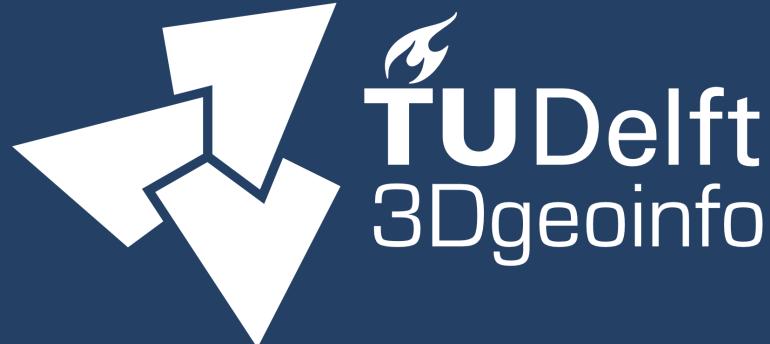


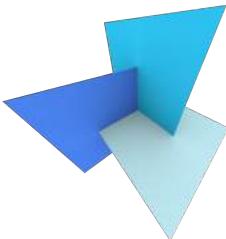
Basisbestand 3D geluid

Ravi Peters, Balázs Dukai, Tom Commandeur, Jantien Stoter
AHN congres, Utrecht, 16-04-2019



3D geoinformation group @ TU Delft

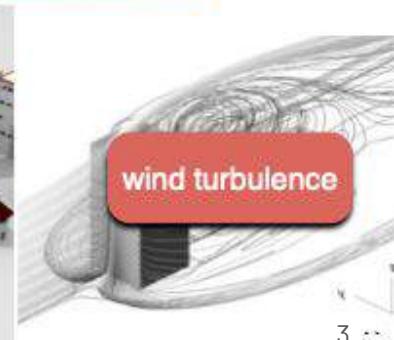
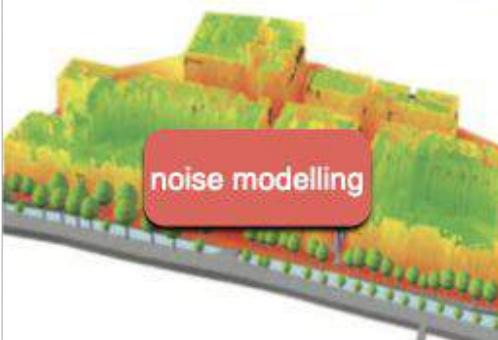
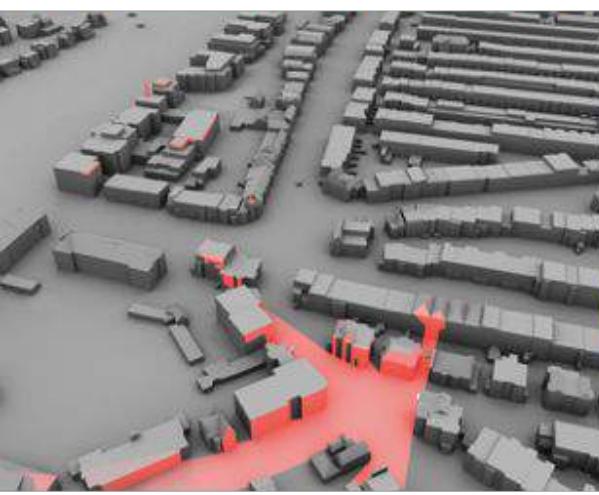
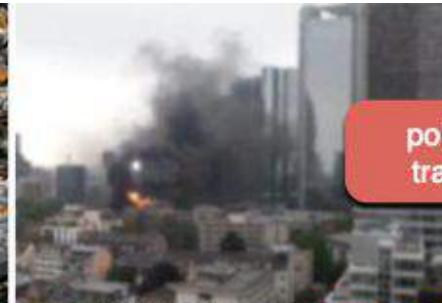
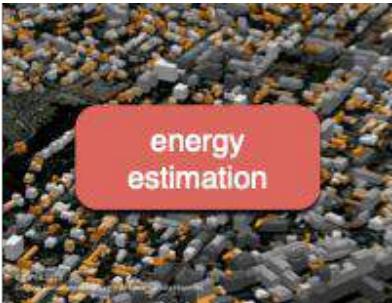
- Reconstruction, modelling and application of 3D geoinformation



3D geoinformation

Department of Urbanism
Faculty of Architecture and the Built Environment
Delft University of Technology



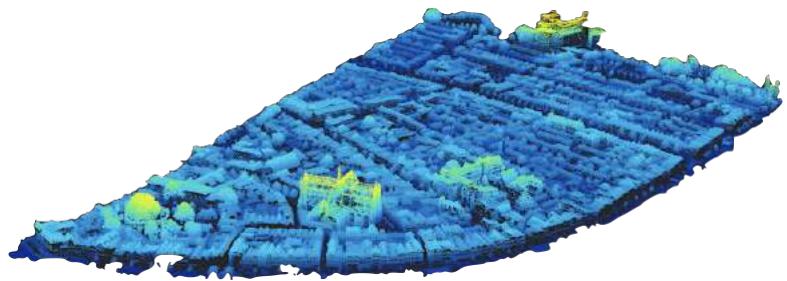


3dfier

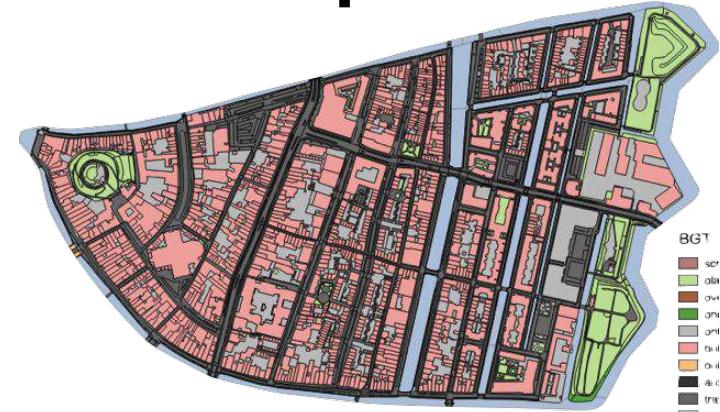
kadaster



Urban scene reconstruction from BGT + point cloud



+

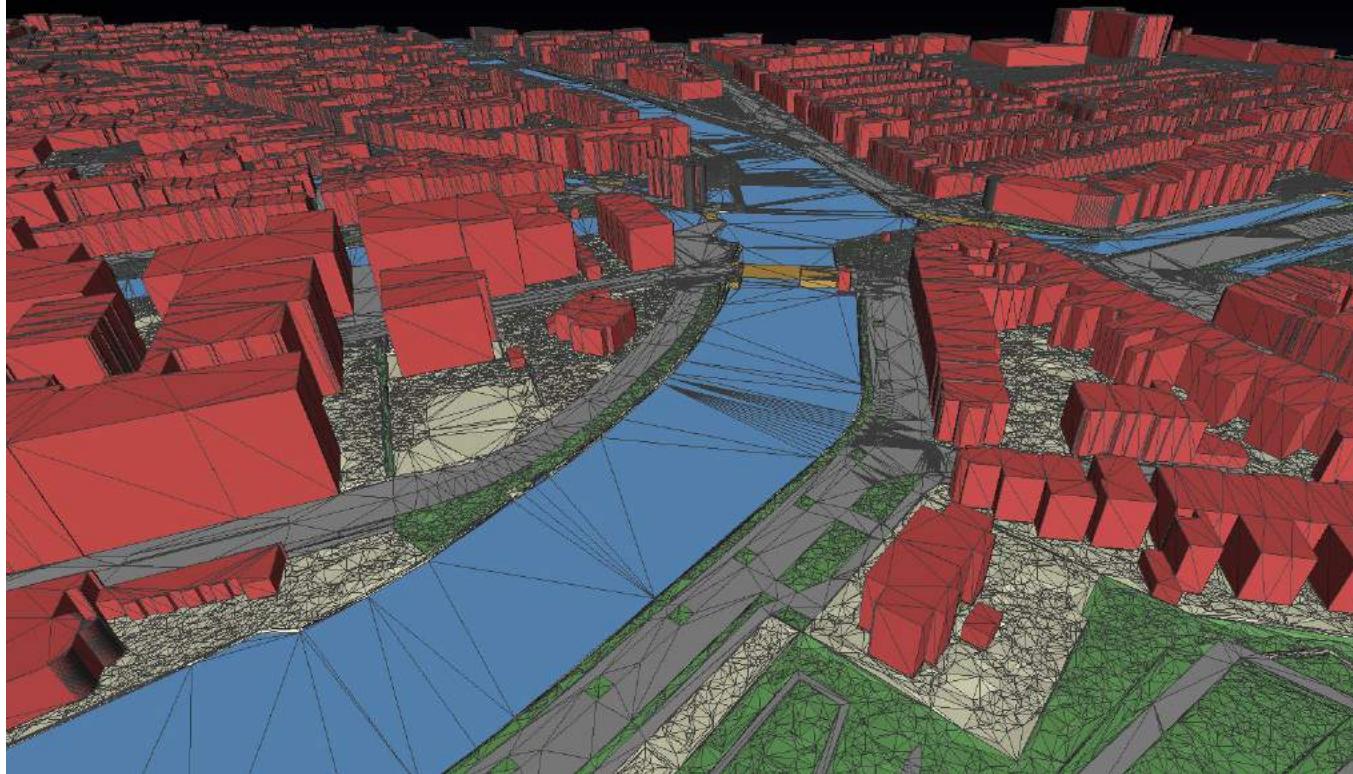


1



3dfier

Open source software: <https://github.com/tudelft3d/3dfier/>



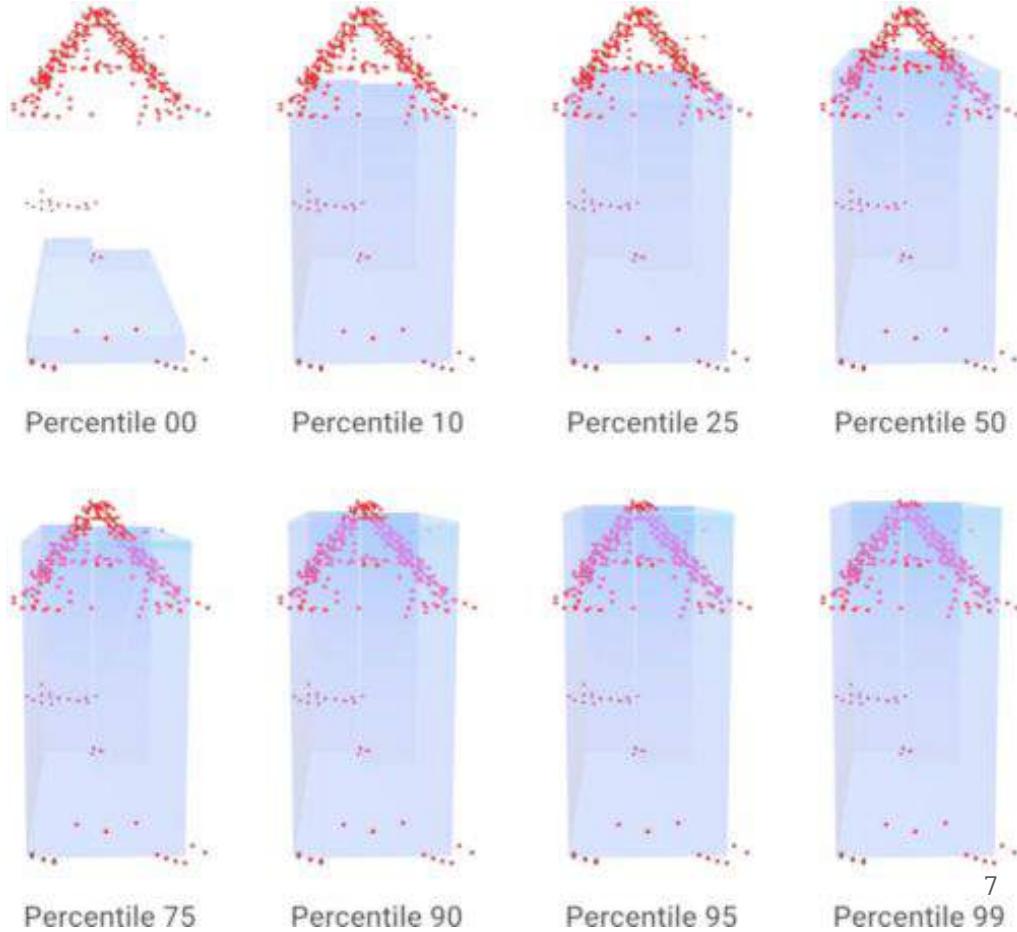
3D BAG

Reliable and up to date LoD1 building heights for BAG based on AHN3



3D BAG - Attributes

Attribute	Description
ground-00, ground-10, ground-20, ground-30, ground-40, ground-50	The height of the ground surface of the building at the given percentile.
roof-25, roof-50, roof-75, roof-90, roof-95, roof-99	The height of the roof surface of the building at the given percentile. For example roof-99 is the height of the building when the roof surface is set at the 99th percentile of the z-coordinates of the point cloud of the building.
rmse-25, rmse-50, rmse-75, rmse-90, rmse-95, rmse-99	The Root Mean Square Error or the geometric difference between the 3D building model and the point cloud that was used for generating the model. Or, the average discrepancy in meters between the 3D building model and the real-world building. This measure also accounts for the whole building, not only the roof.
roof_flat	Indicates that roof of the real-world building is flat or not. The value 1 means a flat roof, the value 0 means a not flat roof. The classification is still under development, with a current accuracy of 80%.
nr_ground_pts	The number of points in the point cloud that were used for determining the ground-height of the building model. If this value is 0, that means that the ground-points are missing from the point cloud at given model.
nr_roof_pts	The number of points in the point cloud that were used for determining the roof-height of the building model. If this value is 0, that means that the roof-points are missing from the point cloud at given model.
ahn_version	The version of the AHN that was used to obtain the height information.
ahn_file_date	The creation date of the AHN file that was used to obtain the height information. This is not the same as the timestamp of the LiDAR points of a particular building.
height_valid	0 - invalid height, because the building was build after the point cloud was acquired; 1 - valid height, because the building was built before the point cloud was acquired
tile_id	The ID of the tile where the building belongs to.



3D BAG

Web app, documentation, downloads and WMS/WFS available at 3dbag.bk.tudelft.nl

The screenshot shows a web browser window displaying the 3D BAG application. The title bar reads "Not Secure — 3dbag.bk.tudelft.nl". The main content area is titled "3D Basisregistratie Adressen en Gebouwen (BAG)". Below the title, there is a navigation menu with links: Map, Downloads, Data quality, Documentation, Software, Terms of use, and Contact. On the left side, there is a legend titled "Legend" for "Roof height at 75th percentile [m]". The legend categories are: < 0.00 (light blue), 0.00 - 5.00 (medium light blue), 5.00 - 8.50 (medium blue), 8.50 - 21.00 (dark blue), 21.00 < (dark red), Outdated height (red), and Missing height (grey). A callout box is overlaid on the map, containing a table of building attributes:

roof-0.25	10.21
rmse-0.25	1.88
roof-0.50	12.51
rmse-0.50	1.75
roof-0.75	16.51
rmse-0.75	1.5
roof-0.90	18.75
rmse-0.90	1.45
roof-0.95	19.54
rmse-0.95	1.45
roof-0.99	20.25
rmse-0.99	1.45
roof flat	false

A tooltip message "Click on a building to see its attributes!" is visible near the bottom left of the map. The map itself shows a detailed urban area with buildings colored according to their roof height. The map includes street names such as "Berkelpoort", "Ballonstraat", "Bankstraat", "Mensiedijkkanaal", "Leidseweg", "Graaf van Roggenweg", and "Graaf van Roggenhof". The bottom left corner of the map contains logos for the European Union and the European Research Council (ERC).

