FACULTY OF
BIOSCIENCE ENGINEERING

DEPARTMENT OF ENVIRONMENT
HYDRO-CLIMATE EXTREMES LAB (H-CEL) & REMOTE SENSING | SPATIAL ANALYSIS LAB (REMOSA)

AN OBJECT-BASED APPROACH FOR FLOOD MAPPING IN VEGETATED AREAS BASED ON S-1 AND S-2 IMAGERY

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CONTEXT & GOAL

Open flooding: distinguishable on SAR due to specular reflection

⇔ Flooded vegetation: often complex backscattering mechanisms depending on vegetation type and structure

Pixels: most often used in image processing

⇔ Objects: allow for consideration of context and inclusion of additional input features

CONTEXT & GOAL

→ Up to which extent can floods in vegetated areas be observed using freely available Sentinel imagery? What is the added value of S-2 imagery?



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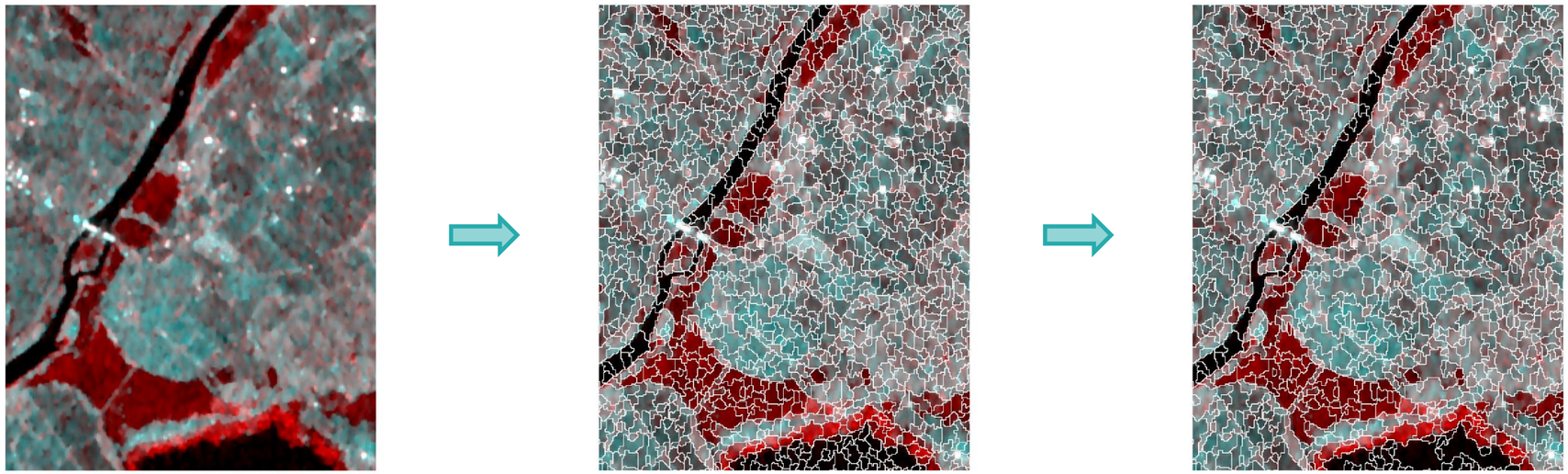
METHODOLOGY

1. Image segmentation
   a. Object prior using quickshift clustering on VV and VH bands flood/reference image pair
   b. Object refinement based on objects' mean, st. dev. and shape



