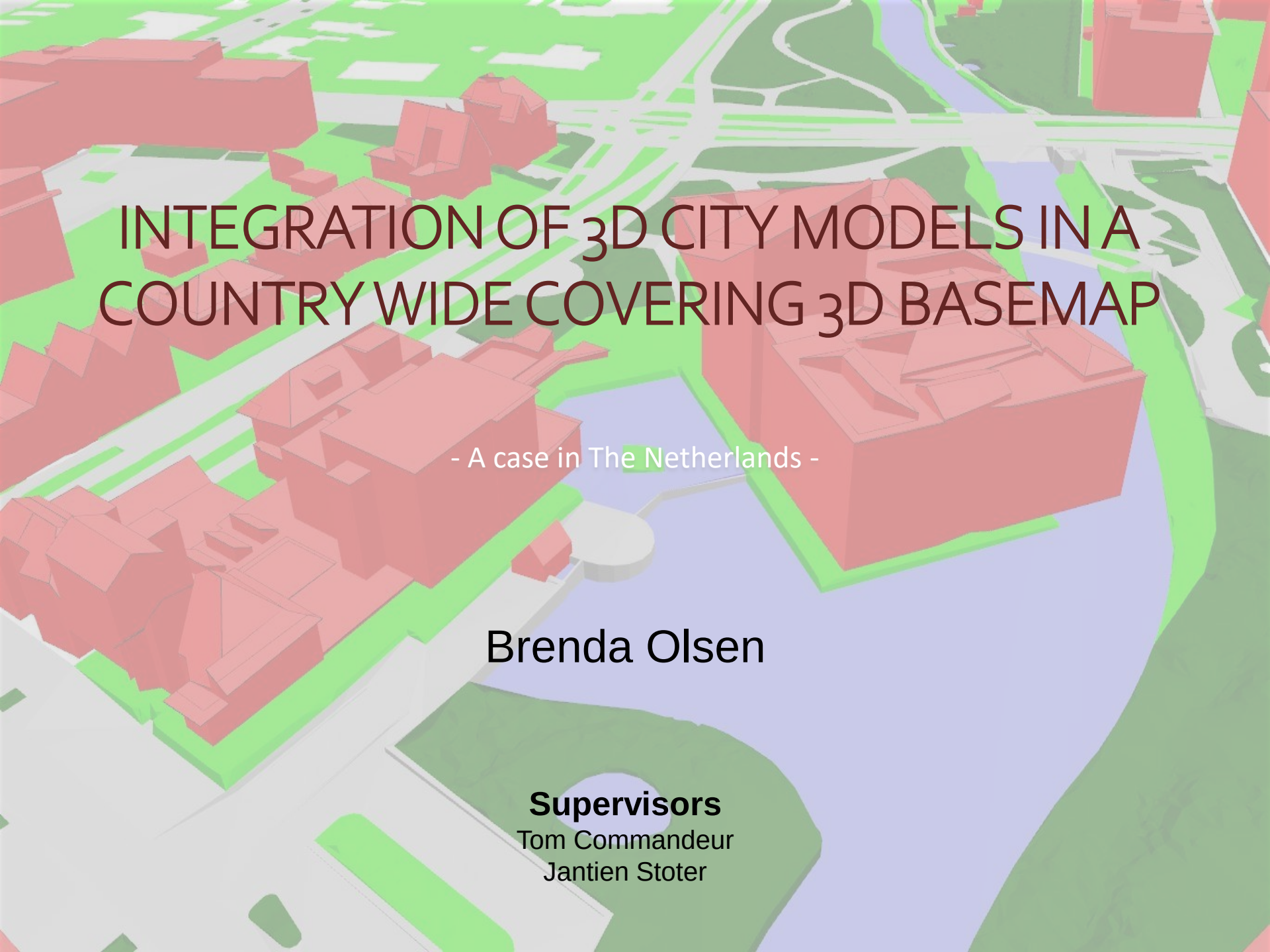


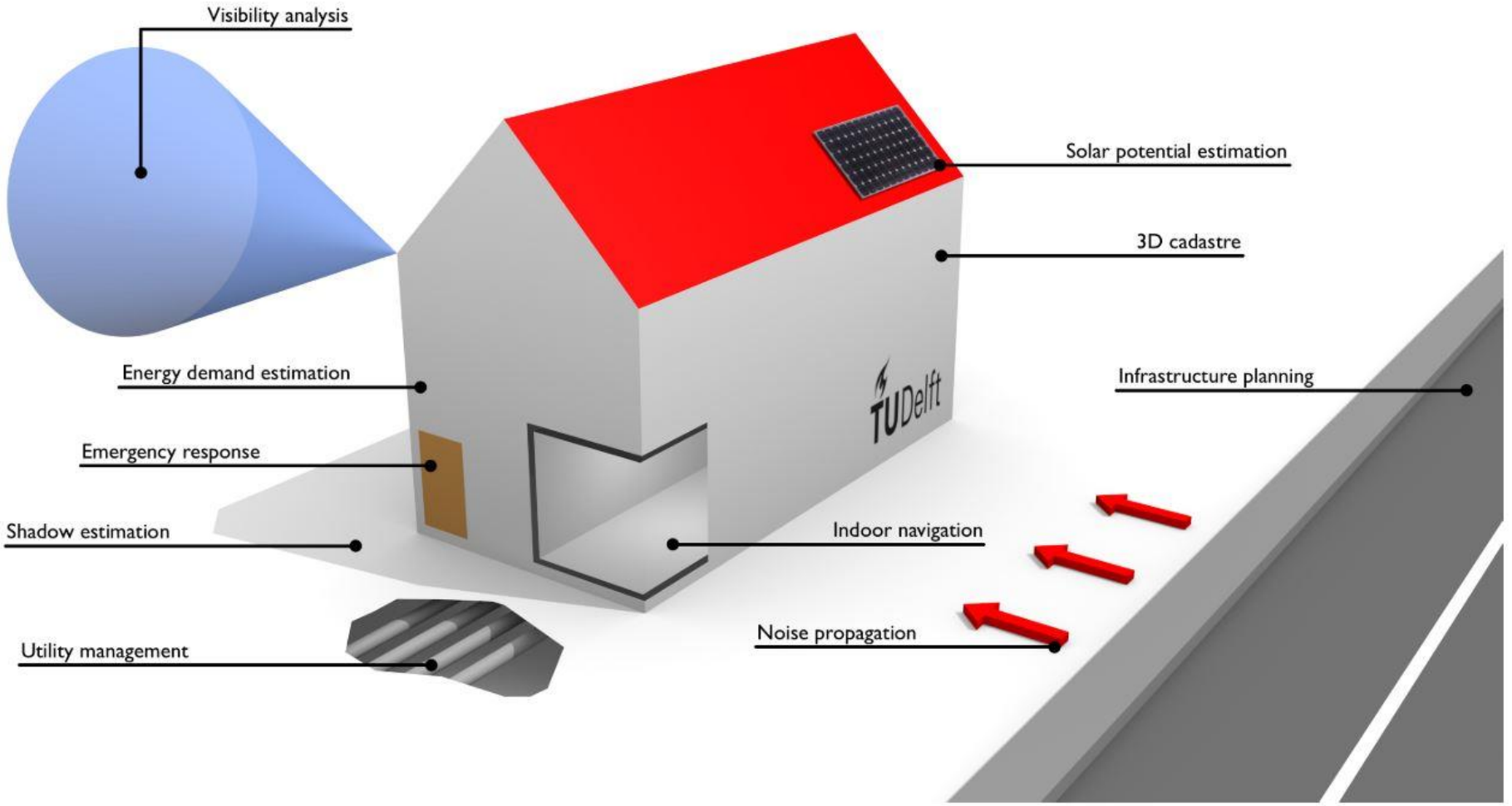
INTEGRATION OF 3D CITY MODELS IN A COUNTRY WIDE COVERING 3D BASEMAP

- A case in The Netherlands -

Brenda Olsen

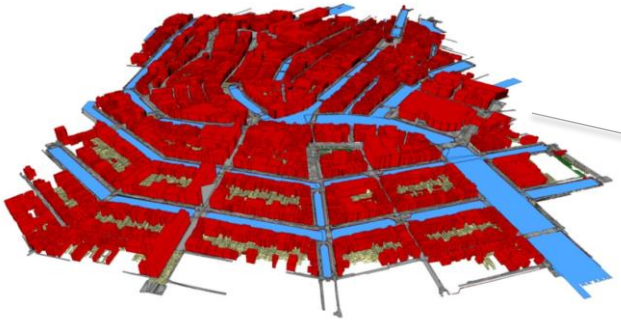
Supervisors
Tom Commandeur
Jantien Stoter

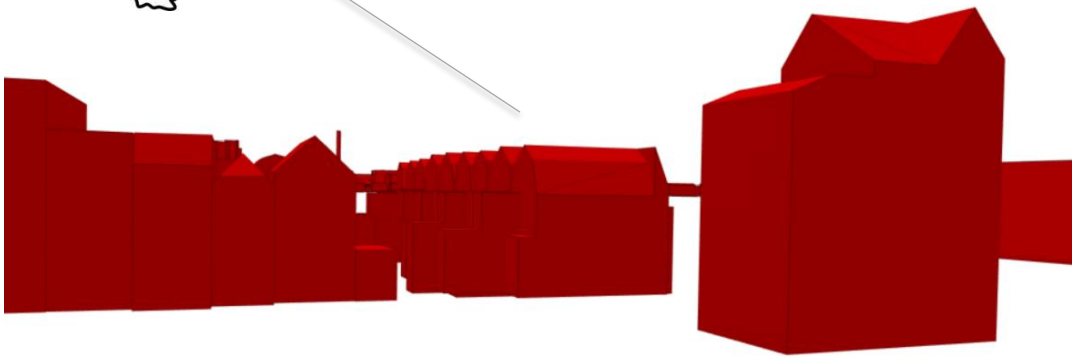
Motivation



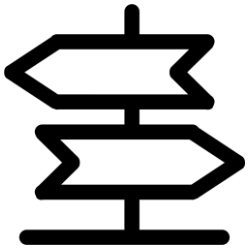
[Biljecki et al., 2015]

