Building change detection

Exploring object based classification and machine learning

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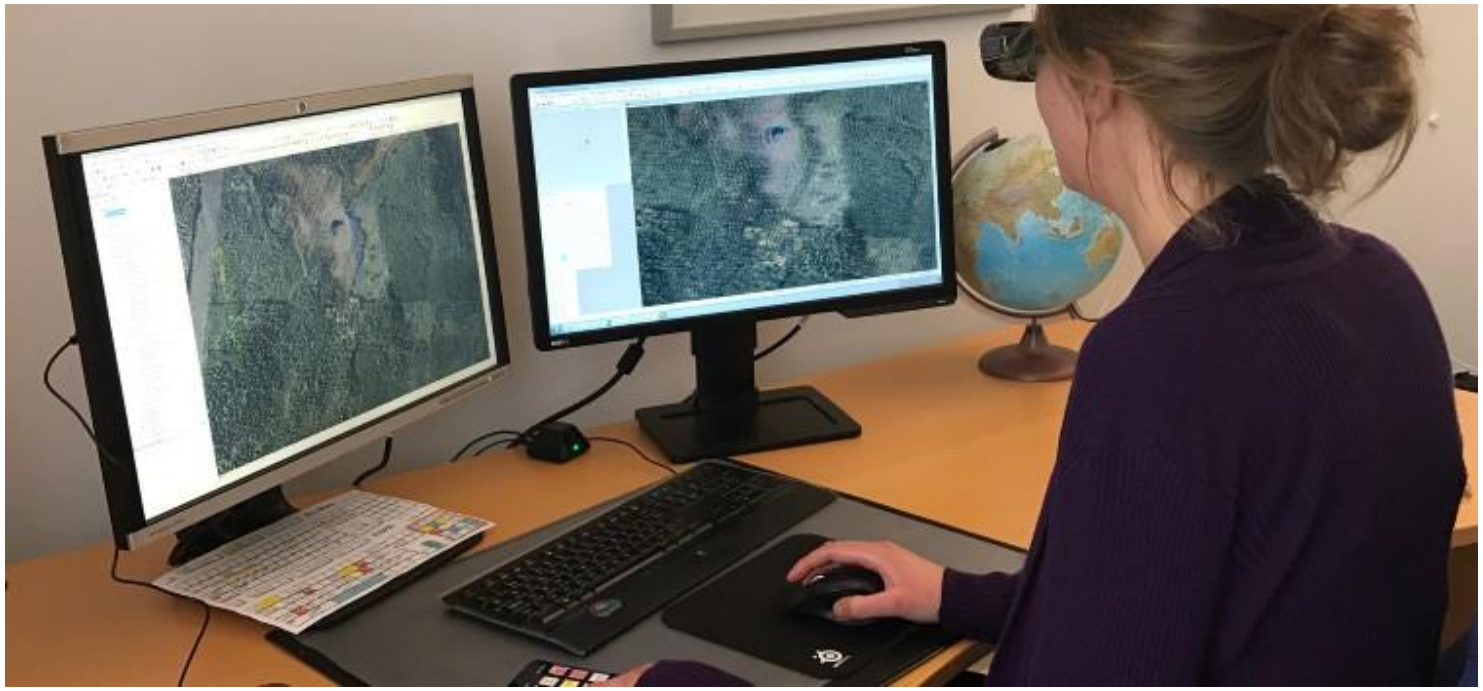
Updating buildings – Present method

- Manual detection using stereoscopic mapping technique (aerial photos).
- 10x10 km at a time.
- More than 90% of true changes are detected.
- Resource demanding.



Automatic change detection

- Two techniques tested:
  - Object based classification using software eCognition.
  - Machine learning tool (artificial neural network) developed by a summer worker.
- Long term goal:
  - Develop a tool that detects building changes automatically.

