The optimal processing chain for flood mapping using polarimetric SAR in a temperate zone wetland

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Study area and data

- Biebrza basin, located in northeastern Poland

- The low vegetation: sedges, reeds, scrubs, meadows, and high vegetation: alder forests

- Radarsat 2 C-band image

- Field measurements and radar image obtained during spring conditions (end of march 2019)

POLAND

FVA

FVB

DV

DV
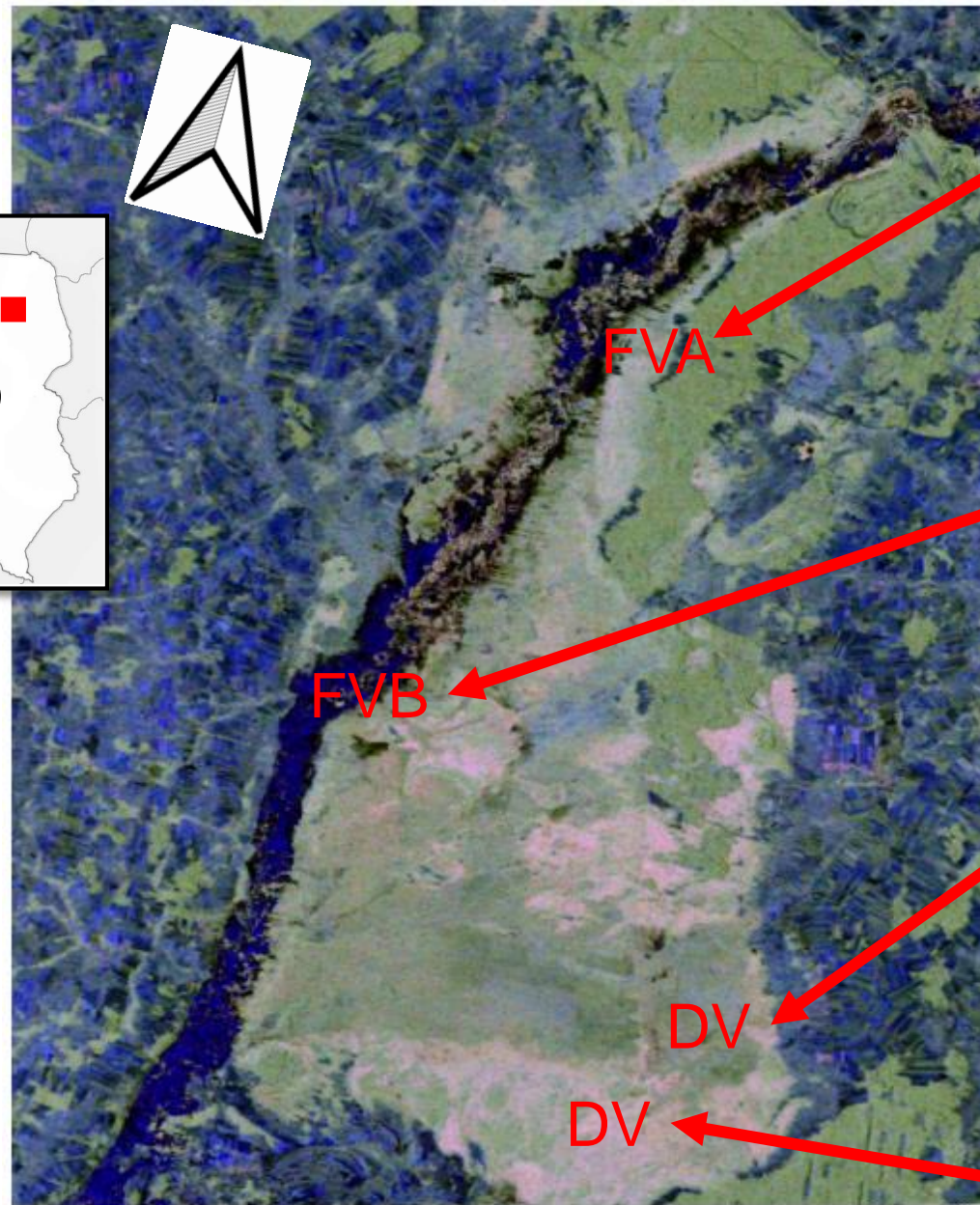
DV– dense vegetation
FVA – flooded vegetation>10cm
FVB – flooded vegetation<10cm

