Mapping of land covers in South Greenland using very high resolution satellite imagery

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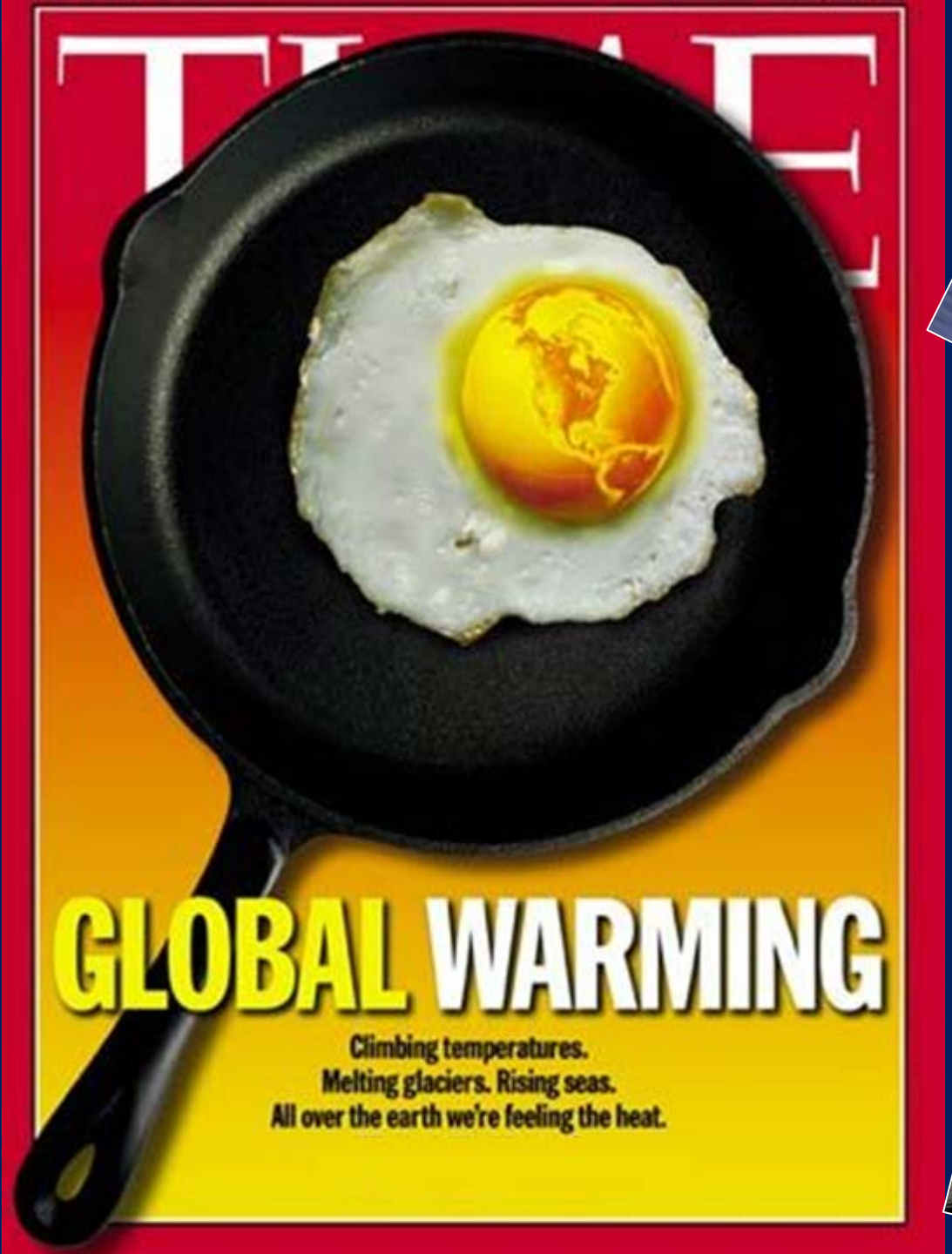
Outline: Introduction - Data used - Methods - Results


GLOBAL WARMING
Climbing temperatures.
Melting glaciers. Rising seas.
All over the earth we're feeling the heat.

‘Arctic warming , a boon’

‘Arctic warming, a boon’

