ALICE project - Towards a bette

BGIN POLICY ISSUES

developing tools to characterise bIodiversity and eCosystem sErvices

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IH cantabria

Interreg Atlantic Area

European Regional Development Fund

EUROPEAN UNION

ATLANTIC AREA PROGRAMME 2014-2020

Interreg Atlantic Area

European Regional Development Fund

Priority 4: Enhancing biodiversity and the natural and cultural assets

ERDF: EUR 52.6 million

This priority will serve the identified need of protecting the environment and promoting cultural identity in order to make the Atlantic region a more attractive place for local communities and visitors. Securing its vast natural heritage and the richness of the existing natural resources, as well as further protecting the cultural heritage that gives the Atlantic Area its unique character will be key for promoting a sustainable economic and territorial development. This priority has two objectives:

Objective 4.1: Improving the protection of biodiversity and enhancing ecosystems' services

Support cooperation in the field of environmental and natural resources management. The common challenges to tackle here are the following: acquiring an in depth knowledge of the Atlantic ecosystems, their wealth and their vulnerability, and the conditions for their preservation in connection with the development of new marine and land activities.

Some examples of actions to be supported:

- ✓ Development of pilot actions to test new solutions and methods concerning the preservation and restoration of biodiversity;
- ✓ Development of methods for quality monitoring and enhancement of the coastal and inland waters;
- ✓ Development of collecting and disseminating natural environmental data (environmental observatory network), modelling aimed at improving forecasts and environmental management.

Objective 4.2: Enhancing natural and cultural assets to stimulate economic development

Support ways to exploit and preserve the natural and cultural heritage as a key element of the Atlantic Area identity. The intention is to promote cooperation in order to generate new sources of wealth and a sustainable development of the area. A specific emphasis is placed on locally based actions, with the involvement and empowerment of local communities and local authorities, therefore playing a key role in bringing concrete benefits to their territories.

Some examples of actions to be supported:

- ✓ Development of joint actions to preserve the cultural and natural heritage;
- ✓ Enhancement of the attractiveness of traditional economic and productive activities, jobs and services;
- ✓ Practical on-the-ground demonstrations of new techniques and processes and of best practices.

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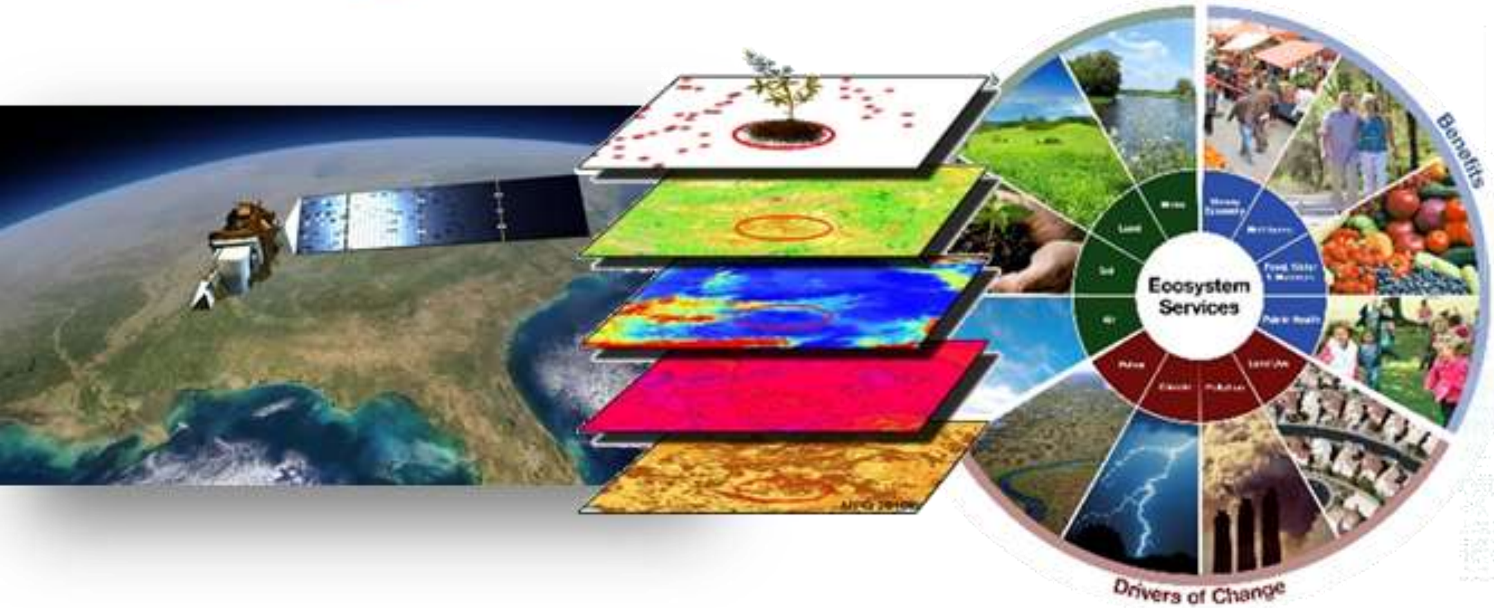
www.project-alice.com

Improving the management of ATLANTIC LANDSCAPES: accouting for biodiversity and ecosystem services

ALICE



From satellite data to collaborative management

An innovative foundation sets **ALICE** apart from existing programs, by integrating social, economic and environmental analytical tools and models

A strong partnership

5 countries ▪ 14 research centres, administration, NGOs and private companies ▪ 12 organizations-stakeholders ▪ 4 key demonstration sites across the Atlantic area

Budget: 2.976.034,16 €

ALICE Project
www.project-alice.com
@ALICE_Interreg

Carlingford Lough

NORTHERN IRELAND

Located on the East Coast of Ireland straddling the border between Northern Ireland and the Republic of Ireland. The case study is a coastal embayment surrounded by mountains.

Couesnon Catchment and Estuary

FRANCE

The Case Study includes the Couesnon river catchment located in North-Western France in the Armorican massif. This small river catchment discharges into the bay of Mont-Saint-Michel.

Paiva River

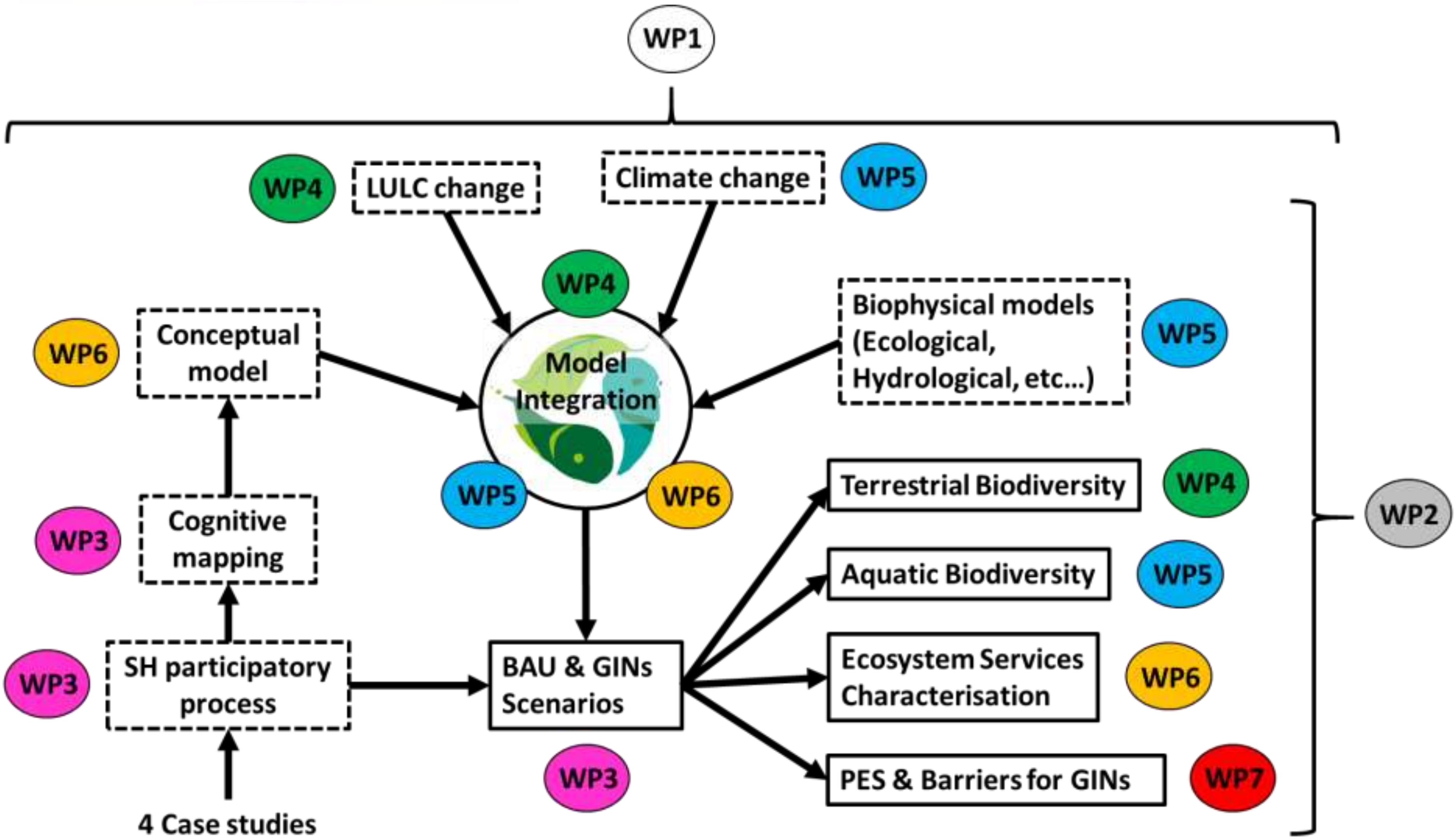
PORTUGAL

Paiva river is a tributary of the Douro, situated in Northern Portugal and it is considered one of the least polluted in Europe.

Pas, Miera & Asón Catchments

SPAIN

The study case encompasses Pas, Miera and Asón river basins and estuaries, located in Northern Spain. The basins are enclosed in the oriental part of the Cantabrian Cordillera.


WP1
WP4
LULC change
Climate change
WP5
WP4
Biophysical models
(Ecological,
Hydrological, etc...)
WP5
WP6
Conceptual model
Model Integration
WP5
WP6
Terrestrial Biodiversity
WP4
WP3
Cognitive mapping
Aquatic Biodiversity
WP5
WP2
WP3
SH participatory process
BAU & GINs Scenarios
Ecosystem Services Characterisation
WP6
WP3
PES & Barriers for GINs
WP7
4 Case studies

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INSTITUTO DE HIDRÁULICA AMBIENTAL

ALICE

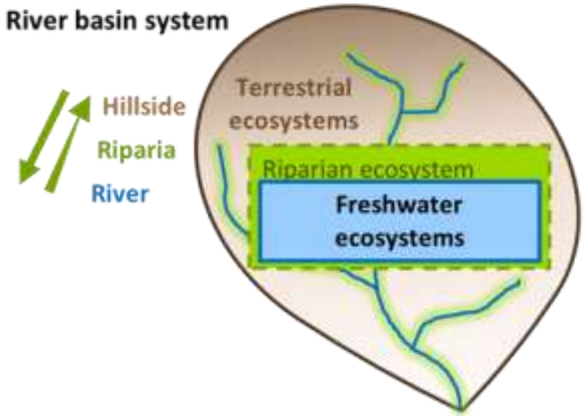
Improving the management of Atlantic Landscapes accounting for biodiversity and eCosystem sErvices

KEY OBJECTIVES

- ✓ Develop a full-package of **new methods, tools and procedures to assist with coastal and inland landscape management**
- ✓ **Targeting and stimulating** BGI investment within the 4 CS **by quantifying the benefits for ES including biodiversity conservation**
- ✓ **Identify solutions for the economic and social barriers**, which may limit **investment in BGI** in each of the 4 CS
- ✓ Provide with **stronger scientific and socioeconomic support** for the **effective implementation of future BGI** and **environmental policy.**

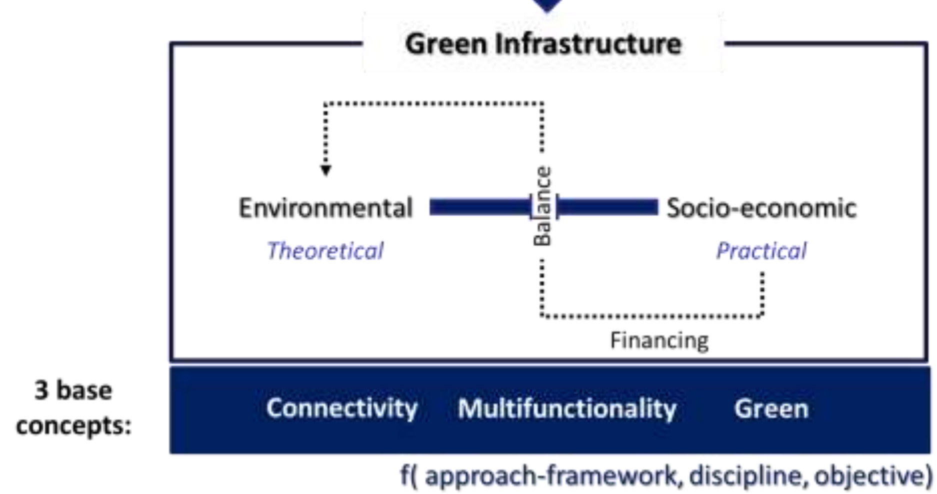
What is Green/Blue Infrastructure Network (BGIN)?

LANDSCAPE STRUCTURE



Biodiversity ⇄ Ecosystem Functioning → - Ecosystem Services

"An ambiguous and essentially contested concept" ***Wright H., 2011***



Where we want to go

GOALS

Contribute to a common methodology to assist local and regional actors with coastal and inland landscape management.

- Designing Blue-Green Infraestructure Networks (BGINs)
- Developing methods to model multiple ecosystem services
- Identifying economic and social barriers on BGINs investments

Blue-Green Infrastructure Network (BGIN) refers to all natural and semi-natural landscape elements that can form a green-blue network. These infrastructures are designed and managed to deliver a wide range of ecosystem services. Restoration of coastline forests, retention of nutrients (to improve water quality), habitat improvement for target species are some of the multiple functions provided by blue and green infrastructures.

Ecosystem Services (ES) are the benefits that humans obtain from natural environment and from properly-functioning ecosystems, such as clean air, purified water and food provision.

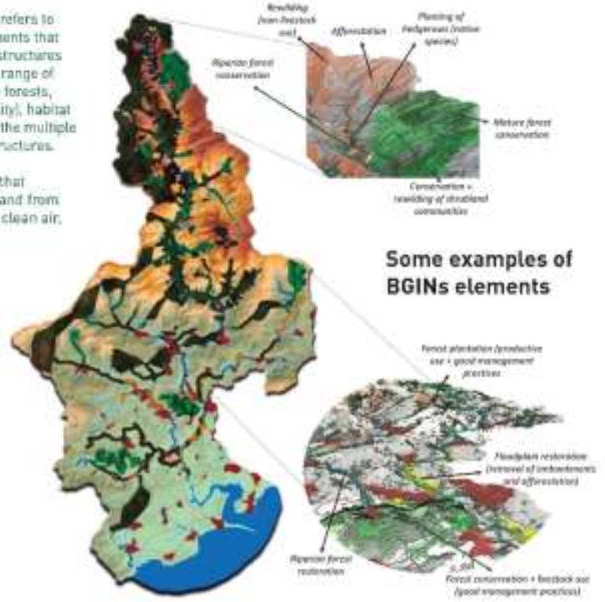
BGIN elements

To be conserved
Hillside ecosystems
Riparian and other lineal habitats

To be restored
Hillside areas
Floodplains
Riparian areas

Water bodies
Water courses

Population centre
Road



Some examples of BGINs elements

How are we getting that

MEANS

Integrate social, economic and environmental analytical tools and models.

- Satellite images, GIS data and modelling frameworks
  MAPPING AQUATIC AND TERRESTRIAL FORMATIONS
- Multi-model platform
  ENHANCING THE PREDICTIVE CAPACITY
- Social learning
  BETWEEN RESEARCHERS AND STAKEHOLDERS

Improving the management of ATLANTIC LANDSCAPES accounting for biodiversity and ecosystem services

ALICE

ALICE partners will work across the four case studies and project work packages, ensuring the use of local knowledge and making models and approaches comparable across countries.

Interreg Atlantic Area

www.project-alice.com | contact@project-alice.com | /aliceinterreg | @alice_interreg

ALICE

_5 countries of the Interreg Atlantic region: Portugal, Spain, France, UK and Ireland.

_14 research centres, NGOs and private companies with skills in Earth and Social Sciences, Economics and Resource Management.

_4 key demonstration sites across the Atlantic area.

An integrative landscape management approach incorporating socioeconomic and climate change scenarios is critical to ensure the suitable investments in Blue-Green Infrastructure Networks and maximise their benefits.

ALICE will identify and provide solutions to overcome the economic and social barriers that may limit investment in Blue-Green Infrastructure Networks and will improve the characterisation of biodiversity and ecosystem services at the land-sea interface of the Atlantic Region and beyond.

OUTPUTS

Practical guidance on Blue-Green Infrastructure Networks (BGINs) investment in coastal, rural and urban planning to increase Ecosystem Services (ES) delivery;

User-friendly integrative modelling platform that facilitates ES evaluation by managers, stakeholders and business communities;

New methods for habitat mapping and conservation monitoring using remote sensing and ecological modelling tools;

Guidance to identify thresholds controlling ES delivery under realistic scenarios of global change;

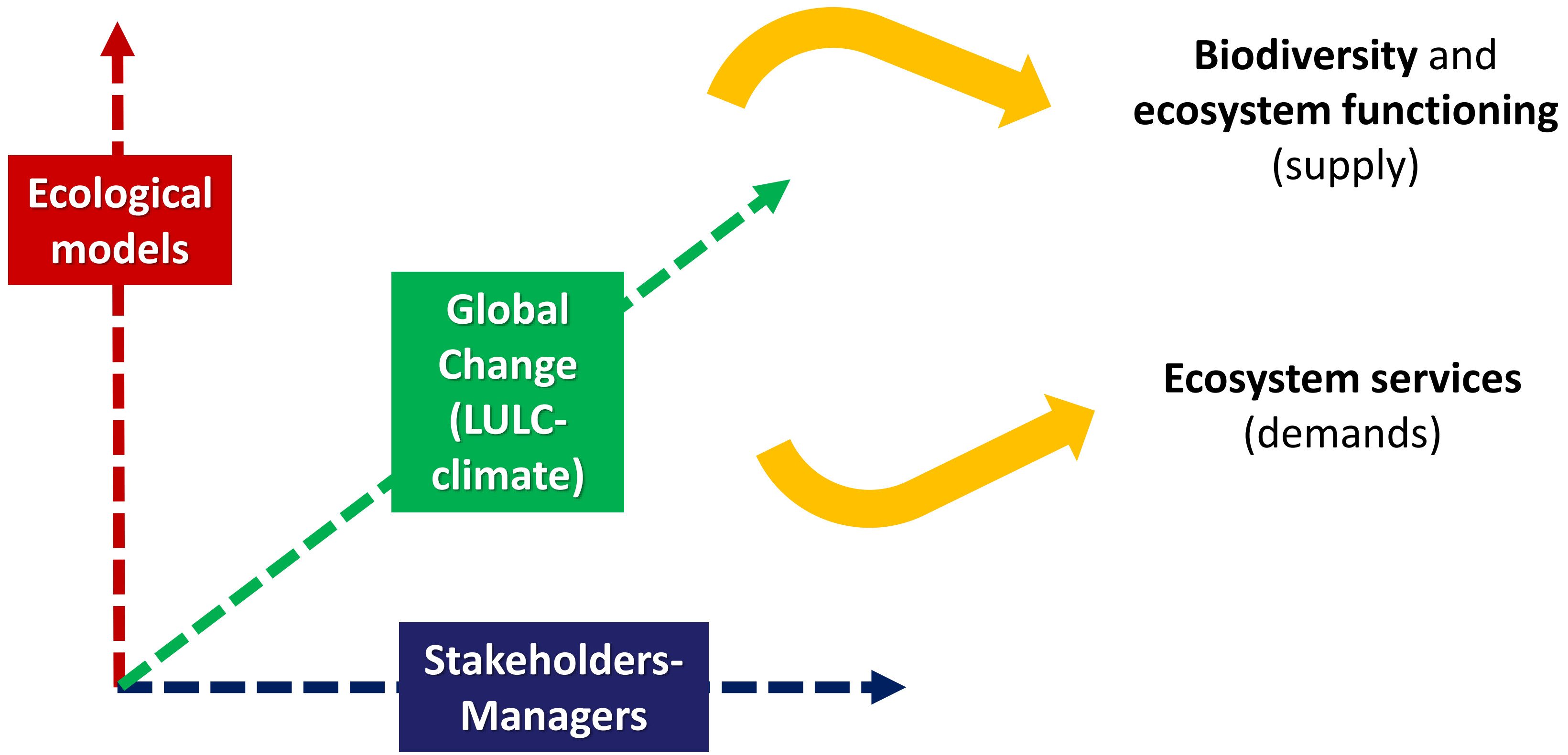
Innovative participatory approaches for decision support to realistically inform environmental policy;

Practical guidance for developing an integrated EU policy agenda such as:

HABITATS DIRECTIVE
COMMON AGRARIAN POLICY
MARINE STRATEGY FRAMEWORK DIRECTIVE
WATER FRAMEWORK DIRECTIVE
FLOOD RISK MANAGEMENT AND EU 2020 BIODIVERSITY STRATEGY

