The Third Dimension of GIS and LADM – Current Status and Perspectives

Alias Abdul Rahman, Ainn Zamzuri, Hanis Rashidan & Wahyu Marta Mutiarasari

3D GIS Research Lab
Faculty Built Environment & Surveying,
Universiti Teknologi Malaysia

Contents

3D GIS

- The literature shows that the development and research expanded from **basic in 1990's to more advanced today.**
- Among the first ideas were by Pilouk (1996), Zlatanova (1998) and Abdul-Rahman (2000).
- Introduced **data structures for 3D** spatial objects modelling**.**

3D GIS

- The **data structures** and **data model** able to **accommodate** 3D objects.
- Then, the **data modelling**, processing, **database**, and **3D visualization.**
- Recently on **new 3D data exchange formats** (CityGML, CityJSON, Interlis) trigger various processing modules – record and indexing and searching mechanism within database with 3D visualization e.g. Cesium.

3D GIS

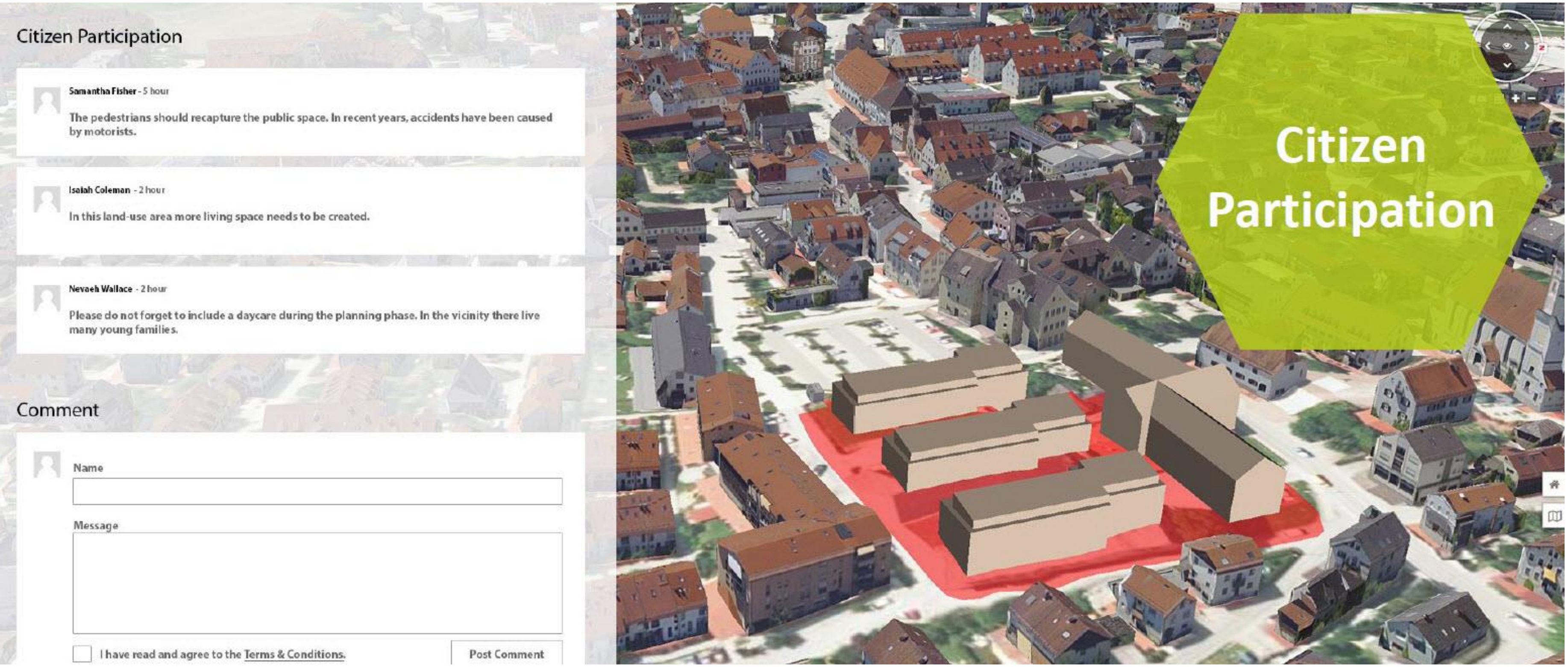
- 3D city models via CityGML ver. 2 and ver. 3
- Then enhanced 3D city models as part of Digital Twins development.
- E.g. Munich and Rotterdam.

