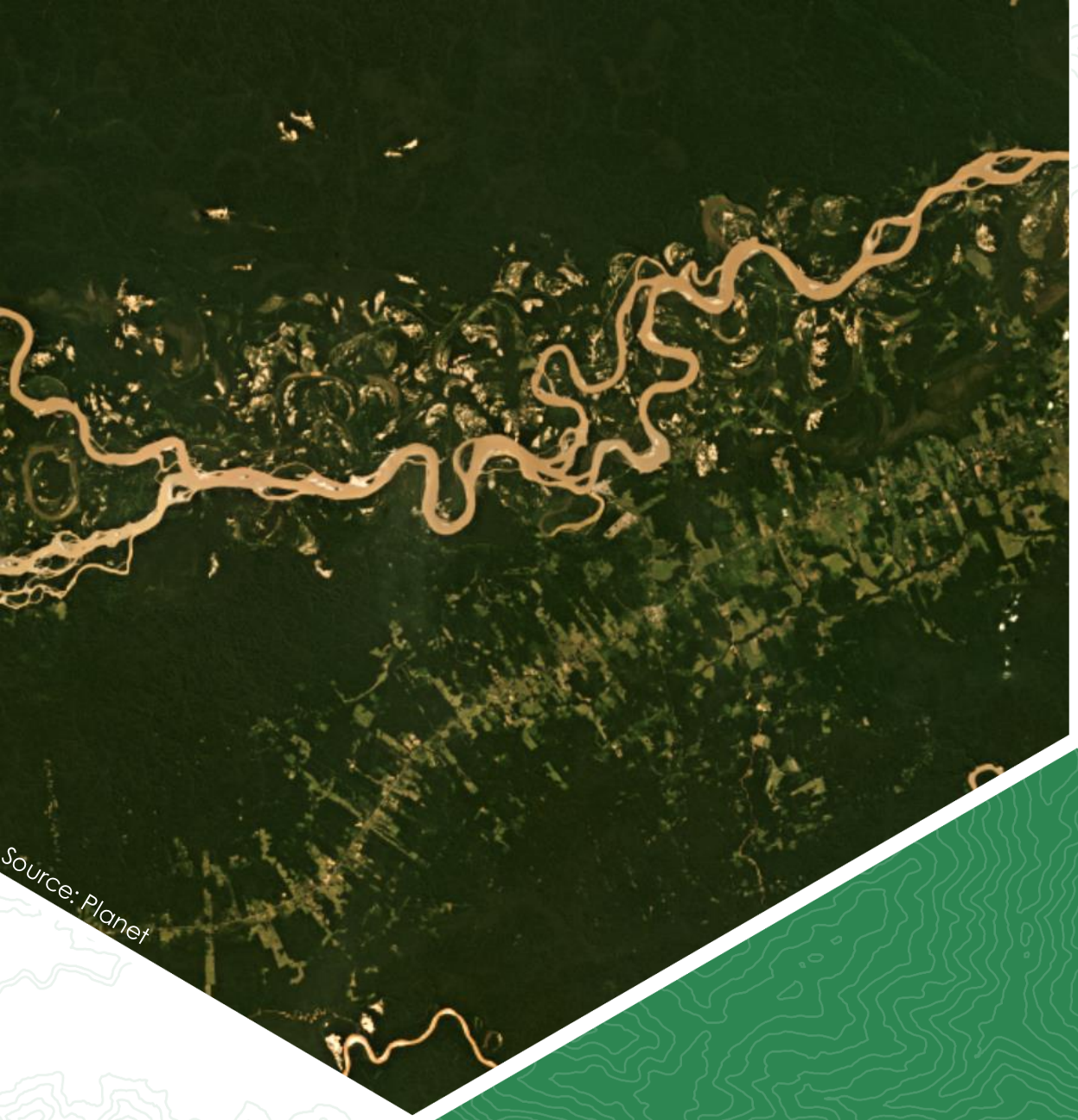


THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

SERVIR

NASA

Distinction of deforestation drivers in the Amazon using Synthetic Aperture Radar (SAR) C-band data

2019 AGU Fall Meeting

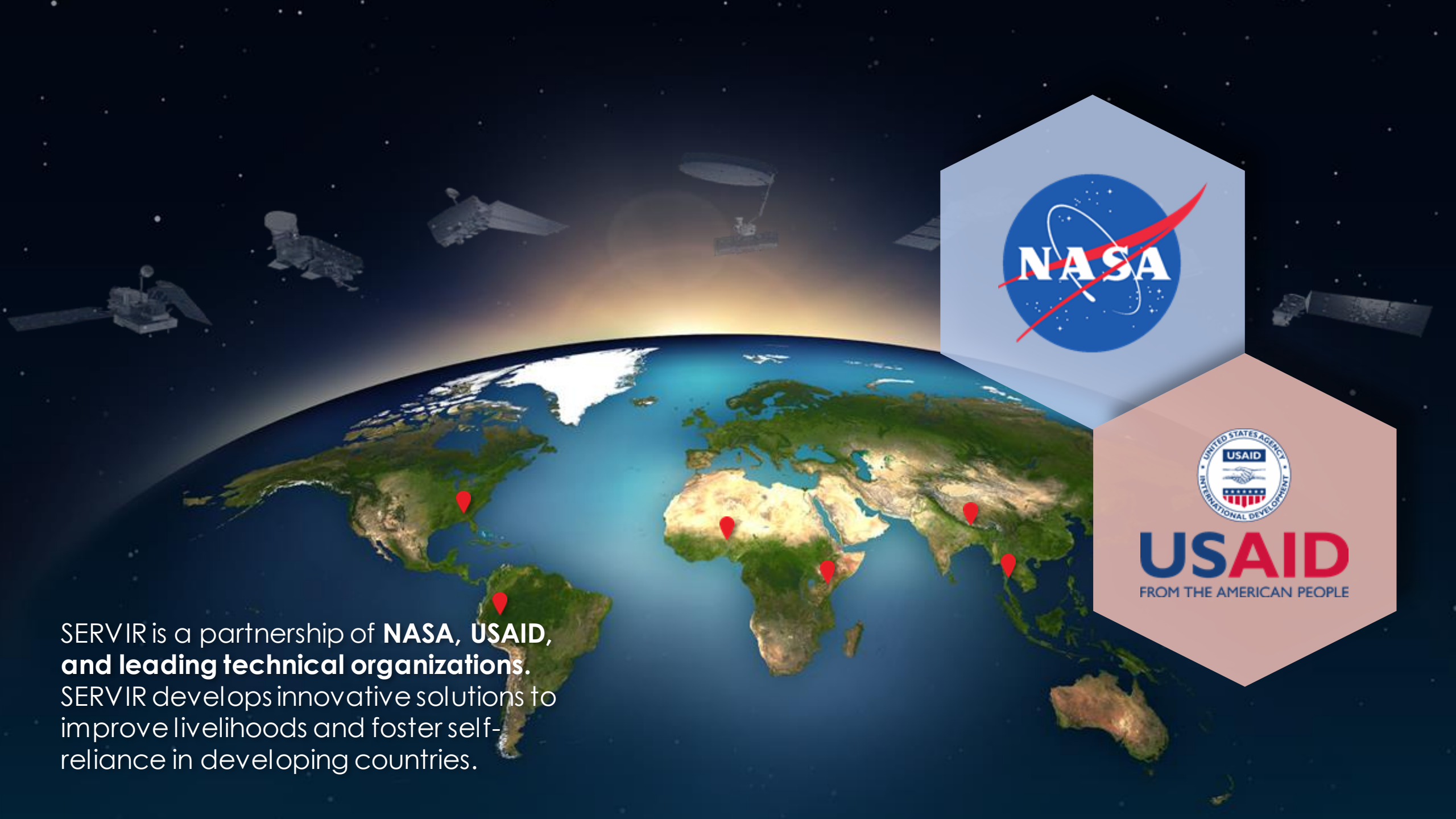
Thursday, December 12, 2019

Andrea Puzzi Nicolau

Africa Flores-Anderson

Dr. Robert Griffin

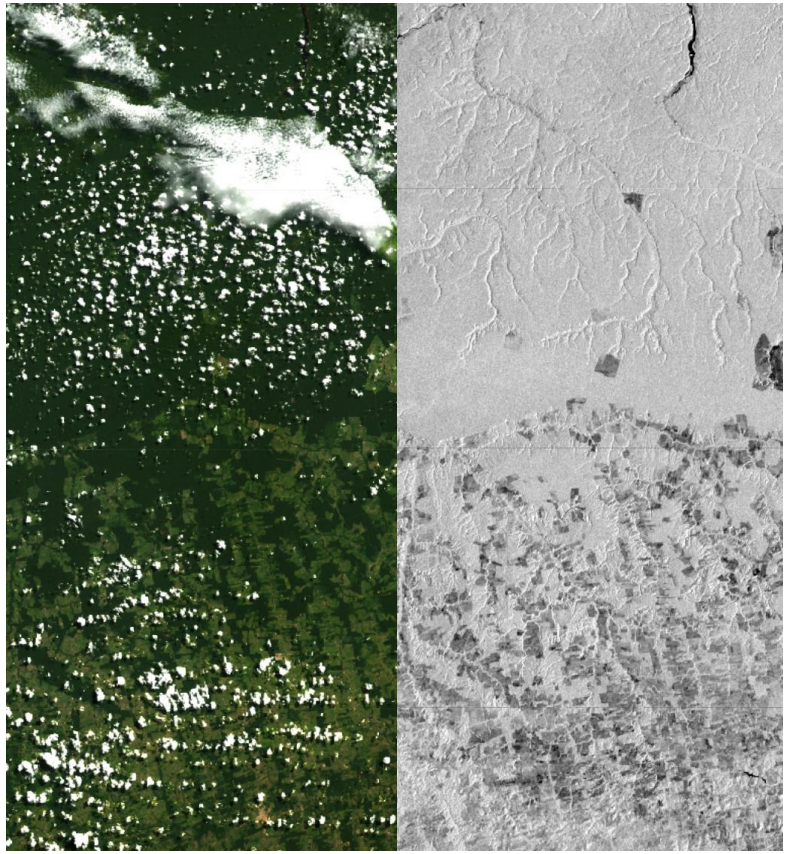
Kelsey Herndon



SERVIR is a partnership of **NASA, USAID, and leading technical organizations.** SERVIR develops innovative solutions to improve livelihoods and foster self-reliance in developing countries.

