# RECENT DEVELOPMENTS IN 3D WITH SPECIAL REFERENCE TO CADASTRAL REGISTRATION

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REMARKABLE PROGRESS IN THE FIELDS OF 3D GEOSPATIAL MODELS AND SYSTEMS (BIG DATA, DATA MANAGEMENT, CITY MODELING, INFRASTRUCTURE MANAGEMENT)

THESE HAVE AN IMPACT ON THE CADASTRAL DOMAIN: IMPROVED LAND DATA MANAGEMENT, MODELLING AND VISUALIZATION OF 3D PARCELS

BASED ON THESE ADVANCES AND RESEARCH, MORE OPERATIONAL 3D CADASTRAL SYSTEMS ESTABLISH

… SO, 3D REALITY NEEDS 3D DATA – MAPPING & CADASTRAL AGENCIES ADDRESS THIS NEW 3D REALITY

# OVERVIEW

- ❑ NEED FOR 3D INFORMATION IN LAND ADMINISTRATION
- ❑ CURRENT TECHNOLOGICAL DEVELOPMENTS AND INITIATIVES
- ❑ INTEGRATING PHYSICAL AND LEGAL REALITY
- ❑ FUTURE TRENDS

# NEED FOR 3D INFORMATION IN LAND ADMINISTRATION

DO WE REALLY NEED 3D INFORMATION IN LAND ADMINISTRATION ?

- 2D data is not sufficient to describe our world of growing large cities, with complex buildings and infrastructures
- 3D modelling techniques are rapidly developing, providing new challenges and new roles in LA
- Smart cities are mapped in 3D with buildings in several LoDs. These data can be potentially reused for land administration purposes
- Stakeholders, decision makers and planners demand for 3D information to support their work

WHAT KIND OF DATA DO WE NEED AND HOW THIS DATA IS ACQUIRED?

WHAT ABOUT SOFTWARE AND DATA STANDARDS?

WHAT ABOUT DATA MANAGEMENT SYSTEMS?

HOW THIS DATA IS VISUALISED?

IS TEMPORAL INFORMATION IMPORTANT?

WHAT ABOUT SUPPORTED LAWS AND REGULATION? WHAT NEEDS TO BE CHANGED?

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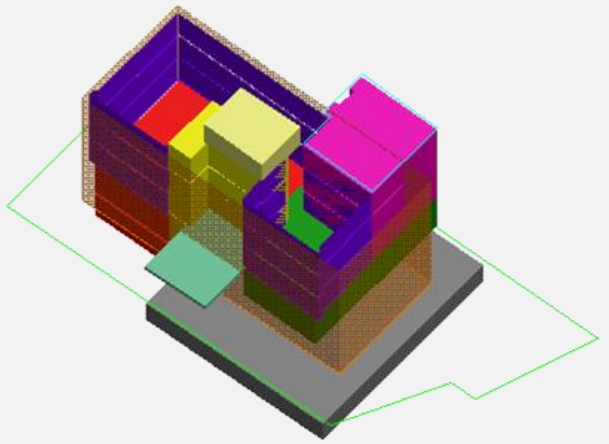


Source: Kitsakis and Dimopoulou, 2014

# CURRENT TECHNOLOGICAL DEVELOPMENTS AND INITIATIVES

- 3D DATA ACQUISITION AND MODELLING
  - SOURCES OF 3D DATA: Aerial imagery, Lidar and digital photogrammetry, ground surveying systems, digitized records, architectural and engineering plans, web services
- ➢ To transform these huge amounts of data into useful information, 3D data needs to be structured into well-defined DATA MODELS
  - PURE LEGAL MODELS: LADM (ISO1915, 2012), ePlan (2010)
  - PURE PHYSICAL MODELS: CityGML, InfraGML, IndoorGML, BIMs, IFC
- 3D REPRESENTATION - VIRTUAL MODELS IN DIFFERENT LODs – GEOVISUALISATION SYSTEMS
- 3D DATA STORAGE AND MAINENANCE IN SPATIAL DATABASES (Geo-DBMSs)
- 3D FILE FORMATS FOR DATA EXCHANGE (LandXML, InfraGML, ..)
- WEB-SERVICES THAT SUPPORT 3D DATA - 3D WEB TECHNOLOGIES (WebGL and HTML5 technologies for 3D visualization)