3D GIS

C. Nagel (2018)

3D GIS

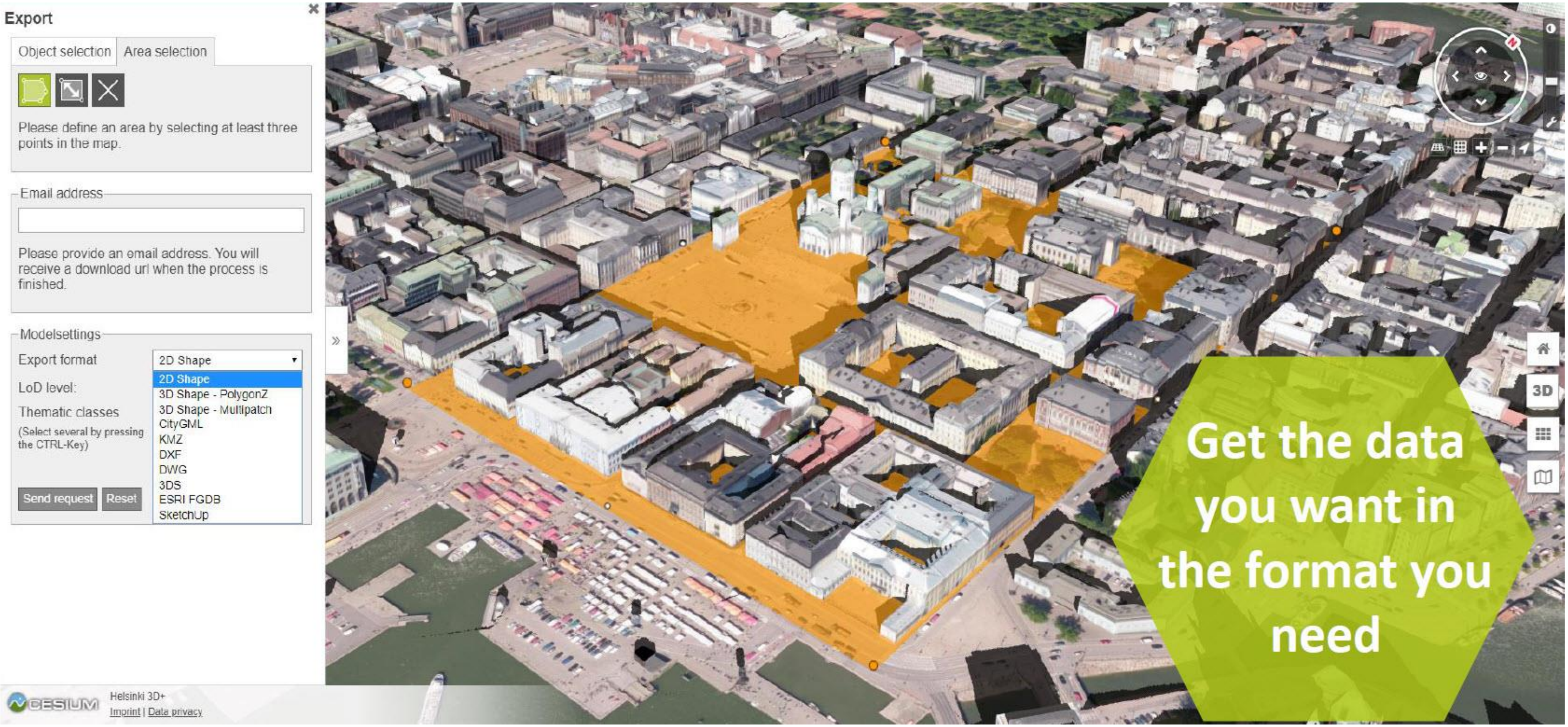
C. Nagel (2018)