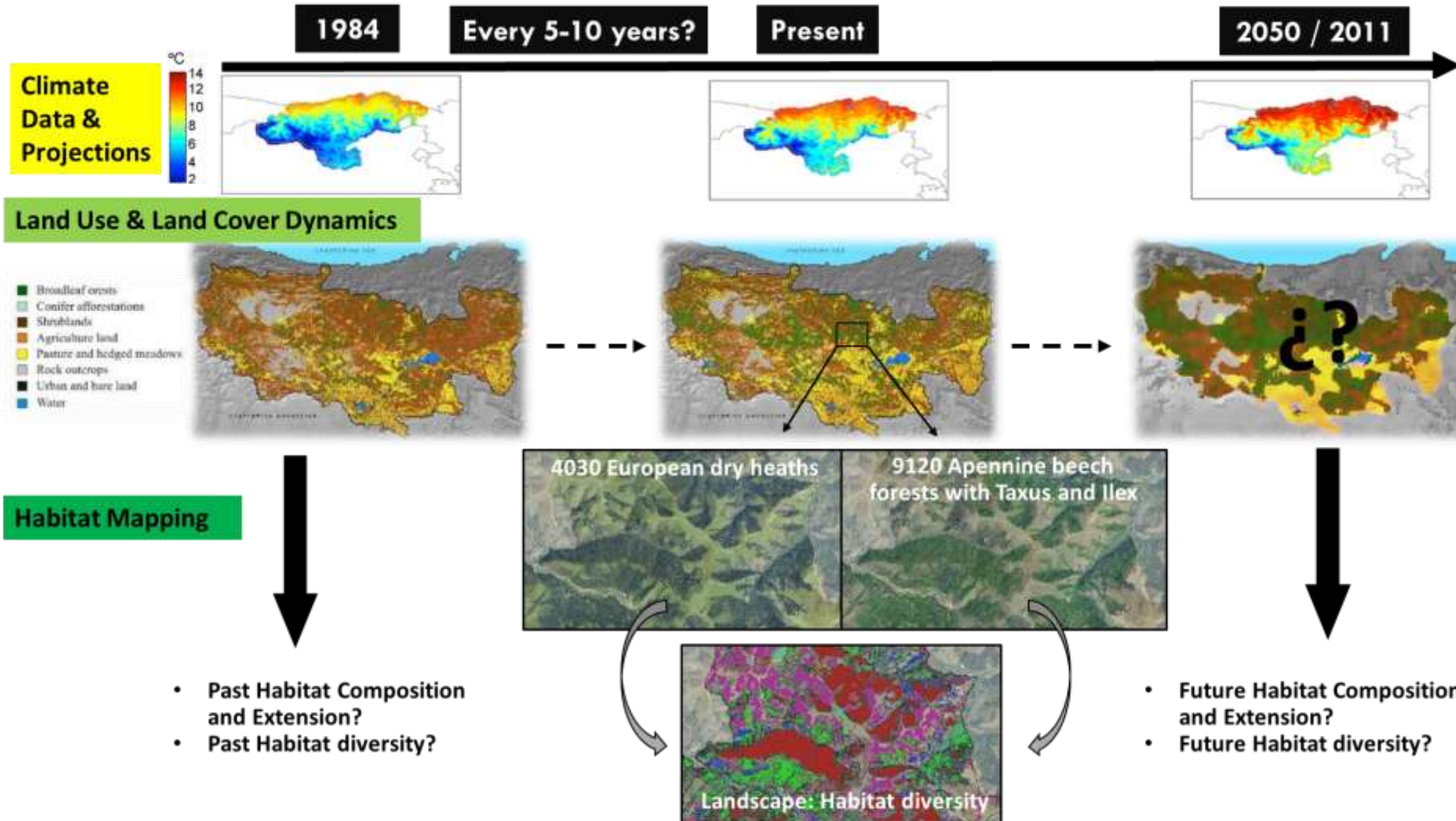
Blue-Green Infrastructures Networks: towards an adaptive territorial management

In our **Global Change context**, BGINs design should be respond to the **main drivers** that control the **landscape evolution**.



What do we need?

Developing a methodology to design **BGINs** for following two main criteria:
the optimization of the **landscape structure** and the **improvement of ecosystem services**



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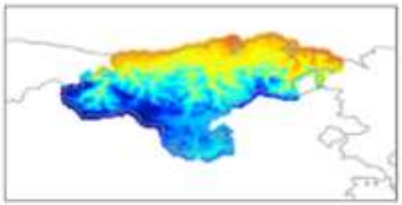
Climate Projections + **Land Use & Land Cover**



→

River and Estuarine Ecosystem models

- Hydrological models
- Flood models
- Water Temperature
- Nutrients (NO_3^4, PO_4^3)
- Suspended solids
- DOM
- Ecological Status (Aquatic biodiversity)

- Land Use & Land Cover
- Habitat Maps
- R&E Ecosystem Models

\+ Selected Green Infrastructure, Scenarios & Case Studies

→

- Ecosystem Service Valuation and analysis of trade-offs
- Terrestrial and Aquatic Biodiversity

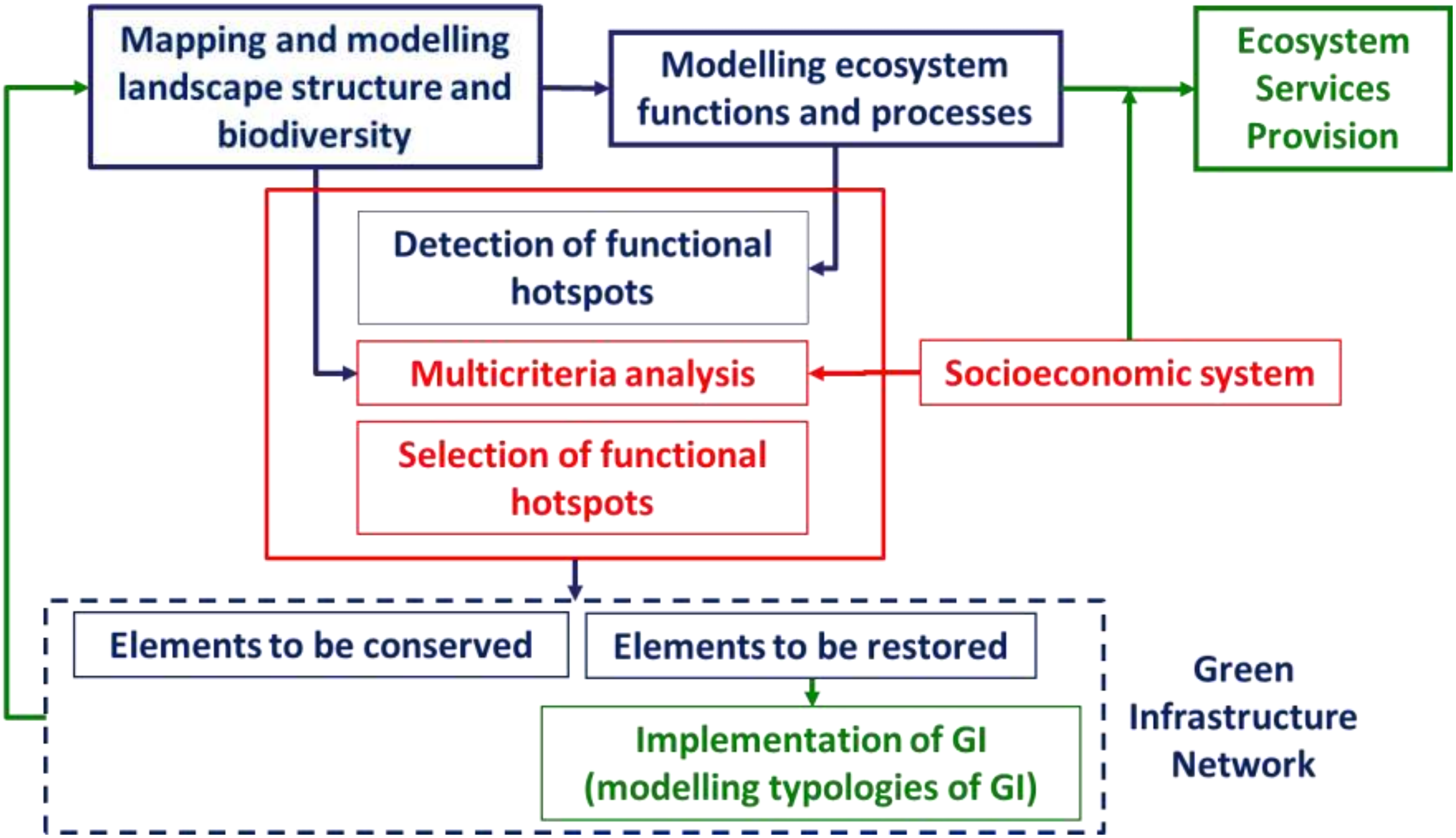
↓

Stakeholder Participation process

↓

Establishment of schemes for payment for ecosystem services and biodiversity conservation

General framework for GIN design and implementation



The ALICE project

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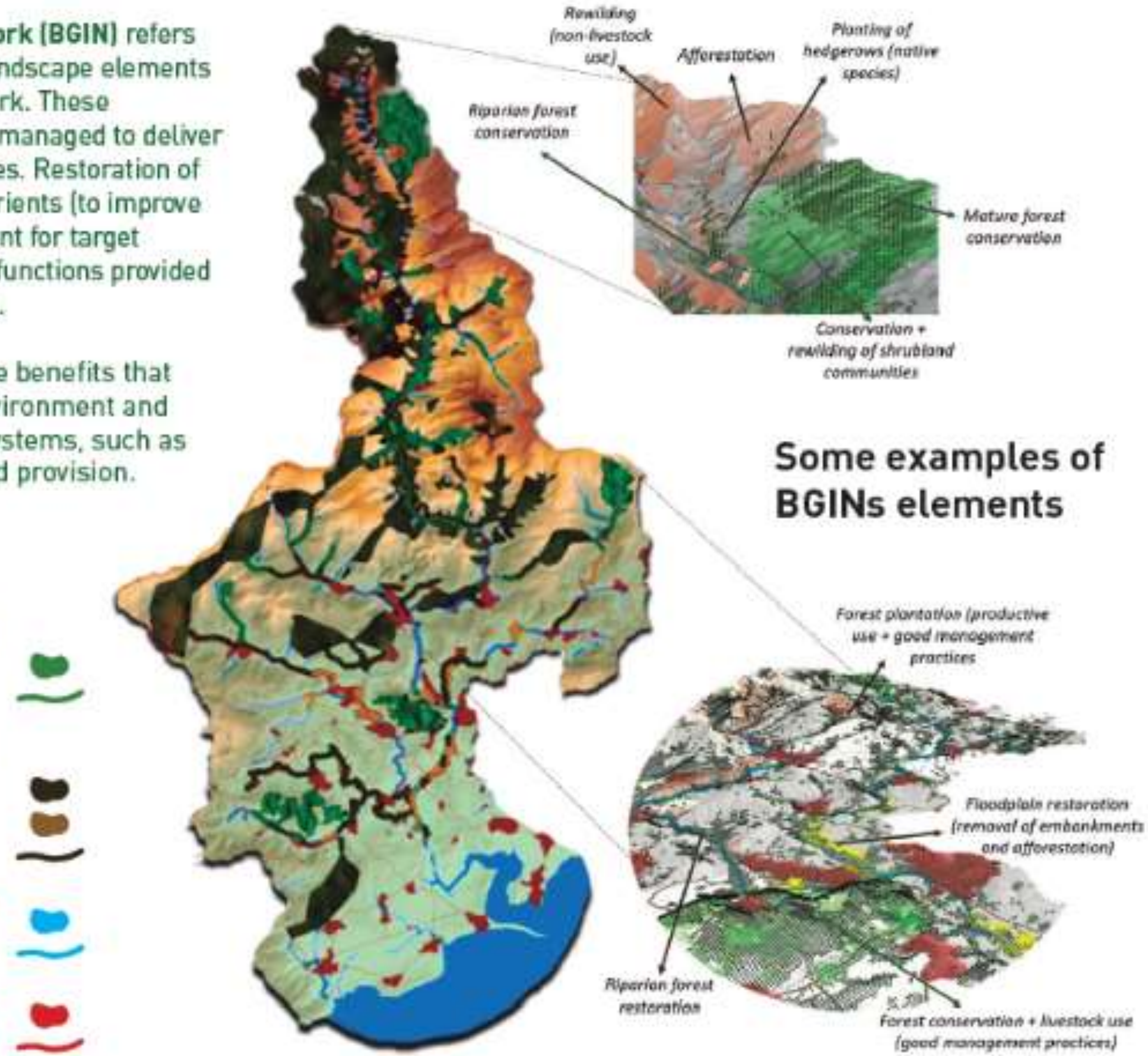
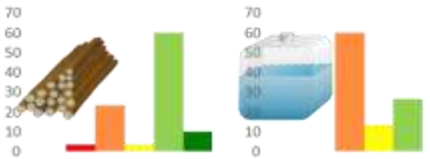


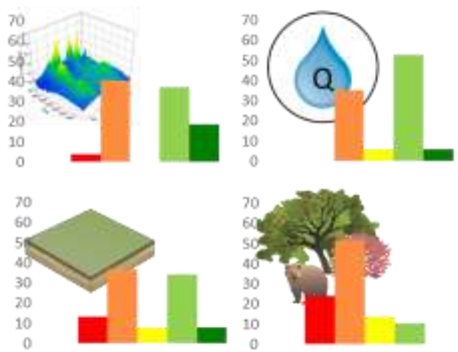
The ALICE project

BGIN

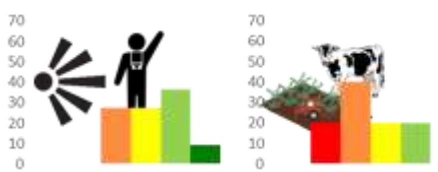
Provisioning



Regulation and Maintenance



Cultural



Ecosystem services

Why ALICE ??

Ecosystem degradation at the EU level

Biodiversity losses

Climate (Global) change

EU strattegy for GI

Year 2013

The ALICE project

National Level advances

Law 33/2015 … 2007,
of December … DE
227, 2015), i… e
concept of " …
introduces in… the
Strategic Fra…
ecological co… g to
the" State St… gical
Connectivity…
objective, co…


ESTRATEGIA ESTATAL DE INFRAESTRUCTURA VERDE Y DE LA CONECTIVIDAD Y LA RESTAURACIÓN ECOLÓGICAS

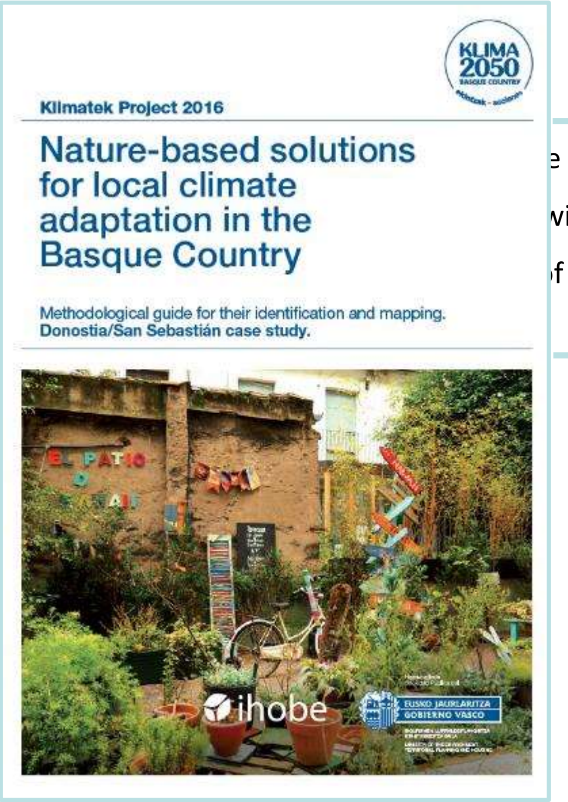
BORRADOR DICIEMBRE 2018

GOBIERNO DE ESPAÑA — MINISTERIO PARA LA TRANSICIÓN ECOLÓGICA

1

First steps at the regional level

Based on … e
Autonom… within a
maximun… f said
Strategy, …


KLIMA 2050

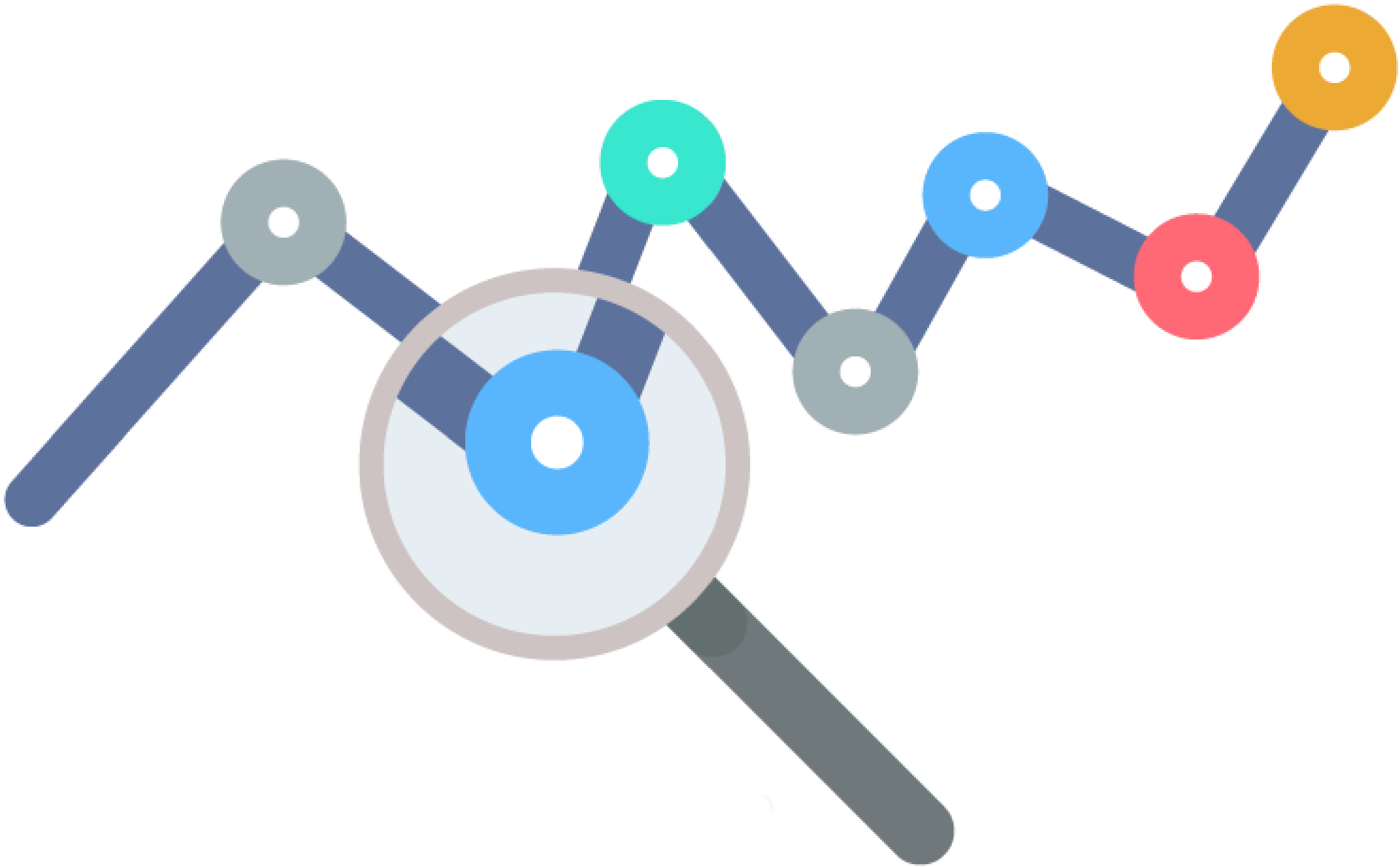
Klimatek Project 2016

Nature-based solutions for local climate adaptation in the Basque Country

Methodological guide for their identification and mapping. Donostia/San Sebastián case study.

