

Course introduction

GEO1004:
3D modelling of the built environment

<https://3d.bk.tudelft.nl/courses/geo1004>



3D geoinformation

Department of Urbanism
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guest
lecture



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And you?

Name, experience and interest in 3D modelling

Course contents

- How is the built environment modelled in 3D?
 - Fundamentals / concepts
 - Data models and data structures
 - Guest lecture: reconstructing a city in LoD2
 - Guest lecture: digital twins for positive energy districts
- Applications

New-ish course

- Continuous improvements
 - 2020: Entirely new contents
 - 2022: 3D book
 - ...
 - 2026: new guest lecture, new AI policy, updates to materials
- Feedback is appreciated!

Prerequisites

- GEO1000 or knowledge of scripting/programming (in any language)
- GEO1002 or basic knowledge of (2D) GIS
- Optional: GEO1015 (Q2) covers complementary topics (2.5D vs 3D)

Blended learning

Beginning of contact hours:

1. Short (~1h) lectures, demos, discussion
2. Hw intro, hw/exam solutions & feedback
3. Discuss hw progress, common issues

Rest of contact hours + your own time:

1. Answering questions, help with hw assignments
2. Study materials
3. Work on hw assignments

Contact hours?

- Per week:
 - Monday & Wednesday (13:45 - 15:30) - with ~1h of lectures/demos/discussion + ~1h of help
 - Friday (10:45 - 12:30) - 2h of help
- Note: classrooms in different faculties! (check schedule)
- At other times, you can still ask questions on Discord. We might just take longer to answer.

Friday help sessions

- Help with C++ setup and assignments
- Fridays 10:45 - 12:30
- Geolab

How to make the most of it

1. Keep up with the course schedule
2. Study (or at least skim) lessons in advance
3. If you have any doubts, ask questions
4. Make sure you can answer questions (at the end of book chapters)
5. Optional: read one or two external sources (in notes in each chapter)
6. Spend more time on assignments than on lessons

Lessons

- 1.1: Intro [K]
- 1.2: B-rep [K]
- 2.2: 3D DT / Voronoi [H]
- 3.1: Voxels [K]
- 3.2: ISO 19107 [H]
- 4.1: MAT [K]
- 4.2: 3D city models [H]
- 5.1: Curves [K]
- 5.2: CSG [K]
- 6.2: BIM [K]
- 7.1: LoD2 reconstruction [R]
- 7.2: G-maps / c-maps [K]
- 8.1: DTs for PEDs [C]
- 8.2: Applications [K]

Assignments

- Programming tasks using C++ and open source libraries
- 10% hw1, 20% hw2 and 20% hw3
- 0: C++ preparation (no deadline / not marked)
- 1: Simple polyhedron processing (May 8) -> available but we'll cover topic on Wednesday
- 2: 3D city model processing (May 29) -> available in week 4
- 3: BIM processing (June 12) -> available in week 6

Two exams (in person)

- Mid-term
 - Lessons 1.1 - 4.2
 - May 18 (1st hour)
 - not part of final mark
- Final
 - All lessons
 - June 22 @ 9:00
 - 50% of final mark
- minimum 50% in final exam to pass the course

External help, plagiarism and AI

- You are welcome to use external help or AI assistants (eg ChatGPT, DeepSeek or Gemini), but in your final submission:
 - all parts of the work that you submit are understood and checked by you, and
 - how you use form of external help is documented and acknowledged in the submission.
- Code: you've read every line, you can explain what a block of a few lines of code does, and you can justify why you have chosen to implement things in a certain manner
- Report: you've carefully read the text, verified each claim and can personally vouch for each statement in it
- Not compliant? considered as plagiarism with disciplinary action
- How we check? random groups + suspicious submissions will be asked to explain parts of code/report

External help, plagiarism and AI

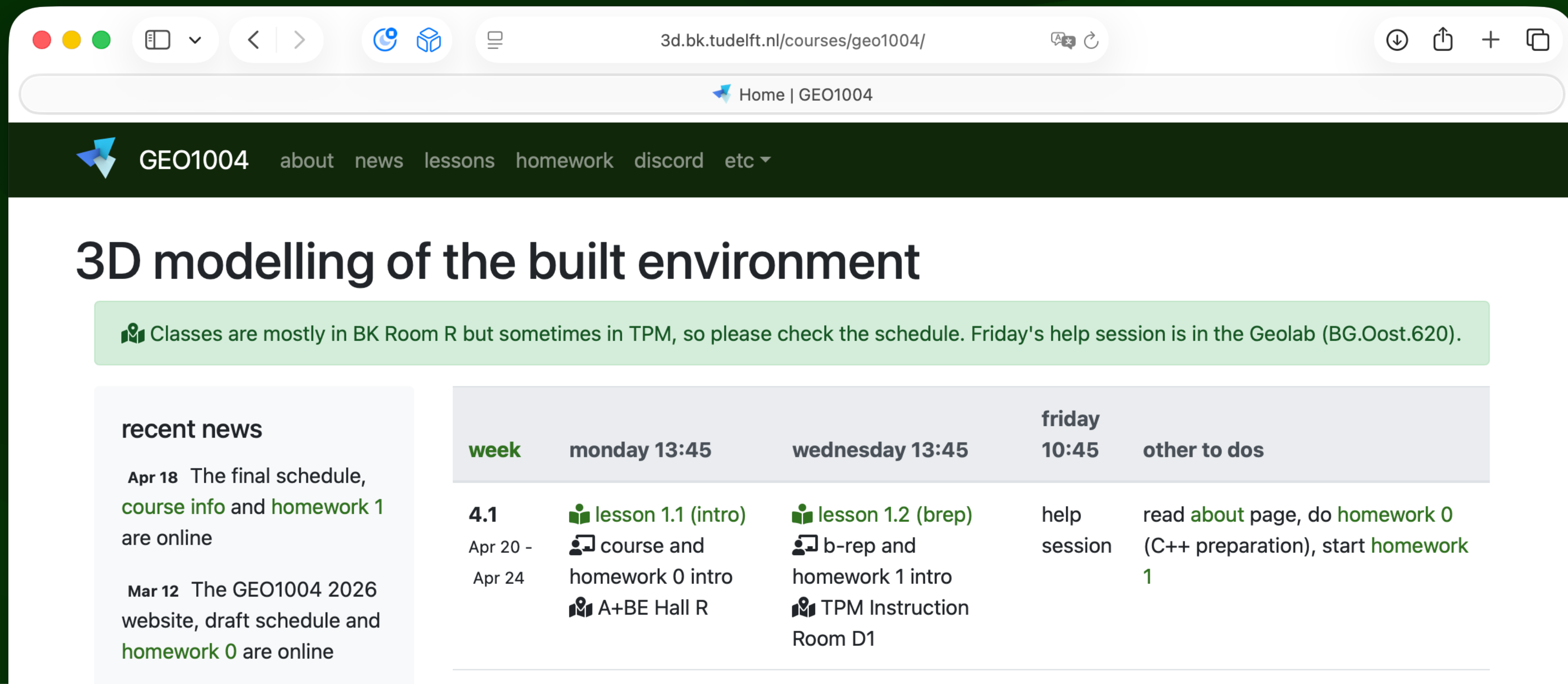
- Examples of good prompts:
 - How do I compute the normal vector of a polygon?
 - What is the difference between a surface and a polygon?
 - How do I use the function ...?
 - What does this part of the code do?
 - What does the error ... mean?
 - What should the sections of my report be?
 - What are some interesting plots I can include in my assignment about ...?
 - Give me a critical assessment of my report
 - Rephrase this paragraph in a clearer way: ...

