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

# *ECOPOTENTIAL: Improving future ecosystem benefits through Earth Observations*

**Starting date: 1st June 2015, Duration: 4 years, 47 partners**


Coordinator: **Antonello Provenzale**

Institute of Geosciences and Earth Resources, National Research Council of Italy

Co-Coordinator: **Carl Beierkuhnlein**

Biogeography, BayCEER, University of Bayreuth, Germany

Project Manager: **Carmela Marangi**

Institute of Applied Mathematics, National Research Council of Italy

External Communication Officer: **Mariasilvia Giamberini**

Institute of Geosciences and Earth Resources, National Research Council of Italy


**www.ecopotential-project.eu**


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# *ECOPOTENTIAL in a nutshell:*

## *Make best use of Earth Observations to study ecosystems and improve management and conservation in Protected Areas and beyond*

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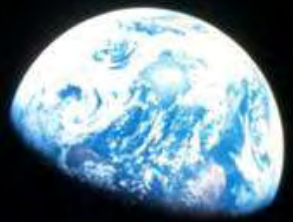
# Ecosystems are seen as “one physical system” with their environment, with cross-scale geosphere-hydrosphere-biosphere interactions

Planet Earth as
“One Grand Organic Whole”

“Earthrise”, Apollo 8, 24 December 1968, photo B. Anders, NASA

# ECOPOTENTIAL

This project is funded by the European Union

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## Working in partnership with **Protected Areas in Europe and beyond**


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# ECOPOTENTIAL

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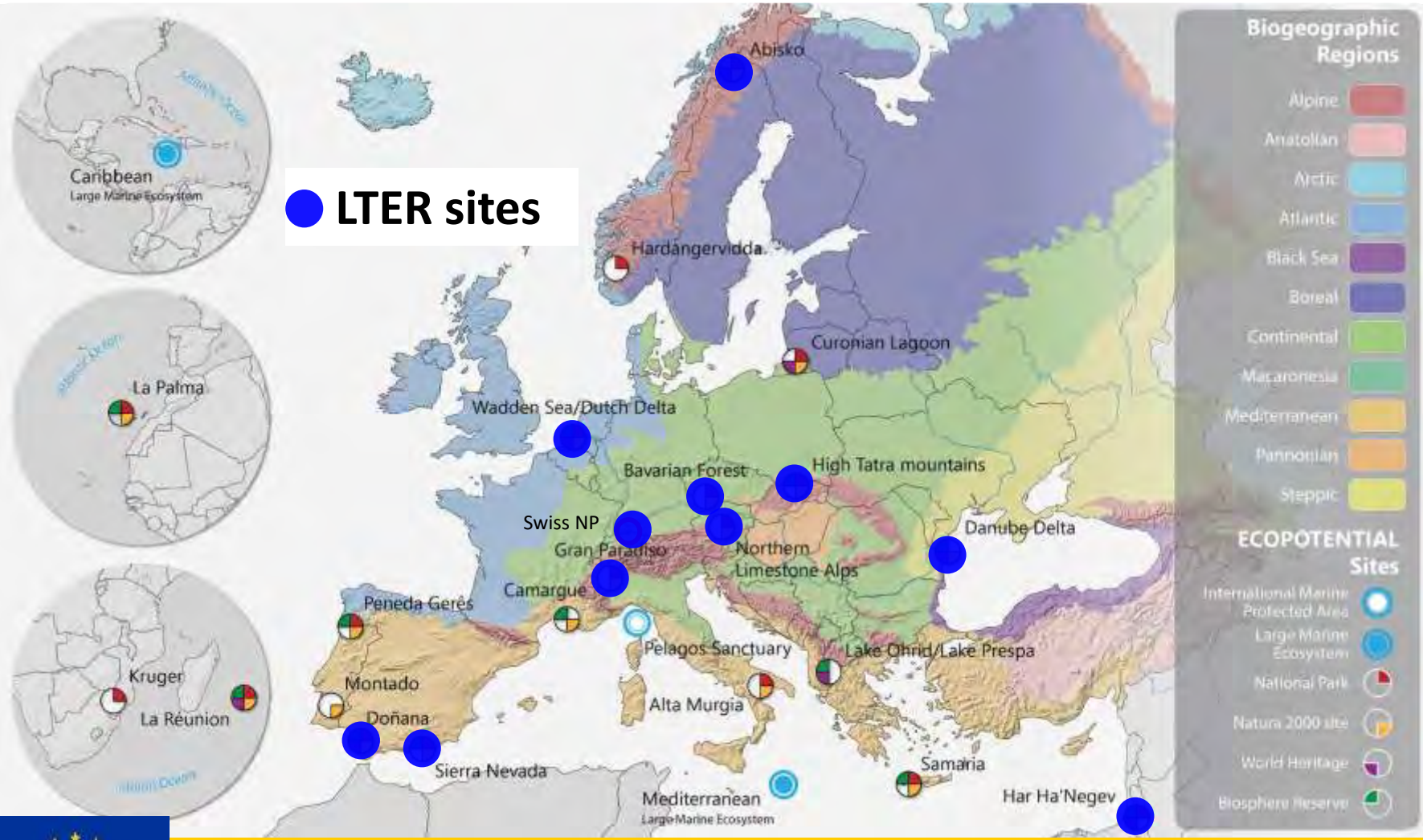
## Working in partnership with Protected Areas in Europe and beyond