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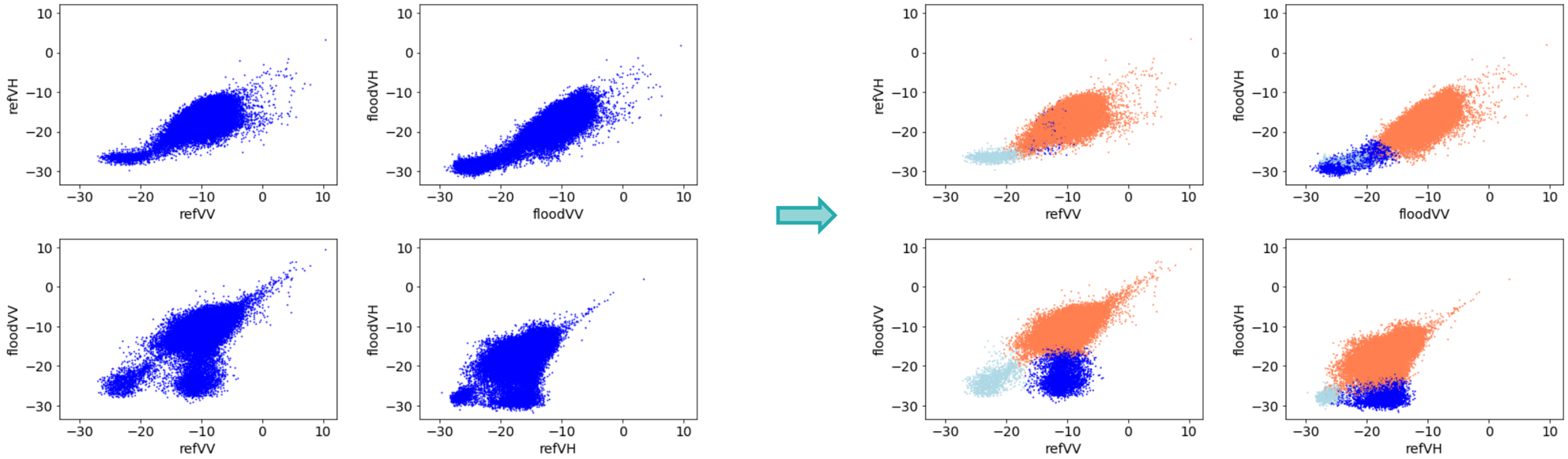
METHODOLOGY

1. Image segmentation
2. Spectral clustering on object means from SAR (and optical) features

   → K-means clustering after dimensionality reduction based on eigenvalues of similarity matrix



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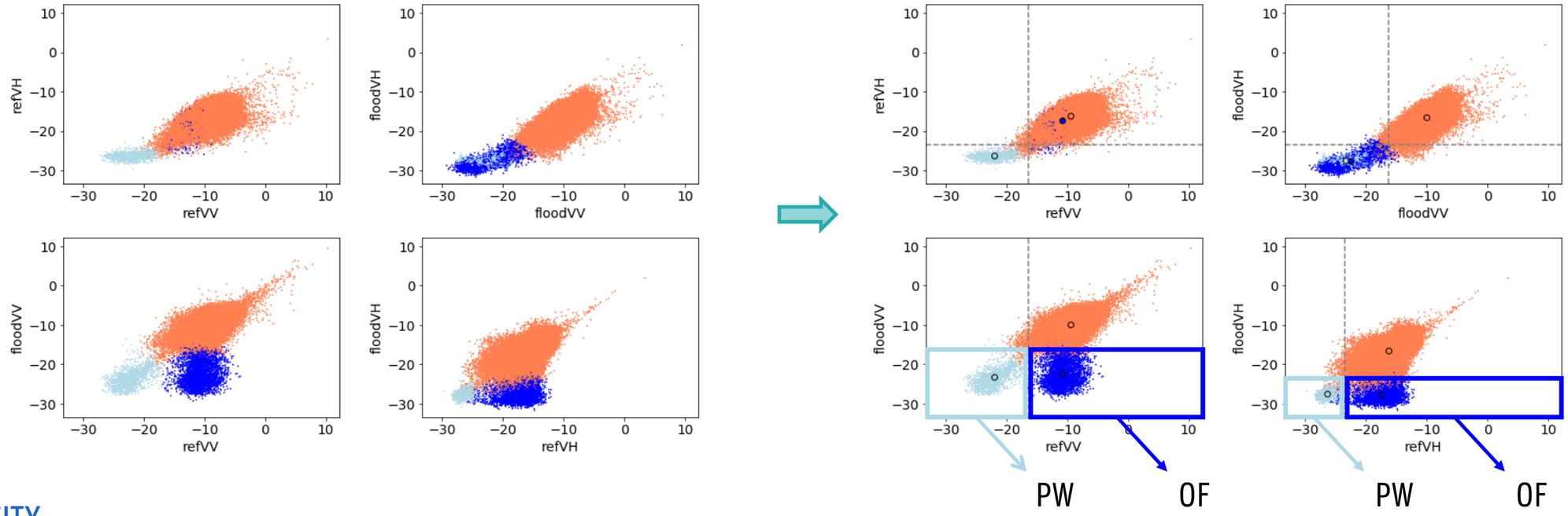
METHODOLOGY

