integrated for any kind of visualisation and analysis, data can be *transformed* in the structure of the conceptual schema using 'mapping' parameters. Therefore, conceptual models and data specifications serve as the basis for conformance testing. These models are subject to an agreement between the geoinformation community members, i.e. data providers, custodians and users.

Conceptual models, sometimes referred to as core models, are widely used in different application fields. In the cadastral domain, Steudler (2006) describes fifteen years experience of the Swiss cadastral core model called INTERLIS. In their paper van Oosterom et al. (2006) present a Core Cadastral Data Model (CCDM) which is suitable for cross-country use and which enables involved parties to communicate information on land property. The FutureFarm initiative (Sørensen et al., 2010) proposes a conceptual model for a farm management information system (FMIS) that is designed to be used at farm level, enabling communication of different applications and devices. The development and implementation of models such as the FutureFarm or LandIT projects (Iftikhar and Pedersen, 2011) are largely based on such initiatives as AgroXML and AgriXchange which are dedicated to standards for data exchange in the farmer's business chain and especially used to exchange data with third party systems such as contractors, suppliers, consultants, etc. (Iftikhar and Pedersen, 2011). The recent adoption of the ISO 19152 *Land Administration Domain Model (LADM)*, which is built upon the CCDM and to which the LCM acted as input to modelling efforts concerning land administration in agriculture, led to comparative analysis of cadastral systems in Pouliot et al. (in press) and implementation of the cadastral system extension in Stoter et al. (in press). A growing number of publications on modelling of land resources can be found in geological science (Sen and Duffy, 2005; Lake, 2005; Babaie and Babaei, 2005; Simons et al., 2006). In the environmental domain, the INSPIRE data specifications (INSPIRE, 2007) are examples of common conceptual models for different data themes agreed by stakeholders. The INSPIRE Directive makes provision for 34 common data specifications covering reference (or general geographic) and thematic environmental data. Several INSPIRE data specifications are relevant to cross-compliance issues in the CAP, e.g. land cover, land use, cadastral parcel and protected sites.