Motivation

- Can we use Sentinel-1 data to help distinguish drivers of deforestation?
  - Why is it important to distinguish drivers of deforestation?

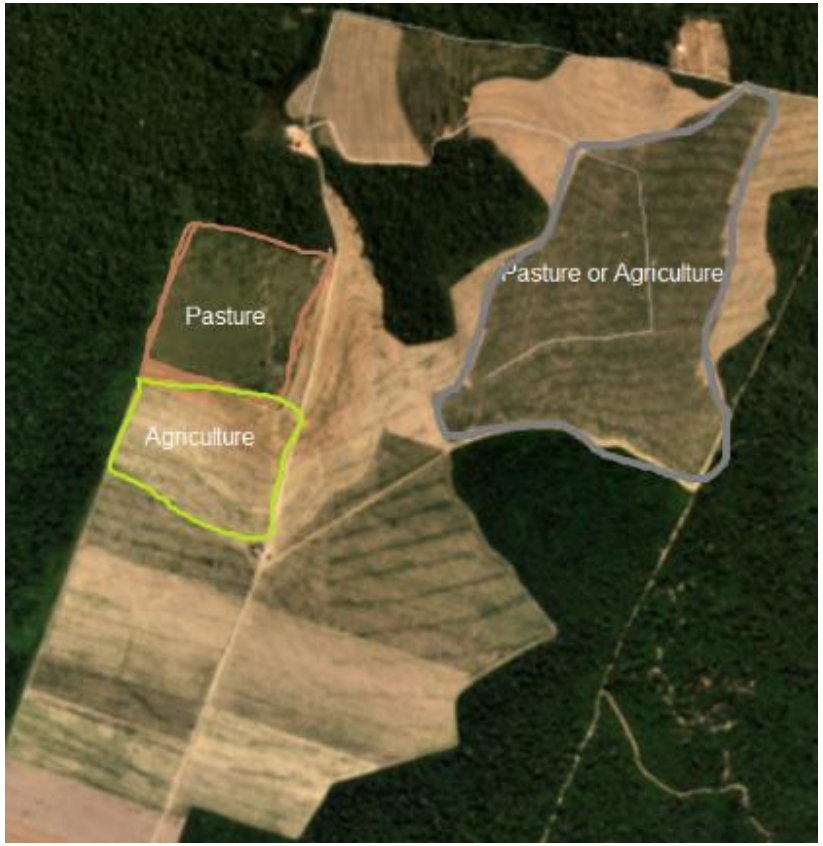


Landsat 8 RGB and Sentinel-1 VV median composites January-July 2019 (Altamira, Brazil)

- We know where and when deforestation is happening, but in order to have an impact in how to prevent deforestation, we need to know what is causing it
- Optical systems:
  - Cloud cover – Sentinel-1 free and openly available
  - Hard to distinguish land uses with similar land cover (Grecchi et al., 2013; Joshi et al., 2016; Hagensieker et al., 2017)
- The identification of drivers of deforestation is a need for early warning deforestation monitoring systems (International Forum of Early Warning Systems, Lima, July 2018)
- Important towards more sustainable land management and to aid global initiatives such as REDD+ (UNFCCC, 2013)
- The use of SAR data is a priority by the Global Forest Observations Initiative/FAO (GFOI, 2013)

Motivation

- Is it possible to use Sentinel-1 data to distinguish drivers of deforestation?
  - Why is it important to distinguish drivers of deforestation?



Source: Planet

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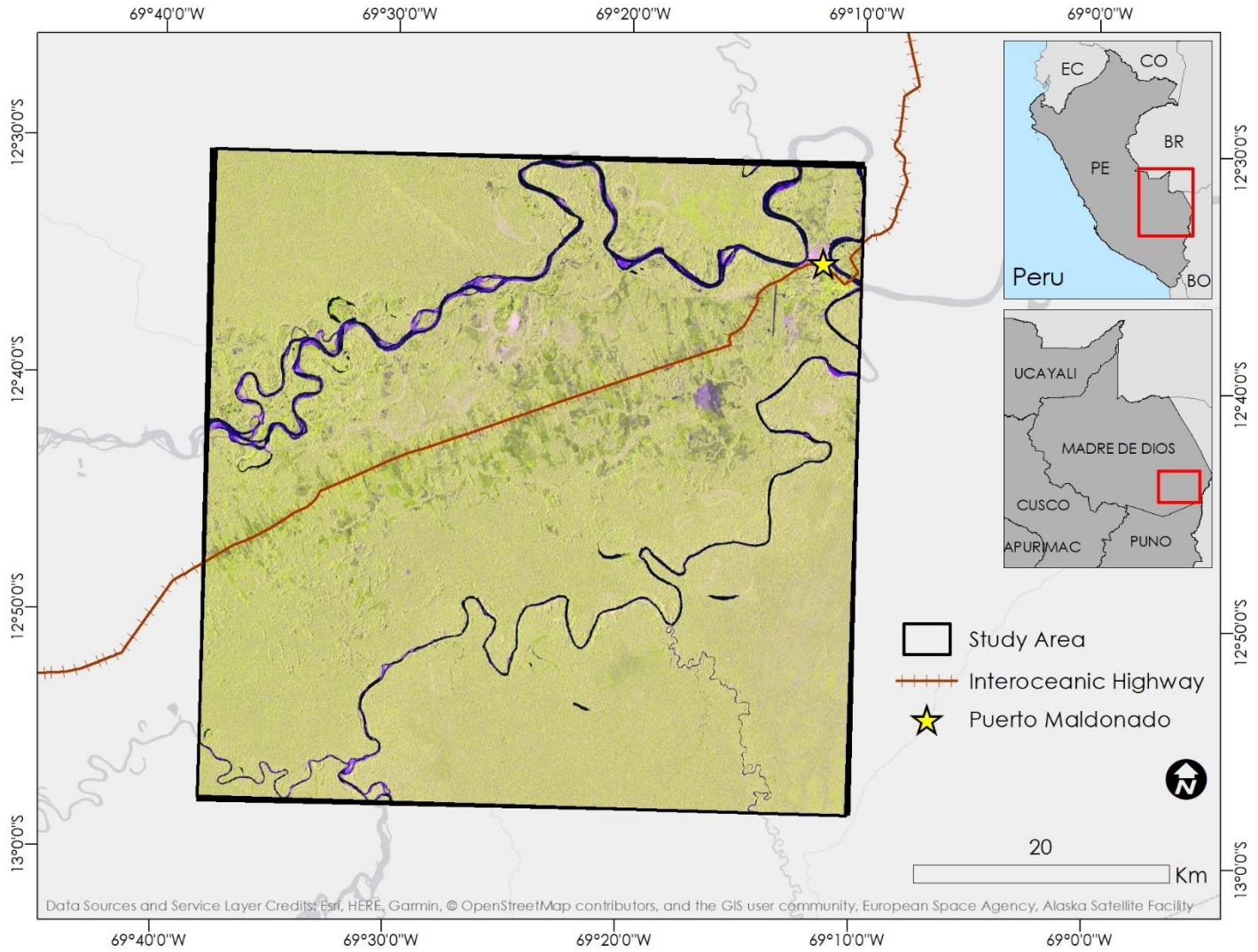
- Important towards more sustainable land management and to aid global initiatives such as REDD+ (UNFCCC, 2014)

Research Questions and Study Area

Can we use Sentinel-1 data to distinguish land uses/covers?

Can we observe signature trends on Sentinel-1 time series data for different LULC?

Can we develop a classification decision tree that results in an accurate LULC map?



Sentinel-1 quarterly composite (July 2, 14, 26, August 8, 2019), R: VV, G: VH, B: VV/VH, total area: ~2,500 km^2

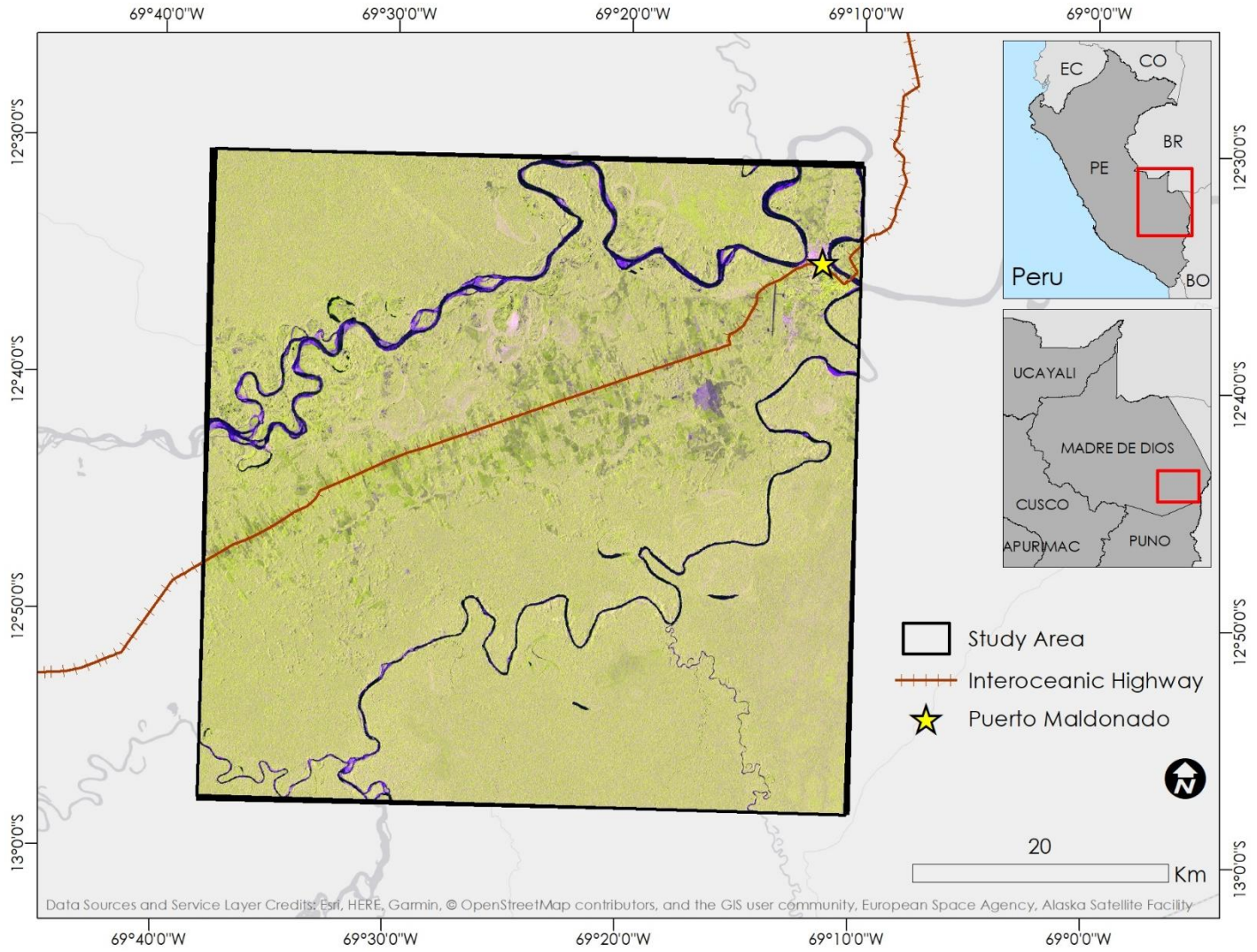
Research Questions and Study Area

Madre de Dios

Capital of Biodiversity (Peruvian Law N° 26311, 1994; Myers et al., 2000)