ihobe

EUSKO JAURLARITZA GOBIERNO VASCO



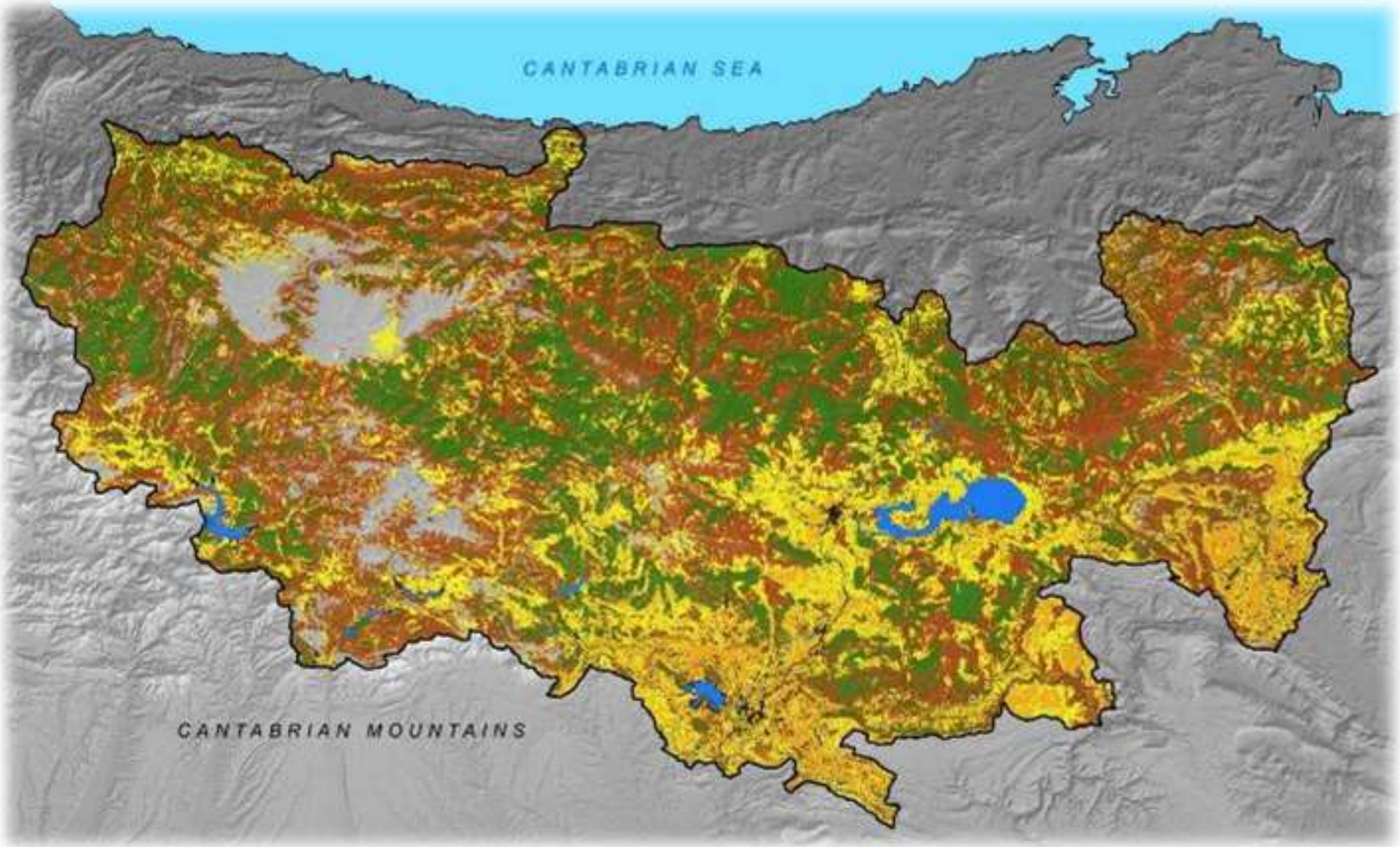
Landscape structure

Patterns, process and dynamics


RESEARCH ARTICLE

Modelling the area of occupancy of habitat types with remote sensing

1 | INTRODUCTION



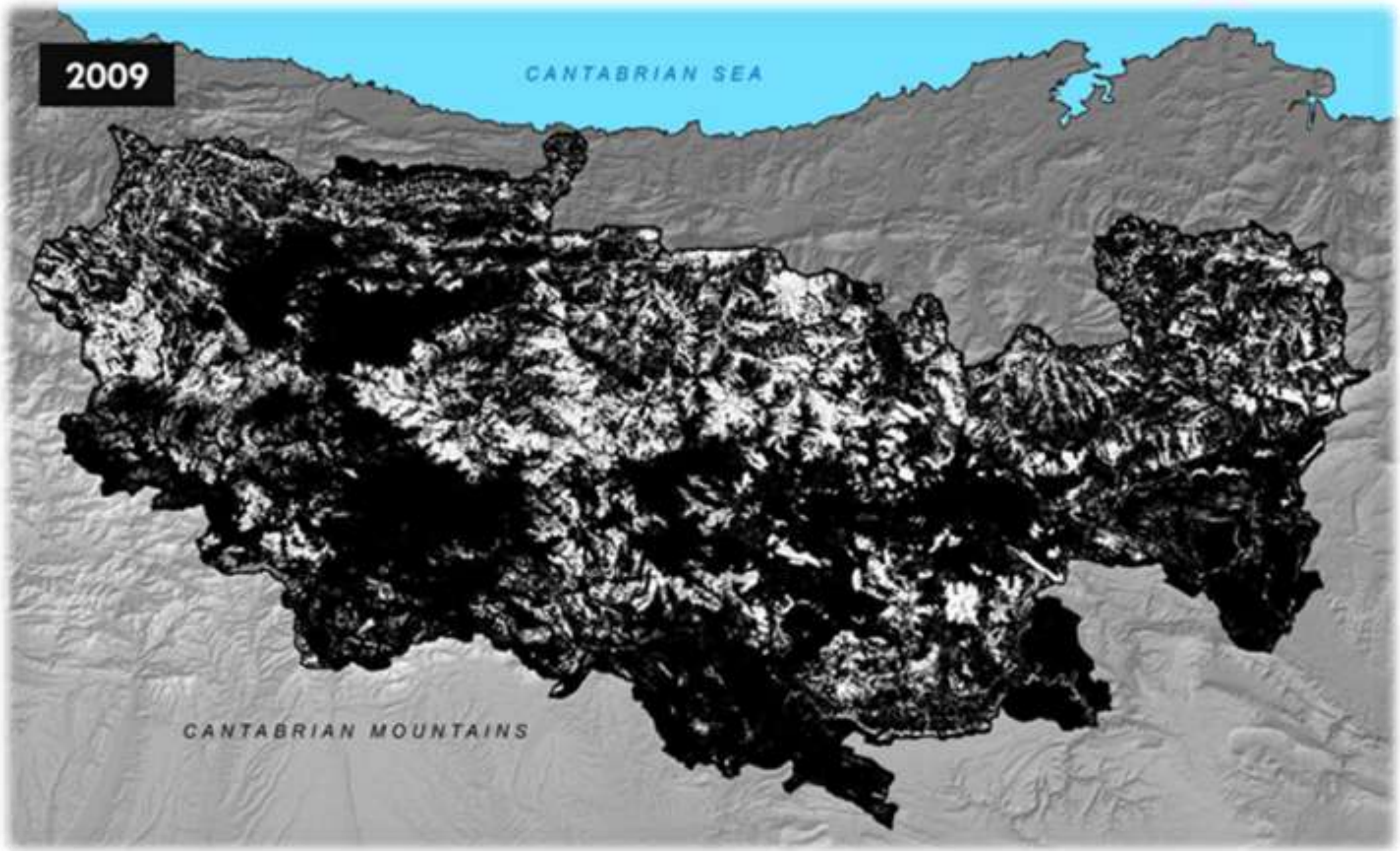
- Broadleaf orests
- Conifer afforestations
- Shrublands
- Agriculture land
- Pasture and hedged meadows
- Rock outcrops
- Urban and bare land
- Water

Classification of land cover using a Landsat image from 2010 (see Álvarez-Martínez et al., 2017)

Landscape structure

Patterns, process and dynamics


Modelling the area of occupancy of habitat types with remote sensing



low 0.1 1.0 high

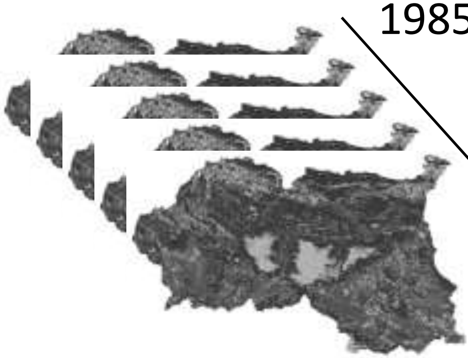
Classification of land cover using a Landsat image from 2010 (see Álvarez-Martínez et al., 2017)

Landscape mapping

Landscape structure

Business as Usual

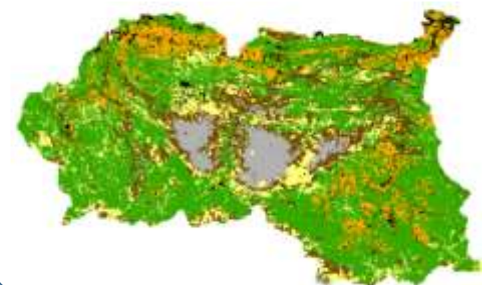
1985



2010

Socio-economic inputs

Spatial resolution:
30m



LANDSAT (1985 – 2010)
Land uses changes (píxel)

Obtaining: **trend lines** and **land change rates**

Land cover/use legend

- Mature broadleaf forest
- Young broadleaf forest
- Coniferous forest/plantation
- Shrubs
- Pastures
- Agrarian
- Rocks
- Urban
- Water

Landscape mapping

Traditionally: visual interpretation and digitalization

SIOSE: Sistema de Información sobre Ocupación del Suelo de España (CNIG)

CLC (CORINE): CoORdination of INformation of the Environment (EEA)

Land use-land cover typologies

Vectorial format

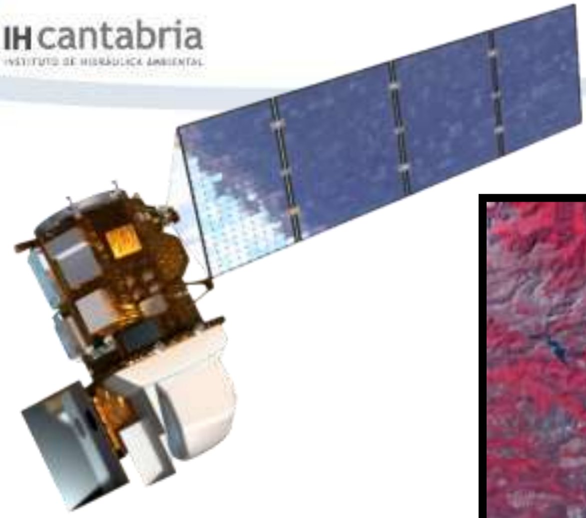
'Homogeneous' land cover patches

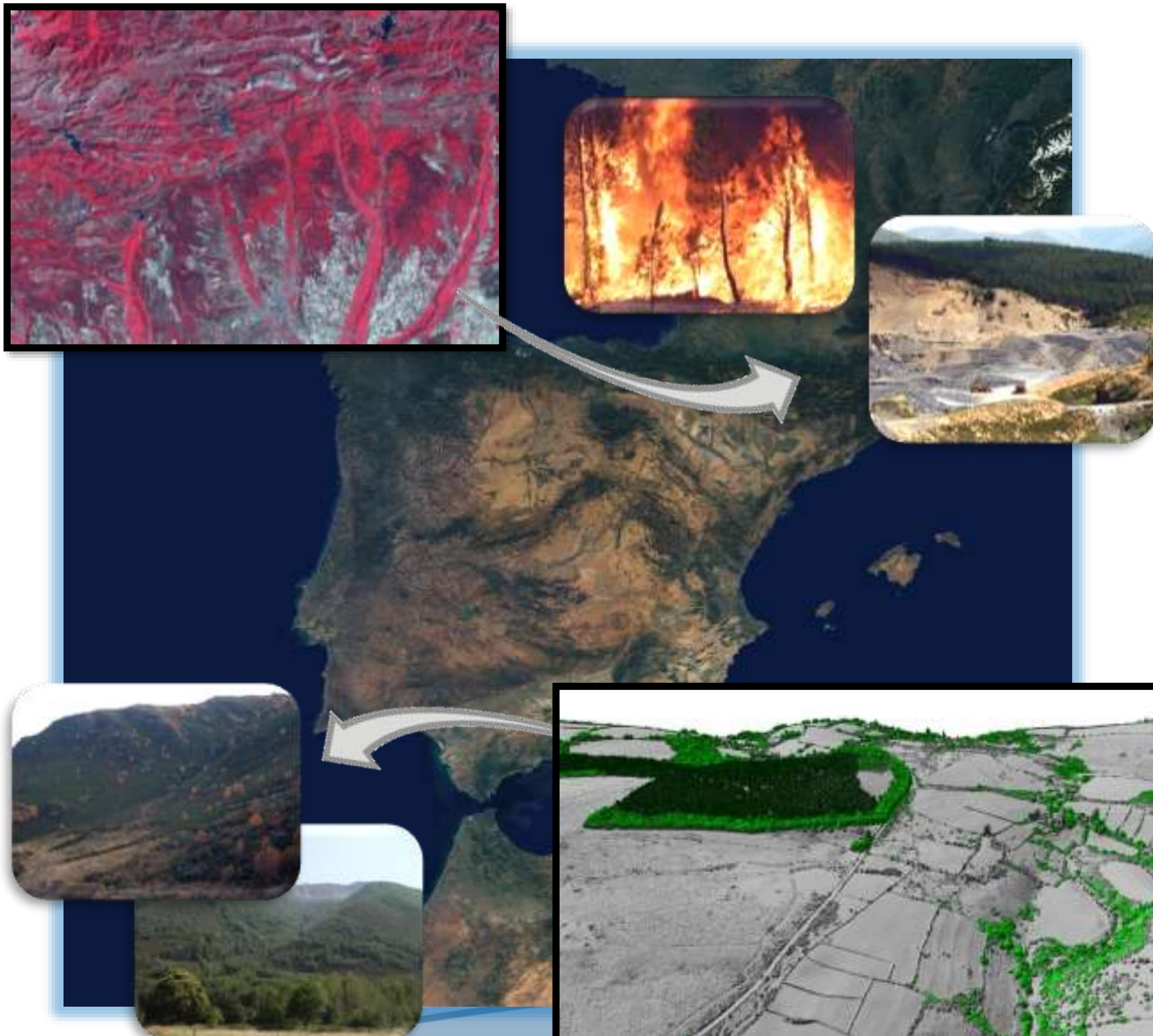
Restricted or null temporal resolution

Habitat mapping

Many classes are similar in structure but not in composition and function

Habitat mapping



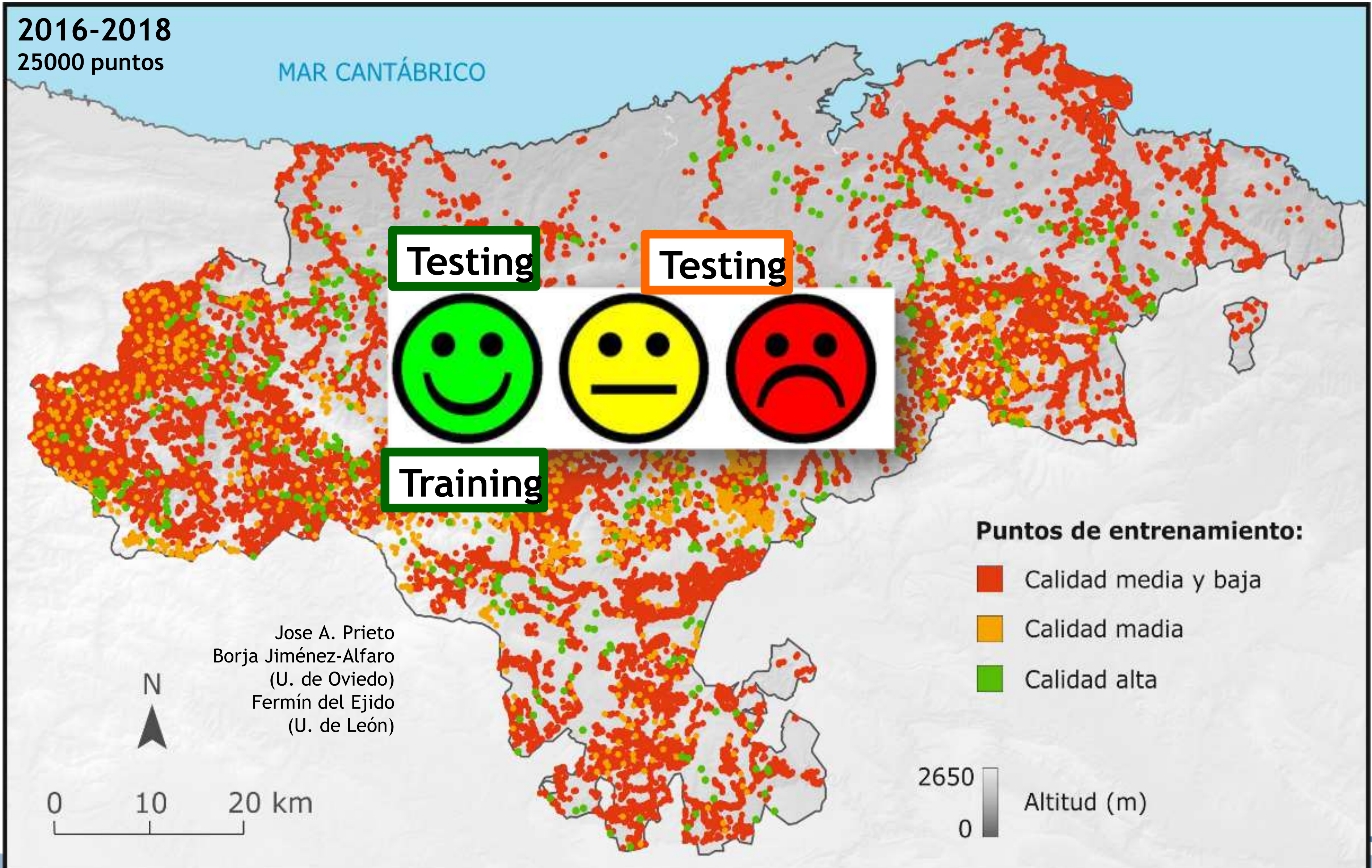


Remote Sensing (RS)

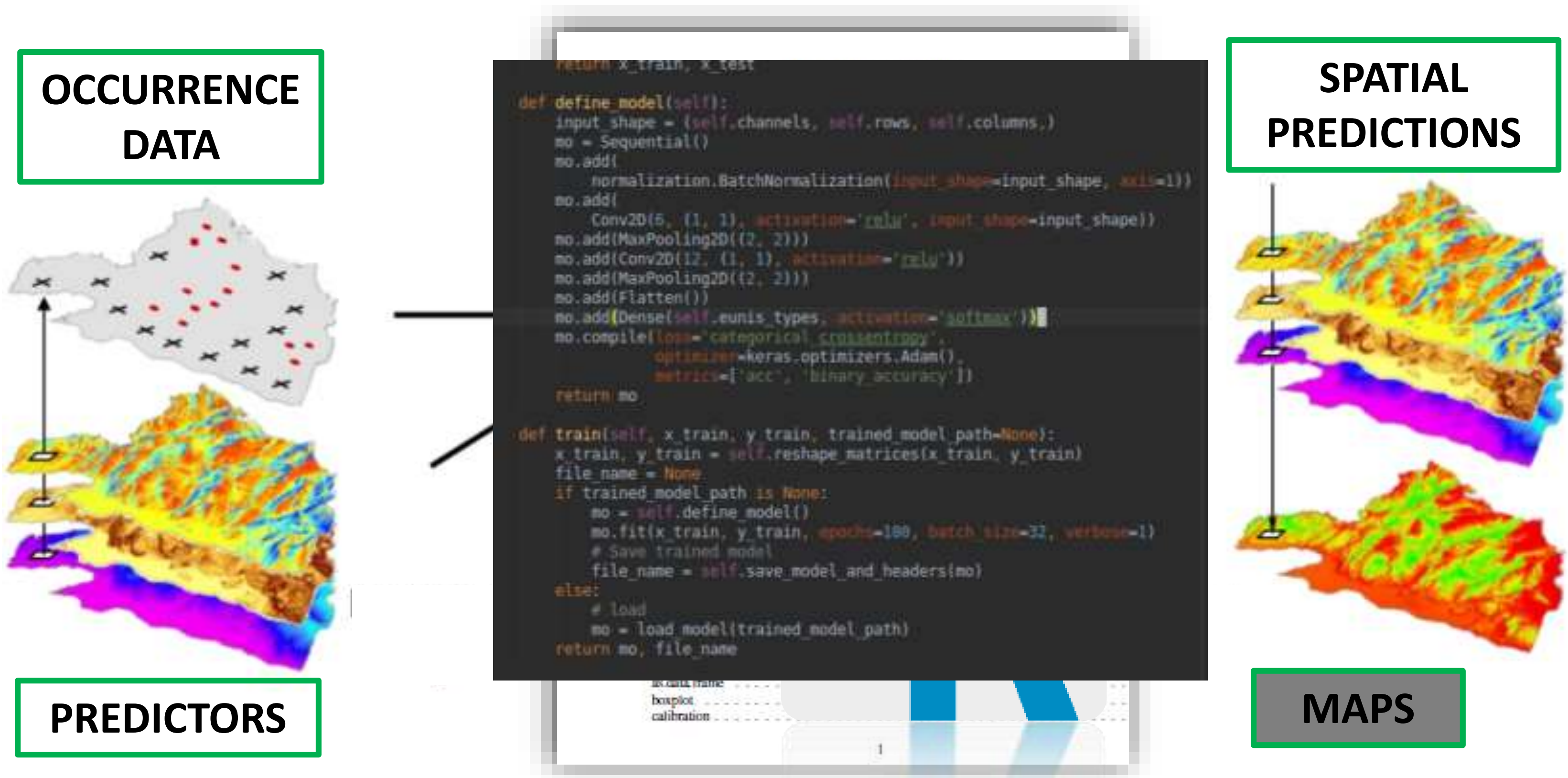
Satellite imagery:
Landsat 5TM and 8OLI 30m
Sentinel 2 A and B, 10-20m
DEIMOS-2, 4m

