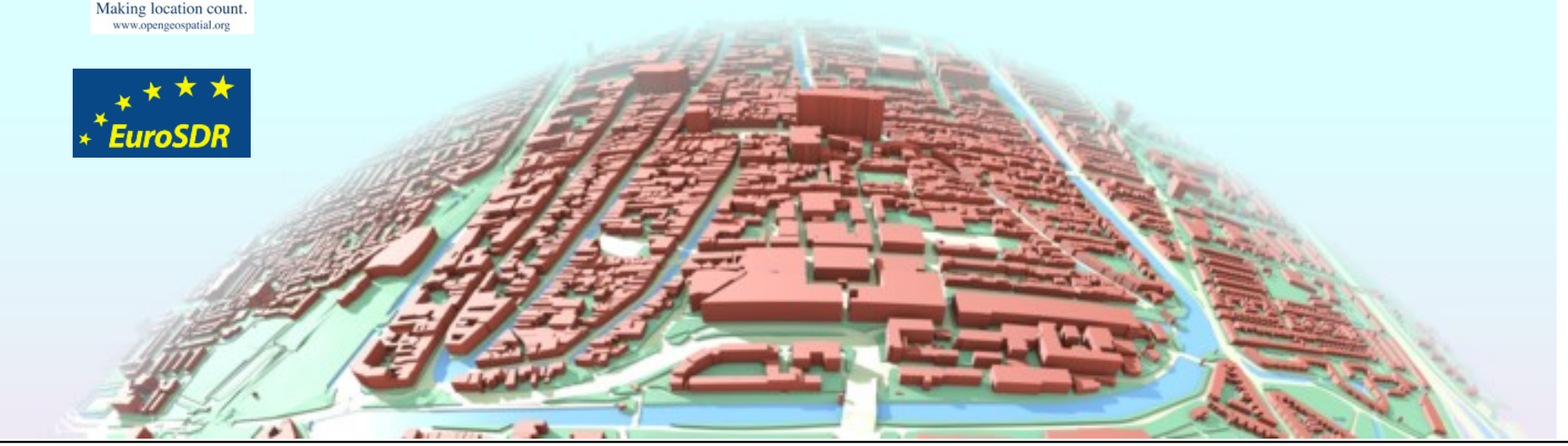
International 3D Developments

Jantien Stoter

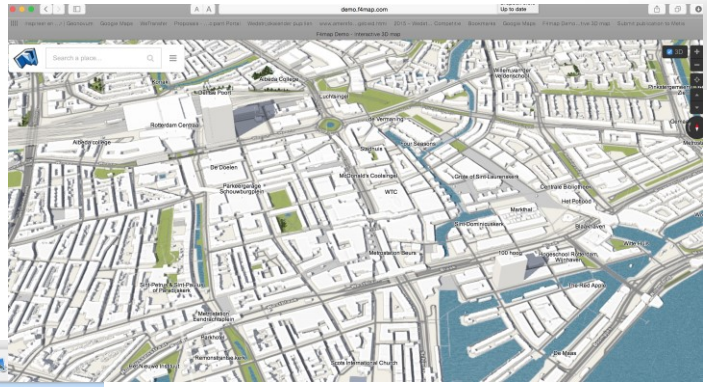
Professor 3D GeoInformation

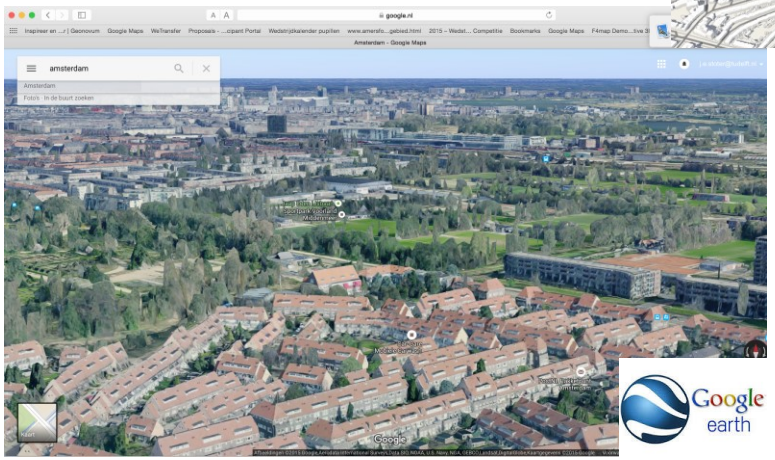


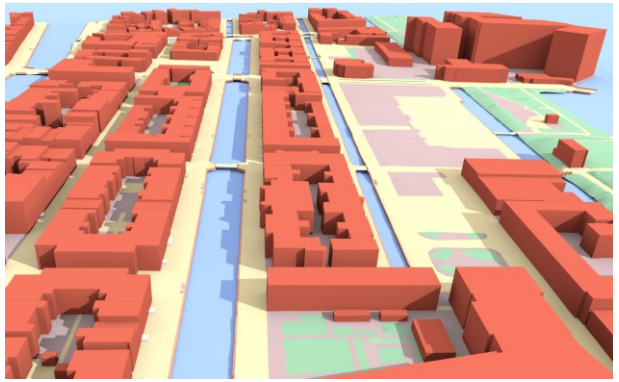
EuroSDR 3D Special Interest Group

Active participants:
Swisstopo, Ordnance Survey UK, Ordnance Survey Ireland, Kadaster NL, LM Sweden, IGN Belgium, ICGC Catalonia, NLS Finland, GUGIK Poland, IGN France, Denmark, Norway

3D is today!

