ECOPOTENTIAL:
Improving future ecosystem benefits through Earth Observations

Starting date: 1st June 2015, Duration: 4 years

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

ILTER OSM, 13 October 2016, Skukuza, SA

Università del Salento

EURAC research

CSIC

Helmholtz Zentrum für Umweltforschung UFZ

KIT Karlsruhe Institute of Technology

Universität Bayreuth

DLR

marbec marine biodiversity exploitation & conservation

University of Leeds

Environment Systems

InBIO Research Network Biodiversity and Evolutionary Biology

Técnico Lisboa

FORTH Foundation for Research & Technology - Hellas

EPFL École Polytechnique Fédérale de Lausanne

אוניברסיטת בן-גוריון בנגב Ben-Gurion University of the Negev

CSIR our future through science

ISPRA

Politecnico di Milano

CREAF

UAB Universitat Autònoma de Barcelona

ugr Universidad de Granada

NIOZ

umweltbundesamt

Starlab Living Science

Earth and Environmental Science

museum für naturkunde berlin

Tour du Valat

Deltares

Aratos Technologies

iDiv German Centre for Integrative Biodiversity Research (iDiv) Halle-Jena-Leipzig

CESBIO

UNESCO

LSE The London School of Economics and Political Science

Universitas Bergensis

terradue 2.0

UNEP

UNSW Australia | Science

ETH zürich

Environmental and Water Agency of Andalusia
REGIONAL MINISTRY OF ENVIRONMENT AND SPATIAL PLANNING

UBO université de bretagne occidentale

Université de Genève

What we do in ECOPOTENTIAL

- Identify relevant ecosystem services
- Focus on ecosystem functions/processes that support these ecosystem services
- Identify relevant Essential Variables
- Build EO data products and make them widely available
- Build models capable of including EO data
- Assess current conditions/trends and estimate future state of ecosystems (processes/functions/services)
- Define policy options and the requirements of future protected areas
- Make all results available to the community, contributing to GEO/GEOSS

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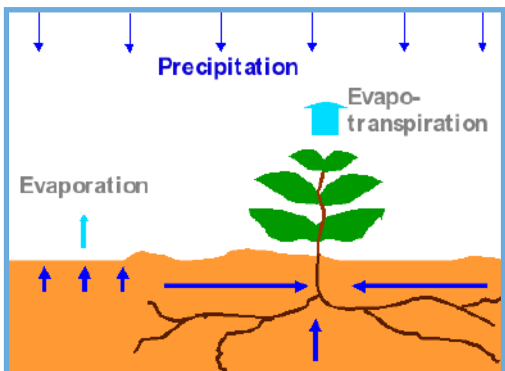
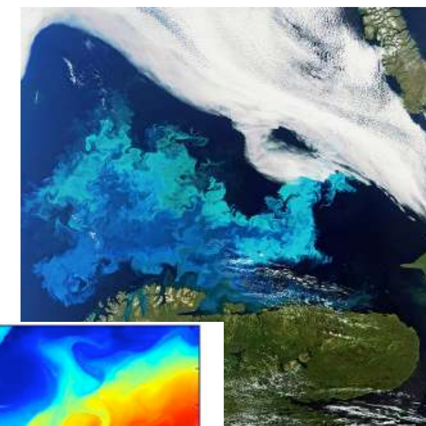
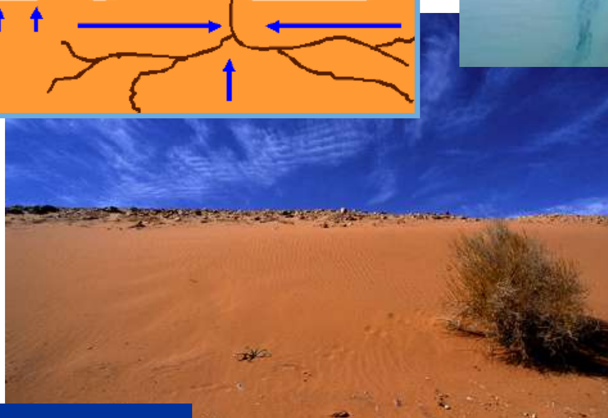
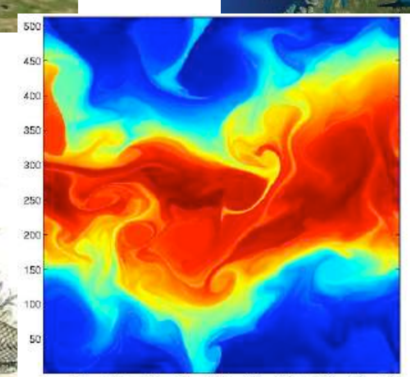
Background approach

In ECOPOTENTIAL, ecosystems are seen as complex adaptive systems characterized by strong geosphere-biosphere interactions across multiple space and time scales









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Working in partnership with 23 Protected Areas in Europe and beyond

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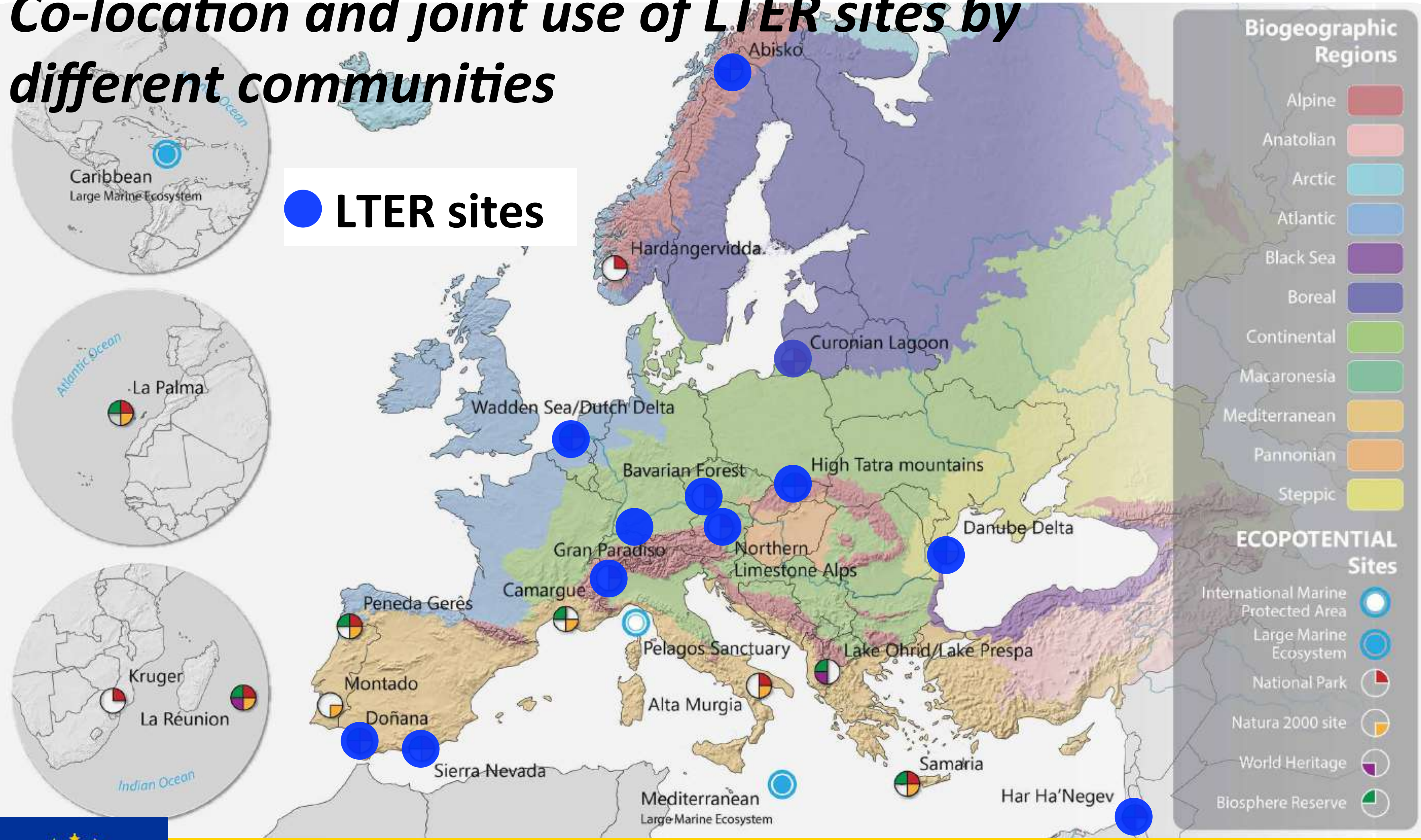
Working in partnership with 23 Protected Areas in Europe and beyond