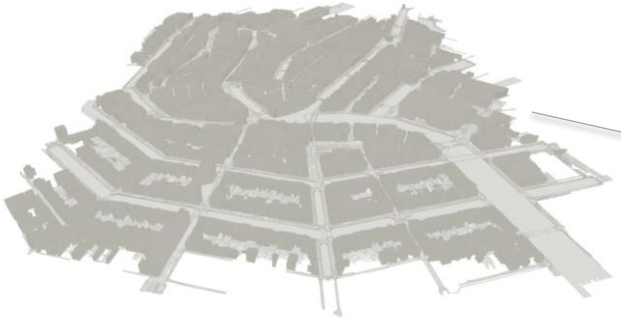
Motivation

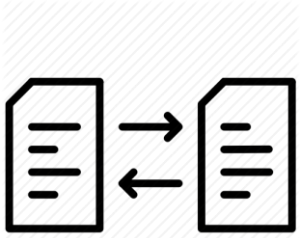


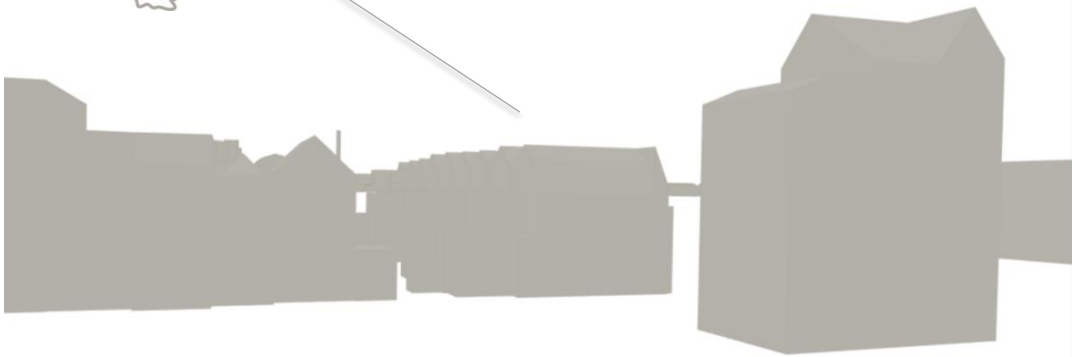


Problem





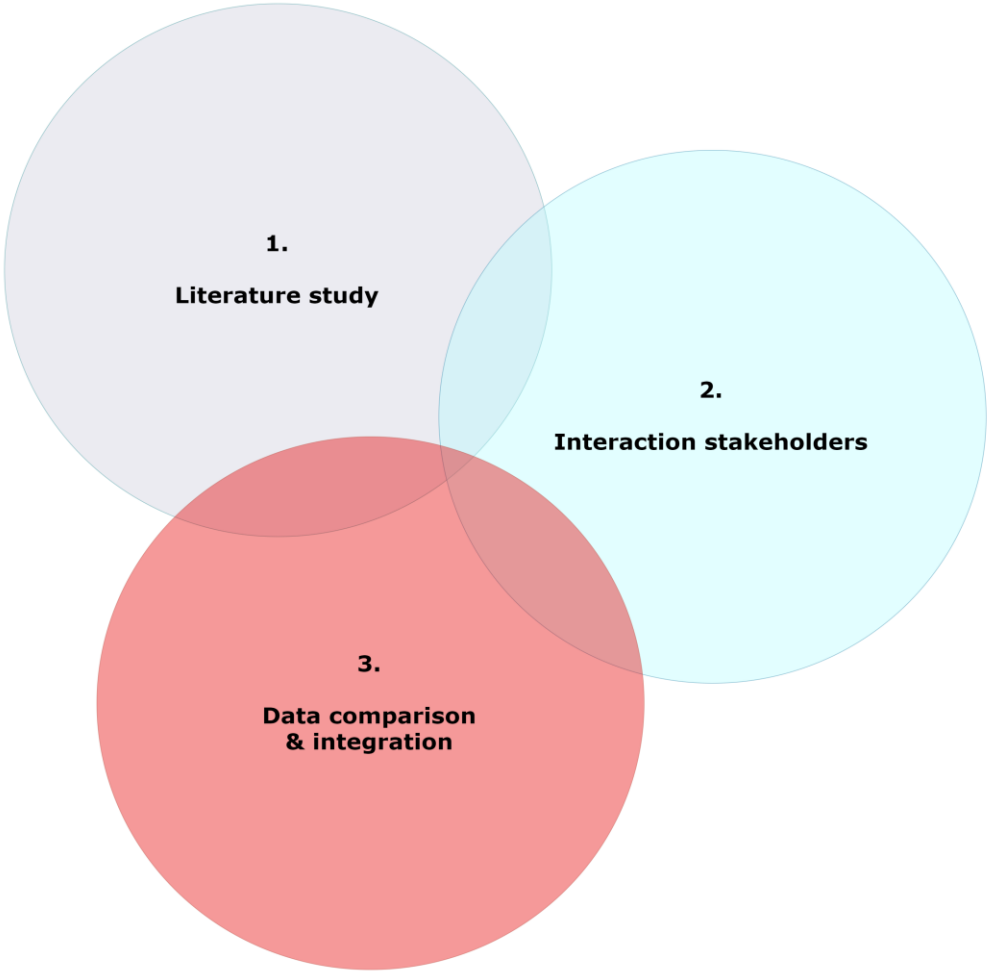




Research Question

How can a variety of 3D city models be integrated in a country wide covering 3D basemap based on large-scale topography?

Methodology



3D City Models

CityGML

BGT/IMGeo

CityJSON

Use Cases

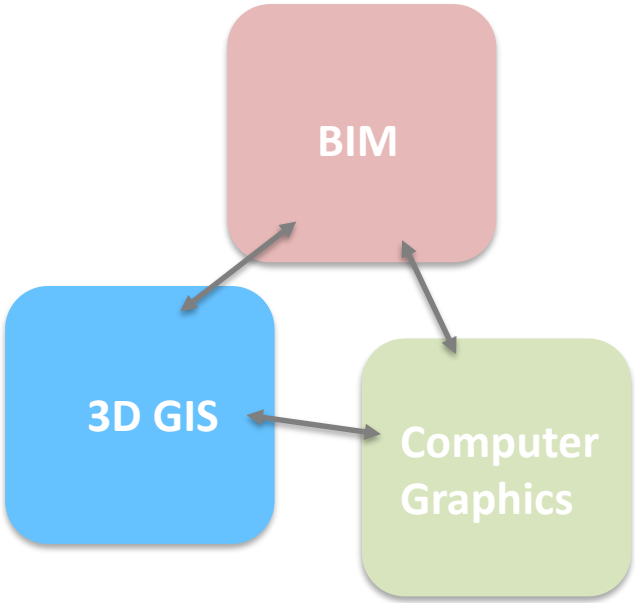
- 3D Cadastre / Mapping
- Tourism
- Simulators
- Navigation
- Real Estate
- Urban Planning
- Environment Protection
- …

Applications

- Energy demand estimation
- Noise propagation
- Vulnerability analysis
- Solar potential estimation
- …

Study 3D city models in Finland

- Missing coordination
- Legislation not up to date
- Unclear privacy issues
- Lack of expertise
- Wish to be more independent
- Wide variety of applications not reached



[Julin et al., 2018]

Stakeholders

-> surveys

-> interviews

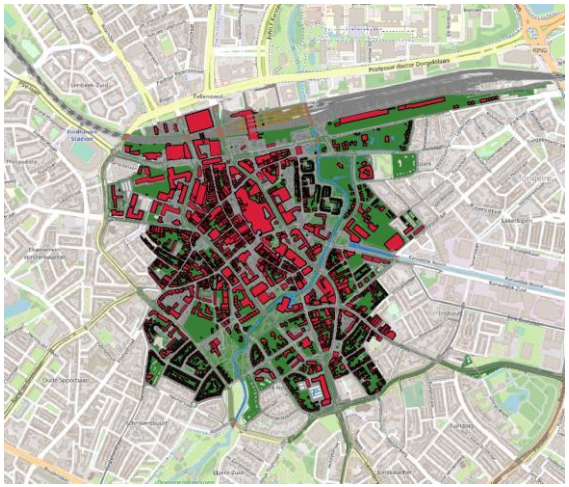
-> meetings

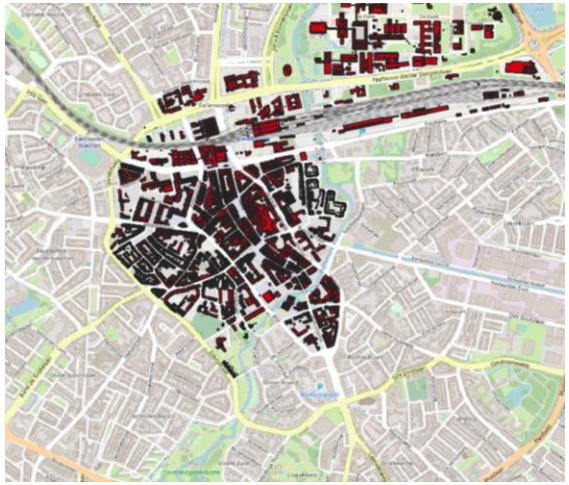
Data Kadaster

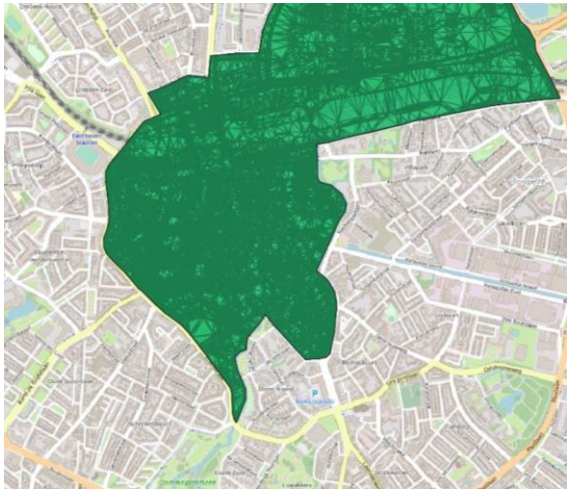
	Kadaster					
Format	CityGML					
Version	2.0					
System	EPSG:7415					
		File1 Amsterdam	File 2 The Hague	File 3 Eindhoven	File 4 Noord-Brabant	File 5 Rotterdam
Features	Bridge:	173	61	75	2	32
	Building:	3523	2468	2531	89	3387
	CityModel:	1	1	1	1	1
	GenericCityObject:	341	51	264	0	142
	LandUse:	17295	8685	5242	619	7949
	PlantCover:	30	992	1041	151	1169
	Road:	2858	2599	2975	154	4015
	WaterBody:	104	38	43	170	23

Data Eindhoven

Municipality of Eindhoven			
Format	CityGML		
Version	1.0		
System	EPSG:28992		
		File 1 (Buildings)	File 2 (Terrain)
Features	Building:	11350	0
	CityModel:	1	1
	GenericCityObject:	0	140607







Data Rotterdam

Municipality of Rotterdam		
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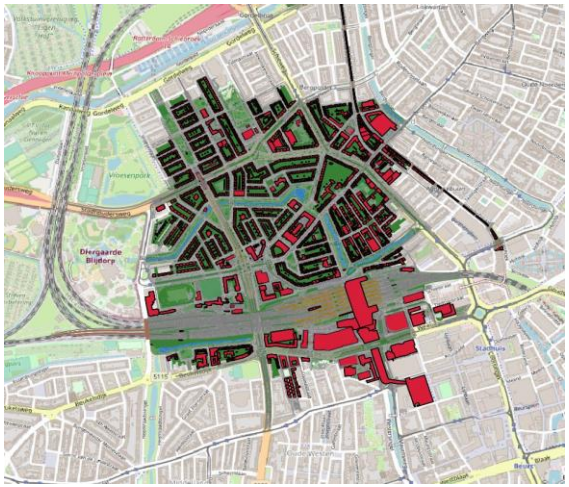
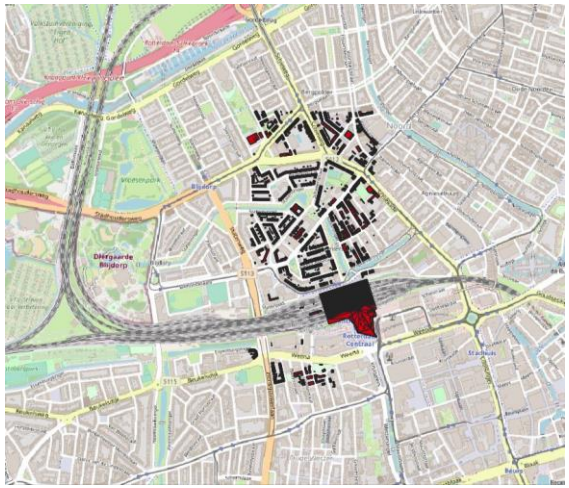
Version	1.0	
System	EPSG:28992	
		File 1 (Buildings)
Features	Building:	1744
	CityModel:	1





Data Den Haag

Municipality of The Hague		
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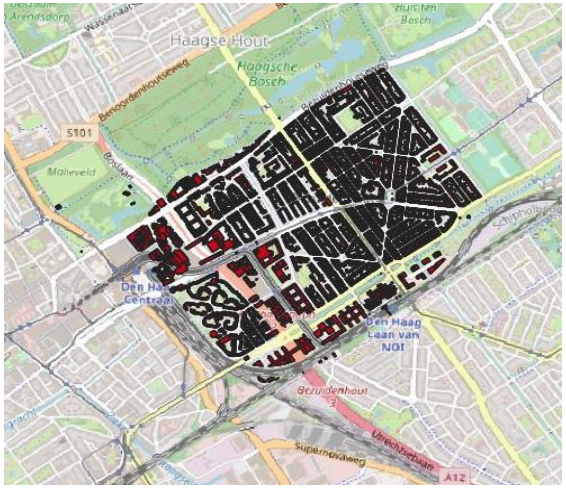
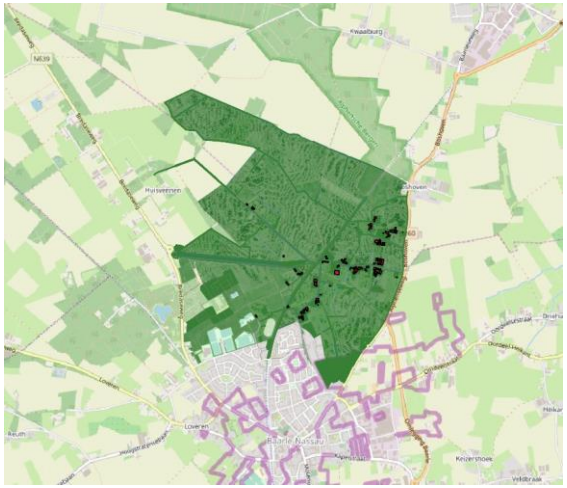
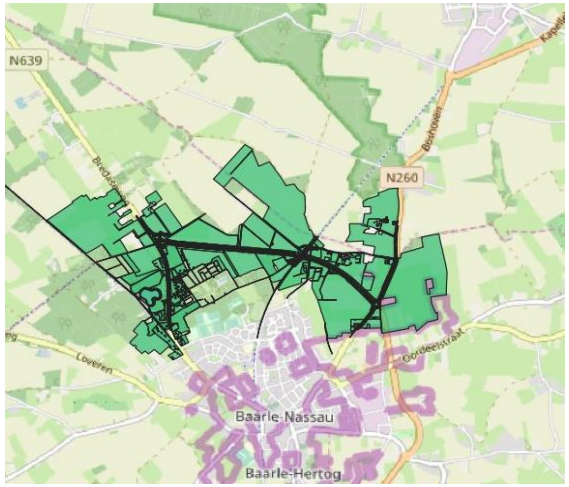
Version	1.0	
System	EPSG:28992	
		File 1 (Buildings)
Features	Building:	4203
	CityModel:	1