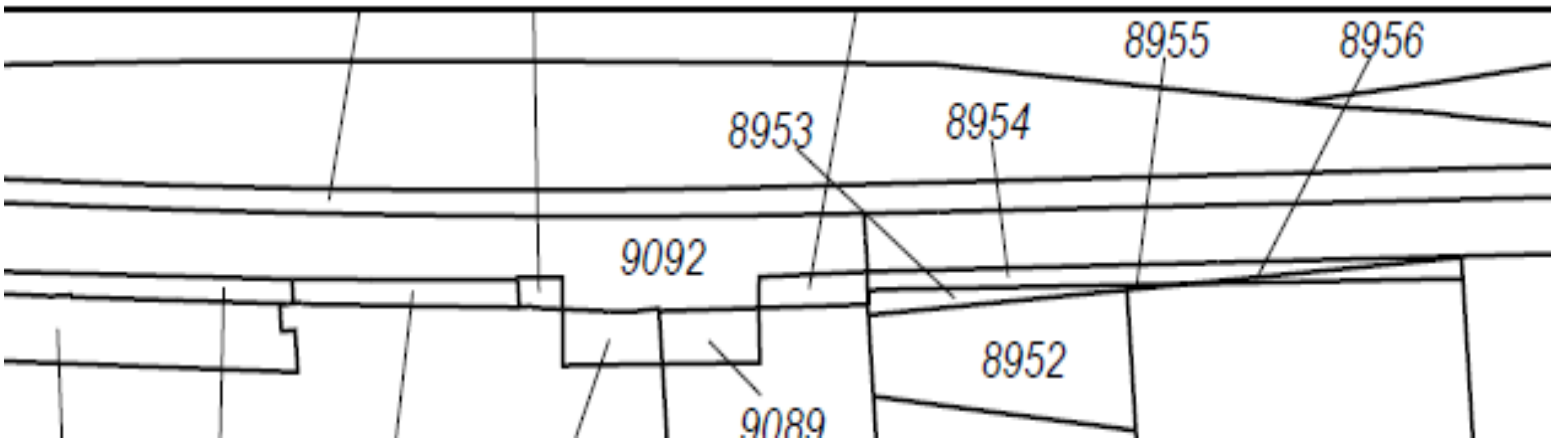






But:
Potentials of 3D are insufficiently used in geo

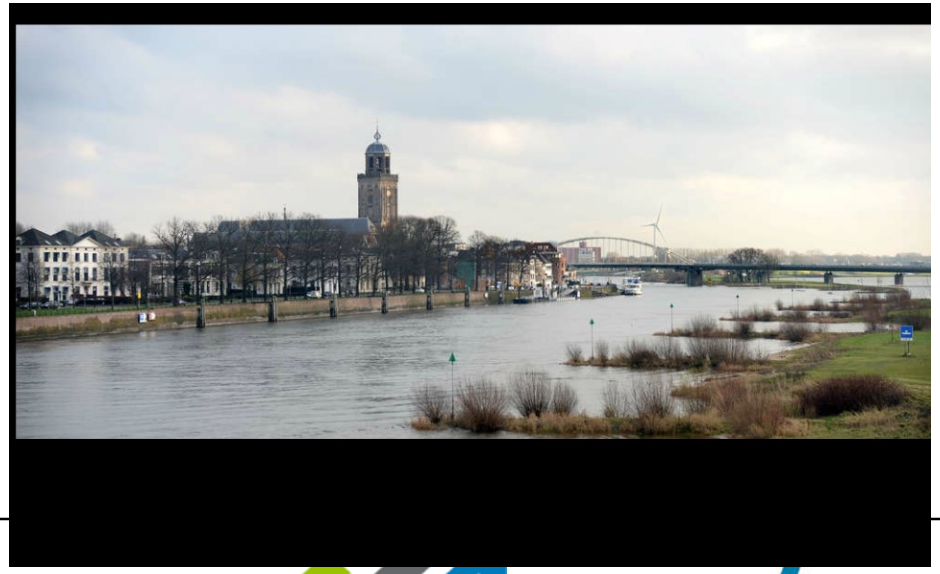
Uittreksel Kadastrale Kaart



In 2D: important information gets lost

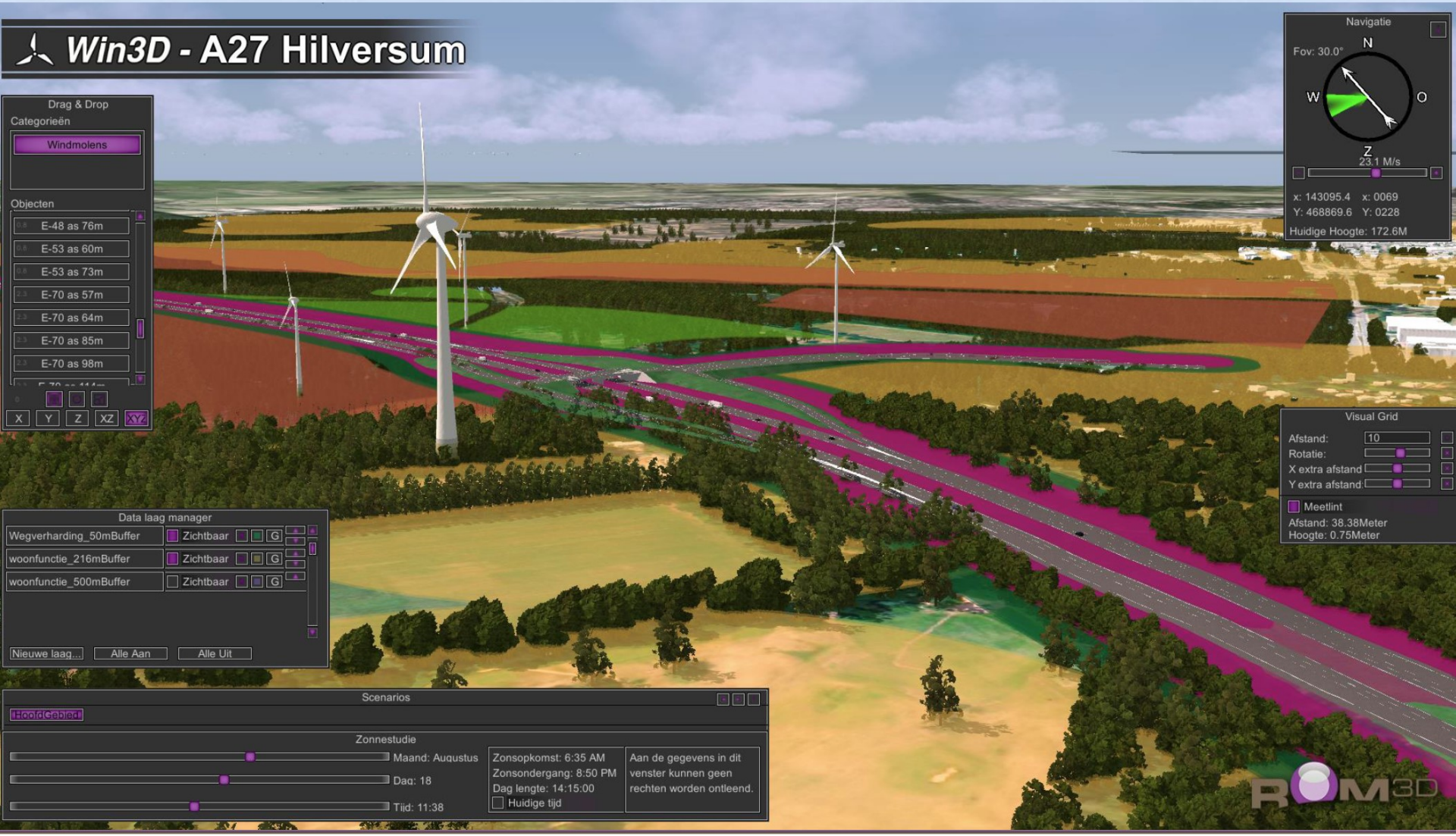
3D potentials are insufficiently used

Planned situation



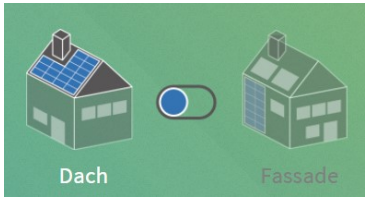
De Volkskrant 6 January 2016

WIN3D



ROM3D
ENERGIE VOOR HET LANDELIJK GEBIED

Example of good practice of 3D – Solarpotential (swissBUILDINGS^{3D} 2.0)



www.sonnendach.ch

Untere Bahnhofstrasse 8
8640 Rapperswil SG

Eignung: Sehr gut

Entweder Solarstrom im Wert von bis zu 1'400 Franken...

...oder Solarwärme für 15 % weniger Heizkosten.

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Bundesamt für Energie BFE
Bundesamt für Meteorologie und Klimatologie MeteoSchweiz
Bundesamt für Landestopografie swisstopo

“3D data have the potential to generate $13 billion in new benefits annually.”

–Snyder, GI, 2012, The 3D Elevation Program—Summary of Program Direction U.S. Geological Survey (Fact Sheet 2012-3089)

EuroSDR project on economic value of 3D geoinformation for NMAs (2016)

Main conclusion:

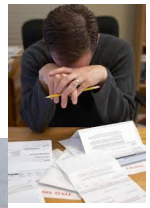
- significant positive return on investment from 3D geo-information even when considering **only two use cases in isolation (flooding & urban planning)**

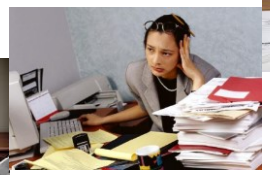
If 3D techniques have matured….

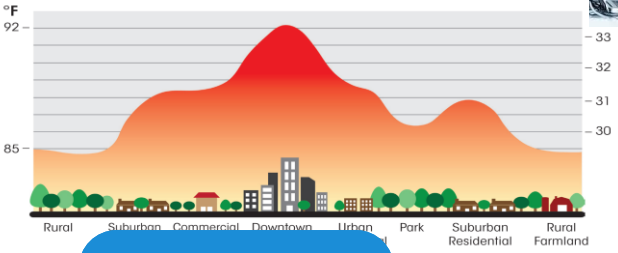
If 3D gives added value….

What is the problem?

Data, Data, Data

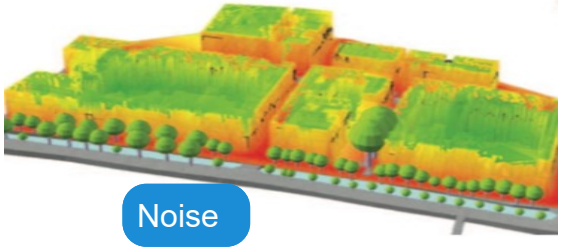






urban heat island

Where do I find usefull 3D data?



And thus it remains expensive and complicated to use 3D

What do we need?

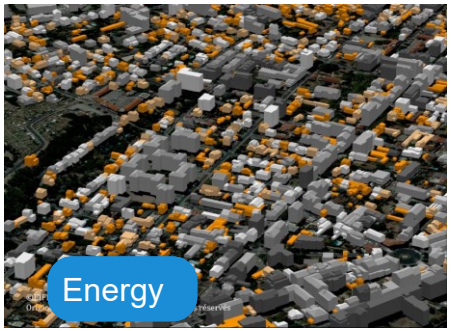
3D Geoinformation

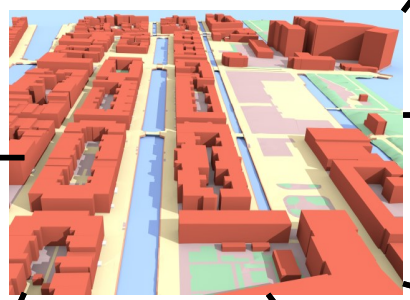
What do we need (and where are we working on)?

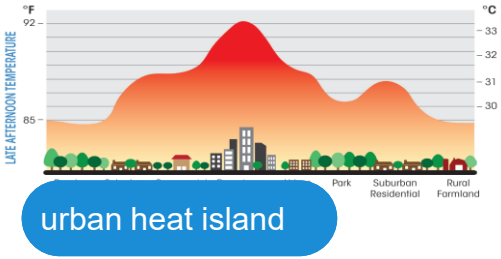
- **3D (national) standard**
- 3D data maintenance & quality
- 3D base data
- 3D data integration

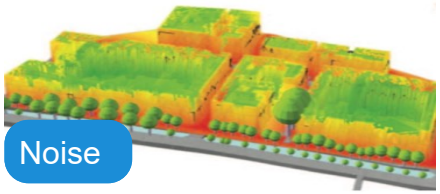
(National) 3D standard

- Solid, uniform base for 3D
- Makes 3D more efficient



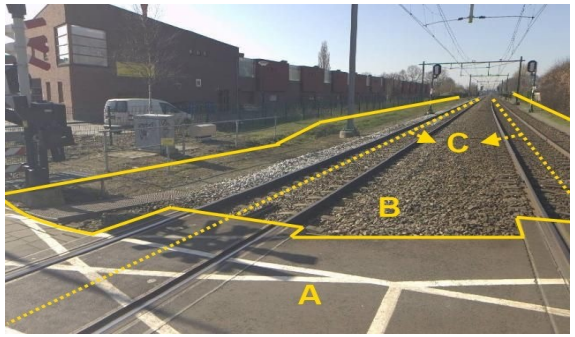






In NL: 2D standard for large scale topography Information Model Geography (IMGeo)

- Mandatory for governmental organisations

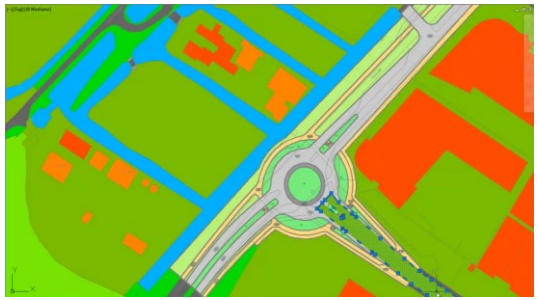


3D IMGeo?

