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Building detection from Lidar data using 3D-UNet

27.2.2024

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Outlines

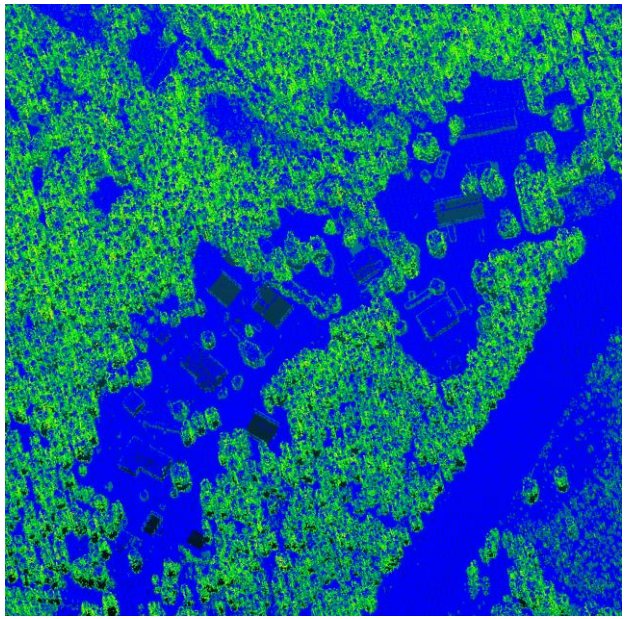
- Data
- Data processing
- 3D-UNet
- Training
- Results
- Challenges

Data

- .Laz point clouds, 5p/m^2 , around 10-20 million points/file
- Contains both urban and rural areas from
  - Helsinki
  - Akaa
  - Lappeenranta
  - Outokumpu
- 83550 training crops, 21000 validation crops

Data processing

- Point clouds are cropped into 100m x 100m areas
- Voxelize the cropped areas into 256x256x32 voxels
  - Before voxelizing, the minimum height difference should be >15m, if not, add a point with minimum height + 15m
  - X, Y, Z, intensity, number of returns (averaged from points within each voxel)



