

# living planet symposium | BONN 23–27 May 2022

TAKING THE PULSE  
OF OUR PLANET FROM SPACE



## The EO4ALPS Ecosystems project – ECO4Alps

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# Alpine Regional Initiative (eo4alps)



Application oriented activities: support geoinformation needs relevant to the Alpine region



- **Alpine Convention:** Regional environmental protection and management initiative
  - Sustainable development
  - Preservation of the alpine ecosystems
- **EUSALP:** European macro-regional strategy for the Alpine region (Endorsed by EU)
  - Focus on alpine-specific challenges - ensuring sustainable development.
  - Relevance of protecting and enhancing biodiversity
  - Preservation and maintenance of ecosystems and their services

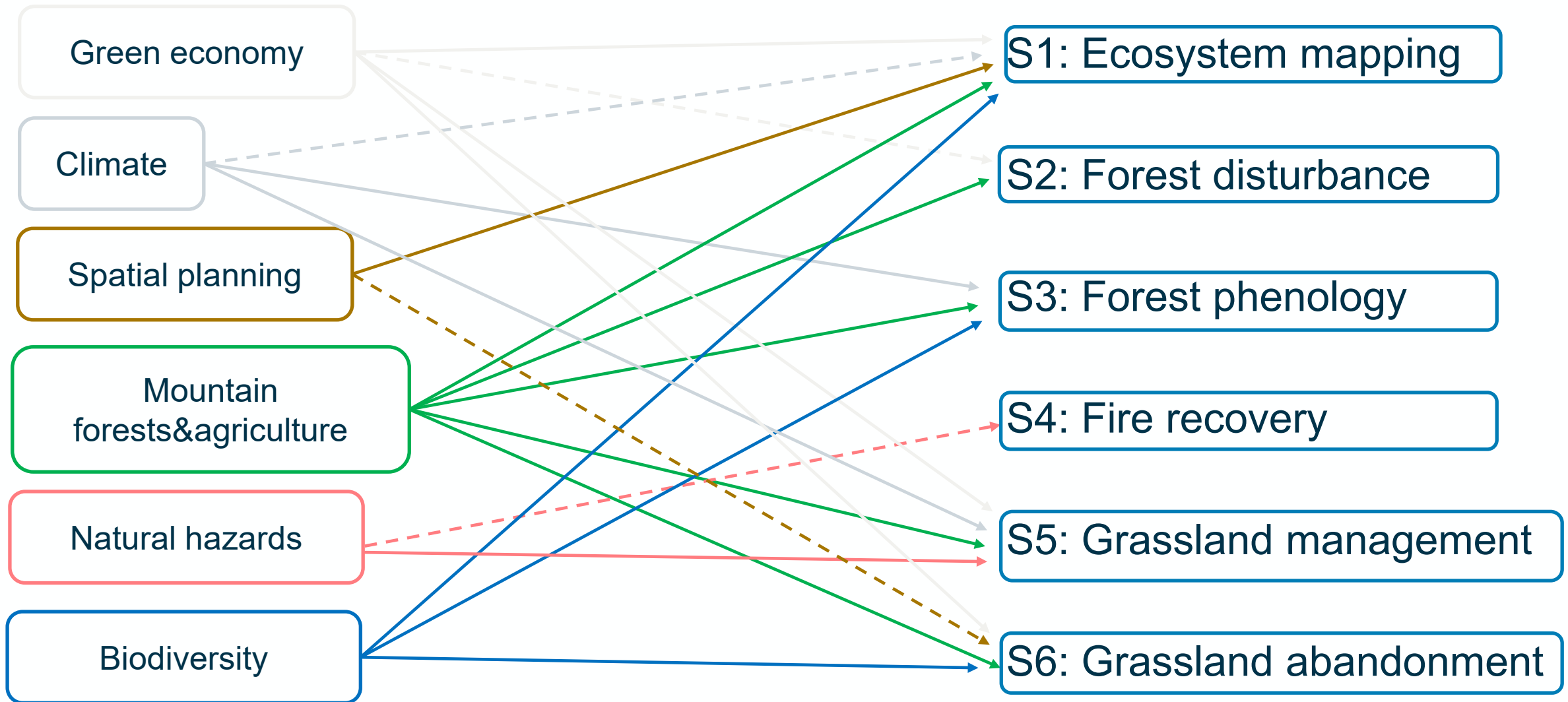


- Characterisation of alpine ecosystems extent and changes
- Analysis of the resilience of alpine ecosystems to climate
- Direct and indirect impacts of natural hazards on alpine ecosystems

➔ Development of 6 services integrated in a cloud environment



# The Alpine Convention and EO4Alps – needs and services



# 1. Ecosystem mapping service

## Need:

- Changes in the extent of ecosystems -> human impacts and loss of biodiversity (flora and fauna).
- European datasets (CLC, HRL) don't represent all ecosystem equally well
- Regional product, comparable across time and space (consistent, harmonized and updateable)

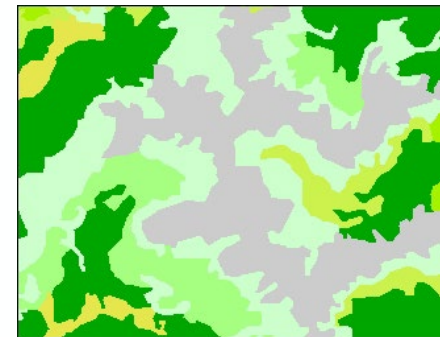
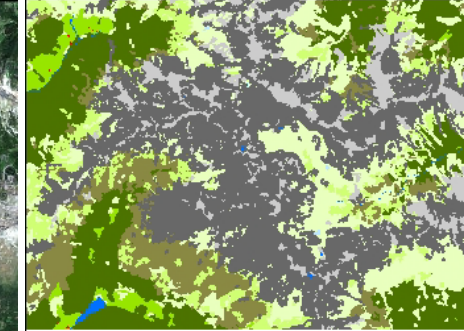
## Service:

- Information on the spatial distribution of land cover
- Land cover classification legend addressing alpine ecosystems
- User-defined minimum mapping unit

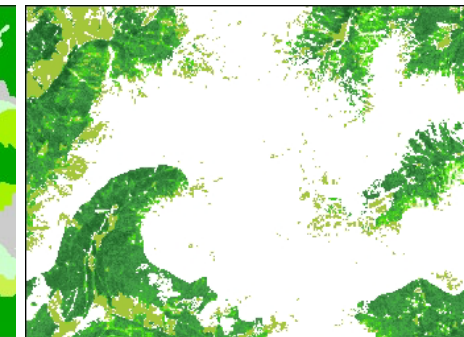
Sentinel-2 image



Local land cover map



CORINE LC map



HR Layer forest and grassland

# 1. Ecosystem mapping service

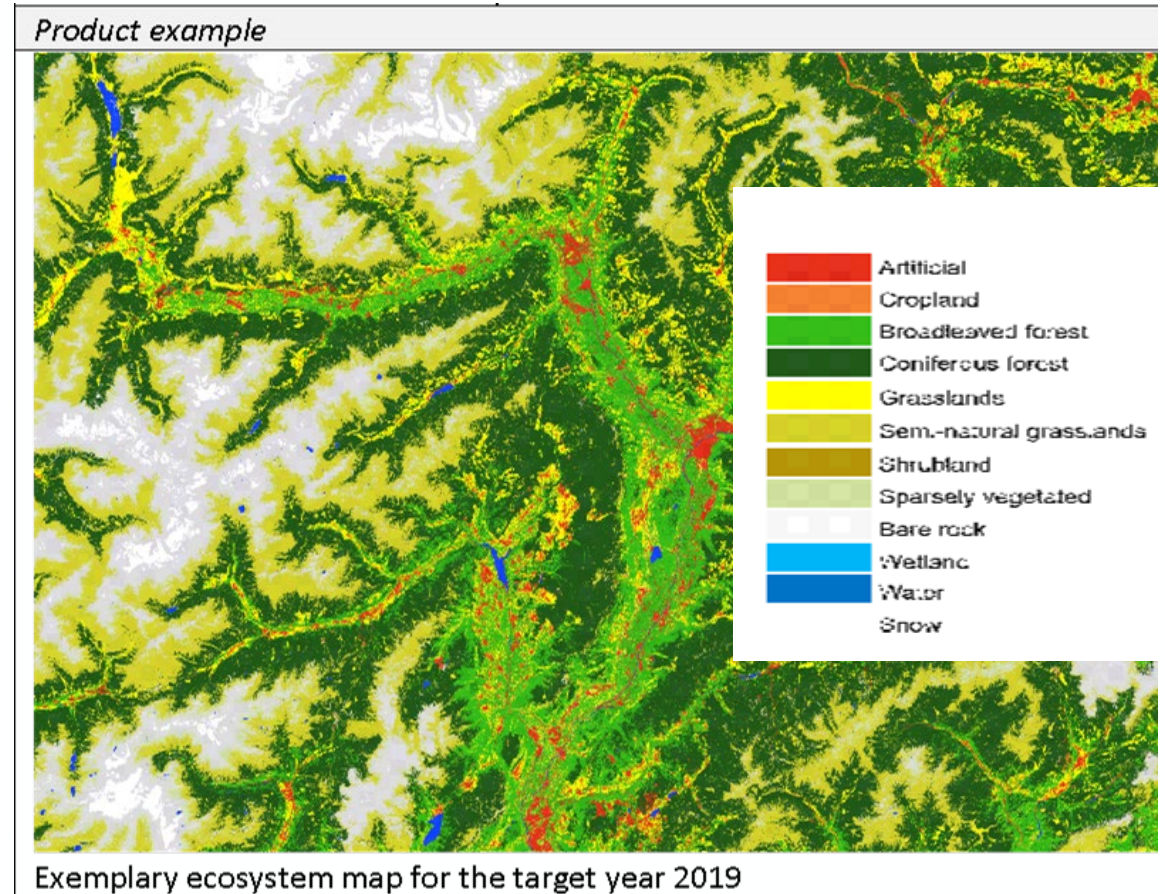
**Method:** Multi-temporal classification of Sentinel-2 data based on spectral-temporal features and reference data

