NLS
NATIONAL
LAND SURVEY
OF FINLAND

Artificial Intelligence at National Land Survey of Finland

Improving Topographic Data Production using AI/ML methods

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AI Strategy at National Land Survey of Finland

Use of AI and ML methods in foundation data maintenance will be a key success factor in:

1. **Ensuring** up-to-date, high quality and timely delivered topographic data and maps, for the benefit of the society.
2. **Improving productivity** of our operations.
3. **More meaningful work** for our employees; *from* browsing the imagery for changed objects manually -> *to* training the models and ensuring high quality output.

Looking into use of AI also in other contexts.

Why is NLS FI Developing AI/ML?

- Currently topographic data is being updated using stereo models of aerial images with ~130 human operators --- **labour intensive work**
- **A huge amount of data** needs to be processed annually
  - The ongoing aerial imagery program started in 2020 --- aerial images yearly covering **one third** of Finland in 30-50cm resolution. One of the use cases is topographic map updating.
  - The new national lidar program also started in 2020 --- new Lidar data yearly covering **one sixth** of Finland to provide 5pts/m2 density for point cloud data.
  - Next round of the national aerial imagery and lidar program from 2026-> is estimated to reach 10cm resolution for aerial imagery and 20pts/m2 density for lidar.

AI/ML Initiatives at NLS FI

1st phase: ATMU project to develop methodology and PoC

- A two-year project (2021-2022), funded by the Ministry of Finance, with a funding of 400 000 €.
- Train AI (Deep learning technology) to make National topographic map updating process more productive.
- Focusing on buildings, roads, and hydrographic features updating.
- Results are very promising!

2nd phase: Refining the developed methods

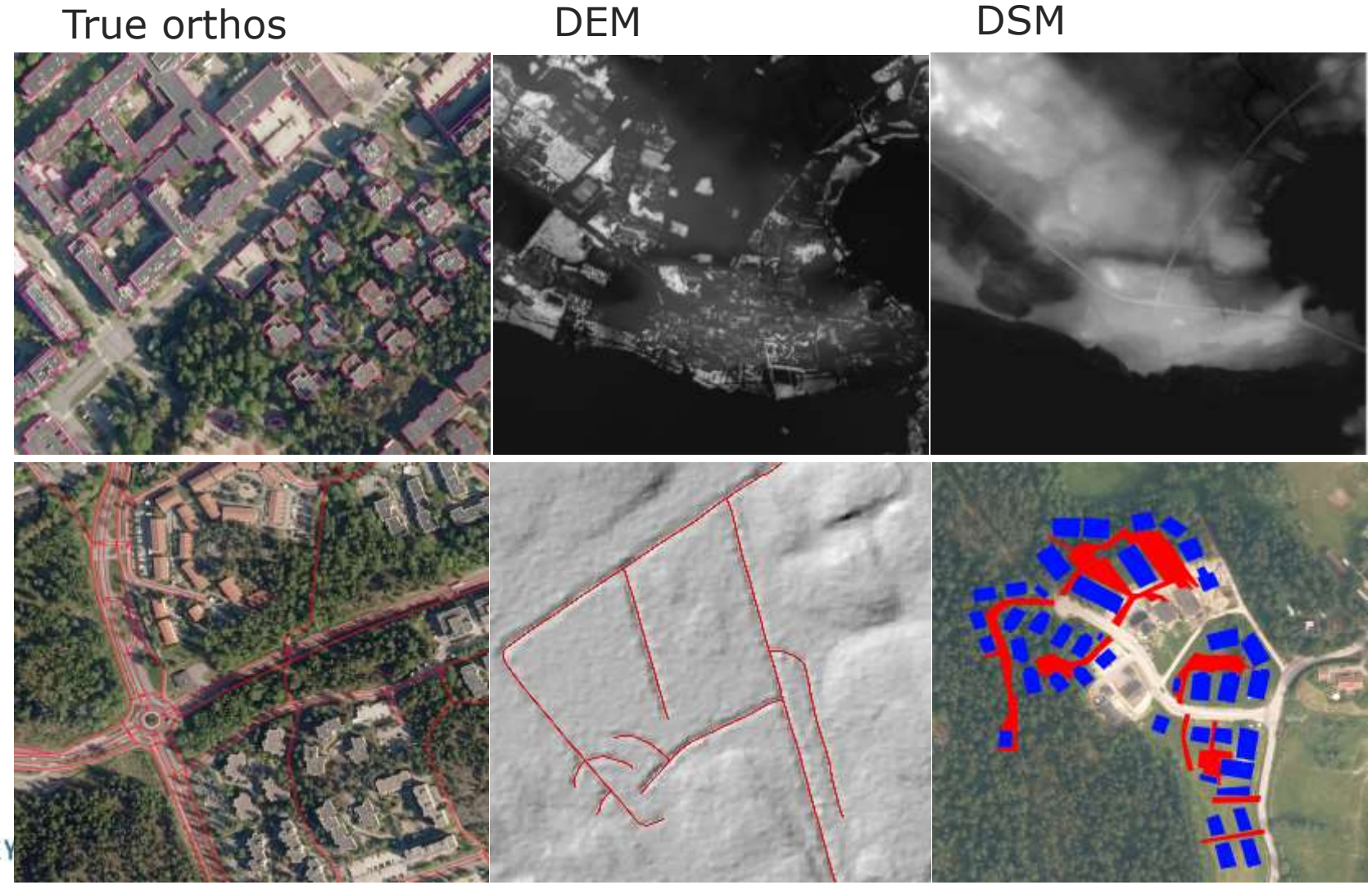
- One year project (2023), co-funded by Ministry of Agriculture and Forestry and NLS FI.
- Improving the positional accuracy of the TDB building vectors.
- Moving topographic database building footprints to match with the building polygons created in the first phase.
- Further development of watercourse detection using the AI method.