Co-location and joint use of LTER sites by different communities



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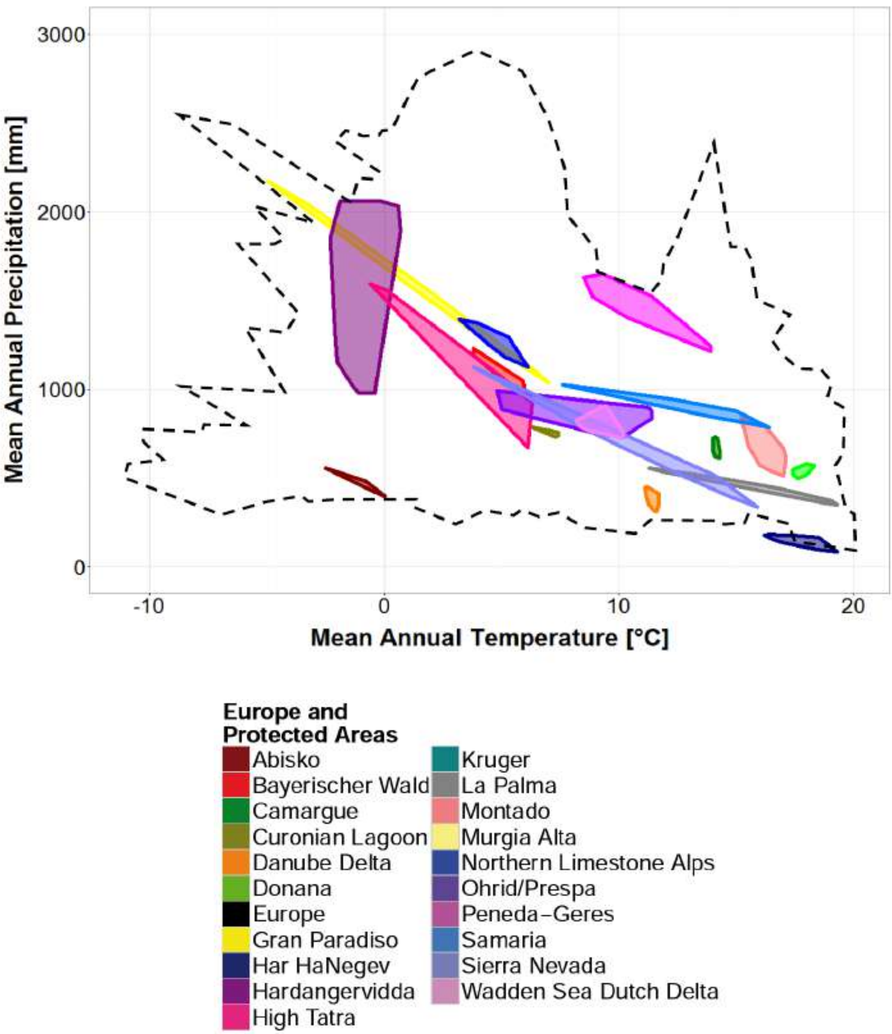
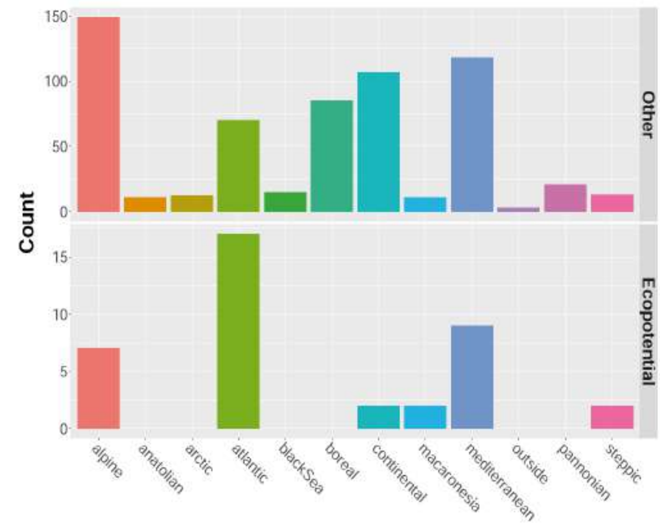
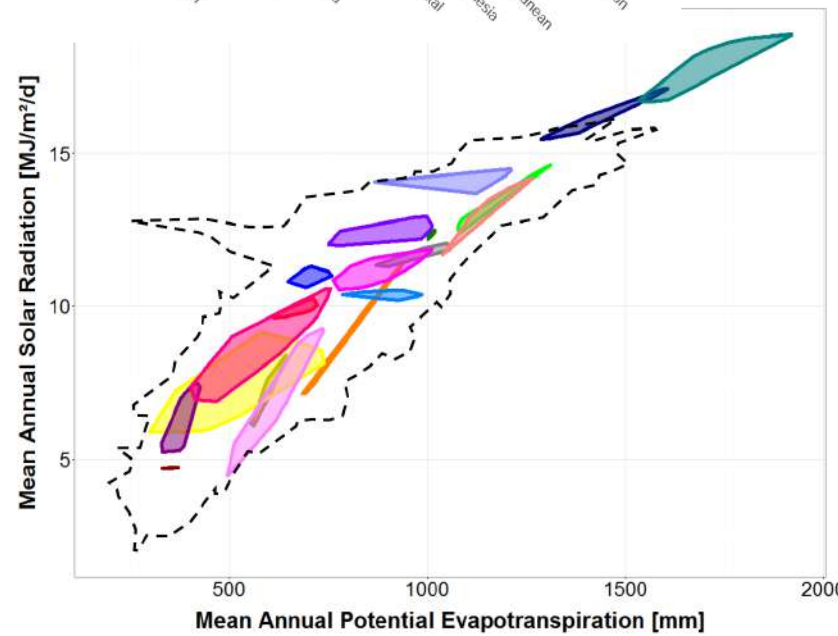
Representativeness of ECOPOTENTIAL PAs

Carl Beierkuhnlein, Samuel Hoffmann & Antonello Provenzale







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Organisational and conceptual example for integrating/integrated approaches

The ECOPOTENTIAL storylines

- Focus on given Protected Area(s) and identify the main ESS of interest and the functions/processes supporting them
- Identify indicators for the state of the ecosystem and of ecosystem processes (DPSIR SoE), and for the most important (abiotic and biotic) control factors on the ecosystem
- Identify indicators that can describe the main (human-induced) pressures (DPSIR Pressures)
- Identify the most critical/endangered/fragile ecosystem processes 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
- Identify societal and management responses (DPSIR Responses) and develop conservation and management policy options

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An arid/semi-arid storyline: Spatial-temporal dynamics of savanna ecosystems as a life support system to wildlife and livestock production in and around Kruger National Park (A. Ramoelo)

