Simplifying AHN Point Cloud Labelling Using BGT Map Data

By
Geethanjali Anjanappa (4th Year PhD Researcher)

Supervisors: Dr. Ir. S.J. Oude Elberink, Prof. Dr. Ir. M.G Vosselman

Faculty of Geo-Information Science and Earth Observation

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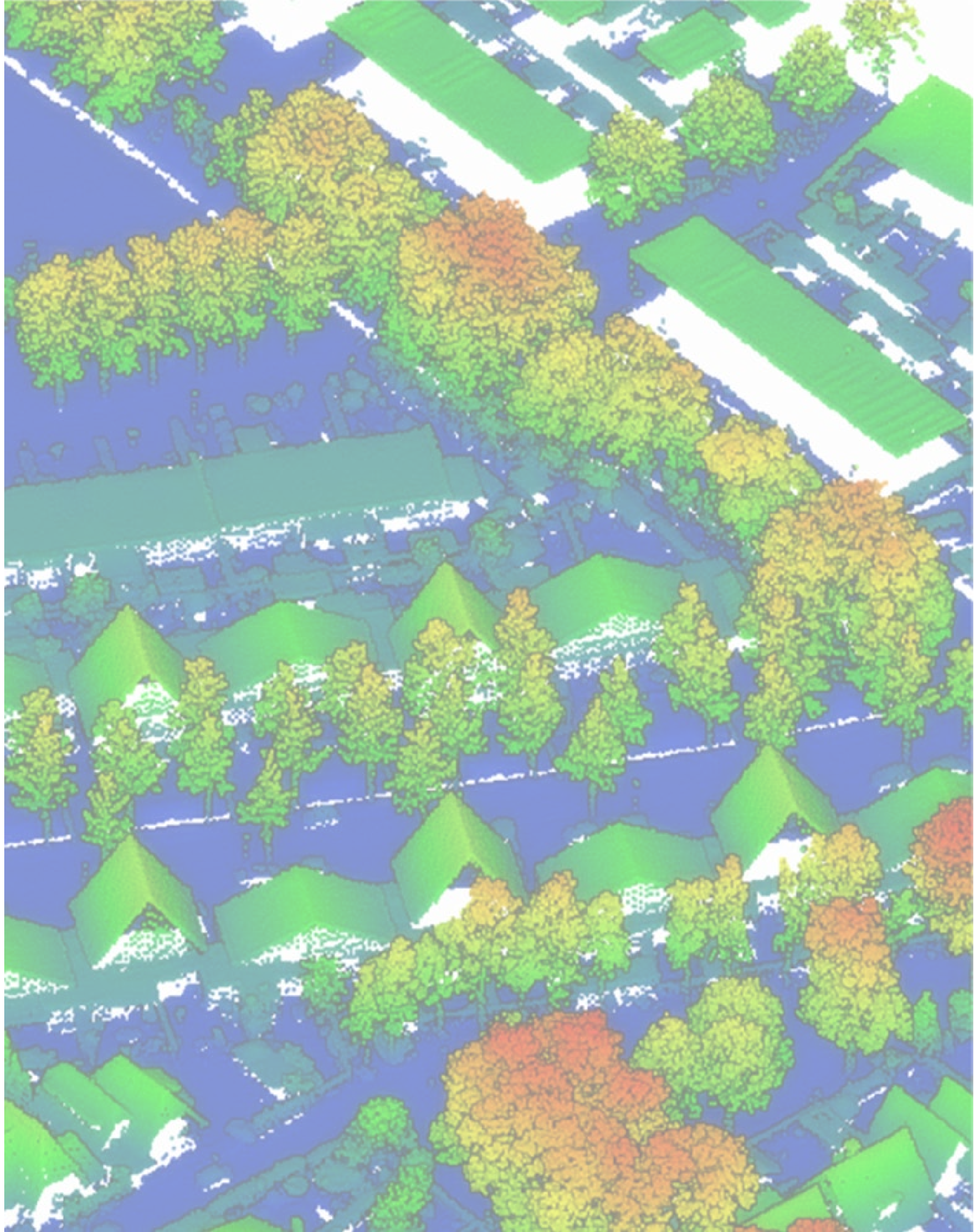


Actueel Hoogtebestand Nederland (AHN)

- Elevation data for the entire Netherlands
- **Products**: DTMs, DSMs, labeled point clouds.

