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TAKING THE PULSE OF OUR PLANET FROM SPACE

EUMETSAT ECMWF EUSPA

An End-to-End Solution for Repeat Mapping of Tree Cover Density in Tropical Dry Forest Areas from EO, Contributing to Effective Forest Monitoring

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Background and Context

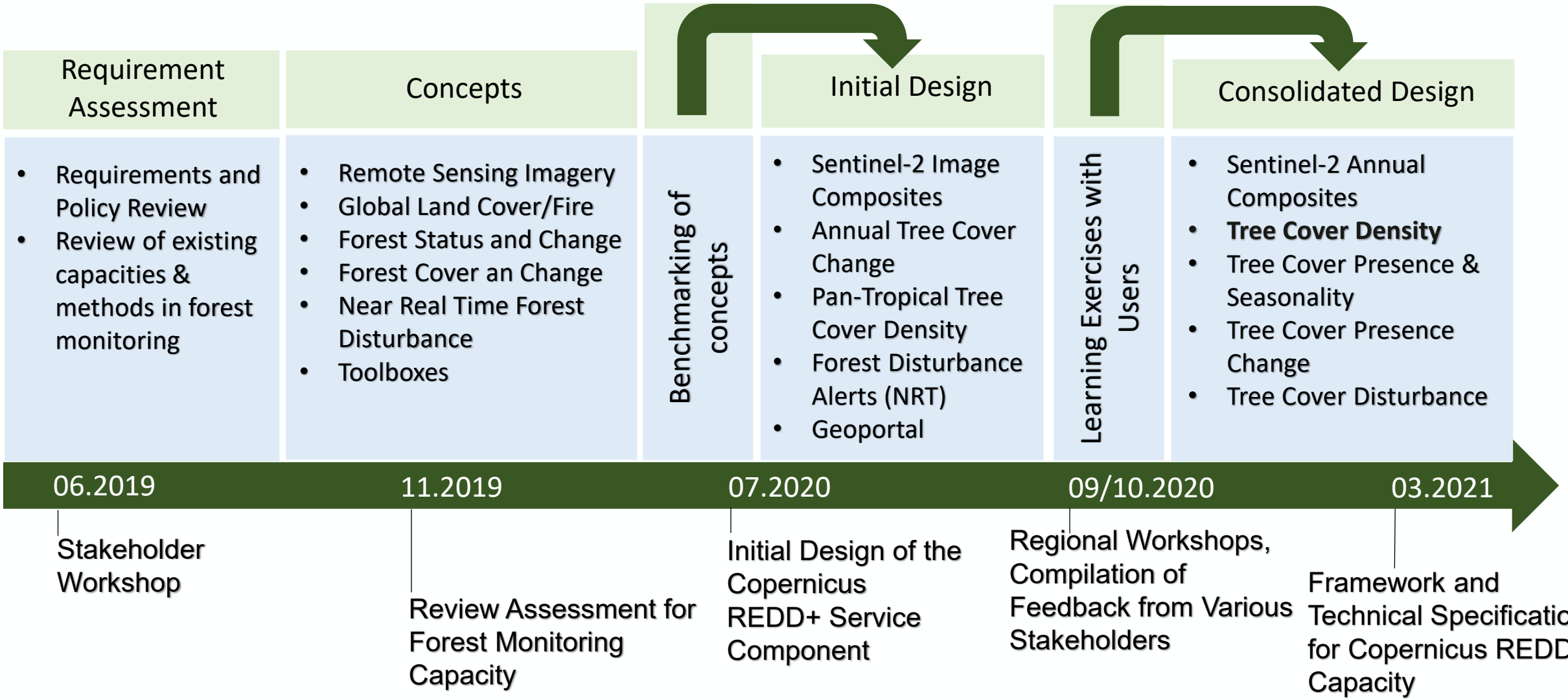
REDDCopernicus Project (2019 -2022)

- To define a future Global Copernicus REDD+ Service which would be freely available
- Recommend a framework for a Copernicus REDD+ Service/programme to establish long-term European Capacity
- https://www.reddcopernicus.info