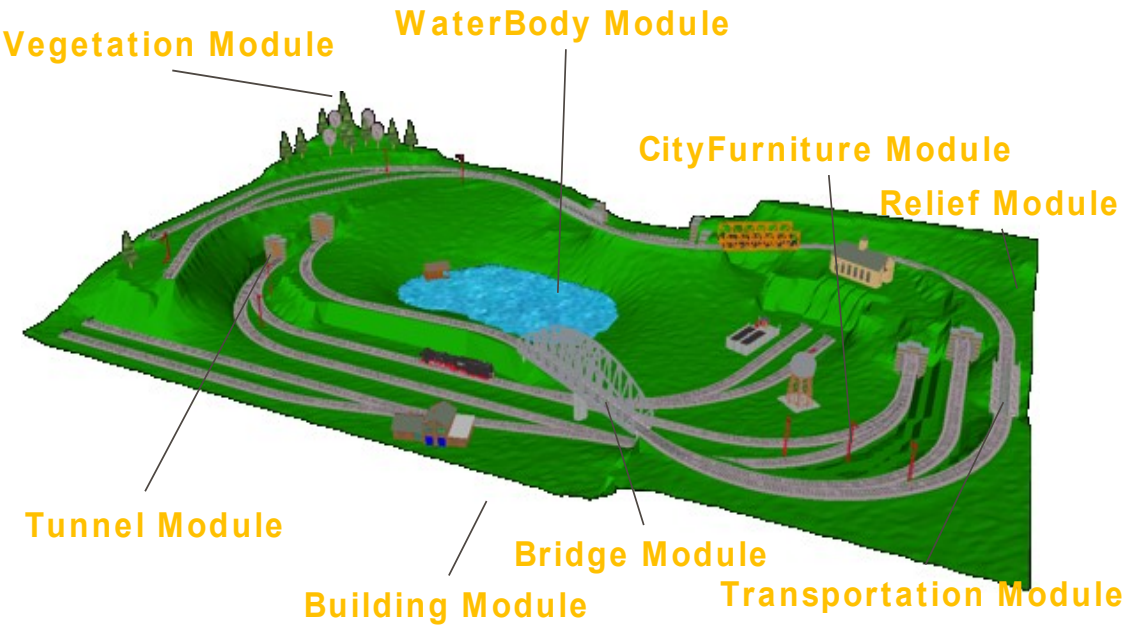
- **3D (national) standard**
- 3D data maintenance & quality
  - 3D base data
  - 3D data integration

Yes!
IMGeo modelled as CityGML ADE

IMGeo



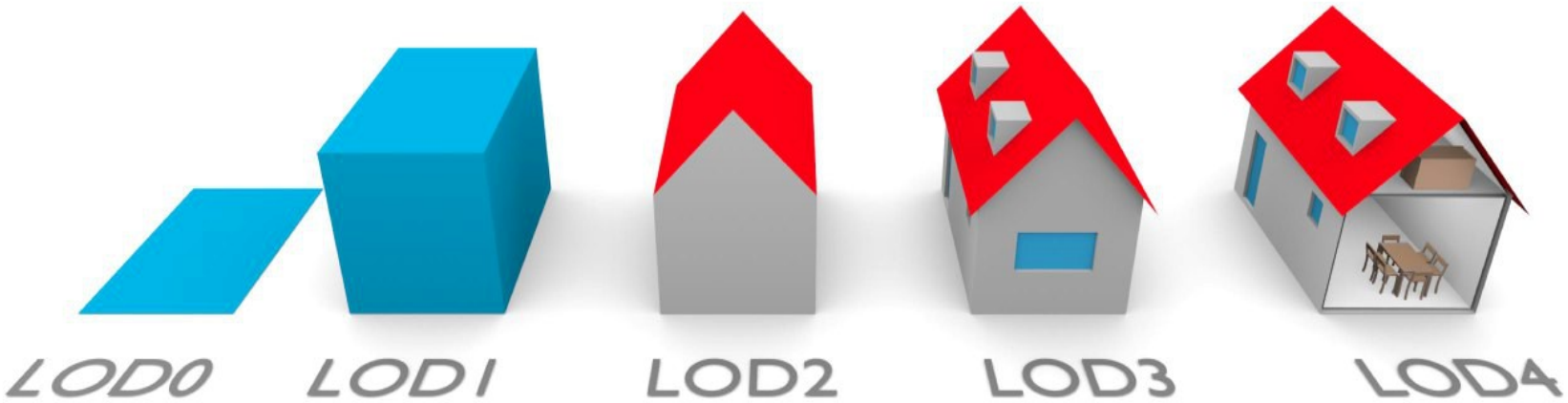
CityGML



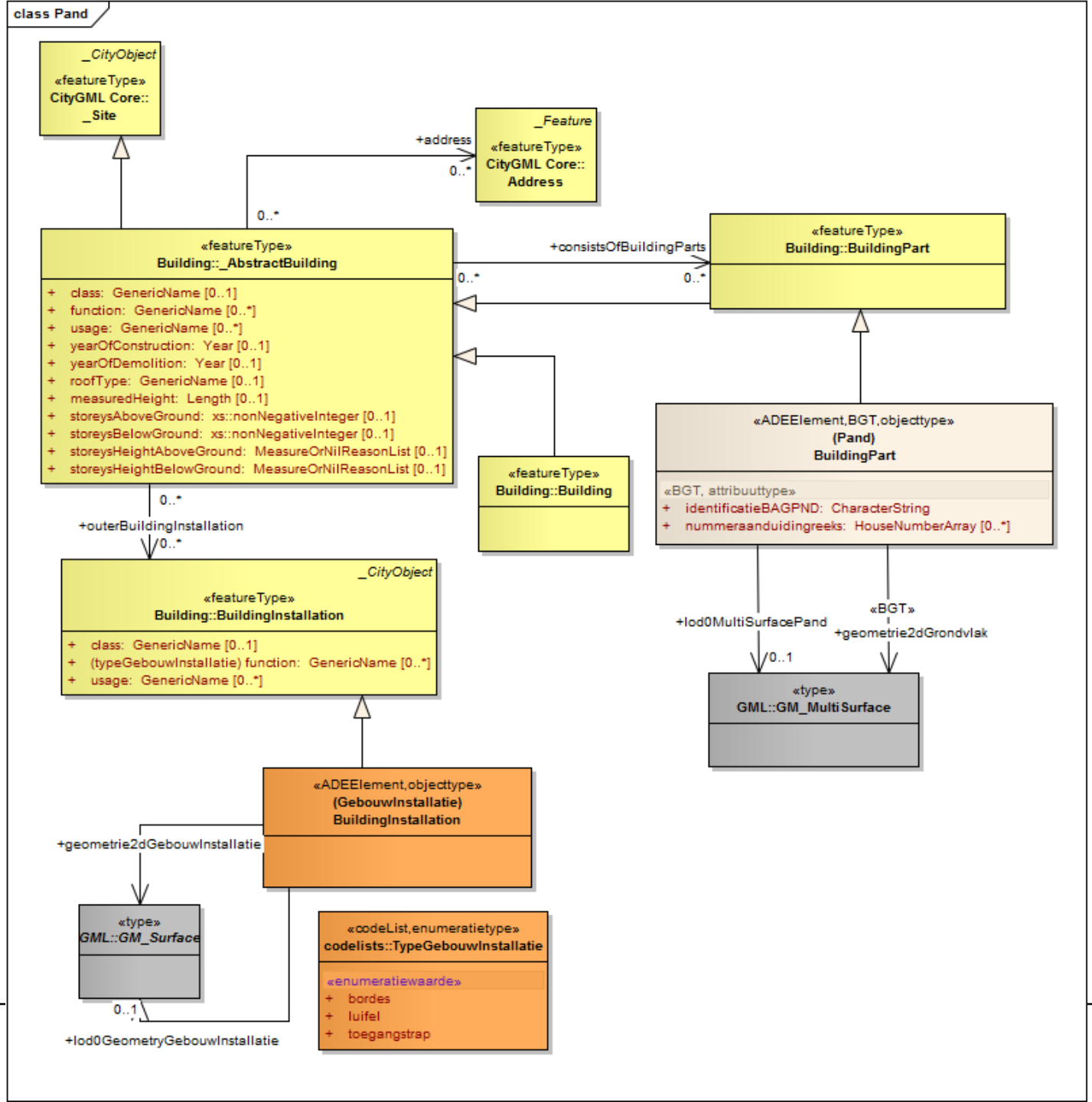
OGC
Making location count.
www.opengeospatial.org

