Multi-source data integration

Ecopotential's Virtual Laboratory and Earth Observation Data for EcoSystem Monitoring (EODESM) System

(*WP4-WP10)*

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The questions

- How EO data can detect spatial-temporal ecosystem dynamics and scales over which ECOPOTENTIAL can provide a whole portfolio of services to Protected Areas (PAs)?
- Any similar qualitative changes among PAs? *(Monica Turner's presentation, May 2017)*
- Are rates of change in PA_X consistent in direction, slope, among PAs? Why or why not? *(Monica Turner's presentation, May 2017)*
- Can ECOPOTENTIAL improve predictive modeling about ES Functions and ES Services by multi-scale EO data/derived products (e.g., phenology, biomass) assimilation?

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EODESM development (WP4)

Sea Surface Wind Fields (Sentinel-1),

Chlorophyll-a (MERIS/Sentinel-3),

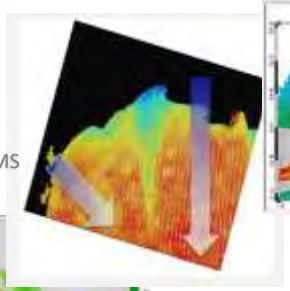
Water depth (Landsat 5)

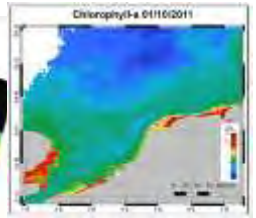
Water hydroperiod (Landsat/ Sentinell2)

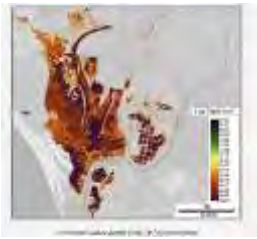
DEM(5 m; LIDAR)

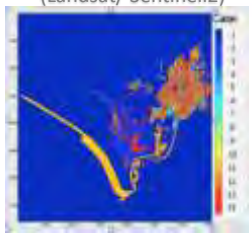
265 m 3475

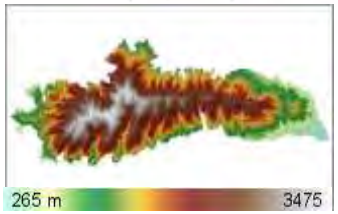
Geophysical variables (T4.1, T4.2)



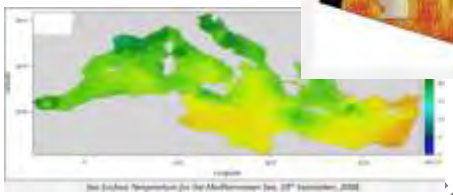








Sea Surface Temperature(CMEMS /Sentinel-3)



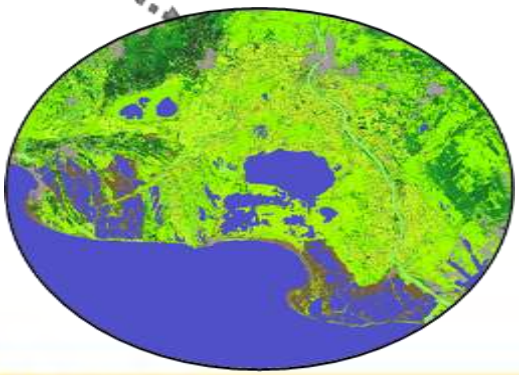
EO images (WP3)

Knowledge bases: story line; domain ontologies.

(T4.3)

