National Institute for Public Health and the Environment
Ministry of Health, Welfare and Sport

Generating consistent triangular terrain elevation data for noise modelling

Laurens van Rijssel

Thesis defence

41 slides
13-01-2022

Please mute yourself when not speaking, thank you!

Mute

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TU Delft : Balázs Dukai
Jantien Stoter
RIVM: Arnaud Kok

TU Delft

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04 Approach
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What is noise?

Unwanted or harmful outdoor sound created by human activities

01 Background

02 *What is noise?*

Unwanted or harmful outdoor sound created by human activities

03 *Why is noise important?*

Health effects affect 135 ml. people in the EU (European Environmental Agency, 2020).

- Displeasure
- Increased stress levels
- Reduced learning performance
- Reduced energy level (Basner et al., 2014)

Loss of 1.0 to 1.6 ml. Disability-Adjusted Life-Years (DALY's) (World Health Organization and Joint Research Committee, 2017)

01 Background

02 *What is noise?*

Unwanted or harmful outdoor sound created by human activities

03 *Why is noise important?*

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- Increased stress levels
- Reduced learning performance
- Reduced energy level

04 (Basner et al., 2014)

Loss of 1.0 to 1.6 ml. Disability-Adjusted Life-Years (DALY's) (World Health Organization and Joint Research Committee, 2017)

05 *What is the aim of noise modelling?*

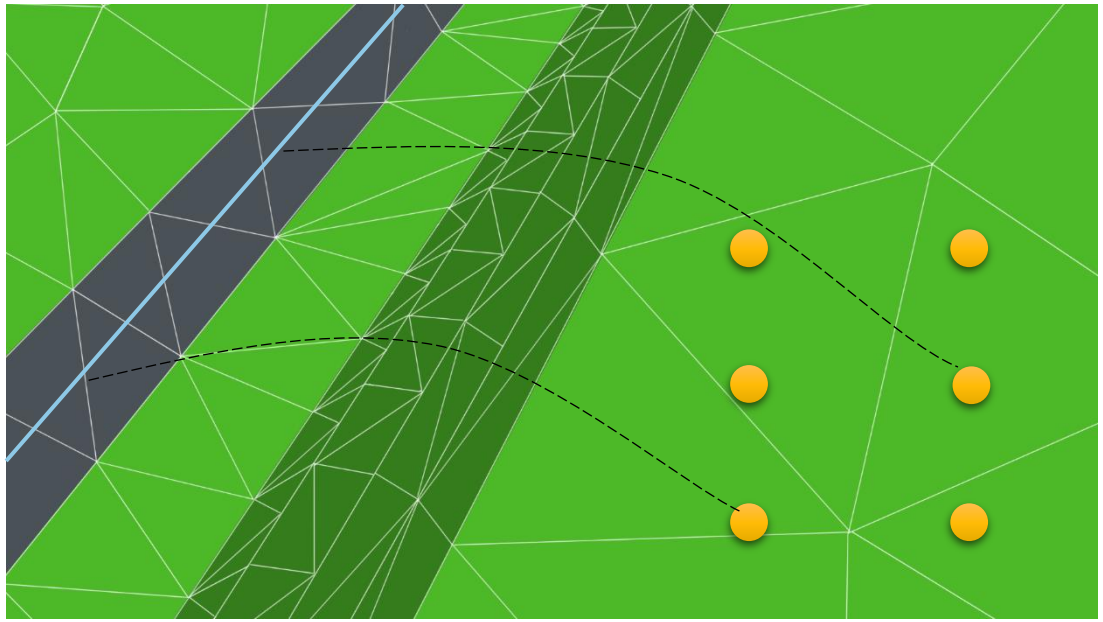
Reduce long term noise exposure to levels over 55 dB (WHO Regional Office for Europe, 2018)

06

01 Background

Why not measure noise?

(https://geluidsmetingen.com/geluidsmeting)



01 Background

02 *Noise modelling in Europe*

03 *What are the models used for?*

04

05 *Upcoming regulations*

06

Common
Noise Assessment Methods
in Europe (CNOSSOS-EU)

(Kephalopoulos et al., 2012)

Problem statement

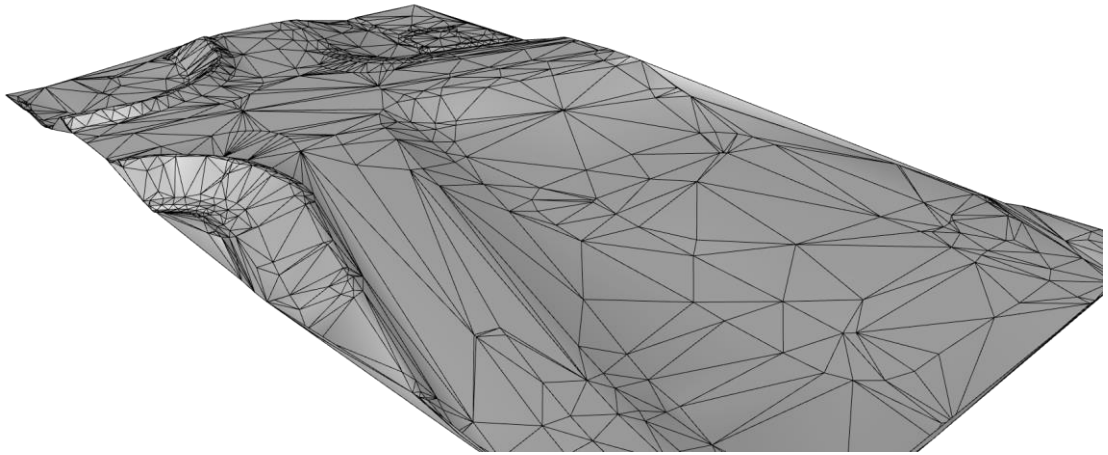
Issues with current height line model

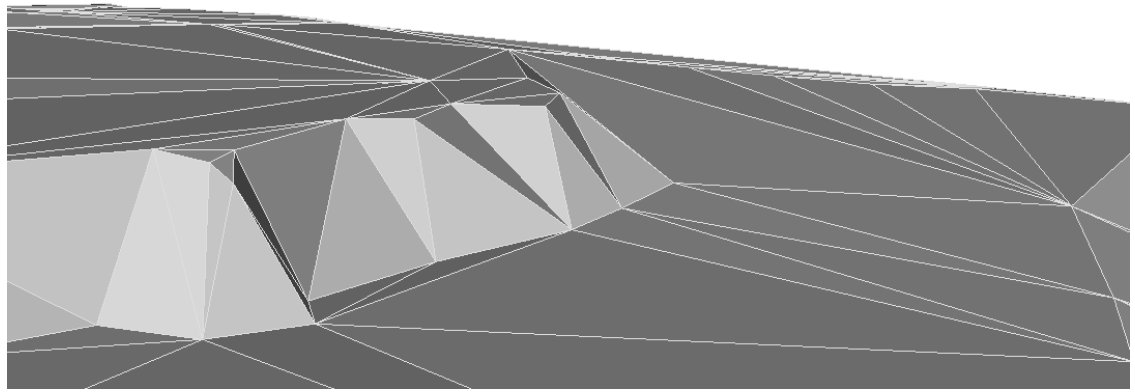
- No quality assurance, requires manual verification
- Multiple data conversions

(Stoter et al., 2020)

Problem statement

Alternative structure: triangulated irregular network
- Quality assurance
- Single conversion
- Large data size





01 Objective

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What is the local minimal accuracy for a triangular irregular network to produce accurate noise predictions according to Dutch and European noise methods?

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01 Introduction

02 Related work

Noise modelling
Terrain modelling

03 Methodology

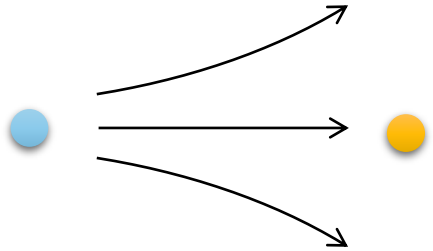
04 Approach

05 Verification

06 Conclusions

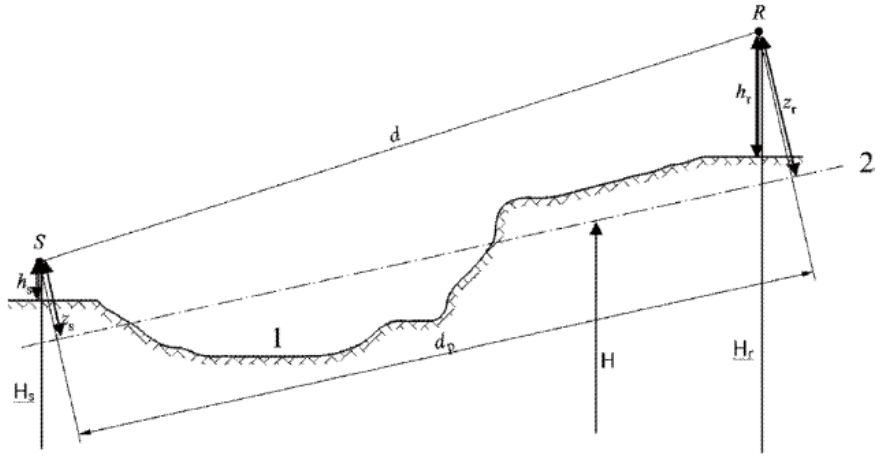
Noise reduction

Divergence



Absorption

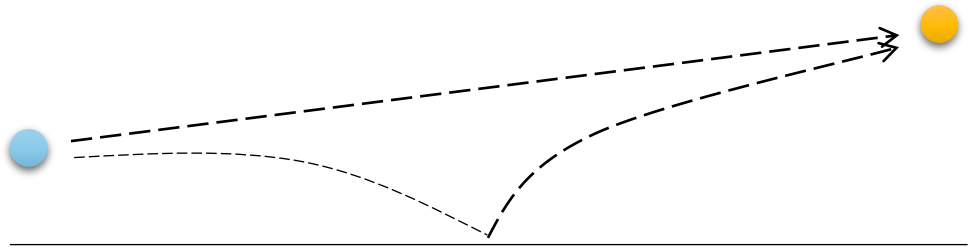
Ground effect



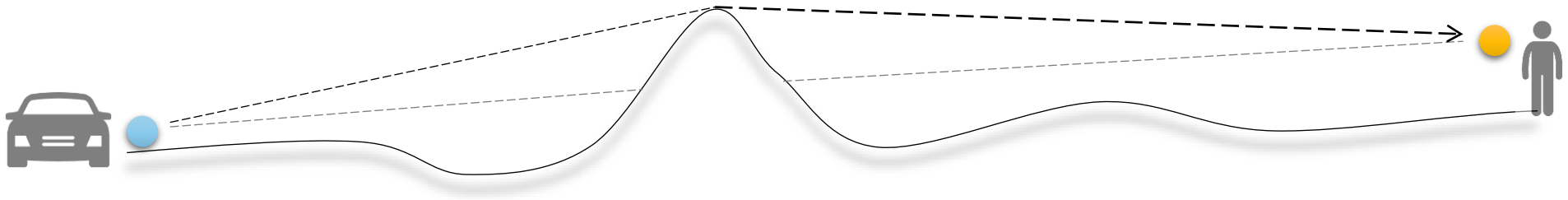
1: Actual relief

2: Mean plane

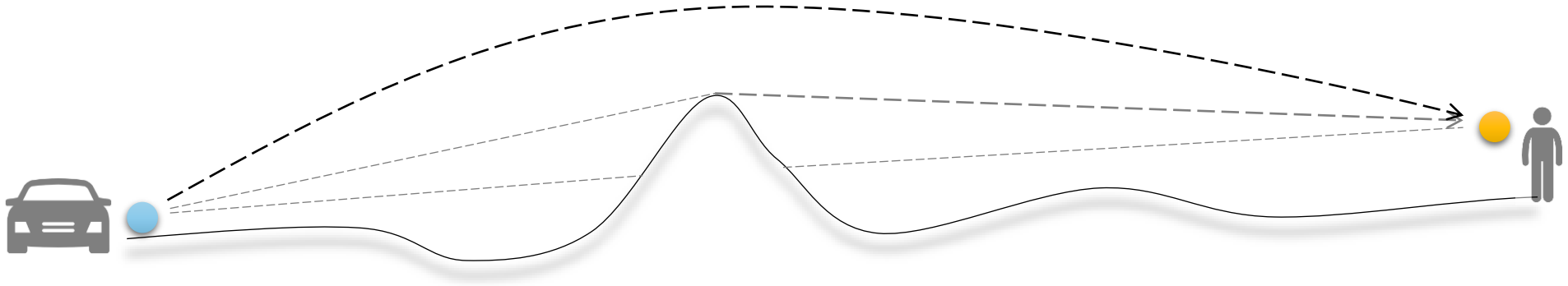
(Kephalopoulos et al., 2012)