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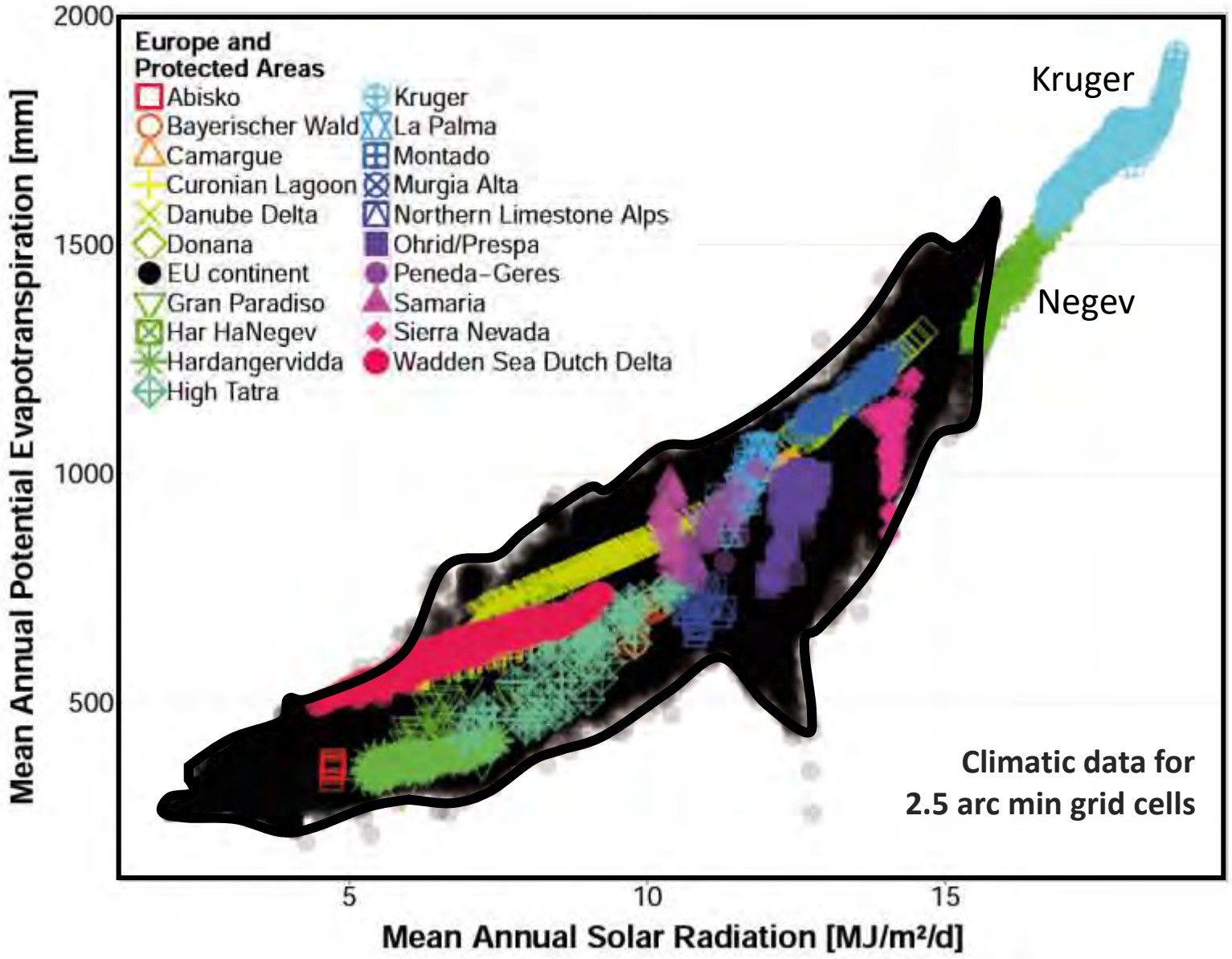
# ECOPOTENTIAL PAs and climate

## Hoffmann et al, 2017, submitted



# *What do we study in the ECOPOTENTIAL Protected Areas:*

**Current state of Protected Areas from Remote Sensing**

**Ongoing changes in the ecosystems and the environment**

**Future projections on the state of the ecosystem**

**Narratives related to Protected Area needs: The Storylines**

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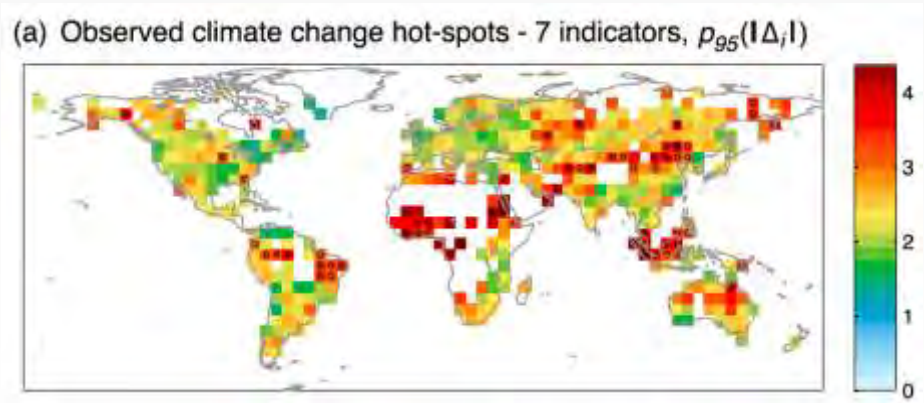
# Changes in Protected Areas: from EOBS

**E-Obs, a European daily high-resolution gridded dataset of surface temperature and precipitation**

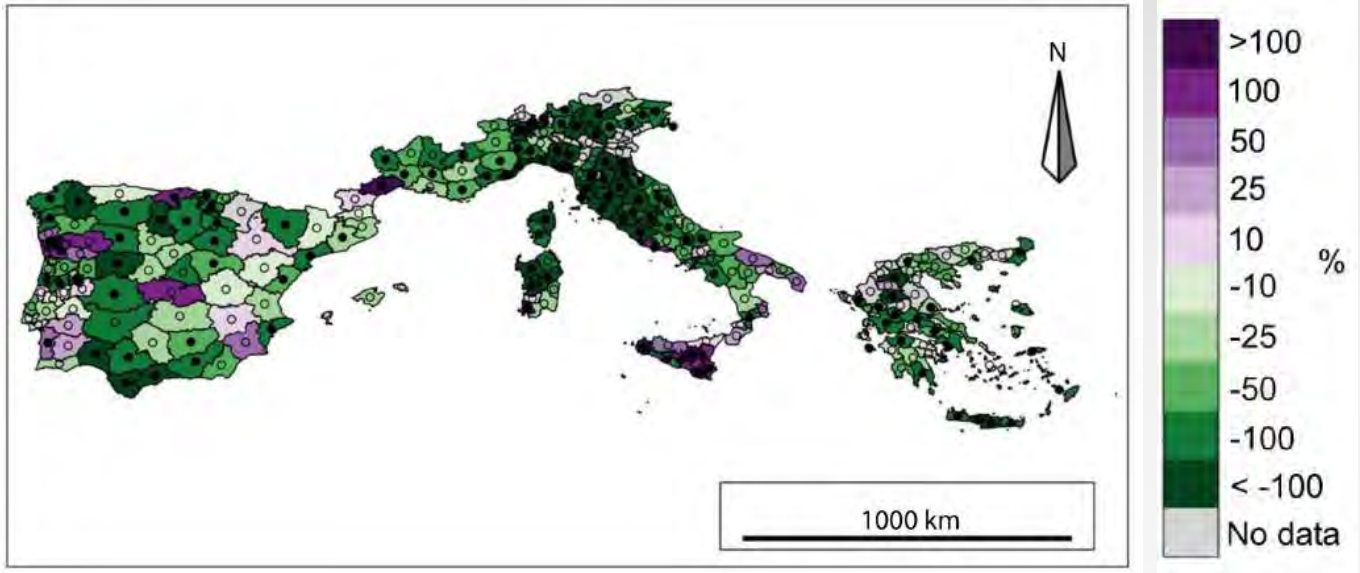
$T_{min}$, $T_{max}$, $T_{mean}$ and precipitation
daily temporal resolution
spatial resolution 25 km
period 1950-2016