Arctic to sub-arctic

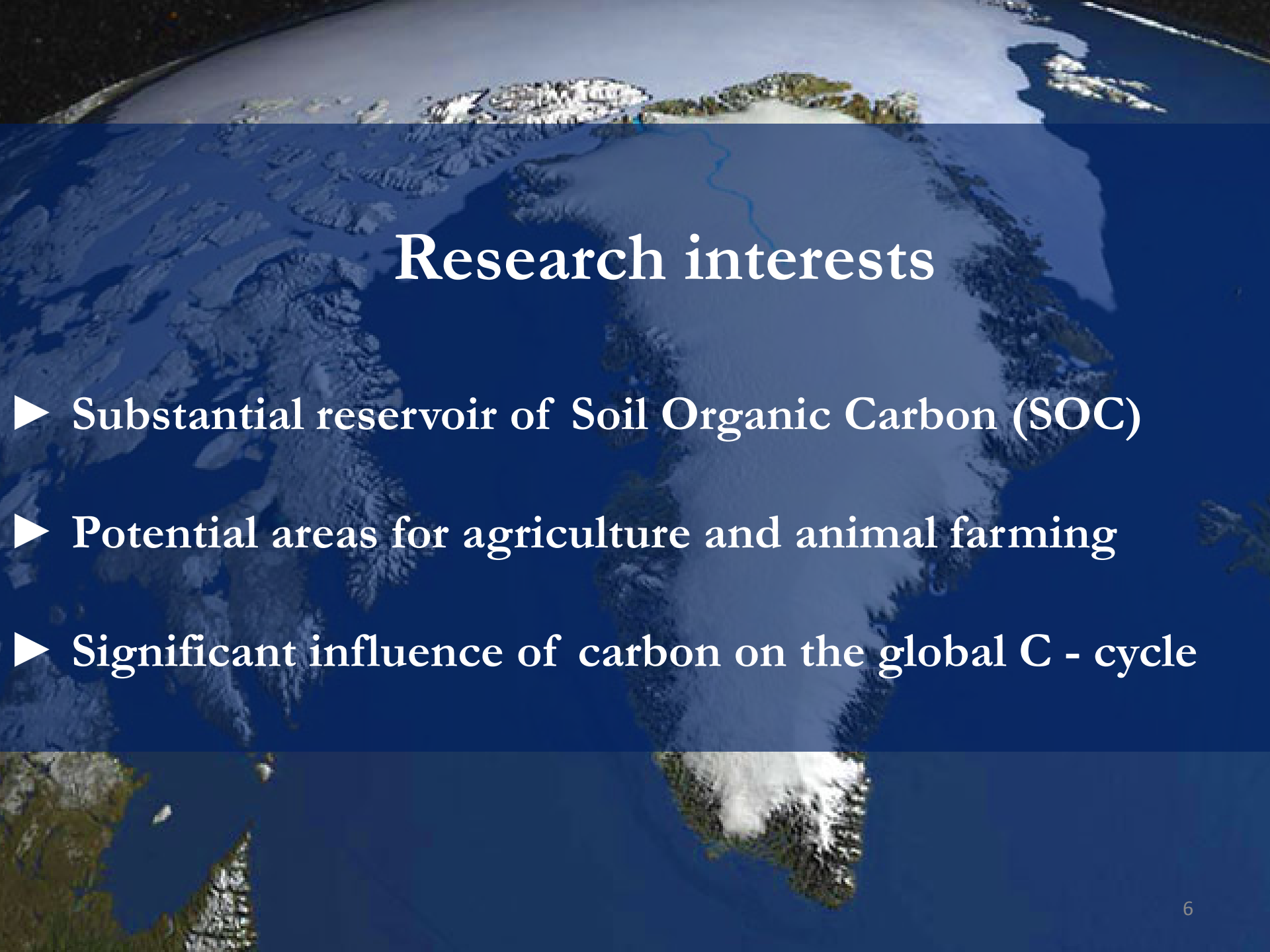
8 to 12°C increment

ipcc

INTERGOVERNMENTAL PANEL ON climate change

WMO UNEP

Agriculture in young soil

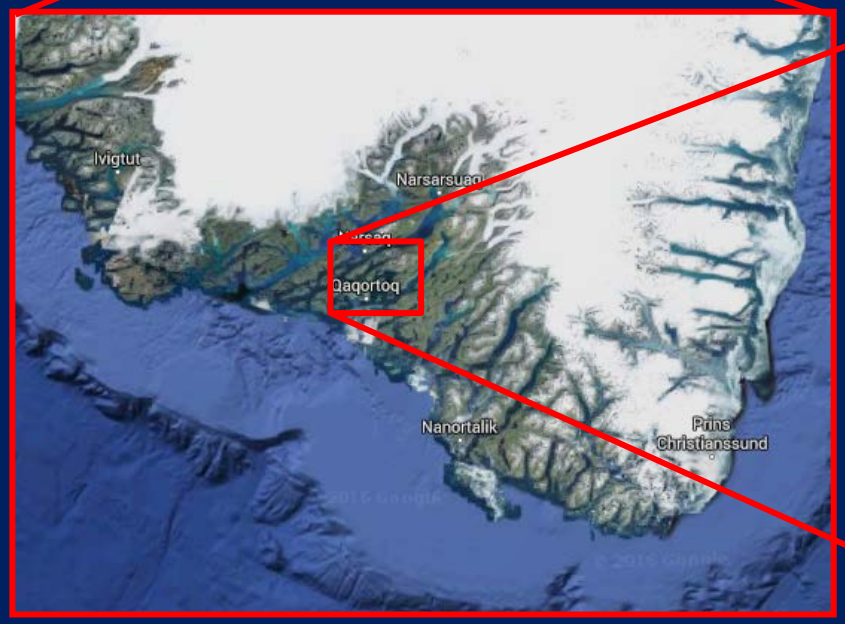


Research interests

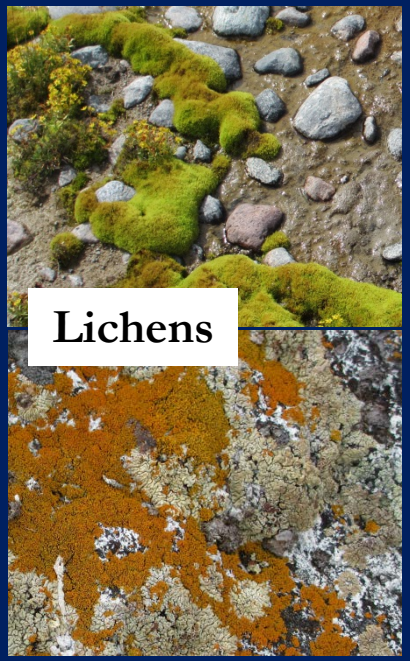
- Substantial reservoir of Soil Organic Carbon (SOC)
- Potential areas for agriculture and animal farming
- Significant influence of carbon on the global C - cycle

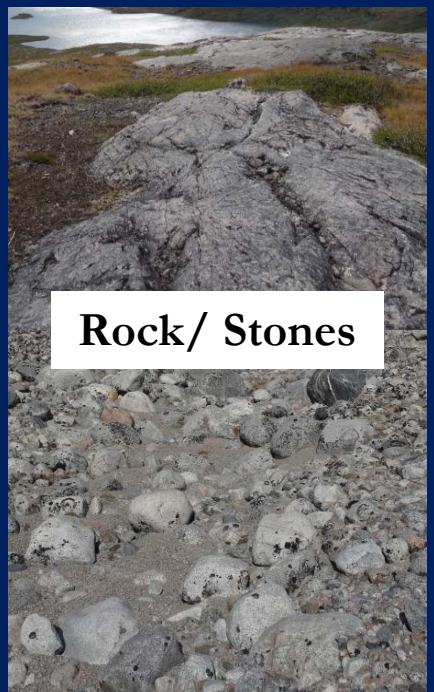
Study area

- Upernaviarssuk, 17,500 km²
- Focus on top soil, down to 25 cm depth
- Land cover map for SOC upscaling



