This project is co-financed by
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LULUCF-TR
GHG Monitoring and Reporting System

Component 4 Activity Review

W 4.2 Workshop

January 22, 2019

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GeoVille GmbH

CFCU
CENTRAL FINANCE & CONTRACTS UNIT

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ÇEVRE VE ŞEHİRCİLİK
BAKANLIĞI

Presentation Content

Data acquisition

Gathering of reference data & assessment

Class definitions

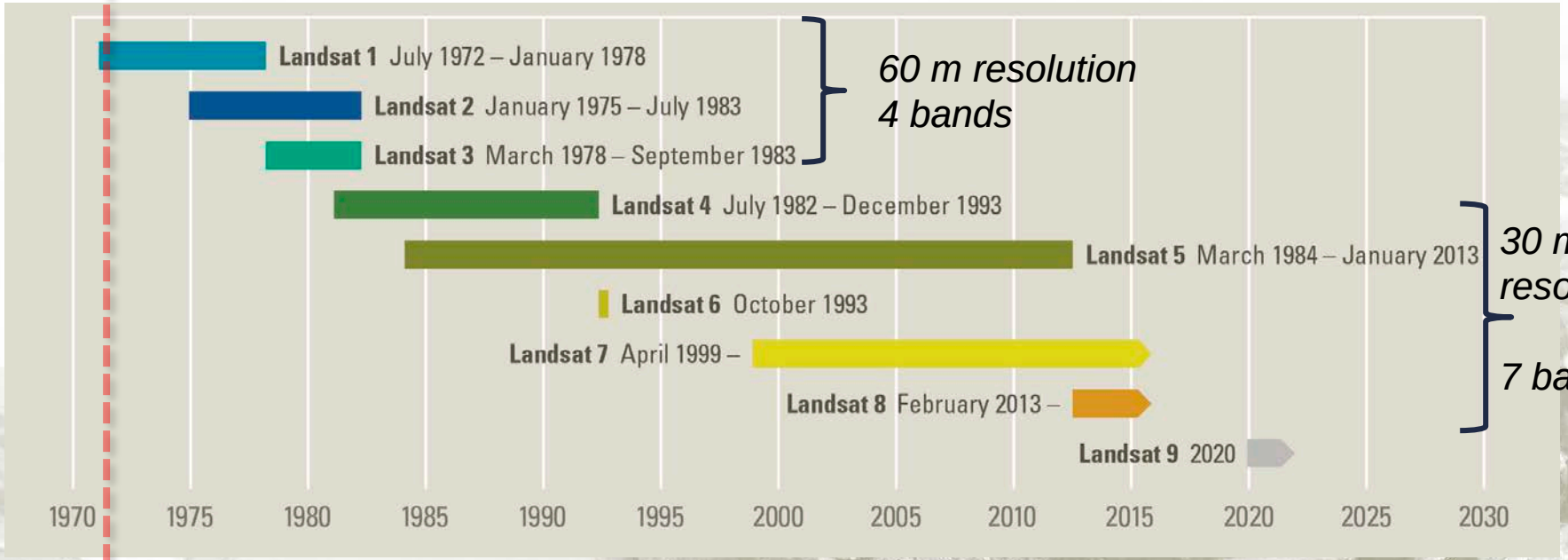
Processing Infrastructure

Methodological overview on

- Pre-processing
- Classification (baseline 2015)
- Change Detection
- Historic Forest Map (1970-1990)
- Validation

Component 4 Activity Review

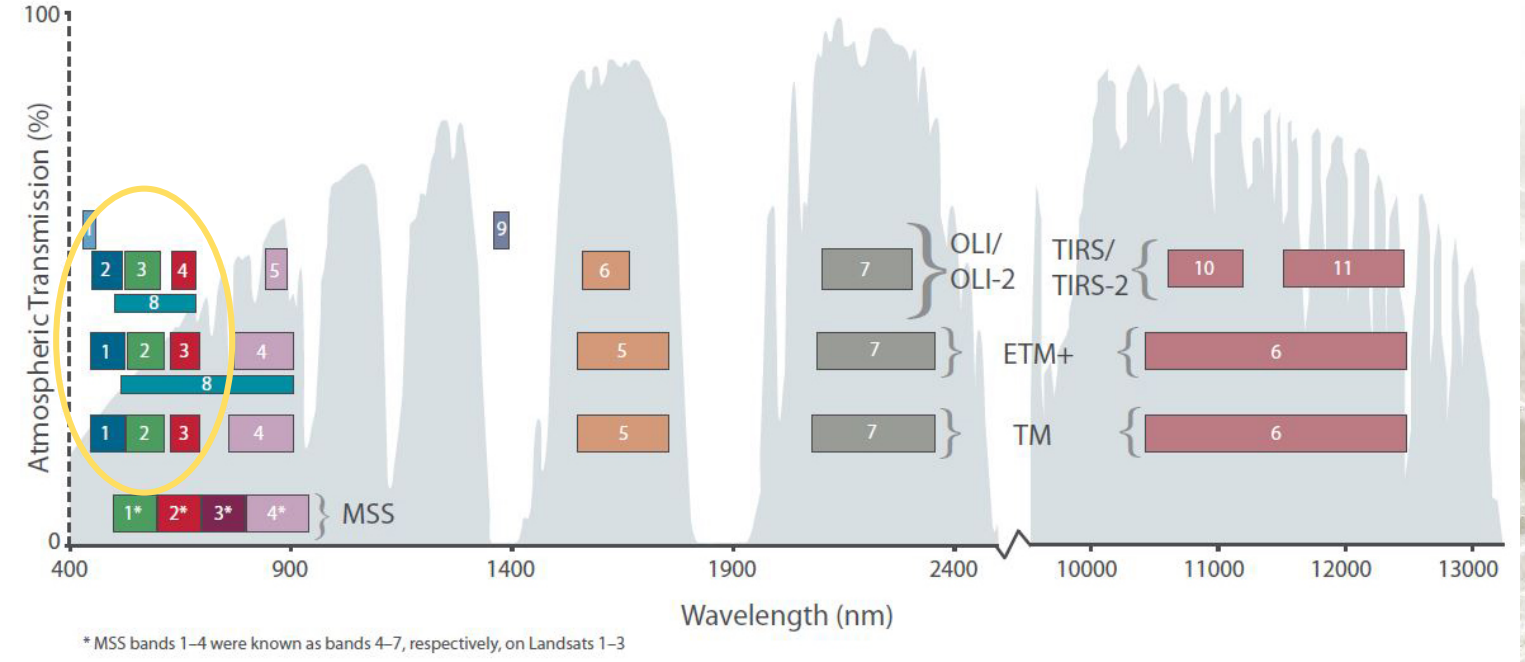
Data Acquisition



Source and more information: https://landsat.usgs.gov/what-are-band-designations-landsat-satellites