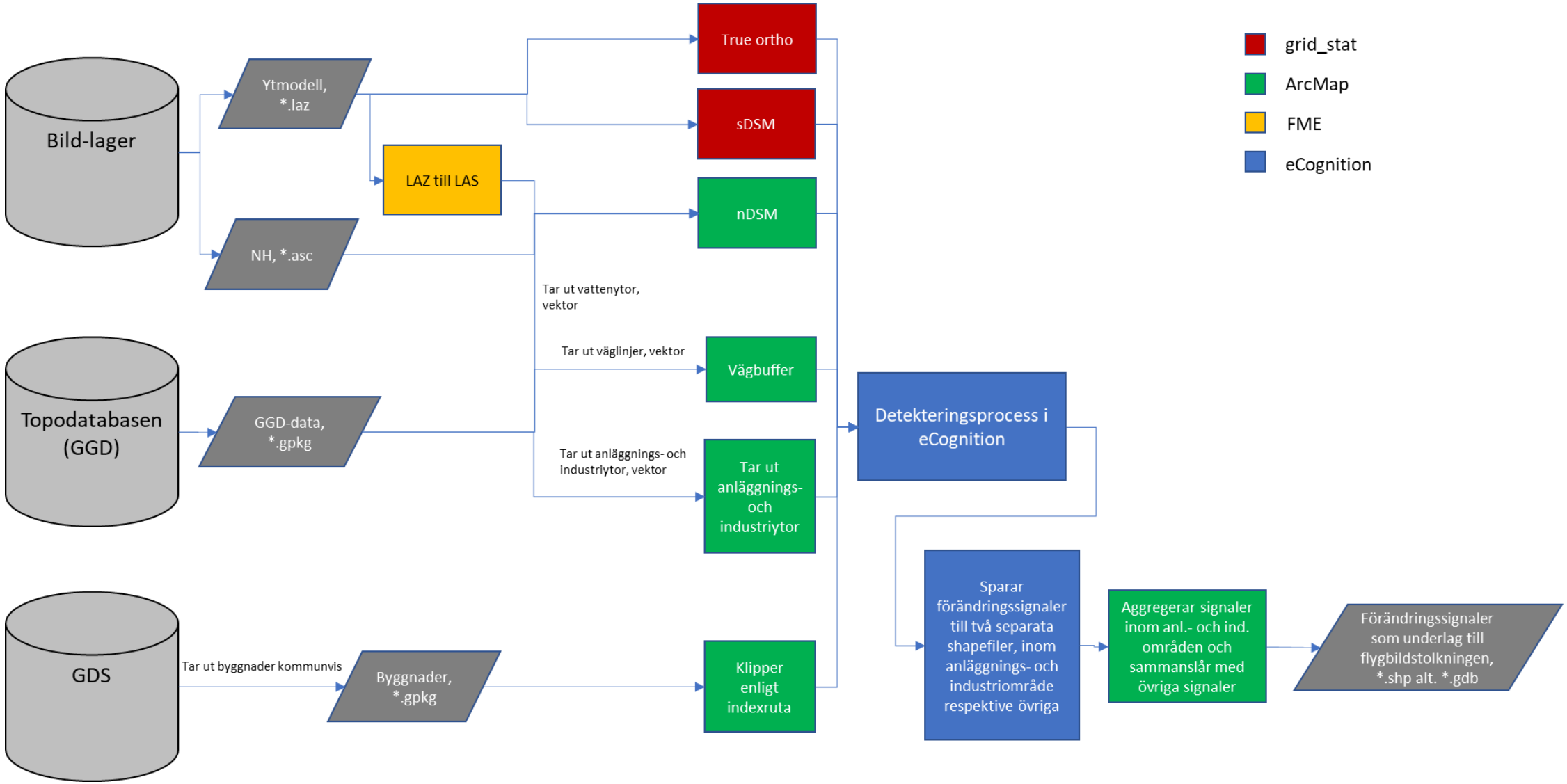
Input och process

Main input data

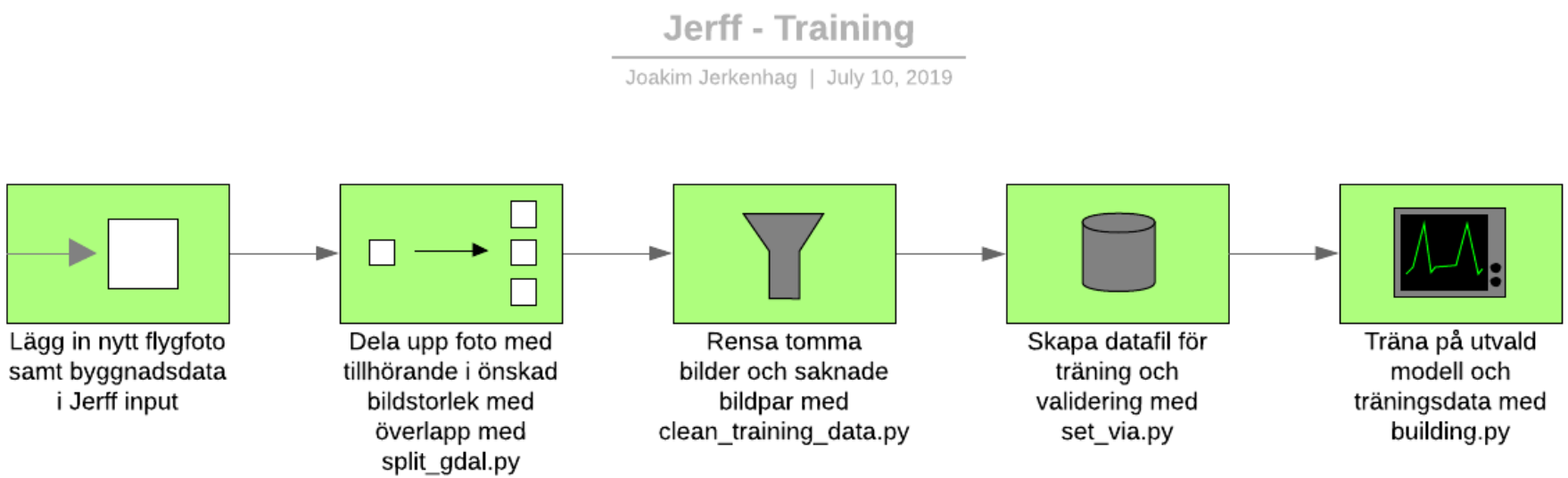
- True orthophoto generated from Digital Surface Model (from image matching of aerial photos).