EODESM

In–situ Ancillary Data



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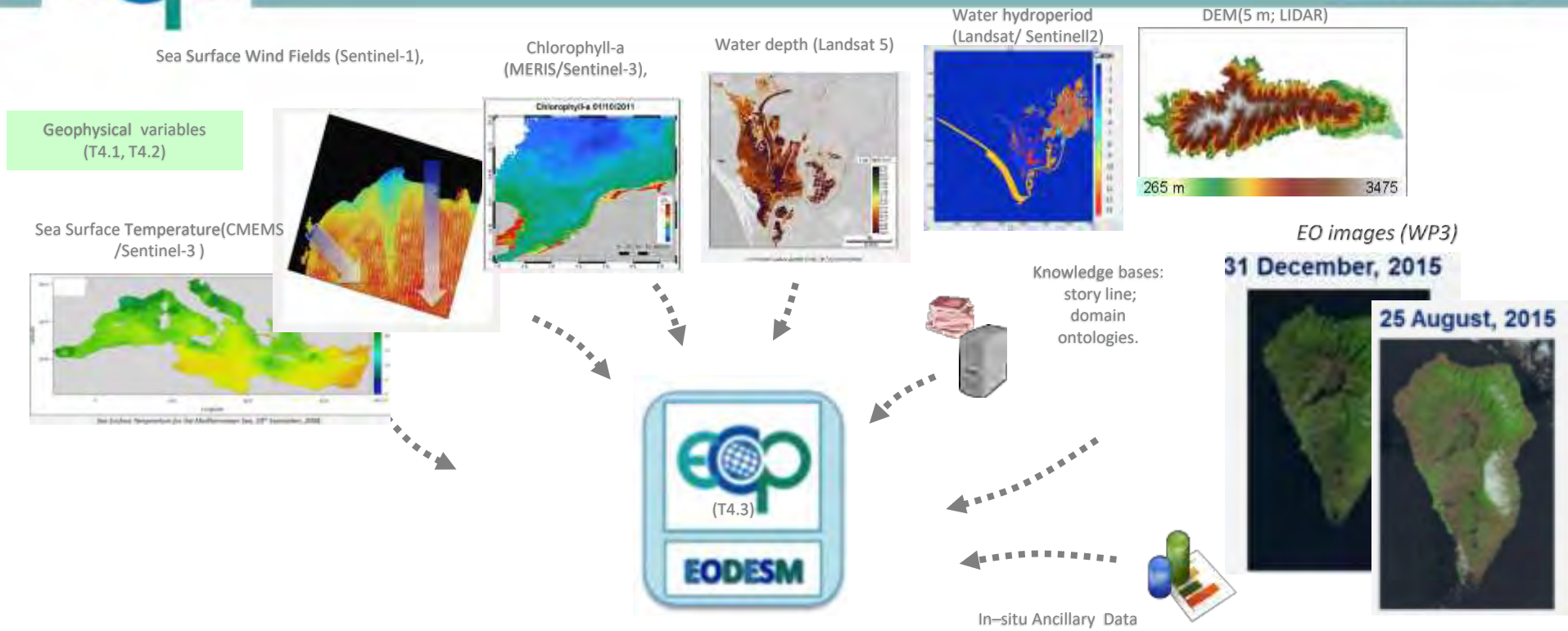
UNSW AUSTRALIA

EODESM development: inputs



- Food and Agriculture Organisation (FAO) Land Cover Classification System (LCCS2) hierarchical structure
- Python open source software
- KEA files provide raster attribute tables