**Looking at the climatic change driver hotspots in Europe**




**Protected Areas and Climate Change Hotspots**

# Changes in Fire Occurrence in the Mediterranean: Burned Area




Turco et al, PLOS ONE 2016

Turco et al, Scientific Reports 2017

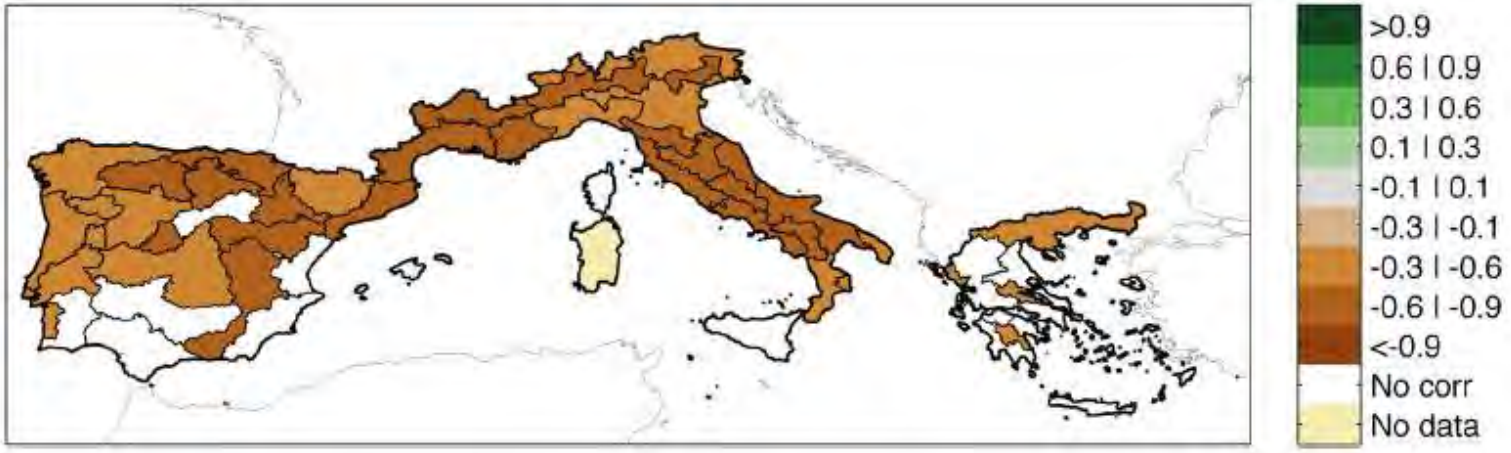
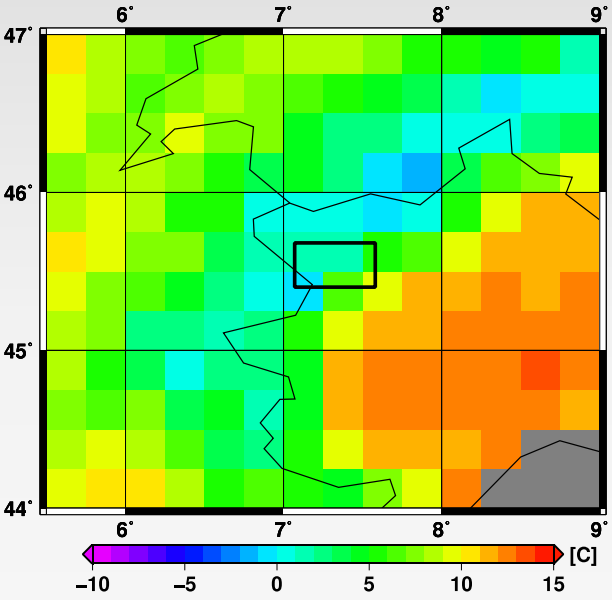


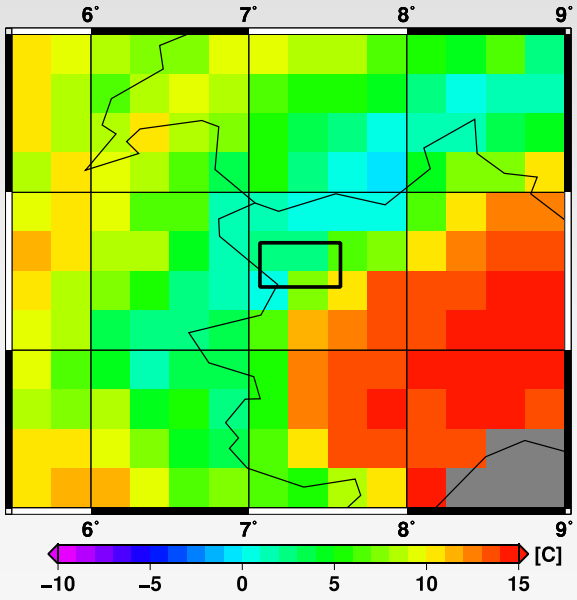

**Figure 1.** Correlations between detrended log(*BA*) and $SPEI_3(0, 8)$, the SPEI for an accumulation time scale of 3 months and calculated in August (8) of the coincident summer (i.e. with the time lag of 0 year). Only correlations that are collectively significant from an FDR test[45] are shown. This figure is created with Matlab version R2012a (http://www.mathworks.com/).