Resits

- One resit for the final exam (50%)
- One resit that combines all assignments
- July 14 @ 9:00

Course website

- No Brightspace!
- Everything is here: <https://3d.bk.tudelft.nl/courses/geo1004/>



The screenshot shows a web browser displaying the course website for GEO1004. The browser's address bar shows the URL 3d.bk.tudelft.nl/courses/geo1004/. The website has a dark green header with the GEO1004 logo and navigation links: about, news, lessons, homework, discord, and etc. The main content area has a white background with the title "3D modelling of the built environment". Below the title is a green box with a location pin icon and text: "Classes are mostly in BK Room R but sometimes in TPM, so please check the schedule. Friday's help session is in the Geolab (BG.Oost.620).". To the left is a "recent news" section with two entries: "Apr 18 The final schedule, course info and homework 1 are online" and "Mar 12 The GEO1004 2026 website, draft schedule and homework 0 are online". To the right is a table with a light blue header and a white body. The header row contains: "week", "monday 13:45", "wednesday 13:45", "friday 10:45", and "other to dos". The first row of the table body shows: "4.1" in the week column, "lesson 1.1 (intro)" in the monday column, "lesson 1.2 (brep)" in the wednesday column, "help session" in the friday column, and "read about page, do homework 0 (C++ preparation), start homework 1" in the other to dos column. The dates "Apr 20 - Apr 24" are listed below the week number. The locations "A+BE Hall R" and "TPM Instruction Room D1" are listed below the lesson titles.

3d.bk.tudelft.nl/courses/geo1004/

Home | GEO1004

GEO1004 about news lessons homework discord etc

3D modelling of the built environment

📍 Classes are mostly in BK Room R but sometimes in TPM, so please check the schedule. Friday's help session is in the Geolab (BG.Oost.620).

recent news

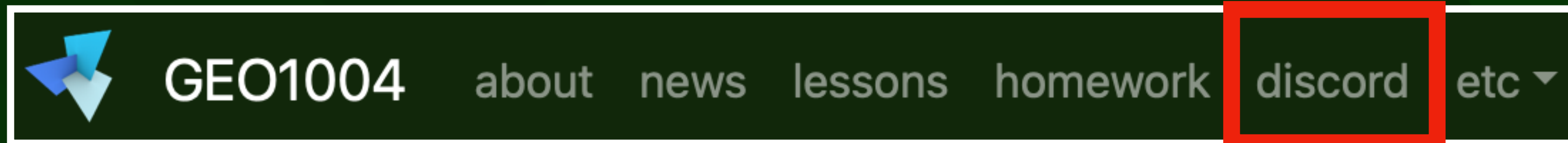
Apr 18 The final schedule, [course info](#) and [homework 1](#) are online

Mar 12 The GEO1004 2026 website, draft schedule and [homework 0](#) are online

week	monday 13:45	wednesday 13:45	friday 10:45	other to dos
4.1 Apr 20 - Apr 24	📖 lesson 1.1 (intro) 📺 course and homework 0 intro 📍 A+BE Hall R	📖 lesson 1.2 (brep) 📺 b-rep and homework 1 intro 📍 TPM Instruction Room D1	help session	read about page, do homework 0 (C++ preparation), start homework 1

Questions?

- In person during contact hours or Discord anytime:



- Don't hesitate to ask! General software/programming questions are fine too
- If possible, use geo1004 channel -> everyone can benefit from answers
- E-mail or Discord DM for personal matters

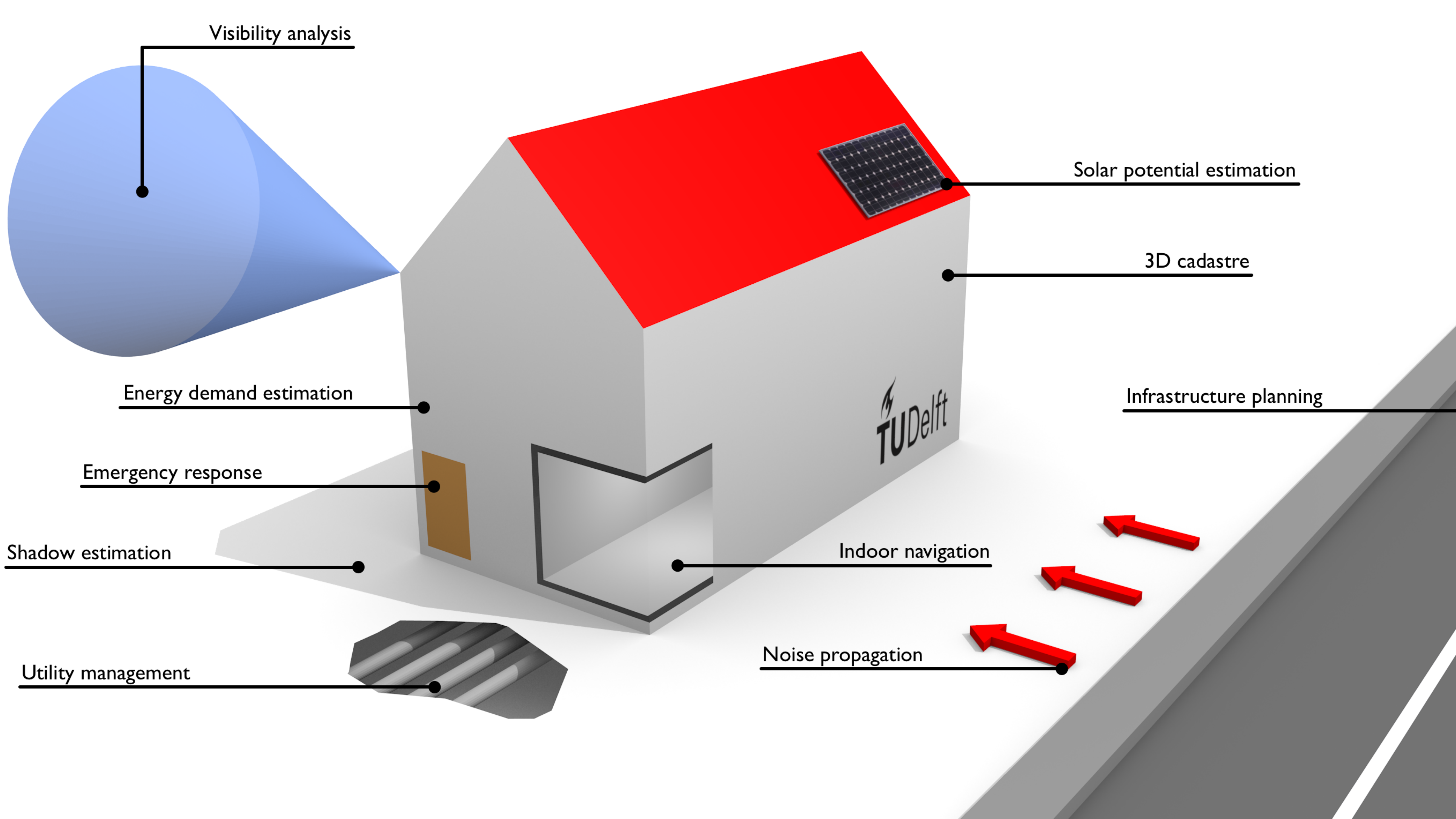
Introduction to 3D modelling of the built environment

Introduction to 3D modelling of the built environment

3D modelling of the built environment

- creation of 3D representations
- ...of anything, real world or not
- ...for animation, films, video games, industrial design, etc.
- focus on representations and techniques that are useful
- ...for real-world objects and fields
- ...in applications within geomatics and related fields

Why 3D?