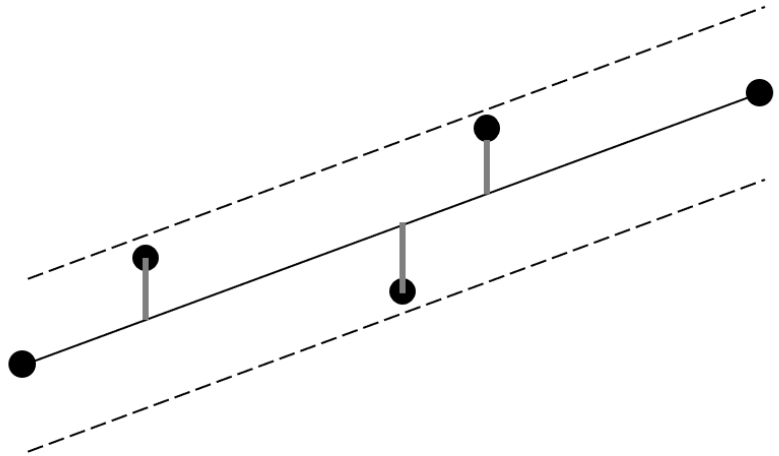
Diffraction



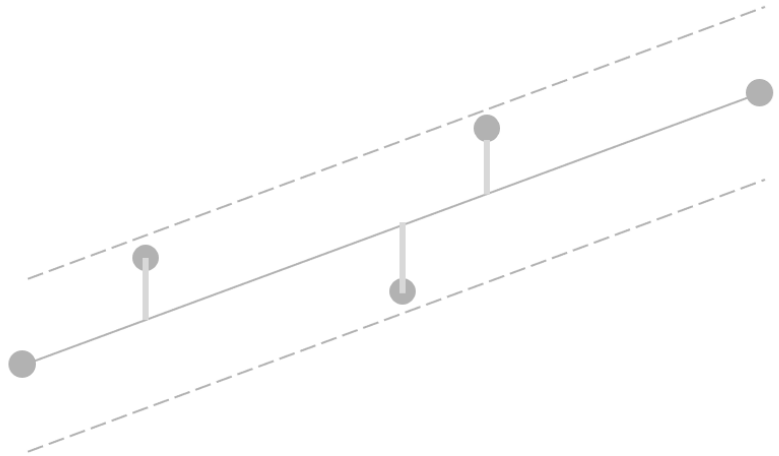
Diffraction

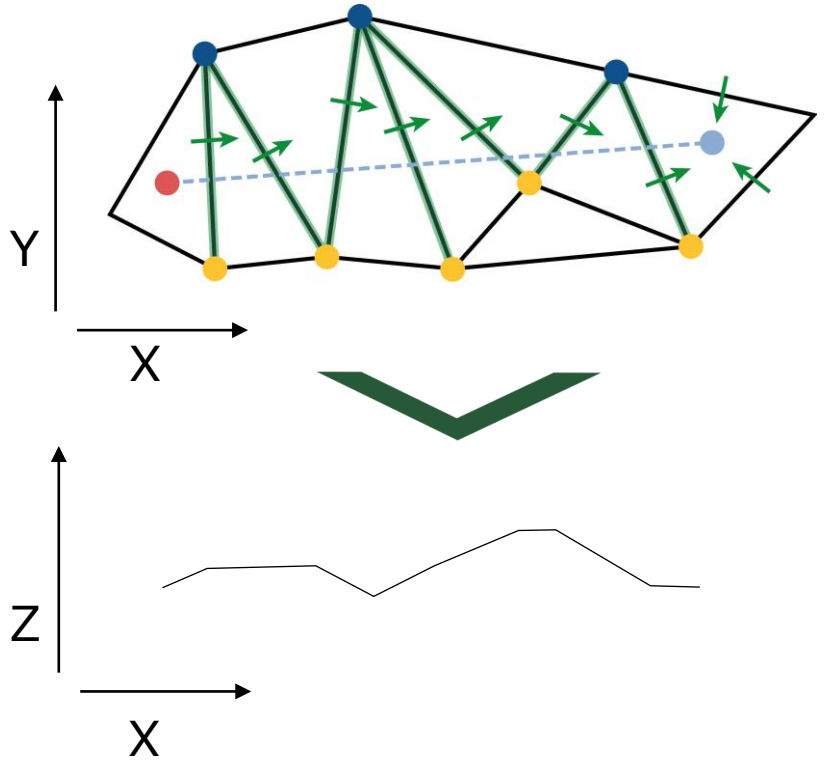


Properties of a TIN

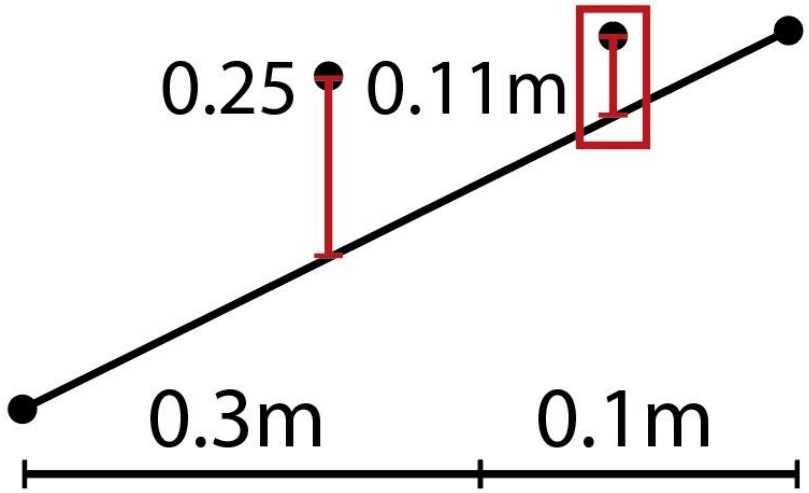


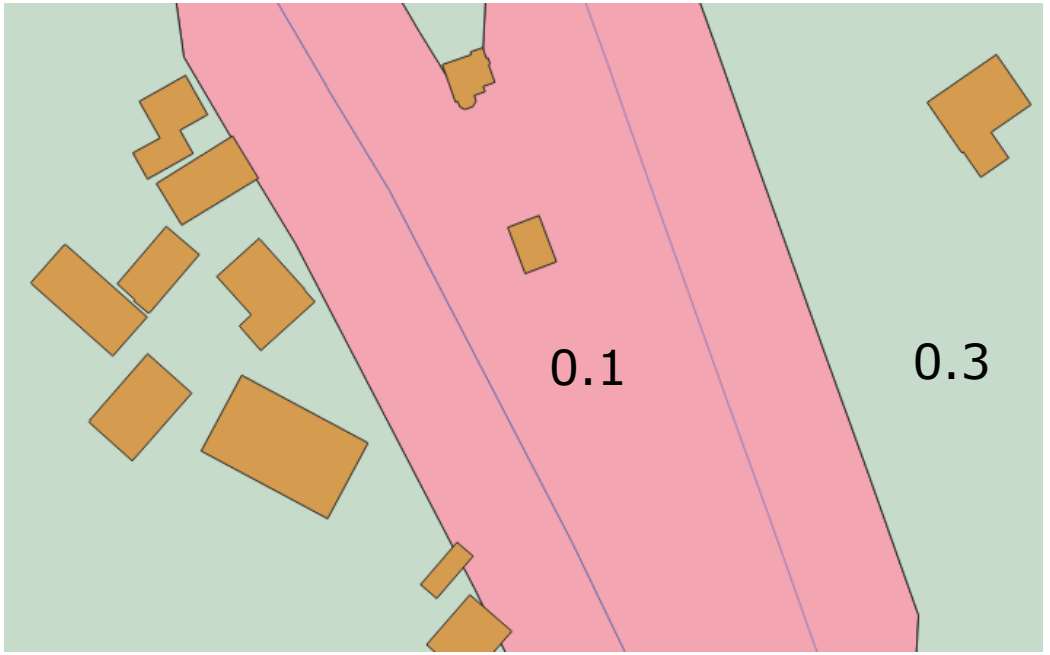
Properties of a TIN



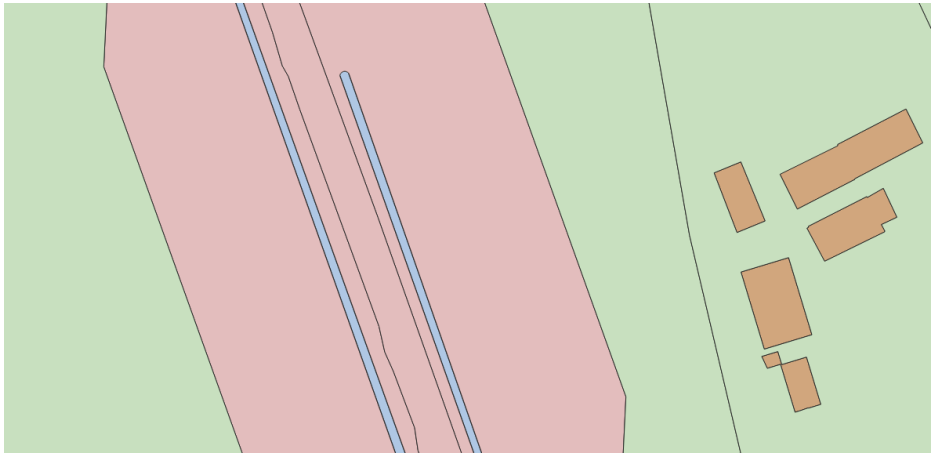


Generating a TIN





Generating a TIN in practice



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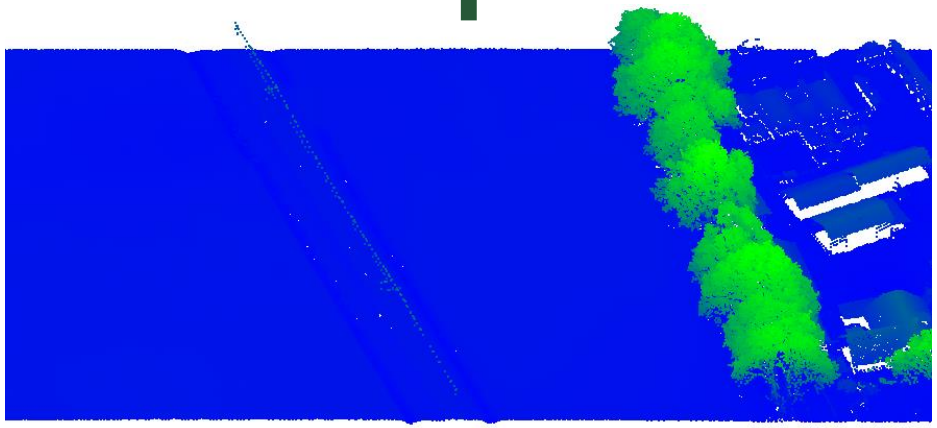
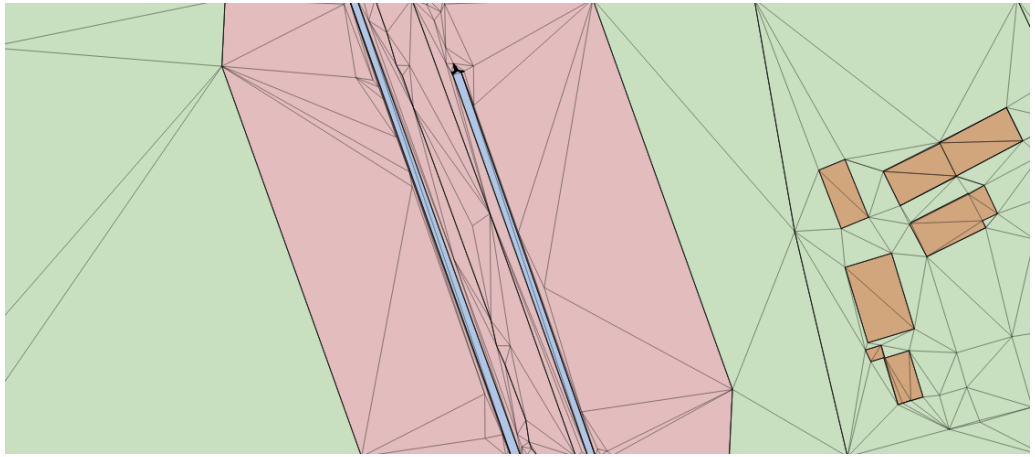
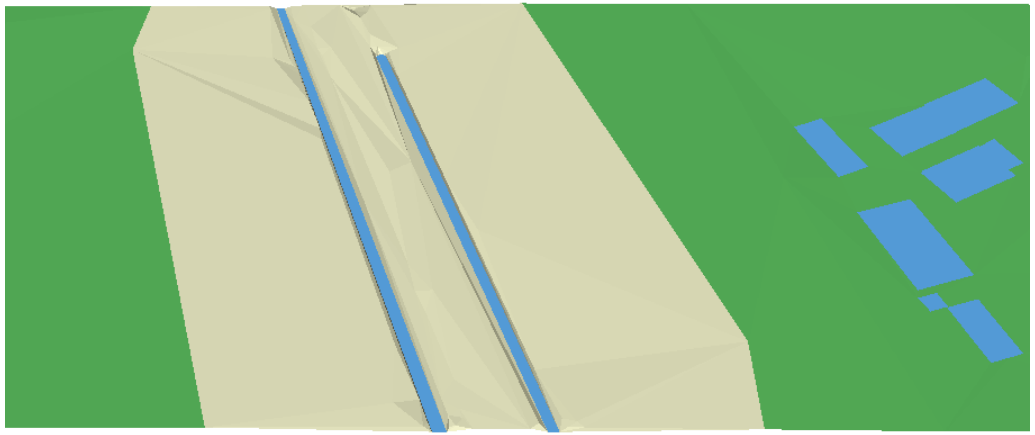