0 2 4 6 km
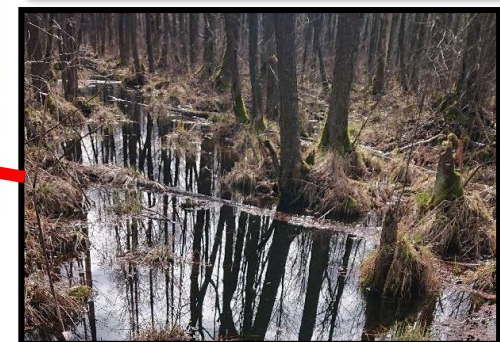
Methodology

Filter window size
(except NL-SAR):
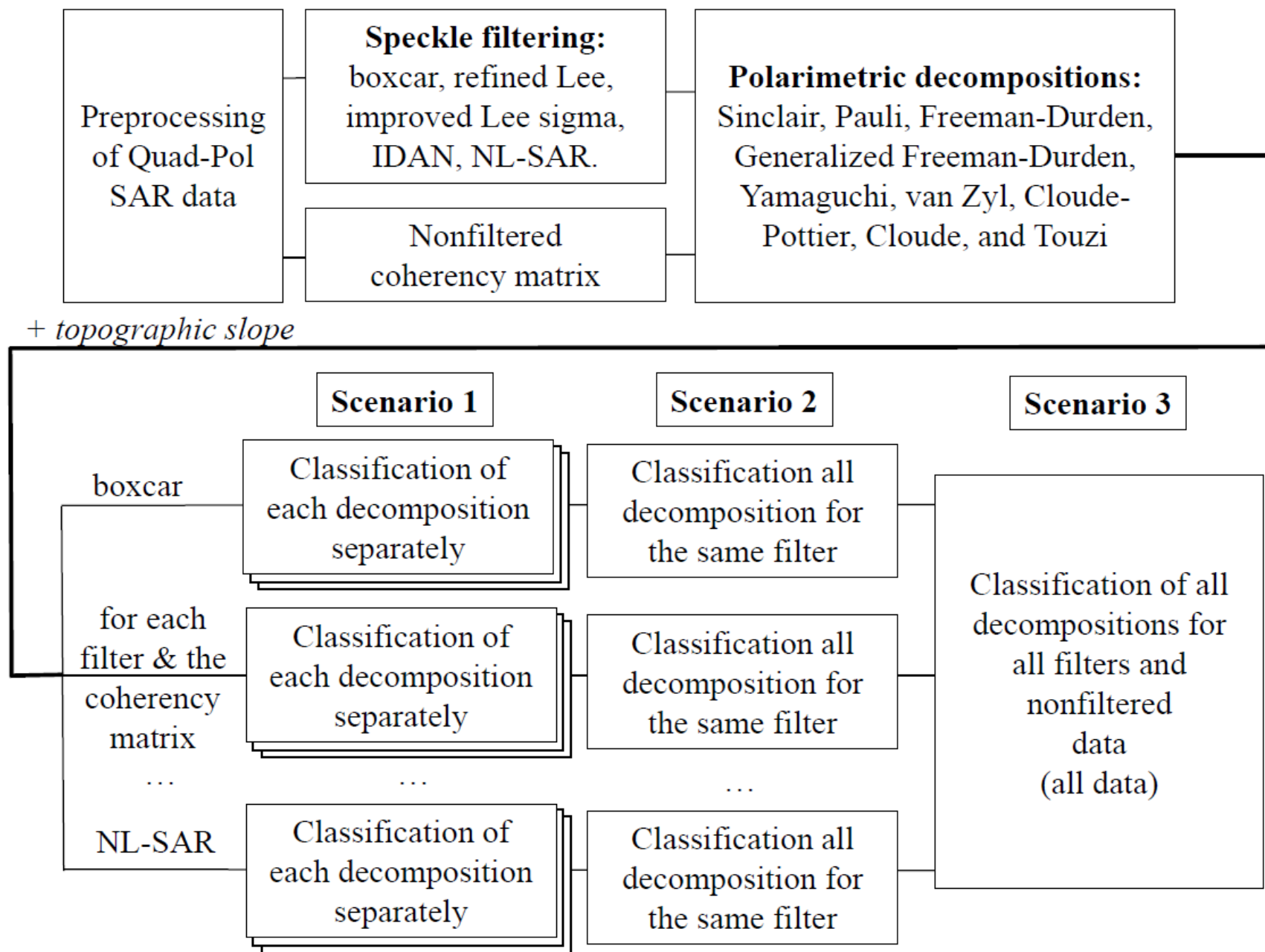- 5x5
- 7x7
- 9x9
- 11x11