3D GIS

C. Nagel (2018)

3D GIS


Export
Object selection
Area selection
Please define an area by selecting at least three points in the map.
Email address
Please provide an email address. You will receive a download url when the process is finished.
Modelsettings
Export format
2D Shape
2D Shape
3D Shape - PolygonZ
3D Shape - Multipatch
CityGML
KMZ
DXF
DWG
3DS
ESRI FGDB
SketchUp
LoD level:
Thematic classes
(Select several by pressing the CTRL-Key)
Send request
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CESIUM
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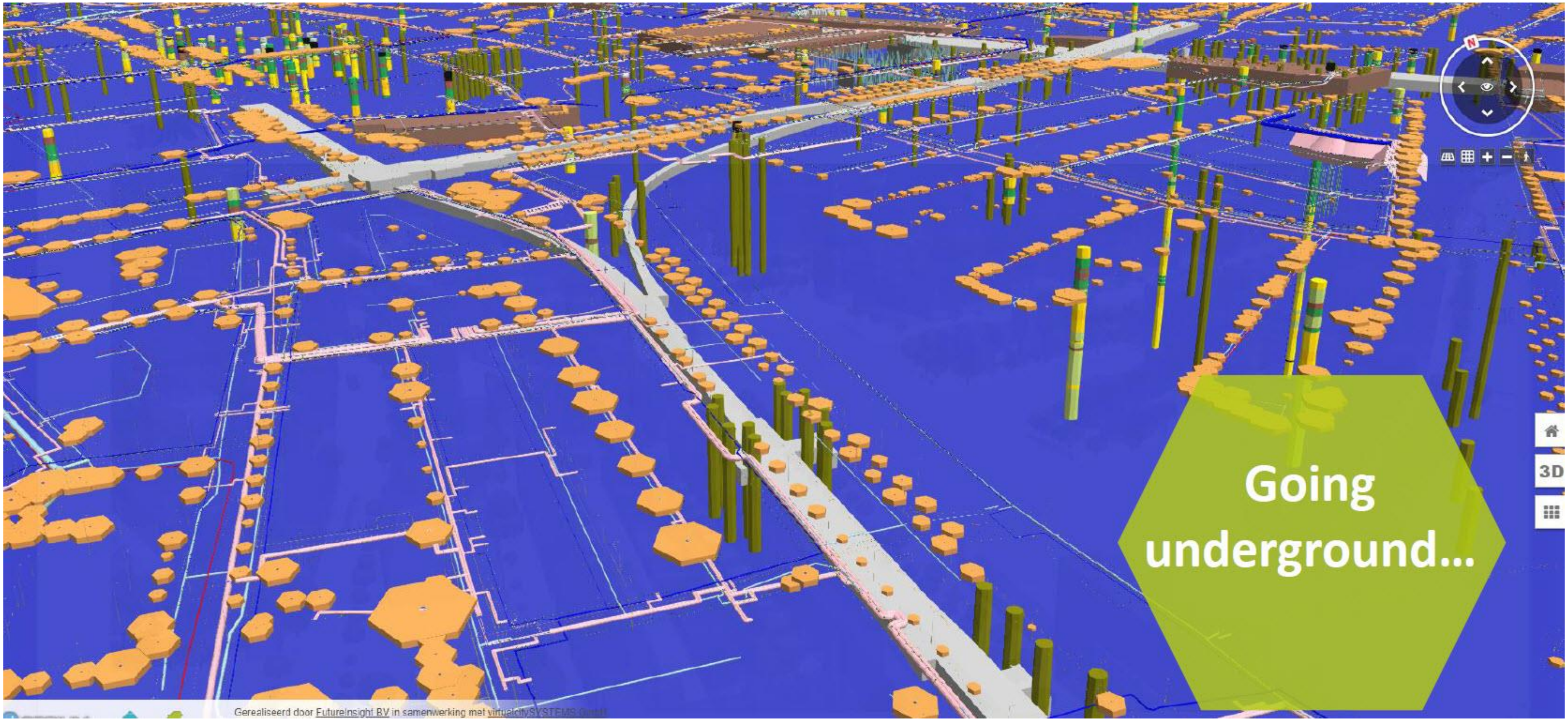
Imprint | Data privacy
3D
Get the data you want in the format you need