- Channels: NIR, red, green
- Spatial resolution: 0.5 m

Standard orthophoto **True orthophoto**

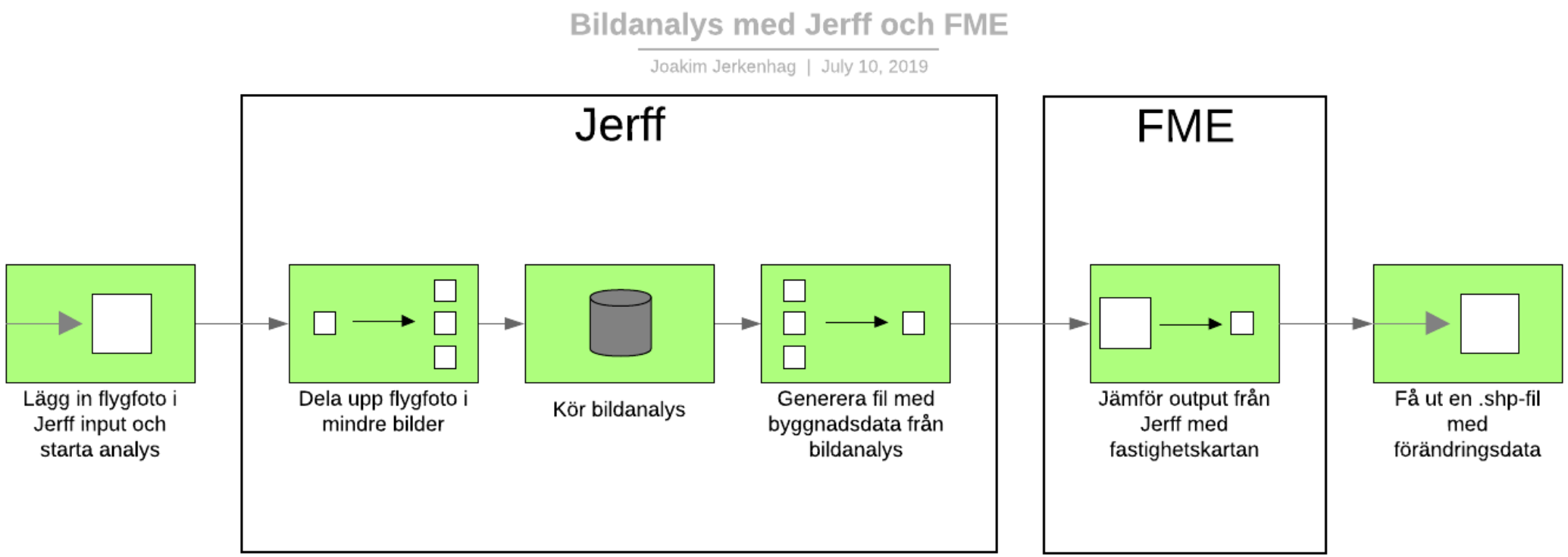
Object based classification (eCognition)