Ecosystem service	Ecosystem property needed to keep / improve the service	Supporting ecosystem characteristics
Ecotourism	Species abundance and diversity e.g. presence of wild animals (Elephants, Rhino, Buffalo, Lion, Leopards etc),	healthy state of open grasslands and woodland habitats and vegetation diversity
Grazing and Browsing resources (wild and domesticated animals)	Grass and tree foliage or cover	Quality and quantity grass and leaves for grazing and browsing respectively.
Woody resources (energy and timber)	Woodland components (trees)	Quantity and species of trees
Water	Vegetation productivity, soil quality	Vegetation cover, low alien species cover

Driver of change	Indicator	Method [reference] (type)*
Fire	Burnt area – frequency of fires	http://www.afis.co.za/
Grazing activities	Biomass and quality	Ramoelo et al. (2012; 2015) (R)
Elephant tree pushovers	Tree cover (%)	Wessels et al. (2011), Mathieu et al. (2013), Naidoo et al. (2014) (R,M)
Fuel wood collection	Tree cover (%) or woody biomass (tons/ha)	Mathieu et al. (2013), Naidoo et al. (2014), Mograbi et al. (2015) (M)
Bush encroachment	Tree cover (%)	Naidoo et al. (2014) (R)
Land use – settlement and agriculture	Land cover or use	National Land Project – SA (R)

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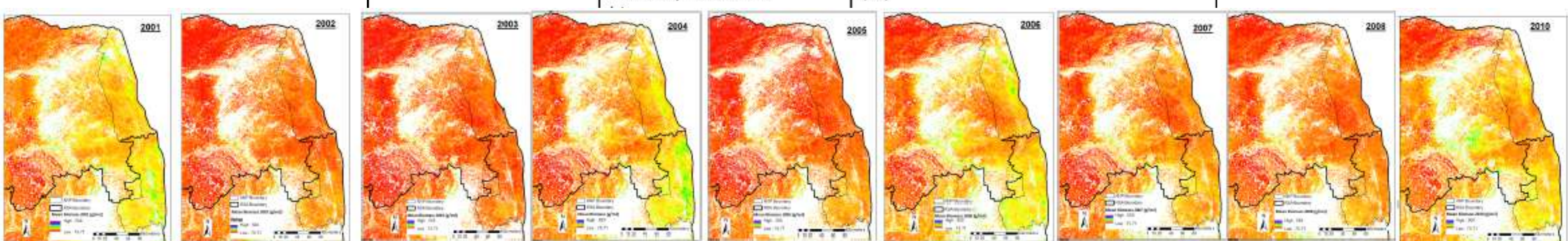
SoE	Indicator	Method [reference] (type)*
Distribution of grazing and browsing resources in the semi-arid environments	amount of grass per unit area (biomass)	empirical techniques [Ramoelo et al. 2015] (M)
	percentage of nutrients in dry matter (leaf N (%))	empirical techniques [Ramoelo et al. 2012; 2015]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



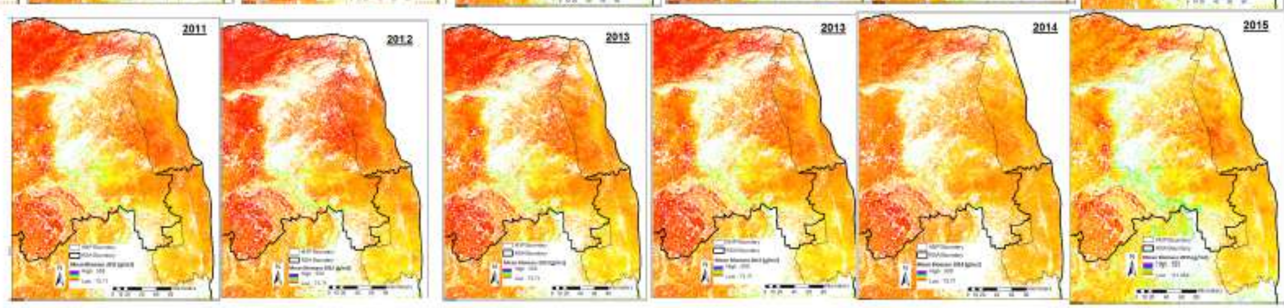


Figure 2: Time series of mean annual biomass data based on 500m spatial resolution MODIS data (2001 – 2015).

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An arid/semi-arid storyline: Spatial-temporal dynamics of savanna ecosystems as a life support system to wildlife and livestock production in and around Kruger National Park (A. Ramoelo)

DPSIR Type	Indicator Variable	Nearest Essential Variable (and originating typology)
State	Herbaceous biomass (g/m^2)	Above ground biomass (ECV)
	Leaf nitrogen (%)	Ecosystem function (EBV)
	Tree biomass (ton/ha)	Above ground biomass (ECV)
	Tree cover (%)	Habitat structure (EBV)
	Habitat structure/type	Habitat structure (ECV)
	Vegetation productivity – LAI	LAI (ECV)
	Precipitation dynamics - Drought	Precipitation (ECV)
	Landscape diversity index	Land cover (ECV)
	Water and carbon fluxes	Evapotranspiration, soil moisture, carbon fluxes (ECV)

Link with Essential Variables

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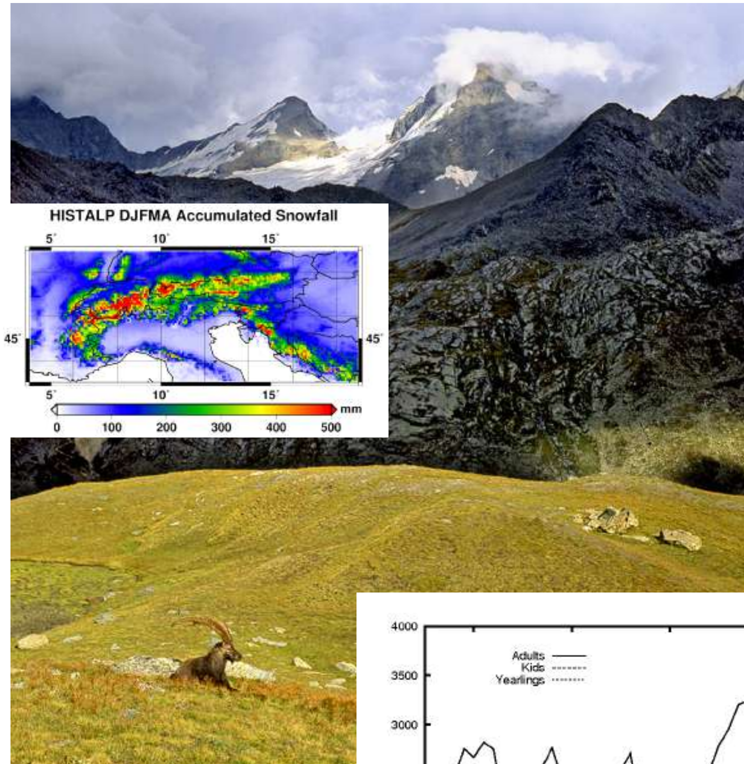
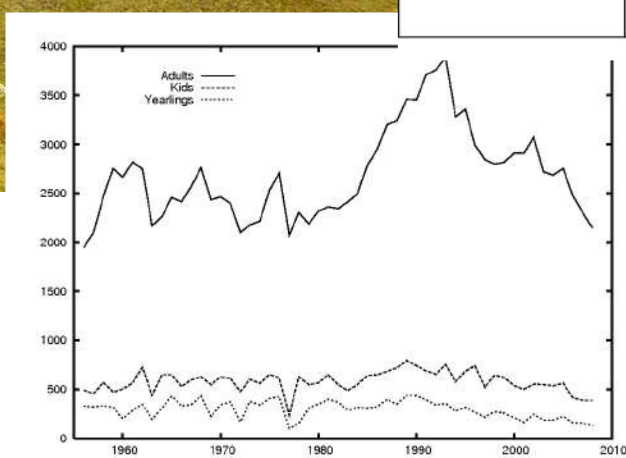
A mountain storyline: high-altitude environments as a life-support system to wild herbivores (S. Imperio, T. Bargmann)