3D GIS

C. Nagel (2018)



3D GIS

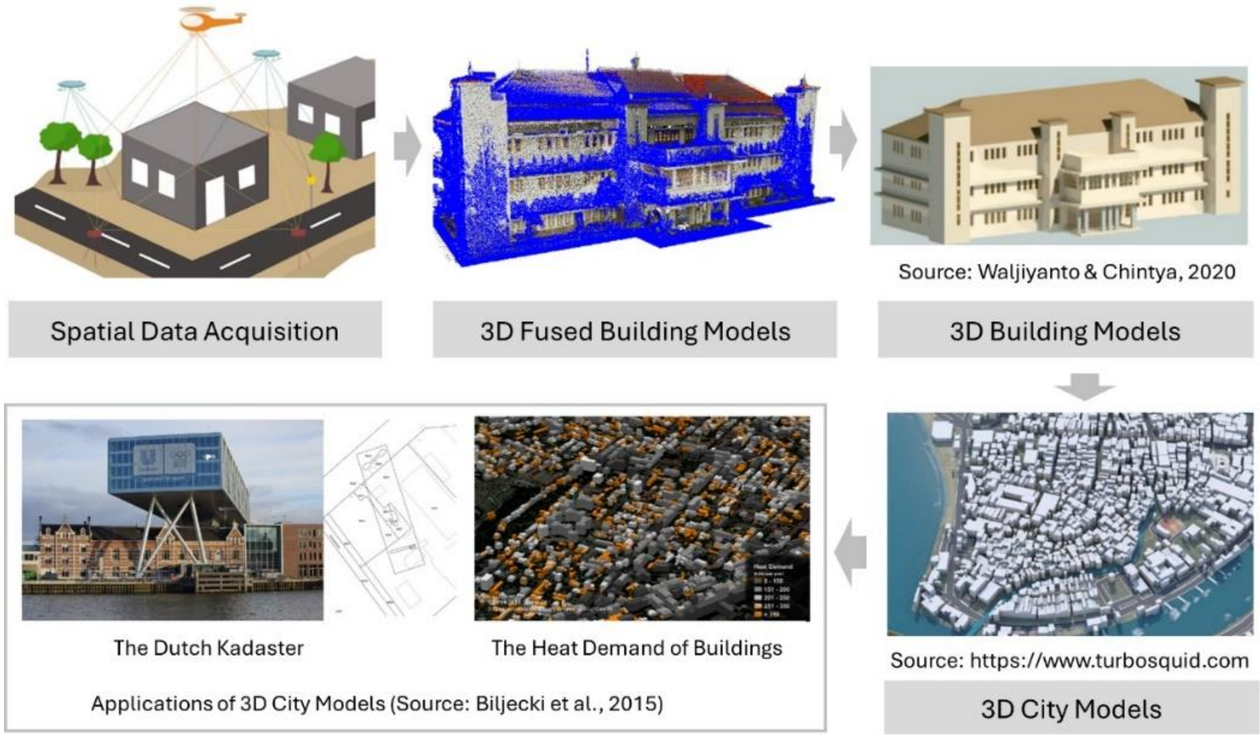

Legende
Messen
Schatten
Query
Feature Explorer
Legende
LoD1
LoD2
Fazit pro Wohnblock
Baselayer
Themen
Solar Potenzial
Energieeinsparung
0 - 50 (kWh/m2/jr)
51 - 80 (kWh/m2/jr)
81 - 110 (kWh/m2/jr)
111 - 140 (kWh/m2/jr)
> 140 (kWh/m2/jr)
Energieverbrauch
Wärme-Netz Potenzial
Eigentum
Geothermie Potenzial
Geothermal potential
Ansichten
Anfangsansicht
3D Analysis and What-If Scenarios
AGENCY9

3D data fusion

- 3D buildings generation via fusion method comes with low accuracy; however, recent research utilizing point cloud data and Laplacian improves accuracy.
- A key challenge of data fusion is to develop effective data integration methods of different datasets.