Decomposition window size
(except Sinclair and Pauli):
- 5x5
- 7x7
- 9x9
- 11x11

Classification algorithm:
- Random forest

Preprocessing of Quad-Pol SAR data	**Speckle filtering:** boxcar, refined Lee, improved Lee sigma, IDAN, NL-SAR.	**Polarimetric decompositions:** Sinclair, Pauli, Freeman-Durden, Generalized Freeman-Durden, Yamaguchi, van Zyl, Cloude-Pottier, Cloude, and Touzi
	Nonfiltered coherency matrix	

+ topographic slope

Scenario 1 | **Scenario 2** | **Scenario 3**

boxcar — Classification of each decomposition separately | Classification all decomposition for the same filter

for each filter & the coherency matrix — Classification of each decomposition separately | Classification all decomposition for the same filter | Classification of all decompositions for all filters and nonfiltered data (all data)

… | … | …

NL-SAR — Classification of each decomposition separately | Classification all decomposition for the same filter

Classification accuracy for all models

Decomposition	Median accuracy [%]
Cloude-Pottier (C-P)	**66.4**
Cloude	54.6
Freeman-Durden (F-D)	58.2
Gen. Freeman-Durden (G F-D)	58.4
Pauli (PL)	59.7
Sinclair (SR)	58.4
Touzi	50.6
van Zyl	59.5
Yamaguchi	59.9