Methodology

01
Create model

Theoretical analysis
Determine parameters

02
Implement

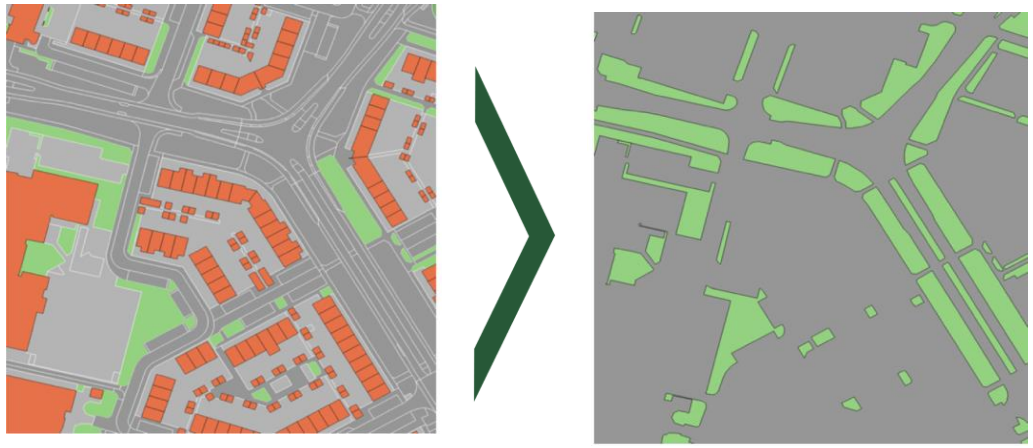
QGIS for
Verification

03
Verify

Locate testing areas
Define parameter settings
Noise calculations
Locate balance

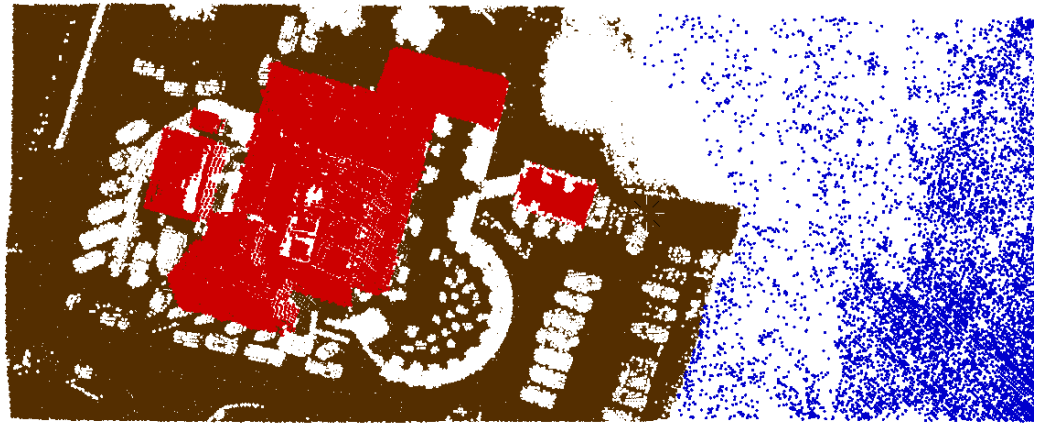
Surface types

Reflective and absorbing areas

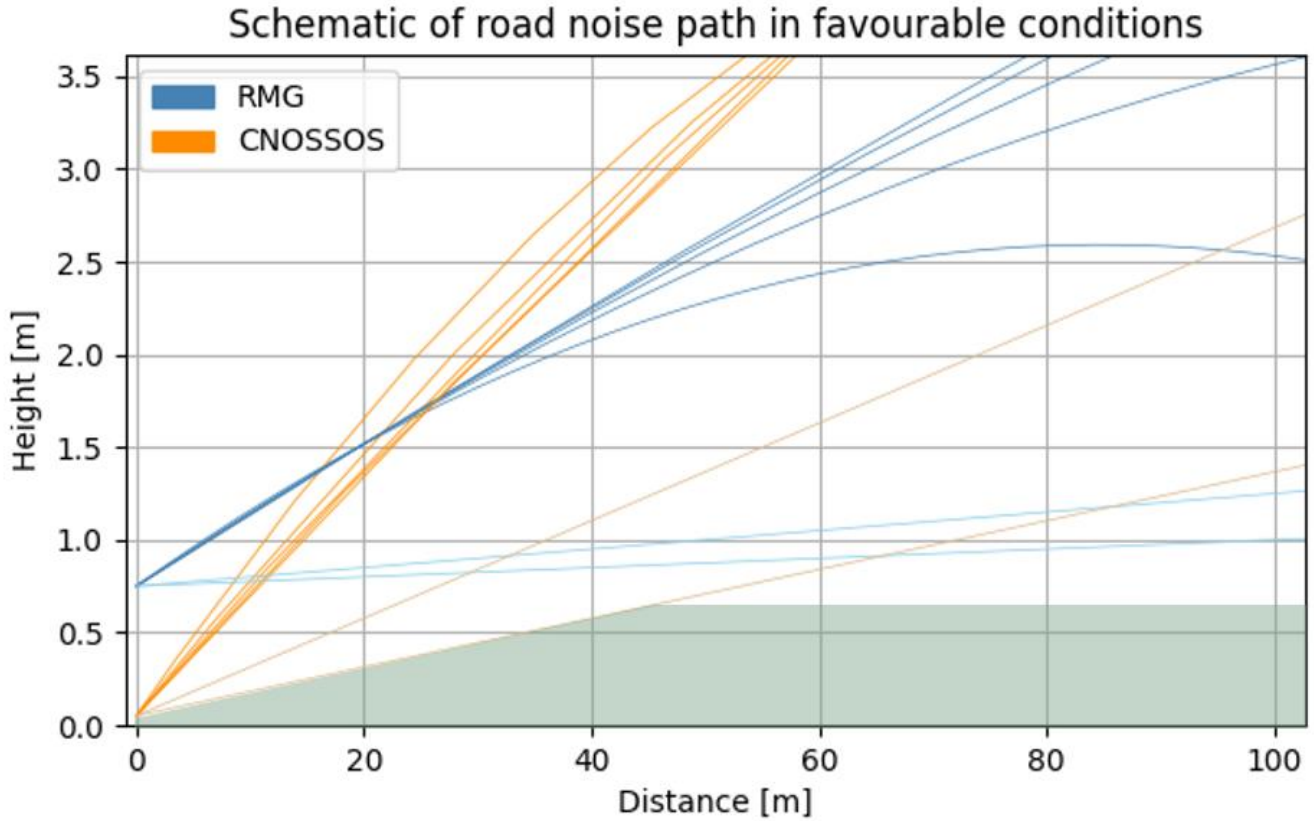


(Stoter et al., 2020)

Water

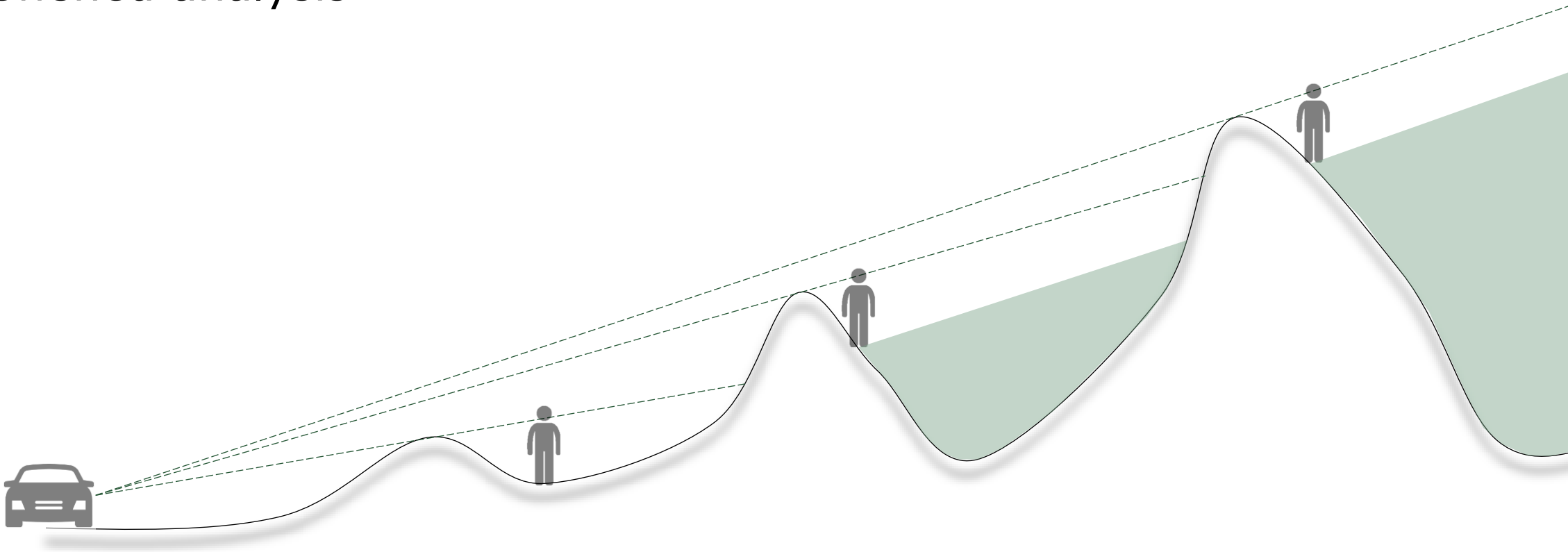


Distance to objects

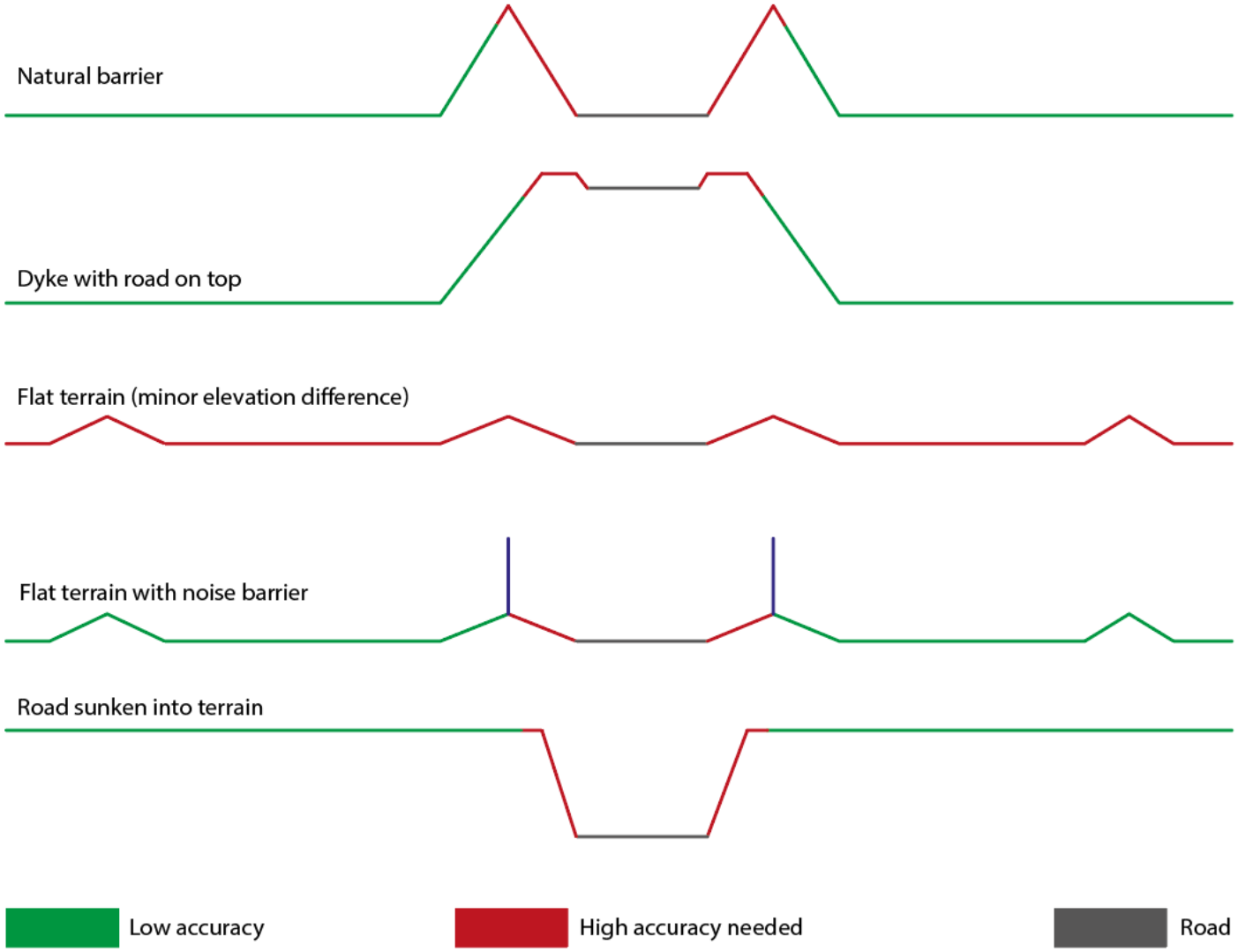


Elevation topology

Viewshed analysis



Elevation topology



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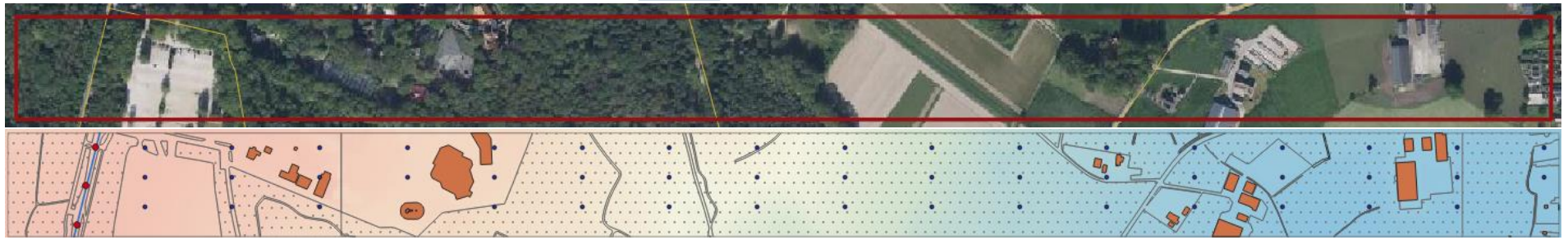
Testing areas
Terrains
Noise calculations

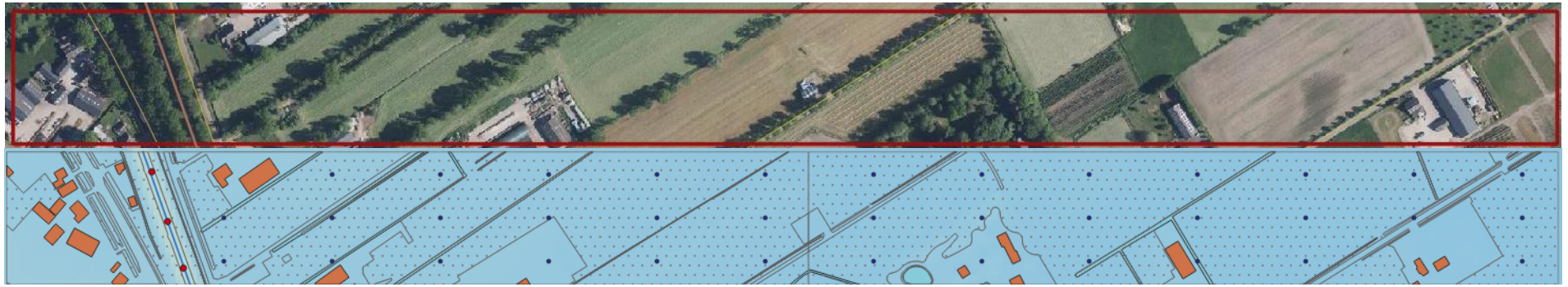
06 Conclusions

Test setup - areas

01



02



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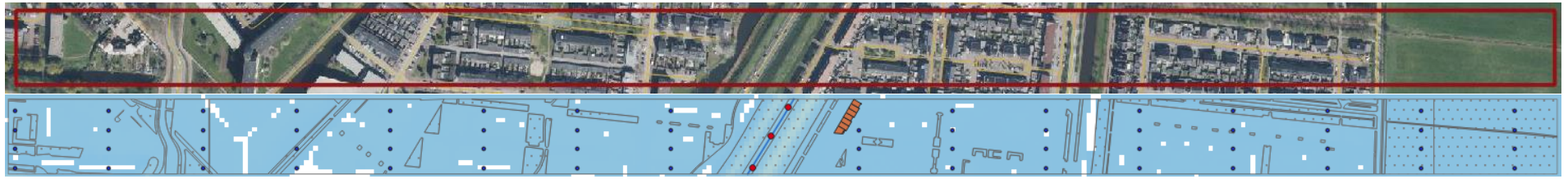
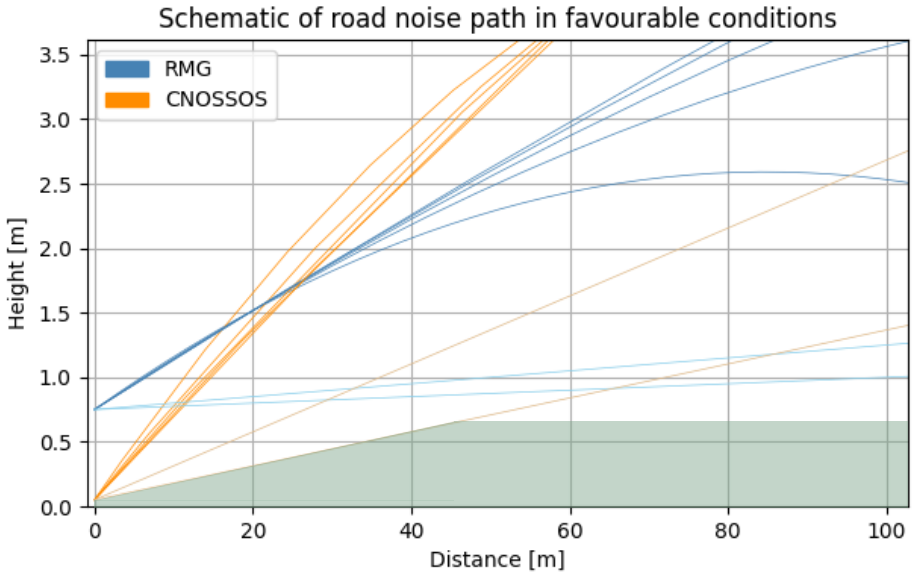
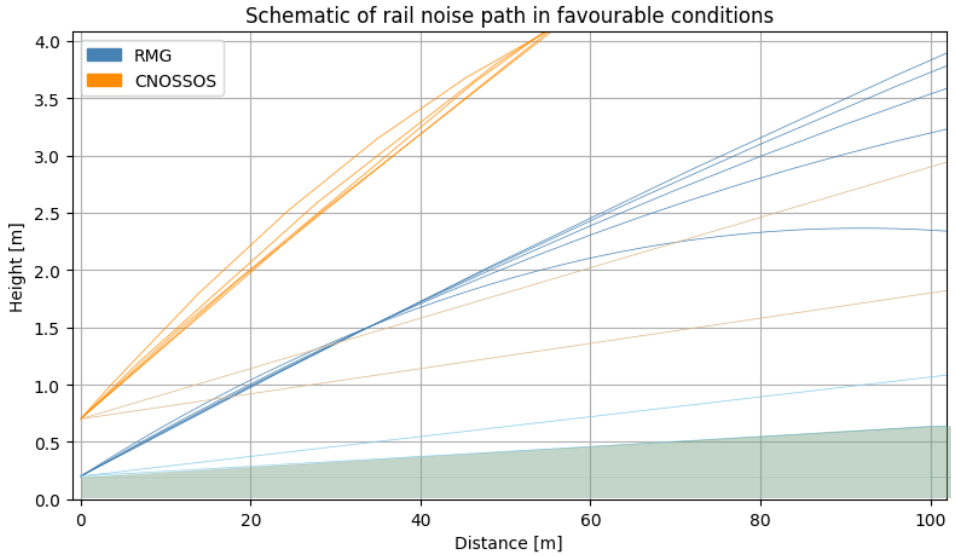
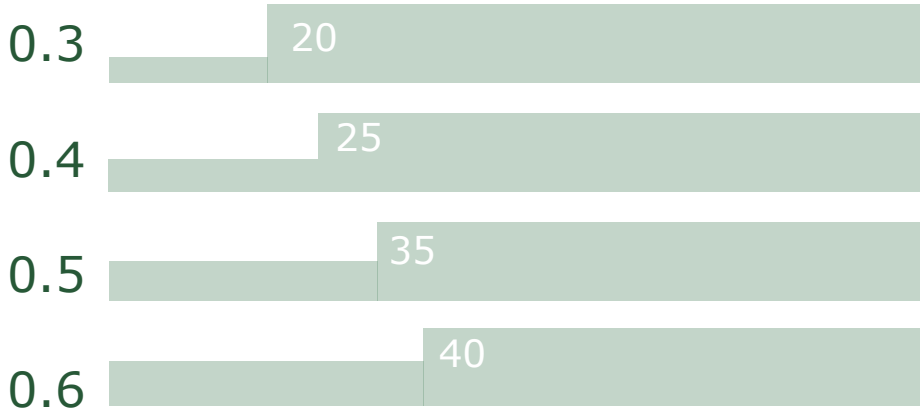