Ecosystem service	Ecosystem property needed to keep / improve the service	Supporting ecosystem characteristics
Sustainable tourism (GPNP, HNP) / hunting (HNP)	• Traditional landscape • Biodiversity • Presence of flagship species (Alpine ibex, chamois, wild reindeer)	• Floristic, arthropod and avian diversity • Wild ungulates distribution and abundance • Disturbance regimes
Habitat for rare and/or endemic species and/or of cultural value	• Micro-habitat diversity • Low human disturbance rates (tourism, pollution, land management)	• Species and community population dynamics • Phenology • Precipitation and temperature regimes • Disturbance regimes
Food production	• Cattle (GPNP), sheep (HNP) • Wild meat production (reindeer, grouse, fish)	• Gross primary production • Plant forage value
Water provision	• Soil moisture • Water budget	• Precipitation and temperature regime • Soil water content • Evapotranspiration
Carbon balance/storage	• Carbon cycling between soil, vegetation and atmosphere	• CO_2/CH_4 exchanges • Soil organic carbon • Resilience to extreme events and to soil freeze–thaw cycles



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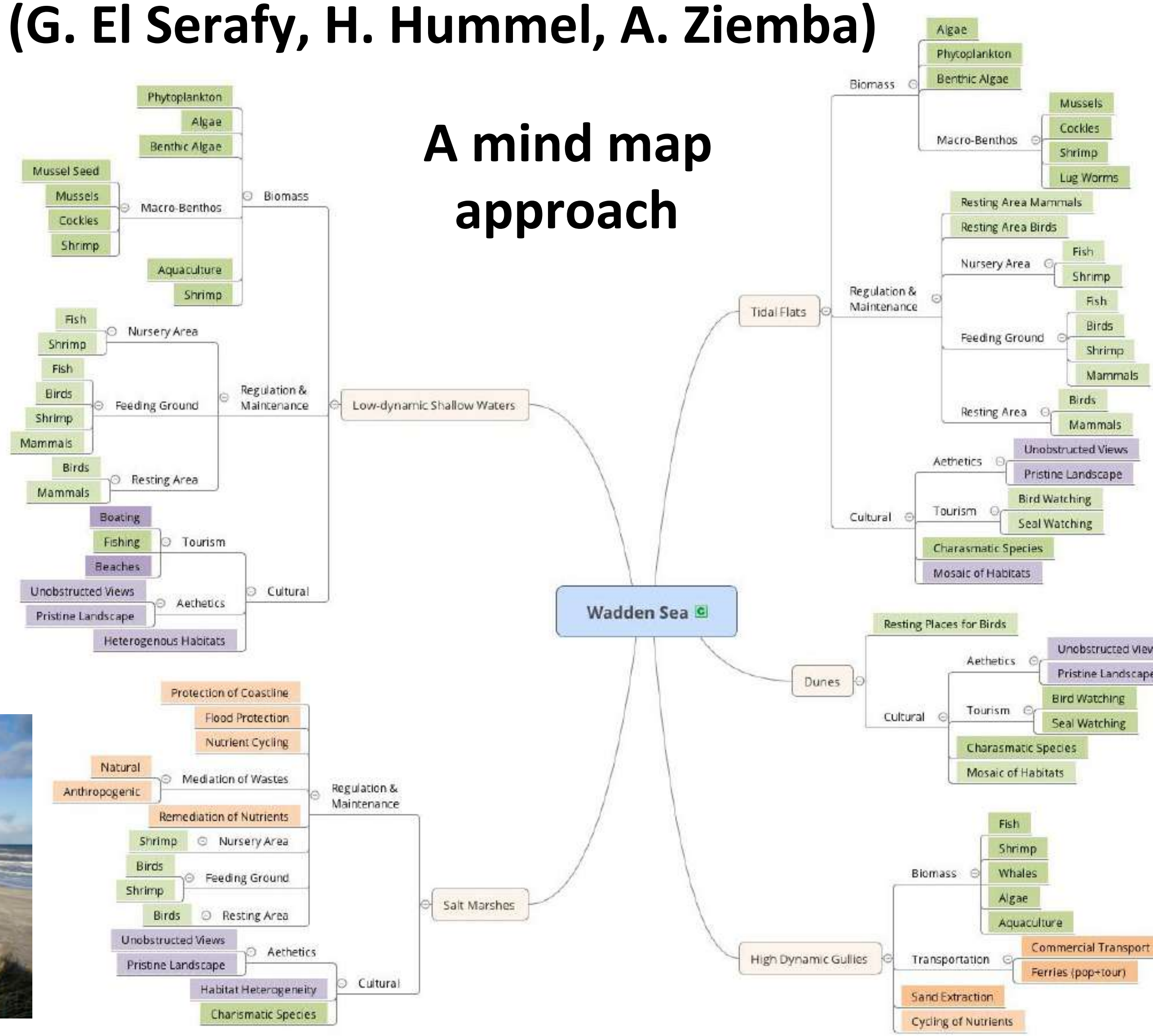
A coastal storyline: the Wadden Sea improving coastal lagoon benefits under multiple pressures (G. El Serafy, H. Hummel, A. Ziemba)

A mind map approach



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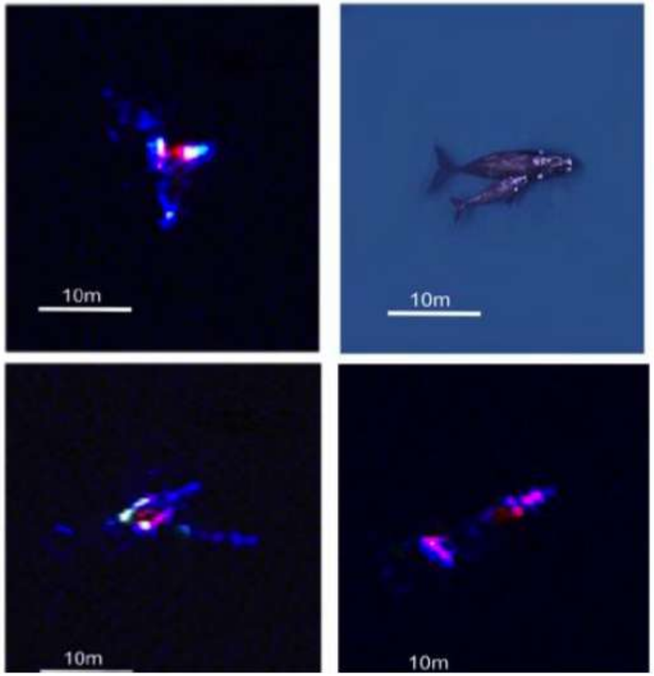
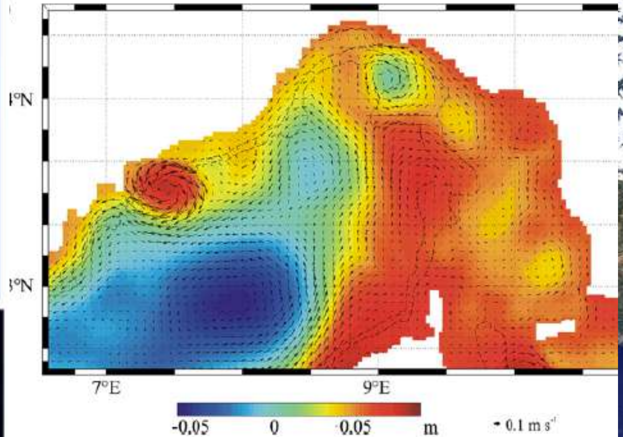
A marine storyline: the Pelagos sanctuary (V. Drakou, L. Pendleton, W. Appeltans)