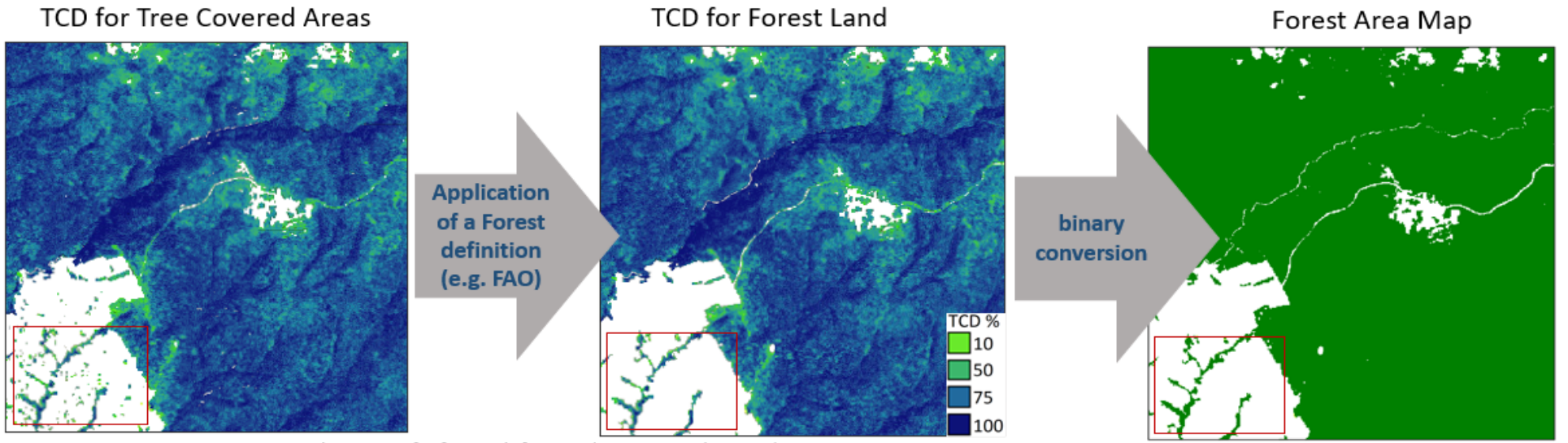
EO4SD – Forest Management (2020 ongoing)

- The ESA EO4SD Forest Management Cluster project – aims to demonstrate the utility and benefit of mainstreaming EO-based forest related products and services for improved Forest Management for IFI programmes and stakeholders in Client States (CS).
- The project is collaborating with International Financial Institutions (IFI), such as the World Bank (WB) and the Asian Development Bank (ADB) to demonstrate program tailored EO-based information to support their Forestry Management decision making.
- https://www.eo4sd-forest.info

