UPDATING TOPOGRAPHIC REFERENCE DATA (PROCESSES, METHODS, NEEDS, RESEARCH): PROGRESS REPORT IN THE BELGIAN NGI-IGN

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SUMMARY:

From 1994 to 2008, NGI Belgium (the Belgian national mapping agency) achieved a complete new collection of topographic reference data (at the conceptual scales 1:10 000 and 1:50 000). From 2000 to 2005, the NGI set up the design stage of a new spatially seamless database structure in order to process those data. Since 2008, the NGI has restructured its topographic data in the new structure and has launched the update stage of its data. The achievement of the update has implied various methodological choices in the tools to be used (photogrammetry, fieldwork, photointerpretation, subcontracting, external sources, general public, …) and in the production processes (distinct update cycles, thematic approach). This presentation (and this paper) aims to illustrate and explain these choices and to show how certain constraints (in terms of resources) can influence them. Our purpose is indeed to share the pragmatic approach of NGI Belgium with the participants.

RÉSUMÉ:

De 1994 à 2008, l'IGN-Belgique (l'agence cartographique nationale belge) a réalisé une nouvelle collecte complète de données topographiques de référence (aux échelles conceptuelles de 1:10 000 et de 1:50 000). De 2000 à 2005, l'IGN a entrepris une phase de conception d'une nouvelle structure de base de données spatialement continue afin de gérer ces données. Depuis 2008, l'IGN a restructuré ses données topographiques dans cette nouvelle structure et a entamé une phase de mise à jour de ses données. Pour réaliser cette mise à jour, différents choix méthodologiques ont été réalisés concernant les outils utilisés (photogrammétrie, travail terrain, photo-interprétation, sous-traitance, sources externes grand public, …) et les procédures de production (cycles de mise à jour différents, approche thématique). Le but de cette présentation (et de ce papier) est de montrer et d'expliquer ces choix et de montrer comment certaines contraintes (en termes de ressources) peuvent les influencer. Il est donc question de partager l'approche pragmatique de l'IGN-Belge avec les participants.

1. INTRODUCTION

1.1. Context at the NGI

At the start of the 2000s, the NGI drew up a technical strategic plan aiming at paving the way for NGI's future by drafting improvement projects for the production methods of NGI cartographic data. The purpose of this technical strategic plan was notably to prepare the NGI to the transition from the mere role of topographic map producer to a much broader role including also producer and provider of topogeographic data (for instance via Web services). One of the goals was to set up a new centralised seamless spatial database structure for the collection, management and distribution of NGI topogeographic data. This project led to the realisation of the ITGI, which stands for « Inventaire Topo-Géographique – Topo-Geografische Inventaris » (Topogeographic inventory).

1.2. Content of the ITGI

The ITGI (the centralised seamless spatial database) is today the management tool of NGI topographic and geographic information. It contains the topogeographic reference data (produced between 1994 and 2008) as well as a generalised version of these data (produced between 2002 and 2006), namely:
- vector data conceptually 1:10 000 (reference data);
- vector data conceptually 1:50 000 (generalised data);
- symbolised raster data conceptually 1:10 000;
- symbolised raster data conceptually 1:50 000;

- colour orthophotographs (50 cm resolution);
- altimetric data (DEDS) ;
- a link to toponyms (in the meantime, a specific database for toponyms management is set up);
- a link to geodetic points (in the meantime, a specific database for the management of geodetic points is maintained);
- a link towards the metadata database.

It was decided that the reference vector data (conceptually 1:10 000) stored and processed in the ITGI would have xyz-coordinates in Lambert 2008.

The ITGI will also feature discovery, usage and exploitation metadata. The new structure will also make it possible to manage the update history.

The ITGI shall also accomodate the geocoding data (as street names and police numbers) associated with topogeographic data. Currently, only street names are associated with road segments (in production).

So, the NGI is equipped with a centralised management tool of fully digital and integrated topogeographic reference data

1.3. The ITGI in practice

The set-up of this spatial data database is based on the existing NGI topographic and geographic data (restructuring and dataloading stage) without prior update of these data.

Consequently, the NGI is faced with a major challenge, which consists in adjusting its organisation, its working methods and partly its production tools in order to optimise the update of the topographic and geographic data contained in the ITGI.

2. THE CONSTRAINTS

2.1. Technical constraints

When setting up the new database model (ITGI), it was decided that the database should make it possible to recover existing topographic vector data, which means that the new model could not be very far from the existing model.