Southern Right Whales in Valdes Peninsula, captured with WorldView3 images from Digital Globe – © British Antarctic Survey/Digital Globe



Fin Whale observed in the Pelagos Sanctuary – Photo ©: F. Bendinoni – Thetis Research Institute

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A freshwater storyline:
ESS approach for the sustainable management of Lake Ohrid
(S. Giamberini, O. Tasevska, I. Baneschi)

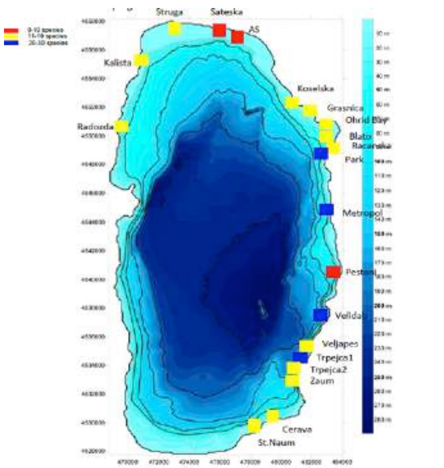
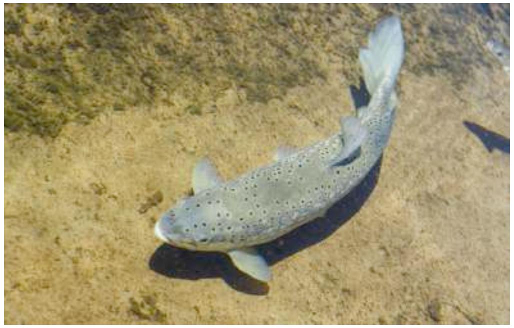
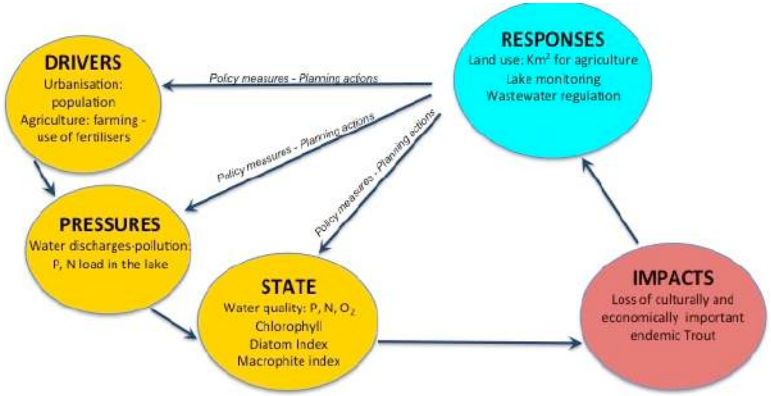
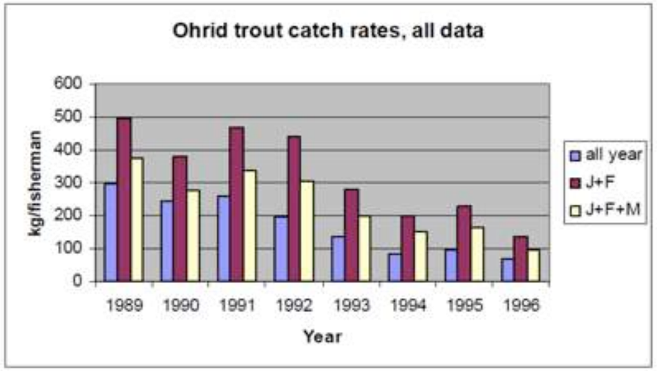
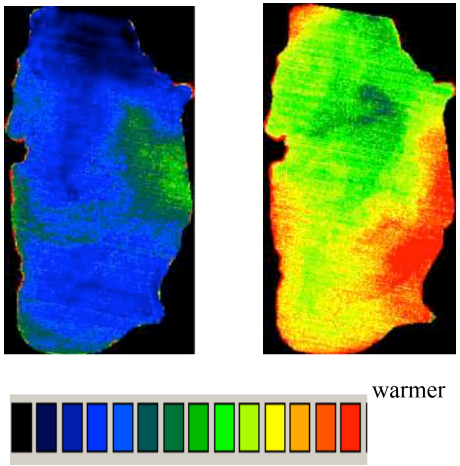


Figure 7. Distribution of the endemism of the macroinvertebrates in Lake Ohrid









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Research themes requiring and triggering integration (to be extended in GEO ECO)

An emerging thread: ongoing changes in PAs

Meteo-climatic drivers from gridded and local data

LC/LU, vegetation, turbidity, chlorophyll-a and other info from Remote Sensing

In situ data on ecology/biology/pop.dyn./ geomorphology/hydrology/water

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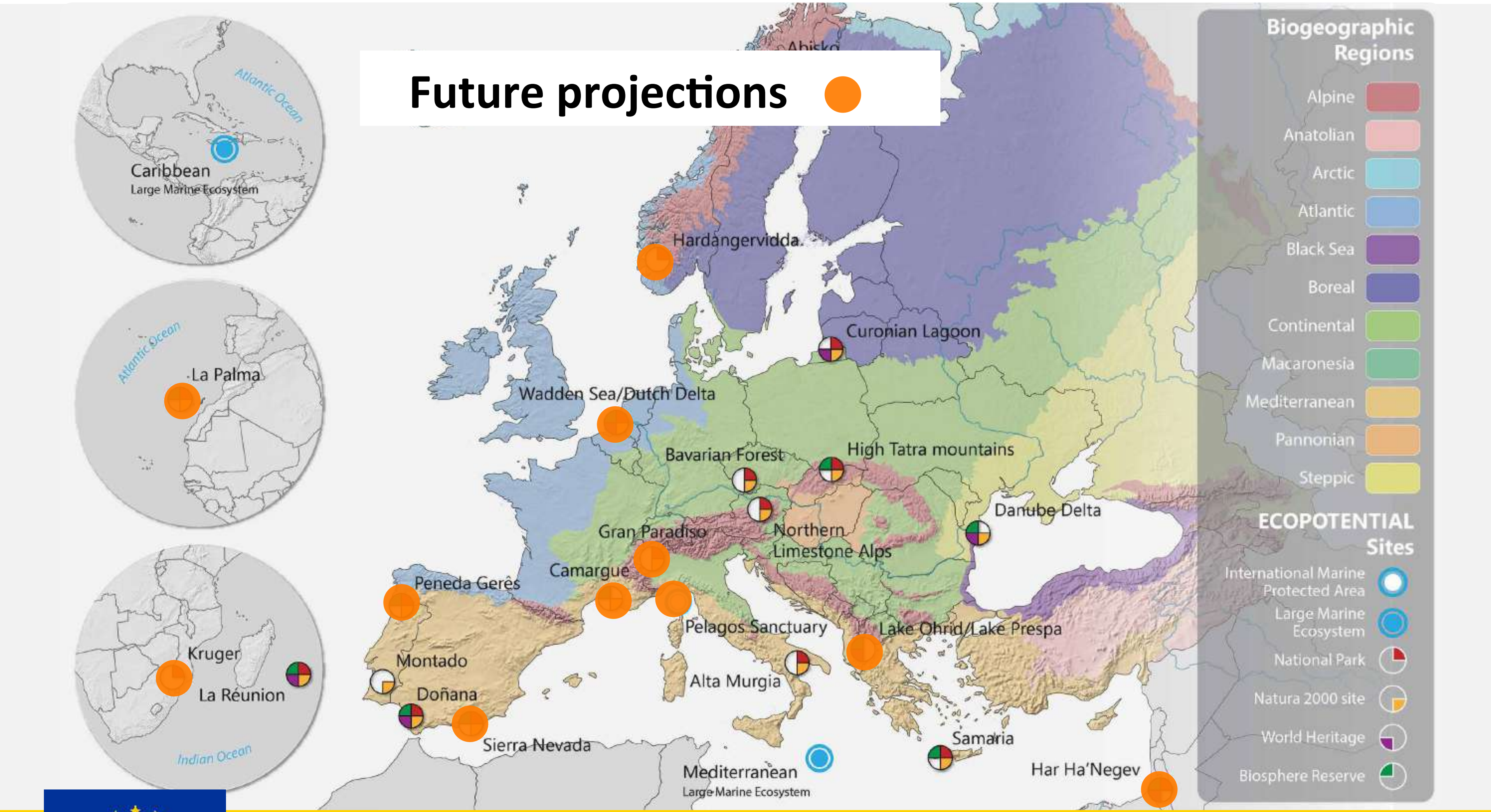
Working in partnership with 23 Protected Areas in Europe and beyond