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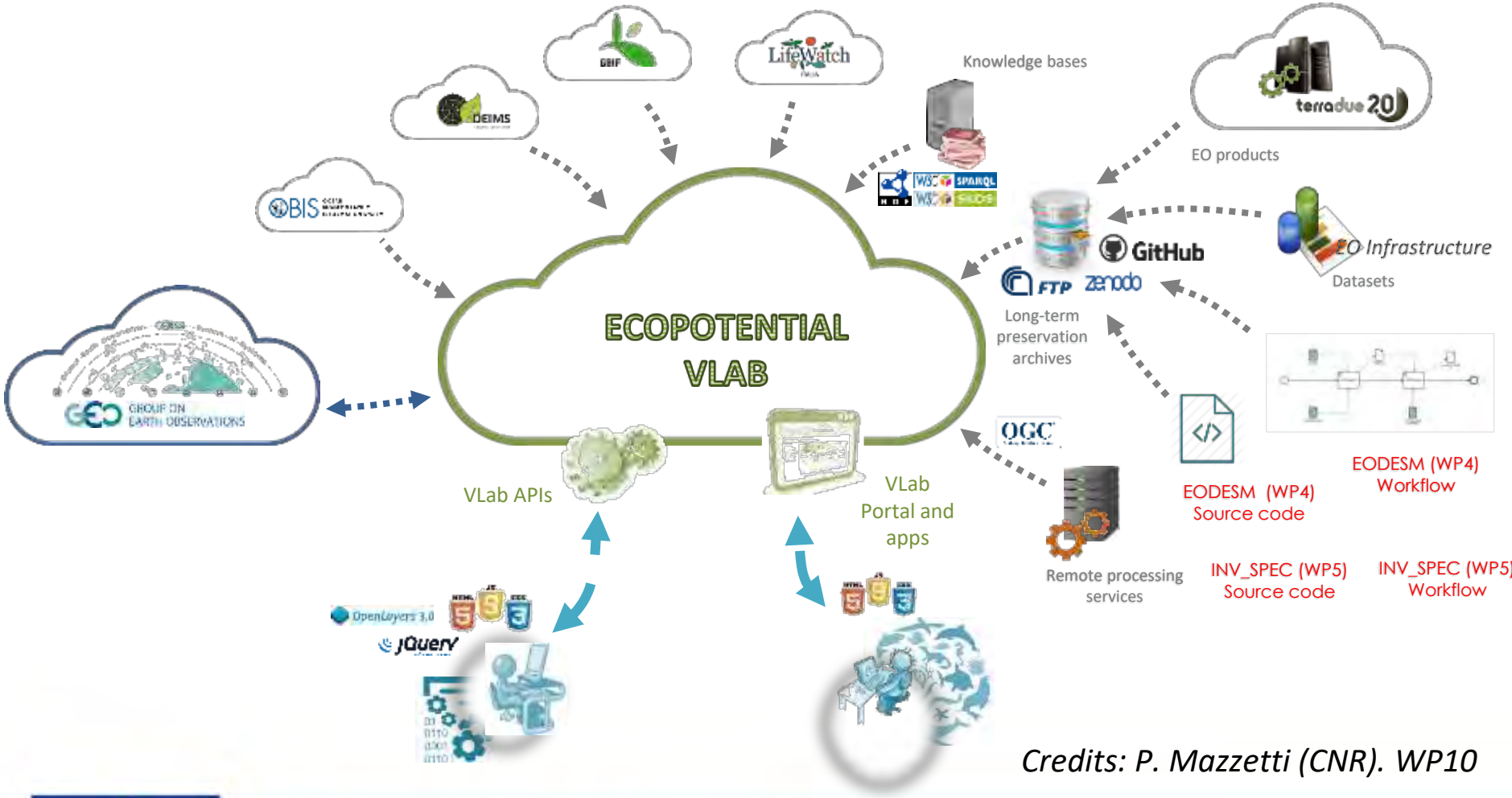
Virtual Laboratory (VL) (WP10)

Generating products from EODESM and other modules



Credits: P. Mazzetti (CNR). WP10

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EODESM within the Virtual Laboratory

ECOPotential VLab GUI

ECOPOTENTIAL DOMAIN | WORKFLOWS | MODEL UPLOAD

Developed by

Select an Ecosystem

Arid/semi-arid

Arid and semi-arid ecosystems represent life under extreme conditions. They are water- limited ecosystems especially vulnerable to impacts associated with global change. In addition, they exhibit unique pathways of ecosystem functions and specialized ecosystem services. In water-limited ecosystems, temporal variability is particularly important.

Coastal/Marine

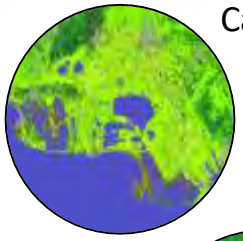
Coastal and marine ecosystems are essential components of the Earth's global ecosystem and are critical in sustaining biodiversity. The health of oceans and coasts is being negatively a ected by the impact of human activities, leading to a loss of biodiversity, decreased abundance of species, damage to habitats and loss of ecological functions and ultimately, ecosystem services. Coastal areas, in particular, are particularly important for the migration and refuge of species with complex habitat requirements.

Mountains

Mountain ecosystems, rich in endemic and endangered species, are directly linked to downstream regions through ecosystem goods and services including food and energy production, recreational services and options for tourism. Mountain ecosystems are "sentinels of change" with respect to climate change and human pressures, and they show several altitudinal zones and ecosystems. In Europe, the spatial heterogeneity of mountains (cloudiness, shade, etc.) creates methodological challenges for Earth Observations.

Capacity for European Classification of LC and LC Change within the Virtual Laboratory: Outputs

