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Chapter 5: Visualization and New Opportunities

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Overview

1. Cadastre visualization
2. Understanding 3D visualization
3. Benefits of 3D Cadastre visualization
4. Challenges/research opportunities
5. Conclusion

Cadastre visualization

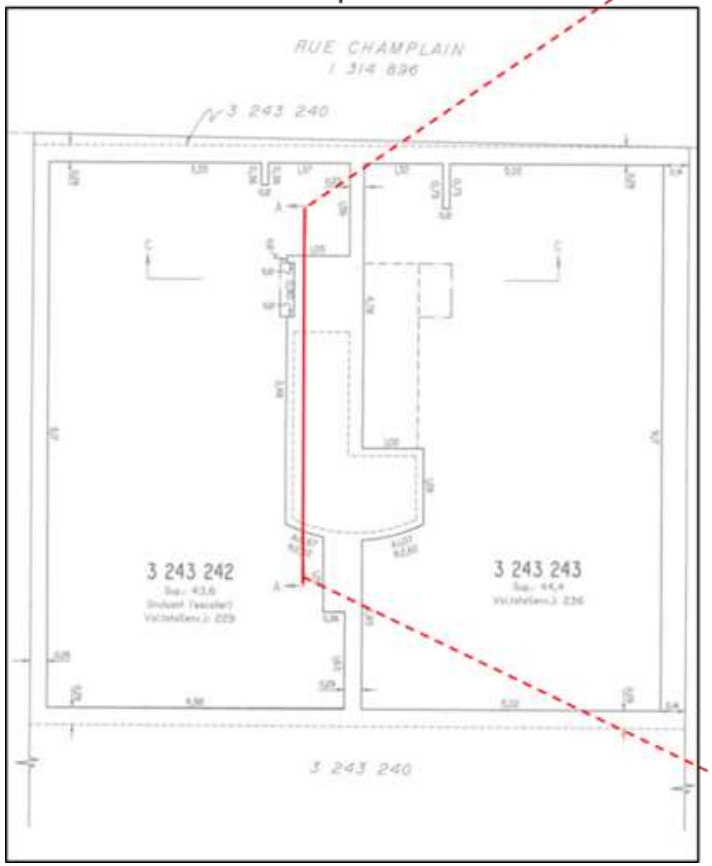
- Core to land administration: clarity about boundaries
- Maps are traditionally 2D, planimetric representation

- In cases of complex 3D ownership this is not clear anymore
- One 'solution' is for buildings: floorplans + cross sections

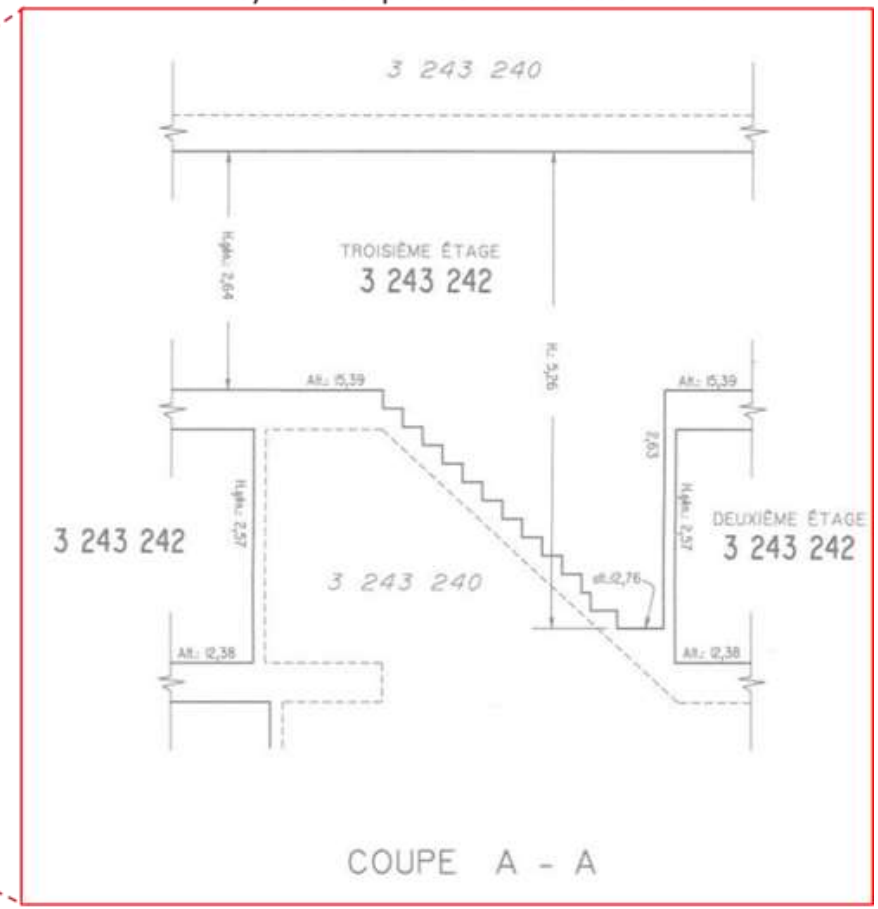
- For addressing all 3D Cadastre cases and long term solution: interactive 3D visualization system is needed