LiDAR derived data, 5-30m

ENV. LIMITING FACTORS
topography, climate, soil

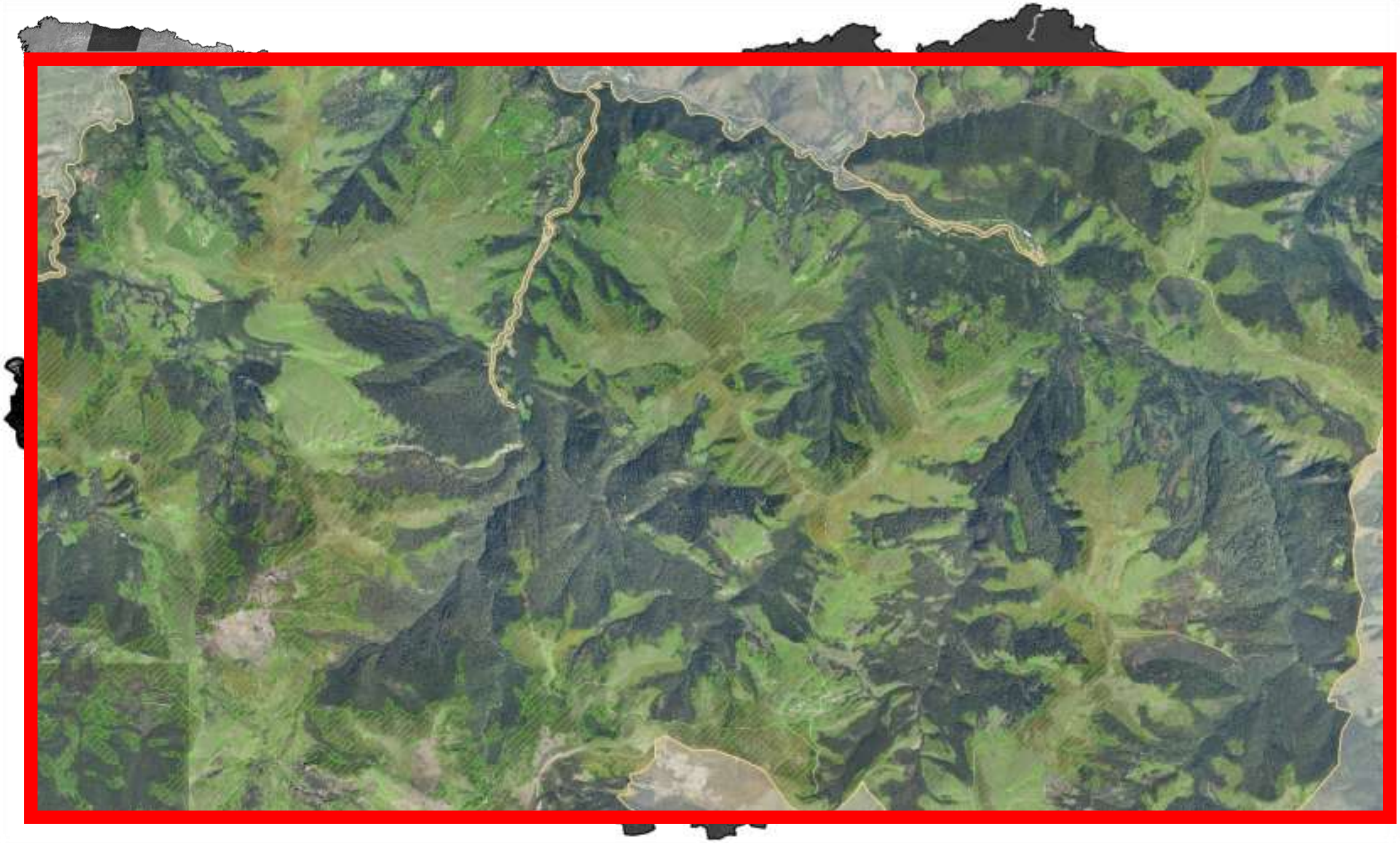

2016-2018
25000 puntos
MAR CANTÁBRICO
Testing
Testing
Training
Puntos de entrenamiento:
Calidad media y baja
Calidad madia
Calidad alta
Jose A. Prieto
Borja Jiménez-Alfaro
(U. de Oviedo)
Fermín del Ejido
(U. de León)
N
0
10
20 km
2650
0
Altitud (m)

A **DATA MINING method or modelling algorithm** for habitat mapping relates occurrence data and the process-based environmental and RS predictors

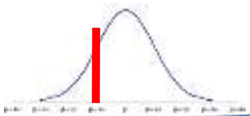


MaxEnt: SWD format, Tunning parameters, *Phillips et al (2006)*
SDM: Multiple algorithms, Bootstraping, *Naimi and Araújo (2016)*

Habitat mapping



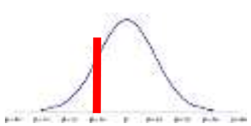
E 1:50 000



0 1

Habitat mapping

E 1:25 000



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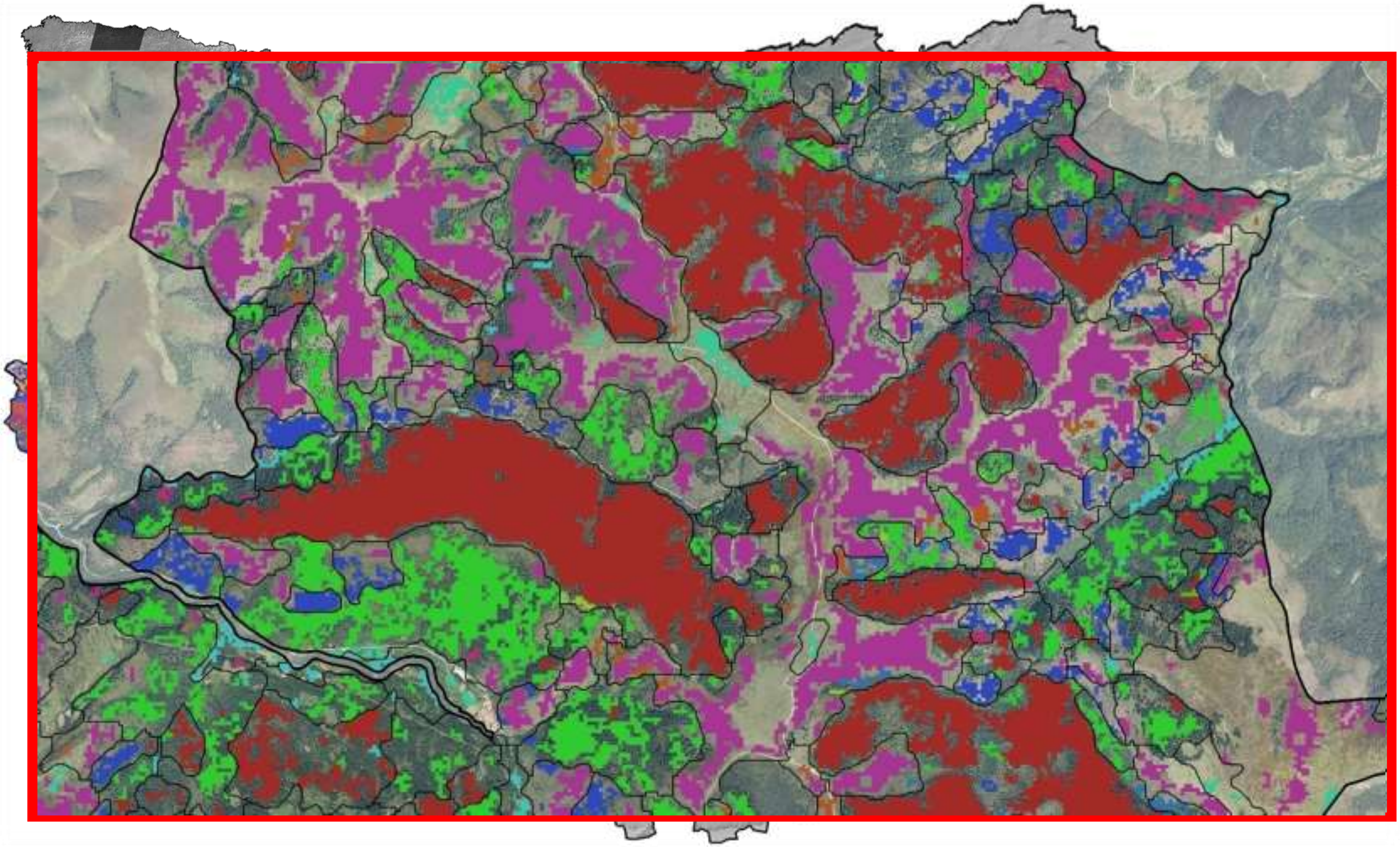
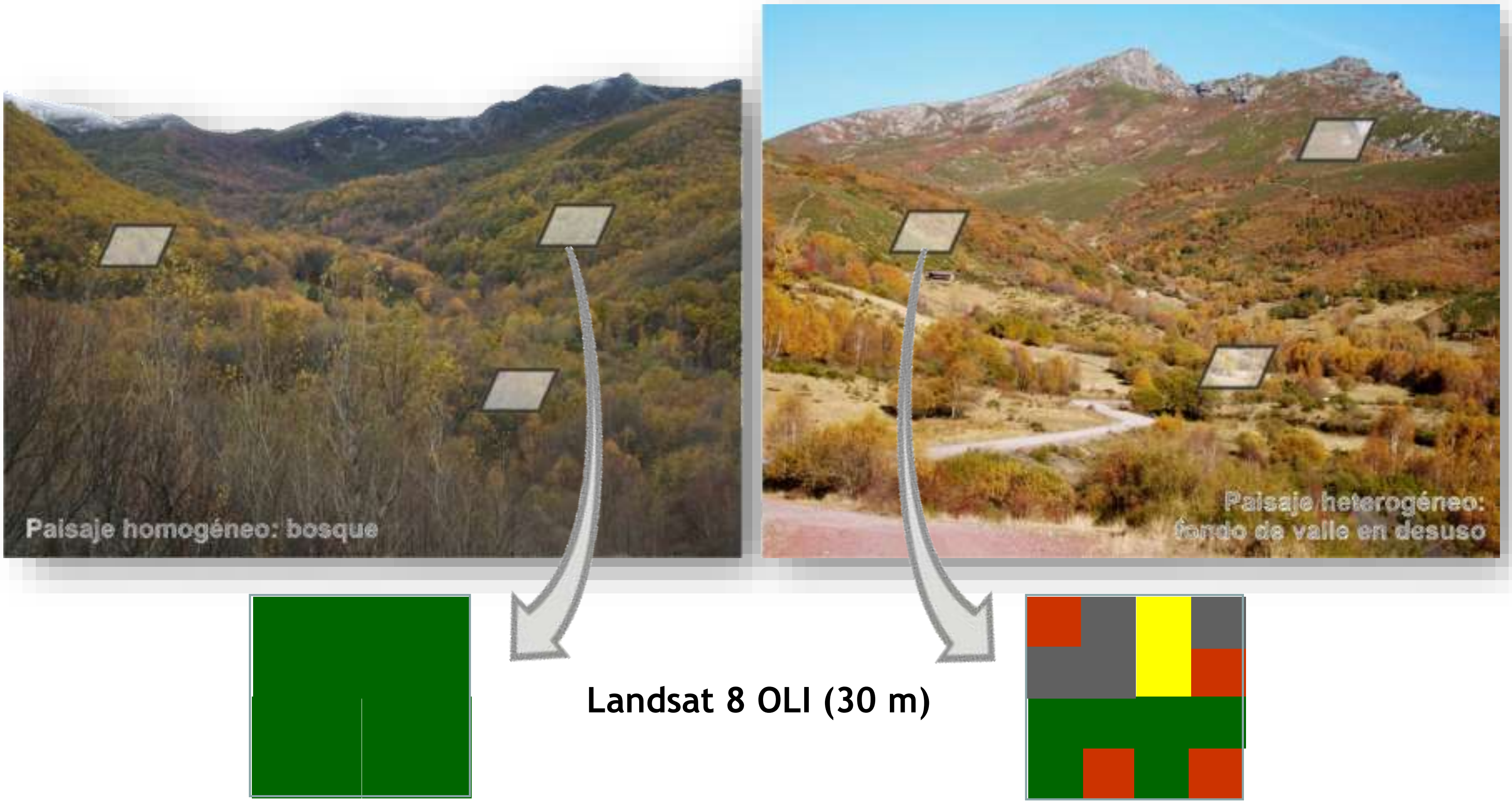
Habitat mapping



E 1:25 000

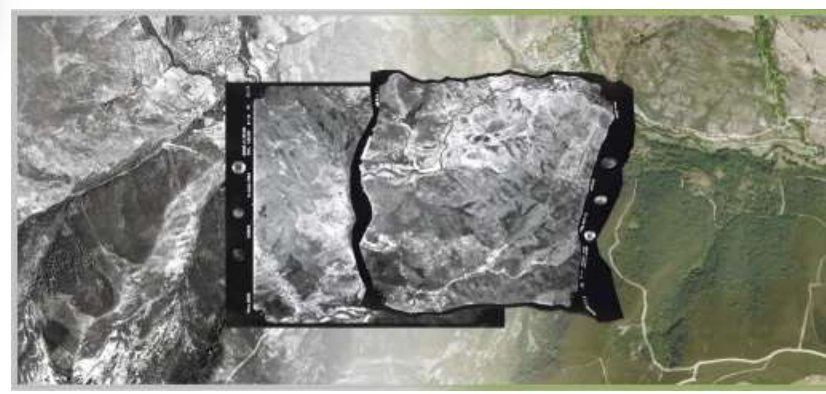
DOMINANCE + UNCERTAINTY



Temporal dynamics, spectral uncertainty

Habitat mapping

Data with different spatial, spectral and temporal resolutions allow addressing a variety of scale processes

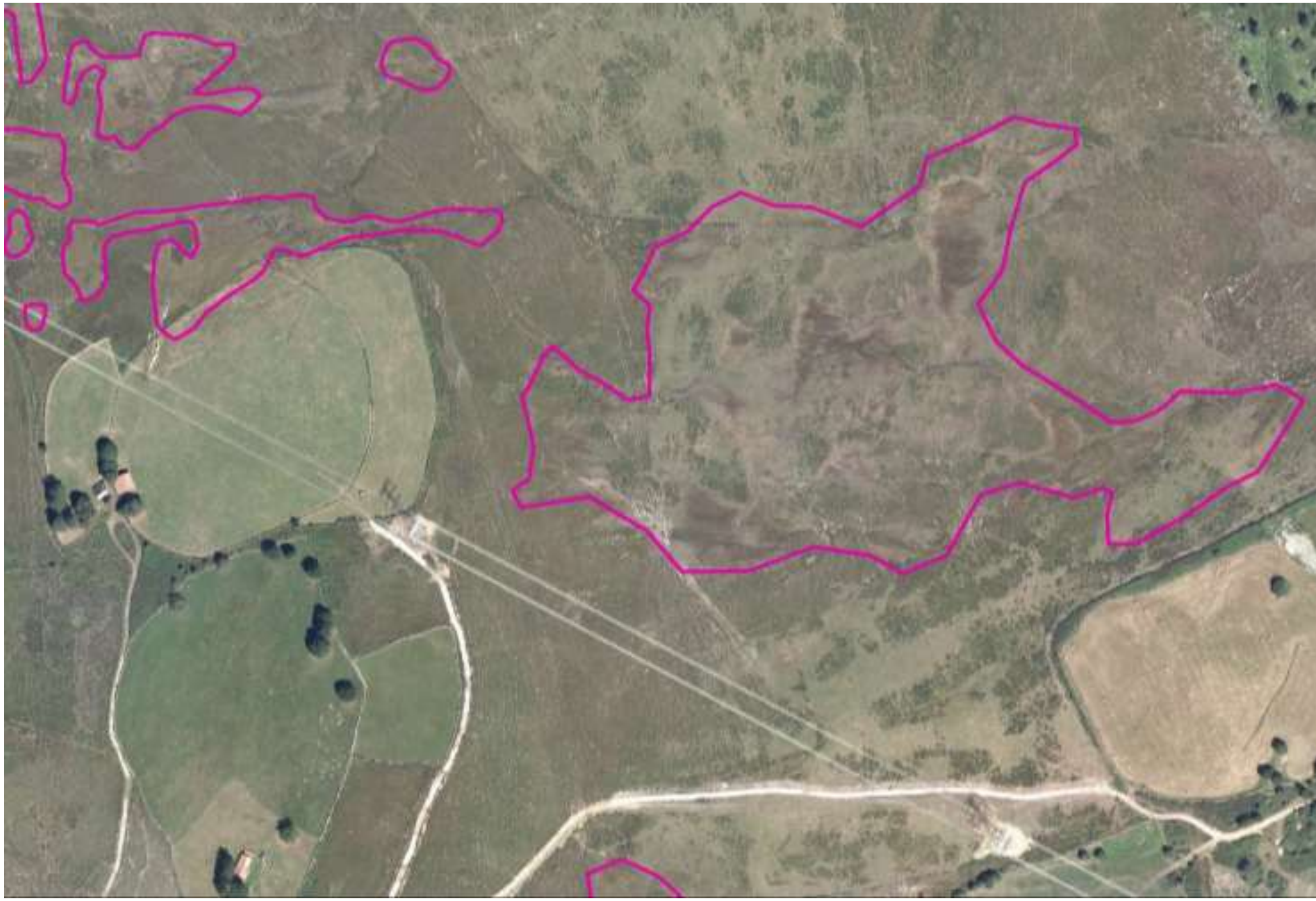


Satellite imagery *LiDAr data* *Landsat 8 (30m)* *Sentiel 2A (10-20m)*

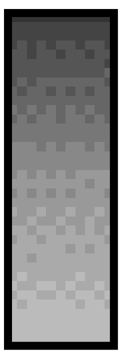
Habitat mapping

Locally monitored acid fens

Landsat 8 MVC
Landsat8 x2
Sentinel2 x2
Deimos2 x2
+LiDAR +MDT



High suitability

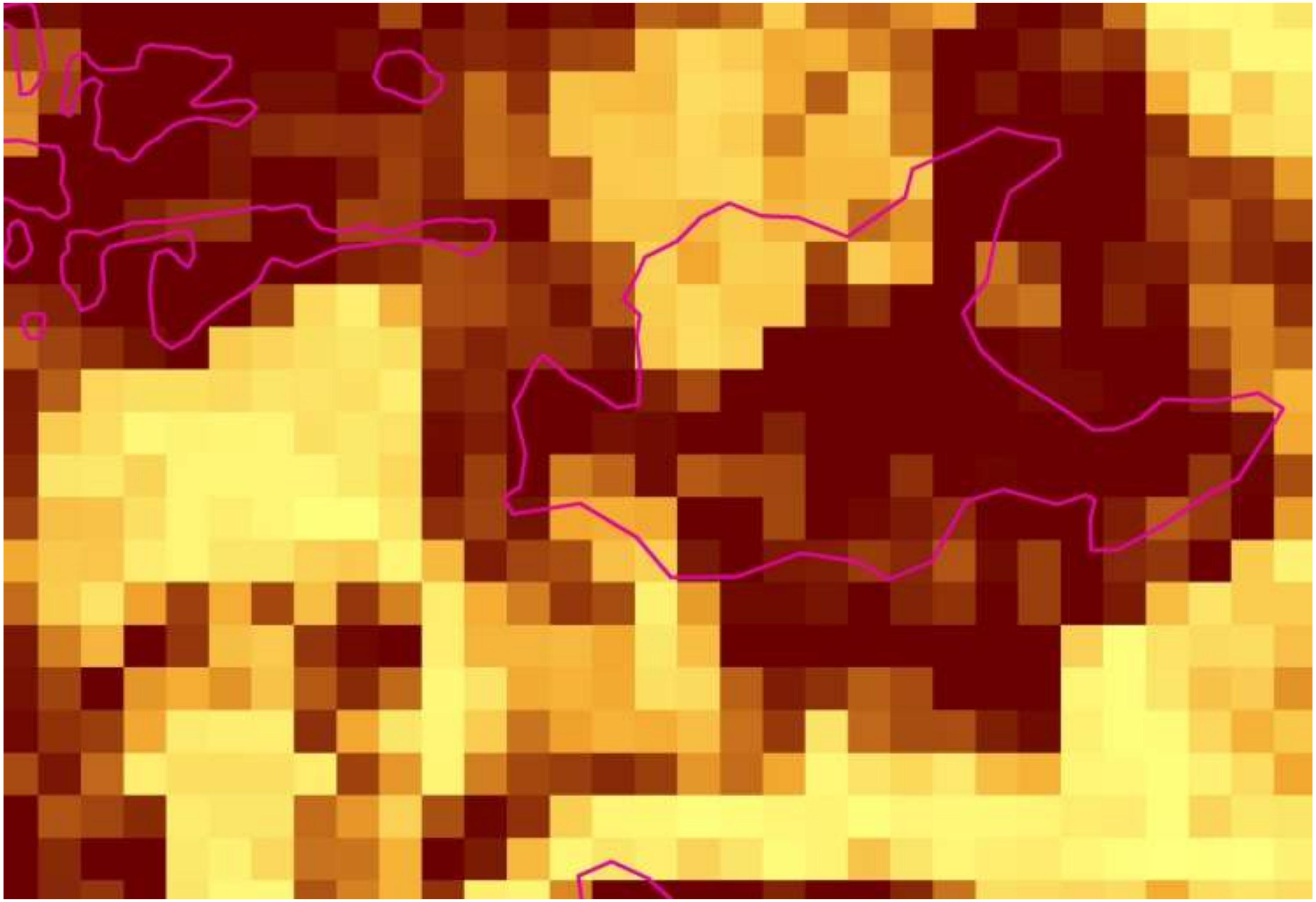


Low suitability

Landsat 8 MVC
Landsat8 x2
Sentinel2 x2
Deimos2 x2
+LiDAR +MDT

High suitability

Low suitability



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Landsat8 x2
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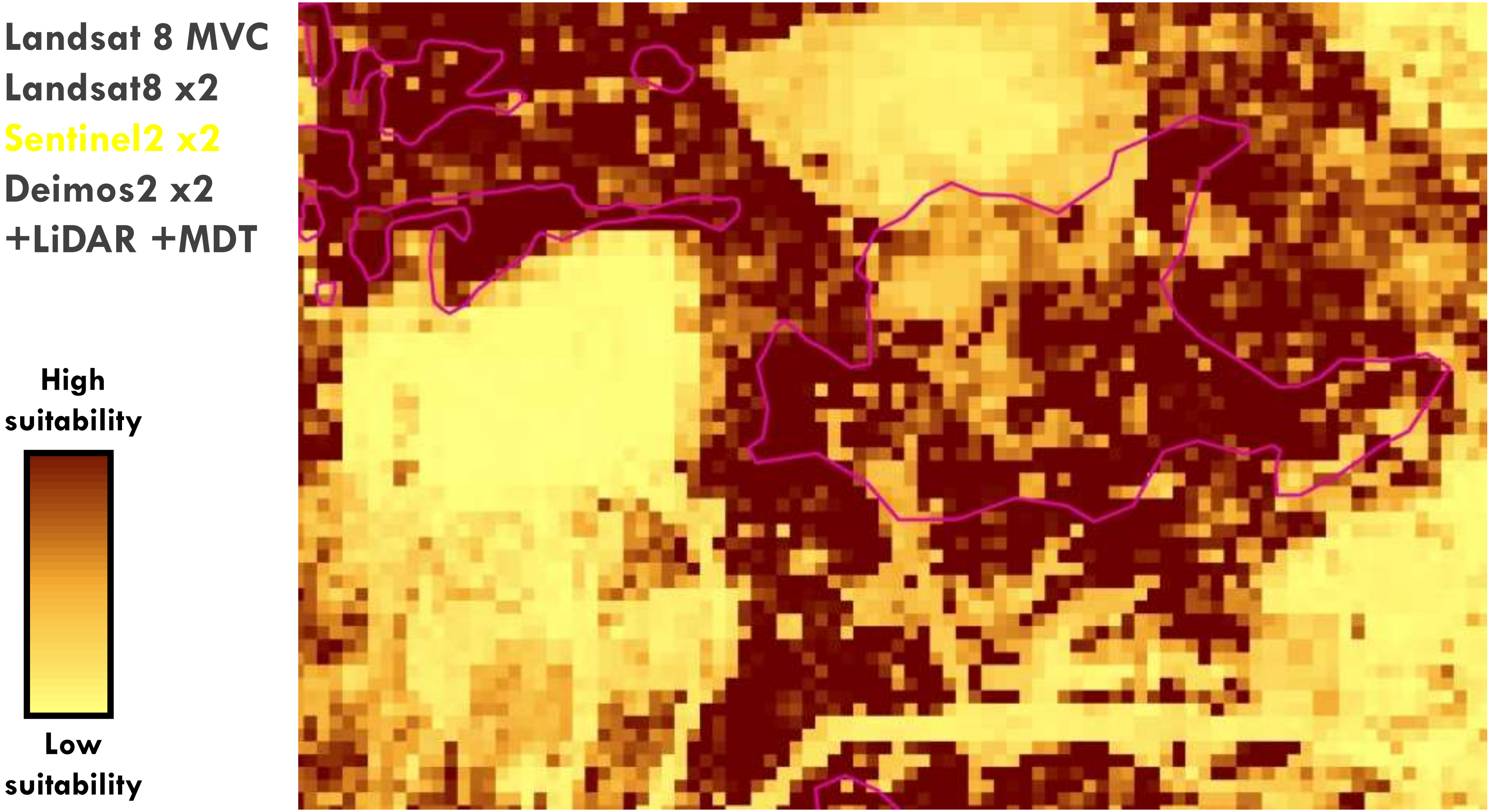