Machine learning – Training



Machine learning – Image analysis



Test

Testing the two techniques

- The purpose was to evaluate and compare generated building changes from both techniques (eCognition and machine learning).
- 5 test areas (10x10 km) with mixed landscape.
- An operator examined each change signal and labeled true changes. Thereafter the whole area was searched manually to find any remaining true building changes not detected by the two methods.

Results

TP = True change
FP = False change
FN = True change not detected

Statistics

- Precision – What proportion of detections was actually true changes?

$$\text{Precision} = \frac{TP}{TP + FP}$$

- Recall – What proportion of actual true changes was detected?

$$\text{Recall} = \frac{TP}{TP + FN}$$

- Object classification (eCognition):

Test area	Precision	Recall
649_44	18%	44%
651_44	26%	62%
657_49	27%	60%
658_39	54%	73%
658_45	34%	36%

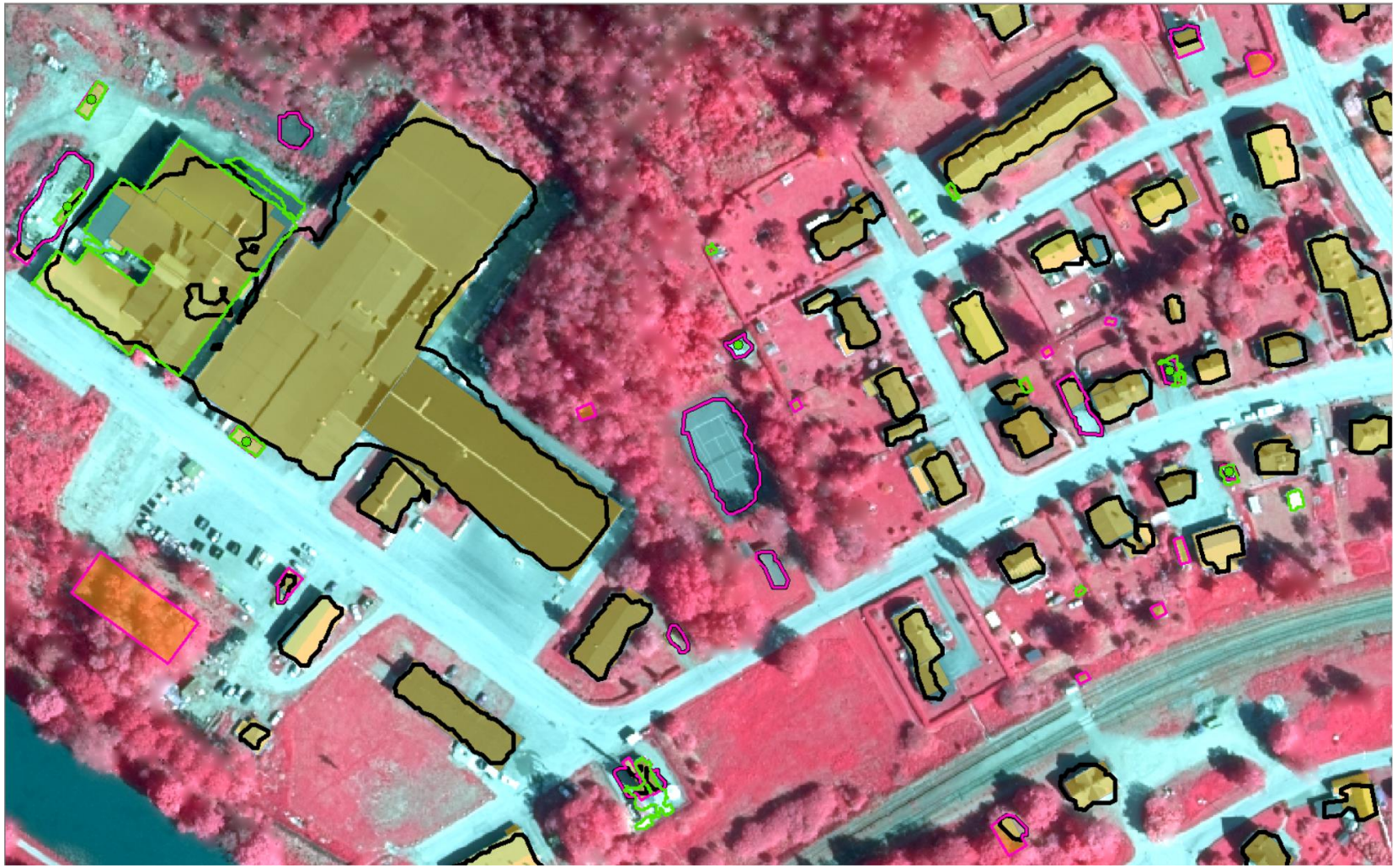
Machine learning:

Test area	Precision	Recall
649_44	11%	65%
651_44	12%	74%
657_49	8%	62%
658_39	21%	77%
658_45	10%	52%

Example 1


Legend
True change registered by an operator
Change signal from eCognition
Change signal from Machine Learning
Building detected by Machine Learning
Existing building from database

Example 2


Legend
True change registered by an operator
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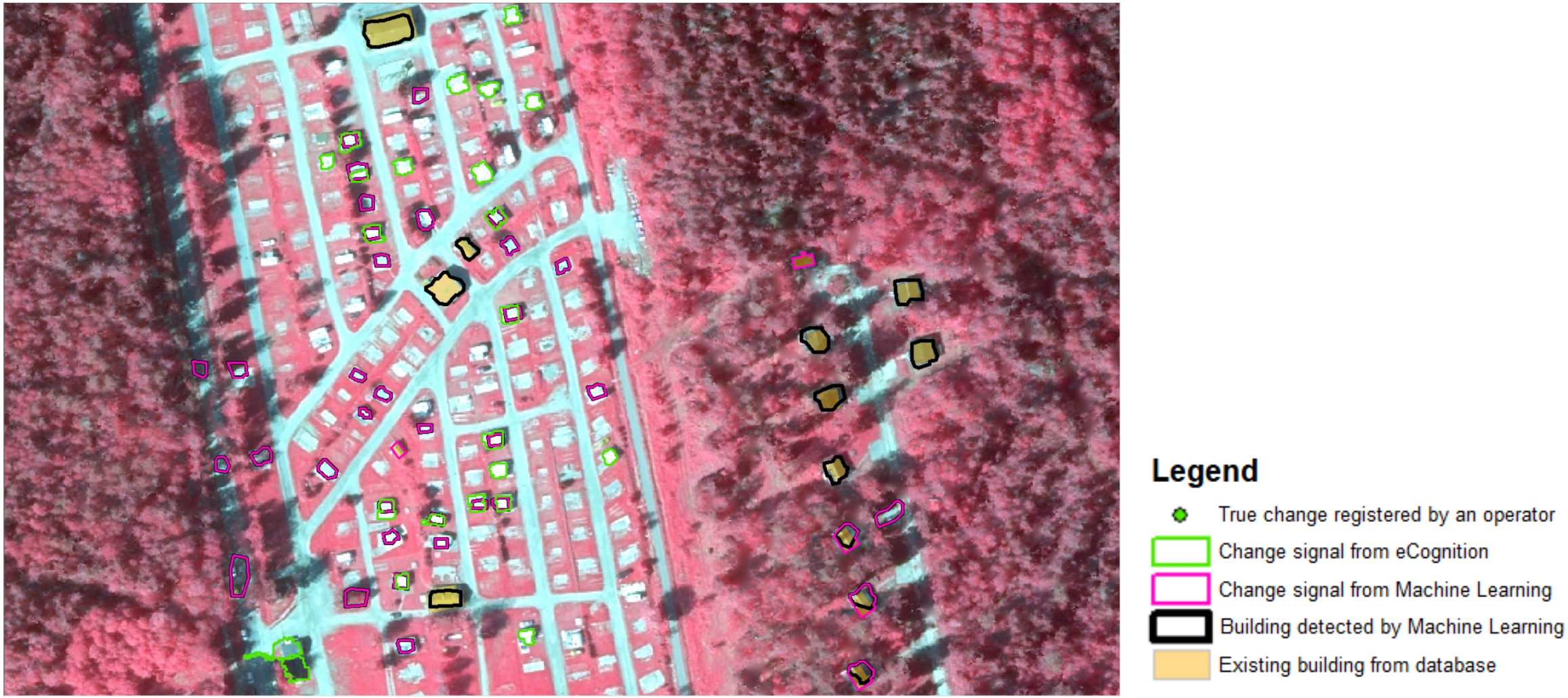
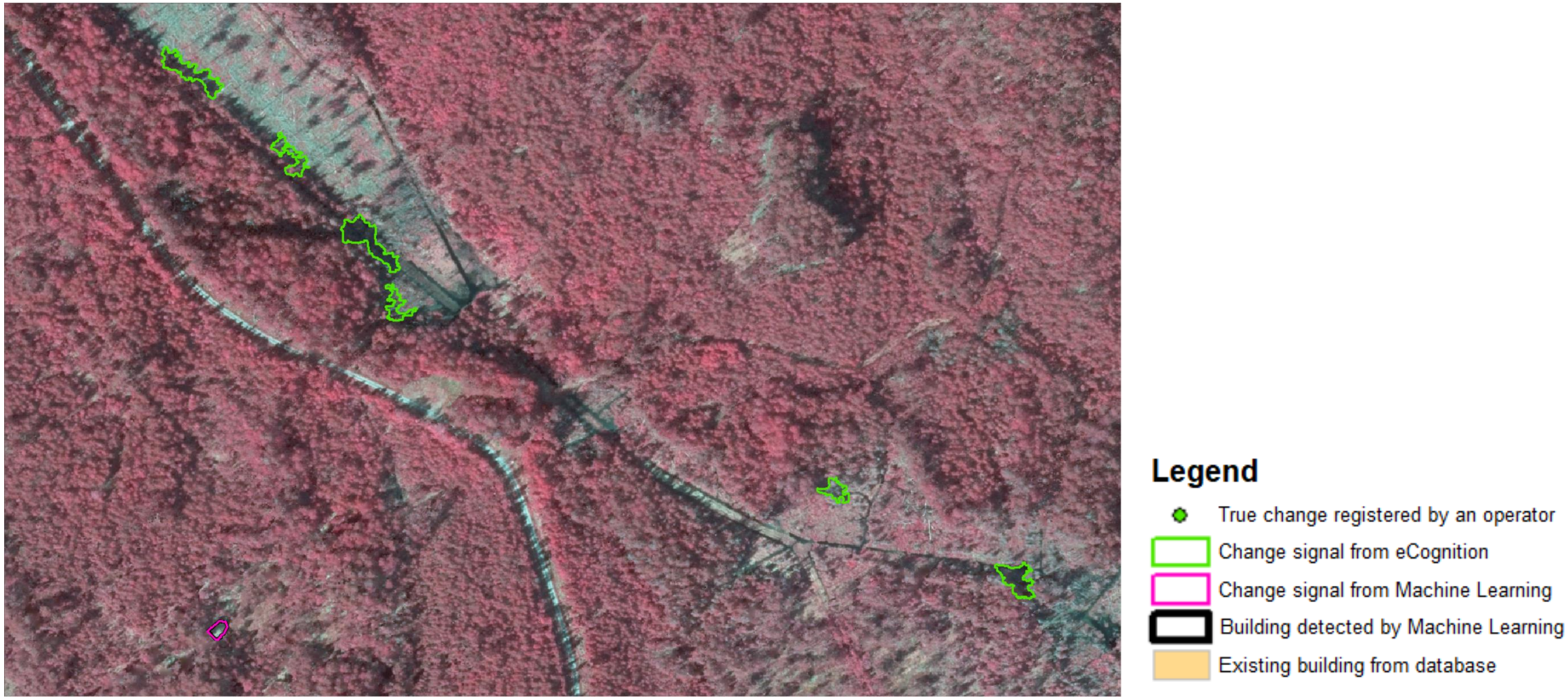
Change signal from Machine Learning
Building detected by Machine Learning
Existing building from database

Example 3


Legend
True change registered by an operator
Change signal from eCognition
Change signal from Machine Learning
Building detected by Machine Learning
Existing building from database