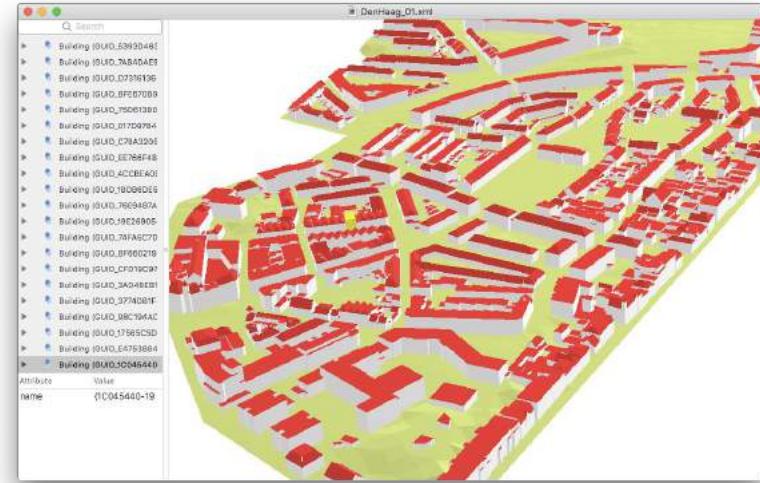
CityJSON - CityGML without the GML

A JSON encoding for CityGML - <http://www.cityjson.org>

The screenshot shows the official CityJSON website at www.cityjson.org/en/0.9/. The page title is "CityJSON (version 0.9)". On the left, there's a logo with stylized buildings and trees, and a sidebar with links like "Watch 29", "Navigation", "CityJSON specifications", "Schema validation", "Software", "Extensions", "CityGML support", "Example datasets", "Changelog", "Contact", "JSON homepage", "CityGML homepage", "GitHub repository", and "cji (CityJSON/io)". A "Quick search" bar is at the bottom. The main content area displays a portion of the CityJSON JSON schema, showing objects like buildings with attributes such as roofType, geometry, vertices, and appearance.

```
{
  "type": "CityJSON",
  "version": "0.9",
  "extensions": { "Noise": "https://someurl.org/noise.json" },
  "metadata": { "referenceSystem": "urn:ogc:def:crs:EPSG::7415" },
  "CityObjects": [
    {
      "id-1": {
        "type": "Building",
        "attributes": { "roofType": "gable" },
        "geometry": [
          {
            "type": "Solid",
            "lod": 2,
            "boundaries": []
          }
        ],
        "id-56": {...}
      },
      "vertices": [
        [23.1, 2321.2, 11.0],
        [14.0, 2299.5, 14.0],
        ...
      ],
      "appearance": {
        "textures": []
      },
      "geometry-templates": {}
    }
  ]
}
```

CityJSON is a format for encoding a subset of the CityGML data model (version 2.0.0) using JavaScript Object Notation (JSON). A CityJSON file represents both the geo-

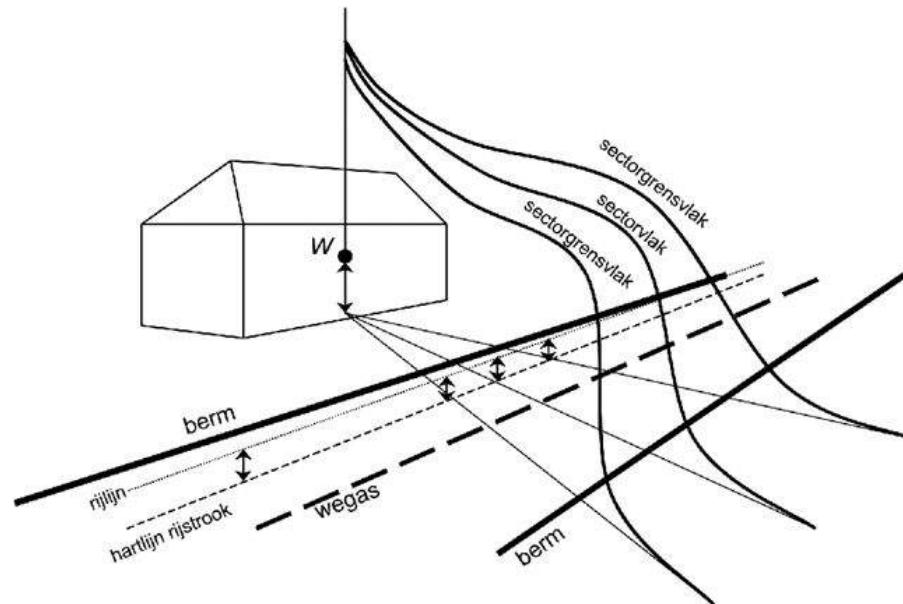


Azul - open source macOS viewer for city models
<https://github.com/tudelft3d/azul>

Basisbestand 3D geluid

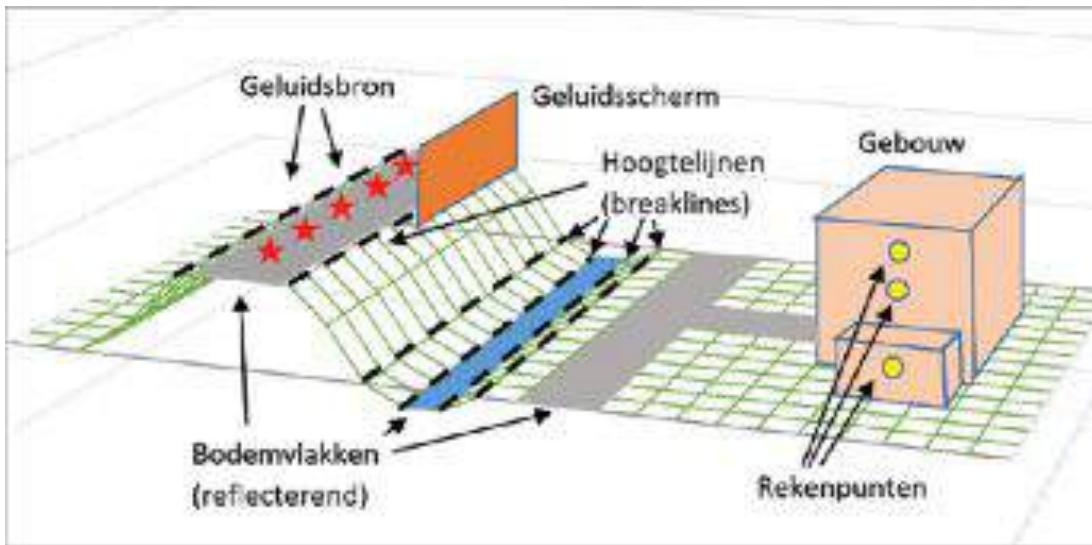
Geluidsimulatie

- Onderdeel van geluidstudies
- In Nederland vastgelegd in Standaard Rekenmethode II (SRM2)
- Geïmplementeerd in software (GeoMilieu, Winhavik)



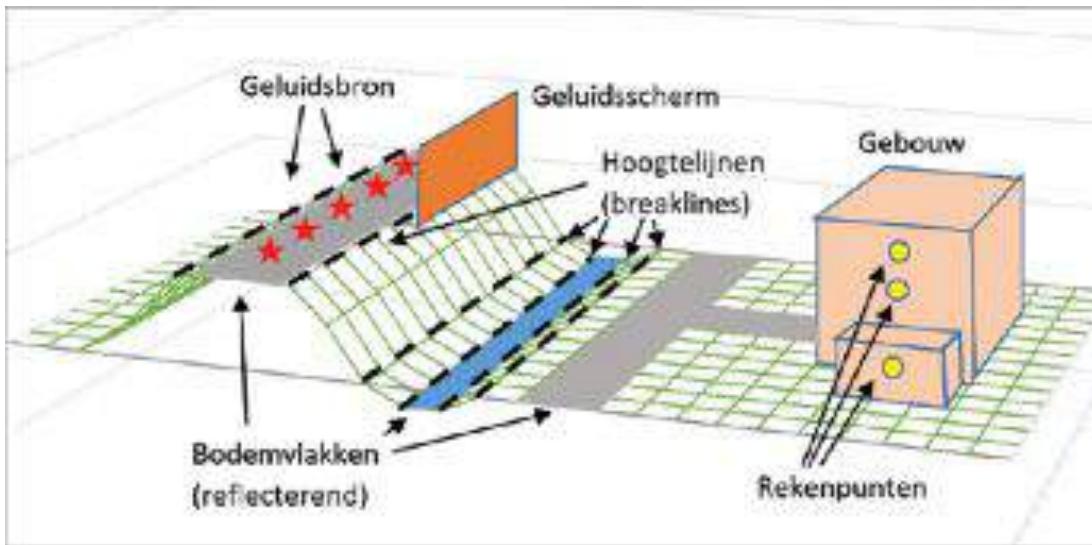
Input data nodig voor geluidsimulatie

1. Informatie over geluidemissie: geluidsbron (o.a verkeersintensiteit)
2. 3D representatie van omgeving voor berekenen geluidoverdracht
3. rekenpunten



Input data nodig voor geluidsimulatie

1. Informatie over geluidemissie: geluidsbron (o.a verkeersintensiteit)
2. **3D representatie van omgeving voor berekenen geluidoverdracht**
3. rekenpunten



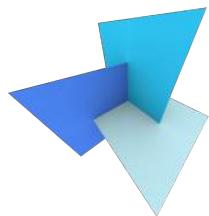
Huidige praktijk

Voor iedere studie wordt 3D afzonderlijk ingewonnen

- Niet efficient
- Niet consistent: verschillen in input data kunnen leiden tot verschillen in resultaten
- Niet automatisch: beperkt innovaties

Ons project

- Automatisch genereren van input data voor geluidstudies vanuit bestaande data sets:
 - BGT/BAG
 - AHN, hoogtepunten
- Consistent bestand met ruimte voor innovatie



3D geoinformation

Department of Urbanism
Faculty of Architecture and the Built Environment
Delft University of Technology



Rijkswaterstaat
Ministerie van Infrastructuur en Milieu



Rijksinstituut voor Volksgezondheid
en Milieu
*Ministerie van Volksgezondheid,
Welzijn en Sport*

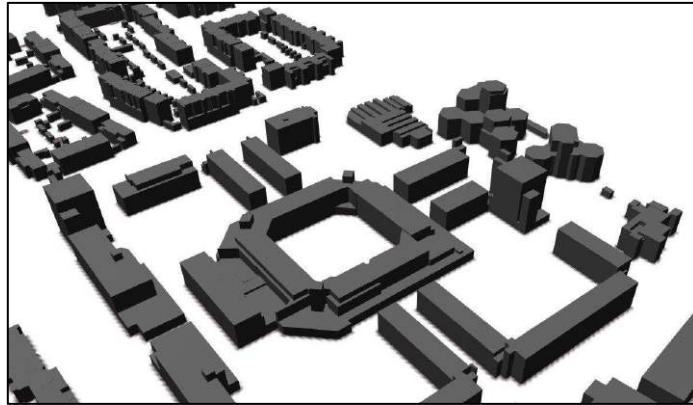


kadaster

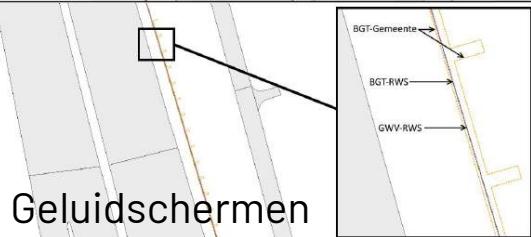
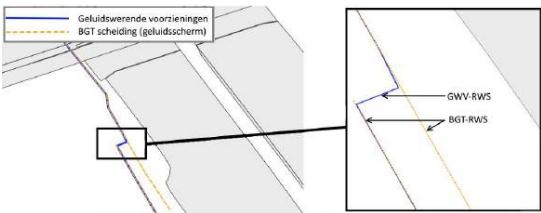


Interprovinciaal Overleg
van en voor provincies

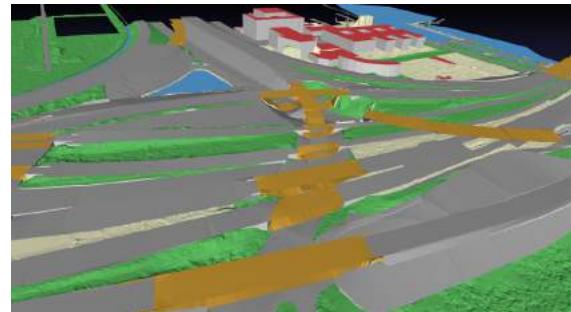
Gegenereerde input data in ons project



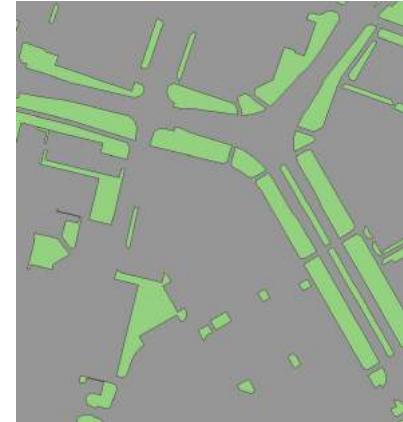
Hoogtelijnen



Geluidschermen

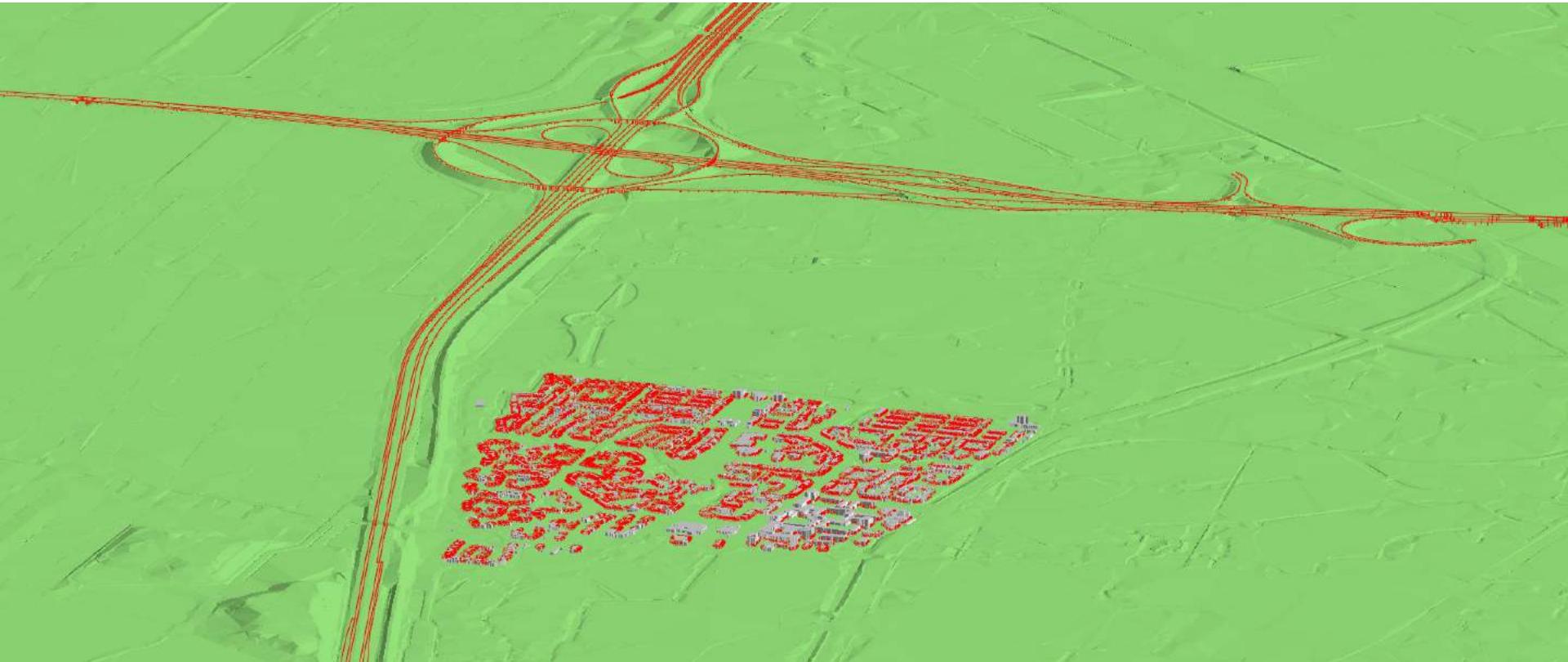


Bruggen



Bodemvlakken
(geluidabsorptie/reflectie)

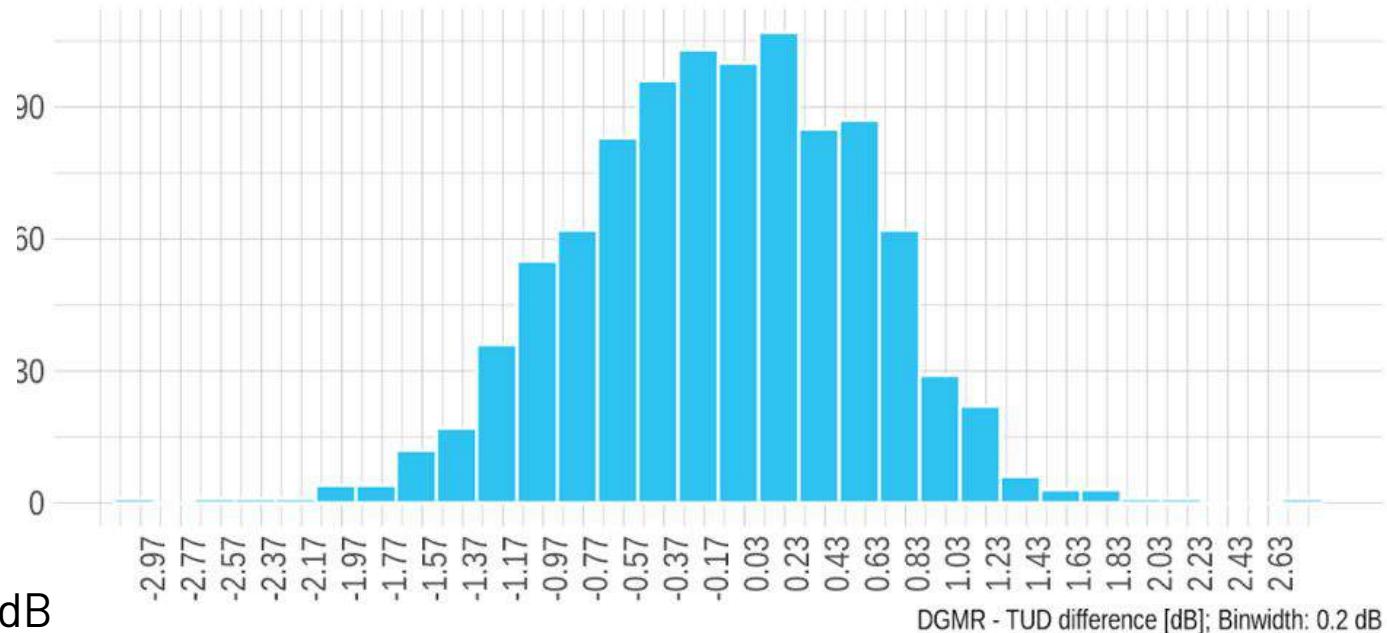
Gegenereerde input data in ons project



Test van onze resultaten

Histogram of differences in noise simulation

Cleaned data

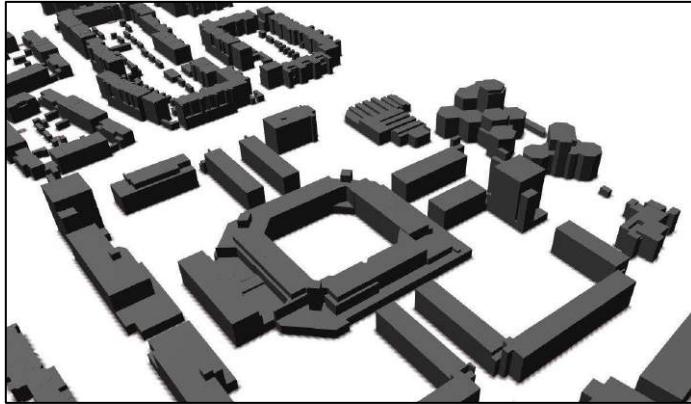


Mean difference 0.1 dB

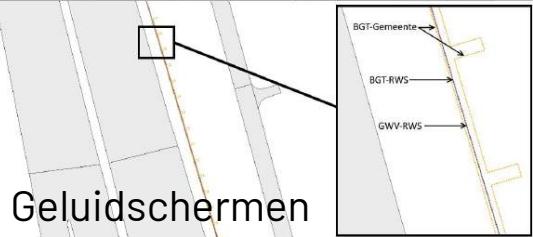
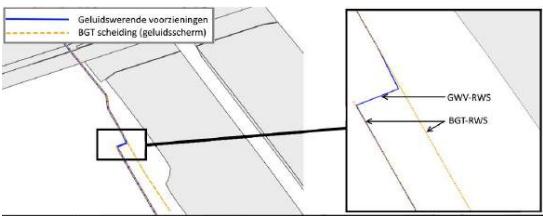
Standard deviation 0.7 dB

95% confidential interval 0.1 dB

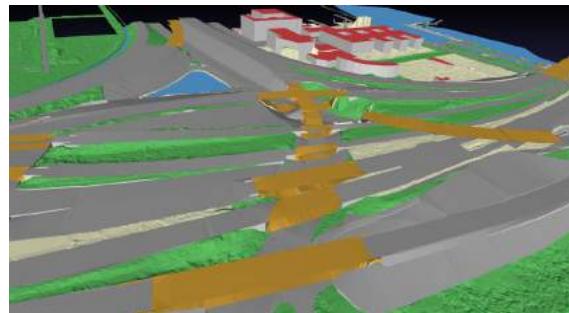
Waar zit het AHN?