Voxelization

- Turns the point cloud into a regular grid in three-dimensional space

+ Reduces the number of points

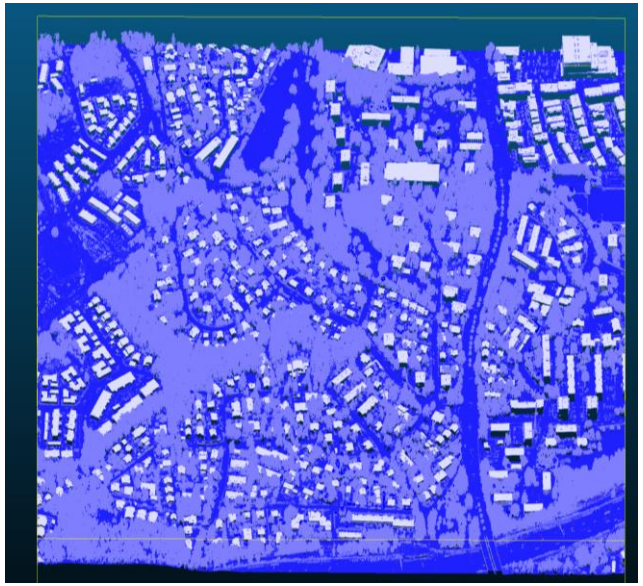
+ Data is uniform

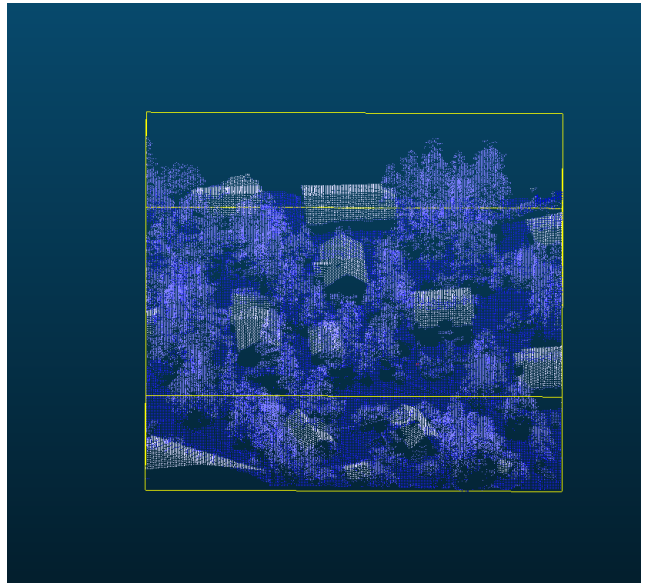
+ Relatively fast process

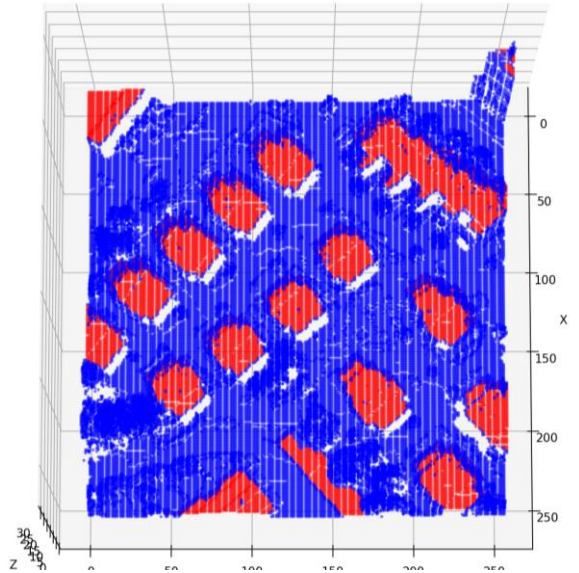
- Lose some information

Data processing

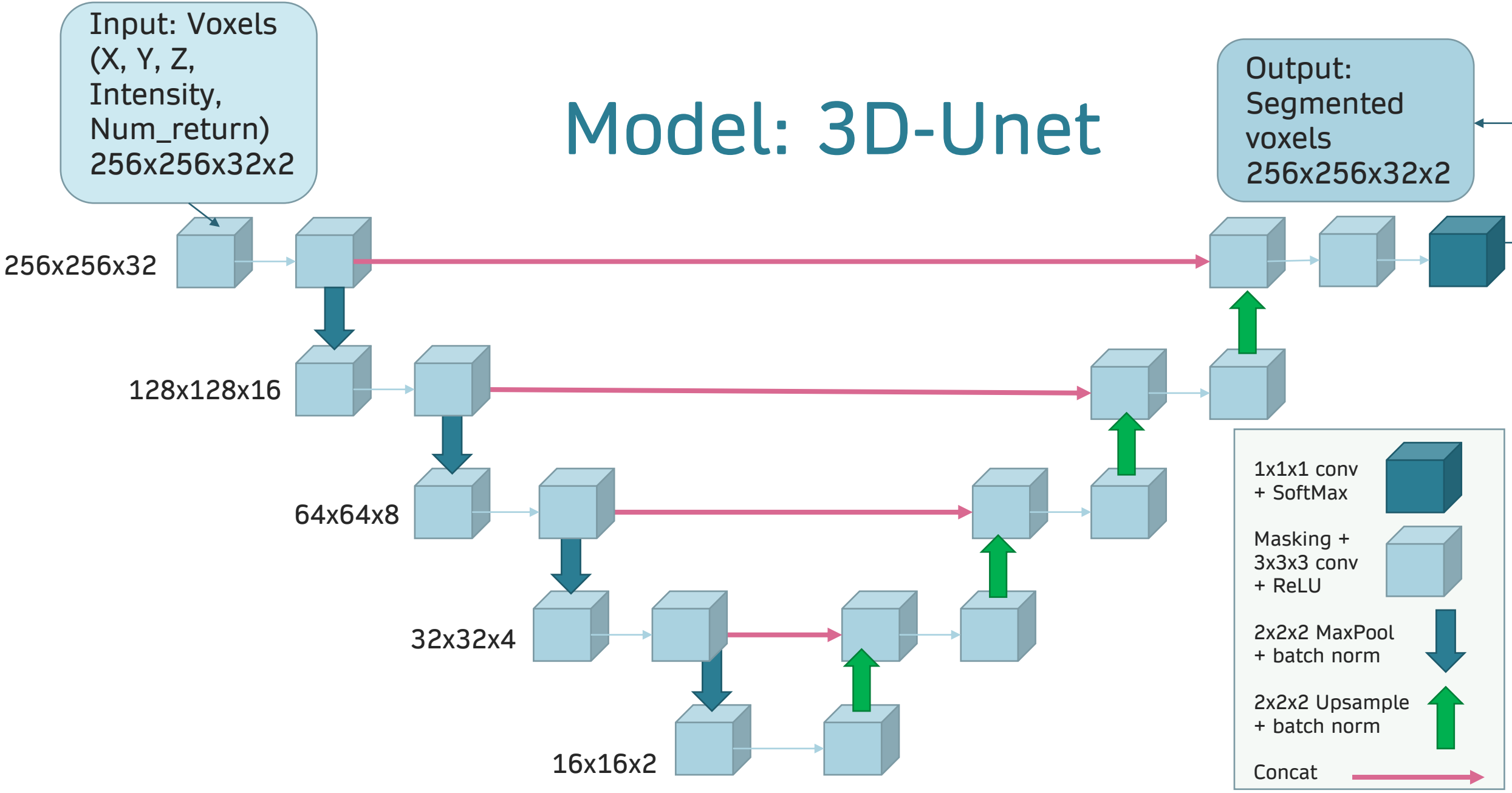
Point cloud → cropping → 100m x 100m point cloud → voxelizing → 256x256x32 voxels