Visibility analysis

Solar potential estimation

3D cadastre

Energy demand estimation

Emergency response

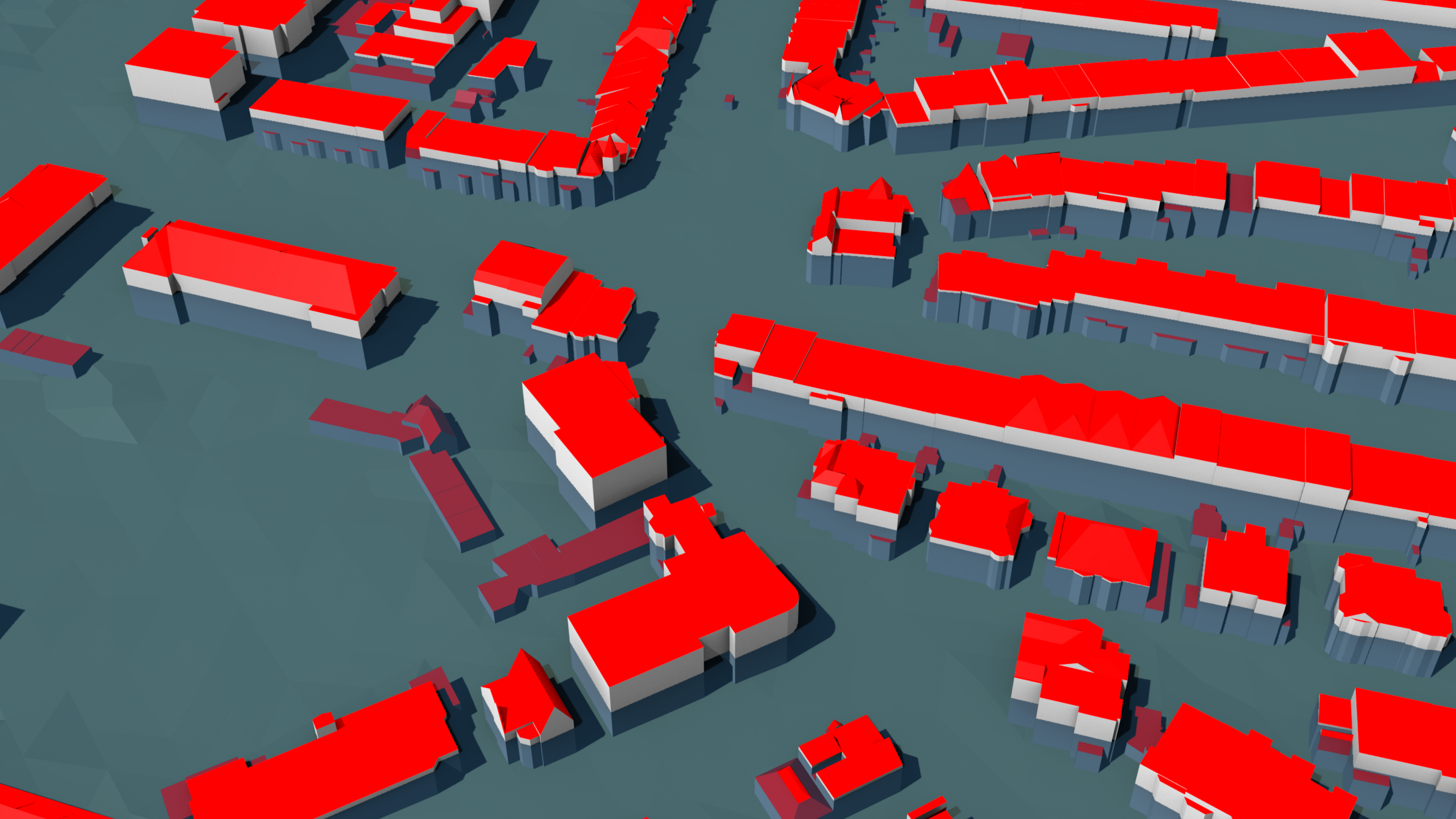
Infrastructure planning

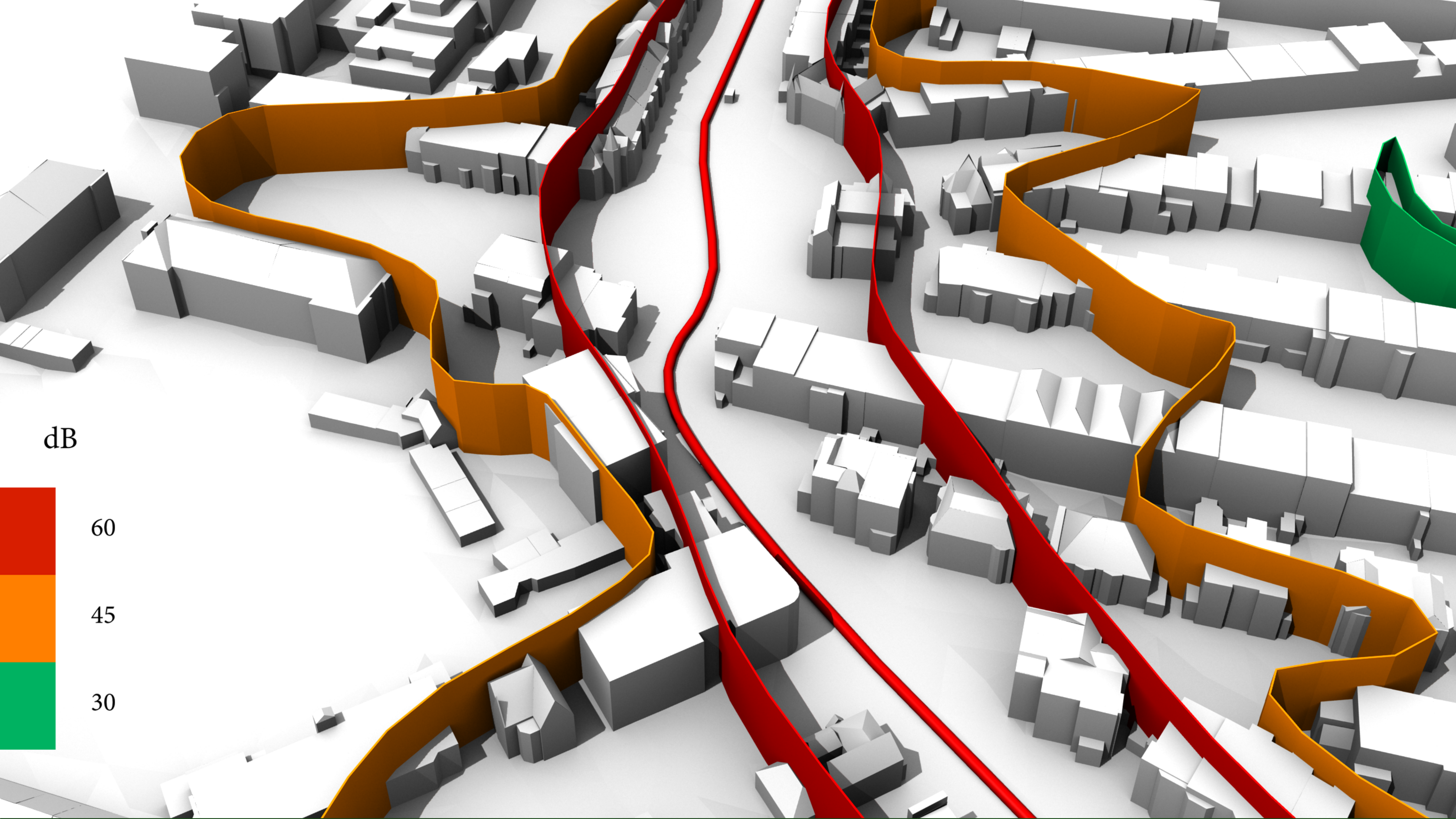
Indoor navigation

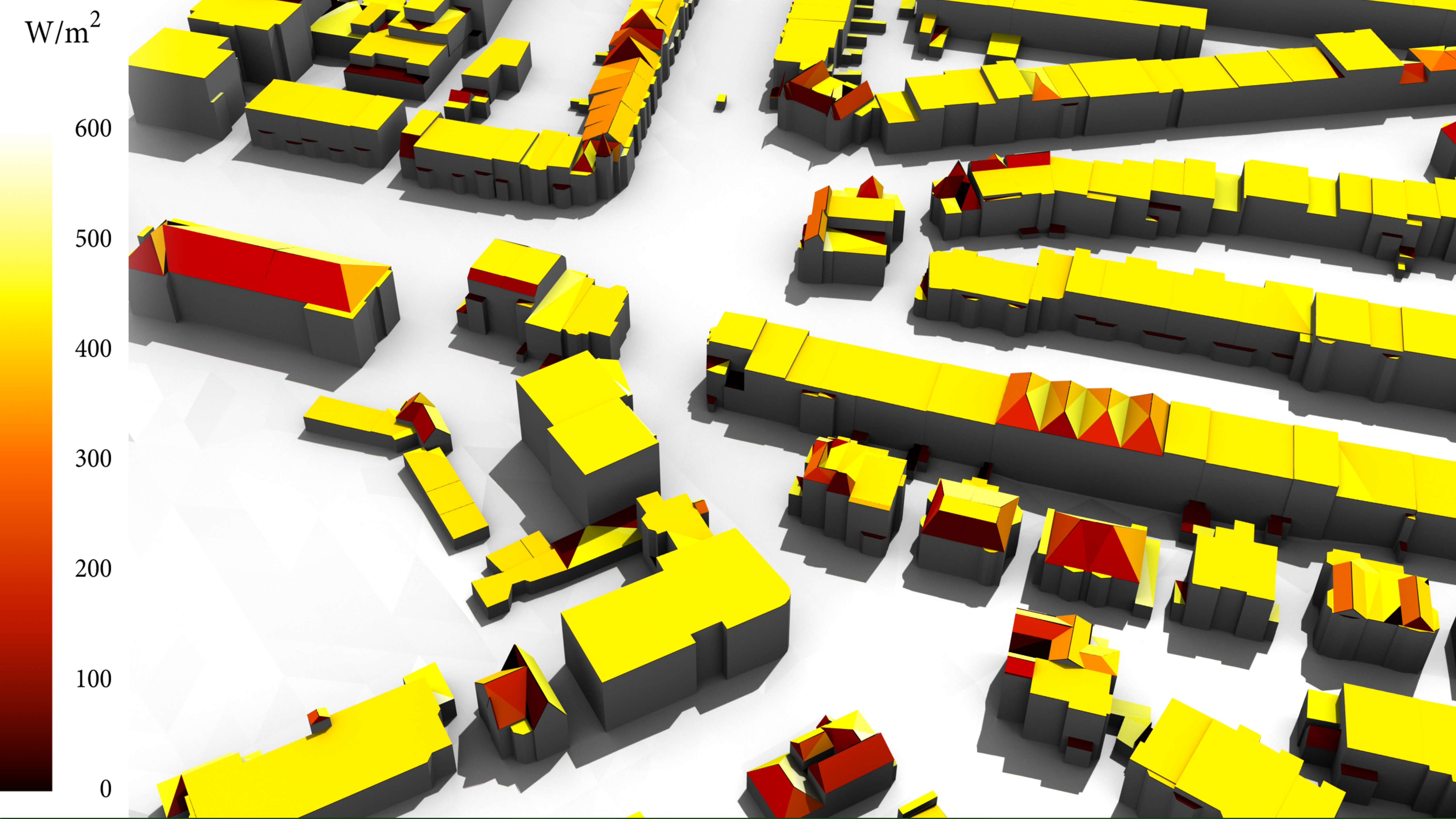
Noise propagation

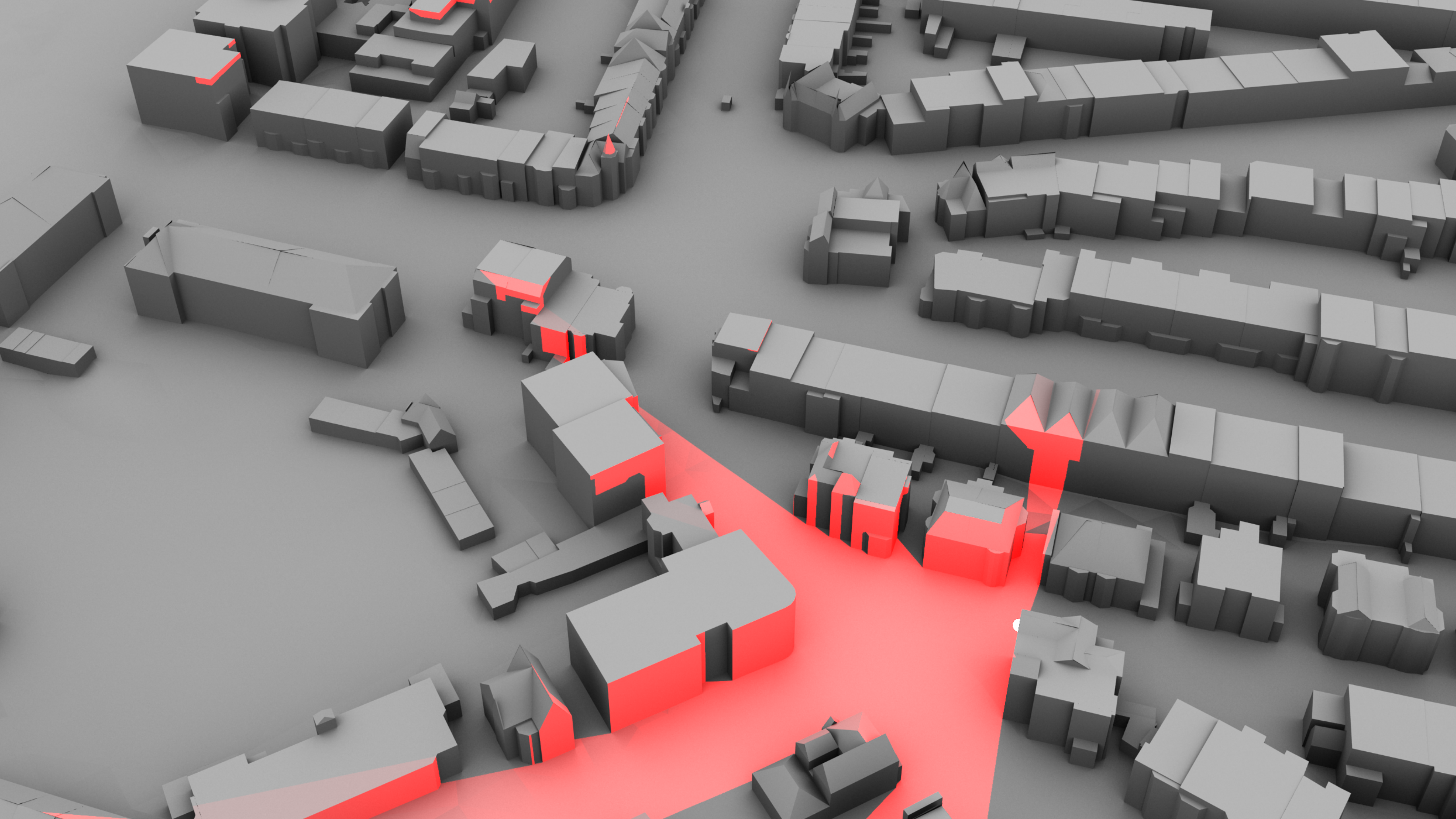