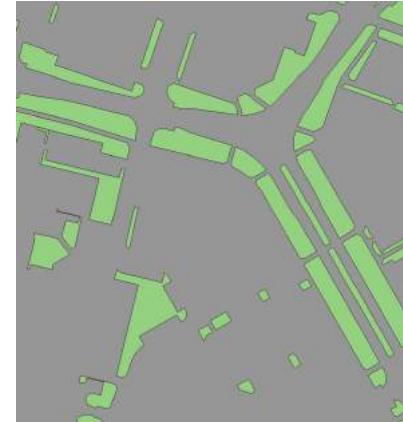
Hoogtelijnen



Geluidsbeschermen

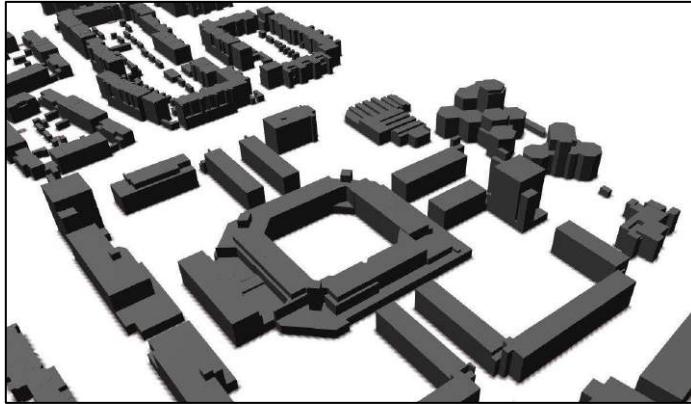


Bruggen

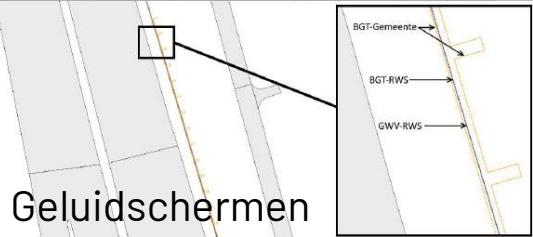
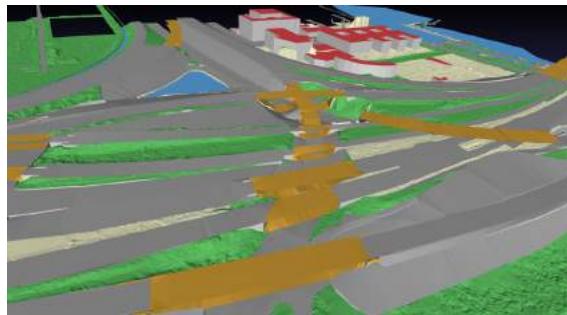
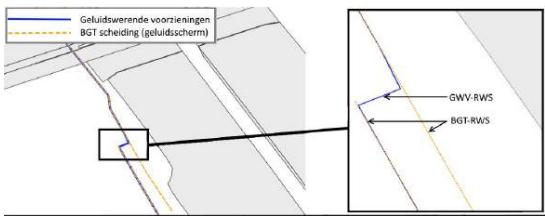


Bodemvlakken
(geluidabsorptie/reflectie)

Waar zit het AHN?



Hoogtelijnen



Geluidsbarrières

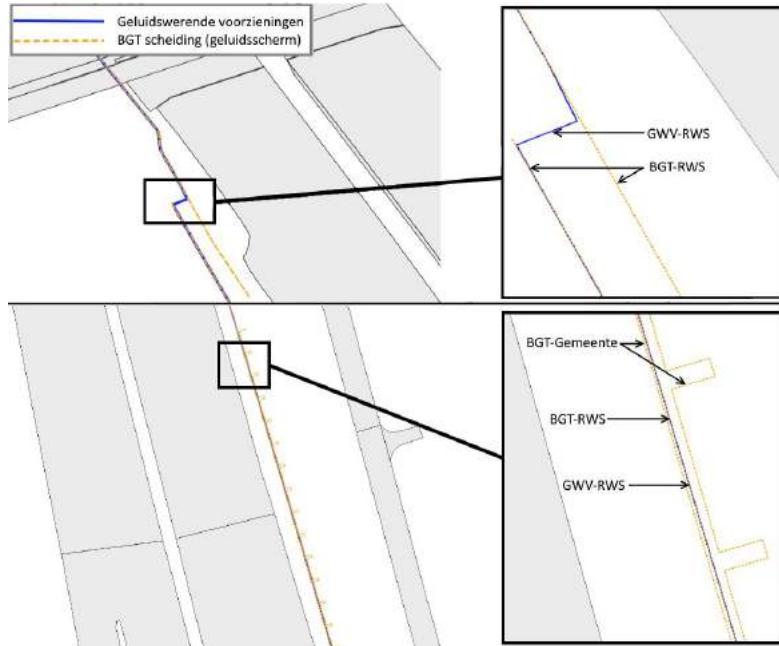
Bruggen



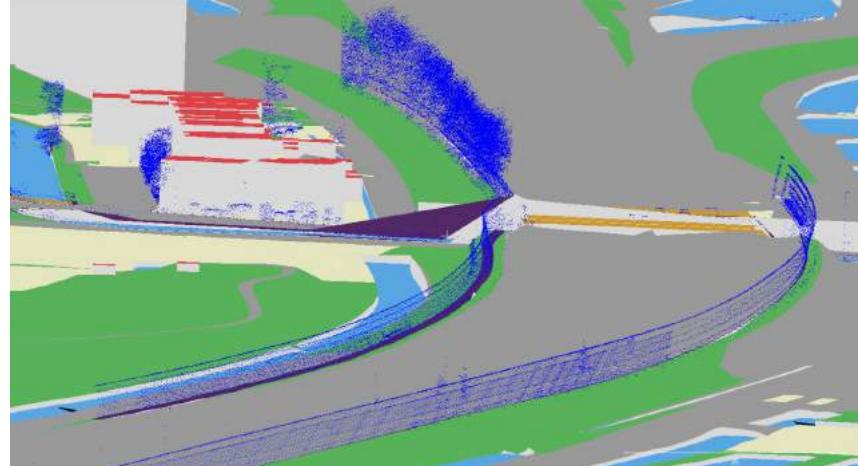
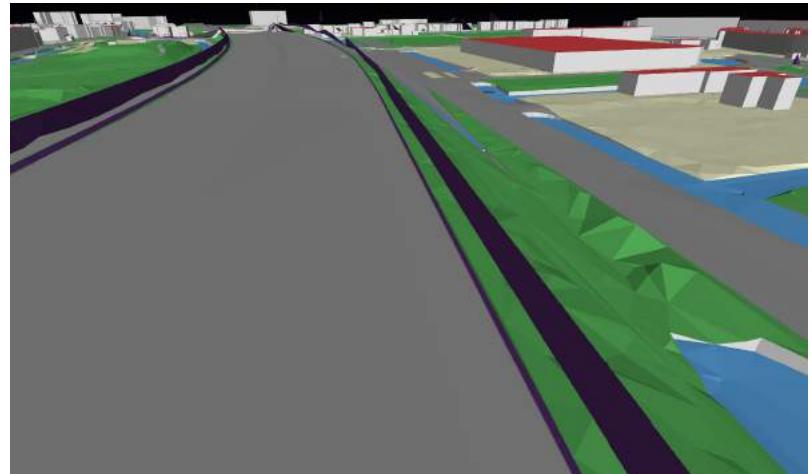
Bodemvlakken
(geluidabsorptie/reflectie)

Geluidschermen

In principe vastgelegd in GWV (Geluidswerende voorzieningen) en BGT



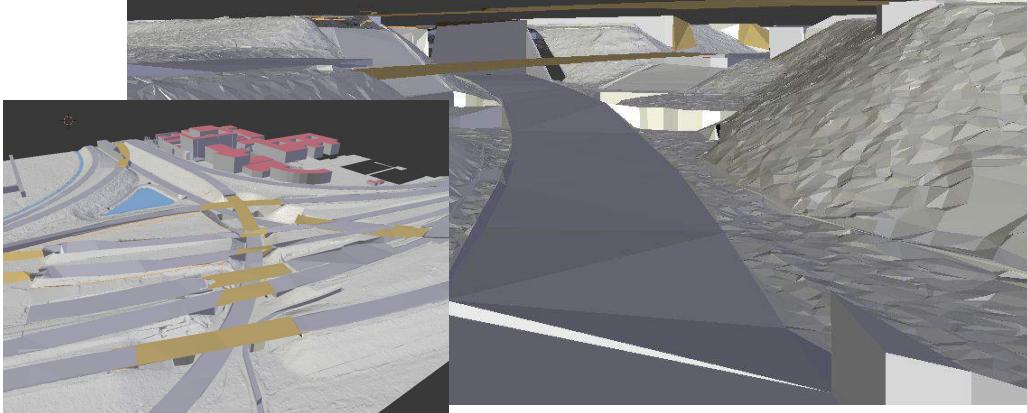
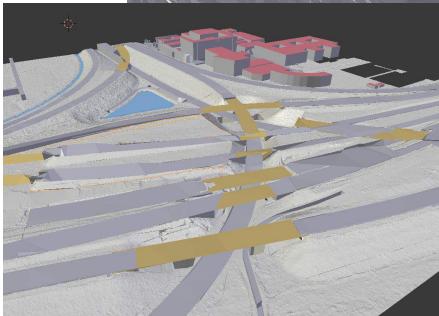
LAS klasse unassigned 1m buffer scheiding



BGT uit 3dfier puntenwolk met klasse 'unassigned'

Bruggen uitdagingen

1. Occlusie puntenwolk
2. Geen volledige topologie/rijrichting in BGT
3. Classificatie grond/brugdeel

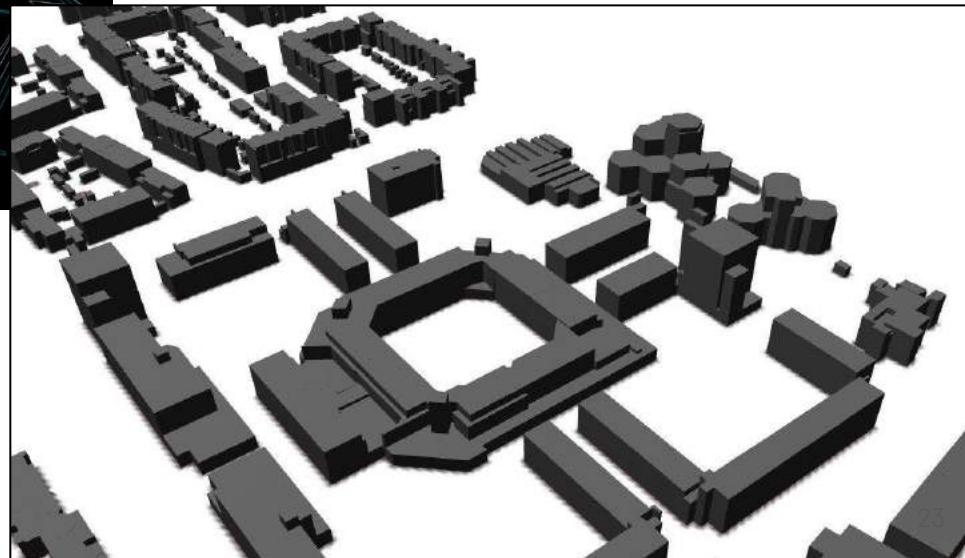


Waar zit het AHN?