Data Noord-Brabant

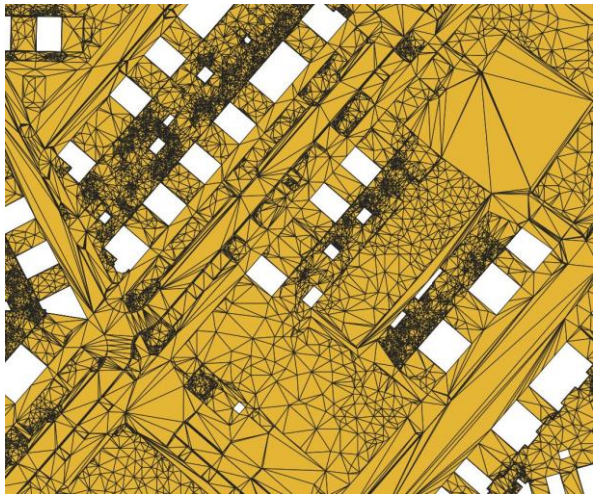
Province of North-Brabant		
Format	ESRI Shapefile	
Version	-	
System	EPSG:28992	
		File 1 (Terrain)
Features	Polygon:	914





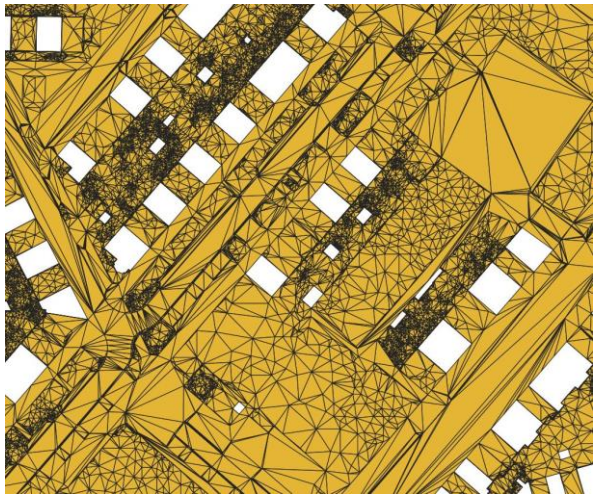
Implementation

- Data



Implementation

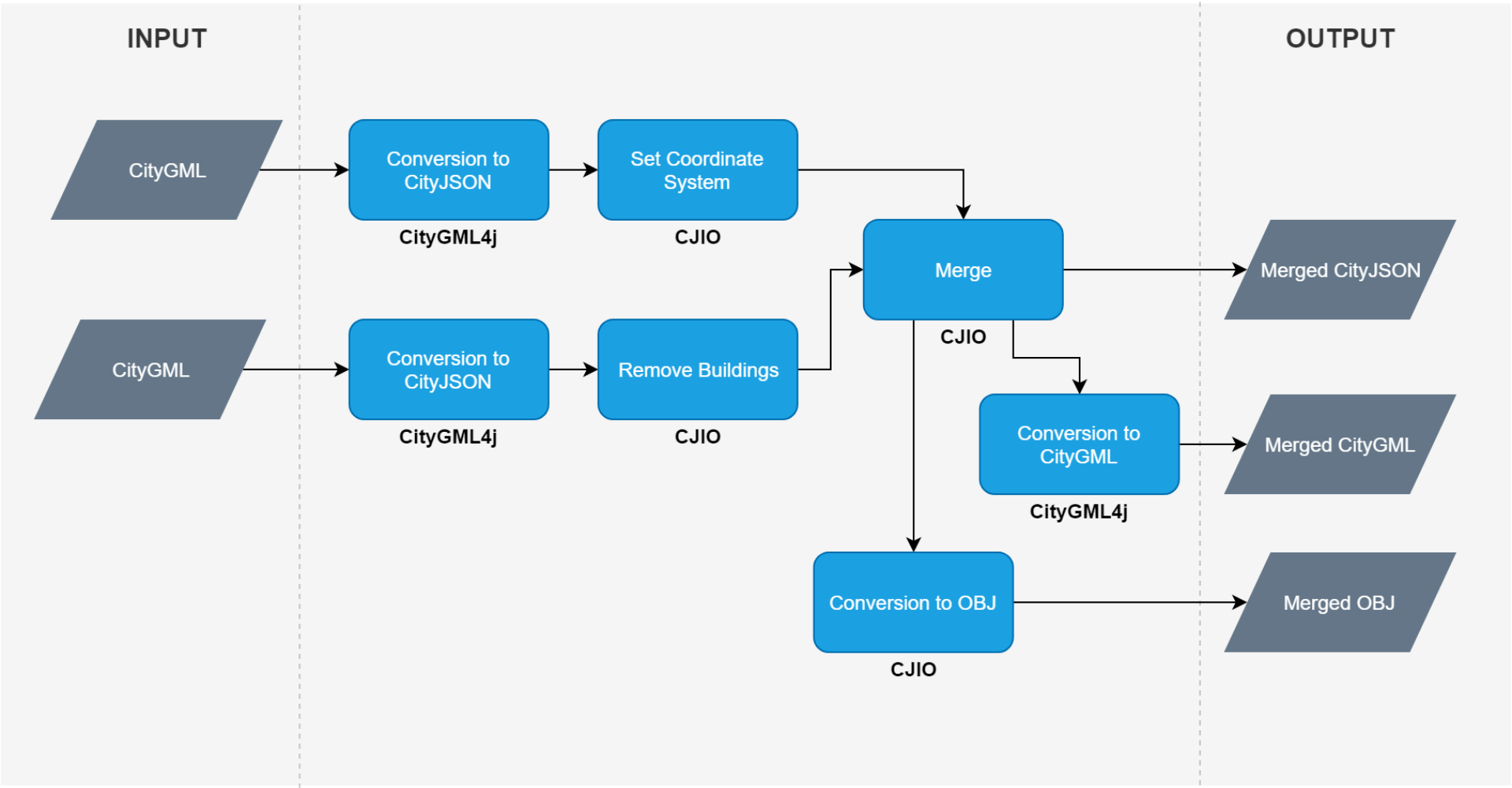
- Data



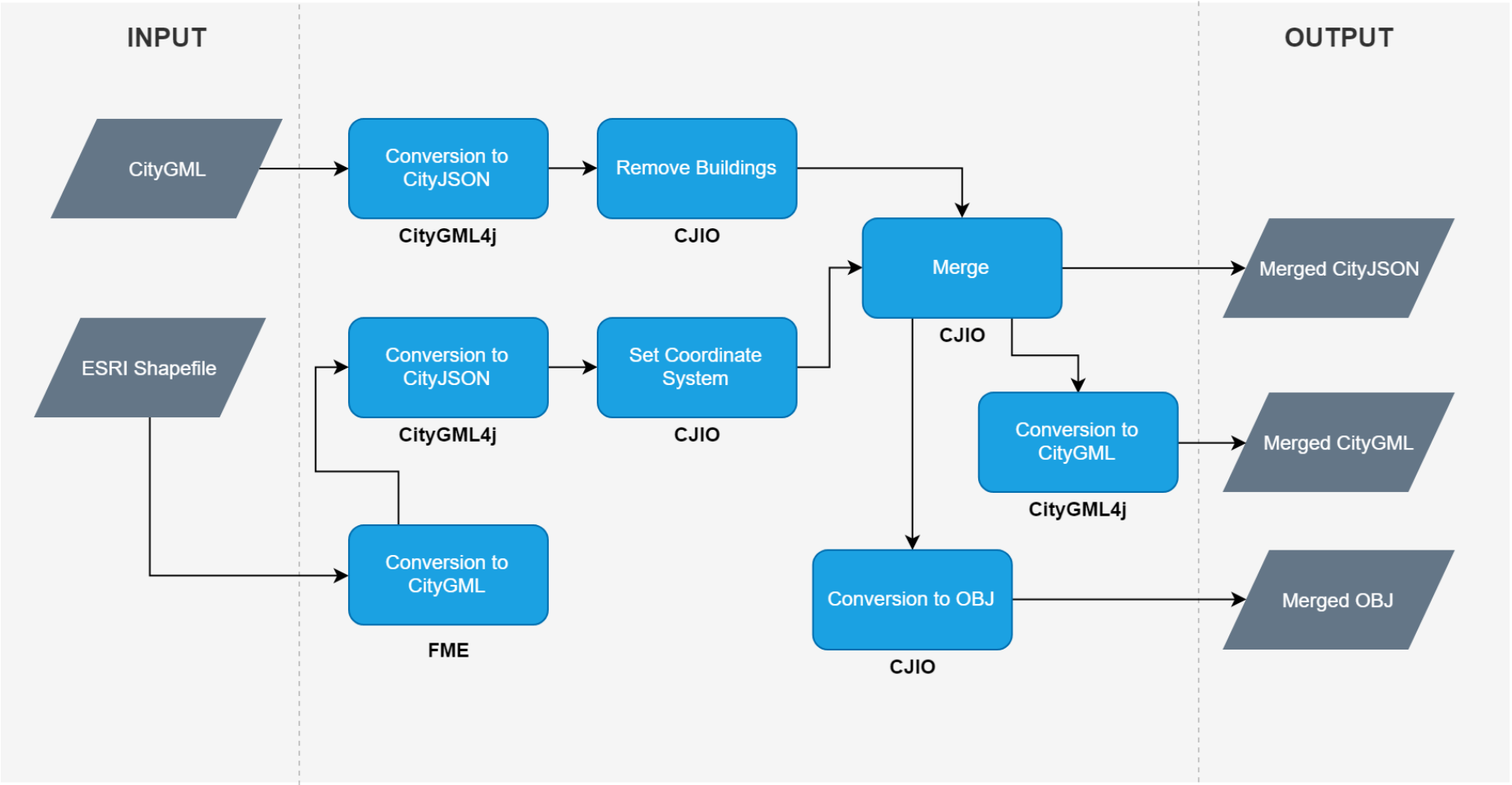
- Tools

- CityGML4j
- cjio

Data integration



Data integration



	Kadaster	Eindhoven	Rotterdam	Den Haag	Noord-Brabant
Format	CityGML	CityGML	CityGML	CityGML	ESRI Shapefile
Version	2.0	1.0	1.0	1.0	-
System	EPSG:7415	EPSG:28992	EPSG:28992	EPSG:28992	EPSG:28992
Max. Level of Detail	1	3	2	2	1
Geometries	MultiSurface Solid	MultiSurface Solid	Solid	MultiSurface	MultiSurface *after conversion to CityGML
Attributes	bgt_status, objectbegintijd, lokaalid, tijdstipregistratie, plus_status, eindregistratie, bronhouder, plus_type, identificatie, relatievehoogteligging, objectid, objecteindtijd, measuredHeight, lv_publicatiedatum, bgt_type, inonderzoek, Namespace Aanduidingrecordcorrectie, Aanduidingrecordinactief, Begindatumtijdvakgeldigheid, bouwjaar, Documentnummer, Documentdatum, Einddatumtijdvakgeldigheid, Identificatie, Inonderzoek, Min height surface, Min height units_surface, Objectid Pandstatus, Shape_area, Shape_lenght	name	statusOmschr, gebouwnummer, creationDate, typeOmschr, yearOfConstruction, deviation, aantalBouwlagen, laagste_bouwlaag, avineonStatus, hoogste_bouwlaag	Model, Adressen, GoothgtNap, NokhgtNap, Maaiveld, Bouwjaar, NokhgtRel, Wijkcode, Bron, Wijknaam, GoothgtRel, Pandstatus, PandID	IMGEO_BEHE IMGEO_BRON IMGEO_INON IMGEO_KLAS IMGEO_LVPU IMGEO_SLEU IMGEO_TYPE IMGEO_TYP0 TEXT_DGDTW NIVO_DGDTW LOKAALID_D OBJECT_DGD CT_1IMGEO_ CK_1BEHEER CT_2IMGEO_ CK_2BRONHO CT_4IMGEO_ CK_4PARENT CT_7IMGEO_ CK_7PARENT CT_8IMGEO_ CK_8PARENT

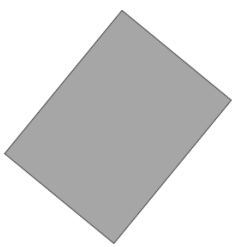
		Kadaster	Amsterdam	Den Haag	Eindhoven	Noord-Brabant	Rotterdam
Contents	Buildings LOD1	✓	✓				✓
	Buildings LOD2			✓			✓
	Buildings LOD3				✓		
	Terrain	✓	✓		✓	✓	✓
	Trees		✓	✓			✓
	Bridges, platforms etc.	✓				✓	✓
	Other objects						✓
Source Data	BAG	✓	✓	✓	✓		✓
	BGT	✓	✓		✓	✓	✓
	AHN2				✓		
	AHN3	✓	✓				
	Own point cloud	✓		✓	✓	✓	✓
	DigTop			✓			
Process	Fully automatic	✓	✓			✓	
	Partly automatic and partly manually			✓	✓		✓
Management & actuality	Managed	✓	✓	✓	✓	✓	✓
	Distributed			✓			✓
	Standard File Formats	CityGML	QM tiles OBJ FBX	CityGML	DNG FGDB CityGML	Shapefile	CityGML
	First version	2017	2019	2010	2013	<2000	2016
	Update frequency	Yearly	?	?	incidental	daily	incidental
	Fully updated or based on mutations	fully	fully	fully	based on mutations	based on mutations	based on mutations

Interviews

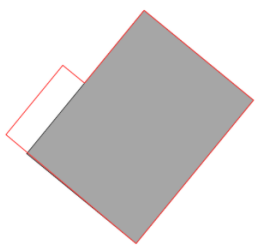
Data:
- AHN considered not detailed enough for the construction of 3D objects. Almost all stakeholders use their own point clouds derived from photogrammetry and tachymetry.
- Not one specific file format is preferred, as long as it keeps the semantics of the objects.
- Recent 3D models are focused on terrain and building.
- Overall use of the BGT and BAG for the feature polygons that will be extruded to 3D.
- Unclear/undecided strategies for the (future) management of the 3D models.