TU Delft
GEONOVUM
kadaster

CityGML Levels of Detail



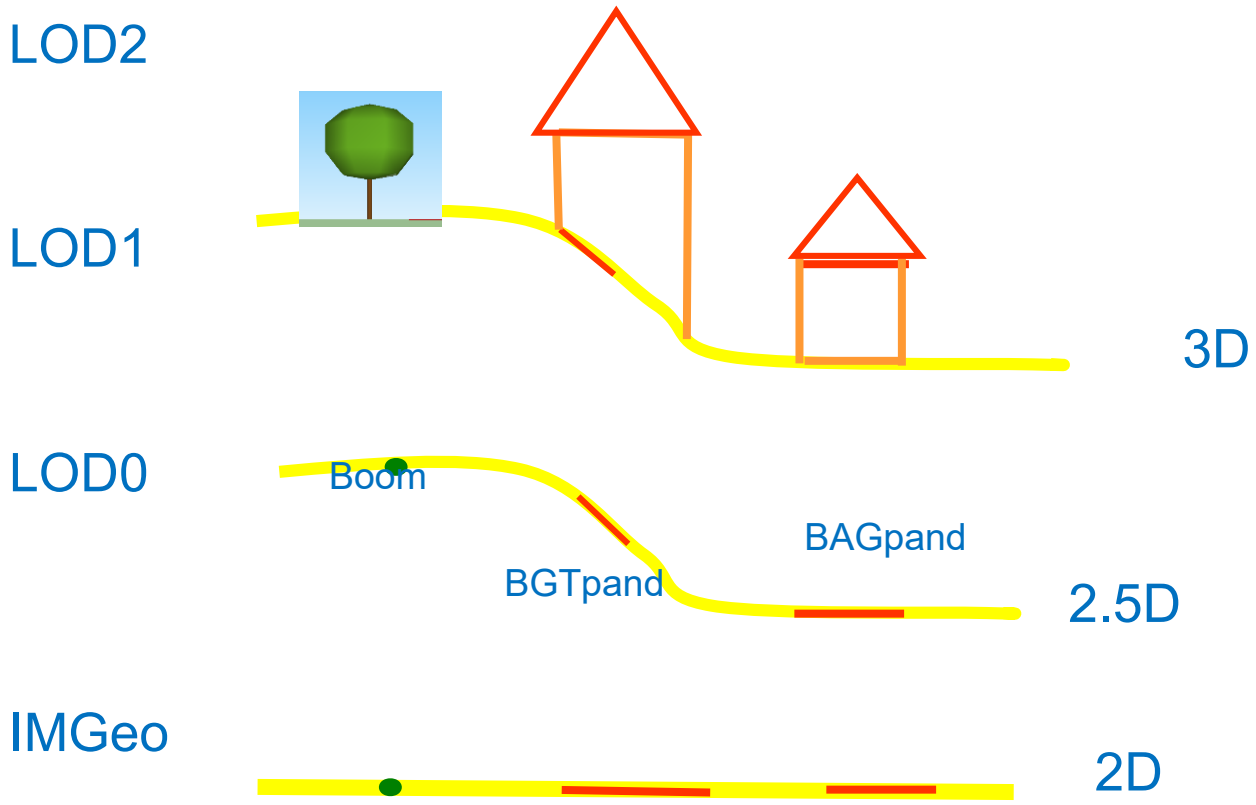
Filip Biljecki


class Pand
_CityObject
«featureType»
CityGML Core::
_Site
_Feature
«featureType»
CityGML Core::
Address
+address
0..*
0..*
«featureType»
Building::_AbstractBuilding
+ class: GenericName [0..1]
+ function: GenericName [0..*]
+ usage: GenericName [0..*]
+ yearOfConstruction: Year [0..1]
+ yearOfDemolition: Year [0..1]
+ roofType: GenericName [0..1]
+ measuredHeight: Length [0..1]
+ storeysAboveGround: xs::nonNegativeInteger [0..1]
+ storeysBelowGround: xs::nonNegativeInteger [0..1]
+ storeysHeightAboveGround: MeasureOrNilReasonList [0..1]
+ storeysHeightBelowGround: MeasureOrNilReasonList [0..1]
+consistsOfBuildingParts
0..*
0..*
«featureType»
Building::BuildingPart
«featureType»
Building::Building
«ADEElement,BGT,objecttype»
(Pand)
BuildingPart
«BGT, attribuuttype»
+ identificatieBAGPND: CharacterString
+ nummeraanduidingreeks: HouseNumberArray [0..*]
0..*
+outerBuildingInstallation
0..*
_CityObject
«featureType»
Building::BuildingInstallation
+ class: GenericName [0..1]
+ (typeGebouwInstallatie) function: GenericName [0..*]
+ usage: GenericName [0..*]
+lod0MultiSurfacePand
0..1
«BGT»
+geometrie2dGrondvlak
«type»
GML::GM_MultiSurface
«ADEElement,objecttype»
(GebouwInstallatie)
BuildingInstallation
+geometrie2dGebouwInstallatie
«type»
GML::GM_Surface
0..1
+lod0GeometryGebouwInstallatie
«codeList,enumeratietype»
codelists::TypeGebouwInstallatie
«enumeratiewaarde»
+ bordes
+ luifel
+ toegangstrap

TU Delft

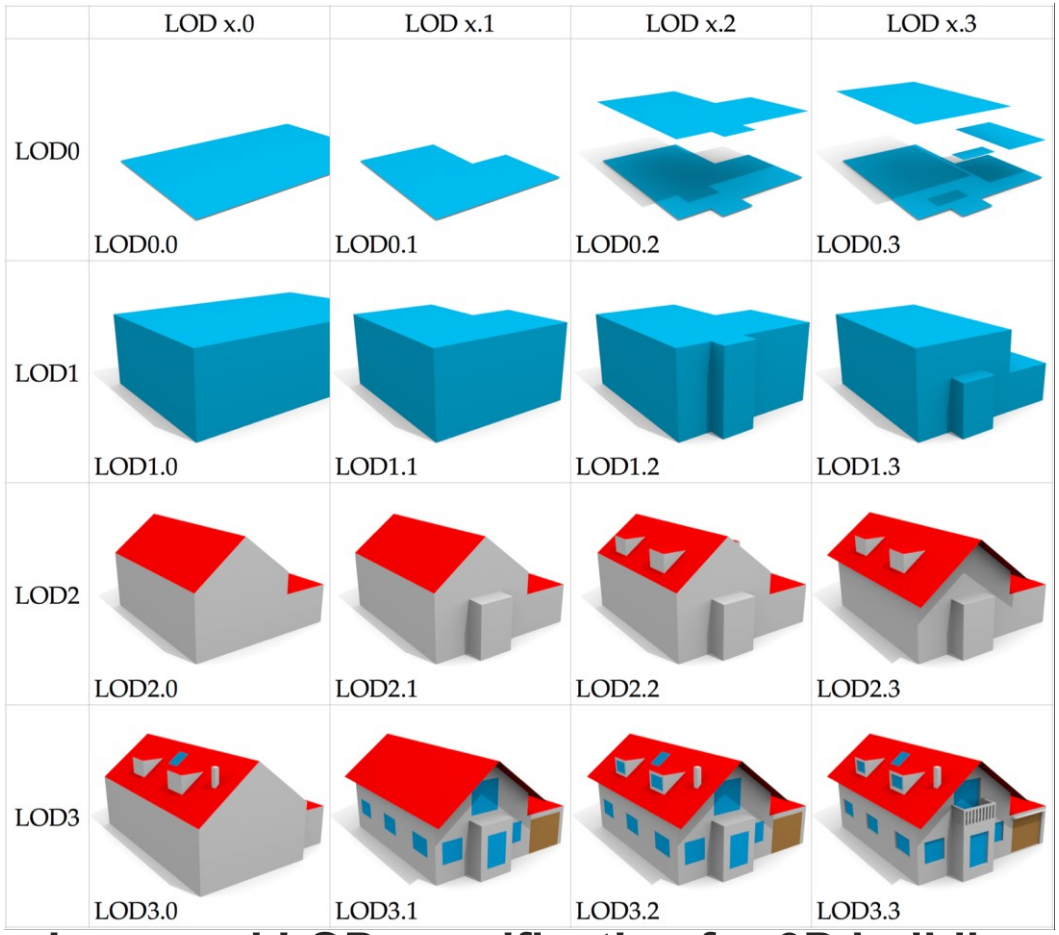
Information Model Geography

- **3D (national) standard**
- 3D data maintenance & quality
  - 3D base data
  - 3D data integration



Specifying Levels of Detail of 3D data
Which one is optimal for the application?

- **3D (national) standard**
- 3D data maintenance & quality
  - 3D base data
- 3D data integration

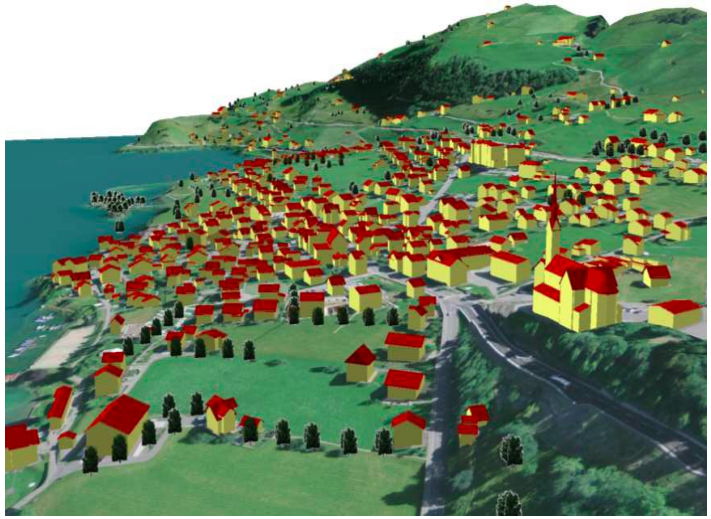


An improved LOD specification for 3D building models
Filip Biljecki, Hugo Ledoux, Jantien Stoter
Computers, Environment and Urban Systems, vol. 59, September 2016, pp. 25-37.

TU Delft GEONOVUM kadaster

Common definition (classification) of 3D modelling

- To have same understanding (needed for collaboration)
- To be able to articulate our 3D needs to industry, standardisation organisations, science



3D Geoinformation

What do we need?