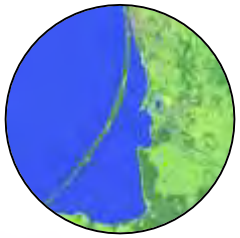
Camargue France



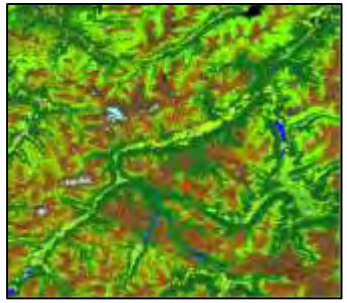
Donana Spain

Danube Romania/ Ukraine

Curonian Lagoon Lithuania

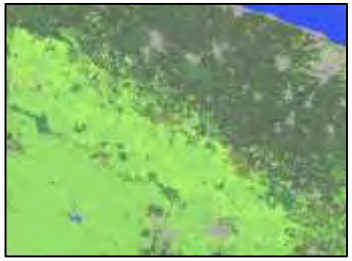


Swiss NP, Switzerland



Sierra Nevada, Spain

Murgia Alta, Italy



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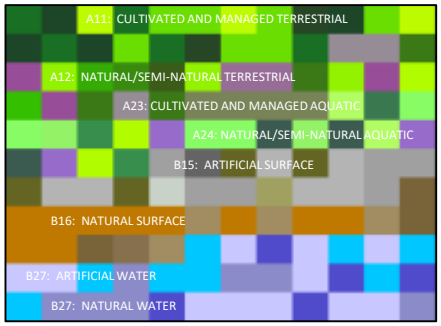
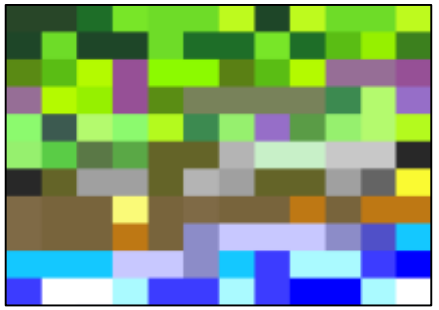
FAO Land Cover Classification System

Gran Paradiso NP, Italy

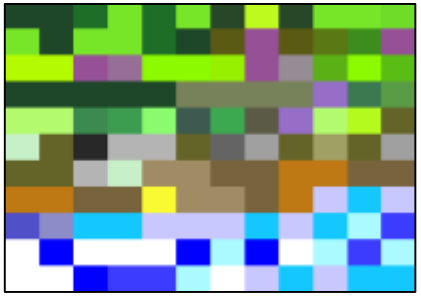
LCCS Level 4 Classification



Period 1



Period 2



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Change at multiple temporal/spatial scale

- EODESM can detect changes in both classes and ENV variables according to the FAO-LCCS2 scheme.
- Changes are *targeted* depending on the storylines of *21 PAs*, according to the type, spatial extent and temporal frequency
  - ✓ Changes in the LC class and attributes, e.g., canopy cover or height
  - ✓ Changes in geophysical variables, e.g., hydro-period, water turbidity
- A change process needs to refer to the alterations in **classes but also in ENVs** that have taken place over different time periods.
- When image time series are available, EODESM outputs combined with the analysis of time series can provide **convergence of evidence of specific changes and trends**.
- *Validatio*n through the development of mobile applications for recording LC and LCC in near real time (*citizen-science* based campaigns).