Deforestation rates have been increasing since 2001 (MINAM, 2017)

Presents a mosaic of land uses and covers



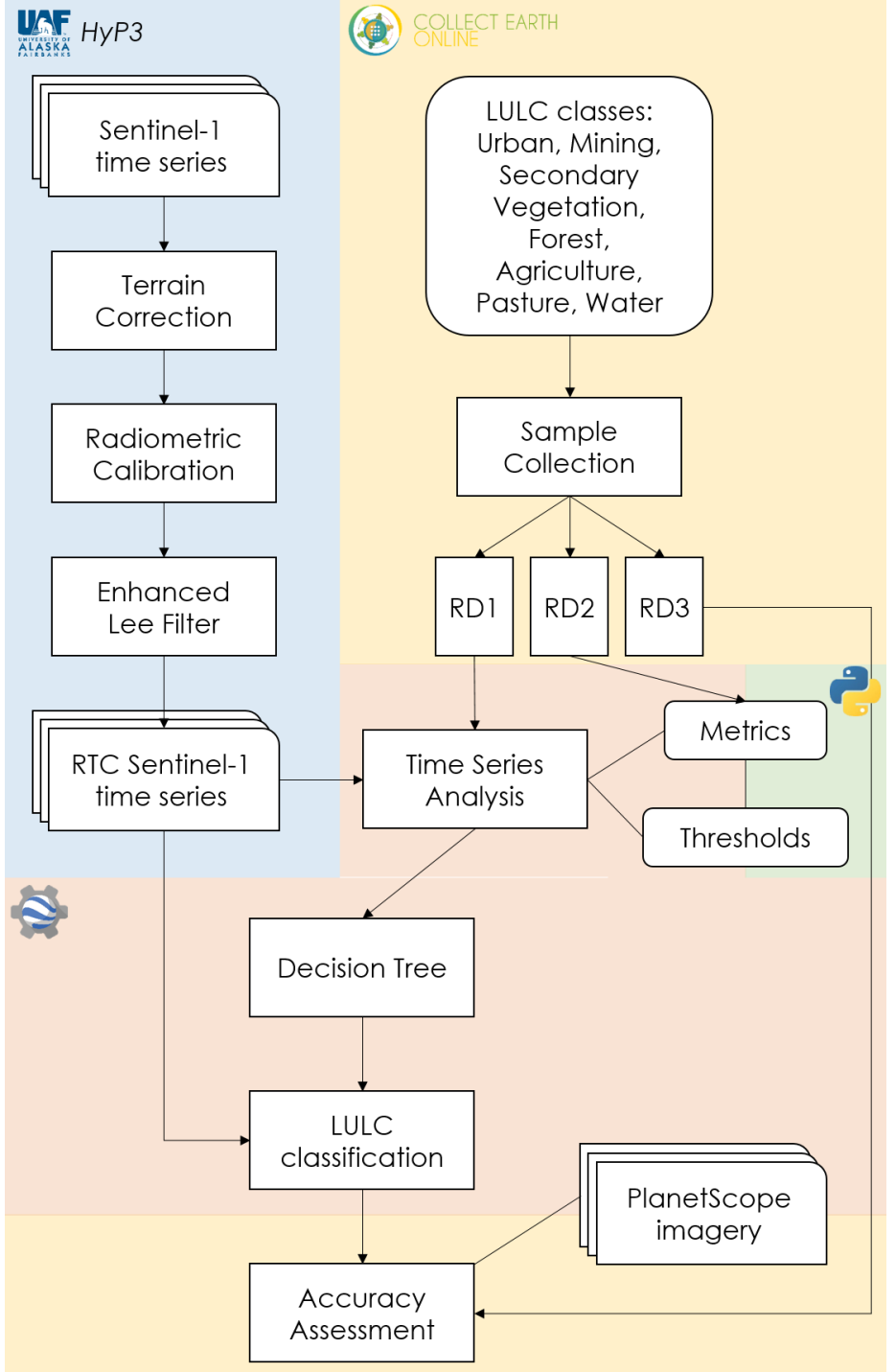
Sentinel-1 quarterly composite (July 2, 14, 26, August 8, 2019), R: VV, G: VH, B: VV/VH, total area: ~2,500 km^2

Methodology

- Preprocessing: Alaska Satellite Facility's Hybrid Pluggable Processing Pipeline (HyP3, Hogenson et al., 2016)
- Collect Earth Online (Bey et al., 2016) – Digital Globe
- Quarterly Composites
  - January 2017 - August 2019 (76 images)
- Reference Datasets (RD): 3,500 samples points
- VV, VH, VV/VH, modified Radar Forest Degradation Index (RFDI; Mitchard, 2012)
- Mean, Min, Max, Max-Min ratio, Standard Deviation, Coefficient of Variation, Value Difference
- Separability Measure (Wu et al., 2011)

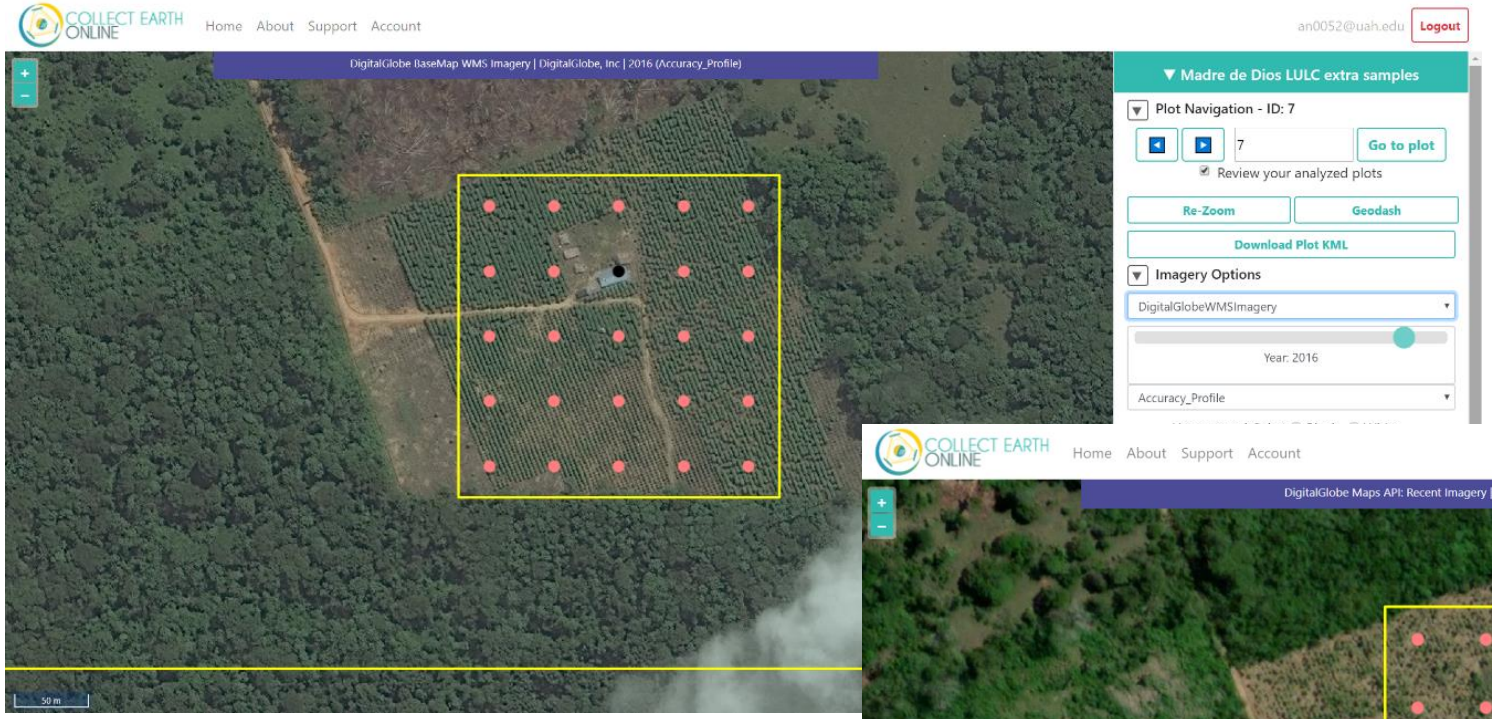
$$RFDI = \frac{\gamma^o_{HH} - \gamma^o_{HV}}{\gamma^o_{HH} + \gamma^o_{HV}} \qquad RFDI\ mod. = \frac{\gamma^o_{\boldsymbol{VV}} - \gamma^o_{HV}}{\gamma^o_{\boldsymbol{VV}} + \gamma^o_{HV}}$$

