NLS
NATIONAL
LAND SURVEY
OF FINLAND

Increasing spatial data accuracy in Finland using Artificial Intelligence

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11th May 2023

Outlines

- AI team
- The ATMU project (1.1.2021-31.12.2022)
  - Background
  - Training data
  - Deep learning technology
  - Results and evaluation
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- Current AI project: AI4TDB (1.1-31.12.2023)

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AI Team







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Education background: Master and Doctoral degrees in Computer science and Geomatics

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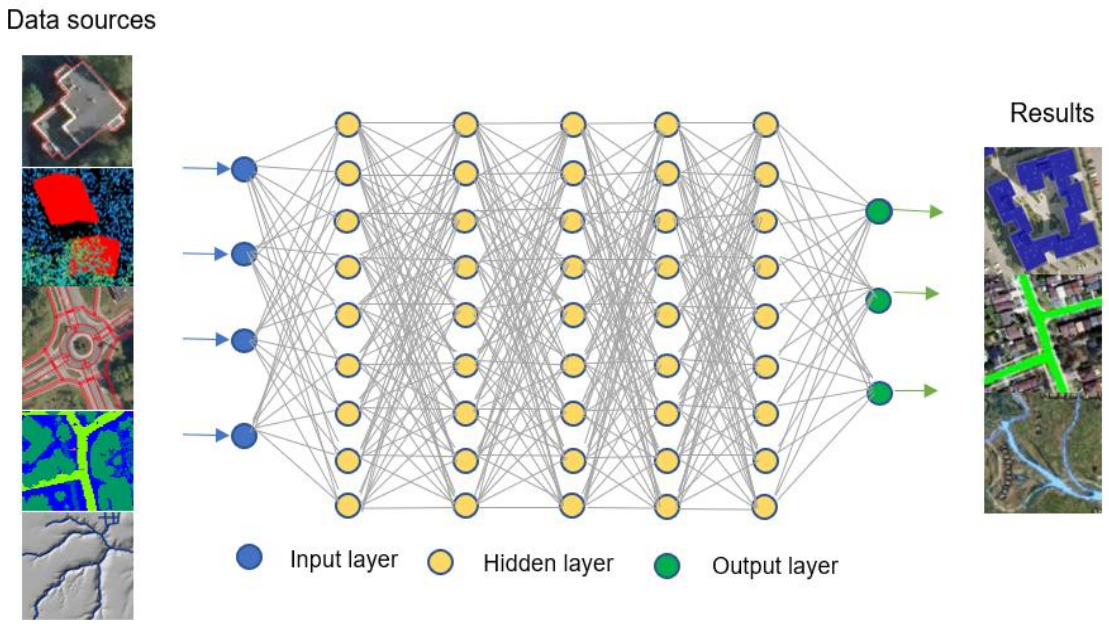
The ATMU project