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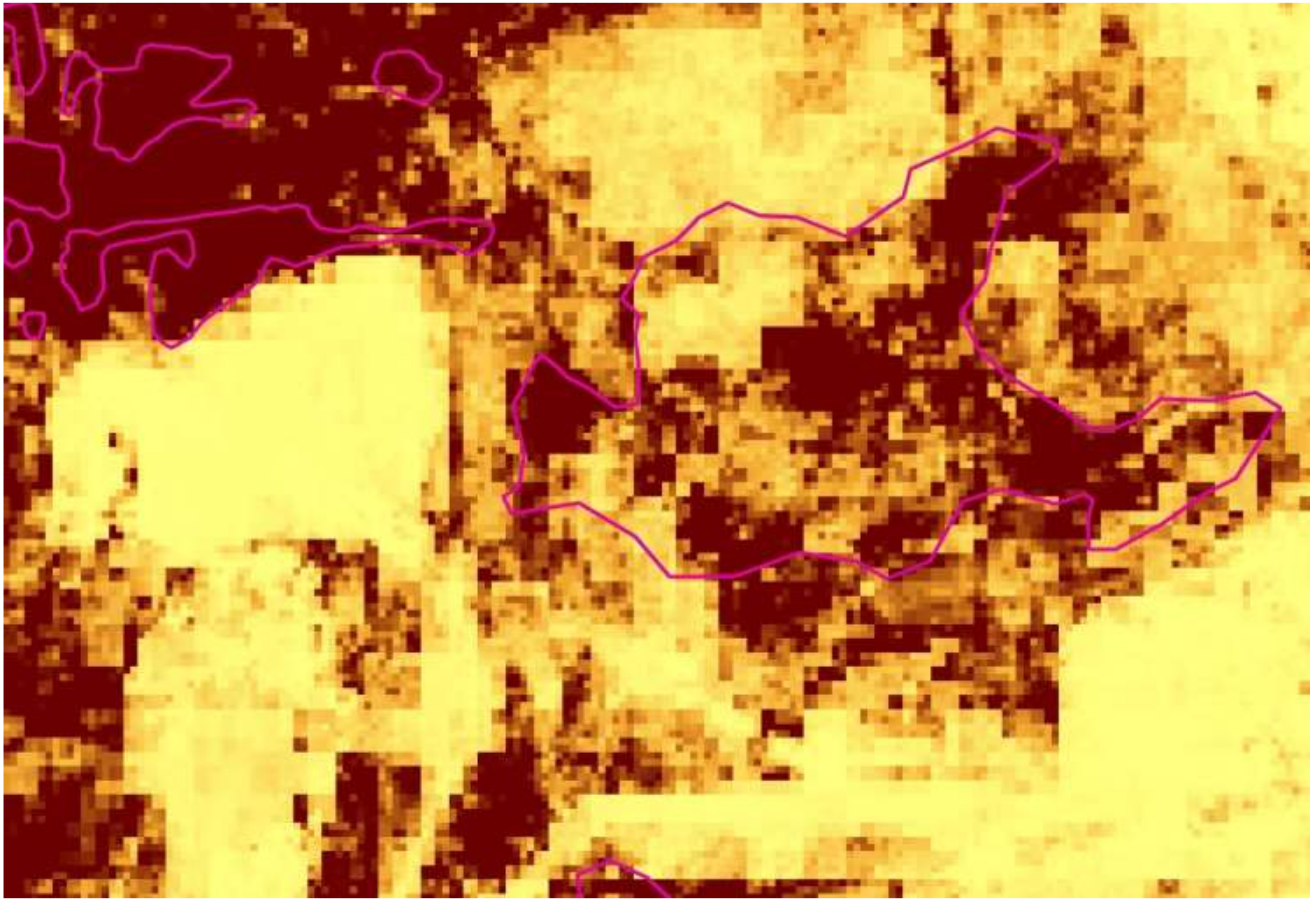
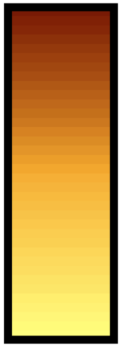
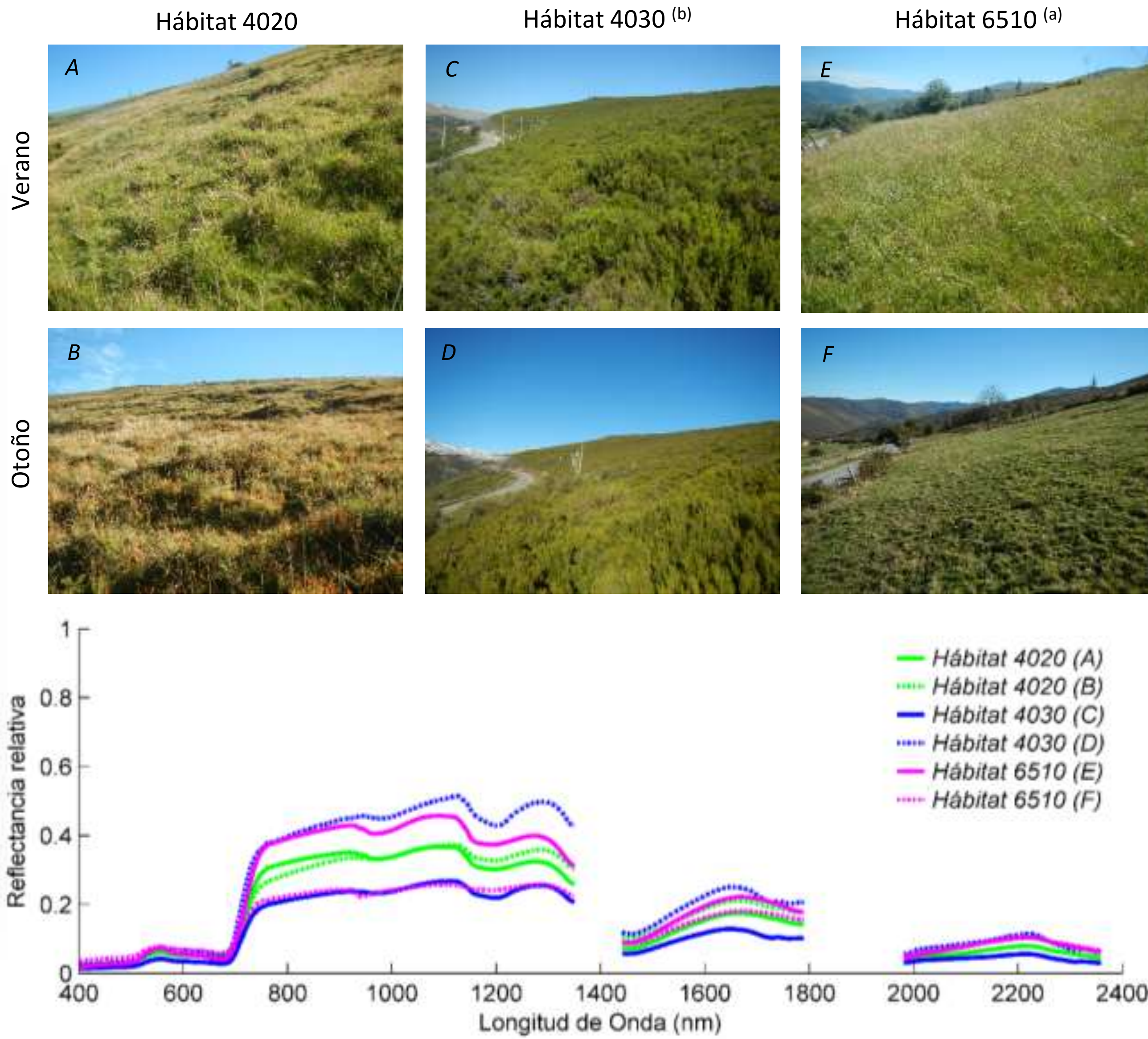




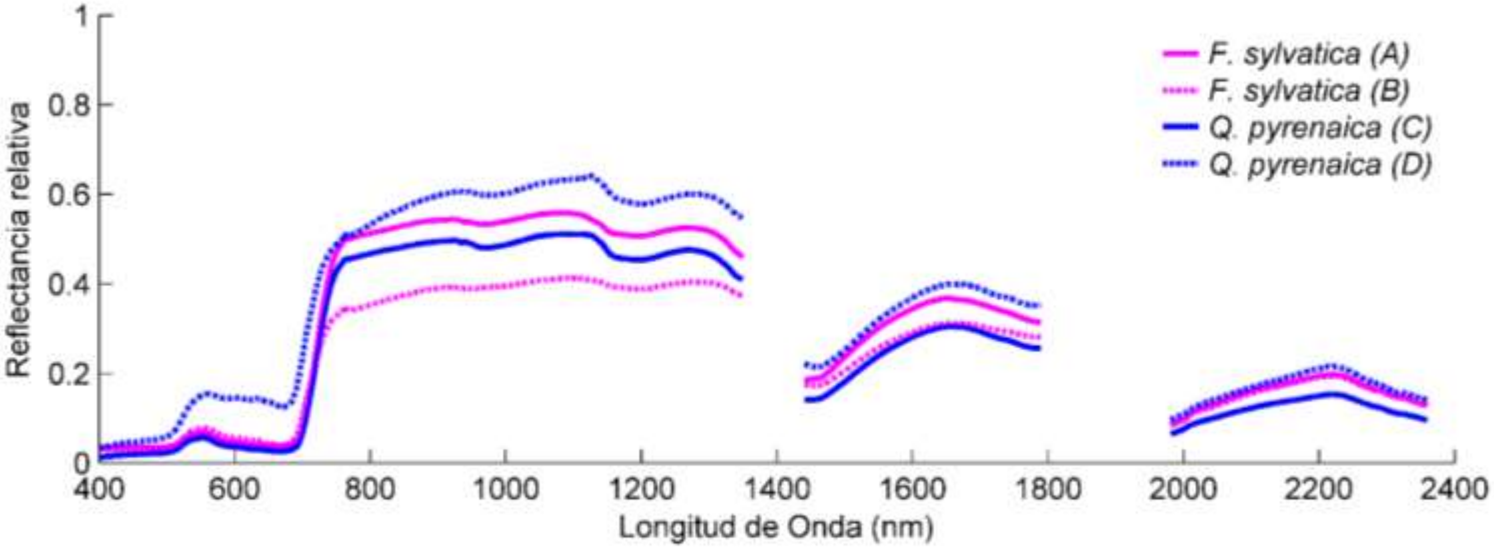
Soectral library: HABITAT TYPES



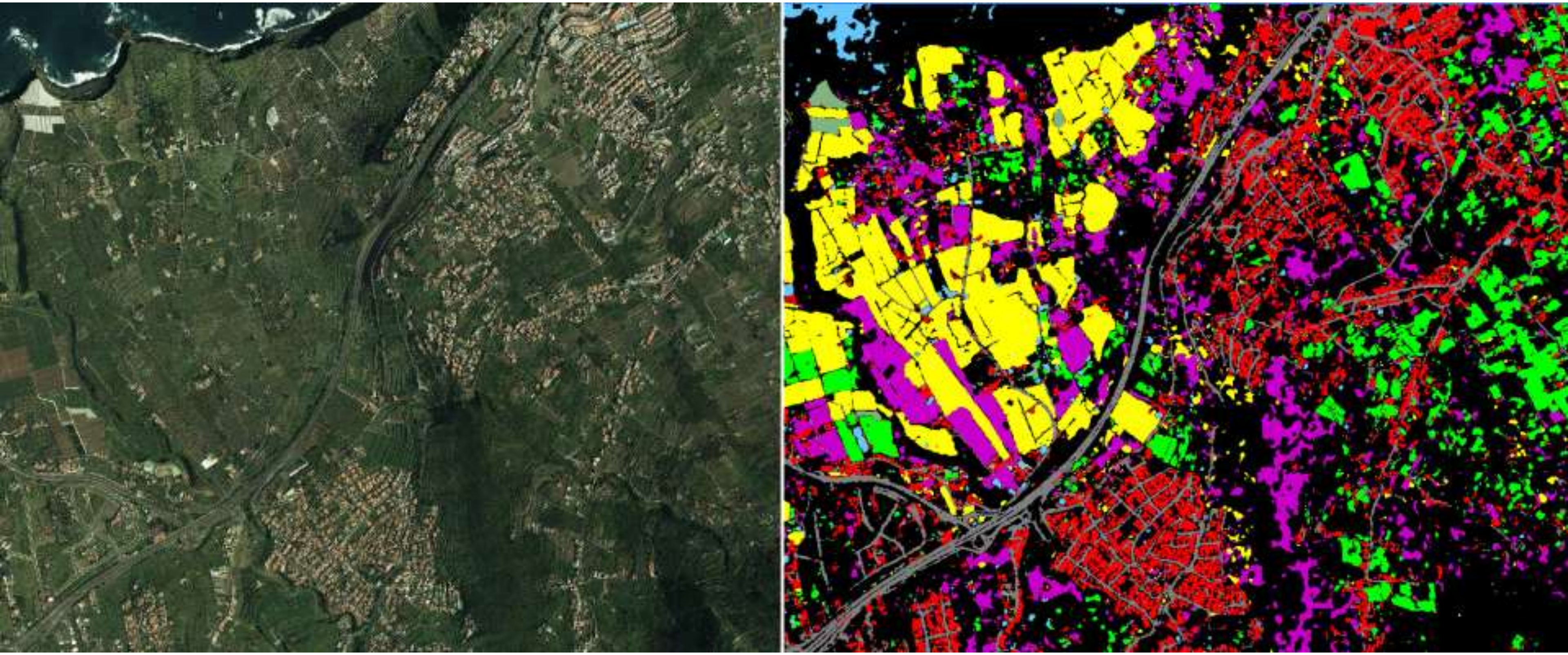
Spectral library: PHENOLOGY

Hábitat 9120 (*F. sylvatica*) → Verano / Otoño

Hábitat 9230 (*Q. pirenaica*) → Verano / Otoño



Deep learning *spatial outputs*



Deep learning with multispectral imagery and limiting factors

Promising… but what more actually matters??

Agriculture and farming

Puerto model (J. Busqué)

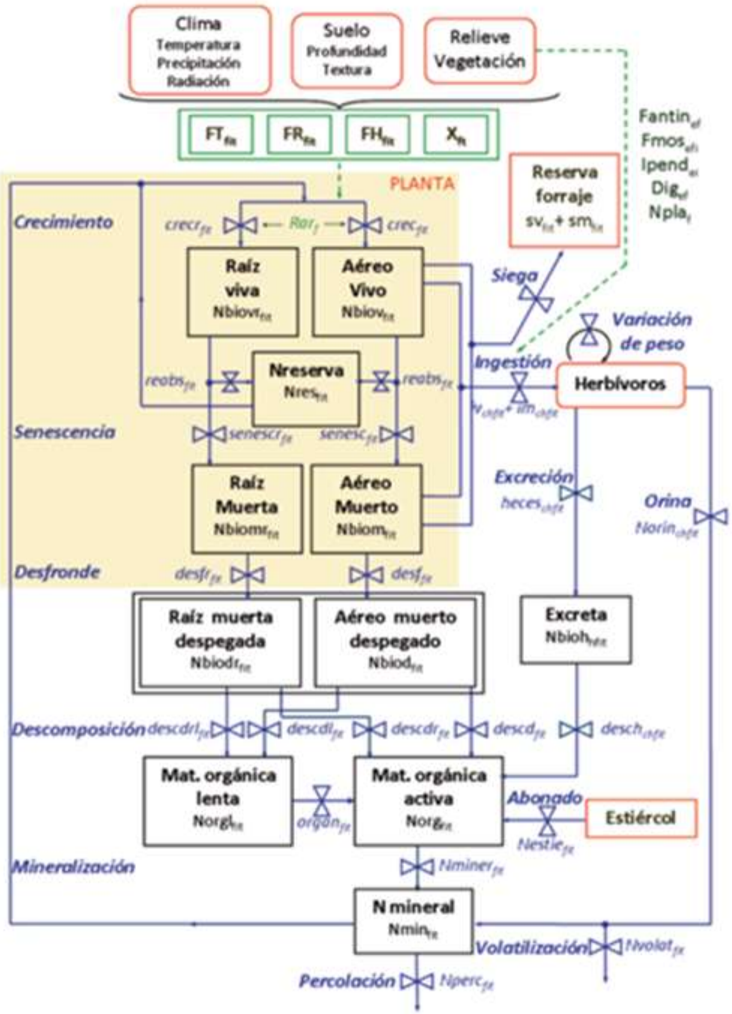


FIGURA 1. Variables principales de estado (cajas negras) y de procesos (azul) simulados por el modelo PUERTO para un tipo de pasto *f*, localizado en una tesela *i*, aprovechado por herbívoros de un sub-rebaño *c* de un rebaño *h* en un tiempo *t*. La información de partida necesaria para correr el modelo está contenida en los cuadros de borde rojo. Los cuadros en verde son variables que afectan la velocidad de los procesos. Los nombres de las variables están explicados en el apartado 5.