Component 4 Activity Review

Data Acquisition



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Component 4 Activity Review

Data Acquisition

Natural Colour
4,3,2

Component 4 Activity Review

Data Acquisition

False Colour 6,5,2
Vegetation

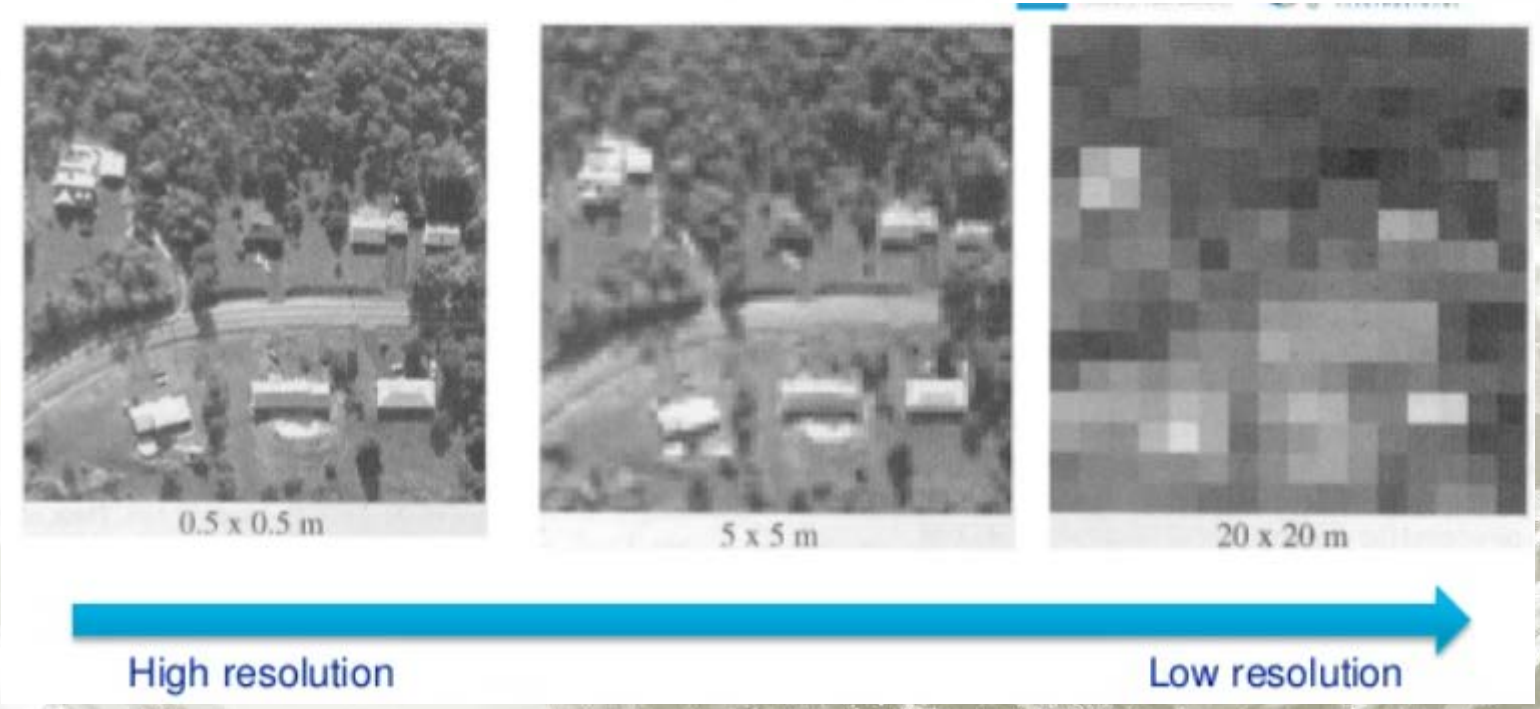
False Colour 7,6,4
Urban

Colour IR 5,4,3
Vegetation

False Colour 5,6,4
Land/Water

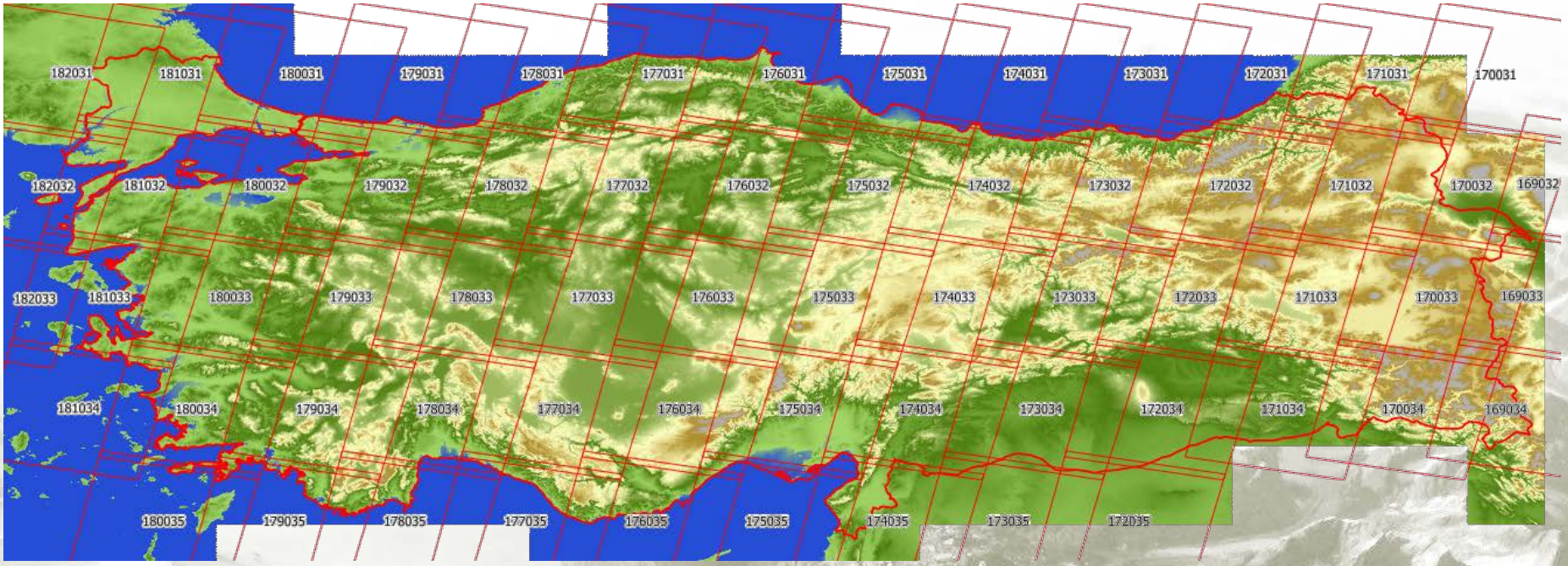
Component 4 Activity Review

Data Acquisition



Component 4 Activity Review

Data Acquisition



Component 4 Activity Review

Data Acquisition

Landsat 1-3 (~1000 scenes)
Landsat 4 (~8000 scenes)
Landsat 5 (~18.000 scenes)
Landsat 7 (~7800scenes)
Landsat 8 (~3000 scenes)
~ 37 800 scenes
→ 261 600 images
→ **5.6 Terabytes of data (~7600 CD roms)**

Component 4 Activity Review

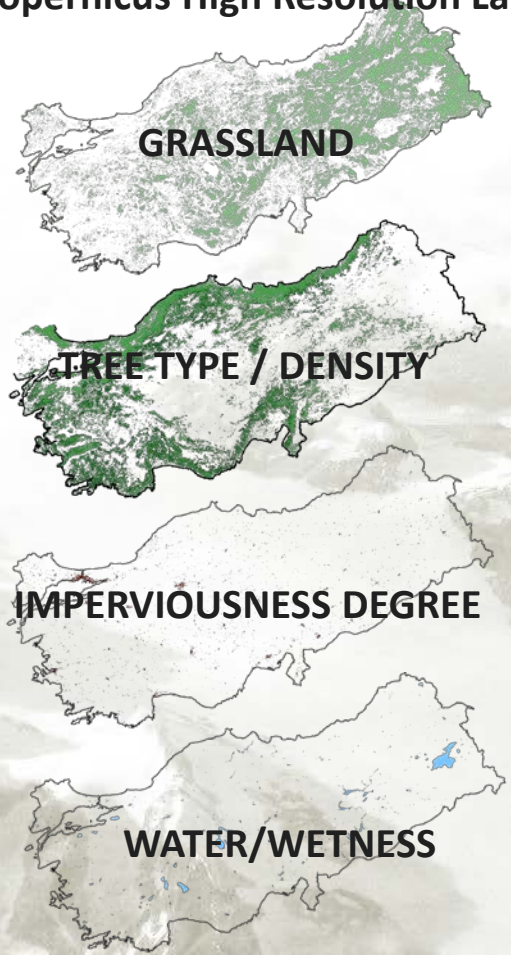
Gathering of reference data & assessment

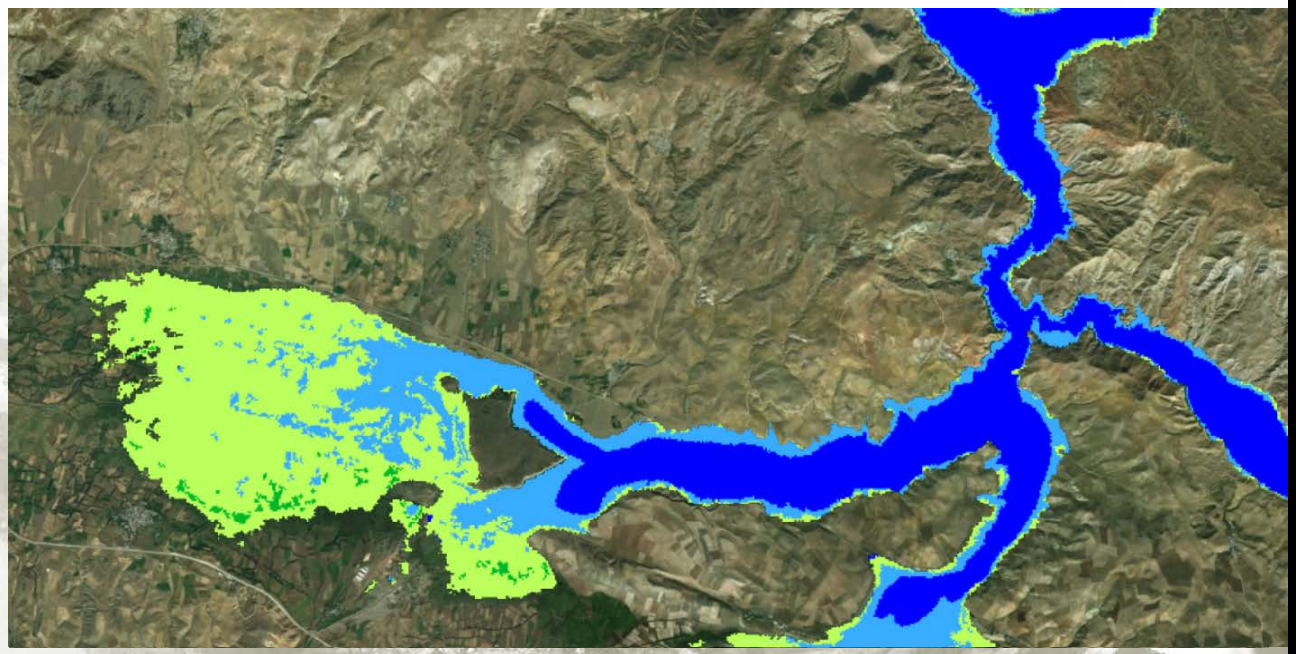
- **Why is reference data important?**
  - Provides knowledge about predominant Land Cover in the area
  - Its distribution in space and time
  - Reference data are a **key component** for the training of the classification model

