Visualization, Distribution and Delivery of 3D Parcels
Position Paper 4

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1. INTRODUCTION

Visualization issues in the context of implementing 3D Cadastre systems was one important outcome identified at the 1st 3D Cadastres workshop (Fendel, 2001). At that time, no specific recommendations were made about the requirements associated to the visualization of 3D parcels. Based on the hypothesis that 3D cadastre contributes to sustainable, uniform and efficient land administration system, questions about viewing and distribution aspects are thus relevant. Is it mainly a "technical problem" as it was underlined in the report of the 1st 3D cadastres workshop?

This position paper will first propose a brief state of the art about visualization, distribution and delivery concepts from a general point of view and then about 3D parcels. Afterward important issues and possible solutions will be stretched out to stimulate the discussion. This paper is intended to be the starting point of further consideration and helping to structure them.

For the benefit of this discussion, 3D parcels will refer to 3D spatial units with right, restriction, responsibility (RRR) attached to it where the ownership spaces (parcels) should not overlap other ownership parcels (Oosterom et al, 2011). This definition is different from the classical one denoting land parcel as a piece of "land" with defined boundaries, on which a property right of an individual person or a legal entity applies (FIG 2011).

2. STATE-OF-THE-ART

Investigating data visualization requires the combination of a large variety of domains all converging to communicate a comprehensive and coherent message to human. As mentioned by Friendly (2009), MacEachren and Kraak (1997) and McCormick et al (1987) data visualization integrates computer graphics and computer-aided design, computer vision, image processing and signal processing, and user interface. Furthermore, anyone who is interested by visualization should take into consideration the human perception (Miller 1956). Both quantitative and categorical data can be visualized depending on the representational goals which will have to be specified. Data visualization investigation is thus a huge sphere of research. It is also interesting to have a look at some of the taxonomy proposed about visualization (Card et al, 1999, Herman 2000). Addressing visualization techniques require an investigation about data type, display mode, interaction style, analytic task and the data schema (Qin et al, 2003).

For this workshop we are certainly mainly interested in Geovisualization or geographic visualization (ICA 2011) to support geospatial data analysis, exploration, communication and even collaboration. MacEachren et al (1992) defines the Geo-visualization as "… the use of concrete visual representations…to make spatial contexts and problems visible, so as to engage the most powerful human information-processing abilities, those associated with vision.". For geovisualization purpose, the practice may highlight the geometry (location, form, size and orientation) and/or the spatial distribution (patterns, trends, correlation, etc) of geographic characteristics. The rudimentary medium to support geovisualization is certainly paper map whereas 3D Geovisualization takes advantage of modern digital computers capabilities to render 3D models in real time. The geovisualization can be mono or stereo, immersive or not, with or without collaborative mode, synchronized or not, static or interactive, supplied on local plat-form or on a mobile device (with various communication networks like cellular, internet). Data viewing can be done on an individual machine, via a local network or via the Web.

Various categories of geotechnologies exist such as Geographic Information System (GIS), spatial database management system (S-DBMS), Computer Aided Design (CAD), computer graphics, virtual reality, video games, web-based browsers (based on 3D Globes or not), mobile device (like smartphone), or even simple viewer such Adobe Acrobat Reader (3D PDF). Some progresses in GIS and S-DBMS have been made for 3D geovisualization. For instance, we can highlight that GIS now supports various categories of 3D spatial representations, manages levels of details (LoD) models or proposes enhanced import/export capabilities. CAD software already offer powerful capabilities for 3D visualization but are currently improving the management of georeferenced and descriptive data and 3D laser point cloud, the integration of spatial standards and the on-the-fly creation of solids from faces.

Internet and the Web have to be specially considered since 2D/3D displaying in browser is now offered be several parties. The use of 3D globes such Google Earth, Bing Map largely contribute to the democratization of spatial data to a huge public. For example, IGN France proposes a GeoPortail (http://www.geoportail.fr/) based on the solutions of TerraExplorer plugin (based on DirectX) for the 2D or 3D visualization of 2D/3D objects. In the 3D interface, we can find a level called Cadastral parcels, it consists of 2D parcels draped on a digital elevation model (DEM). At a first glance we can easily recognize the underground features such as train path. The development of Web browser usually requires user to install a plug-in, to provide better performance but yet may reduce the accessibility for mobile device (like iPhone) or the interoperability between systems. HTML5 (by W3C), still in progress, may become a dominant technology on 3D visualization in browser. This also related to the buzz word "mashups", solutions that integrate the concepts of tagged geographical data and API (application programming interface) to enable the superposition of various sources of geospatial data. For example a corporation could decide to publish the cadastral limits in combining them with Google Earth through a simple Web browser.

