
WS2 Progress on three studies/papers, next steps and alternatives

FG3 activities

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Ideas proposed by CERTH/ ITI to advance FG3 activities



✓ Paper 1 idea

Working Title: Inland surface water mask derivation via a fast and automatic thresholding approach: transferability and validation of an existing approach to areas within SCERIN

Related reference: G. Kordelas, I. Manakos, D. Aragonés, R. Diaz-Delgado, J. Bustamante, "[Fast and automatic data-driven thresholding for inundation mapping with Sentinel-2 data](#)", 2018, Remote Sensing, 10, 910.

✓ Paper 2 idea

Working Title: Complementary ability of S-2 and Landsat for the derivation of phenology metrics: derivation from the real situation and validation in SCERIN area

Related reference: Lange, M.; Doktor, D. [Phenex: Auxiliary Functions for Phenological Data Analysis, R Package Version 1.4-5](#). Available online: <https://CRAN.R-project.org/package=phenex>

✓ Paper 3 idea

Working Title: Canopy height derivation using S-2 bands' texture features

Related reference: Z. Petrou, I. Manakos, T. Stathaki, C. A. Múcher, M. Adamo, "[Discrimination of vegetation height categories with passive satellite sensor imagery using texture analysis](#)", 2015, IEEE Journal of Selected Topics in Applied Earth Observations and Remote Sensing, 8(4), 1442–1455

3 Google Docs were created and three skype meetings organized (August 2018) by CERTH to search for interested members in relation with the three paper ideas



Paper 1 discussions (1/2)



Interested members	Affiliation	Pilot Area	Data availability/ experience	Comments
P. Kenderessy, A. Halabuk	Slovak Academy of Sciences	Podunajska niizina (Danubian) lowland	Expertise focused on mapping the ephemeral water bodies in agricultural landscape. So far developed S2 composite mosaic of arable land of Podunajska niizina lowland in Slovakia. Could also offer in-situ measurements taken by UAV system or field spectrometry.	
L. Filchev	Bulgarian Academy of Sciences	area of Burgas or close to Sofia area	Application of interest flash floods. Limited ground data.	will work together with the Romanian team
P. Campbell, J. Albrechtova, L. Kupkova, P. Stych	Charles Univ.	Czech site (to be selected)	Petya: "I am working on a project for evaluating tundra in Alaska, using AVIRIS data. We could apply the approach to AVIRIS data. There is a lot of standing water in the tundra, so it is not hard to mask with AVIRIS and test the approach and the idea for validating it (using spectral data). To bring it close to SCERIN Petya may ask for spectral data for a Czech site, which Frantisek and Olga would have."	will further search for sites
M	Univ. of Zagrah			interested to

Paper 1 discussions (2/2)

Interested members	Affiliation	Pilot Area	Data availability/ experience	Comments
A. Irimescu, D. Mihailescu	Meteo Romania	There is not regularly flooded area in Romania. One possible area on Danube Delta (where the vegetation does not allow to see the water surface), or any other open lakes in the plain or mountain areas	Anisoara: "In 2018, floods occurred in the central part of Romania. All products based on S1, since the S2 data were covered by clouds. There are 6 flooded areas, including the Danube Delta. Many products are based on MODIS data since it was an historical flood event. We are not allowed to use any more (will ask for permission) the data taken by International Disaster Charter. There are ground data (taken in 2005 or 2006) but can not guarantee to find them. Since S2 launch two flood events occurred in Romania: in 2016 and 2018, but S2 could not be used to monitor the floods because of the clouds. There are old events as mentioned above, but I have to look for the raw data."	will work together for the Romanian case
N. M. Daniel	Brasov University			
Volodymyr Starodubtsev	Ukraine			

Paper 1 wrap-up

- **Possible pilot areas.** Danube Lowland (Slovakia), area of Burgas or a close to Sofia area, a Czech site, a Danube area (Romania, close to borders with Bulgaria)
- **Ground data.** Limited access to available ground data. Need to intensify efforts.
- **Satellite data.** If we go for floods, Sentinel-2 data are probably inappropriate because of clouds. Need to discuss further on the topic/ area of interest before and choose the appropriate satellite data and method (e.g. fusion of multi-source data is also a possibility).

Steps forward (technical)

- How many pilot sites are we going to select finally? Describe their main characteristics (e.g. flat areas, free-fluctuating-through-time boundary).
- Find out ground data (preferably taken in dates within operational time of S-2 or even, in case of cloudy areas, Landsat data).
- Check the environmental or socioeconomic interest of sites to maximize impact.
- Work allocation and assignments.
- Timeline

Workload	Assignments	Timeline
Pilot site(s) selection & description		
Ground data		
Literature review/ State-of-the-art analysis		
Satellite data retrieval and processing		
Statistics		
Discussion		

Steps forward (authorship)

Chapter	Assignments	Timeline
Introduction		
Materials and Methods		
Results		
Discussion		
Conclusions		

Paper 2 discussions (1/2)



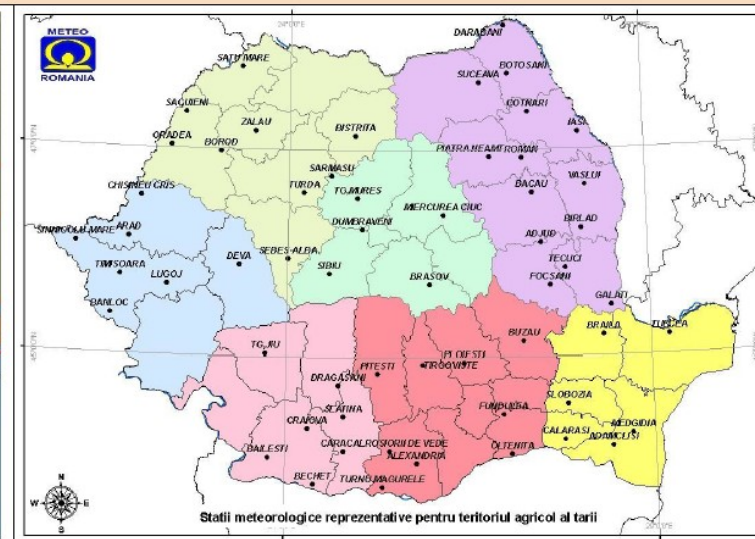
Interested members	Affiliation	Data availability/ Experience/ Comments
A. Halabuk & team	Slovak Academy of Sciences	Experience in calculating phenology metrics & simple thresholding for the detection of cutting in grasslands using MODIS time series (http://www.mdpi.com/2072-4292/7/5/6107). Increasing spatial resolution would be of added value. Discuss possible specific research objectives (e.g. detection of grasslands (for creation of grassland mask) and identification of grassland management practices and some crucial driving processes (e.g. spring flooding, overgrowing or intensive pasturing)).
I. Manakos	Centre for Research and Technology Hellas	CERTH modules for the calculation of phenology metrics may serve all processes as a common basis. Also following the finalization of the ideas and concept, CERTH will seek inland what may be provided in terms of ground data.
A. Irimescu	Meteo Romania	Anisoara-Mihai: Network across country for data takes about phenology metrics (around 55 meteo stations). Agriculture phenology: phenology parameters for main crops (corn/maize & winter wheat) available in the plain areas at country level; no field polygons available; more than 5 years data available (but there is no S-2 data available); a protocol available; no digital format for data; only one measurement point for each crop type [there are 55 points/crop type for the entire country; the crops are: corn/maize and winter wheat; we know the number of points (one point for each station); we know the date the measurements are done (the date is recorded); the database is at least 5 years old]. Forest phenology: some phenology parameters exist for the forest in the Brasov County; 1 or 2 years archive available; one student can be involved for future measurements
N. M. Daniel	Brasov University	

www.meteoromania.ro

NMA – Surface Observation Network

Synoptic and climatological network
– 160 automatic stations

Agrometeorological network
– 55 automatic stations



- 7 Regional Meteorological Centres
- 160 weather meteorological stations
- 55 weather stations integrating a special program of agrometeorological measurements – soil moisture and phenological data (winter wheat, maize, sunflower, rape, fruit trees and vineyards).

Paper 2 discussions (2/2)

Interested members	Affiliation	Data availability/ Experience/ Comments
P. Campbell, L. Kupkova, P. Stych, J. Albrechtova	Charles University	<p>According to Jana and Lucie, there exist individual efforts and possibilities for which we will be informed with an e-mail of theirs, following an international search they will perform. Lucie: "Right now we deal with phenology in tundra area in the Krkonoše Mts., Czechia. We will have also field data and some field spectra of selected species/ communities."</p> <p>Jana: "Phenological data (green up and senescence for sure) gathered by children in the framework of the program GLOBE, may be used. Data are archived centrally and available for scientific purposes (https://www.globe.gov/de/web/european-phenology-campaign). The data are not so often used and any use for scientific research is very welcome. I have been collaborating with GLOBE program for many years, contributed to creation of other protocols on carbon cycle (contact person Jana). Extra comment: GLOBE Europe is lead by Czech GLOBE Office in TEREZA - Jana will retrieve the info and update."</p>
L. Filchev	Bulgarian Academy of Sciences	<p>Existing network (similar to Romania) but data are for sale only. Lachezar is aware of a team that gathers data for smaller areas. Also he has some acquaintances in Montenegro and Turkey, where ground data may exist and be utilized for the purpose of our common work. Lachezar will inform us about what may be achieved in these cases. Lachezar pointed out that GLOBE is not performing equally well in the SEE countries but at least for Czech republic it is a good source. In some other SEE countries is also nice resource but it strongly depends on schools involvement and the coordination.</p>

Paper 2 wrap-up

- **Possible pilot areas.** Maybe go for the Danube site considered for Paper 1 as well.
- **Possible application areas.** Monitoring of agricultural cultivations or detection of grasslands and identification of grassland management practices/ driving processes or monitoring of a forest area.
- **Ground data.** Extensive data available for the main crops from the monitoring network in Romania.
- **Other data.** Maybe use data gathered in the framework of the program GLOBE (contact person P. Campbell).

Steps forward (technical)

- Decide whether we go for agricultural cultivations or else (e.g. grasslands).
- How many pilot sites within SCERIN we will finally select? Describe their main characteristics.
- Reference data (preferably taken in dates within operational time of S-2 or even, in case of cloudy areas, Landsat data).
- Check the environmental or socioeconomic interest of sites to maximize impact.
- Work allocation and assignments.
- Timeline

Workload	Assignments	Timeline
Pilot site(s) selection & description		
Ground data		
Literature review/ State-of-the-art analysis		
Satellite data retrieval and processing		
Statistics		
Discussion		

Steps forward (authorship)

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Paper 3 discussions

Interested members	Affiliation	Data availability/ Experience/ Comments
O. Brovkina	Czech Globe	<p>Olga: Test the approach to forest site in the Czech Republic (Krkonoše area). The site has about 50 forest plots (circle, area of the plot is 500 m²) with prevalence of spruce and beech. Field measurements of forest stand height are available for validation and testing the suggested approach. In addition, Olga reported about having time-series airborne lidar and HS data 2010, 2013, 2015 on the Tesinske Beskydy site, and a person who could work with them, provided that the method is made understood.</p> <p>Lucie & Premek reported having Lidar data for habitats in Krkonoše area (5 points per m²) for 2012. Similar situation is assumed for Šumava forest. At the same time, they can make available APEX HS airborne data, out of which we could simulate S2 ones or also work with them directly. Issue is the person to find to work with, with some programming skills. In a longer term this person could be found or they could cooperate with a third party person from another Entity of this team to work upon these data.</p>
P. Campbell, J. Albrechtova, L. Kupkova, P. Stych	Charles University	
L. Filchev	Bulgarian Academy of Sciences	Will send a summary of forest stands data takes in Bulgaria and then may find out whether a case may be set up there. Issue is to find a person to work on the data.
M. Gašparović	University of Zagreb	interested to contribute
A. Irimescu	Meteo Romania	Mihai reported about 1ha plots in Romania with height information and 5cm spatial resolution data takes from a drone. Mihai shall send more info

Paper 3 wrap-up

- **Possible pilot areas.** Forest site in the Czech Republic (Krkonoše or the Sumava forest?) and/or another Romanian site.
- **Reference data.** Available airborne datasets and field measurements.
- **Human resources:** Issue to find a person with some programming skills as well to work with data.

Steps forward (technical)

- How many pilot sites are we going to select finally? Describe their main characteristics.
- Reference data (dates/ resolution)
- Check the environmental or socioeconomic interest of sites to maximize impact.
- Work allocation and assignments
- Timeline

Workload	Assignments	Timeline
Pilot site(s) selection & description		
Ground/ airborne data		
Literature review/ State-of-the-art analysis		
Satellite data retrieval and processing		
Statistics		
Discussion		

Steps forward (authorship)

Chapter	Assignments	Timeline
Introduction		
Materials and Methods		
Results		
Discussion		
Conclusions		

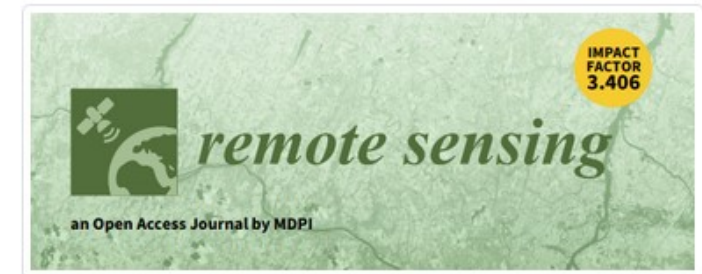
Alternative ideas

- EODESM application in sites of SCERIN (**Annex I**)
- Analysis Ready Data development on the basis of Open Data Cube format (**Annex II**)
- Aesthetic vision as a quality status Indicator for Protected Areas within SCERIN (**Annex III**)
- Continuation of the validation of continental land cover layers

Open special issues for submissions (1/2)

Special Issue "Remote Sensing in Ecosystem Modelling"

https://www.mdpi.com/journal/remotesensing/special_issues/ecosystem_modelling_RS



Deadline: 30 September 2020

Topics of interest

- direct comparisons of EO with in-situ data
- assessment of the added value of EO to ecosystem models
- interoperability topics, for example spatial and temporal scale issues, derived from the incorporation of EO in ecosystem models
- uncertainty propagation of EO-derived inputs in ecosystem models
- benefits by the EO assimilation and side-effects in the designed processing chains
- adjustments in ecosystem models to better integrate EO inputs
- the new capacity being developed and explored by the installation and operation of the Data and Information Access Services (DIASs)

Open special issues for submissions (2/2)

Special Issue "Monitoring Land Cover Change: Towards Sustainability"

https://www.mdpi.com/journal/land/special_issues/EARSeL

Topics of interest

- New instruments and data processing methods
- Geological, hydrological, land and ice applications
- Climate and climate change
- Agriculture and Forestry
- Urban and Thermal remote sensing
- Use of LIDAR and RADAR data for various applications
- Applications employing UAVs and UASs
- Synergy of remote sensing technologies for land-use change monitoring-
- The role of earth observations within the Water–Energy–Food nexus
- Social and behavioral aspects of land use supported by remote sensing observations
- Advances and outlook in the processing and analysis of remotely sensed data



Deadline: 31 December 2019

With a smile and a vision

Thank you
for your attention

At your disposal
for questions/ clarifications



eo services

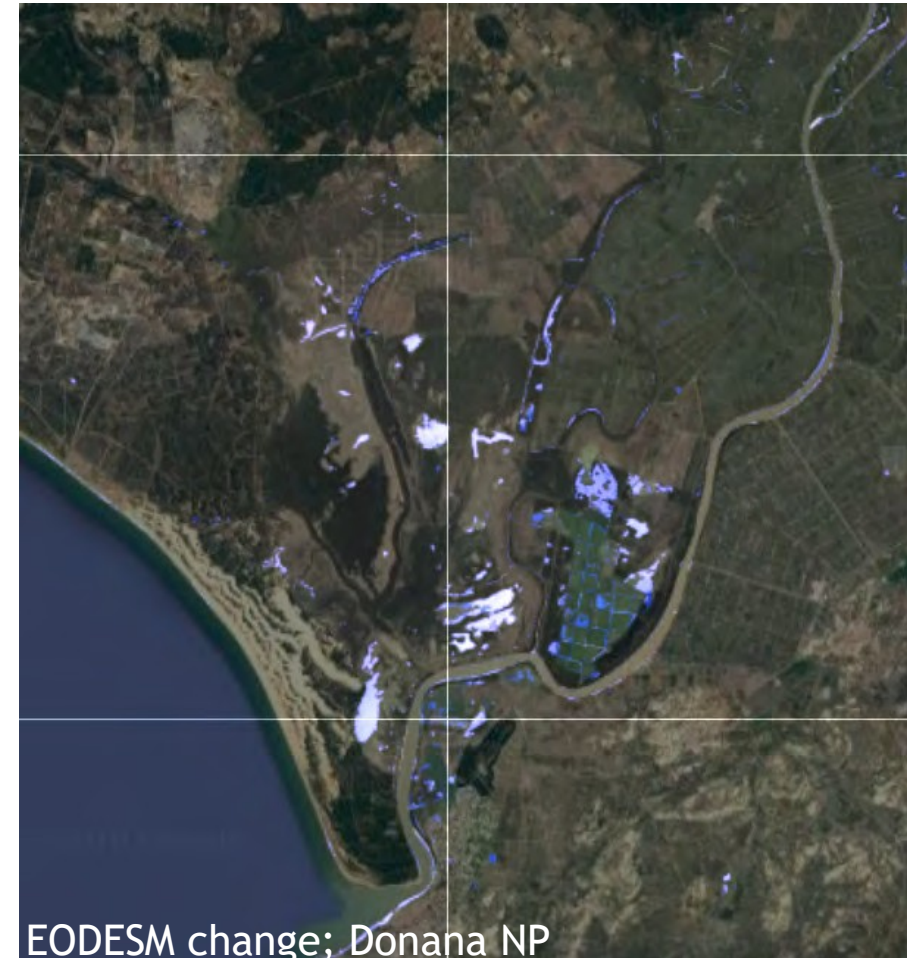
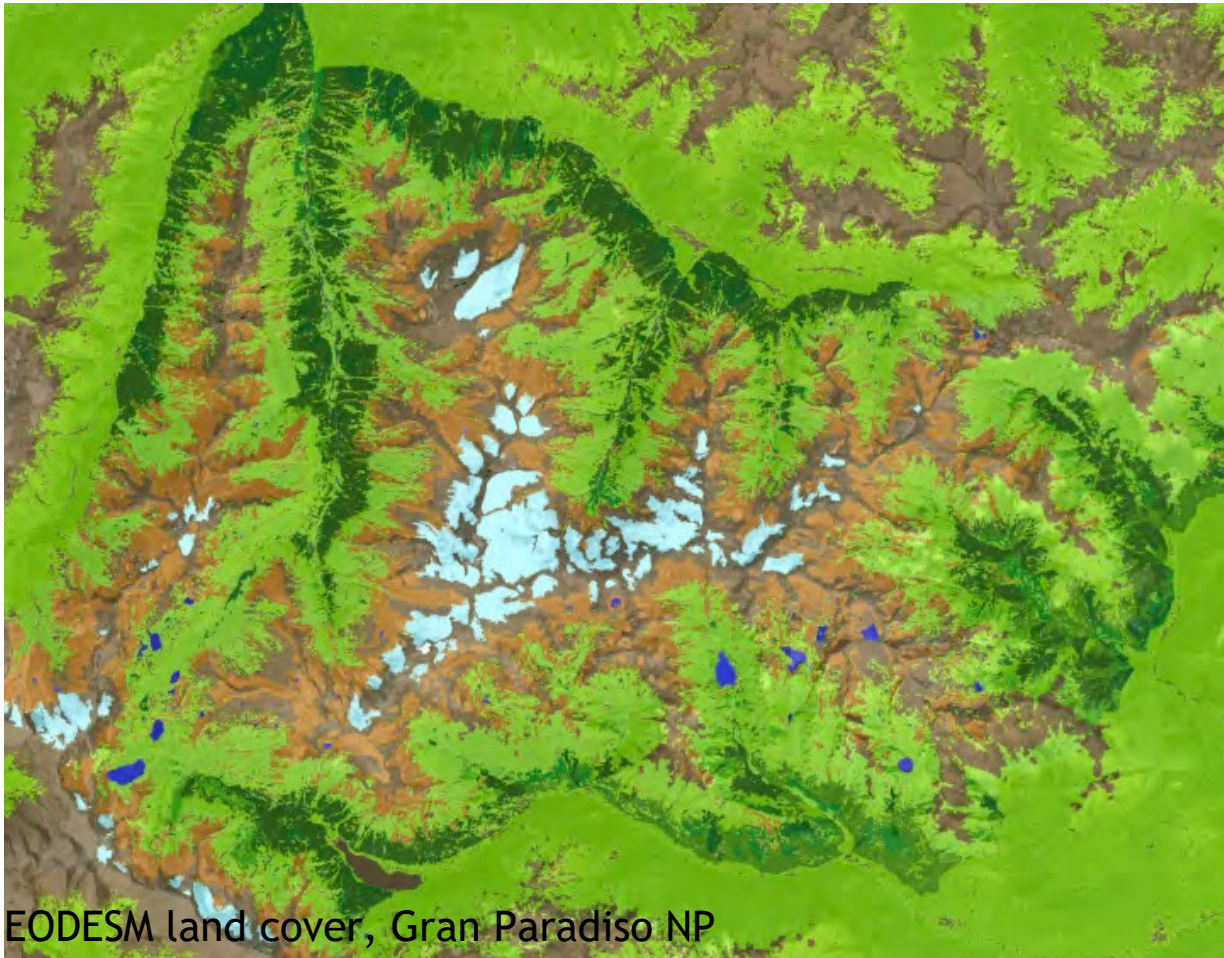
<http://www.eoservices.itigr/>

imanakos@itigr.

Annex I



The Earth Observation Data for Ecosystem Monitoring (EODESM)



This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No

ECOPOTENTIAL 4th General meeting, 20-24 May 2019, Rome (Italy)

ECOPOTENTIAL: improving future ecosystem benefits through earth observations



Challenge:
Standardized
Classification
and Land
Cover
Change



Environmental Variables with Unit

Measures



Leaf Area Index (m²/m²)
The Leaf Area Index (LAI) is defined as the total area of one-sided leaves per unit ground surface area.