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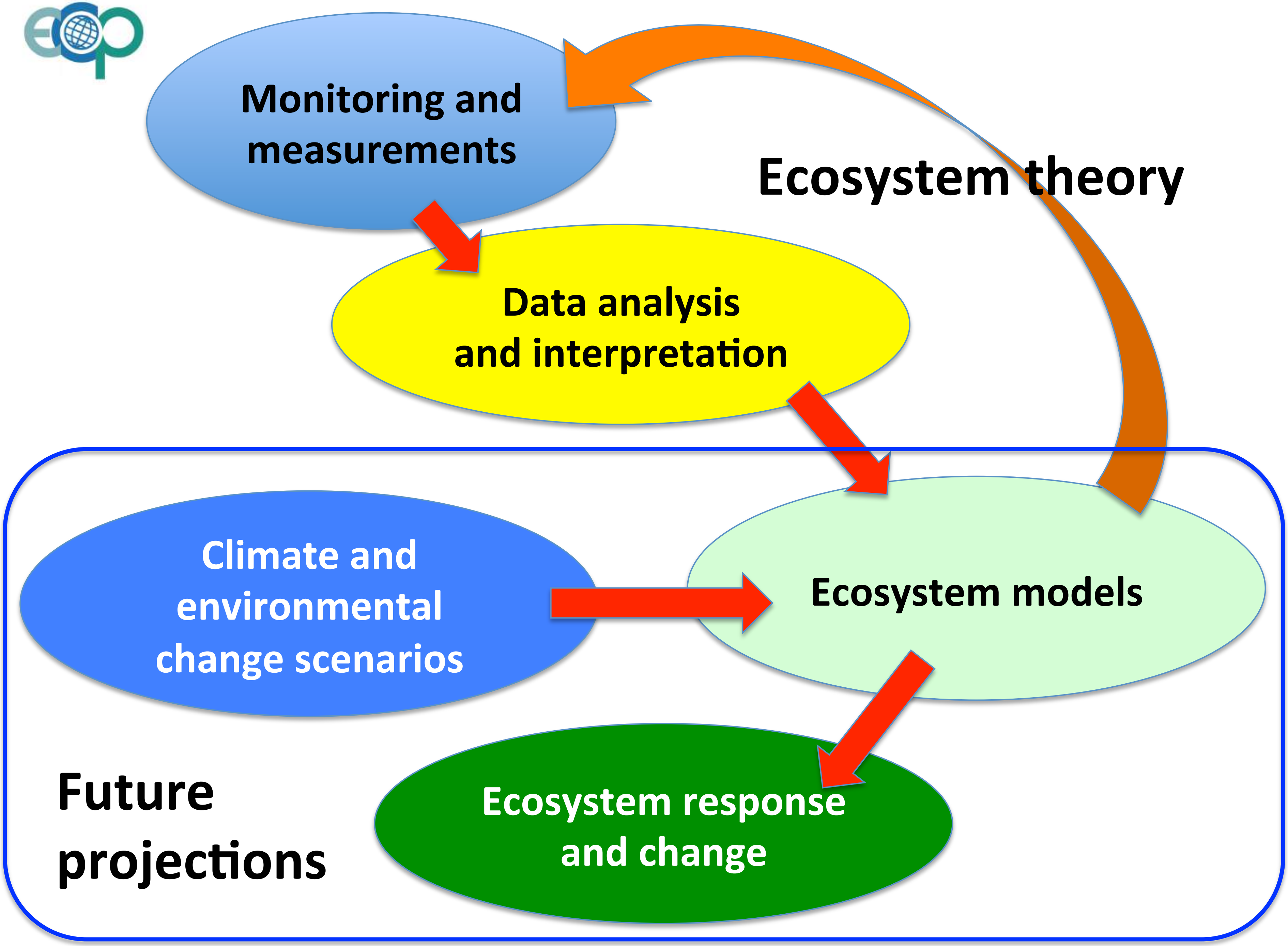
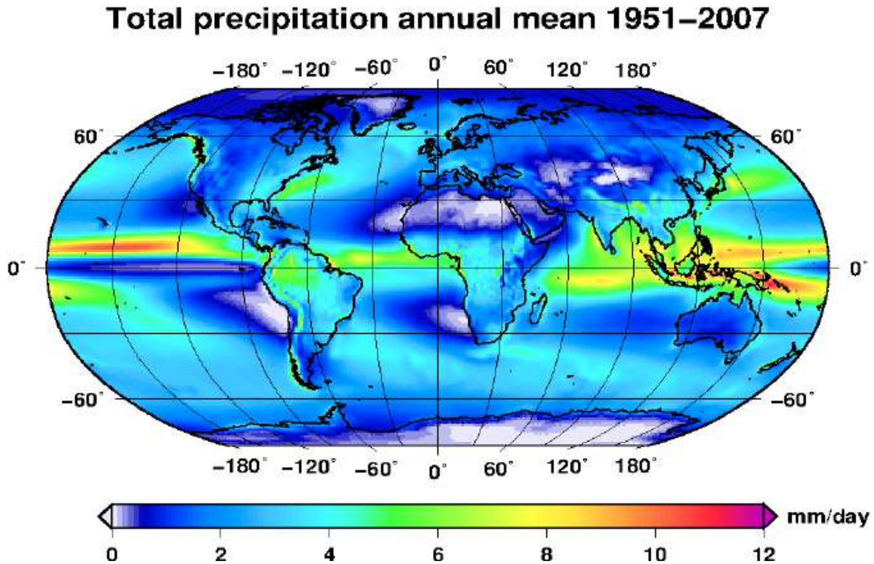


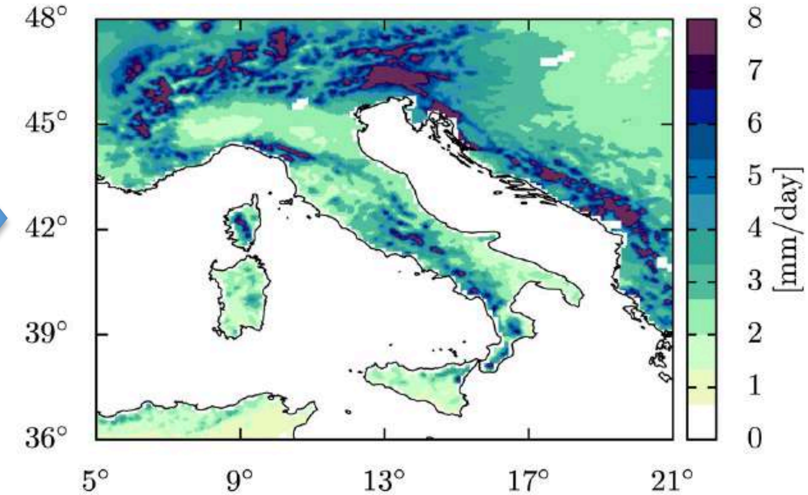
Monitoring and measurements
Ecosystem theory
Data analysis and interpretation
Climate and environmental change scenarios
Ecosystem models
Future projections
Ecosystem response and change

