Global Forest Biodiversity Initiative Symposium 2017

Assessment of forest degradation, regeneration, deforestation and afforestation by combining high resolution satellite time series and plot based inventory data

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Structure of the presentation:

- Background
- Demonstration site
- Sampling design
- Response design
- Analysis
- Conclusions & recommendations

Background

Copernicus
Europe's eyes on Earth

Global Land Hot Spot Monitoring Service

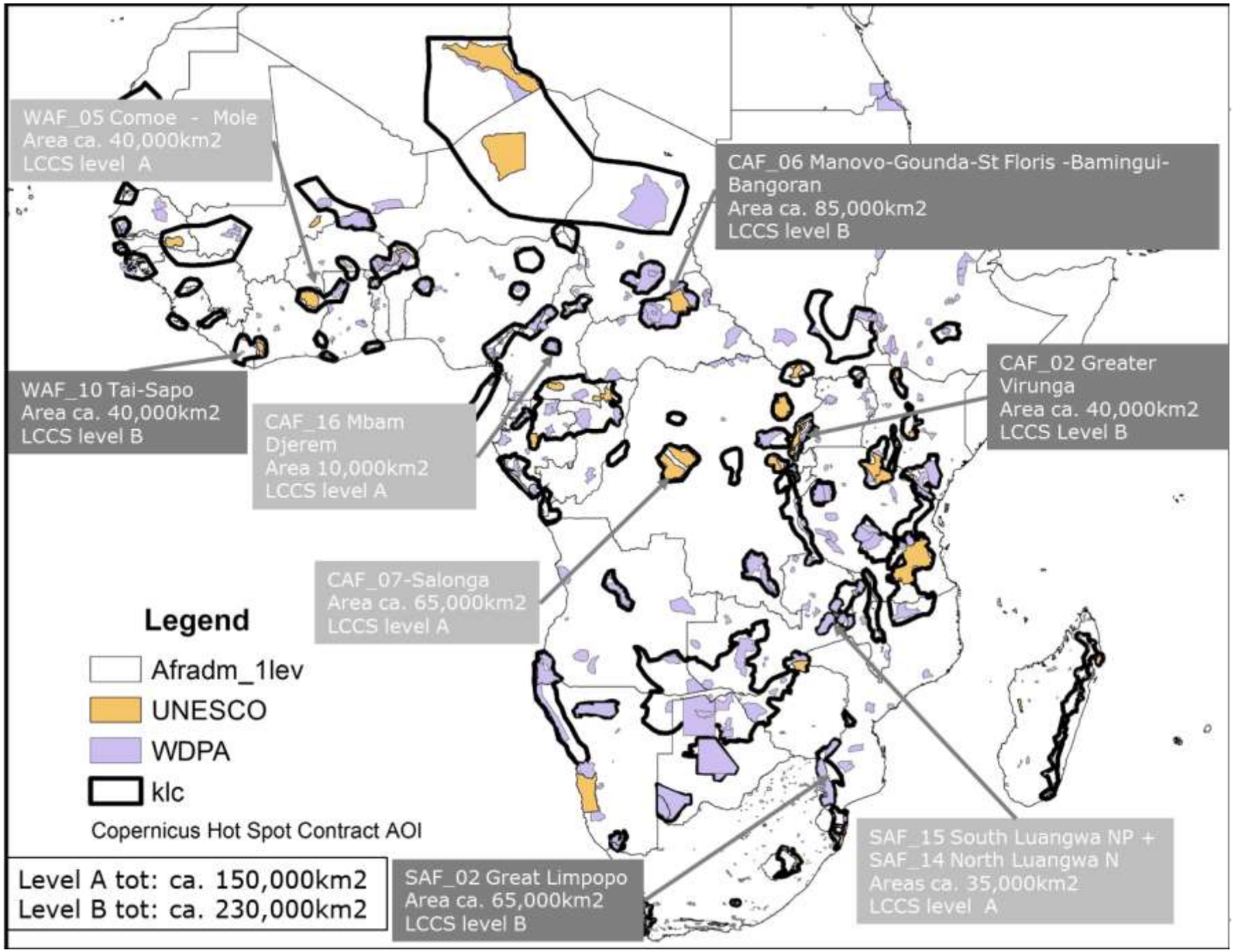
- To provide detailed land information on specific areas of interest for the EU outside of its territory
- For such areas of interest, including protected areas or hot spots for biodiversity and land degradation, land cover and land cover change products are provided
- Initial focus is on the African continent

Background

Global Land Hot Spot Monitoring Service

- Coordination: Joint Research Centre, European Commission – JRC
- Production/mapping: e-GEOS, Telespazio Iberica, ITHACA, CNR-IREA, ISPRA, Paola Codipietro, EXELIS
- Validation: IGN-FI, JOANNEUM RESEARCH, Luxspace space4environment, EOXPLORE, GISBOX, ONFI