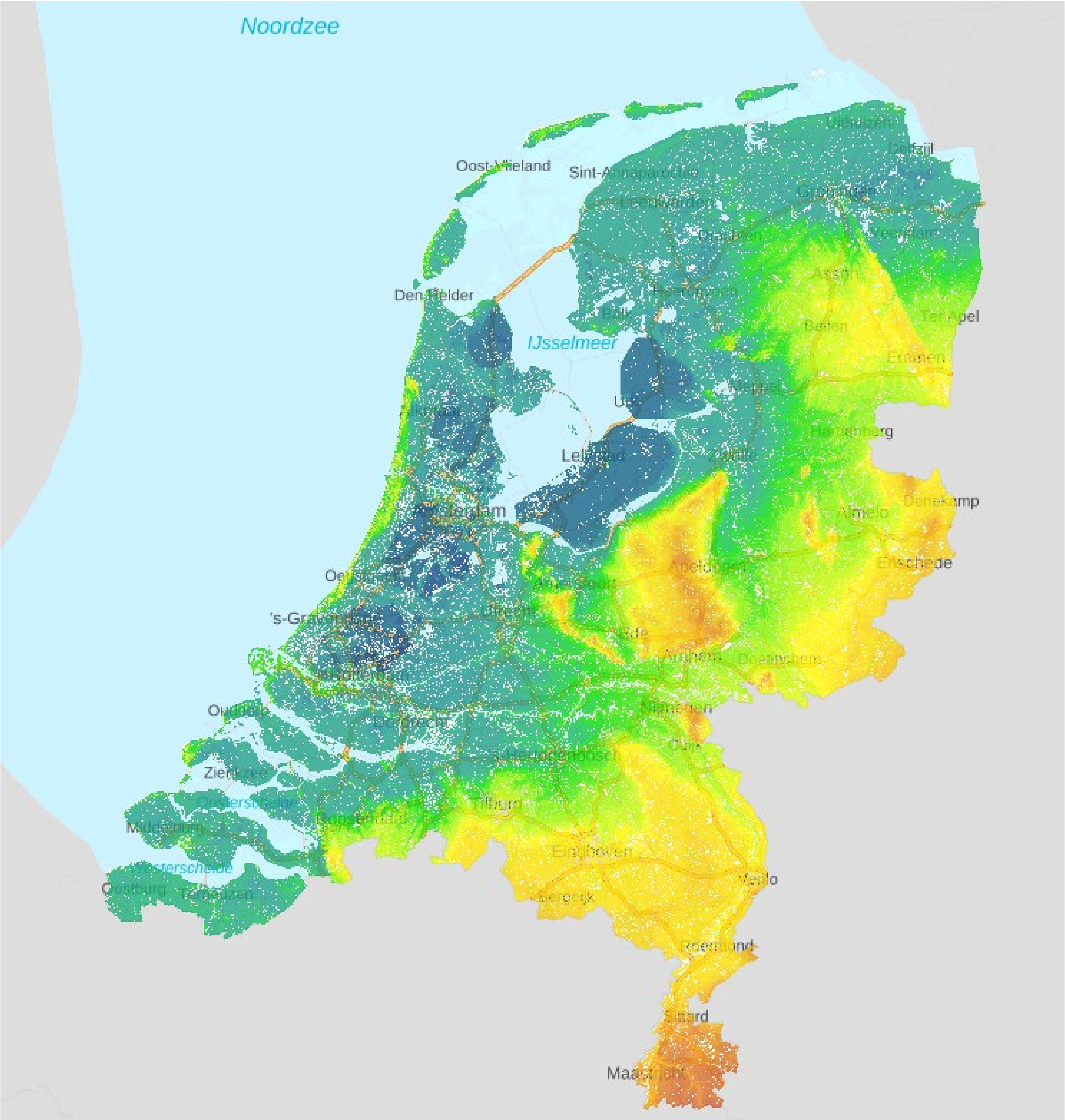


Image: AHN Viewer

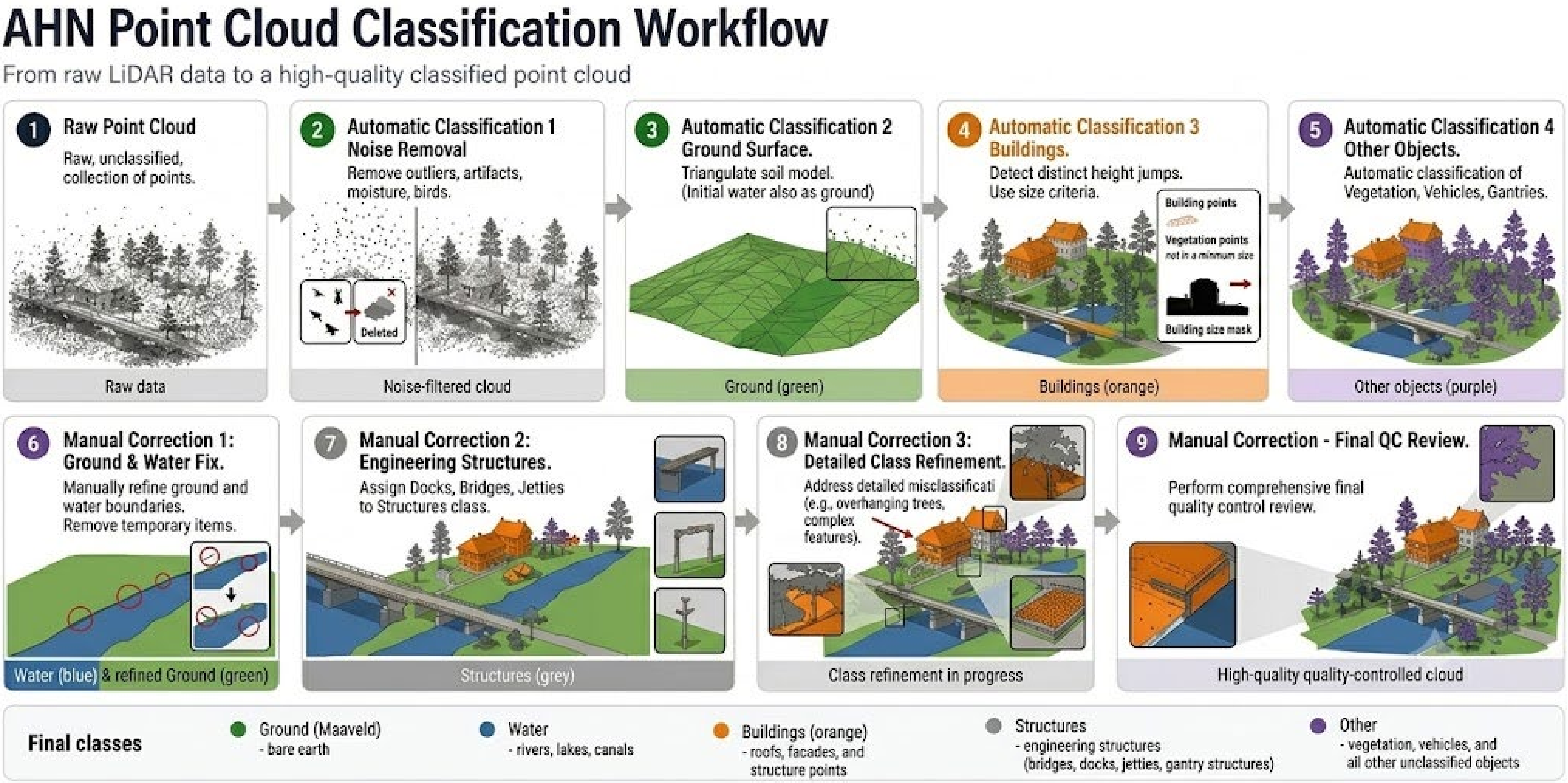


Image: ChatGPT & Gemini (can have errors)

Bottlenecks in current AHN Labeling Workflow

AHN Labels

Limited Semantic Classes

Class	Description
Overig	Other
Maaiveld	Ground
Gebouw	Building
Water	Water
Kunstwerken	Structures

Limitations

Overig: Catch-All Class

- Diverse objects grouped into "Overig" → Limited semantic details.

Manual Efforts:

- Water and structures require manual refinement
- Large-scale labelling and quality control requires significant effort and time.
- Prone to human bias in labelling.

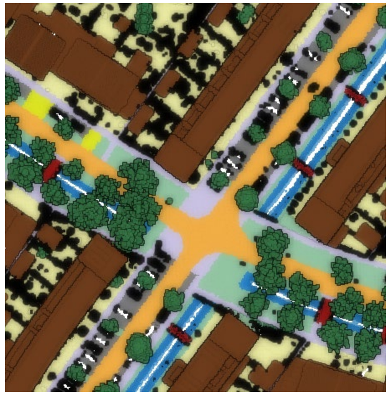
Overig class in purple

Deep Learning for AHN Labelling

Deep Learning for 3D Point Cloud Labelling

DL-based semantic segmentation can label 3D point clouds by automatically learning features.

Point Cloud



Semantic Segmentation

Why use AI for AHN?

- AHN covers the entire Netherlands and is regularly updated.
- AI can automate repetitive labeling tasks and improve consistency.

However, DL methods are highly **data-driven**.