Rendering and highlighting techniques (Robinson 2006) are certainly methods to be investigated as well. How to use variables such as color, texture or depth to improve or ensure maximum visibility? Trapp et al (2010) presented an interesting talk of such techniques where they compare style-variance, outlining and glyph-based techniques applied to the scene texture. Similarly augmented reality systems are of great interest for many domains of application since they propose new visualization and interaction with spatial data (e.g. Layar or Wikitude). For example, VIDENTE (Schall et al 2009) propose the augmentation of the reality with urban 3D model of relevant objects like pipelines, buildings and walls. The user can select an augmented pipe to view the related attributes. In the same way, providing services to smartphone as location based services applications also become part of societal demand and will have to be taken into account for delivery purpose.

Talking about data distribution and data delivery, various solutions or approaches exist and several facets have to be considered when making decisions. The price and data accessibility are certainly on the top of these considerations. People are expecting that data and information are for free and available from everywhere. This place much pressure on the authorities - cadastre included – in order to give a free access to the database content. Personal information protection in electronic document production will have to be considered in any data delivery strategy.

Several categories of medium can be used to deliver spatial data; paper and file format (e.g. compact disc, portable key, internet) are certainly the main. If we admit that data are more and more digitized we could focus our investigation on digital data delivery approaches. It exist much file formats to support data exchange, we will not give a list here it will be too long. But formats are 2D or 3D, vector or raster, open or restricted, some mainly focus on the graphical aspects (e.g. X3D) some others integrate the semantic (e.g. CityGML), some are specifically designed for data exchange (e.g. Collada).

Based on the use of communication protocol (TCP/IP), internet opens the planet for potential market. Different levels may be involved such as communication (email, voice, IRC), data sharing/transfer (FTP, Website servers, peer-to-peer) and viewing and interlinking Web pages (HTTP). The emergence of Web 2.0 more oriented towards collaboration, user center, information sharing and interoperability or even the Web 3.0 about semantic and intelligent Web also have to be considered. As well Web services based on HTTP protocol is a big tendency for delivery data. OpenGeospatialConsortium (OGC) proposes Web Map Service (WMS), Web 3D Service (W3DS) / Web Coverage Service (WCS) / Web Terrain Service (WTS) / Web Feature Service (WFS) or WVS (Web View Services). They are all based on XML (eXtensible Markup Language) and/or GML (Geography Markup Language) languages. Map, Coverage and Terrain services are more concerning about online data viewing (zoom, pan, etc) on the Web and less interactions with data are offered (e.g. we could not edit data except for viewing purpose). For example it is possible to use Google Earth and Cadastral WMS layer to see current cadastral plans as a layer in Google. If we are more interested by distributing the data and giving a full access to the data, Web Feature Service should be investigated. We could even go a step forward and considering cloud computing solutions to support internet based development strategy.

3D standards specially design for geospatial distribution is also an important aspect to examine. CityGML (Groger et al, 2008) adopted as an international standard of the OGC is certainly one to consider. Building information model (BIM) that supports georeferenced model and encompassed geometry, spatial relationships and properties of building objects could also be a good source of information. The same way as land administration domain model (LADM) specifications, INSPIRE (Infrastructure for spatial information in Europe) make recommendations about data specification; among others on cadastral parcels (documents D2.8.I.6, 2009 and ISO/DIS 19152-LADM 2011). For example, one of the objectives of the INSPIRE initiative is to propose a simple but flexible data structure that allows data providers to publish existing data related to cadastral parcels. These initiatives will have to be taken in consideration of further planning and development strategy about data distribution and delivery. These recommendations also clearly point out the importance of having an interoperate approach regarding data accessibility and sharing. The development of spatial data infrastructures and service-oriented architecture (SOA) are also correlated to this issue.