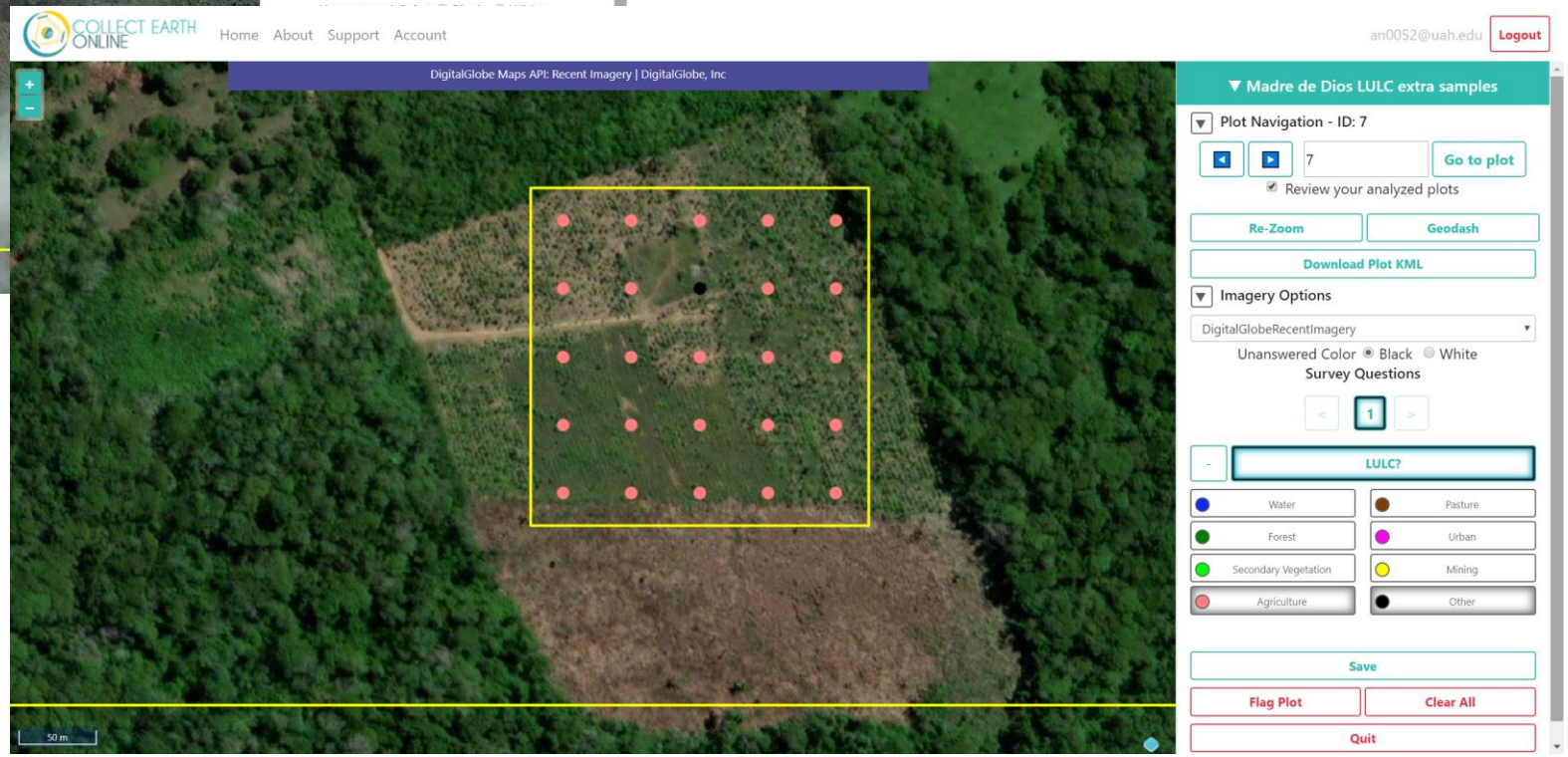
$$S_{ab} = \frac{|\mu_a - \mu_b|}{\sigma_a + \sigma_b}$$