Example cadastral plan and vertical profile (Quebec cadastre)

a) 2D Cadastre plan of the second floor of an apartment unit



b) Vertical profile for a section A-A



Overview

1. Cadastre visualization
2. Understanding 3D visualization
   - Concepts
   - 3D Data Sources
   - 3D Technologies
3. Benefits of 3D Cadastre visualization
4. Challenges/research opportunities
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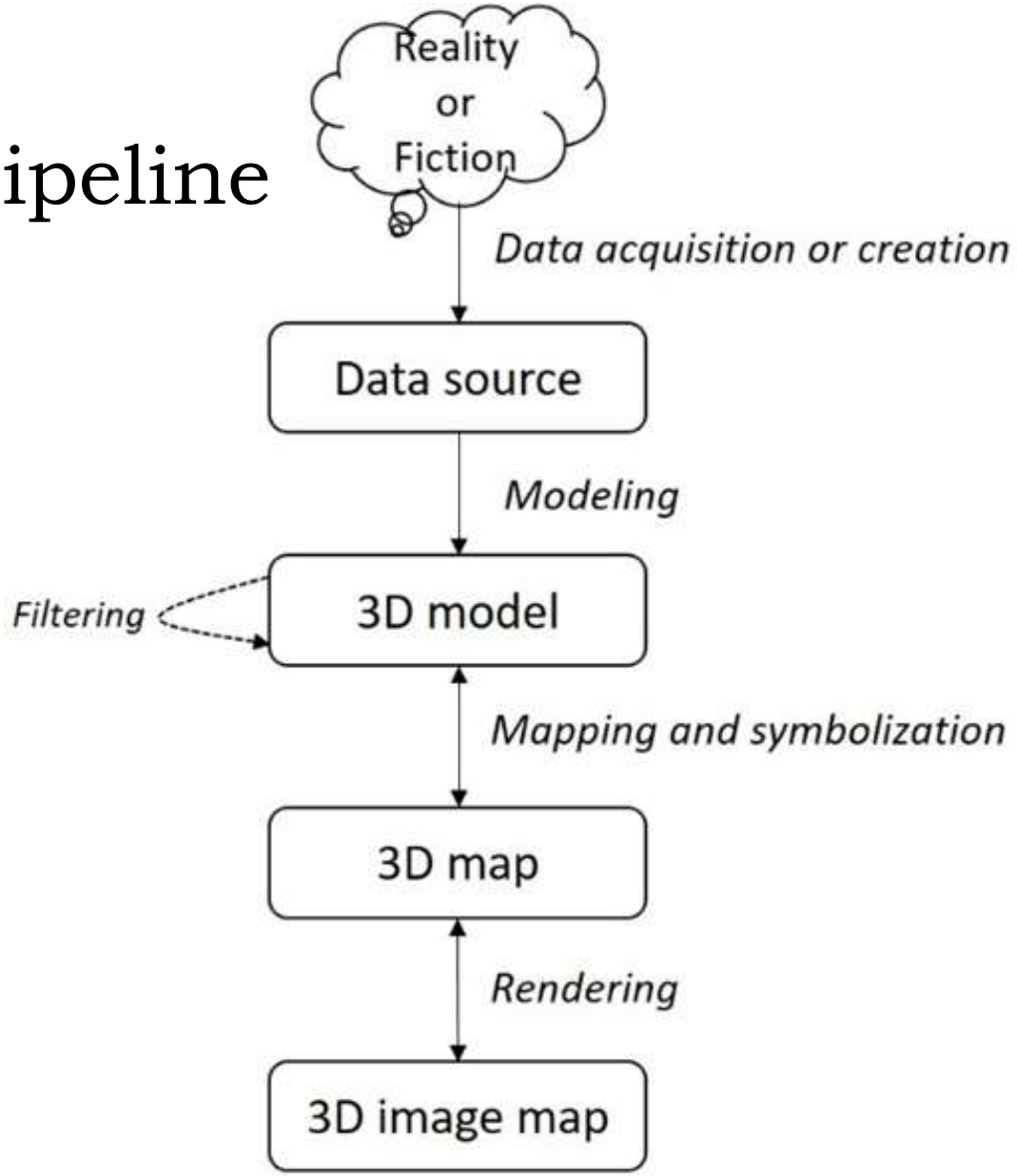
Understanding 3D visualization