Where are we standing about (geo)visualization/distribution/delivery of 3D Parcels?

The FIG working week held in Marrakech in 2011 introduces some interesting discussions about displaying 3D parcels. For instance, Fredericque et al (2011) present a benchmark about the use and the development of 3D GIS for 3D cadastre. They largely talked about the needs of having valid (topology and geometry) 3D objects, an important concern. The survey made be van Oosterom et al (2011) clearly shows that no jurisdiction stores volumetric objects. Several cadastral system are still using paper format (so no access to 3D visualization capabilities of computer). Some others countries via subdivision plans (engineering or architectural plans) propose hybrid or 3D displaying solutions (19 countries over 35). Current practices of representing 3D parcels are (Aien et al, 2011; Pouliot et al, 2010; Stoter, 2004):

- No graphical information (only literal description of the 3D parcels)
- Only footprints of overlapping properties are displayed on a 2D map or draped on a DTM or a 3D Globe
- Through subdivision plans, vertical profile or cross-sections are available
- Through subdivision plans, isometric view are available
- Through subdivision plans, the height of some objects are indicated (such as ceiling or floor levels)
- Volume produce by extrusion of the ground parcel
- Volume produce by the extrusion of specific objects (like walls, floor)

Although these aspects are more related to data storage and management, this information is important to know since somehow they will influence the choices make upon data visualization/distribution/delivery of 3D Parcels. Nevertheless, our literature review reveals that very few papers specifically address the challenges of visualizing, distributing and delivery 3D parcels. Aditya et al (2009) propose 3D visualization to support the creation of a hybrid cadastral system in adding for example 3D measurements on the floor plan of a CAD map. Several authors export in KML their 3D buildings containing several 3D parcels in order to integrate their model into Google Earth. Many countries propose the use of regular cadastral plan on which are superimposed the orthogonal projection of overlapping properties; this solution is mainly 2D. Some propose the use of 3D tag linked to external co-ownership, architectural or urbanism plans in order to produce the 3D spatial representation associated to overlapping properties (Aien, 2011, Dalmasso 2011, Pouliot et al, 2010). Some propose new text data format and use commercial CAD software (Jarroush and Even-Tsur, 2004). Others propose the use of GIS or CAD coupled with DBMS (Hassan and Abdul Rahman, 2010). The solution proposed by Spain is a bit distinctive since they proposed the automatic construction by extrusion of 3D buildings in using specific encoding of the cadastral parcel number (Velasco 2010). A DBMS is coupled with a CAD software and the 3D visualization process is done in this last environment. Some propose the simple superposition of cadastral plan with others municipality's maps and aerial photo (Ville de Québec, 2011). Finally one interesting work proposes the establishment of a Web portal specifically dedicated to real estate cadastre in Macedonia (Domovski et al 2011).

Nevertheless for most of them they are still at the level of being prototype that requires lots of validations in order to transfer them in a real application context. This situation could be explained by the fact that the spatial representation of 3D parcels rarely exist in cadastral system. Moreover we still have to get an agreement about what is a 3D parcel! This is why, in preparing this position paper, we estimate that visualization/distribution/delivery of 3D parcels face the same challenges as other 3D applications. We thus organize our literature review from a more general point of view (not specific to 3D parcels). The next section will help us to focus on the specific topics investigated by this workshop.

3. KEY ISSUES AND SOLUTIONS

Here are some questions to initiate the debate. For some, suggested items/solutions are included:

What are the *preconditions* to be able to discuss data visualization/distribution/delivery of 3D parcels?

- The existence of a functioning 3D cadastral system
- The existence of a data management/storing system, no matter is the spatial representations used (1D, 2D, 3D, or any hybrid solution) and the categories of software (GIS, DB, CAD, etc).
- Having a (topology) valid 2D/3D geometric representation
- Having a computer display that allow 3D viewing (that manage data projection)
- Having staffs with specific skills (e.g. in geomatics, in programming, in computer science, in computer graphics, in video games, ETC).
- 3D data available (traditional land survey instruments but also new techniques like Lidar and the collection of 360 degrees ground imagery)

What is the *new reality* we are facing and is it influencing our decision about strategy for visualization/distribution/delivery of 3D parcels?

