Fundamental Base of Topographic Data of Czech Land Survey Office as a Source for Database Cartography and other applications.

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Abstract. The Fundamental Base of Geographic Data of Czech Land Survey Office (ZABAGED®) is approaching twenty years of its existence. Today it serves not only as a source for database cartography production of State Map Series, but also for online map visualizations and as a basic datasource for information systems containing spatial data in governmental institutions.
The presentation describes the shift in requirements on source data with transition of the cartography at Land Survey Office of the Czech Republic from the digital file based cartography, to the database one, managed by the change detection and processing.
The technical aspects of communication interface and data transfer, as well as necessary change of attitude in all workflows concerning creating, updating and modifying relevant data in the source topographical database with impact on the change detection are discussed.
Latest developments, including publication of INSPIRE compliant datasets, linking ZABAGED® and database of geographical names, relation between ZABAGED® and base Registry of Territorial Identification, Addresses and Real Estates, and advances in creation of common watercourse network shared between responsible institutions in the Czech Republic are described as well.

Keywords: ZABAGED®, database cartography, digital topographic database, NMA, INSPIRE, spatial identifiers.

1. Introduction

Coexistence of Fundamental Base of Geographic Data, (ZABAGED® ,which is the czech acronym and registered trademark as well) and cartographic products of Czech Land Survey Office (LSO) , namely the Base map of 1:10 000 scale (ZM10) goes back to the year 1994, when creation of ZABAGED®was started by vectorization of master films of ZM10. Since then ZABAGED® became principal source for creation of Base maps, un-

derwent three updating cycles and substantial accuracy and detail improvements, made possible by improved parameters of aerial imagery and recently by availability of aerial lasercanning data. Our cartographic production in the meantime underwent substantial evolution, from classical cartography, through digital, file based cartography, to contemporary database cartography. All the time cartography department remained one of ZABAGED® largest users and most respected customer.

Another important use of ZABAGED® data is for publication of web maps, using fully automated methods for visualization. Both uses define their own set of requirements for source data.

ZABAGED® data have other uses, they should form a base for other information systems of government institutions containing spatial data, they serve as a source for publication of multiple datasets harmonized with INSPIRE data specification.

2. Fundamental Base of Geographic Data of the Czech Republic (ZABAGED®)

Fundamental Base of Geographic Data of the Czech Republic is a digital vector model of the territory of Czech Republic, which is maintained by Czech Land Survey Office. The product is commonly refered to by it‘s registered name ZABAGED®.

Creation of ZABAGED® was started in the year 1994 with vectorization of Base map of CR 1:10 000 master films. At first, to speed up process, the urban areas were excluded and substituted by raster map patches. By the year 2005 the database was filled, including urban areas and partial first revision, including photogrammetric revision, using both stereo and ortophoto sources and field revision. At the beginning of second updating process it was obvious, that the platform based on MGDM database system, with data stored by individual sheets, while adequate for creation of database is not optimal for updating.

In the year 2006 new concept ZABAGED® maintenance was introduced, with the data stored in seamless form in centralized database environment and maintained by system with three layer architecture, with data access based on long optimistic transactions. The system was built by winner of public tender, company Berit (later Asseco).

There are two updating principles of ZABAGED® data. So called “Area update” consist of full revision of specific area, usually defined by the outlay of corresponding map sheets of ZM10. Revision is based on overview

of the area using ortophoto , aerial imagery and aerial laserscanning products, consultation of internet resources published by respective municipalities and other institutions and the field topographic survey. Aerial update is performed by LSO seven regional branches. The regional branches do have online access to central database through cadastral WAN. The period of area update varies between 3-5 years, depending on resources of LSO.

The other principle, the "Periodic update" consists of centralized update, when specific object type or property is updated for full area of the country, with the use of data of other public sector institutions, or publicly available resources. Such update is performed 1-2 times in a year, depending on update source availability. Typical examples of periodically updated objects are railway network and stations, higher class roads, environmentaly protected areas, airfields, administrative units. Other sources are constantly being evaluated, for inclusion into periodic update process.