1st Phase: ATMU Project

Exploiting deep learning methods for **object detection** and **change recognition**

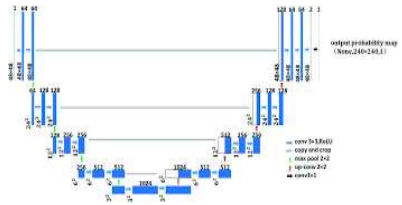
Building detection and change recognition	Road detection and change recognition	Watercourse detection
		
Convolutional neural network	Convolutional neural network Multitask learning	Convolutional neural network

Source data and Training datasets



Methods used in the process

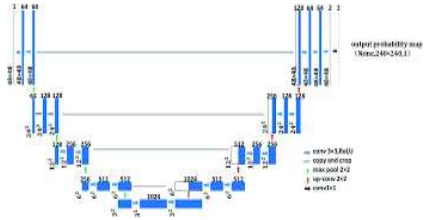
UNet



RoadVecNet

Multitask learning

UNet



Neural Network

Changer

NestNet2

Finland looks mostly like this…

Building Detection

Results from the **ATMU UNet model** for building detection

Before postprocessing

Post processed result and vectorization

Buildings from Laajasalo, Helsinki, for evaluation

NATION

Expert Evaluation on Laajasalo test area

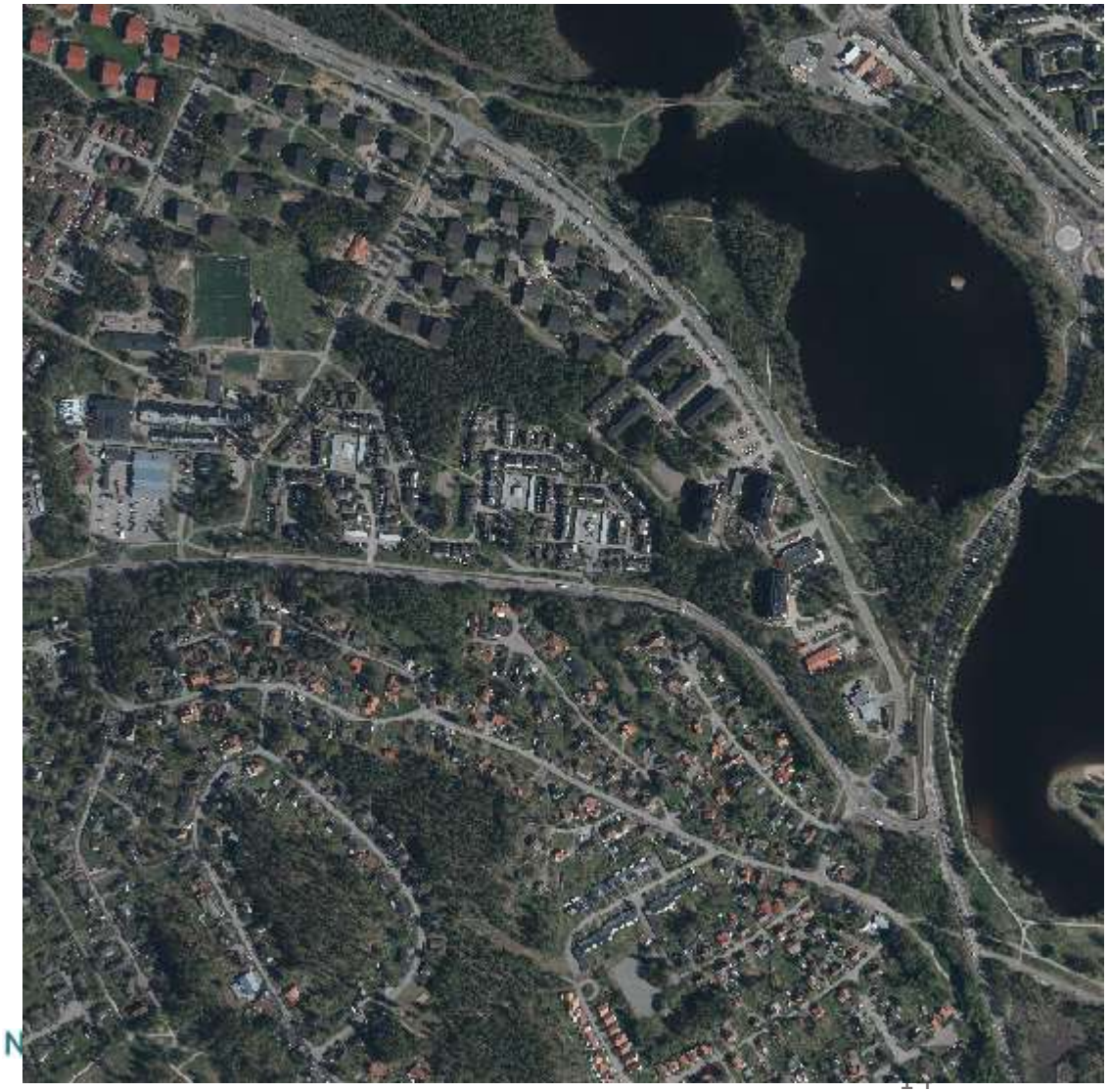
Reference datasets were used to evaluate the ATMU building vectors:

a. Building vectors from the NLS topographic database
b. Building permit registry (point locations of buildings)
c. Helsinki city open building database
d. Building classifications deducted from lidar data

The evaluation results showed that the ATMU UNet model achieved an accuracy up to **97.9%** on the object level in this area.

More work still needed on different kind of areas.