Foreseen use of 3D models by stakeholders:
- Spatial Planning
- Visualisation
- Simulations (traffic, water flooding, routing, shadow)
- Analysis (noise, air quality)
- Participation citizens in projects
- Distribution of 3D model as open data

State of art:
- Lack of knowledge of GIS and 3D within the organization.
- Not all stakeholders have enough public & financial support within their organization. 3D is seen as an (big) investment with unclear/not enough benefits.



BAG



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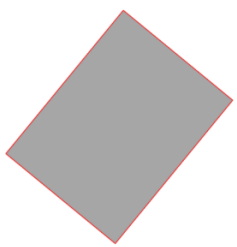
BGT



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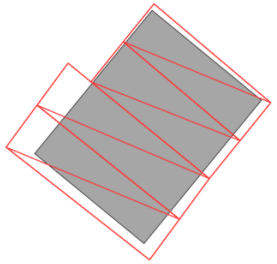
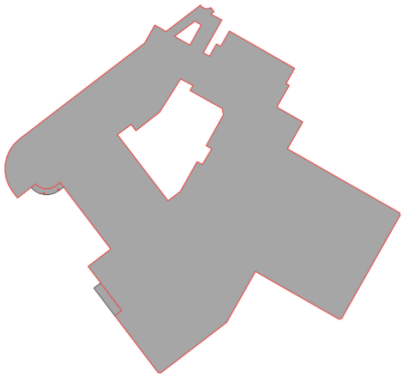


BAG

Den Haag

BAG



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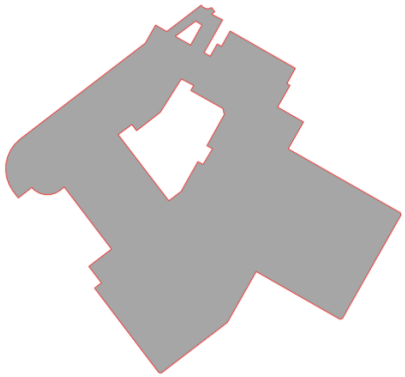
BGT



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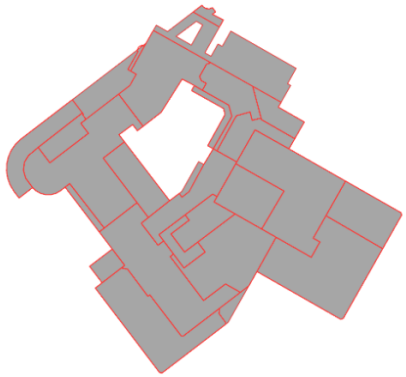

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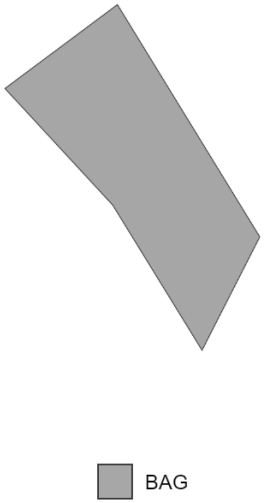
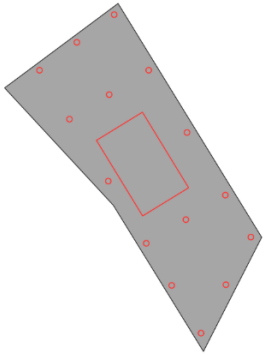
Den Haag

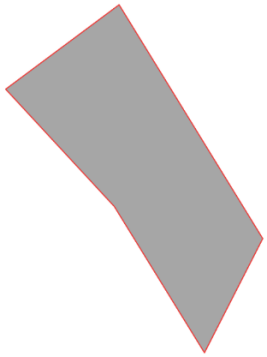


BAG



BAG

BGT



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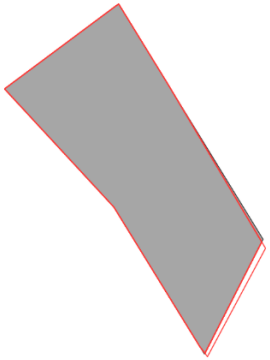
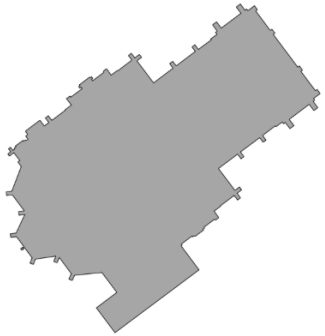
Kadaster



BAG

Eindhoven



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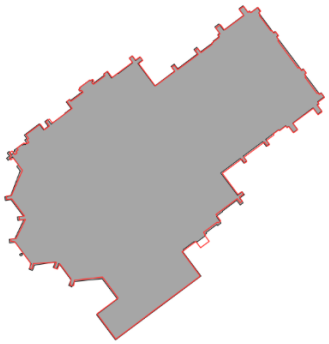

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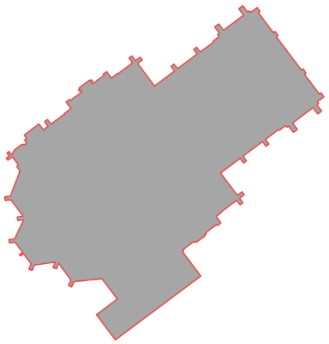
BGT



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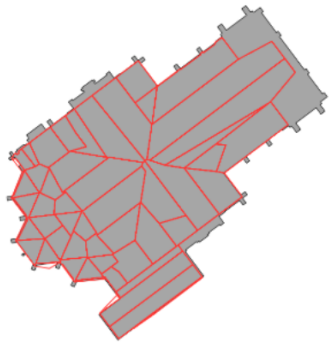

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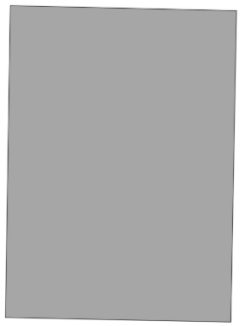
Eindhoven



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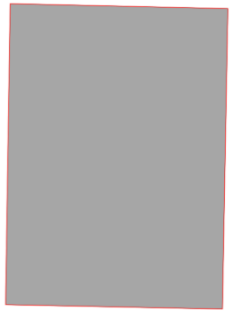
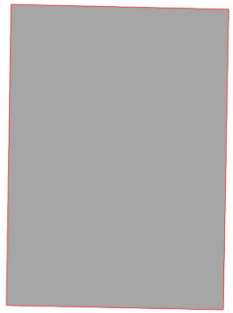
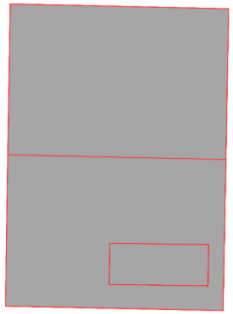


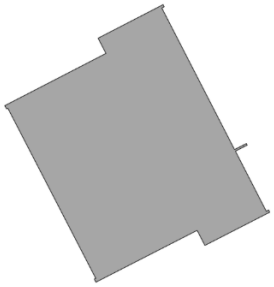
BAG
BGT



BAG
Kadaster



BAG
Rotterdam



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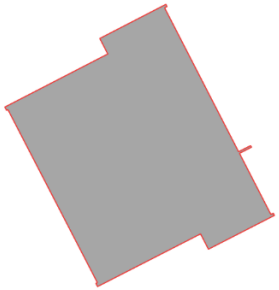

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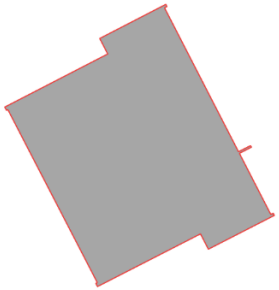

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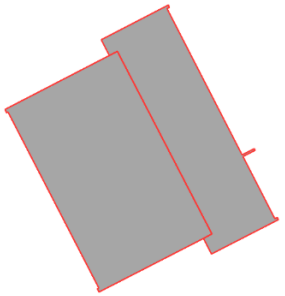

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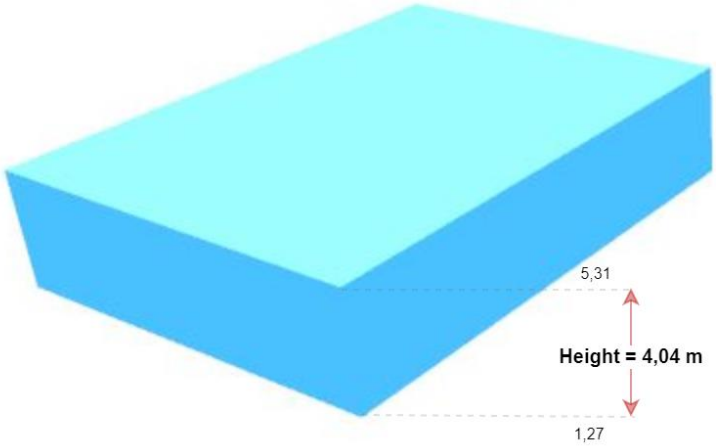
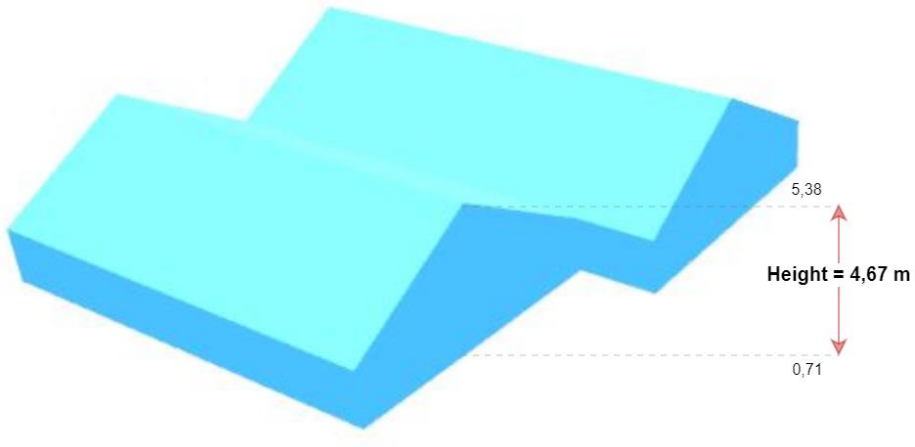
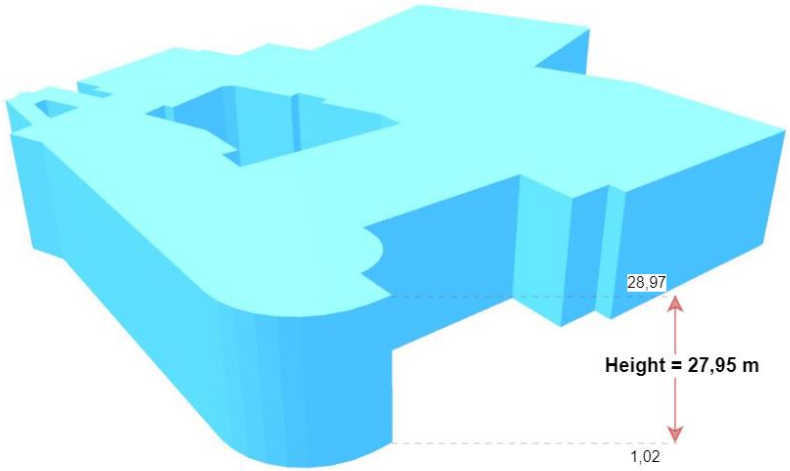
Rotterdam