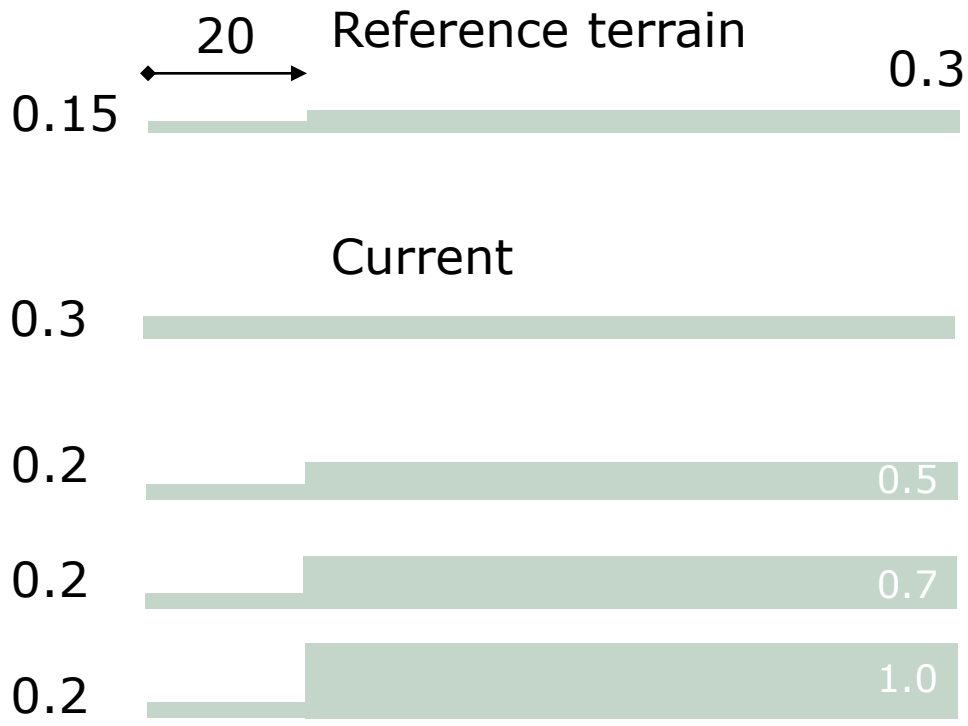
Test setup – settings 1



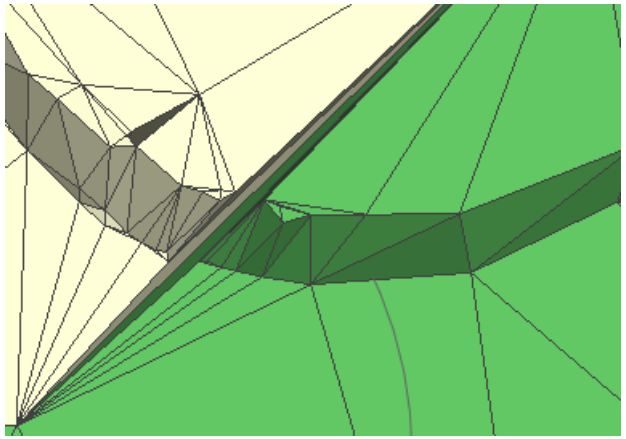


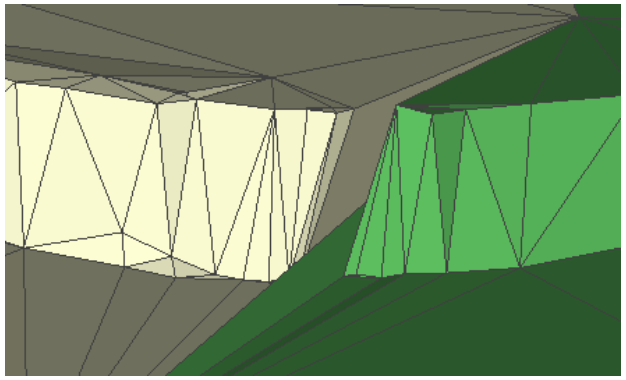


Test setup – settings 2

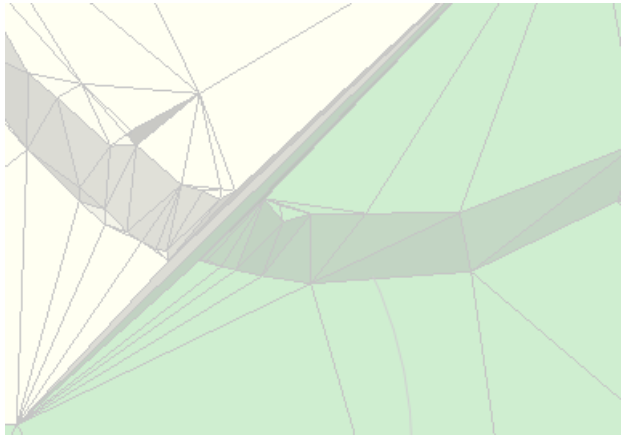


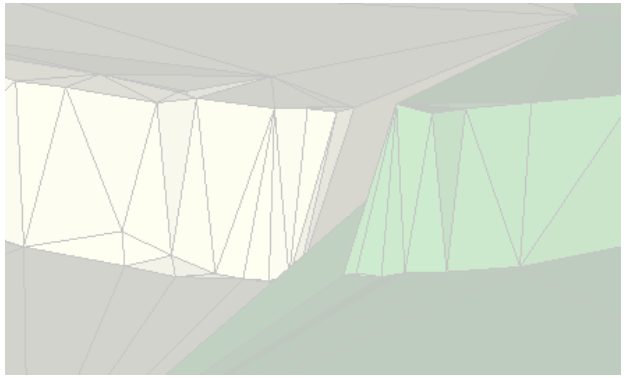
Intermediate results Terrains - overview