1. Image segmentation
2. Spectral clustering on object means
3. Classification of clusters of visible flooding based on cluster centroids and thresholds obtained from tiled thresholding



PW = permanent water; OF = open flood

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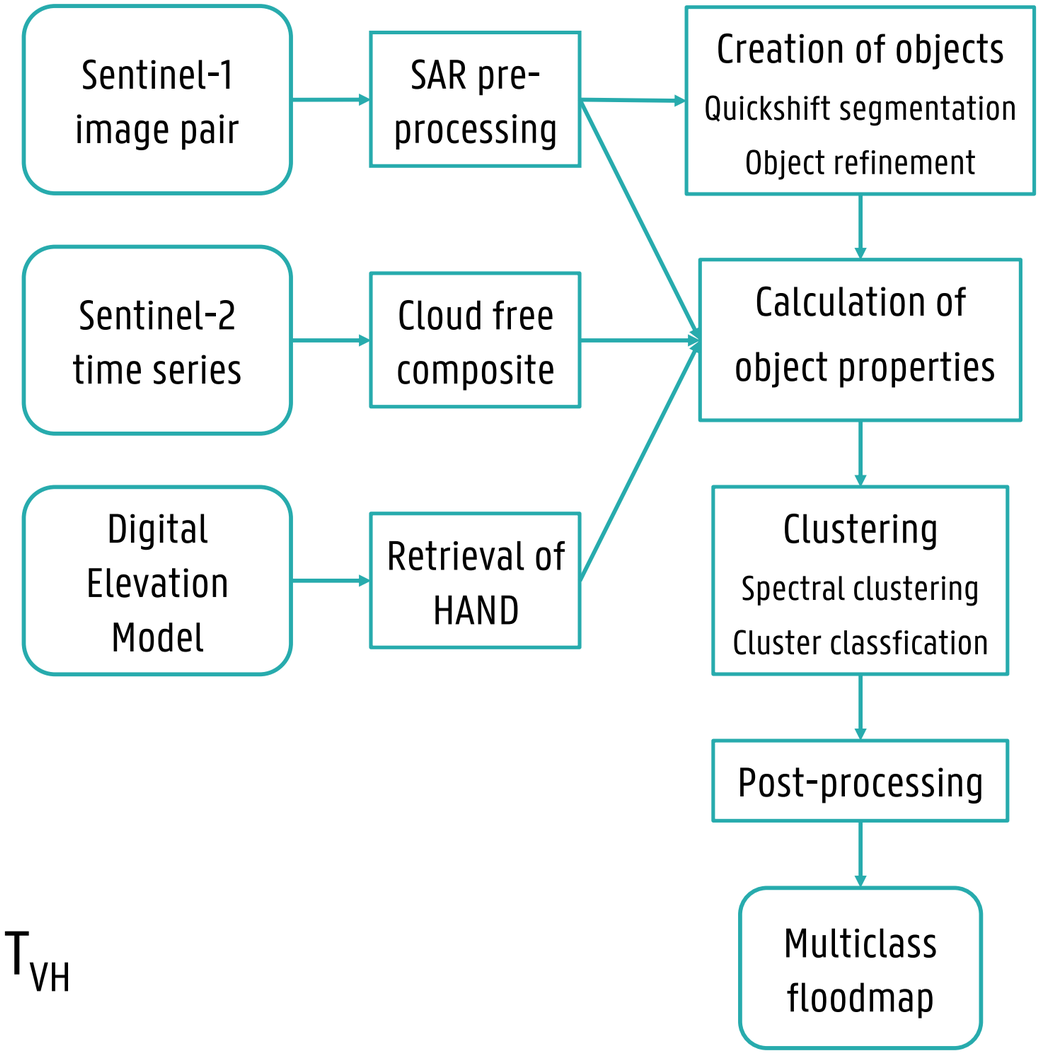
HAND = Height Above Nearest Drainage

METHODOLOGY

1. Image segmentation
2. Spectral clustering on object means
3. Classification of clusters
4. Post-processing [in progress]



Benchmark = pixel/segment-based thresholding:

Flood $\Leftrightarrow$ $flood_{VH} < T_{VH}$ & $flood_{VV} < T_{VV}$

PW $\Leftrightarrow$ $floodVH < T_{VH}$ & $flood_{VV} < T_{VV}$ & $ref_{VV} < T_{vv}$ & $ref_{VH} < T_{VH}$

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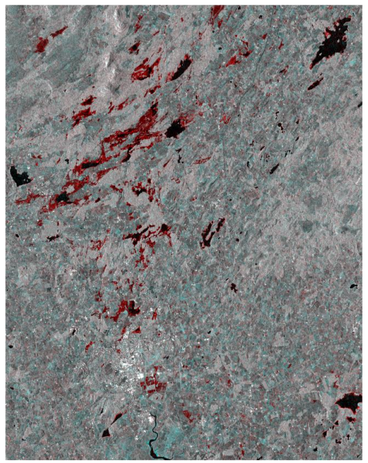
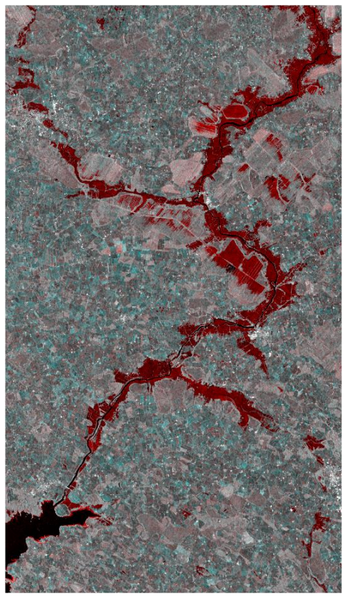
STUDY CASES

- 5 study cases (results shown for 3):
  - 3 cases comprising mainly visible flooding (cfr. Landuyt et al., 2019)
  - 2 cases comprising vegetated areas
- Annotation of truth classes: dry land (DL), permanent water (PW), open flood (OF), flooded vegetation (FV, if present)