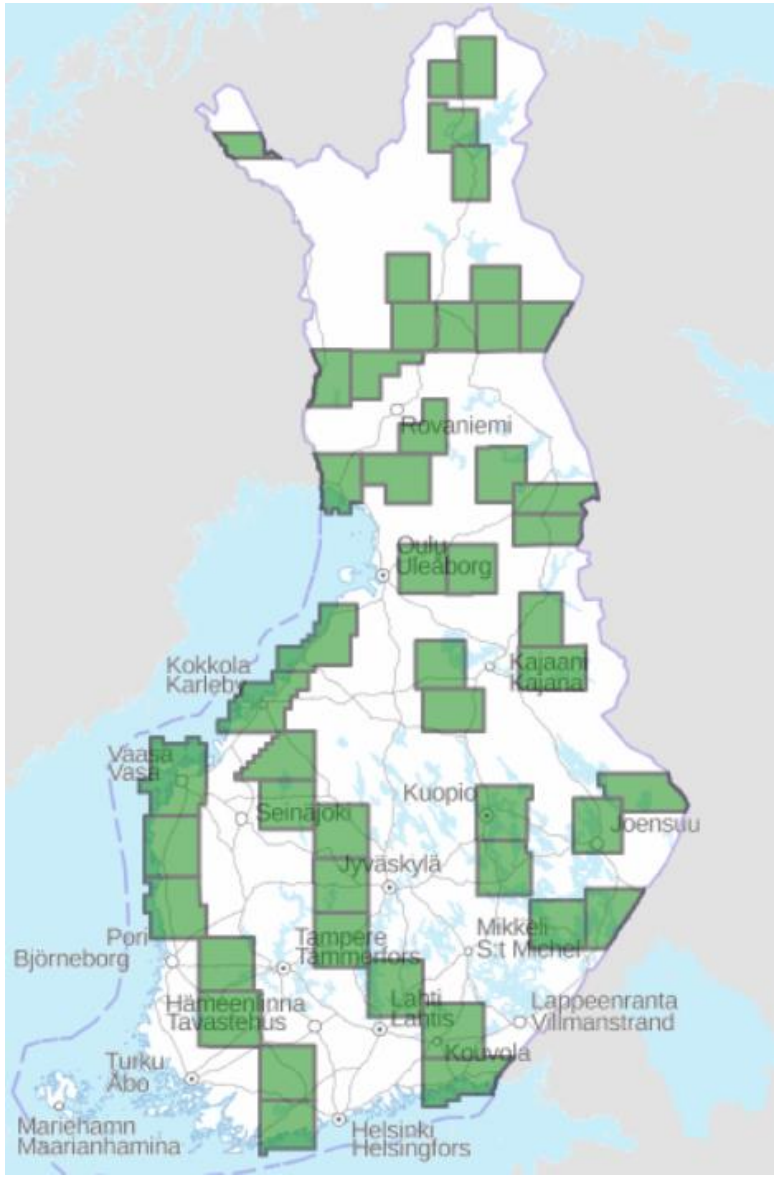
--- The Advanced Technology for Topographic Map Updating

- The ATMU -project was a two-year project (2021-2022), with funding supported by:
  - The **Ministry of Finance** Robo funding (399,200 eur),
  - MML-PATI: **Heli Laaksonen**,
  - MML-FGI: **Juha Hyyppä (**Three Master thesis).
- Using AI (Deep learning technology) for National topographic map updating
- Focusing on buildings, roads, and hydrographic feature detection and updating



Finland

- **Area**: 338 440 km²
- **National Land Survey of Finland** (NLS)
  - **Aerial imaging programme**: 1/3 of the country annually
  - **Lidar programme**: 1/6 of the country annually
  - **Change updating**: 100 human forces annually



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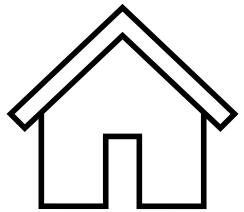
The ATMU project

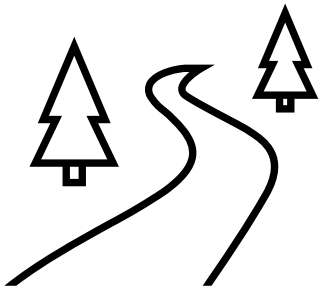
--- Introduction

- The Advanced Technology for topographic Map Updating (ATMU) project employed deep learning technology for object detection and change recognition