Utility management

Shadow estimation









Other applications

- Visualisation (eg for gaming, tourism, navigation, etc)
- Energy demand estimation (and potential for retrofitting)
- Computational fluid dynamics (eg for wind speeds, air quality, effects on buildings, etc)
- Shadow casting (eg for building permits, visibility analysis, improving energy demand/solar potential calculations, etc)

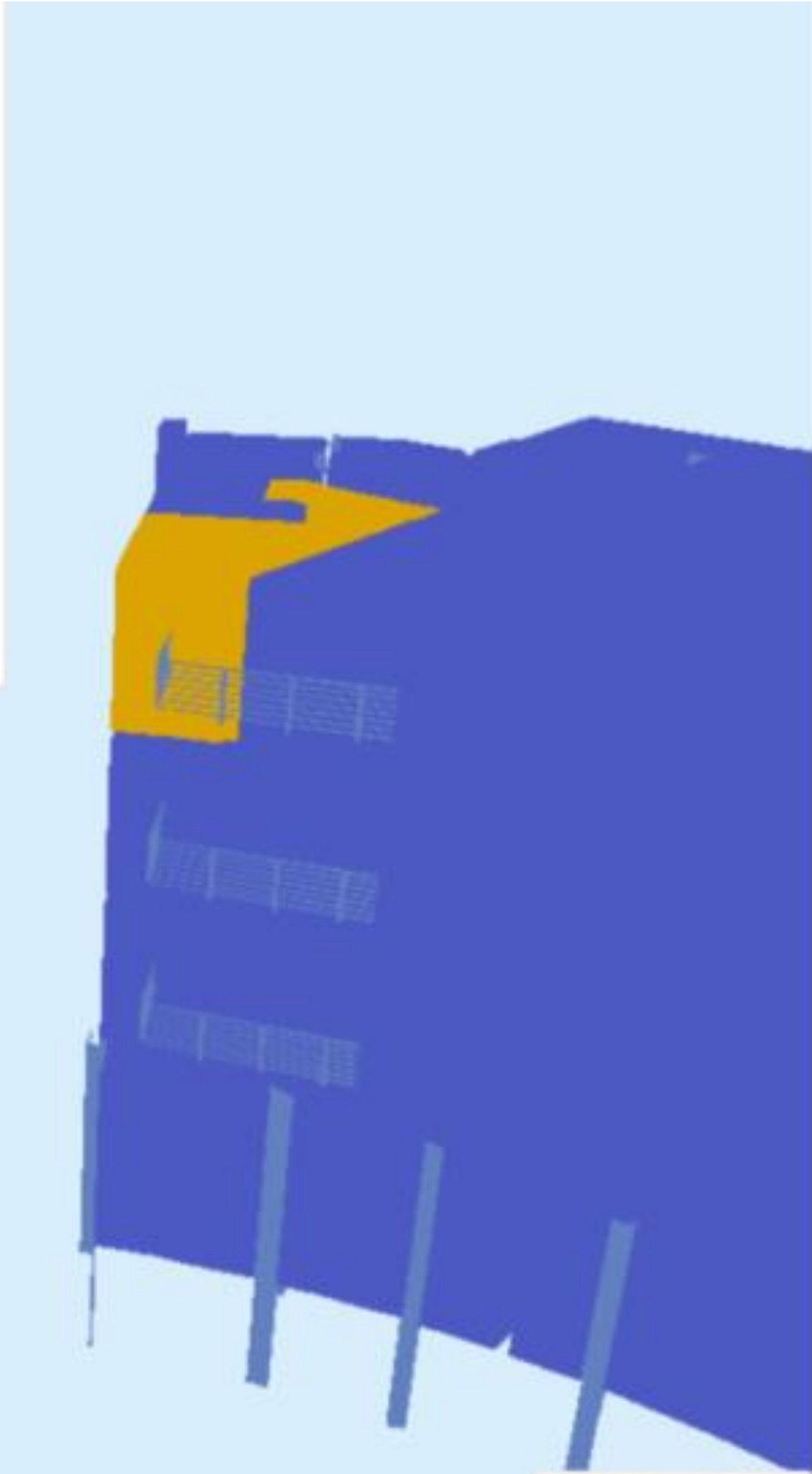
Some nice recent-ish results

Property valuation

Parents: 

5 Attributes  **1 Geometries** 

PropertyUnit	Appt 8
Level	3ème étage
indoor daylight	98
indoor daylight quality	yes
RoomName	LivingRoom