## Main products:

- Ecosystem map
- Land cover statistics

## Additional outputs:

- Class probabilities (pmax)
- Accuracy assessment





## 2. Forest disturbance service

### Need:

- Changes in forest disturbance regimes
- Global datasets miss small-scale disturbances and do not provide temporal information
- European datasets (e.g. HRL) don't offer frequent updates

### Service:

- Spatial information on forest cover changes
- Temporal information on the timing of the change event



Impact of the storm Vaia 28.-30.10.2018

# 2. Forest disturbance service

## Method:

- BFAST for extraction of breakpoints related to forest Disturbances

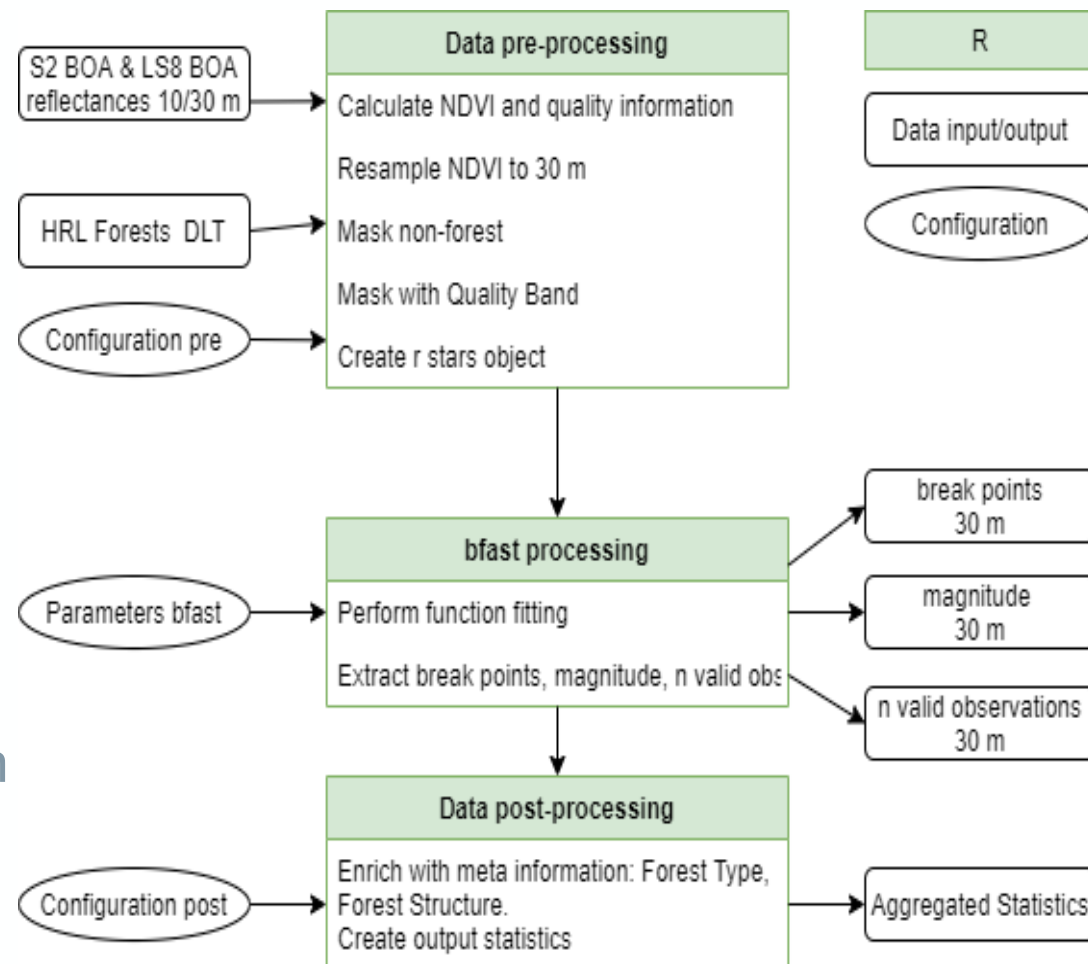
- Forest cover map for masking

## Main products:

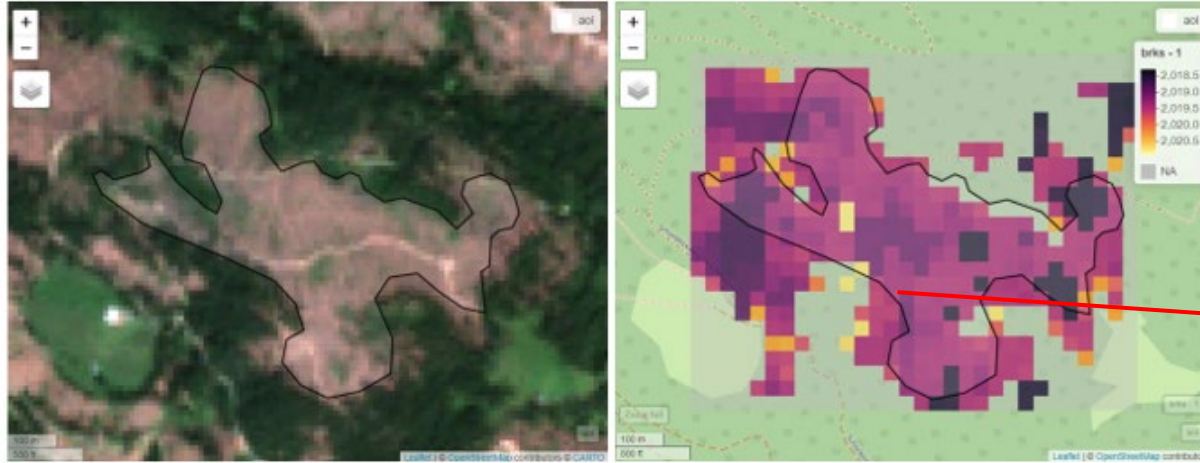
- Annual forest disturbance maps
- Upon request (small areas)