## INTEGRATION OF LADM AND CITYGML THROUGH THE DEVELOPMENT OF A CityGML LADM ADE

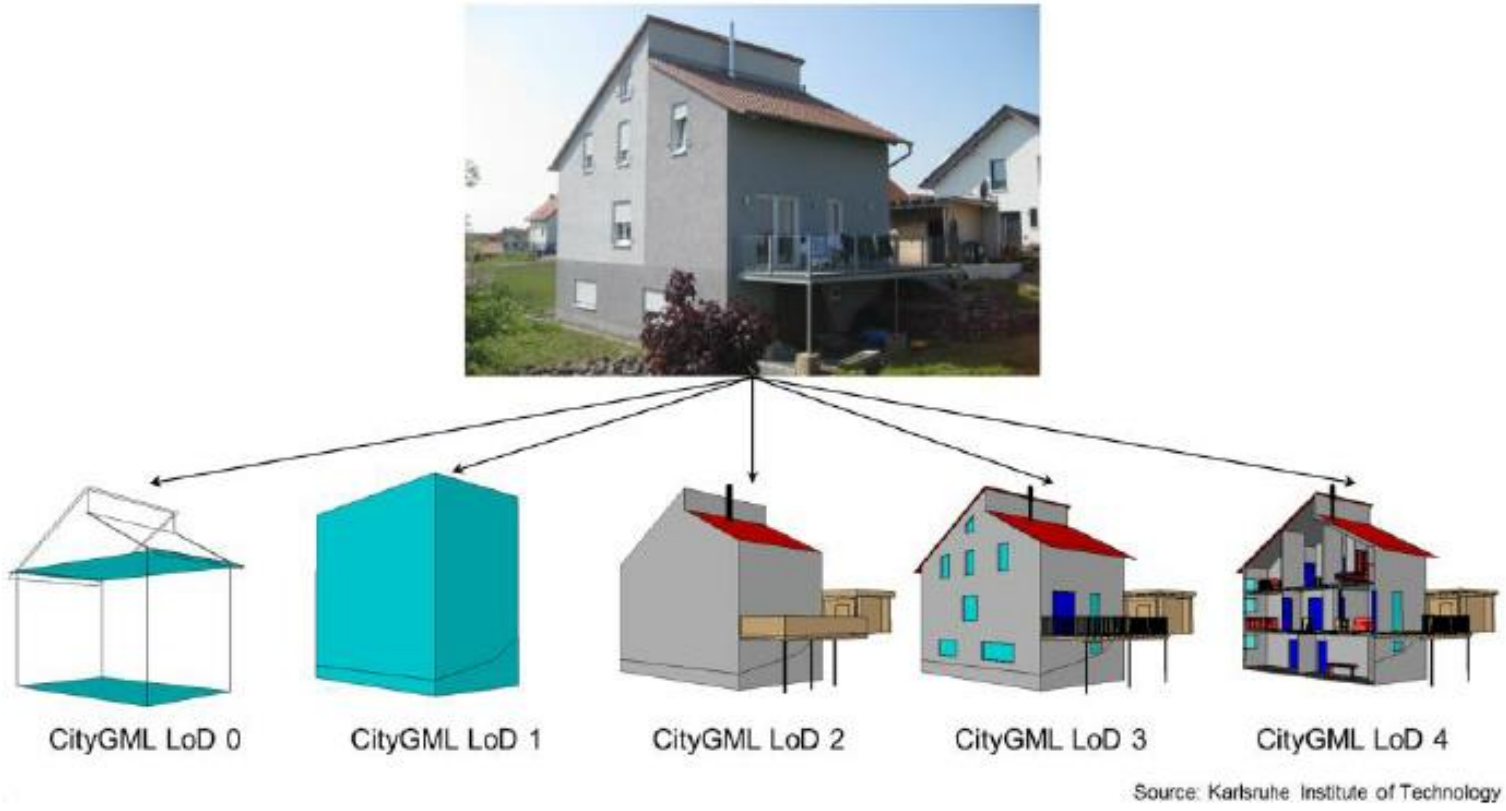
- **CityGML** is an open standardised data model and exchange format to store digital 3D models of cities and landscapes. CityGML mainly describes the geometry, attributes and semantics of different kinds of 3D city objects.
- CityGML does not contain features that describe the legal information about spatial objects!!