3D data fusion

- Development of 3D building models and applications as illustrated.
  - Spatial data acquisition
  - 3D fused building models
  - 3D building models
  - 3D city models
  - Application of 3D city models



3D data fusion

- **3D fused building models** are generated by using several datasets.
  - Terrestrial laser scanning
  - Airborne laser scanning
  - Drone photogrammetry

- The datasets are integrated and enhanced into a more complete 3D building models through a process of **data fusion**.

- For urban environments, 3D building models can be developed into **3D city models** and **3D LA** applications.

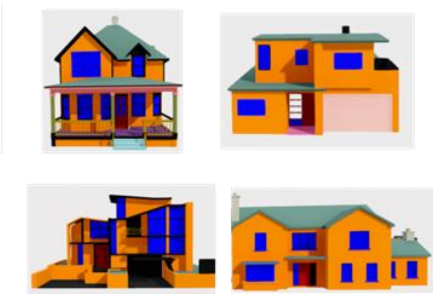
Semantic Segmentation of 3D Models

- **Semantic Segmentation *(technique)***
  - Identify objects (building elements) through classification and labeling.
- **3D Urban Environment *(application)***
  - Enables detailed analysis and visualization of urban spaces.
  - Aids in infrastructure maintenance and management.
- **CityGML *(standard)***
  - Embeds semantic information, enhancing data utility.
  - Supports multi-scale representations, from building components to entire city models.

Semantic Segmentation of 3D Models

1. THE CONCEPT

3D models



Semantically segmented

CityGML
Building Database

2. METHODOLOGY

DATASET
- 3D building models
- Labelled exterior components

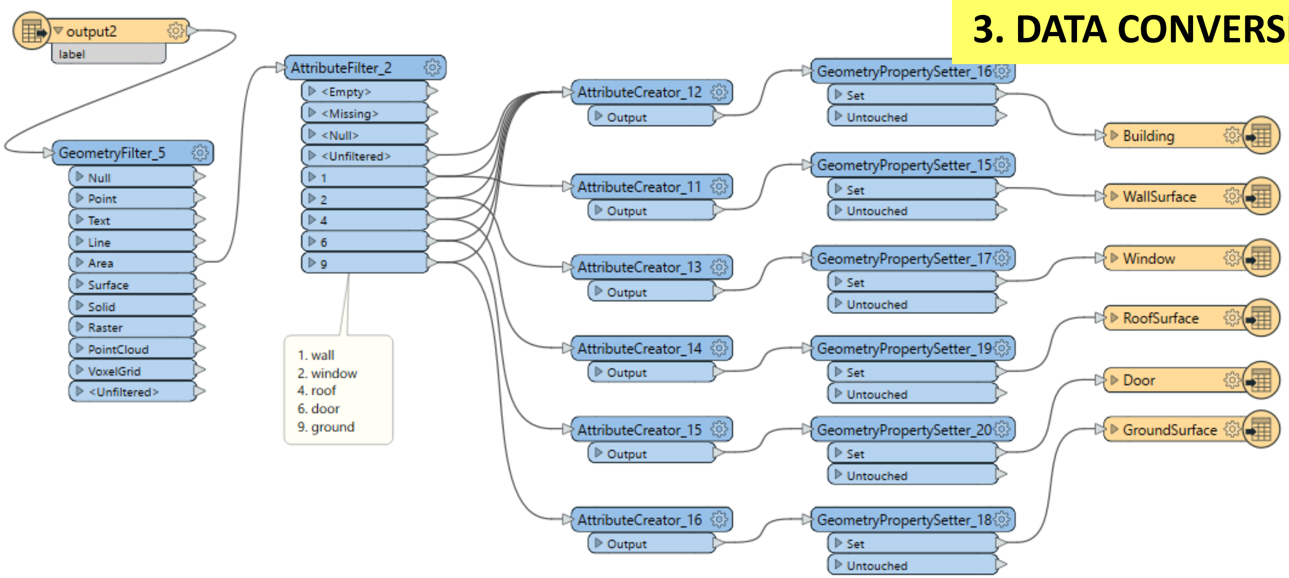
DATA PREPROCESSING
- Preprocess into a required format