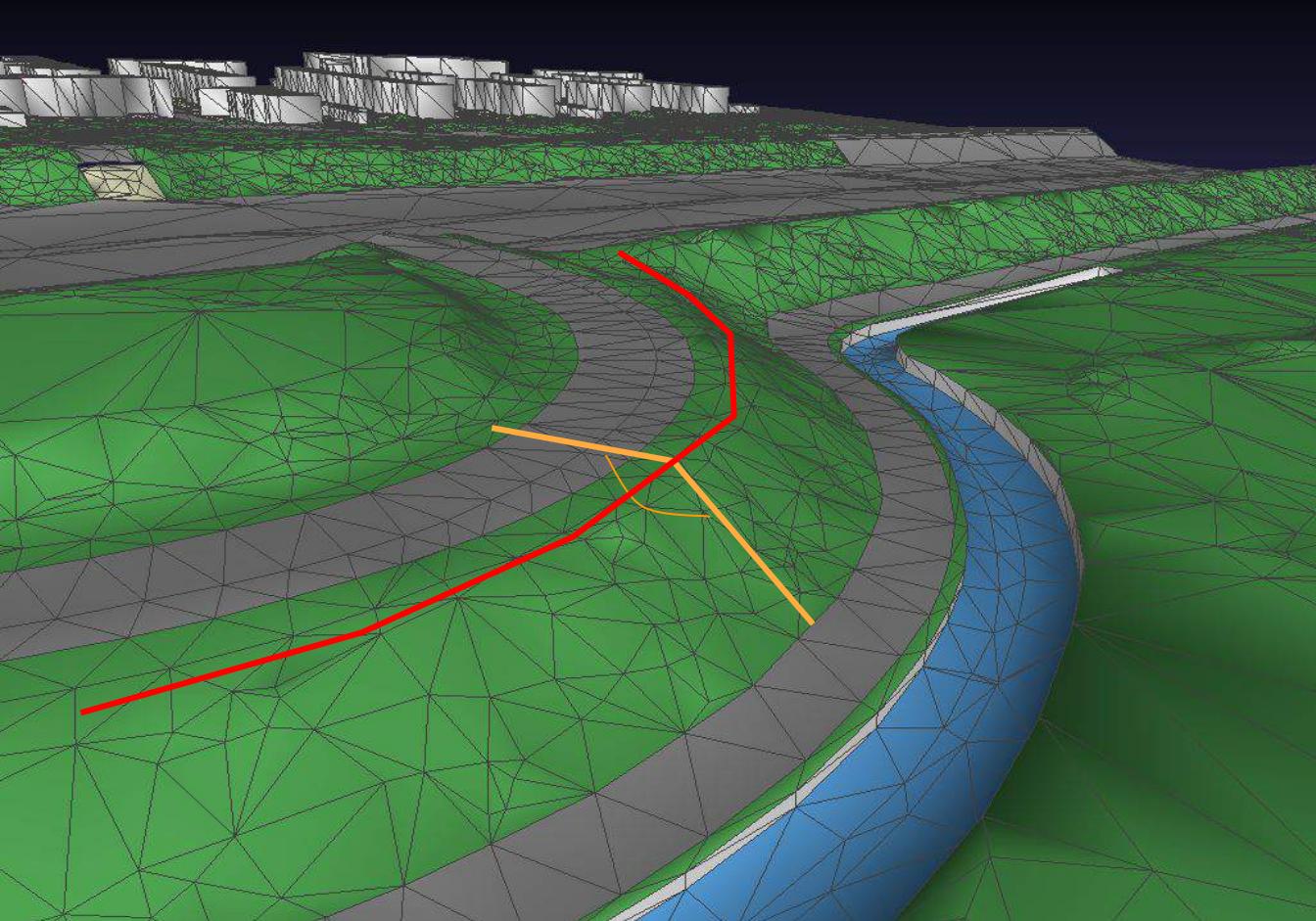
Hoogtelijnen

Gebouwen

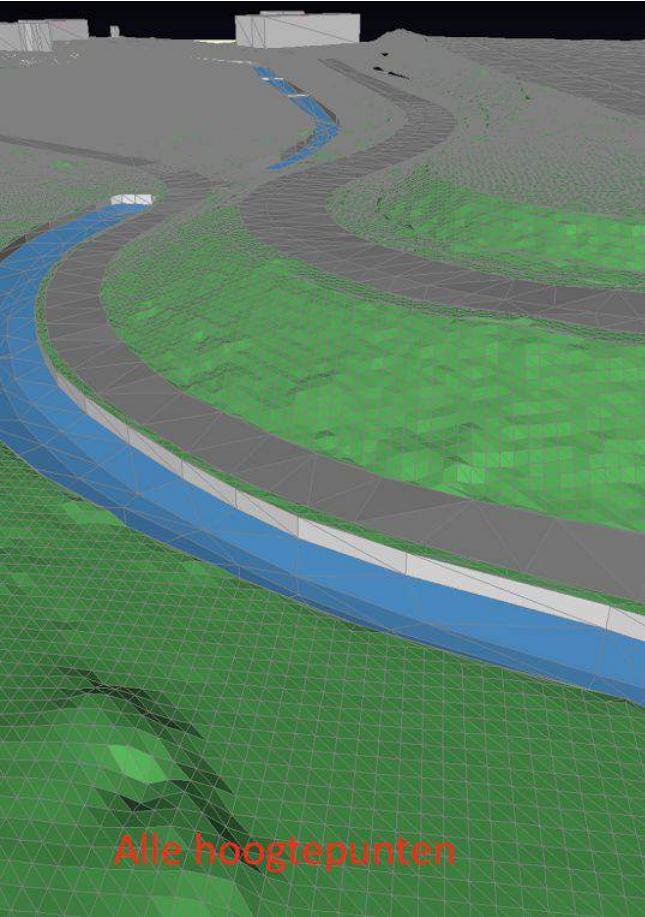


Hoogtelijnen

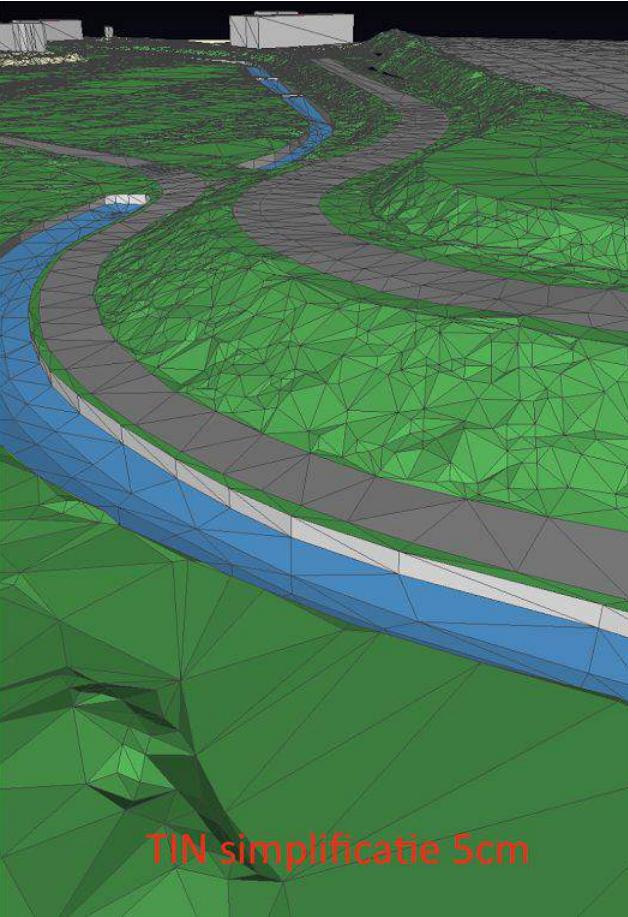
Hoogtelijnen



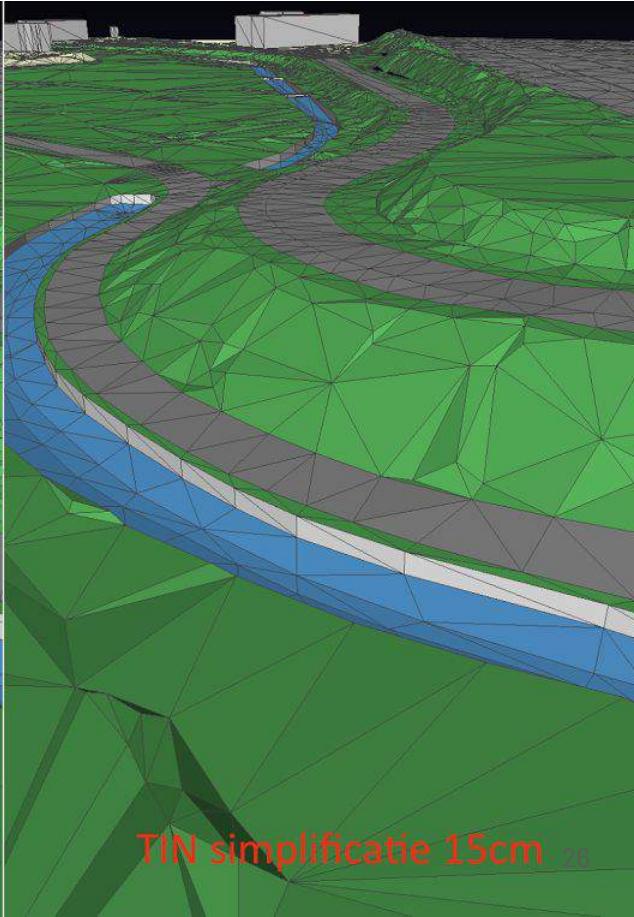
TIN simplificatie (3dfier)



Alle hoogtepunten



TIN simplificatie 5cm



TIN simplificatie 15cm

Hoogtelijnen

1. **Voorselectie lijnen uit BGT**
2. Op hoogte leggen met AHN
3. Filter lijnen op 3D geometrie
4. Isolijnen hoogteverschil
5. 3D lijn simplificatie



Hoogtelijnen

1. Voorselectie lijnen uit BGT
- 2. Op hoogte leggen met AHN**
3. Filter lijnen op 3D geometrie
4. Isolijnen hoogteverschil
5. 3D lijn simplificatie



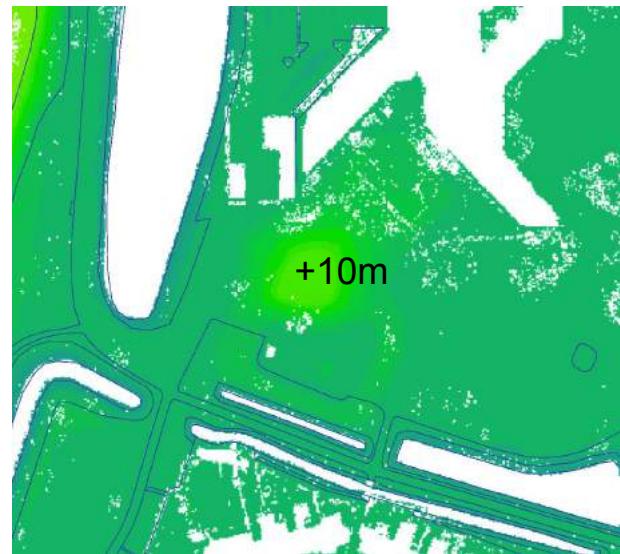
Hoogtelijnen

1. Voorselectie lijnen uit BGT
2. Op hoogte leggen met AHN
- 3. Filter lijnen op 3D geometrie**
4. Isolijnen hoogteverschil
5. 3D lijn simplificatie

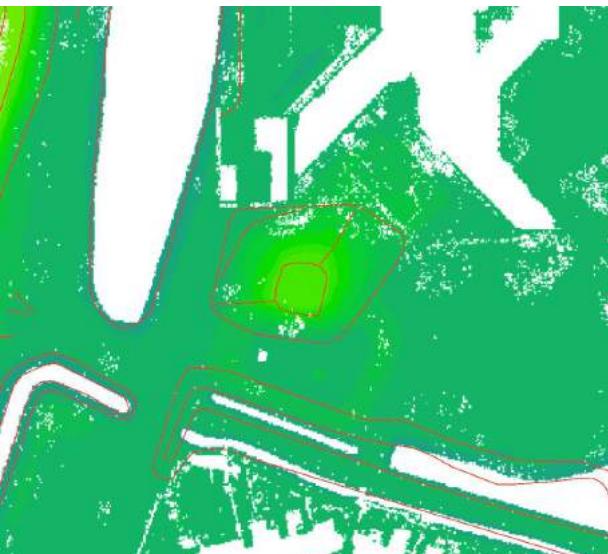


Isolijnen hoogteverschil

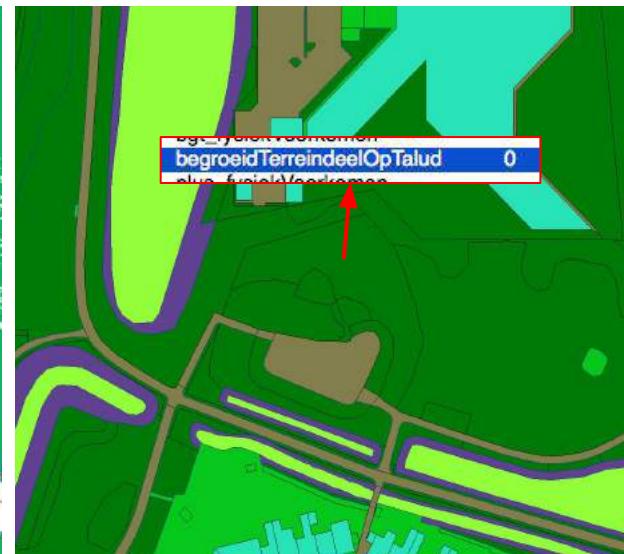
Can we rely on BGT geometry and attributes?



Basisbestand 3D v0.1



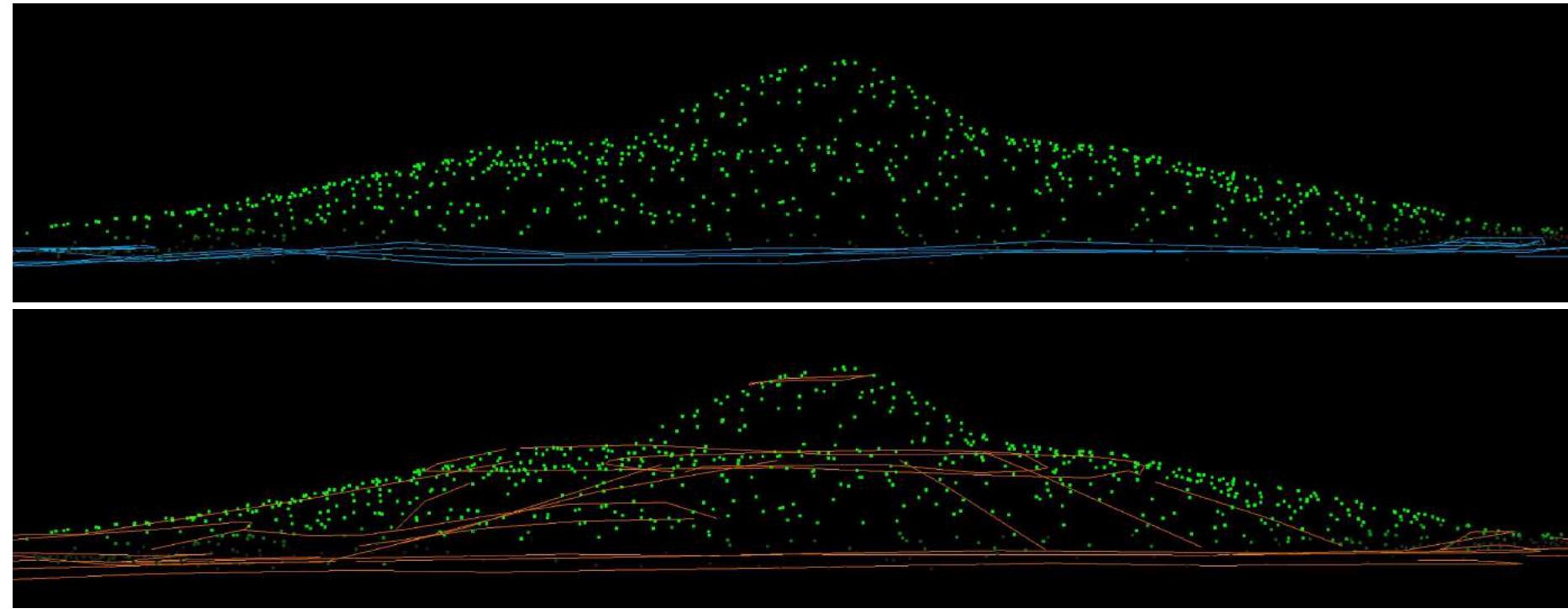
DGMR reference



BGT

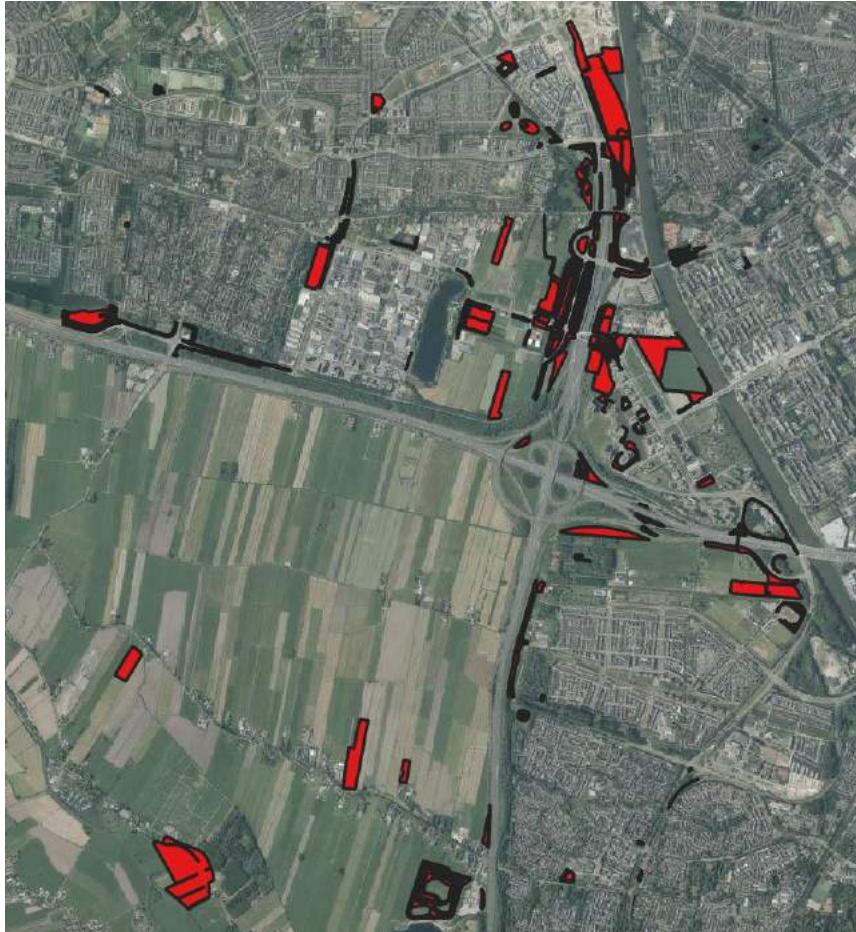
Isolijnen hoogteverschil

Can we rely on BGT geometry and attributes?

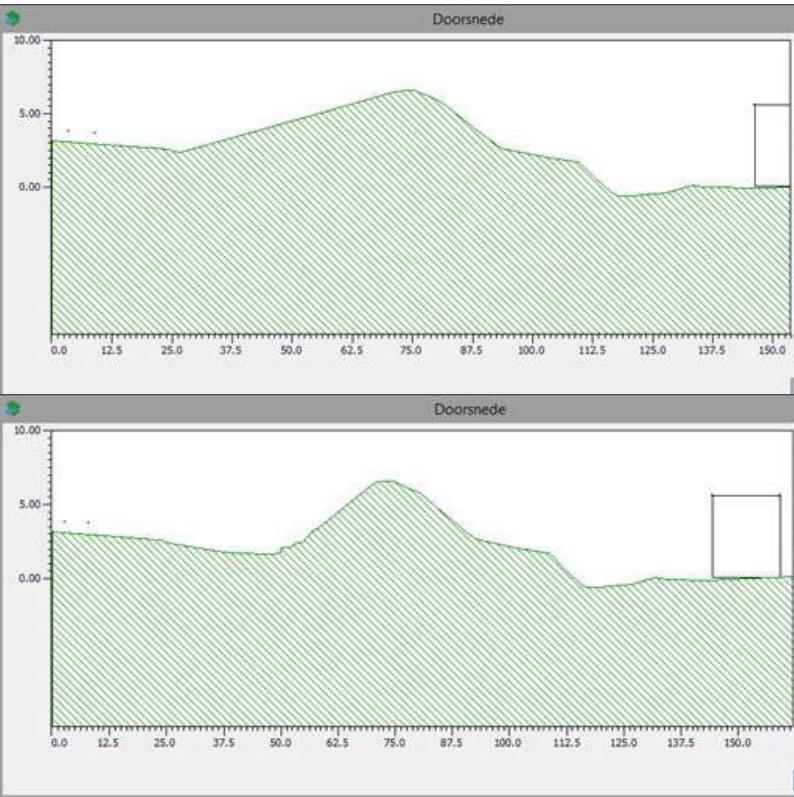


Isolijnen hoogteverschil

Ontbrekende waarde voor
OpTalud attribuut BGT

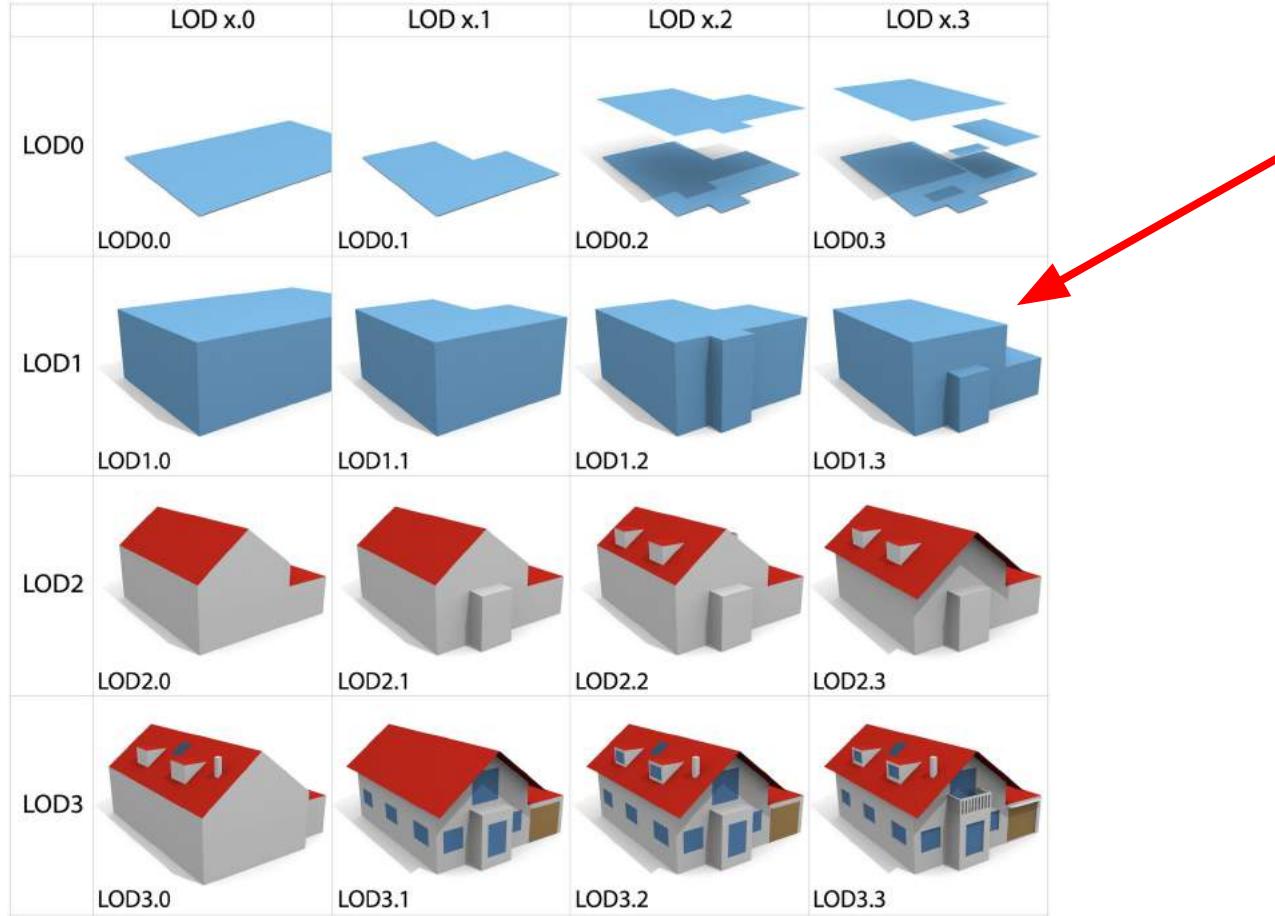


Isolijnen hoogteverschil



Gebouwen

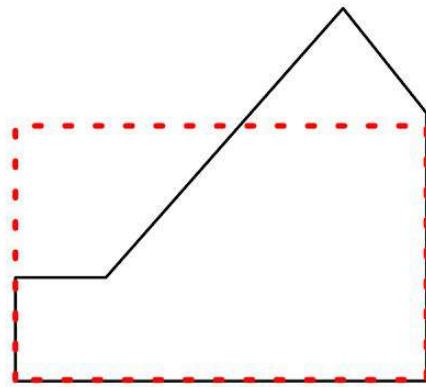
Levels of Detail (LoD)



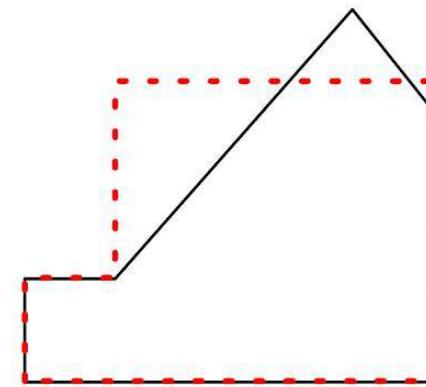
Wat is LoD 1.3?