Model: 3D-Unet



Training

Puhti was used for training

Tensorflow

Adam optimizer
    learning rate 1e-4
    Dice-loss

Batch size: 4

Metric: F1-score

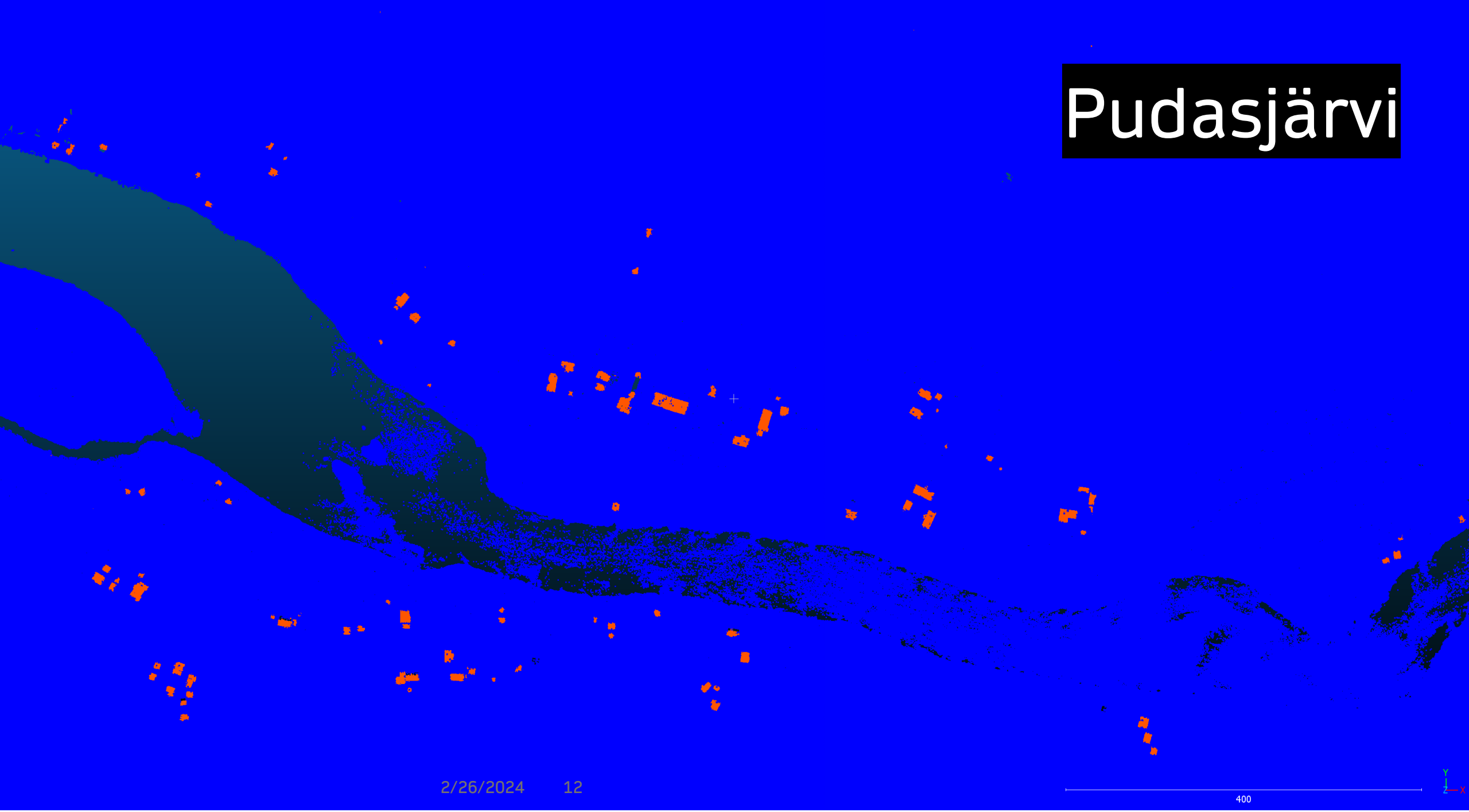
Results

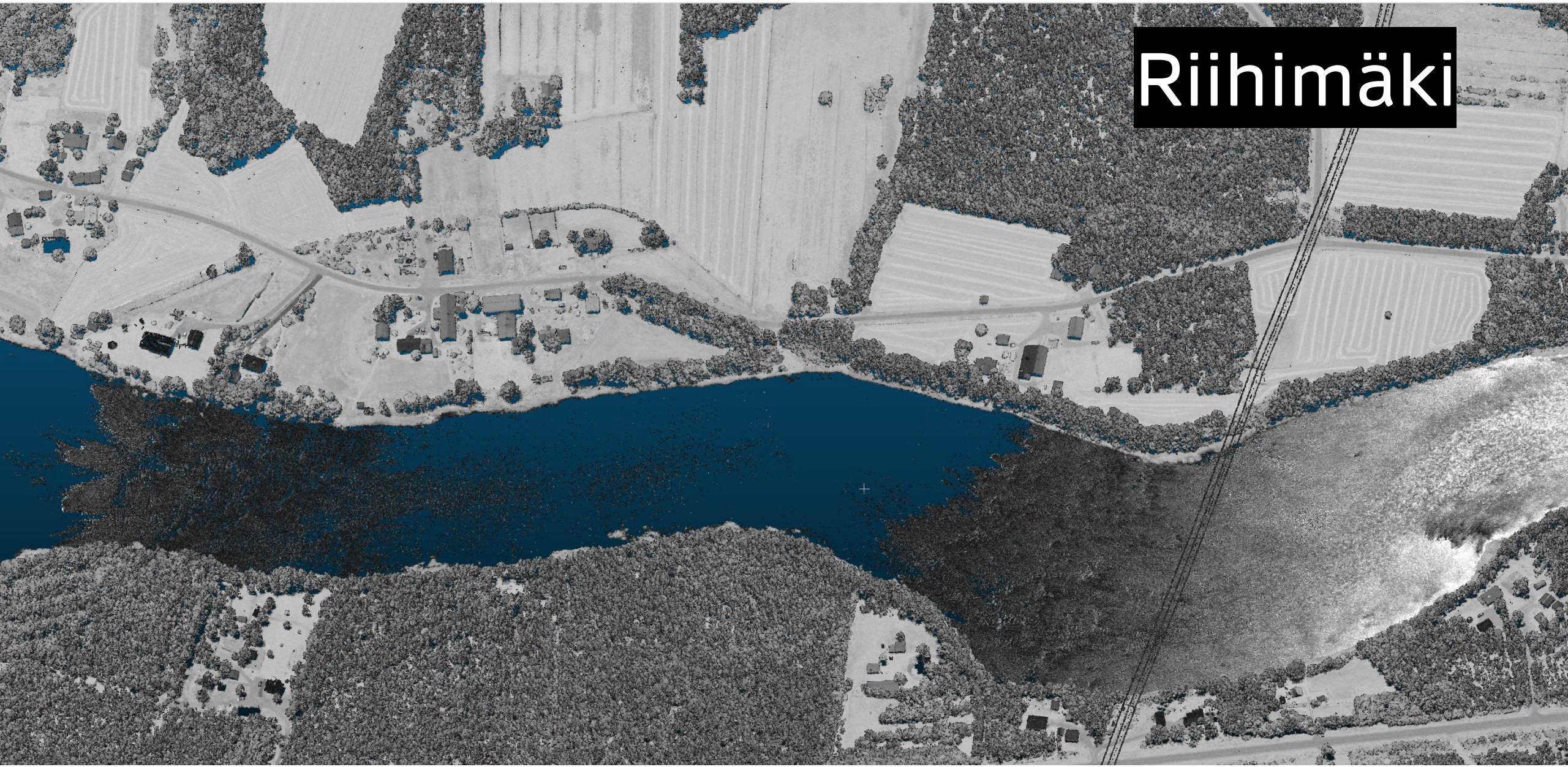