AI DEVELOPMENT
- Semantic segmentation model training
- Evaluation metrics

INFERENCE
- Generate semantic labels for 3D models

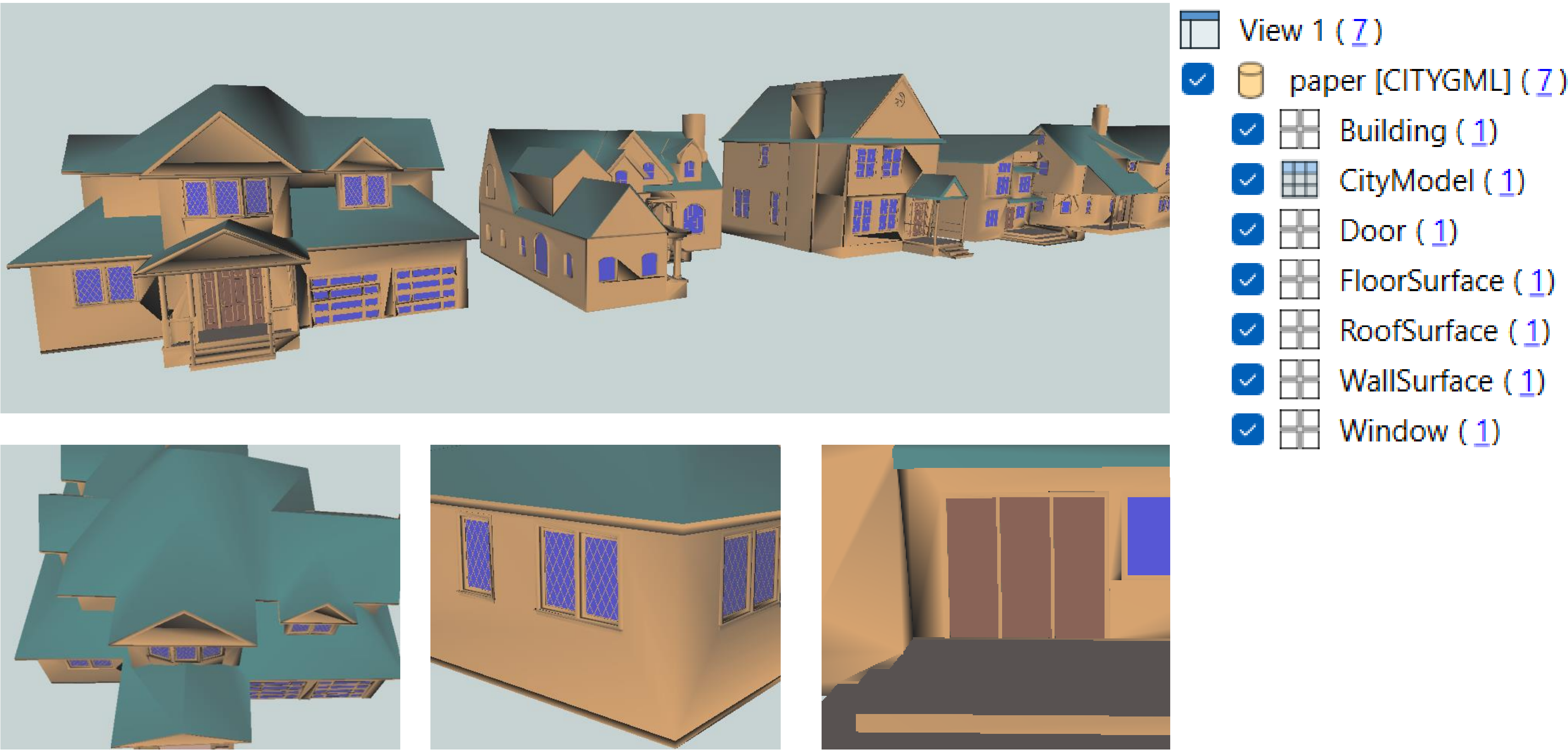
CONVERT LABELS TO CITYGML
- Manually fix missing/incorrect generated labels
- Convert semantic labels into CityGML data format

3. DATA CONVERSION



Semantic Segmentation of 3D Models

4. THE OUTCOME



The CityGML building models with semantic information.