- 3D visualization needs to provide perception of depth (on flat 2D screens) achieved by using
  - physiological cues such as eye convergence, binocular disparity or motion parallax and
  - psychological cues like retinal image size, perspective or shadows
- Interaction is crucial: being able to select and object in 3D

- 3D visualization requires knowledge and expertise from various disciplines including cognitive sciences, human-computer interaction, information visualization, cartography, computer sciences, image processing and photogrammetry.

Visualization pipeline

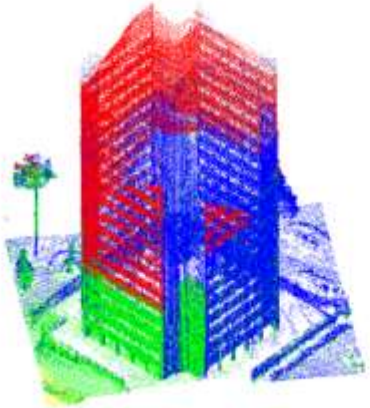
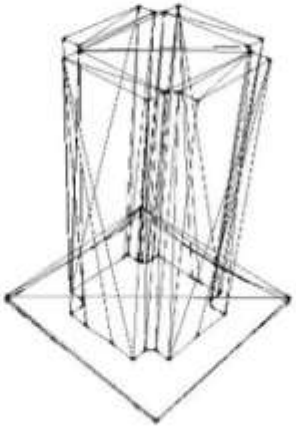
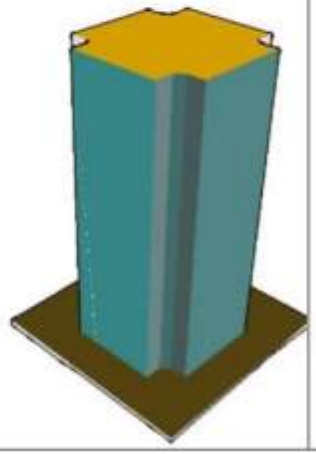
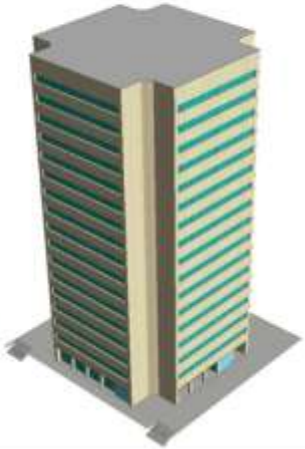


adapted from:

- Häberling et al. 2008
- Semo et al. 2015
- Terribilini 1999

Example 3D Visualization pipeline

- outputs corresponding to each stage of the visualization pipeline
- one campus building at Université Laval, Canada