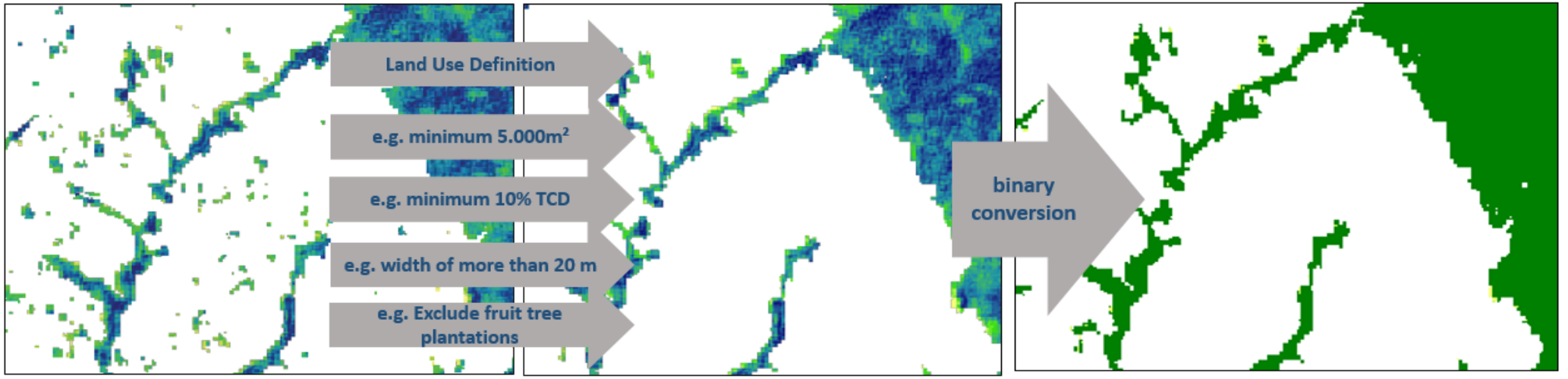
Evolution of Service Specifications



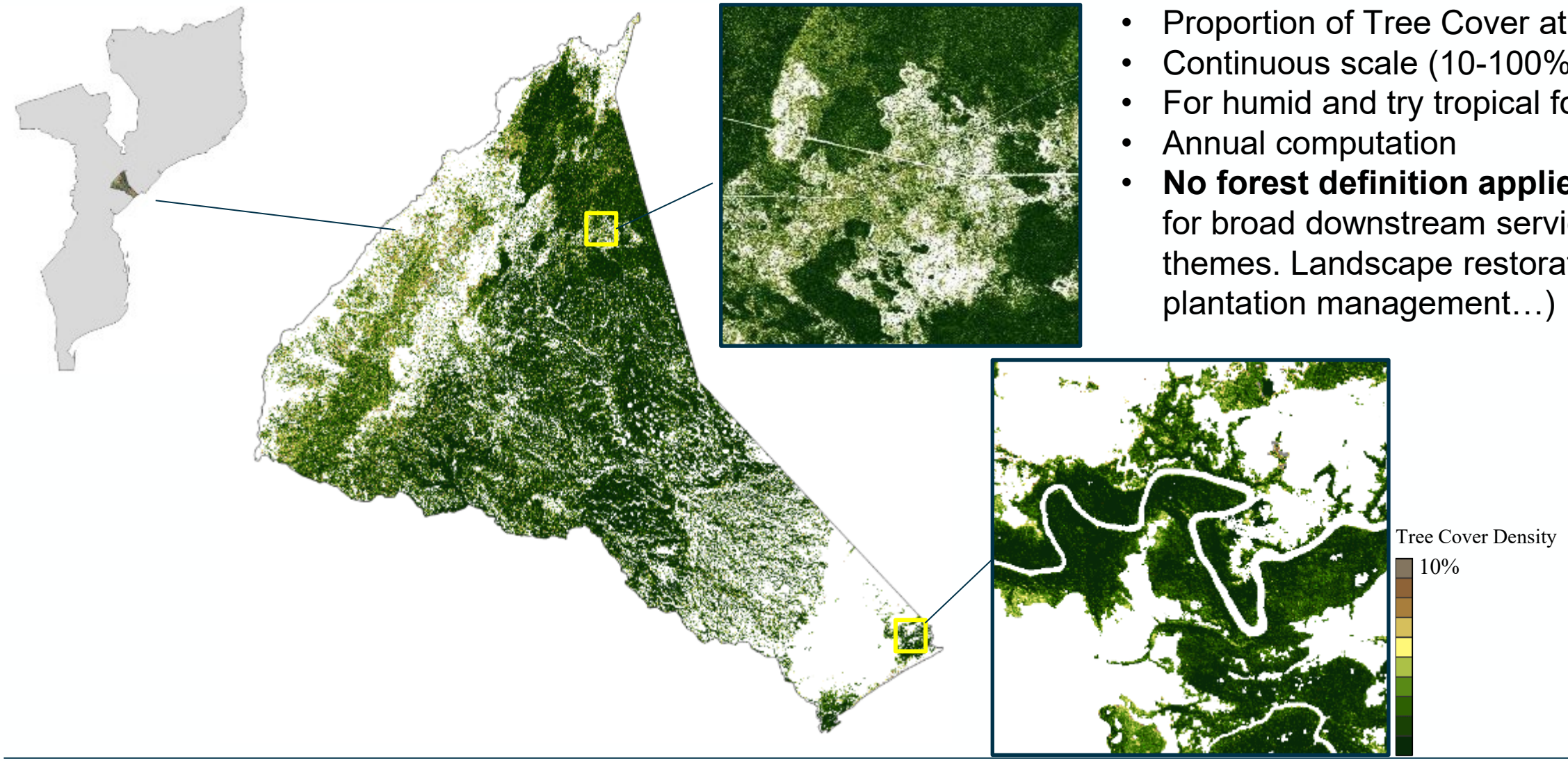
Tree Cover Density for Forest Area



elements of a forest definition (not comprehensive)