- Data are more and more digitized
- The presence of Internet
- Expectation that data and information are for free and available from everywhere
- People change and are more educated, more critical
- Citizens, professionals and officials become more and more informed and connected
- Globalization, social media and virtual environments become part of the real life of individuals and organizations
- Improved communications and rapid evolution of technologies
- More oriented towards service provider.

Data visualization of 3D parcels for what *purpose*?

- Same as cadastral plan

- To get a better understanding of the 3D geometry
- To create a strong visual impression (aesthetics), add special effects, and draw or keep the attention of audiences (for entertainment, marketing, ...)
- To support the cadastral system
- To easiness/make it possible, the integration with others systems like infrastructure, facilities, transportation, communication networks, flood risk modeling, protection of the environment, contaminant propagation, rescue strategies, etc.
- To discover new knowledge
- To influence or help decision making (at a strategic level)
- As a basis of normative activities (legal, fiscal, regulation aspects)
- To facilitate dialogue and communication
- To facilitate collaborative work

Is the *visualization strategy* of 3D parcels *distinct* from displaying roads, buildings, forest, ?

- Taking into consideration that 3D parcels are bona fide concepts while physical objects are fiat. See Smith and Varzi 2000, where fiat boundaries mainly refer to physical objects (e.g. buildings) while bona fide boundaries are based on human arbitrary demarcation (e.g. cadastral parcel, administrative zones, census zones, etc).

Who are the *users* interested by the visualization/distribution/delivery of 3D parcels and is the strategy depends on the category of users (user's requirements)?

- Users: planners, general public, notaries, lawyers, land surveyors,
- Should we adapt the message depending on the category of user

Is the visualization/distribution strategy related to the category of cadastral objects under study?

- Any overlapping properties
- Condominium-Co-ownership
- Infrastructure above and below the ground
- Utilities or private network as cables and pipes

What about *technical* problems; are still existing or are they surmounted?

- a new generation of users, of decision makers, of producers, etc
- new enhanced software (more interoperable)
- new performing computers

What *kind of visualization* should we privilege?

- 2D or 3D
- mono or stereo
- immersive or not
- with or without collaborative mode
- synchronized or not
- static or interactive (e.g. with on-the-fly production of 3D scene, or animation)
- supplied on local plat-form or on a mobile device (Onsite viewing)
- with scientific visualization or data mining or graph drawing capabilities

What about the *geotechnologies*, should we support one more than another?

- Geographic Information System (GIS)
- Geodatabase (Database management system)

- Computer Aided Design (CAD)
- computer graphics
- virtual reality
- video games
- web-based browsers (based on 3D Globes or not)
- mobile device (like smartphone)
- simple viewer such Adobe Acrobat Reader (3D PDF)
- open source or not

What about *graphical aspects* (desktop mapping and publishing) related to 3D parcels?
- Legend, is the same in 3D?
- 3D interactive tools such slider, 3D axes, the same of 2D?
- One view, multiple views
- Camera movement and control,
- Giving access to multiple levels for visualizations (like level of detail)
- Is the graphical variables are the same (color, scale, contrast, symbol,
- The use of texture (material or photo realistic)
- The mutual occlusion of objects in the scene
- The use of transparency
- Adding warning message about the restrictions, the accuracy, the possible usages,

What about *geometric aspects* for the visualization of 3D parcels?
- Raster (image)/Vector
- Geometric objects itself that could be 1D, 2D, 3D, 2.5D
- Geometric properties: Position / Area / Length (distance) / Angle / Slope / Volume
- altitude (Z) and/or height (H)
- The superposition of cadastral plans (2D) with 3D parcels
- Vertical profile or cross-section
- Digital elevation model
- The level of accuracy/incertainty of geometric primitives
- Survey points (like cloud point) or interpreted features (from an expert)
- The level of detail (like sketchup model, or CAD model, or simplify model,

Do we need to view/distribute/deliver *descriptive (textual/categorical) attributes* of 3D Parcels? If yes, what are these possible attributes of interest?
- Official measures such as length, area, volume
- The 3D Parcel number
- The owner
- The address
- The data of survey, of construction, of RRR,

How about *metadata*, in the context of visualization/distribution of 3D parcels?
- Same as 2D
- User versus producer of metadata
- Is exist specific metadata for 3D parcels?