It is also important to bear in mind that there is a transitional stage between the complete data collection (which at the NGI for instance required 15 years for reference data) and the first real update stage. At the NGI, this stage is called "revision" stage and includes various steps: loading in the new model, validation, control and first systematic update of all data.

This new structure also needed to make it possible to produce topographic maps of a symbological quality similar to existing maps.

Topogeographic reference vector data needed to be spatially seamless (without map sections) and vectors needed to be described by xyz-coordinates. Every vector had to be identifiable by a unique identifier.

Historically, the image source used at the NGI is aerial photography. A comparative study « aerial photographs » vs « VHR satellite pictures » has been conducted. For economic and methodological reasons, the NGI decided to carry on working with aerial photographs (stereoscopic pairs, colours with 30 cm resolution) and to derive from them orthophotographs (50 cm resolution).

2.2. Other constraints

Beside the usual constraints relating to the current economic context (overall cut in the budgets and human resources), it is sometimes necessary to take into account the running political context.

In Belgium, it implies that updating topographic data requires accessing update information and such information can be more or less difficult to obtain because three key parameters are to be considered: the multiplicity of authority levels (municipality, province, region, and federal administration), multilingualism and the lack of a clear definition of the role and responsibilities of the various actors concerned (the federal Law on « geo-information » is being drawn up, which means that there is no clear legal basis shared by all actors).

In the context of topogeographic data update activities, it is also necessary in Belgium to take into account the European position, and particularly the recommendations and specifications stipulated in the INSPIRE Directive (in terms of timing, models, content, …).

3. METHODOLOGICAL CHOICES

3.1. Technical choices

In order to take into consideration the technical constraints, it was decided that all updates of the current NGI topogeographic data (or any development of a solution for change detection for instance) should be achieved based on stereoscopic pairs of aerial photographs (or derived orthophotographs) in a GIS software environment which processes xyz-coordinates and unique identifiers.

After several public procurements, the software solutions used are:
- database management and derived applications: SDE/Oracle, ArcGIS ESRI;
- photogrammetric plotting: ISSG/Geomedia, Intergraph;
- plotting on orthophotographs: ArcGIS ESRI;
- fieldwork: ArcGIS ESRI;
- data validation: Radius Studio 1Spatial;
- data transfer: FME Safe Software.

The variety of this software environment had an impact on unique identifier management and on the choice of working « outside DB » in disconnected edition.

3.2. The tools used

In order to collect updates, the NGI decided to use 4 different tools:
- the use of external sources
  - institutional
  - general public (crowdsourcing)
- photogrammetric stereoplotting
- plotting on orthophotographs
- fieldwork

First, the NGI checks whether there is an institutional external source in Belgium (another organisation) holding update information for a certain theme. If there is one, the contact is established and a cooperation agreement is drawn up. This solution is currently applied for the power transmission network (with the main Belgian carrier) and the railway network (with the company in charge of the railway infrastructure in Belgium).

Concurrently with institutional external sources, the NGI finishes the set-up of a Web solution for the collection of update information from the general public (crowdsourcing). This solution consists in a web.2 application providing free viewing of NGI cartographic raster products and a module allowing citizens to locate and transmit suggestions of structured update information.

The NGI established that for certain themes (communication networks and buildings) the geometrical quality (xyz-coordinates) of reference topogeographical data required the use of stereoplotting. Considering the lack of human resources available for stereoplotting, the work is partly done at the NGI and partly entrusted to contractors. Stereoplotting is achieved in a GIS stereoscopic environment, which required heavy investment in the development of the production tool.

For the themes where the quality of the z coordinate is considered less important (land cover for instance), the NGI affected a team of plotting on orthophotographs, which updates topogeographic data in a GIS 2D-environment based on a

geometry (xy-coordinates) collected on orthophotographs and draped on a DEM (z-coordinate).

All the update information which is not visible on aerial photographs (either in stereo or on orthophotographs) is collected by a team of field topographers. This team is mainly responsible for collecting all attribute data which can not be identified on photographs (building use for instance).

Most of the time, the choice of a tool is pragmatic and motivated by priority choices and human resource availability.

3.3. Update cycles

A swift analysis of users' needs emphasised the variety of time and data quality expectations according to data themes. Users prioritise accurate and updated road data, then data concerning the other communication networks (railway, hydrography and electricity) and buildings, and at last land cover.

The human and budgetary resources available for updating the data are limited.

That is why the NGI suggested to work according to different thematic update cycles.

A first theoretical approach suggested achieving the update of:
- roads every year;
- other networks and buildings every 3 years;
- other themes every 6 years.