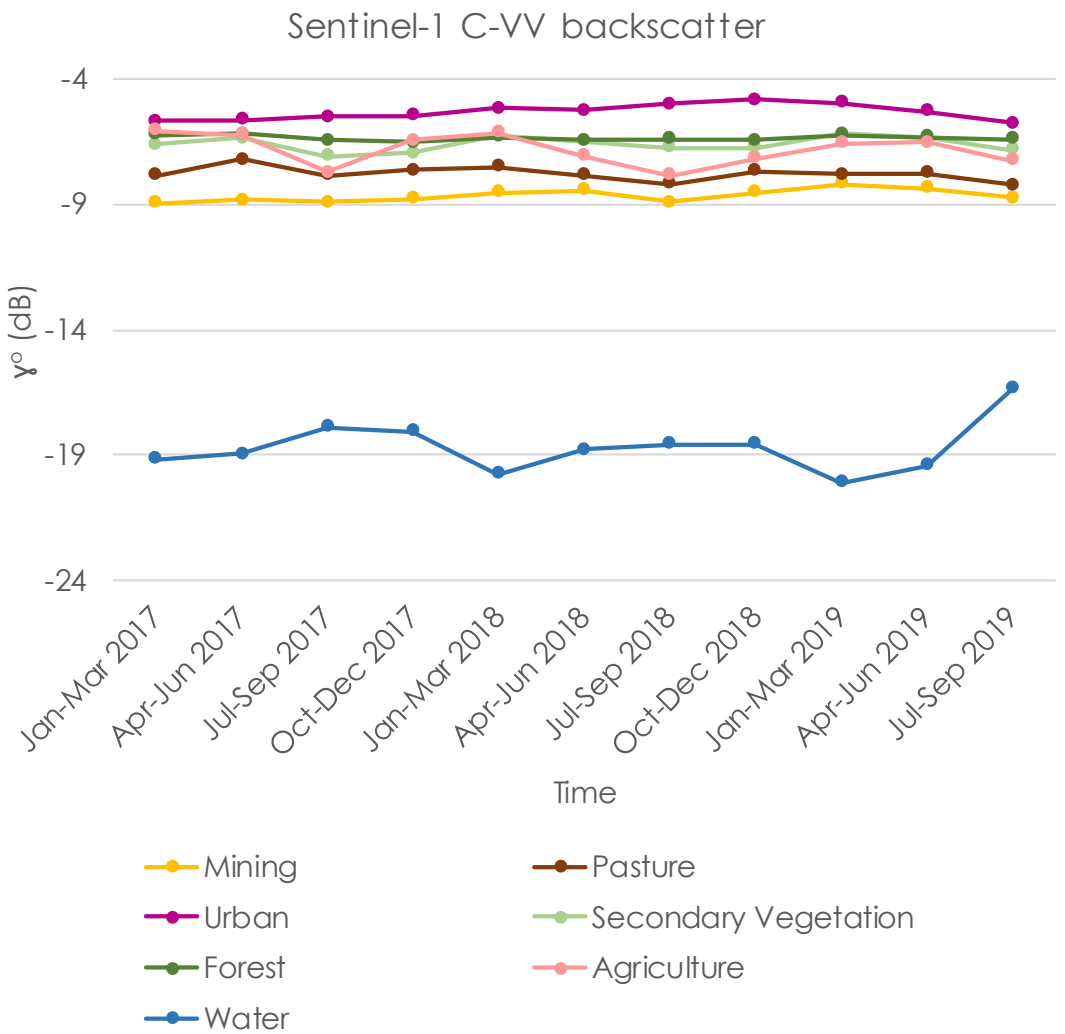
Collect Earth Online

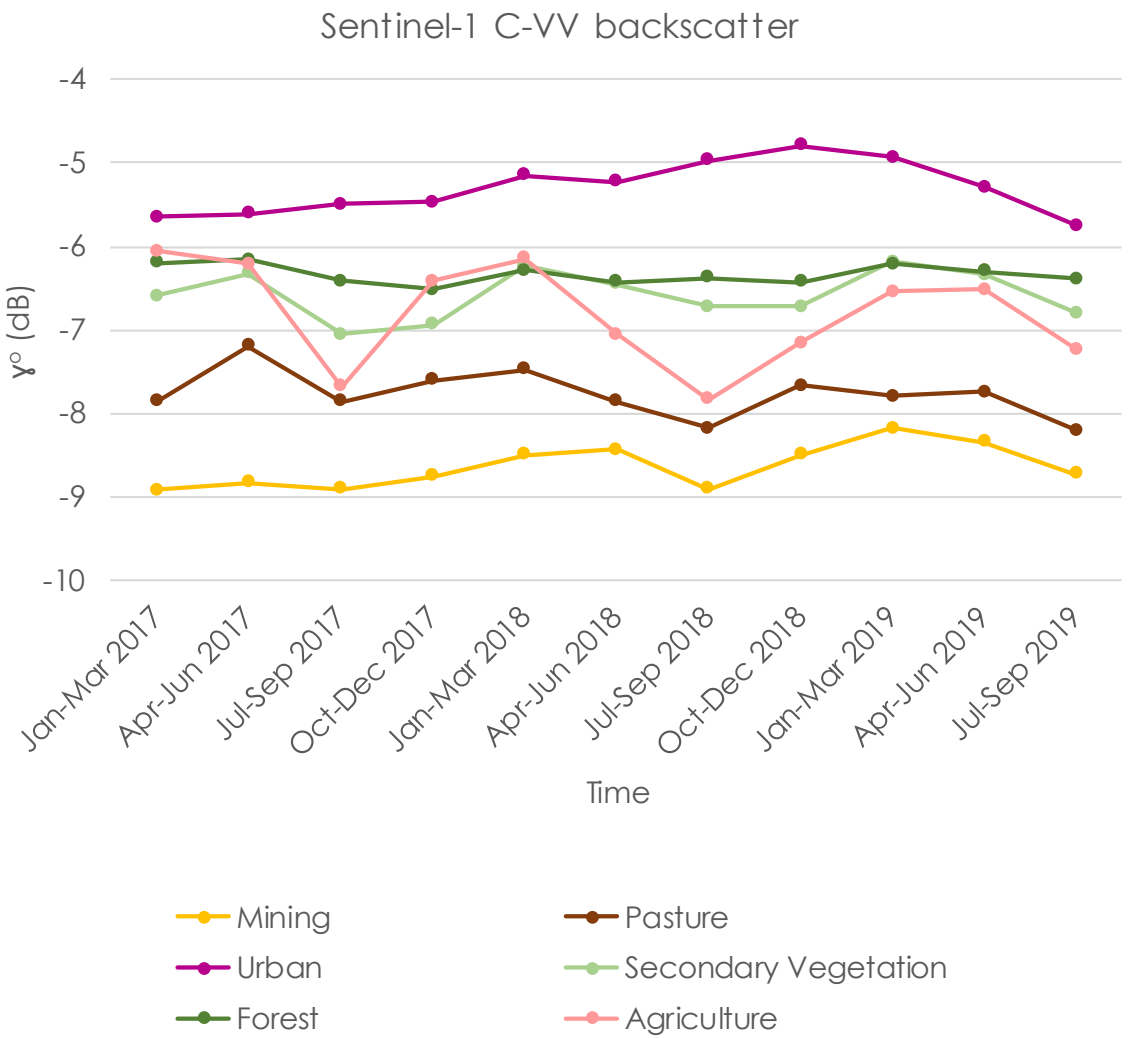
http://collect.earth



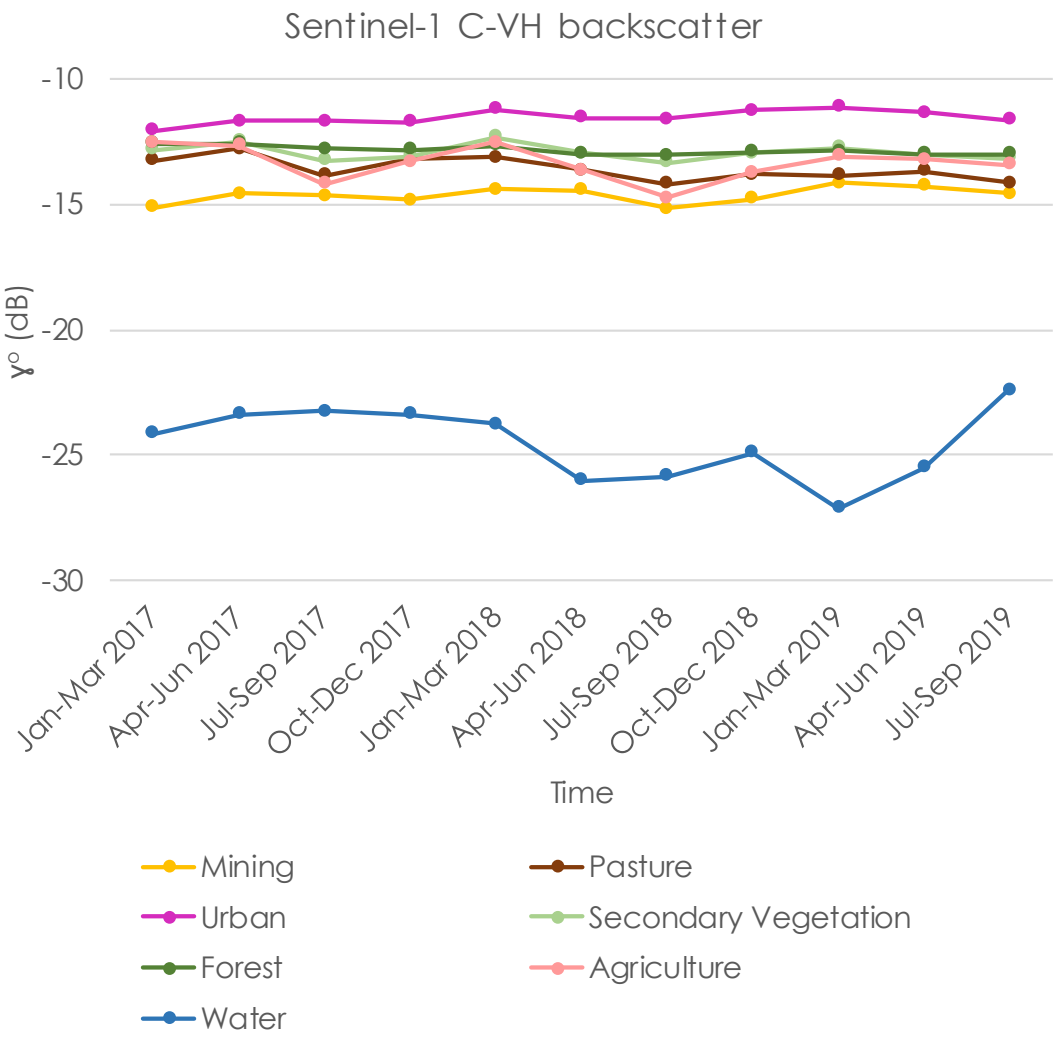


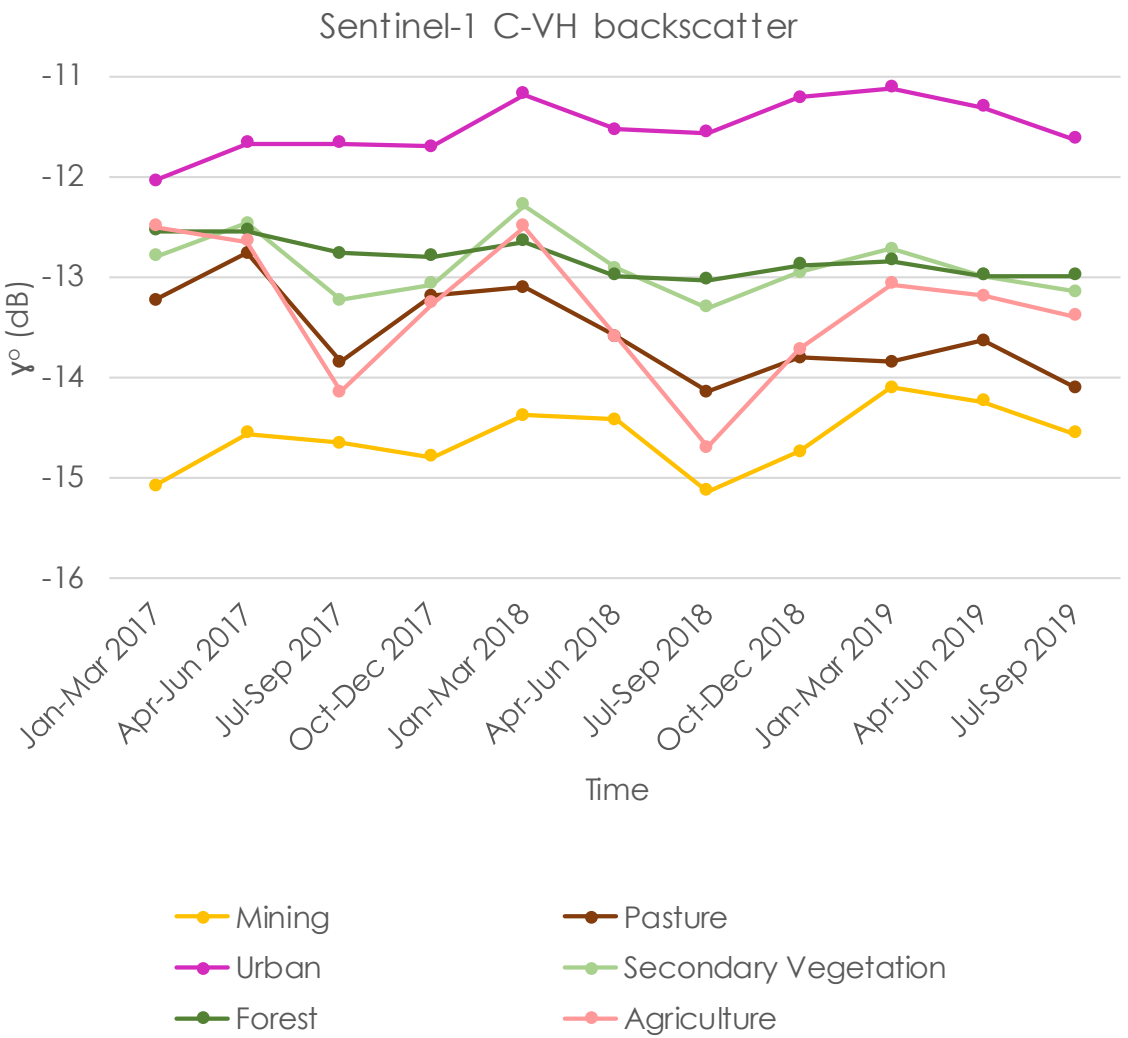
Time Series Analysis



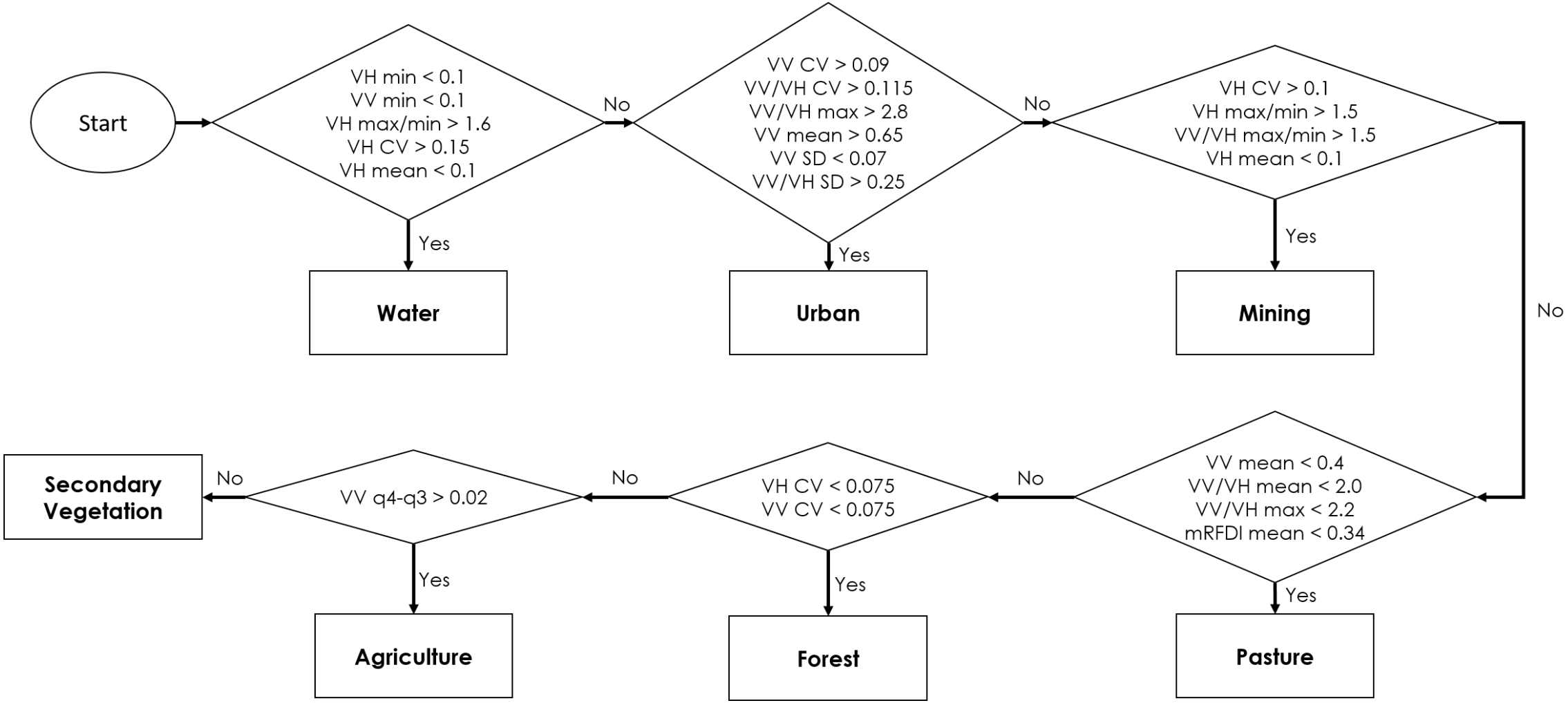