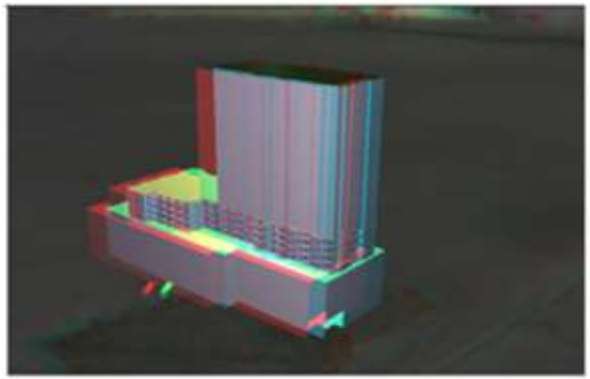
Image of reality	Lidar data source (coloured point cloud)	3D model (wireframe)	3D map (with colour code)	3D image map (with material)
				

3D technologies

- Formats and standards:
  - With semantics/attributes: CityGML and BIM/IFC (ISO-16739)
  - With geometry focus: X3D, OBJ or KML/KMZ

- Software tools offering 3D visualization:
  - graphics and game tools: Blender, Google Sketchup, Unity3D
  - computer assisted design: Bentley Microstation, Autodesk Autocad
  - geographic information systems: ESRI ArcGIS or CityEngine, QGis
  - 3D Viewers:Adobe 3D PDF, Google Earth, ParaView

- 3D visualization devices:
  - monoscopic display screens and
  - stereoscopic 3D devices (using 3D glasses or stereoscopes)



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Benefits of 3D Cadastre visualization

- Enables users to explore representations of modern, complex, urban situations
- Providing interactive functionalities such as zooming in/out and panning, tooltips, mapping and rendering controls
- 3D cartography: the color, the type of symbol, the level of transparency, the shadow effect, etc.

- First list 15 benefits, followed by number of examples/illustrations

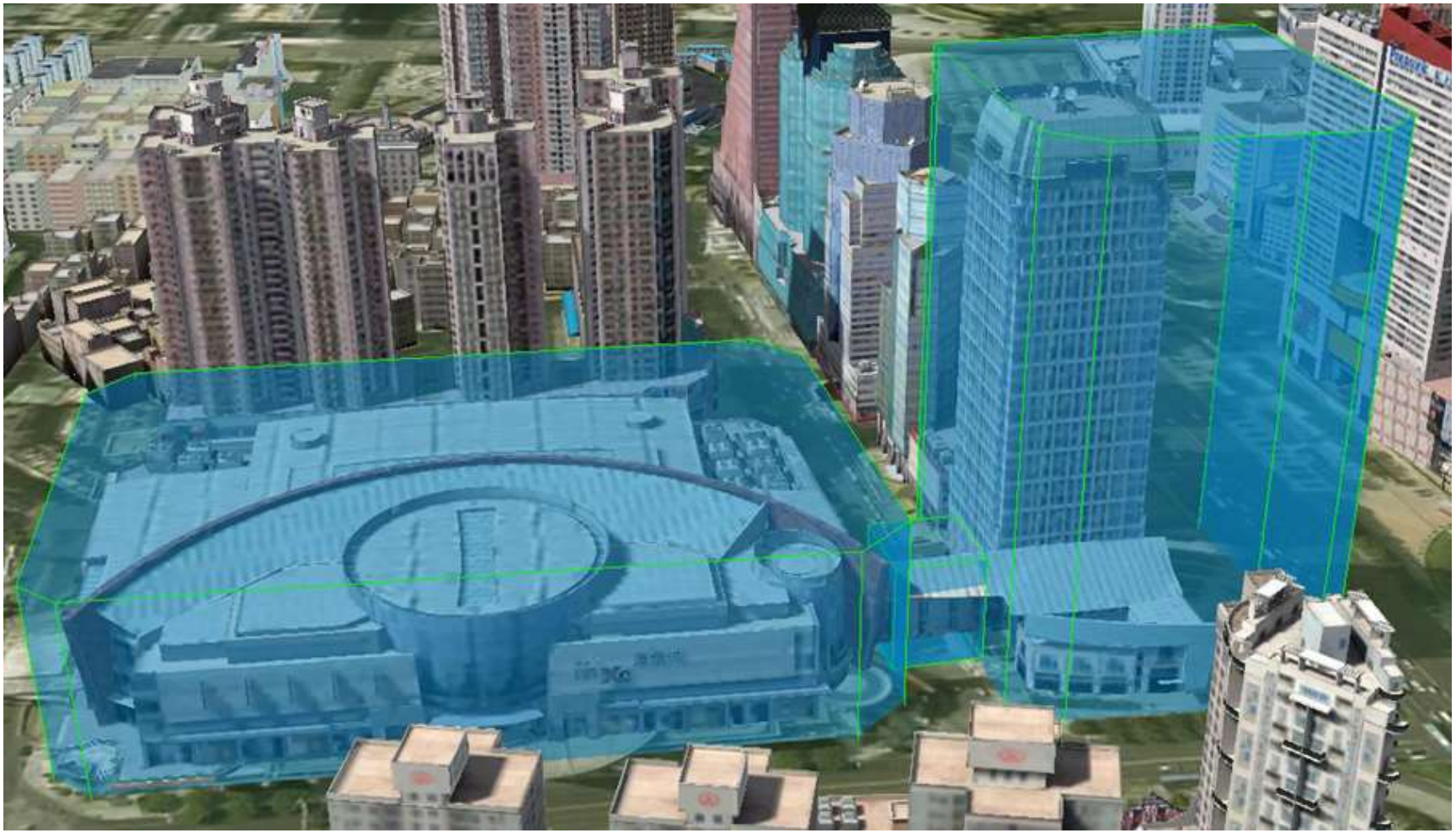
Benefits (1/2)