# Individual areas: GRAN PARADISO NATIONAL PARK – E-Obs

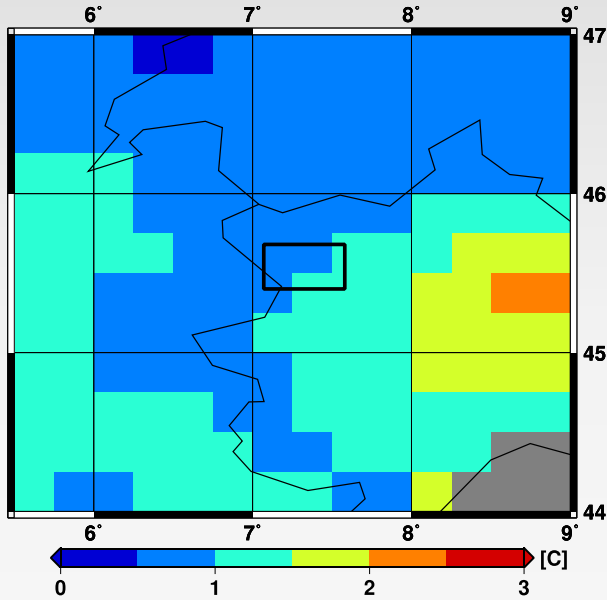
Temperature 1951–1980 average



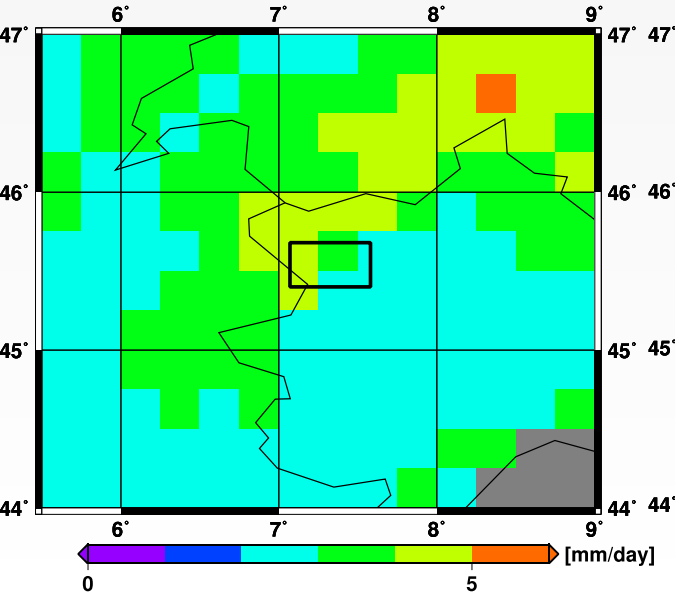

Temperature 1986–2015 average



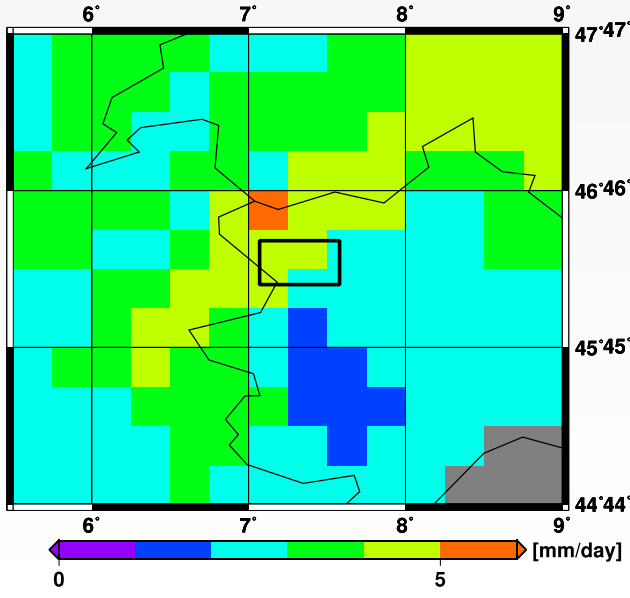

Temperature Change



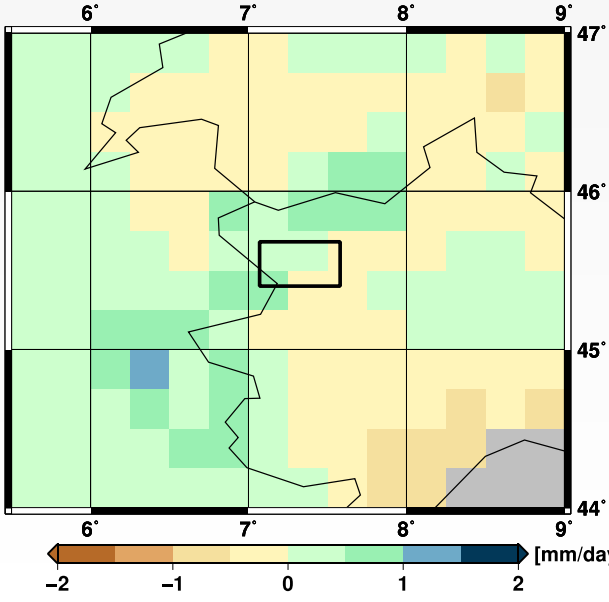

Precipitation 1951–1980 average




Precipitation 1986–2015 average




Precipitation Change



# Changes in Protected Areas: from EOBS

| Natural Park | HDD_spring | HDD_summer | HDD_autumn | HY-INT | GSL | Seas_T | Seas_R | FD | ID | TR | SU | TN | TX | TG | RR | TX-TN |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Abisko | -1,177333 | 25,4 | 36,426 | -0,08362 | 5,066667 | -1,38328 | -0,50938 | -9,2 | -10,3333 | 0 | -0,2 | 1,400015525 | 0,878543 | 1,017271 | -0,14028 | -0,52147 |
| Bayerischer-Large | 69,762697 | 166,45 | 186,819818 | -0,09427 | 7,778788 | -0,02678 | -0,15206 | -13,6545 | -5,69697 | 0,00303 | 8,939394 | 0,815567954 | 0,923283 | 0,854244 | 0,095767 | 0,107715 |
| Bayerischer-NP | 68,659667 | 174,96933 | 195,9405 | -0,0556 | 5,916667 | 0,270193 | 0,019368 | -13,9167 | -5,25 | 0 | 7,283333 | 0,893614612 | 0,810995 | 0,885221 | 0,219342 | -0,08262 |
| Camargue | 139,19189 | 295,44878 | 390,001556 | 0,239029 | 7,366667 | 0,740715 | 0,130625 | -4,11111 | -0,56667 | 17,35556 | 19,03333 | 1,158638356 | 1,216558 | 1,193081 | -0,01536 | 0,05792 |
| Curonian | 71,730667 | 157,759 | 179,605 | -0,04193 | 13,43333 | 0,377047 | -0,23404 | -19,1 | -10,3333 | 0,533333 | 5,966667 | 0,977149772 | 0,990397 | 1,037073 | 0,12257 | 0,013247 |
| Danube | 61,796472 | 174,18431 | 208,46975 | 0,017621 | 9,755556 | 0,678803 | -0,24361 | -7,31111 | -1,03333 | 12,01667 | 10,51389 | 0,717978463 | 0,598025 | 0,745651 | -0,03099 | -0,11995 |
| Donana | 112,48233 | 224,89911 | 271,873222 | 0,025039 | 0,211111 | 0,6374 | -0,34045 | -0,58889 | 0 | 14,02222 | 14,24444 | 0,794999391 | 0,918713 | 0,817879 | -0,04647 | 0,123714 |
| GranParadiso | 15,464667 | 111,29283 | 106,212833 | 0,468773 | 9,333333 | -0,14611 | 1,770416 | -12,3167 | -19,2 | 0 | 0 | 0,659606393 | 1,036889 | 0,839632 | 0,268425 | 0,377283 |
| Hardangervidda | -2,967639 | 8,2265833 | 13,0146389 | -0,01997 | -1,99444 | -0,38159 | 0,783944 | -8,81389 | -7,35833 | 0 | -0,05 | 0,831961568 | 0,285912 | 0,497706 | 0,400035 | -0,54605 |
| HarHaNegev | 46,654258 | 106,74724 | 148,562207 | -0,08775 | 0,093182 | 0,241519 | -0,34409 | -0,1625 | 0 | 41,125 | 6,920139 | 1,100707393 | 0,458589 | 0,695242 | 0,01106 | -0,59464 |
| LaPalma | 148,29195 | 201,17724 | 291,025333 | -0,48005 | 0 | -0,78547 | -0,17118 | 0 | 0 | 7,942857 | -1,46905 | 1,372550579 | 0,654181 | 0,940203 | 0,019053 | -0,72332 |
| Limestone | 74,349 | 190,74033 | 216,608667 | -0,0304 | 10,53333 | 0,308047 | -0,11826 | -14,0667 | -5,56667 | 0 | 15,76667 | 0,672459361 | 1,232489 | 0,889424 | -0,0322 | 0,56003 |
| Montado | 138,46029 | 249,66415 | 296,09685 | 0,099681 | 0,483761 | 0,422503 | -0,1544 | -1,97265 | 0 | 5,27735 | 15,69658 | 1,144939211 | 0,96322 | 0,891785 | -0,11228 | -0,18172 |
| Murgia | 105,36472 | 251,0315 | 332,939389 | 0,091106 | 4,883333 | 0,991524 | -0,10464 | -3,71111 | -0,24444 | 19,57222 | 18,33333 | 0,953256469 | 1,052078 | 0,983527 | -0,16987 | 0,098821 |
| Ohrid | 23,806889 | 120,72422 | 158,829 | -0,0166 | -0,53889 | 0,513471 | -0,92207 | -10,4444 | -1,72222 | 0,15 | 8,377778 | 0,738008067 | 0,398936 | 0,551937 | -0,4358 | -0,33907 |
| Peneda | 140,439 | 232,35856 | 279,099667 | -0,24094 | 4,366667 | 0,002198 | -3,85076 | -5,47778 | -0,21111 | 0,211111 | 15,8 | 0,664470624 | 1,203506 | 0,922306 | -1,15593 | 0,539035 |
| Samaria | 7,9095088 | 88,608991 | 125,441289 | 0,163936 | -1,64737 | 1,217683 | -0,66024 | -0,49386 | 0,078947 | 18,15351 | 13,14912 | 0,8580826 | 0,074032 | 0,305027 | -0,2628 | -0,78405 |
| SierraNevada | 306,68067 | 432,92317 | 603,93825 | 0,033544 | 39,85 | -1,95327 | -0,10777 | -41,5667 | -0,26667 | 3,958333 | 8,725 | 3,205257763 | 0,407152 | 2,29375 | -0,04987 | -2,79811 |
| SwissNP | 7,7373333 | 89,359667 | 91,559 | 0,196717 | 13,53333 | 0,131902 | 0,49951 | -14,7667 | -23,3667 | 0 | 0 | 0,932899543 | 1,1541 | 0,9273 | 0,243151 | 0,2212 |
| Tatra | 44,83975 | 176,87083 | 196,5565 | -0,0208 | 4,858333 | 0,630134 | -1,04164 | -11,9667 | -4,25 | 0 | 7,35 | 0,901816667 | 0,805988 | 0,88073 | -0,64056 | -0,09583 |
| WaddenSea | 105,16036 | 185,82217 | 227,496405 | 0,046257 | 34,44524 | 0,019823 | 0,288561 | -15,4548 | -5,32857 | 0,07619 | 4,642857 | 0,971991063 | 0,952546 | 0,98325 | 0,120599 | -0,01945 |