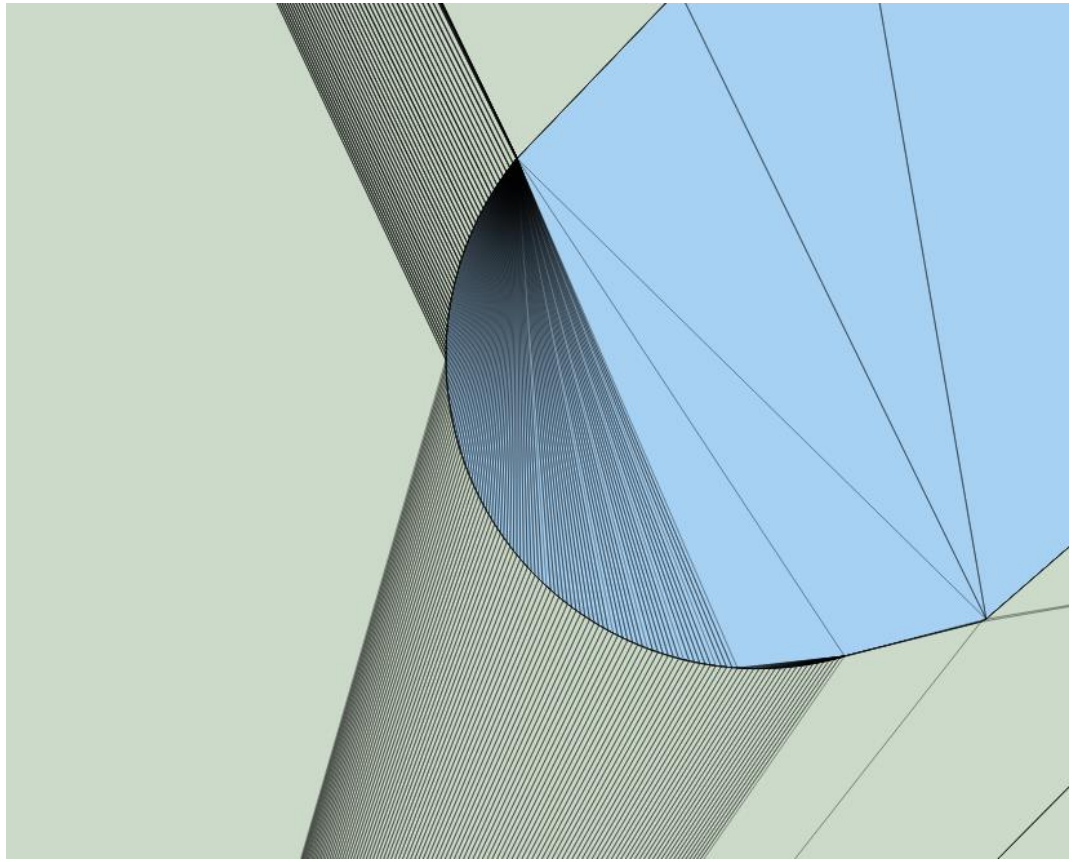




Intermediate results Terrains - overview

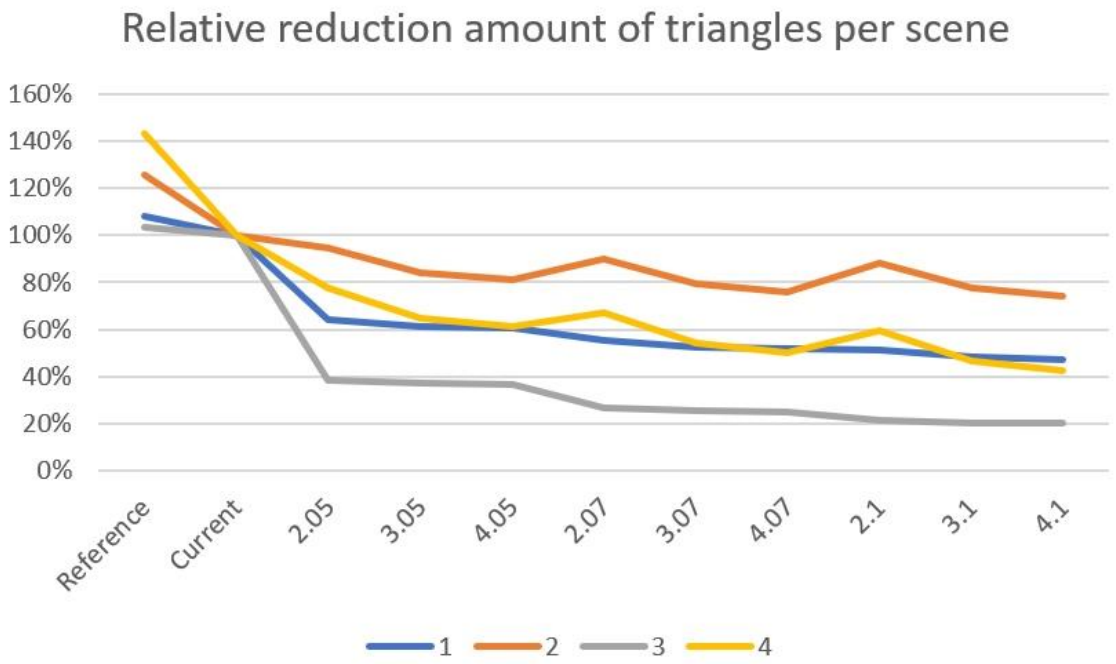




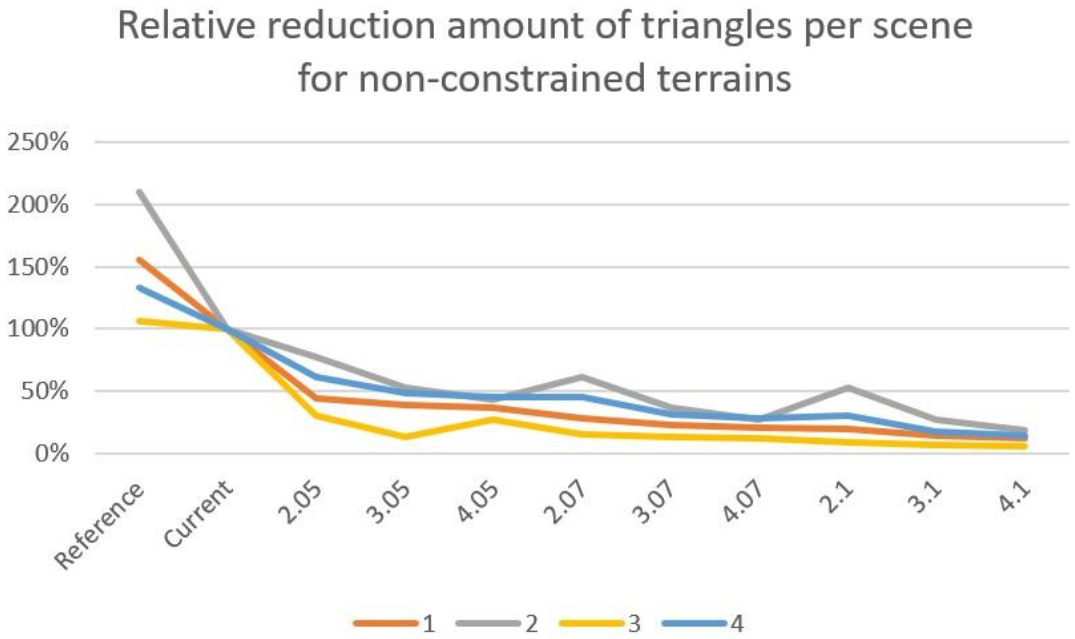


Intermediate results Terrains – sizes

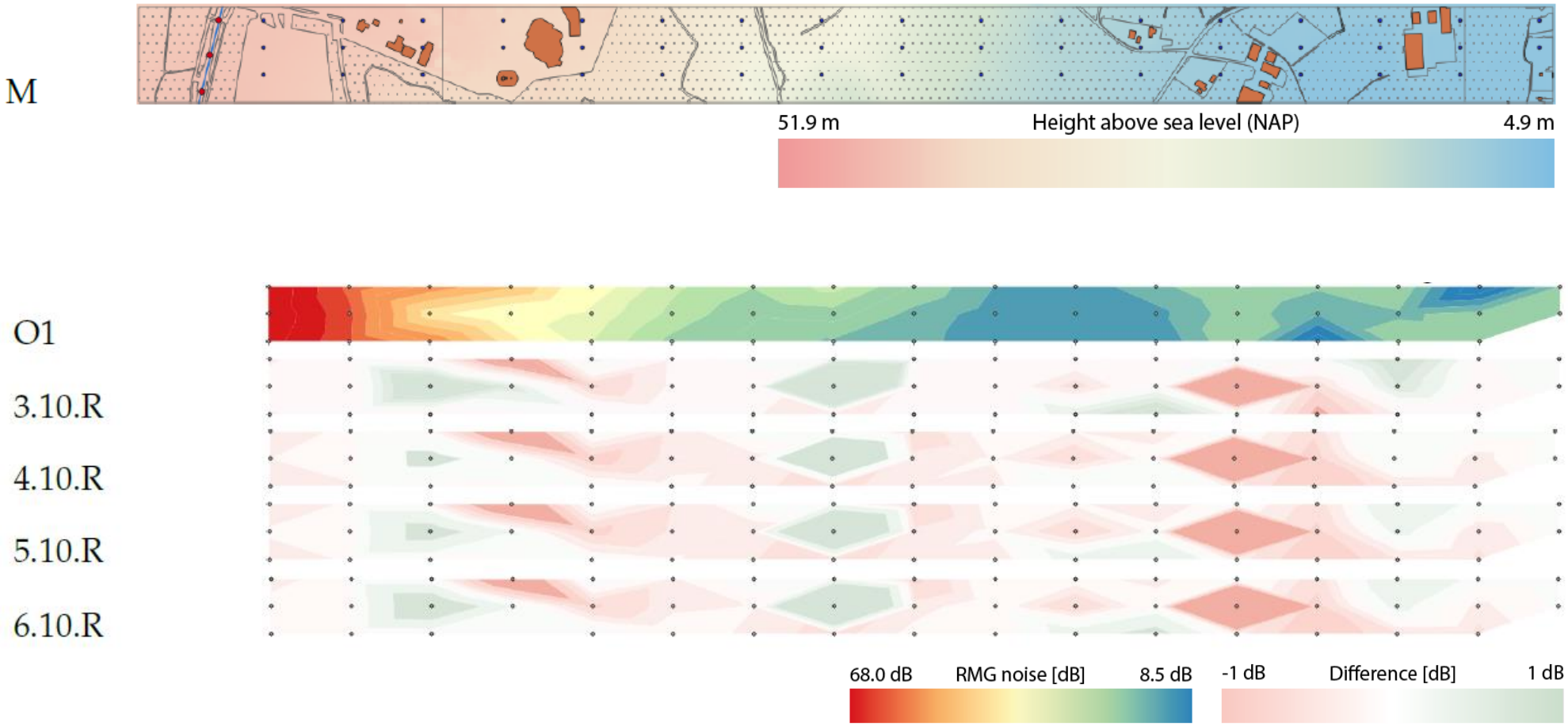
With buildings, water and ground types



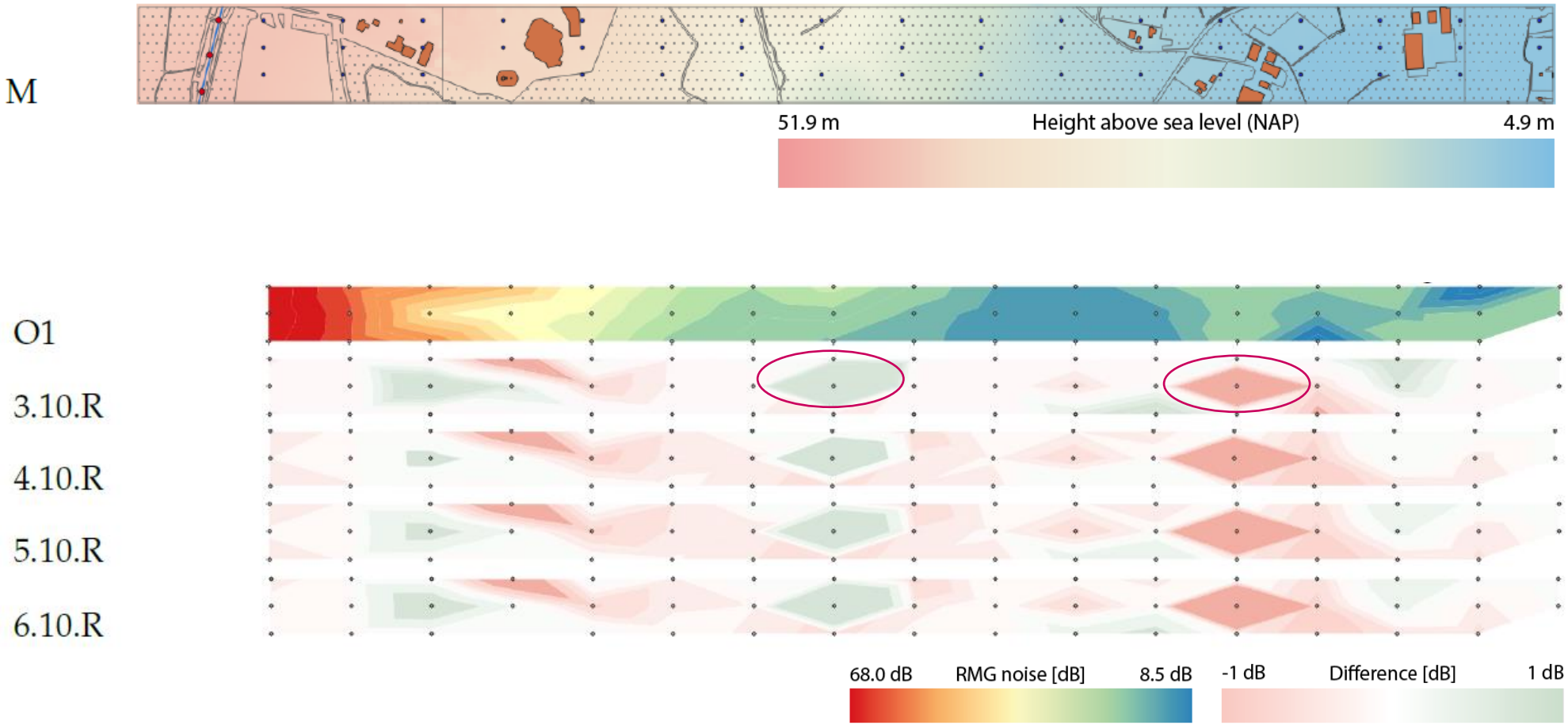
Without any object



Noise calculations

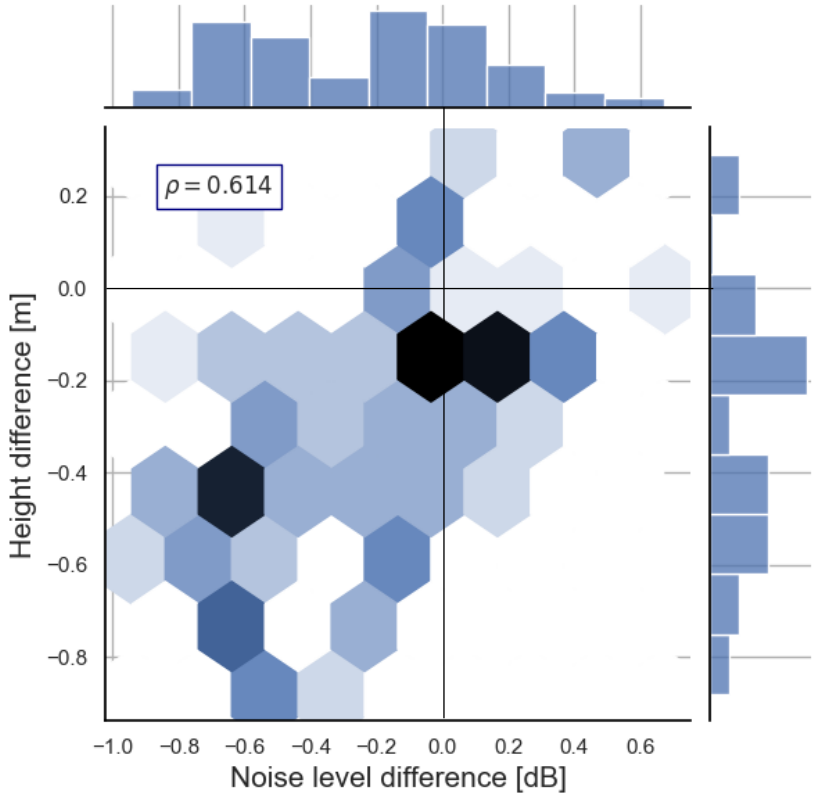


Noise calculations

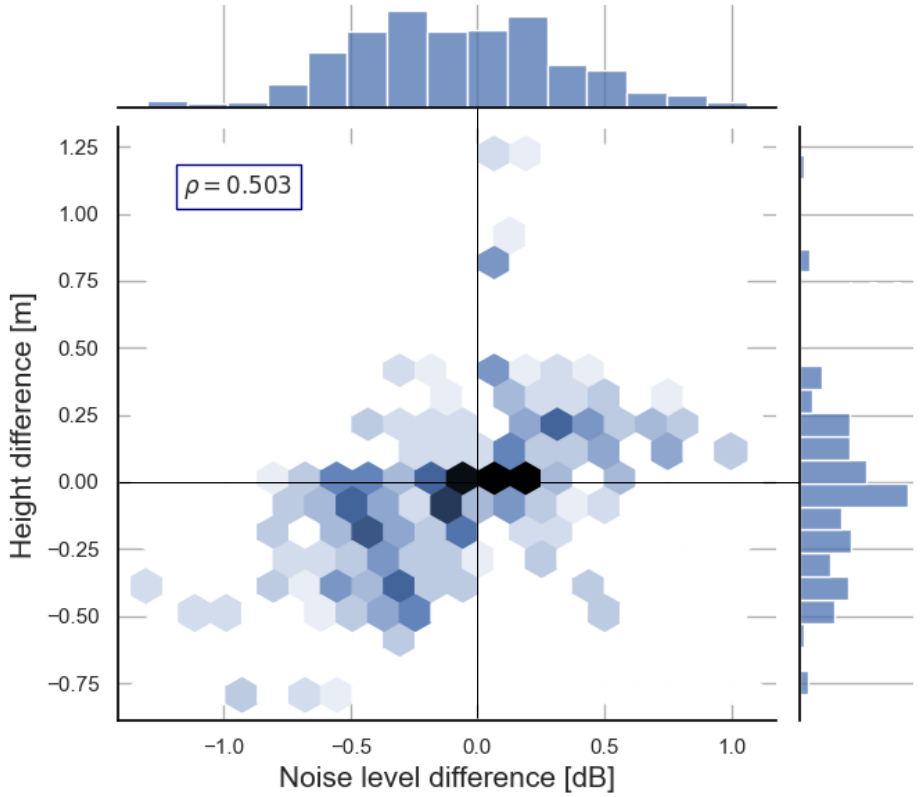


Noise calculations

Scene 2



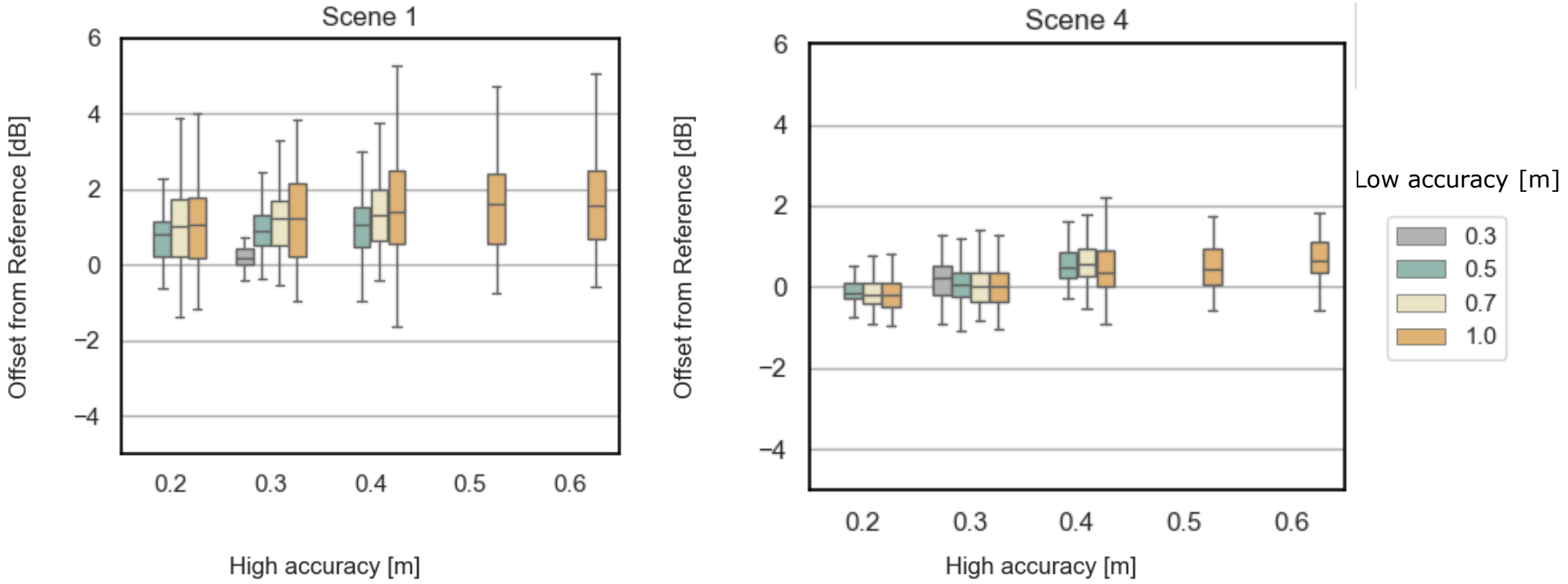
Constrained



Not constrained

Noise calculations

CNOSSOS



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Terrain modelling

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Surface types
Distance to objects
Elevation topology

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Testing areas
Accuracy maps
Terrains
Noise calculations

06
Conclusions

Conclusions
Future work

Conclusions

What is the local minimal accuracy for a triangular irregular network to produce accurate noise predictions according to Dutch and European noise methods?