Time Series Analysis

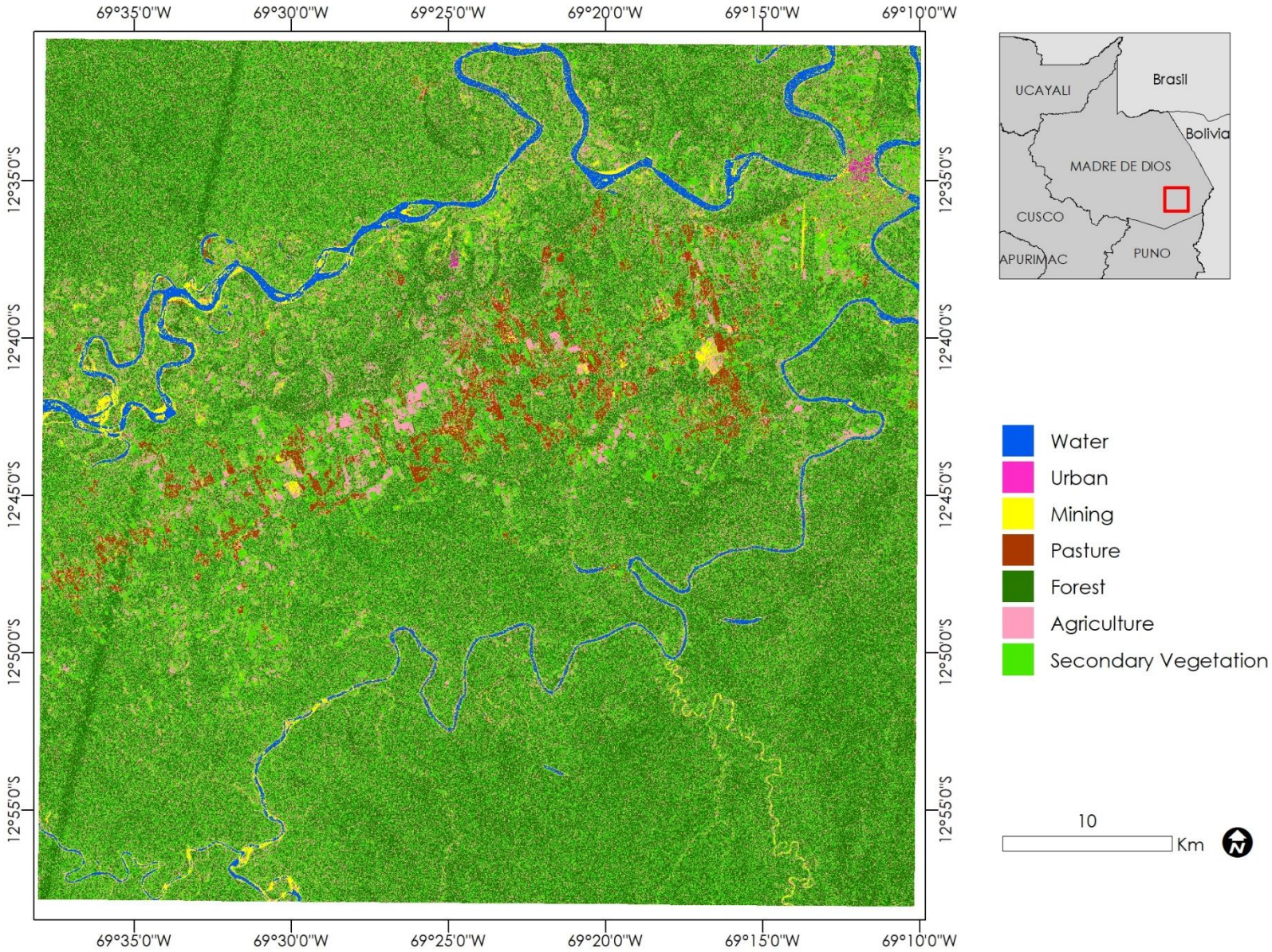




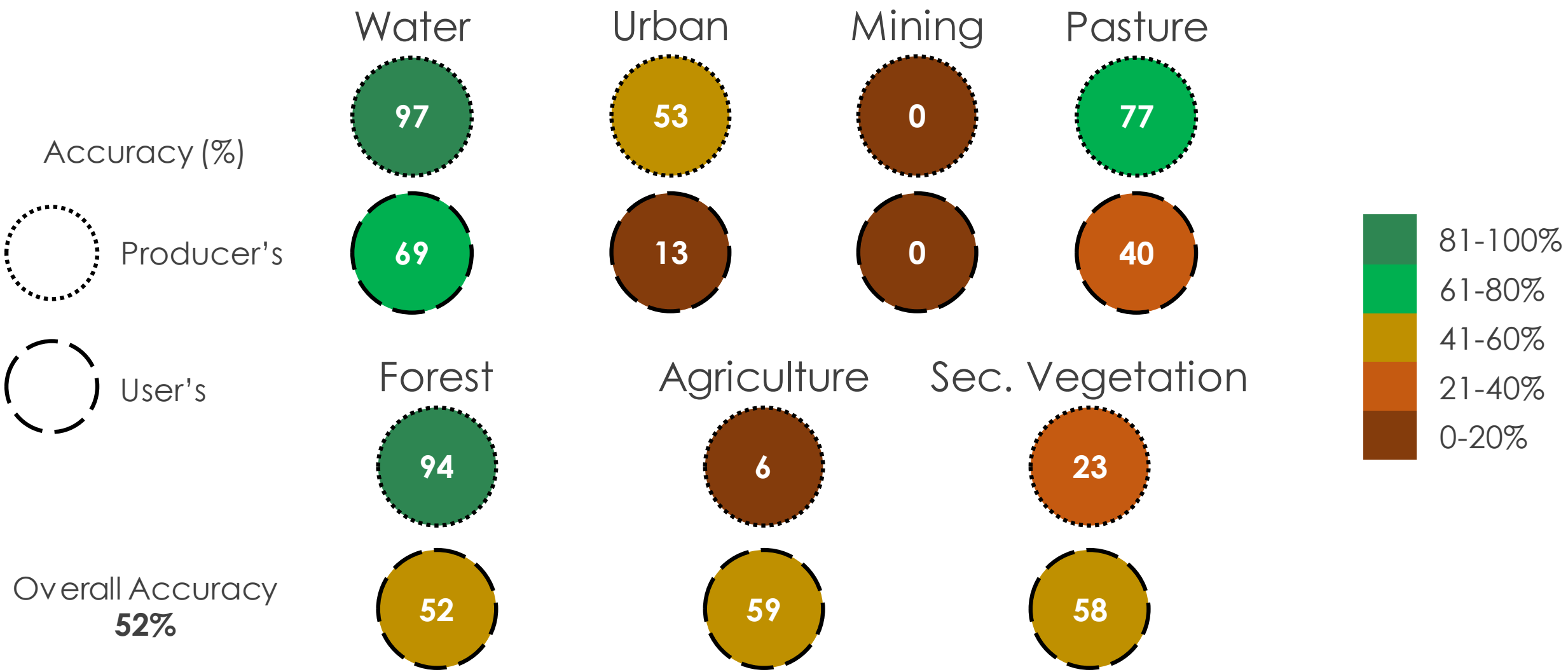
Decision tree



Classification

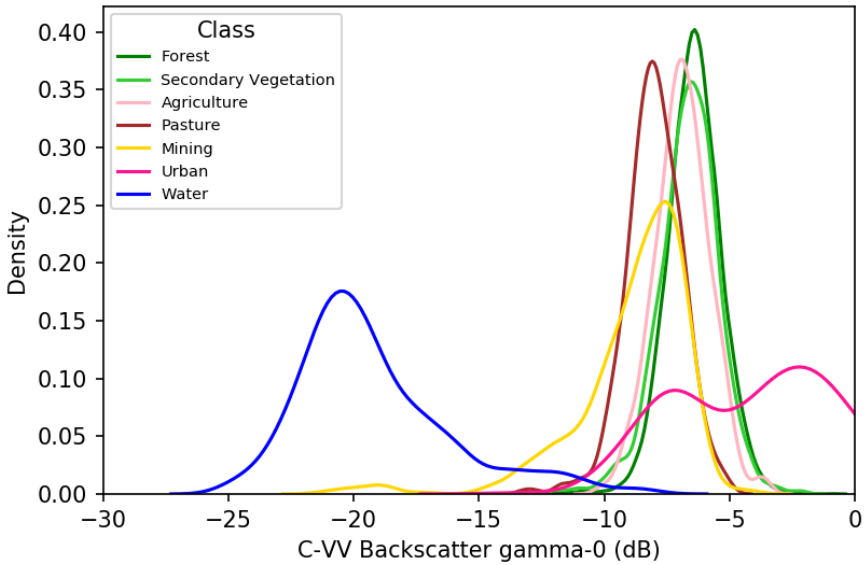


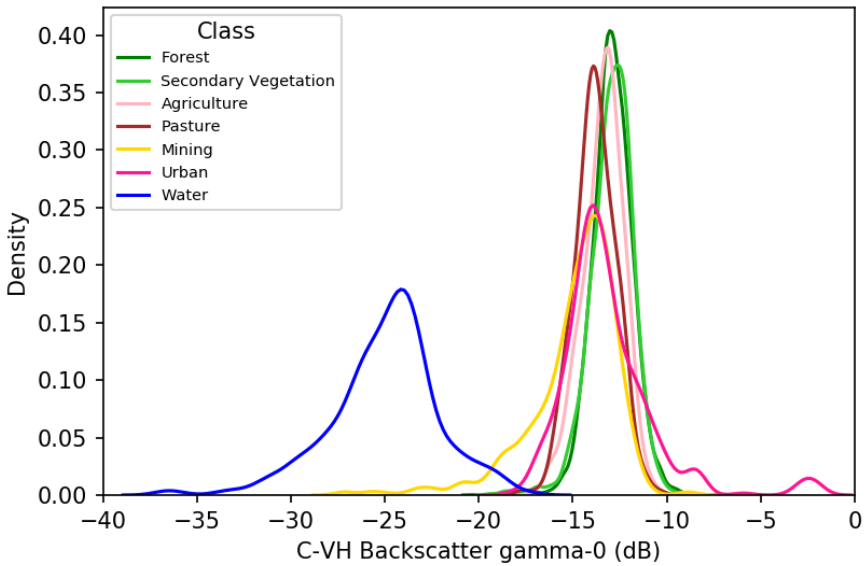
Accuracy Assessment



Overall Accuracy
52%

Probability Density Functions