1. Identify and understand 3D geometric boundary of property unit
2. Locate a specific 3D property unit
3. Look inside and outside boundary of 3D property unit
4. Find adjacent objects of a 3D legal object, both vertically and horizontally to identify affected RRRs
5. Distinguish boundaries of 3D property units and associated parts
6. Distinguish the private and common parts in 3D co-ownership apartment buildings.
7. Merge and subdivide volumes to facilitate registration processes
8. Trace utility networks and infrastructures (tunnel and bridges) and control proximity with ownerships boundaries and detect collisions

Benefits (2/2)

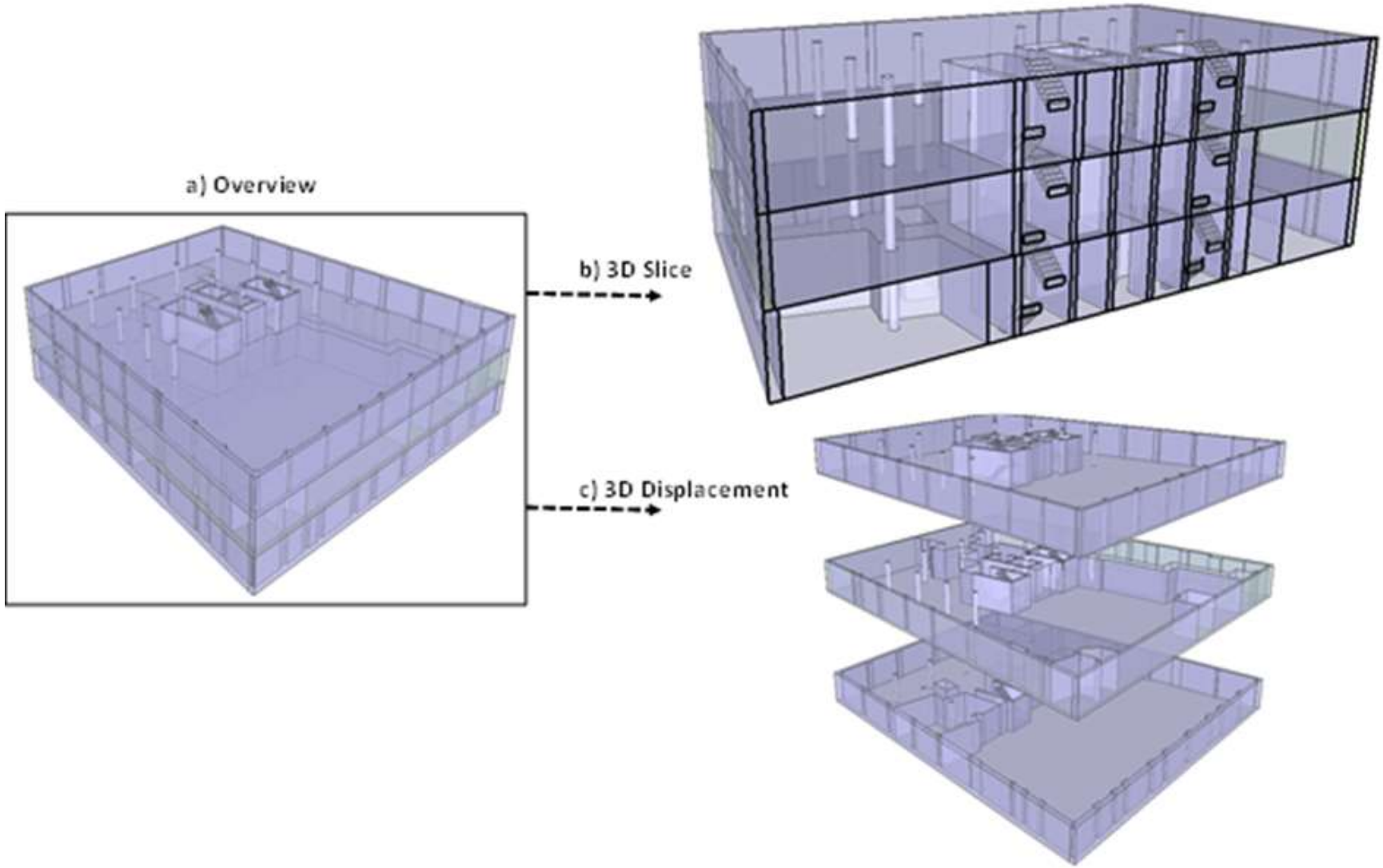
9. Visually check spatial validity and data quality: volume is closed, no overlap between neighboring volumes, and no unwanted 3D gaps
10. Examine property units in context of their 3D environment
11. Associate public and building elements with 2D land parcels and compare their 3D geometry and spatial relationships
12. Perform 3D measurements such as calculating surface area or volume of property
13. Perform 3D geometric analysis such as 3D buffering, e.g. in case of easement applications
14. Perform 3D spatial relationships such as 3D overlapping analysis to identify RRR conflicts
15. Support other management systems including land taxation, construction permits, urban planning, and land use regulation