Demonstration site



Global Land Hot Spot Monitoring Service

First implementation year:

- 8 sites in Africa

For all sites:

- Land Cover & Land Cover Changes 2000/2015

Nomenclature

DGROUP	LCCLabel
A11 - Cultivated and managed terrestrial areas	Continuous Large To Medium Sized Field(s) (>2 ha) Of Tree Crop(s) Crop Cover: Plantation(s)
	Continuous Small Sized Field(s) (<2 ha) Of Tree Crop(s) Crop Cover: Plantation(s)
	Continuous Large To Medium Sized Field(s) (>2 ha) Of Tree Crop(s) Crop Cover: Orchard(s)
	Continuous Small Sized Field(s) (<2 ha) Of Tree Crop(s) Crop Cover: Orchard(s)
	Continuous Large To Medium Sized Field(s) (>2 ha) Of Shrub Crop(s)
	Continuous Small Sized Field(s) (<2 ha) Of Shrub Crop(s)
	Continuous Large To Medium Sized Field(s) (>2 ha) Of Herbaceous Crop(s)
	Continuous Small Sized Field(s) (<2 ha) Of Herbaceous Crop(s)
A12 – Natural or semi-natural terrestrial vegetation	Continuous Closed (>70-60)% Trees
	Continuous Open (70-60)-(20-10)% Trees
	Continuous Closed to Open (100-40)% Shrubs
	Continuous Open (40 - (20-10)%) Shrubs
	Continuous Closed to Open (100-40)% Herbaceous Vegetation
	Continuous Open (40 - (20-10)%) Herbaceous Vegetation
B15 - Artificial surfaces and associates area(s)	Built Up Area(s)
	Non Built Up Area(s)
A23 – Cultivated aquatic or regularly flooded areas	Continuous Large To Medium Sized Field(s) (>2 ha) Of Woody Crops - Aquatic Or Regularly Flooded
	Continuous Small Sized Field(s) (<2 ha) Of Woody Crops - Aquatic Or Regularly Flooded
	Continuous Large To Medium Sized Field(s) (>2 ha) Of Graminoid Crops - Aquatic Or Regularly Flooded
	Continuous Small Sized Field(s) (<2 ha) Of Graminoid Crops - Aquatic Or Regularly Flooded
A24 – Natural or semi-natural aquatic vegetation	Closed (>70-60)% Trees - Aquatic vegetation
	Open General (70-60)-(20-10)% Trees - Aquatic vegetation
	Closed to Open (100-40)% Shrubs - Aquatic vegetation
	Very Open (40 - (20-10)%) Shrubs - Aquatic vegetation
	Closed to Open (100-40)% Herbaceous Vegetation - Aquatic vegetation
	Very Open (40 - (20-10)%) Herbaceous Vegetation - Aquatic vegetation
B27 – Artificial water bodies, snow and ice	Artificial Waterbodies (Flowing)
	Artificial Waterbodies (Standing)
B28 – Natural water bodies, snow and ice	Natural Waterbodies (Flowing)
	Natural Waterbodies (Standing)
	Snow
	Ice

LCCS-2 aggregated to:

- Unchanged forest
- Afforestation
- Deforestation
- Forest degradation
- Forest regeneration
- Other classes

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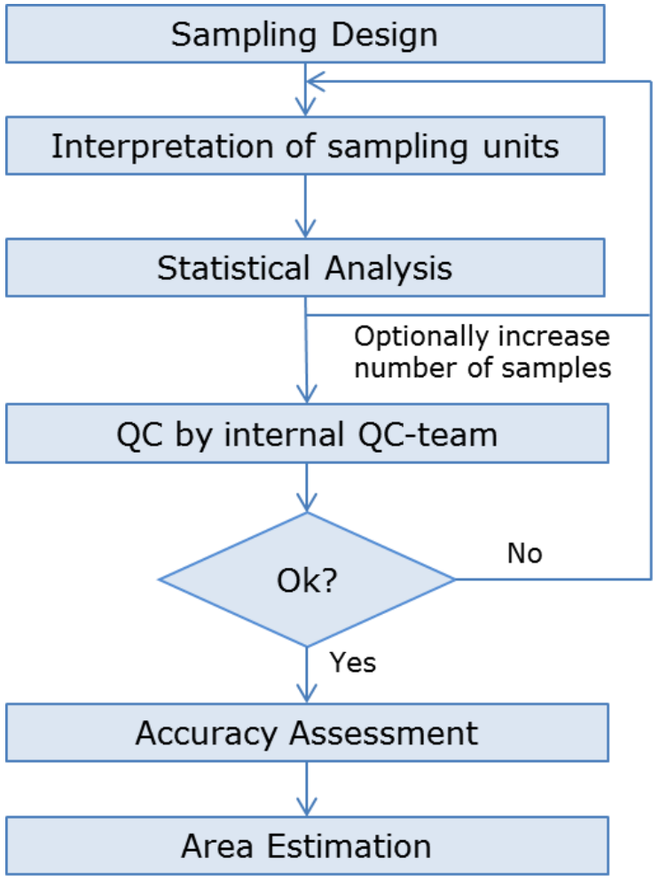
General Workflow:



Sampling Design

Stratified random sampling:

- LC & LCC maps are used as strata
- Step 1 : optimisation regarding error of commission (minimum number of samples per category, based on estimated category accuracies)
- Step 2: optimisation for area estimation & estimation of overall accuracy by applying Nyman optimal allocation

➢ Result: 4401 sampling units

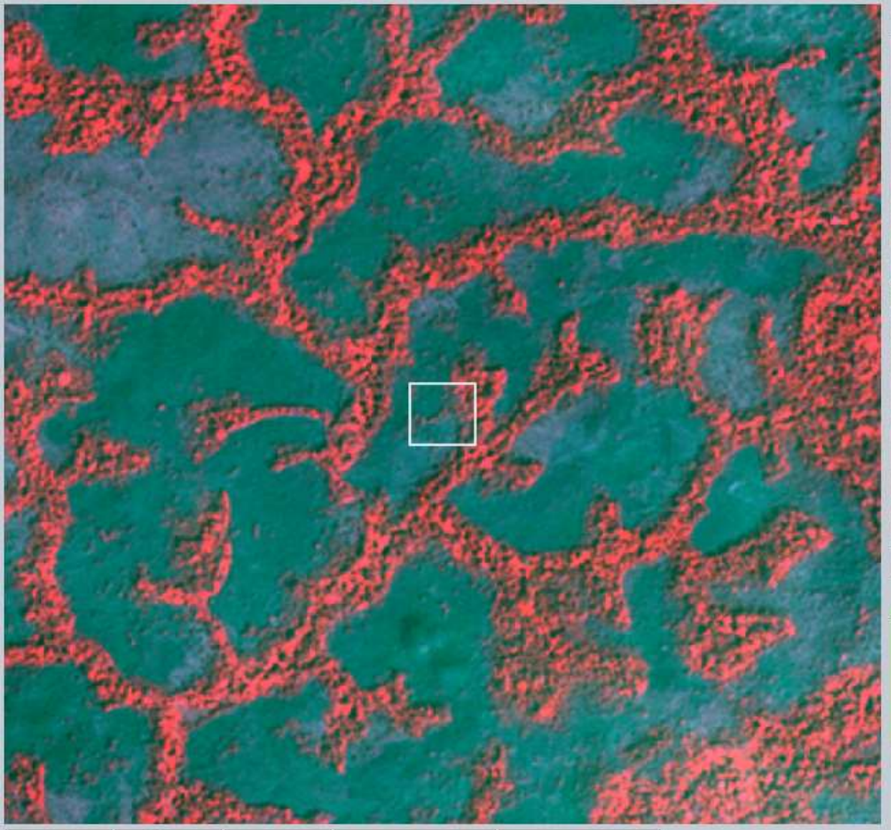
Response Design

The response design encompasses the procedures for assigning the class label to each sampling unit

Reference data (for all 8 sites):	VHR:	several hundred SPOT6, 7 scenes
		google/bing/ESRI basemap
	HR:	6000 Landsat 5,7,8 and ASTER scenes
		2000 Sentinel2-Granules (L2A processed with sen2cor)
	DSM:	ALOS3DW30 gap-filled with SRTM-1arcsec
	Ancillary:	OSFACO-Project,
		JRC global water explorer

Web-based interpretation tool:

- View and annotate different data in a web-browser
- Time series: trajectory and matrix view
- Multi-user interface
- PostgreSQL database with PostGIS extensions



1783 (ica_caf_16)

Show Bing | Copy coords to clipboard | TS_Trajectory | TS_542_3000_Matrix | TS_CIR_3000_Matrix

Reset

			2015	2000
VEG	Terrestrial	Cultivated and Managed Areas	○	○
		Natural & Semi-Natural	○	○
	Aq./flooded	Acquatic agriculture	○	○
		Natural & Semi-Natural Acquatic	○	○
NO-VEG	Terrestrial	Artificial Surfaces & Associated Area(s)	●	●
		Bare Area(s)	○	○
	Aq./flooded	Artificial Waterbodies, Snow and Ice	●	●
		Natural Waterbodies, Snow and Ice	○	○
Unknown			○	○

Select reliability

Low | Medium | High

NONE SELECTED

GEOM ERR

NONE

Save and Proceed | Save and Goto Overview | Don't save and goto next | Cancel

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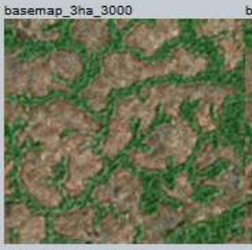