3. ZABAGED® data for production of Base Map 1:10000

3.1. State map series, Base maps 1: 10 000 and other scales

The Czech Office for Surveying, Mapping and Cadaster (COSMC) is the editor of the state map series for the civil branch in the Czech Republic. The generation, updating and publishing of the base map series is facilitated by the Land Survey Office. Base map series is produced for scales 1:10 000, 1:25 000, 1:50 000, 1:200 000, 1:500 000, 1: 1000 000. LSO is the administrator of data bases, from which particular map series are derived at the present time as well. Maps of scale 1:10 000 and 1:25 000 are produced from dataset DATA 10, which is closely linked to source ZABAGED® database. All Base maps are produced both in printed and raster form. Datasets DATA 50 and DATA 200 used for production of other scales use different updating methods and will not be further discussed in this paper.

3.2. File based digital cartography

Since the year 2000, when updating of master films for Base Maps was discontinued and all updating efforts were put into updating ZABAGED® data, the Base map production used the vector ZABAGED® data as primary source. From ZABAGED® database was exported appro-

priate map sheet in vector DGN format with connected MDB tables, which was then processed in cartographic production line into vector Base Map. This vector graphic was then used for printing paper maps and creating raster map. The cartographers had full control over the vector files they worked with, so it was possible and common, that additional updating was done directly in cartographic line. The workflow is illustrated in *Figure 1*.

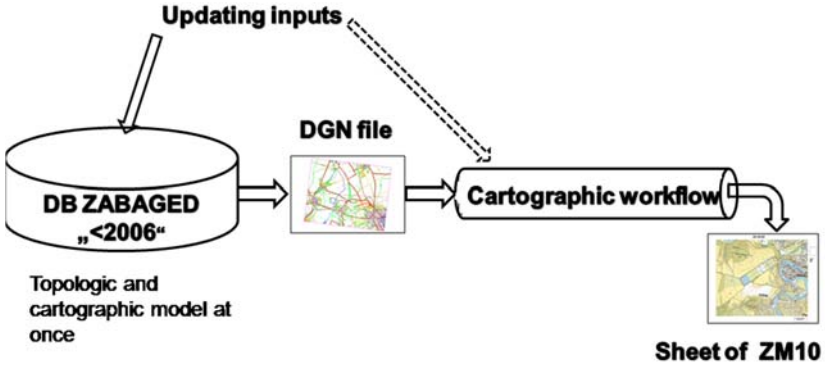

Figure1. The file based digital cartographic production workflow

Main disadvantage of this process was, that each time the map sheet was created from the input data from scratch, the previous cartographic work could not be reused. The edition of a new map and updated edition of the same map had the same cost, in terms of man-hours invested. Due to the sheet oriented nature of production, it was not easy task to use the data for other customized outputs, like different map sheet size or orientation.

3.3. Database cartography workflow

The requirements for faster updating of paper and raster maps, reducing the amount of invested work for each update, production of custom sheet sizes and thematic cartographic representation and also increased requirement for seamless raster equivalent of Base Maps for Web services (WMS) were main impulses for designing brand new cartographic production line in 2009. The new cartography line is based on database storage of vector data, with their cartographic representation in the form of “cartographic exceptions”. Cartographic database is updated by change data from source ZABAGED® database.