To comprehend 3D Parcels, do we need to integrate or give access to *auxiliary documents*?
- Title
- Deed

- Declaration of co-ownership
- others plans
- is it a category of metadata
- and if yes in what form?

Should we *embed* the visualization/distribution of 3D parcels into larger *3D models*?
- Kind of City Model, Virtual City Model, spatial data infrastructure, etc
- With 3D globes
- Should we talk about 3D parcels or 3D model of parcels
- Dynamic computer simulations used to show possible pollution diffusion

How do we define *quality* for visualization of 3D parcels?
- Same criteria as in 2D?
- Low complexity, enhanced graphic functionalities, support customization and interactivity, easy to explore data, easy to navigate,
- Internal and external quality
- How about quality control
- How about risk management
- How about ethical questions? See 3D ethics charter.
- Should we promote the viewing of uncertainties?
- How about privacy protection?

Visualization capabilities of 3D parcels, *is it enough* for a suitable cadastral system?
- or if we also need some facilities to delete, add, and modify the geometry and the attributes of the 3D parcels?
- Or to be able to measure (and compare this with the official measures)
- Creating other views/data, like iso-surface, DEM-interpolate, profile, visibility analysis,

Should we promote the use of *virtual objects* in the viewing process?
- About the augmented reality, what could be these virtual objects
- Official measures
- Others kinds of underground object like parking, infrastructure, pipe, etc

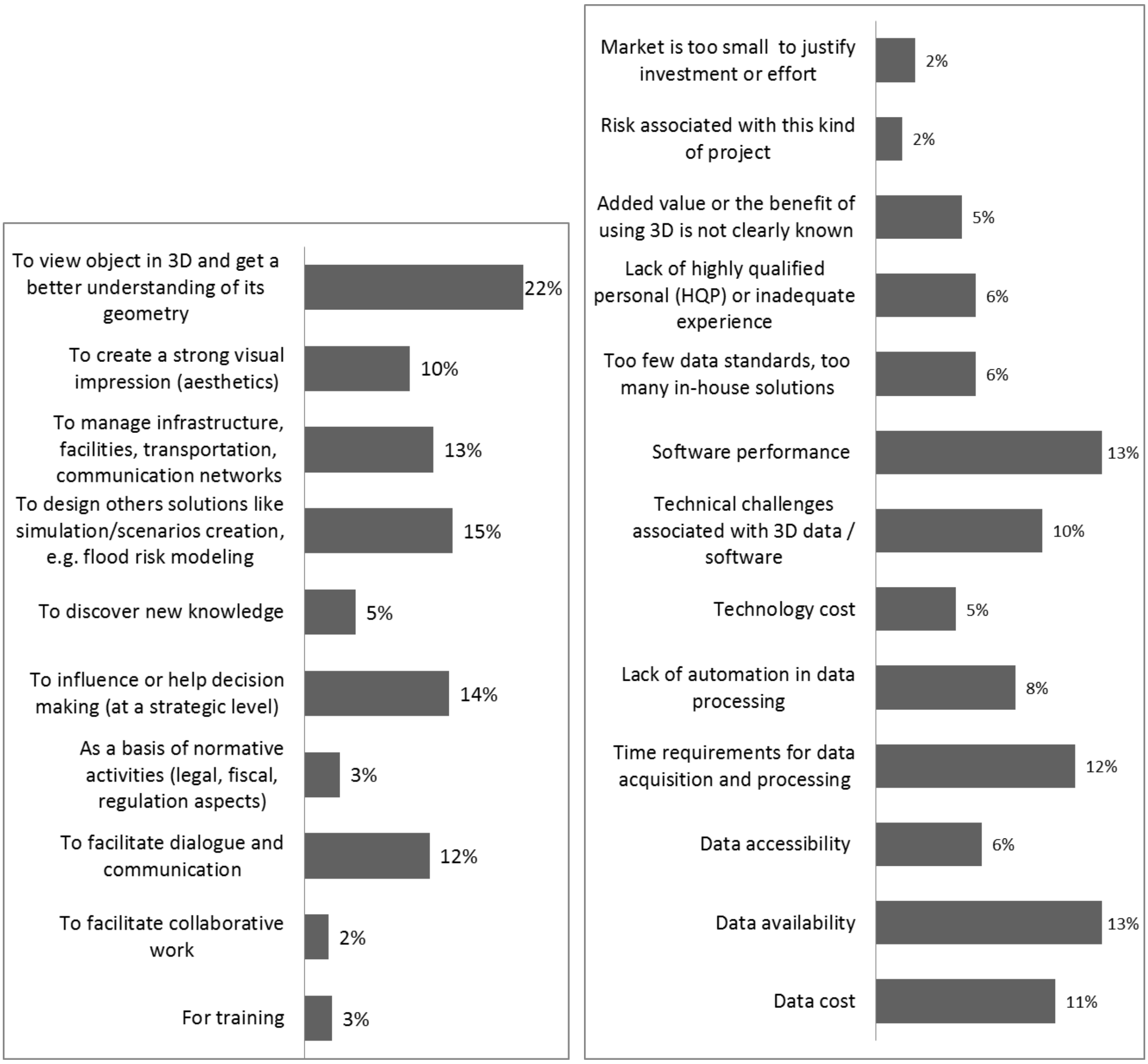
Should we propose the development of *interoperable/standards* based solution (if yes which)?
- LADM
- INSPIRE
- CityGML
- IFC-BIM
- GML
- KML