Land cover classes





Sampling

- 780 land cover samples
- Cluster sampling

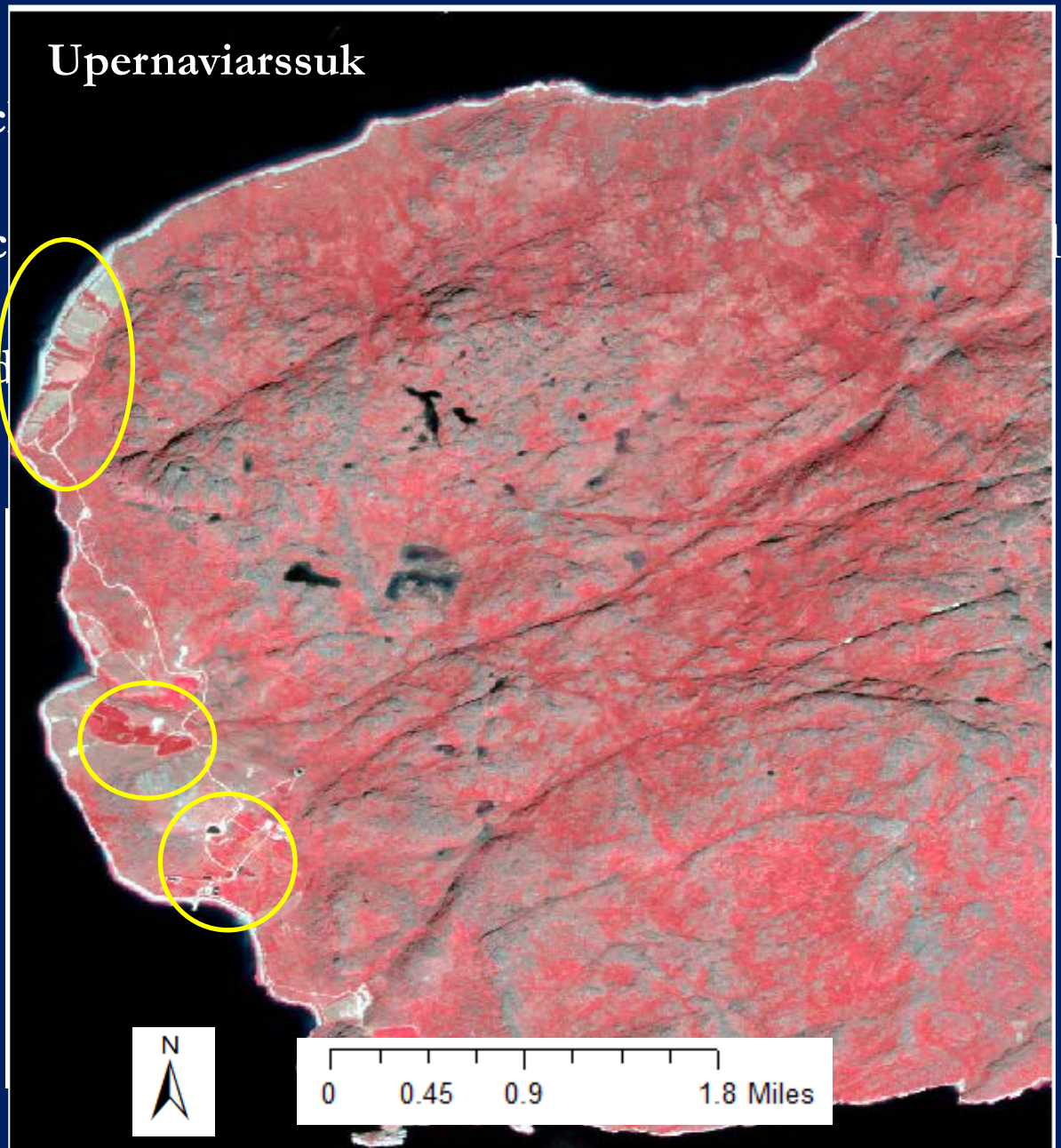
eBee drone

Satellite :Worldview2

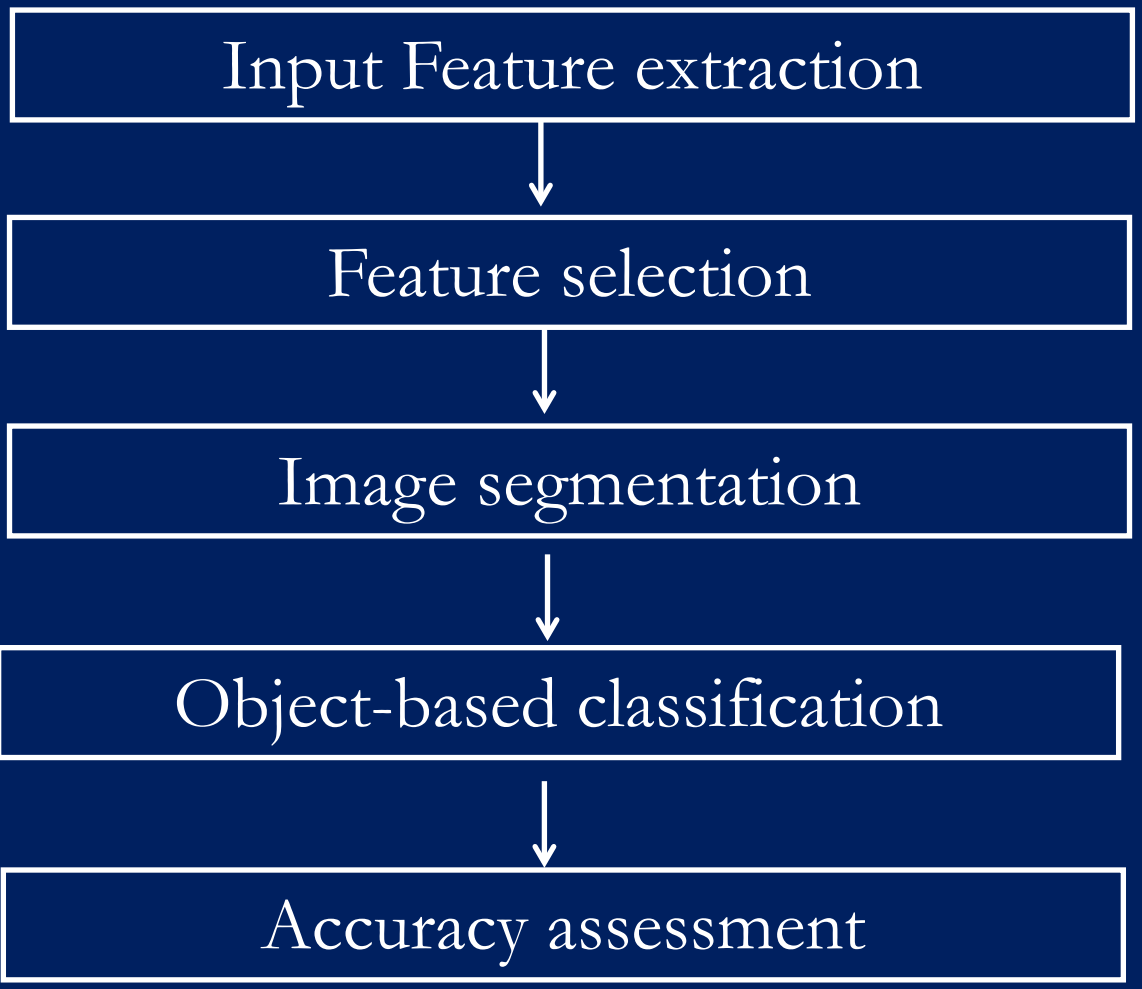
Field visit

Worldview 2 Very High Resolution (VHR) satellite imagery

- Launc
- First c l resolution
- 8 banc



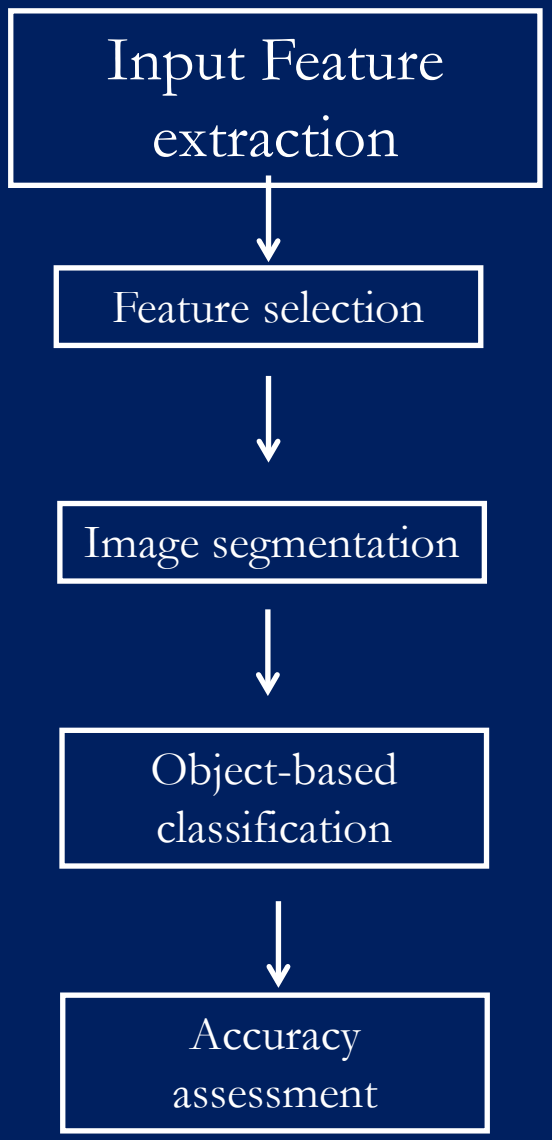
Object-based supervised classification method



Comparison: 4 traditional band vs 8 bands

Object-based supervised classification method

- 215 from 4 bands / 392 from 8 bands, Matlab R2016a
- Spectral reflectances from each band
- Gabor texture from each band (5 frequencies and 8 orientations)
- Gabor texture from1st principal component from spectral bands
- Spectral indices (water, soil, pigment, yellowness, biomass)



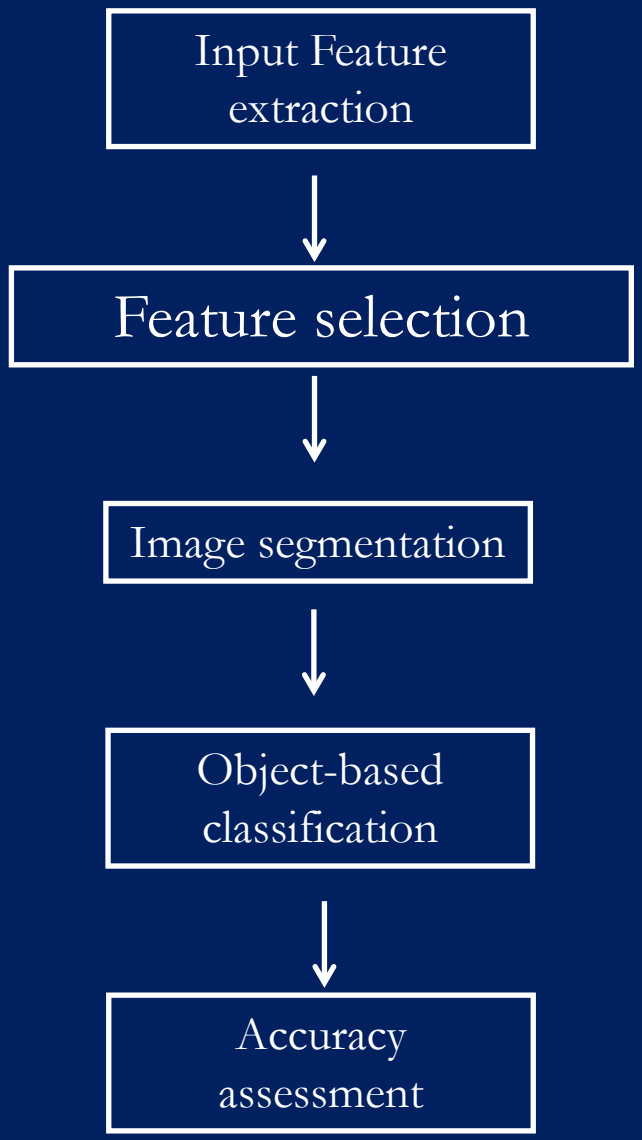
Object-based supervised classification method