Fraction of Absorbed Photosynthetically Active Radiation (percent)
FAPAR expresses the energy absorption capacity of vegetation and thus its growing capacity.



Canopy Height (m)
Canopy height of the aboveground vegetation influences a large number of processes such as energy balance, evapotranspiration, etc.



Canopy Cover (percent)
Canopy cover is a fraction of ground covered by green vegetation and represents the horizontal dimension of vegetation.



Lifeform (class)
Lifeform classes such as woody, herbaceous, lichens/mosses are based on structural similarities of plants.



Leaf Type (class)
Leaf type defines the type of leaf morphology such as broadleaves and needle-leaves. It is linked to the botanical groups such as angiosperms and Gymnosperms.



Phenology (Day of Year)
Phenology is the study of the timing of vegetation life-cycle such as budburst, flowering, leaf colouring, leaf fall, etc.



Net Primary Productivity (gC/m²/day)
NPP is the net amount of carbon uptake after subtracting plant respiration from Gross Primary Productivity over a period of time.



Gross Primary Productivity (gC/m²/day)
GPP is defined as the amount of carbon uptake by plants per time unit through photosynthesis.



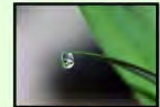
Woody Biomass (g/m²)
Woody biomass is the total mass of living plant material per unit of woody area.



Plant Species (presence/absence or probability)
Presence or absence of plant species is an indicator of genetic diversity and key variable to monitor environmental changes.



Crop Type (class)
The type of crops grown in the fields during the main growing season is important for various applications such as hydrological modeling, plant health, monitoring biodiversity.



Vegetation Moisture (g/m²)
Vegetation moisture content represents the amount of water per unit area of leaf. It is important variable to monitor water stress.



Foliar Chemistry (gC/m²)
Foliar chemistry represents chemical content of leaves. Chemicals of interest could be chlorophyll, carotenoids, anthocyanin, foliar nitrogen, etc.



Burnt Area (presence of burnt area or date of fire)
Burnt area maps indicate areas affected by fires and also provide temporal information about the fire event.



Herbaceous Biomass (g/m²)
Herbaceous biomass represents the total mass of living plant that have a non-woody stem, per unit area.



Canopy Layers (count)
Canopy layers provide information about vertical stratification in forests such as upper-story, under-story, shrub layer, etc.



Non Photosynthetic Vegetation (ratio or percent)
NPP is dormant or senescent plant material that is not photosynthesizing.

Vegetation



Bathymetry (m)
Bathymetry is defined as the underwater depth of the floor of water bodies and it represents underwater relief.



Sea Surface Temperature (Kelvin or degree Celsius)
SST is defined as the temperature of the uppermost mixed layer of the ocean and it is a key variable affecting various biological and climate processes.



Sea Surface Salinity (PSU or PPT)
SSS is defined as the salt concentration in seawater. More precisely, it is the number of grams of salt per 1000 grams of water.



Net Primary Productivity (gC/m²/day)
NPP is defined as the net amount of carbon uptake of the ocean through phytoplankton photosynthesis. It measures the mass of Carbon available for marine ecosystem.



pH
pH is a measure of the ocean acidity on the scale (normally) of 0 to 14. Lower values (below 7) represent high acidity, whereas higher values (above 7) represent alkaline conditions.



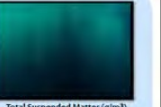
Chemistry (g/m³ or mol/m³)
It refers to the concentration of elements such as oxygen, carbon, phosphate, etc. in the marine water.



Chlorophyll (g/m³)
Chlorophyll concentration is the amount of chlorophyll in per cubic meter of water and it is also a proxy for the phytoplankton biomass in the sea.



Colored Dissolved Organic Matter I (m⁻¹)
CDOM is the absorption coefficient of various organic materials in the sea water. Higher CDOM represents less light penetration in the water.



Total Suspended Matter (g/m³)
Total suspended matter includes both organic and mineral particles and it is a measure of water turbidity. It also measures light penetration.

Marine



Snow Cover Fraction (fraction of percent)
SCF is defined as fraction of land area covered by snow. It is important variable strongly influencing surface energy balance.



Snow Water Equivalent (mm)
SWE is defined as the amount of water contained within the snowpack. It correlates with snowpack depth and snow density.



Snow Depth (cm)
It represents depth of the snowpack and correlates with the snow water equivalent. Both of these variables are crucial for water stock monitoring and flood events.



Water Turbidity (NTU)
Water turbidity is a measure of water transparency as well as quality and hence important in terms of analyzing drinking water. According to WHO drinking water should have less than 5 NTU.



Water Depth (m)
It is the underwater depth of the floor of water bodies. It affects the amount of sunlight reaching the floor and hence floral and faunal life.



Water Seasonality (month)
Water seasonality measures the persistence of the water on the surface. It is strongly affected by terrain relief, soil permeability, geological formations and precipitation rate.



Soil Moisture (m³/m³)
Soil moisture is calculated as volume of water per cubic meter of soil. It is important input for climate and land surface models. Soil moisture status has strong implications on vegetation water stress.



Soil Acidity (pH scale)
Soil acidity is expressed on pH scale (normally 0 to 14). Values lower than 7 represent acidic soil and higher than 7 represent alkaline soils. Soil acidity strongly influence species distribution and plant productivity.



Soil Texture (class)
Soil texture is important soil physical variable. Soil can be classified into textural classes such as loamy, sandy, clayey soil, etc. It influences soil water conditions, vegetation species distribution and ecosystem processes.

Snow

Water

Soil

Urban

Energy

Terrain

Atmosphere



Artificial Material (class)
Artificial material represents mostly impervious surfaces such as buildings, roads, rail network, etc. These surfaces immensely modify surface energy balance and climate.



Urban Vegetation (class)
Urban vegetation represents vegetation growing in the cities; for example playgrounds, parks and gardens.



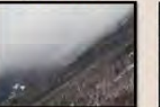
Albedo (fraction)
Albedo is the ratio of total upwelling to total downwelling solar radiation. It is important input in land surface and climate models to represent radiation partitioning.



Land Surface Temperature (Kelvin or degree Celsius)
LST is the radiative skin temperature of the land. It strongly influences land surface processes and energy balance.



Digital Elevation Model (m)
DEM represents elevation of the terrain surface. Digital terrain models represent elevation of the bare ground, whereas digital surface models represent all the objects over the land surface.



Slope (degree)
Slope of the ground represents its steepness or degree of inclination to the plane surface. It influences speed and direction of wind, streams, etc.



Aspect (degree)
Aspect depicts the orientation of slope. It is measured clockwise from north. Along with the slope it regulates range of land surface processes.



Rainfall (mm)
Rainfall is important weather variable that regulates many land surface processes as well as floral and faunal distribution and crop types. Along with the magnitude of rainfall, seasonality and intensity are also very crucial factors.



Air pollutants (ppm or µg m⁻³)
Air pollutants are of various types, such as gases (nitrous oxide, ammonia, sulfur dioxide) and particulate matter. Their concentrations inform about the air quality standards.



Environmental Variables with Unit

Measures



WOODY BIOMASS

Woody biomass is defined as the total mass of living plant material per woody area. Aboveground biomass plays a key role in the carbon cycle and climate processes. It can be measured through direct or indirect in situ sampling (see here) or estimated through satellite/airborne sensors. Typically, biomass in woody areas ranges between 0 (poorly...

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HERBACEOUS BIOMASS

Herbaceous biomass is defined as the total mass of living plants, that have a non-woody stem, per area. Aboveground biomass plays a key role in the carbon cycle and climate processes and is of major importance in various field such as agronomy, biodiversity, climate, energy production, etc. Herbaceous biomass can be measured through destructive or...

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LEAF AREA INDEX

The Leaf Area Index (LAI) is defined as the total area of on-sided leaves per ground surface area. It is a fundamental property of the plant canopy as it plays a key role in the absorption of solar radiation, through photosynthesis, and thus on the vegetation growth. LAI can be estimated by ground measurements...

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ALBEDO

Albedo is defined as the ratio of total upwelling to total downwelling solar radiation at the surface. It represents the energy balance at the soil-vegetation-atmosphere interface. The albedo allows to quantify the part of the energy that is absorbed by Earth surface and then transformed to heat. The albedo is a unitless variable ranging from...

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Accessing Environmental Variables



CANOPY COVER

The canopy cover is defined as the fraction of ground covered by green vegetation. This variable represents the horizontal dimension of the vegetation and allows to quantify its spatial extent. Canopy cover is an essential variable as vegetation extent strongly influences the water, energy and matter fluxes of land surface. Canopy cover is notably very...

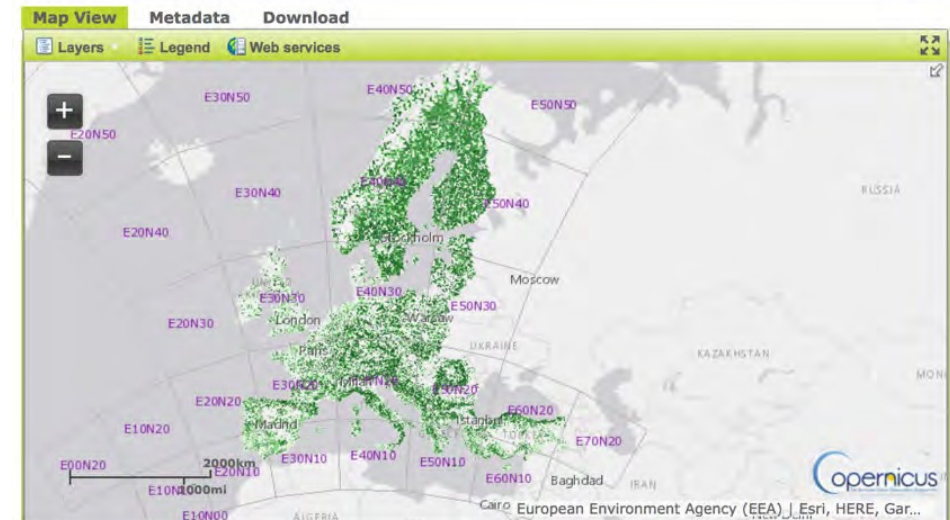
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- [COPERNICUS BioPAR GEOv1](#)
- [COPERNICUS BioPAR GEOv2](#)
- [COPERNICUS PROBA-V GEOV3](#)
- [USGS Landsat 7 ETM+ Global Tree Canopy Cover \(circa 2010\)](#)
- [NASA Landsat 5 TM / ETM+ Global Tree Canopy Cover](#)
- [NASA MODIS MOD44B VCF](#)
- [CYCLOPES FCOVER](#)
- [COPERNICUS HRL Tree Cover Density](#)



PROTECTED AREAS from SPACE
ECOPotential view

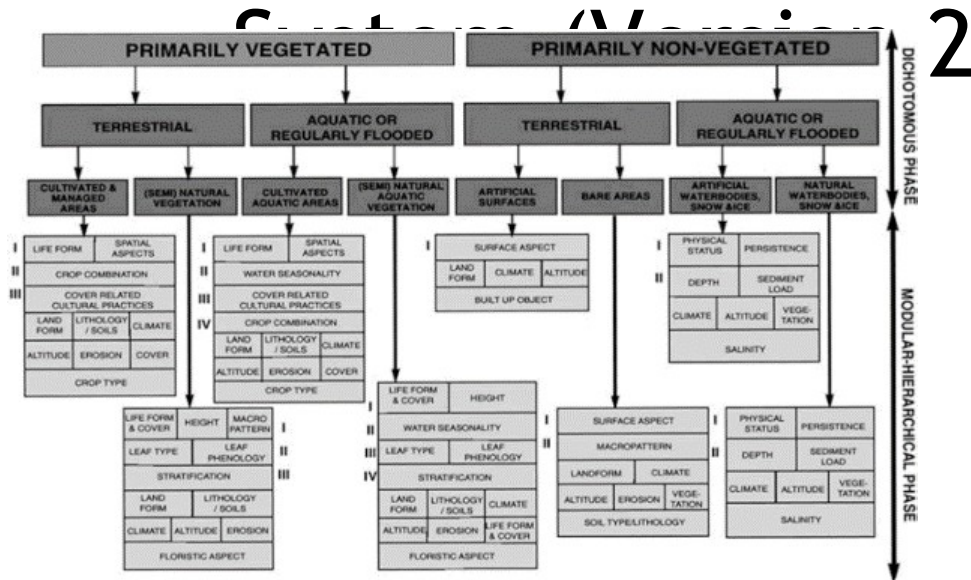
Tree Cover Density 2015



This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 641762

ECOPOTENTIAL 4th General meeting, 20-24 May 2019, Rome (Italy)

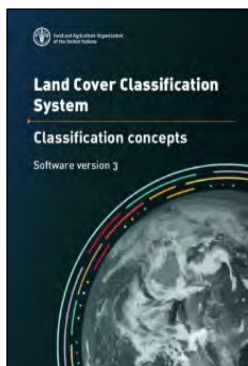
The Food and Agriculture Organisation (FAO) Land Cover Classification



Code	Code	Code	Code	Code	Code	Code	Code	Code	Code	Code							
Woody	A1	closed (>70-99%)	A10	(1-2 m canopy)	B1	continuous	C1	broadleaved	D1	evergreen	E1	1st layer	F1	closed (>70-99%)	F7	(7-10 m canopy)	G1
Trees	A3	open (10-99 to 10-10%)	A11	(2-3 m canopy)	B2	fragmented	C2	needleleaved	D2	semi-evergreen	E3	2nd layer	F2	closed (>70-99%)	F8	(>14 m)	G5
Shrubs	A4	open (70-99 to 40%)	A12	(>14 m)	B5	fragmented	C4	Aphyllous	D3	deciduous	E2	2nd layer	F3	open (70-99 to 20-10%)	F9	(14-7 m)	G6
Herbaceous	A2	open (40-20 to 10%)	A13	(4-7 m)	B6	cellular	C5		D4	semi-deciduous	E5	2nd layer	F4	open (70-99 to 20-10%)	F10	(7-3 m)	G7
Forbs	A5	closed to open (100-1%)	A20	(7-3 m)	B7	cellular	C3		D5	mixed	E4	2nd layer	F5		F10	(3-0.3 m)	G3
Graminoids	A6	closed to open (100-4%)	A21	(3-6.3 m)	B8				D6	mixed	E6	2nd layer	F6		F10	(3-0.3 m)	G8
Lichens/mosses	A7	scattered (10-1% - 1%)	A14	(3-0.05 m)	B14				D7	herbaceous (Annual)	E7	2nd layer	F7		F10	(2-0.5 m)	G9
Lichens	A8	scattered (<20-10 - 4%)	A15	(5-2 m)	B8				D8	herbaceous (Perennial)	E8	2nd layer	F8		F10	(4-0.5 m)	G10
Mosses	A9	scattered (4-1%)	A16	(2-0.5 m)	B9				D9		E9	2nd layer	F9		F10	(3-0.3 m)	G4
				(<0.5 m)	B10				D10		E10	2nd layer	F10		F10	(3-0.3 m)	G11
				(0-0.01 m)	B4				D11		E11	2nd layer	F11		F10	(0.3-0.03 m)	G12
				(3-0.3 m)	B13				D12		E12	2nd layer	F12		F10	(3-0.3 m)	G11
				(3-0.8 m)	B11				D13		E13	2nd layer	F13		F10	(3-0.3 m)	G11
				(0.8-0.3 m)	B12				D14		E14	2nd layer	F14		F10	(0.3-0.03 m)	G12
				(0.03-0.03 m)	B13				D15		E15	2nd layer	F15		F10	(0.03-0.03 m)	G12

A3.A10.B2.C1.D1.E1.F1.F9.G7

Trees closed canopy (>70-60 %) tall (14-30 m) continuous broadleaved evergreen with 2nd layer supporting open canopy 7-3 m in height.

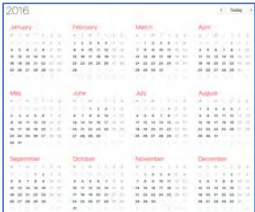




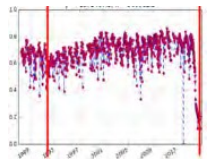
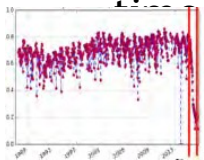
EODES



Independence of scale



Adaptable in time

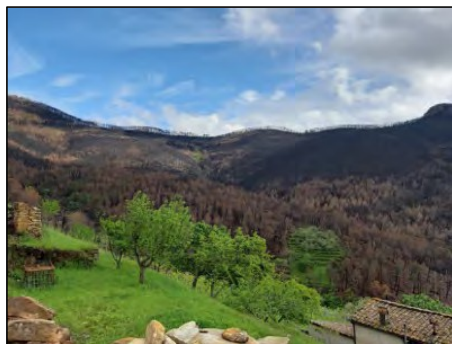
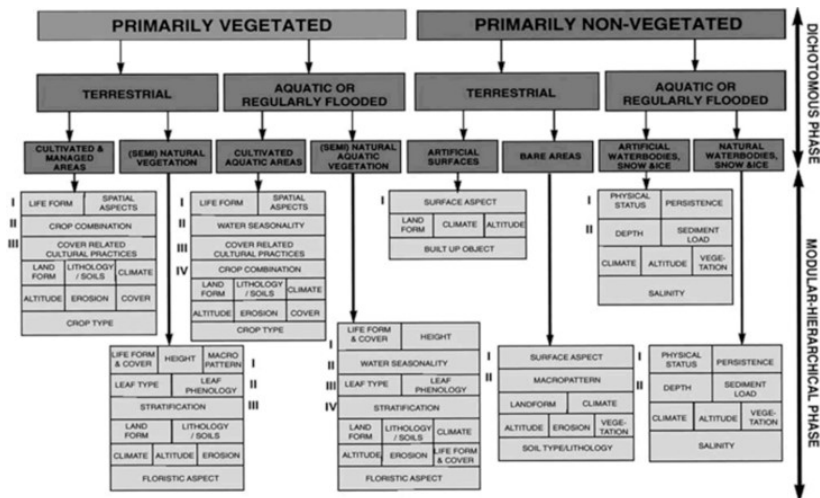


Built from

Integrating Environmental Variables into Land Cover Change

Classifications

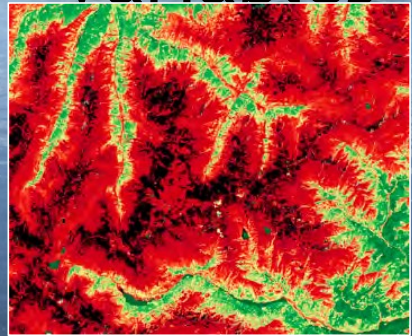
Classifications Generated from Environmental Variables according to the Food and Agriculture Organization (FAO) Land Cover Classification System (LCCS) and derived from **Environmental Variables** with unit quantities (e.g., m, %, days)



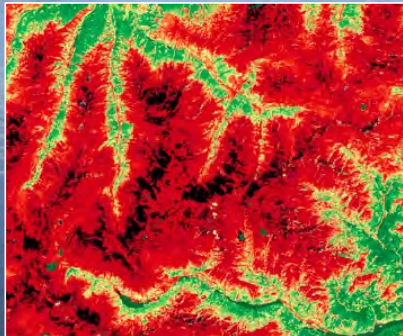
Trees closed canopy (>70-60 %) tall (14-30 m) continuous needle-leaved evergreen with 2nd layer supporting open canopy 7-3 m in height; Above Ground Biomass of 210 Mg ha⁻¹; dominated by *Pinus sylvestris*)

Trees closed canopy (< 20 %) tall (14-30 m) continuous needle-leaved evergreen (Above Ground Biomass of 157 Mg ha⁻¹; dominated by *Pinus sylvestris* (e.g. following wildfires)

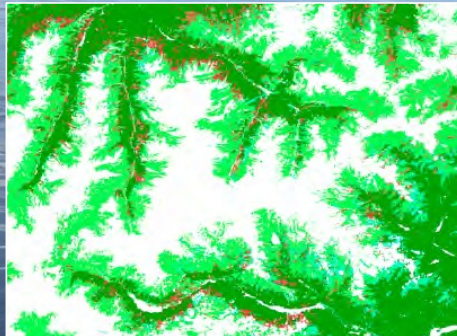
Detection of Change Through Integration of Environmental Variables



Tree cover density (2000)



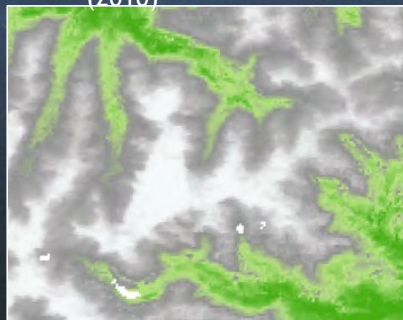
Tree cover density (2010)



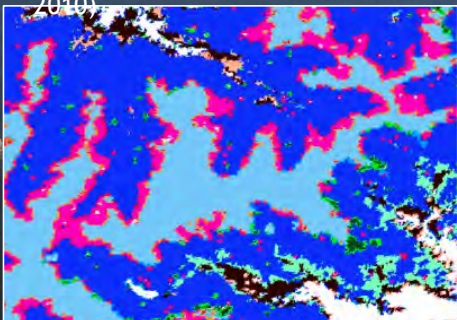
Tree cover density changes (2000-2010)



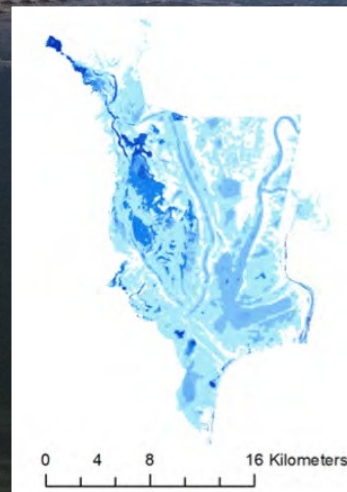
Snow hydroperiod (2015/16)