The model was trained for 20 epochs

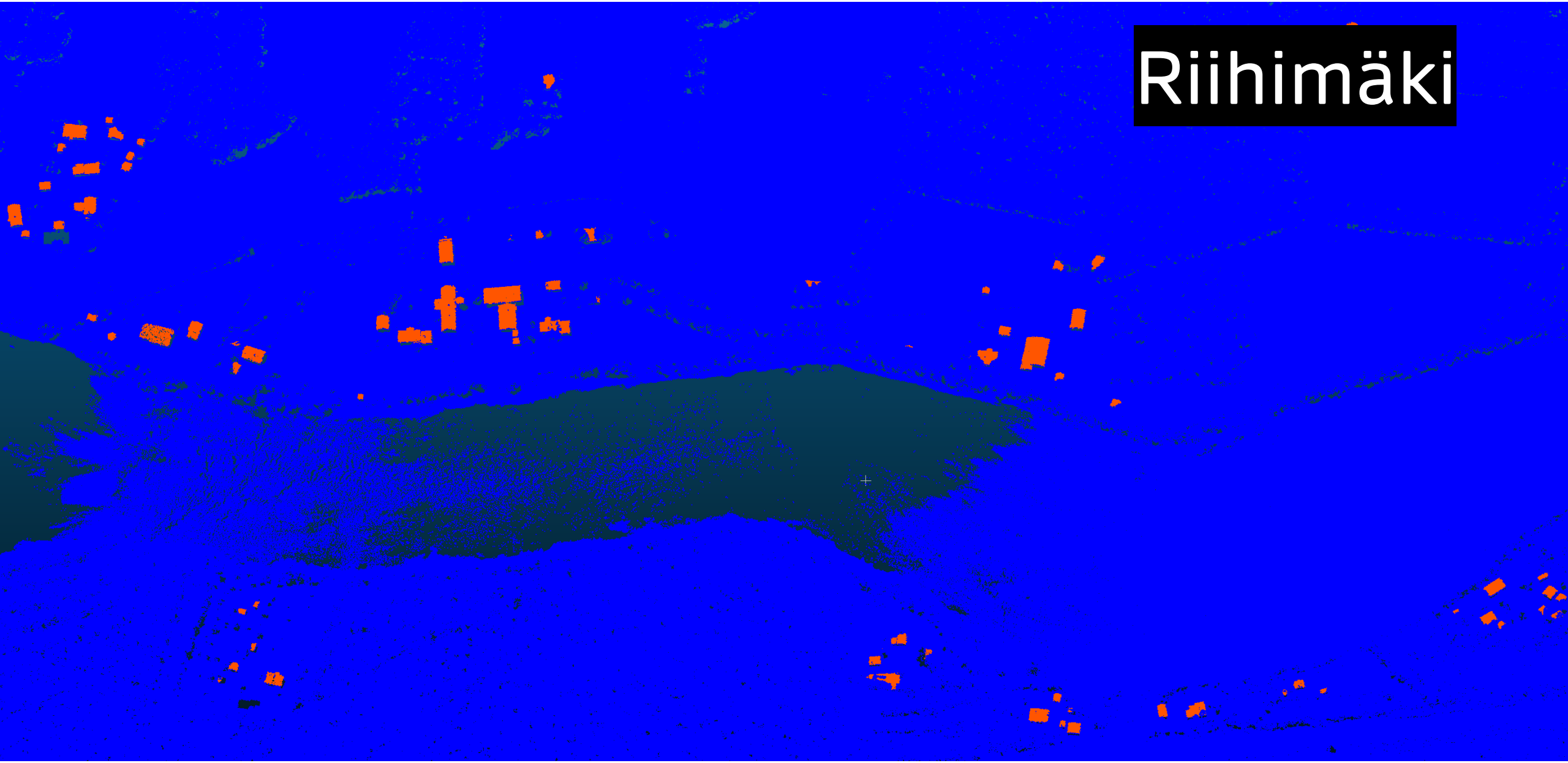
It achieved .96 validation F1-score

Additionally, tested the model on point clouds from different areas

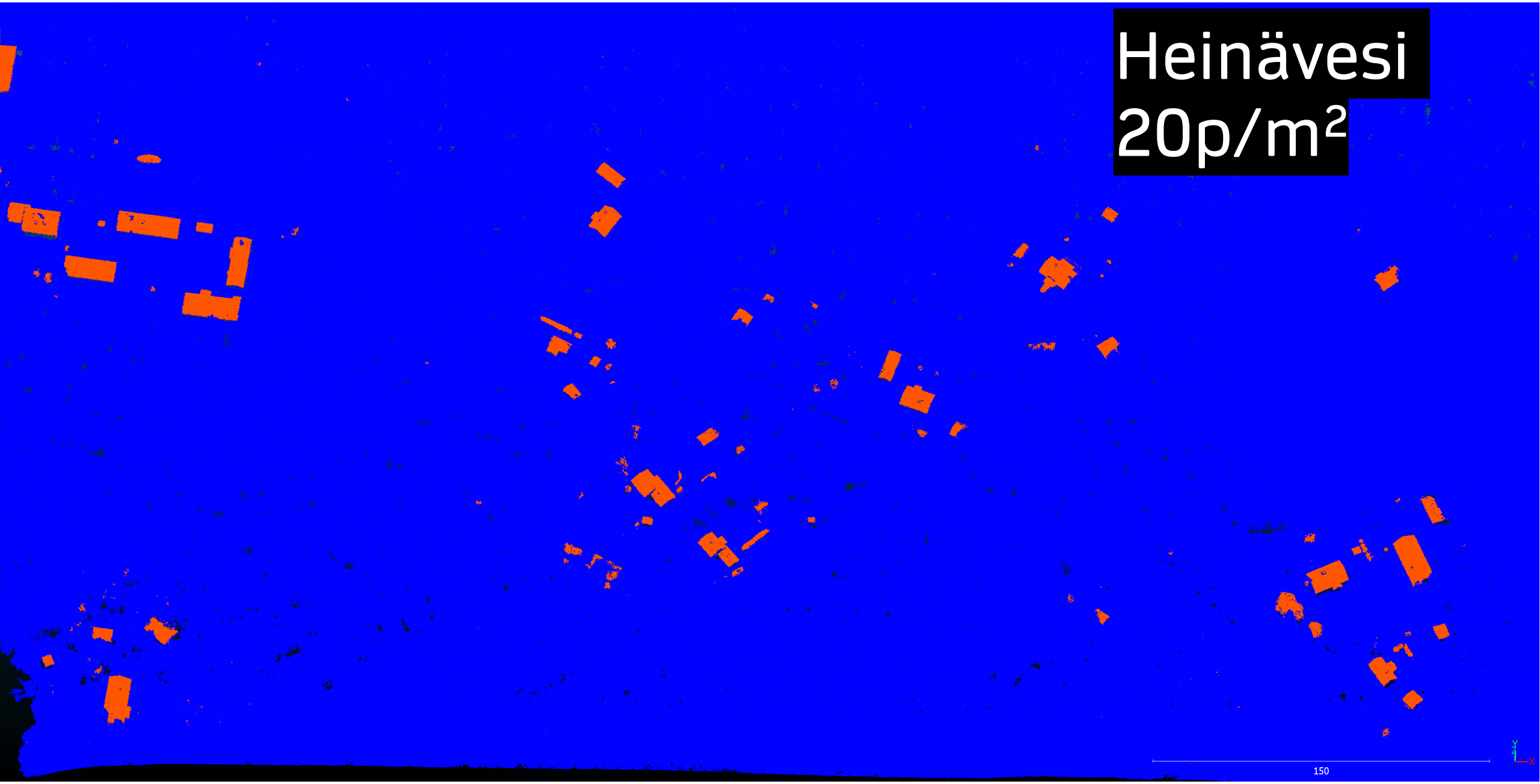

Pudasjärvi
400

