An Approach to Cadastre Map Quality Evaluation

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Abstract—An approach to data quality evaluation is proposed, which is elaborated and implemented by State Land Service of the Republic of Latvia. The approach is based on opinion of Land Service experts about Cadastre map quality that depends on its usage points. Quality parameters of Cadastre map objects identified by experts and its limit values are used for evaluation. The assessment matrix is used, which allow to define Cadastre map quality that depends on its usage purpose. The matrix is used to find out, of what quality a Cadastre map should be in order to be used for the chosen purpose. The given approach is flexible, it gives a possibility to change sets of quality parameters and their limit values as well as to use the approach for other type data quality evaluation.

I. INTRODUCTION

Scientific literature identifies several aspects of quality: data quality has several components such as accuracy, relevance, timeliness, completeness, trust, accessibility, precision, consistency, etc. [1], [2]. There are currently two main research streams, which are addressing the problem of ensuring a high level of data and information quality. One is a technical, database-oriented approach, while the second is a management and business-oriented approach. Engineering of information system brings both streams together and addresses issues related to the design and modeling of information systems [3].

This research deals with identification of the parameters important to geographical data quality for specific goals. Geographical data are data describing an object’s spatial location and various properties. Conceptually a geographical database (GDB) may be thought of as consisting of two databases (DB) - one being a common attribute DB and the other is a coordinate DB describing the objects’ global locations and dimensions. High quality geographical data will include space location and object properties at given times (where-what-when) [4].

Data quality is the degree to which data meet the specific needs of specific customer. Note that one customer may find data to be of high quality (for one use of the data), while another finds the same data to be of low quality (for another use) [5]. What features do experts’ working with geographical data use to judge the quality of data? The authors are not aware of any published studies in this area to date. This paper present an approach to the evaluation of the quality of Cadastre map that caters for the differing levels of quality required of various parameters in order to meet different goals.

The subjective assessments of experts in geographical data processing are sought to determine the factors which impact most upon the quality of geographical data. When these assessments are evaluated, freed of subjective elements and classified, it becomes possible to specify parameters for the evaluation of data quality, their values and the required levels of quality. The result of this is a matrix for quality assessment which can be used to determine the data quality level that is necessary for specific purposes or, alternatively, the specific goals for which data at a specific level of quality may be used.

This paper describes the method that is to be taken in preparing the quality assessment matrix and how this approach is used for Cadastre map evaluation in State Land Service (SLS) of the Republic of Latvia.

II. AN APPROACH TO DATA QUALITY EVALUATION

The discussion of quality must begin with identification of the objects of interest. Every object will have a number of quality parameters (QP1, QP2, etc.) (Fig.1.). Each quality parameter QPn has values taken from one or more sets of values QPnVSk (TABLE 1), where QPnVS1 may contain the best values. QPnVS2 contains the second best values for some particular goal, etc. [6]

The quality of the object is based upon several or all quality parameters. For instance, an object can belong to the best values. QPnVS1 may contain the highest level of quality if all of the estimated values of the relevant quality parameters belong to the best sets of values. It belongs to the second level of quality if the values of the relevant quality parameters belong to the second best sets of values, etc.

Fig. 1. Object quality, parameter and value and object quality class

<table>
<thead>
<tr>
<th>Quality parameter (QP)</th>
<th>Quality parameter value set (QPVS)</th>
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<tbody>
<tr>
<td>QPn</td>
<td>QPnVS1 (high)</td>
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<tr>
<td></td>
<td>QPnVS2</td>
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<td></td>
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<td></td>
<td>QPn VS K (low)</td>
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<tr>
<td>from-until</td>
<td>from-until</td>
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As a result, the object quality assessment matrix (TABLE 2) is obtained, which is used to determine, to which quality class the object belongs, as well as to determine, which should be quality parameter values so that the object would correspond to the chosen aim of use.