Ecological functions

Hydrological functioning

Current Situation

Hydrological model

TETIS v9.0

Grupo de Investigación de Modelación Hidrológica y Ambiental

Conceptual and **distributed** model
Spatial resolution: 100 m
Temporal resolution: dialy

Hydrological model

WiMMed

DFH Dinámica Fluvial e Hidrología
Universidad de Córdoba

Physical and **distributed** model
Spatial resolution: 30 m
Temporal resolution: hourly

Climate INPUT

1985 – 2005
(precipitation and temperatura)

Vegetation INPUT:

Landscape structure

Current Situation

Hydrological models OUTPUTS:

Series: flow
Maps of state variables: soil humidity, snow…
Maps of flows: Surface flow, subsurface flow, aquifer recharge…

Ecological functions

Hydrological functioning

Business as Usual

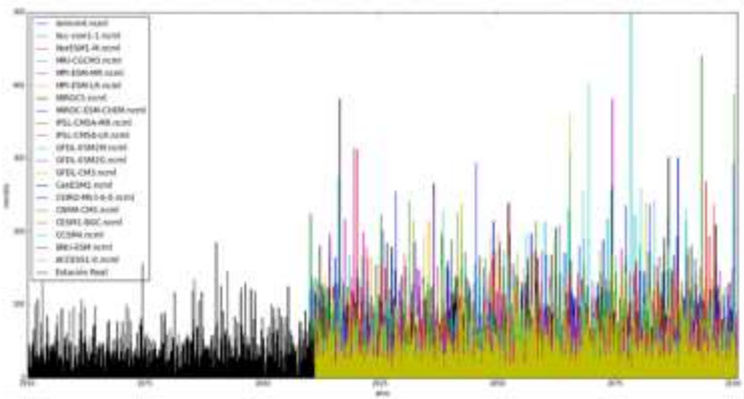
TETIS v9.0

Grupo de Investigación de Modelación Hidrológica y Ambiental

WiMMed

Dinámica Fluvial e Hidrología
UNIVERSIDAD DE CÓRDOBA

Climate INPUT: 2045 – 2065 (RCP8.5) (precipitation and temperatura)



$Serie_{Futuro}$= $DeltaREA$ x $Serie_{Presente}$

$MF \rightarrow Modelo\ Futuro$

$MP \rightarrow Modelo\ Pesente$

1986-2005 (MP) 2046-2065 (MF)

$$DeltaREA = \sum_{M=1}^{21} \frac{MF_i}{MP_i} W_i$$

Vegetation INPUT:

Landscape structure

Business as Usual

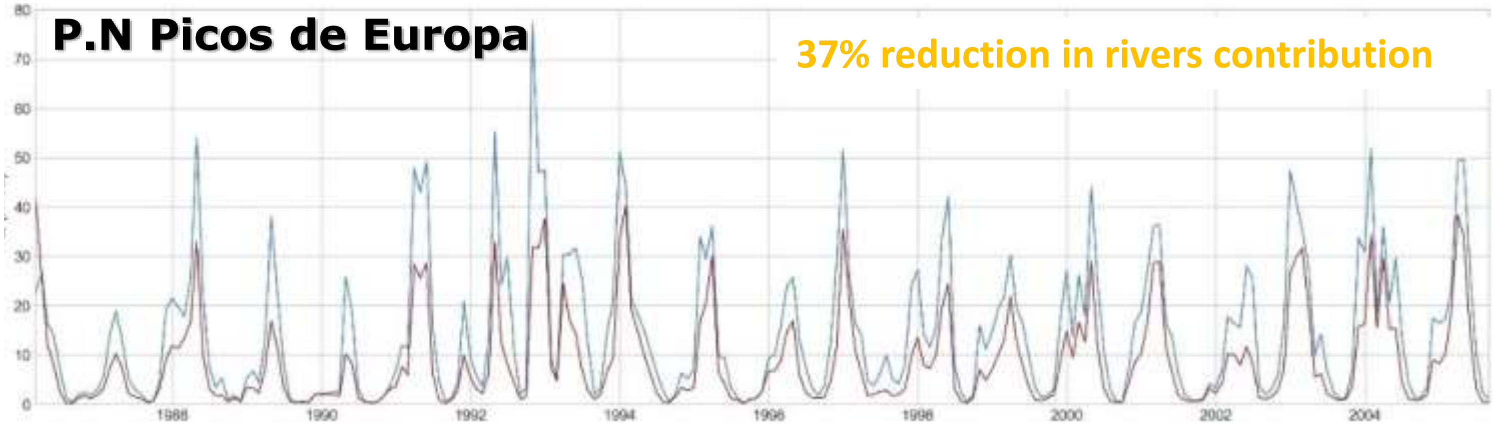
Ecological functions

Hydrological functioning

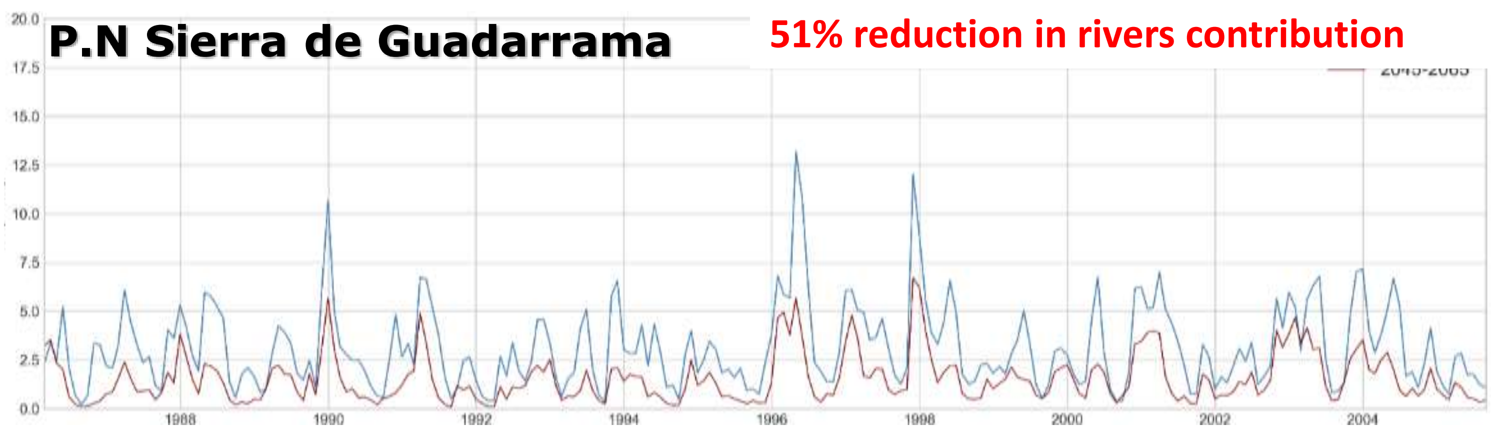
Current Situation

Business as Usual

Q (m^3/s) monthly average



Peñamellera Baja (Deva river)



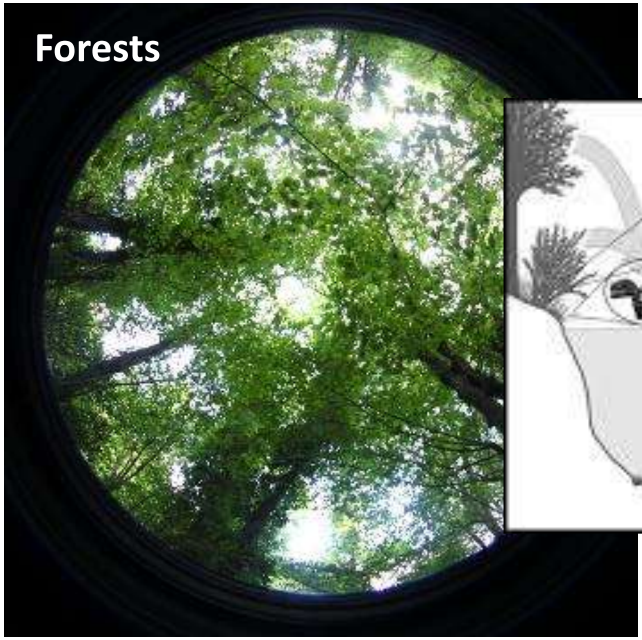
Segovia (Eresma river)

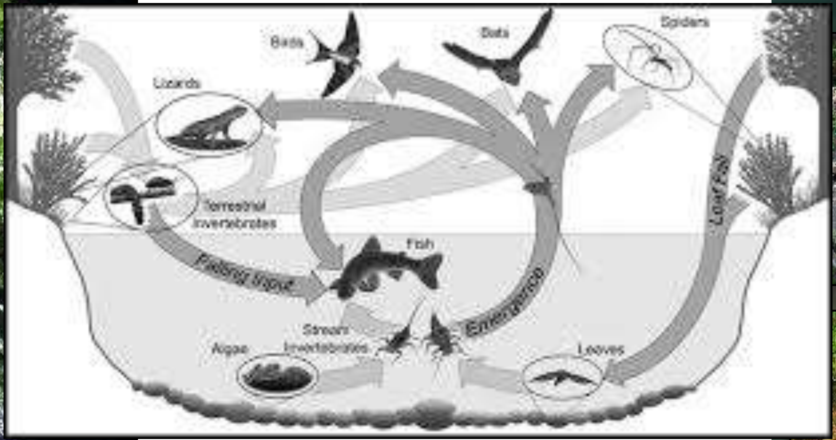
Ecological relationships

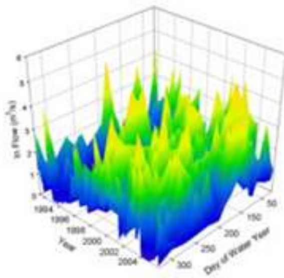
Differences: Rivers are dendritic and open ecosystems with an important role of stochastic processes (e.g. flood disturbances), while forest are more closed ecosystems in which deterministic processes dominate (competition).

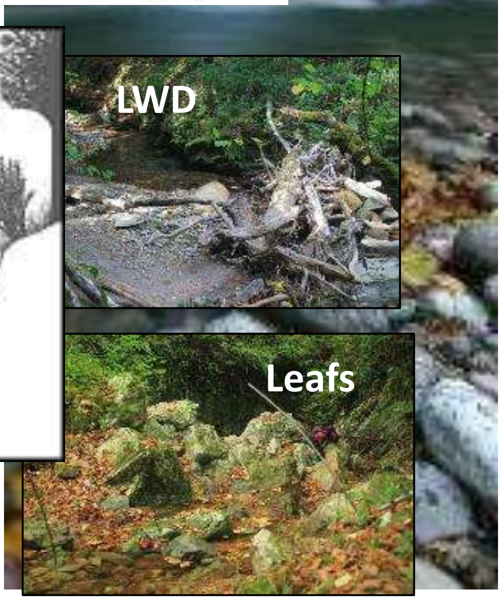
Dependencies: Both ecosystems interchange water, nutrients, sediments and C-sources (e.g. Leafy debris, LWD, DOM).

A need for conecting models and services



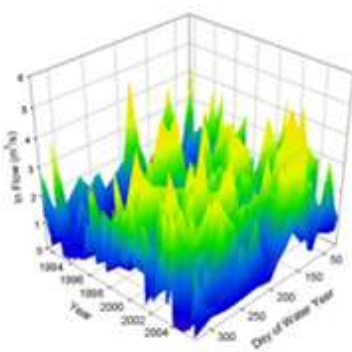


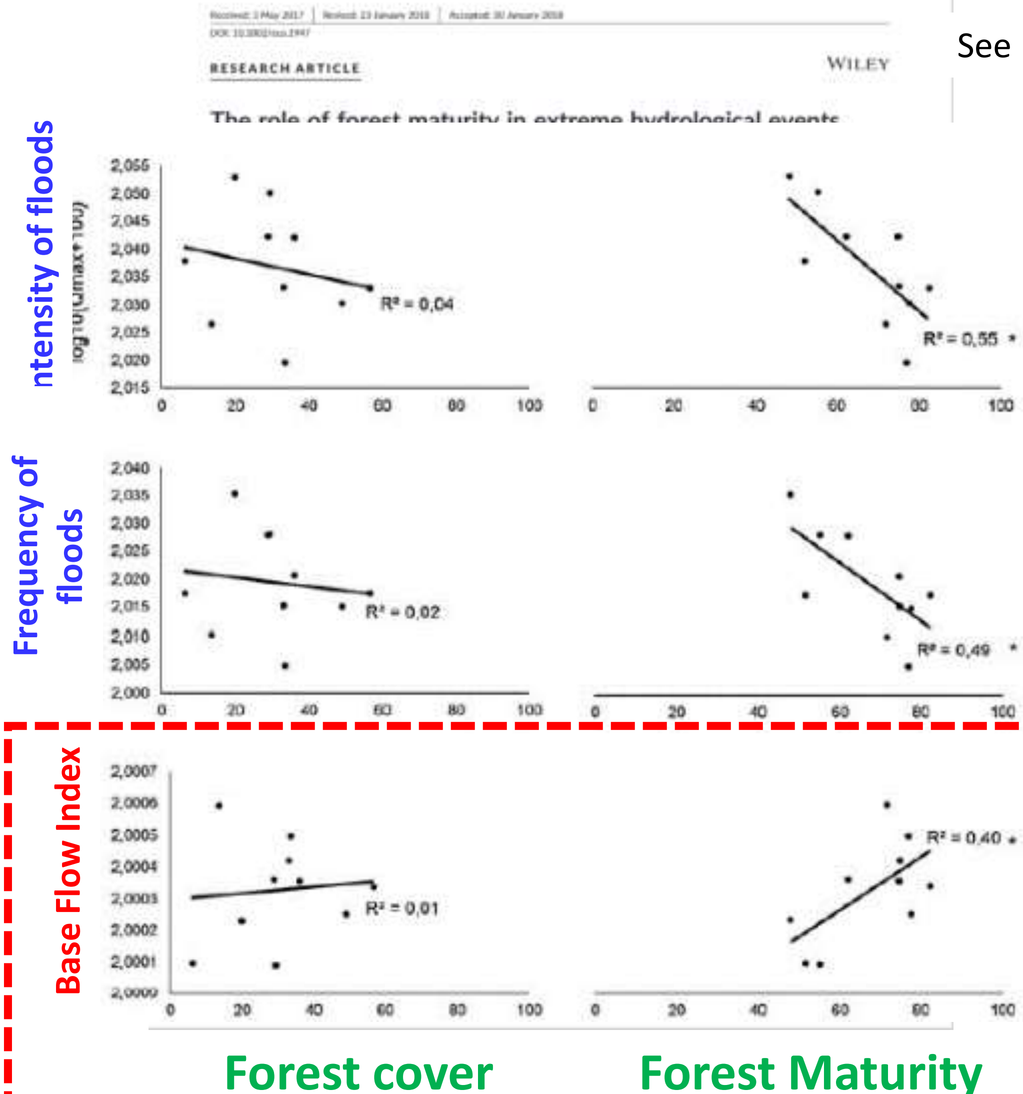




Rivers and Forests

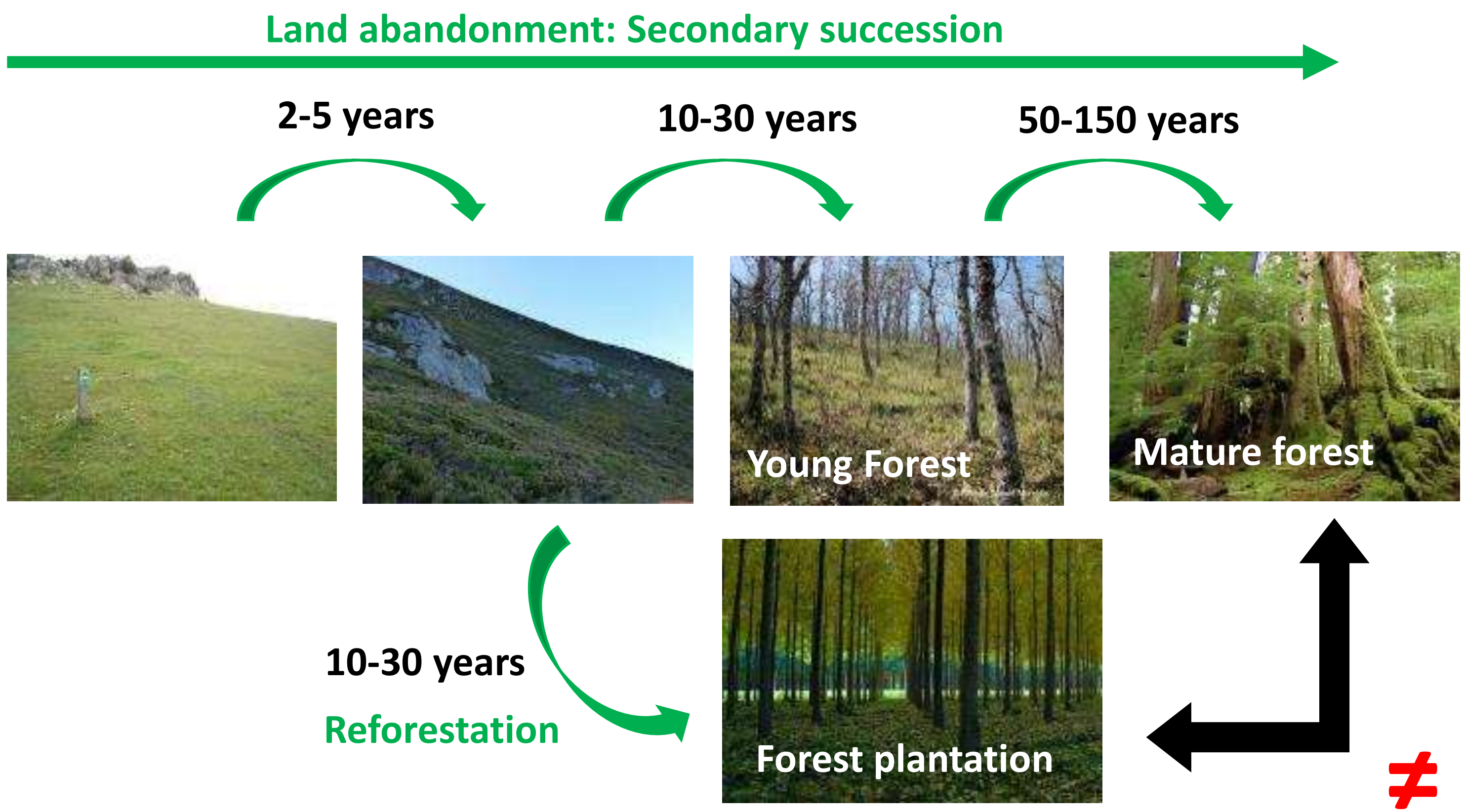
See Belmar et al., 2018





Unexpected ??

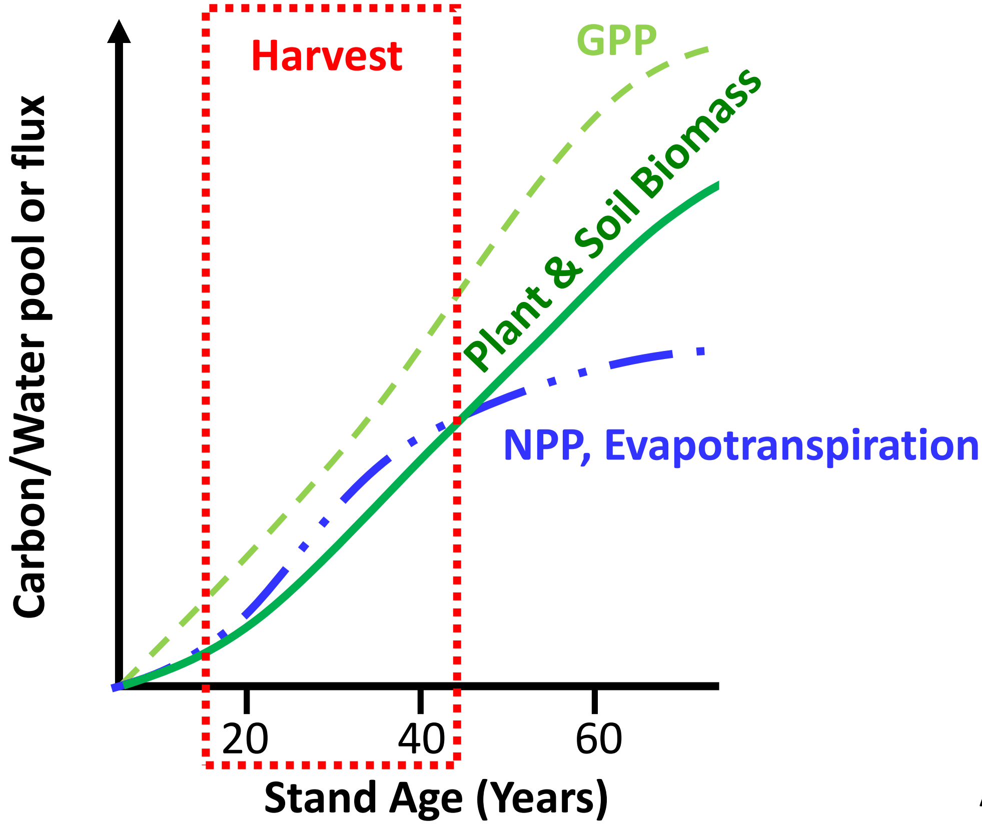
Land use intensification produces a lost of mature native forests, while land abandonment opens opportunities for the natural vegetation to recover and mature through **secondary succession**.



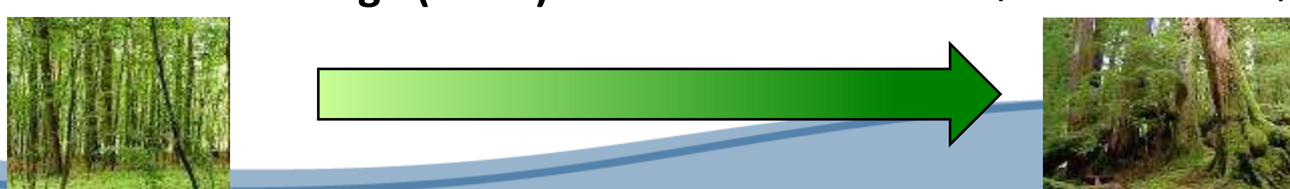
Secondary succession generates properties that differentiate young and mature forests, while traditional forestry practices will not achieve this properties…

A dangerous message: All forests dry rivers ?? Or is it just young forest and plantations?