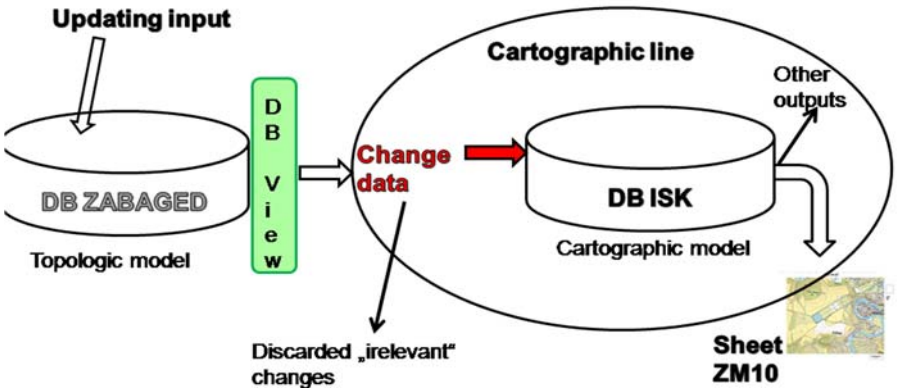

Figure 2. Workflow of database cartography production

The new cartography production line was build on several expectations of ZABAGED® source:

- Source data would keep history of it's modification, namely the time of creation and last modification.
- Source data elements are identified by unique identifiers
- The combination of previous two prerequisities would enable creation of change data

3.4. Unique Identifiers management

In the ZABAGED® system Unique identifiers (UID's) are assigned by Oracle Workspace Manager (OWM). Assigned UID's are "globally unique" , containing also the identification of database, project, feature type and the entity itself. Structure of such UID is shown in *Figure 3*. Side effect of such a complex UID is, that its length in binary representation is up to 128 bites, which translates to up to 38 characters long decimal number. For number of identified objects in ten million range it's real length is about 27 decimal positions. When the element count increases by one, UID of next element is increased by 18446744073709551616 (or by 2^64) .

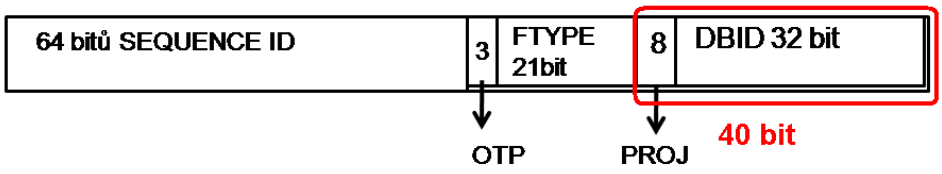

Figure 3. Structure of "Globaly unique UID", with red aligned pard of UID, which is common for all elements in specific project

Such number is rather problematic to work with, many application have tendency to cut the number of significant digits and represent it in expo-

nential form. So there were explored the methods of shortening the UID, while preserving its uniqueness. From the structure of UID (fig.2) we can see that a portion of UID is common for single project, so could be safely omited. We decided to create new UID using the upper 88bits of UID. This shorter UID cannot be enforced to be assigned by OWM, so now we derive those "short" UID for export purposes, using integer quotient after division of original UID by 2^40.

3.5. Change detection ,update information.

At the time of the development of the new cartographic line, ZABAGED® system was not able to provide change data, without additional programming work being invested. Therefore it was decided to create the change detection procedure as a part of the cartographic system in development. Change detection is using two full datasets, the last one incorporated into cartographic data, and the fresh, update dataset. All data are first replicated to a cartography system server. Acces to a replicated database is ensured by database views, which enable to filter out all data not relevant for the cartography. Great caution must be exercised while modifying views definition, because a small mistake in the definition can easily completely redefine whole dataset used for change detection, thus creating unpredictable amount of (non-existent) changed data.

First filtering condition for detection of changed data is "UPDATE_DATE" property of elements, which has to be later than date stamp of previous data set. During analysis it was found, that some updated data don't pass through this first condition, namely data relationally connected to external enumeration lists, when those lists underwent changes. Also a few import functions of ZABAGED® circumvented three layer architecture, modifying database records directly, and the change of "UPDATE_DATE" was omitted. Another group were data with modified "UPDATE_DATE" where no actual update could be detected. Mostly those were the result of manual operation, when operator moved some data to make some space for operation with underlying data and then returned the geometry to it's original position. Such operation was recorded as modification, though without contens and after analysis was discarded in later steps of change detection.