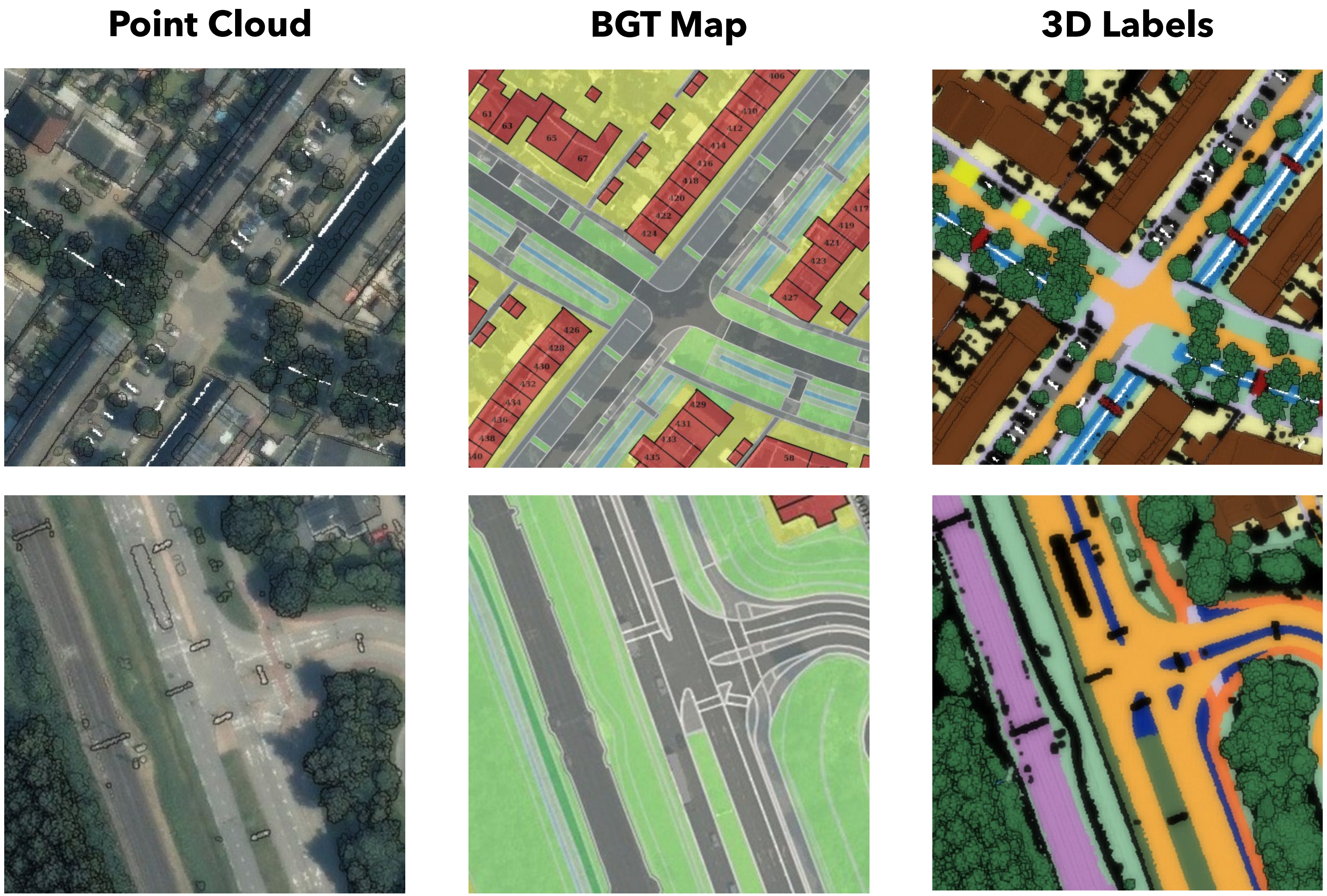
BGT as Training Labels

- Contains detailed objects and is well maintained.
- Available for the entire Netherlands.
- AI can learn semantic patterns from map-derived labels.

Example BGT map

Map2ImLas

- Large-scaled labeled dataset using BGT maps and AHN labels.
- Data from five regions of the Netherlands → 217Km^2
- Covering urban, suburban, rural and forested scenes.