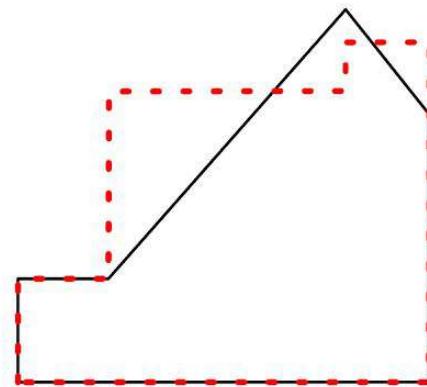
(a)



(b)

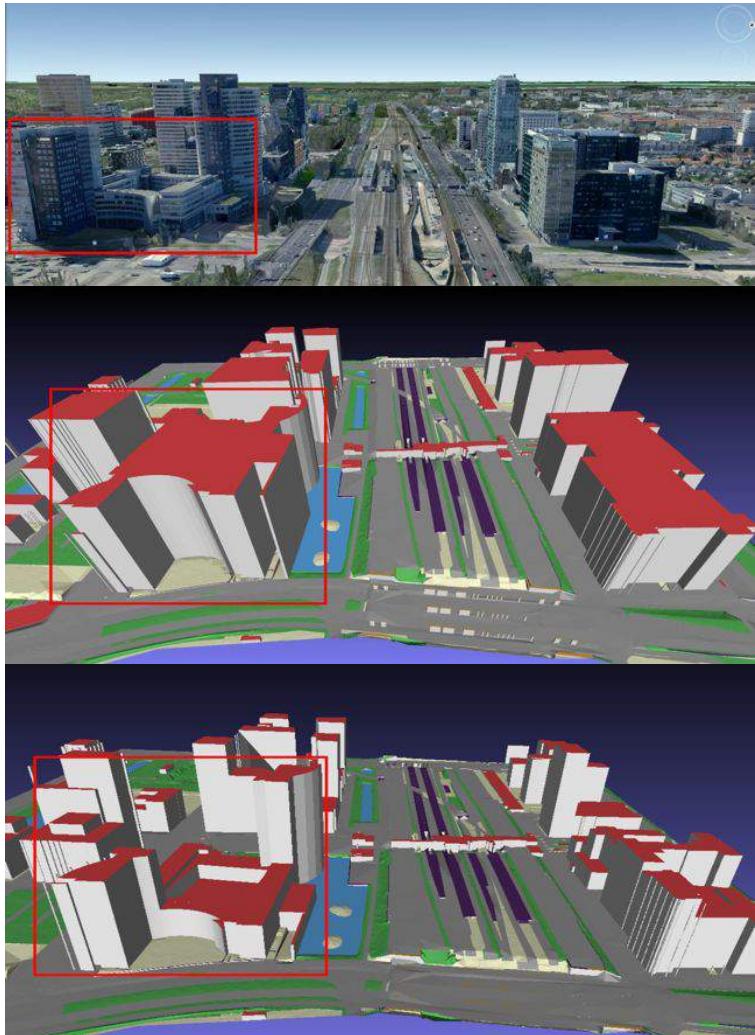
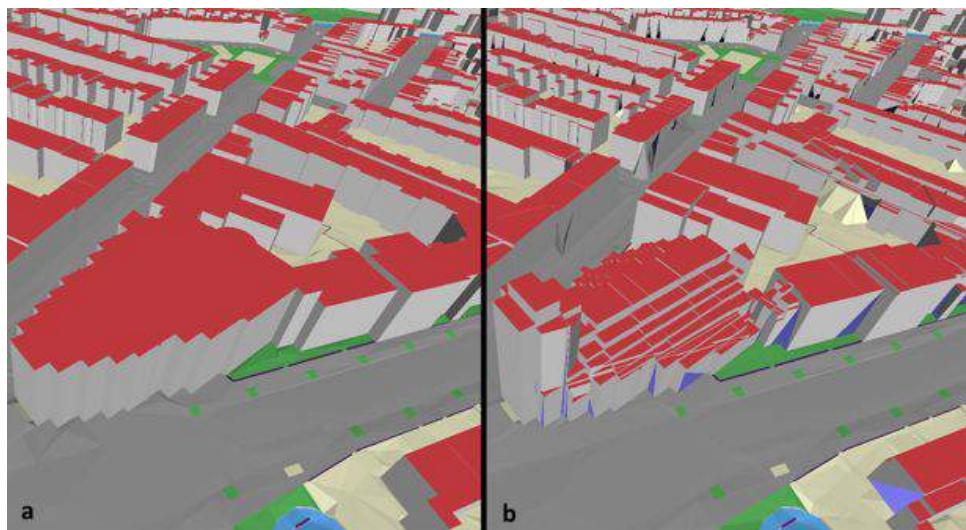
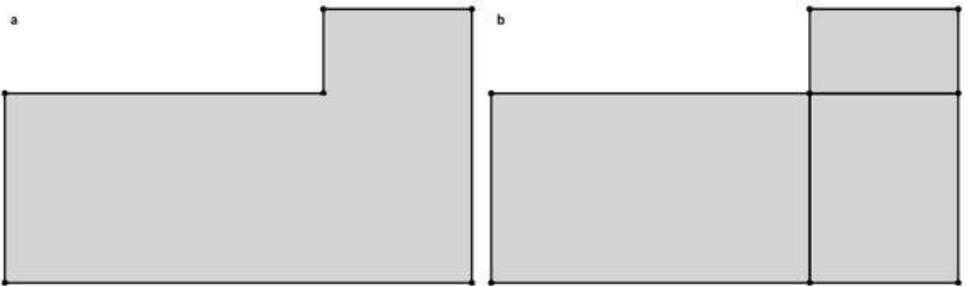


(c)



(d)

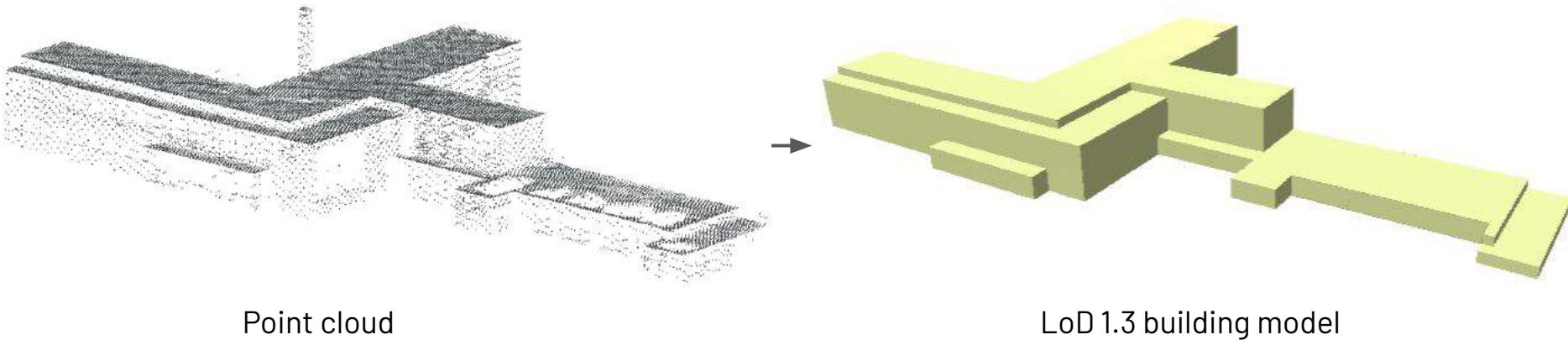
Footprint decompositie



Objective

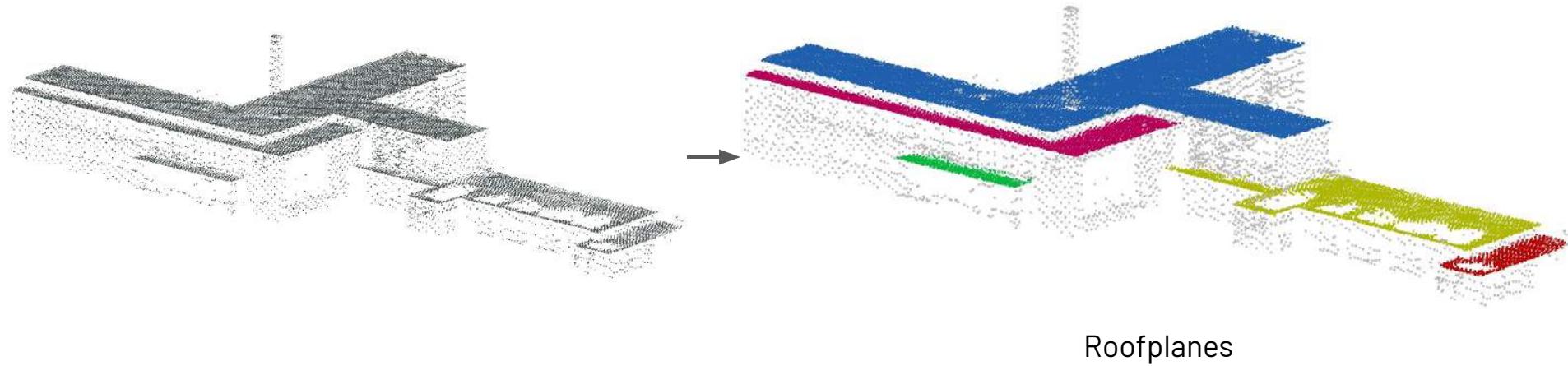
Obtain an **LoD 1.3** building model from the (AHN3) point cloud of a building

In LoD 1.3 a building's footprint is subdivided in separate roof parts. Each roof part is assigned its own height.