About distribution of 3D parcels, should we promote *web services* (if yes which one)?
- No, import/export is enough
- Mashups is a good compromise solution
- Yes:
- Web Map Service (WMS), Web 3D Service (W3DS)
- Web Coverage Service (WCS)
- Web Terrain Service (WTS)

- Web Feature Service (WFS)

4. CONCLUSION

To conclude, we can bring up some results obtained by Pouliot and Daniel (2011) about a survey on 3D Geospatial markets: Land management and urban planning. Figure 1a clearly shows that data visualization is the main reason identified to work in 3D (22%). Figure 1b somehow confirms that technical problems and 3D data availability are still identified as major challenges to address.



a b

Figure 1. Extracted from Pouliot and Daniel 2011, percentage of respond at the question: a) What are the three main advantages of using 3D geospatial data/technologies b) What are the three main constraints you face when working with 3D geospatial data/technologies

REFERENCES

Aien, A., Rajabifard, A., Kalantari, M., Williamson, I. (2011). Aspects of 3D Cadastre - A Case Study in Victoria, FIG Working Week 2011, Marrakech, 15 p.

Aditya, T., Subaryono, Waljiyanto, Istarno, Diyono, Raharja, U., Muryamto, R., Iswanto F. (2009). Understanding the Urgency for 3D Cadastre in Indonesia: Development & Visualization of a Hybrid 3D Cadastre Model, 10th South East Asian Survey Congress, 2009, Bali, 5 p.

Frédéricque, B., Raymond, K., Van Prooijen, K. (2011). 3D GIS as Applied to Cadastre - A Benchmark of Today's Capabilities, FIG Working Week, Marrakech, 14 p.

Card, S.K., Mackinlay, J.D., Shneiderman, B. (Eds.) (1999). Readings in Information Visualization – Using Vision to Think. Morgan Kaufmann, San Francisco, CA.

Dalmasso, A. (2011). Procedures for the Cadastral Registration of a New Building and its Three-D Representation, FIG Working Week 2011, Marrakech, 6 p.

Dimovski, V., Pecalevska, M., Cubrinoski, A., Lazoroska, T., (2011). WEB portal for dissemination of spatial data and services provided by the Agency for Real Estate Cadastre of Republic of Macedonia (AREC), Republic of Macedonia. Paper to be publish at the second nd International Workshop on 3D Cadastres organized by FIG, EuroSDR and TU Delft, 16-18 November 2011, Delft, The Netherlands.

Elwannas, R. (2011). 3D GIS: It's a Brave New World, FIG Working Week, Marrakech, 9p.

Fendel, E. (2001). Report on the Working Sessions, International Workshop on 3D Cadastres, 2001, Delft, 8 p. Papers published in Van Oosterom, P.J.M., Stoter, J.E., Fendel, E.M. (Eds.) 2001, Proceedings 3D Cadastres, Registration of Properties in Strata, International Workshop on "3D Cadastres", 28-30 November 2001, Delft, ISBN 87-90907.