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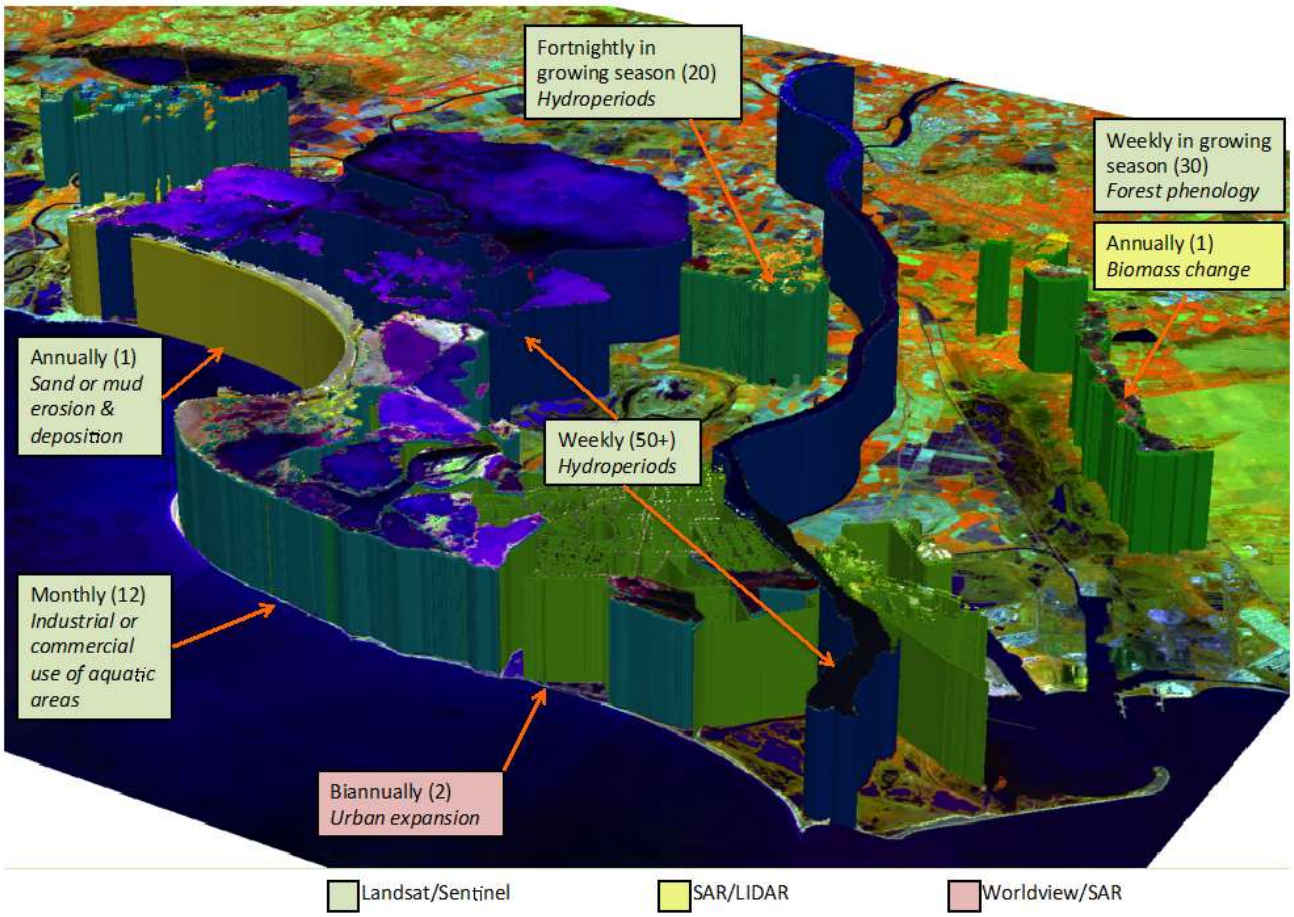
Change at multiple temporal scale



Credits: R. Lucas (UNSW) D5.3. Figure 7.2. Examples of changes occurring in the Camargue over different time frames, the requirement for observations and the types of sensors that can be used collectively to quantify change.

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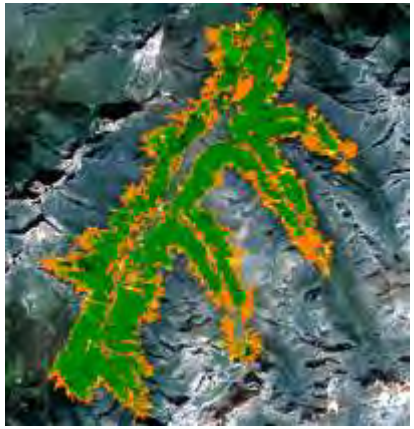
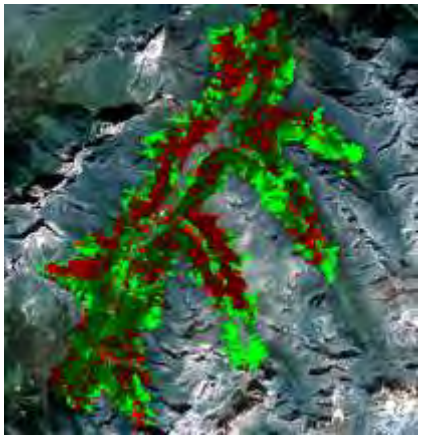
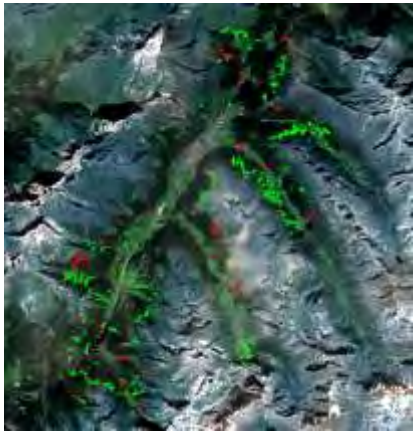
EODESM Evidence-based change detection