- **LADM** (ISO 19152:2012) is a conceptual model that allows land administration objects and relationships to be described. LADM provides a strong modeling of RRRs, but has a general / abstract model of Spatial Units

**APPLICATION DOMAIN EXTENSIONS (ADE)** – A SOLUTION?

- A mechanism extending the schema with new classes and attributes, which are not explicitly modelled in CityGML, defined in specific application fields and, creating application specific extensions (e.g. for cadastral purposes, or valuation/taxation)

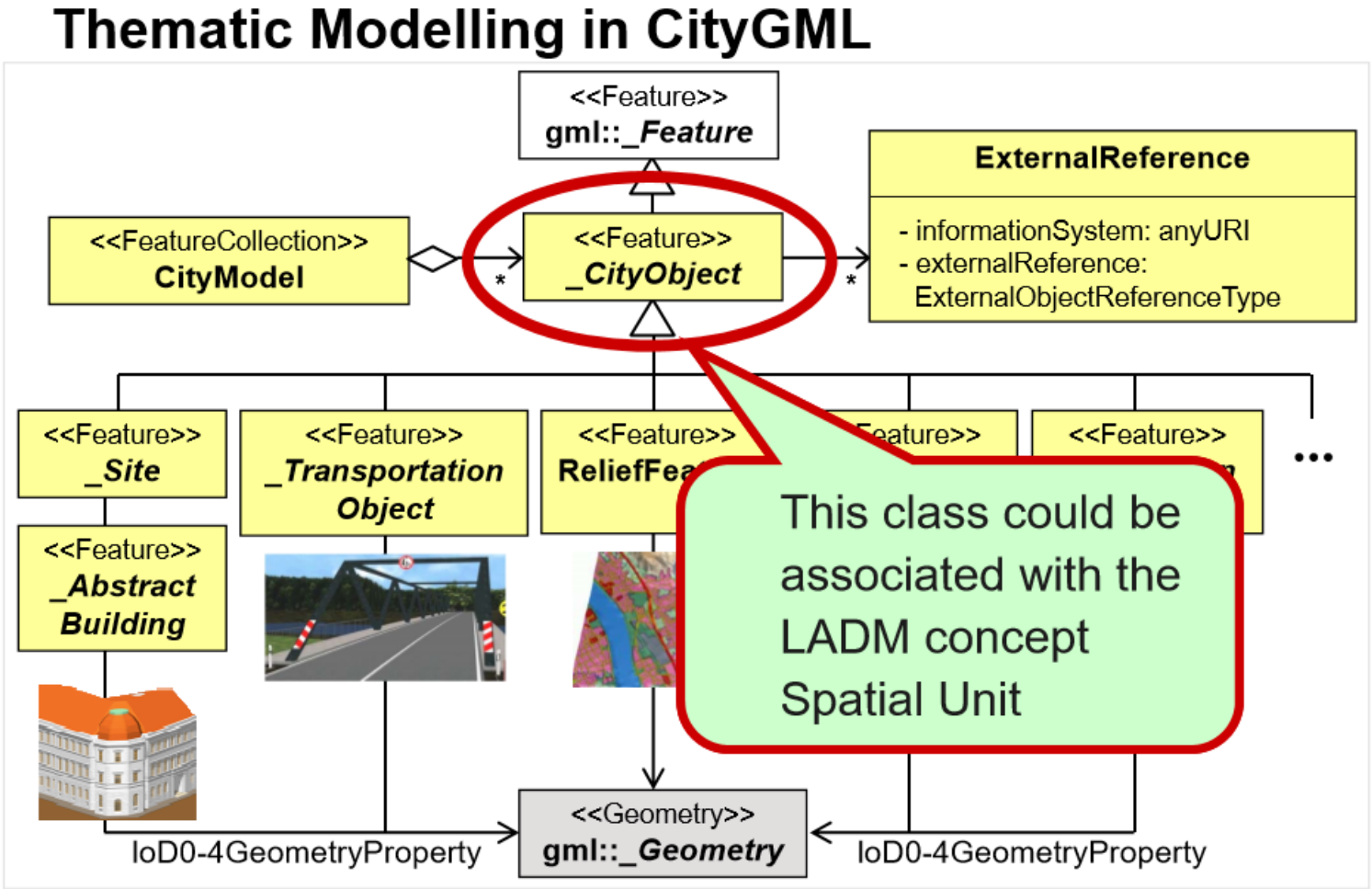
## CityGML - LoDs




BUILDINGS' REPRESENTATION IN:

- LoD0 by footprint or roof edge polygons
- LoD1 as blocks model comprising prismatic buildings with flat roof structures
- LoD2 with separated roof structures and thematically separated boundary surfaces
- LoD3 represents architectural models with detailed wall and roof structures (including doors and windows)
- LoD4 completes a LoD3 model by adding interior structures (rooms, stairs, furniture)

POSSIBILITIES OF APPLYING CITYGML FOR CADASTRAL PURPOSES or THE “LADM AS A CITYGML ADE“