Scale mismatch: the downscaling-impact chain

Global climate model



Regional climate model



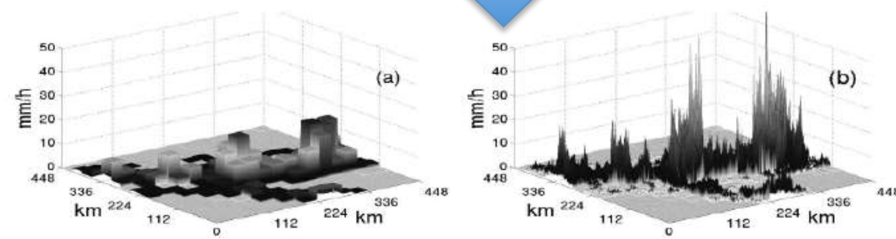


FIG. 10. (a) A snapshot of the forecasted rain field obtained from the LAM forecast and (b) one example of a downscaled field obtained by application of the RainFARM. The vertical scale indicates precipitation intensity (mm h^{-1}) and it is the same for the two fields.

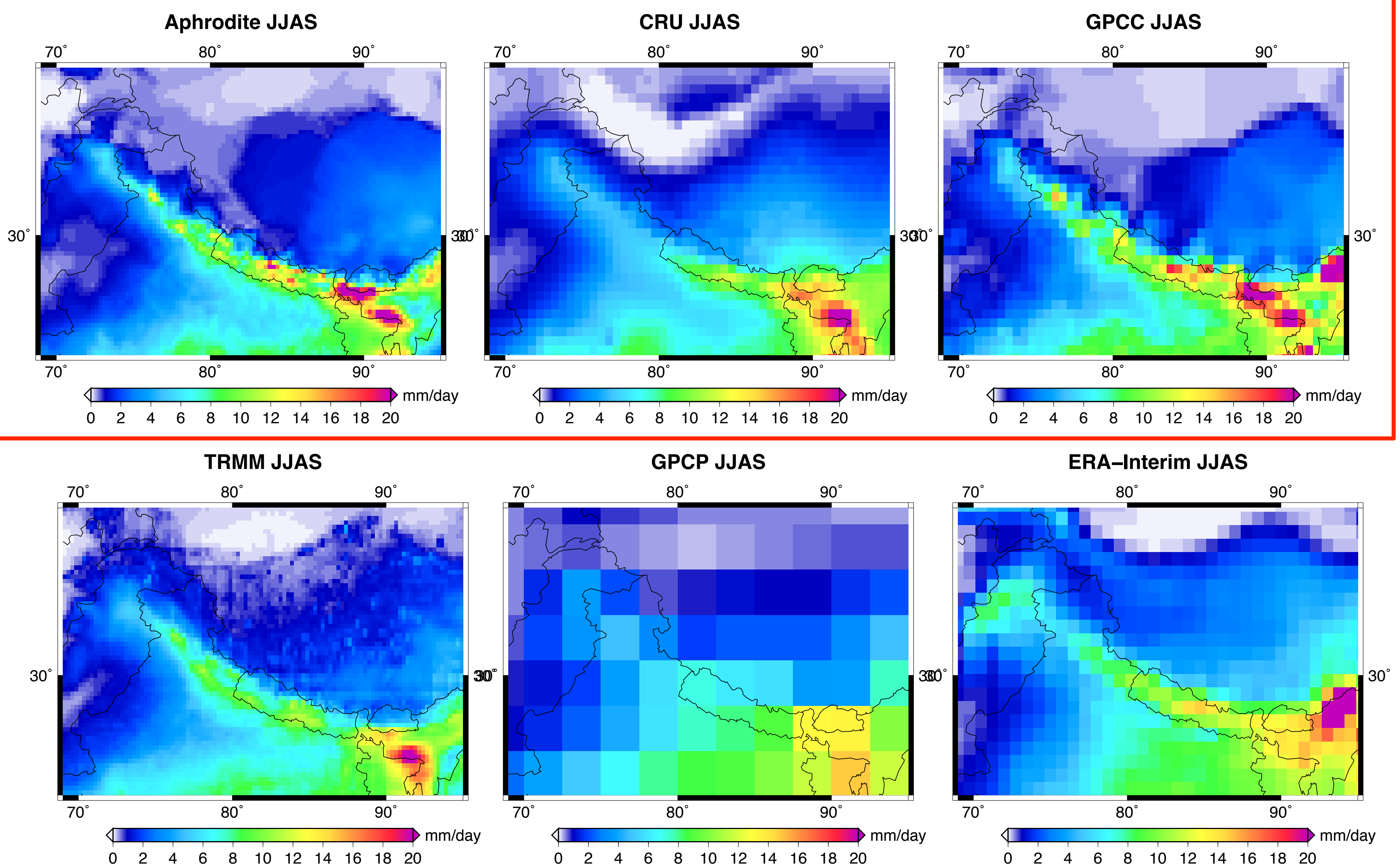
Statistical/stochastic downscaling

Impact on eco-hydrological processes


Troubles, oh troubles
(Research themes requiring and triggering integration)

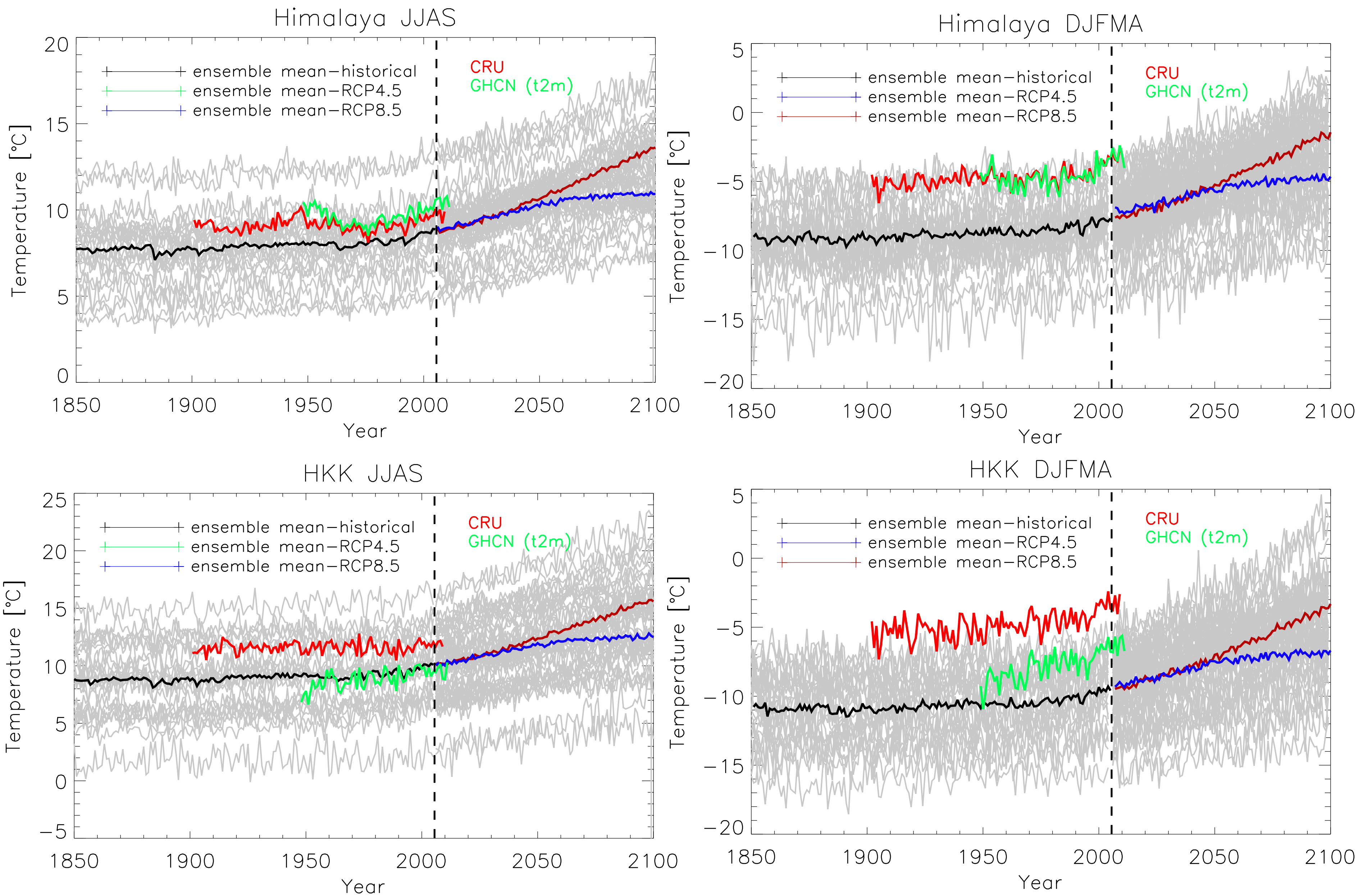
The chain of uncertainties: data for model validation