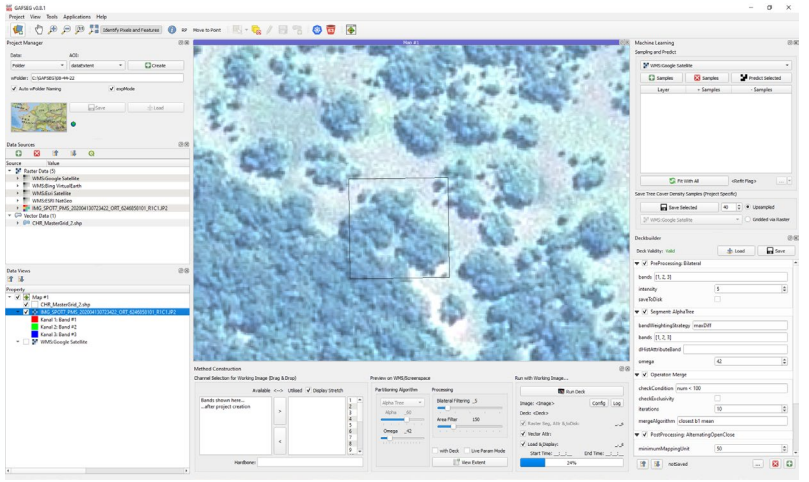


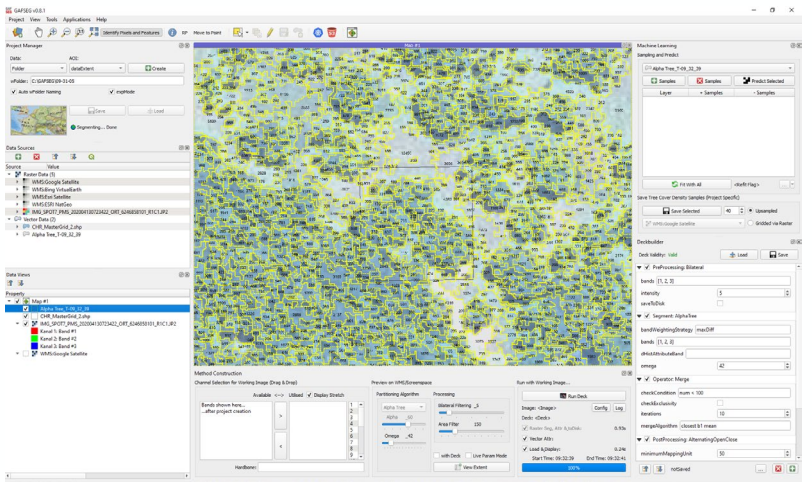
Tree Cover Density

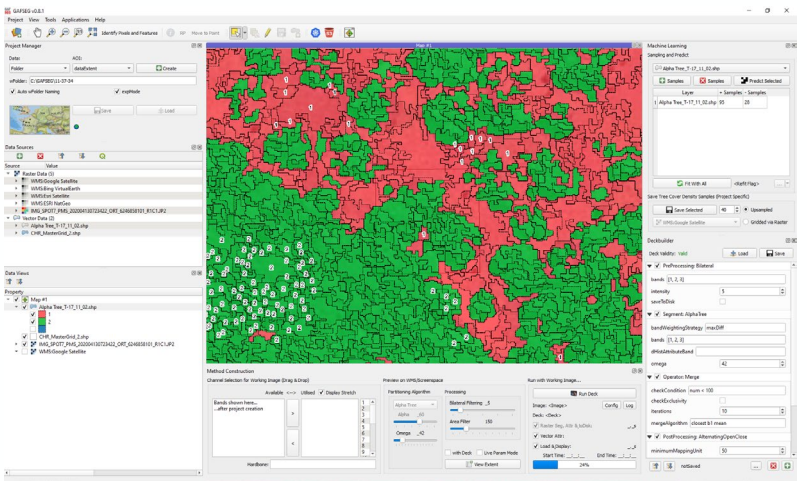


- Proportion of Tree Cover at pixel level
- Continuous scale (10-100%)
- For humid and try tropical forests
- Annual computation
- **No forest definition applied** (useful for broad downstream services and themes. Landscape restoration, plantation management…)

GAFSeg – QGIS GUI for stepwise TCD mapping







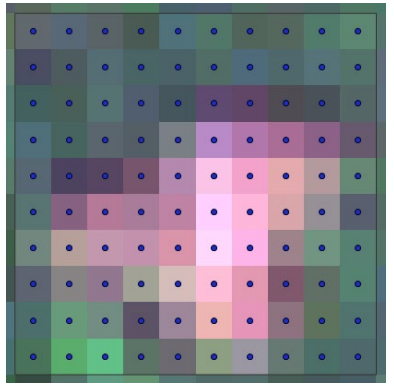
- Segmentation
- Parameter adjustment
- Class assignment
- Preview and re-sampling
- Prediction
- WMS and VHR sources

In-depth details in poster by C. Fourie: A Self-contained Operational System Targeting Resource Constrained Environments
for Mapping Tree Cover Density in Tropical Dry and Humid Forest Areas