ATMU Building Model was tested on Swedish data

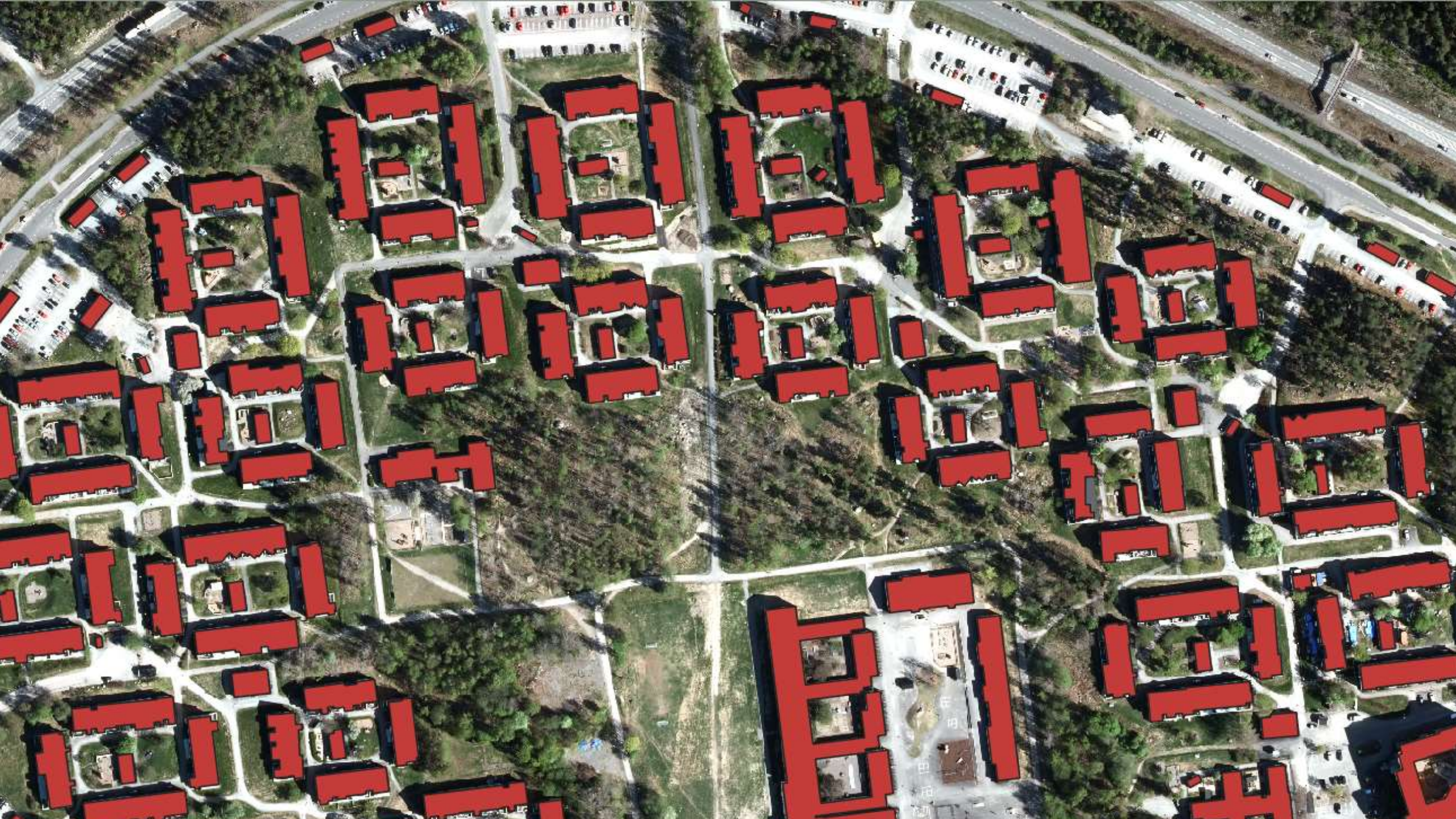