## Additional products:

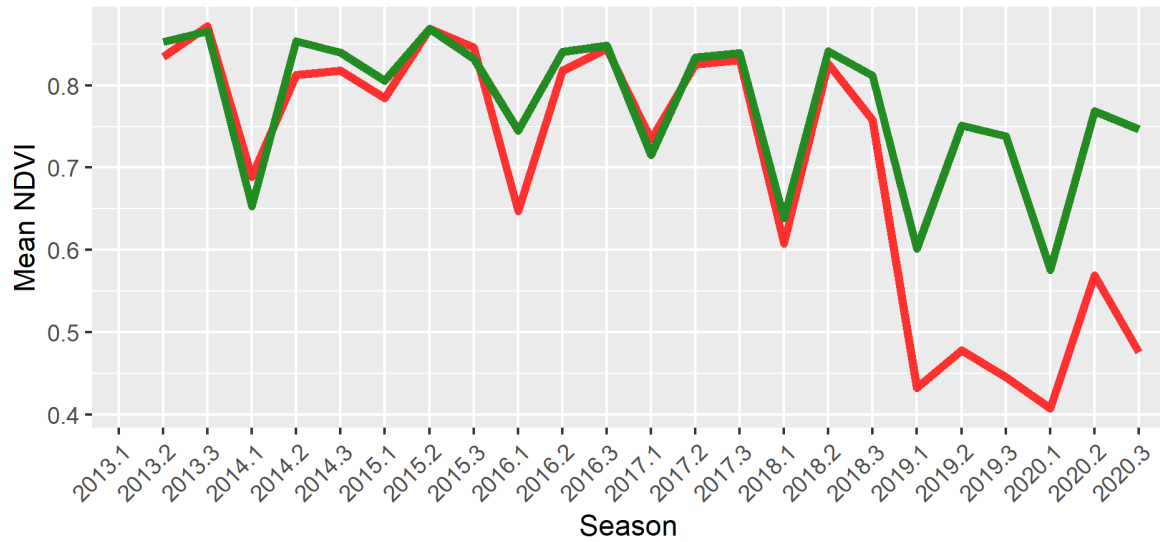
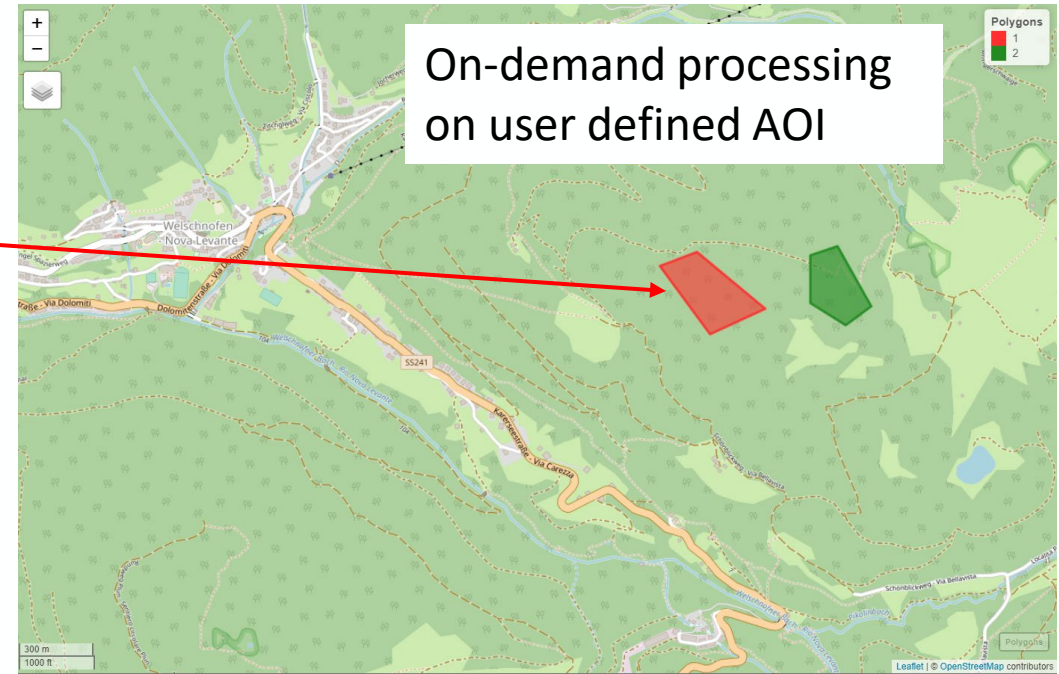
- Magnitude of deviation from fit – Quality of Detection
- Number of valid observations – Quality of Detection
- Forest Type / Forest Density / Altitude – Thematic Interpretation



# 2. Forest disturbance service



Exemplary windthrow patch caused by Storm Vaja 2018-10-28 (left) and detected breakpoints (right).



Id  
 1- disturbed  
 2- undisturbed

# 3. Forest phenology service

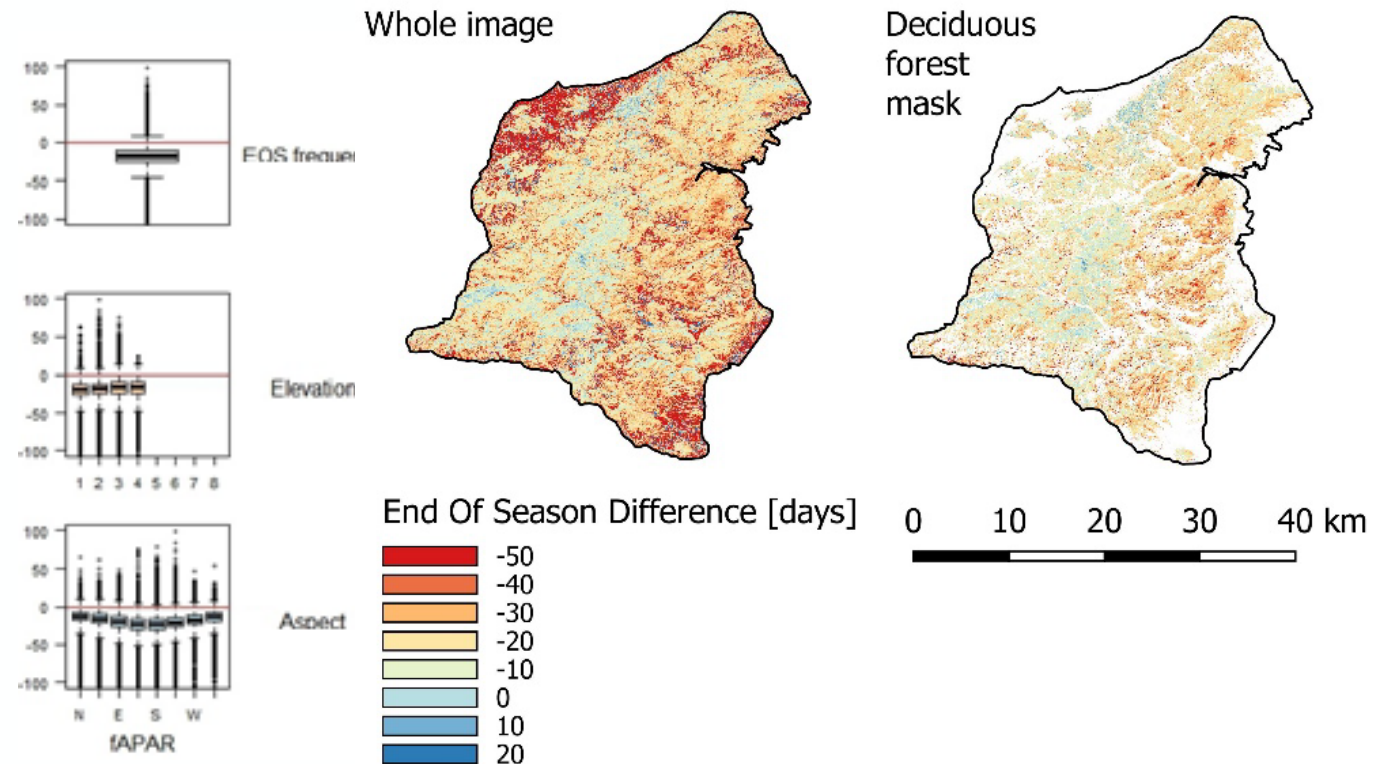
## Need:

- Phenological autumn shifts in the Alps have not yet been studied in detail – studies indicate earlier end of season
- Impact on hydrological and climate systems

## Service:

- Spatial information on End of Season
- Trends on End of Season
- Quality of information

*Differences in End-Of-Season (EOC) between „normal“ years (2010-2014) and „dry“ year (2015) detected by time series analysis of fAPAR showing that forests react to this more and more common climatic anomaly in the alpine region (BOKU master thesis)*



# 3. Forest phenology service



## Methods:

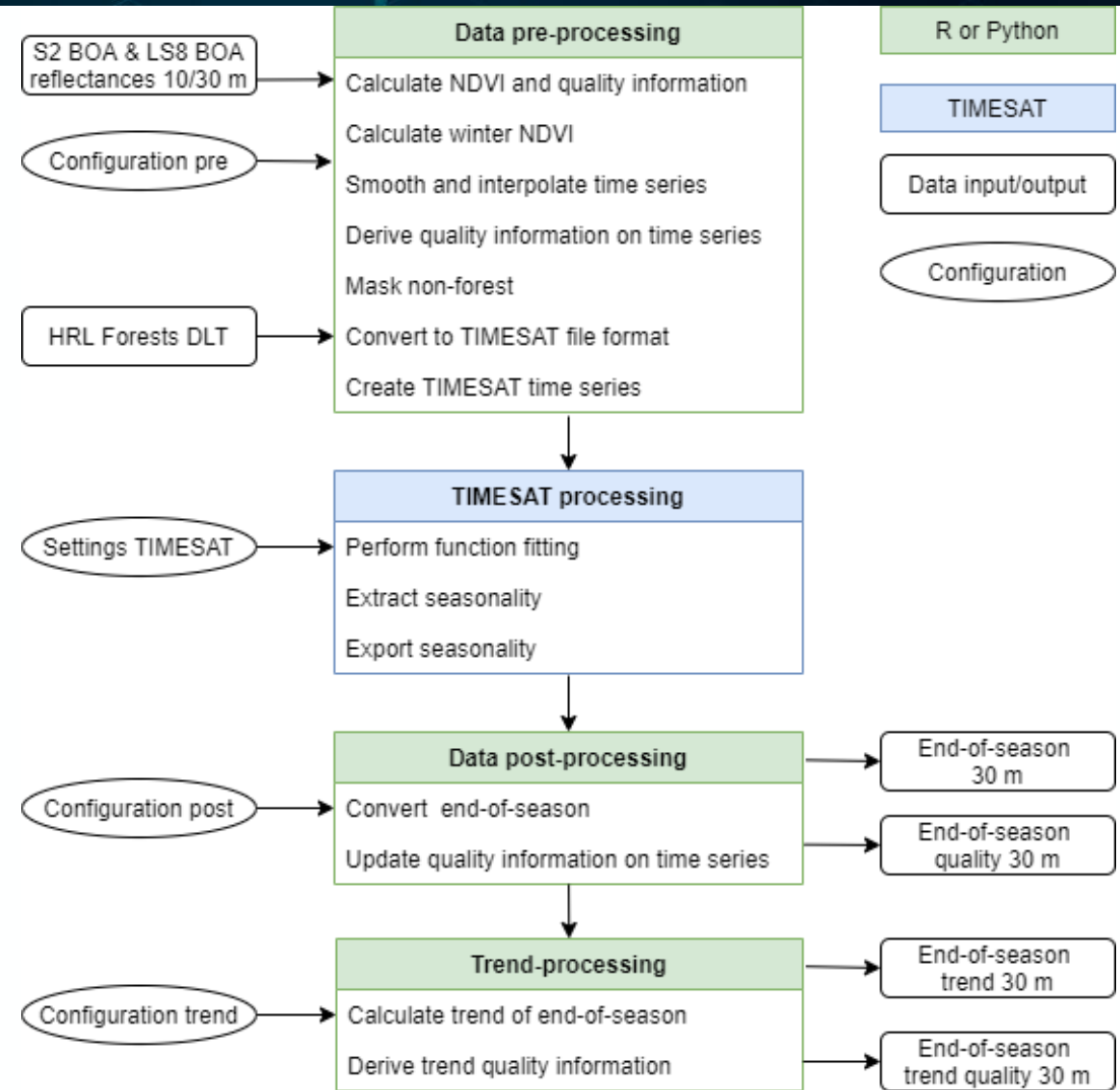
- EOS calculation using NDVI time series (TIMESTAT)
- Multi-annual trend analysis (S2 + ...)
- Evaluate linkages to specific weather pattern (e.g. dry summer)