**HDD: Heat Degree Days**
**GSL: Growing Season Length**
**Seas_T: Temperatur Seasonality Index**
**Seas_R: Precipitation Seasonality Index**
**TN: Minimum Daily Temperature**
**TX: Maximum Daily Temperature**
**TG: Average Daily Temperature**

**HY-INT: intensity of the water cycle**
**FD: Number of frost days**
**SU: Number of summer days**
**RR: precipitation**

# Remote sensing variables

| Type of ecosystem | RS variable | Period | Frequency | Spatial resolution | Satellite | Referent expert |
|---|---|---|---|---|---|---|
| Mountains | NDVI | 2000-2017 | Daily averages | 250 m | MODIS TERRA/AQUA | BGU, CREAF |
| | Snow cover (duration) | 2002-2016 | yearly | 250 m (EURAC) 500 m (MODIS) | MODIS TERRA/AQUA | EURAC, FORTH |
| | Land surface temperature | 2000-2017 | Daily averages | 1 km | MODIS TERRA/AQUA | FORTH |
| Arid ecosystems | NDVI | 2000-2017 | Daily averages | 250 m | MODIS TERRA/AQUA | BGU, CREAF |
| | Albedo | 2000-2015 | Yearly | 500 m | MODIS | FORTH |
| | Land surface temperature | 2000-2017 | Daily averages | 1 km | MODIS TERRA/AQUA | FORTH |
| Marine | Chlorophyll a | 1998-2015 | monthly | 4 km | Several | ISPRA |
| | Sea Surface Temperature | 1986-2016 | Daily | 2 km-4km | Several | ISPRA |
| | Total suspended solids /Turbidity | From 1984 | 16 day images (if available and no clouds) | 30 m | Landsat /Sentinel 2 | EBD-CSIC provides software not product |
| Common to all PAs - Global | GPP proxy | 2002-2016 | Yearly | 250 m | MODIS | UFZ |
| | Phenological metrics | 2002-2016 | Yearly | 250 m | MODIS | UFZ |

# Spatial-temporal dynamics of savanna ecosystems in and around Kruger National Park (A. Ramoelo et al, CSIR)

| SoE | Indicator | Method [reference] (type)* |
|---|---|---|
| Distribution of grazing and browsing resources in the semi-arid environments | amount of grass per unit area (biomass) | empirical techniques [Ramoelo et al. 2015] (M) |
| | percentage of nutrients in dry matter (leaf N (%)) | empirical techniques [Ramoelo et al. 2012; 2015] (M) |
| | percentage of tree cover per unit area (%) | field, LiDAR and SAR empirical techniques [Mathieu et al. 2013, Naidoo et al. 2014, Urbazaev et al. 2015] (M) |
| | above ground woody biomass per unit area (ha) & woody volume as biomass proxy | field, LiDAR and SAR empirical techniques [Mathieu et al. 2013, Naidoo et al. 2014] (M) |

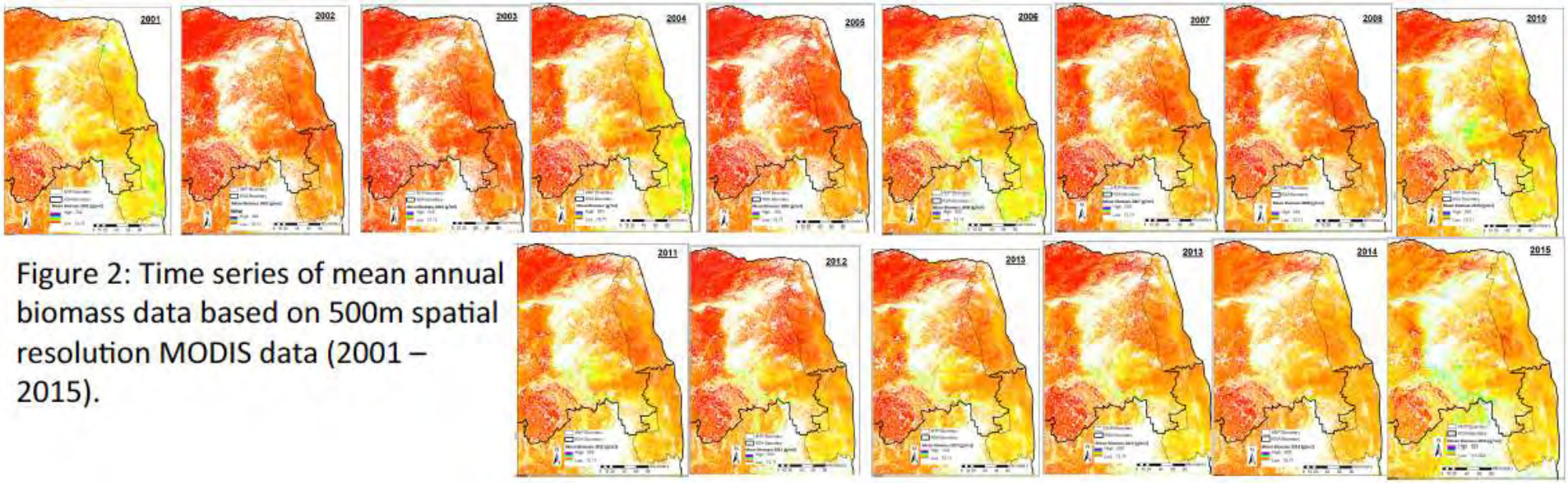


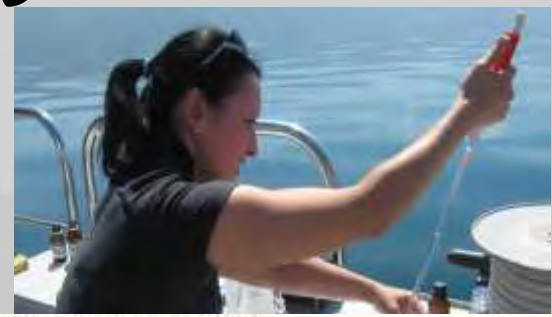

Figure 2: Time series of mean annual biomass data based on 500m spatial resolution MODIS data (2001 – 2015).