*Kolbe, 2017*

… how the LADM conceptual model, the representation of legal spaces in particular, can be mapped to and encoded as a CityGML Application Domain Extension (ADE)

## DIFFERENT APPROACHES:

- Çağdaş (2013) developed a CityGML extension for the immovable property taxation system in Turkey. It integrates physical objects specified by CityGML with the legal and administrative concepts defined in Turkish law.
- Góźdź et al (2014) developed an ADE within the context of the Polish Cadastre
- Soon et al., (2014), proposed an extension of the LADM Web Ontology Language (OWL) to integrate CityGML with 3D LandXML, adopting ePlan as conceptual model.
- Rönsdorf et al (2014) demonstrated how the OGC CityGML standard can be used to provide an encoding for 3D land administration information.
- Dsilva (2009), focused on the development of a CityGML Building Module ADE for cadastral purposes, focused on identification of the apartments and the ownership rights attached to them.

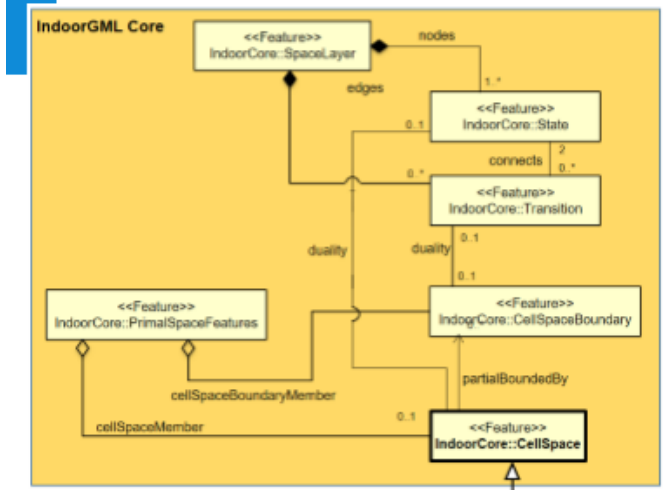
# INTEGRATING PHYSICAL AND LEGAL REALITY 5/8