Snow hydroperiod (2016/17)



Snow hydroperiod change (2016/17)



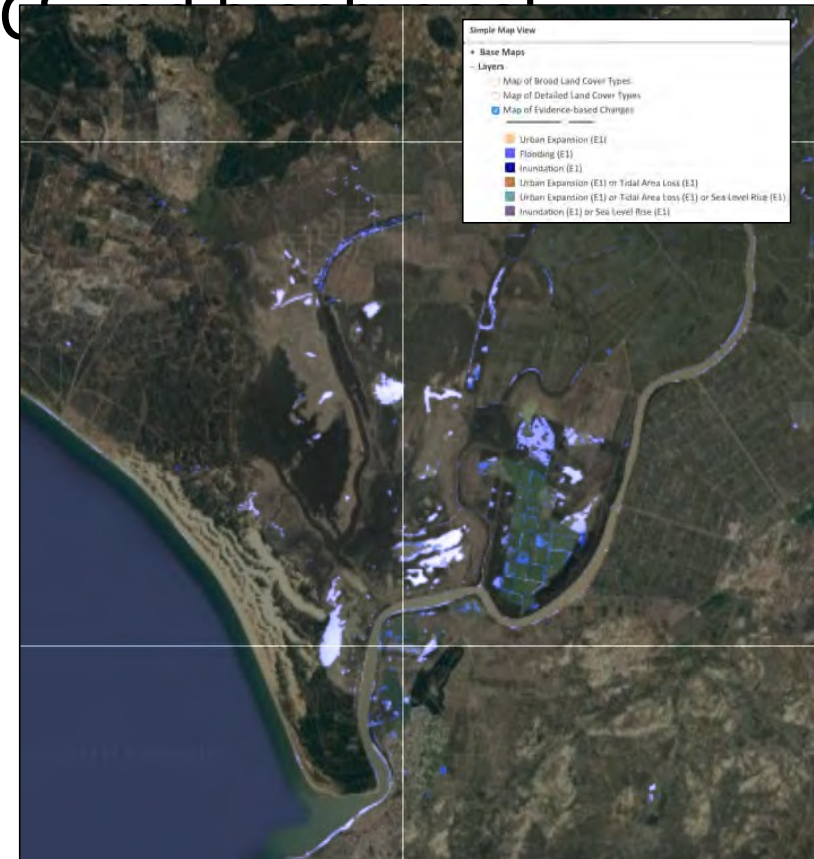
Change based on Evidence (Flooding) 2016/17



Automated Detection of Change with Alerts

(Based on Weighted Evidence of LCCs change)

Natural Vegetation	Agriculture	Urban	Water	Bare Ground
Deforestation	Herbicide Spraying	Road Abandonment	Flooding	Lava Flows
Degradation	Burning	Greening	Inundation	Sedimentation
Select Logging	Cutting	Browning	Drying Event	Ice Melt
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	Snow Fall	
Thickening	Agri. Water Supp	Comm. Installation	Snow Melt	
Encroachment	Agri. Time Factor	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		Tidal Loss	
	Plantation Growth			
	Grass Fertilization			
	Orchard planting			
	Slurry or sediment spreading			
	Liming			



Layers used for evidence-based detection of change (deforestation)

Level 3 Change: Chg_L3

Level 4 Change: Chg_L4_Lifeform, Chg_L4_MCanopyco,

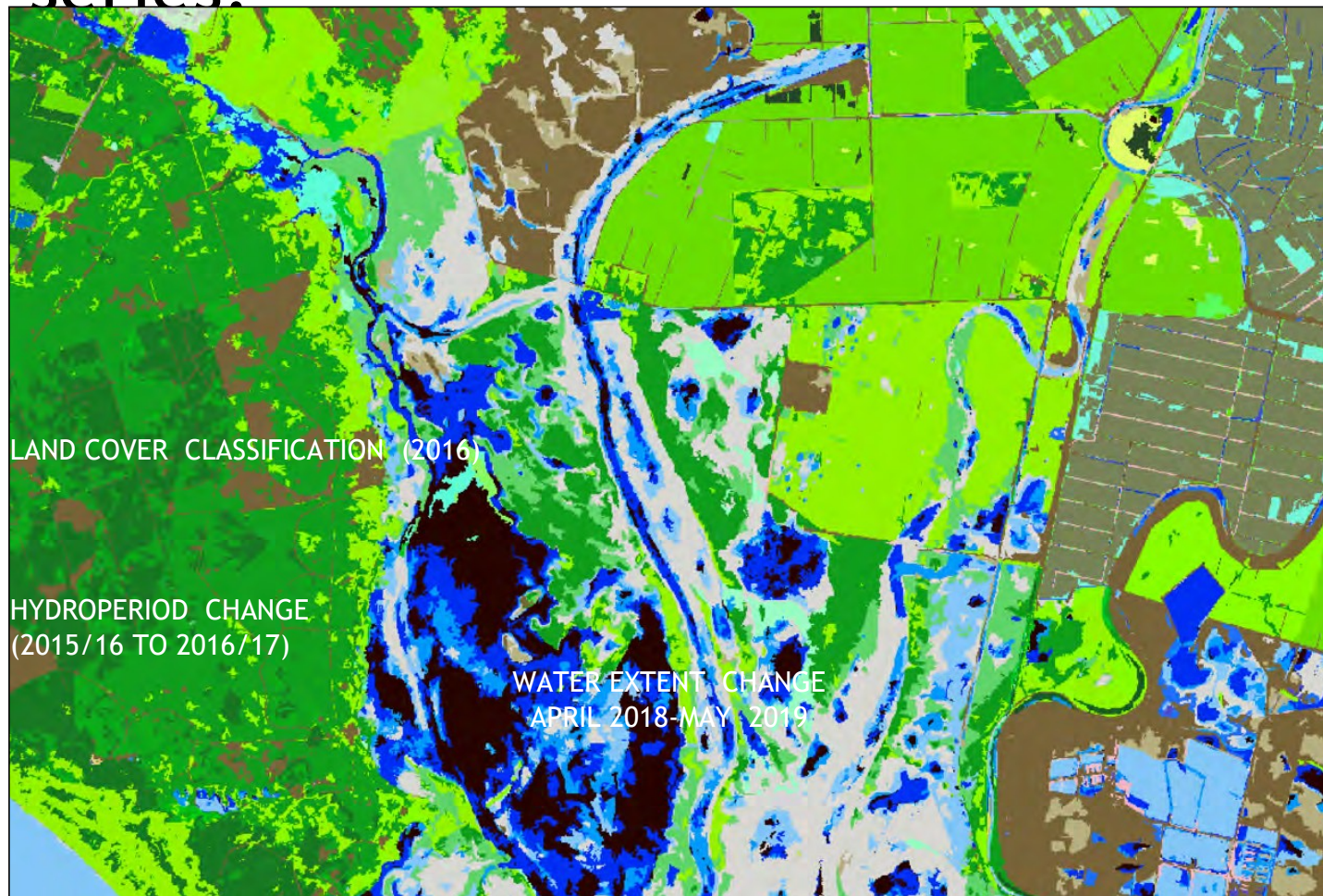
Changes in Environmental Variables: P1AvPlantspD, P1AvAGB,

P1AvCanopyco, P1AvCanopyht, P2AvPlantspD, P2AvAGB, P2AvCanopyco,

P2AvCanopyht



Comprehensive Detection of Change Over Multiple Time-series.

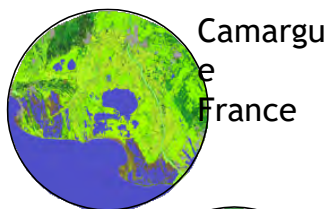


EXAMPLE FROM DONANA NATIONAL PARK, SPAIN, USING SENTINEL-2

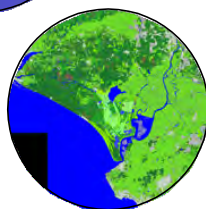
Earth Observation Data for Ecosystem Monitoring

(EODESM)

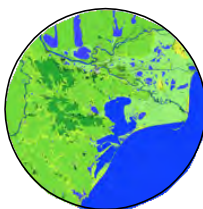
- Consistent classification of land covers for any site globally using the FAO LCCS-2 taxonomy.
- Inclusion of biophysical layers (thematic and continuous), including time-series (e.g., hydroperiod, snow cover, phenology), both internal and external to the classification.
- Detection of change in LCCS codes and environmental variables
- Evidence-based approach to change detection.
- Attribution of change to a potential cause and consequence.
- Capacity to translate LCCS to Habitat and other taxonomies.



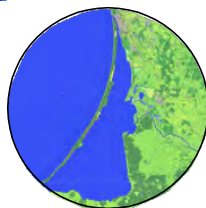
Camargue
France



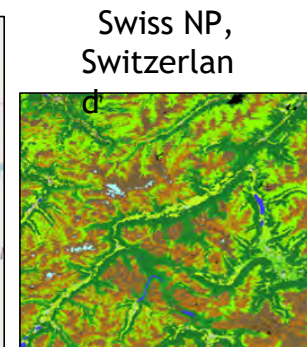
Donana
Spain



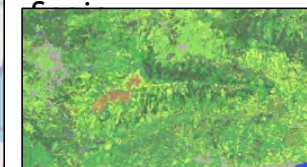
Danube
Romania /
Ukraine



Curonia
Lagoon
Lithuania



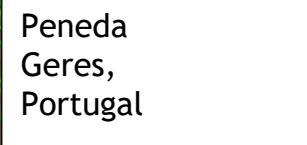
Swiss NP,
Switzerland



Sierra Nevada,
Spain



Murgia Alta,
Italy

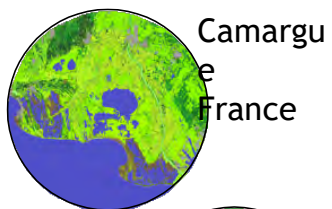


Peneda
Geres,
Portugal

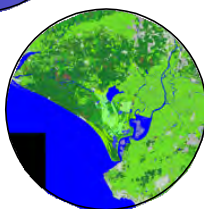
Earth Observation Data for Ecosystem Monitoring

(EODESM)

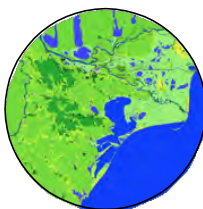
- Selection of any data layers into the classification, no matter how derived and including knowledge.
- Inclusion of local to global layers
- Applicable at any spatial scale
- Facilitates comparison between any two time-separated periods and considers dense time series.
- Can be replicated with in situ data and has dedicated Mobile App
- Able to ingest all forms of earth observation and other geographical (spatial) data.
- Simple to use, understand and implement
- Is informative, utilizes ecological knowledge, and allows for targeted applications.
- Open source software (Python, RSGISLib, KEA, EODESM, ARCSI)



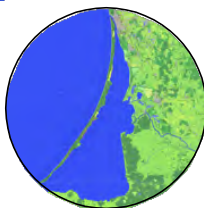
Camargue
France



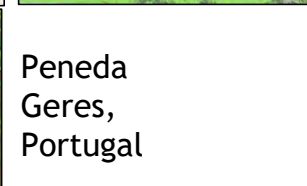
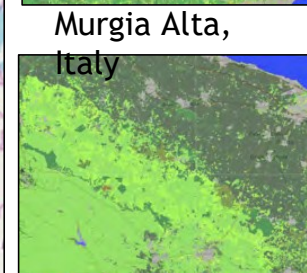
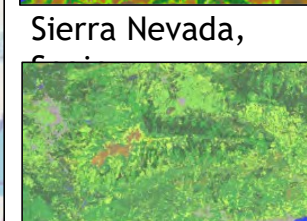
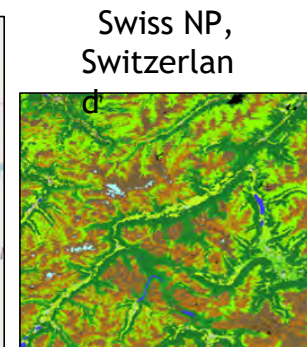
Donana
Spain



Danube
Romania /
Ukraine



Curonia
Lagoon
Lithuania



Swiss NP,
Switzerland

Sierra Nevada,
Spain

Murgia Alta,
Italy

Peneda
Geres,
Portugal

EODESM within Ecopotential's Virtual

Laboratory


<https://vlab.geodab.eu>

ECOPOTENTIAL VLab GUI BETA
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 affected 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.





ECOPOTENTIAL VLab GUI BETA
Developed by

ECOPOTENTIAL DOMAIN **WORKFLOWS** MODEL UPLOAD

Workflows Under test

EODESM - Earth Observation Data for Ecosystem Monitoring

All stable



EODESM - Earth Observation Data for Ecosystem Monitoring

Description

The EODESM system classifies land covers according to the Food and Agricultural Organisation's (FAO's) Land Cover Classification System (LCCS2) taxonomy. The EODESM system can use, as input, any remote sensing or other spatial datasets (including modelled output) and at any scale of choosing. The system is designed for use by a wide range of users and is entirely open source and freely available. This document provides a simple summary allowing users to access and easily use the EODESM system.

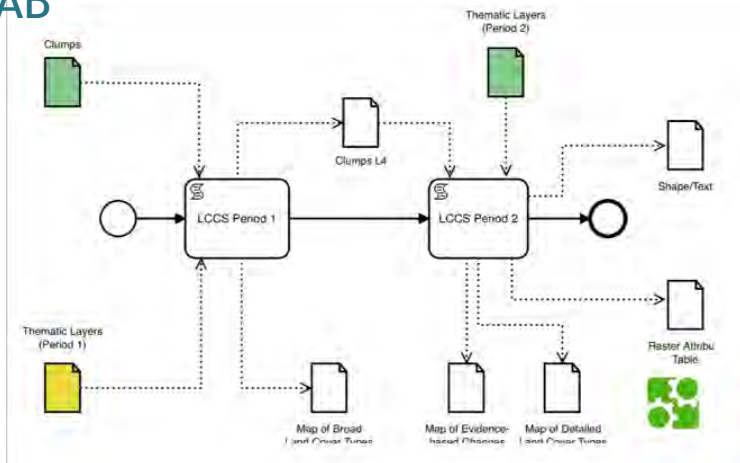


This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 641762

ECOPOTENTIAL 4th General meeting, 20-24 May 2019, Rome (Italy)



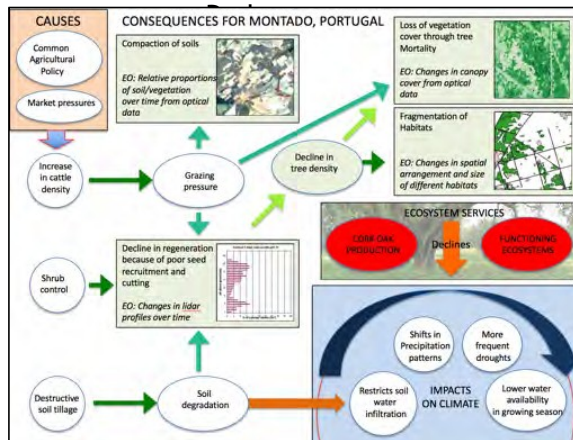
THE ECOPOTENTIAL VIRTUAL LAB



Show Output (available after processing completed successfully)



LCCS Level 4 Classification (P1) Swiss National



Input

S	P1LReform_0	P1LReform_1	P1LReform_3	P1LReform_4	P1LeafType	P1LeafType_0	P1LeafType_1
0	-1	0.00	0.00	0.00	-1	0.00	0.00
1	3	0.00	0.92	0.98	1	0.25	0.76
2	4	0.02	0.48	0.50	1	0.28	0.72

Environmental Variables

Variable	P1AvAGB	P1AvChla	P1AvNitrogen	P1AvLignin	P1AvVegmos
32.39	4.62	0.00	0.00	0.00	0.00
42.08	5.54	0.00	0.00	0.00	0.00
26.81	5.57	0.00	0.00	0.00	0.00

LCCS Classification

P1_LCCS	P1_LCCSdescription
A24.A3.A20_A21.B2.B6.D1.E1	Broadleaved PhenEvergreen Closed to Open (40-100%) Medium Trees on Flooded land
A24.A3.A20_A21.B2.B6.D1.E1	Broadleaved PhenEvergreen Closed to Open (40-100%) Medium Trees on Flooded land
A24.A3.A20_A21.B2.B6.D1.E1	Broadleaved PhenEvergreen Closed to Open (40-100%) Medium Trees on Flooded land
A24.A3.A20_A21.B2.B6.D1.E1	Broadleaved PhenEvergreen Closed to Open (40-100%) Medium Trees on Flooded land

LCCS Classification

P2_LCCS	P2_LCCSdescription
A24.A3.A20_A21.B2.B7.D1	Broadleaved Closed to Open (40-100%) Low Trees on Flooded land
A12.A3.A20_A21.B10.D1	Broadleaved Closed to Open (40-100%) Trees
B26.A1.B2	Natural Non-Perennial waterbodies
B26.A1.B2	Natural Non-Perennial waterbodies

Changes in LCCS classes (P1 and P2)

Chg_L1	Chg_L2	Chg_L3	Chg_L4	Chg_L4_MCanopy	Chg_L4_MCanopyHt
NAV-NAV	Remained as...	NA	Trees (14-7 m)(B6) to Shrubs (< 0.5 m)(B10)		
NAV-NAV	Remained as...	NA	Shrubs (5-3 m)(B8) to Forbs and/or graminoids (3-0.8 m)(B7)		
NS-NTV	Remained as...	NA	NA		
NTV-NTV	Remained as...	NA	Trees (7-3 m)(B7) to Shrubs (< 0.5 m)(B10)		

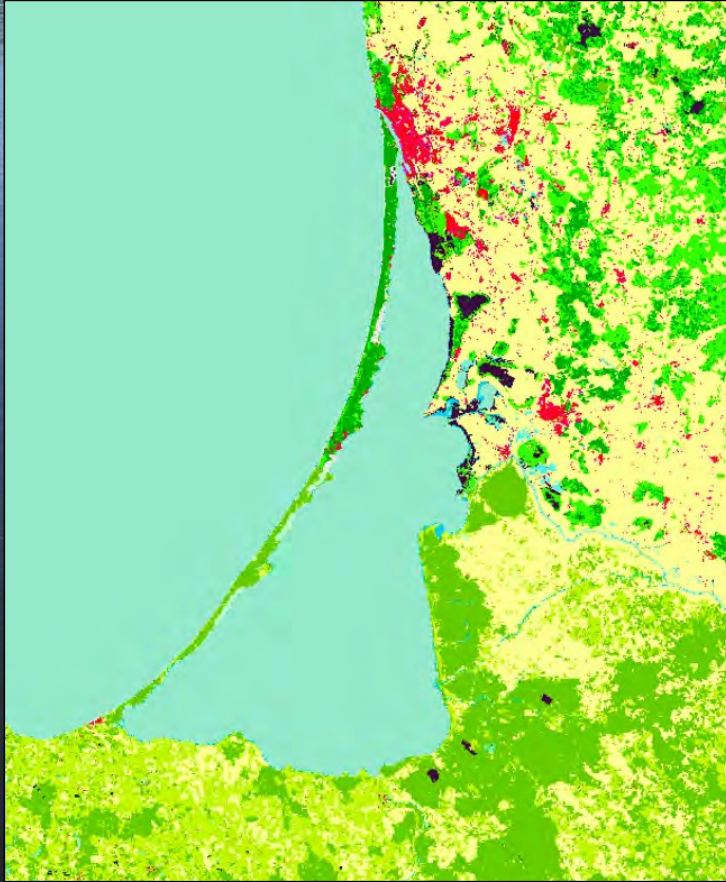
Evidence-based change alerts

TidalLoss	SeaLevelRise	Sedimentation	Erosion
Tidal Area Loss (E1)	Sea Level Rise (E1)	NA	NA
Tidal Area Loss (E1)	Sea Level Rise (E1)	NA	NA
NA	NA	NA	NA
NA	NA	NA	NA

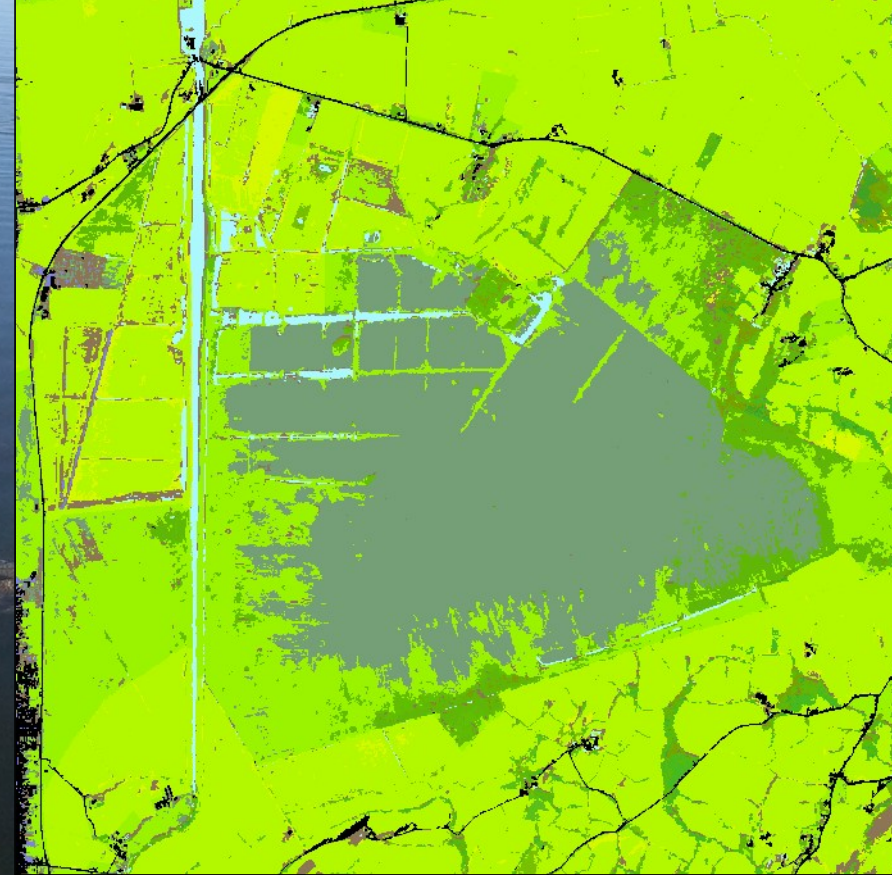
- Causes and consequences
- Movement of materials and gases
- Implications for policy, society & economy