Data which passed first step are then sorted by relevance for the cartographic application, both by the scope of it's geometric shift and by the types of modified properties. Non relevant changes are discarded, relevant changes are projected into the cartographic database and marked for operator inspection.

3.6. Visualisation for the Web

In adition to the cartographic map production ZABAGED® data are published through the COSMC Geoportal (geoportal.cuzk.cz) in the form of fully automatic visualization of the vector data, offered through WMS service.

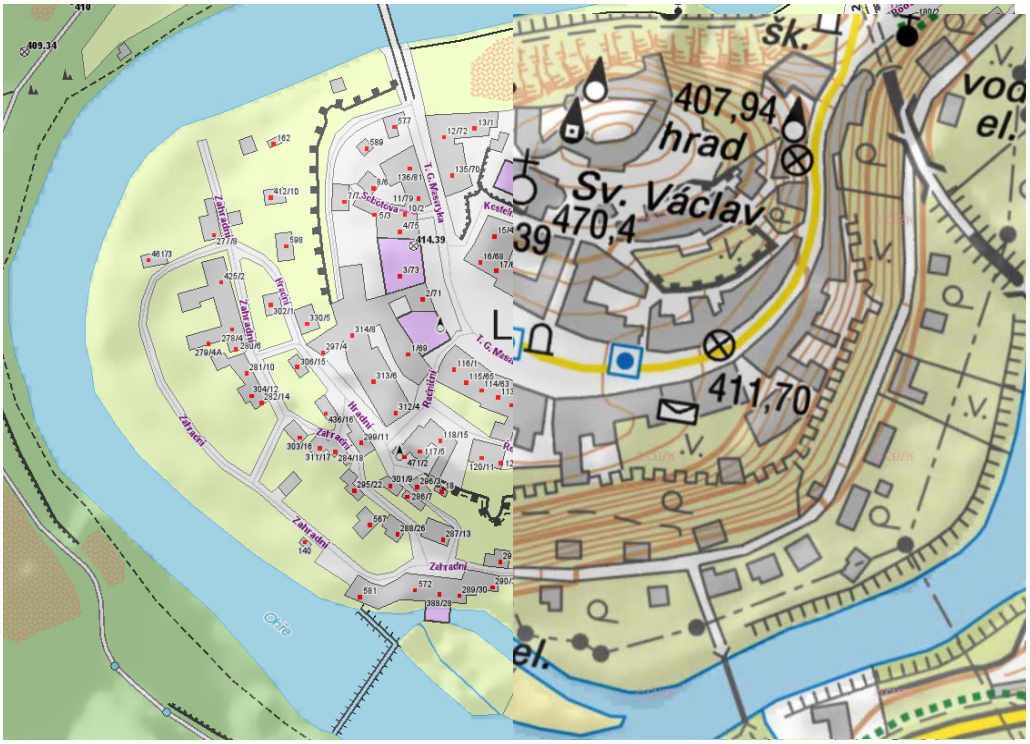

Figure 4. Comparision between "non-cartography" automated visualization (left) and cartographic product (right)

Requirements on the data for those two methods differ. While map production follows preset Edition Plan, covering the area of the Czech Republic by updated cartographic product once in few years, the requirement being to have input data most up to date in the area of produced map sheets and if possible seamless in the scope of one year Edition plan, while the product stays unchanged for several years, the Web publication serves for fast delivery of most up to date data to public.

3.7. Edification

Having an in-house customer, who decided to rely on declared ZABAGED® platform capabilities identified some weak spots in our ZABAGED® maintenance procedures, starting with the definition of views and relationaly connected data at the output end, through data updating proce-

dures, which initially at times ignored the metadata component of information, to the manual editing work done by operators, who were used to work with DGN "drawings" not realizing, that any and all actions are logged and do have impact on data,. Those lessons were valuable for improving our procedures, and finally, improving the data and metadata we maintain and offer for further applications.