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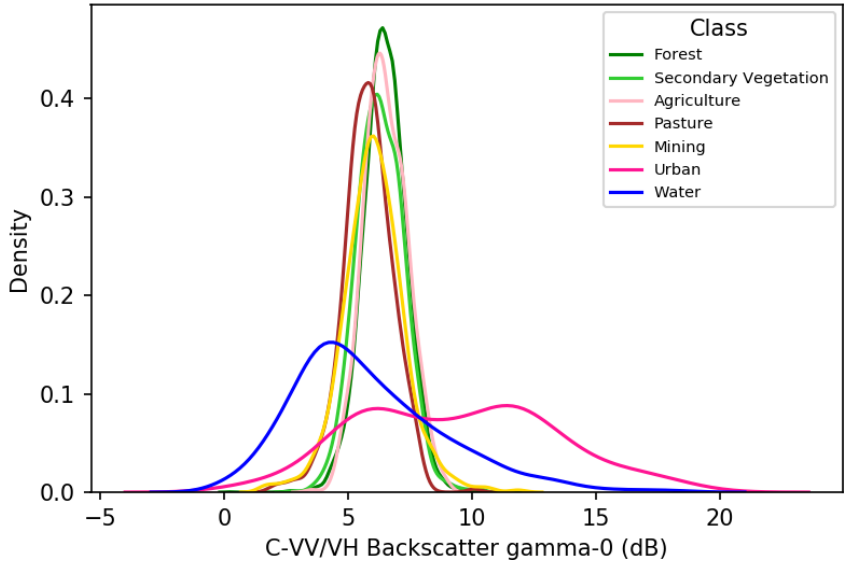

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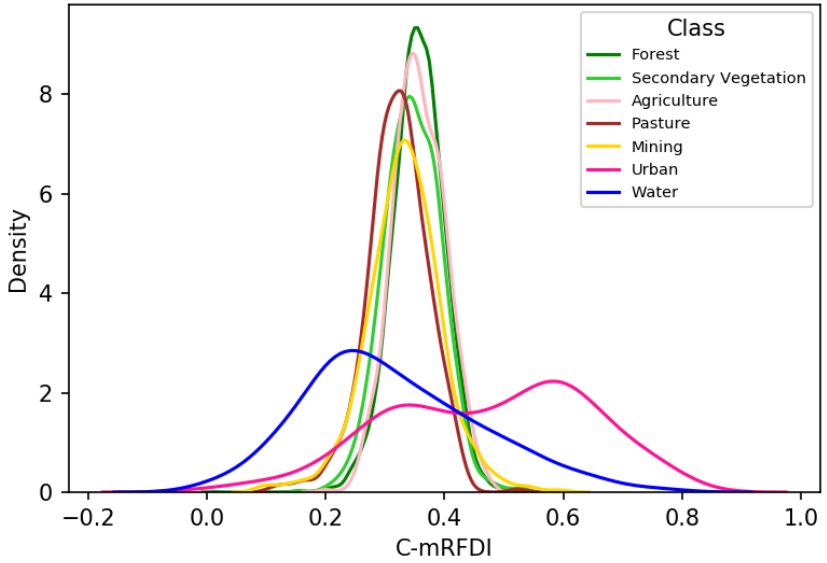
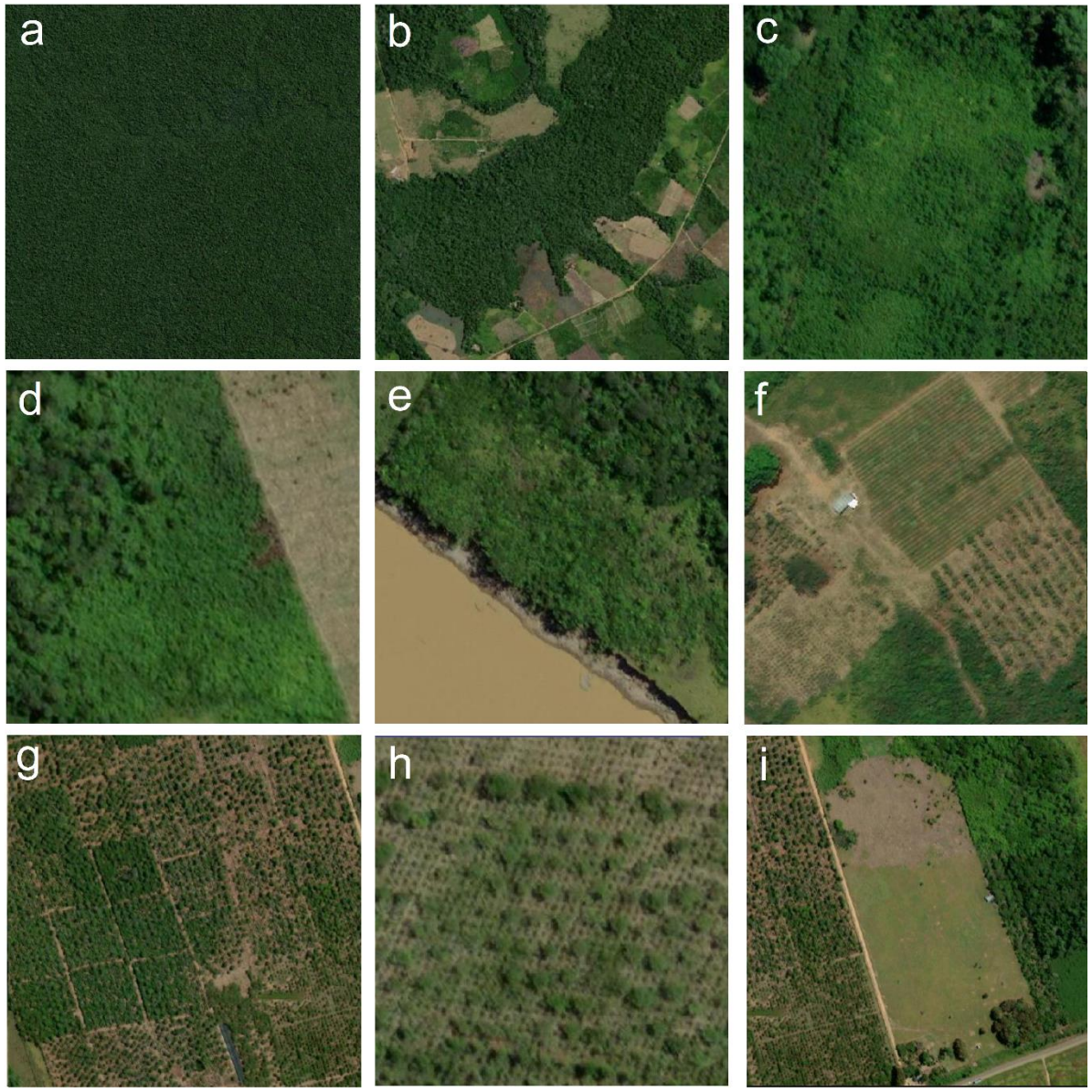
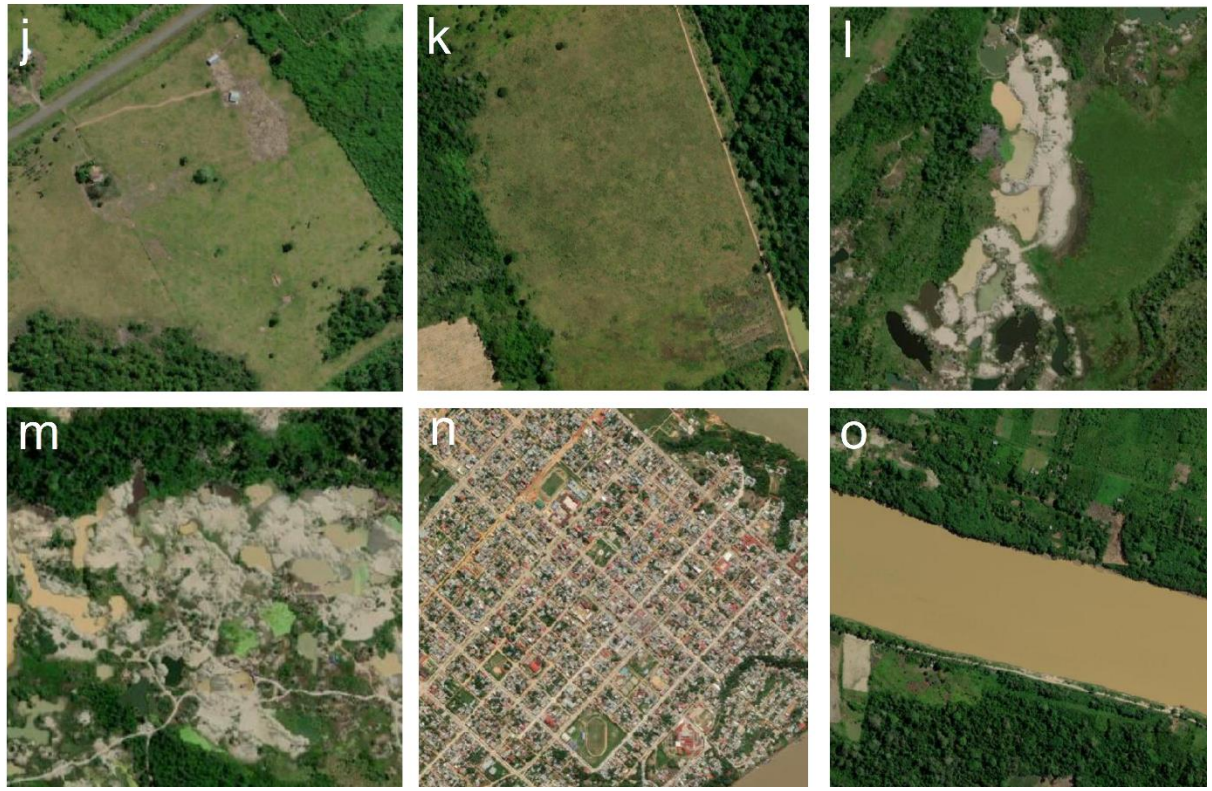