| Filter	Median accuracy [%]
Nonfiltered (NF)	54.0
Boxcar (BC)	56.8
IDAN	**61.6**
Improved Lee sigma (ILS)	58.4
Refined Lee (RL)	57.6
Nonlocal NL-SAR (NL)	60.7
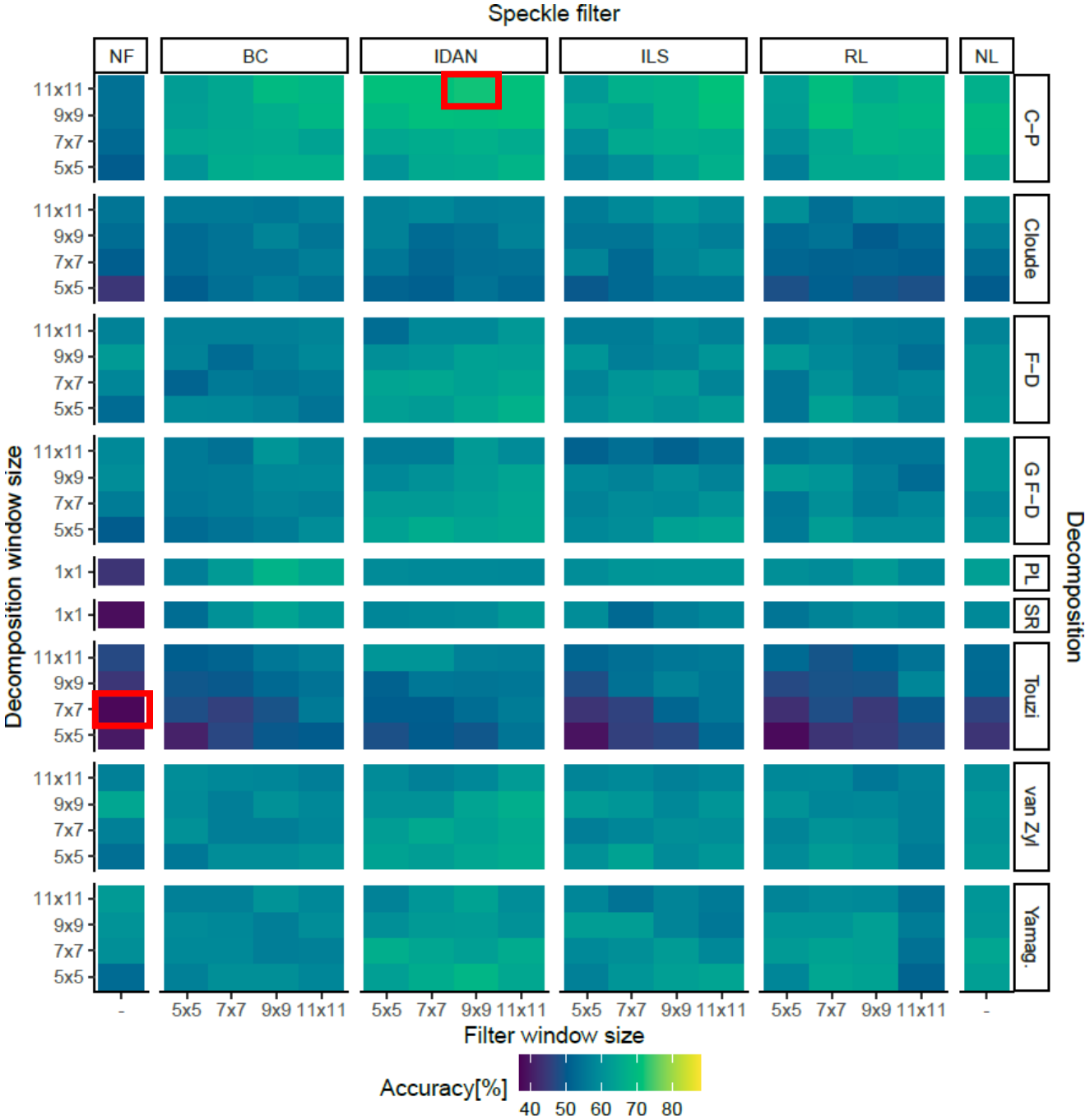
Speckle filtering effect – visual comparison
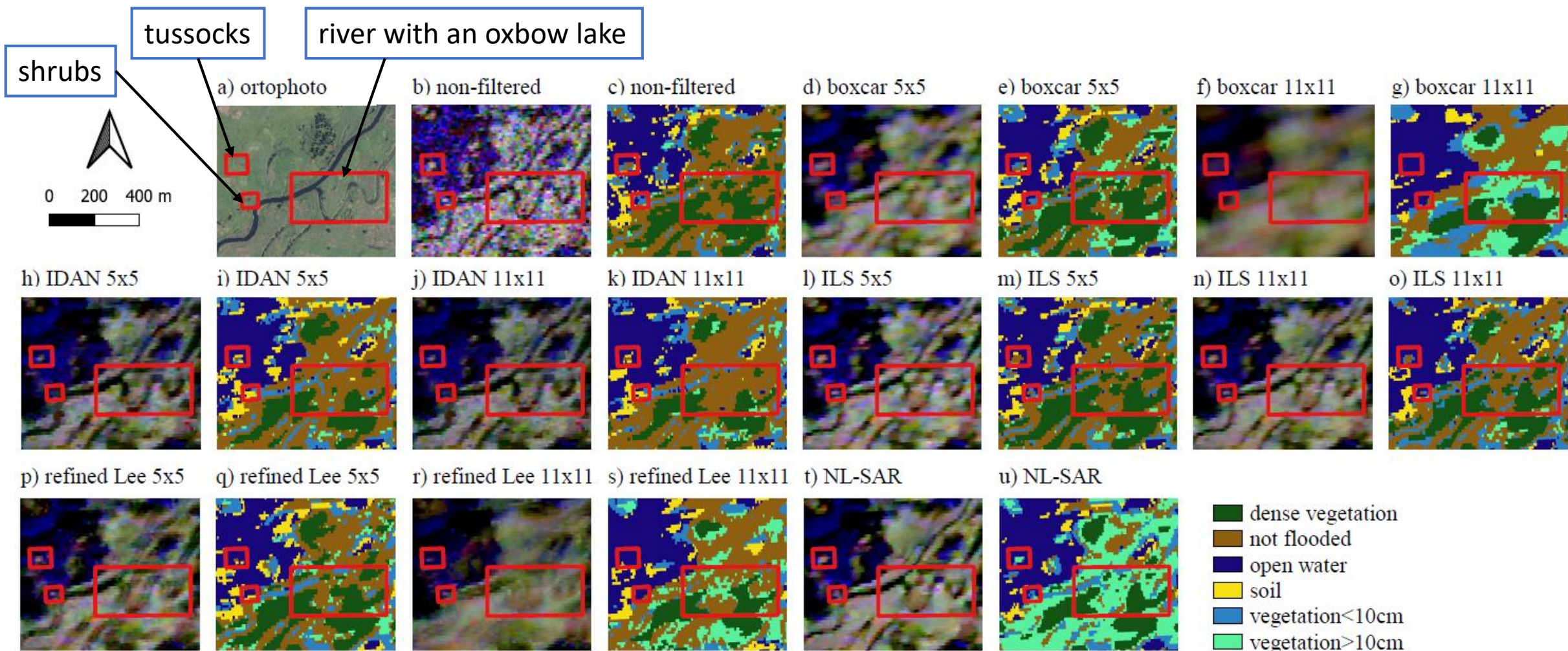
5x5 and 11x11 – filter window size
ILS – improved Lee sigma