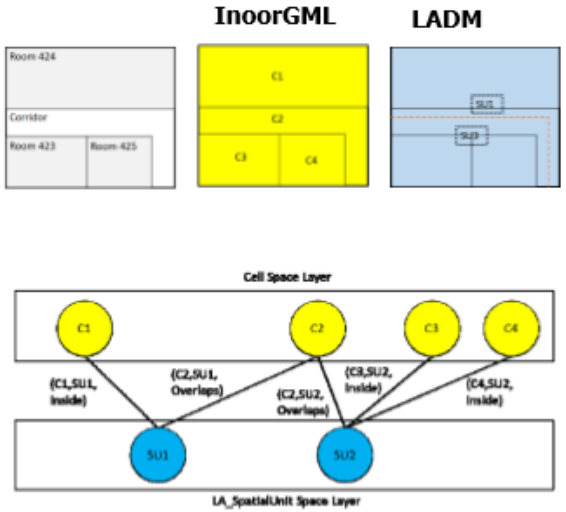
- Ying et al (2014) provide a framework and workflow of the conversion from CityGML data to 3D Cadastral unit, testing with city data of CityGML in LoD3.
- Roschlaub and Batscheider (2016) used 3D City Database (3DCityDB2 ) to store 3D buildings in LoD2, created as a combination of 2D digital building ground plans derived from the official digital cadastral map and LIDAR .
- Li et al. (2016) developed a LADM-based ADE for CityGML for 3D modeling of the ownership structure of condominium units in China by proposing a legal and physical hierarchy.
- Isikdag et al. (2014) proposed that integrating 3D RRR spaces with 3D physical models (IFC or CityGML) could provide significant benefits for valuation and taxation of properties.
- …

## POSSIBLE SYNERGY BETWEEN OGC'S IndoorGML AND LADM

- **LADM** is a conceptual model, while **IndoorGML** is also an actual XML schema (technical model), which can be used directly for data exchange and storage. **LADM** models legal and administrative concepts (use and ownership rights of spaces) related to certain parties, while **IndoorGML** puts emphasis on connectivity of spaces related to the navigability as one of the main use cases.

### IndoorGML & LADM




- Zlatanova, et al. (2016) proposed an approach for linking RRR information to indoor environment by an LADM-based extension for IndoorGML.

**BIM + 3D CADASTRE (is it possible to reuse information to create 3D parcels?)**

- **BIM**: a digital representation of how a (physical) building (including its facilities) is designed, realized and monitored over its lifecycle. BIM is a fast-growing technology for the development of an n-Dimensional (nD) virtual model of a facility by involving many stakeholders throughout its lifecycle.
- **IFC**: a common data schema to hold and exchange relevant data between different software applications, promoting interoperability within the industry.

- Clemen and Grundig, (2006): stated that the IFC models have the ability to support 3D topology and geometric representation of building elements, so they can be extended for land surveying purposes.
- El-Mekawy and Ostman, (2015): proposed to enrich the Unified Building Models (UBM) with all types of boundaries required to define RRR spaces in the context of Swedish jurisdiction.
- Atazadeh, et al. (2016): implemented what Clemen and Grundig have stated about IFC models.