Transparency visualization of 3D cadastre and building spaces



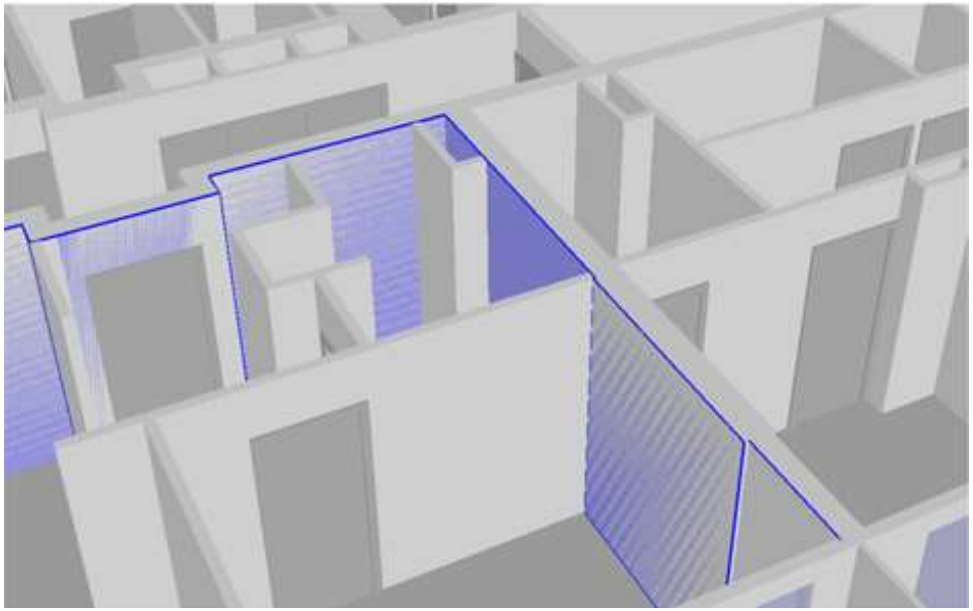
source Ying et al. 2012

3D Slice and displacement

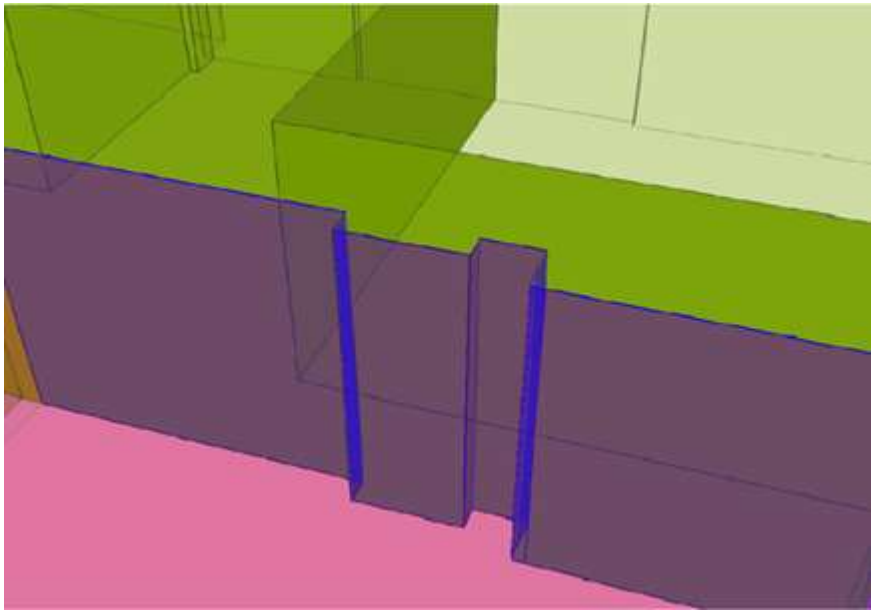


BIM distinction between legal and physical boundaries

Legal boundary defined by walls

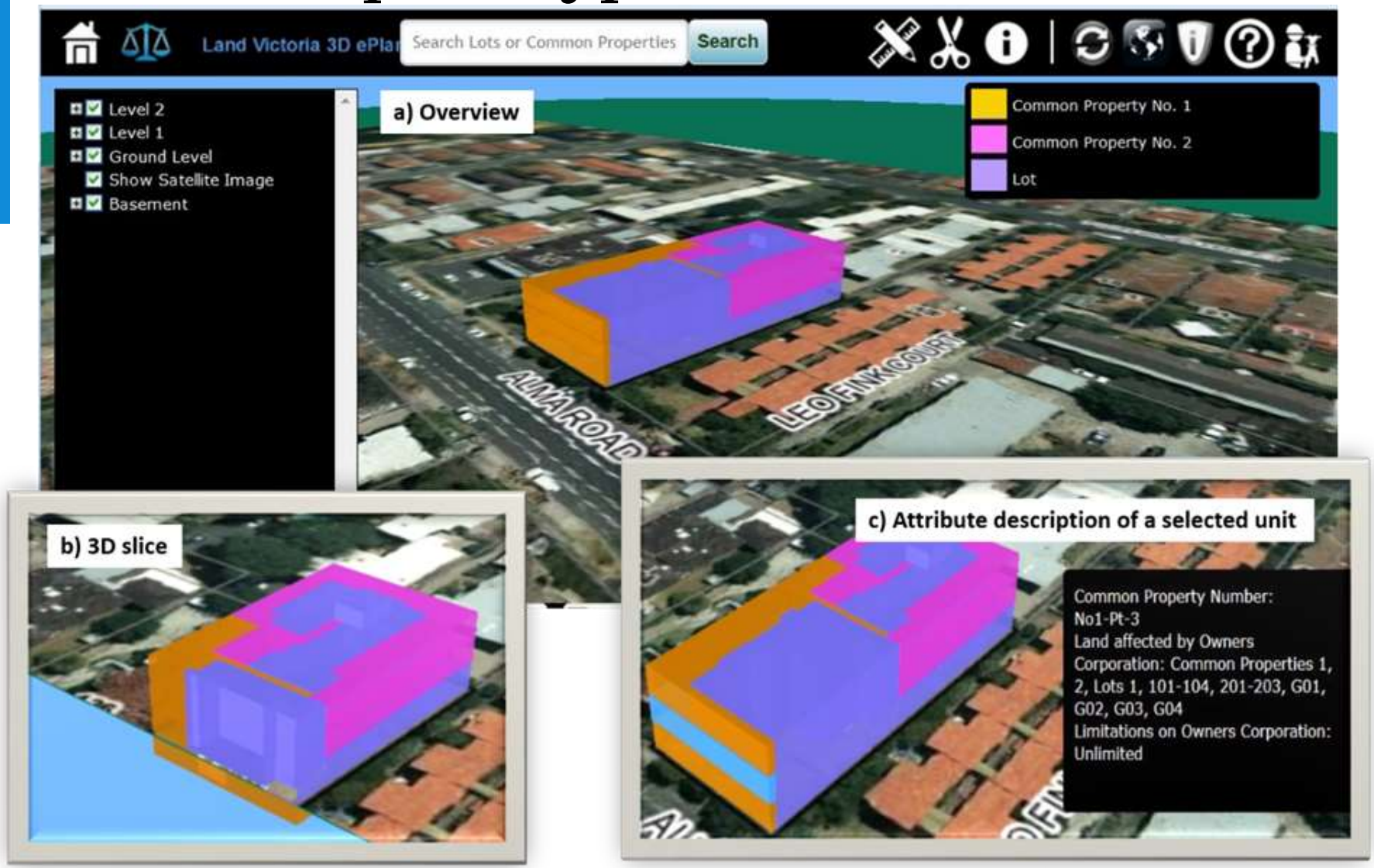


Legal boundary not defined by walls



built from Atazadeh et al. 2017

Victoria prototype online 3D ePlan



Augmented reality

Locate underground networks

Inform about occupancy

Source left: Rajabifard 2015 and Grant 2012
Source right: https://petitinvention.wordpress.com/2009/09/04

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   - Semiotics and Rendering
   - Functions
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Users and User Requirements of 3D cadastre system visualization

User Groups	Requirements	Challenges
- Land Registry - Local Government - Land surveyors, Notaries, Land lawyers - Architects, Engineering and Construction - Land and urban planners - Property development - Building Management - Real Estate - General Public	- Identify 3D property - Understand the 3D geometry - Locate and compare - Measure and do