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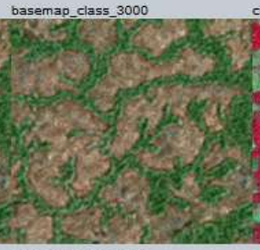

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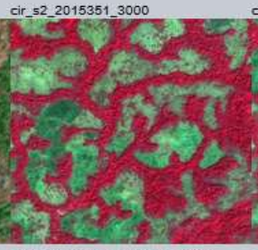

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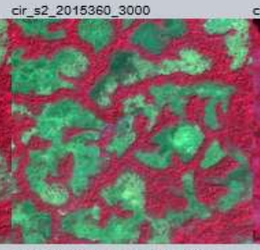

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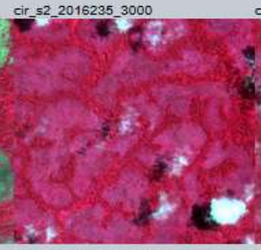

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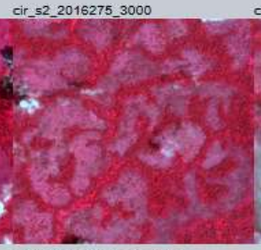

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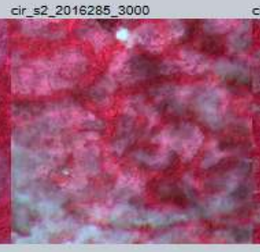

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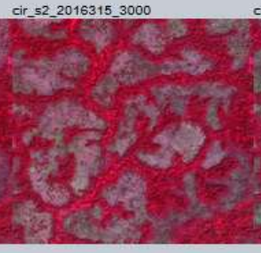

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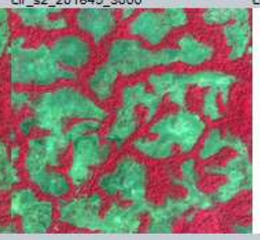

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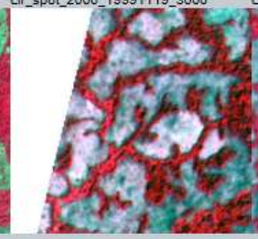

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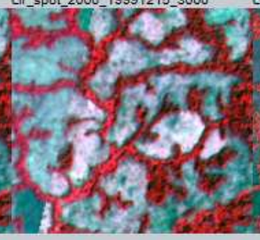

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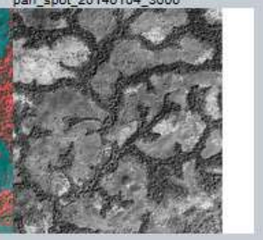
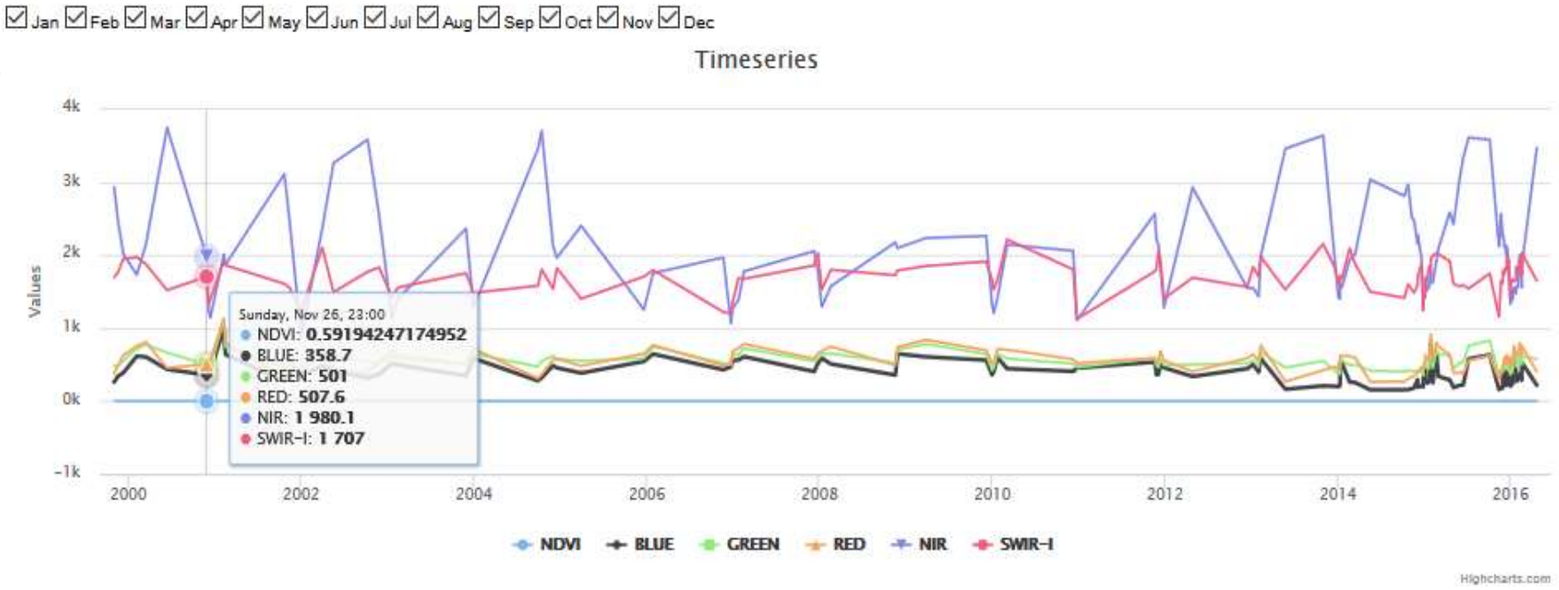