Anjanappa, G., Oude Elberink, S., Maiti, A., Lin, Y., & Vosselman, G. (2025). Map2ImLas: Large-scale 2D-3D airborne dataset with map-based annotations. ISPRS Open Journal of Photogrammetry and Remote Sensing, 100112. https://doi.org/10.1016/j.ophoto.2025.100112

Semantic Segmentation for AHN

AHN point cloud in → Semantic labels out

Inputs

Point Cloud

Map-derived Labels

DL Network
KPFCNN (Thomas et al. 2019)

Labeled AHN Data

Classes

- Water
- Pervious Ground
- Tree
- Impervious Ground
- Railroad
- Building
- Bridge

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Quantitative Results

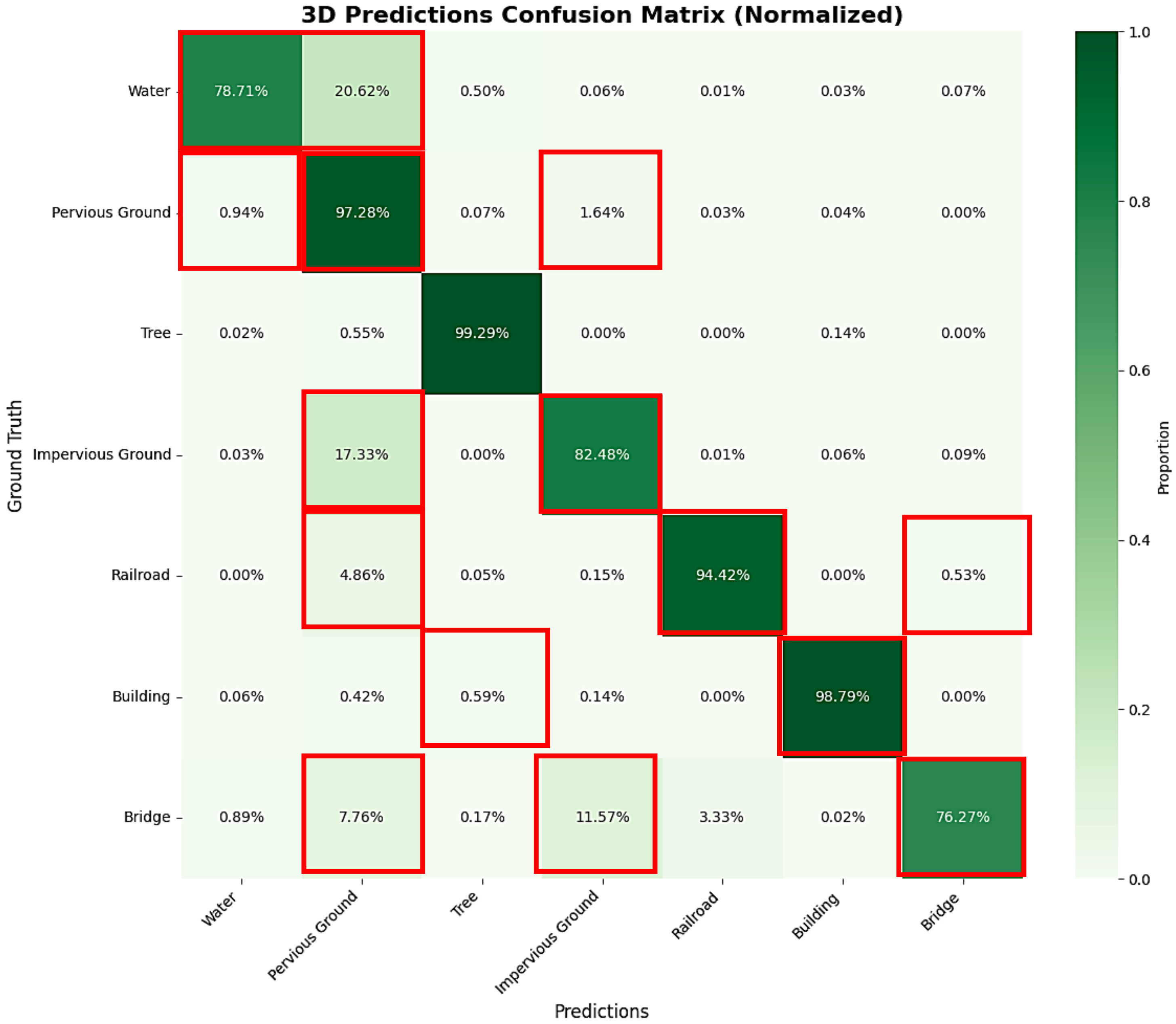
mIoU: 83.3% **Accuracy: 96.2%**

Class	3D	Class	3D	Class	3D
Water	67.5	Impervious Ground	72.4	Building	98.1
Pervious Ground	94.2	Railroad	88.3	Bridge	63.8
Tree	98.8				

Confusion Matrix

- What percentage of each class is misclassified where

Highest misclassification is between water and pervious ground.