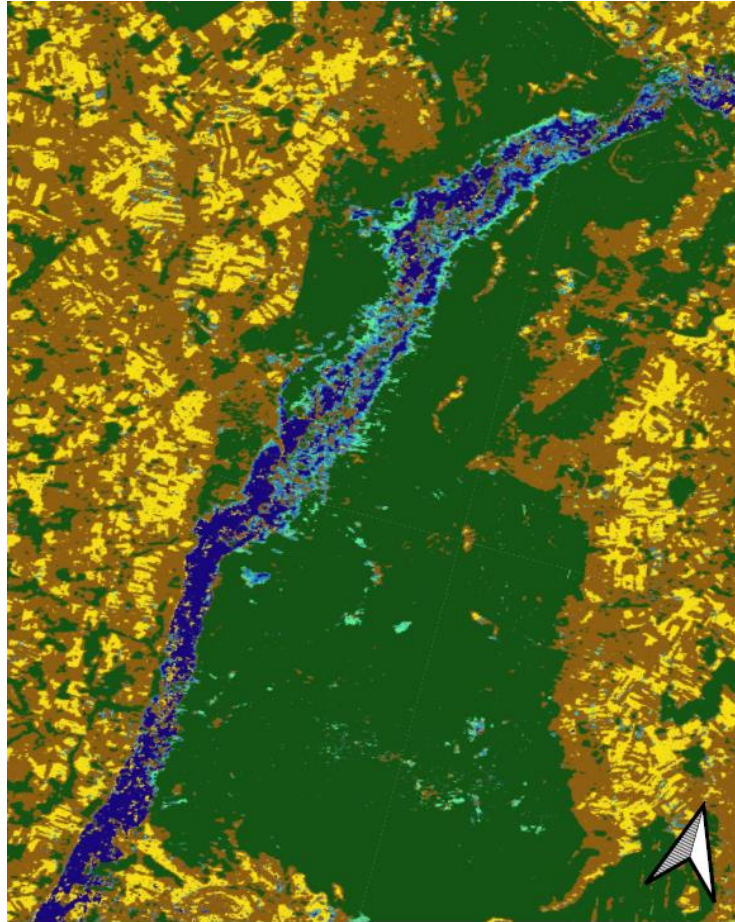# The best classification accuracy in scenarios 1-3