Component 4 Activity Review

Gathering of reference data & assessment

Copernicus High Resolution Layers → Accuracy 80-90%, Resolution: 20m





Component 4 Activity Review

Gathering of reference data & assessment

Corine Land Cover 2012

→ Accuracy 85%, Vector Type, 100m MMW, 25ha MMU

→ 44 Classes

Component 4 Activity Review

Gathering of reference data & assessment

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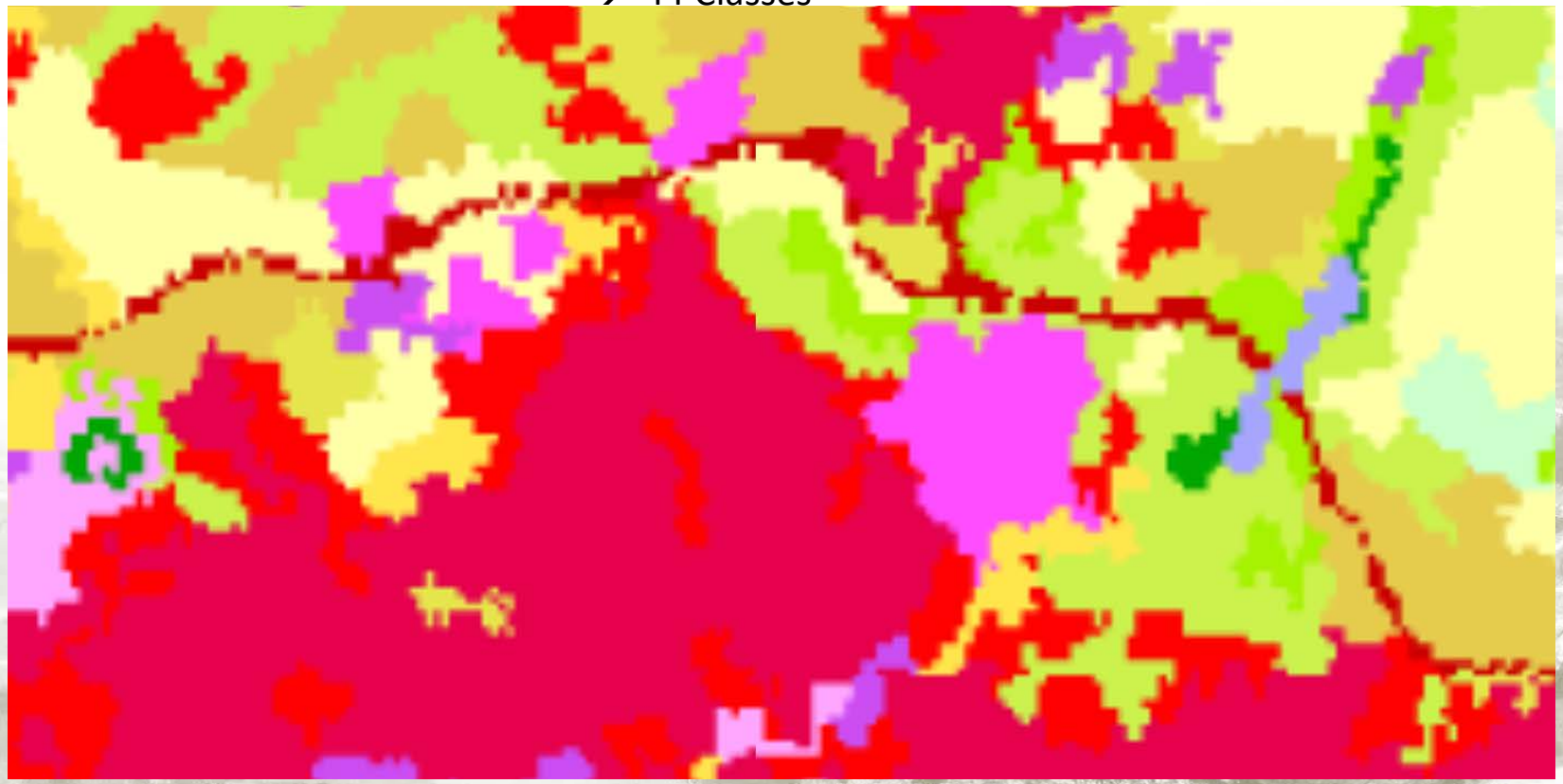


Component 4 Activity Review

Gathering of reference data & assessment

Corine Land Cover 2012

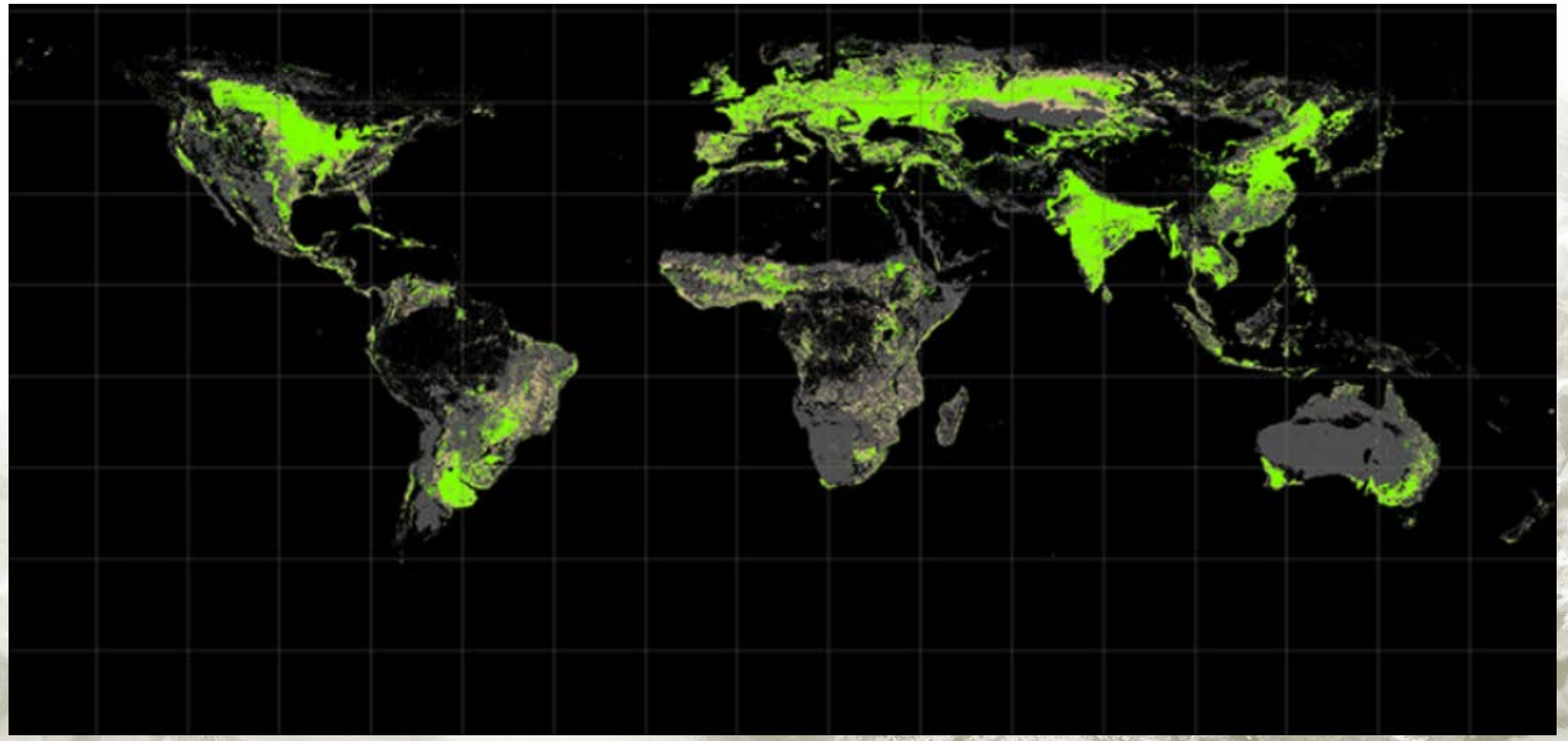
→ Accuracy 85%, Vector Type, 100m MMW, 25ha MMU

→ 44 Classes

Component 4 Activity Review

Gathering of reference data & assessment

Global Crop Extent → Accuracy 80%, 250m Resolution



Component 4 Activity Review

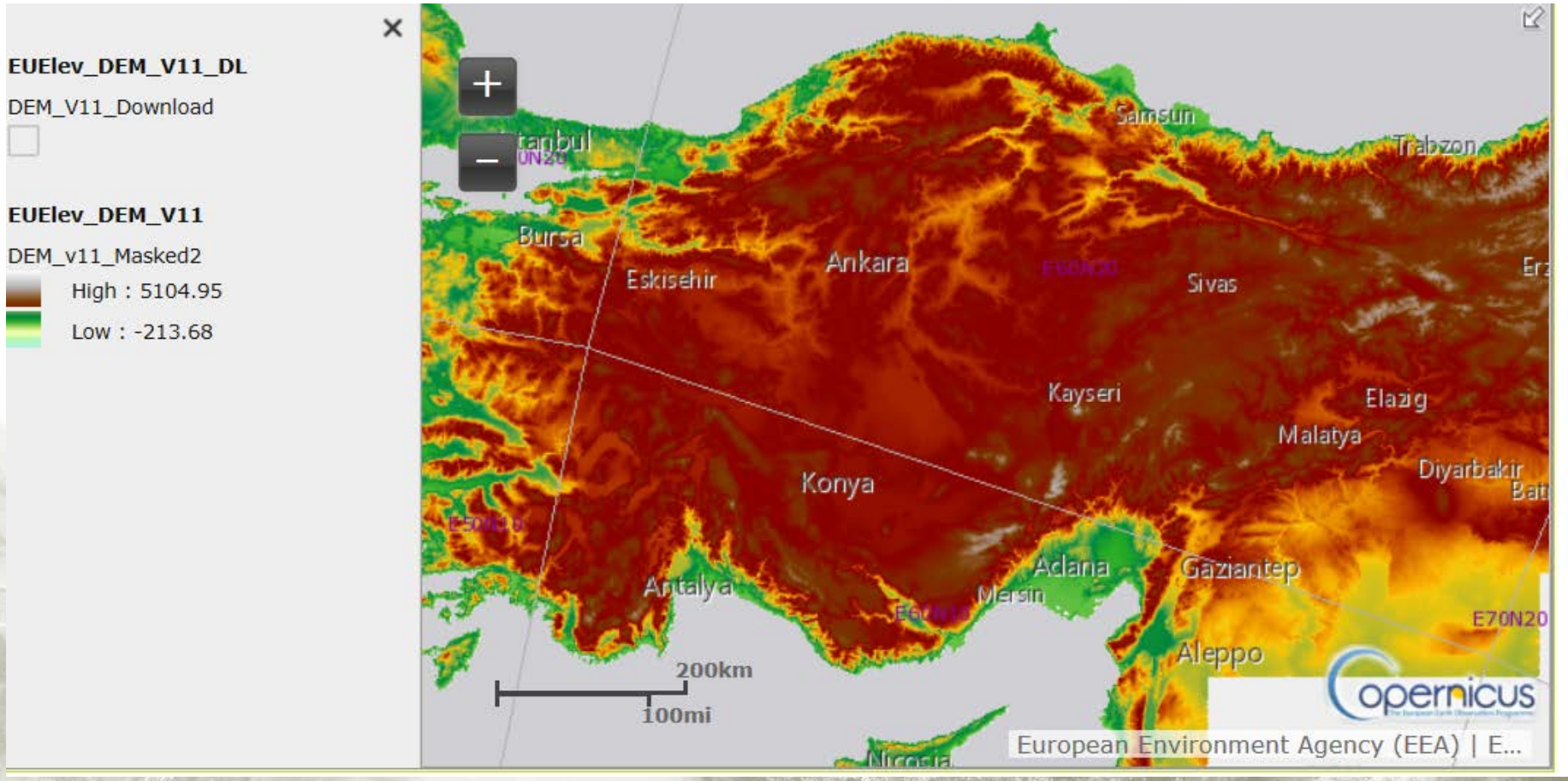
Gathering of reference data & assessment