Response Design - Temporal Trajectory view



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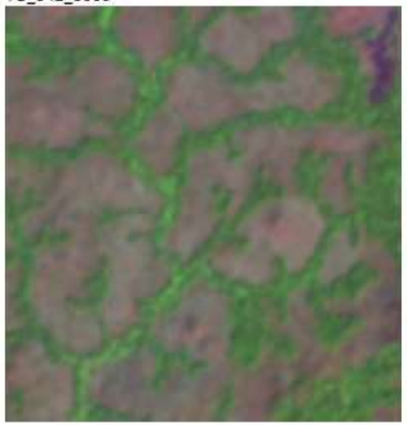

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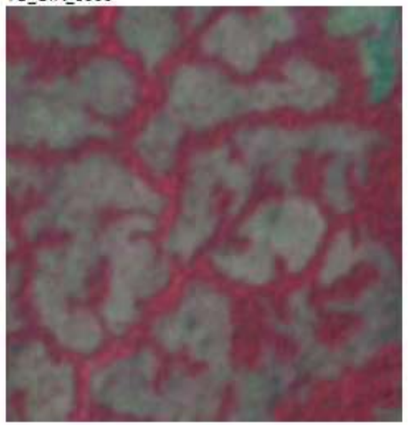

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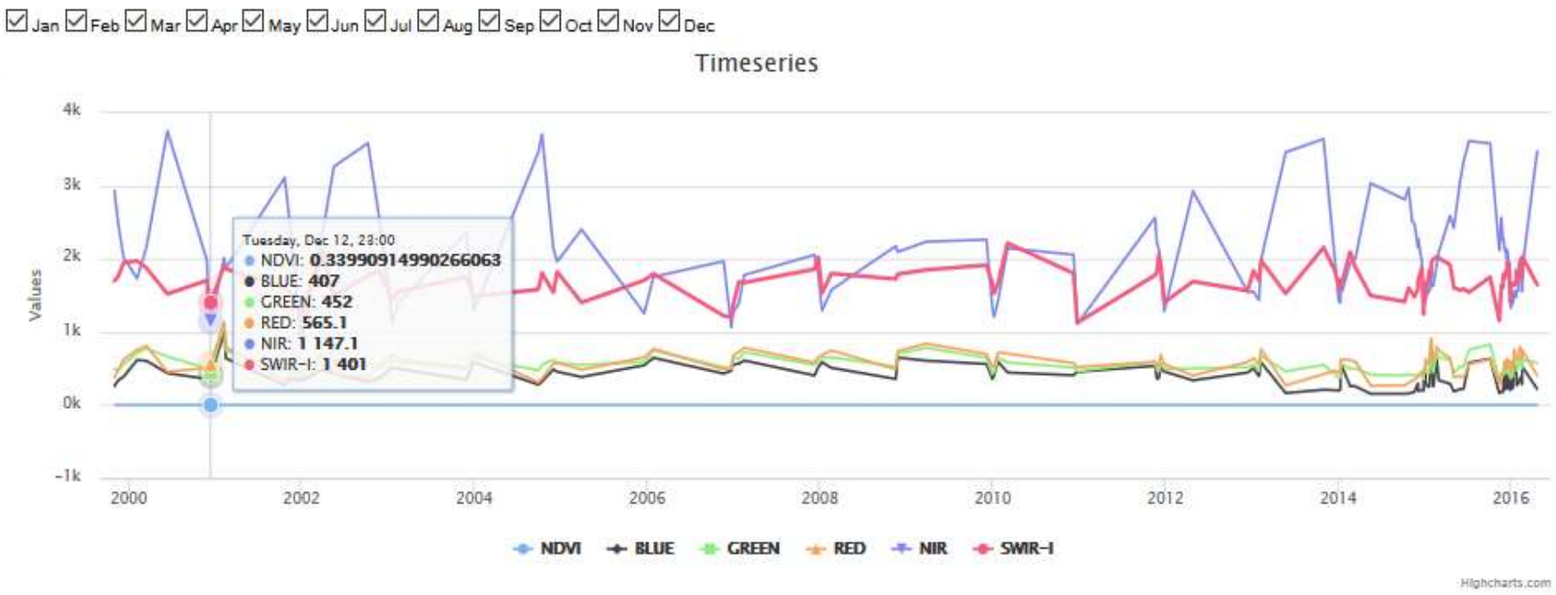
Response Design - Temporal Trajectory view