4. Harmonization of ZABAGED® with other datasets

4.1. Geonames

Geonames is the database of geographic names of the Czech Republic. Geonames contains a complete set of spatial and attribute data on standardized geographic names and names of settlement units. It is now maintained as a seamless database for the entire territory of the ČR in a same centralised information system as ZABAGED® data. Before the year 2009 Geonames was mainly the database of geographical names and their position on a base map series. During integration with ZABAGED®, in connection with the transfer of Geonames data to ZABAGED® infrastructure, those ZABAGED® objects, which could be identified by the names in Geonames database were linked to the Geonames names. Remaining names, without proper object representation in ZABAGED® dataset, primarily all the field and forest lots and local parts of settlements keep a simplified geometry corresponding to the location of its map lettering in the Base Map 1:10 000. This way we established a foundation for system of management of named objects. The process of the harmonization between ZABAGED® and Geonames datasets is still outgoing.

4.2. Registry of Territorial Identification, Addresses and Real Estates

The law no.111/2009 established a Base registry system in CR. Concerning spatial data, the relevant registry is Registry of Territorial Identification, Addresses and Real Estates. Registry (known as RUIAN according to czech acronym of it's long name) should provide a reference data binding for whole government sector. The registry is in full production run since june 2012. There are some overlaps of content between ZABAGED® data types and RUIAN reference data. The main overlap is the street network. ZABAGED® street data formed the initial data of the register, but it was necessary to establish a maintenance process, which would both oblige the law, declaring that responsible for street names are the municipalities, while the editor of street line geometry is COSMC, using the proposal from municipality, and at the same time alow upkeep of interconnected road

network, including street lines in ZABAGED® data, which will not differ from RUIAN official street lines. Solution was found, which enables ZABAGED® to prepare the street lines based on the proposal of municipalities, and then transfer it via web service to the Base Registry editorial system ISUI. Only after approval from COSMC editors it may be submitted to Base Registry data. All corrections and editions are first handled in ZABAGED® dataset and then sent to the RUIAN data, so the datasets remain identical.

Other important reference data types, address points, administrative units borders are gradually implemented into ZABAGED® data. The problem to be yet solved is how to handle a reference set of RUIAN buildings, because approach to buildings for cadastre, which is source for RUIAN data and for geographical database differs.

4.3. Watercourse network

Until recently, in Czech republic coexisted three watercourse networks, maintained separately, with minimal exchange of information:

- . "CEVT" maintained under supervision of Ministry of Agriculture, by water management authorities,
- "DIBAVOD" maintained for the purposes of Ministry of Environment
- ZABAGED® layer, maintained for the purpose of state map series publication and public use.

Thanks to the agreement between the Ministries from the July 2012, all three authorities started cooperating in creation of single "Unified register of watercourses". Land Survey Office should contribute to the register with improved geometry of the watercourses, linked with classification and other parameters supplied by the water management authorities and interconnected into the network with the expertise of Ministry of environment agencies. This unified network should then form a reference data for use by other government or public institutions.

4.4. INSPIRE

Land Survey office is compulsory provider of INSPIRE harmonized data sets. ZABAGED® data would participate at publication of four Annex I and II themes:

- Geographical names – already published as view and offline download service
- Hydrography - already published as view and offline download service
- Transport Networks – in preparation
- Land Cover – in analysis

The setup of online download service is scheduled for this year, All published datasets and services, either derived from ZABAGED® data, or other sources, like RUIAN, of Elevation data and Ortoimagery should be described by metadata and available throught Geoportal of COSMC: http://geoportal.cuzk.cz//Default.aspx?mode=TextMeta&text=INSPIRE_dSady&head_tab=sekce-04-gp&menu=41.

5. Conclusion

ZABAGED® data form the backbone of the spatial data portfolio of Czech Land survey Office. To further promote the use of the data throughout the public sector we feel the need to better involve the public sector institutions in the ZABAGED® updating process, which would, at the same time, improve the trustworthiness of the data and would open the way for applications which require the use of guaranteed data, like urban and rural planning and development.