Convolutional neural network
Transfer learning

Building detection and change recognition



Convolutional neural network
Multitask learning

Road detection and change recognition

Convolutional neural network

Watercourse detection

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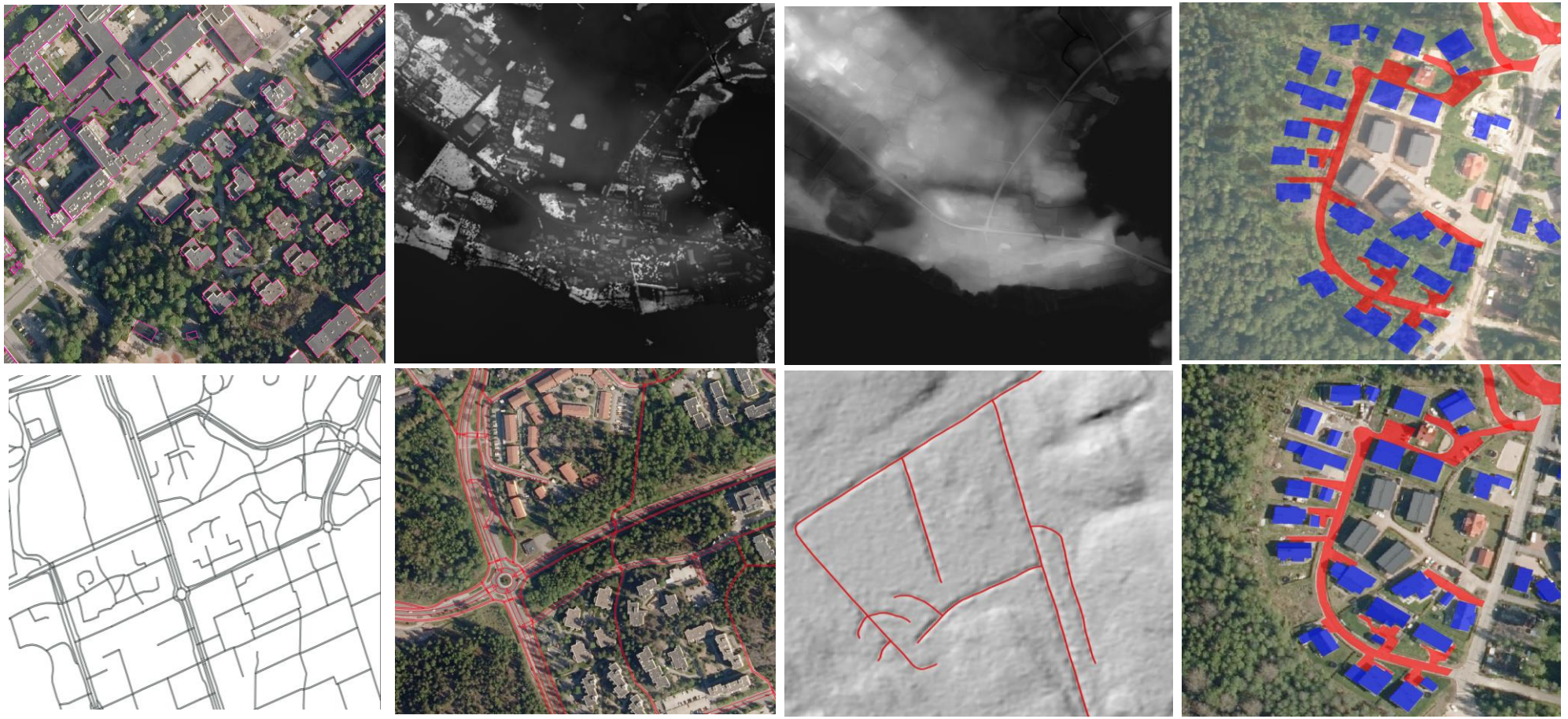
The ATMU project