Translation to Other

Terminologies



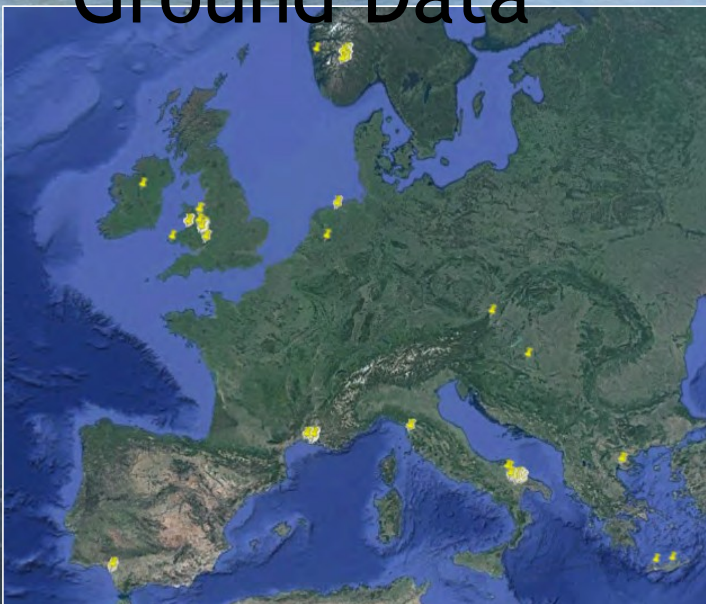
To Corine Land
Cover



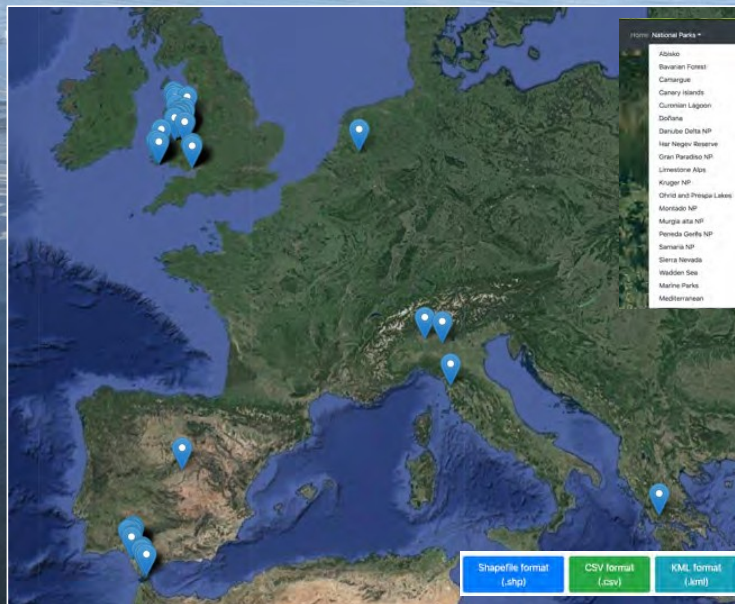
To General Habitat
Categories



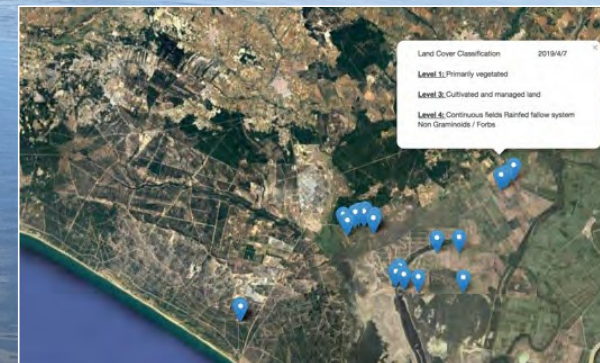
Near Real Time Collection and Delivery of Ground Data



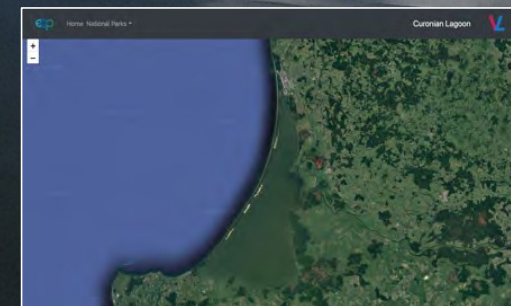
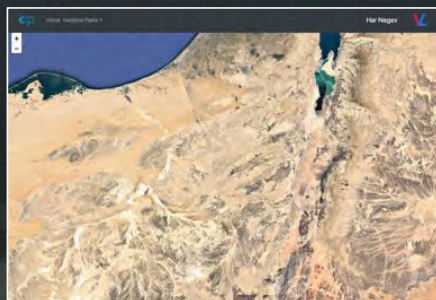
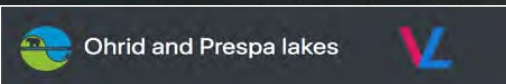
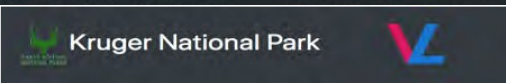
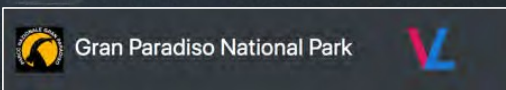
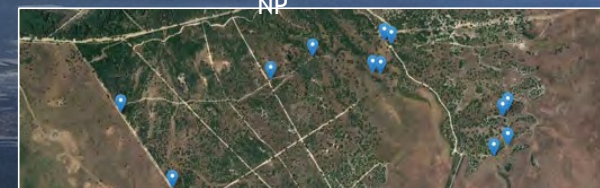
Demonstration of near real time data collection



Implementation with easy data access (including for protected areas)



Donana NP



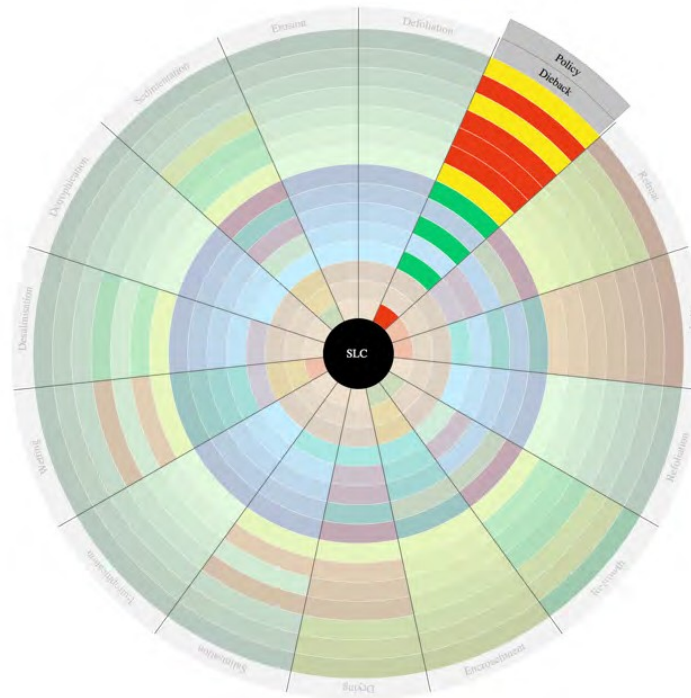
Policy, Planning and Future

UN Sustainable Development Goals



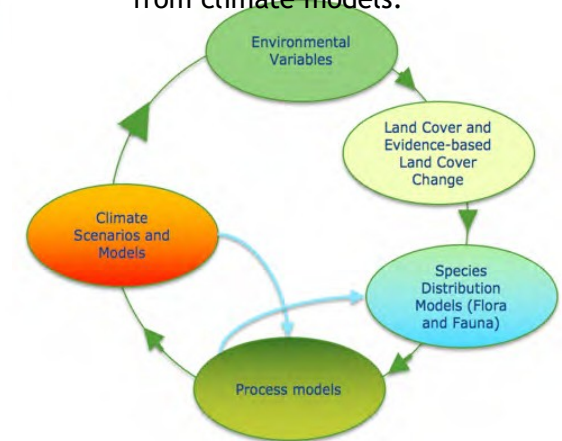
Change in LCCS Level 3 Categories

		PERIOD 1							
		CTV	NTV	CAV	NAV	AS	BS	AW	NW
PERIOD 2	CTV	Stable	Agricultural expansion	Agriculture drainage	Wetland drainage	Withdrawal of settlements	Agriculture expansion	Wetland drainage	Wetland drainage
	NTV	Afforestation	Stable	Afforestation/Abandonment	Wetland loss	Withdrawal of settlements	Vegetation establishment	Wetland drainage	Vegetation encroachment
	CAV	Change in agriculture	Agricultural expansion	Stable	Wetland establishment	Withdrawal of settlements	Vegetation establishment	Vegetation establishment	Wetland drainage
	NAV	Afforestation	Inundation	Vegetation establishment	Stable	Withdrawal of settlements	Vegetation establishment	Vegetation establishment	Vegetation encroachment
	AS	Urban expansion	Urban expansion	Urban expansion	Urban expansion	Stable	Urban expansion	Urban expansion	Urban expansion
	BS	Vegetation loss	Vegetation loss	Vegetation loss	Vegetation loss	Withdrawal of settlements	Stable	Wetland drainage	Wetland drainage
	AW	Inundation	Inundation	Inundation	Inundation	Inundation	Inundation	Stable	Urban expansion
	NW	Inundation	Inundation	Inundation	Inundation	Inundation	Inundation	Wetland establishment	Stable

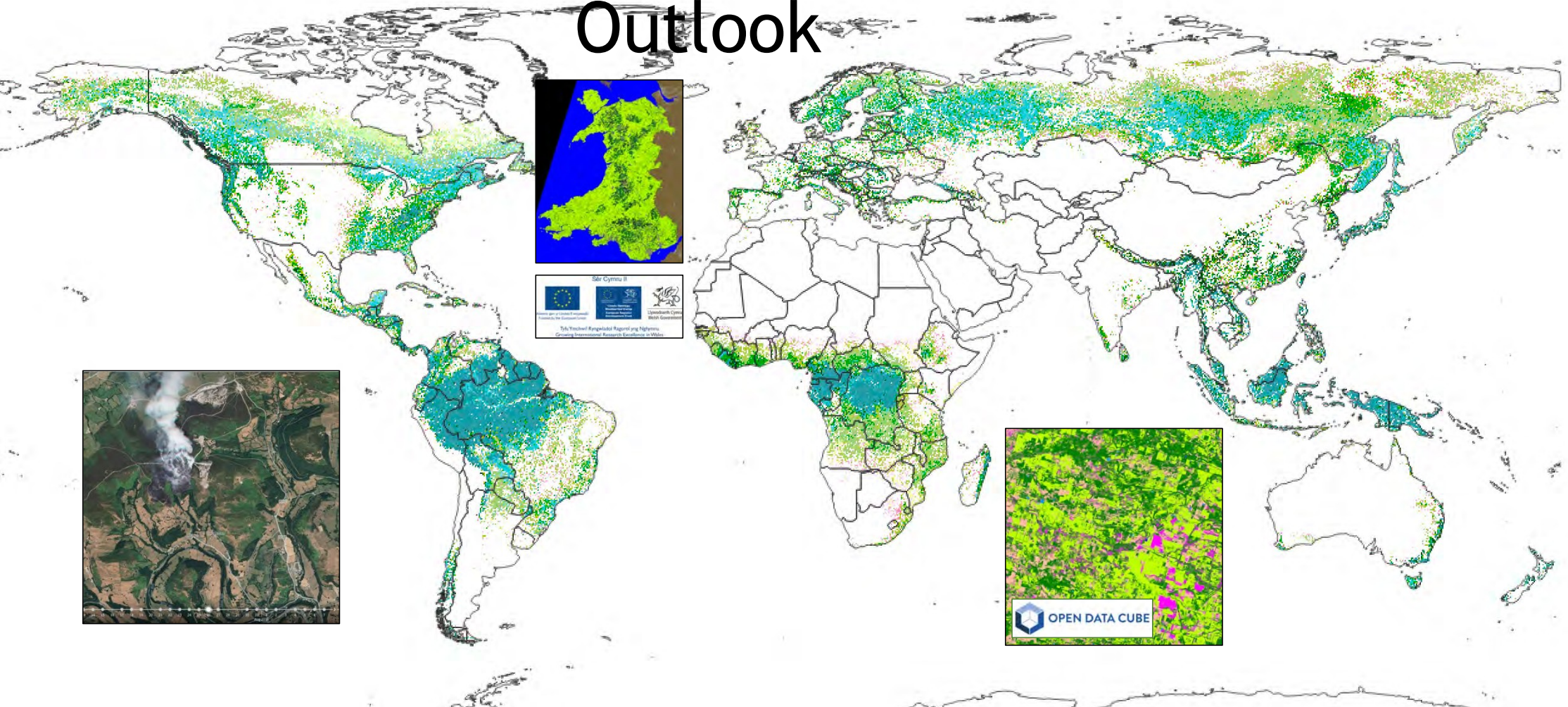


Future Predictions

- Environmental variables can be used as direct input to species distribution models.
- Ability to predict future land cover using environmental variables predicted from process models (e.g., plant growth, hydrological).
- Changes in environmental variables (e.g., plant growth, sea level rise, glacial processes) can be predicted from climate models.



Future Outlook

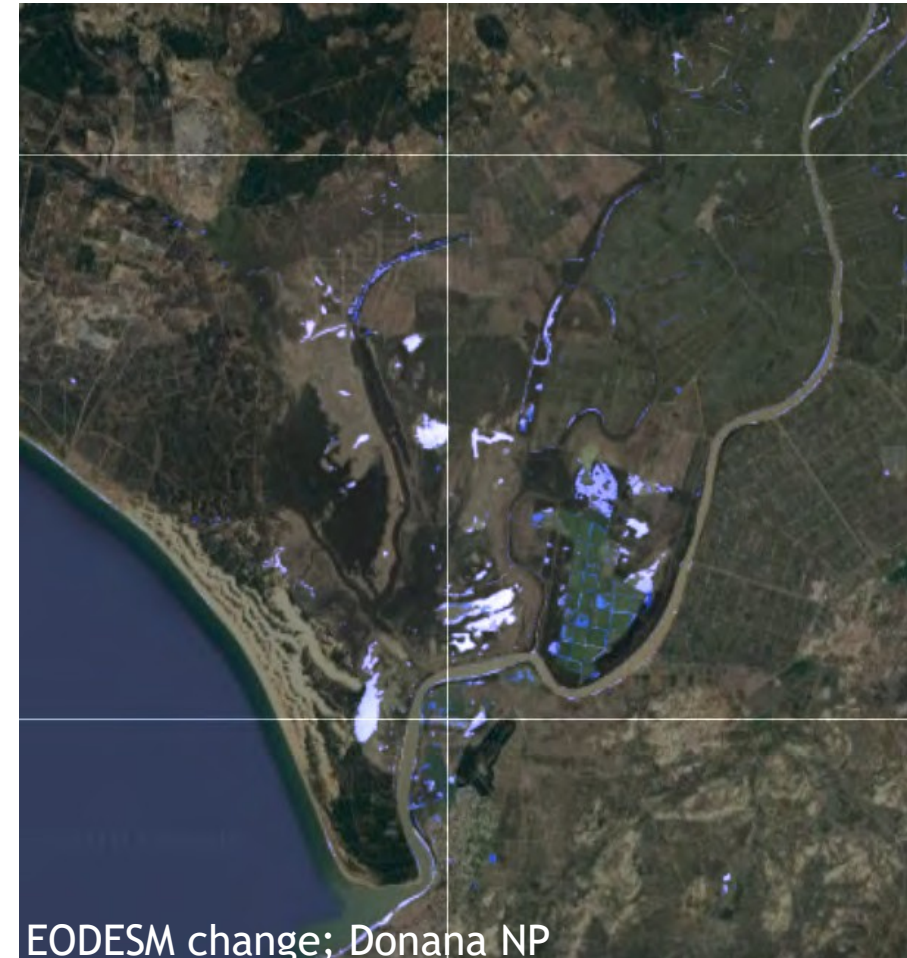
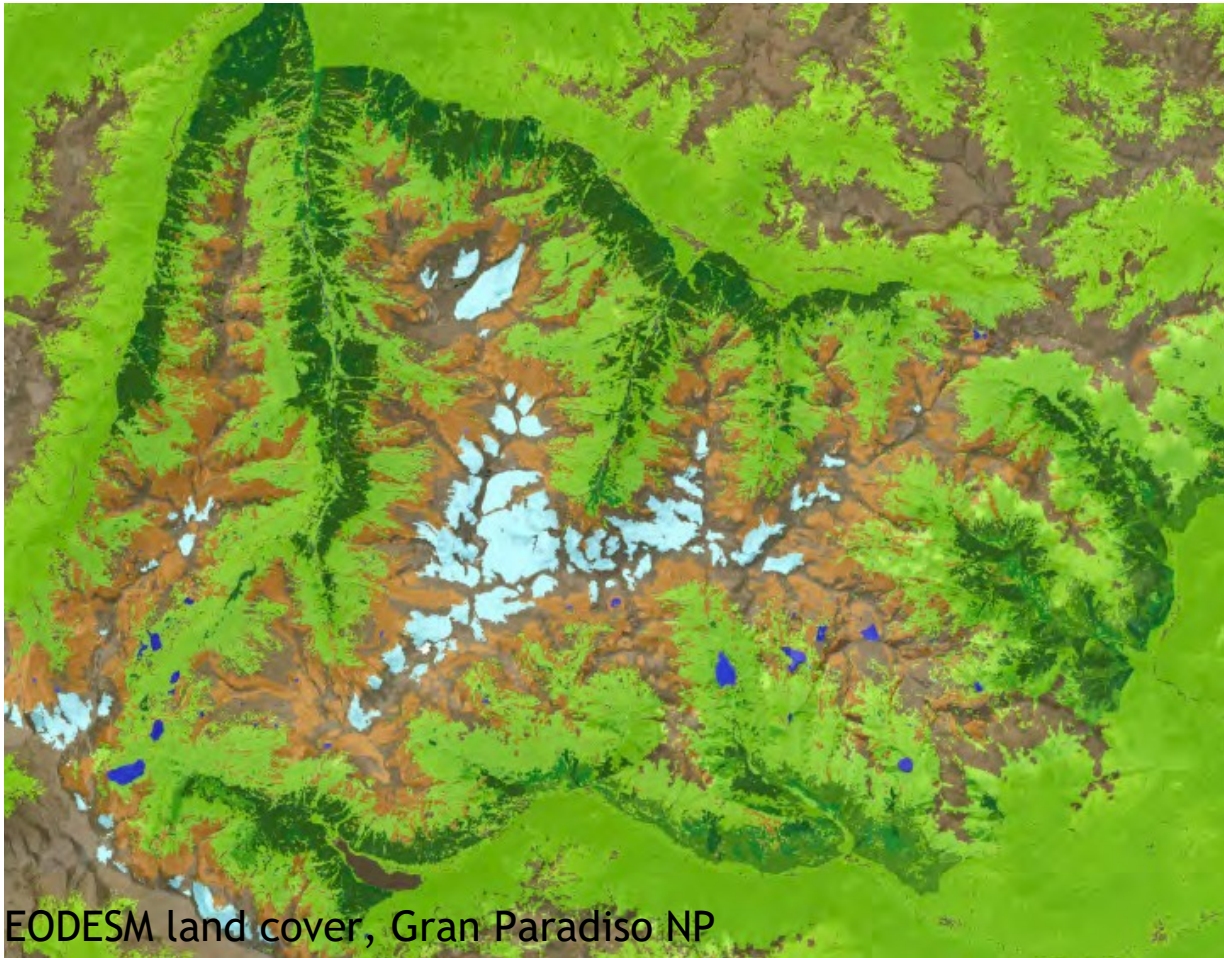


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ECOPOENTIAL 4th General meeting, 20-24 May 2019, Rome (Italy)



The Earth Observation Data for Ecosystem Monitoring (EODESM)



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ECOPOTENTIAL 4th General meeting, 20-24 May 2019, Rome (Italy)

Annex II

Exploring the potential of Earth Observations Data Cube for monitoring a protected area



***Ioannis Manakos¹, Danai Aristeridou¹, Georgios Kordelas¹,
Kalliroi Marini¹, Gregory Giuliani², Yaniss Guigoz², Bruno Chatenoux²,
Nektarios Chrysoulakis³, Dimitris Poursanidis³**

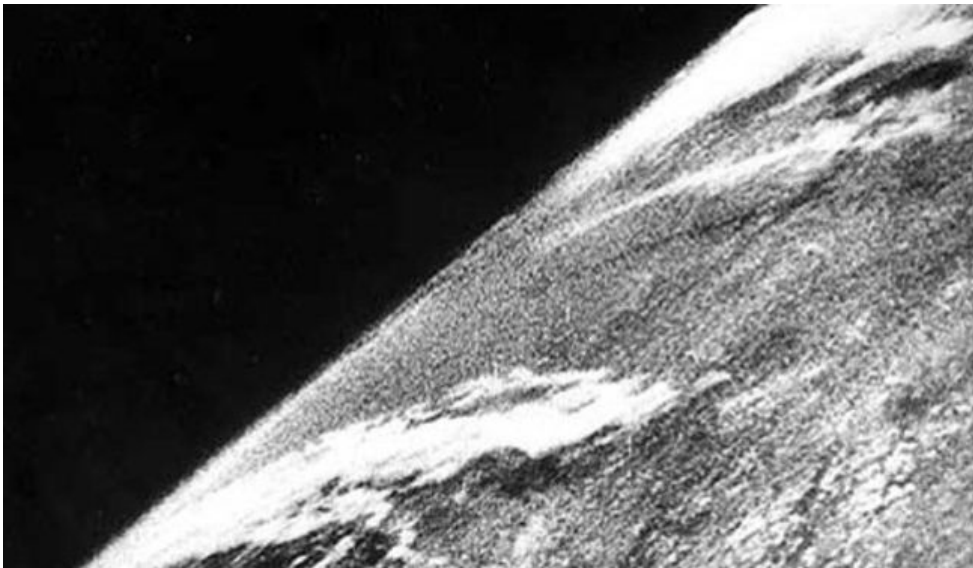
¹Centre for Research and Technology Hellas/Information Technologies Institute, Greece

²United Nations Environment Programme/GRID – Geneva & University of Geneva, Switzerland

³Foundation for Research and Technology Hellas, Greece



Satellite data (1)



NOW

✓ By the end of 2018, a total of 13,049,181 Copernicus Sentinel products had been published on the Open Hub since the start of operations, with a total data volume of **9.69 PiB**.