River Fergus, 2015

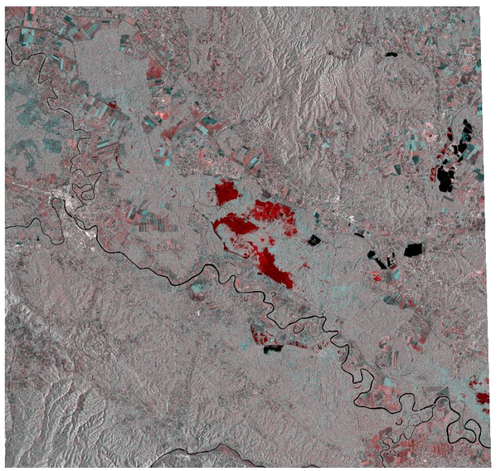


River Shannon, 2016

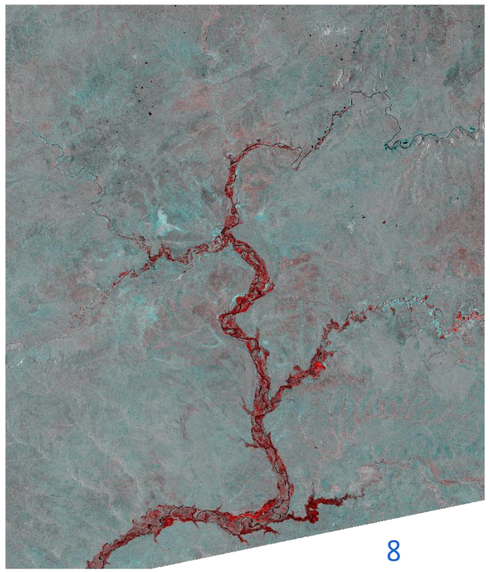


Lake Tay, 2017

River Sava, 2019



River Volta, 2018



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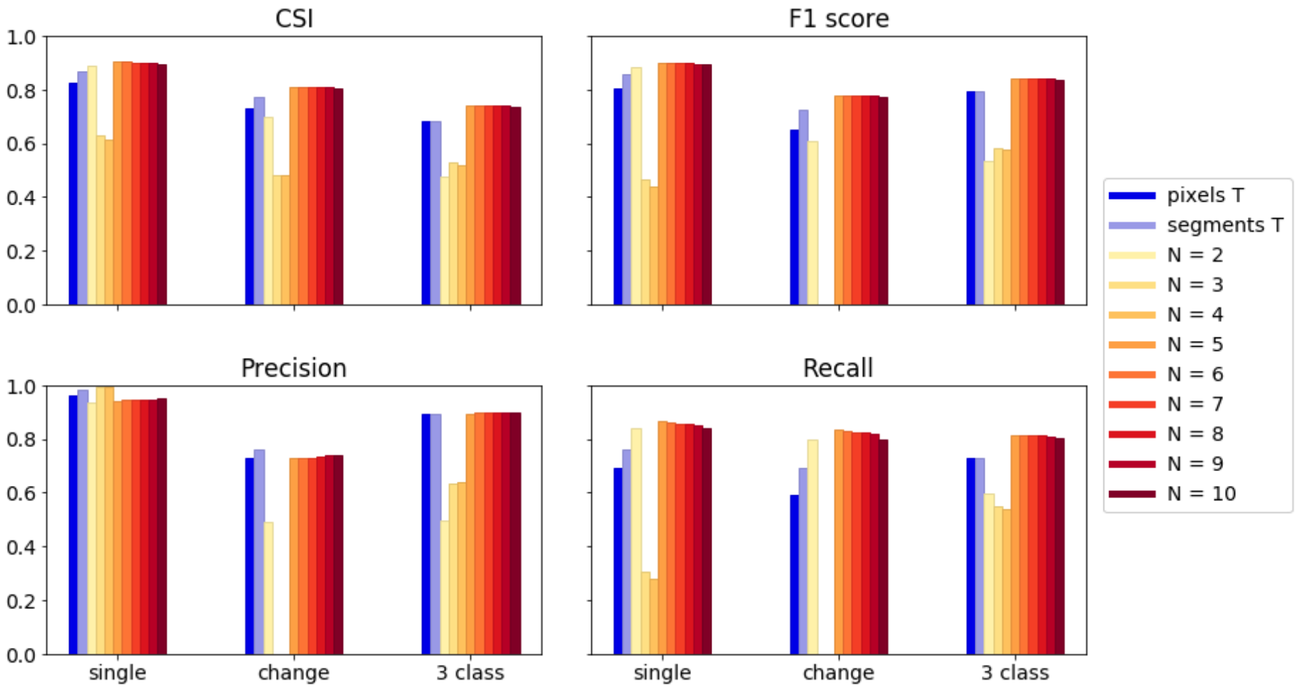
RESULTS – VISIBLE FLOODING

single: OF + PW vs. other

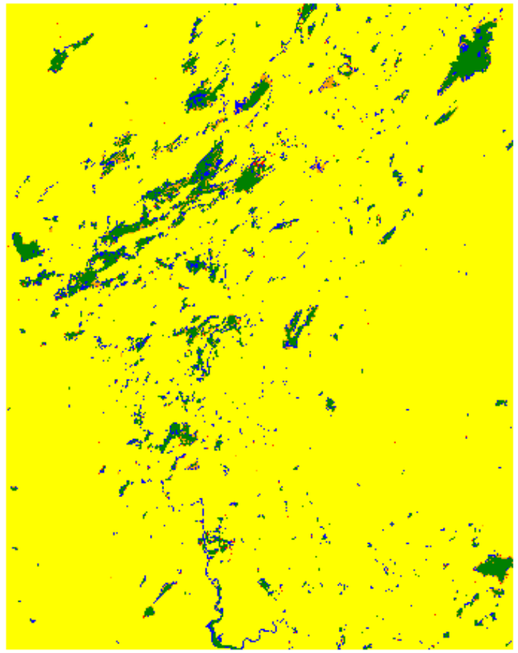
change: OF vs. other

3class: OF vs. PW vs. DL

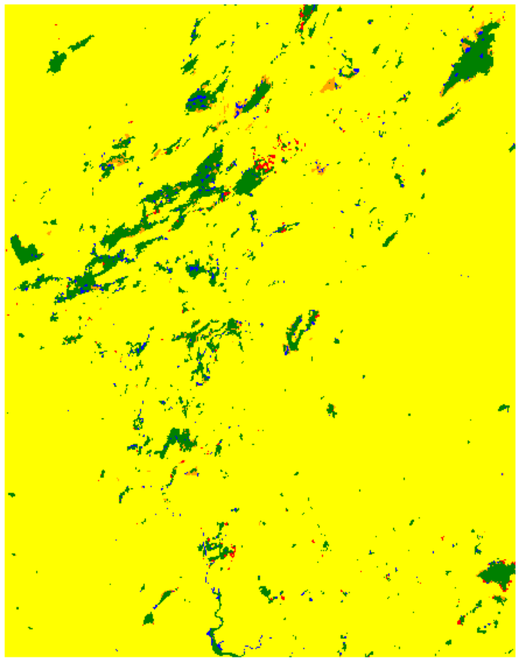
River Fergus – clustering on SAR mean features:



Pixel-based benchmark



Object-based clustering, N = 8



TN
TP
FN
FP
PW-flood confusion

→ Overclustering needed to fully capture the different classes

→ Improved accuracies compared to benchmark

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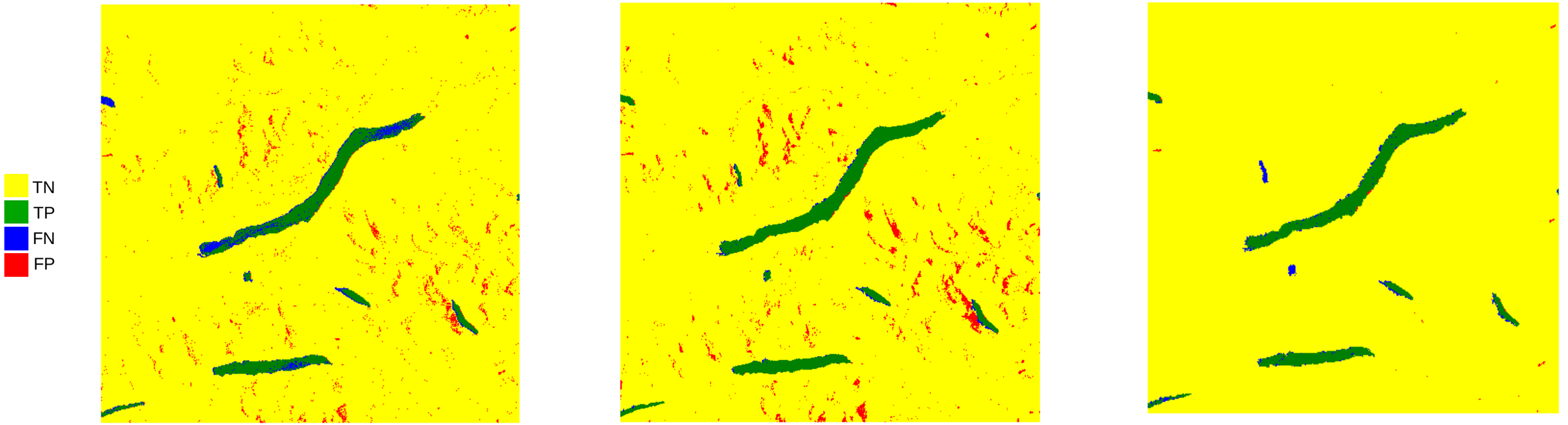
RESULTS – VISIBLE FLOODING

Lake Tay – clustering on SAR (+ HAND) mean features:

Pixel-based benchmark

Clustering on SAR mean features, N = 8

Clustering on SAR+HAND mean features, N = 8



→ Clustering-based classification limits false negatives due to wind roughening

→ Inclusion of HAND in clustering space (without additional classification rules) eliminates false positives due to radar shadow