Given the reality of the resources available, achieving the update of the road network every year proved currently unfeasible, so the NGI re-evaluated update cycles as follows:
- communication networks and buildings every 3 years;
- other themes every 6 years.

In order to have updated image sources, it was also decided to carry out a complete aerial photographic cover (stereoscopic pairs) of the territory every 3 years (and to systematically derive from it orthophotographs).

3.4. Organisation and update processes

Update processes have been described and the organisation of the NGI itself has been adapted in order to take into account the new processing structure of topogeographic data (ITGI) and the various update processes.

The organisation of NGI technical departments is centred around the ITGI (spatial data database), the departments upstream are responsible for the update processes (in-house and on the field), one department is in charge of ITGI management and one of the applications derived from the ITGI (maps, Web services, etc.). Technical departments are supported by the ICT department.
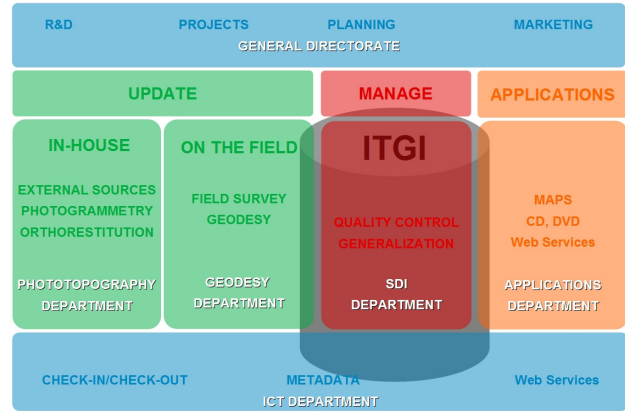
Update processes have been organised as follows:
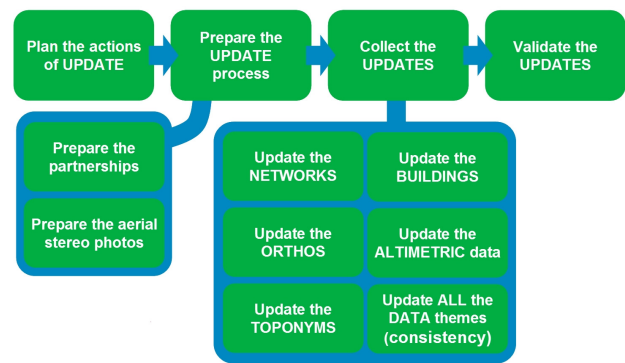
There is one person in charge and a dedicated staff for each process. Besides, one person was entrusted with the coordination of all update processes.

4. CURRENT RESEARCH PROJECTS

The NGI has started a number of cooperation projects with research laboratories in order to develop practical solutions for further improving the update processes of these data. In that context, the NGI is considered as the assumed final user.

These research projects concern the following fields:
- « change detection » in cooperation with the University of Brussels and the Royal Military School;
- « semi-automatic DEM production » by correlation of aerial photographs with the Royal Military School;
- « feature extraction » from update information on buildings and roads based on aerial photographs with the Royal Military School.

5. CONCLUSIONS

The topic of this workshop is « Core Spatial Databases - Updating, Maintenance and Services - from Theory to Practice ». As the NGI experience shows, the updating of reference topogeographic data requires taking into account a few constraints, some of them technical, and making pragmatic choices in the organisation, in the production processes and in the data models.

It is also important to know the stage you are in (data acquisition, restructuring, reviewing or update).

In the very update stage, it is necessary to have at one's disposal tools allowing to target the zones or objects to update without having to go through a systematic inspection of all data. That is why change detection tools are needed. Once the zones or objects to update are identified, feature extraction tools can be used for optimising editing operations.

In the practice, these change detection and feature extraction tools need to take into account the following elements:

- data are described in xyz-coordinates (« think 3D »);
- data have a unique identifier which has to be managed;
- the software environment is varied, so it is important that they are interoperable in the practice;
- certain production processes use stereo GIS softwares, which are recent solutions still requiring further development;
- the solutions chosen need to be pragmatic and efficient;
- the solutions must be integrated in an existing production environment (with various update cycles for instance).

To conclude, the NGI (like most mapping agencies) has experienced for the last ten years a deep transformation of its activity. The core business has indeed moved from map producer (based on digital topographic data) towards developer of geo-services providing access to the most up-to-date reference topogeographic data.

The implementation of this new model has required and still requires many developments. The technical challenges are about to be overcome but the workload is considerable.

Beyond technical aspects, it requires a real shift of the way all actors perceive their roles.