Open Street Map → Accuracy ?%, Vector Type

Component 4 Activity Review

Gathering of reference data & assessment

EU-DEM → 25m resolution with vertical accuracy: +/- 7 meters



Component 4 Activity Review

Gathering of reference data & assessment

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Component 4 Activity Review

Gathering of reference data & assessment

- **Summary:**
  - Various datasources
  - Varying Quality/Accuracy
  - Mapped class ≠ target LULUCF class
  - Heterogenous specifications
    - MMU
    - Resolution

Component 4 Activity Review

Class definitions

UNFCCC Category	Land-use Sub-Category
Forest lands (1ha MMU)	Deciduous forest
	Coniferous forest
	Mixed forest
	Degraded Forest (<10%)
Croplands	Annual crops
	Perennial crops
Grasslands	Herbaceous
Wetlands	Reservoirs
	Natural water bodies
Settlements	Settlements
Other lands	Other lands

Component 4 Activity Review

Class definitions

UNFCCC Category	Land-use Sub-Category	Definition
Forest lands	Deciduous forest	Forest dominated by deciduous trees
	Coniferous forest	Forest dominated by deciduous trees
	Mixed forest	Mixed forest with deciduous and coniferous trees
	Degraded Forest	Woody vegetation (e.g. individual trees)

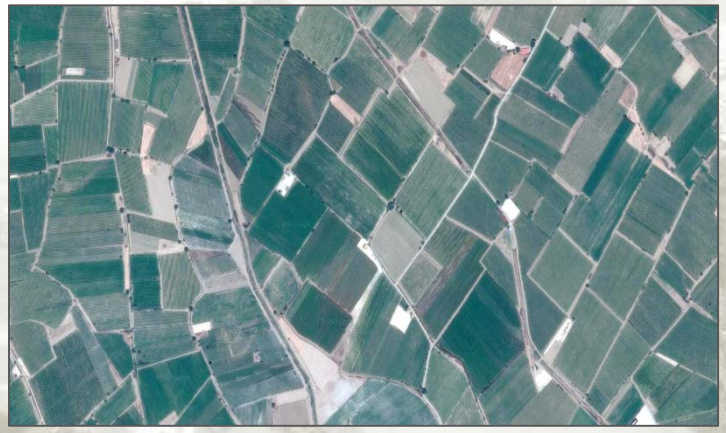
>10%

<10%

Component 4 Activity Review

Class definitions

UNFCCC Category	Land-use Sub-Category	Definition
Croplands	Annual crops	Cultivated land with annual crops
	Perennial crops	Cultivated land with perennial tree crops



Component 4 Activity Review

Class definitions

UNFCCC Category	Land-use Sub-Category	Definition
Grasslands	Herbaceous	Grassland without woody vegetation

Component 4 Activity Review

Class definitions

UNFCCC Category	Land-use Sub-Category	Definition
Wetlands	Reservoirs	Water reservoirs that come into existence following the construction of a dam
	Natural water bodies	All natural water bodies, incl. rivers, lakes, ocean (and reservoirs that have achieved equilibrium)

Component 4 Activity Review

Class definitions

UNFCCC Category	Land-use Sub-Category	Definition
Settlements	Settlements	Build-up areas incl. all sealed areas (e.g. infrastructure)*

* Grassy or forested recreational areas (e.g. parks) are considered grassland or forest land, respectively (assuming they meet the respective category definition).

Parks = grassland/forest

Component 4 Activity Review

Class definitions

UNFCCC Category	Land-use Sub-Category	Definition
Other lands	Other lands	All land that does not fall into any of the other categories (e.g. bare soil, sand, rock, permanent snow & ice

Component 4 Activity Review

Processing Infrastructure

- **Download:**
  - Time: 3-4 weeks
  - Theoretical Maximum Download Speed (Backbone): 40 Gbit
- **Storage:**
  - Raw Data Volume (Zipped): 5.5 TB
  - Total Volume ~ 20 TB
- **Processing Hardware:**
  - Cloud Computing Infrastructure
  - 7 Virtual Machines:
    - 82 CPUs
    - 664 GB RAM

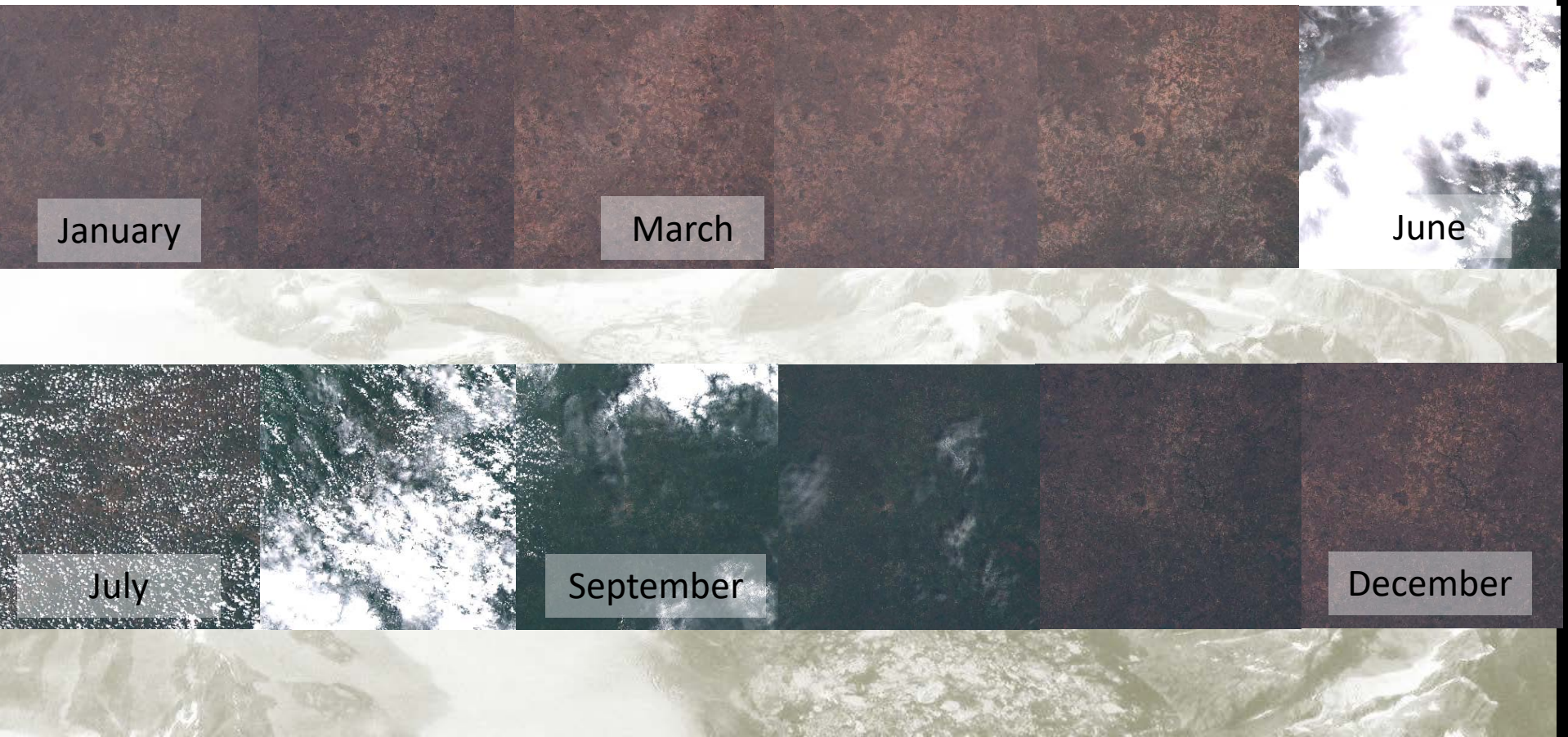
Component 4 Activity Review

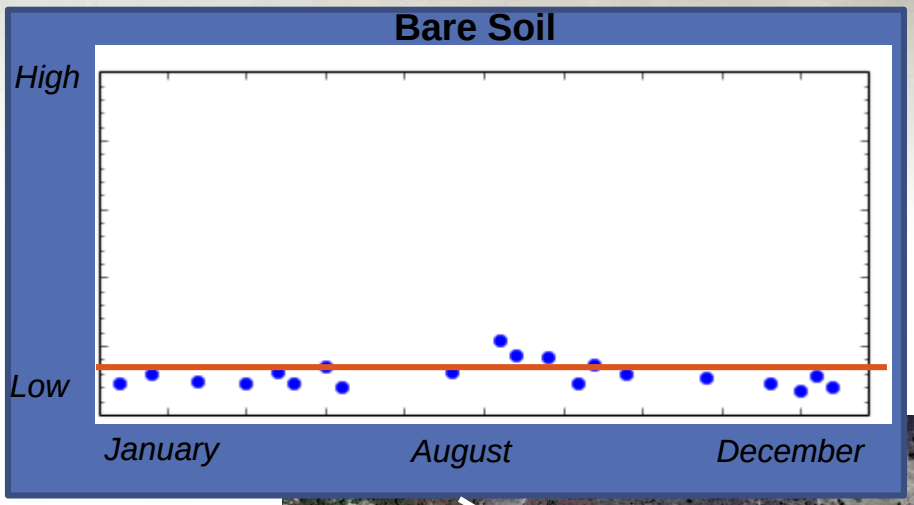
Method | Pre-processing

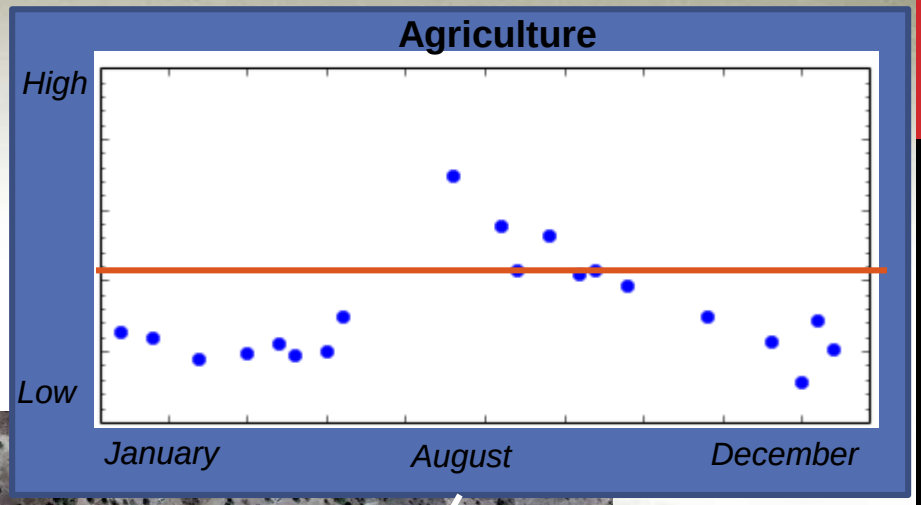
- **Purpose of pre-processing**
  - Enhancement
  - Correction
  - Filtering
  - Reduction