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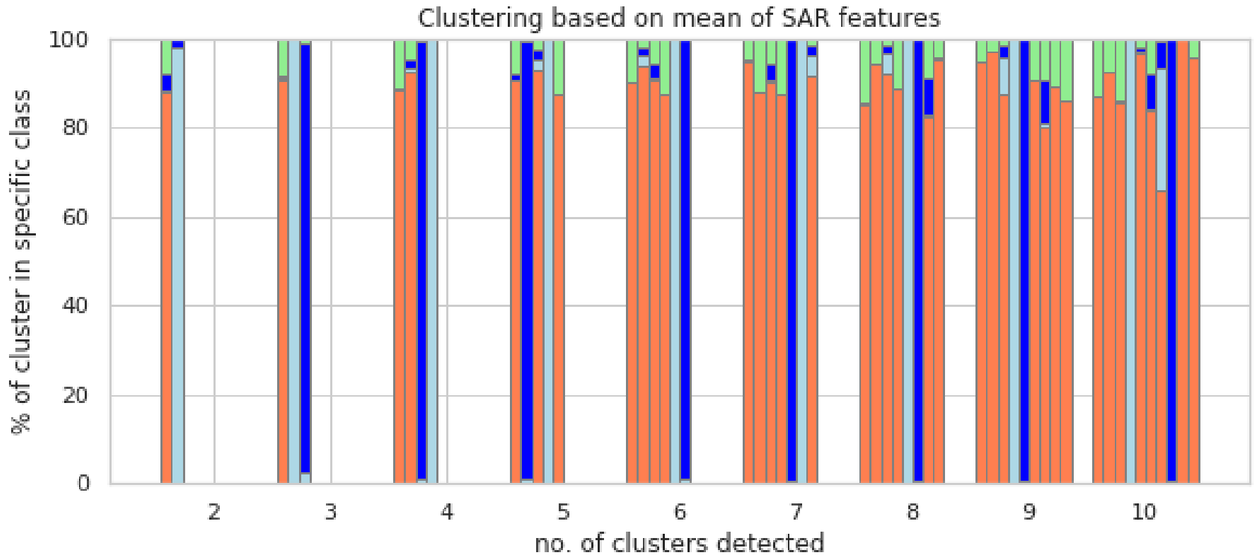
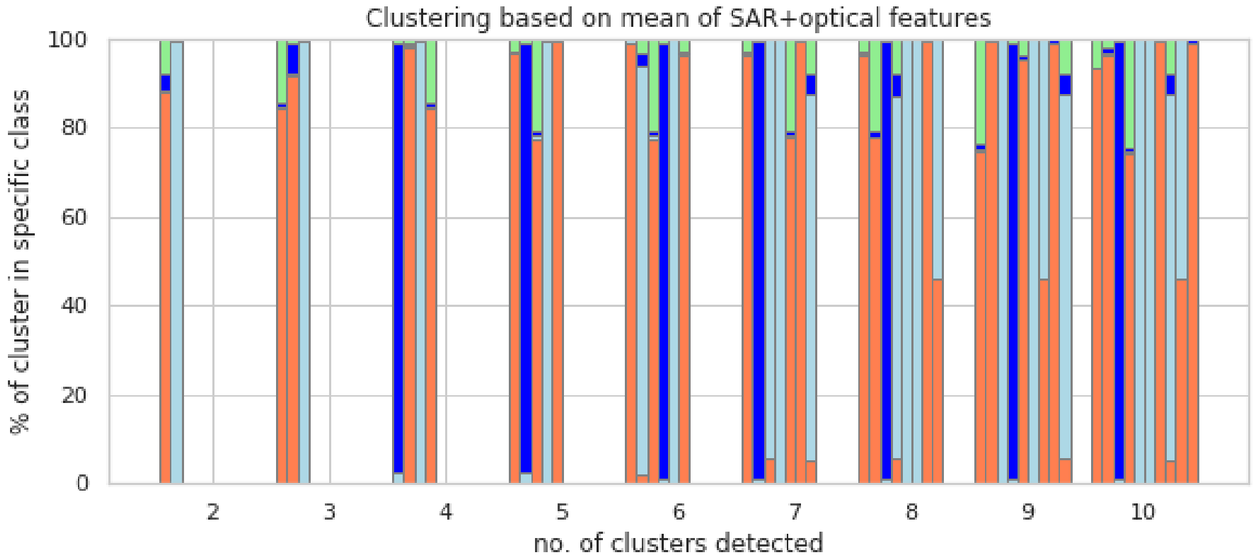
RESULTS – FLOODED VEGETATION

River Sava - clustering on SAR (+ optical) features:

Does clustering algorithm find a FV cluster?





→ FV class never captured as “pure” cluster (i.e. no fully green bars)

→ C-band does not allow for detection of FV purely based on spectral information

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CONCLUSIONS AND FUTURE PERSPECTIVES

- By taking into account the inherent data structure, object-based clustering approach leads to improved accuracies compared to thresholding benchmarks for visible flooding
- Unsupervised clustering is not capable of capturing flooded vegetation as a separate cluster/class

- (Potential) FV areas might be flagged by means of context-based post-processing
- Inclusion of time series information might improve characterization of vegetation

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