- Weka system (Novack et al, 2011)

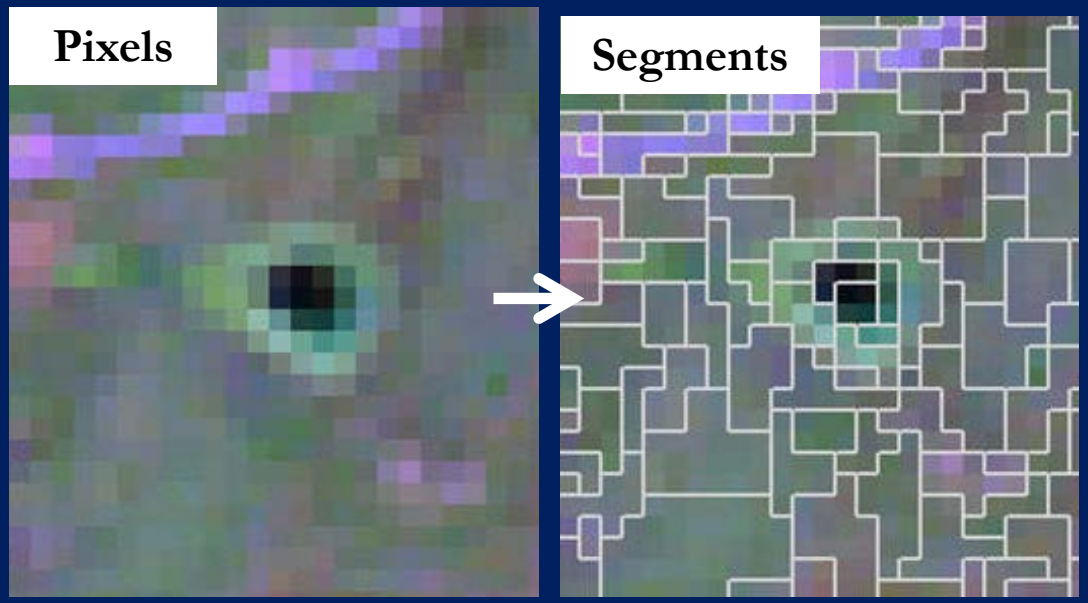
- Random Forest (RF)
- Fast Correlation-Based Filter (FCBF),
- InfoGain (IG)
- Relief-F (Re-F).

- 5 most relevant features from each algorithm are selected

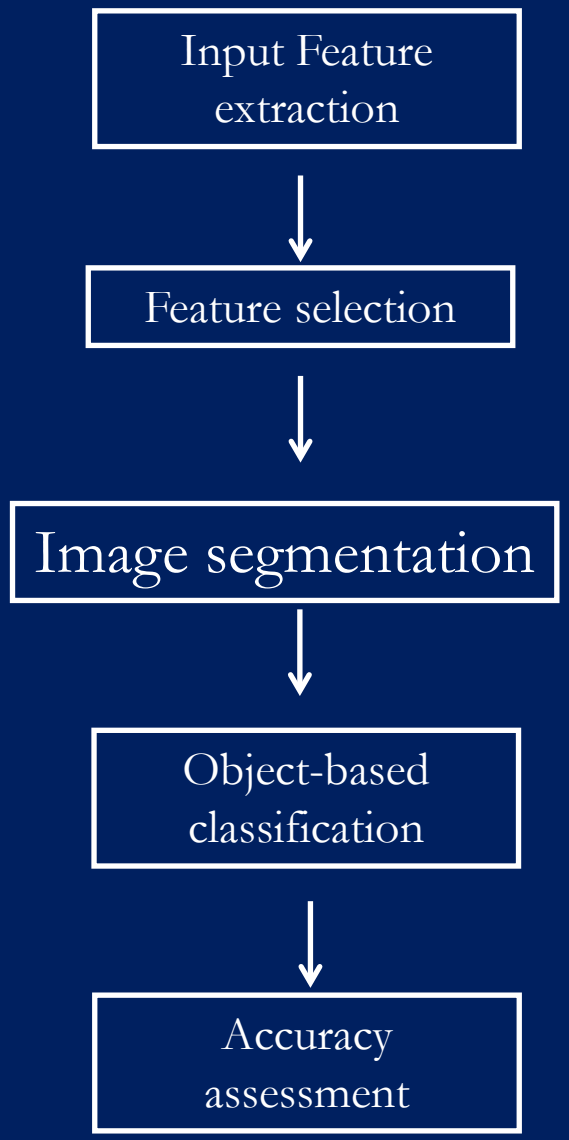
- 12 for 4 band / 18 for 8 band



Object-based supervised classification method

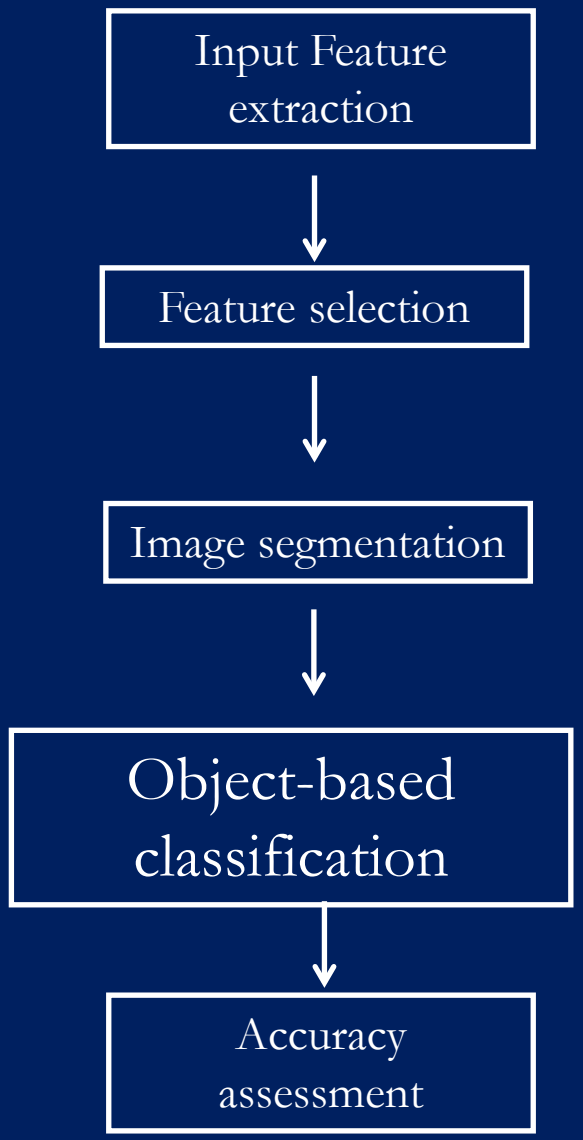


- Multi-resolution segmentation, eCognition 9.1
- Scale 30, 50, 70, 100
- compactness: 0.5, smoothness: 0.5, color: 0.9 and shape: 0.1



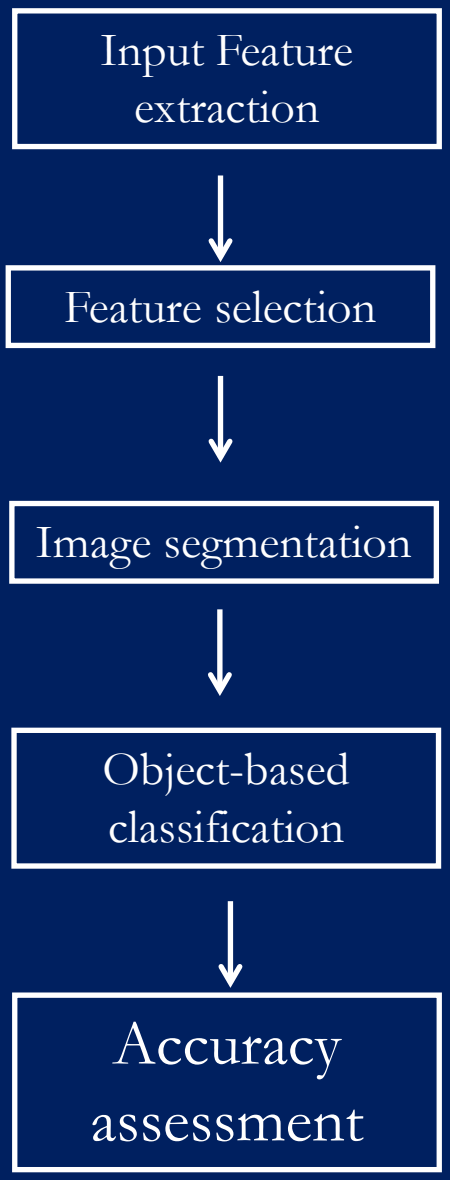
Object-based supervised classification method

- 448 training image objects, Matlab R2016a
- 70 as base scale for classification
- mean; standard deviation; mean difference to neighbors; mean difference to scene; mean and standard deviation difference to super and sub objects;
- Support vector machine: radial basis function.