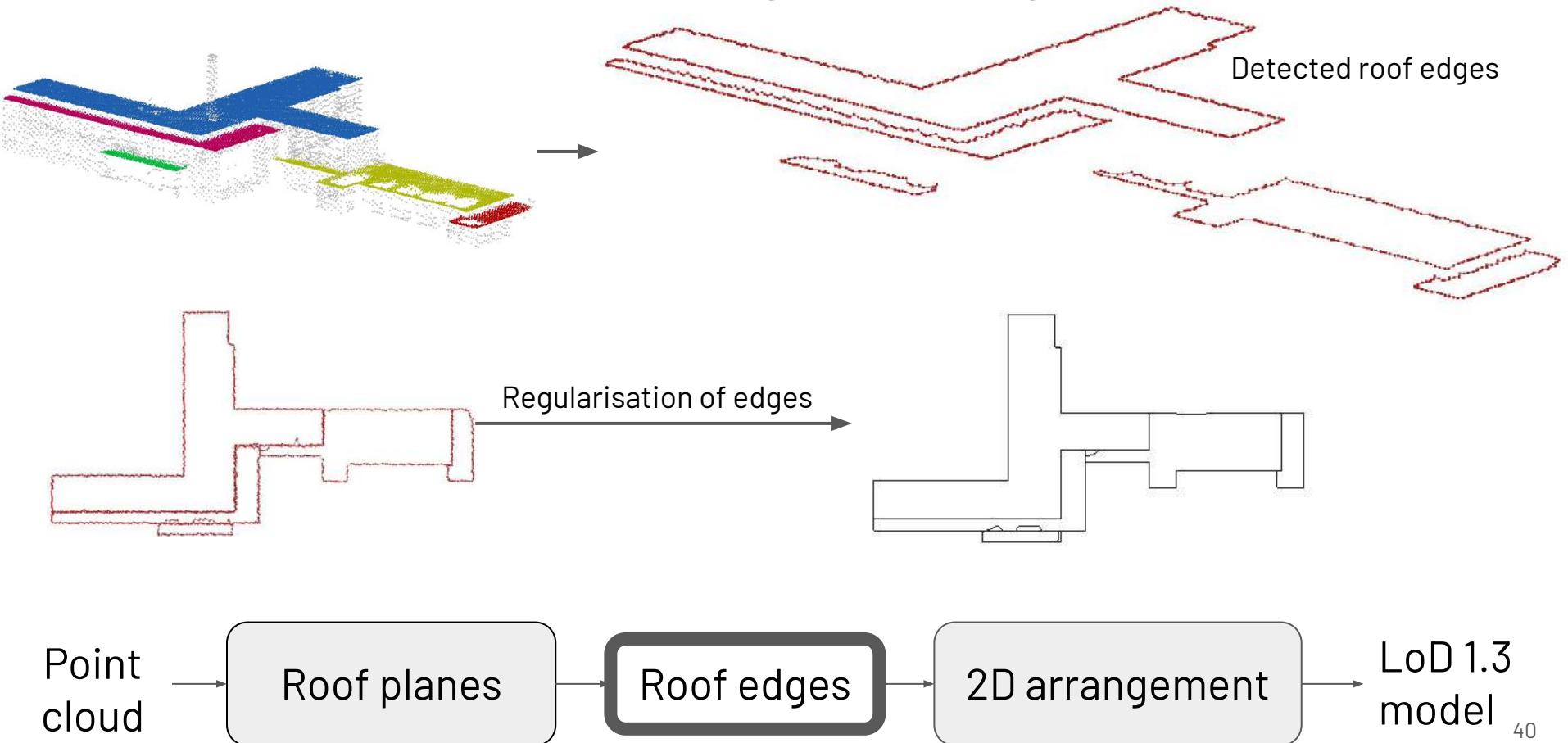


Step 1: Detect roof planes

Perform plane detection in the point cloud and identify the roof planes

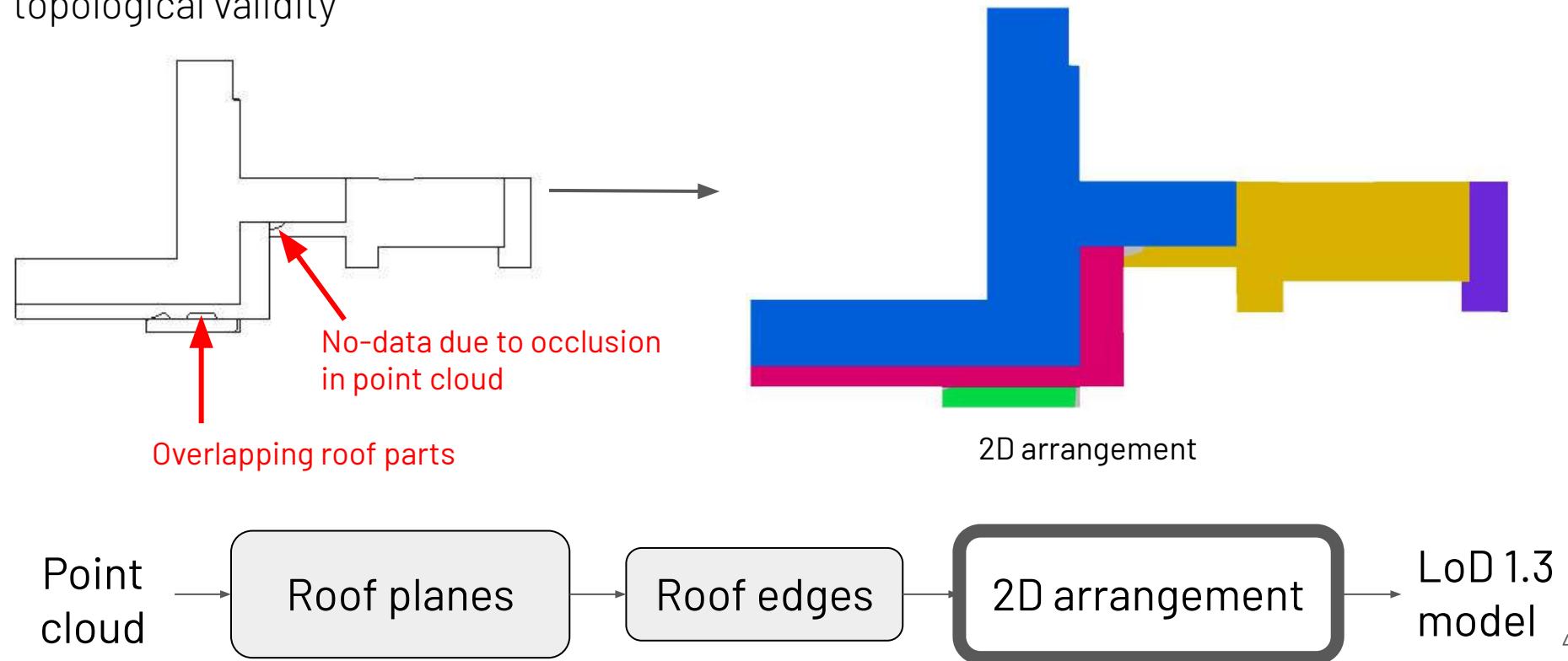


Step 2: Detect roof edges + regularisation



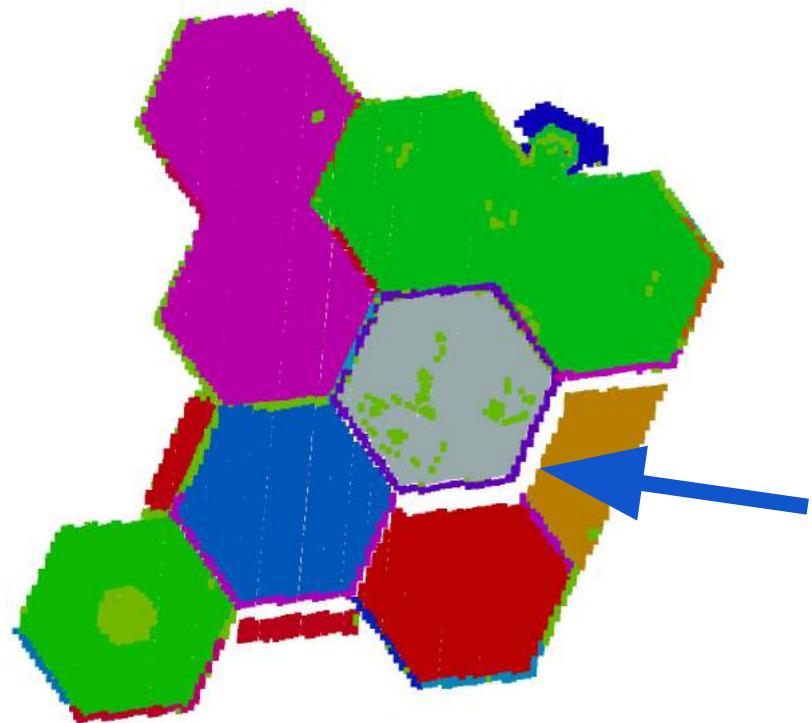
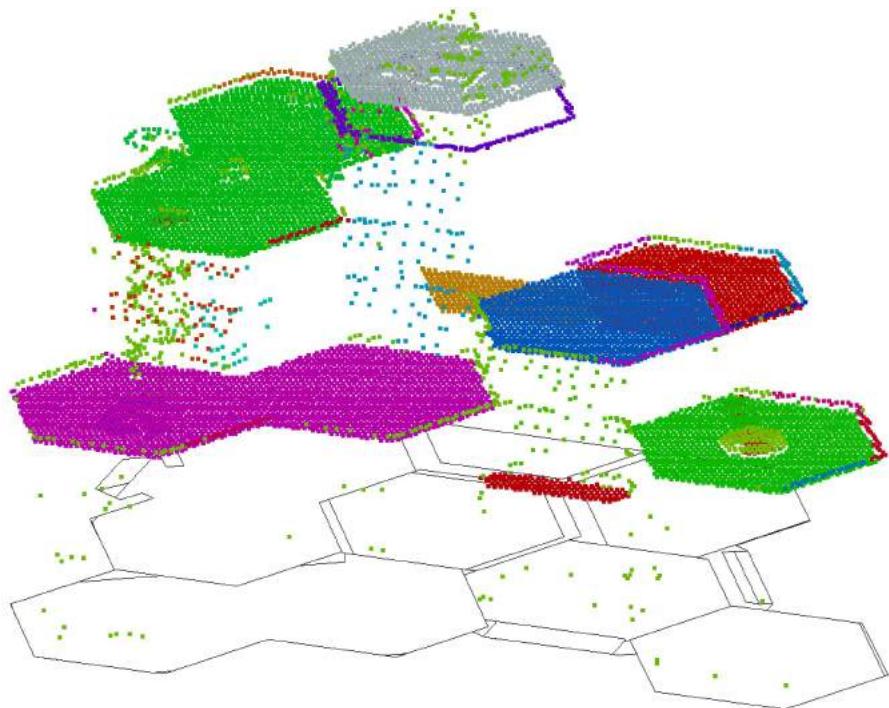
Step 3: Build 2D arrangement

The 2D Arrangement helps to solve conflicts (in)between roof parts and enforces topological validity



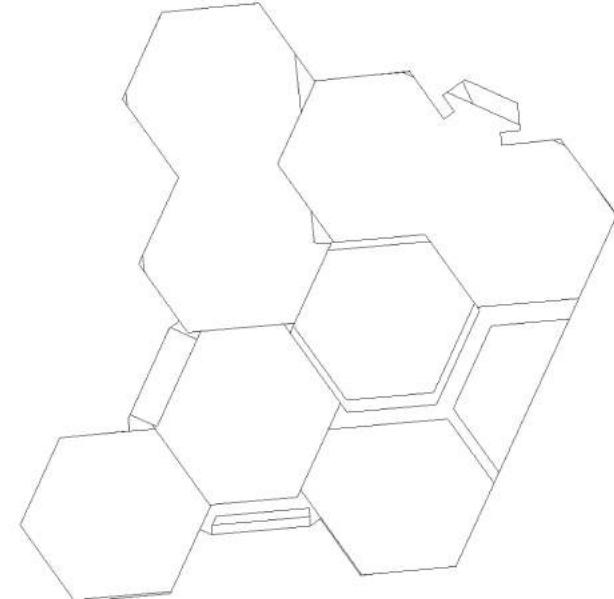
2D planar arrangements

Used to recover from occlusion

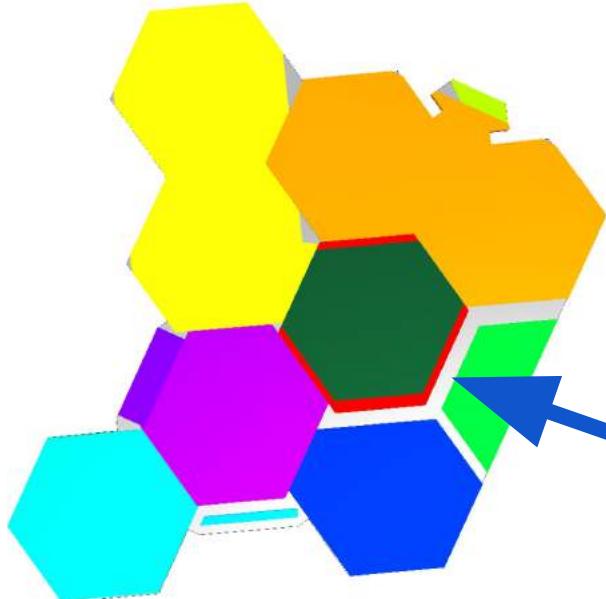


2D planar arrangements

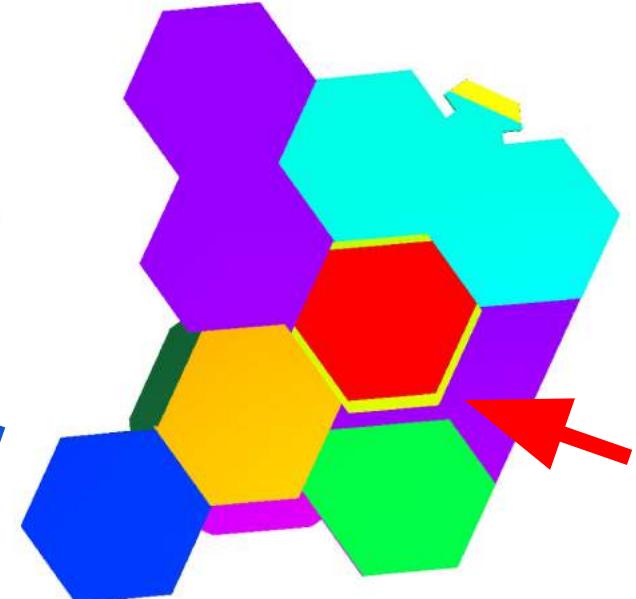
Can be used to recover from occlusion



Boundary lines

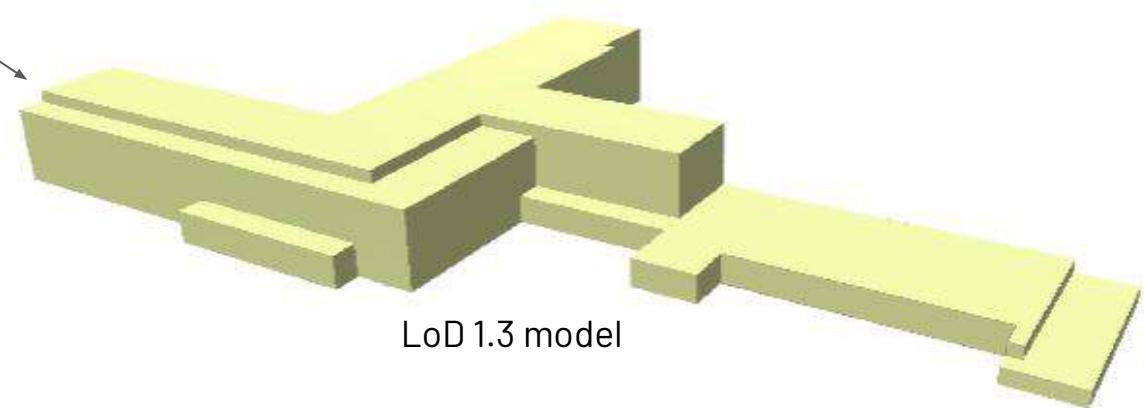
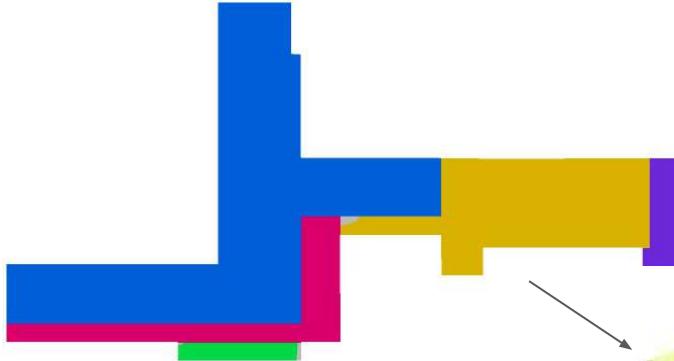


Roofpart labels



Floodfill from low
to high parts

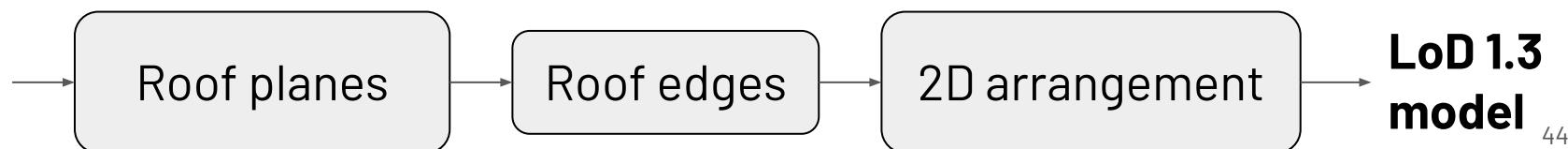
Step 4: Extrusion of roof parts



Original point cloud

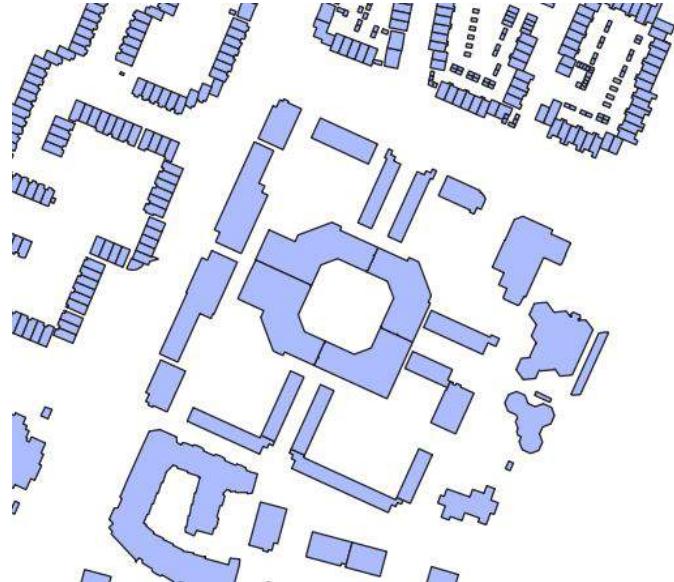
LoD 1.3 model

Point
cloud

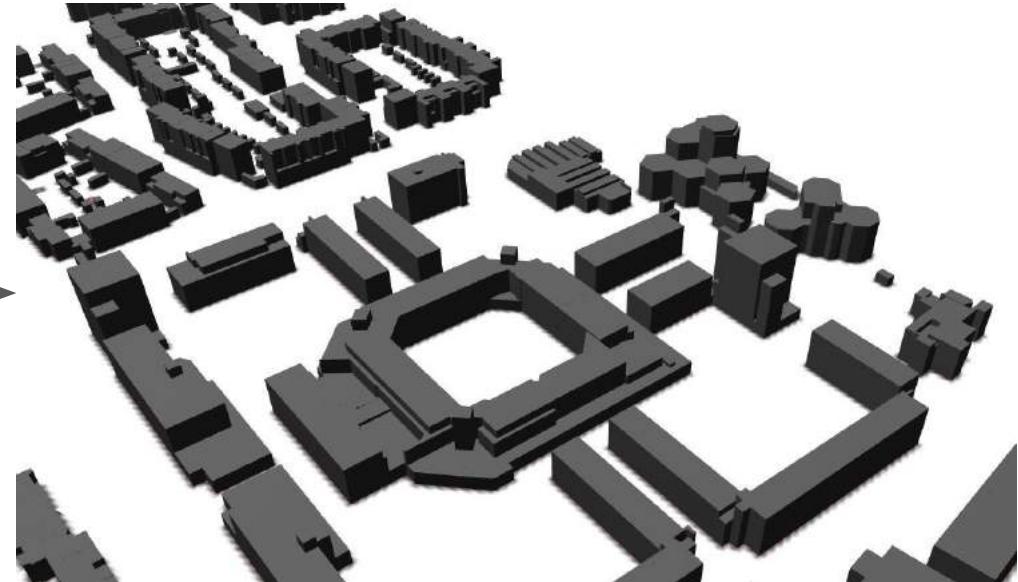


**LoD 1.3
model**

Result

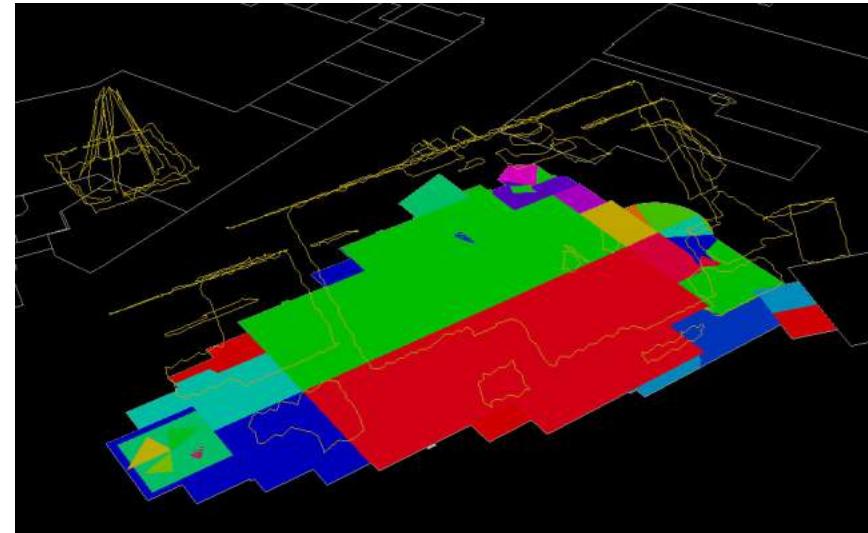
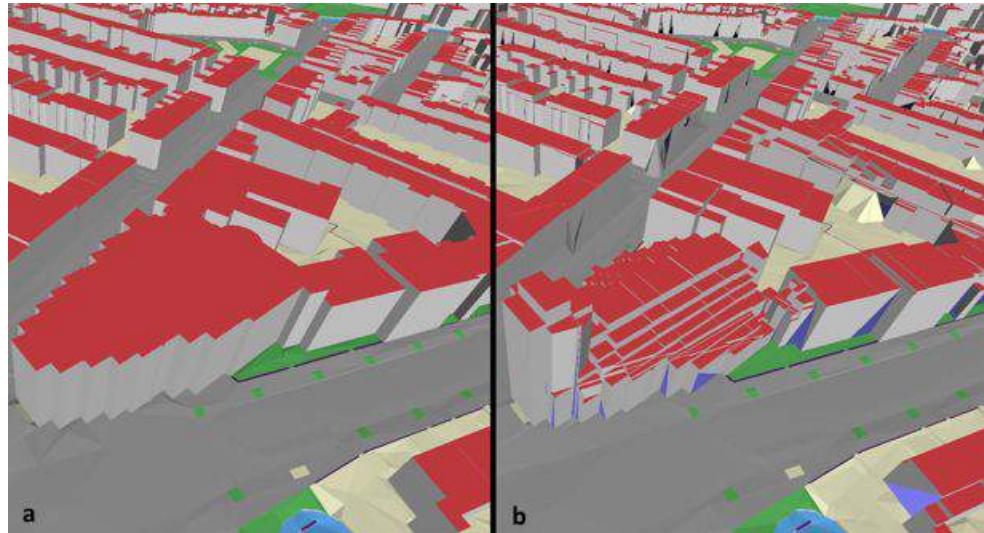


BAG footprints



Automatically generated LoD1.3 models

LoD 2



Notes

- If two adjacent roof parts have an elevation difference of less than 1 meter they are merged. The highest elevation is used for the merged roof part.
- Small planes with less than 20 points will not be detected in the point cloud.
- Non horizontal parts of the roof are extruded as one and not decomposed further.
- This method is still in an experimental phase, quality of results may vary.