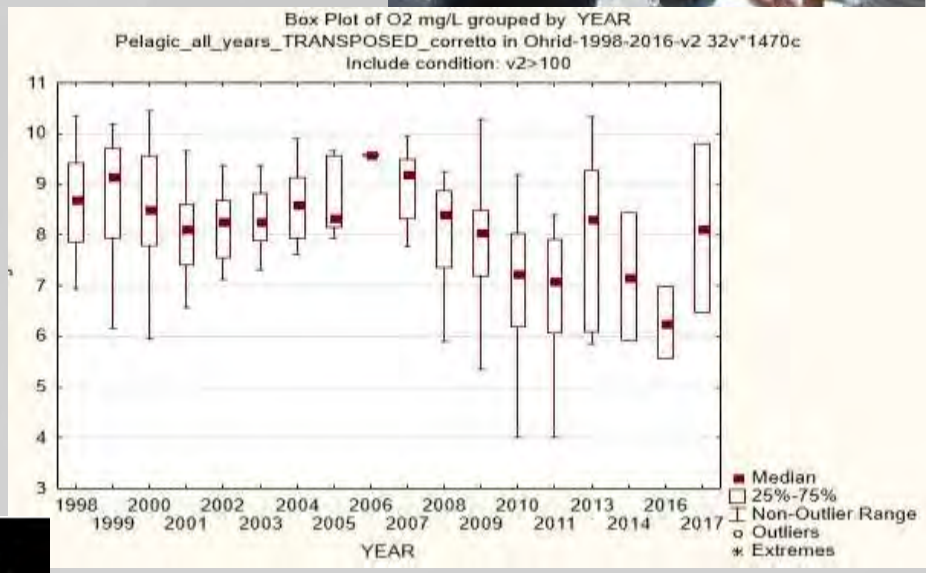
This project has received funding from the *European Union's Horizon 2020 research and innovation programme* under grant agreement No 641762

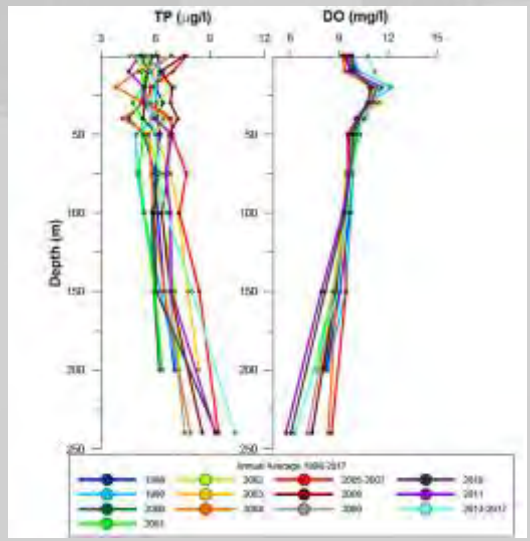
# Changes in Protected Areas: in situ data (e.g., Lake Ohrid)

Habitat for endemic species is endangered by eutrophication in the most diverse lake in the world

Essential Variables for Ecosystems






## *Integrated approach with PA Staff:*
# *The ECOPOTENTIAL storylines*

- **Focus on given Protected Area(s) and identify the main Ecosystem Services of interest and the functions/processes supporting them.**
- **Identify indicators for the state of the ecosystem and of ecosystem processes (DPSIR SoE), for the most important control factors on the ecosystem, for the main (human-induced) pressures (DPSIR Pressures).**
- **Identify the most critical/endangered/fragile ecosystem components and identify indicators of the impacts/response of ecosystem structure, functions and services (DPSIR Impacts).**
- **Identify, retrieve, collect and possibly extend the data base (in situ and Remote Sensing) for the above indicators and the relevant Essential Variables.**
- **Identify societal and management responses (DPSIR Responses) and develop conservation and management policy options.**

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Sierra Nevada is the highest mountain of southern Europe and one of the most important biodiversity hotspot in the Mediterranean region.

# Sierra Nevada, Spain

ECOPOTENTIAL

Water management is a key issue to sustain economic activity as well as ecosystem functioning in this area.

Sierra Nevada, Spain

ECOPOTENTIAL


ECOPOTENTIAL aim to assess how irrigation channels, created by Romans and Muslims over centuries, affect the functioning of socio-ecosystems in Sierra Nevada, and whether they can be considered as tools to buffer the impact of climate change.
Sierra Nevada, Spain
ECOPOTENTIAL


# Har HaNegev, Israel

ECOPOTENTIAL


The multitude of competing land uses, particularly settlements, are the most pressing driver of change to the ecological integrity of this area.
Har HaNegev, Israel
ECOPOTENTIAL

A major goal of ECOPOTENTIAL is to develop tools to use Earth Observation in arid environment in order to track changes in biodiversity, ecosystem dynamics, and ecosystem services provisioning, driven by land use changes.

Har HaNegev, Israel

ECOPOTENTIAL


The Camargue, UNESCO Man and Biosphere Reserve, is an emblematic wetland formed by the Rhone River delta in southern France.
Camargue, France
ECOPOTENTIAL

Climate change is affecting the water availability, threatening the functioning and biodiversity of these ecosystems.