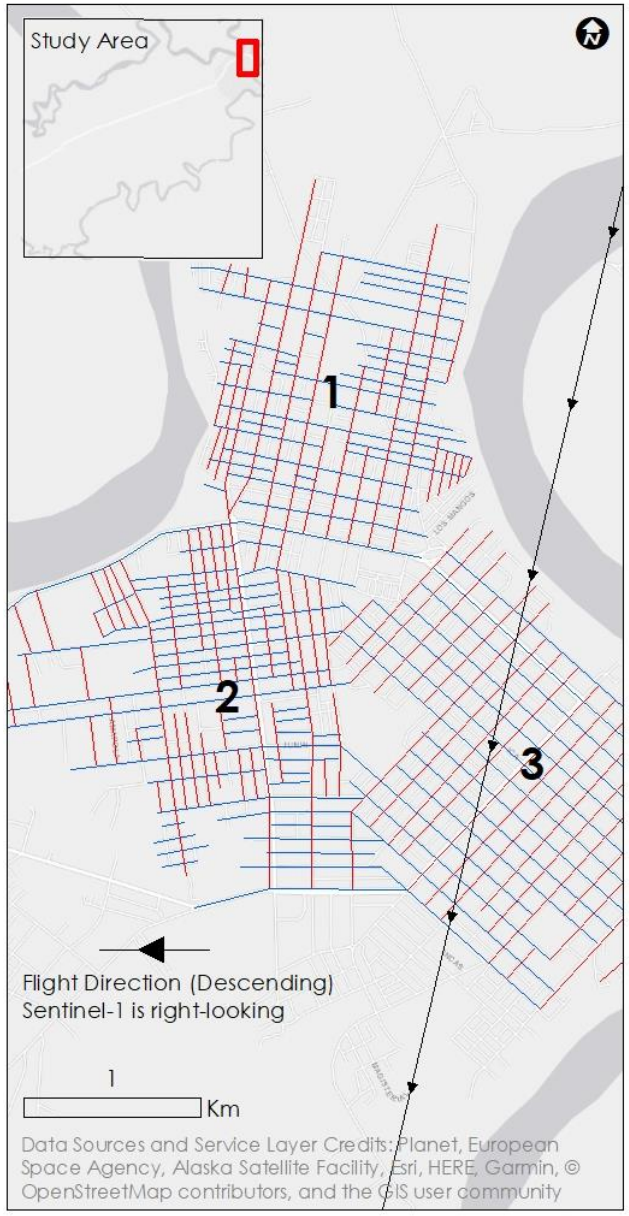
Classes

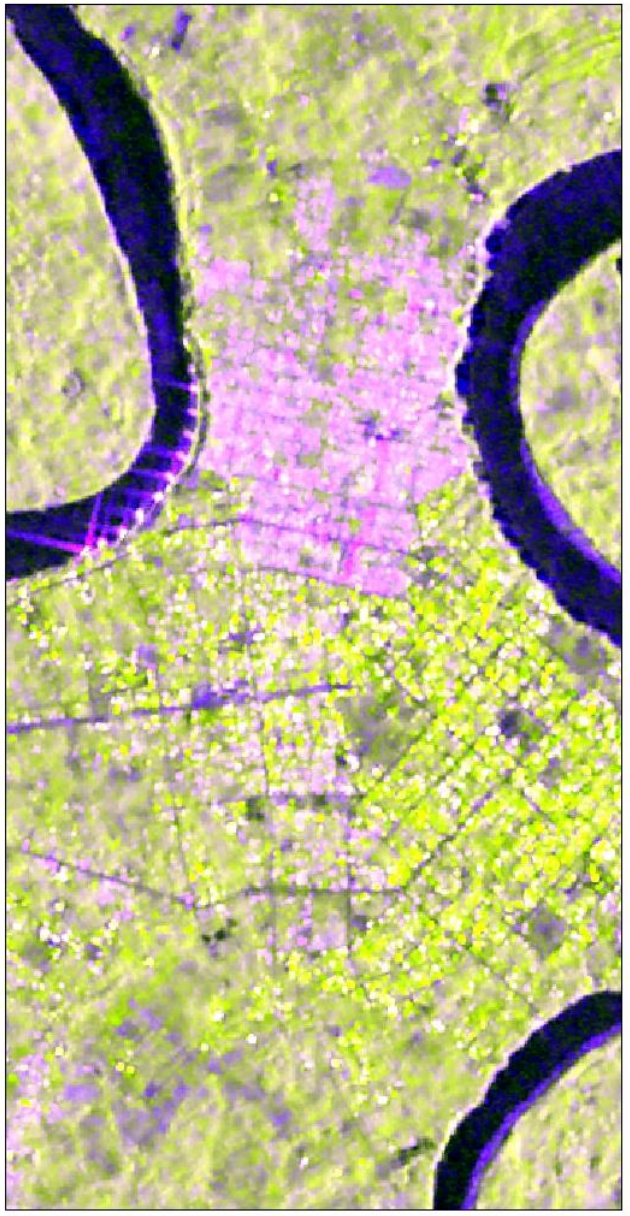




(a) Forest, (b) Forest (patch), (c) Secondary Vegetation, (d) Secondary Vegetation (next to cropland), (e) Secondary Vegetation (next to river), (f) Agriculture (surrounded by Secondary Vegetation), (g) Agriculture, (h) Agriculture, (i) Pasture (middle), (j) Pasture, (k) Pasture, (l) Mining, (m) Mining, (n) Urban, (o) Water

Streets orientation





Conclusions and Future Work

- Agriculture, Secondary Vegetation, and Forest classes are characterized by land covers with very similar structure
- Overall accuracy was low (52%)
- Thresholds and rules for Pasture classification (user's accuracy = 77%) could be used as an improvement to distinguish deforestation due to Pasture from deforestation due to Agriculture
- Urban class is highly dependent on streets orientation
- Limitations
  - Thermal noise effects could be reduced with algorithms (Ali et al., 2018; Park et al., 2019)
  - Median filter could be applied to the classified map (Chen et al., 2016)
  - An addition of a bare soil class could improve the classification
- Explore texture information (Grey Level Co-occurrence Matrix)
- Object-based classification

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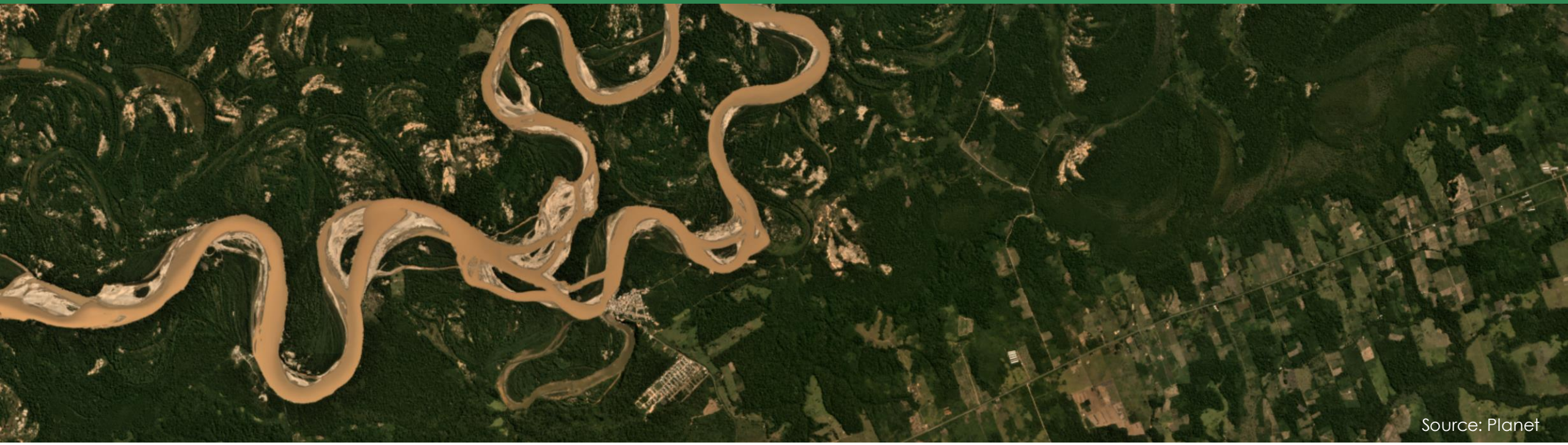

Thank you!

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