Swedish Data (Left)

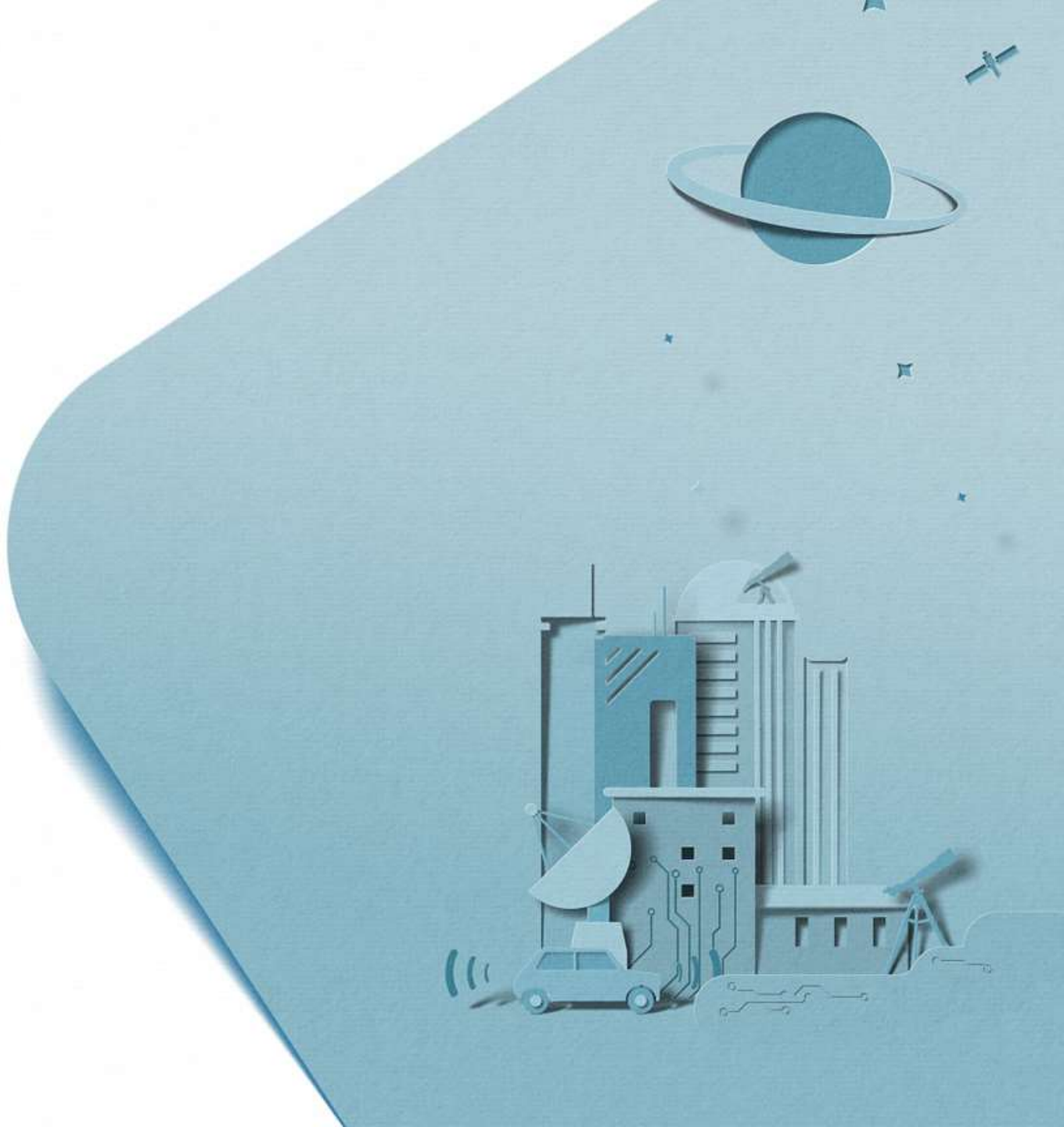
VS.