Kadaster



Den Haag



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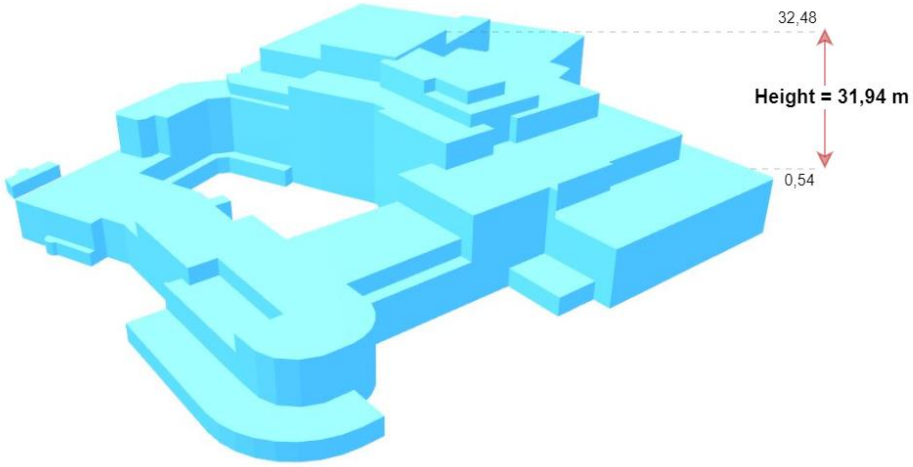
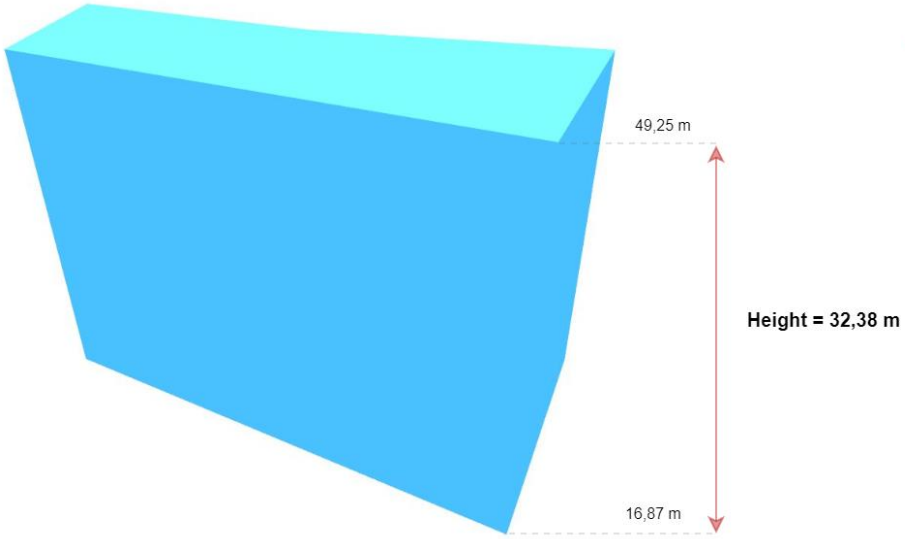


Den Haag



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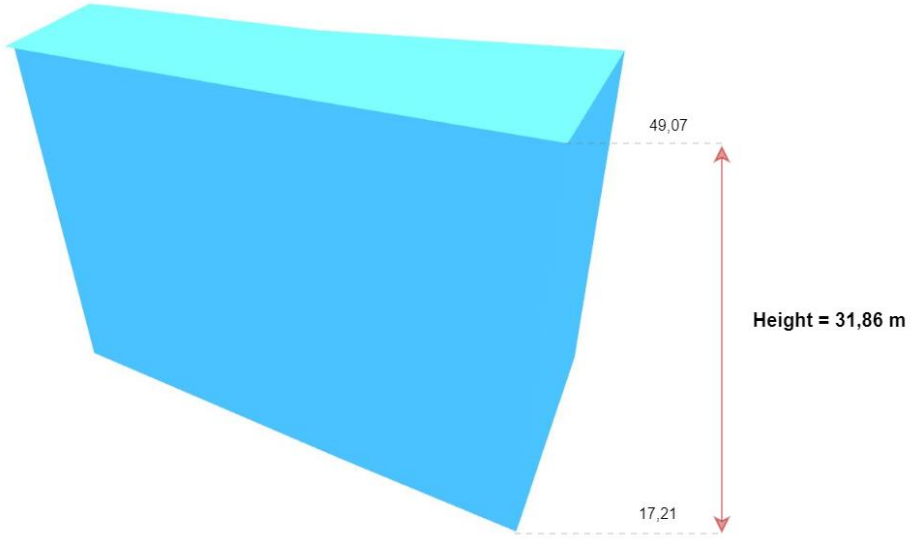
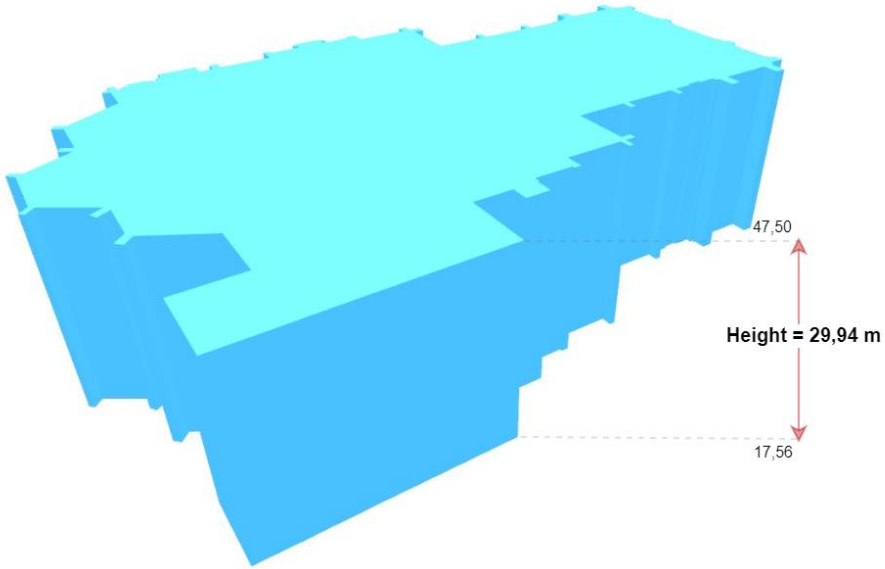
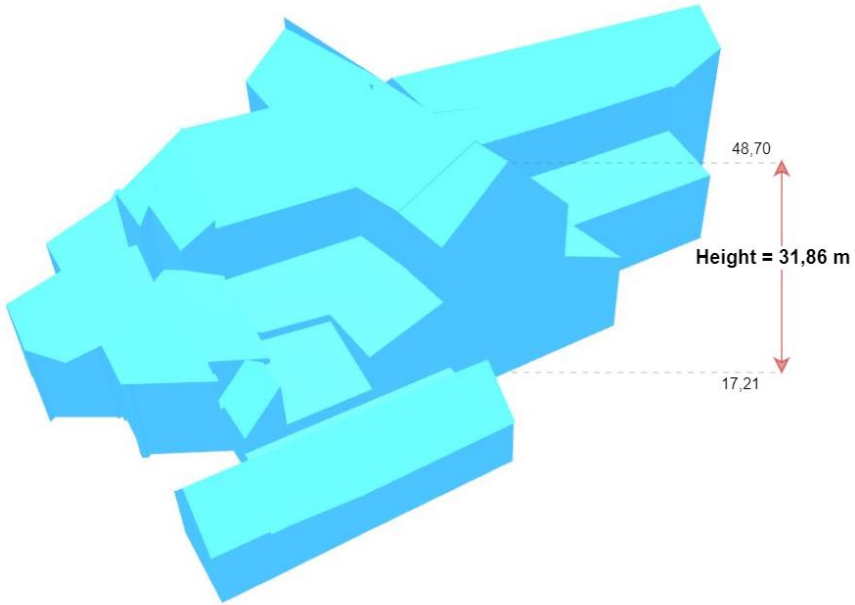
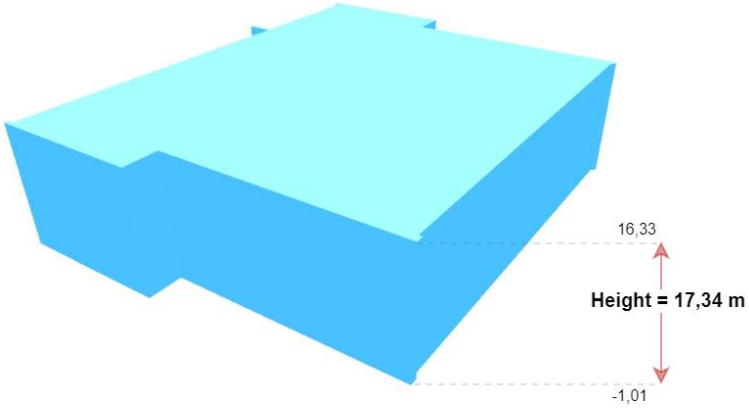


Eindhoven







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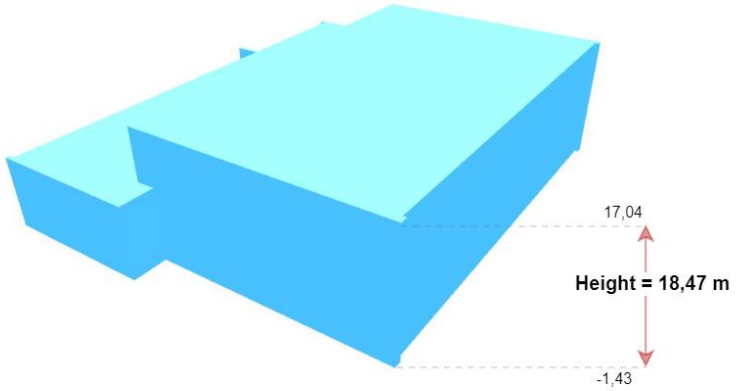
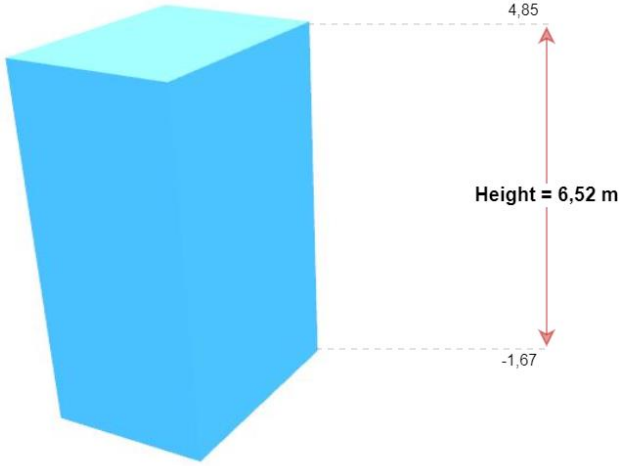