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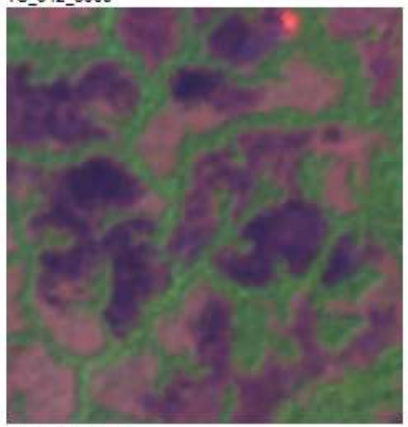

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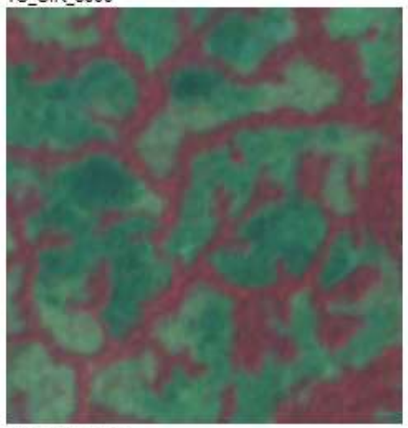

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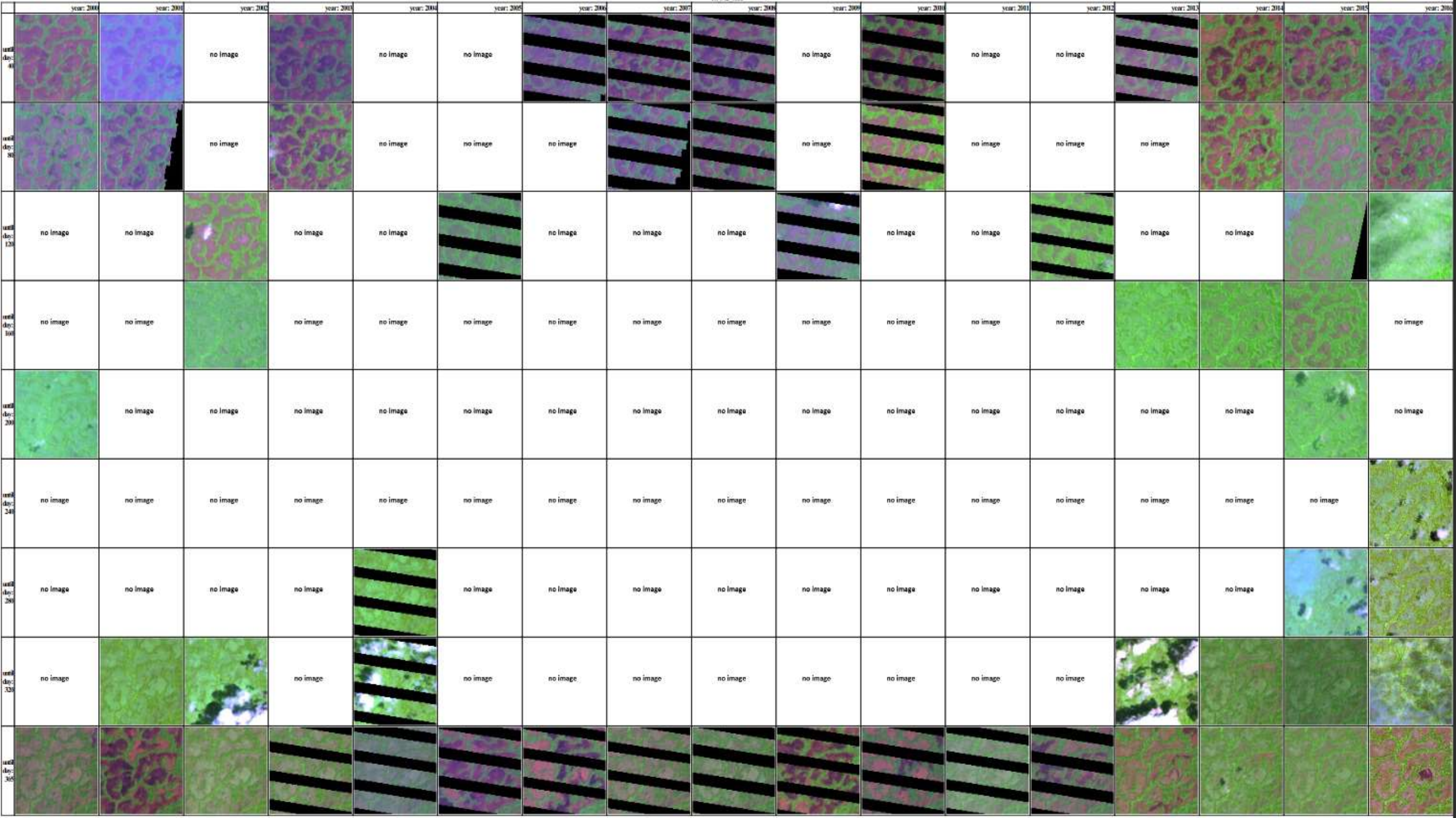
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until day: 160
until day: 200
until day: 240
until day: 280
until day: 320
until day: 365
no image