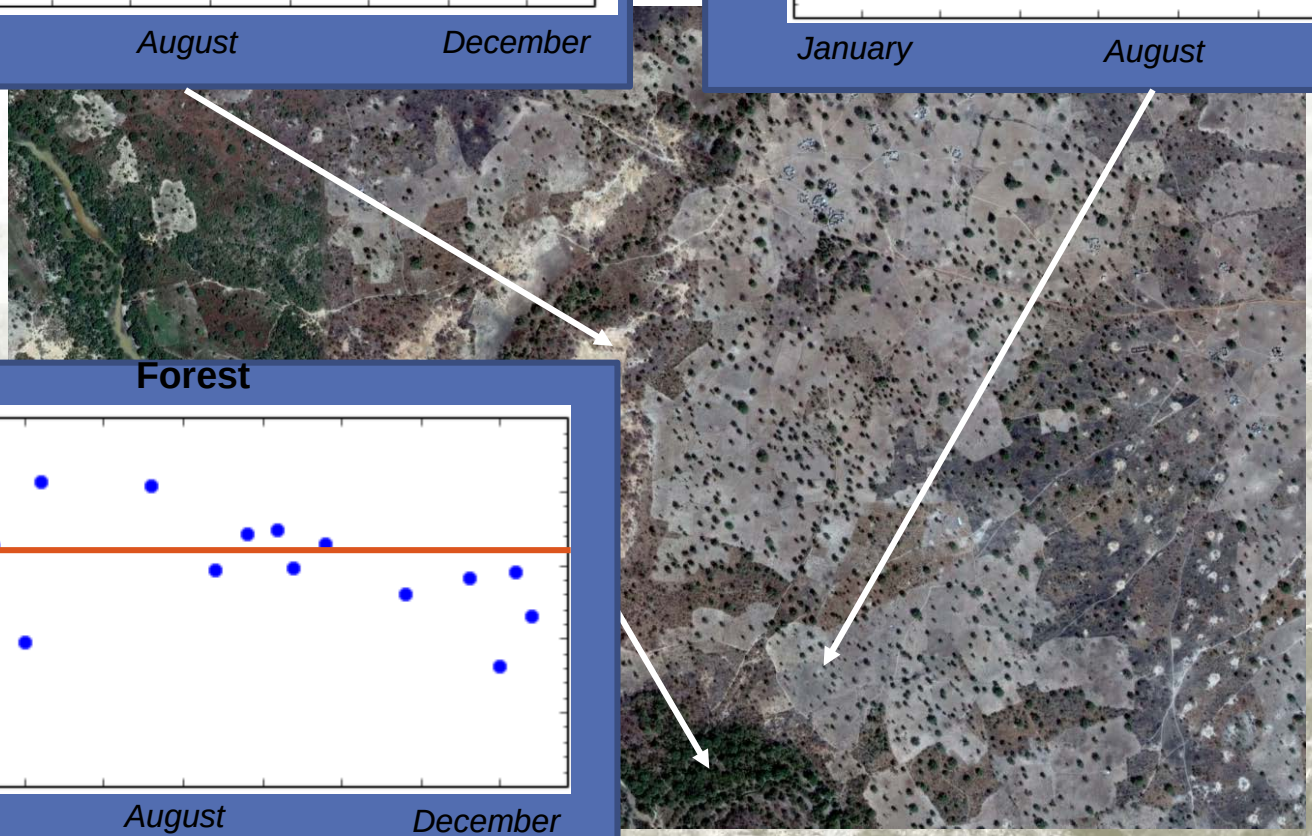
Component 4 Activity Review

Method | Pre-processing




Bare Soil
High
Low
January
August
December

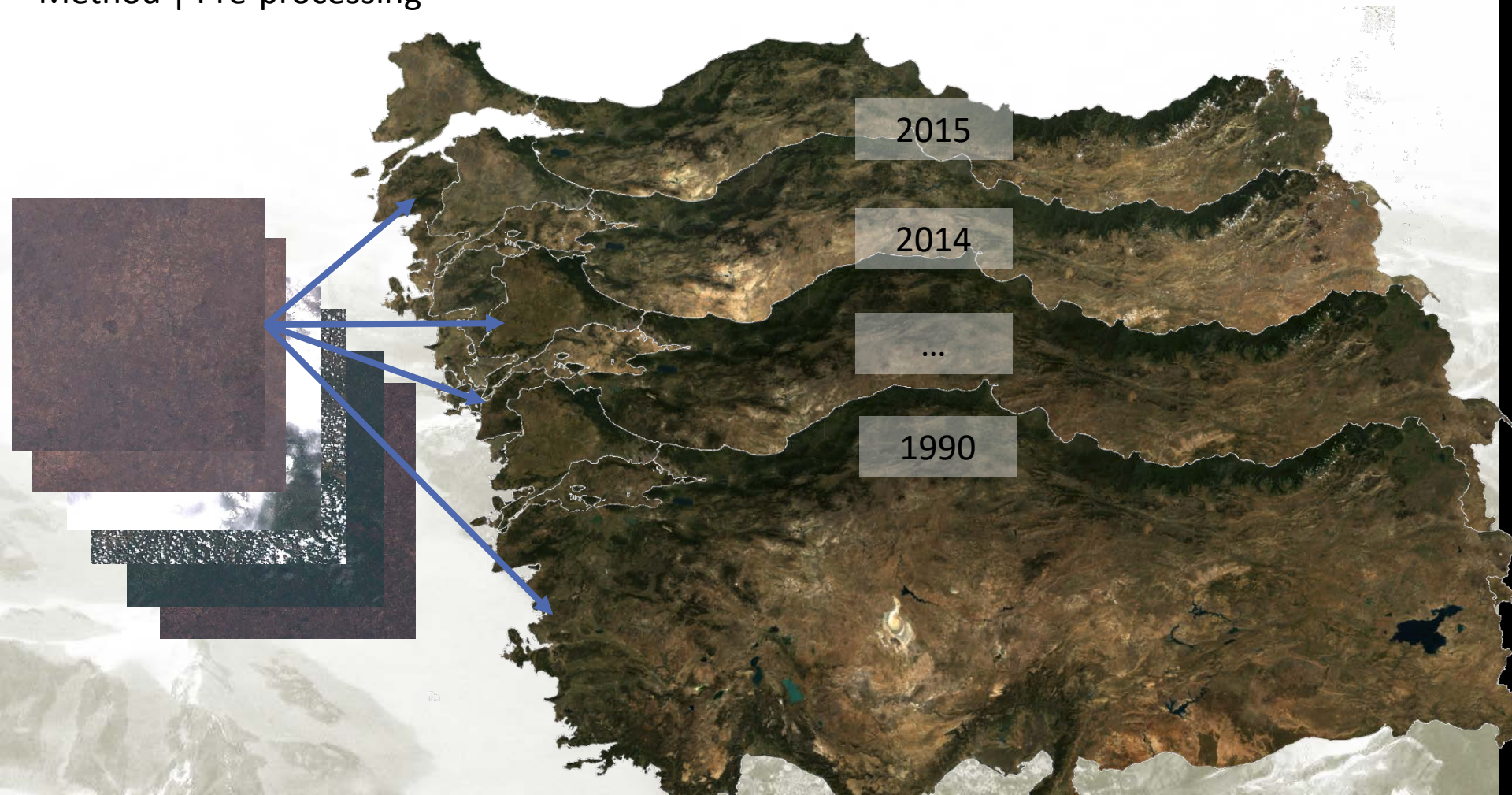

Agriculture
High
Low
January
August
December



Forest
High
Low
January
August
December

Component 4 Activity Review

Method | Pre-processing



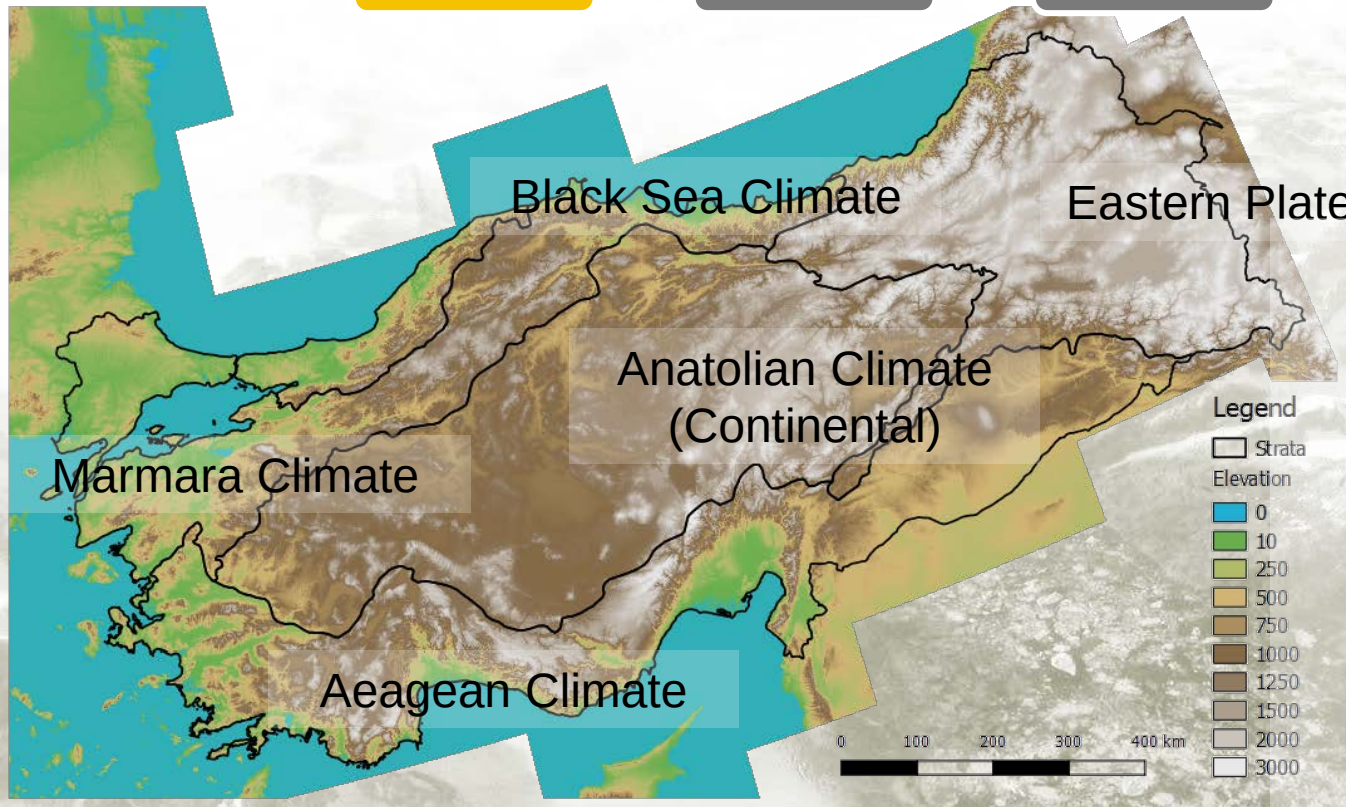
Component 4 Activity Review

Method | Classification (baseline 2015)

Component 4 Activity Review

Method | Classification (baseline 2015)

Stratification → Sampling → Supervised Classification → Post-processing



Substrata for Elevation

- 0-100m
- 100-500m
- 500-1500m
- 1500m +

Agricultural Areas