Rotterdam



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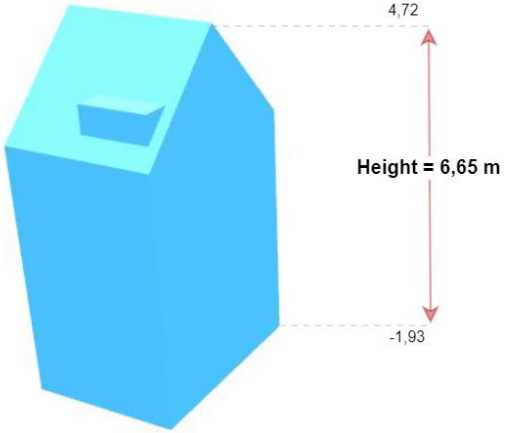
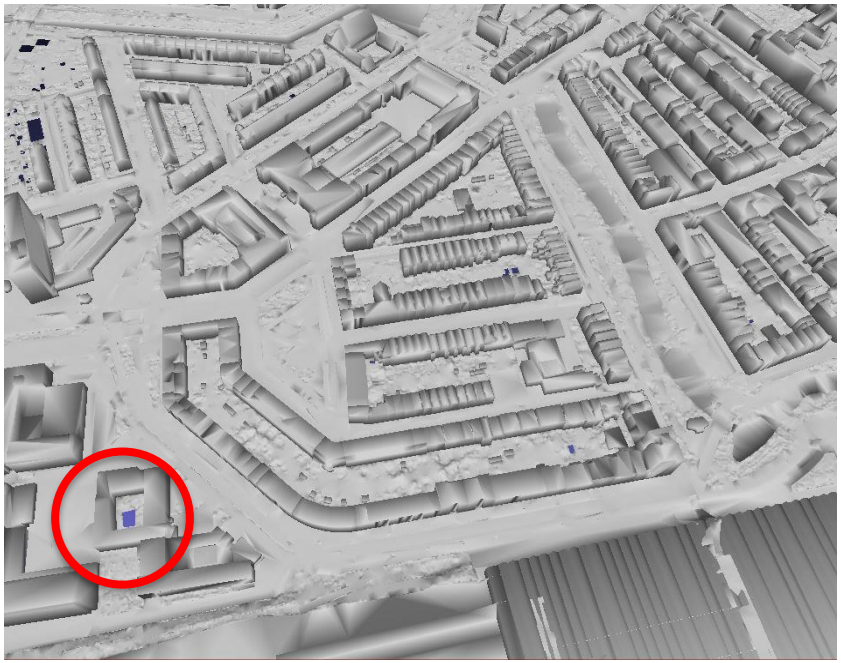
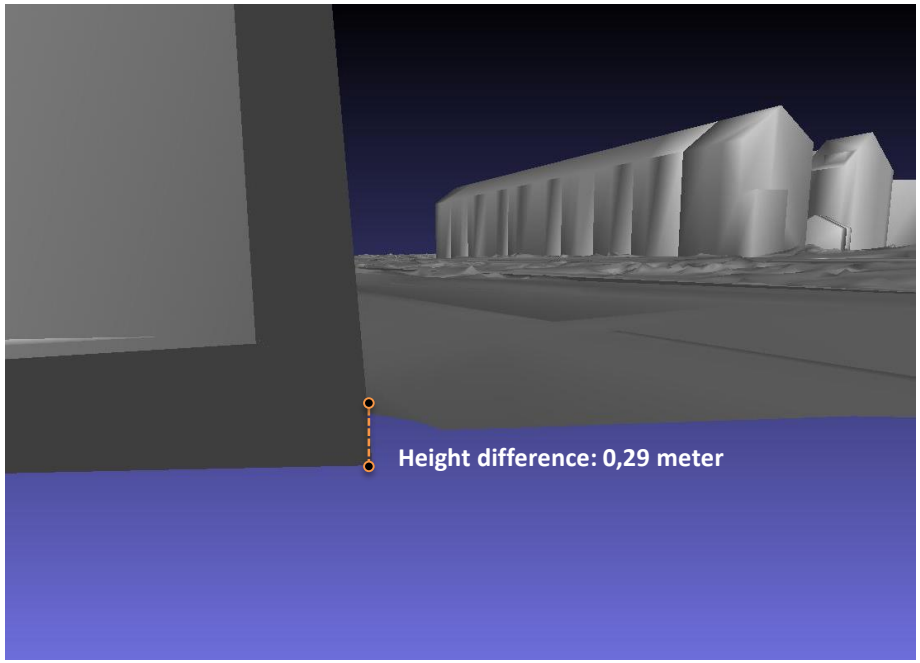