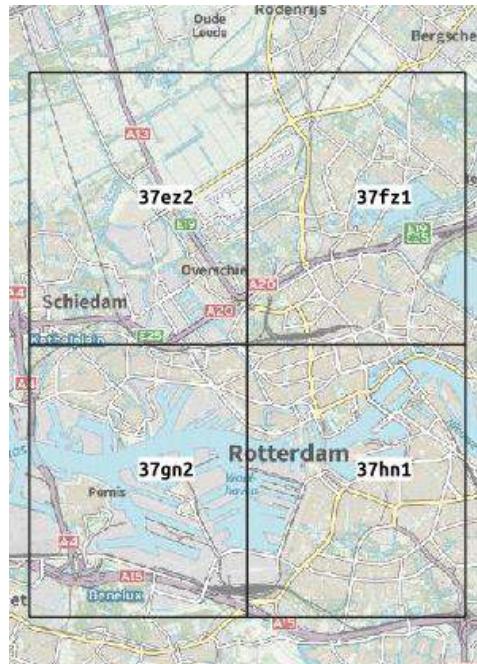
Tot slot

Beperkingen AHN

Proef dataset v0.2

3dgeluid.tudelft.nl

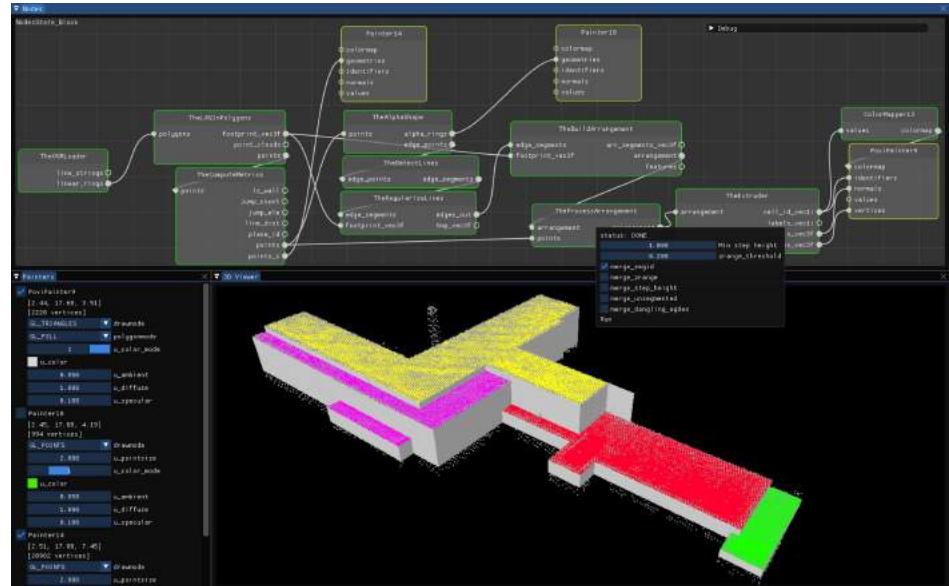
- Bodemvlakken
- Hoogtelijnen
- Gebouwen LoD1, LoD1.3



The screenshot shows a web browser displaying the [3D geluid NL website](https://3d.bk.tudelft.nl/opendata/noise3d/nl.htm). The page title is "3D input data voor geluidssimulaties versie 0.2 (experimenteel) [English version]". Below the title is a 3D rendering of a city area with numerous orange 3D building models. A red arrow points from the bottom left towards a text block at the bottom of the page. The text block reads: "Feedback Sessie op 28 Mei 2019" followed by a paragraph about a feedback session on May 28, 2019, at the Kadaster in Rotterdam, with a link to register. At the bottom of the page is a navigation menu with links like "Wat is 3D geluid NL? Introductie", "Beschrijving test data versie 0.2", etc.

En nu?

- Luisteren naar feedback van gebruikers
- Verder ontwikkelen software tools
- Verder afstemmen parameters/impact op simulatie resultaat
- LoD2 gebouwen
- Standardisatie ZOAB, geluidschermen in BGT
- Opschalen naar heel NL (Kadaster)
- Update met puntenwolk uit luchtfotos



Thank you!
3d.bk.tudelft.nl

Hoogtelijnen v0.2 eerste resultaat



DGMR reference

Input



Basisbestand 3D v0.1

Hoogtelijnen v0.2 eerste resultaat



DGMR reference



Basisbestand 3D (1 m)

Hoogtelijnen v0.2 eerste resultaat



DGMR reference (2 m)

Selectie
hoogte fout tot 2 m

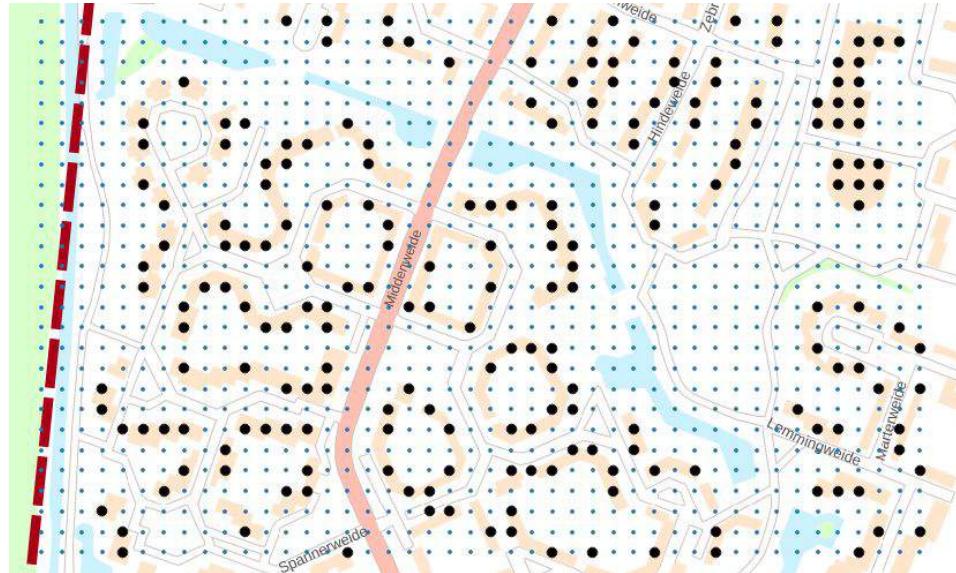
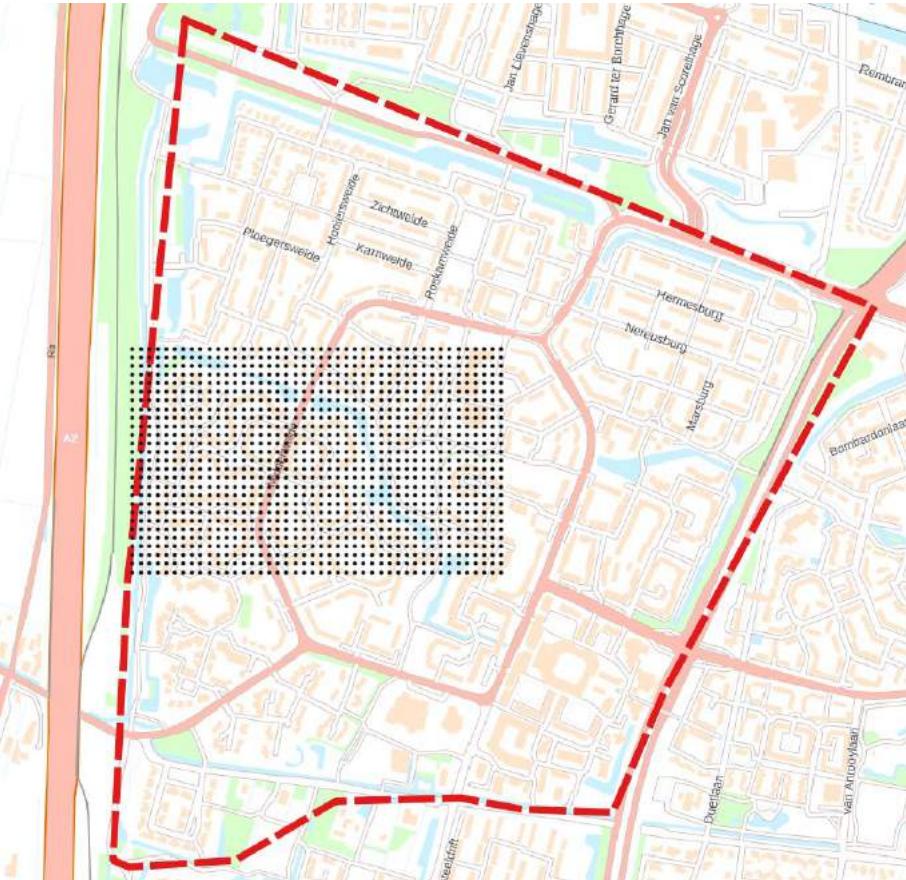


Basisbestand 3D (2 m)

DGMR's comparison of noise simulations

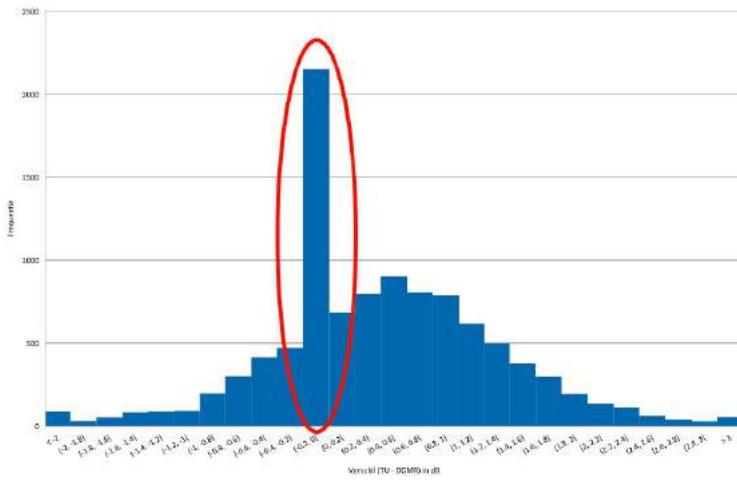


DGMR's comparison – Sampling points



The sampling points marked with strong black indicate missing noise levels. The points with small blue indicate that noise was computed for the point.

DGMR's comparison – Sampling points



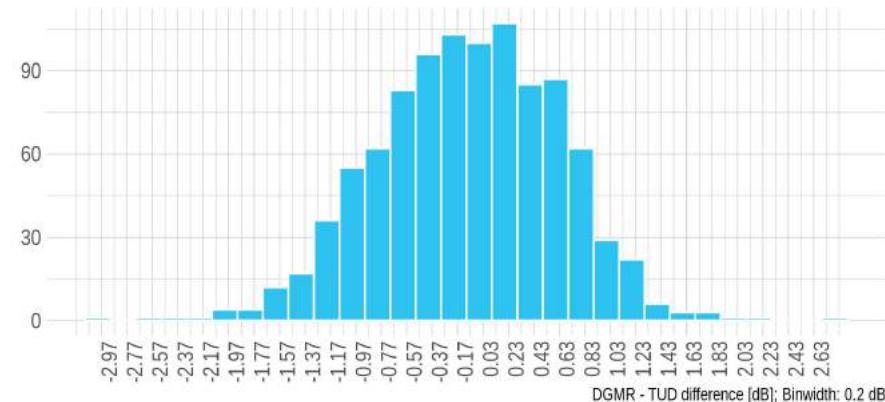
The peak due to missing noise levels is marked with red circle.

Average difference: **0.4 dB**

Standard deviation: **0.9 dB**

Histogram of differences in noise simulation

Cleaned data



With removing the locations with the missing noise levels we computed the following statistics on the values of DGMR - 3D Geoinfo:

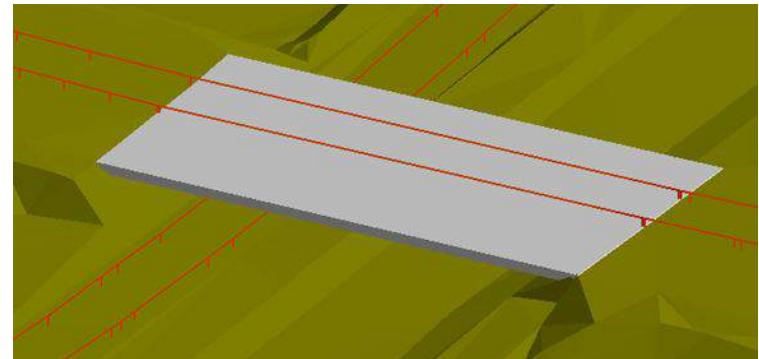
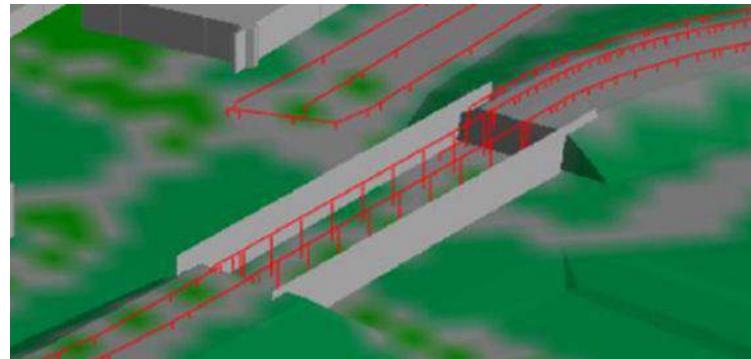
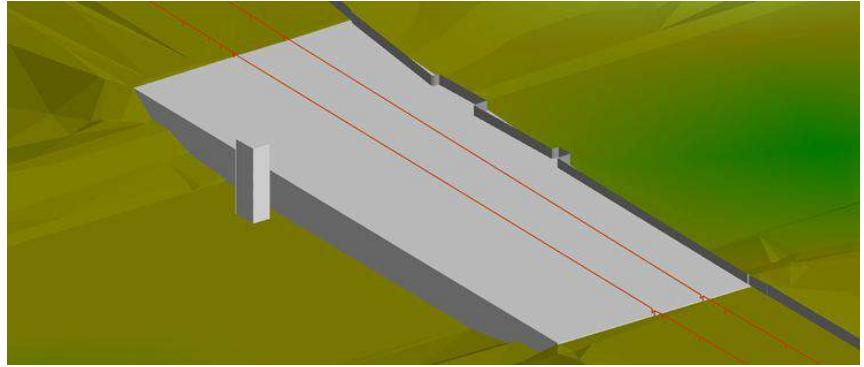
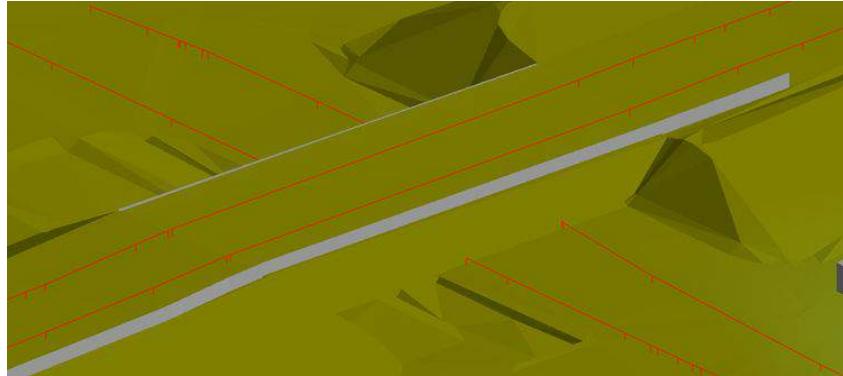
Mean difference: **-0.1 dB**

Standard deviation: **0.7 dB**

Median difference: **-0.1 dB**

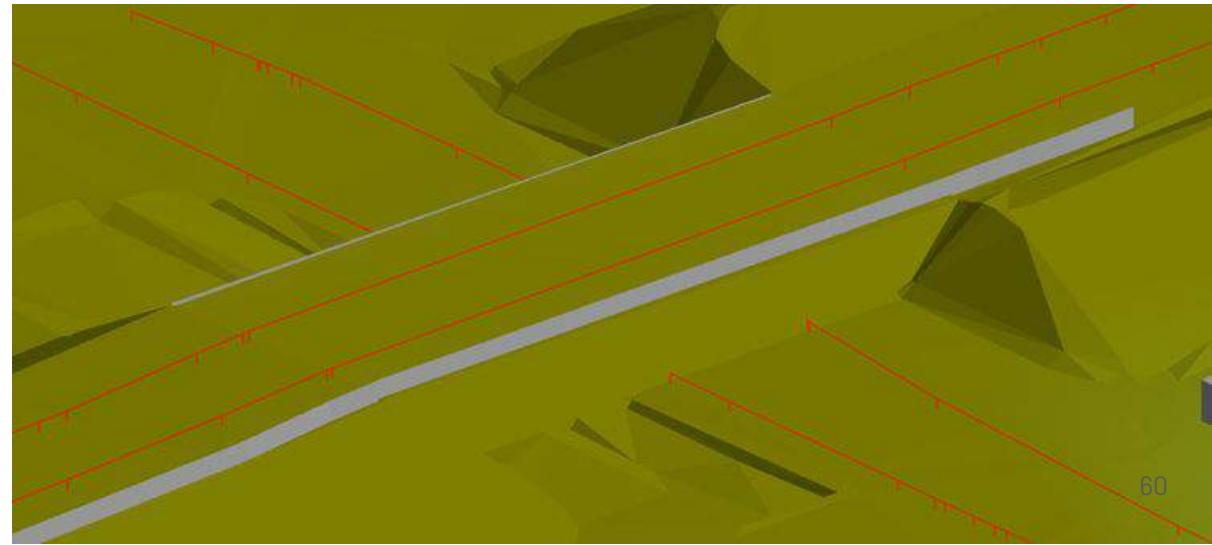
Bruggen

4 different ways to model bridges according to noise experts

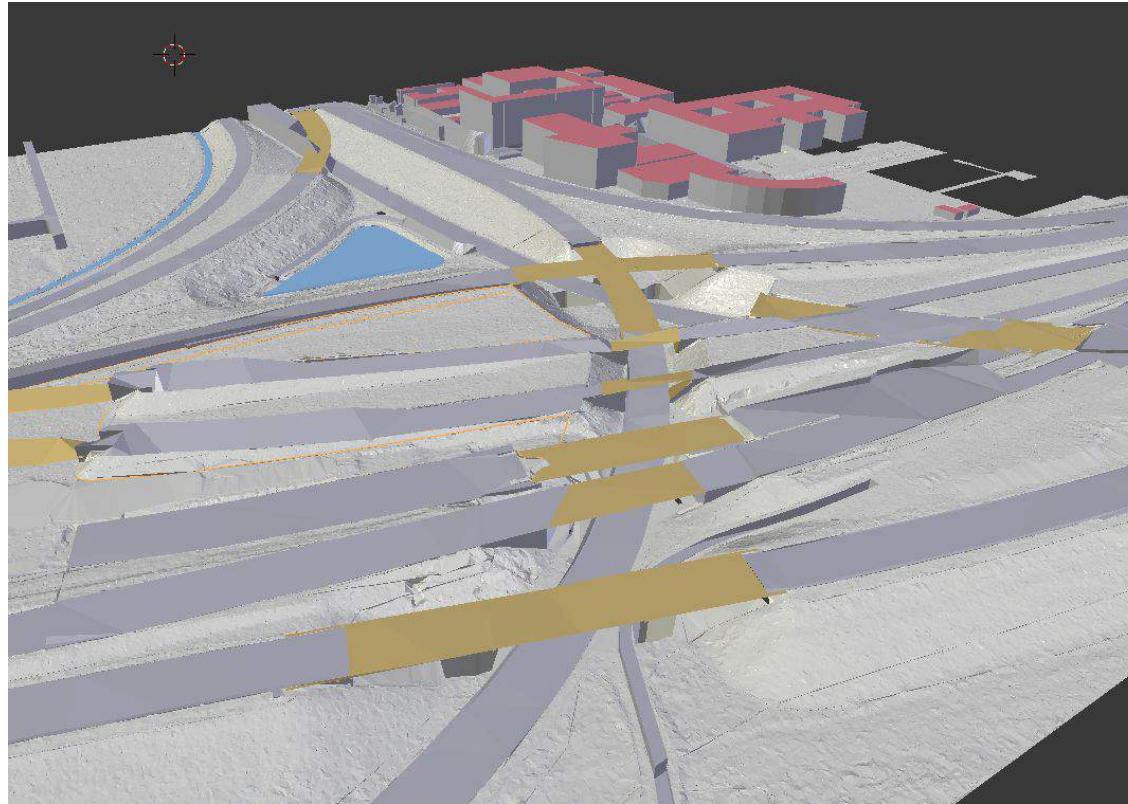


Contour lines

- Easy to assign the height of traffic lines relative to the terrain
- Traffic lines need to be cut
- Ground type under the bridge?
- Noise under the bridge?