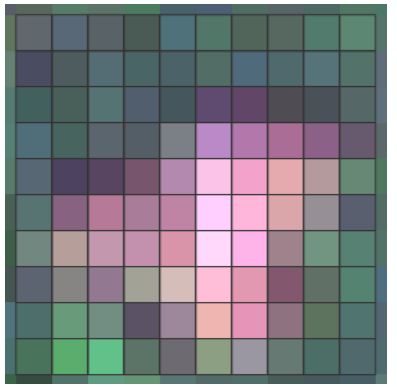
Sampling strategies

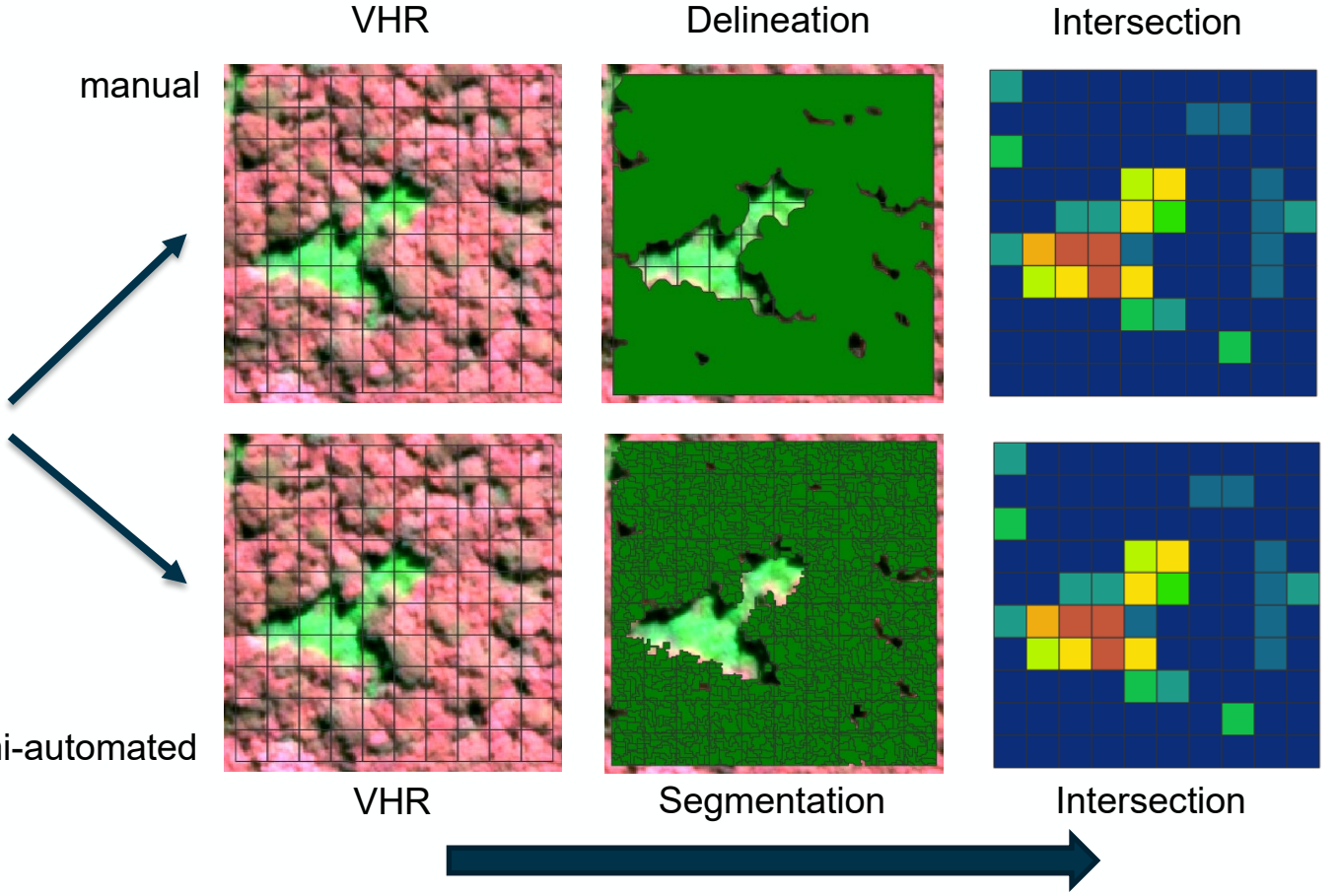
- Training data generation for TCD modelling
- Point based and Pixel-level based
- 1 manual delineated set
- 1 GAFSeg with individual segmentation settings
- 1 GAFSeg data set with a regional (default) setting

Point based (1 ha plot)



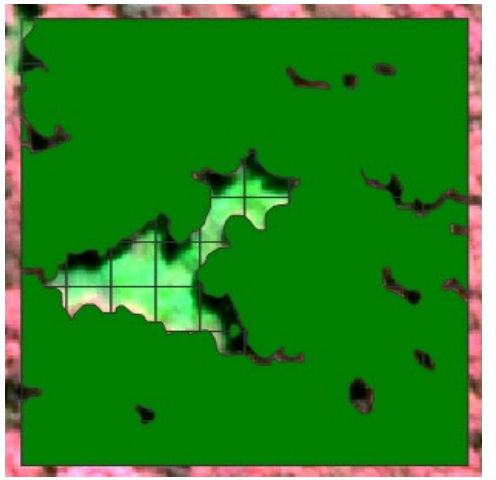
Pixel based (100m²)