The 3D LADM

- **Edition I** – Focus on Part 2: Land Registration (Main Packages - Party, Administrative, Spatial Unit)
- **Edition II** – (Part 3: Marine Georegulation, Part 4: Valuation Information, Part 5: Spatial Planning)
- **LADM adoption** – approximately 35% of the countries involved
- **Adoption purposes** – standardized data exchange, comprehensive land administration, 2D and 3D representation, linking to source document (e.g., BIM/IFC, CityGML)

The 3D LADM

- **Standardization –** ensuring consistency various systems
- **Interoperability –** facilitates data exchange
- **Data quality –** reduces inconsistencies
- **Flexibility –** allowing for the inclusion of additional attributes
- **Support for Sustainable Development –** promotes SDGs

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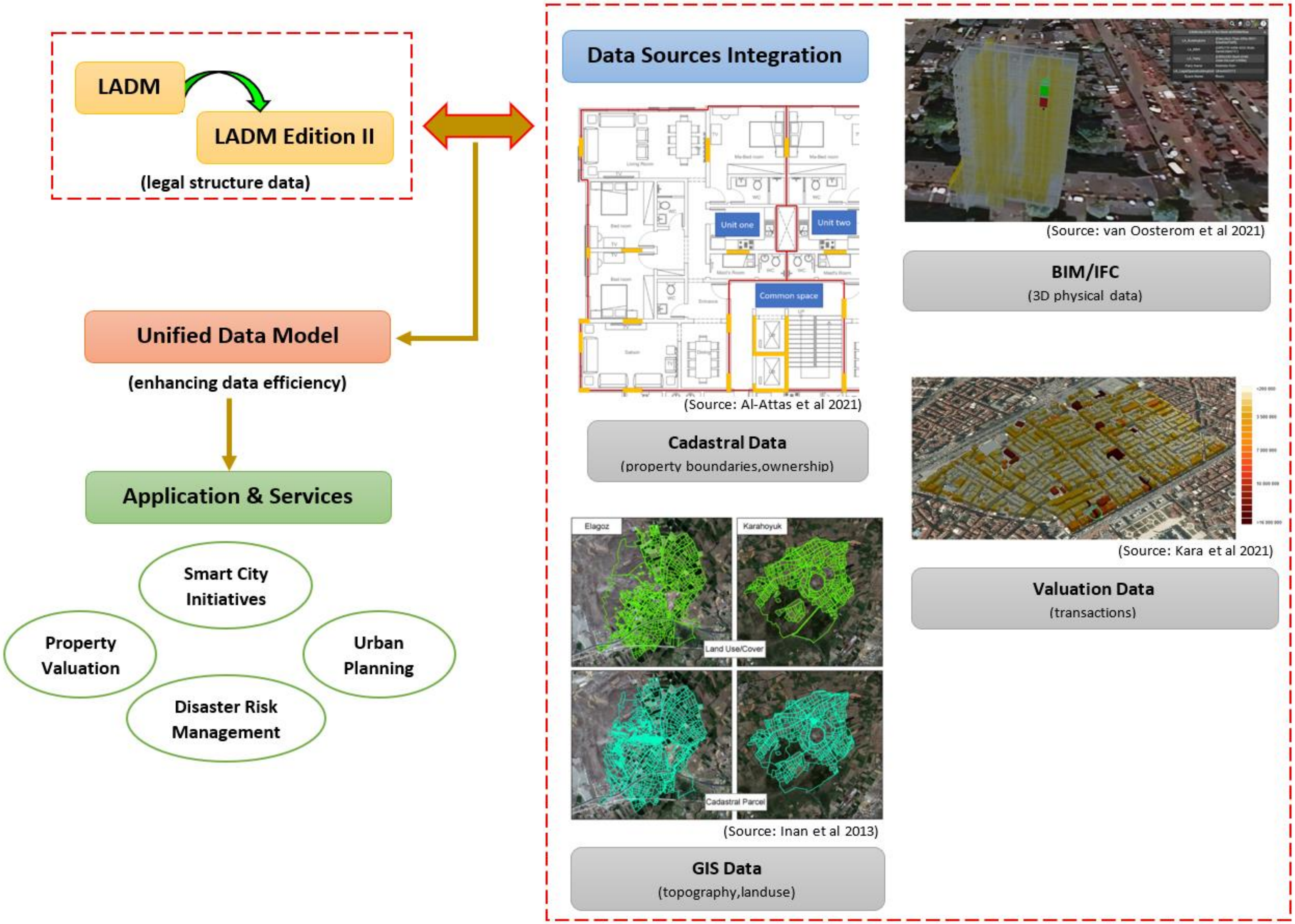
The LADM