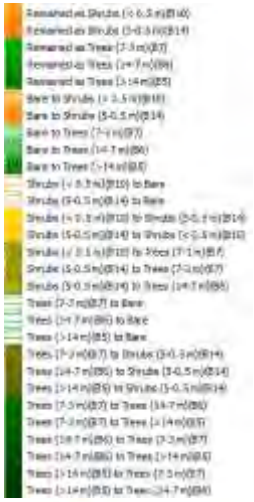
Swiss NP, Switzerland

Land Cover Classification + Environmental Variables = Evidence for Change









Deforestation
Regrowth

Natural Vegetation	Agriculture	Urban	Water	Bare ground
Deforestation	Herbicide Spraying	Road Abandonment	Flooding	Lava Flows
Degradation	Burning	Greening	inundation	Sedimentation
SelectLogging	Cutting	Browning	DryingEvent	Erosion
Defoliation	Grazing	Planning	Long Term Drying	Dune Change
Thinning	Growth	Urban Densification	Net Snow Accumulation	
Dieback	Stubble Formation	Urban Renewal	Net Snow Loss	
Growth	Agri Expansion	Waste Dumps/Extraction	SnowFall	
Thickening	Agri WaterSupp	Comm Installation	SnowMelt	
Encroachment	Agri TimeFactor	Comm Abandonment	Waterlogging	
Abandonment	Tillage	Rail Conversion	Water OutBurst	
Hedgerow removal	Pasture Degradation	Rail Construction	Dam Creation	
	Pasture Replanting	Urban Expansion	Land Drainage	
	Crop Change	Road Conversion	Freezing	
	Crop Growth	Road Construction	Thawing	
	Crop Sequence change	Road Improvement	Glacial Flow	
	Agri Homogenisation	Industrialisation	Sea Level Rise	
	Agri Division	Infilling/levelling	Water Pollution	
	Plantations		Tide loss	
	Plantation Growth			
	Grass Fertilisation			
	Orchard planting			
	Slurry or sediment spreading			
	Liming			