--- Training datasets



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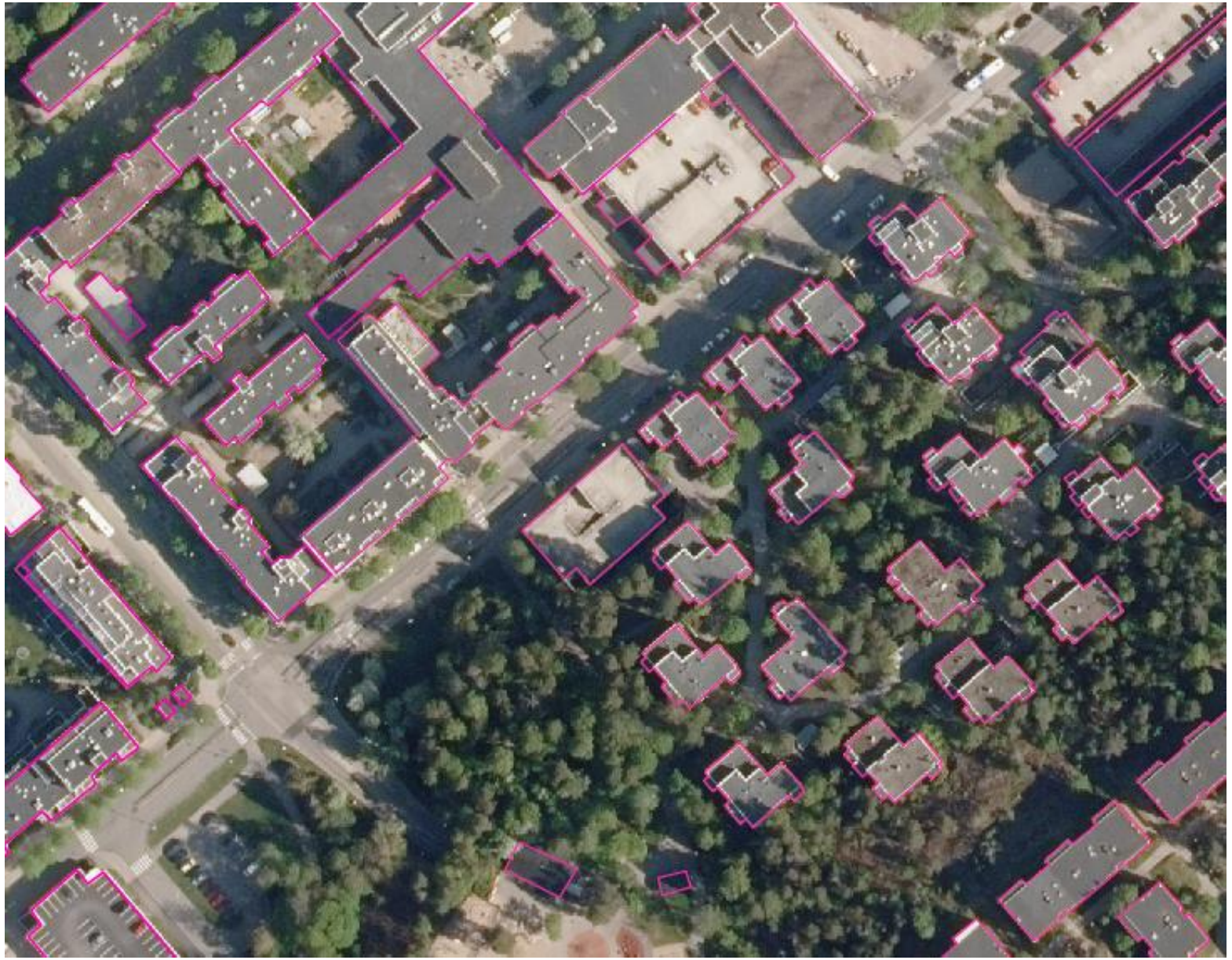
The training data for building detection



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The ATMU project

--- Deep learning technologies

Building detection

UNet model

Input data
True orthophotos
Building vectors
DEM and DSM

Output data
Building outlines

Expert evaluation (Yes)

Road detection

RoadVecNet model

Input data
Orthophotos/True orthophotos
Road vectors

Output data
Road edges
Road surfaces

Expert evaluation (Yes)

Watercourse detection

UNet model

Input data
0.5m Lidar-DEM
Watercourse vectors

Output data
Segmented watercourses

Expert evaluation(No)

Change recognition

NestNet2 model

Input data
True orthophotos
Labels with changed areas

Output data
Polygons of changed areas

Expert evaluation(Yes)