## Main products:

- End-of-season
- End-of-season trend

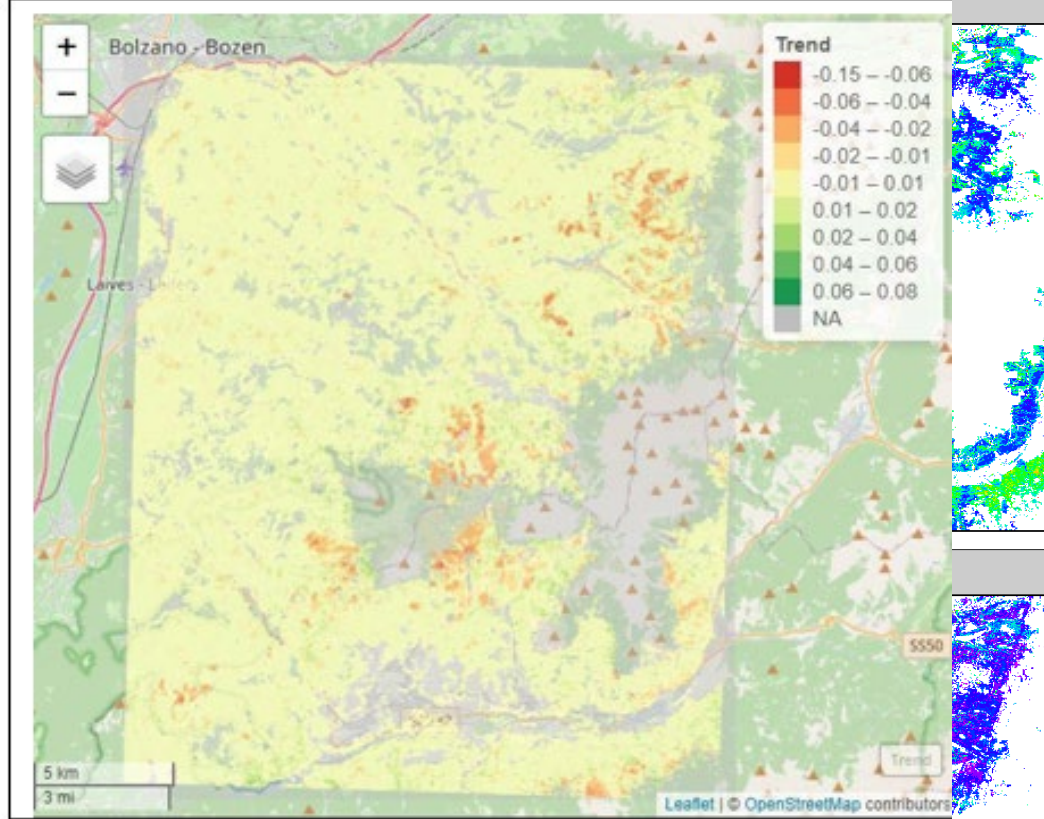
## Additional outputs:

- End-of-season quality
- End-of-season trend quality (p-value)

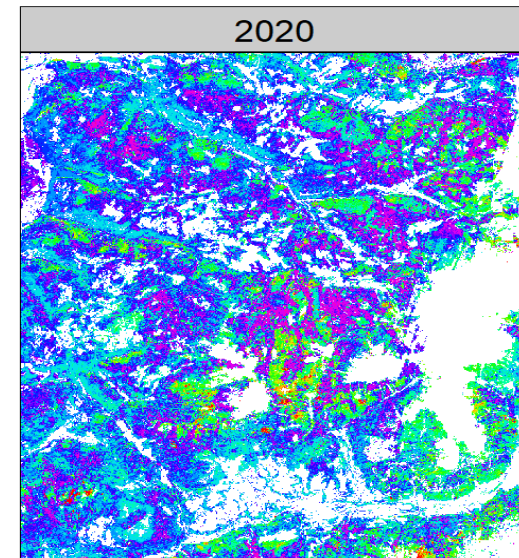
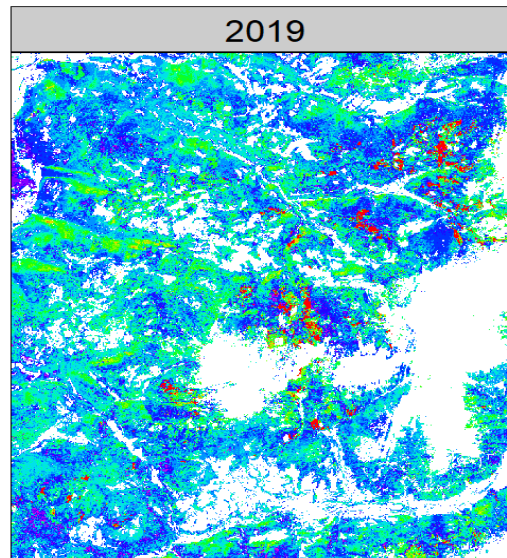
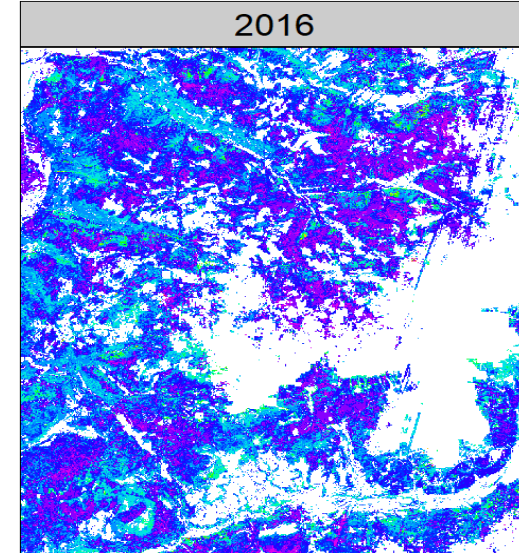
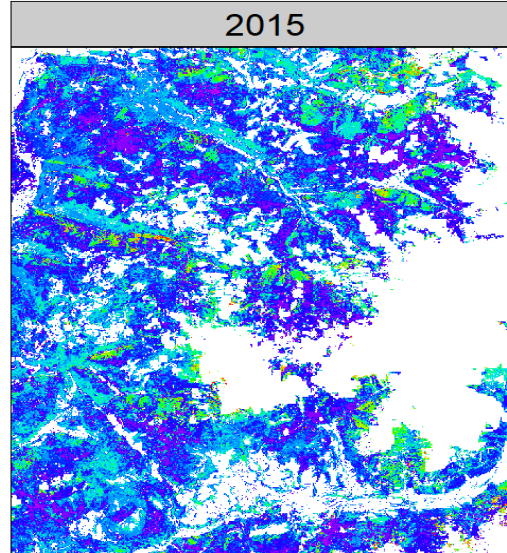
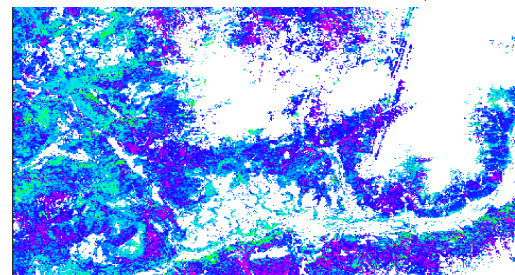
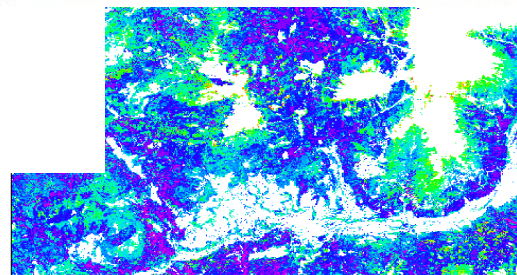
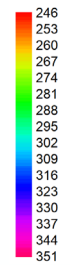