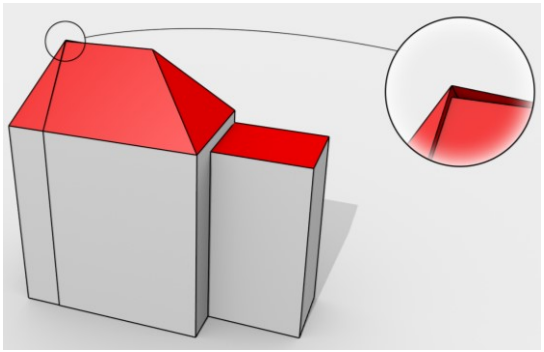
- 3D national standard
- **3D data maintenance & quality**
- 3D base data
- 3D data integration

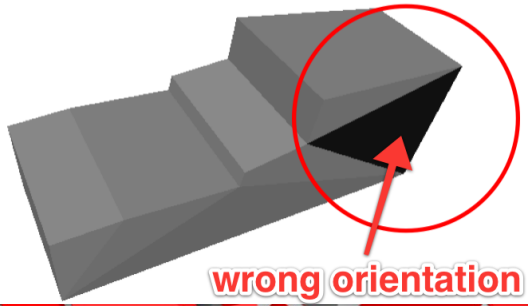
3D data is required

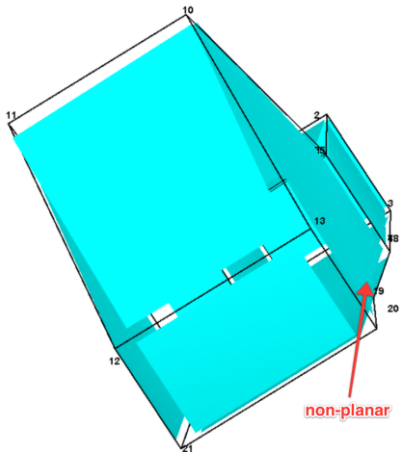
- Beyond the “wow” effect
  - Up to date (always)
  - Consistent
  - Authentic
  - Nationwide
  - Without errors
  - etc

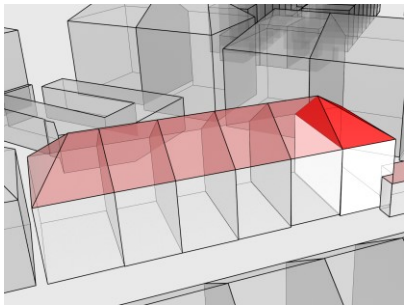
errors = common in 3D

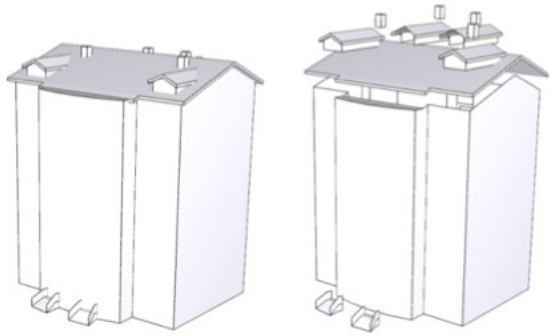
- 3D (national) standard
- **3D data maintenance & quality**
  - 3D base data
  - 3D data integration









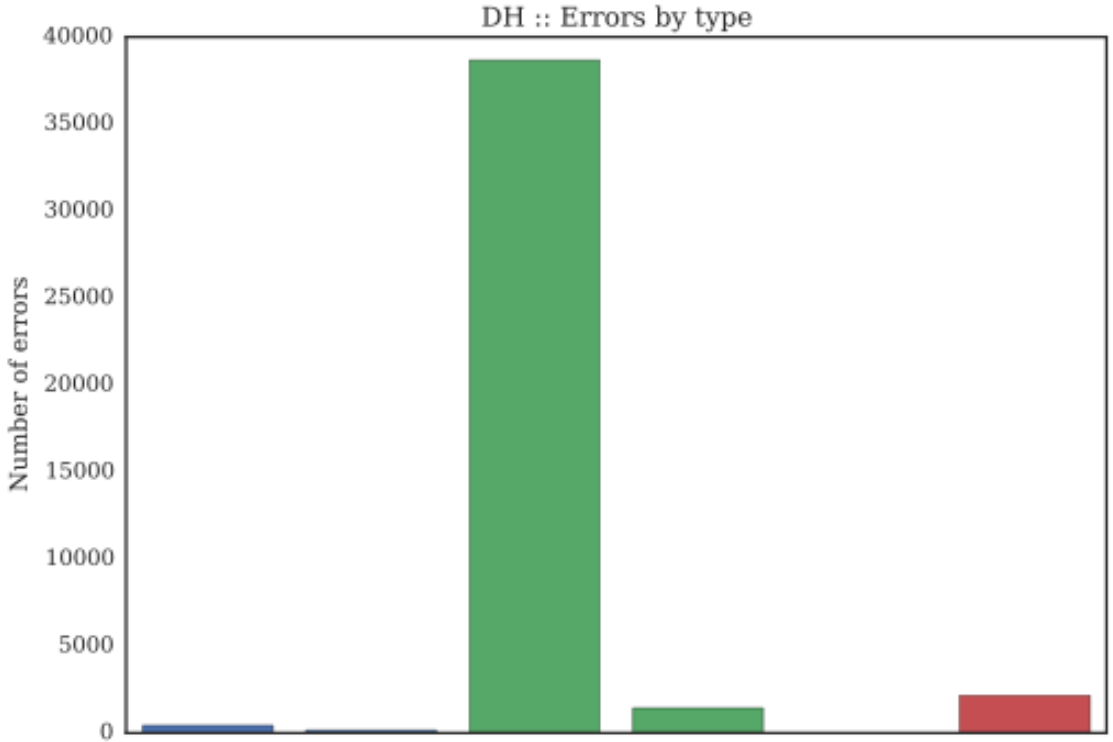


Software to validate 3D data

- free & open-source
- web interface: http://geovalidation.bk.tudelft.nl
- According to international standards (ISO19107 & OGC)
- Reads CityGML

By: Hugo Ledoux

- 3D (national) standard
- **3D data maintenance & quality**
  - 3D base data
  - 3D data integration



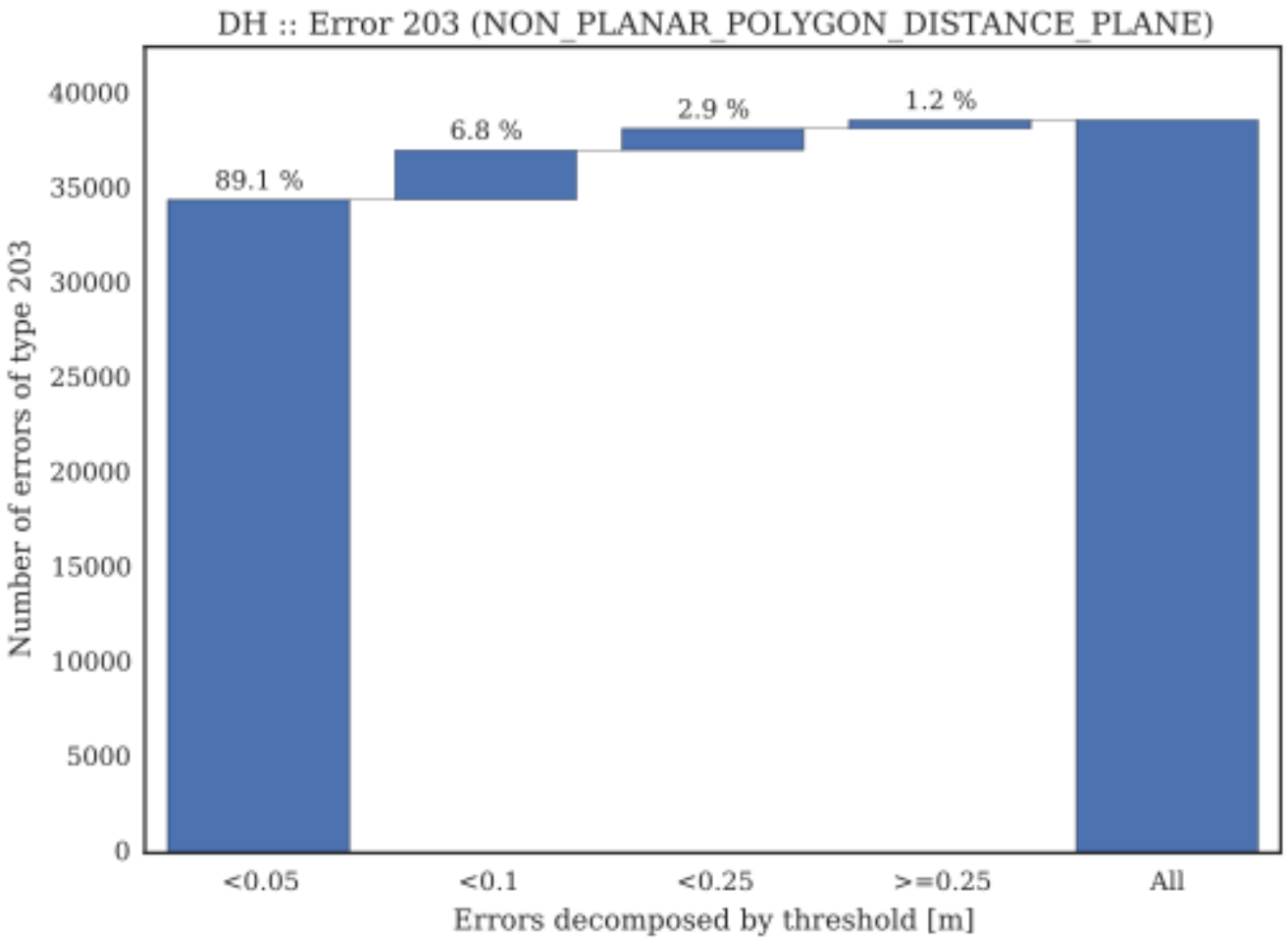
ISPRS Annals of the Photogrammetry, Remote Sensing and Spatial Information Sciences, Volume IV-2/W1, 2016
11th 3D Geoinfo Conference, 20–21 October 2016, Athens, Greece

THE MOST COMMON GEOMETRIC AND SEMANTIC ERRORS IN CITYGML DATASETS

F. Biljecki [a,*], H. Ledoux [a,*], X. Du [a], J. Stoter [a], K. H. Soon [b], V. H. S. Khoo [b]

[a] 3D Geoinformation, Delft University of Technology, Delft, The Netherlands — (f.biljecki, h.ledoux, x.du-2, j.e.stoter)@tudelft.nl
[b] Singapore Land Authority, Singapore — (soon_kean_huat, victor_khoo)@sla.gov.sg