✓ More than **1,000 scenes** from Landsat 7 and Landsat 8 are added to the USGS archive each day.



<https://earth.esa.int>
2018 Sentinel Data Access Annual Report

In 1946, rocket-borne cameras **gave us our first look** at Earth from beyond the atmosphere.

Satellite data (2)

The volume of the available satellite data has **increased significantly**. This information could help us to create products with great impact to important environmental, economic and social challenges, including at the local, regional and global scales.



Issue 1: in order to process them scientific knowledge is needed

Issue 2: lack of resources - infrastructure

About the Open Data Cube (1)

What is the Open Data Cube?



The Open Data Cube (ODC) is an **Open Source Geospatial Data Management and Analysis Software project** that helps you harness the power of satellite data in an efficient and easy way.

Purpose

The ODC's objective is to increase the **value and impact of global Earth observation satellite data**. It is based on a an open and freely accessible exploitation architecture.

"The ODC seeks to foster a community to develop, sustain, and grow the technology and the breadth and depth of its applications for societal benefit."

➔ <https://www.opendatacube.org/>

About the Open Data Cube (2)

Where does it come from?

The **Committee on Earth Observation Satellites** (CEOS) is a founding partner in the Open Data Cube (ODC).

This project was born out of the work done under the "Unlocking the Landsat Archive" and the **Australian Geoscience Data Cube** (AGDC) projects.

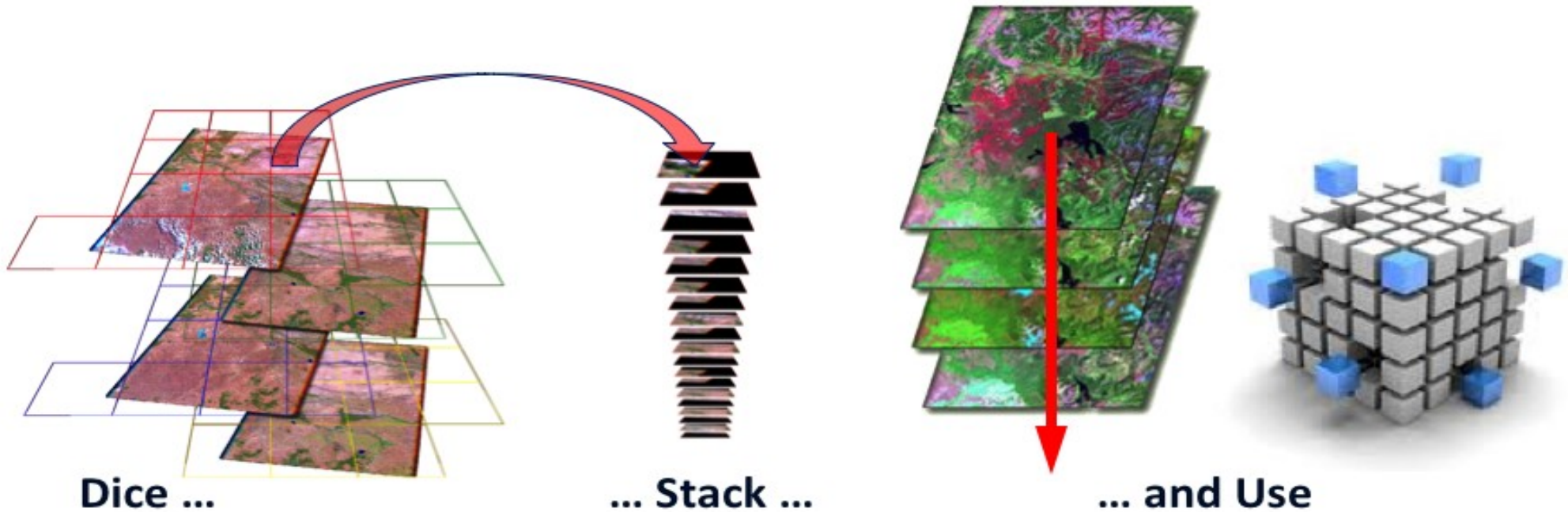
What does it provide?

ODC allows **analysis-ready satellite data** to be packaged in "cubes" in order to minimize data preparation complexity. It also yields rapid results, and utilizes an international global community of contributors.

 <http://ceos-cube.org/>

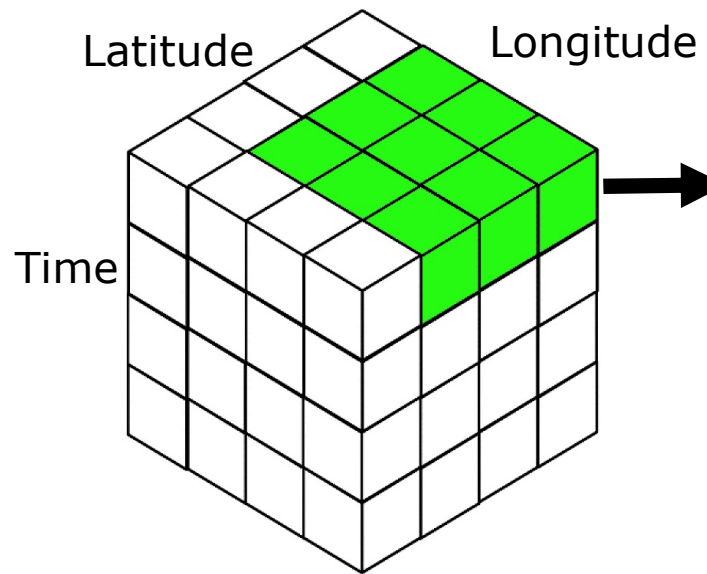
How Data Cubes work (1)

Data cubes are time-series multi-dimensional (space, time, data type) stack of spatially aligned pixels. Data cubes include modules which can be used to perform analysis in matters such as Urbanization, Water Detection, etc.



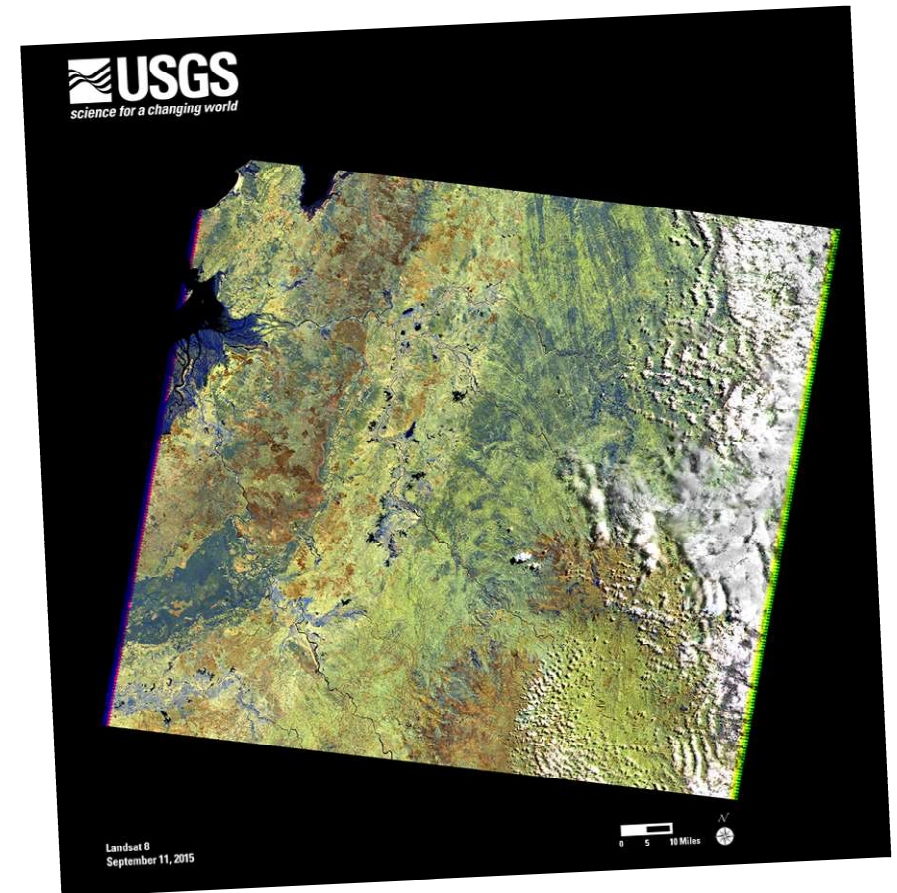
➔ Australian Geoscience Data Cube <https://www.opendatacube.org/>

Sampling a Data Cube (1)



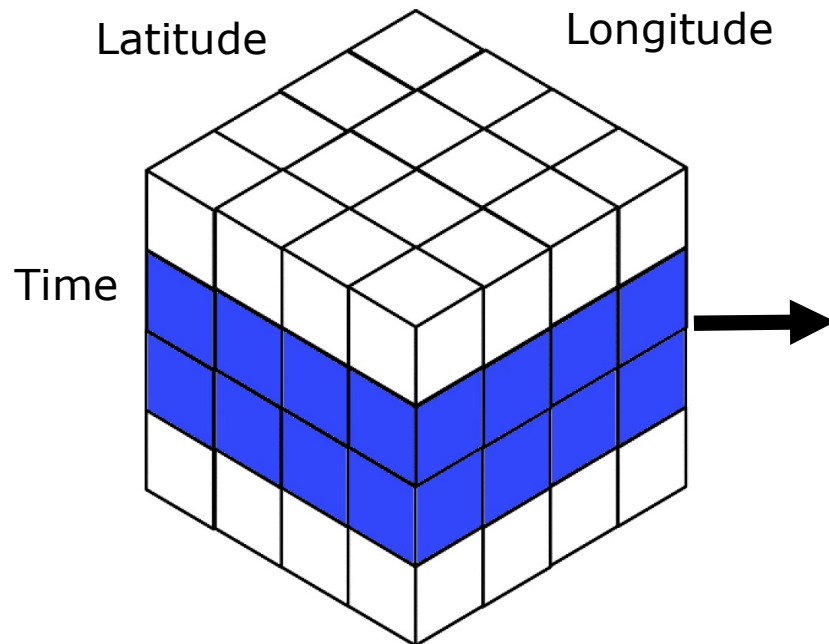
A single time slice, similar to a standard **“scene”** can be used to assess a single point in time

Pixels in the Data Cube are processed, aligned, and compressed and ready for data analysis

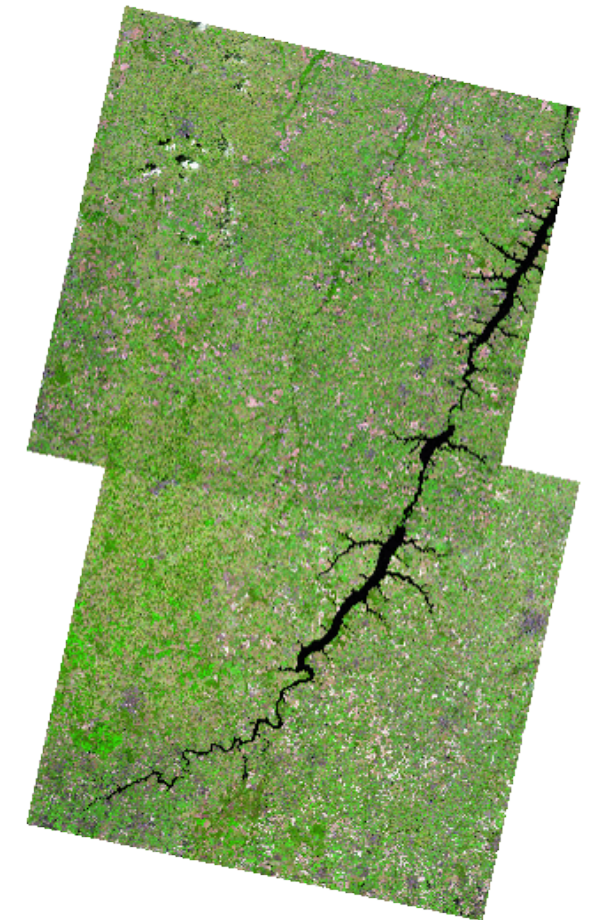


➔ Adapted from CEOS

Sampling a Data Cube (2)



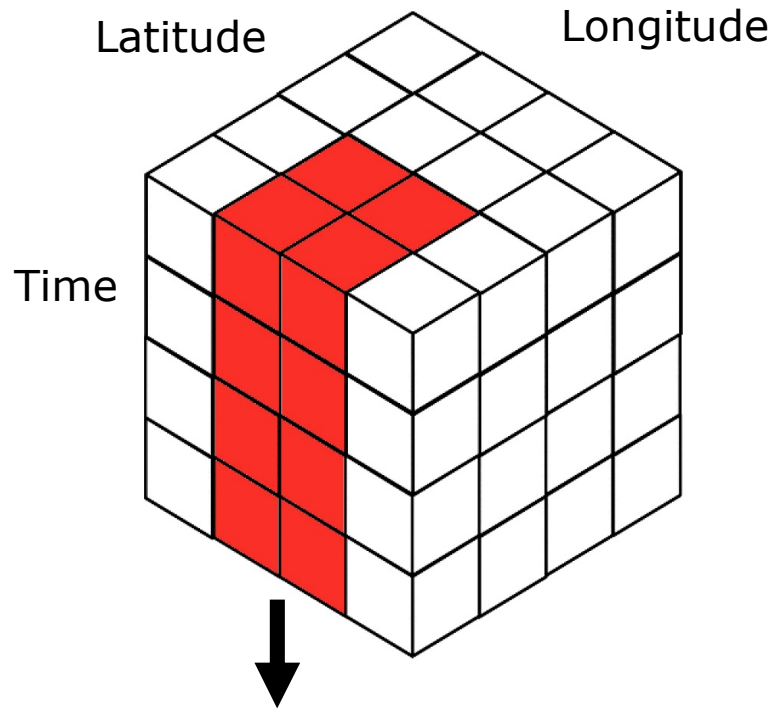
Several time slices can be combined into one to form a "**Mosaic**". This is often used to reduce clouds or create seasonal or annual images.



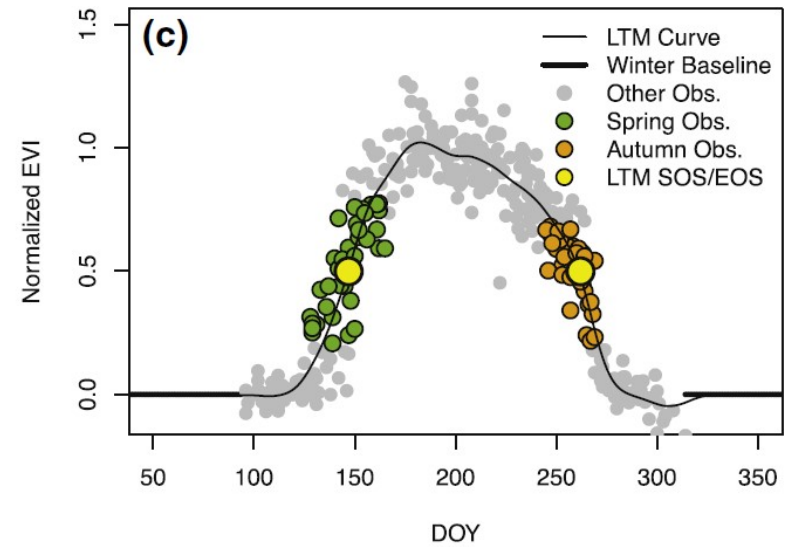
Typical Mosaics ... Most/Least Recent Pixel, Mean/Median, Geomedian, Min/Max NDVI

➔ Adapted from CEOS

Sampling a Data Cube (3)



Examples of **Time Series** analyses include: Land Change (PyCCD), Water Change (WOFS), Parameter variation along a transect (Hovmoller plot)



Time Series analyses consider the variation of data over time to assess change

Data Cube capabilities (1)

Data cube allows the user to easily calculate **metrics**, including:

Data cube modules for Analysis Ready Data

Land

- Urbanization
- Spectral Indices
- Slip
- NDVI anomaly
- Fractional Cover

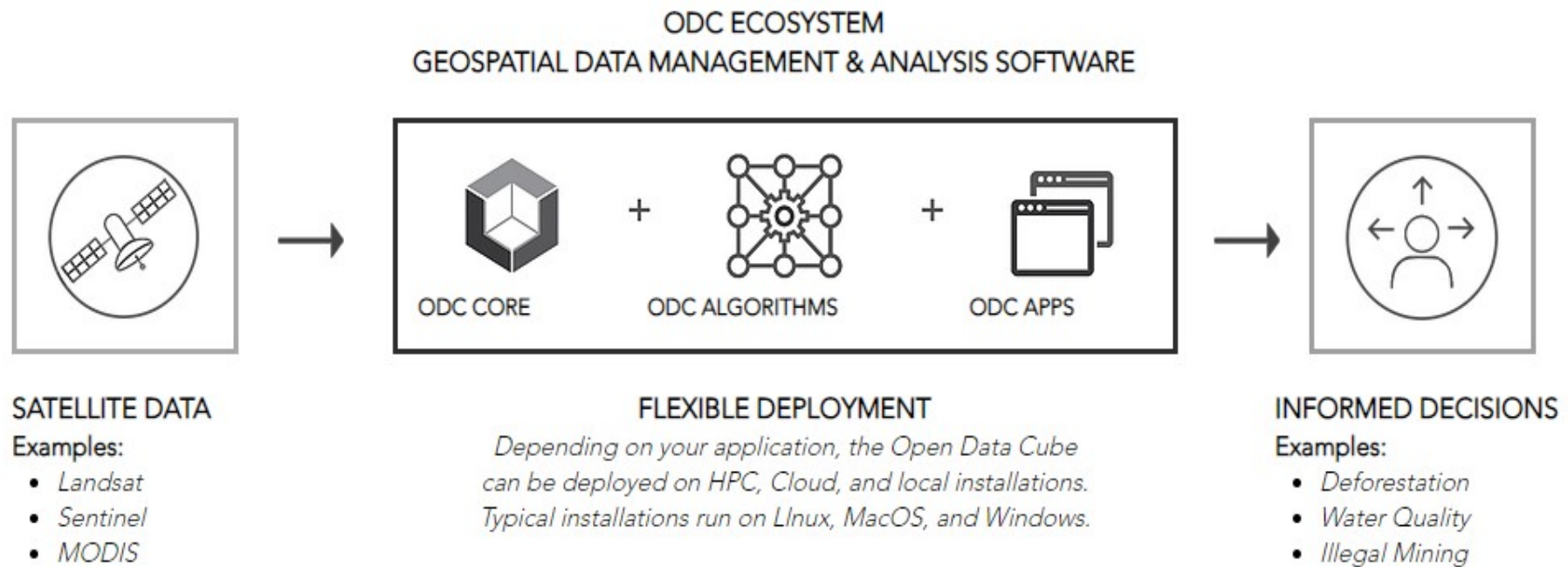
Water

- Coastal Change
- Water Detection
- Water Quality TSM

General

- Cloud Coverage
- Custom Mosaic

Data Cube capabilities (2)



➔ <https://www.opendatacube.org/>

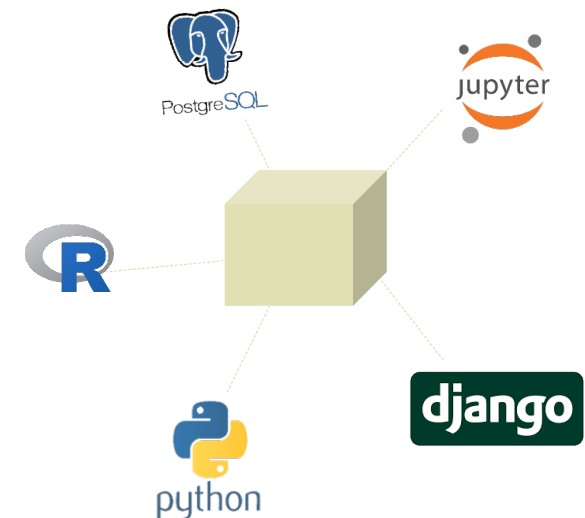
Data Cube Technologies

Technologies

The Data cube is an open source software (Apache 2.0 license). At its core, the Open Data Cube (ODC) is a set of Python libraries and PostgreSQL database that helps you work with geospatial raster data.

In summary:

- ✓ Django administration panel
- ✓ Jupyter notebooks
- ✓ PostgreSQL database
- ✓ Custom scripts – modules written in R and Python



Operating Data Cubes

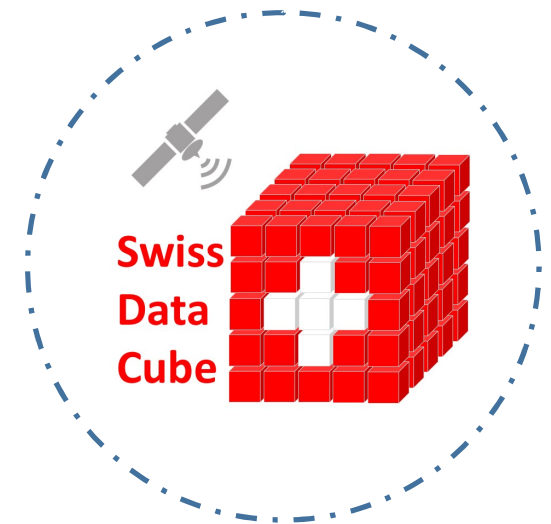
 Digital Earth Australia



 Digital Earth Africa



 Swiss Data Cube



... and many others Data Cubes in development

Swiss Data Cube (1)

- Swiss Data Cube is powered by University of Geneva and UN Environment/GRID-Geneva. It contains Landsat 5,7,8 and Sentinel 1, 2 collection in Analysis Ready Data for the whole Switzerland.
- Based on the results from the analysis performed within the Swiss Data Cube, a new product was created, the **Swiss Data Cube Viewer**.