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Results: building detection

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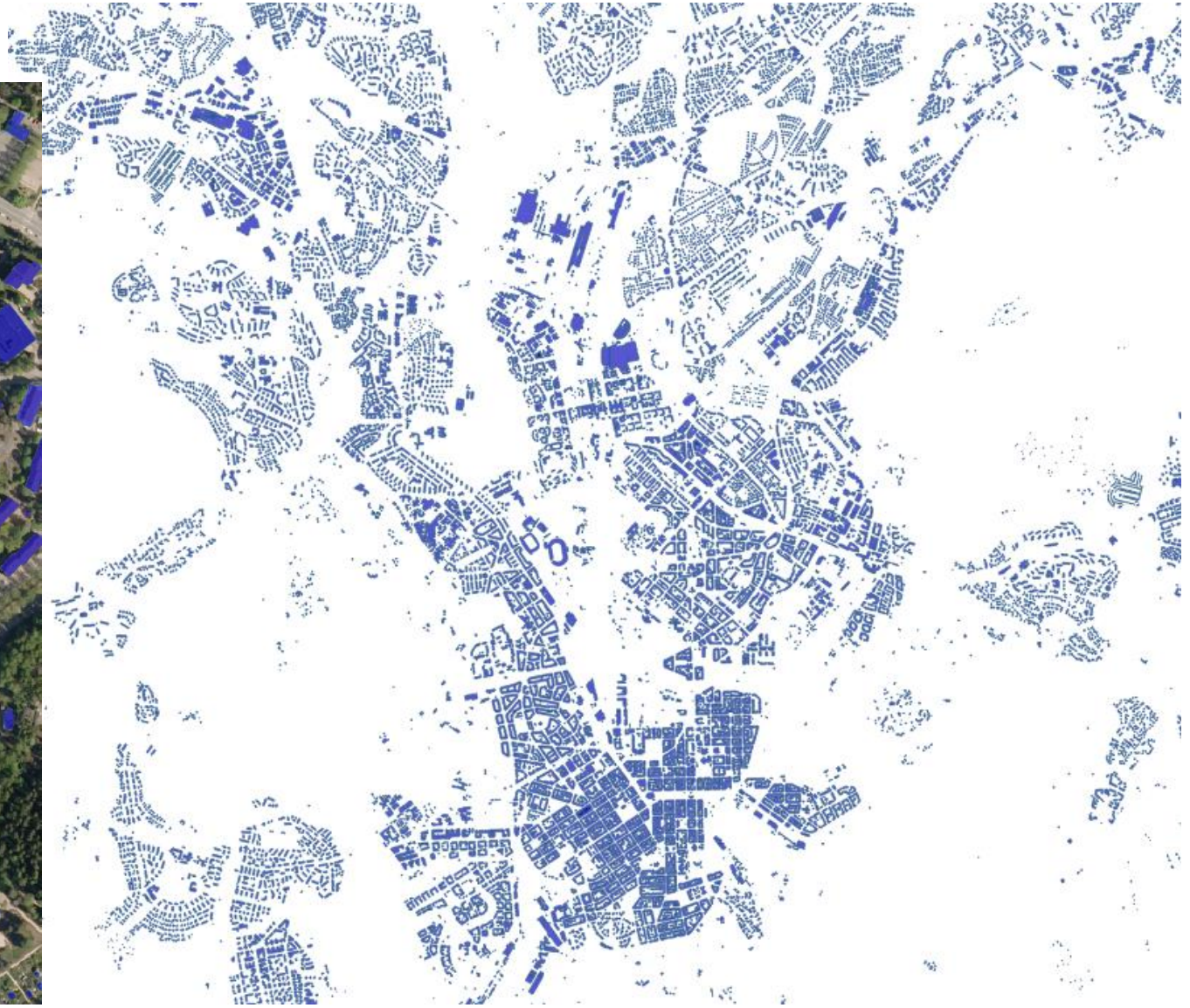
Results: building detection