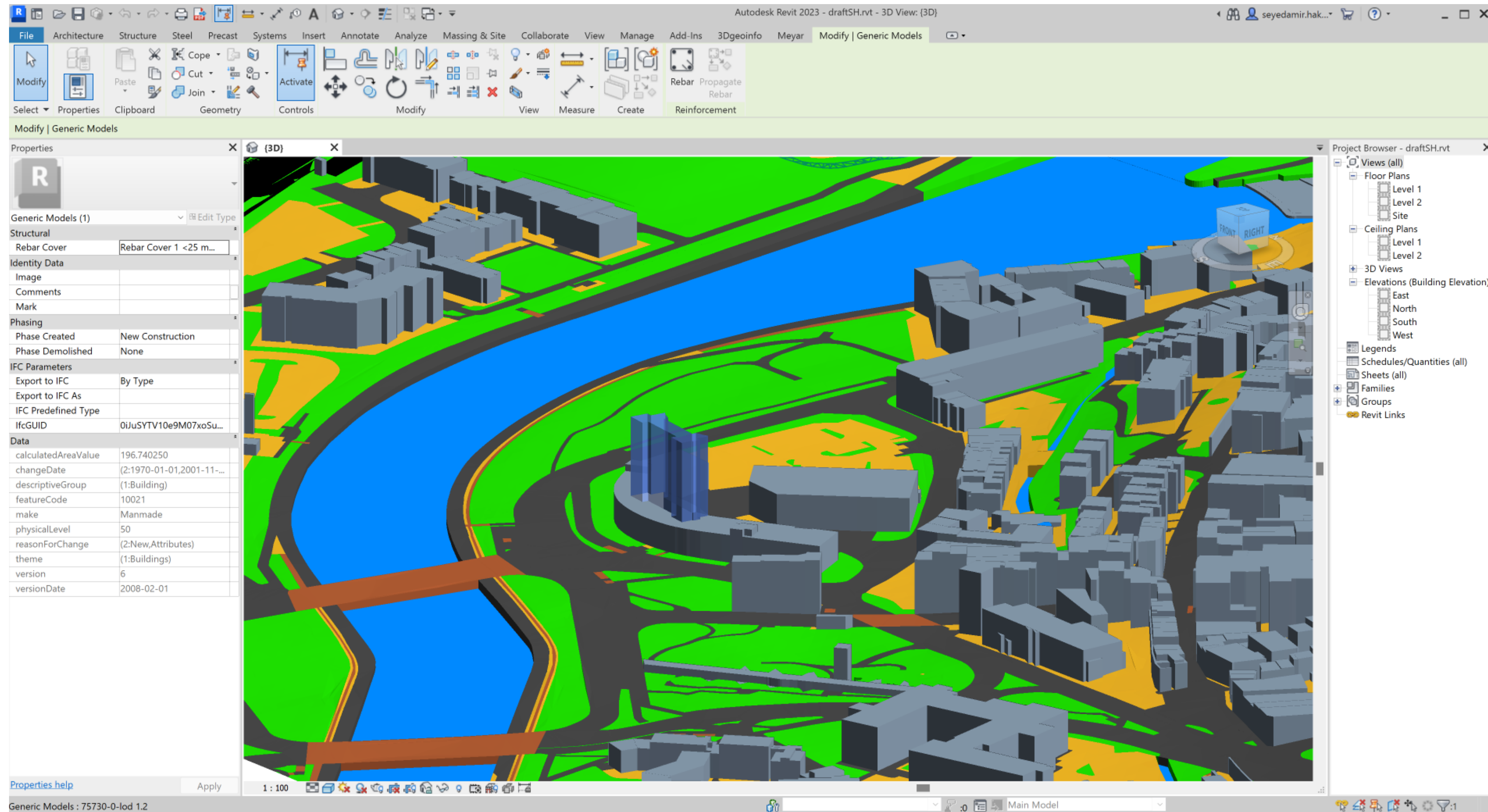
CityJSON
ninja v0.7.0

☐ Select surface