# 3. Forest Phenology Products : End of Season, Trend EOS

Product example for 2013-2020



End-of-se  
in day-of-:



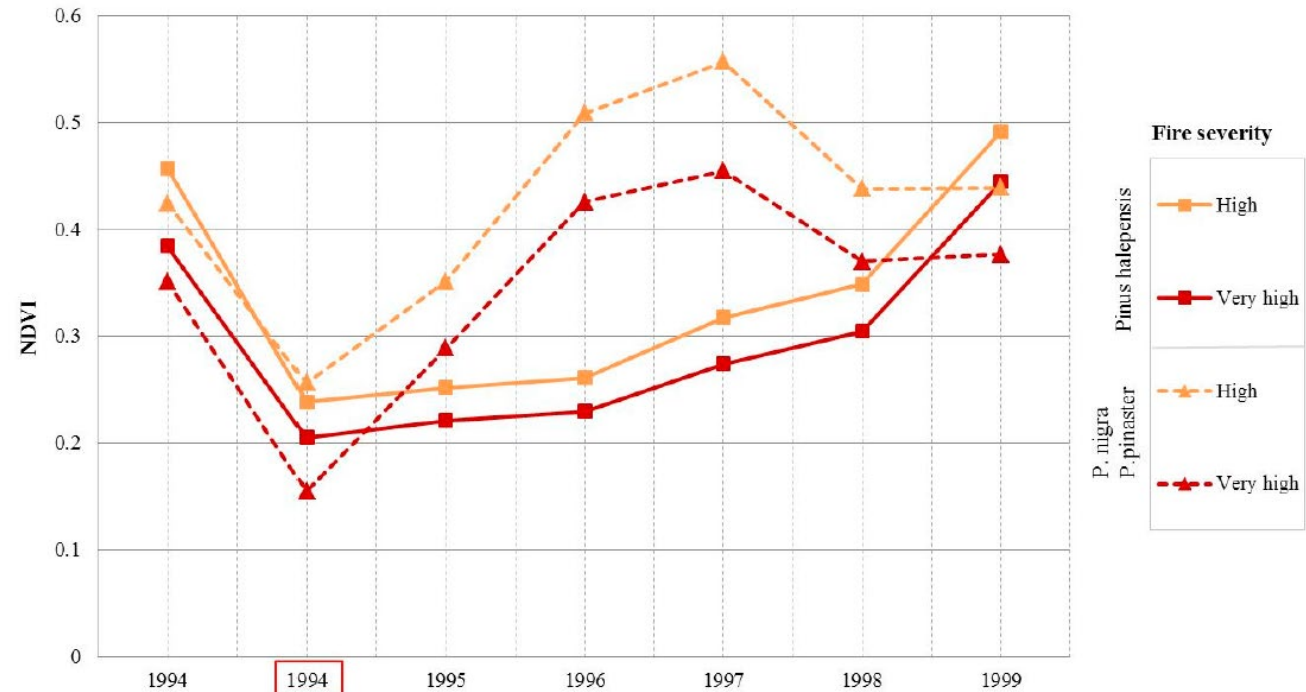
# 4. Fire recovery service

## Need:

- Widely unknown but important to assess forest ecosystem services and to ensure that forests can maintain their protective function (e.g. against avalanches)
- Hazard protection

## Service:

- Forest recovery seasonal trajectory
- Forest recovery annual trajectory
- Quality



*NDVI response after fire events showing differences related to tree species and fire severity (Viana-Soto et al., 2017)*

# 4. Fire recovery service

## Method:

- Selection of fire events
- Trend analysis on seasonal NDVI composites

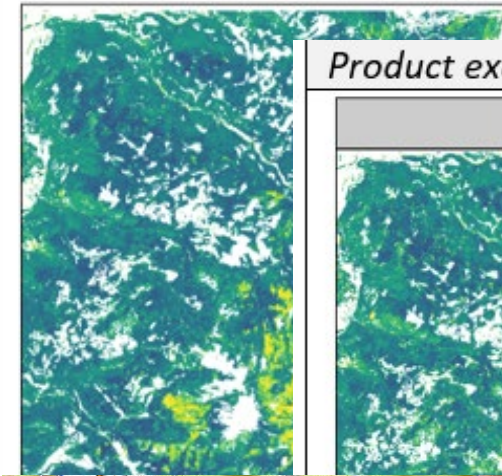
## Main products:

- Annual trajectory of forest recovery
- Seasonal trajectory of forest recovery

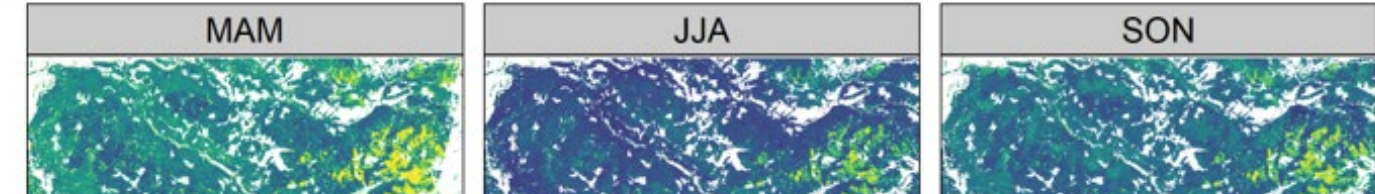
## Additional outputs:

- Quality of annual trajectory
- Quality of seasonal trajectory

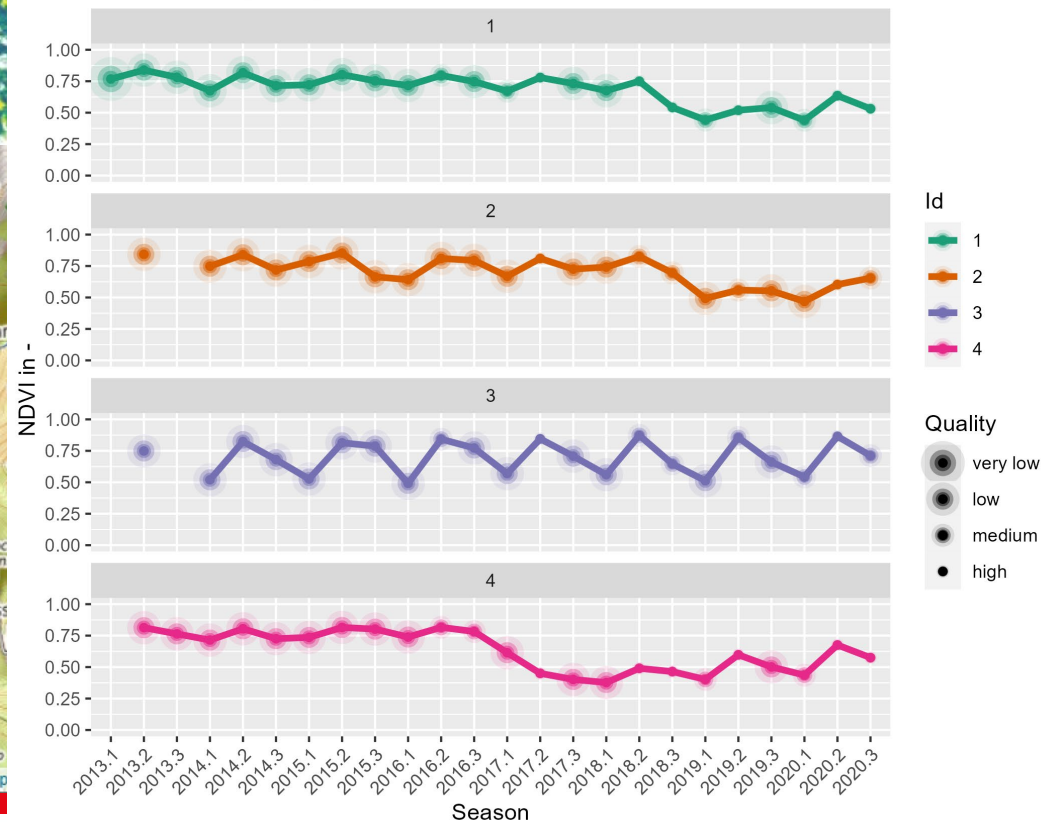
Product example for 2020



Product example for 2020



Seasonal trajectory derived from Sentinel-2 and Landsat 8





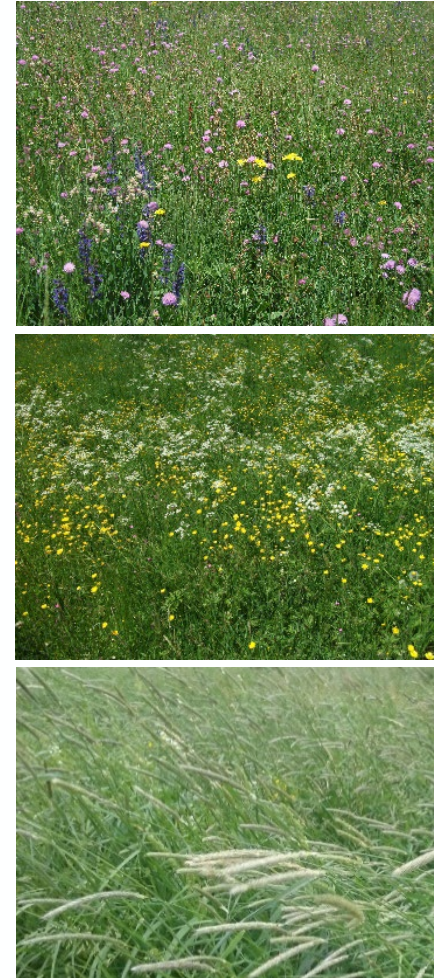
# 5. Grassland management service

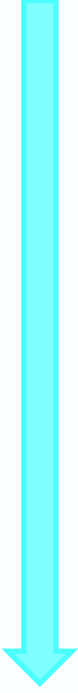
## Need:

- Grassland management and ecological status of alpine grasslands are strongly linked
- Map grassland mowing frequency and timing of cuts
- No ready-to-use dataset available and mapping initiatives (e.g. Sen4CAP) require specific information of users (e.g. parcel information)

## Service:

- Spatial information on the timing of grassland mowing events
- Annual frequency of mowing events



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- Increase in fertilization
  - Increase in mowing frequency
  - Earlier mowing
  - Loss of species-rich meadows
  - Loss of habitats

Examples of alpine meadows with different use intensity

# 5. Grassland management service

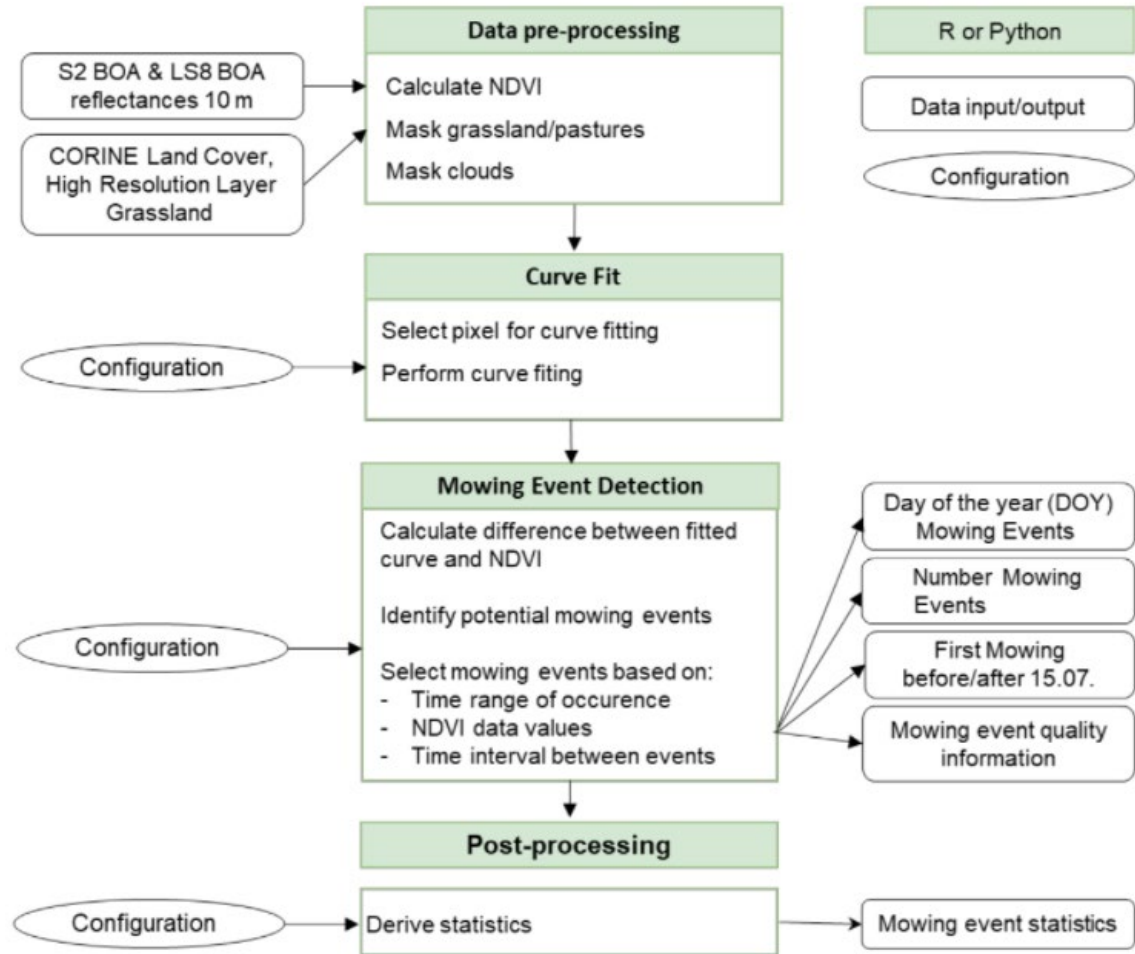
**Method:** Time-series thresholding techniques based on Sentinel-2 and Landsat 8 NDVI

**Main products:**

- Timing of mowing events
- Number of mowing events

**Additional products:**

- First mowing event before/after
- Mowing event quality information



# 5. Grassland management service

## First Mowing Event



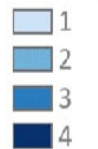
Day of the Year (DOY)



## Number of Mowing Events



Number of Mowing Events



Poster session today: An Earth Observation based Grassland Mowing Detection Service for the Alpine Region

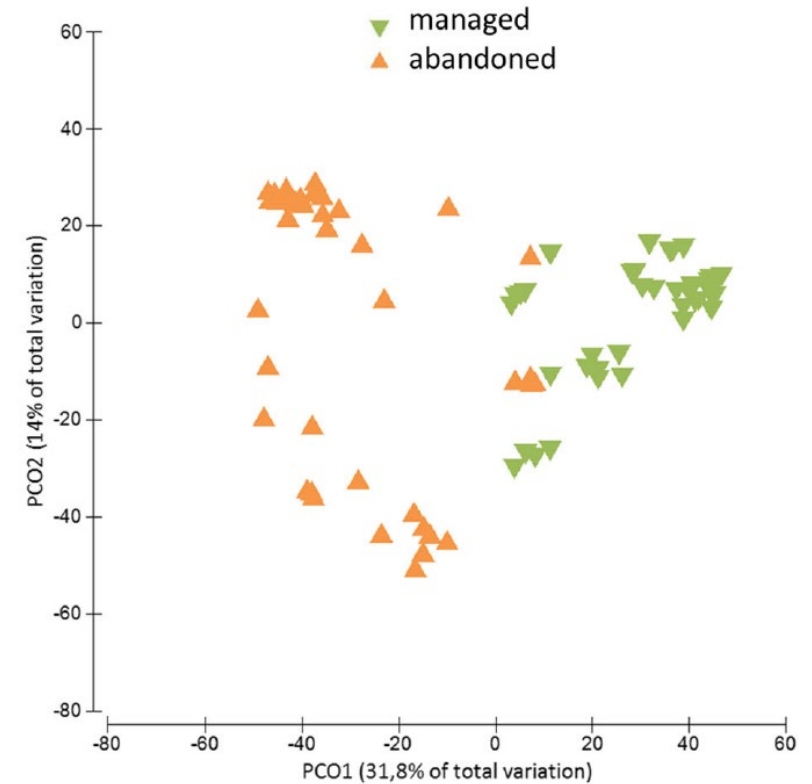
# 6. Grassland abandonment service

## Need:

- Grassland abandonment (in particular the most important marginal grasslands) implies a severe risk of losing cultural ecosystem services (e.g. for tourism and human well-being) as well as biodiversity
- Tourism policy
- Biodiversity protection

## Service:

- Spatial information on identified abandoned areas
- Quality



*Results of principal coordinate analysis (PCO) of plant species composition of managed and abandoned grasslands in three test regions of Eastern Alps – Abandonment caused a marked decrease in species richness illustrating the important of regular mowing for maintaining species richness (Bohner et al., 2018)*