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Results: Road detection

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Results: Road detection

with multitask learning technique

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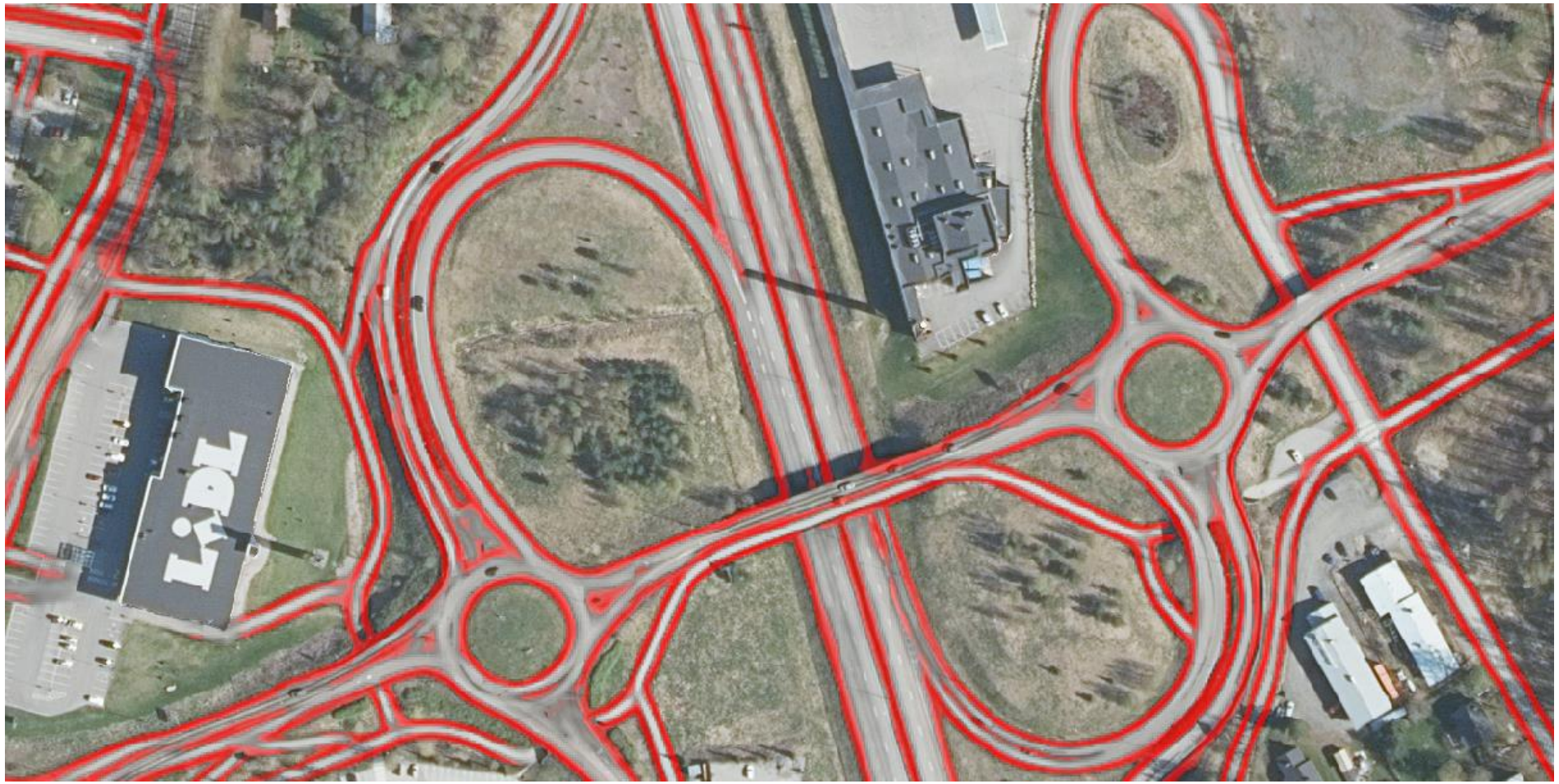
Results: Road detection



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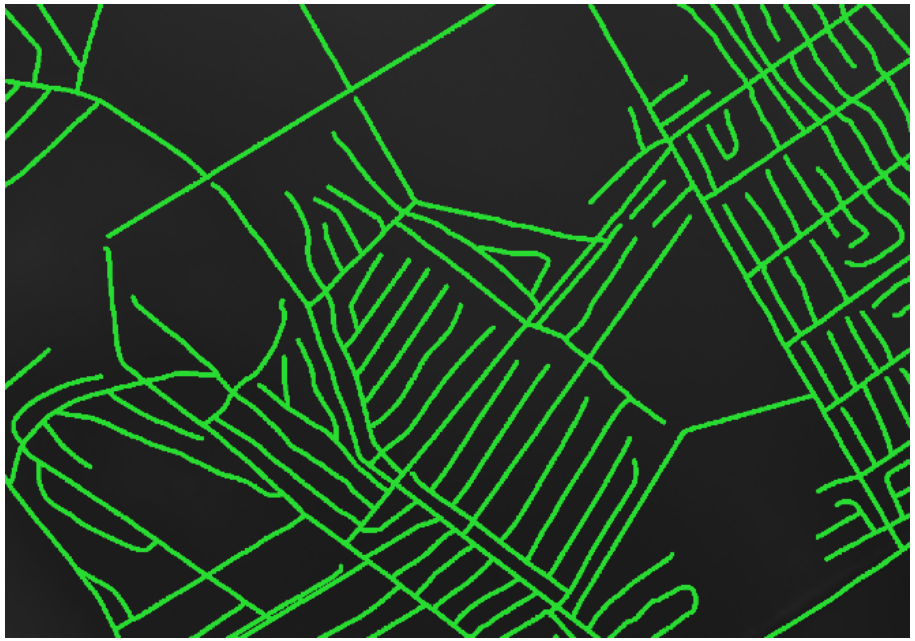
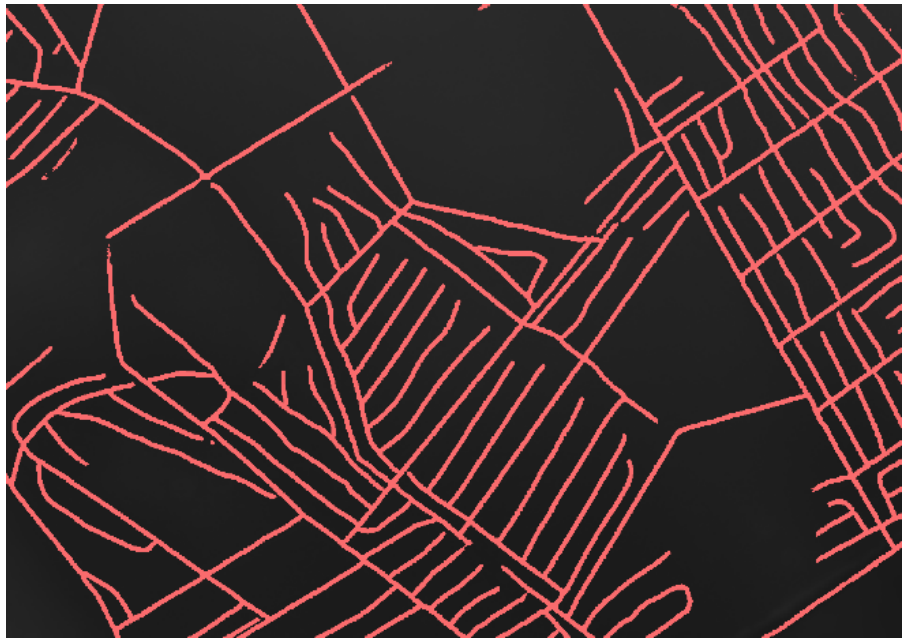
The ATMU project