Finnish data (Right)

Swedish post processed data using the ATMU building model



Road Detection



Road detection outputs:
Road surfaces and Road edges

Result of road surfaces

Result of road edges

Result from road detection

One more example of the result

Change Detection
Watercourse Detection


Change
Detection
Results


Change
Detection
Results

Result of building and road change detection

96 %

of building and road changes were correctly identified.

Watercourse detection

Ground truth

Detected watercourses by UNet

Knowledge and experience sharing during the ATMU project

- High quality building training data (about 50km2) released to the public with an open license.
- Four open seminars hosted by ATMU to share our experiences (300+ registered participants in total).
- A workshop ”Deep Learning—sharing experience from the ATMU project” for the Nordic Land Mapping Network.
- The ATMU work has been presented in many international events: webinars, conferences, workshops and articles.
- Three Master’s thesis have been completed in the ATMU project.
- One conference paper (full paper) + three Journal papers published

Deliverables of 1st Phase

- Deep learning solution for building detection
  - The AI (UNet) model for building detection was trained with datasets covering an area of more than 60,000 km2. Training data is **Open data**.
  - Produced 100,000+ km2 true orthophotos.
- Deep learning solution for road detection
  - The AI (RoadVecNet) model for road detection.
- Deep learning solution for building and road change detection
  - The AI (NestNet2) model.
- Deep learning solution for watercourse detection
  - 36km2 data were trained.
  - Preliminary result from the UNet was achieved. Further development is needed.

Next Steps

2nd Phase (2023) Expected Outcomes

- Method for correcting topographic db building vectors.
- Building vectors produced in the project with an artificial intelligence method.
- Corrected topographic database building vectors.
- An improved method for watercourse detection.
- Completed Business Requirements regarding the assessment of change effects and the solution concept.
- Evaluation of how automation can increase the productivity of our data production process.
- Expert evaluation / validation report.
- Final project report.

Example: Positional Accuracy Improvement

- To improve the positional accuracy of TDB building vectors by using the building vectors produced by the ATMU 1st Phase as reference.
- After correction, accuracy of the TDB building vectors will be within 1m (original 3m or worse).

*TDB: Topographic Database

3rd Phase (2024-)

- Method Development to be continued…
- Operational use of AI/ML methods in everyday topographic data production work, in parallel with the new production system.

- More Information?
  - See GIM International Article https://www.gim-international.com/content/article/how-the-national-land-survey-of-finland-is-exploring-ai-technology
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Advancing together

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