This new product contains:

- **Cloud-free mosaic of Switzerland** for the year 2016 (Sensor Landsat 8 Algorithm: Custom Mosaic Method: Median)
- **Snow Cover of Switzerland for winter month Years: 1995 - 2005** (Sensor: Landsat 5, 7 Algorithm: Snow Observations from Space)
- **Snow Cover of Switzerland for winter month Years: 2005 - 2017** (Sensor: Landsat 5, 7 Algorithm: Snow Observations from Space)
- **Snow Cover Change**: This layer is the difference between the two periods (1995-2005; 2005-2017) showing gain and losses of snow over the last two decades for winter month.

 <http://www.swissdatacube.ch>

SWISS DATA CUBE *in Numbers*

A unique Analysis Ready Data Archive

Updated every week!

35 years

FROM 1984 to 2019

7 sensors

LANDSAT 5/7/8;
SENTINEL-1/2 A-B

10-30-90m

PIXEL RESOLUTION

> 450 millions

PIXELS

> 200 billions

OBSERVATIONS

~ 10000 images

INGESTED

~6 TB

ANALYSIS READY DATA

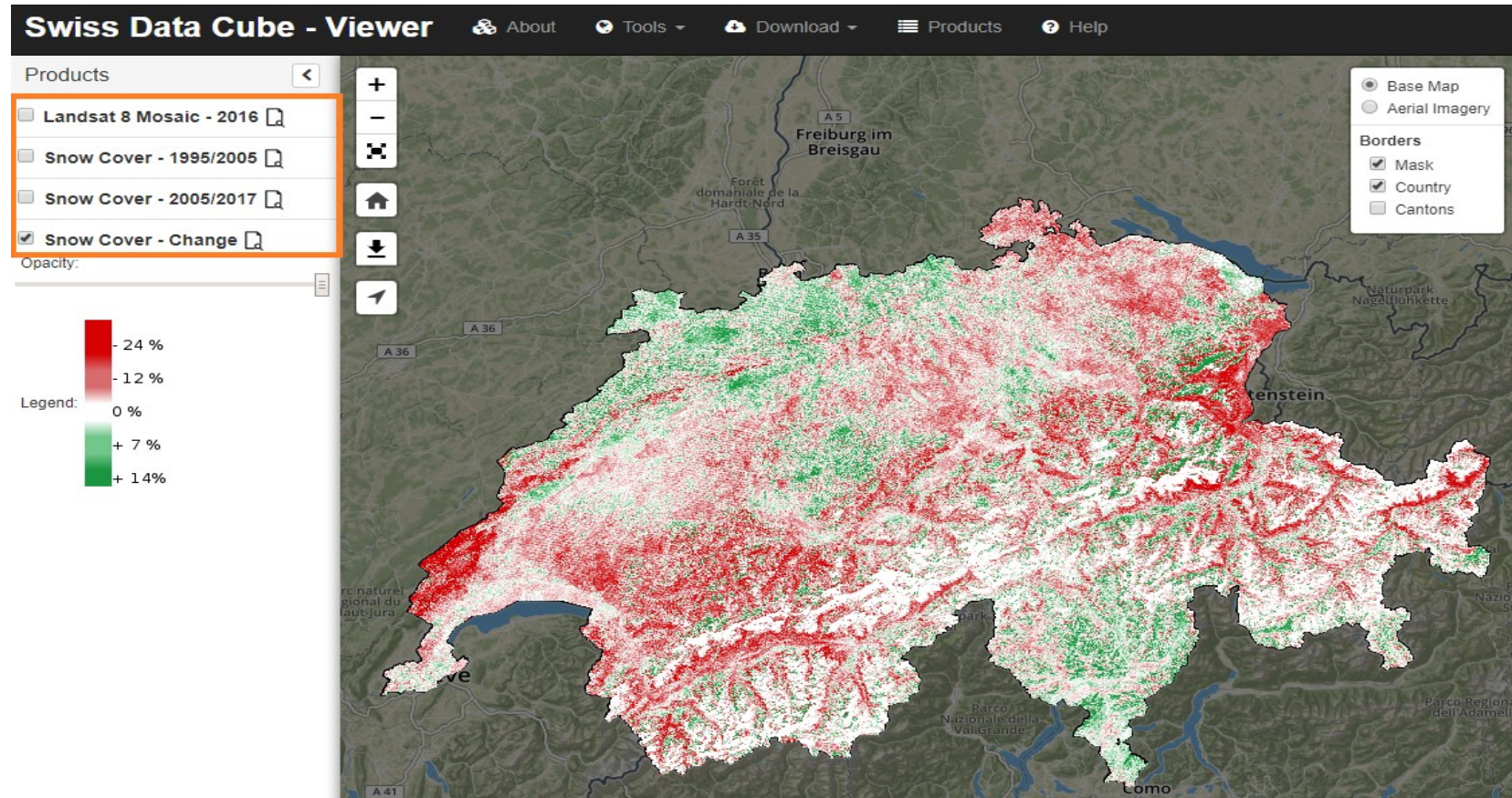
~10 millions CHF

COST OF DATA WITHOUT OPEN DATA
ACCESS POLICY

Giuliani G., Chatenoux B., De Bono A., Rodila D., Richard J.-P., Allenbach K., Dao H., Peduzzi P. (2017) Building an Earth Observations Data Cube: lessons learned from the Swiss Data Cube (SDC) on generating Analysis Ready Data (ARD). *Big Earth Data* 1(1):1-18

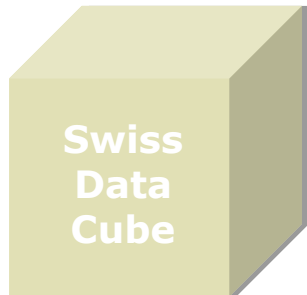


Swiss Data Cube (2)



➔ Example: **Snow Cover Change** layer between the two periods (1995-2005; 2005-2017)
<https://www.swissdatacube.org/viewer/>

Data Cubes Benefits (1)

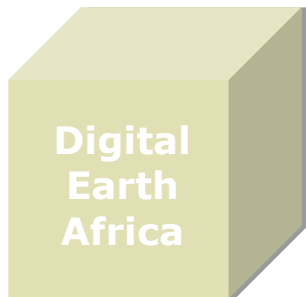


The **Swiss Data Cube (SDC)** will deliver a unique capability to process, interrogate, and present Earth observation satellite data in response to environmental issues of Switzerland.

It will allow tracking changes across Switzerland in unprecedented detail, and will be able to provide new information for every 10 square meters of Switzerland, every five days.

This near real-time information can be readily used as an evidence base for the design, implementation, and evaluation of policies, programs and regulation, and for developing policy advice.

Data Cubes Benefits (2)



Digital Earth Africa will improve understanding of Africa's changing landscape and provide with much-needed insights.

Such insights will enable African governments, NGOs, businesses, and individuals to make more informed decisions about soil and coastal erosion, agriculture, deforestation, desertification, water quality and changes in human settlements.

Digital Earth Africa includes micro-cubes of areas in Kenya, Senegal, Sierra Leone, Ghana, and Tanzania.

The analysis that is performed within Data cube will be even more valuable for protected areas or areas who lack resources/infrastructure.

→ <http://www.ga.gov.au/digitalearthafrica>

Web map browser Sentinel-2 L2A

by CREAM – credit: Joan Maso

- We have developed an automatic procedure to download relevant granules over a protected area
- We have built a data cube based on the Open Data Cube for each PA ready to analyse

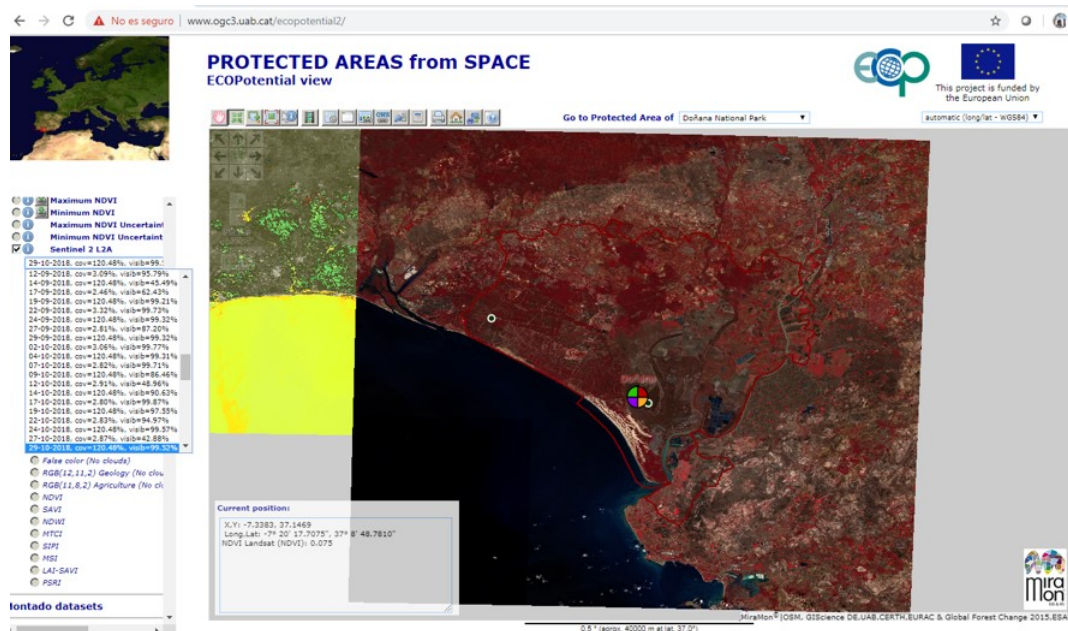
From March 2018 to March 2019

- 15 protected areas
- 2553 granules (199360 jp2 files)
- 1693 dates (adding all PA)
- 4.16Tbytes of JP2 files

Currently limited to:

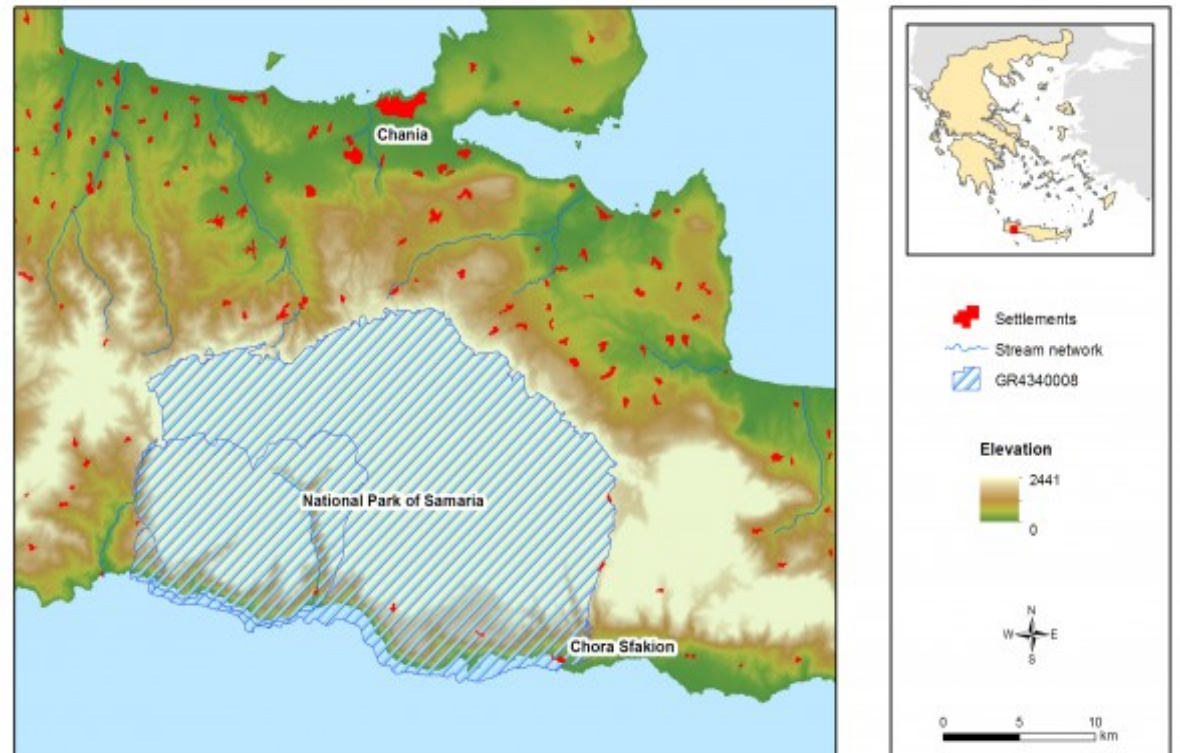
- Abisko
- Bayerischer Wald
- Camargue
- Donana
- Gran Paradiso
- Har Ha Negev
- High Tatra
- La Palma
- Murgia Alta
- Northern Limestone
- Ohrid Prespa
- Peneda Geres
- Samaria
- Sierra Nevada
- Swiss National Park

➔ <http://maps.ecopotential-project.eu/>



Samaria National Park (1)

- **The Samaria National Park is one of the most recognized and awarded protected areas of Greece.** It contains one of the largest gorges in the Balkans, Samaria Gorge, with a total length of 13 km while nine main gorges are located within the area of the White Mountains.
- It is a multi-designated area and specifically a National Park, Landscape of Outstanding Beauty, Natura 2000 site coded GR 4340008 and GR4340014 and Biosphere Reserve in the framework of the “Man and Biosphere” Program of UNESCO.



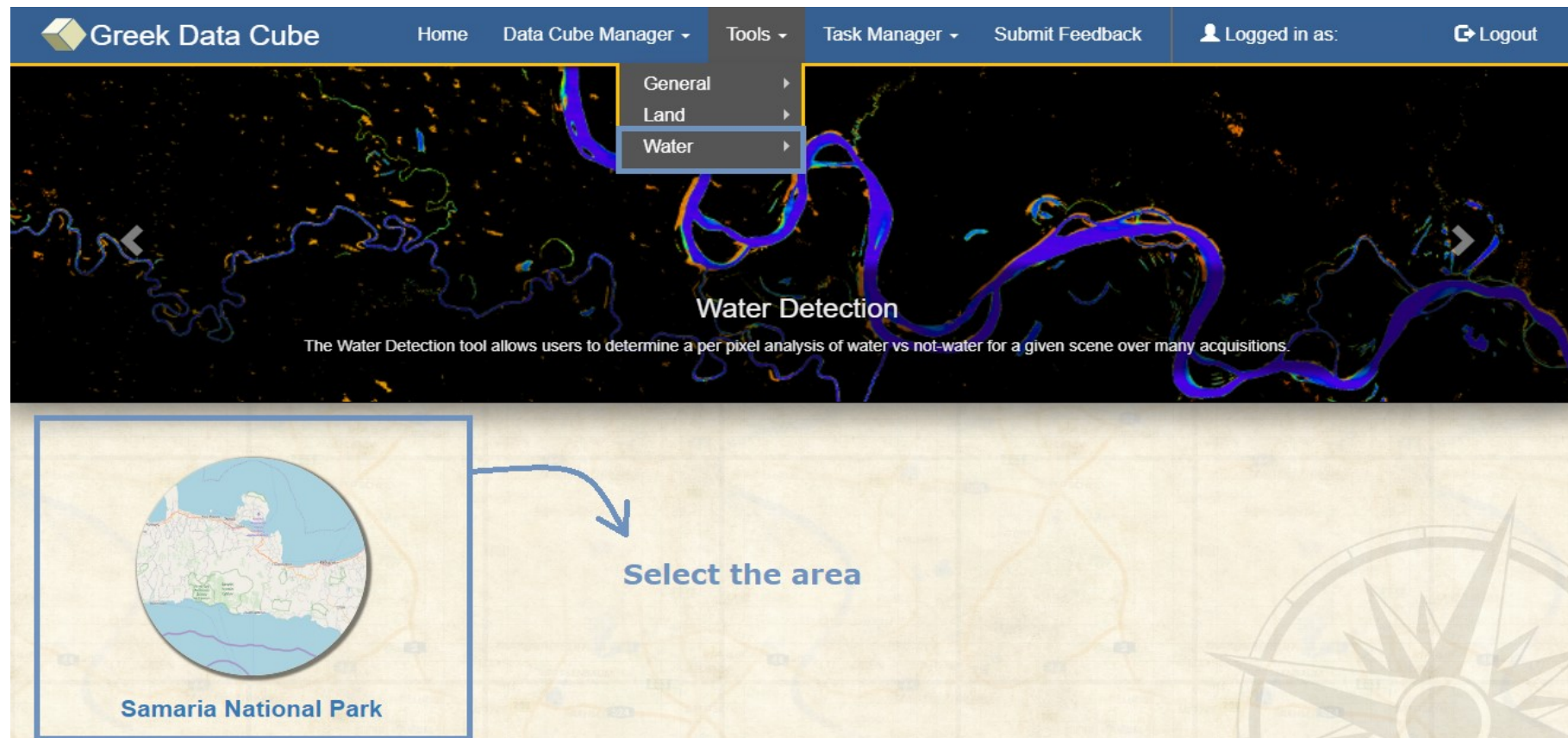
<https://www.samaria.gr>, <https://deims.org>

Samaria National Park (2)

- The National Park is characterized by a rich biodiversity, a high degree of endemism in fauna and flora, distinctive geological configurations and specific landscape features.
- Nowadays, the system is focused on the monitoring and surveillance of 15 terrestrial habitats and 34 species of flora, the recording of meteorological and hydrological conditions, etc.
- The **basic threats and pressures** characterizing the site can be cumulated in:
 - landscape fragmentation
 - desertification induced by overgrazing and uncontrolled fires
 - modifications in water and groundwater regime induced by large scale infrastructures
 - poaching and uncontrolled abstraction of endemic species of flora
 - massive touristic flow and
 - relative medium and large-scale touristic infrastructures
- The creation of Samaria's micro-cube will be highly important and make more efficient the monitoring of the area.

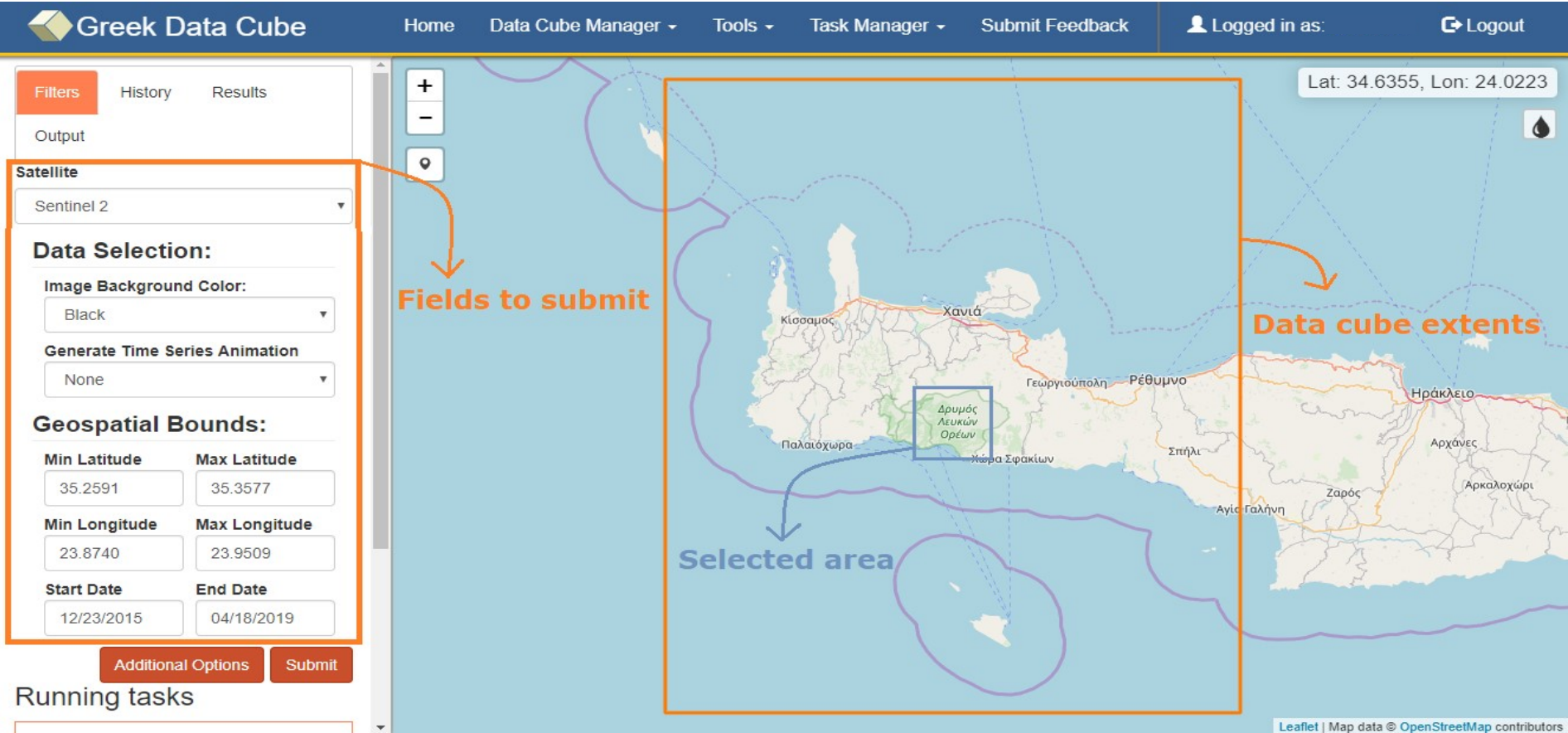
How to use Data Cubes - example (1)

- ➔ From the menu select *Tools*, choose the main category (e.g. Water), the module (e.g. Water Detection) and finally select the area.