Camargue, France

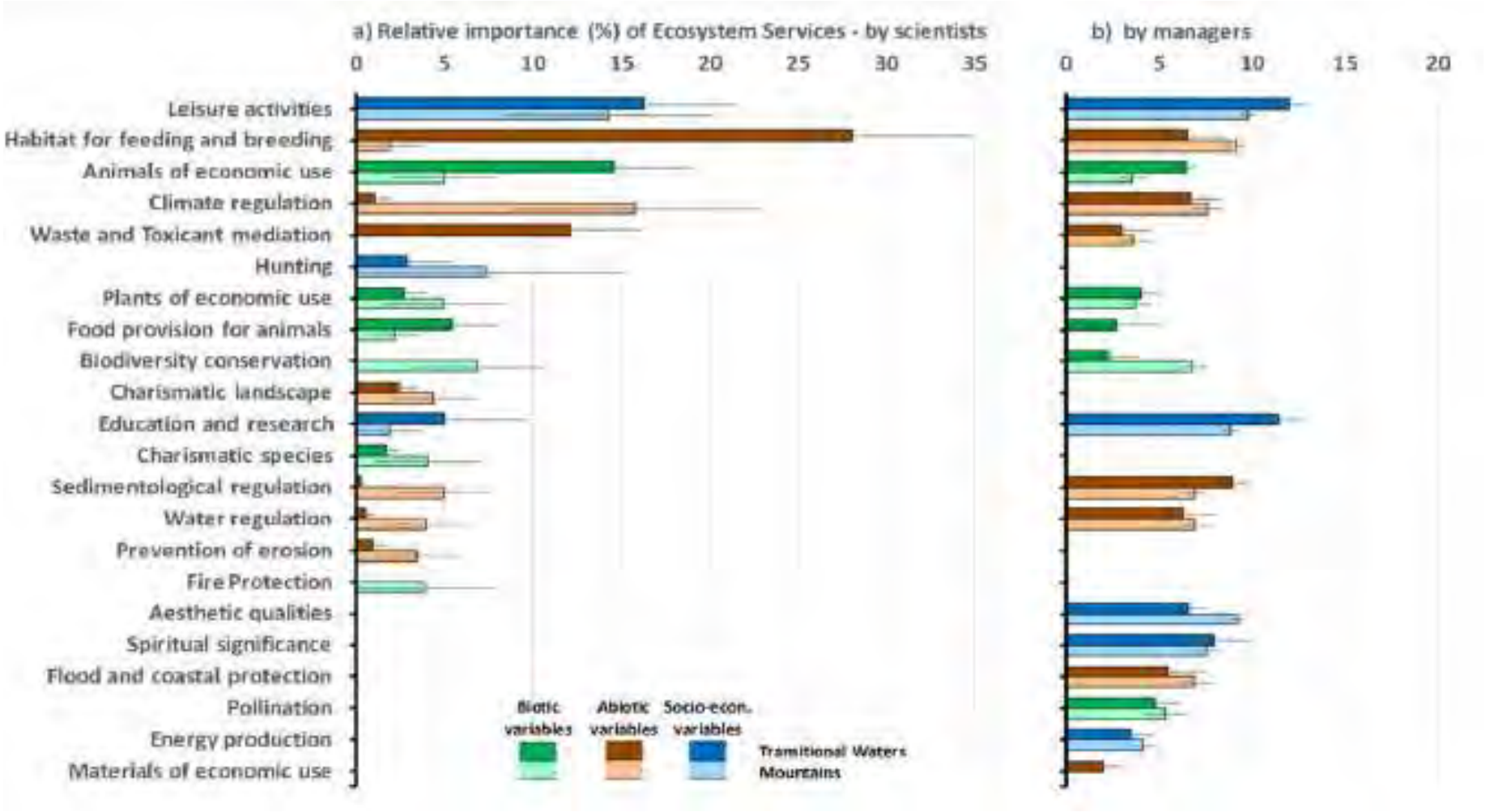
ECOPOTENTIAL


ECOPOTENTIAL monitors water and landscape dynamics through Satellite Images and models the future wetland hydrology and the services it provides.
Camargue, France
ECOPOTENTIAL

# Scientists and PA staff: different perspectives?

Ecosystem services in European protected areas: Ambiguity in the views of scientists and managers?

Christiaan Hummel[1,2,*], Antonello Provenzale[3], Jaap van der Meer[2,4], Sander Wijnhoven[2], Arno Nolte[5], Dimitris Poursanidis[1], Guyonne Janss[6], Matthias Jurek[6], Magnus Andresen[6], Brigitte Poulin[10], Johannes Kobler[11], Carl Beierkuhnlein[12], João Honrado[13], Arturas Razinkovas[14], Ana Strlith[15], Teesa Bargmann[16], Alex Ziemba[6], Francisco Bonet-Garcia[17], Mihai Cristian Adamescu[18], Gerard Janssen[19], Herman Hummel[1]



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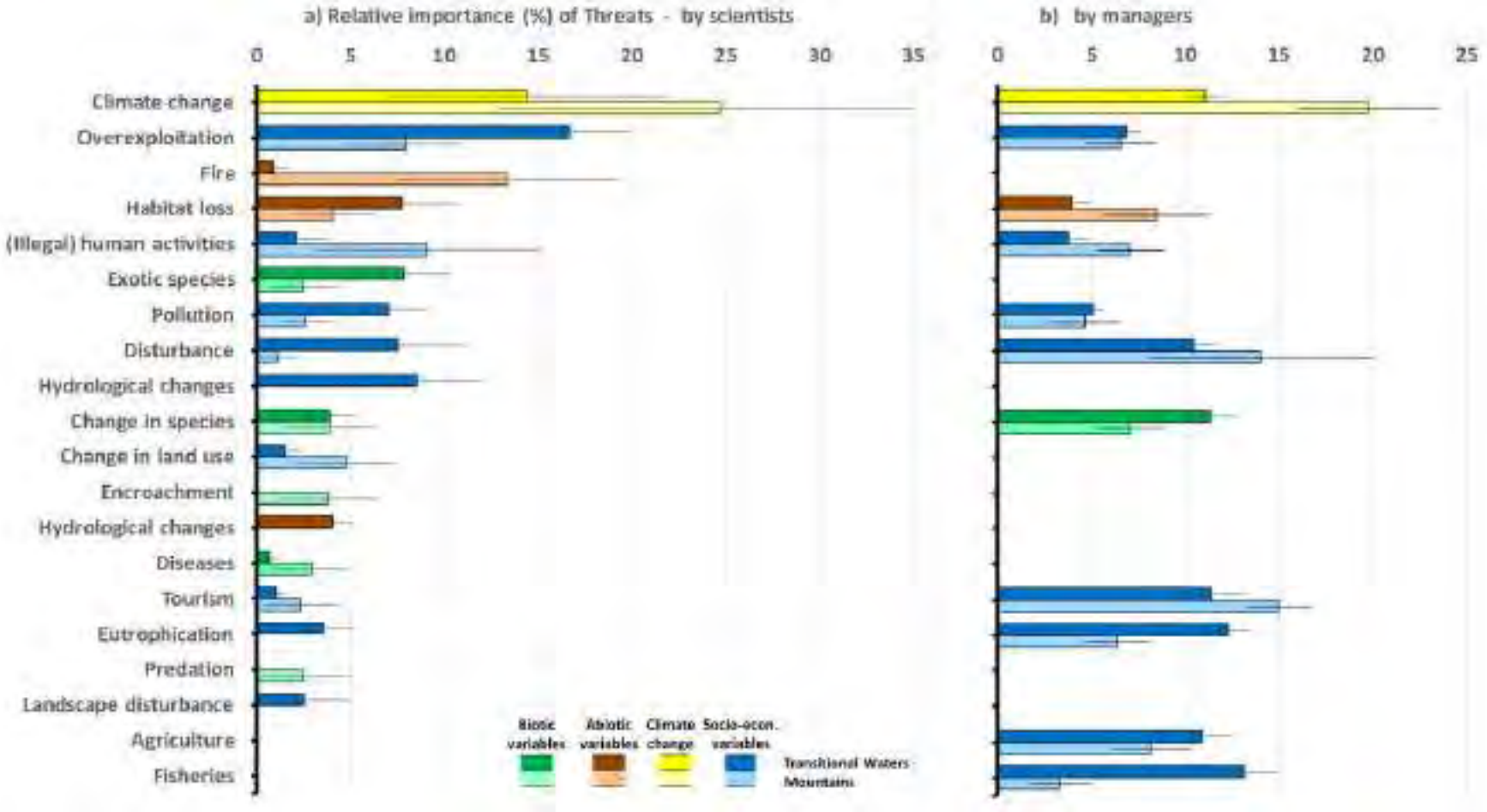