# 6. Grassland abandonment service

## Methods:

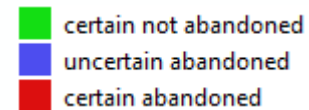
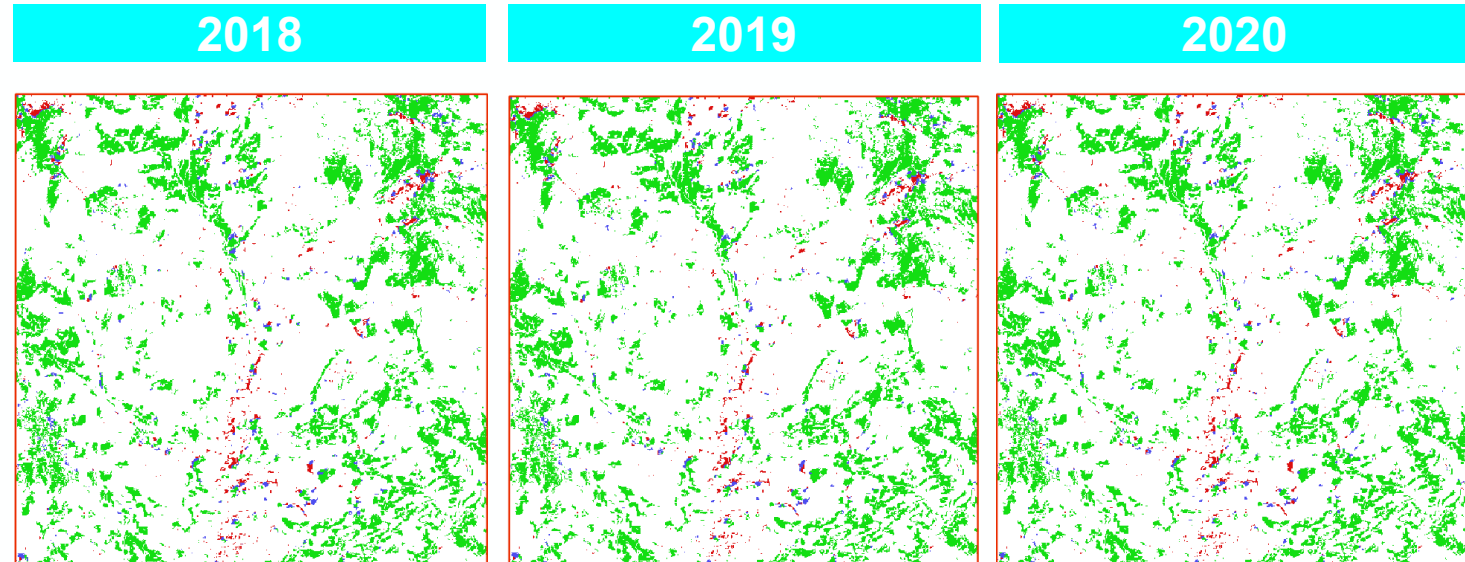
- Mask of grassland pastures will less than one mowing event identified.
- Abandonment index calculation