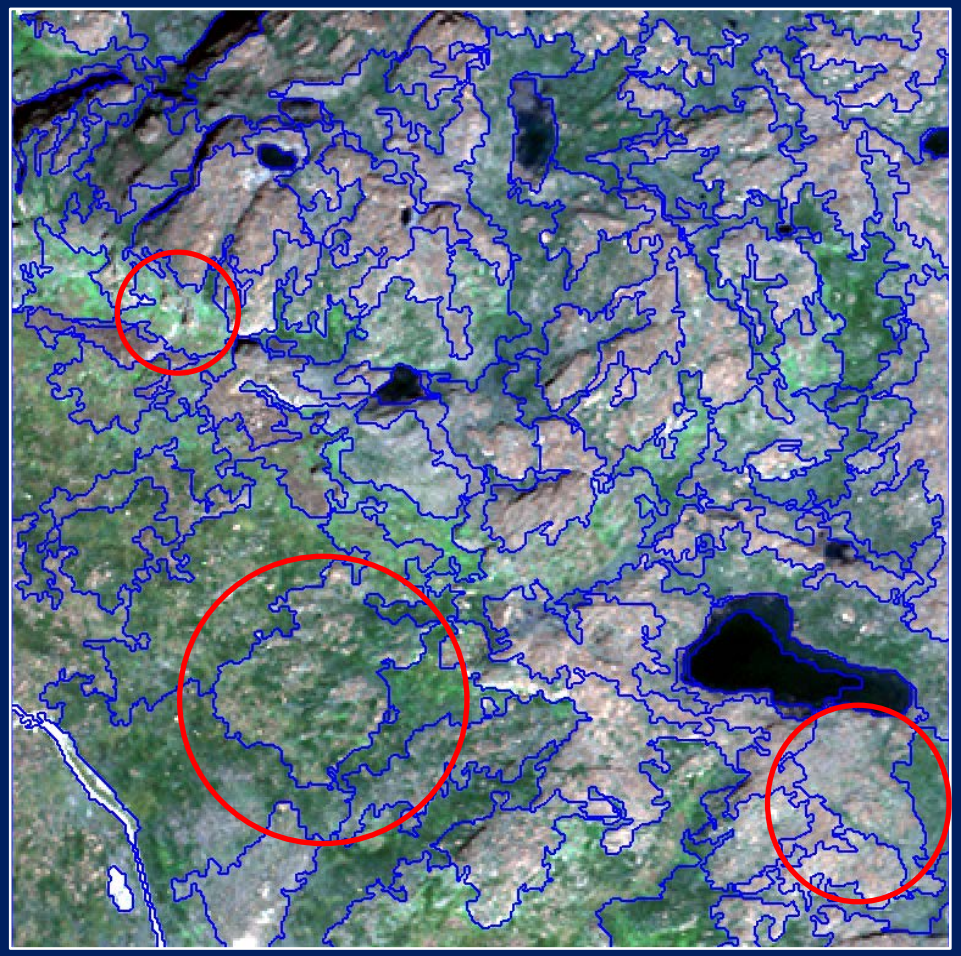
Object-based supervised classification method

- 224 image objects for validation, Matlab R2016a
- Overall classification accuracy (OA), user and producer accuracy, 95% confidence level
- Uncertainity analaysis based on prediction probabilty (Cohen 1985)