Results - Enschede

Point Cloud | Map-derived GT | 3D Predictions

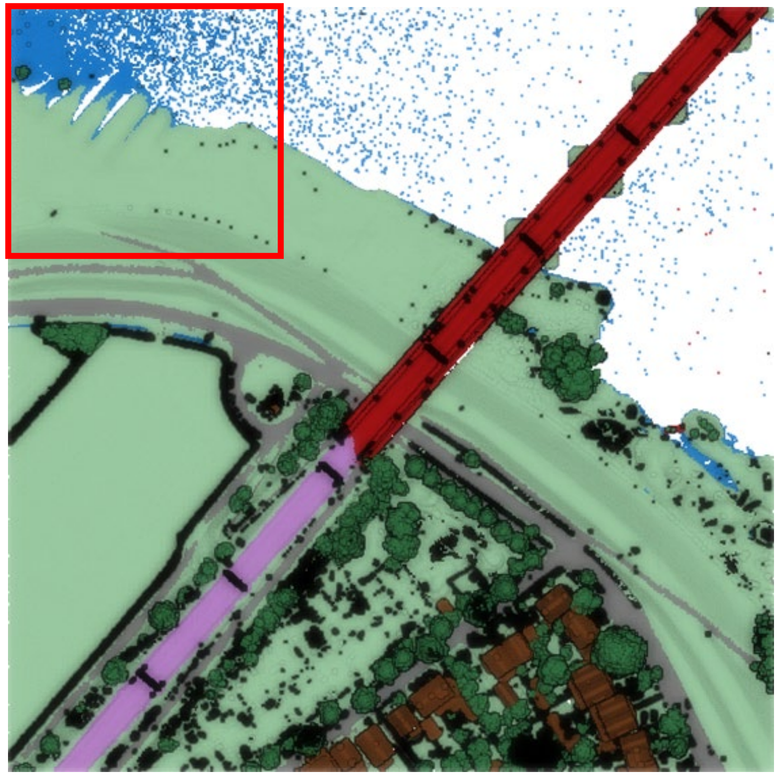
Water | Pervious Ground | Tree | Impervious Ground | Railroad | Building | Bridge

Results - Deventer

Confusion between water and pervious ground.

Point Cloud

Map-derived GT

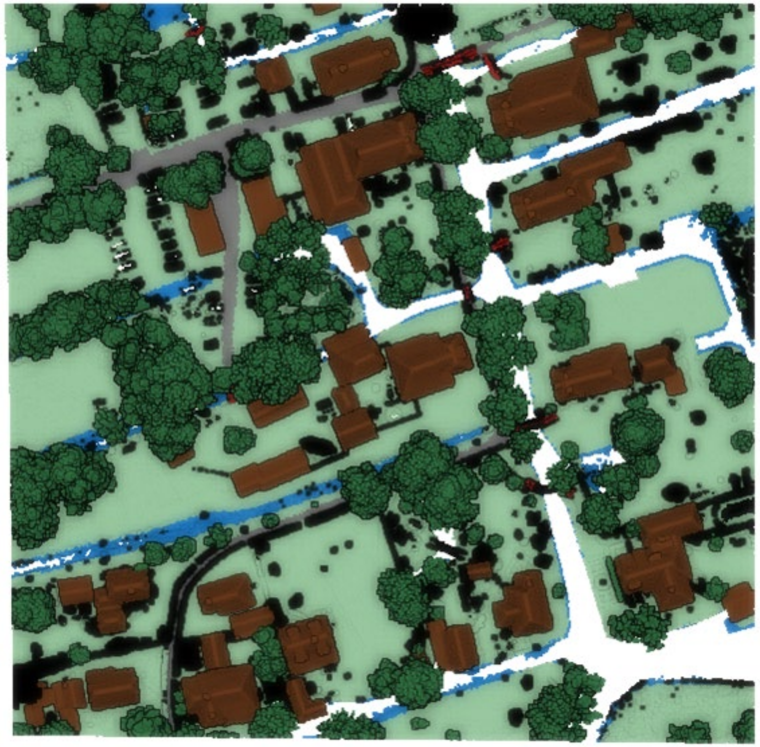


3D Predictions

Water | Pervious Ground | Tree | Impervious Ground | Railroad | Building | Bridge

Results - Giethoorn

Point Cloud



Map-derived GT

3D Predictions

Water | Pervious Ground | Tree | Impervious Ground | Railroad | Building | Bridge

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Key Findings

- Map2ImLas: 217 km² data labeled from BGT in ~4 hours
- AHN tiles ~22Km^2 labeled using AI → ~2hrs
- **mIoU**: 83.3%
- Can further be applied to label more semantic classes.