Analysis

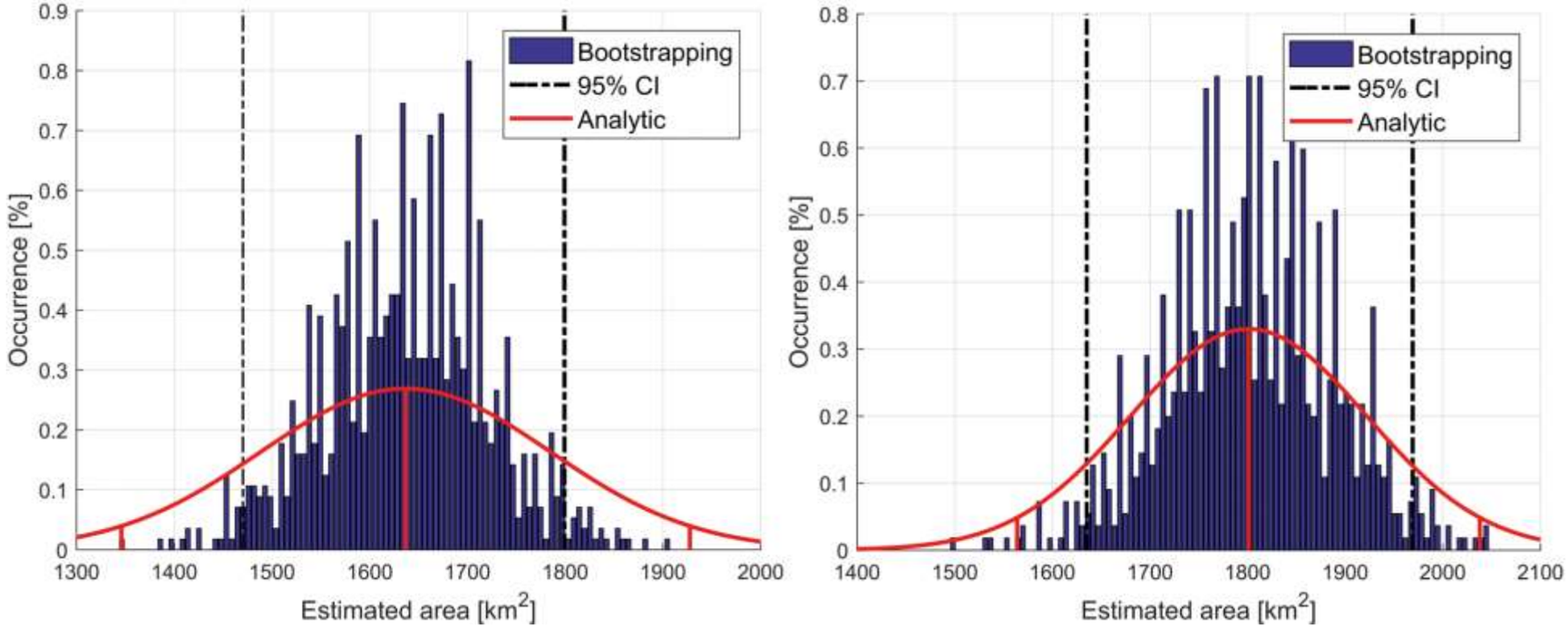
Assessments based on inclusion probabilities:

- Overall accuracy
- Error of omission per LC & LCC category
- Error of commission per LC & LCC category
- Area estimation for LC & LCC categories

Confidence intervals at 95% Level (as required for internatinal reporting) derived:

- by analytical formulas (Formulas see e.g. Olofsson et al. 2014 or Cochran 1977)
- by bootstrapping