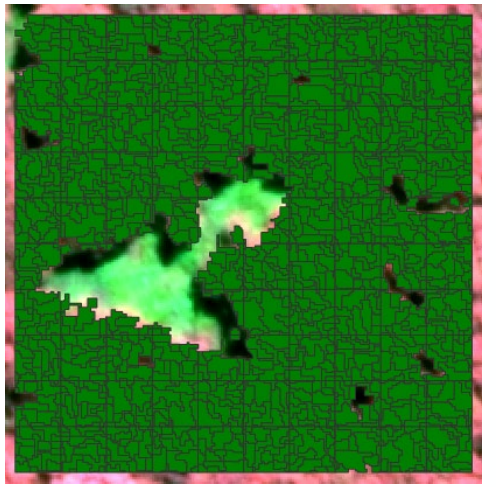




Segmentation evaluation

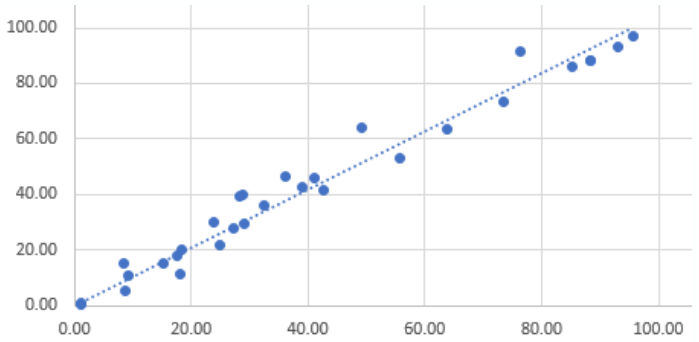
- Semi automated training data generation versus manual delineation
- Same VHR reference data for both methods used
- Semi-automated approach with local settings preferable





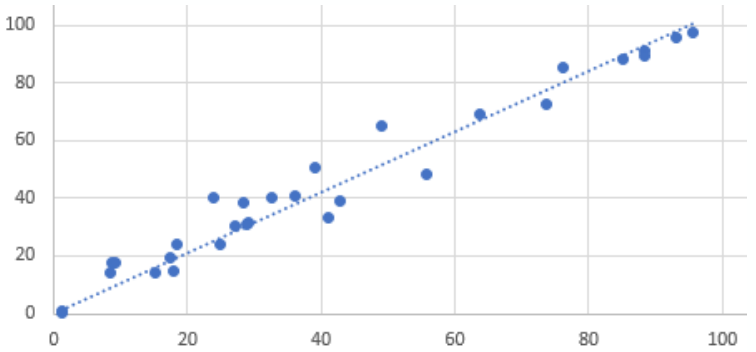
Individual settings

$R^2 = 0.97$
RMSE = 5.81



Regional setting for segmentation

$R^2 = 0.95$
RMSE = 6.78



Model Comparison

- Training/Validation set limited to 4000 samples in this study (comparability to manual approach)
- Sentinel-2 based **mosaic** with RGB, NIR, SWIR bands and NDVI
- Sentinel Time Features (**TF**) data stack (64 bands, Min, Max, Med, P25, P75, P90)

Type	Data source	Random Forest	Catboost
Regional settings	TF Stack	R^2 0.69 RMSE 23.1	R^2 0.56 RMSE 28.61
	Mosaic	R^2 0.68 RMSE 23.7	R^2 0.65 RMSE 25.55
Individual settings	TF Stack	R^2 0.71 RMSE 22.5	R^2 0.57 RMSE 24.58
	Mosaic	R^2 0.70 RMSE 22.5	R^2 0.68 RMSE 28.0
Manual delineated	TF Stack	R^2 0.7 RMSE 22.92	R^2 0.67 RMSE 28.95
	Mosaic	R^2 0.69 RMSE 23.04	R^2 0.56 RMSE 24.95

Conclusion

- Tree Cover Density (TCD) information useful for manifold applications and themes
- TCD information is required to apply forest definitions
- Training and Validation data needs inclusion of Very High Resolution (VHR) imagery (<1m)
- GAFSeg minimises the work effort for training data generation and provides a single framework for TCD mapping by achieving similar results to pure manual based sampling
- Timing of HR and VHR data acquisition is key in tropical dry forests
- Feasibility to validate/calibrate against global products to be researched
- Further improvements by training data preparation (stratification, slicing, big data) foreseen
- Different modelling algorithms tested, whereas source data and geolocation accuracy is key

Acknowledgements

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- Thanks to Cornelia Selle and Philine Rosenfeld for supporting the TCD mapping comparison

- We are hiring as well ;-)