Quality parameter quality class (QPn_QC) depends on a quality parameter value set, to which belongs the quality parameter value (1).

\[
QP_{n-QC} = \begin{cases} 
1, & \text{if } QP_n \in QP_{n-VS1}; \\
2, & \text{if } QP_n \in QP_{n-VS2}, \ldots; \\
M, & \text{if } QP_n \in QP_{n-VS K}, \quad n = \{1 \ldots N\}, \quad k = \{1 \ldots K\} 
\end{cases} 
\]  

In its turn, object corresponds to the lowest quality parameter quality class (2).

\[
QC = \text{lowest (} QP_{1-QC}, QP_{2-QC}, \ldots, QP_{N-QC} \text{)} 
\]  

The aim of object quality evaluation is to determine, which quality class the object belongs to and which aims it can be used for. In order to evaluate an object (Fig. 2.): first, check the correspondence of an object to quality criterions, obtain the list or the number of items not corresponding to the quality criterions, second, calculate object quality parameter values, obtain QPn, third, determine, which parameter value set (TABLE 1) it belongs to, obtain QPnVSk, fourth, determine, which quality class the value belongs to (TABLE 2), obtain quality parameter class QPn_QC and fifth, determine object quality class (2), obtain object QC.

This approach is implemented in SLS of the Republic of Latvia for Cadastre map evaluation and is based on the defined by field experts quality parameters, which describe the usage purpose of a certain Cadastre map.

### III. CADASTRE MAP QUALITY EVALUATION IN THE REPUBLIC OF LATVIA

In the Republic of Latvia, Cadastre map (CM) is created in Latvian coordinate system LKS-92 in Transverse Mercator (TM) projection. Following elements are represented in CM: land parcels -boundaries of parcels and their Cadastre designations; buildings - outlines of buildings and their Cadastre designations; encumbrances - areas occupied by encumbrances of right to use real property and their designations; parts of land parcels- leaseholds and their Cadastre designations; boundaries of Cadastre territories and Cadastre groups. The CM is used to locate Cadastre objects with precision so that any changes in boundaries for administrative or other purposes may be accurately described and to describe the relationships between objects for the purposes of environmental and town planning and for various reports. The principles and content of the CM are established by Regulation, which is an ordinance of the SLS of Latvia. The Cadastre IS databases consist of two parts, the textual part (TP) and the graphical part, which includes the CM in vector graphics form [7].

CM quality depends on the quality of each object, whereof the CM is made. CM can consist of such objects land parcel, building, encumbrance and part of land parcel. Therefore, in order to evaluate CM quality, firstly, it is necessary to evaluate qualities of land parcel, building, encumbrance and part of land parcel – wherewith the approach described above (Fig. 1.) has to be applied for each CM object.

#### A. Cadastre map objects quality parameters, value sets and quality classes

In this article an approach to CM quality evaluation is proposed, which is based on experts’ opinions about CM quality that depends on its usage points. Expert opinions are obtained from more than 50 expert interview surveys. Having summarized the results of surveys, such quality criterions are obtained: the CM meets the legal regulation requirements, CM objects are topologically correct, coordinates of CM land parcels are precise, CM objects (land parcels, building, encumbrance and part of land parcel) are in both Cadastre databases and the data is the same – in the TP and in the CM. Quality criterions are given in TABLE 3.

Experts’ opinions about CM quality are subjective and therefore have to be structured and, according to normative acts and existing IT solutions in SLS, we obtain Cadastre object quality parameters (QPn) (Fig. 1.) – for land parcel (LP) 5 quality parameters are defined (LP_QPn, n=1...5), for building (BD) – 4 quality parameters (BD_QPn, n=1...4), for encumbrance (EB) – 2 quality parameters (EB_QPn, n=1...2), for part of land parcel (PLP) – 3 quality parameters (PLP_QPn, n=1...3) (TABLE 4).

In collaboration with experts and in the result of experiments, sets of quality parameter values are defined.