spatial analysis - Control accuracy - Query geometry and attributes - Integrate with other applications	- Steep learning curve - Presenting a solid value proposition - Barriers to legal and institutional adoption - 3D visualization for other applications - Multipurpose cadastral systems

Cadastral information and 3D semiotic/rendering aspects

Cadastral information to visualize	Semiotics and Rendering	Challenges
- Physical, legal and virtual objects/ spaces/boundaries as: • Annotations and attributes • Descriptive or legal documentation • Private and common parts • Private and publicly owned land - Spatial relationships - Time and "chains" of property rights	- Altering and suitability of visual variables - Applying texture and transparency - Slicing, detaching, cross sections - Discretization and distortion	- Legal boundaries not visible - Embedding within the legal decision making process - Availability of 3D cadastral data - Geometric complexity of apartments and other structures - Temporal data visualization

3D platforms and their functions in context of cadastre visualization

Platforms	Functions	Challenges
- Web/desktop - Open/proprietary - Fully functional (editing) or basic visualization only - Virtual and augmented reality - Gaming platforms	- Zoom in/out - Pan - Changing the color, the type of symbol, the level of transparency, the shadow effect - Spatial analysis - Navigation - Spatial Search - Attribute query - Stereo presentation	- Legal and institutional adoption - Interoperability of software - Absence of mobile devices - Interface for field surveys (not 3D) - Gap between 3D developers/users (e.g. gaming) and cadastral system developers/users

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Conclusion

- Some reflections:
  1. opportunity to enlarge role of cadastre data and involve new users
  2. positive steps have been made in 3D visualization
  3. will 3D will be in everyday duties of land administration players?
  4. changing habits is a long process, to be addressed step by step
  5. reality is 3D, as is any associated decision-making

- Key challenges/future work in:
  1. understanding user needs and functional requirements
  2. usability of tools and training
  3. organizational, legal and ethical issues

Smart Surveyors for Land and Water Management

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