Benefits:

1. Detailed semantic labels
2. Less manual effort
3. Consistent nationwide labelling
4. Better support for urban planning and asset management

Limitations of AI-Based AHN Labelling

Limitations

AI performance depends on the quality of BGT-derived labels.

Point Cloud

Map-derived GT

3D Predictions

!Wrong Performance Measure due to wrong ground truth!: Even though AI labels correctly

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Limitations

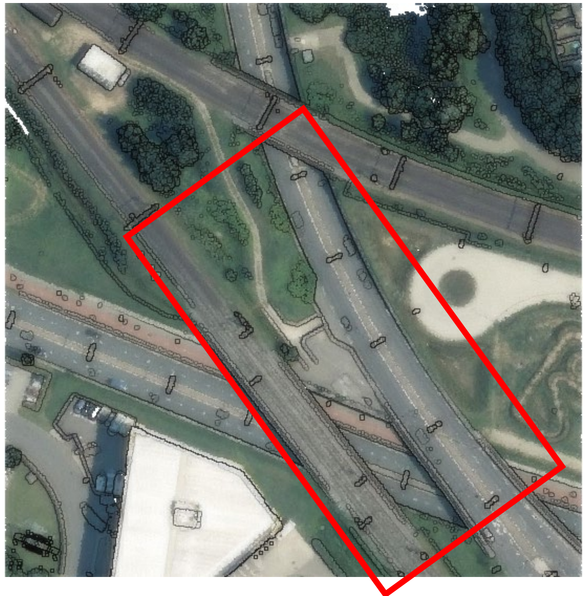
AI performance depends on the quality of BGT-derived labels.

!Wrong Labels!: Impervious ground labeled as pervious ground (erf in BGT)

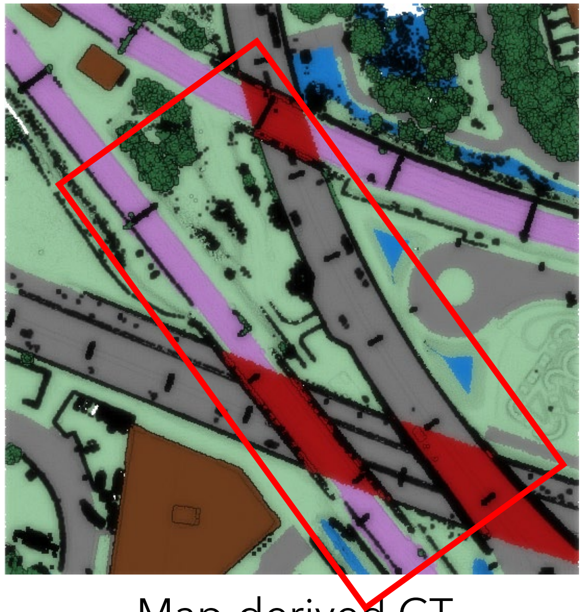
!Wrong Performance Measure due to wrong ground truth!: Even though AI labels correctly

Limitations

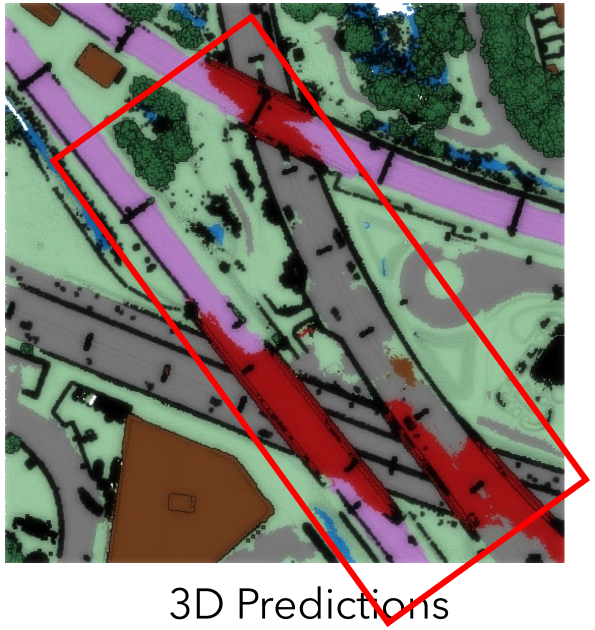
AI can struggle in complex environments with unusual structures.