- Flat terrain works best
- Non-constraints mostlikely better
- 50 to 90% reduction

Parameter	setting
Constrained terrain	20 to 60% reduction
Buffer distance road	20.0m
Buffer distance rail	20.0m
High accuracy value	0.40m
Low accuracy value	0.50m
Non-constrained terrain	50 to 90% reduction
Buffer distance road	20.0m
Buffer distance rail	20.0m
High accuracy value	0.30m
Low accuracy value	0.50m

Future work

- Develop triangulation software that supports variable accuracies
- Further test triangulation without constraints
  OR
- Simplify constraining objects
- Further testing with current models

National Institute for Public Health
and the Environment
Ministry of Health, Welfare and Sport

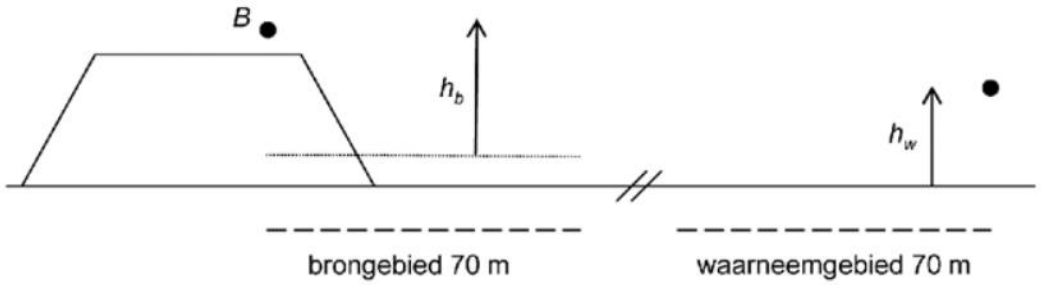
Optimising triangular terrain elevation data for noise modelling

Laurens van Rijssel

TU Delft

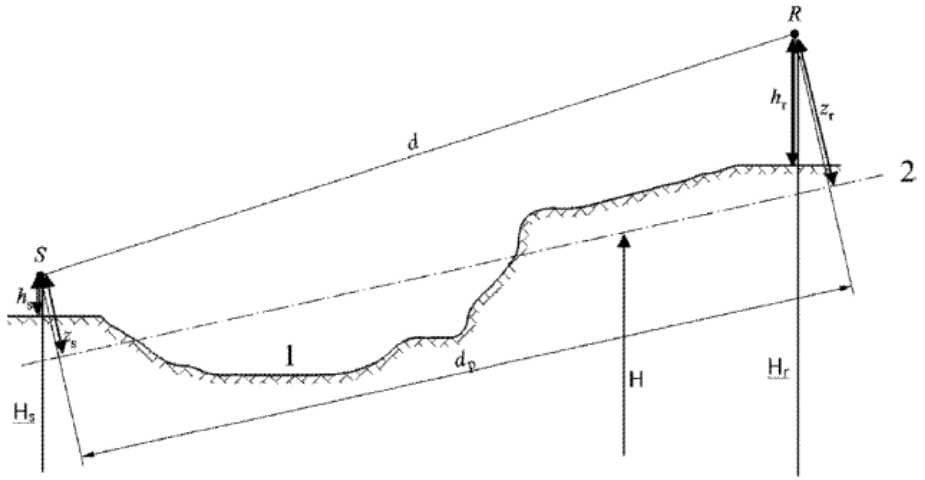
Ground effect per method

RMG



(https://wetten.overheid.nl/BWBR0031722/2021-04-01)

CNOSSOS



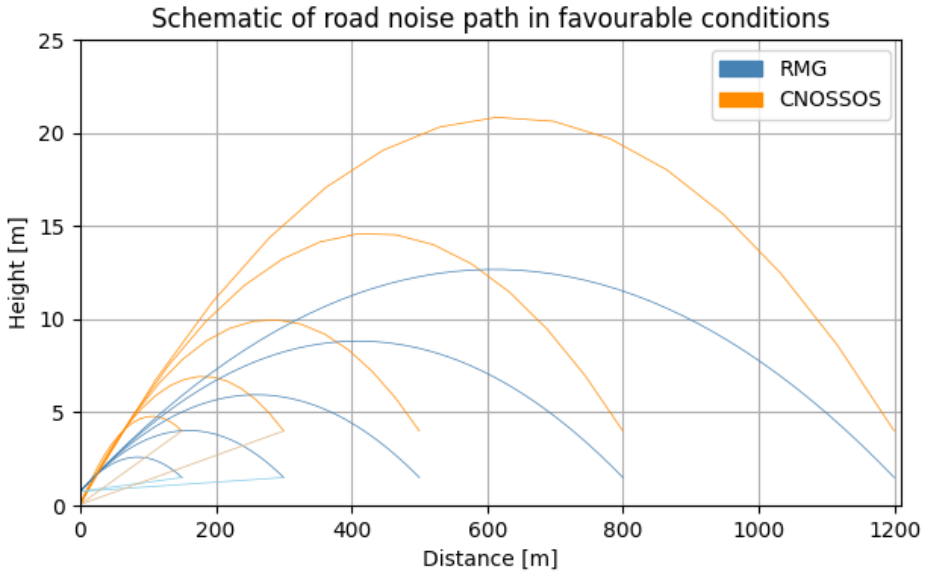
1: Actual relief

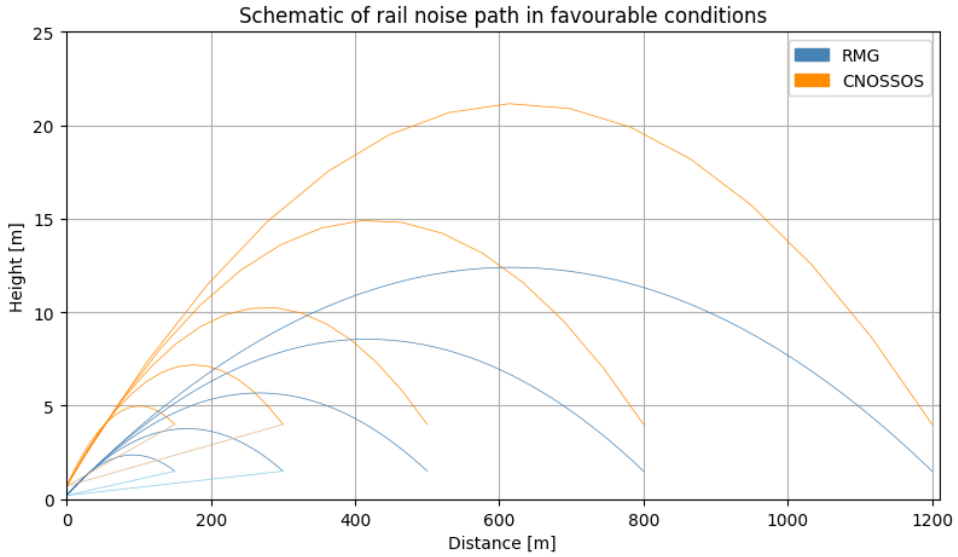
2: Mean plane

(European parliament and European Union, 2015, L 168/27)

Noise propagation

- Homogeneous & favourable conditions

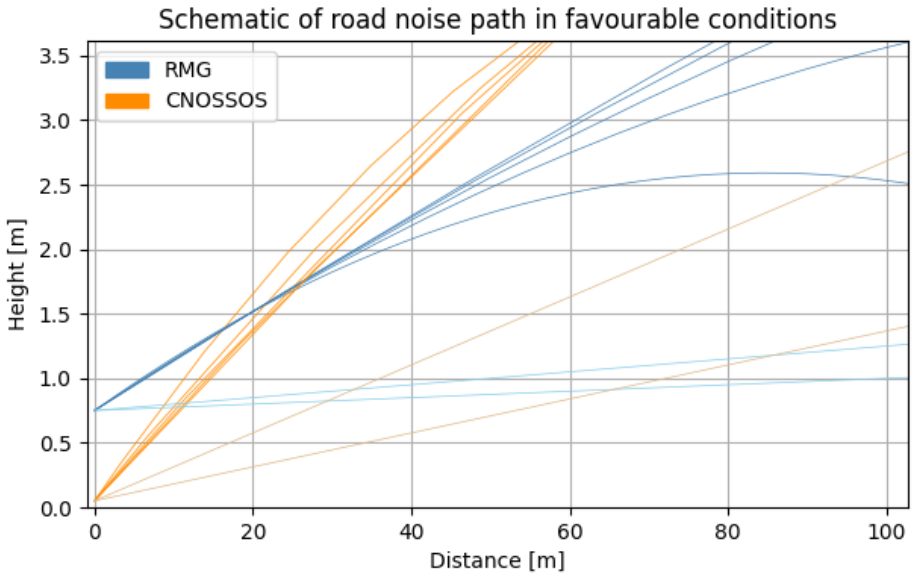


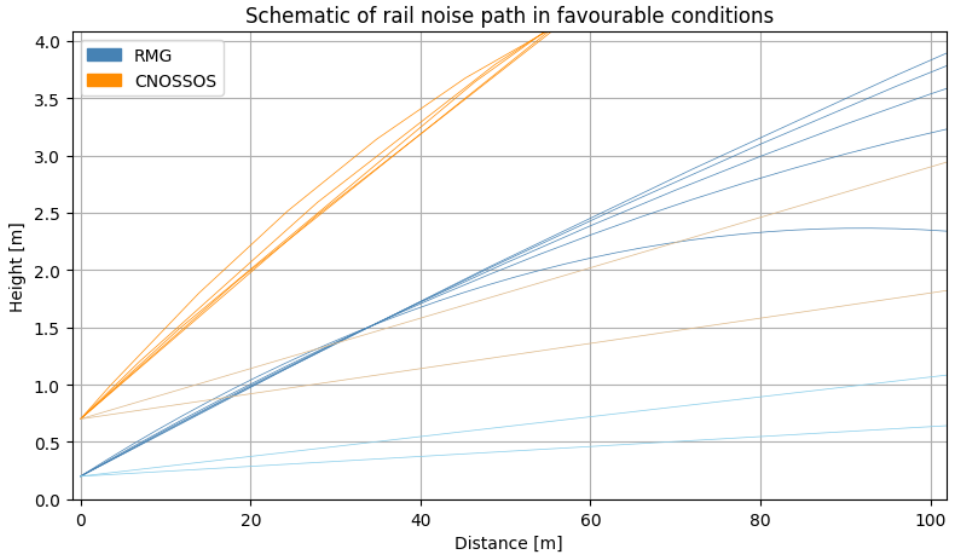


RMG	Source:	0.5m	Receiver:	1.5m	Source: 0.2m (incl. 0.2m rail height)
CNOSSOS		0.05m		4.0m	0.7m