The screenshot shows the 'Greek Data Cube' web application interface. The top navigation bar includes 'Home', 'Data Cube Manager', 'Tools', 'Task Manager', 'Submit Feedback', and 'Logout'. The 'Tools' menu is open, showing 'General', 'Land', and 'Water' options. The 'Water' option is selected, leading to the 'Water Detection' tool page. The page features a satellite image of a river system with a 'Water Detection' overlay. Below the image, a text box explains: 'The Water Detection tool allows users to determine a per pixel analysis of water vs not-water for a given scene over many acquisitions.' At the bottom, a map of Greece is shown with a circular inset highlighting the 'Samaria National Park' area. A blue arrow points from this inset to the text 'Select the area' on a larger map background.

How to use Data Cubes - example (2)



The screenshot shows the Greek Data Cube web interface. On the left, there is a sidebar with a 'Filters' tab. The 'Satellite' dropdown is set to 'Sentinel 2'. Under 'Data Selection:', 'Image Background Color' is set to 'Black' and 'Generate Time Series Animation' is set to 'None'. Under 'Geospatial Bounds:', the fields are: Min Latitude: 35.2591, Max Latitude: 35.3577, Min Longitude: 23.8740, Max Longitude: 23.9509, Start Date: 12/23/2015, and End Date: 04/18/2019. There are 'Additional Options' and 'Submit' buttons below. The main area is a map of Greece with an orange rectangle highlighting a region in the central part of the country, labeled 'Selected area'. A larger orange rectangle encompasses the entire map area, labeled 'Data cube extents'. An orange arrow points from the 'Submit' button to the 'Selected area' label, with the text 'Fields to submit' next to it. The top navigation bar includes 'Home', 'Data Cube Manager', 'Tools', 'Task Manager', 'Submit Feedback', and 'Logout'. The top right shows 'Logged in as:' and 'Logout'. The bottom right of the map area shows 'Leaflet | Map data © OpenStreetMap contributors'.

➔ Complete the fields on the left side, click *Submit* and get the results.



Water Detection

Greek Data Cube
Home | Data Cube Manager | Tools | Task Manager | Submit Feedback
Logged in as: [Logout](#)

Filters | History | Results | Output

Satellite: Sentinel 2

Data Selection:

Image Background Color: Black

Generate Time Series Animation: None

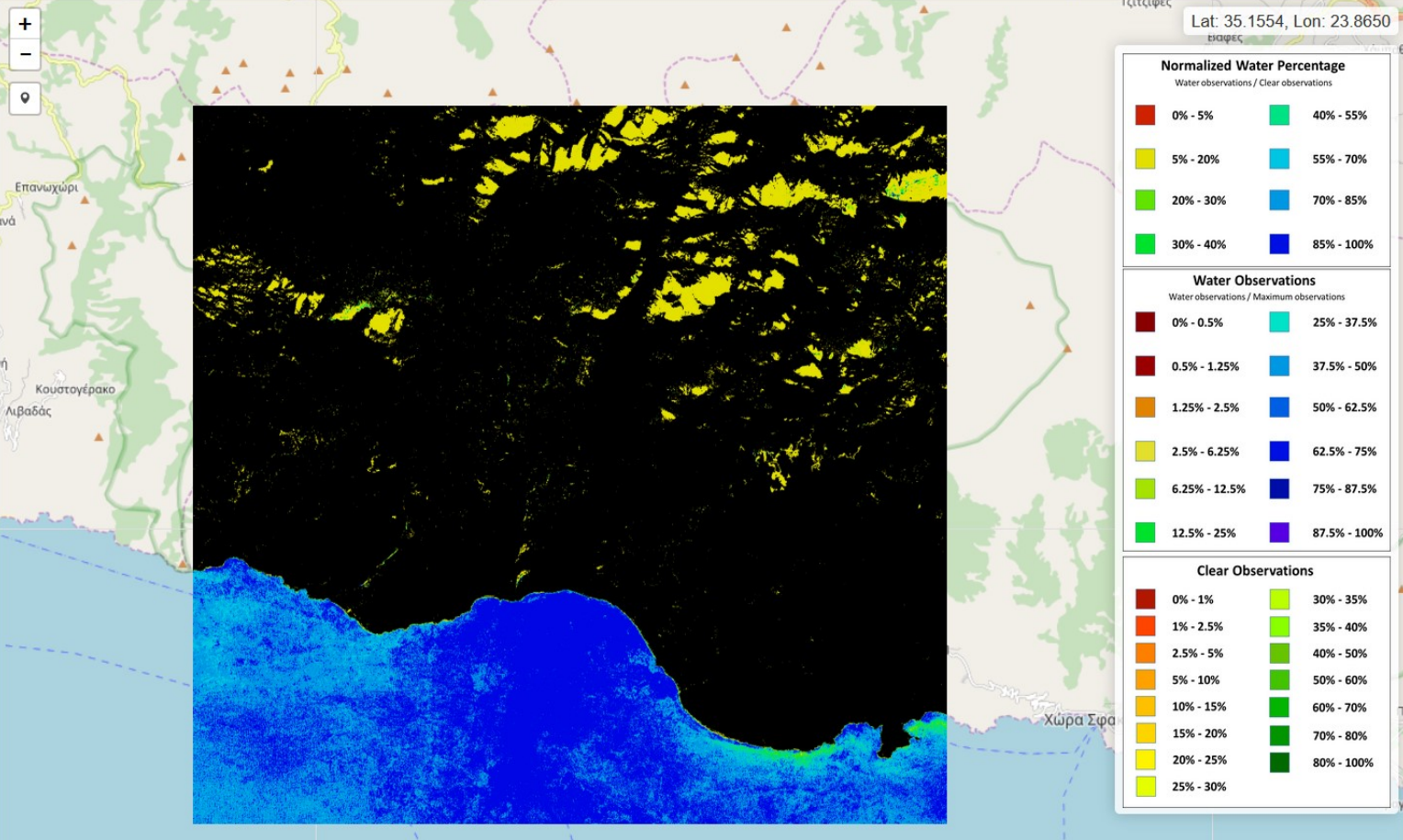
Geospatial Bounds:

Min Latitude: 35.1766 | Max Latitude: 35.3445

Min Longitude: 23.8699 | Max Longitude: 24.0916

Start Date: 12/23/2015 | End Date: 04/18/2019

Additional Options | Submit



Lat: 35.1554, Lon: 23.8650

Normalized Water Percentage
Water observations / Clear observations

0% - 5%	40% - 55%
5% - 20%	55% - 70%
20% - 30%	70% - 85%
30% - 40%	85% - 100%

Water Observations
Water observations / Maximum observations

0% - 0.5%	25% - 37.5%
0.5% - 1.25%	37.5% - 50%
1.25% - 2.5%	50% - 62.5%
2.5% - 6.25%	62.5% - 75%
6.25% - 12.5%	75% - 87.5%
12.5% - 25%	87.5% - 100%

Clear Observations

0% - 1%	30% - 35%
1% - 2.5%	35% - 40%
2.5% - 5%	40% - 50%
5% - 10%	50% - 60%
10% - 15%	60% - 70%
15% - 20%	70% - 80%
20% - 25%	80% - 100%
25% - 30%	

Running tasks



Urbanization

Greek Data Cube Home Data Cube Manager Tools Task Manager Submit Feedback Logged in as: Logout

Filters History Results Output

Satellite: Sentinel 2

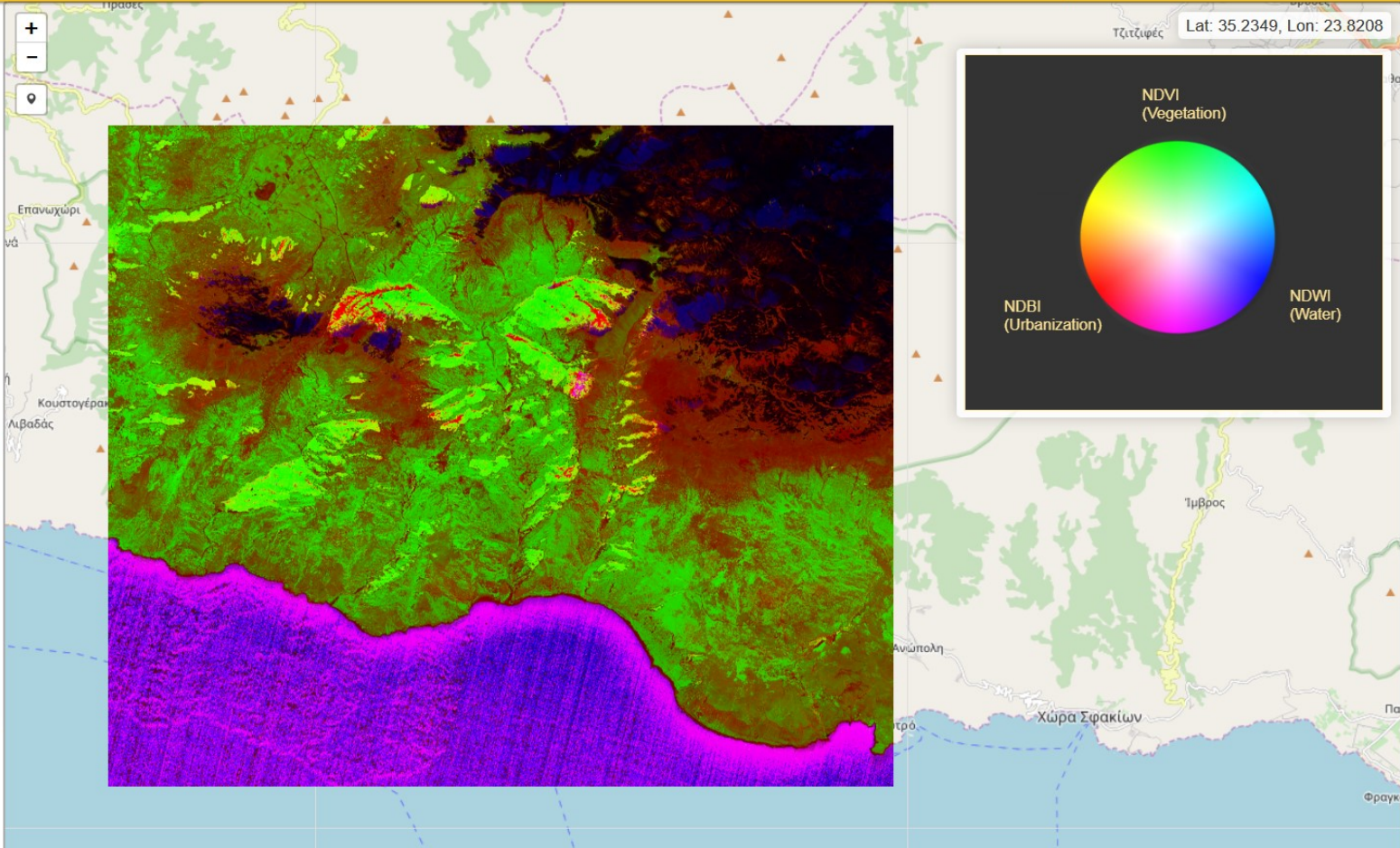
Data Selection:
Compositing Method: Least Recent Pixel

Geospatial Bounds:

Min Latitude: 35.1842	Max Latitude: 35.3464
Min Longitude: 23.8445	Max Longitude: 24.0778
Start Date: 12/23/2015	End Date: 04/18/2019

Additional Options Submit

Running tasks



NDVI (Vegetation)

NDBI (Urbanization)

NDWI (Water)

Lat: 35.2349, Lon: 23.8208

Custom Mosaic

Greek Data Cube Home Data Cube Manager Tools Task Manager Submit Feedback Logged in as: Logout

Filters History Results Output

Satellite
Sentinel 2

Data Selection:

Result Type (Map view/png):
True color

Compositing Method:
Least Recent Pixel

Generate Time Series Animation
None

Geospatial Bounds:

Min Latitude	Max Latitude
35.1794	35.351
Min Longitude	Max Longitude
23.8376	24.1068
Start Date	End Date
12/23/2015	04/18/2019

Additional Options Submit

Running tasks

Lat: 35.1629, Lon: 23.7868

Fractional Cover

Greek Data Cube Home Data Cube Manager Tools Task Manager Submit Feedback Logged in as: Logout

Filters History Results Output

Satellite
Sentinel 2

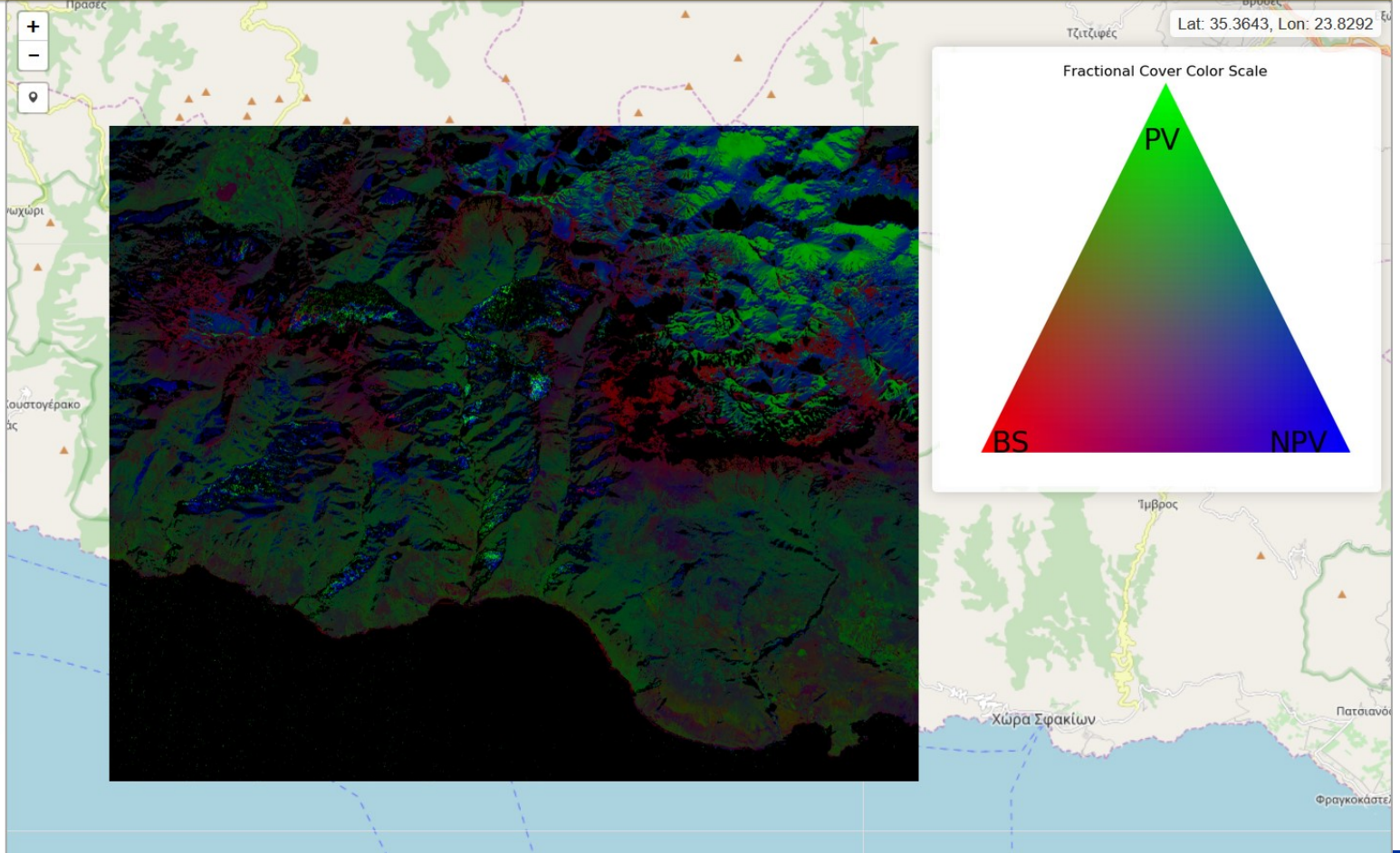
Data Selection:
Compositing Method: Least Recent Pixel

Geospatial Bounds:

Min Latitude	Max Latitude
35.1861	35.3464
Min Longitude	Max Longitude
23.856	24.0986
Start Date	End Date
12/23/2015	04/18/2019

Additional Options Submit

Running tasks



Fractional Cover Color Scale

PV

BS NPV

Lat: 35.3643, Lon: 23.8292

Cloud Coverage

Greek Data Cube Home Data Cube Manager Tools Task Manager Submit Feedback Logged in as: Logout

Filters History Results Output

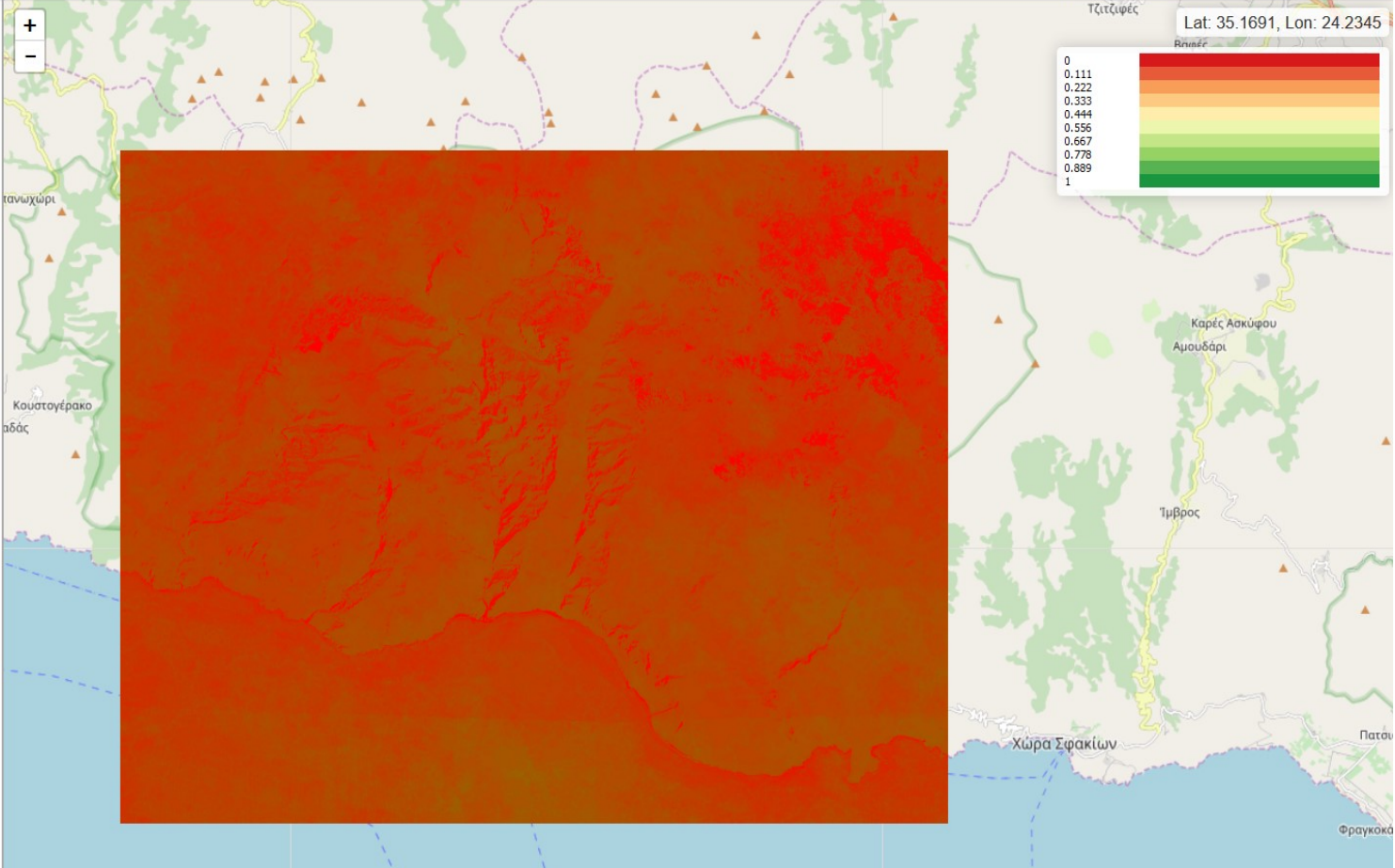
Satellite: Sentinel 2

Geospatial Bounds:

Min Latitude	Max Latitude
35.1828	35.3364
Min Longitude	Max Longitude
23.8554	24.1013
Start Date	End Date
12/23/2015	04/18/2019

Additional Options Submit


Running tasks



Τζιτζιφές
Lat: 35.1691, Lon: 24.2345

Καρές Ασκήφου
Αμουδάρι
Τίμβρος
Χώρα Σφακίων
Πατόν
Φραγκοκά

Spectral indices: NDVI

 Greek Data Cube
Home Data Cube Manager Tools Task Manager Submit Feedback
Logged in as: [Logout](#)

Filters
History
Results
Output

Satellite

Sentinel 2

Data Selection:

Spectral Index: NDVI

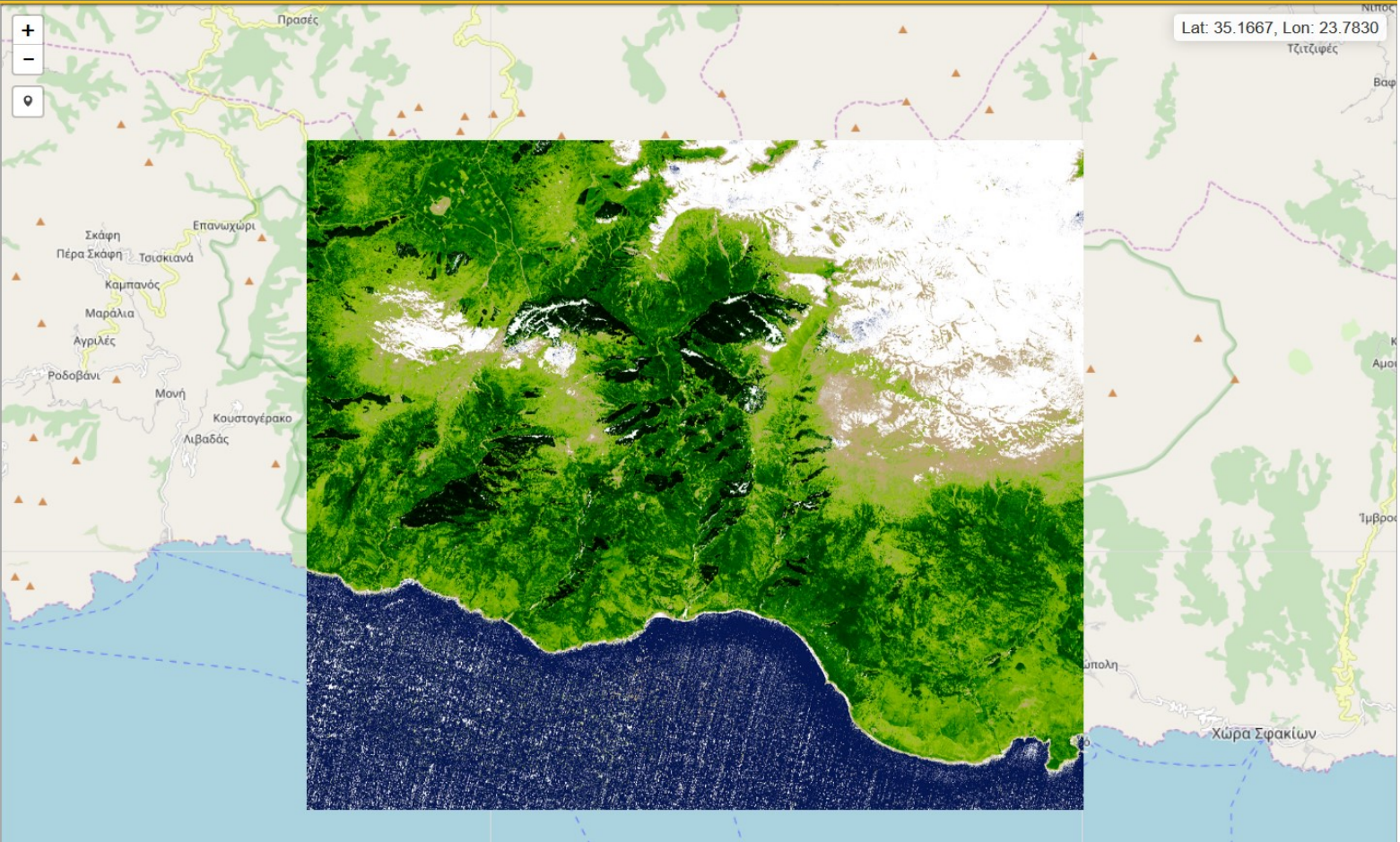
Compositing Method: Least Recent Pixel

Geospatial Bounds:

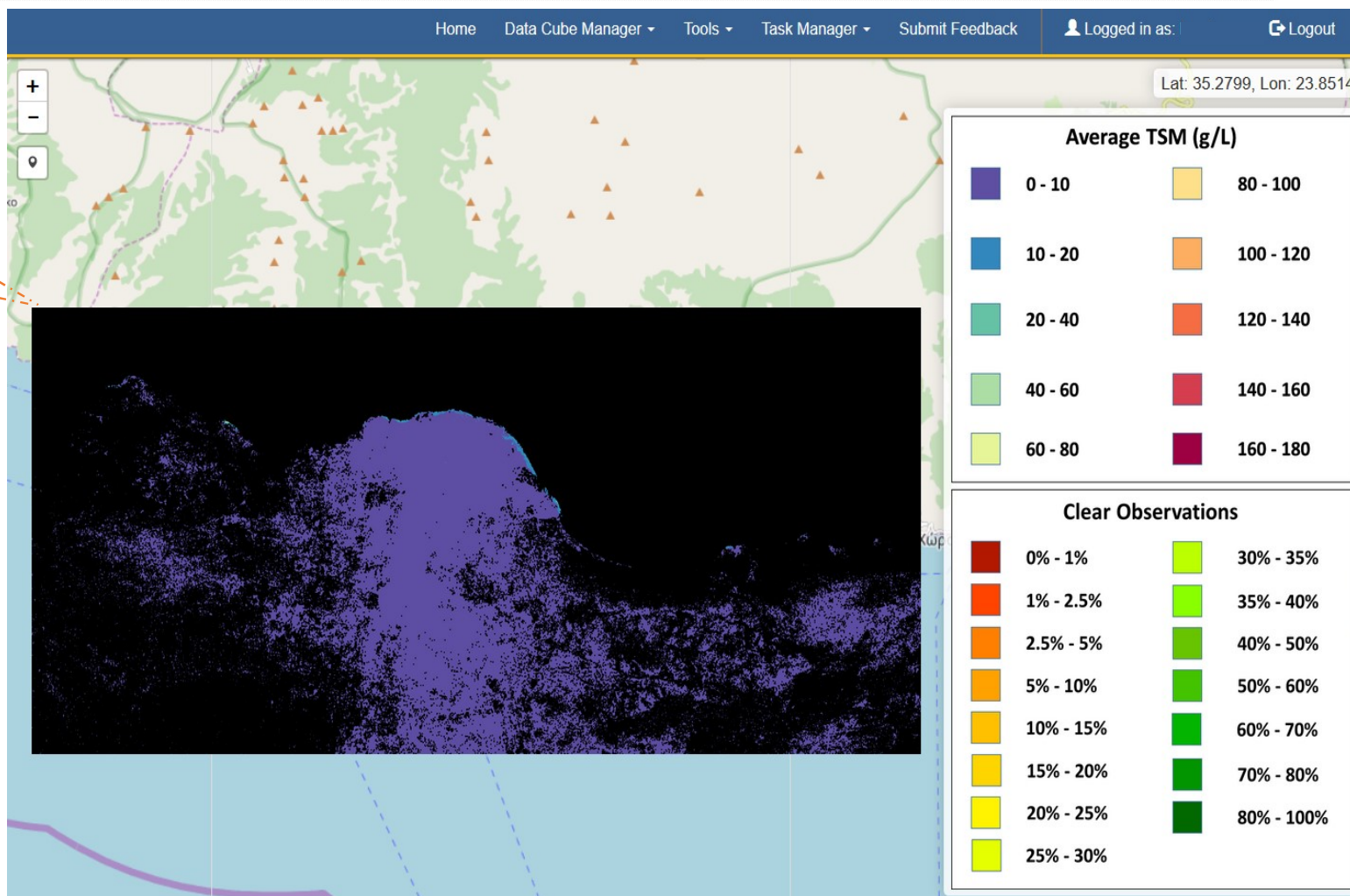
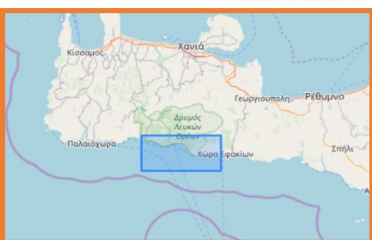
Min Latitude	Max Latitude
35.1823	35.3464
Min Longitude	Max Longitude
23.8514	24.0824
Start Date	End Date
12/23/2015	04/18/2019

Additional Options
Submit

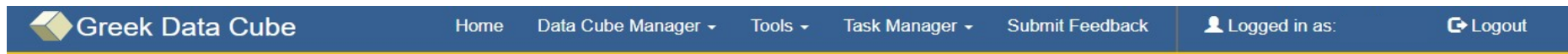
Running tasks



Water Quality TSM



Greek Data Cube



Welcome to the Greek Open Data Cube

CEOS is using the power of the Open Data Cube to help address the needs of satellite data users, giving them a better picture of their land resources and land change.

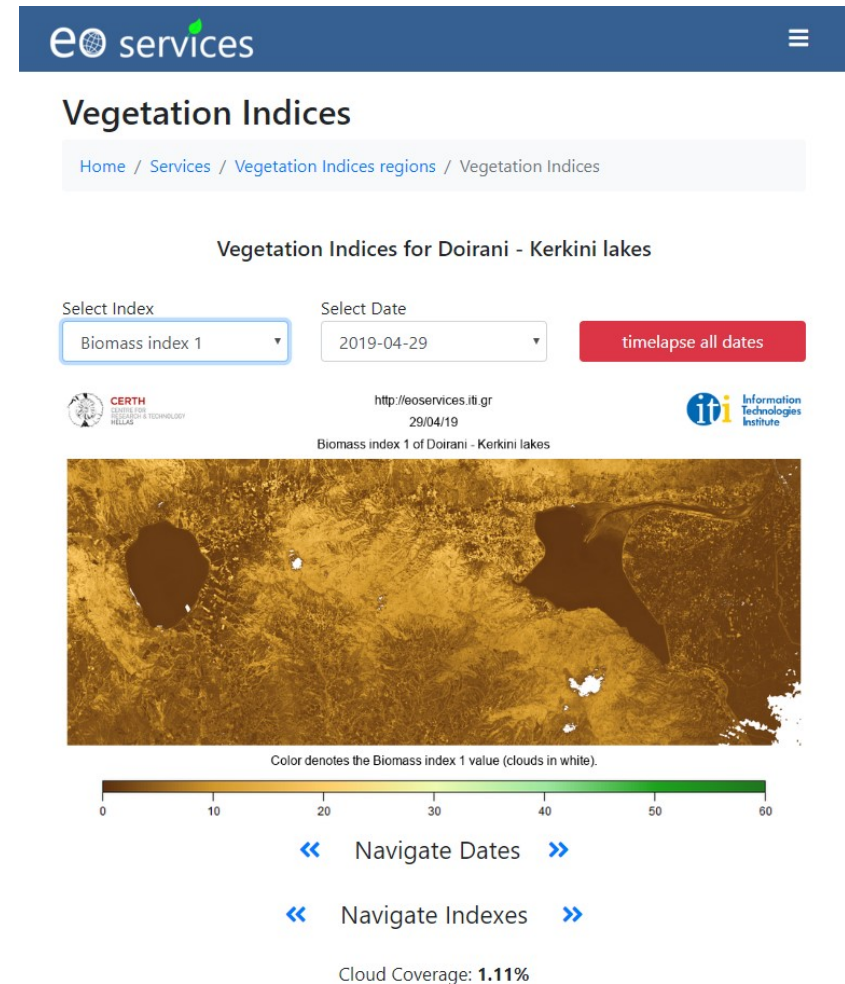
- Ease of use and access to satellite-based data
- Multiple dataset interoperability and spatial consistency
- Use of "Analysis Ready" Data Products
- A Shift in Paradigm from Scenes to Pixels

- Greek Data cube is operating in its first version. It is based on CEOS and the Swiss Data cube. It is currently in the stage of ingesting more satellite data – scenes, in order to export results with scientific value.
- Greek Data cube is currently using Sentinel-2 imagery. Landsat 5, 7 and 8 imagery is going to be added soon. At the moment, Greek Data cube contains only the micro-cube of Samaria National Park.

Future plans

- After the completion of Samaria’s data ingestion, the creation of another micro-cube may follow. For example, the Data cube of another protected area.
- At a next stage, more modules - algorithms are going to be added to the Data cube, through Jupyter notebooks. For example, the modules that have already been created in the website of the eoservices team, **eoservices.iti.gr**.

➔ <http://eoservices.iti.gr>



Exploring the potential of Earth Observations Data Cube for monitoring a protected area



Thank you for your attention

At your disposal for questions/clarifications

On behalf of the working group

Manakos Ioannis, Dr.

imanakos@iti.gr



Annex III

WP9: Aesthetic vision as a quality status Indicator for Protected Areas

Ioannis Manakos¹, Georgios Kordelas¹, Marco Heurich²

¹CERTH, Thessaloniki, Greece

²Bavarian Forest Administration, Germany

Nationalpark
Bayerischer Wald



Aesthetic vision as a quality status Indicator for Protected Areas



Objective:

- Estimate visual pollution and disturbance per pixel within the boundaries of a Protected Area

Demonstration site:

- Bavarian Forest in Germany

Inputs:

- Digital Elevation Model
- Digital Surface Model
- Land Cover Map

Output:

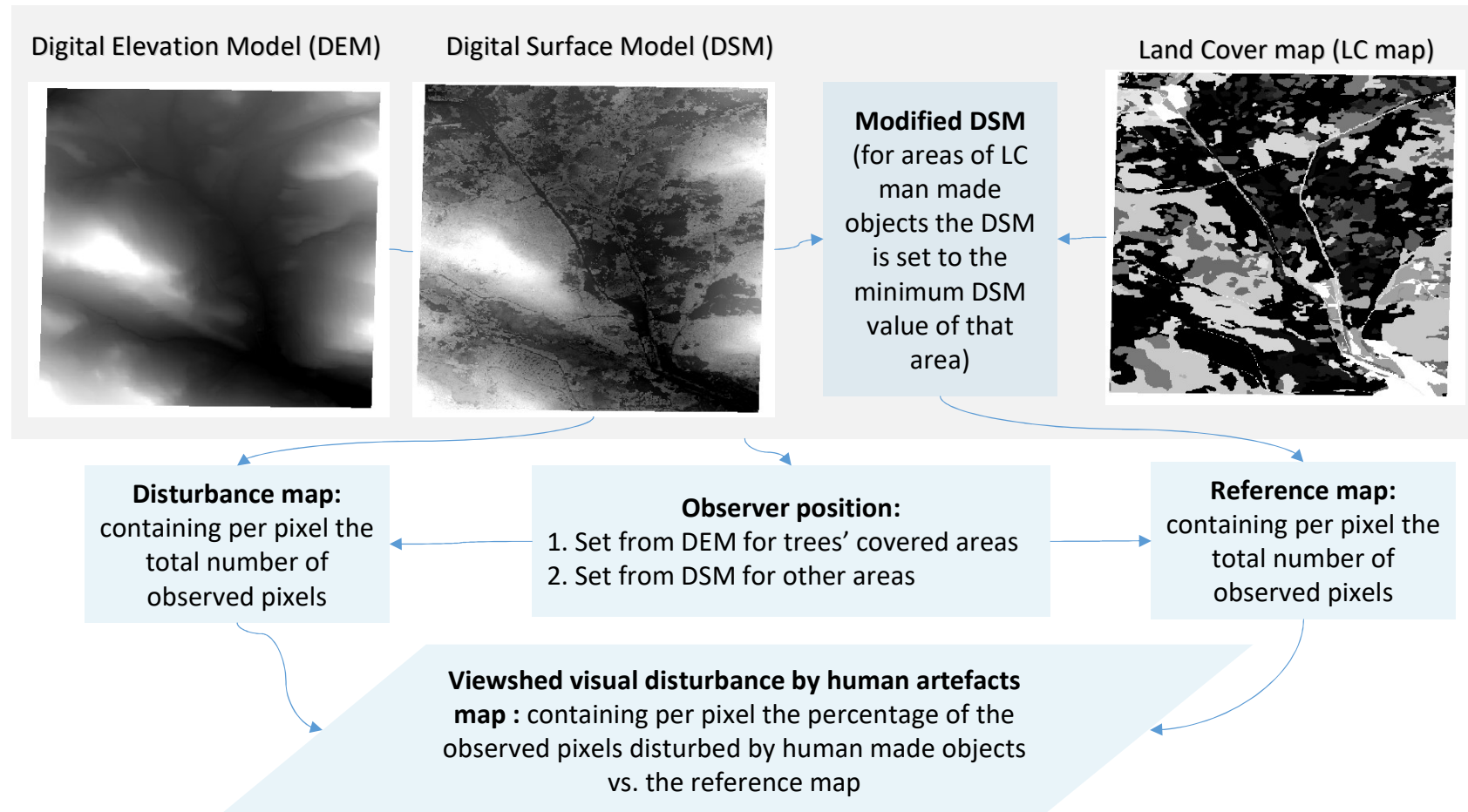
- Viewshed visual disturbance by human artefacts map





Aesthetic vision as a quality status Indicator for Protected Areas

Viewshed analysis

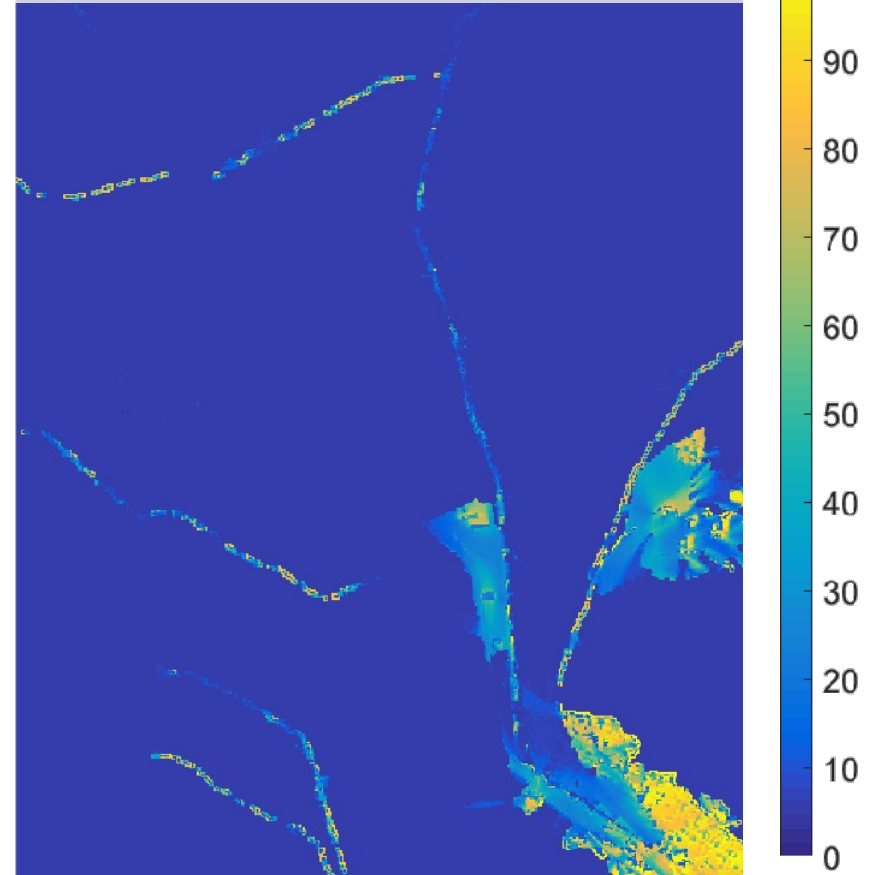


Aesthetic vision as a quality status Indicator for Protected Areas

Bavarian Forest true color airborne image



Bavarian Forest viewshed analysis results

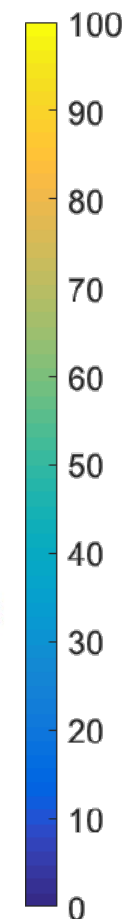
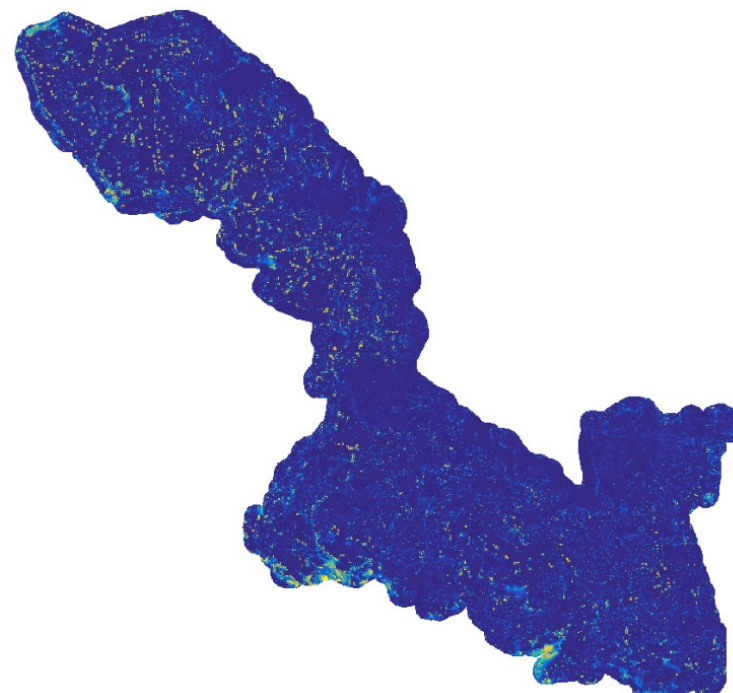


Aesthetic vision as a quality status Indicator for Protected Areas

Bavarian Forest true color airborne image
(downscaled to 30x30m)



Bavarian Forest viewshed analysis
results (downscaled to 30x30m)



2,5 days of continuous computation on a high end PC

Open issues:

- Estimation of the modified DSM:
 - Option 1: to set the DSM value of patches where man-made objects exist to the minimum DSM value.
 - Option 2: to set patches' DSM value equal to the minimum of the DSM values of the neighbouring patches.
 - Option 3: other?
- Position of the observer in relation to human artefacts: On top or inside a building?
- Should a maximum radius of visibility be set for an observer? In such a case which should be the radius value?
- Estimation of visual disturbance in pristine natural areas can be skipped for saving computation cost. Would this be acceptable by PA managers?

Cooperation issues:

- Is it desirable and beneficial to couple viewshed analysis with the assessment of recreational visitor groups using Flickr, developed by the team of the University of Leeds?
- Sharing of computational power with CERTH to run time expensive viewshed analysis.

Aesthetic vision as a quality status Indicator for Protected Areas



At your disposal!

*Ioannis Manakos (imanakos@iti.gr), Georgios Kordelas (kordelas@iti.gr),
Marco Heurich (Marco.Heurich@npv-bw.bayern.de)*