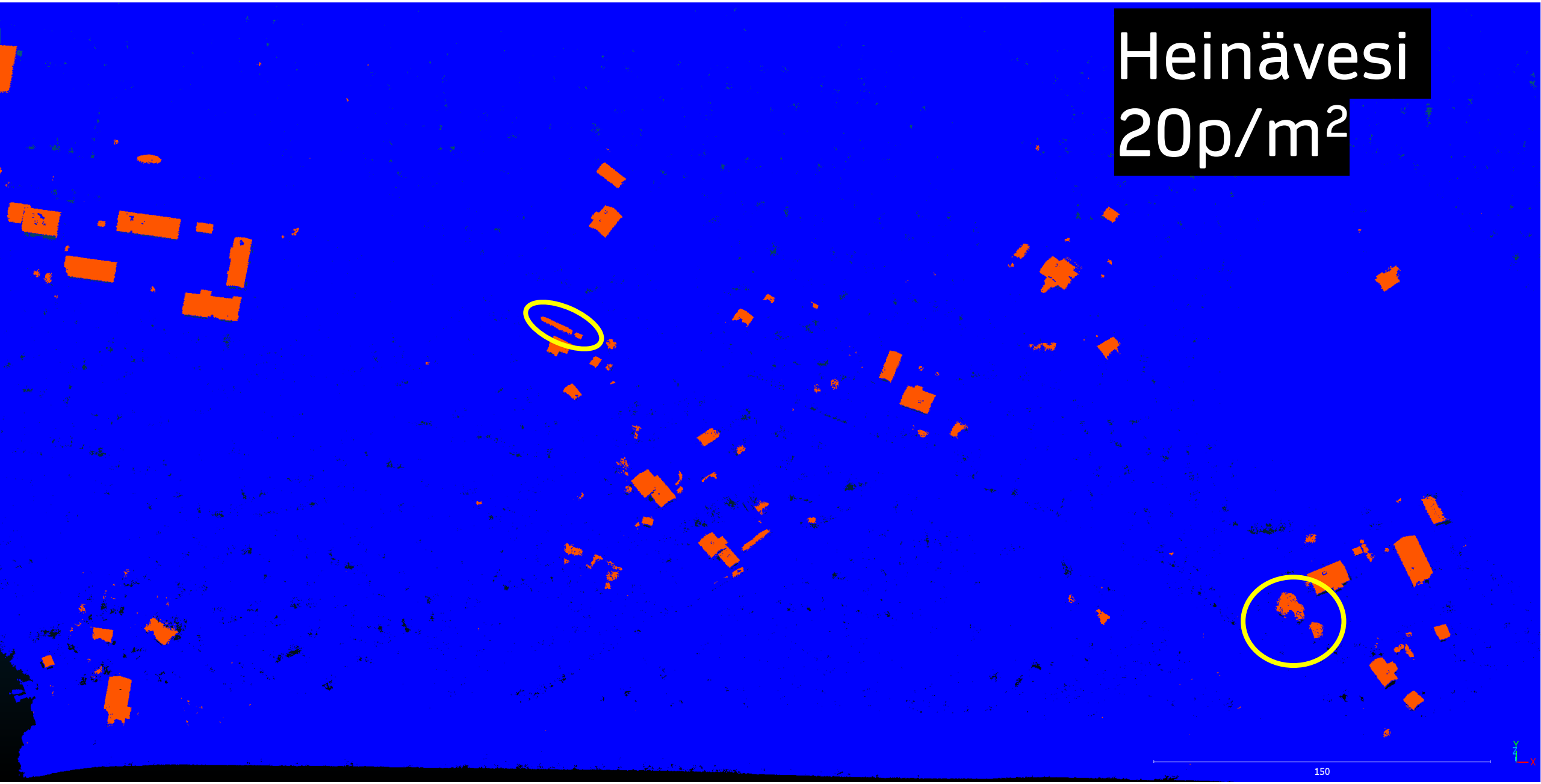

Pudasjärvi
400


Riihimäki


Riihimäki


Heinävesi
20p/m²
150

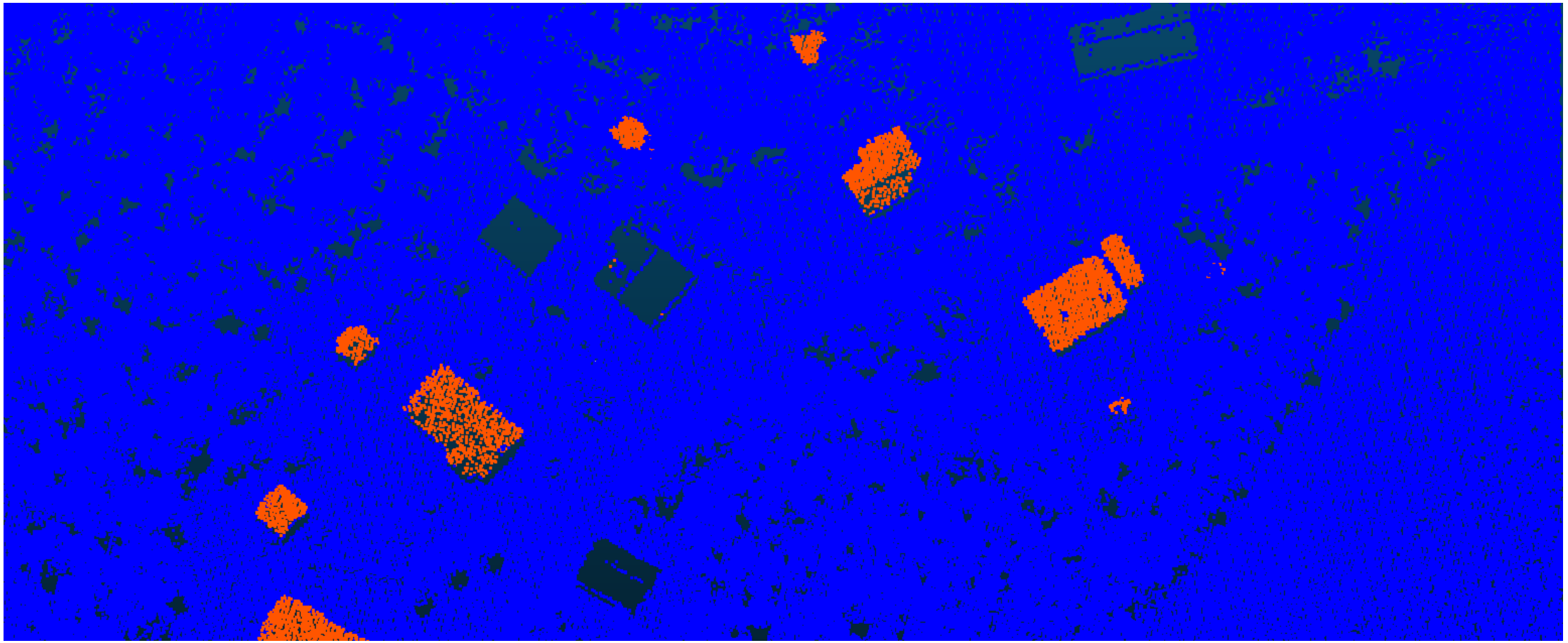

Heinävesi
20p/m²
150


Heinävesi
20p/m²
150

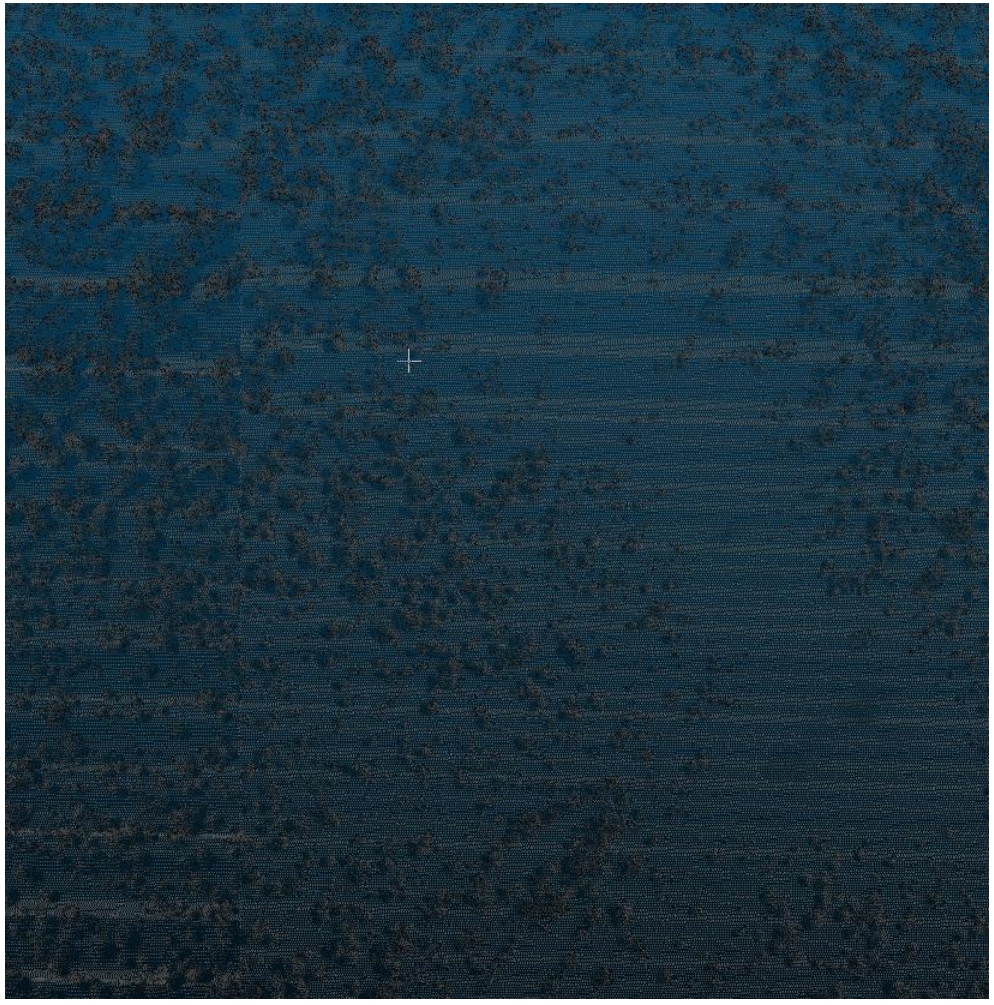
Challenges

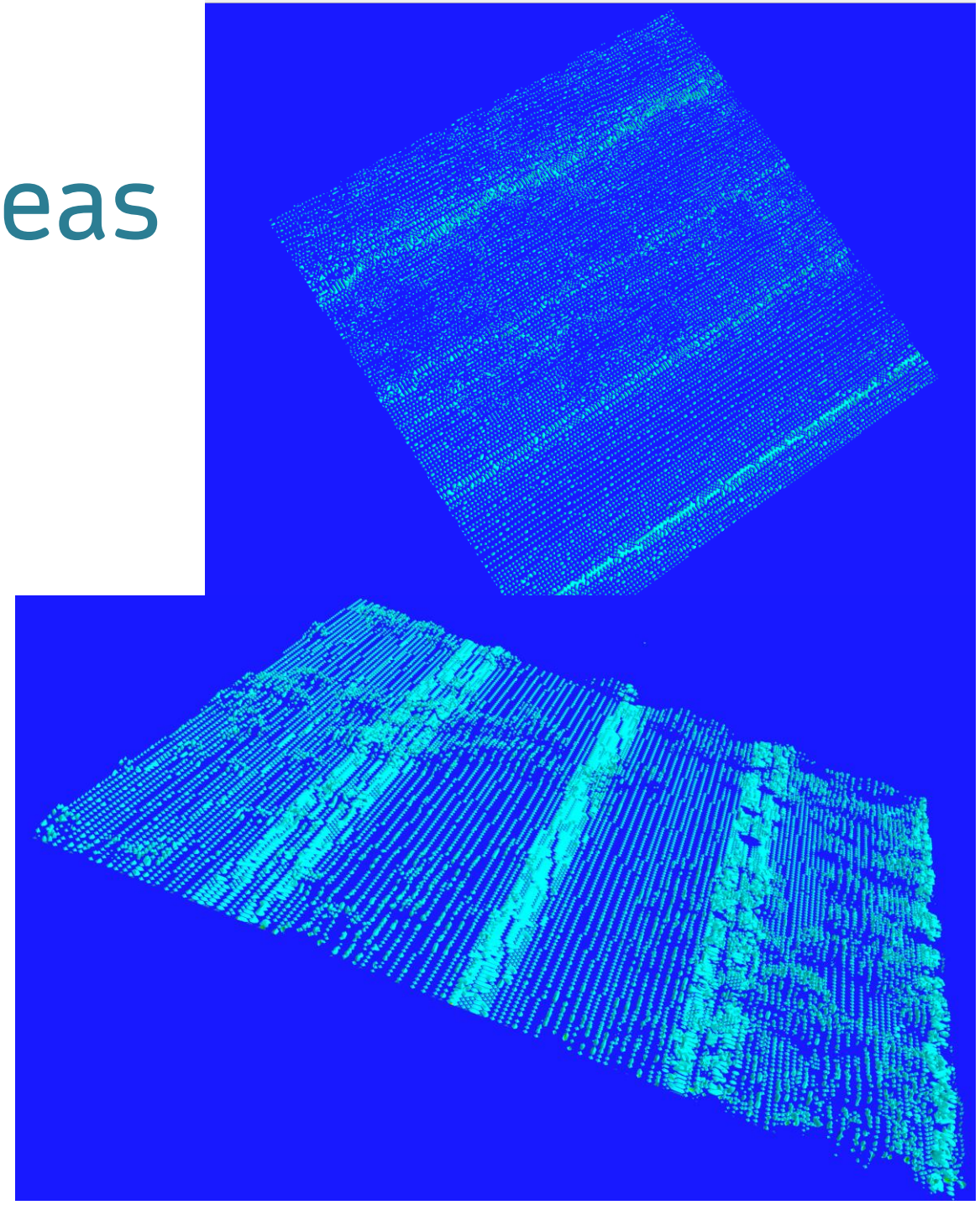
- Large number of points
- Problems with aerial LiDAR data
  - Dense & sparse areas
  - Missing points
  - Different Lidar scanners
    - scanning patterns
    - intensity values

Missing points



Dense and sparse areas





Conclusion

- The 3D-UNet was trained for building detection from voxelized point clouds and achieved .96 validation F1-score
- Data preprocessing included cropping the point cloud into 100m^2 areas and voxelizing the crops into 256x256x32 voxels, which allowed the use of 3D convolutions and reduced the number of points
- The challenges included the large number of points, dense and sparse areas, missing points in data, different LiDAR scanners, and the training time and memory requirements

Advancing together