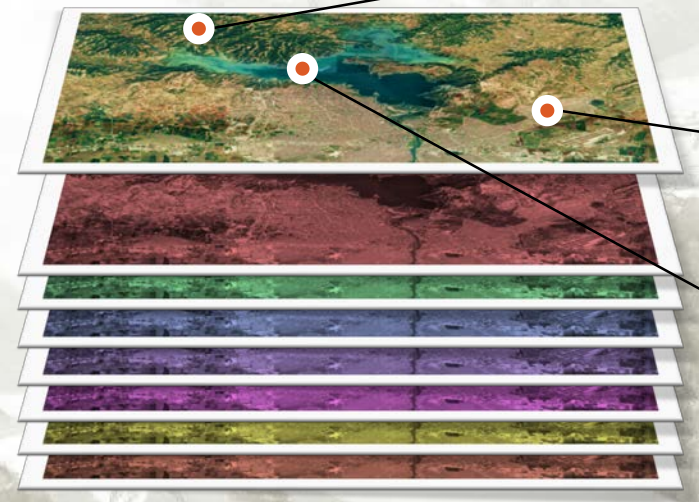
Riparian Zones

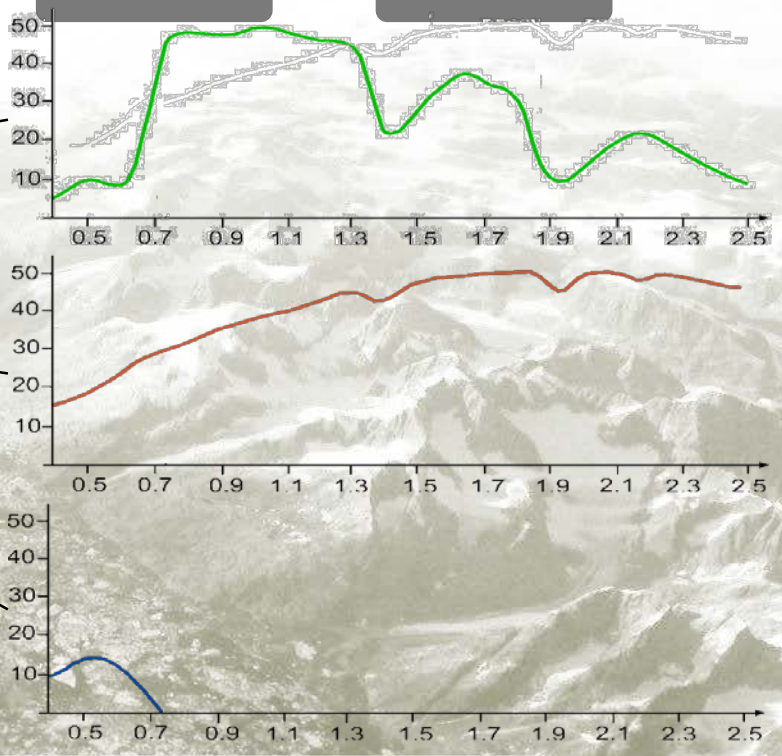
Populated Areas

Component 4 Activity Review

Method | Classification (baseline 2015)

Stratification → Sampling → Supervised Classification → Post-processing





Approximately 1mio samples derived

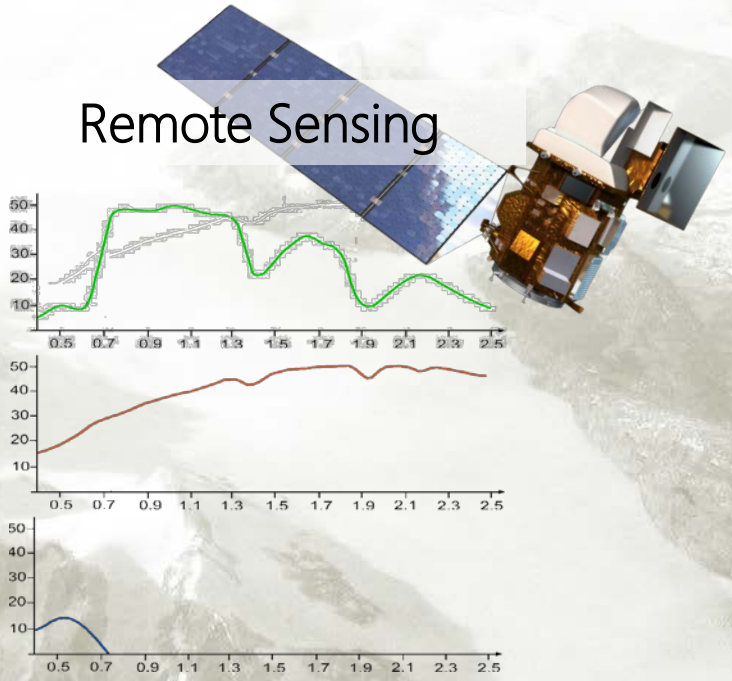
Component 4 Activity Review

Method | Classification (baseline 2015)

Stratification → Sampling → Supervised Classification → Post-processing

State of the art supervised stratified random forest

Remote Sensing



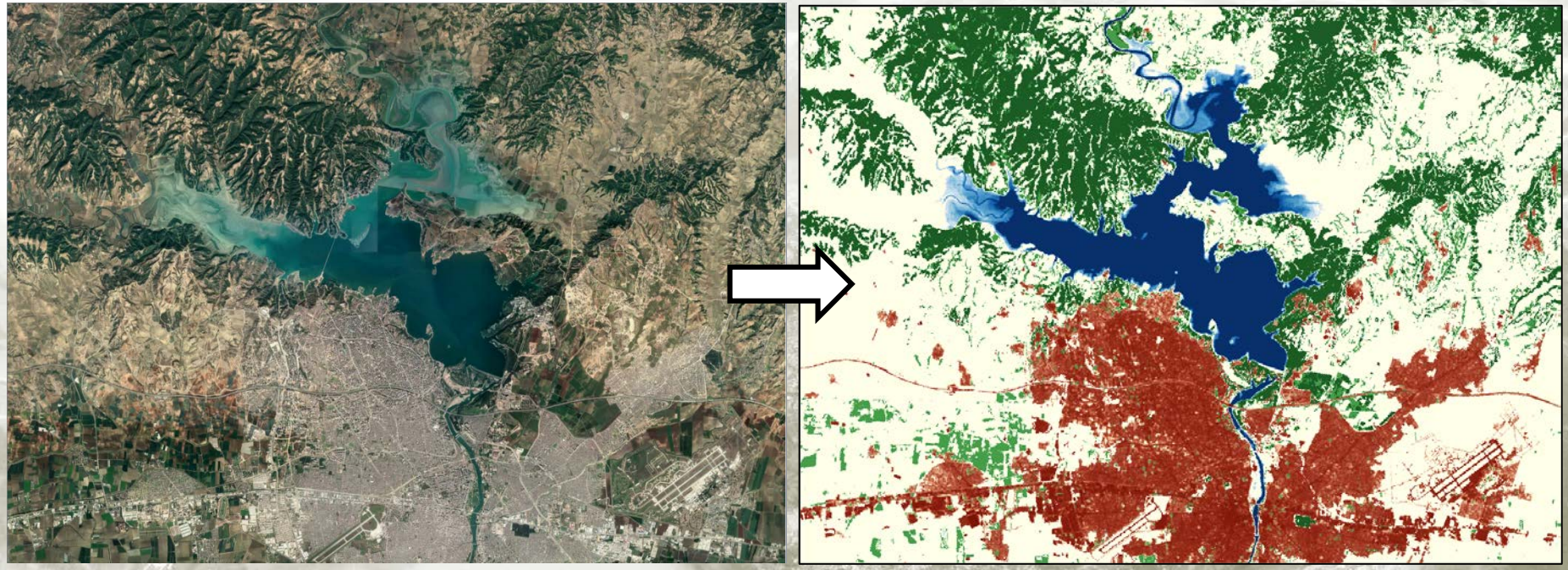
Machine Learning

Component 4 Activity Review

Method | Classification (baseline 2015)