Noise propagation

- Homogeneous & favourable conditions

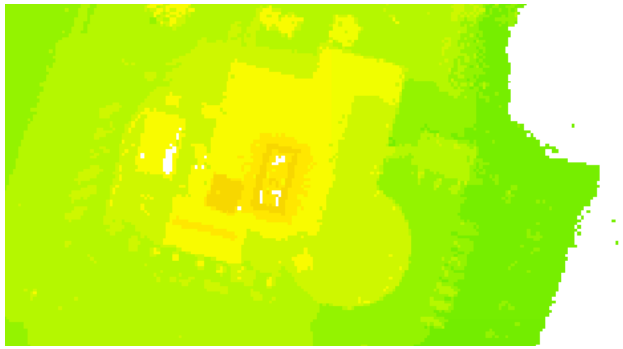




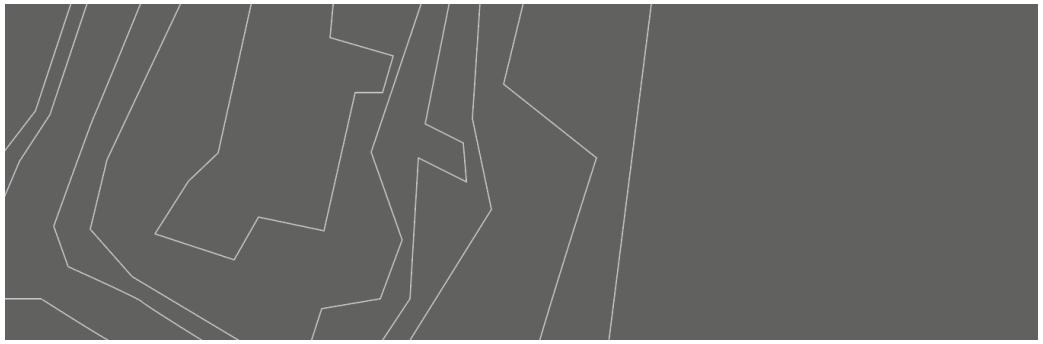
01 02 03 04 05 06

Digital terrain modelling

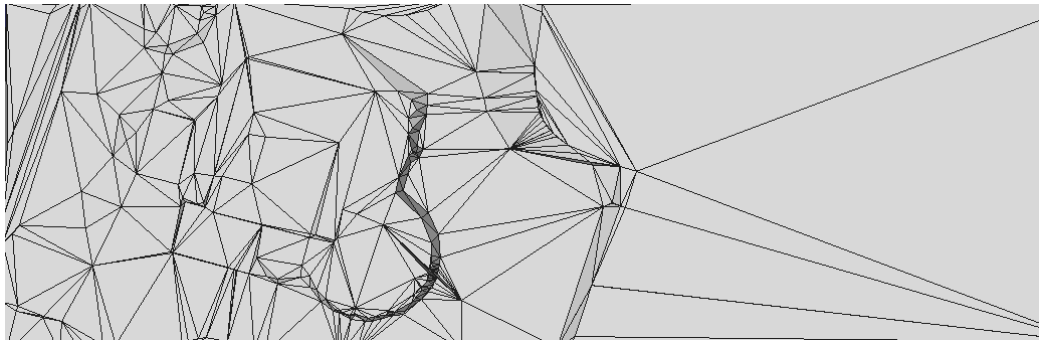
Raster



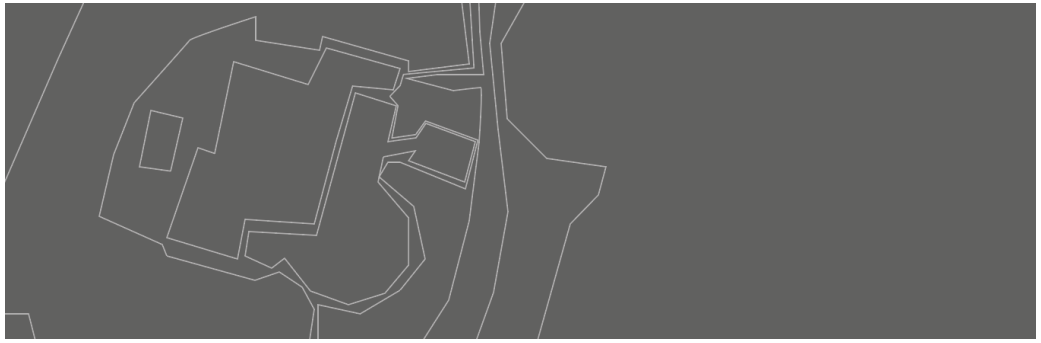
Height lines



Triangulated irregular network

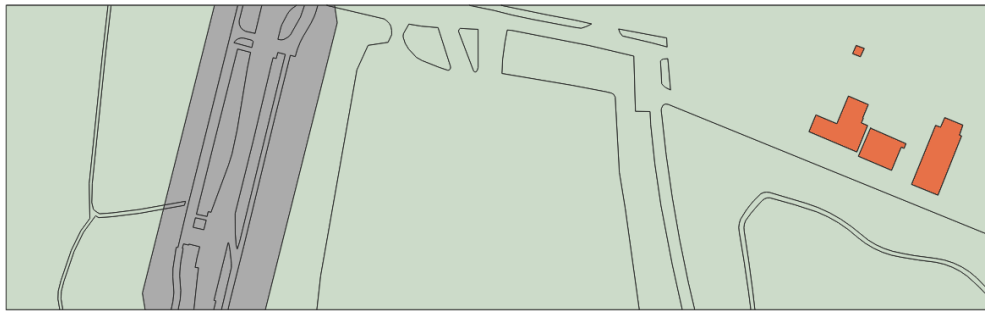


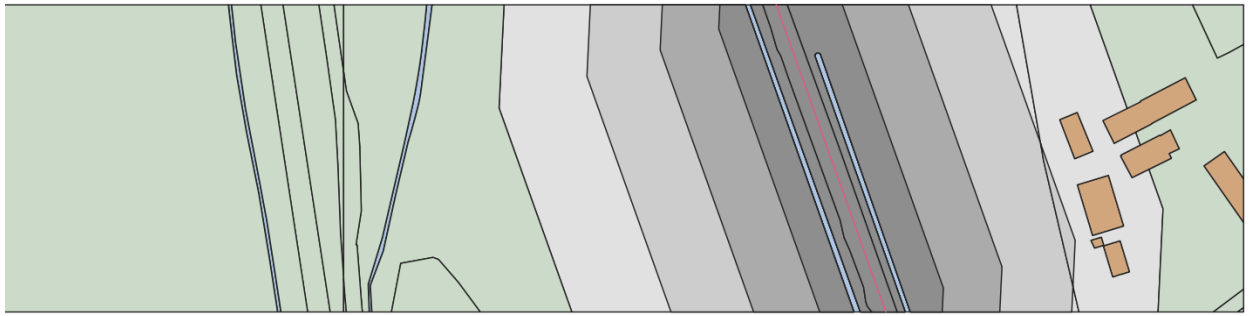
Iso contours

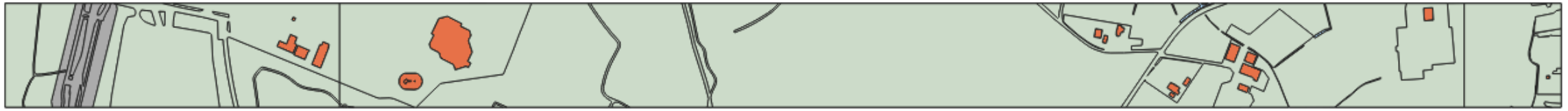


Intermediate results Accuracy maps

Constrained



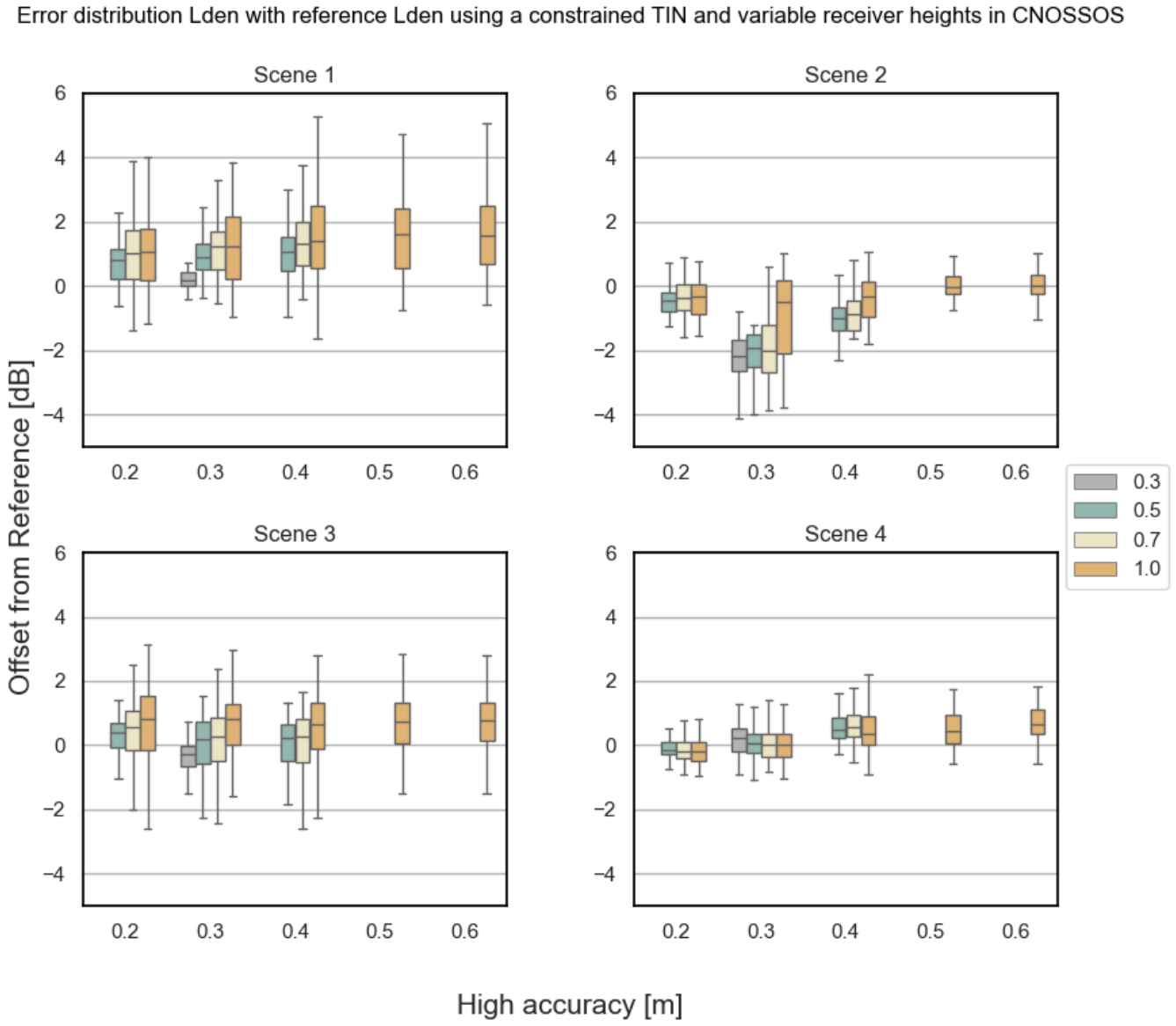