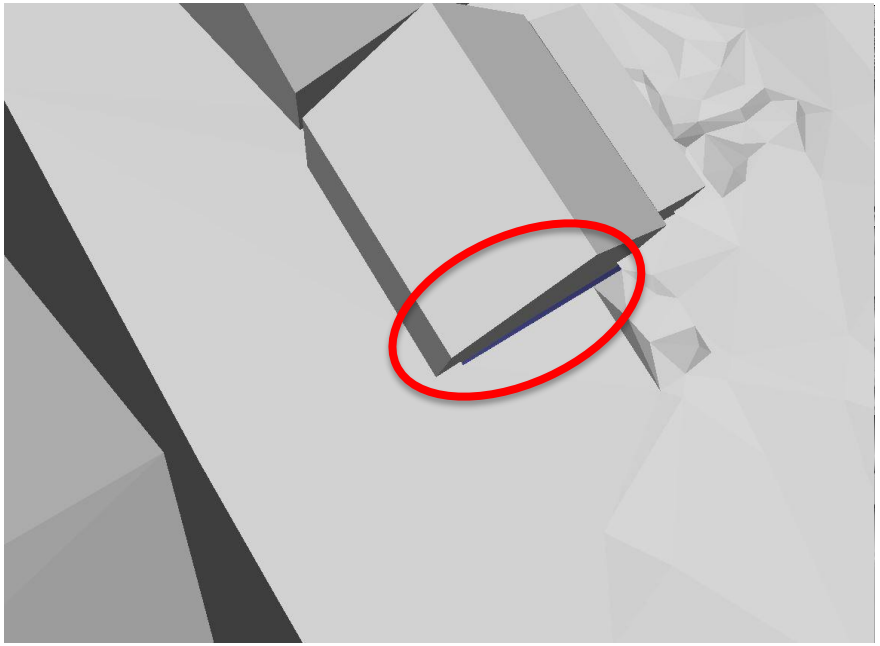
Rotterdam

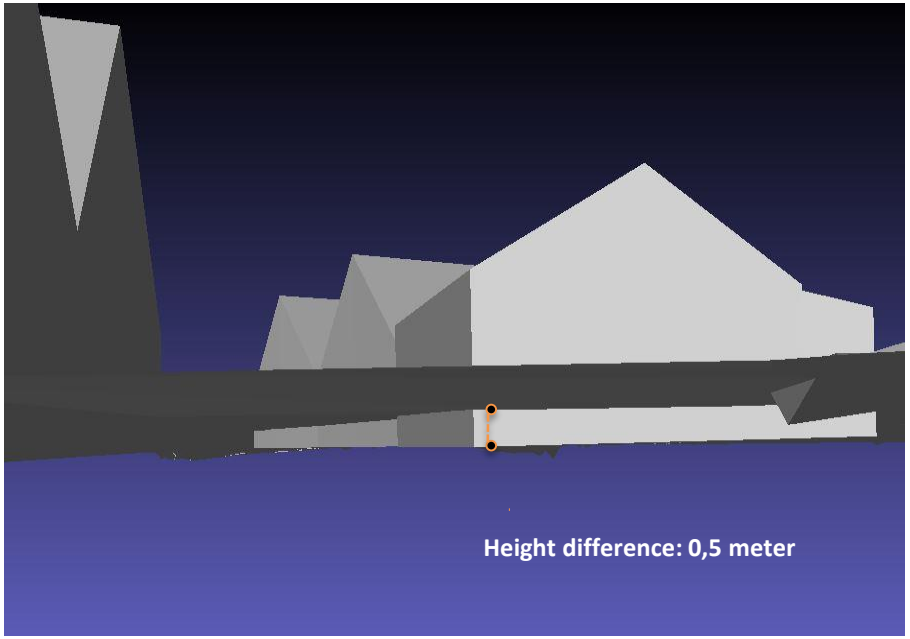
Result Rotterdam



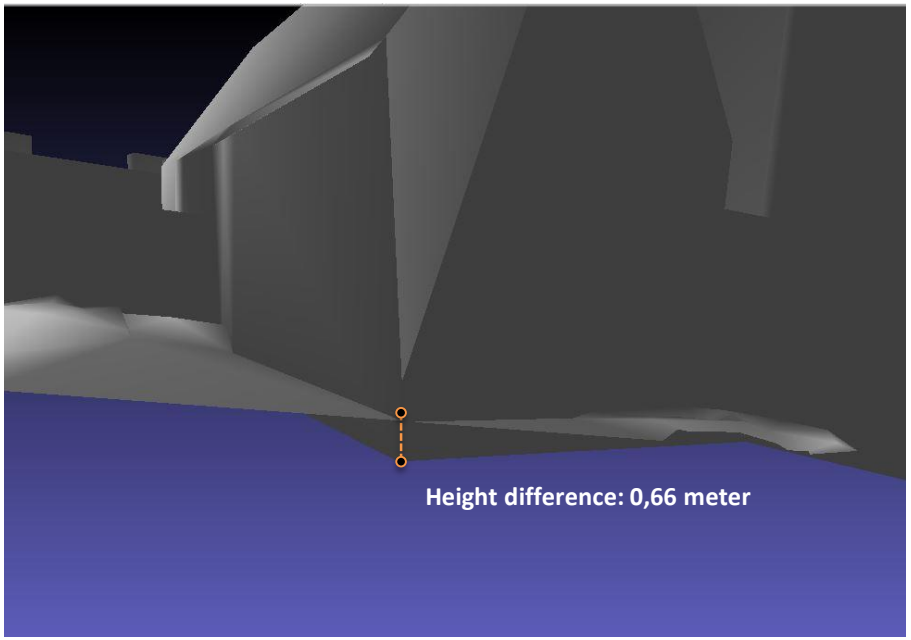


Result Den Haag

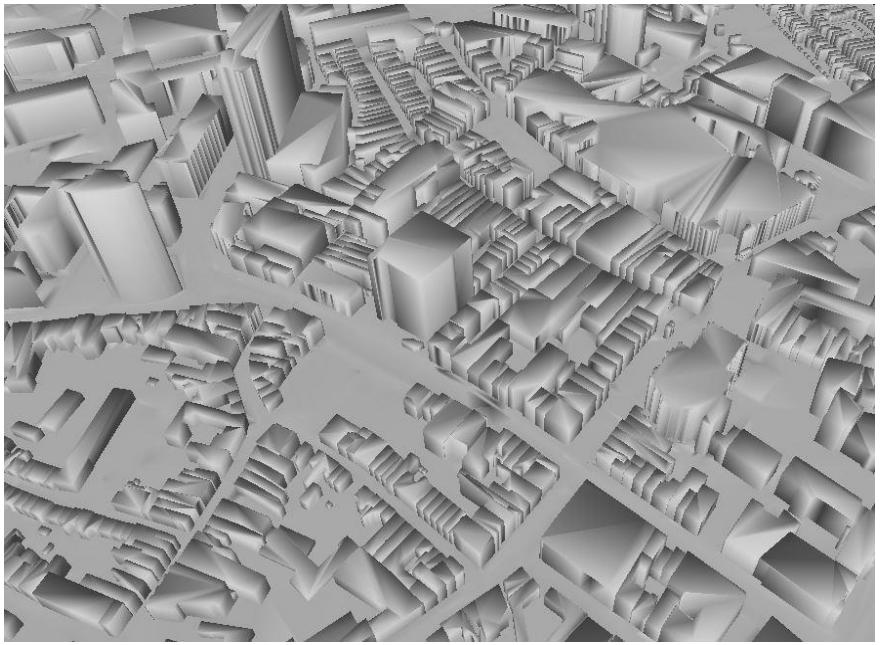


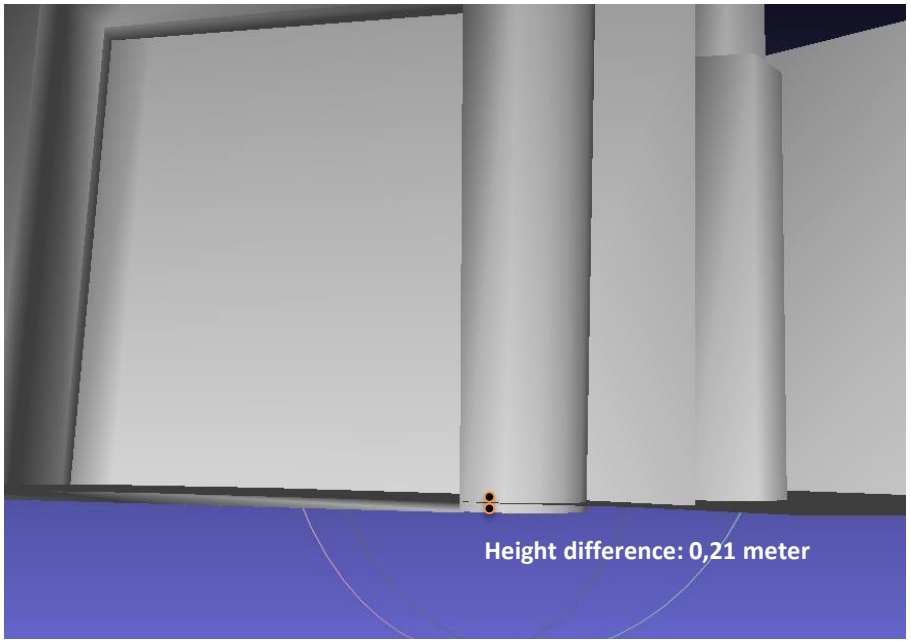


Result Eindhoven

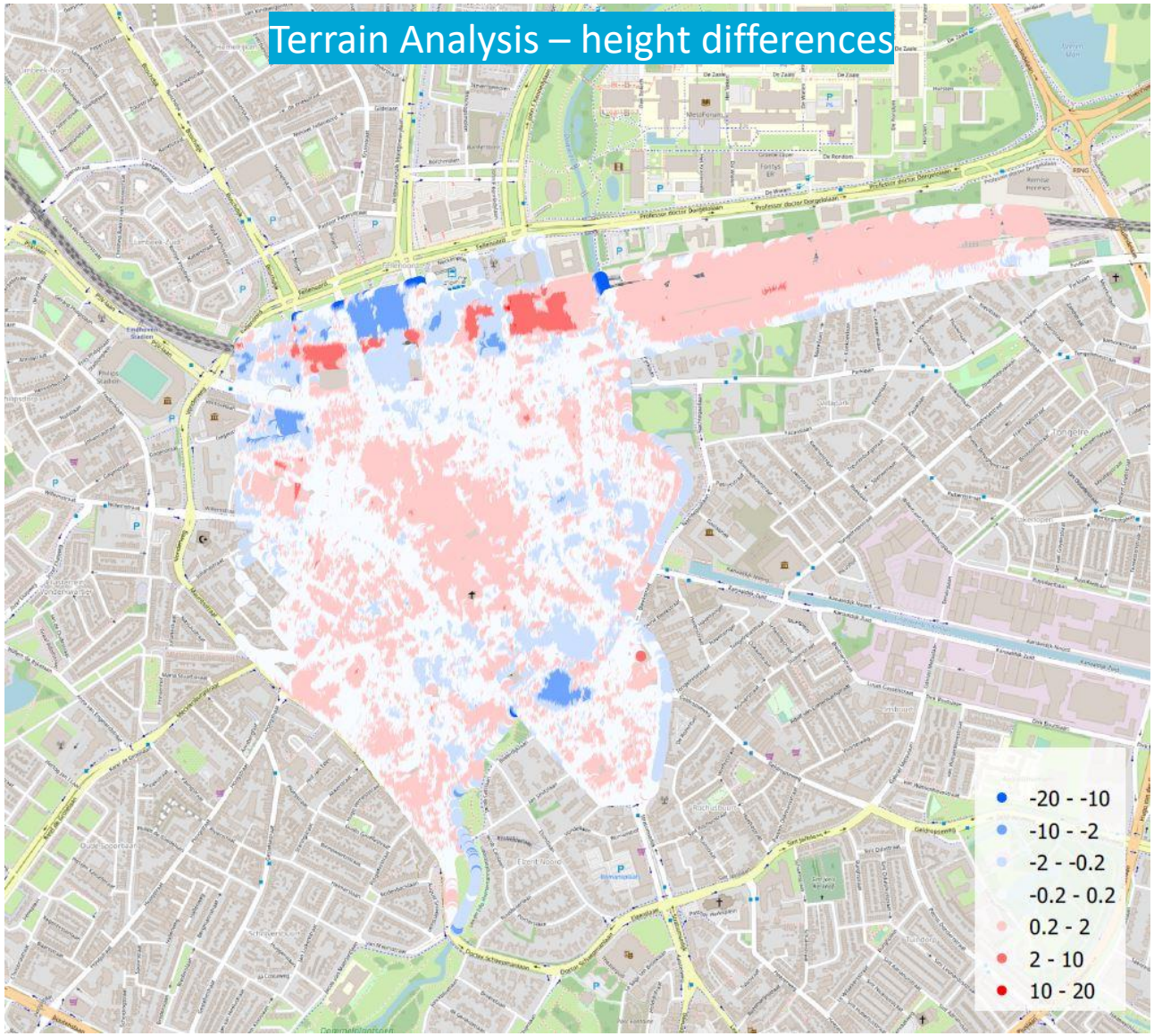


Result Eindhoven 2

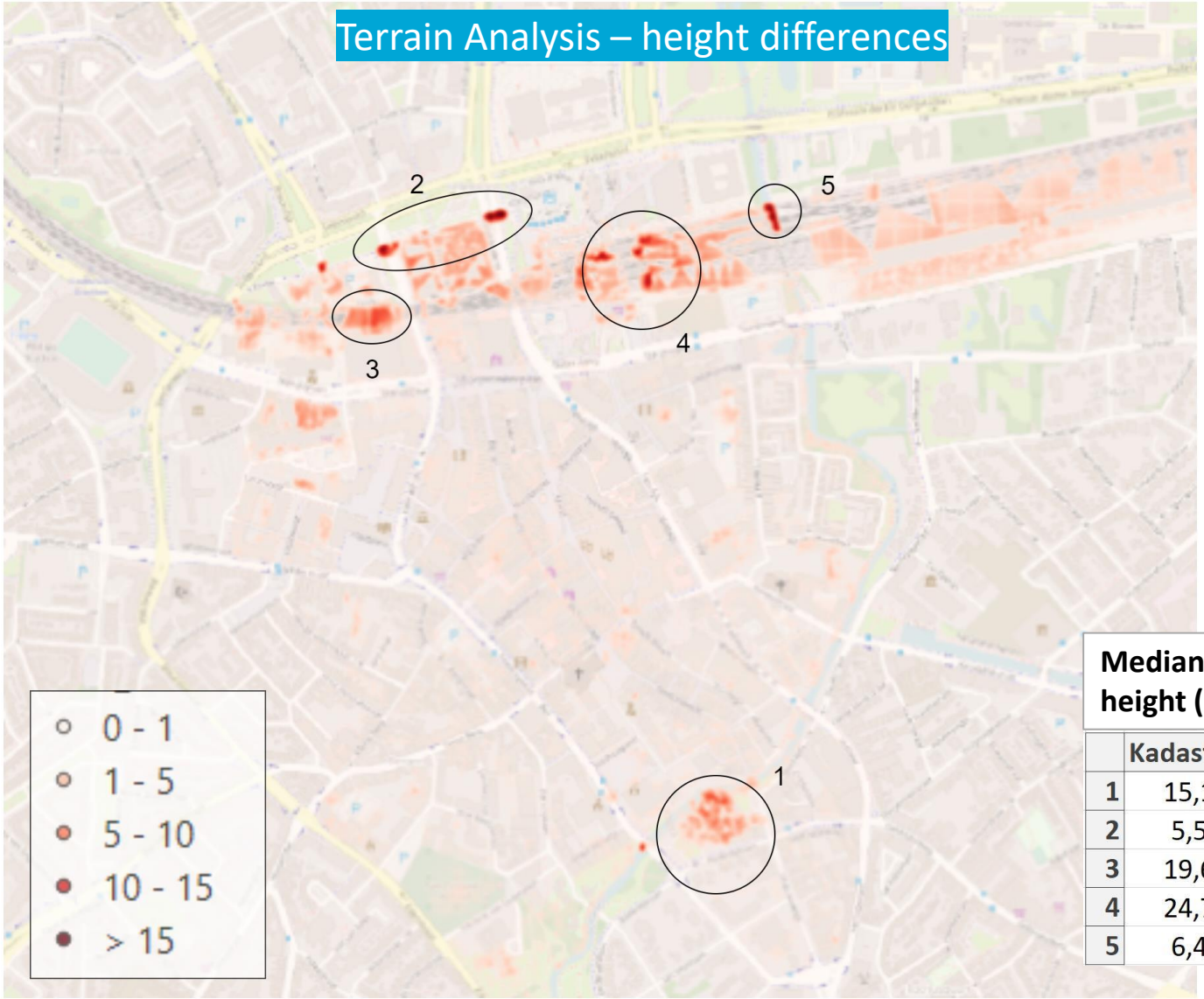




Terrain Analysis – height differences



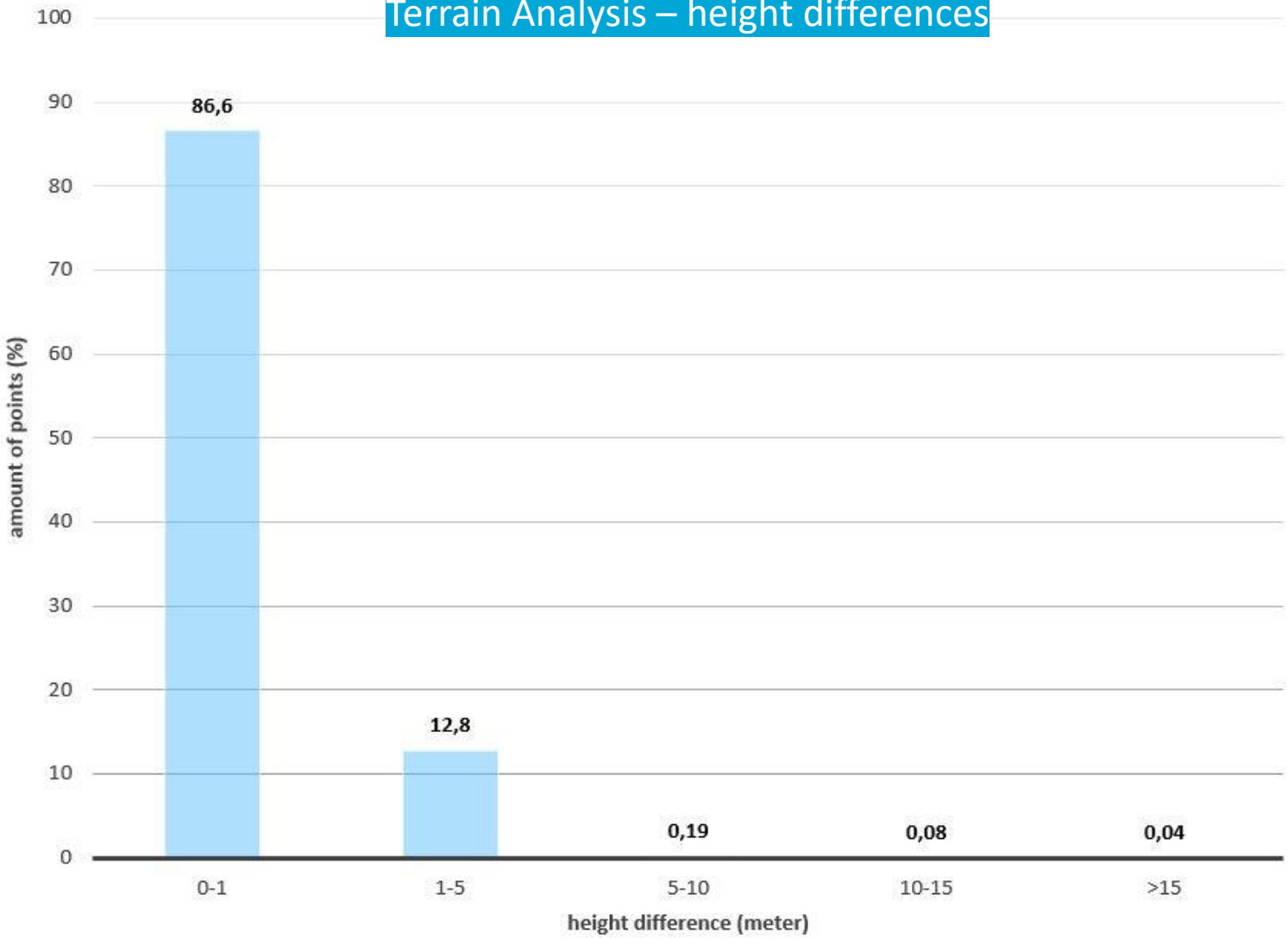
Terrain Analysis – height differences



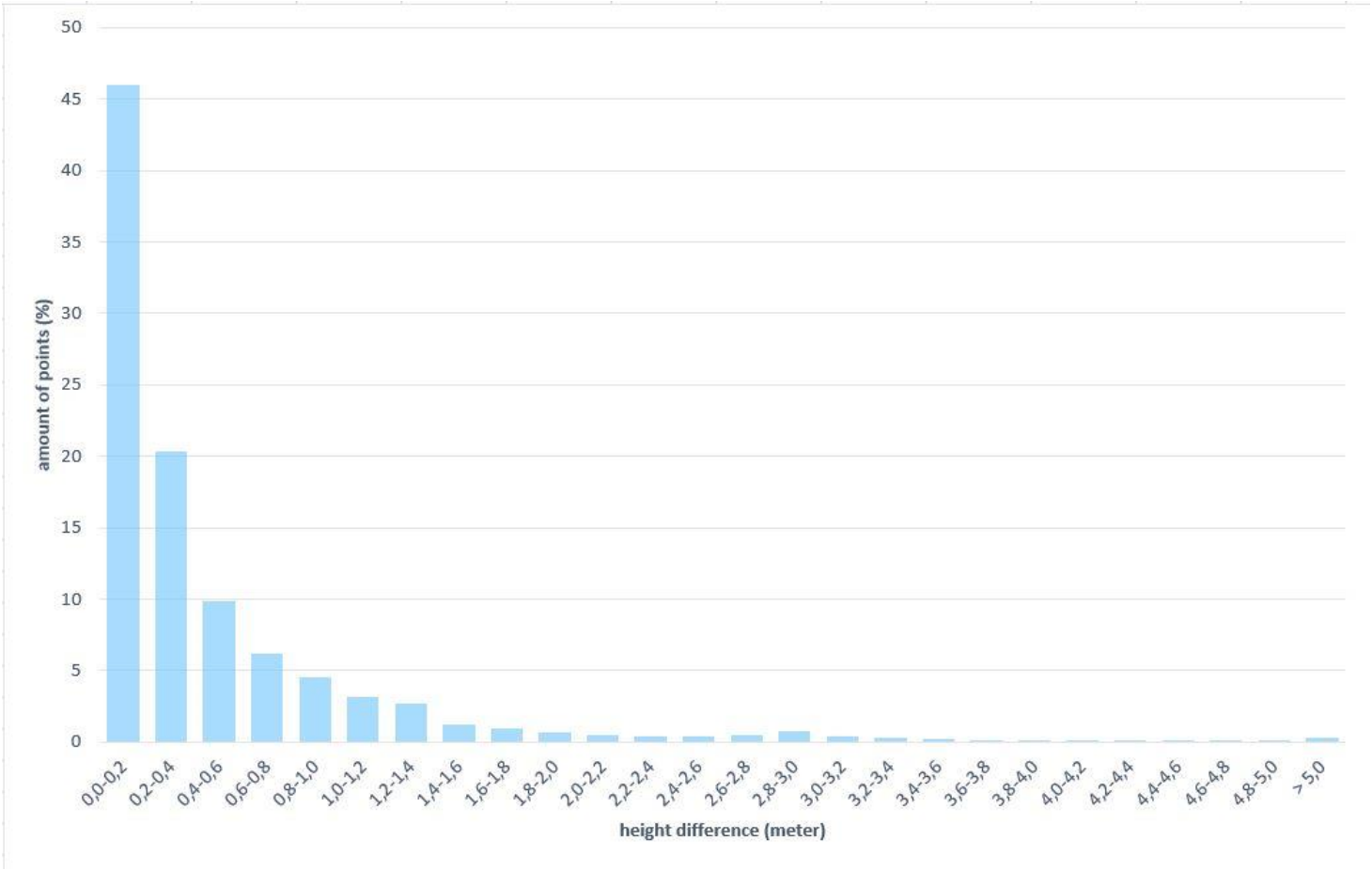
Median absolute height (meter)