# INTEGRATING PHYSICAL AND LEGAL REALITY



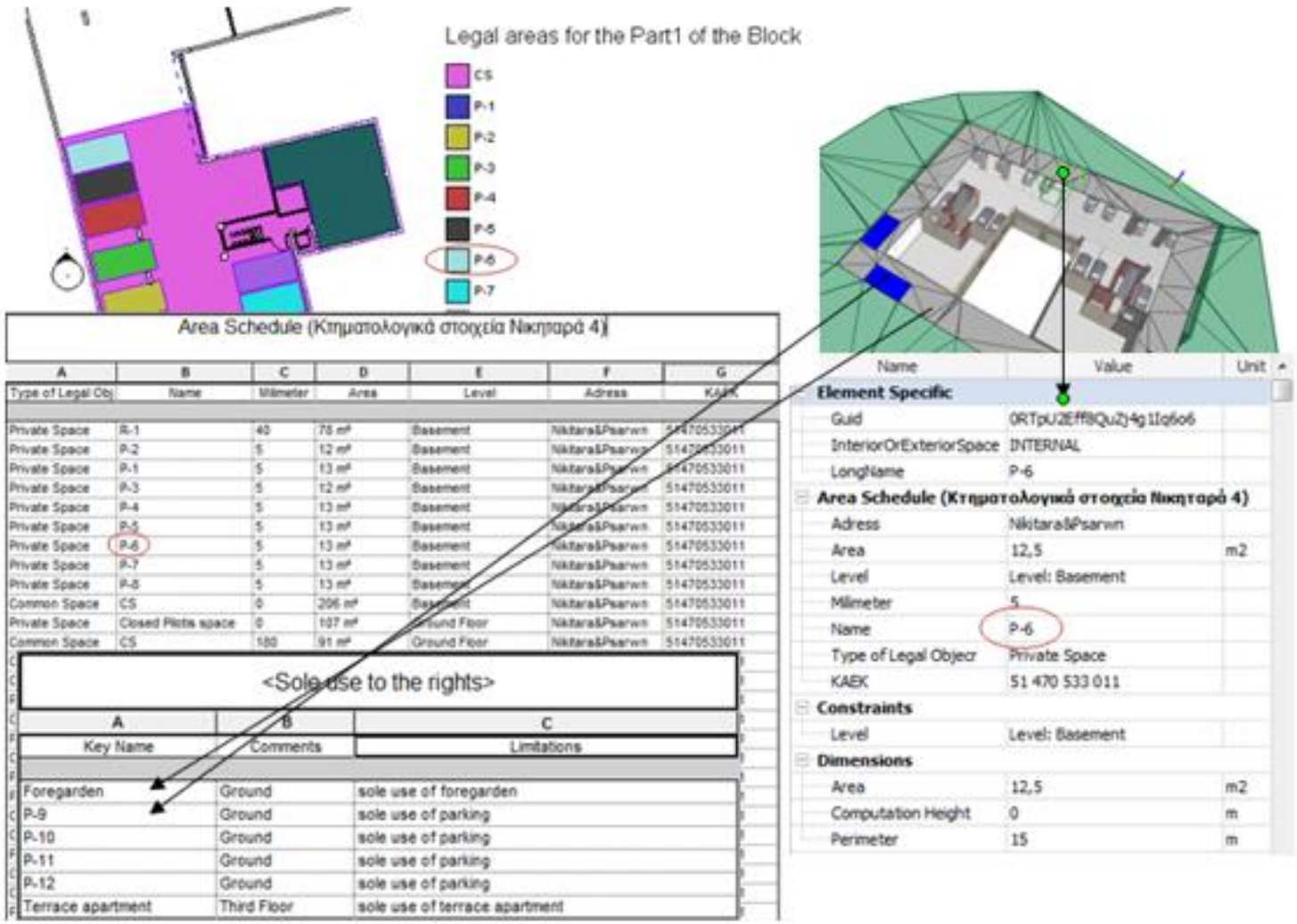



*Illustration of the process of integrating Revit model with cadastral information (ANDRIANESI and DIMOPOULOU, 2017)*

# FUTURE WORK – CONCERNS

- A lot of research is on the integration of physical and legal reality
- CityGML integrates by the use of ADEs
- When using CityGML/ IFC for cadastral applications, differences between geometric locations may identify, because physical models are represented by ”walls”, while cadastral representations are “linear” legal boundaries.
- BIMS are a good source of 3D cadastral data and have already been used by many jurisdictions.
- BIM/ IFC models can be enriched with cadastral information which forms the basis for an interoperability platform for Land Administration
- If legal spaces could be defined at the beginning of the design process of modelling a building, this could provide the way to check if the building is designed and built within cadastral regulations.
- When moving from a 2D to a 3D Cadastre, it is important not only to obtain data, but also to develop an efficient digital collaborative workflow, determining needs, processes and exchange requirements.
- The challenges for future research is on spatial data integration, development of 3D/4D geoinformation systems, and efficient management of big un-processed raw data (large point clouds).


THANK
YOU