Not constrained

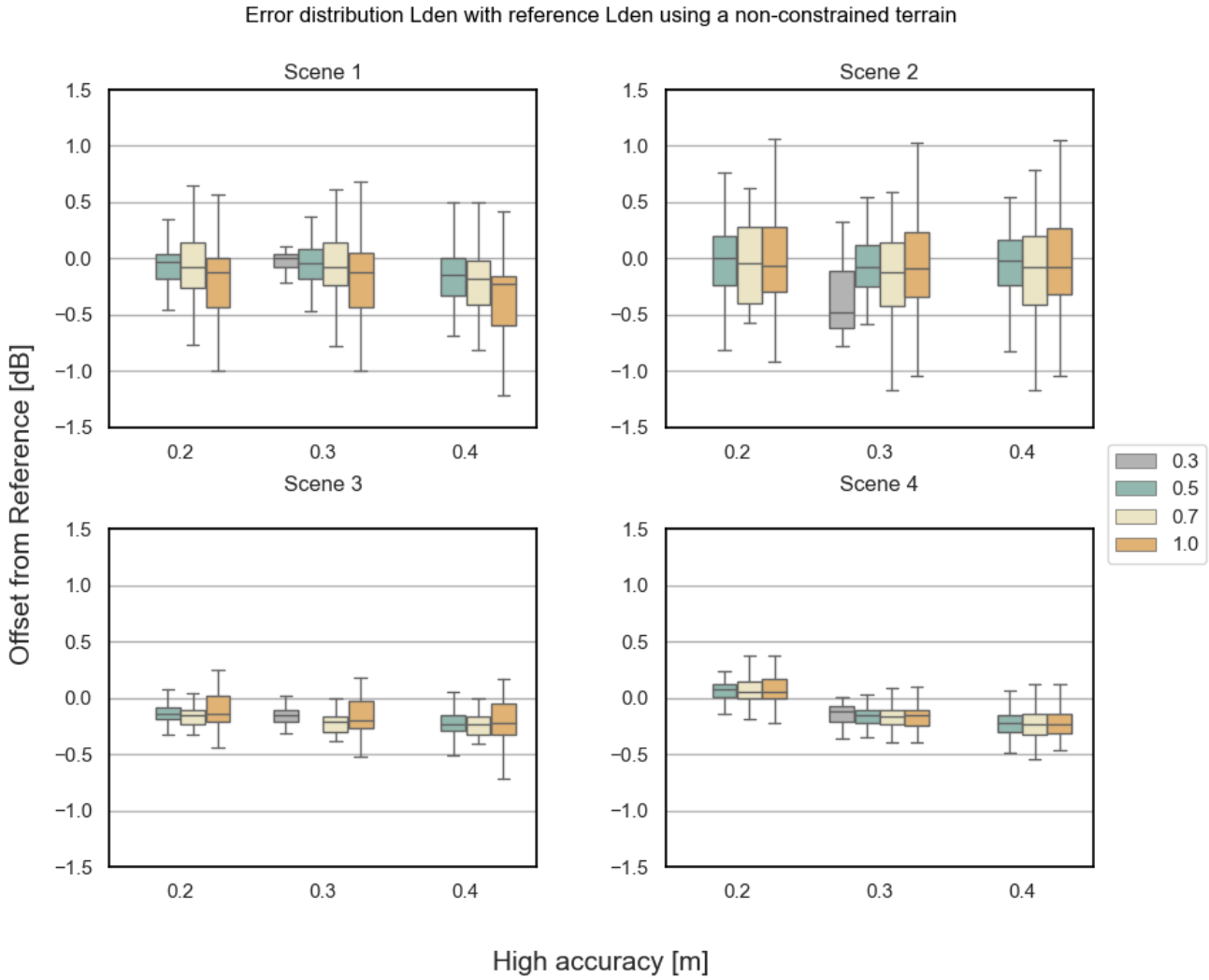
Noise calculations

CNOSSOS



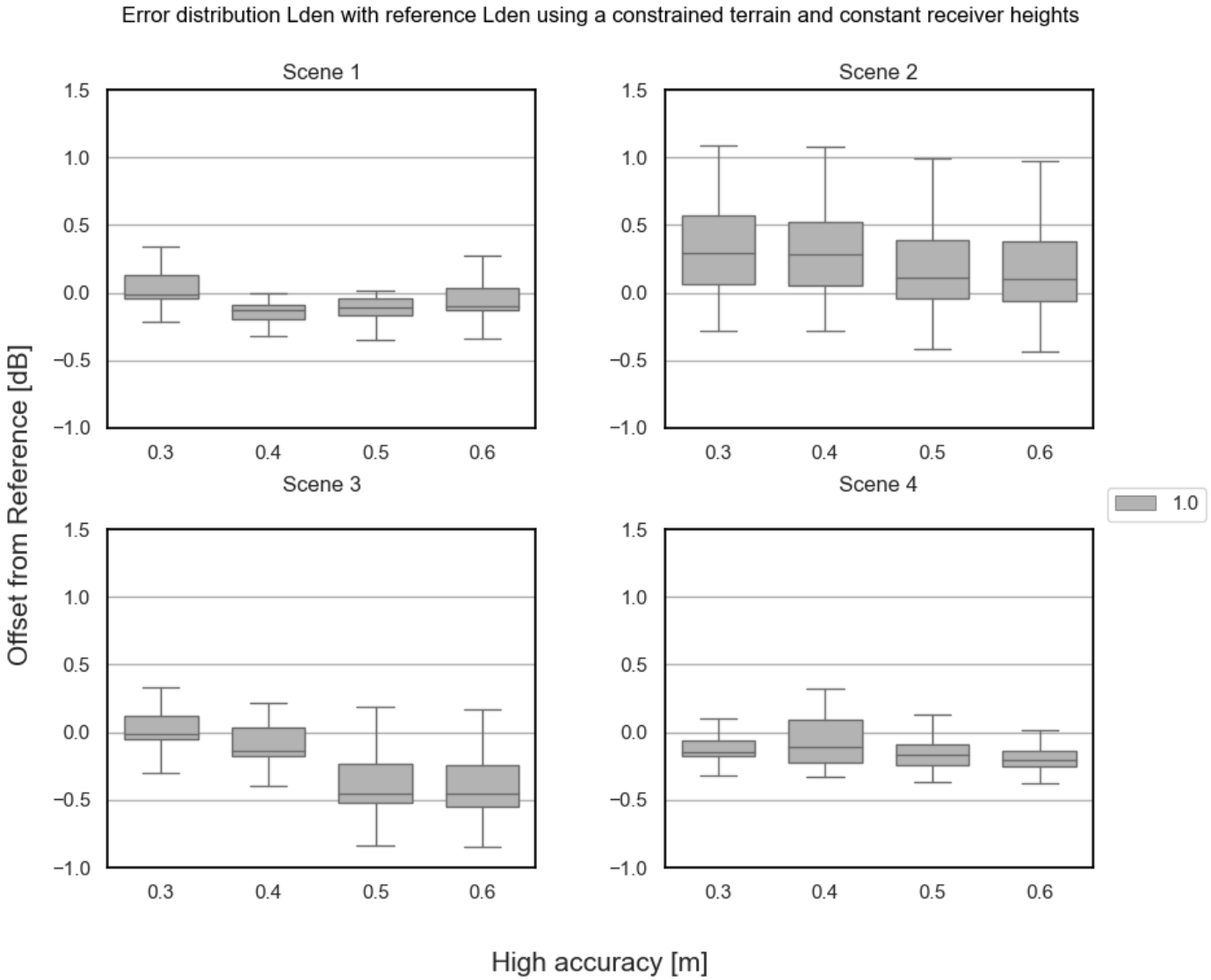
Noise calculations

RMG



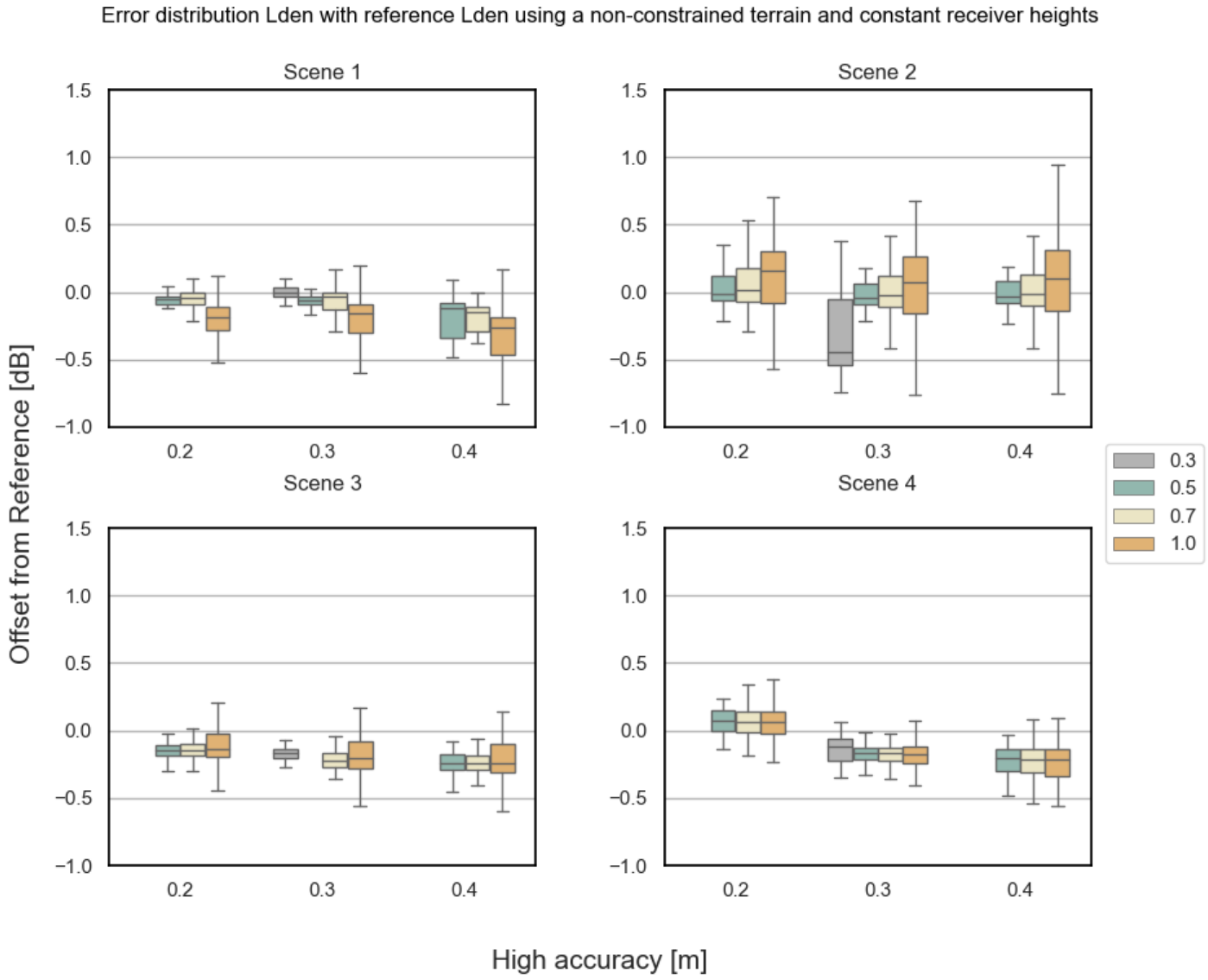
Noise calculations

RMG

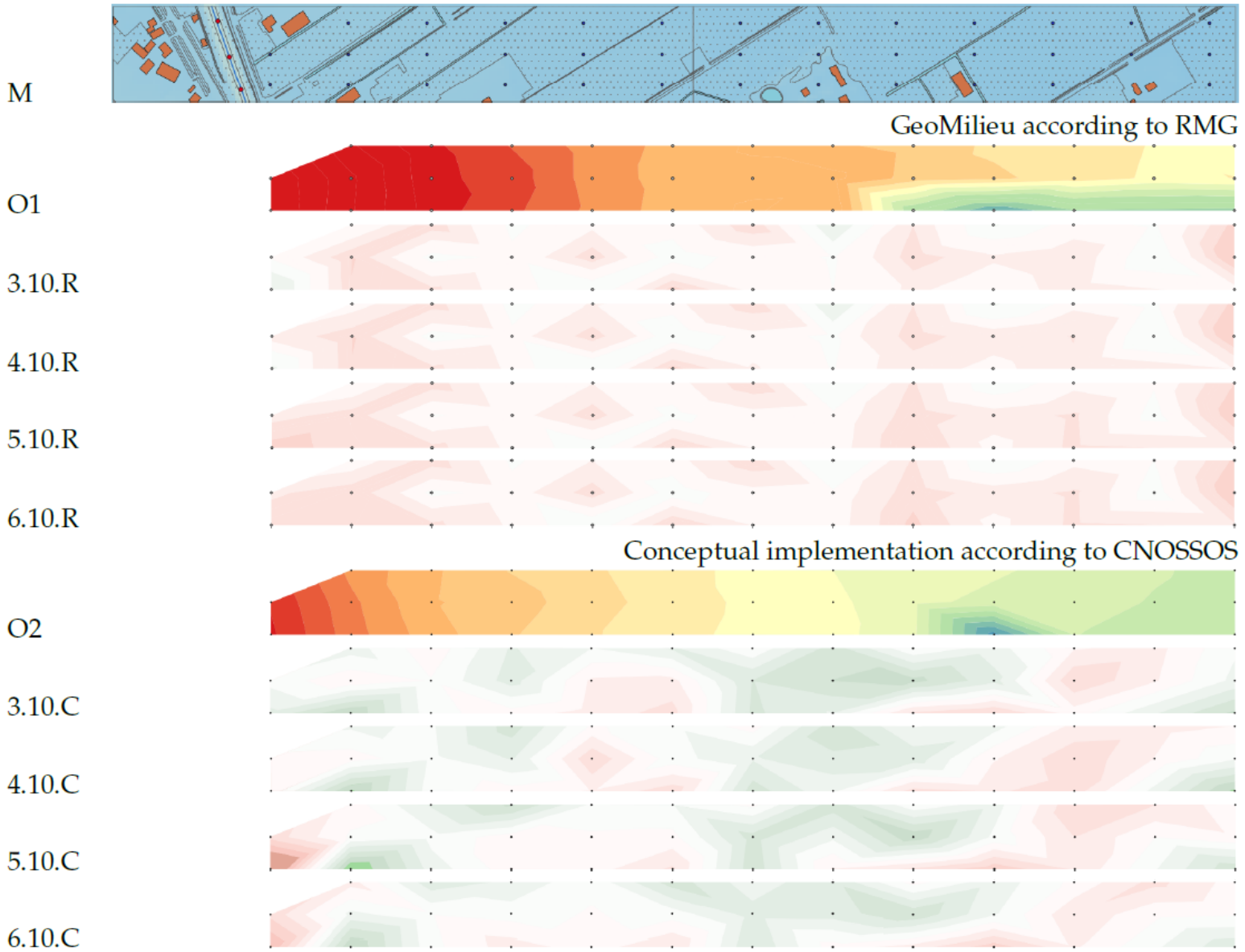


Noise calculations

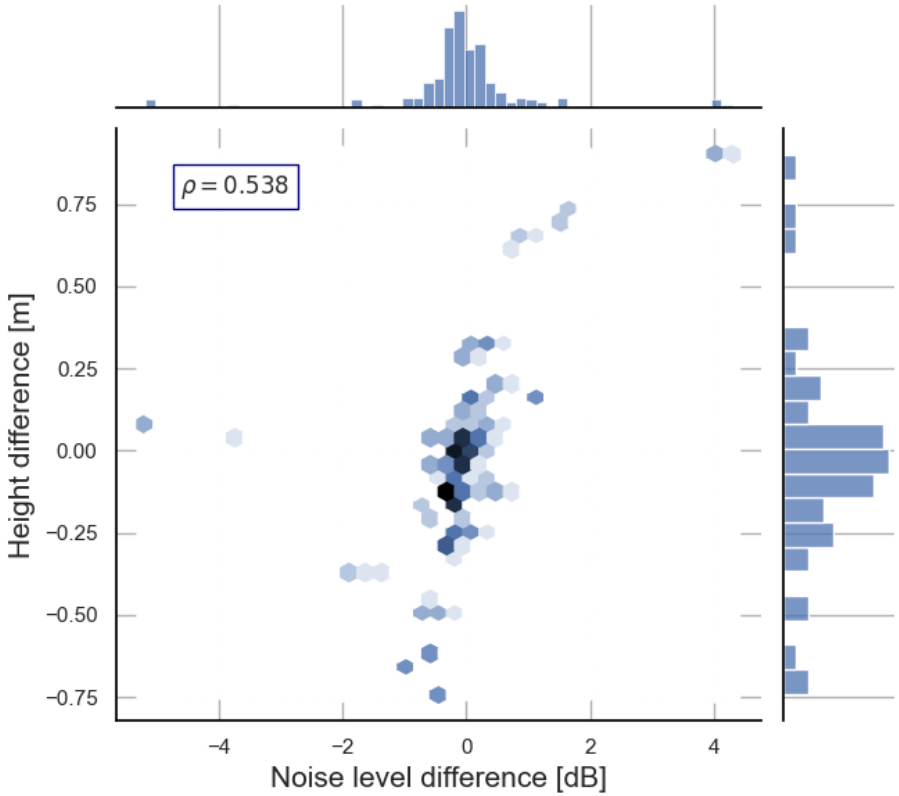
RMG

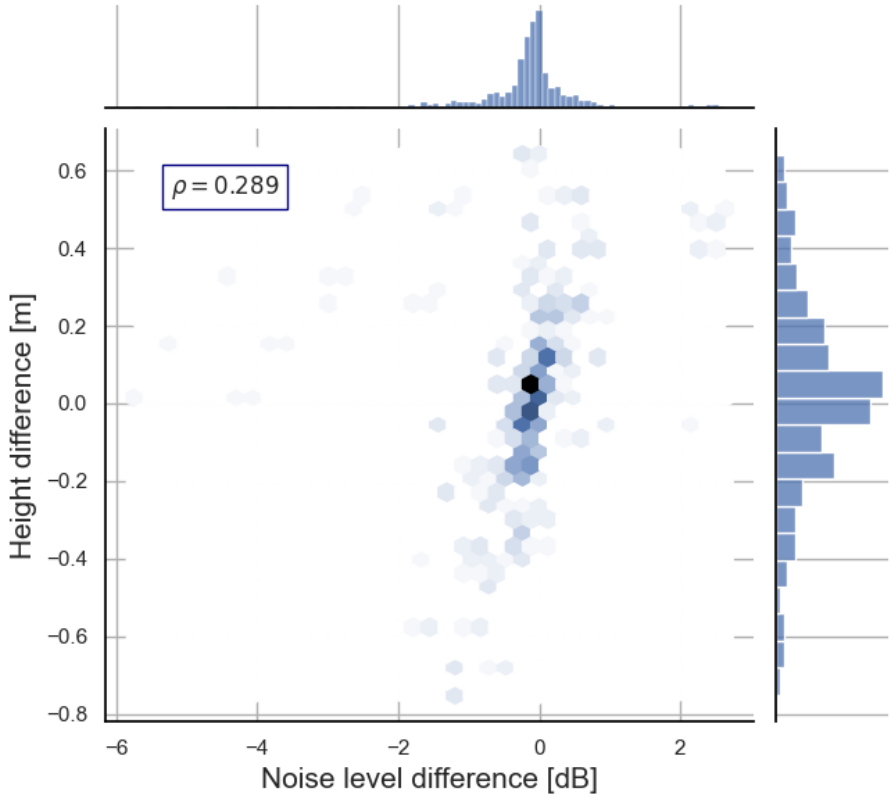


Noise calculations

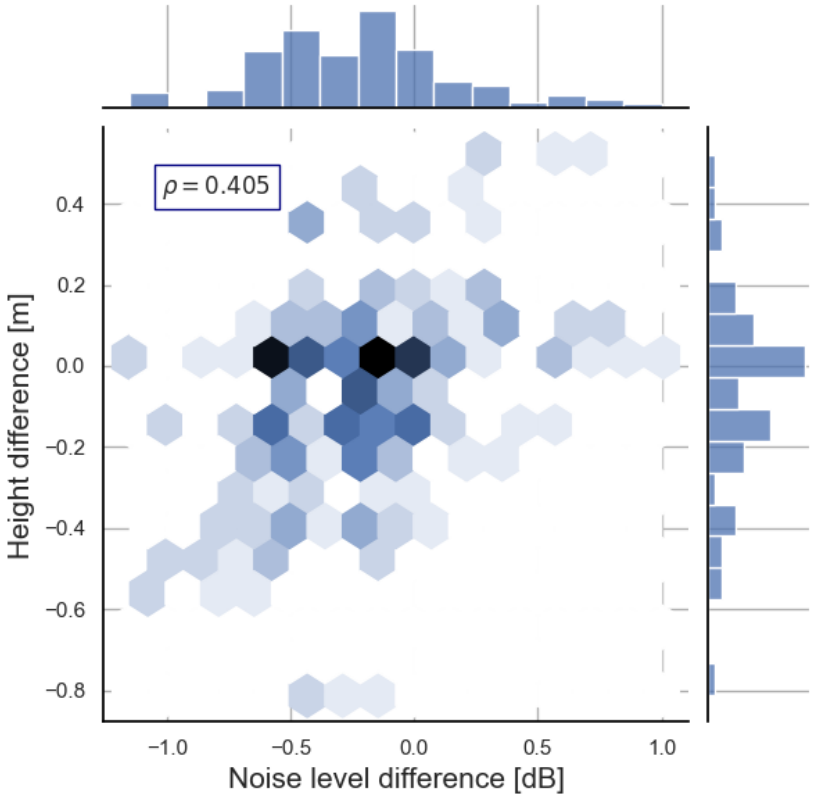


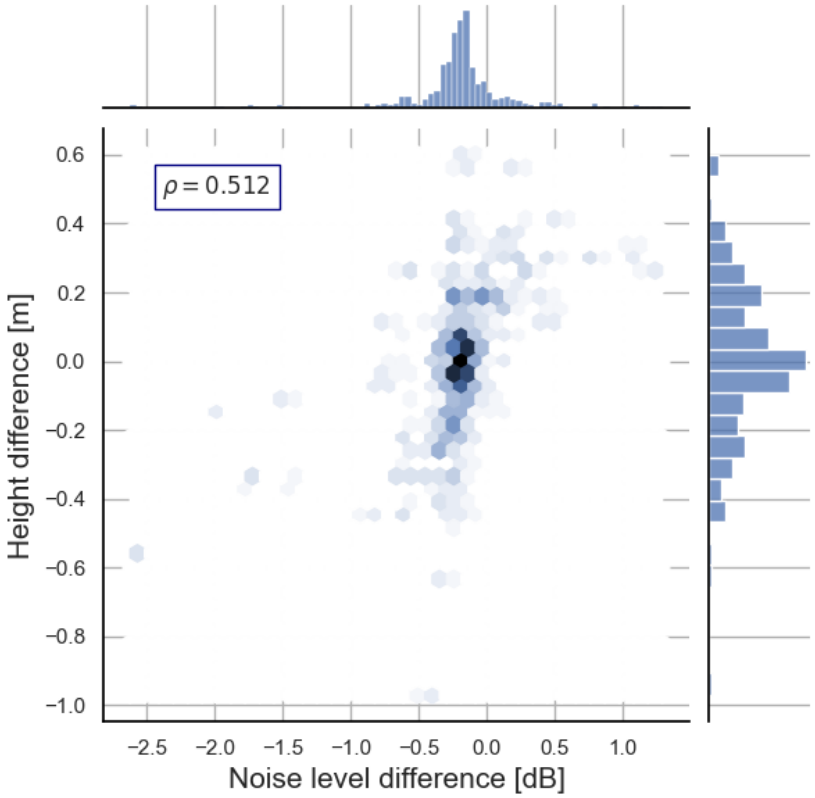
Scatterplot scene 1





Scatterplot scene 3





Scatterplot scene 3