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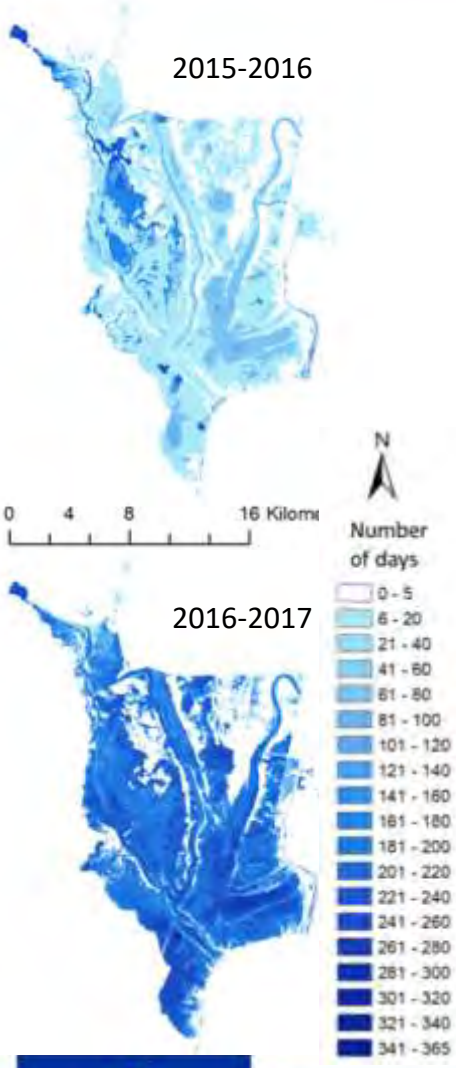
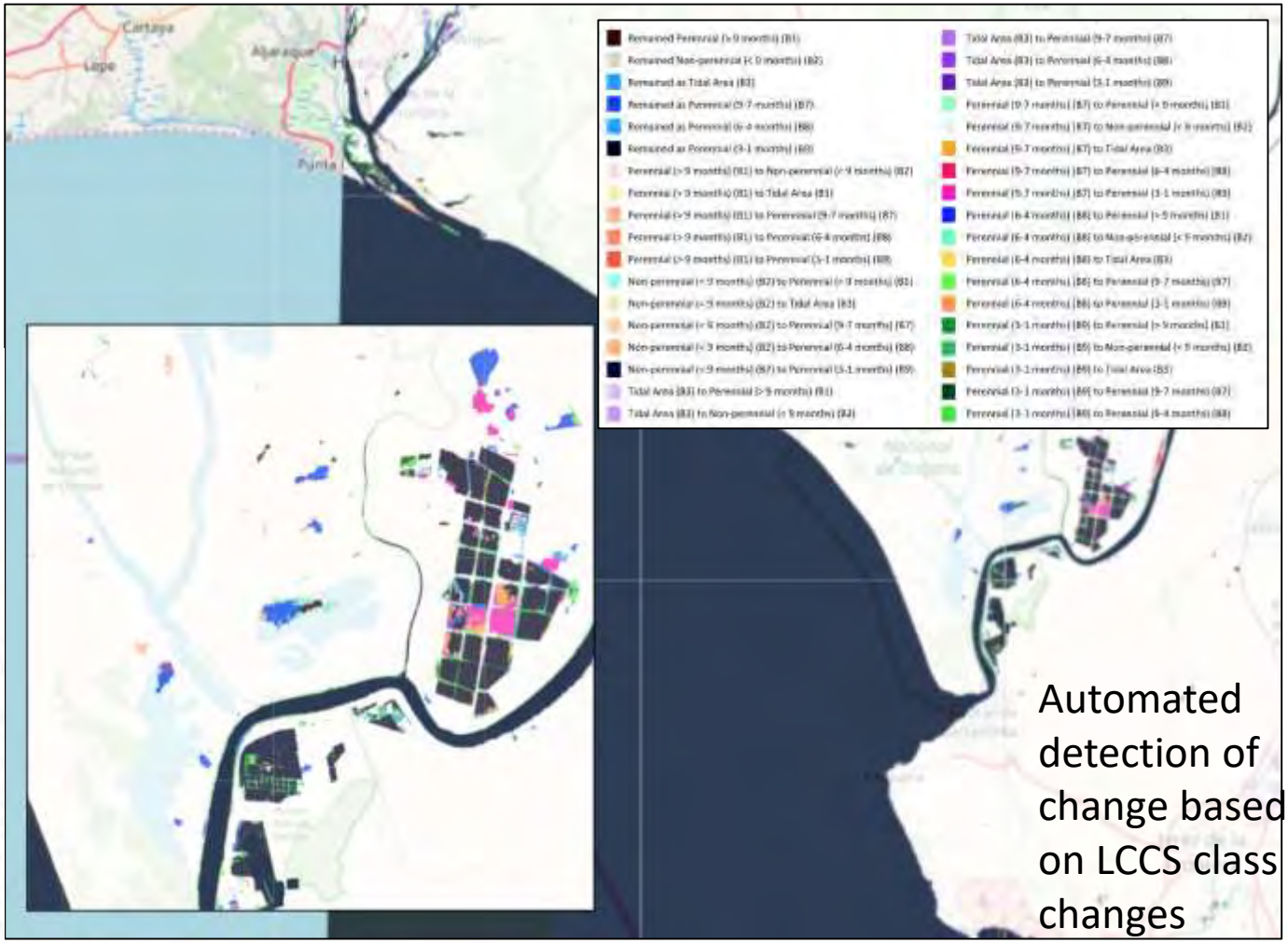
Hydroperiod Change based on LCCS Categories