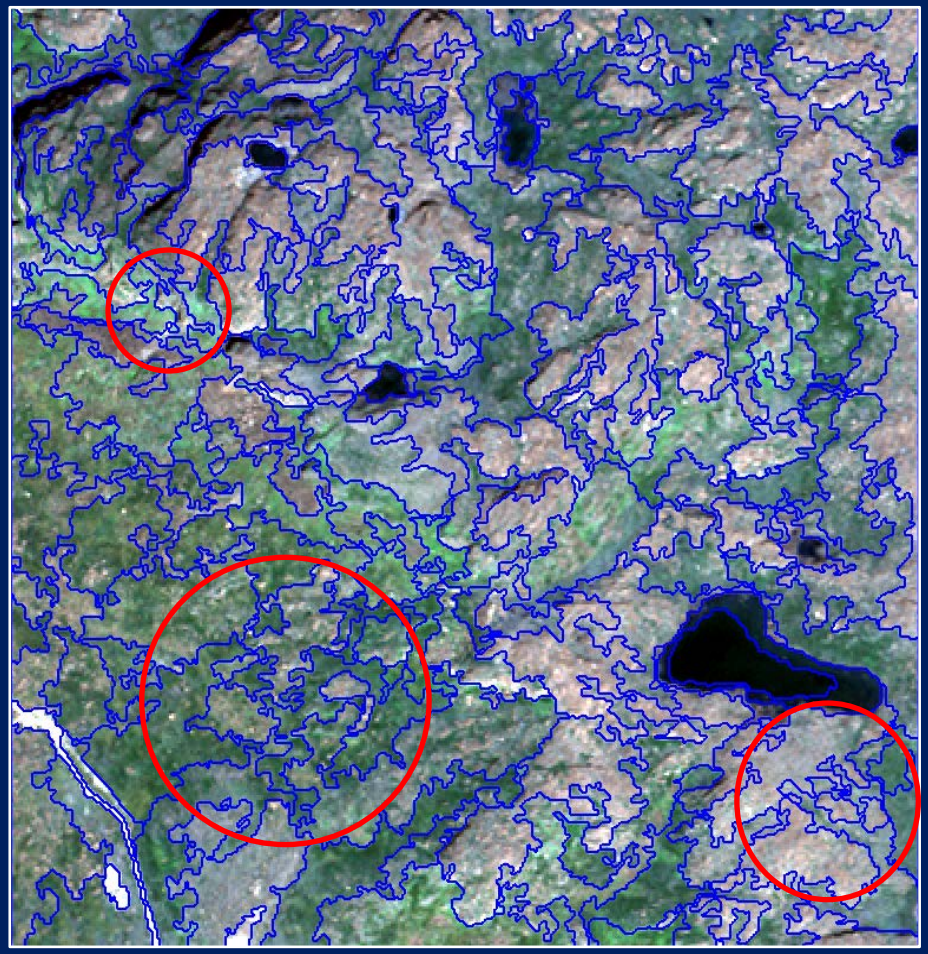


Segmentation results, Scale 70

4 traditional bands

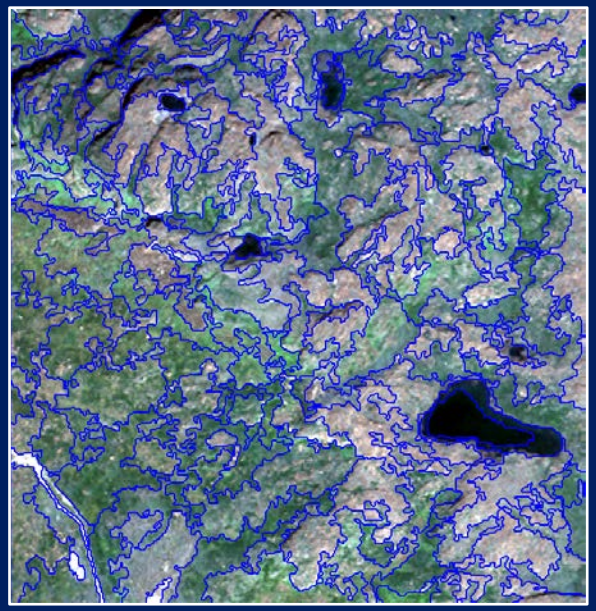


8 bands

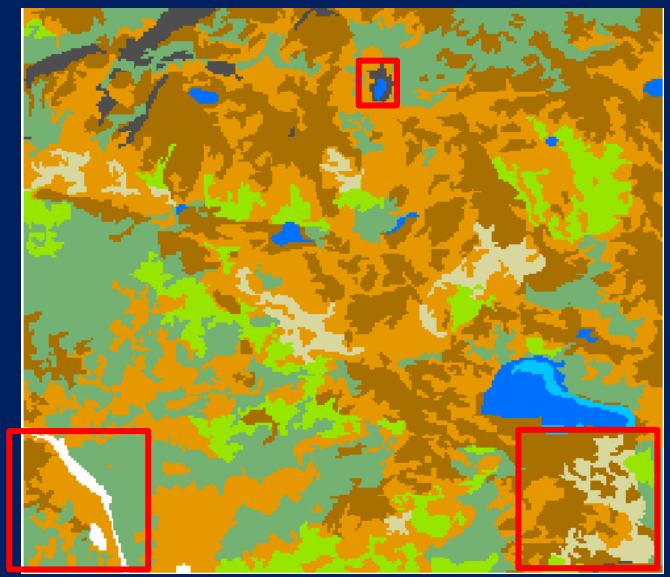


Classification results, Scale 70

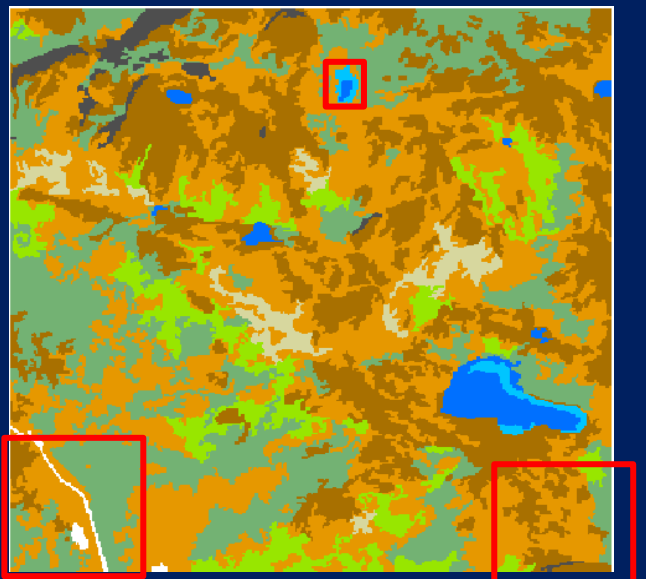
Segmented image



4 traditional bands

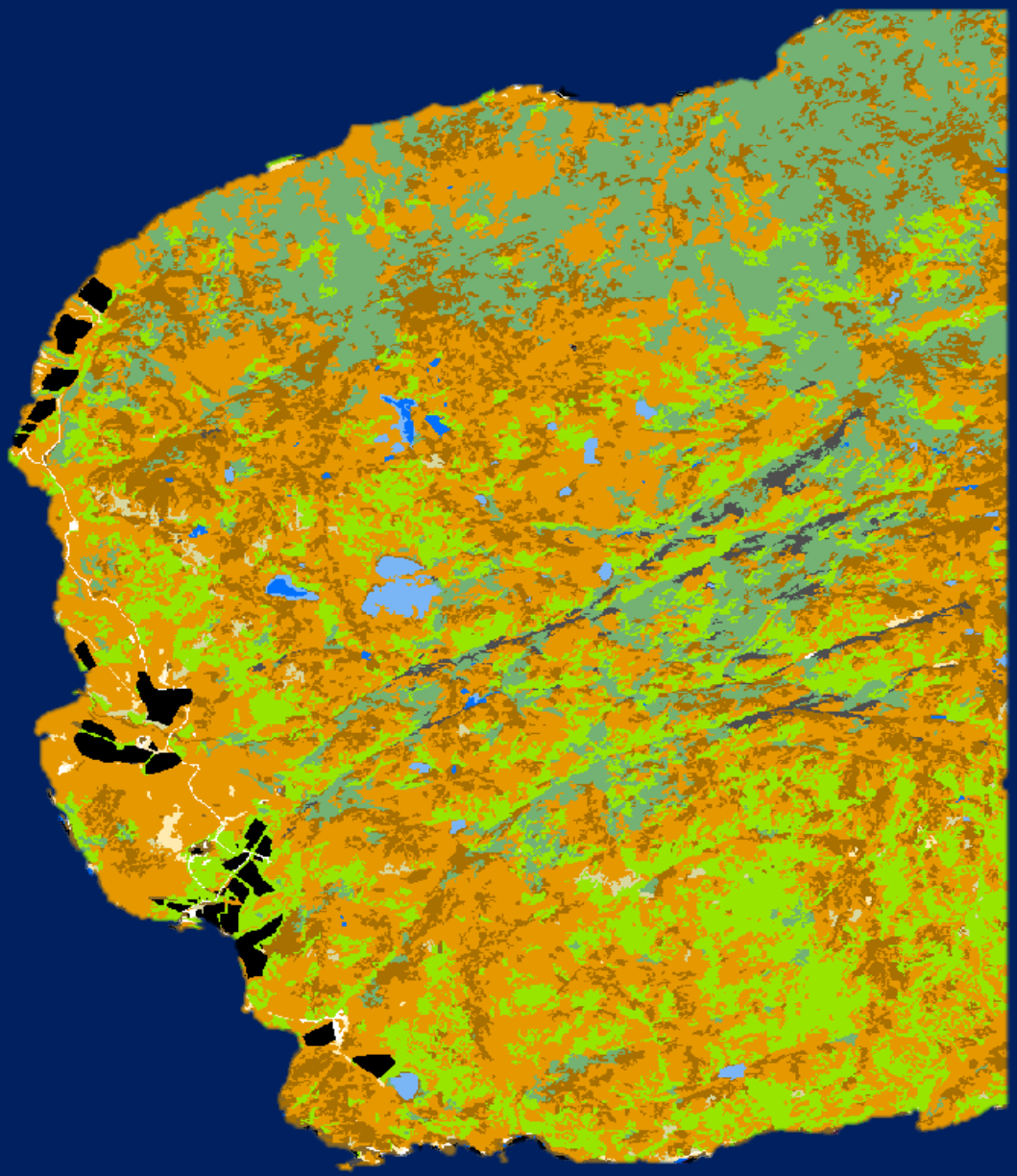


8 bands



- Shrub
- Lichens
- Grass
- Rock/stones
- Road
- Soil
- Sand
- Water
- Shallow water
- Shadow

Classification results, Scale 70



- Shrub (27,6 %)
- Lichens (2,3%)
- Grass (20,5%)
- Rock/stones (11,2%)
- Road (1,5%)
- Soil (32,1%)
- Sand (2,3)
- Water (1,8%)
- Shallow water (0,3%)
- Shadow (0,5%)