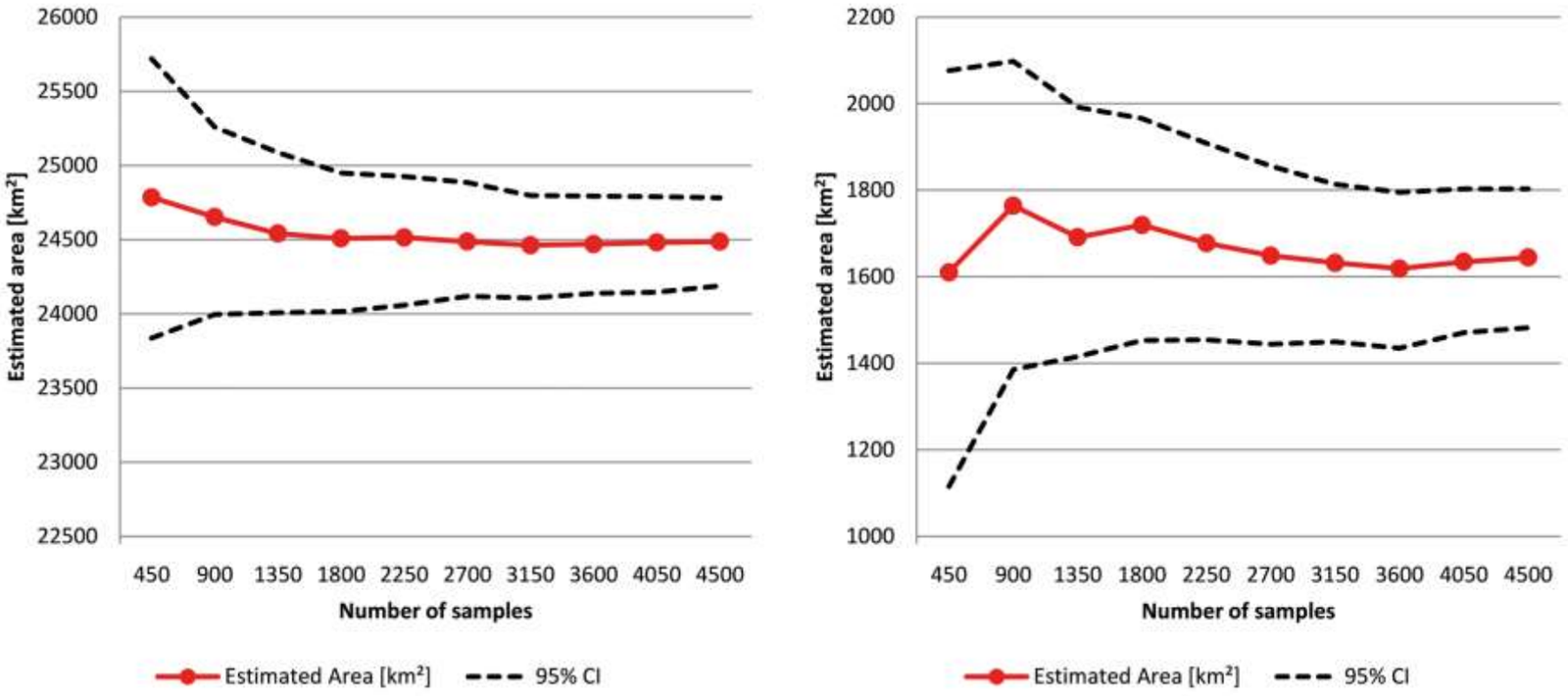
Analysis



Histograms of 1000 bootstrap replications for the area estimation, overlaid with analytic density curves in red.

Left site for afforestation, right site for deforestation

Analysis



Simulation of different sampling intensities with total number of plots ranging from 440 to 4400

Left site for unchanged forest, right site for afforestation

Analysis

Area estimation results including confidence intervals in km²

Category	Strata area	Number of samples	Analytically derived estimates			Bootstrapping results		
			Estimated area	Lower bound	Upper bound	Estimated area	Lower bound	Upper bound
Afforestation	7	168	1637	1346	1928	1644	1482	1803
Deforestation	552	418	1801	1564	2038	1804	1647	1966
Forest degradation	75	76	467	317	617	462	363	571
Forest regeneration	0	50	579	402	756	581	502	656
Other class	9278	1901	11009	10547	11471	11007	10734	11267
Unchanged forest	30072	1788	24491	23921	25061	24486	24188	24782

Conclusions & recommendations

Error rates of remote sensing wall-to-wall monitoring of forest changes are often in the order of change rates

- in such (typical) case RS monitoring should be complemented with sampling approach
- a consistent approach is recommended where the sampling data are used for accuracy assessment and for estimation of areas and for deriving confidence intervals
- in general stratified random sampling with LC & LCC maps as strata is recommended

There are large differences in confidence intervals derived by analytic solutions and by bootstrapping

- As bootstrapping can handle correlations, large uncertainties and complex probability density functions, we recommend to apply bootstrapping

To allow accurate interpretation of VHR data, Sentinel2 time series, historic Landsat & ASTER scenes:

- a specific interpretation tool is required

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