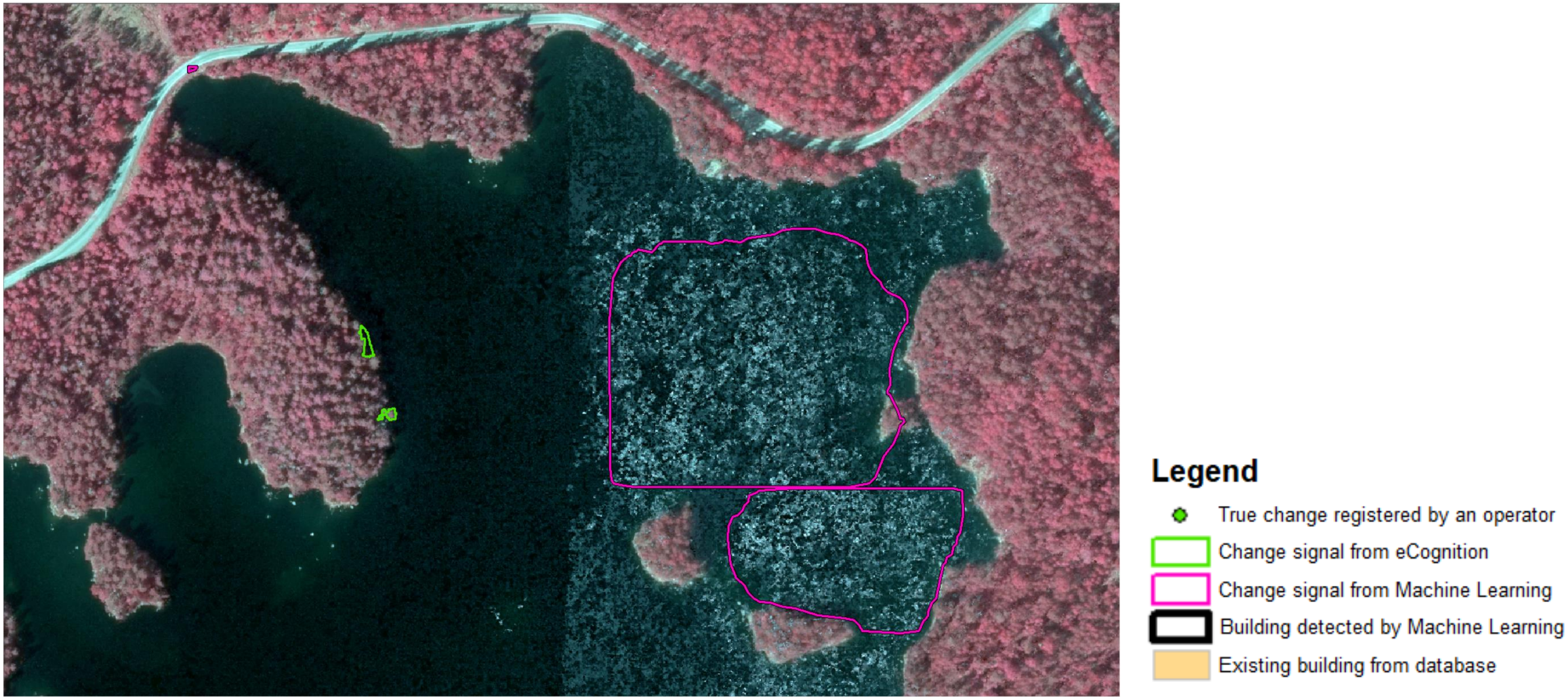
Example 4


Legend
True change registered by an operator
Change signal from eCognition
Change signal from Machine Learning
Building detected by Machine Learning
Existing building from database

Example 5


Legend
True change registered by an operator
Change signal from eCognition
Change signal from Machine Learning
Building detected by Machine Learning
Existing building from database

Example 6


Legend
True change registered by an operator
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Conclusions

- Both methods requires considerable improvements in order to be used in production and meet present quality level.
- Poor transferability of the object based classification method. Requires much work to improve.
- The machine learning method needs more training to reduce missing in detecting buildings.
- Building change detection is a complex problem.
- In traditional image analysis we have to define rules for classification – a difficult task.
- With machine learning we let the "computer" define the rules.
- In later years, great progress has been made in the area of machine learning, in particular within deep learning. Example from Microsoft: https://github.com/Microsoft/USBuildingFootprints/

Forthcoming work

Proceeding work on machine learning

- Further development of the summer work.
- Testing different kind of artificial network architectures, for example Microsoft's.
- Learning from others.
- Collaboration with others?

Contact

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