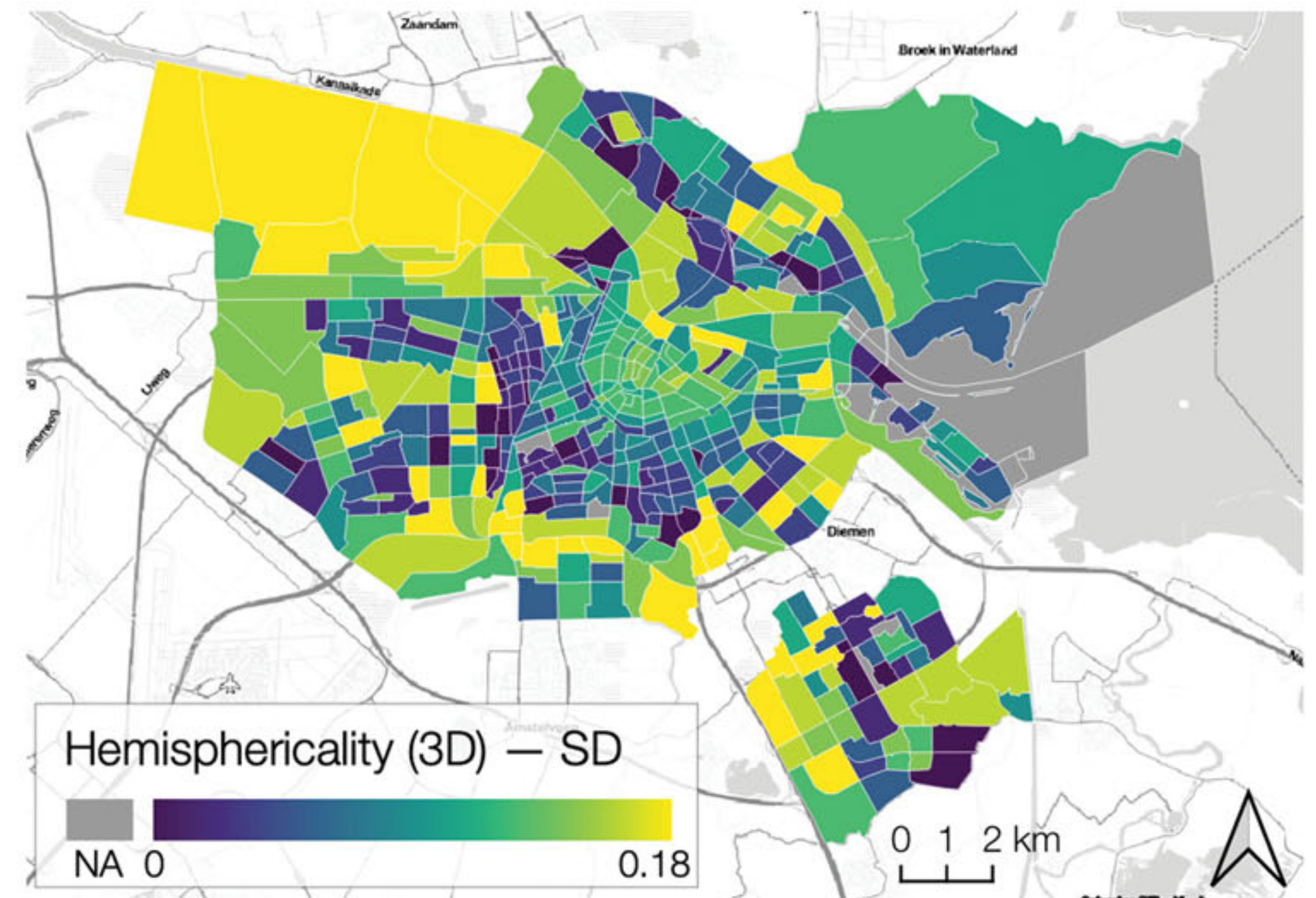
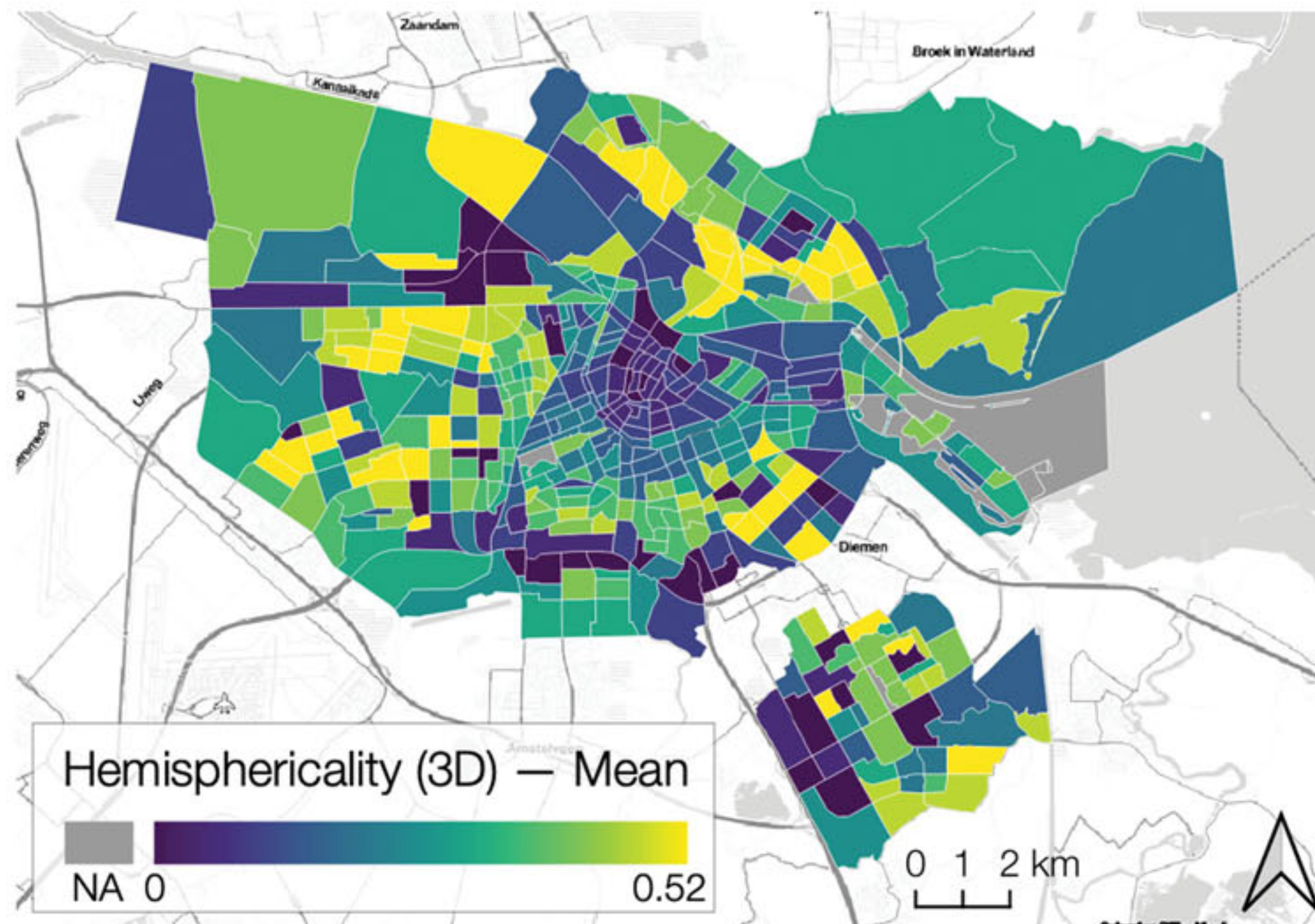
☒ Semantics