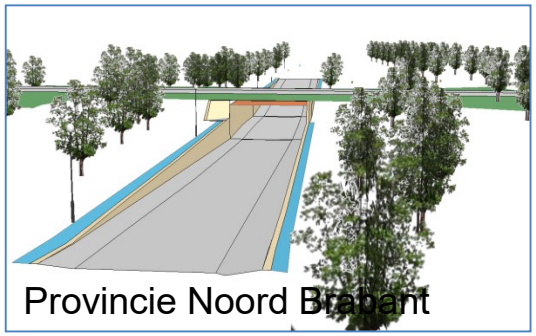
- 3D (national) standard
- **3D data maintenance & quality**
  - 3D base data
  - 3D data integration

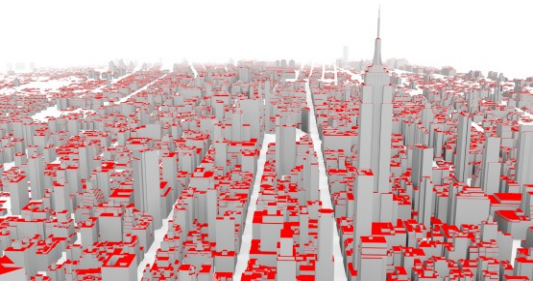


3D Geoinformation

- **What do we need?**
  - 3D national standard
  - 3D data maintenance & quality
  - **3D base data**
  - 3D data integration

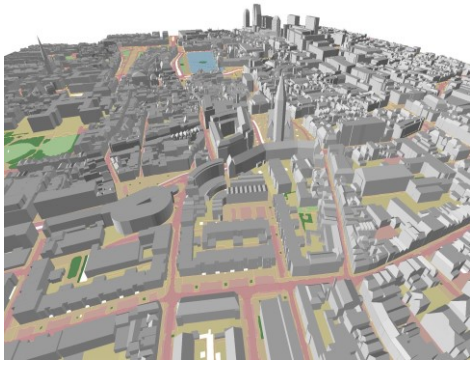
3D data available



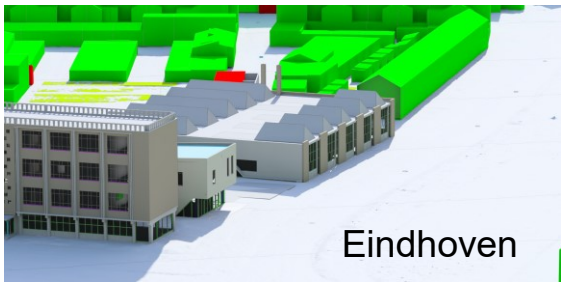


New York

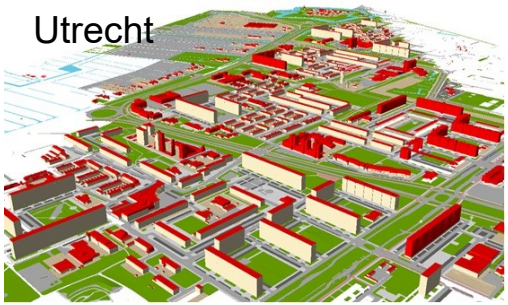
Rotterdam



Den Haag

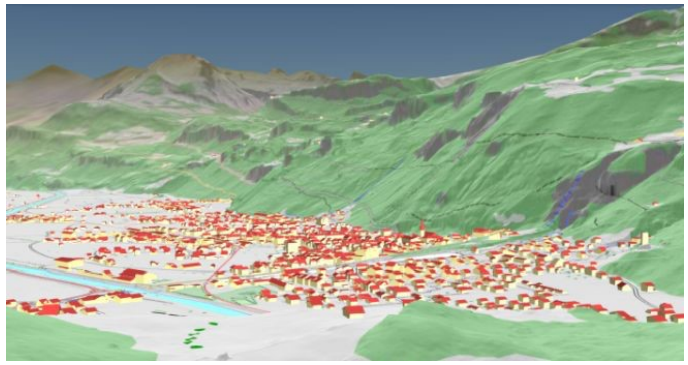


Utrecht



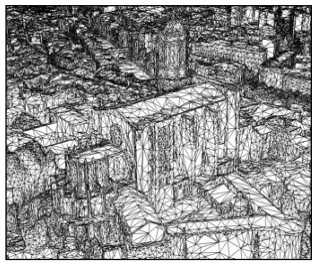
3D data products

Two possibilities

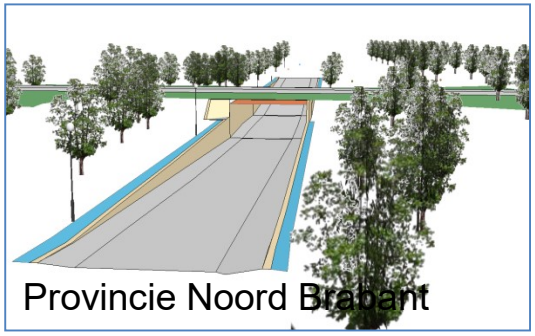


swisstopo

- 3D as base -> 2D derived



ICGC
Institut
Cartogràfic i Geològic
de Catalunya

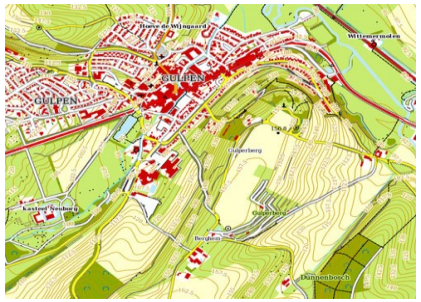


Provincie Noord Brabant

- More often: 3D models are generated from 2D

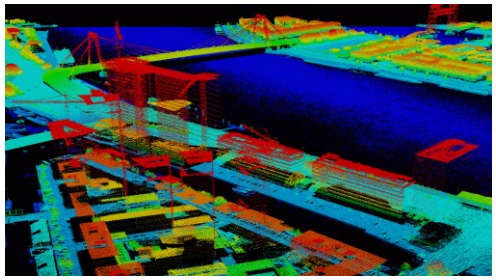
- 3D (national) standard
- 3D data maintenance
- **3D base data**
- 3D data integration

3D NL: available for whole NL

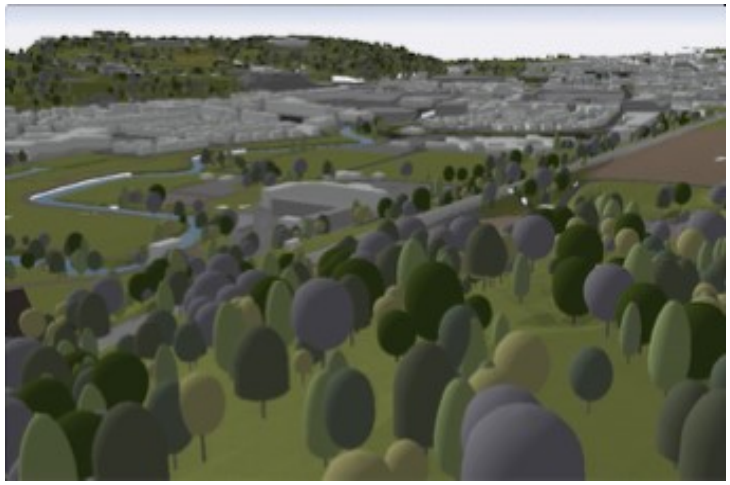


TOP10NL

+



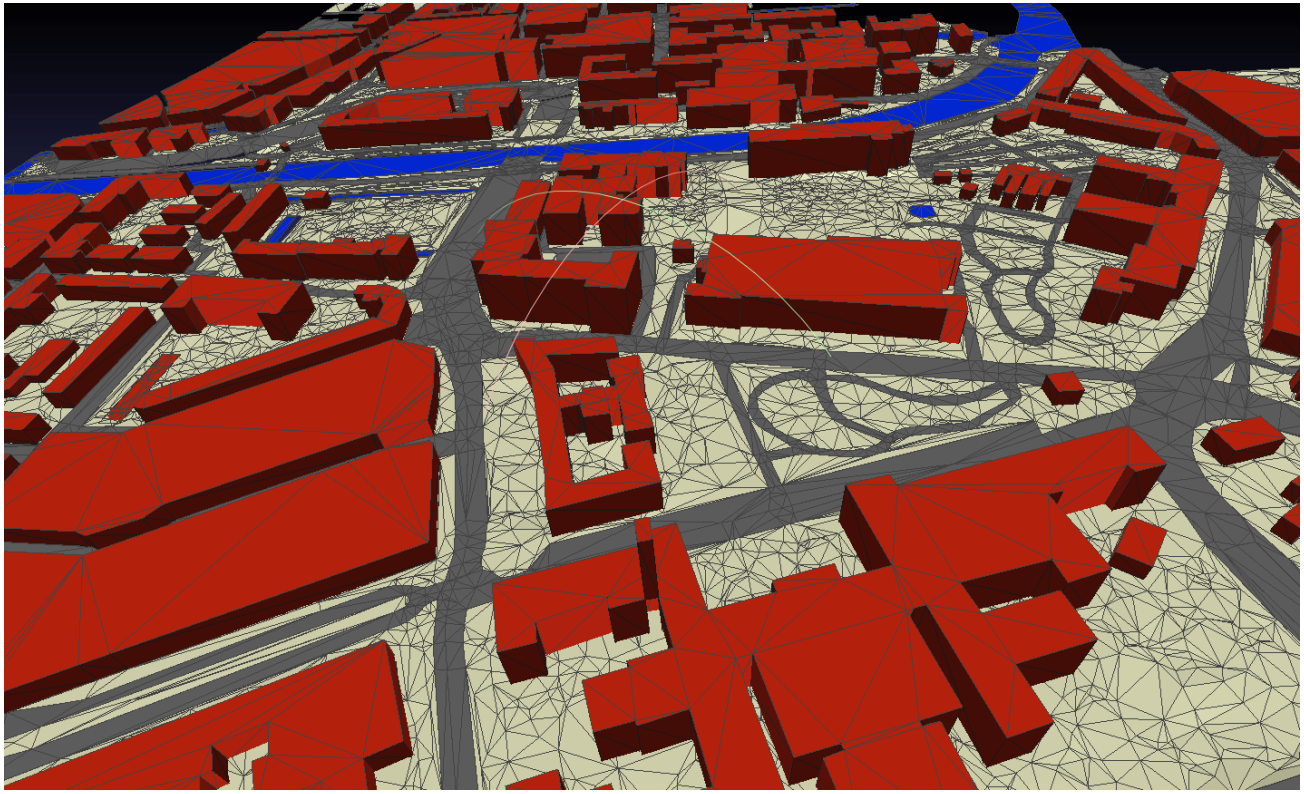
Lidar point clouds



3dfier

- 3D (national) standard
- 3D data maintenance
- **3D base data**
- 3D data integration