Point Cloud



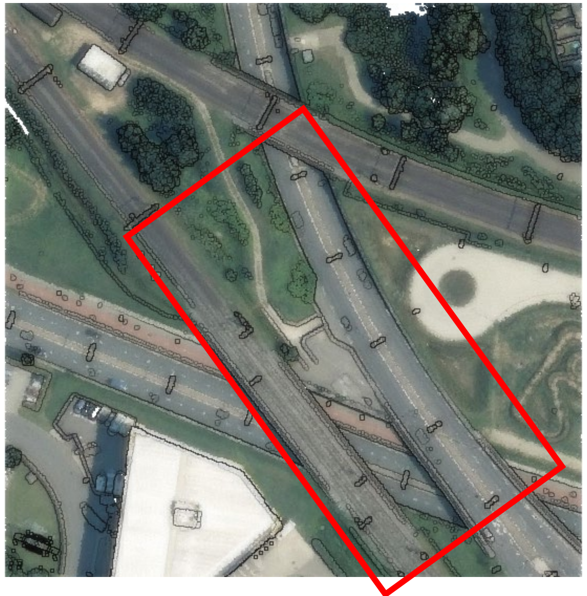
Map-derived GT



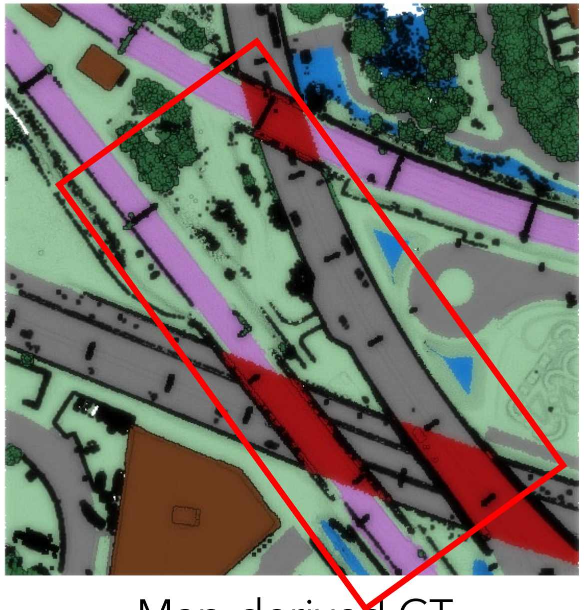
3D Predictions

Limitations

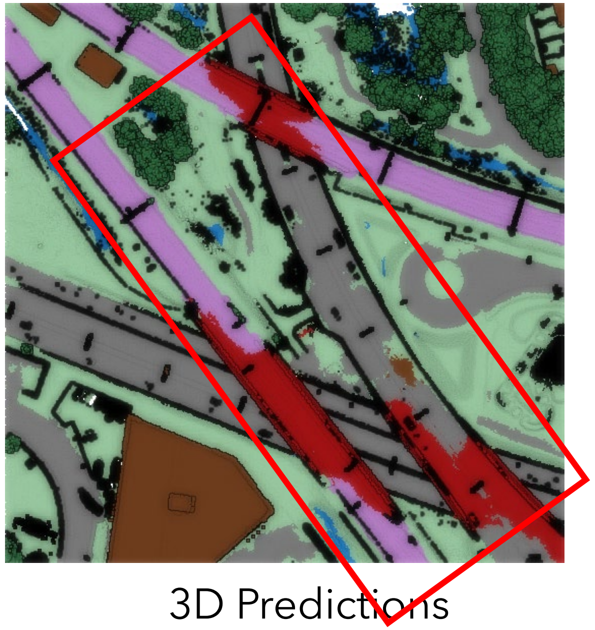
Precise object boundary delineation in 3D point clouds is difficult.



Point Cloud



Map-derived GT



3D Predictions

Other Limitations

- Small objects like jetties, are difficult to identify using AI.
- Human quality control is still required for quality assurance.

AI reduces manual effort and improves speed but does not completely remove the need for expert review.

Conclusion

- Current AHN Workflow → Few Broad Classes + Manual Refinement
- **Proposed workflow:** BGT + Deep Learning
    - Can labels more semantic classes
    - Reduced manual effort
    - Scalable nationwide processing

Learning From Maps To Create New Ones

This project aims to detect changes in BGT maps by automatically interpreting newly acquired airborne data with semantic guidance from existing maps.

MEET THE TEAM

G. ANJANAPPA
PhD Candidate

PROF.DR.IR. M.G. VOSSELMAN
Promotor

DR.IR. S.J. OUDE ELBERINK
Co-promotor

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FACULTY OF GEO-INFORMATION & EARTH OBSERVATION

Thank You!