All LoD3

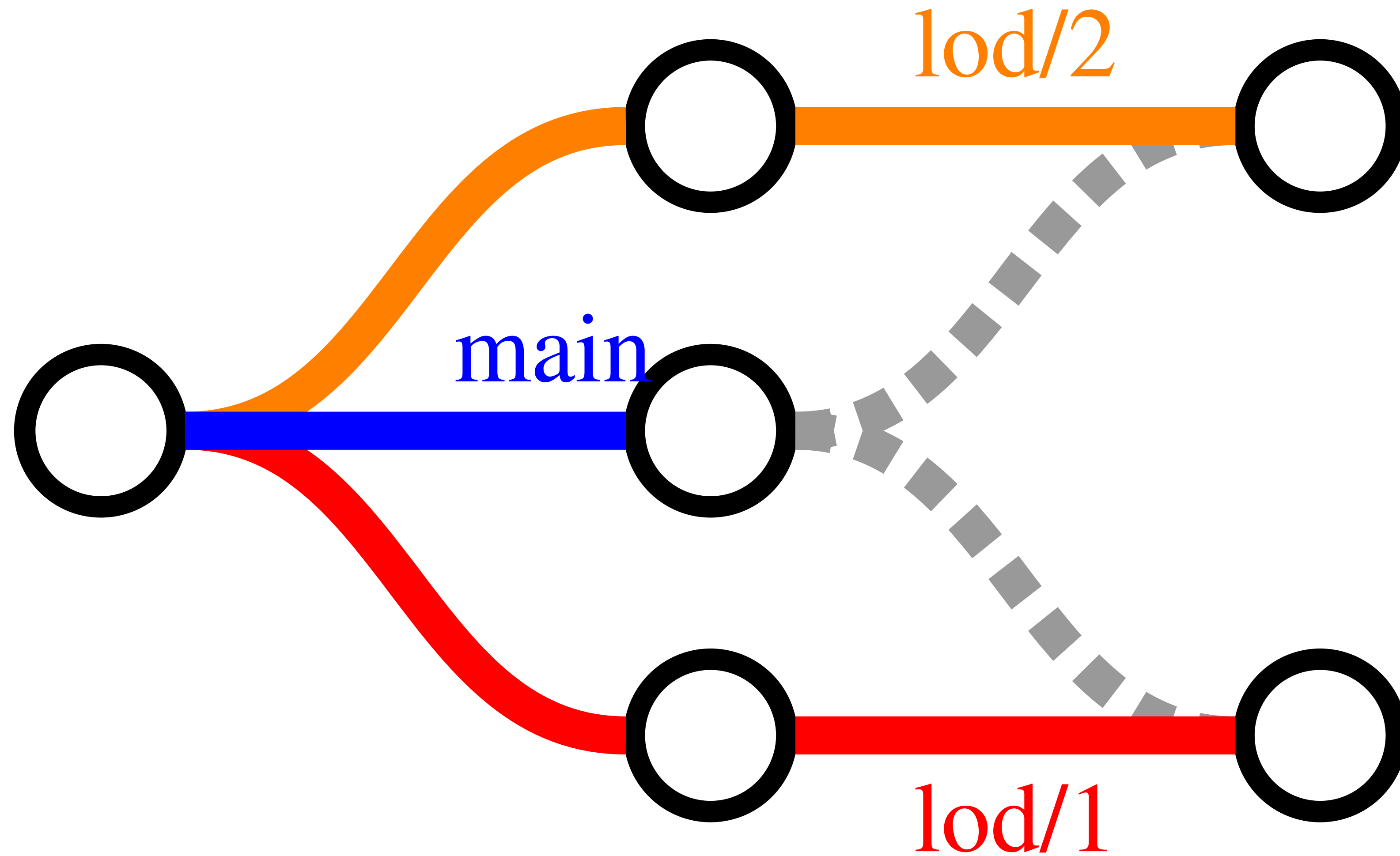
Importing 3D city models into Revit



3D metrics to characterise neighbourhoods



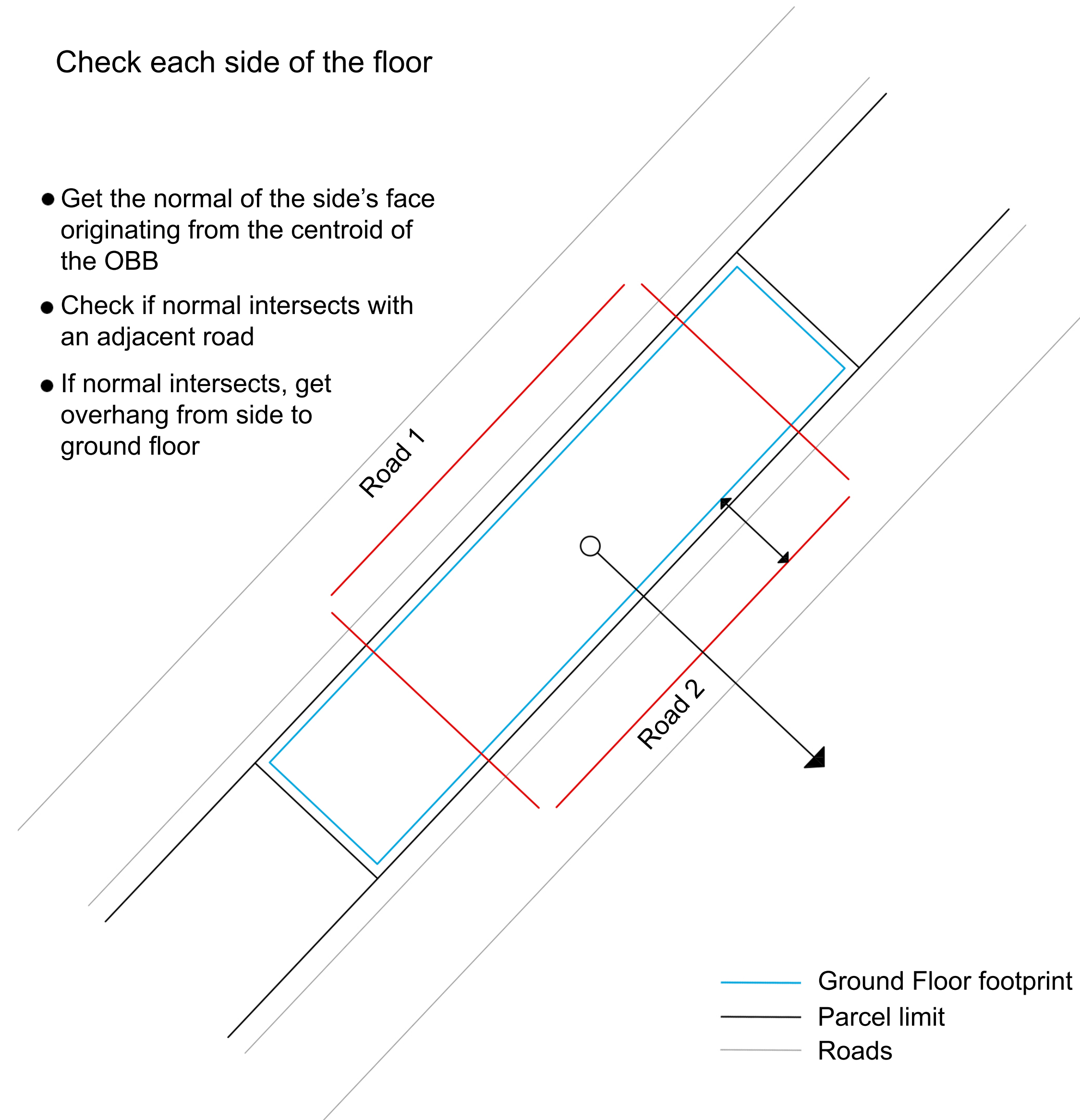
Applying versioning to 3D city models



Calculations for building permits

Check each side of the floor

- Get the normal of the side's face originating from the centroid of the OBB
- Check if normal intersects with an adjacent road
- If normal intersects, get overhang from side to ground floor



Homework 0 intro

Lesson 1.1 (intro)

- More of a glossary than a lesson. Read to know some important concepts and revisit it if you have doubts later in the course.
- Concepts behind the 3D modelling of the built environment:
 - Different ways to conceptualise 3D modelling process (abstractions vs. chain)
 - Geometry, topology and semantics: links to branches of mathematics
 - Objects vs. fields
 - Data models and data structures

What to do next?

1. Today:

- Homework 0 (install required software for C++ assignments)
- Go to [geo1004](#) website and study today's lesson (3D book Chapter 1)
- If you have extra time, study Wednesday's lesson (3D book Chapter 2)

2. Wednesday: short lecture on b-rep, intro to homework 1 and help with any questions about this week's lessons or C++ installation

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References

- [23-27]: Level of detail in 3D city models. Filip Biljecki.
- [30]: Towards extending CityGML for property valuation: property valuation ADE. Siham El Yamani, Rafika Hajji, Roland Billen, Ken Arroyo Ohori, Jasper van der Vaart, Amir Hakim and Jantien Stoter
- [31]: Development of a Geo to BIM converter: CityJSON importer plugin for Autodesk Revit. Amir Hakim, Jasper van der Vaart, Ken Arroyo Ohori and Jantien Stoter.
- [32]: 3D building metrics for urban morphology. Anna Labetski, Stelios Vitalis, Filip Biljecki, Ken Arroyo Ohori and Jantien Stoter.
- [33]: Applying versioning to 3D city models. Stelios Vitalis, Ken Arroyo Ohori and Jantien Stoter.
- [34]: GeoBIM information to check digital building permit regulations. Nadine Hobeika, Jordi van Liempt, Francesca Noardo, Ken Arroyo Ohori and Jantien Stoter.