Scenario 1:
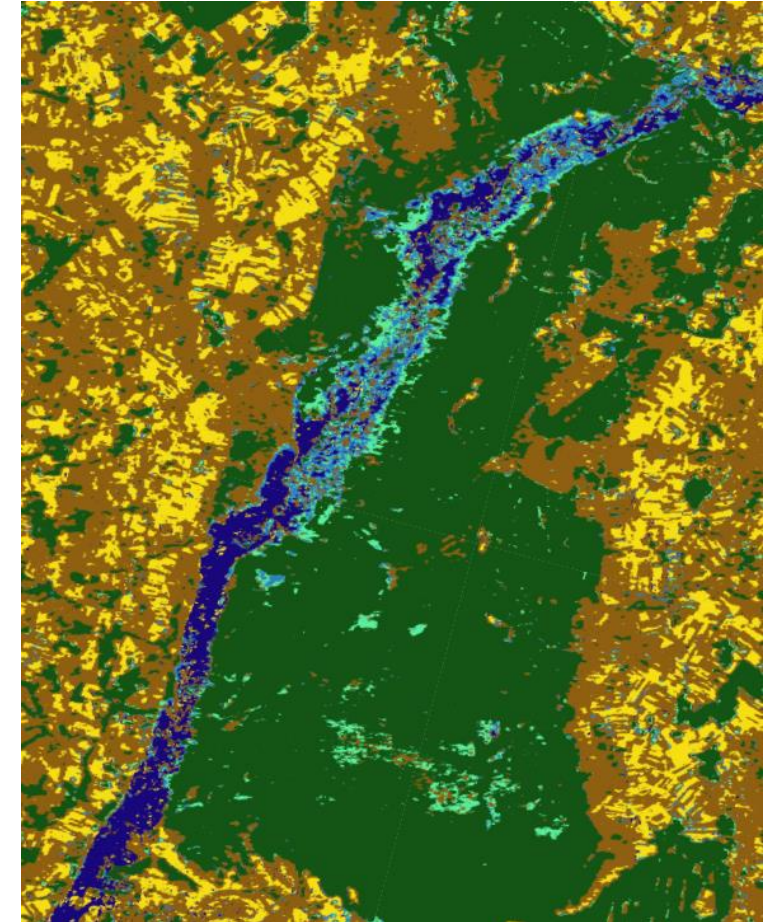Cloude-Pottier in 11x11 window and IDAN in 9x9 window (overall accuracy =72%)
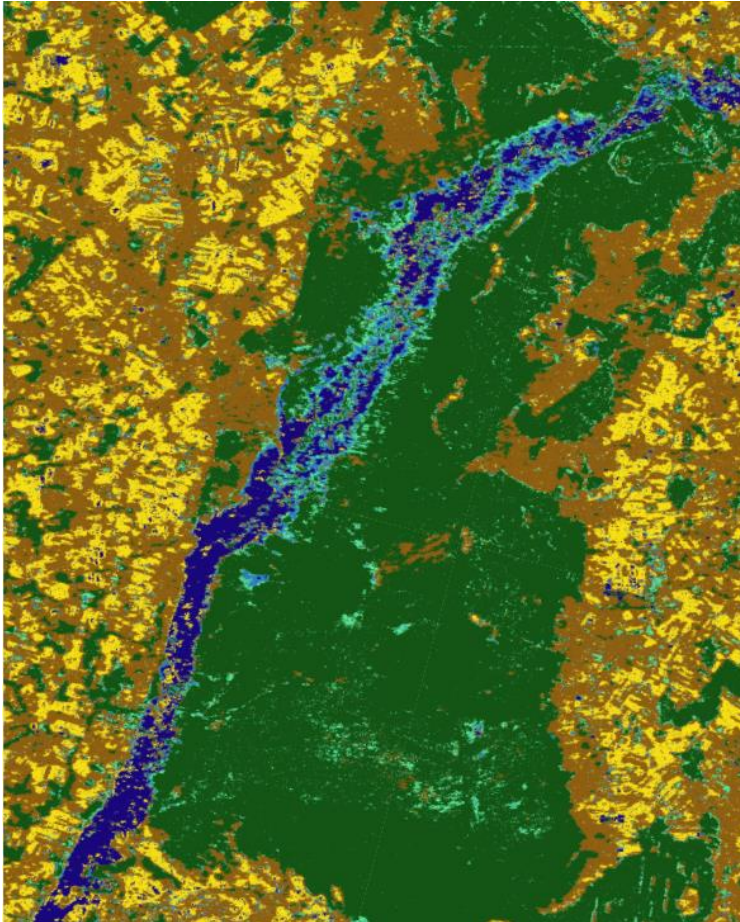
Scenario 2:
All decompositions in 9x9 window and IDAN in 11x11 window (overall accuracy =84%)

Scenario 3:
All filters and decomposition in the 11x11 window (overall accuracy =86%)

dense vegetation
open water
flooded vegetation<10cm
not flooded terrain
soil
flooded vegetation>10cm

2 0 2 4 km

Summary

- It **was not possible** to distinguish between flooded and not flooded **dense vegetation**, such as reed, forest and high tussocks were even in dry, early spring conditions using **C band**.

- Calculation of all decompositions is time consuming. Using the **Cloude-Potier** (H-A-a) together with **van Zyl, Yamaguchi and Pauli** decompositions processed with **IDAN** speckle filter should provide good classification.

- In general, the **improved Lee sigma** and **IDAN** filters with **large window** and **nonlocal** filter provided **more accurate** models than **refined Lee** and **boxcar** filters.

- A **small decomposition window** provided higher classification accuracy for **model-based** decompositions, and a **large** one for **eigenvector-based** decompositions.