Summer precipitation (JJAS), Multiannual average 1998-2007

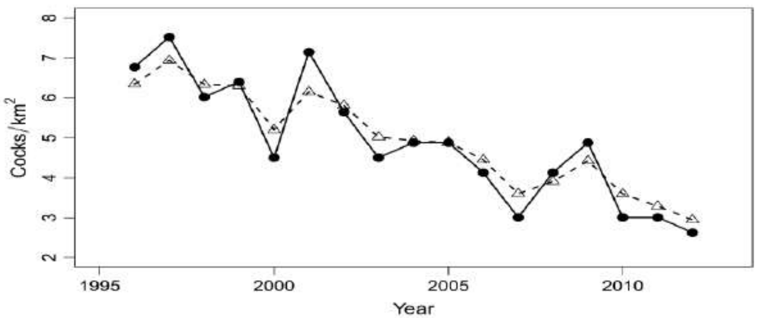


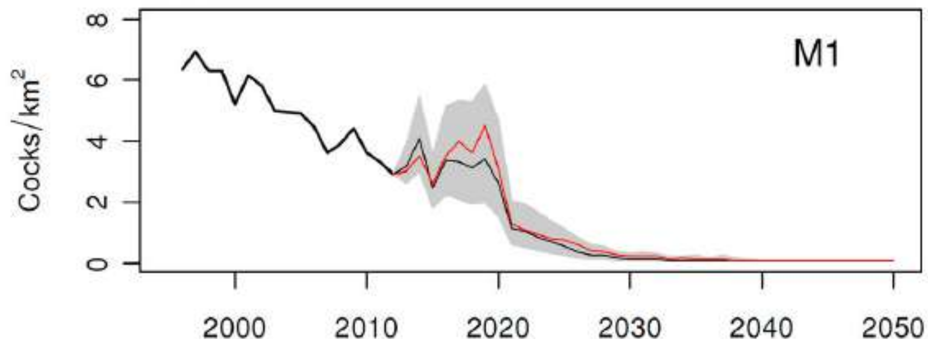
Palazzi E., von Hardenberg J., Provenzale A.: Precipitation in the Hindu-Kush Karakoram Himalaya: Observations and future scenarios, JGR 2013

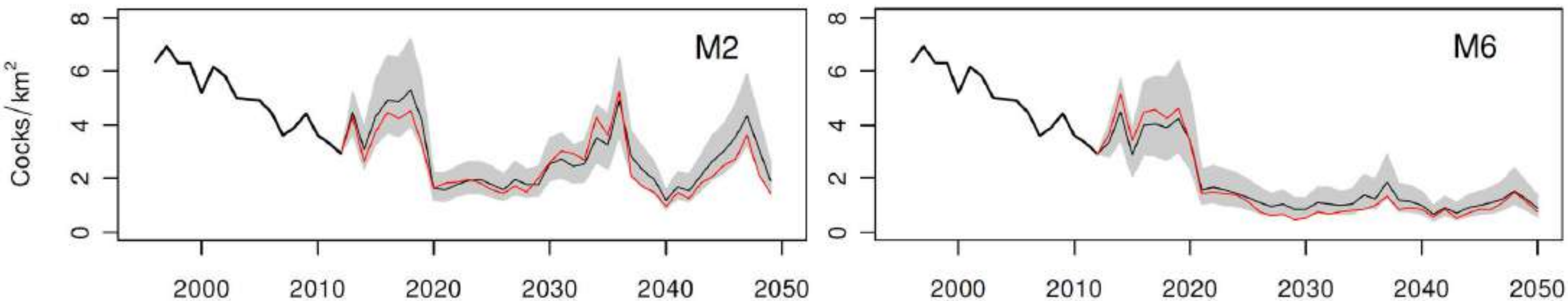
the spread of CMIP5 temperatures



Statistical uncertainties in ecological models







Model	Intercept	lnN_{t-1}	lnN_{t-2}	SE_{t-1}	SS_{t-1}	SP_t	$T(July)_{t-1}$	$P(July)_{t-1}$	$T(Jan-Mar)_t$	$T(Apr-May)_t$	var.	R^2	AICc
M1	-0.07±0.04			**-0.19±0.04**	**-0.18±0.04**						2	0.78	-50.53
M2	0.34±0.24		-0.25±0.14	**-0.19±0.04**	**-0.19±0.04**						3	0.83	-50.20
M3	-0.07±0.04			**-0.19±0.04**	**-0.18±0.04**			0.05±0.03			3	0.82	-49.28
M4	-0.07±0.04			**-0.19±0.04**	**-0.17±0.04**		-0.05±0.04				3	0.81	-48.51
M5	-0.07±0.04			**-0.20±0.04**	**-0.18±0.04**				-0.03±0.04		3	0.79	-47.28
M6	0.08±0.26	-0.10±0.16		**-0.18±0.04**	**-0.17±0.04**						3	0.78	-46.98

Simona Imperio, Radames Bionda, Ramona Viterbi, Antonello Provenzale,
Alpine Rock Ptarmigan, PLOS One, 2013

ECOPOTENTIAL conceptual threads

- Addressing the **scale mismatch** between climate projections and ecosystem response (downscaling and upscaling)
- Propagation and estimate of **uncertainties** in ecosystem projections
- Role of changing **climate extremes** and driver intermittency
- Coupled geo-eco dynamics and the interplay of **geomorphology and ecosystem dynamics**
- How are PAs **identified and selected**

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ECOPOTENTIAL workshop

with ECOP researchers and PA staff

San Rossore Natural Park (Pisa), 2-5 May 2017

Discuss research needs, data needs as driven by conservation questions

Foster use of Remote Sensing observations in PA management and conservation

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Interaction with the US Community:

ECOPOTENTIAL – LIFE meeting

(LIFE: Linked Institutions for Future Earth)

UCI Irvine, November 2016

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ECOPOTENTIAL contribution to GEO/GEOSS:

GEO ECO – the GEO Global Ecosystem Initiative: Extend the ECOPOTENTIAL approach at global level (in particular: long-term changes in PAs)

Creation of a GEO Ecosystem Community of Practice: User-driven questions/issues

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