- Open-source toolkit to construct (valid!) large 3D city models



By: Hugo Ledoux

- 3D (national) standard
- 3D data maintenance
  - **3D base data**
- 3D data integration

Build and update virtual model NL with 3dfier

kadaster

esri Nederland

cyclomedia

- And link to applications (noise, water)

TU Delft

GEONOVUM

kadaster

3D Geoinformation

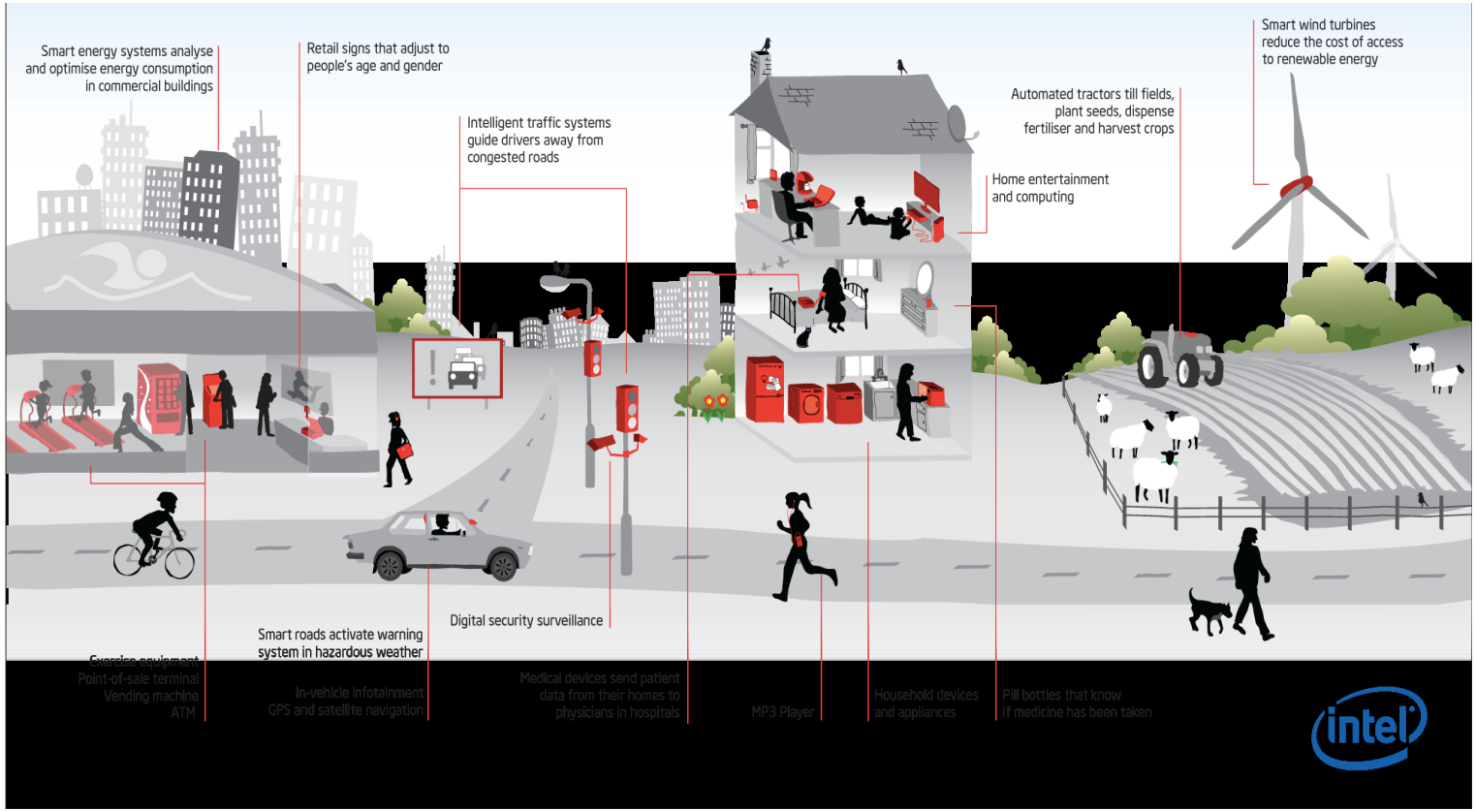
What do we need?

- 3D national standard
- 3D data maintenance & quality
- 3D base data
- **3D data integration**

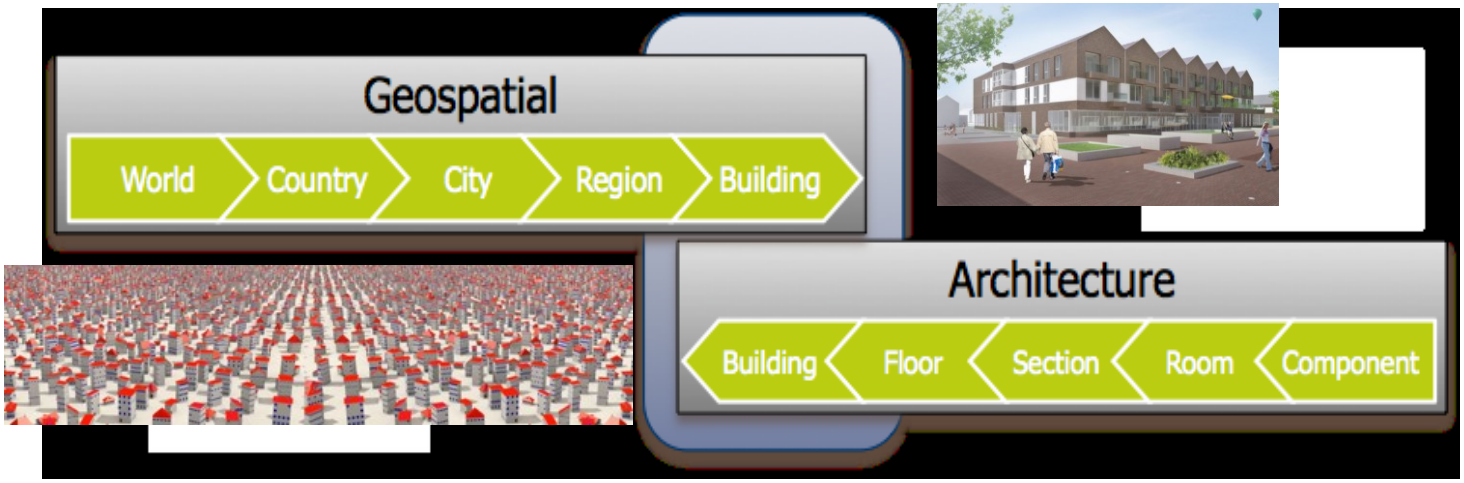
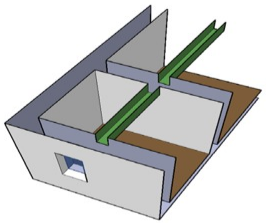
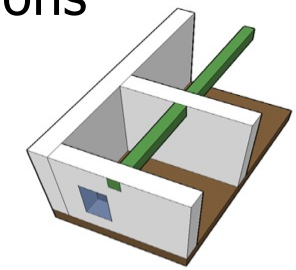
- 3D (national) standard
- 3D data maintenance
- 3D base data
- **3D data integration**

Data integration: power of 3D!

Smart cities: “The city knows what is happening where”

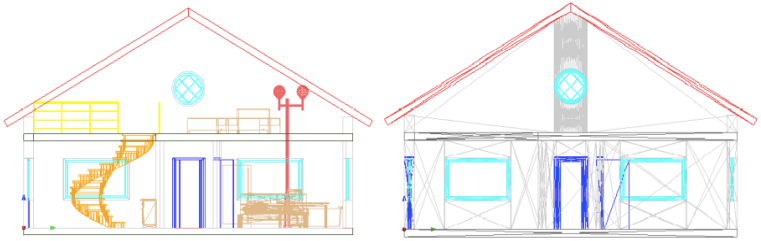


TU Delft GEONOVUM kadaster

	3D GIS	BIM
Focus area:		• 3D (national) standard • 3D data maintenance • 3D base data • **3D data integration**
Concepts:	Geographical concepts: space, outdoor shell 	Constructions 
Data:	Measured	Designed

BIM-GIS integration

= more than geometric conversion from IFC (BIM) to CityGML (GIS)



Without interpretation

With interpretation

Automatic conversion of IFC datasets to geometrically and semantically correct CityGML LOD3 building, Sjors Donkers, Hugo Ledoux, Junqiao Zhao, and Jantien Stoter, 2014

Bridging Geo-BIM gap

- Aims:
  - To reuse each others data
  - To have one, coherent digital view on built environment
- How?:
  - 1st step: understand how BIM data is used in Geo and vv
  - Acknowledge the differences (not “throwing over the fence”)
  - Develop interface to use:
    - Geo data structured in BIM for BIM app
    - BIM data structured in Geo for Geo app
    - Prepare data for better conversion
- With experts and users from both domains

- 3D (national) standard
- 3D data maintenance
- 3D base data
- **3D data integration**

Project GeoBIM

1. open-source API to represent IFC + CityGML with the same data structure
2. Apply to use cases
3. Recommendations for future integration