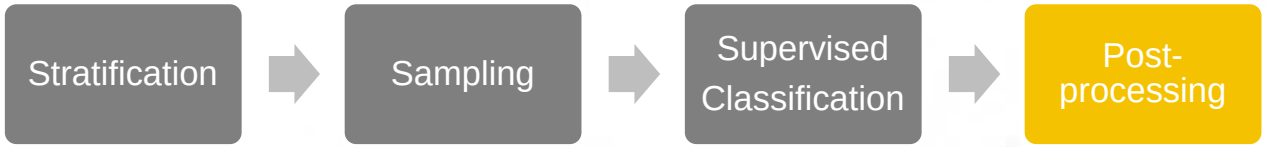
Stratification → Sampling → Supervised Classification → Post-processing

State of the art supervised stratified random forest



Component 4 Activity Review

Method | Classification (baseline 2015)



- Manual enhacement by experts (visual checks)
- Reprojection into Turkish National Projection
- Application of MMU (>=1ha forest definition)
- Introduction of Land Use Classes
- Clipping to official national boarders
  - Buffer at coastlines to be able to account for coastal changes

Component 4 Activity Review

Method | Classification (baseline 2015)

Stratification → Sampling → Supervised Classification → Post-processing

Land Use vs. Land Cover

Land cover = The bio-physical features at the surface of the earth

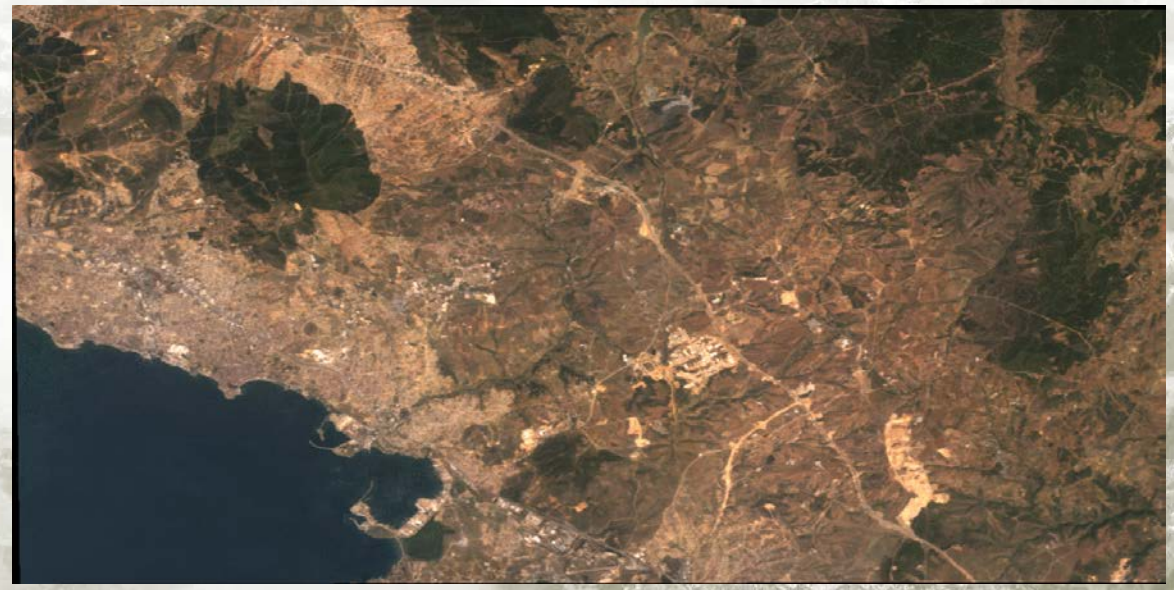
Land use = The utilization of the land

<u>Satellites records land cover!</u>

Component 4 Activity Review

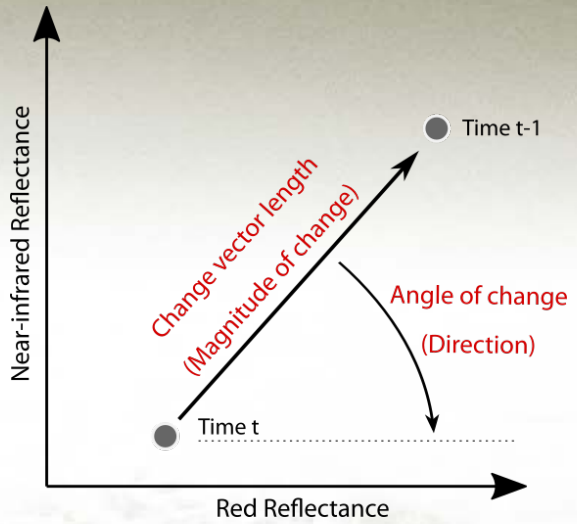
Method | Change Detection

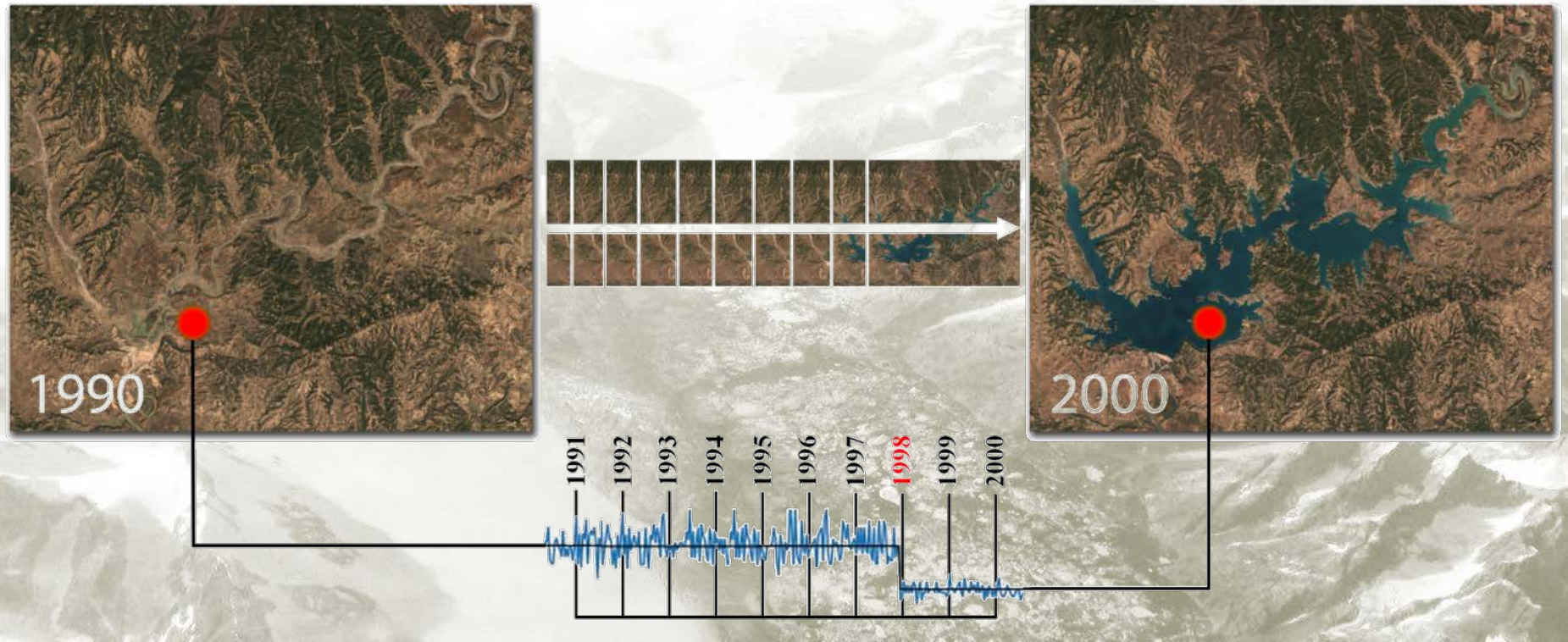
- Not a map to map comparison but a time series based approach of change detection
- Advantages:
  - Higher accuracies
  - Exact Identification of change date (and not linear interpolation)