--- Results: Watercourse detection





Left: Labels

Right: Prediction from UNet

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The ATMU project

--- Results: Change recogntion

2015 true orthophoto

2020 true orthophoto

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The ATMU project

--- Results evaluation for building detection

- Laajasalo island, Helsinki, covering an area about 17.5 km2
- Compared to different reference data such as national topographic data, Helsinki city's open building database, RHR symbols, Lidar data…
- Accuracy was up to 97.9%

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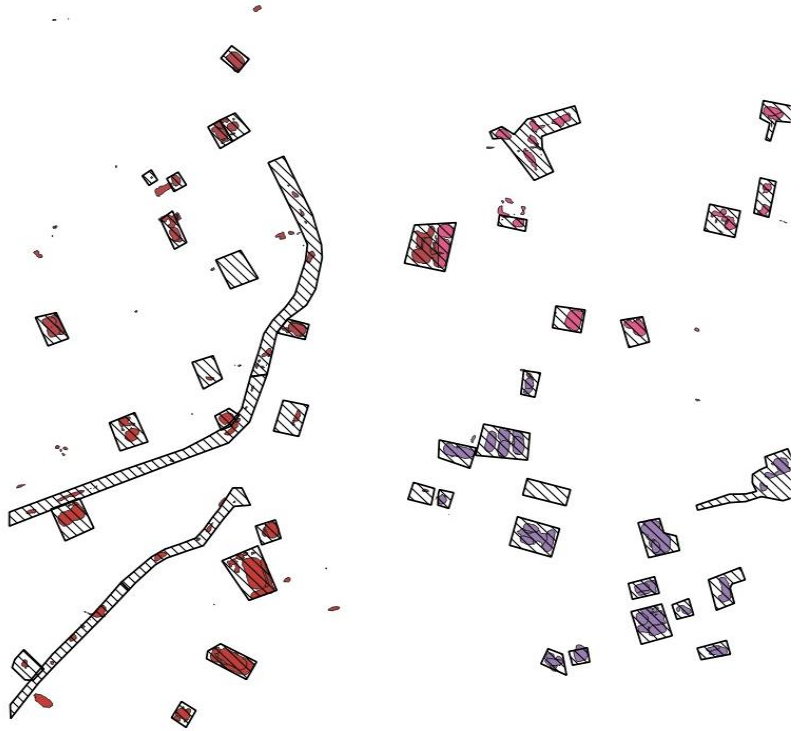
Road evaluation (marked yellow as missing roads)

The ATMU project

--- Results evaluation for change recognition (96% changes found)