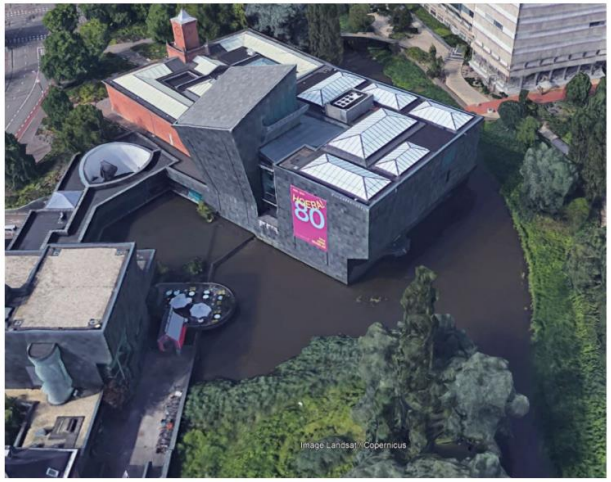
	Kadaster	Eindhoven
1	15,1	19,7
2	5,5	17,4
3	19,6	15,6
4	24,7	17,2
5	6,4	19,1

Terrain Analysis – height differences



Terrain Analysis – height differences





1

2

3

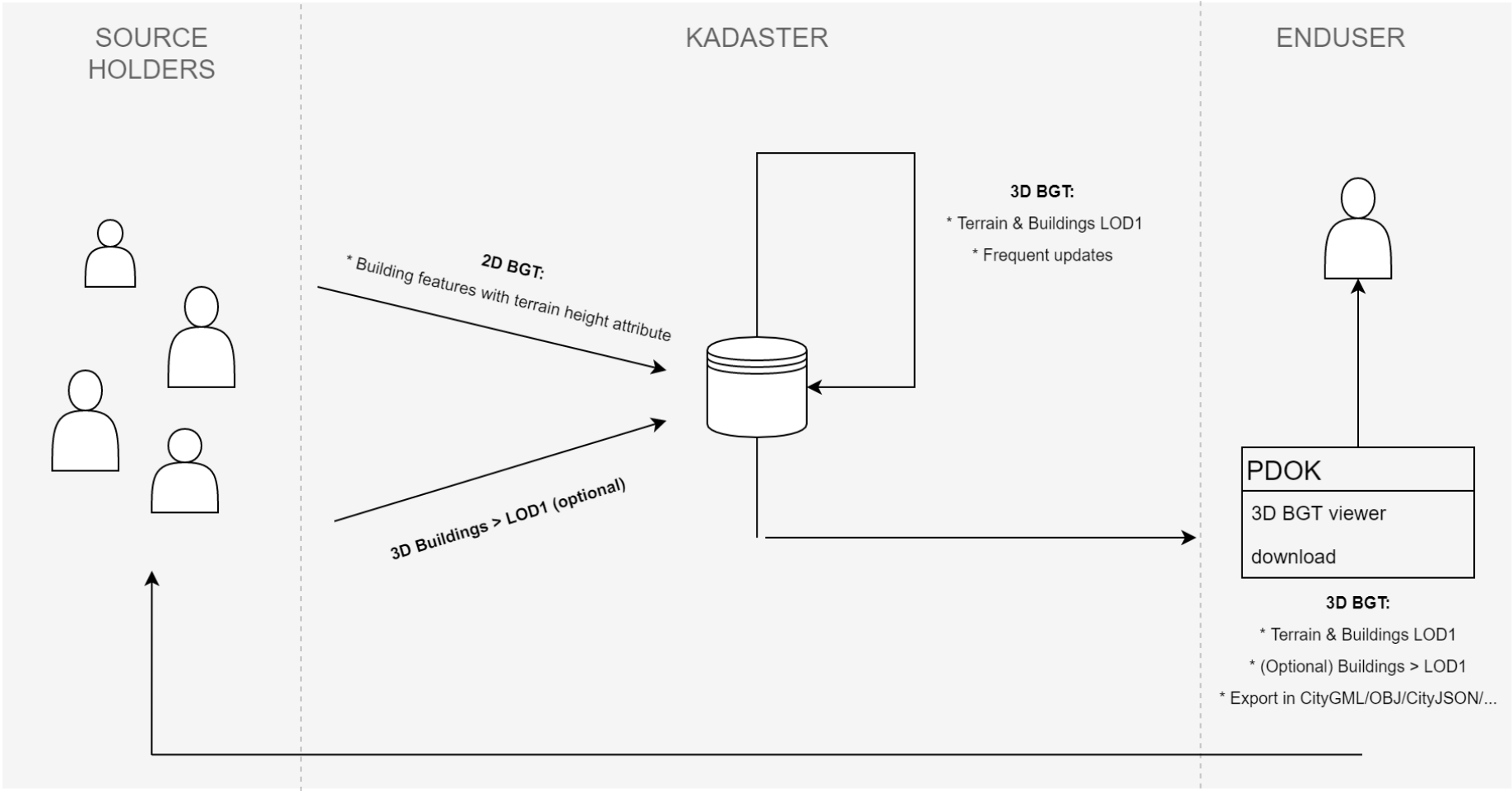
4

5

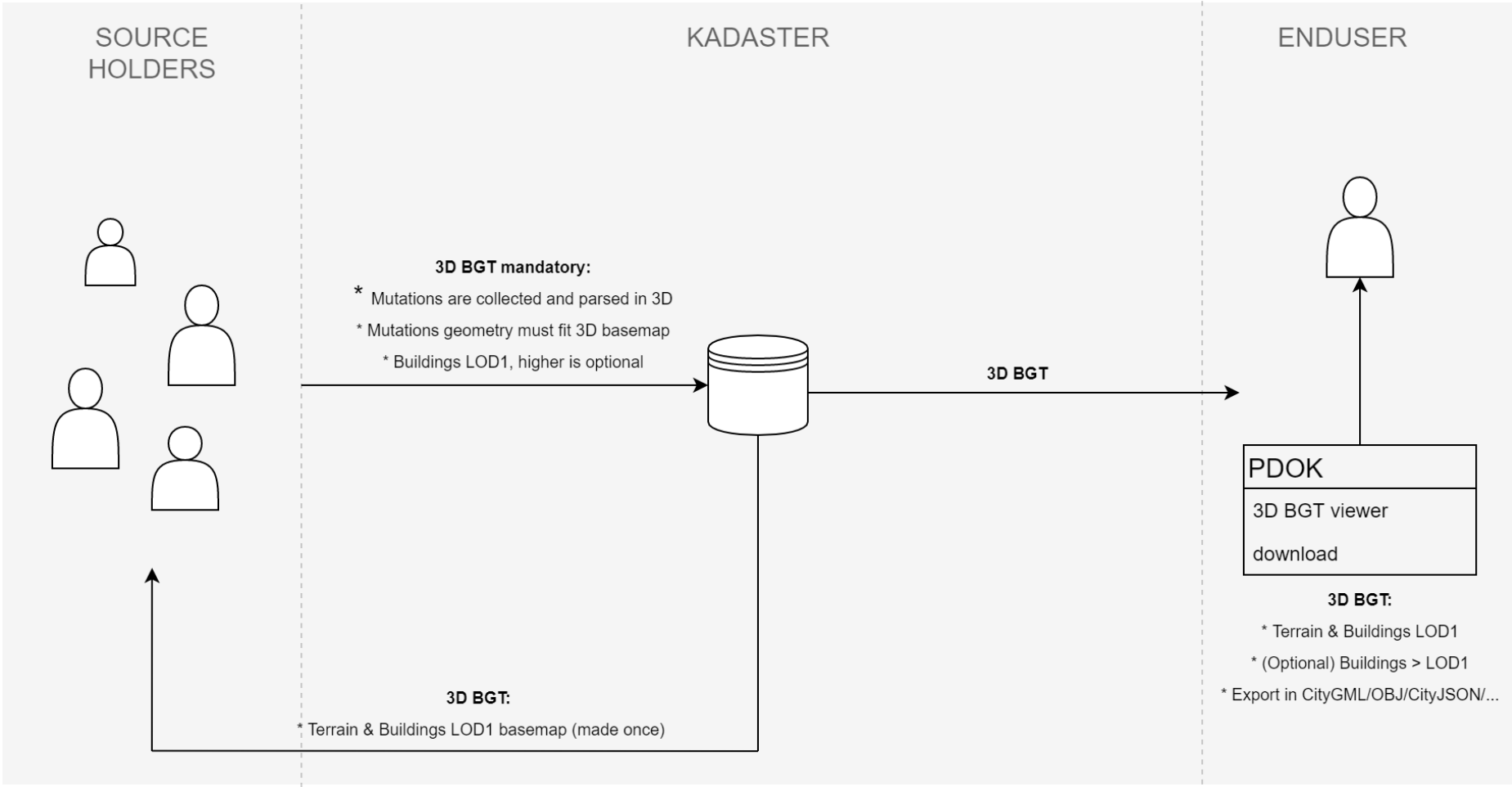
Median absolute height (meter)

	Kadaster	Eindhoven
1	15,1	19,7
2	5,5	17,4
3	19,6	15,6
4	24,7	17,2
5	6,4	19,1

Option 1


SOURCE HOLDERS
KADASTER
ENDUSER
2D BGT:
* Building features with terrain height attribute
3D Buildings > LOD1 (optional)
3D BGT:
* Terrain & Buildings LOD1
* Frequent updates
PDOK
3D BGT viewer
download
3D BGT:
* Terrain & Buildings LOD1
* (Optional) Buildings > LOD1
* Export in CityGML/OBJ/CityJSON/...

Option 2


SOURCE HOLDERS
KADASTER
ENDUSER
3D BGT mandatory:
* Mutations are collected and parsed in 3D
* Mutations geometry must fit 3D basemap
* Buildings LOD1, higher is optional
3D BGT
PDOK
3D BGT viewer
download
3D BGT:
* Terrain & Buildings LOD1
* (Optional) Buildings > LOD1
* Export in CityGML/OBJ/CityJSON/...
3D BGT:
* Terrain & Buildings LOD1 basemap (made once)

Comparison

	Option 1	Option 2
Goal	• Movement towards 3D is accessible for source holders • Bottom up approach • To provide a national 3D base map and stimulate the creation of other 3D models by source holders • Short term solution	• To provide a geometrically correct, consistent and uniform model • Increase amount of possible applications, by increasing the quality • Top down approach • Long term solution
Role source holders	**Additive role** -> Optionally generate and provide 3D city models > LOD1	**Supplying role** -> Mandatory collection and supply of 3D BGT features
Role Kadaster	• Generate, manage & facilitate the BGT in 3D (as addition to the existing BGT) • Collect additional 3D models by source holders.	• Collect data from source holders, manage & facilitate the 3D BGT (as a new/improved basis registration)
Further requirements	• No restrictions for the additional 3D city models are given • Guidelines / expertise from external (/top) organisations is required	• A new 3D information model based on IMGeo/BGT (or an addition) is required, with at least: - **Terrain Height** will be added as obligatory attribute for buildings - 3D objects representing building must follow **BAG** contours • Improve national height elevation data, containing a higher point density