3D Data Management – Relevance for a 3D Cadastre
Position Paper 3

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1. INTRODUCTION

This paper serves as a discussion basis for a working session on '3D data management' held as one of the four working sessions at the 2nd International FIG Workshop on 3D Cadastre.

2. CURRENT TRENDS ON 3D DATA

The amount and use of three-dimensional data has drastically increased over the last couple of years. The reasons for this are manifold and we can currently observe four major technology and business drivers for 3D.
First, there are massive new sensor hardware capabilities, such as automated data capture and model creation on the sensor side, LIDAR with masses of point clouds and automated photogrammetric workflows and processes.
Secondly, 3D data is coming into mainstream. There is newly a mass market with consumer-focused systems and the industry benefits from IT scalability, security, and reliability.
Thirdly, the managing a 3D data in enterprise workflows with improved performance and scalability of existing workflows and bridging the gap between point cloud surveys, GIS, CAD, BIM. Traditional file handling moves to database management.
And fourthly, there is a necessity for 3D data, where 2D data is not sufficient to describe our world and the consumer expectation demands three dimensions, as we all live and act in a three-dimensional environment.

In recent years major progress in 3D Geographic Information Systems has been made on 3D data visualization. However, 3D data management and analysis such as querying, manipulation, 3D map overlay, 3D buffering have been largely neglected in spatial database systems and Geographic Information Systems. Hence, current 3D data representations are quite suitable for visualization but rather inefficient for computation. In addition current 3D data models are often tailored to specific applications and simple 3D spatial objects only, resulting in a lack of ability of handling general and complex 3D spatial objects in a database context.

For cadastral organizations, who traditionally describe their cadastral data in two dimensions and hold their information in 2D (often graphical) files concepts for entering the third dimensions are not yet available, mainly due to the facts that,

- 3D modelling is much more heterogeneous and complex compared to 2D modelling;

- converting 2D data to 3D data on an operational level, with not just adding a Z-Coordinate onto each planimetric pair of coordinates, is quite cumbersome and there is no 'best' solution obvious, as the existing datasets are usually quite specific;.
- one has to migrate from simple data structures to complex data structures;
- and newly on has to deal with the economic and sustainability issues of handling and storing high data volumes compared to (relatively) low data volumes in the current years.

Even though, that some specific actions have already been taken, such as the ISO 19152 Land Administration Domain Model (LADM) (Lemmen et al., 2010), that the new sensor technologies on the data collection side and that new 3D graphics hardware and powerful CPUs on the data visualisation side support the move to 3D; the main problem remains: 3D data management and 3D analysis is in a status where 2D GIS was a decade ago.

3. KEY ISSUES

For the establishment of a 3D cadastre there are several challenges and key issues to deal with. Some of them will be discussed and further elaborated during the working session on '3D data management'. There are open questions to overcome such as:

- Is existing GIS software capable to handle the requirements of managing 3D data today and in the future?
- What should be the main important developments of software manufactures in the near future?
- Where is still need of (scientific) research?
- Identification of country specific similarities and differences (in the regions or in the world)

Several questions have to be posed and answered on a generic or operational level:

- What about data acquisition?
    - Different acquisition methods lead to different initial data sources (e.g. point clouds or structured vector data). What about the vast amount of (sometimes redundant) data, which is acquired?
- What about automatic processes?
    - Complex data structures need a high level of expertise. This expertise is often known to a human user but hard to implement in a robust software or process. What is the best practice in order to introduce human knowledge into the production process?
- What about software?
    - E.g. ArcGIS 3D Analyst (ESRI), LandXplorer, TNTmips, Autodesk Map 3D, WinGrass, Imagine Virtual GIS (Erdas), GeoMedia Terrain (Intergraph), PAMAP GIS Topographer (PCIGeomatics), other …
- What about data standards?
    - raster formats for point data
        - E.g.. GRID, TIFF, TIN, other …
    - vector formats

        - E.g. GML3, VRML, GeoVRML, X3D, CityGML, KML/KMZ, 3DS (3D Studio), DXF, 3D-Shapefile …
- What about system architectures?
    - E.g. file systems vs. DBMS; one software package vs. different software packages; 2D and 3D in the same system; data handling of very large databases; ...
- What are the types of 3D cadastral objects that need to be registered?
    - Are these always related to (future) constructions (buildings, pipelines, tunnels, etc.) or could it be any part of the 3D space, both airspace or in the subsurface?
- What about the segmentation of objects?
    - In case of (subsurface) infrastructure objects, such as long tunnels (for roads, metro, train), pipelines, cables: should these be divided based on the surface parcels or treated as one cadastral object. In case of subdivision, to all parts rights (and parties) should be associated.
- What about 3D data analysis?
    - E.g. terrain analyses (slope, orientation, height lines, lighting, etc.); 3D geometrical calculations; 3D selection; 3D buffer; 3D intersection; 3D route planning; other …
- What about data presentation/visualisation?
    - E.g. textures; 3D annotations; 3D symbols; complex 3D symbols (e.g. trees); camera movements; stereo visualisation; 2D views; high resolution images/videos; lighting; background (e.g. dynamic sky); LOD concepts; other …
- What about robust data management?
    - E.g. high density point clouds: sub-meter point spacing (billions of points); combination with multi-spectral gridded data (terabytes of data); versioning; archiving (terabytes, petabytes); back-up/recovery
- What about temporal aspects?

4. POSSIBLE SOLUTIONS

3D is of relevance for the cadastre in future and the cadastre is not the main driving domain for the development of 3D data acquisition and 3D data management. There is a strong user demand that cadastral data can deal with 3D issues from data acquisition, through the processing, the storage, the data management and the representation of the data in an efficient and user-friendly way.
With this respect cadastre often faces the same problems as other application domains such as urban planning, soil engineering, mapping, aviation, transportation, land use planning, earth science and more. These domains have shown more and more interest in handling large data sets in 3D space from a data management perspective and we can learn from this.
The challenge would be to identify the pros and cons of existing solutions, adopt them in a reasonable way, to identify research issues in a cross-domain approach and to define standards, which allow the efficient use of these data sets.

REFERENCES

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BIOGRAPHICAL NOTES

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