Friendly, M. (2009), Milestones in the history of thematic cartography, statistical graphics, and data visualization, Engineering, 9 (2), pp. 1360-1395.

Gröger, G., Kolbe, T.H., Czerwinski, A., Nagel C. (2008). OpenGIS® City Geography Markup Language (CityGML) Encoding Standard. Open Geospatial Consortium Inc. Reference number of this OGC® project document: OGC 08-007r1 Version: 1.0.0 Category: OpenGIS® Encoding Standard.

Hassan, M.I., Abdul Rahman A. (2010). Malaysian Integrated 3D Cadastre, XXIV International FIG Congress, 2010, Sydney, 14 p.

Herman, I. (2000). “Graph visualization and navigation in information visualization: A survey”, IEEE on Visualization and Computer Graphics, 6(1), pp. 24-43.

ICA (2011). International Cartographic Association - Commission on GeoVisualization, http://geoanalytics.net/ica/.

Jarroush, J., Even-Tzur, G. (2004). Constructive Solid Geometry as the Basis of 3D Future Cadastre, FIG Working Week 2004, Athens, 14 p.

Qin, C., Zhou, T., Pei, T. (2003). Taxonomy of visualization techniques and systems–Concerns between users and developers are different, Asia GIS Conference, pp. 1-14.

ISO/DIS 19152-LADM (2011). Geographic information — Land Administration Domain Model, Draft international standard (DIS), http://www.isotc211.org/protdoc/211n2886/. January 20th, 2011.

MacEachren, A.M., Buttenfield, B.P., James, B., Campbell, J., Monmonier, M. (1992). Visualisation, in Abler, R., Marcus, M. and Olson, J. (eds.), Geography's Inner Worlds: Pervasive Themes in Contemporary American Geography, New Brunswick, NJ: Rutgers University Press, pp. 99-137.

MacEachren, A.M., Kraak, M.J. (1997). Exploratory cartographic visualization: advancing the agenda. Computers & Geosciences, 23(4), pp. 335-343.

McCormick, B.H., DeFanti, T.A., Brown, M.D. (Eds.) (1987). Visualization in Scientific Computing. Computer Graphics, 21(6), 63 pages.

Miller, G.A. (1956). "The Magic Number Seven, Plus or Minus Two: Some Limits on our Capacity for Processing Information", Psychological Review, Vol. 63, No. 2, 1956.

Pouliot J., Roy, T., Fouquet-Asselin, G., Desgroseillers, J. (2010). 3D Cadastre in the province of Quebec: A First experiment for the construction of a volumetric representation, in Advances in 3D Geo-Information Sciences (Series: Lecture Notes in Geoinformation and Cartography) Volume Editor(s): Kolbe, Thomas H.; König, Gerhard; Nagel, Claus. 3DGeoInfo conference, Berlin, Nov. 3-4, pp. 149-162.

Pouliot J., Daniel S. (2011). Survey on 3D Geospatial markets: Land management and urban planning. Scientific report, Geomatics Department, Laval University, available in French and English at http://geoeduc3d.scg.ulaval.ca.

Schall G., Mendez E., Kruijff E., Veas E., Junghanns S., Reitinger B., Schmalstieg D. (2009). Handeheld augmented reality for underground infrastructure visualization. Personal and ubiquitous computing, 13, pp. 281-291.

Smith B., Varzi, A.C. (2000). Fiat and Bona Fide Boundaries. Philosophy and Phenomenological Research 60(2), pp. 401-420.

Stoter, J.E., 2004, 3D Cadastre, Delft : Nederlandse Commissie voor Geodesie (NCG), also 2004. - 327 p. (Netherlands Geodetic Commission NCG : Publications on Geodesy : New Series) PhD thesis Delft University of Technology.

Van Oosterom P., Stoter, J., Ploeger, H., Thompson, R., Karki, S. (2011). World-wide Inventory of the Status of 3D Cadastres in 2010 and Expectations for 2014, FIG Working Week 2011, Marrakech.

Velasco, A. (2010). Questionnaire 3D-Cadastre - Spain. Website consulted on September 30th, http://www.gdmc.nl/3DCadastres/participants/.

Ville de Québec (2011). Interactive map of Quebec City, Website consulted on September 30th, ville.quebec.qc.ca/carte_interactive/index.aspx.

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