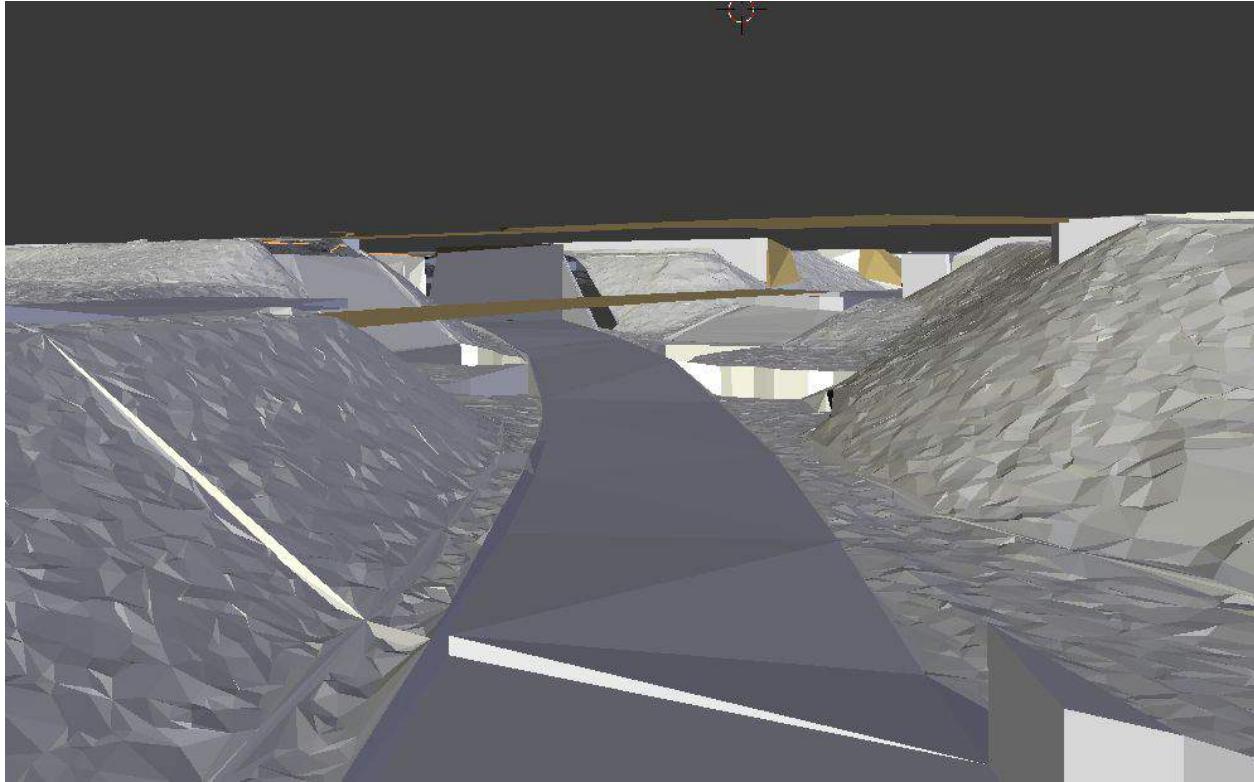
Our proposal



Nieuwe Meer A4/A10 West, Amsterdam

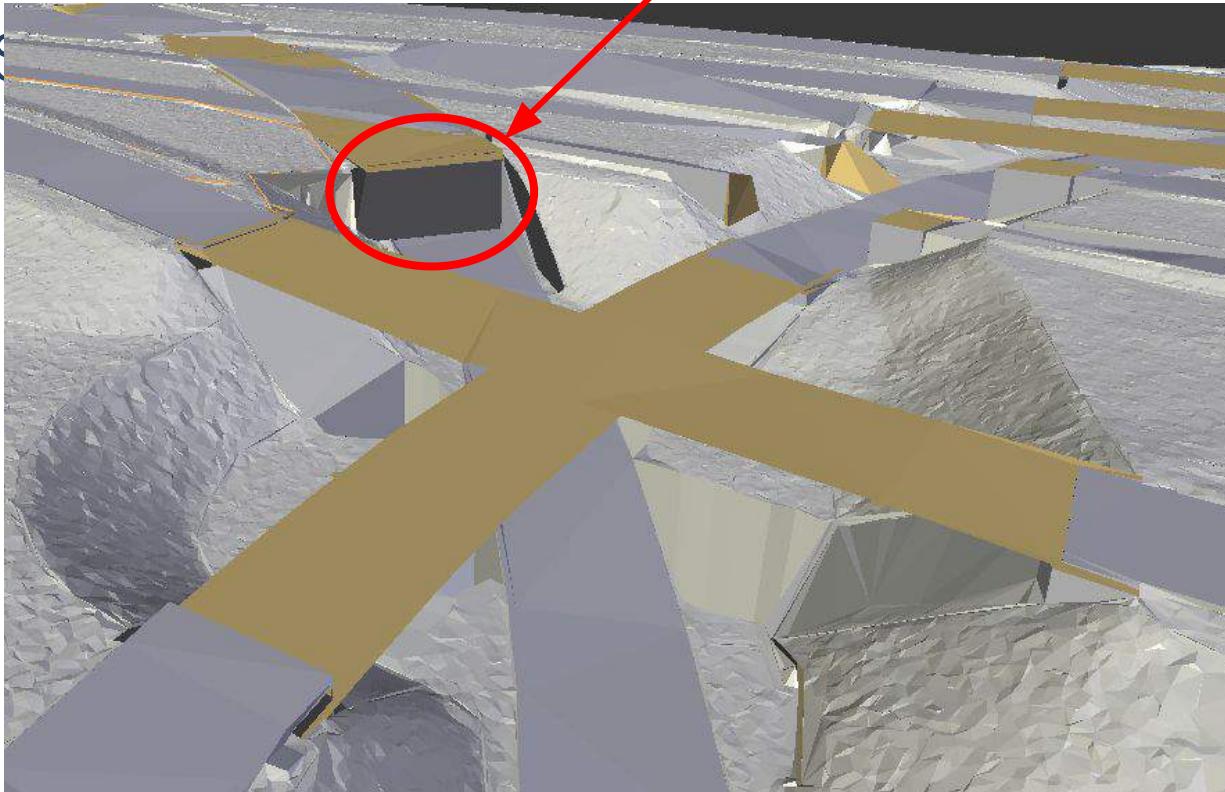


Our proposal



Our proposal

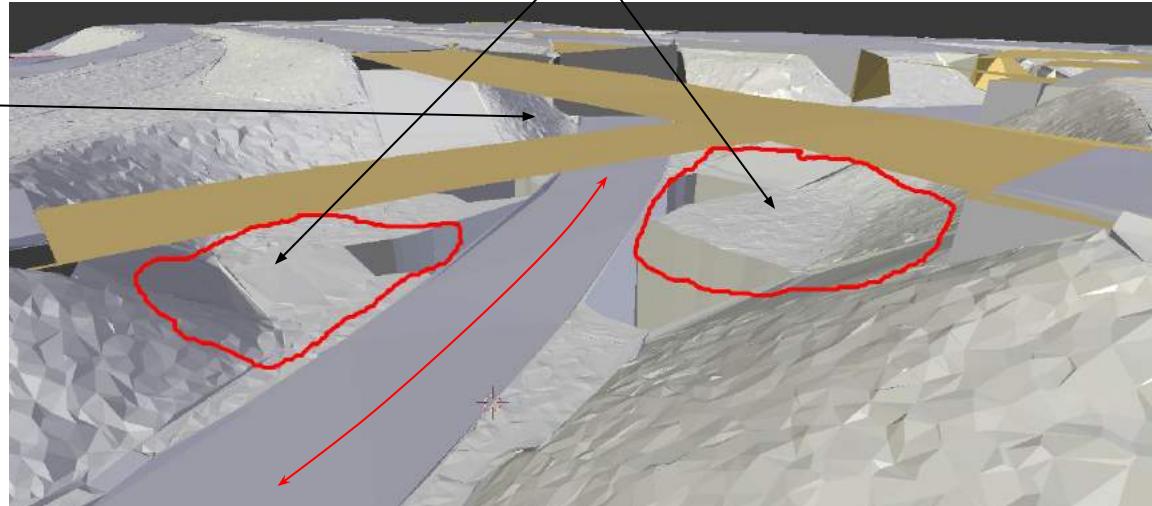
Tunnel is closed / no interior



Advantages

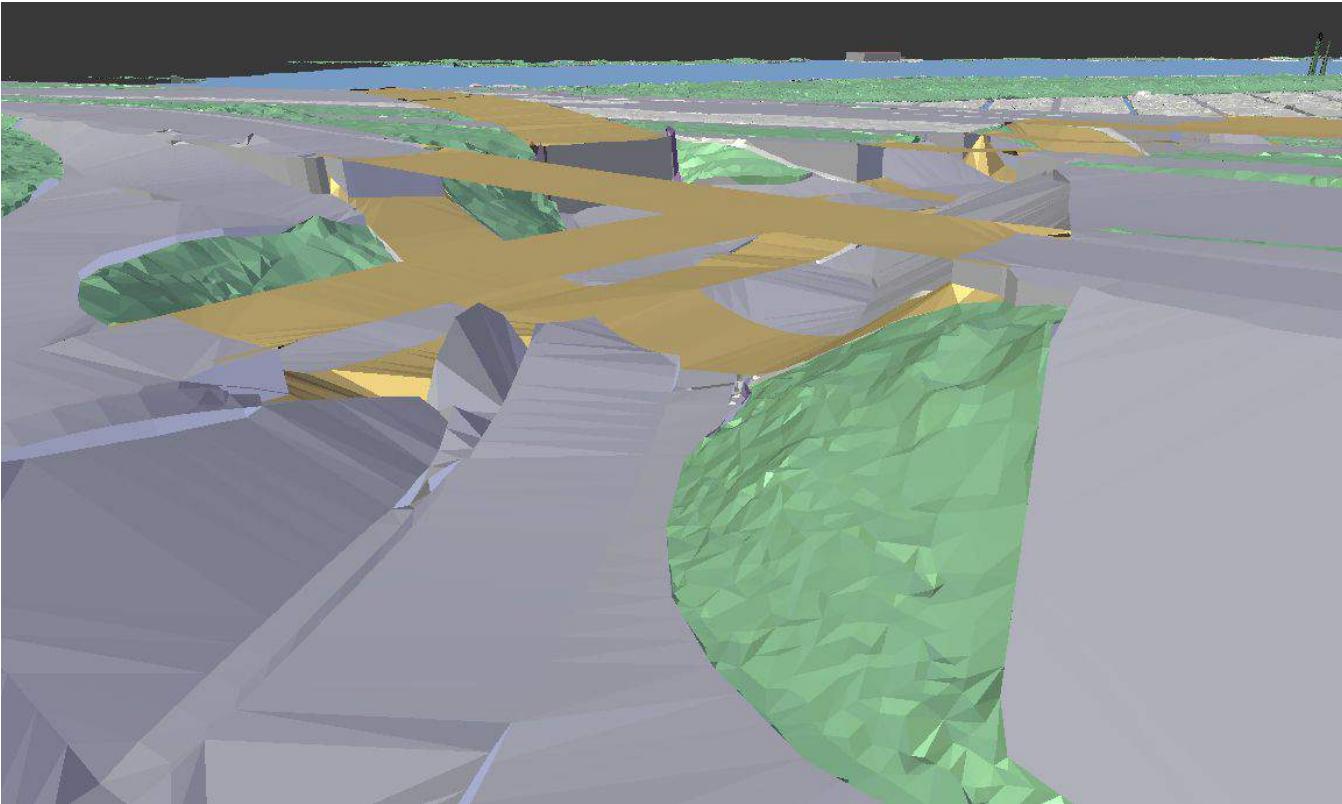
Noise reflection in
multi-level crossings

Different ground type under and on the bridge

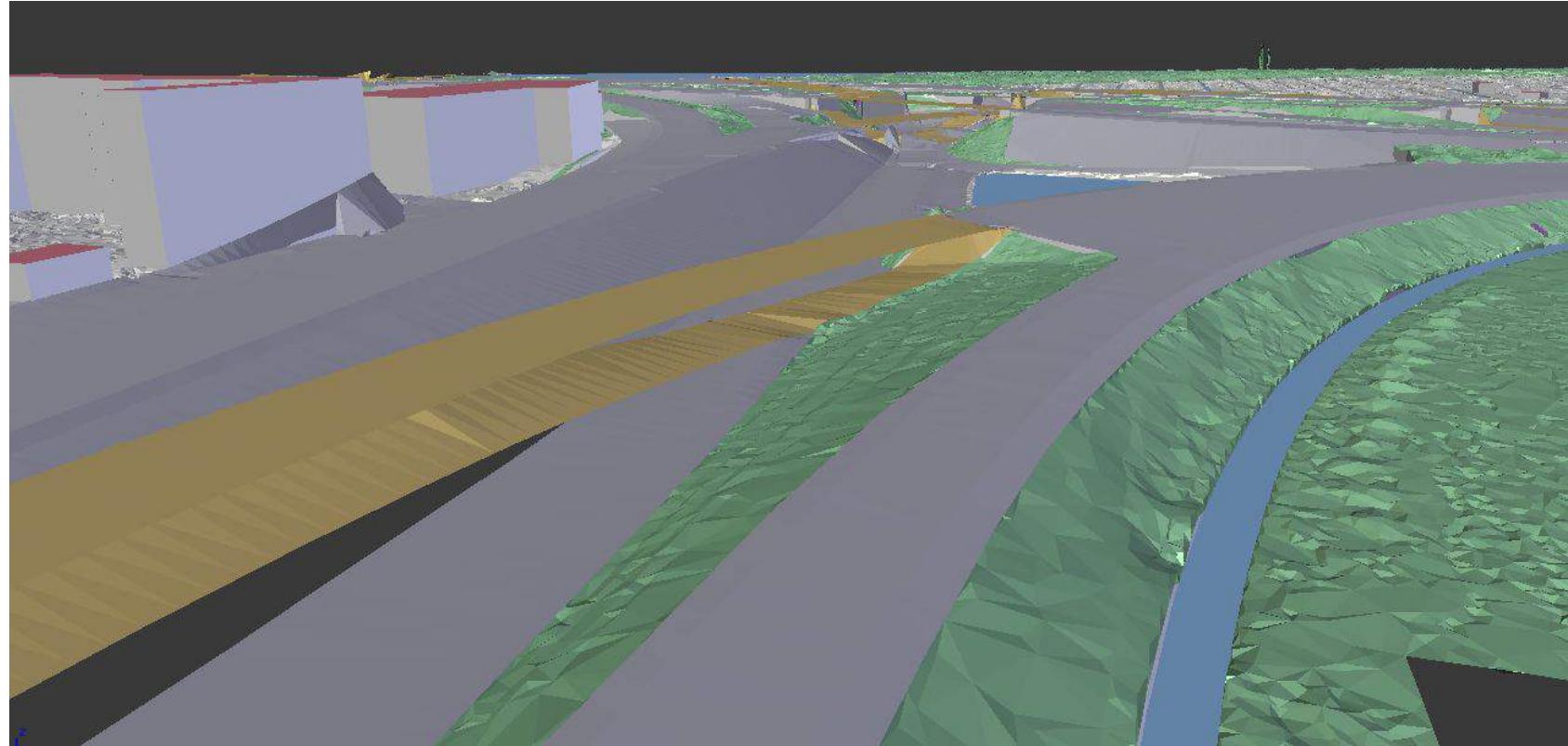


No need to cut the traffic line under the bridge

Current state:



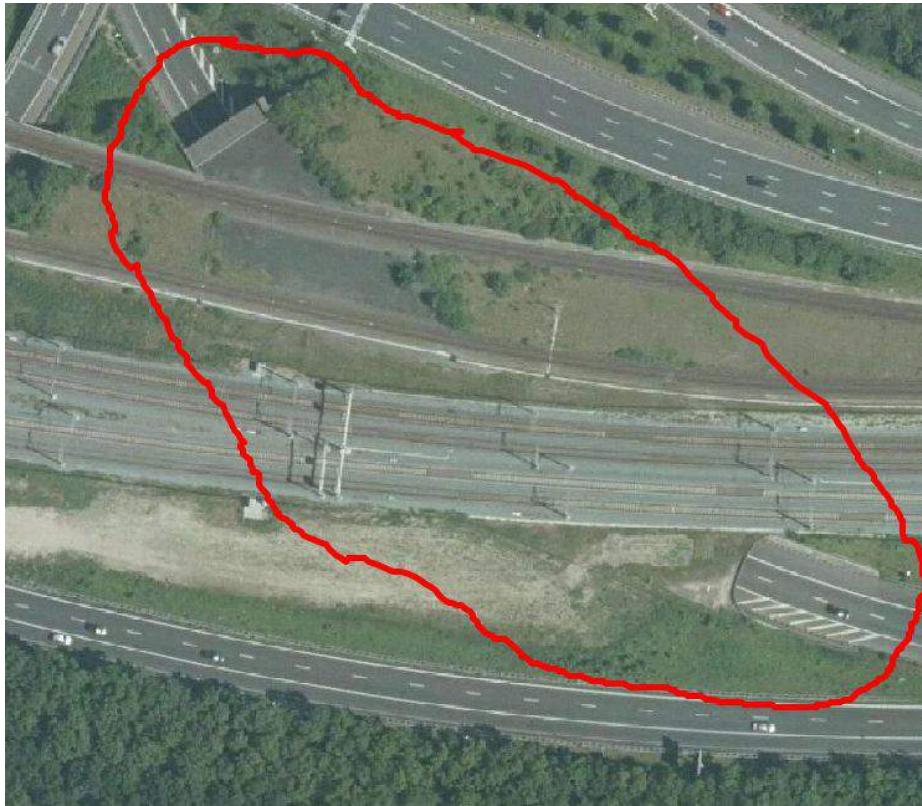
Current state:



Current state:



Anatomy of a tunnel & crossing



Anatomy of a tunnel & crossing