2015 true orthophoto

2020 true orthophoto



Detected changes vs reference data

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Outcomes

- 100,000+ km2 true orthophotos were produced during the project
- The UNet model for building detection has been trained with datasets from 20 production areas (each area covers about 3000 km2)
- With the expert evaluation, building detection method has reached an accuracy level (up to 97.9%) for practical application
- Road detection method was very promising although there was no quantative accuracy result
- For change detection, 96% of change areas were found according to the expert evaluation
- The project has made high-quality training data for building detection publicly available
- Three Master theses had been completed during the project

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Current AI project: the AI4TDB project

- **Funding sources**: Ministry of Agriculture and Forestry (200,000 eur), and MML-PATI
- **AI4TDB**: Enhance the accuracy of topographic database by using the AI
  - To utilize the trained UNet model from the ATMU project to make prediction of buildings from true orthophotos
  - To employ the predicted buildings as references
  - To improve the positional accuracy of building vectors from topographic database
  - To continue developing the watercourse detection using the AI method

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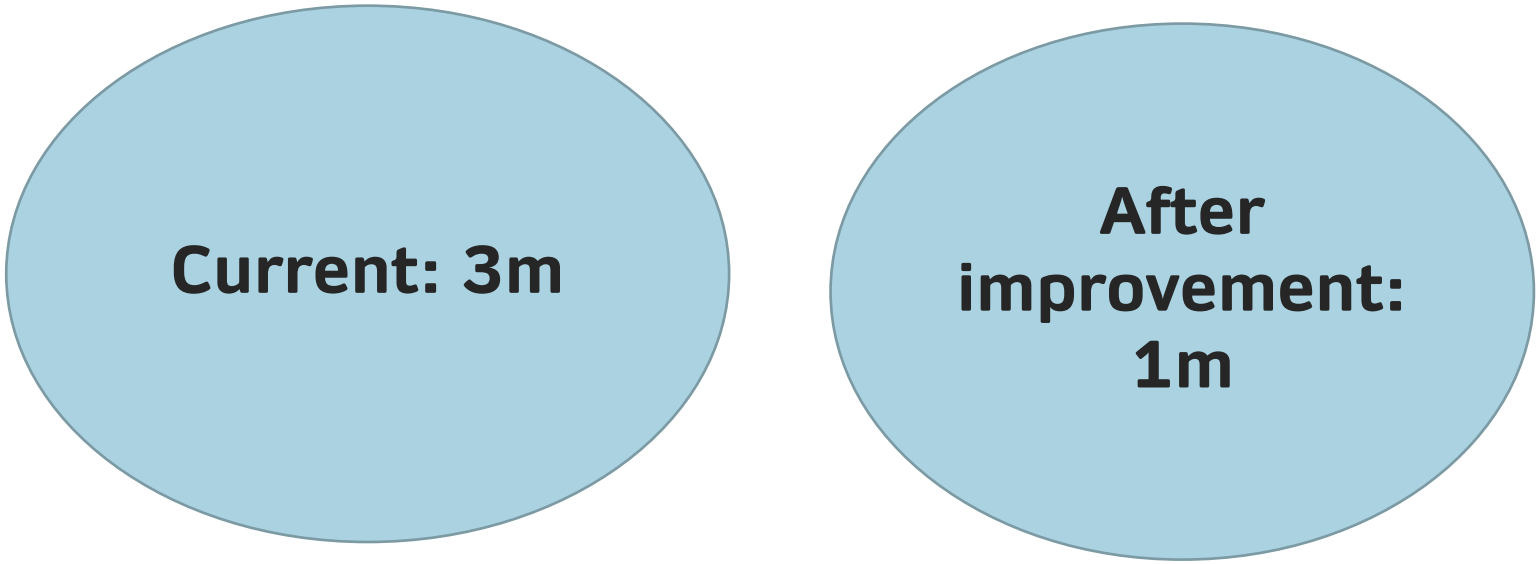
Goals of the project

- Positional accuracy of building vectors in topographic database:



- Watercourse detection improvement by adding ponds, lakes and so on to the training data.

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Summary

- This presentation has introduced two AI projects in the NLS map production: ATMU and AI4TDB
- In the ATMU project, building and road detection and change recognition have achieved great results. The building detection method from the ATMU project is using for current AI4TDB project to improve the quality of building vectors in the topographic database.
- The use of road detection, building and road change recognition methods is under discussion.
- In the AI4TDB project, besides buildings, the watercourse detection is improving.

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Thank you for your attention!

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