# A workshop with PA staff (May 2017) and a EO/RS training week (February 2018)

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

# Open acces to data, results, models and knowledge:

# PA from Space
# EODESM
# The Virtual Laboratory Platform

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Current and future
challenges

# A deeper integration of Remote Sensing with in situ data, possibly mediated by the use of Essential Variables for Ecosystems

# Gaining a cross-scale, cross-PA view of the challenges and drivers of ecosystem modifications

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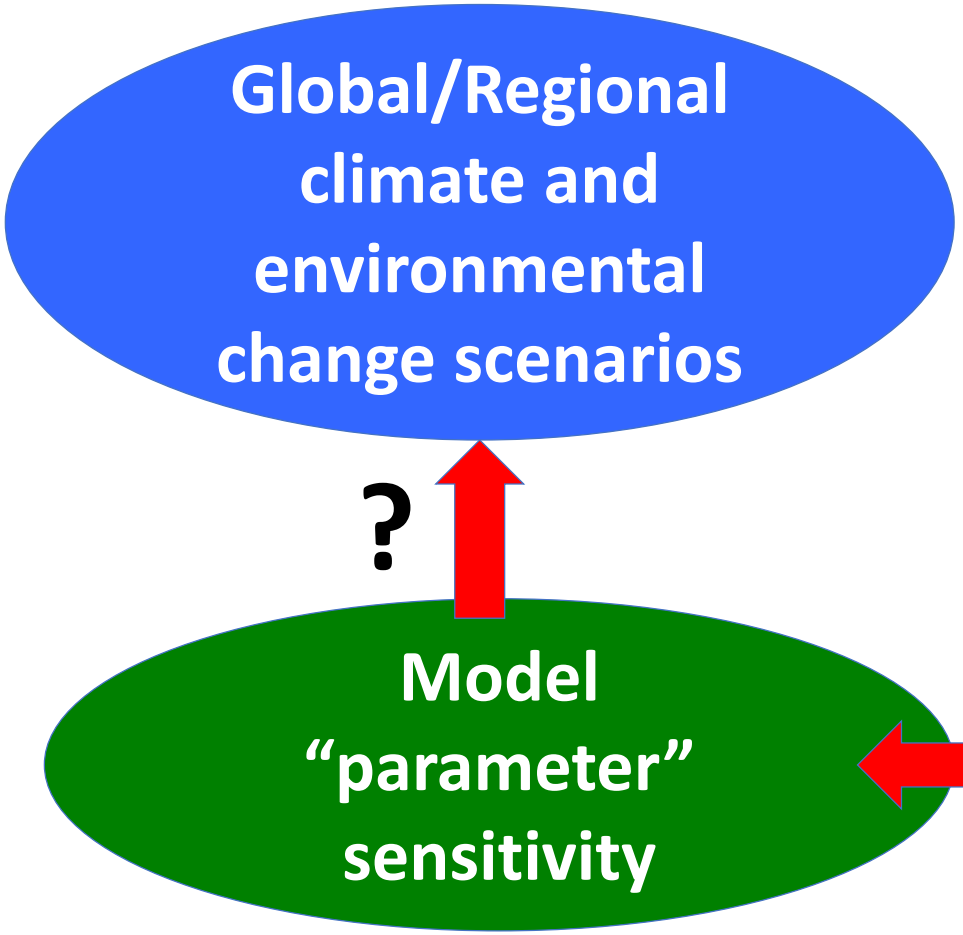
# Need for new approaches to future projections of ecosystem state




## Vulnerability approach ("decision scaling")

Le Roy Poff et al,
Nature Climate Change 2016

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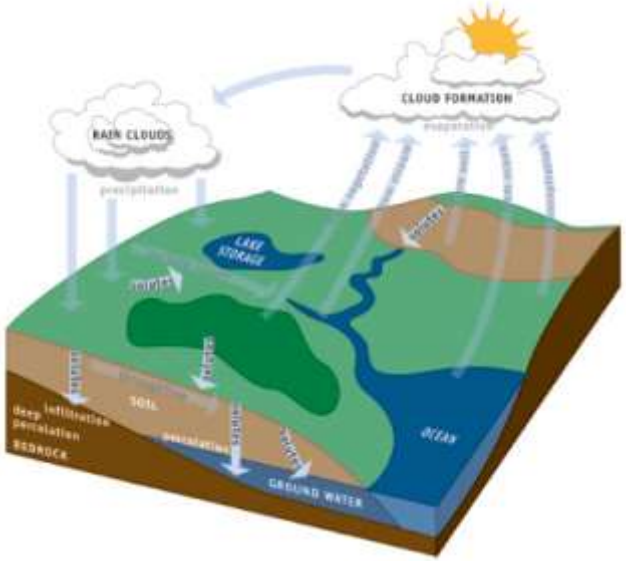
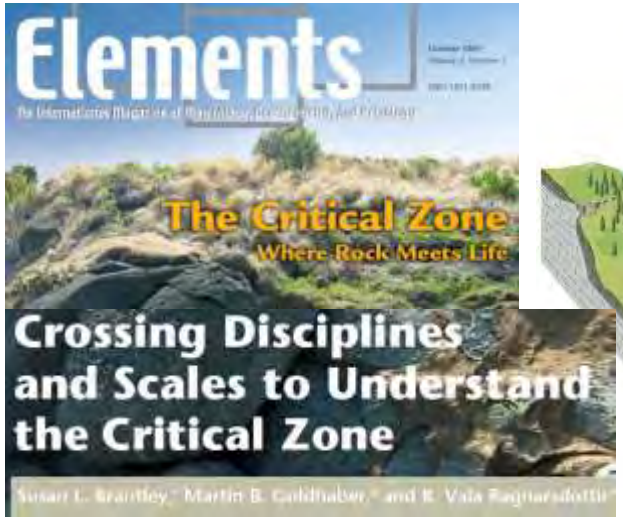
# The Earth Living Skin
# aka the Earth Critical Zone
# aka.. the ecosystem!





**The layer between the top of vegetation canopy and the "rocky matrix", a meeting point of geology, geomorphology, geochemistry, hydrology, soil science and biology: the ECOSYSTEM**

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# Critical Zone Observatories in extreme environments

**Need for combining in-situ measurements, remote sensing and modeling**





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**User uptake of project results:**
**strong link with PA staff and scientists**
**(and other potential users)**
**with continuous assessment of the**
**possibly different priorities, views and needs**

**Provision of data, results and knowledge**
**to larger-scale infrastructures and programs:**
**GEO (GEO ECO), eLTER, LifeWatch**

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**User uptake of RS products:**
**strong link with PA staff**
**(and other potential users)**
**with continuous assessment of the possibly different priorities, views and needs**

**Provision of data, results and knowledge to larger-scale infrastructures and programs: GEO (GEO ECO), eLTER, LifeWatch**

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Thank you for coming and see you soon