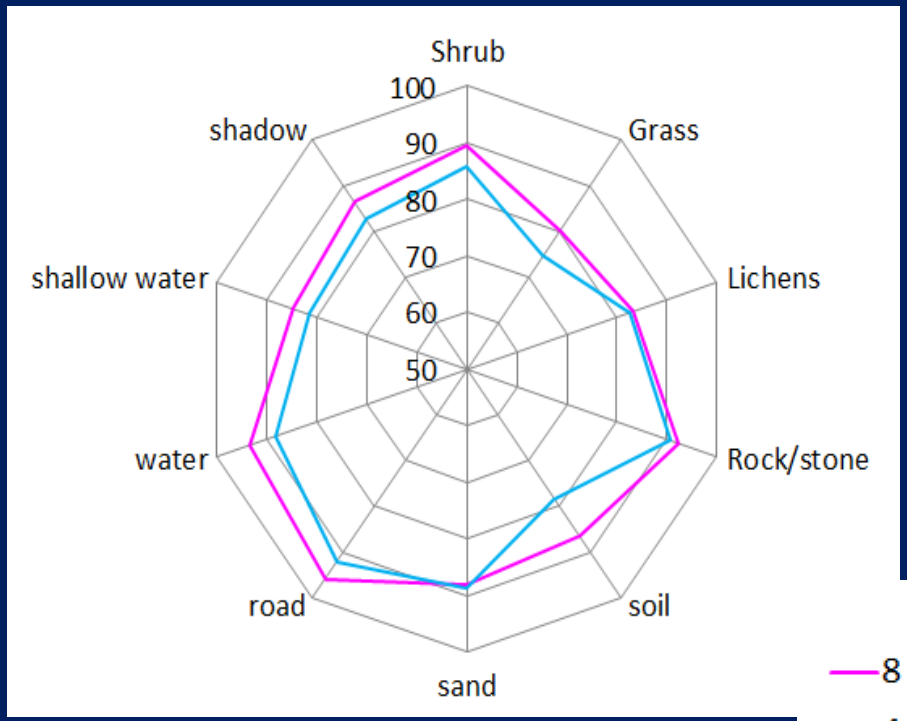
Classification accuracy

Overall classification accuracy:

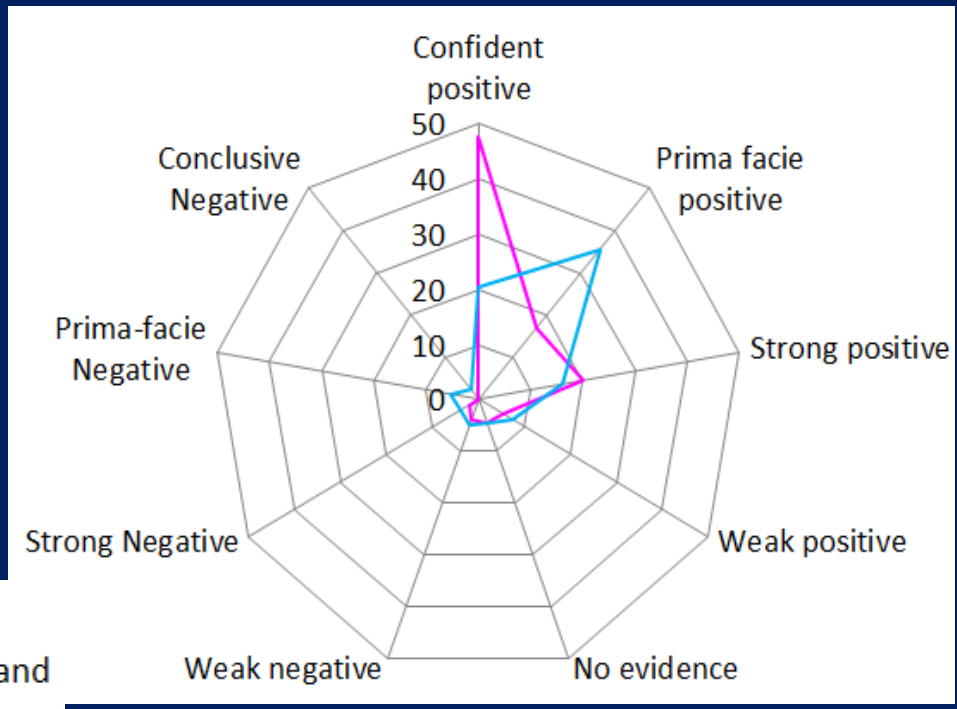
4 traditional bands 82.5%

8 bands 89.3%

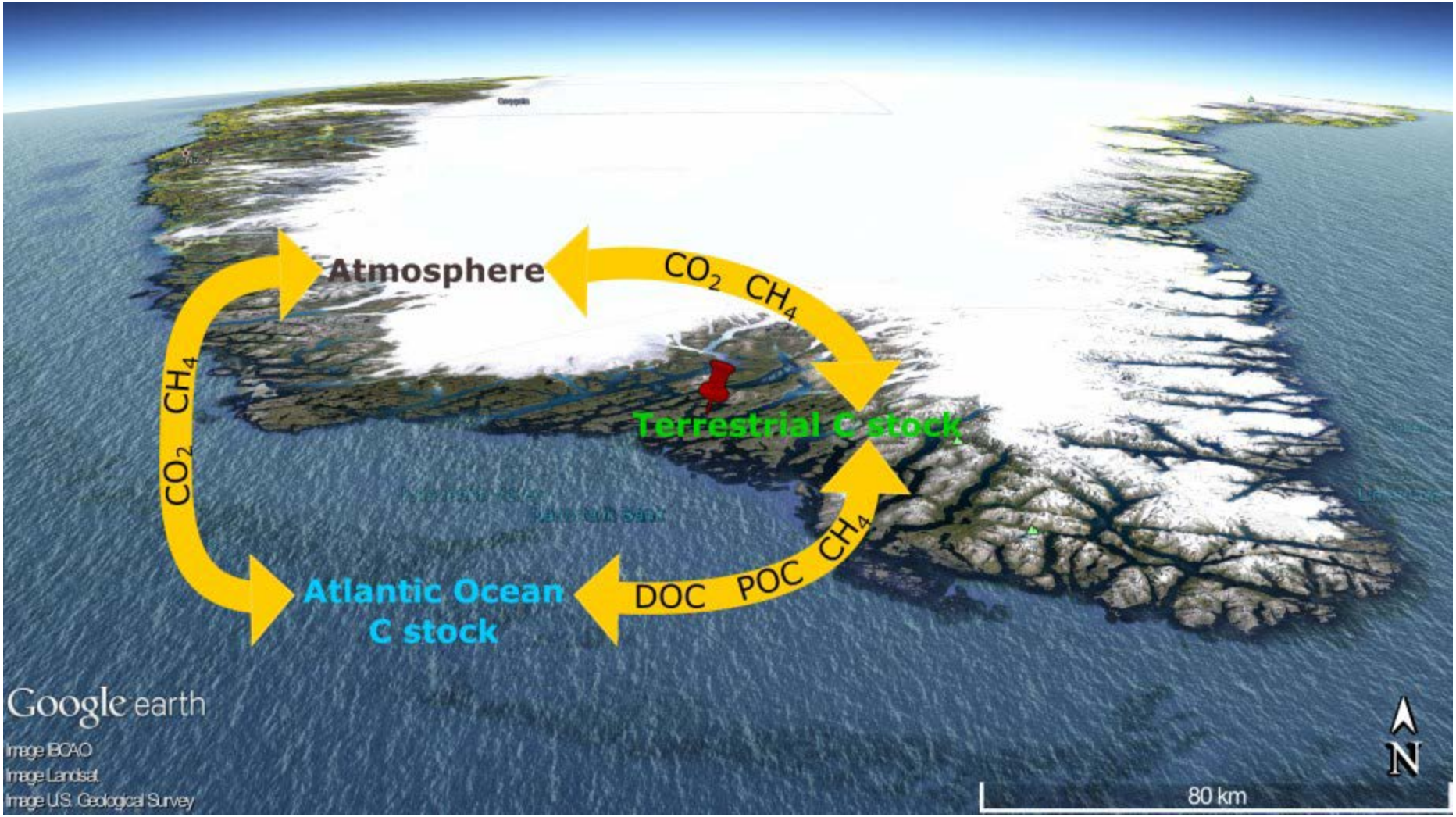
Producer accuracy (%)