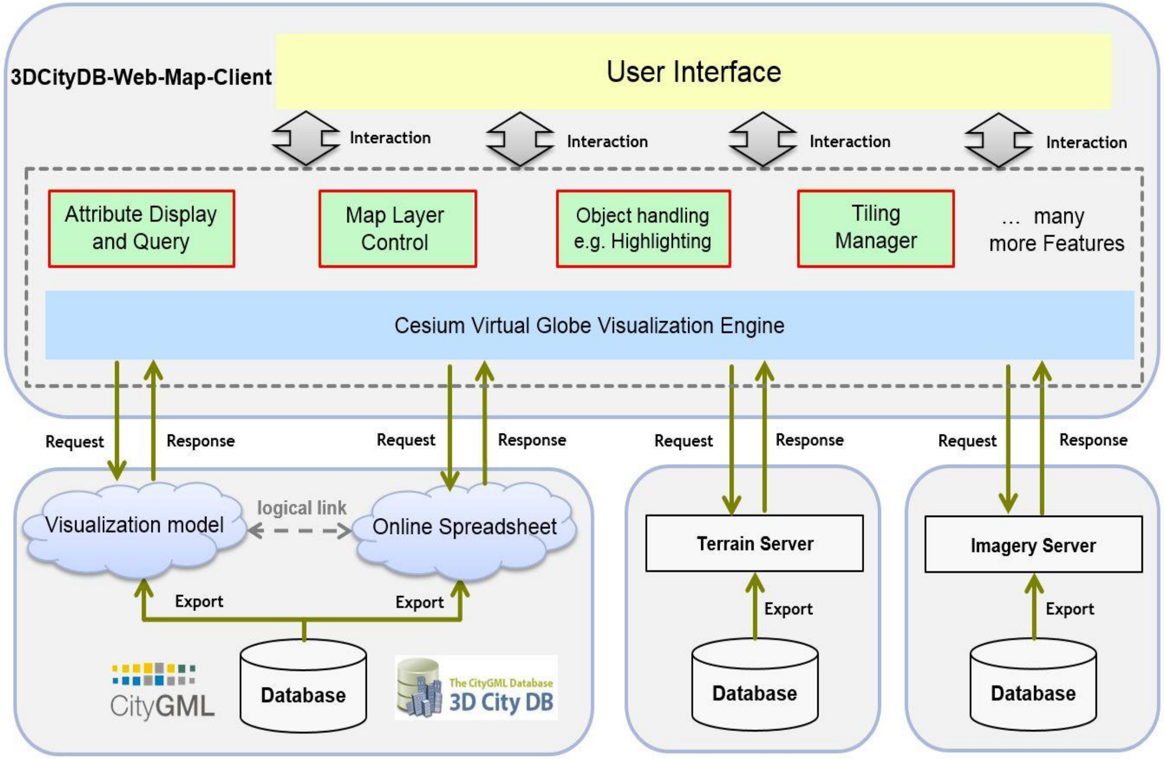


LADM for 3D

- 3D LA system shows physical and legal information (Mao, P., 2024)

Final remarks

Visualizing virtual 3D city models via CityGML database



CityGML database and visualization architecture.
(Courtesy of 3D City DB)

CityGML City of Berlin

Final remarks

- The development of 3D geoinformation – encompassing 3D GIS, 3D data fusion, semantic modeling, and 3D LADM – is highly linked with **computing**, **mathematics**, **databases**, and **visualization** (both web and desktop platforms).
- Significant **advancements** in techniques, processing, computing tools, algorithms, and data exchange standards significantly improved 3D geoinformation and LADM.

Thank you!