Component 4 Activity Review

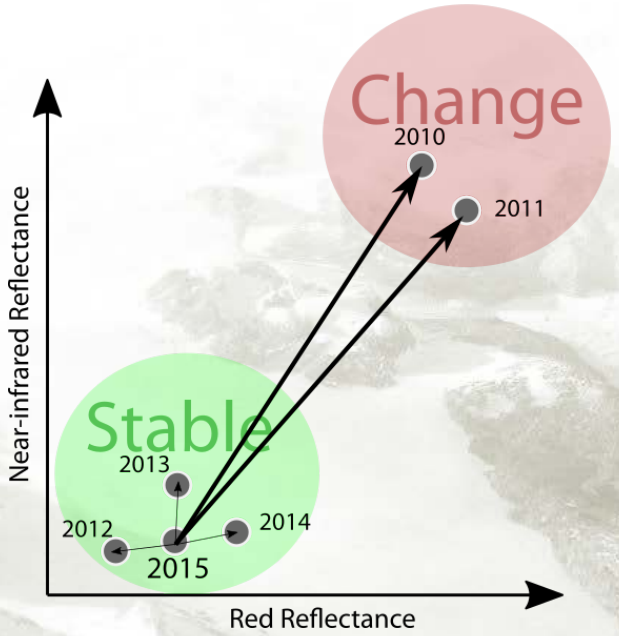
Method | Change Detection

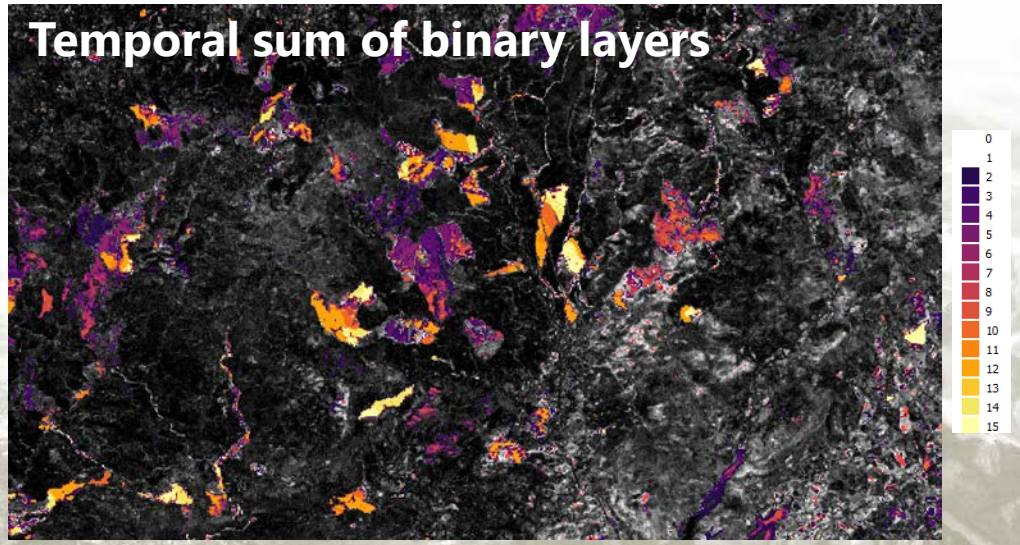




Component 4 Activity Review

Method | Change Detection





- Final change characterisation using Random Forest

Component 4 Activity Review

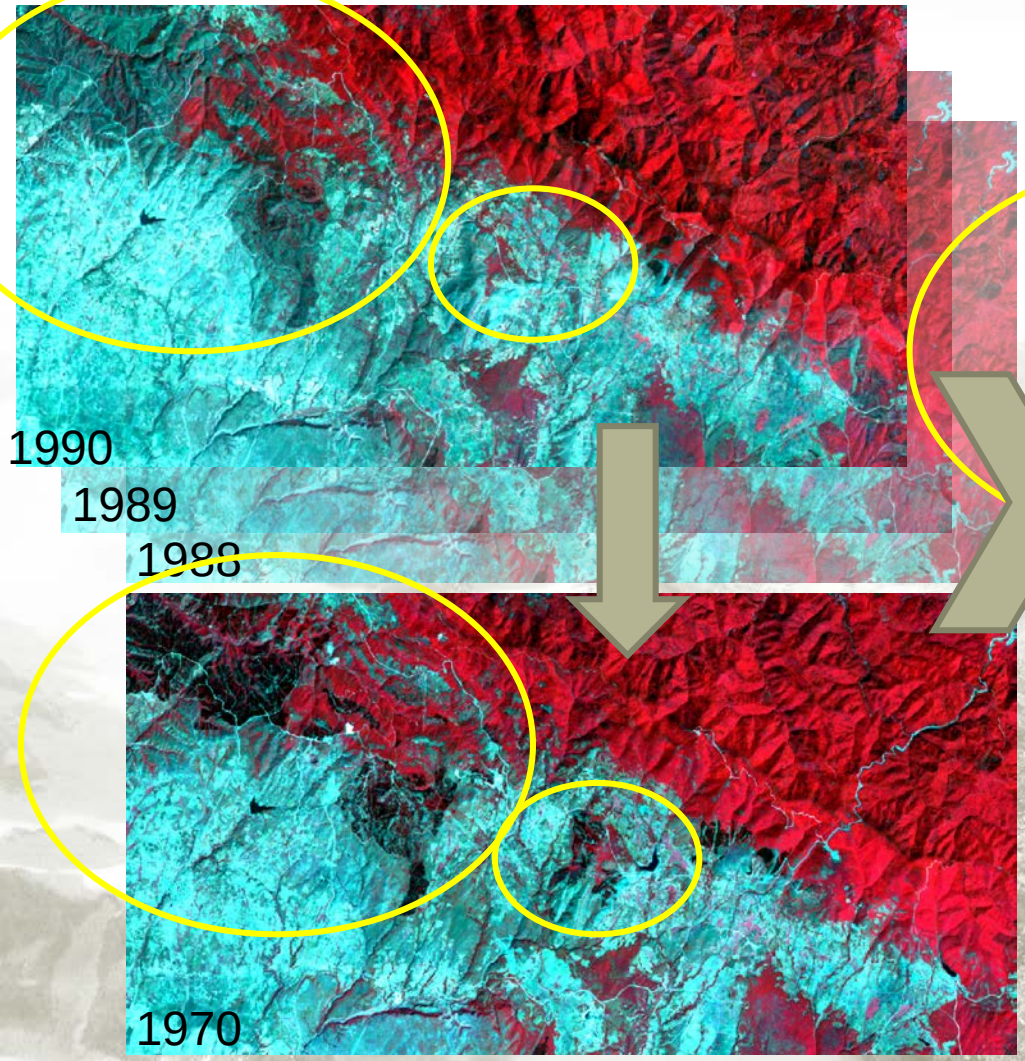
Method | Historic Forest Map (1970-1990)

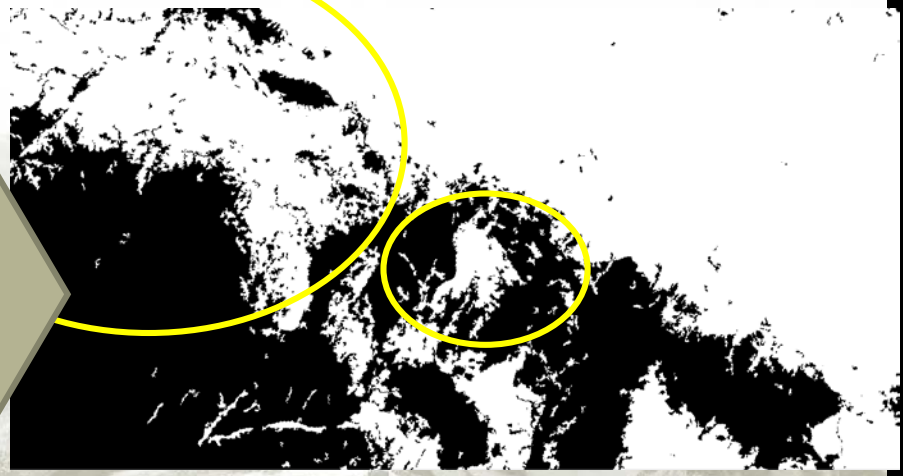
- Incorporation of entire Landsat archive from 1972
- Additive Forest / Non Forest Classification for each year:

- Challenges:
  - Sparse data coverage
    - sensors more prone to errors
    - Longer revisiting time
    - Lower spectral resolution (4 bands – however two NIR bands)
    - Lower spatial resolution (60 meters)

Component 4 Activity Review

Method | Historic Forest Map (1970-1990)



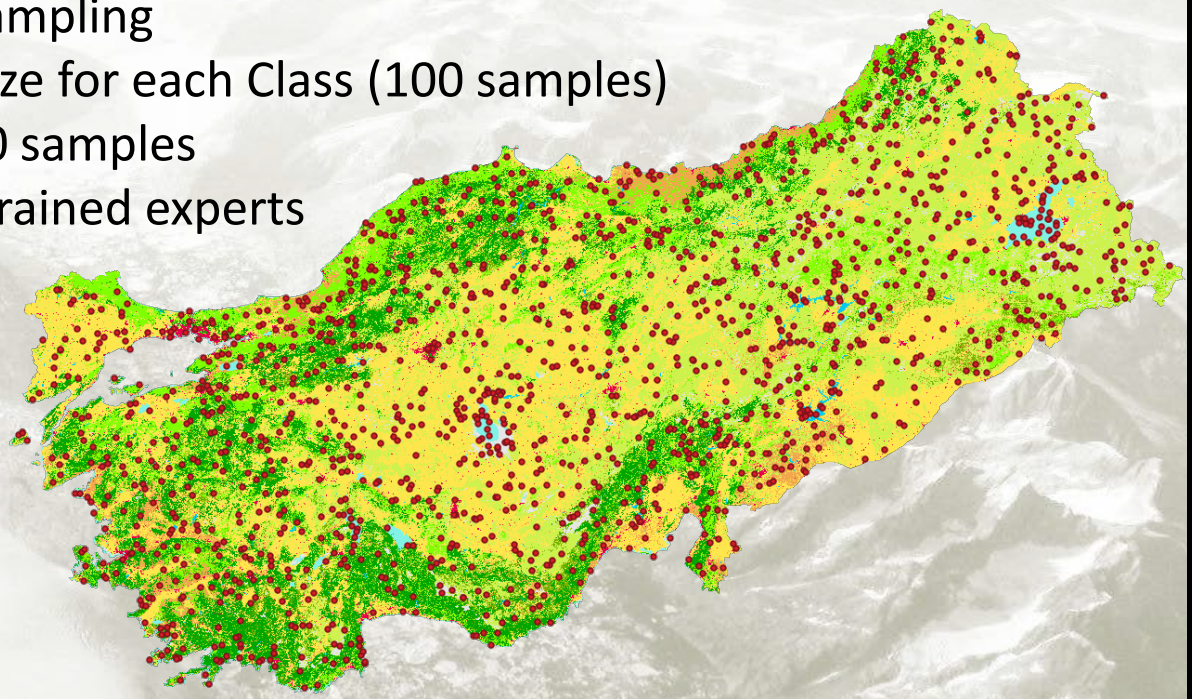


Component 4 Activity Review

Method | Validation

- **Accuracy and Confidence**

- Method
  - Stratified random sampling
  - Minimum Sample Size for each Class (100 samples)
  - In total around 1500 samples
  - Blind validation by trained experts



Component 4 Activity Review

Method | Validation

- Outcome
  - Overall accuracy
  - Class specific accuracies
    - including omission and comisson errors
  - Confusion Matrix
  - Confidence Interval (Range)
  - Target accuracy for each class is atleast 80%

LULUCF – TR

GHG Monitoring and Reporting System

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