## Main products:

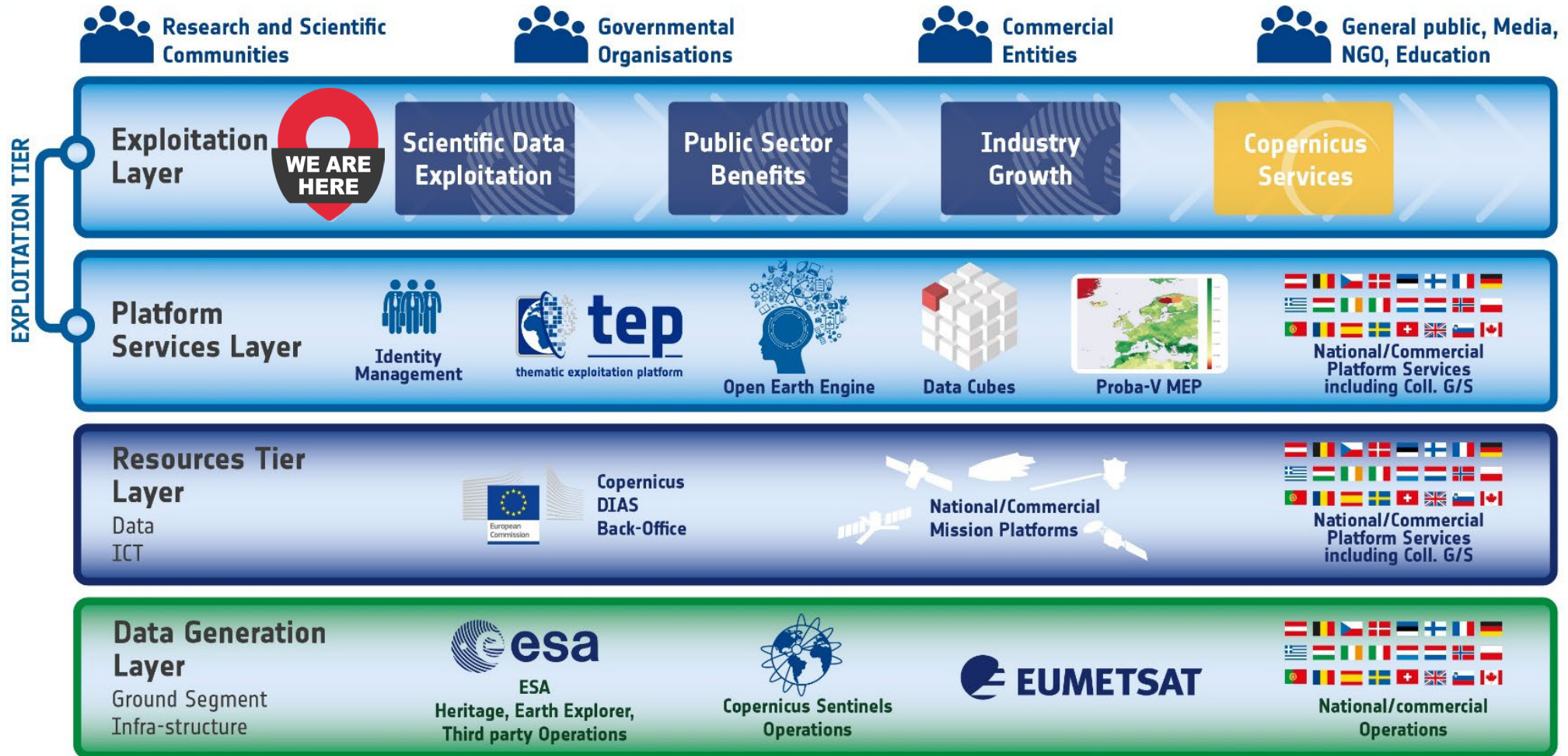
Grassland abandonment

## Additional outputs:

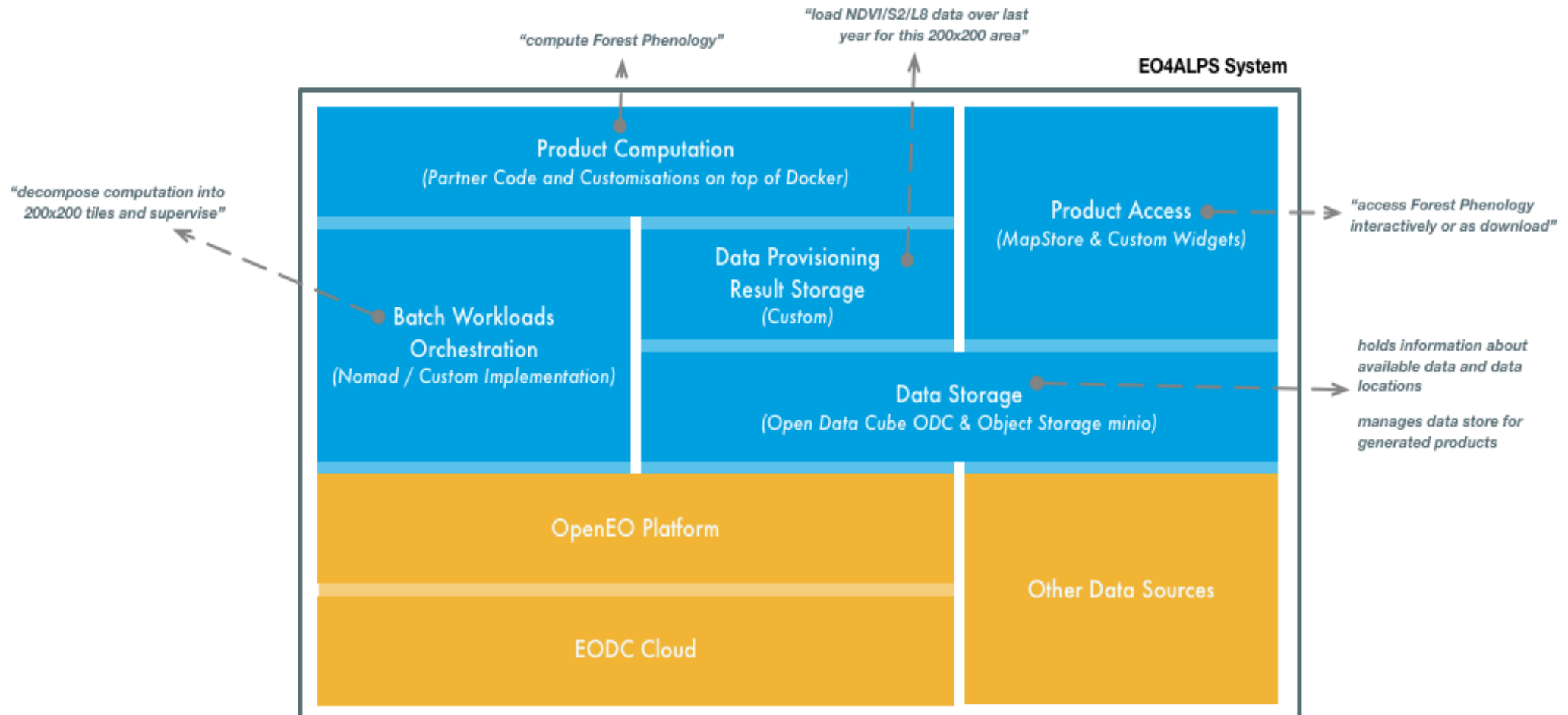
Quality of grassland abandonment



# Where are these services?



# Integration with EODC - openEO



## Task 1: User requirement consolidation

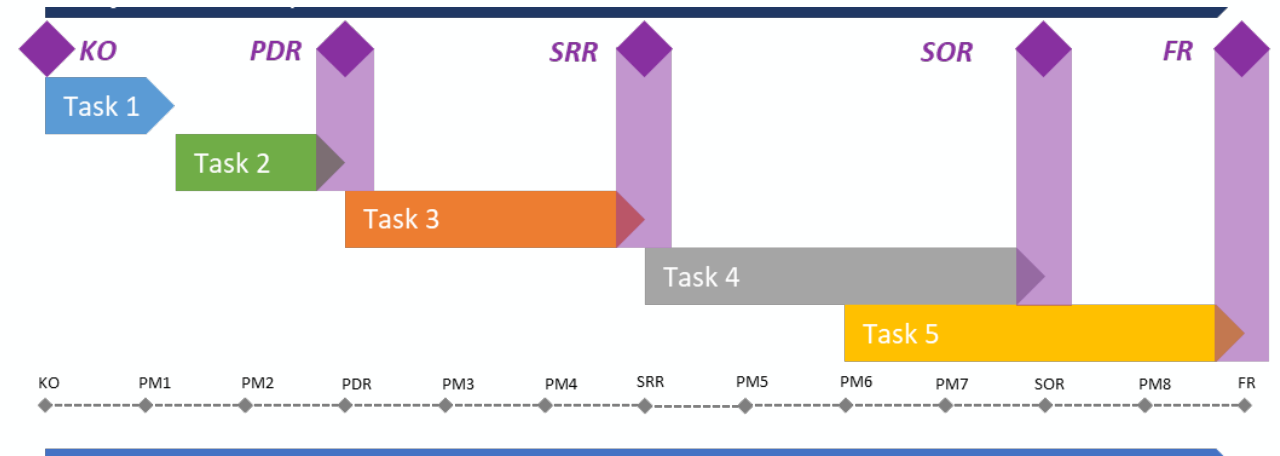
- Compile a comprehensive list of key stakeholders
- Inform stakeholder and user about Eco4Alps project
- Setup of a structured questionnaire
- Motivate stakeholder and users to participate in questionnaire (e.g. online workshop, personal contact)
- Provide feedback to stakeholder and users

## Task 2: Service Portfolio and Chain Specification

- Provide feedback to stakeholder and users

## Task 3: Service Chain Implementation and Testing

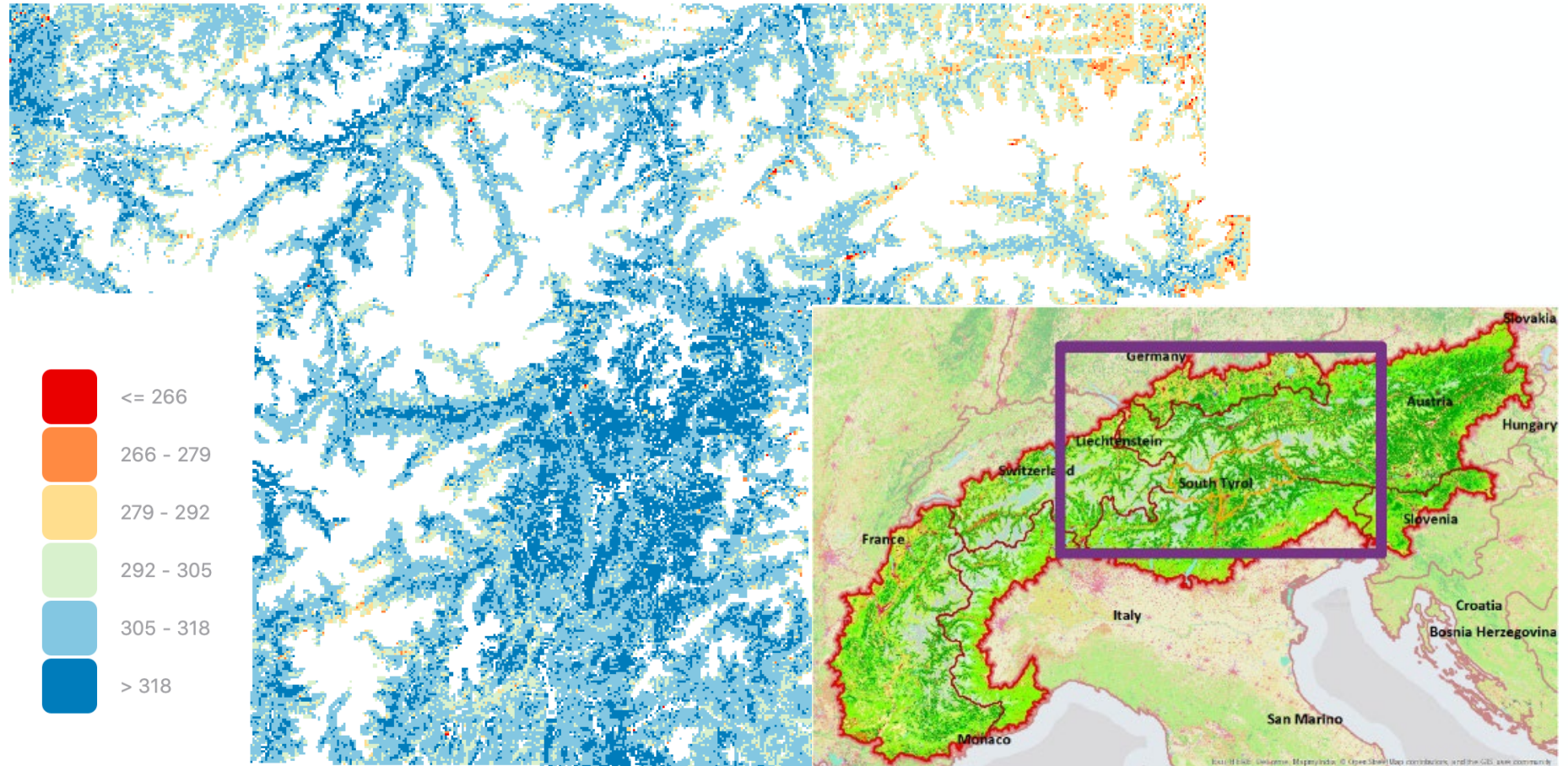
- Inform stakeholders and users about service implementation
- Contact users and stakeholders for reference data within calibration and demonstration site



- 3 services integrated



## Forest phenology – EOS 2020



## Task 4: Service delivery

- Invite stakeholder and users to use services
- Provision of user manual
- User support (technical and thematic)

## Task 5: Service utility and uptake assessment

- Setup of a structured questionnaire
- 2 regional user workshops

- Respond to needs of Alpine stakeholders (Alpine Convention, EUSALP)
  - Characterise changes of alpine ecosystems extent and condition
  - Analyse resilience of alpine ecosystems to climate
  - Evaluate direct and indirect impacts of natural hazards on alpine ecosystems
- 6 services with at least 30m resolution integrated with openEO (available soon)

1. Ecosystem mapping	2. Forest disturbance	3. Forest phenology	4. Fire recovery	5. Grassland management	6. Grassland abandonment
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- On demand – define AOI and time
- Regionally tailored, adapt to specific temporal needs (frequent updates)

# Thank you!

Poster session today: An Earth Observation based Grassland Mowing Detection Service for the Alpine Region E3.01 Alps Regional Applications and Science