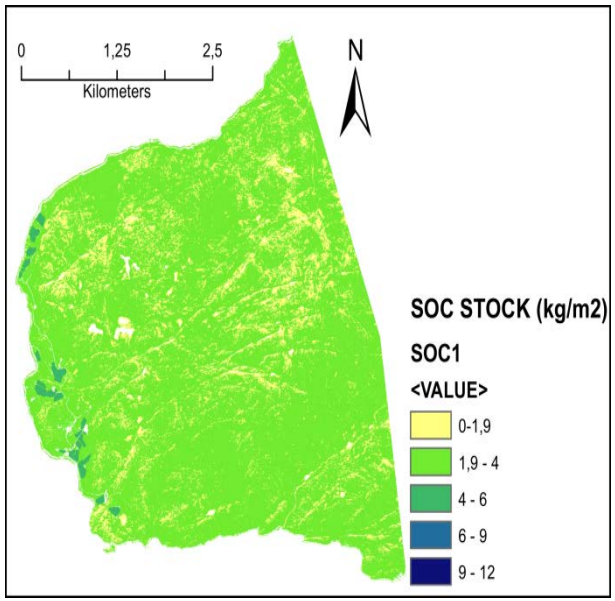
Uncertainty (%)



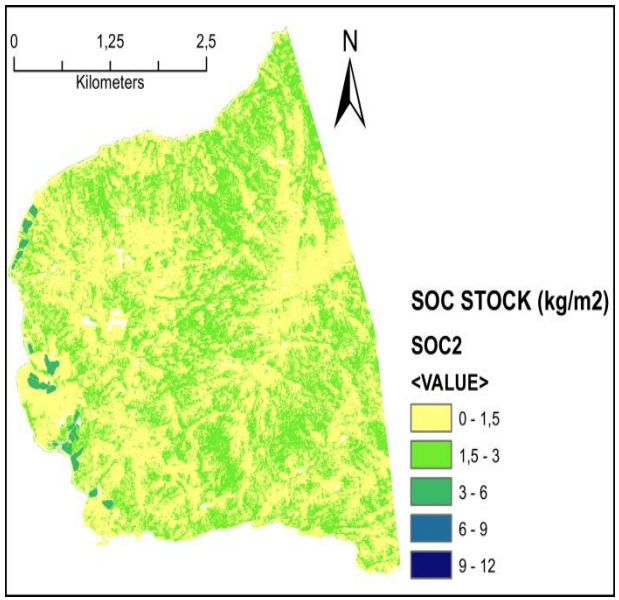
Thank you


Atmosphere
CO_2 CH_4
CO_2 CH_4
Terrestrial C stock
DOC POC CH_4
Atlantic Ocean
C stock
Google earth
Image IBCAO
Image Landsat
Image U.S. Geological Survey
N
80 km

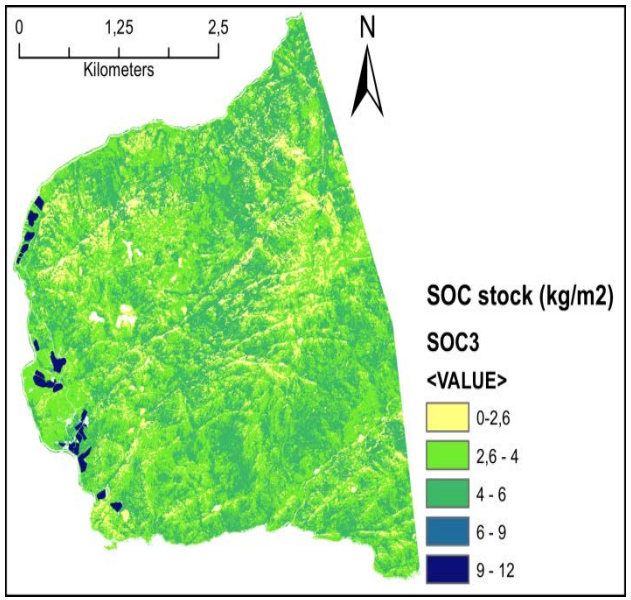
SOC stock maps



SOC stock for depth 0 – 5 cm
RMSE = 0,94 kg/m^2



SOC stock for depth 5 – 15 cm
RMSE = 0,82 kg/m^2



SOC stock for depth 0 - 15 cm
RMSE = 1,12 kg/m^2

Evidence and Impact of Arctic Warming

- **Sea ice – thinning (>40%) and shrinking (11.5% / decade)**
- **Permafrost melting – also releases methane**
- **Land ice melting – sea level change**
- **Loss of sea ice – impacts habitat of polar bears, walruses**
- **Ecosystem shifts – from Arctic to subarctic communities**
- **Increase human activities – shipping and oil production**

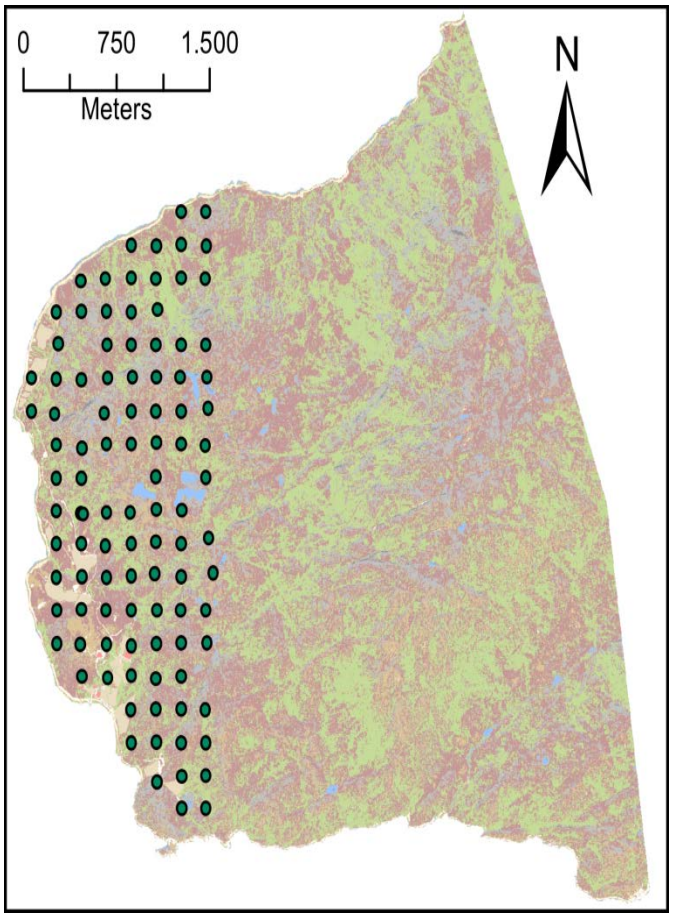
SOC STOCK CALCULATIONS

$$\boldsymbol{SOC\ stock = C \times\ bulk\ density \times sampling\ depth \times (1 - CF)}$$

- SOC stock (kg/m^3)
- Measured C (%)
- Bulk density (kg/m^2)
- Sampling depth (m)
- CF… coarse fractions (%)

dataset

- 233 soil samples
- Two reference depths: 0 – 5 cm, 5 – 15 cm
- Grid sampling: 200 m



- http://www.greenfacts.org/en/arctic-climate-change/l-3/4-arctic-tundra.htm

Table

Image layers/ features calculated from all 8 bands of WV2

Dataset 2: WV2 (8 bands), 392 features		
Feature name	Description	Dimension
Bands 1-8	Spectral reflectance from all 8 bands	8
SDB 1-8	Standard deviations of individual bands 1-8	8
Bright	Brightness, average of means of bands 1-8	1
Ratio 1-8	Individual band mean divided by sum of means of bands 1-8	8
NDVI1	(band7- band5)/(band7 + band5)	1
NDVI2	(band8- band6)/(band8 + band6)	1
Yellow NDVI	(band8- band4)/(band8 + band4)	1
NDWI	(band3- band8)/(band3 + band8)	1
NIR NDVI	(band8- band7)/(band8 + band7)	1
NPCI	(band5- band1)/(band5 + band1)	1
NDSI	(band3- band4)/(band3 + band4)	1
Spectral-texture	Gabor texture features extracted from individual bands 1-8 at different 5 radial frequencies (γ) and 8 orientations (θ)	320
PC texture	Gabor texture features extracted from first principal components of bands 1-8 at different 5 radial frequencies (γ) and 8 orientations (θ)	40

NPCI – Normalized Pigment Chlorophyll index; NDSI – Normalized difference soil index;