Example: Donana NP, Spain





Automated detection of change based on LCCS class changes

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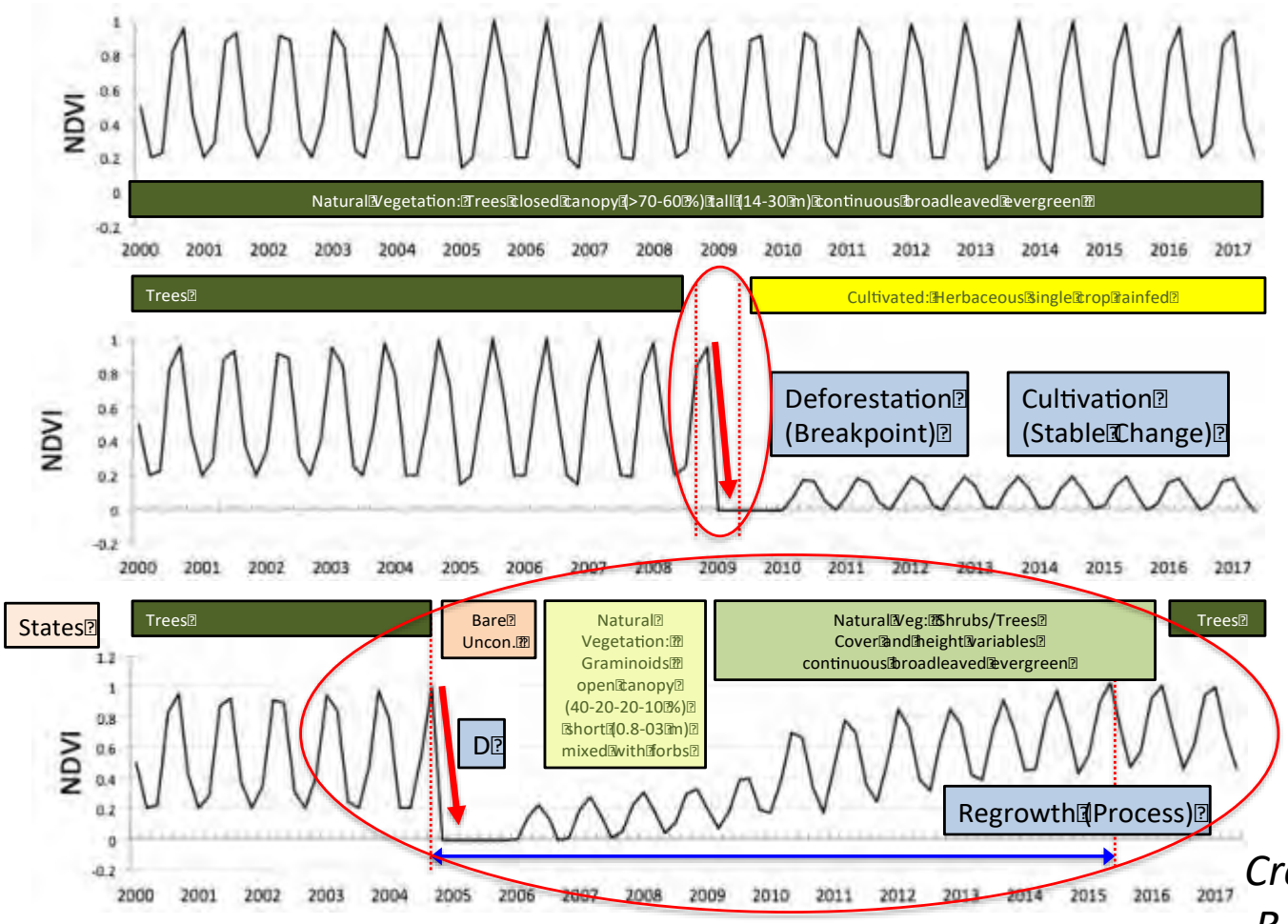
EODESM and Time Series analysis

EODESM classifications and long term analysis,
e.g.,from Breaks For Additive Season and Trend (BFAST)



Season;
Forested area:

Break point

Trend:
Deforestation to regrowth

Credits: D4.3, Fig.9.1; R. Lucas-UNSW

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Gaps

- ✓Networks of in-situ data availability for EO product validation at least in protected areas
  - E.g., lack of an adequate European network of buoys (equivalent to the NOAA infrastructure) for coastal wind speed validation from Sentinel-1.

- ✓End Users take decisions at local-national levels.
  - Availability of VHR (<3m.) data for natural protected areas (including LTER sites) to provide VHR time series.
  - Modelling with VHR/HR EO derived products (maps, variables)

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Future: data from the new micro-satellite

VENμS:
Joint Israeli – French Micro-Spacecraft for Earth Observation Mission

- **Vegetation and Environment monitoring** on a New **Micro-Satellite** (VenμS) : data at high spatial (5-10 m.) and spectral resolution (12 bands in the range 420-910nm.), with temporal repetitivity of 2 days, covering 110 sites of scientific interest among which:

ECOPOTENTIAL sites: PENEDA-GERES, CURONIAN LAGOON, BAYERISCHER-WALD

Product level	Temporal characteristic	Content	Ground resolution
Level 1	single date and single viewing angle acquisition	Top of the Atmosphere reflectances, map projected (orthorectified image)	5 m
Level 2	single date and single viewing angle acquisition	Surface reflectances, map projected (orthorectified image)	10 m
Level 3	10 days time composites of single viewing angle acquisition	Surface reflectances, map projected (orthorectified image)	10 m

Mission	Monitoring of Earth's vegetation
Launch date	August 1st, 2017
Partners	ISA
Instruments	Camera with 12 narrow spectral bands
Localisation	Sun-synchronous, near-polar orbit at an altitude of 720 km for 2½ years (science mission) and 410 km for 1 year (technology mission)
Mission lifetime	3½ years

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