Gemeente Rotterdam

Gemeente Den Haag

TU/e Technische Universiteit Eindhoven University of Technology

IfcOpenShell
the open source ifc toolkit and geometry engine

CGAL

kadaster

Rijkswaterstaat

GEONOVUM

TNO innovation for life

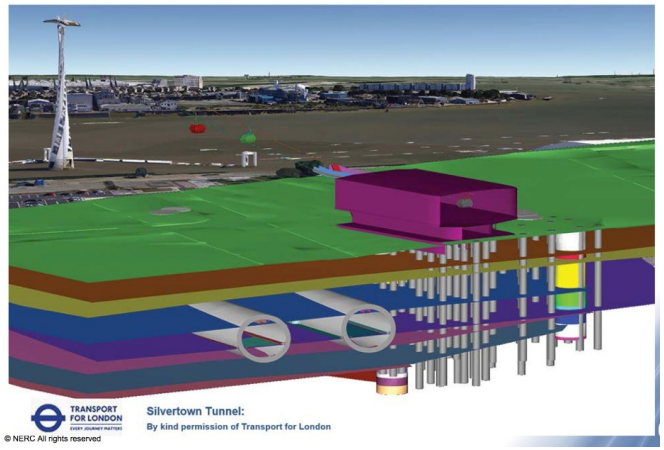
BIM Loket

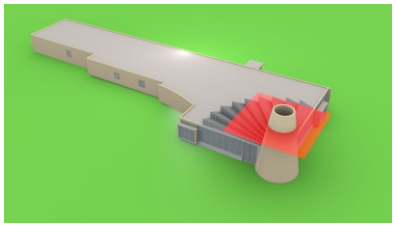
EuroSDR Geo/BIM project

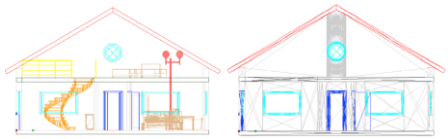
- 3D (national) standard
- 3D data maintenance
- 3D base data
- **3D data integration**

European Spatial Data Research

- Identify use cases
- Develop appropriate transformation in each use case
- Formulate recommendations for standardisation organisations (OGC)



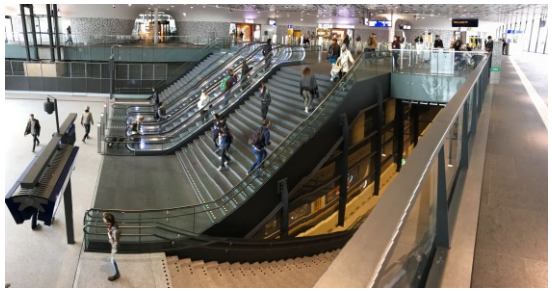




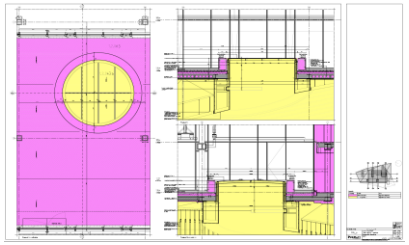
Partners:
OSUK
Swisstopo
OSI
Kadaster
ICGC
GUGiK
IGNF
Lantmateriet
NLS

Example Geo&BIM integration
1st 3D cadastral registration, Railway station Delft

Real situation



2D registration



3D registration

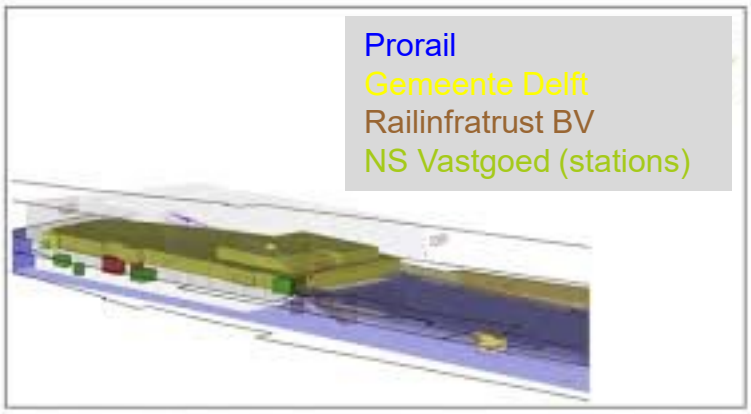
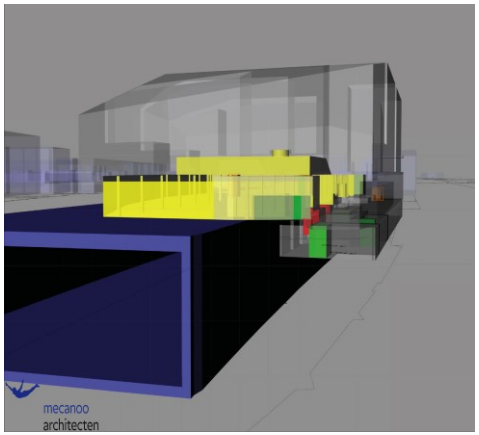
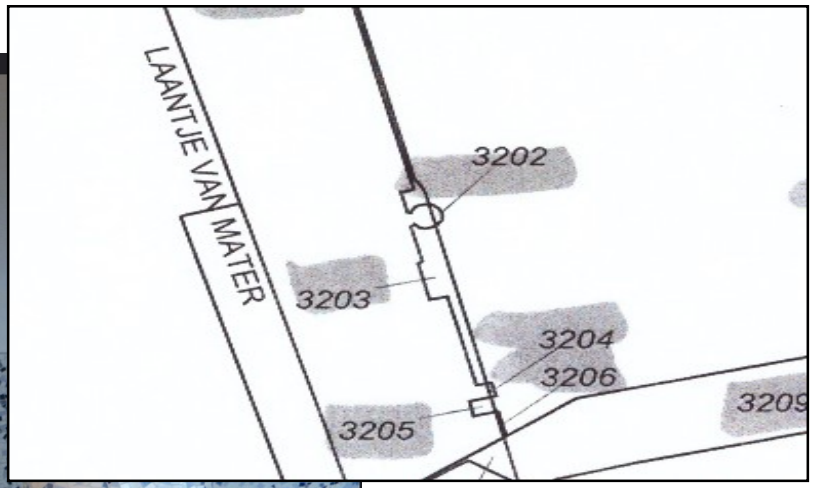
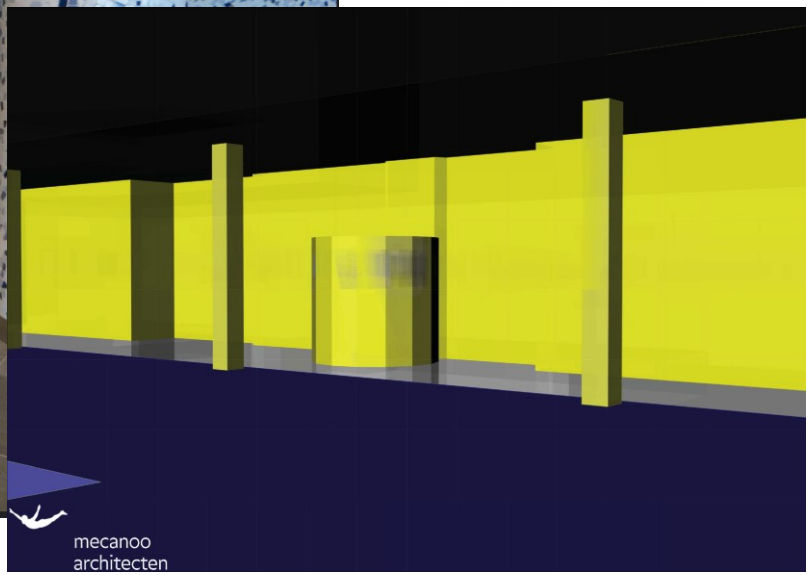


Figure 4. 3D PDF, official document that visualises the multi-level property rights in 3D (case Delft station).



Added value of 3D



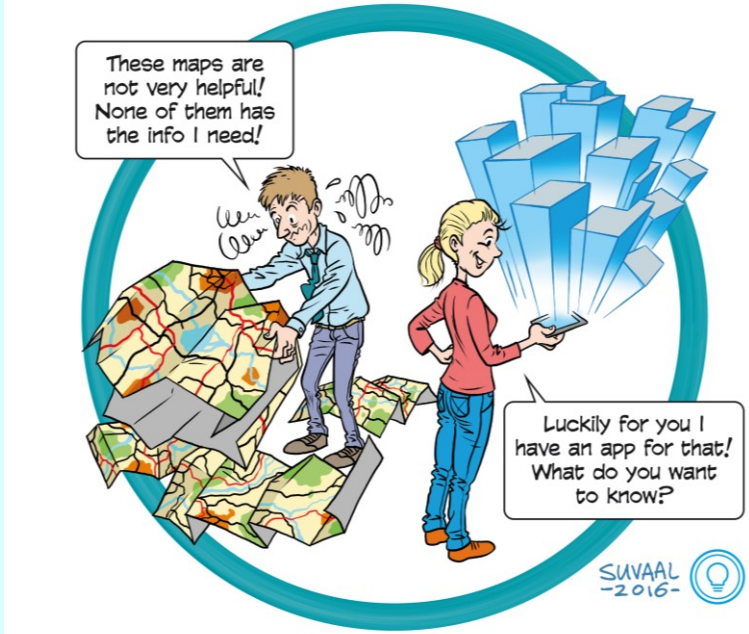


Conclusion
Advances in **3D Geoinformation**

Requires:

- Common 3D base with data beyond the wow effect
- Standardisation, validation: international collaboration!
- Most important challenge: 3D data integration
  - Voxel-vector
  - Below and above surface
  - GIS/BIM
  - Across domain boundaries
  - ……

Thanks to all my colleagues



j.e.stoter@tudelft.nl

3d.bk.tudelft.nl