There is a strong need to better understand the role of old unmanaged forests (i.e. Mature forests) on hydrological processes versus the role of novel forest or tree plantations…



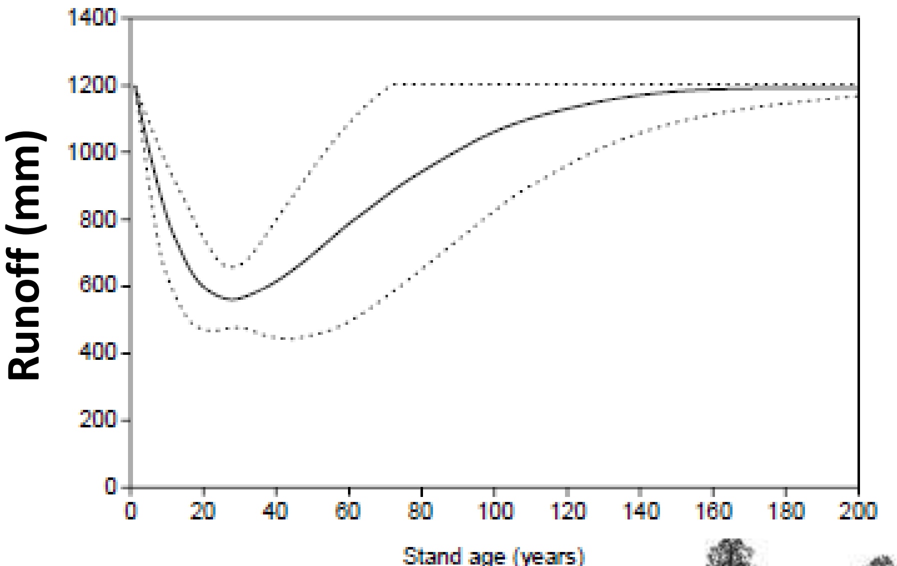
Adapted from Chapin III *et al.*, 2002

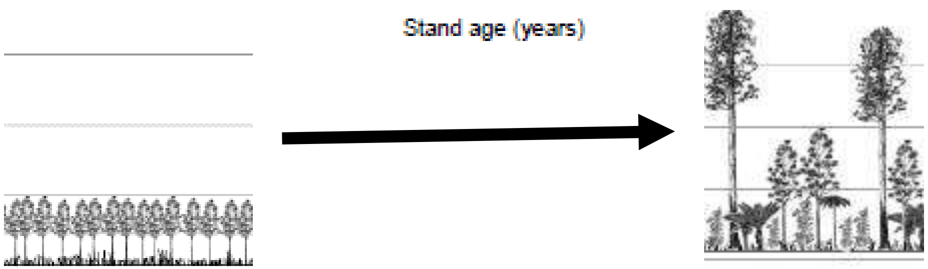


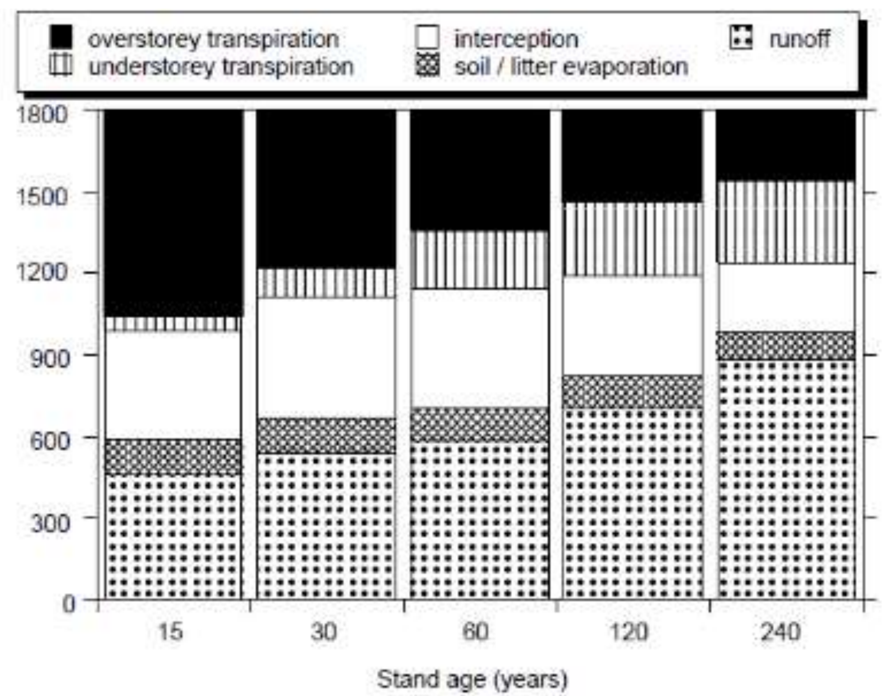
Mountain ash forest (*Eucalyptus regnans*) in Maroondah Reservoir Region, Victoria, Australia, reduce water to streams during the rapid years of growth (up to 40 years), but then recover after forest maturity is reached (>150 years).

The increase in runoff comes from changes in:

- Leaf area index (transpiration, interception)
- Sapwood area (transpiration)
- Reduction of soil evaporation because of accumulation of woody debris and leaf litter..







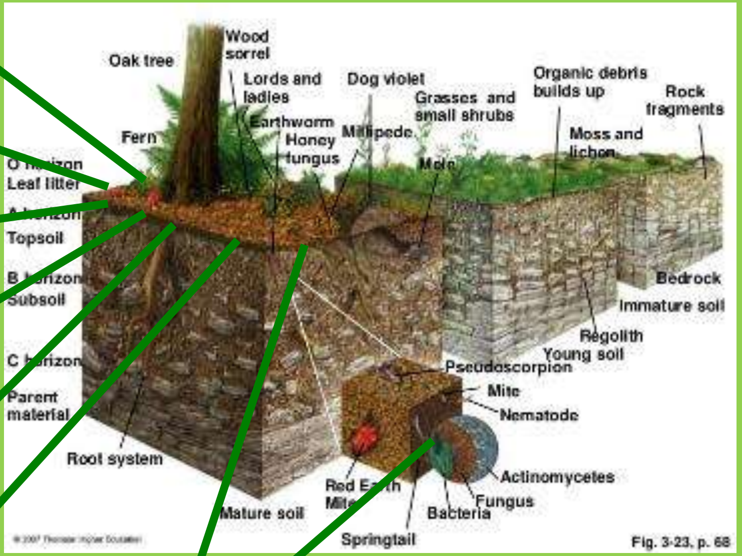
Vertessy *et al.*, 1998

A dangerous message: Do we need to clean forests? Or just tree plantations?

Forest maturation increases the inputs and stocks of large woody debris and leafy debris, increasing the depth of Horizon 0 and many ecosystem functions..

Large Woody Debris

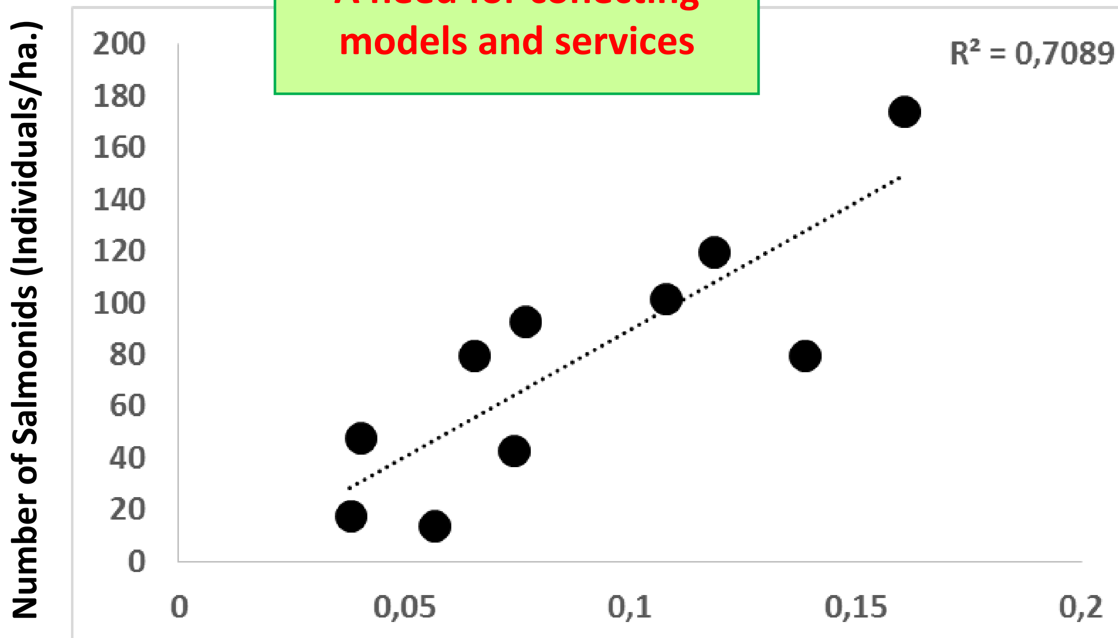
Leaf litter & Horizon 0



- Erosion control
- Water retention
- OM storage
- Increase Heterogeneity
- Reduced Evaporation
- Increased infiltration
- Temperature Buffered
- Increased Biodiversity

Forest and Fish

A need for conecting models and services



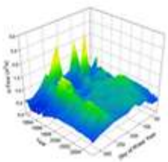
Base Flow Index

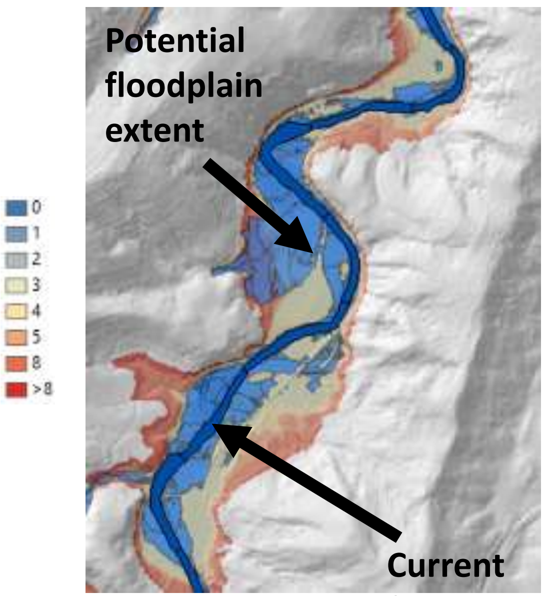
Forest Maturity

Functional Hotspots

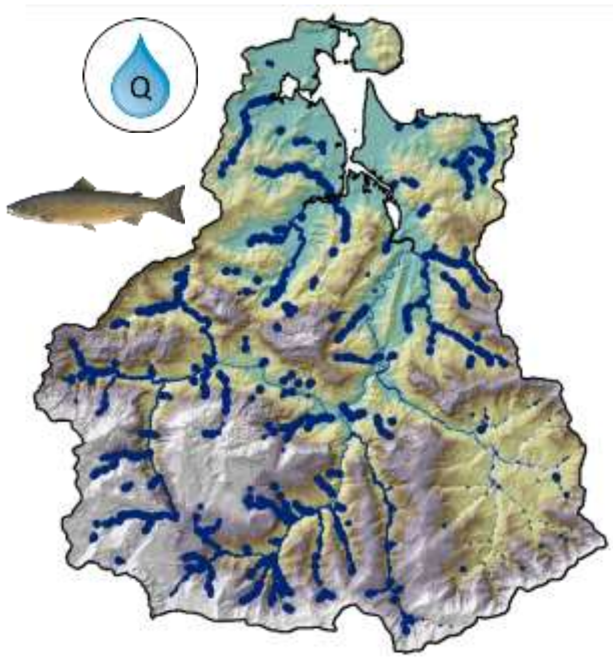
Current Situation

1- Floodplain extent





2 - Thermal loading

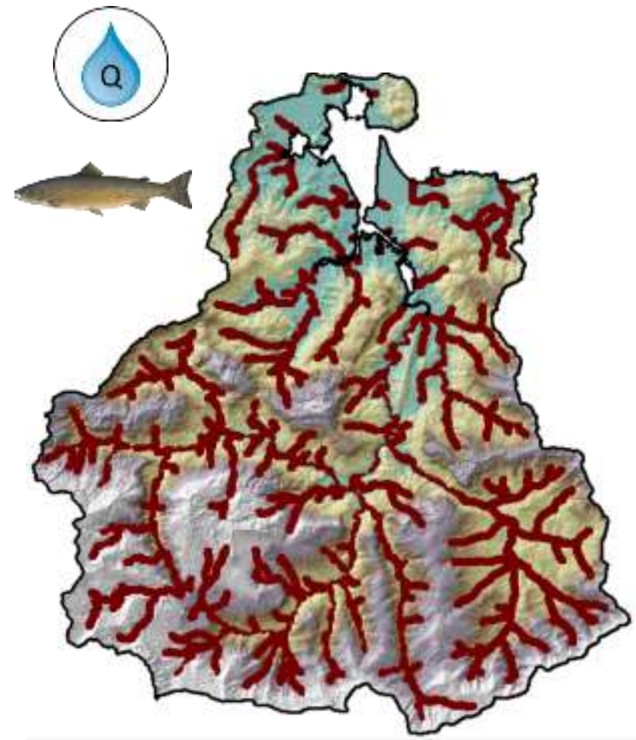


Maximum potential Shade-Thermal Energy *(watt . hour / m²)*

- 3100
- 10570
- 19885
- 30720
- > 30720

Increasing benefit

3- Recruitment of large woody debris



Woody debris *(m³ / year)*

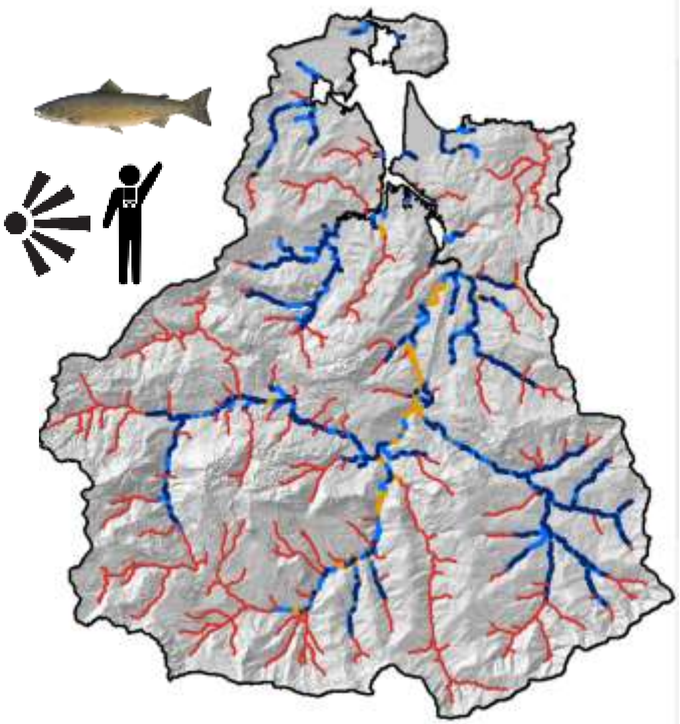
- 0.000000 - 0.105533
- 0.105534 - 0.316250
- 0.316251 - 0.851272
- 0.851273 - 2.687770
- 2.687771 - 68.451930

Increasing benefit

Functional Hotspots

Current Situation

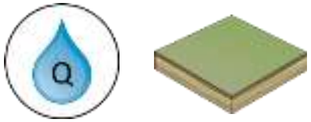
4 - Potential habitat for salmonids



Habitat quality

- < 0.1
- 0.4
- 0.5
- > 0.5

5 - Hillslope surface erosion

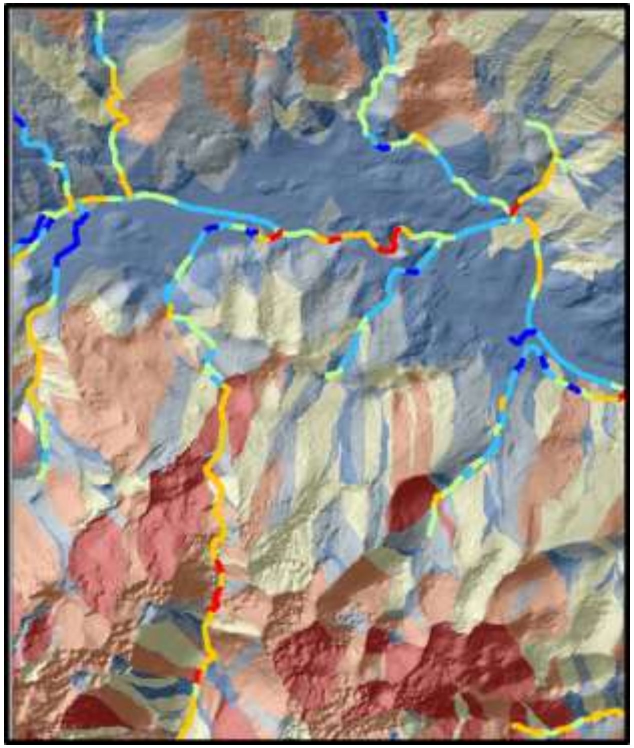


Erosion potential

- 0.00000 - 140.00000
- 140.00001 - 300.00000
- 300.00001 - 500.00000
- 500.00001 - 900.00000
- 900.00001 - 2475.28809

Relative sediment yield for adjacent hillslopes

- 0.0001 - 0.0035
- 0.0036 - 0.0091
- 0.0092 - 0.0190
- 0.0191 - 0.0416
- 0.0417 - 0.5178



Meetings with managers - stakeholders

Products from modelling

1. Probable areas of **forest expansion/regression**
2. Localization of **mature native forests**
3. Localization of **functional hotspots**
4. Hydrology: **reduction** in the **average flow**

Picos de Europa

Forest expansion (evapotranspiration)

Sierra de Guadarrama and Sierra Nevada

Climate change (snow and precipitation reduction + temperature increment)

Criteria for designing BGINs (from managers)

Picos de Europa

Rewilding

Protection of the most **productive pastures**

Riparian buffers in headwaters

Sierra de Guadarrama and Sierra Nevada

Rewilding of shrublands and native forest

Afforestation in the most problematic areas

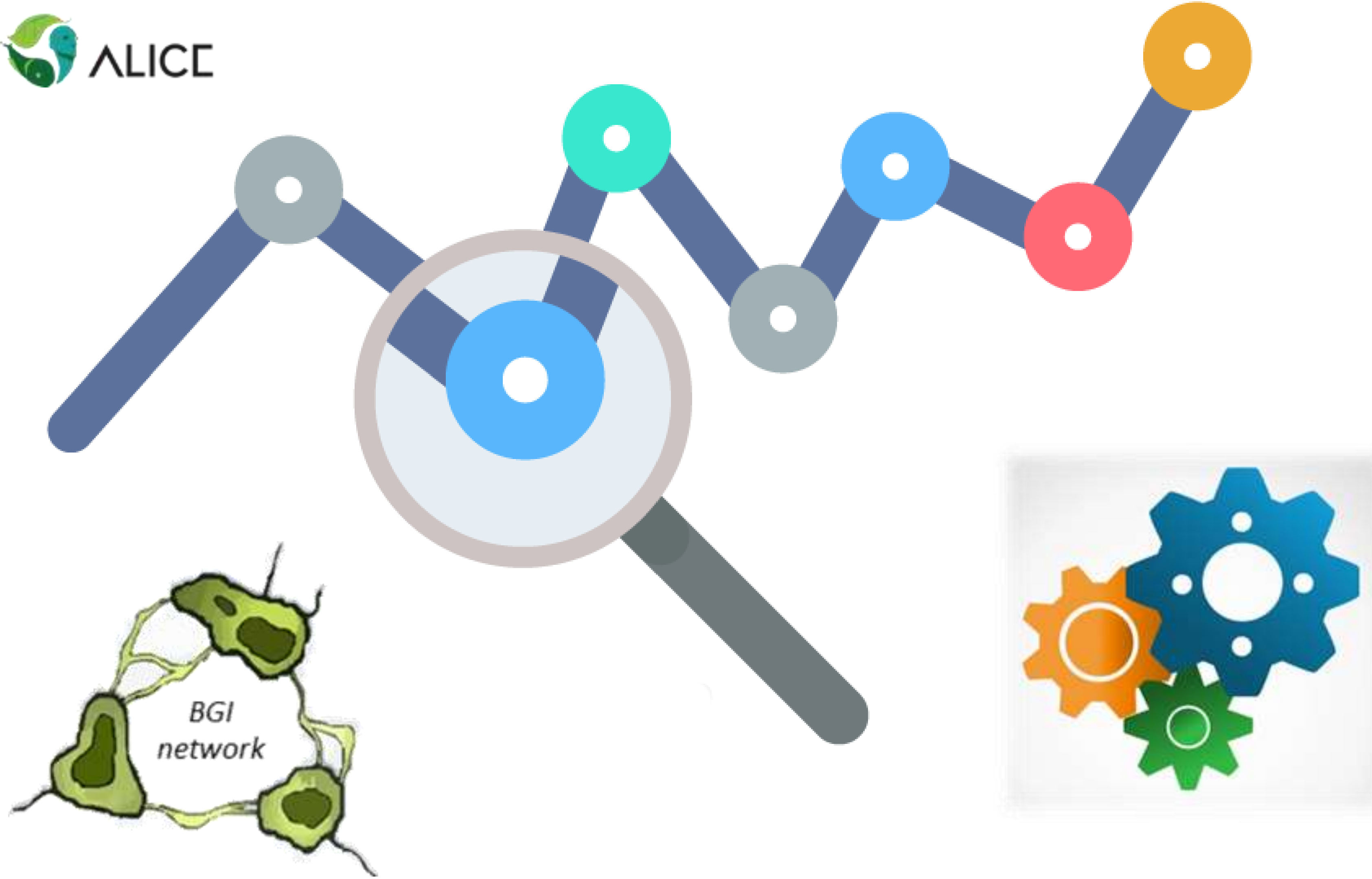
Gradual **replacement of pine** plantations:

Riparian corridors, thinnings…

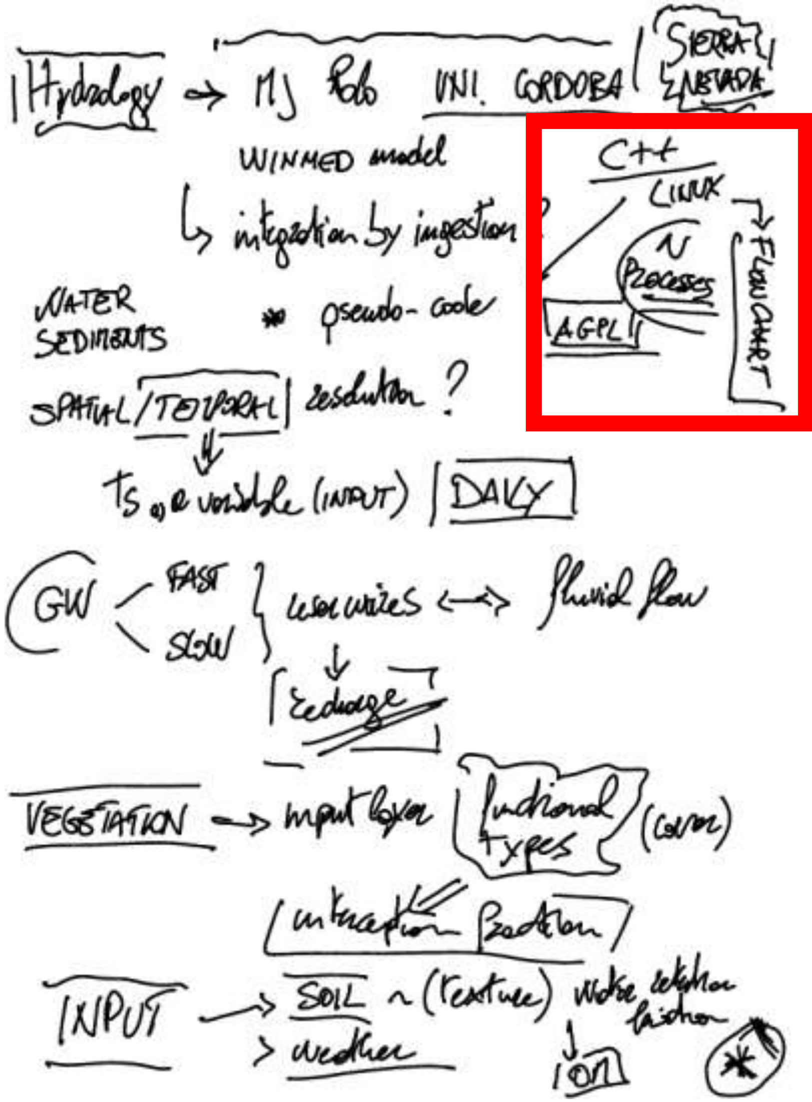
Hydrological models: relationship between soil – water - vegetation

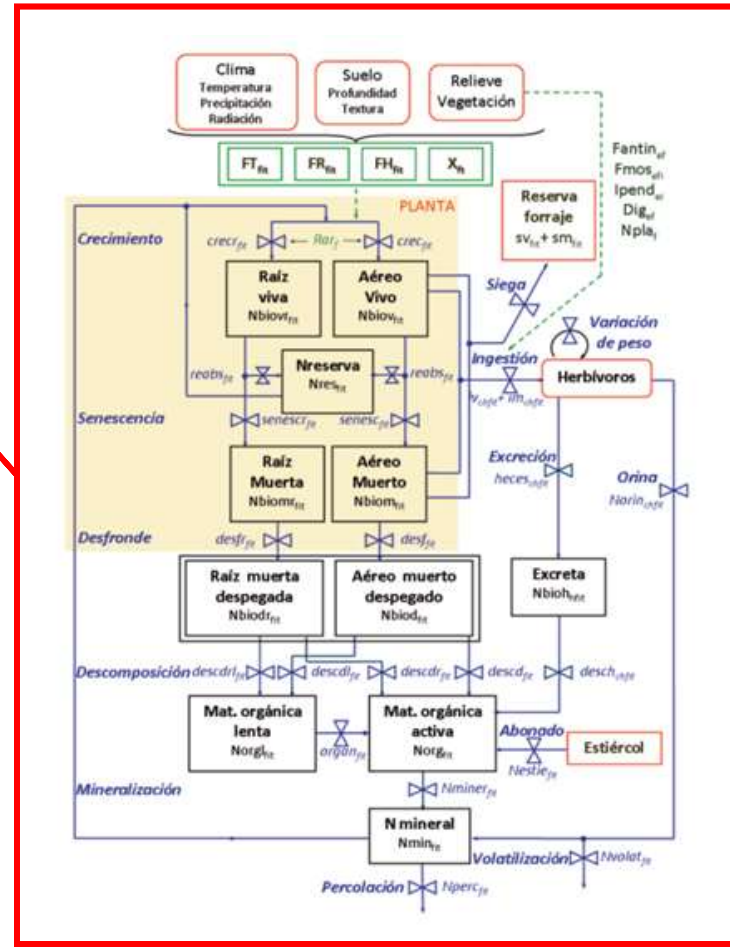
Connectivity and spatial coherence to design BGINs in each National Park

Model integration



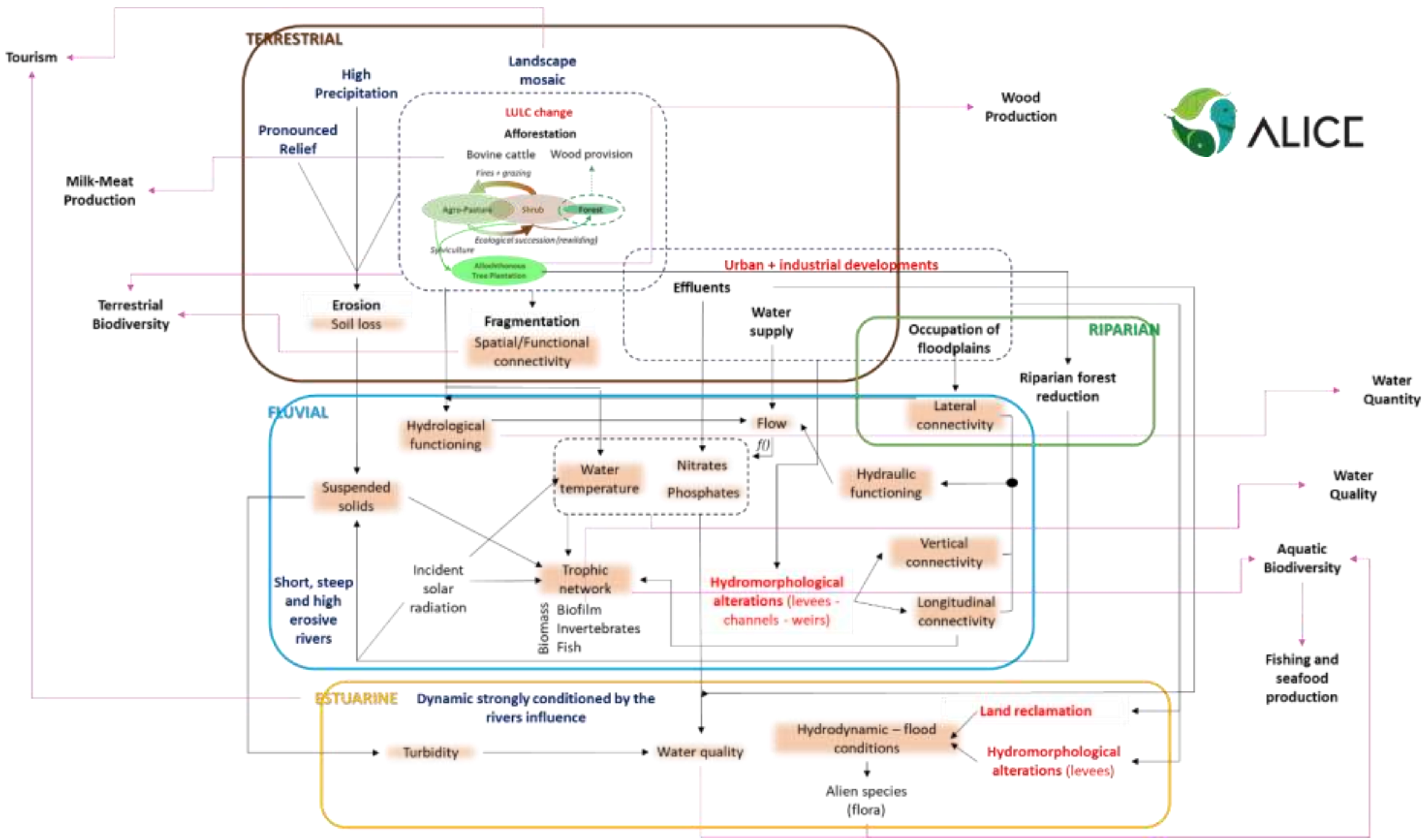
Model integration





Puerto model **(J. Busqué)**

Model integration



http://aries.integratedmodelling.org

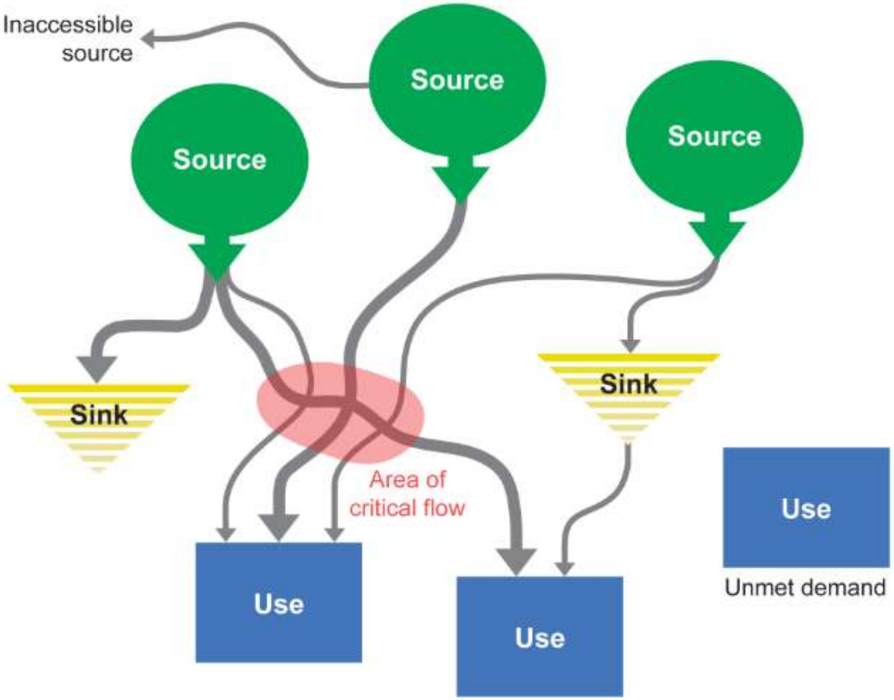
MISSION TECHNOLOGY ON THE GROUND NEWS TRAINING COMMUNITY RESOURCES

ARtificial Intelligence for Ecosystem Services

ARIES is a networked software technology that redefines ecosystem service assessment and valuation for decision-making. The ARIES approach to mapping natural capital, natural processes, human beneficiaries, and service flows to society is a powerful new way to visualize, value, and manage the ecosystems on which the human economy and well-being depend.

Learn more

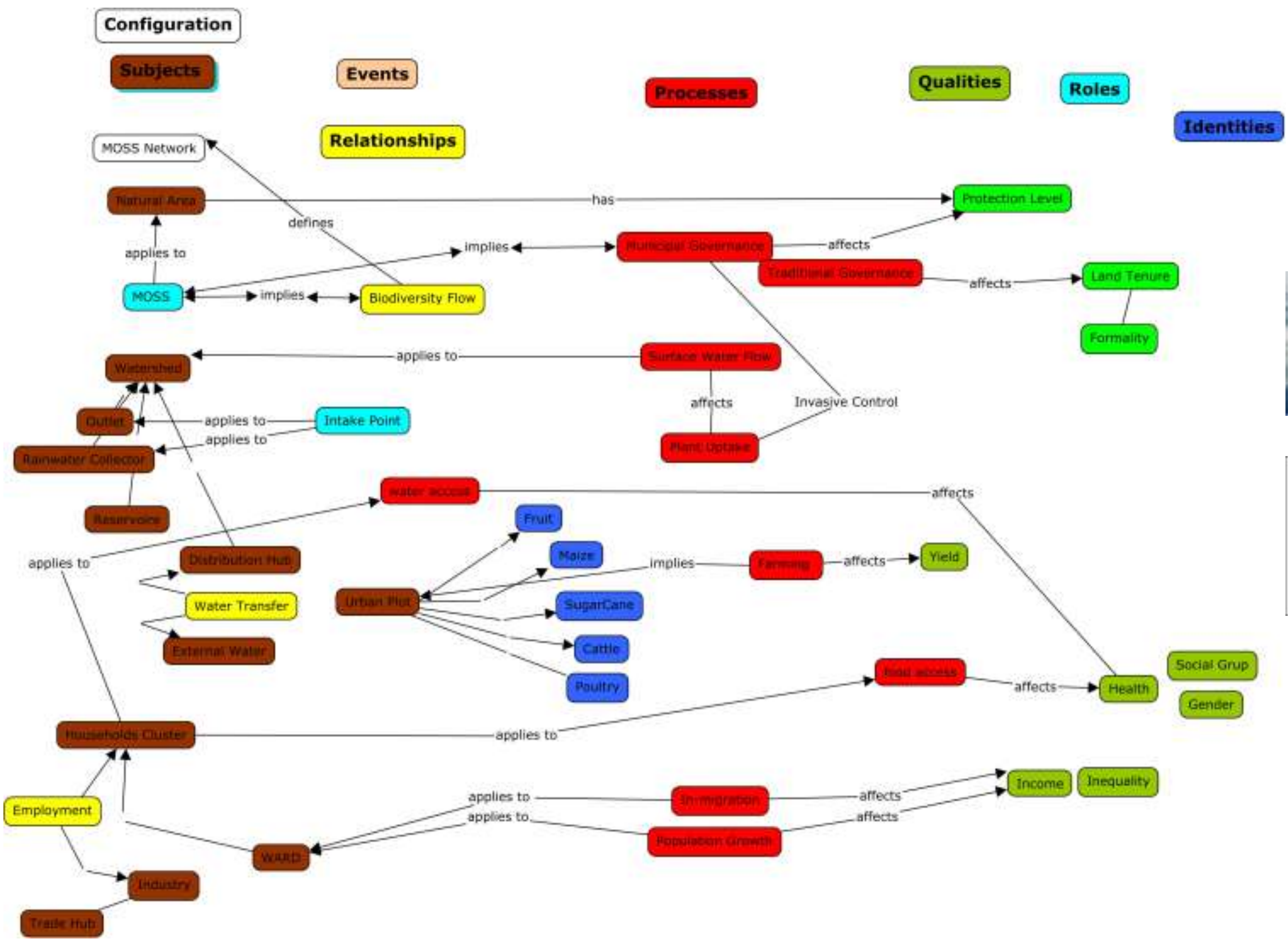
http://aries.integratedmodelling.org



A better way to model ecosystem services

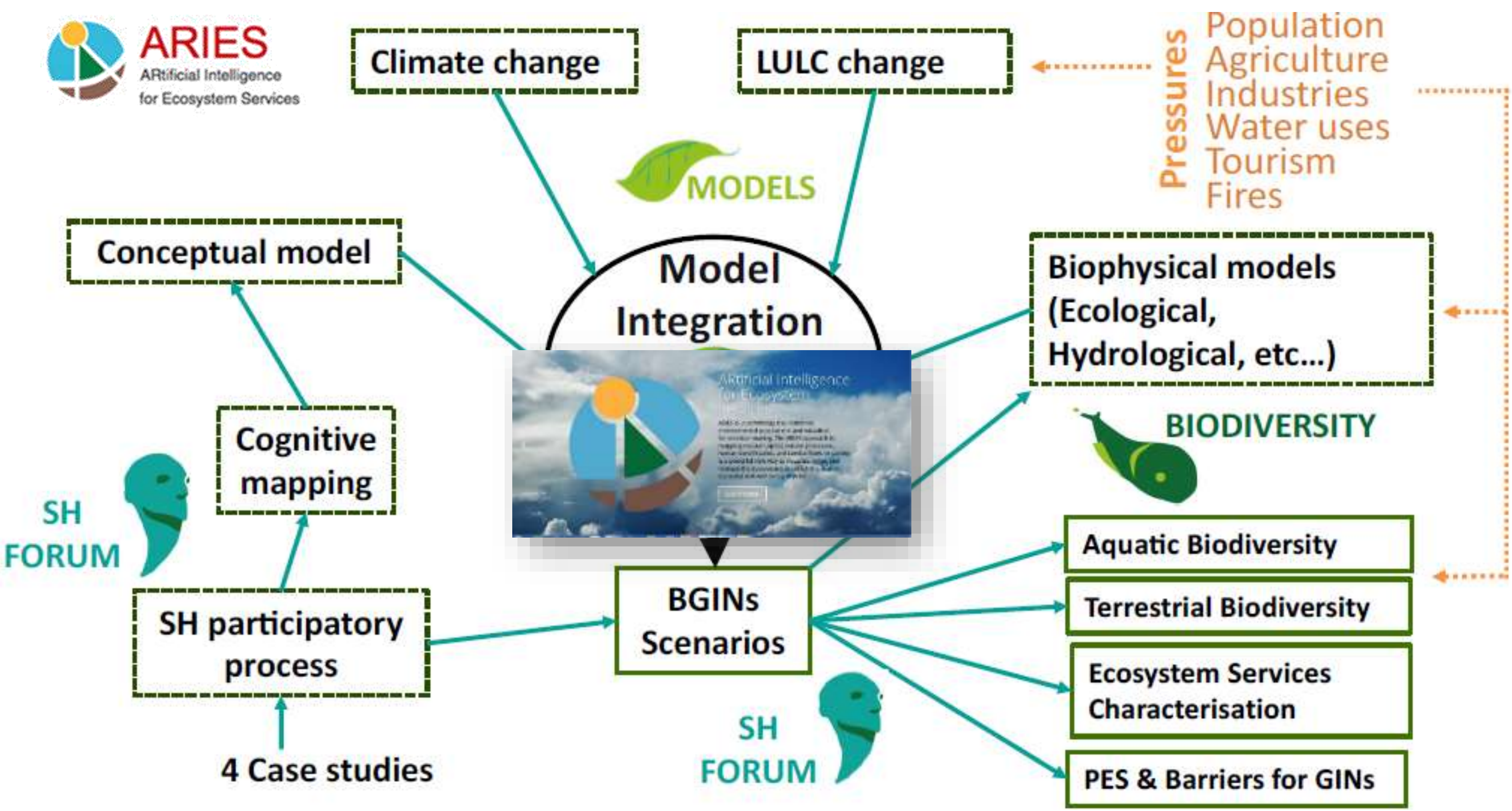
ARIES maps the agents of provision of ecosystem services (sources), their beneficiaries (use), and any biophysical features that can deplete service flows (sinks) automatically choosing the best available models and data. Through artificial intelligence and innovative semantic modeling, ARIES assembles spatial data and expert-contributed model components – deterministic or probabilistic – to quantify and map ecosystem services, at the appropriate spatial scales and specifically for each ecological and socio-economic context.

Model integration



ARIES
ARtificial Intelligence
for Ecosystem Services

MODEL INTEGRATION



Model integration

Ecosystem Services Characterisation

Terrestrial Ecosystem

1. Meat production
2. Milk production
3. Forestry products
4. Carbon uptake
5. Erosion Control
6. Recreation / Tourism
7. Amount of water

River Ecosystem

8. Water Quality
9. Fisheries
10. Recreation / Tourism
11. Water purification
12. Flood protection

Estuarine Ecosystem

13. Water Quality
14. Fisheries
15. Recreation / Tourism

ALICE

Biodiversity / Conservation Diagnosis

16. Terrestrial Biodiversity
17. Freshwater Biodiversity
18. Estuarine Biodiversity
19. Heritage
20. Habitat Conservation Status
21. River Ecological Status
22. Estuarine Ecological Status

		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
		MeatP	MilkP	ForestryP	CarbonU	ErosionC	TRecreation	Water	RiverWQ	RFisheries	RRecreation	Wpurification	FloodP	EstuarineWQ	EFisheries	ERecreation	TBiodiversity	RBiodiversity	EBiodiversity	Heritage	HabitatCS	RiverES	EstuarineES
1	Meat Production		X		Input	Input		Input	Input								X				Input		
2	Milk Production	X			Input	Input		Input	Input								X				Input		
3	Forestry Products				Input	Input		Input	Input								X				Input		
4	Carbon Uptake	Output	Output	Output				Input	Input								X				Input		
5	Erosion Control	Output	Output	Output				Output	Input								X						
6	Terrestrial Recreation																X				X		
7	Amount of Water	Output	Output	Output	Output				X	Input	Input	Input	Input	Input	Input		X	Input	X			X	X
8	River Water Quality	Output	Output	Output	Output	Output		X		Input	Input	Input		Input	Input		X	Input	X			Input	X
9	River Fisheries							X	X		Input	X			X			Input	X			Input	
10	River Recreation							X	X	Output								X				X	
11	Water purification							X	X	X				Input				X	X			X	X
12	Flood protection							X						Input									
13	Estuarine Water Quality							X	X			Output			Input	Input		X	Input			X	Input
14	Estuarine Fisheries							X	X	X		X		X		Input		X	Input			X	Input
15	Estuarine Recreation								X			X		X	Output				X			X	X
16	Terrestrial Biodiversity	Input	Input	Input	Input	Input	Input	Input	Input												X		
17	River Biodiversity							X	X	X	Input	Input					X		X		X	Input	X
18	Estuarine Biodiversity								X			X		X	Output		X	X			X	X	Input
19	Heritage																						
20	Habitat Conservation Status	X	X	X	X		Input			Input**	Input**	Input**	Input**	Input**	Input	Input	X	X	X			X	X
21	River Ecological Status							X	Input	Input /*	Input /*	Input /*	Input*	Input*	Input	Input	X	Output	X		X		X
22	Estuarine Ecological Status							X	X			X		Input*	Input	Input	X	X	Output		X	X	

Model dependencies

Model integration

- Invasive species
- Water quality

changes in
land or stream
corridor use

SH

- Im

y loss

eutrophication,
and lower water
table elevations

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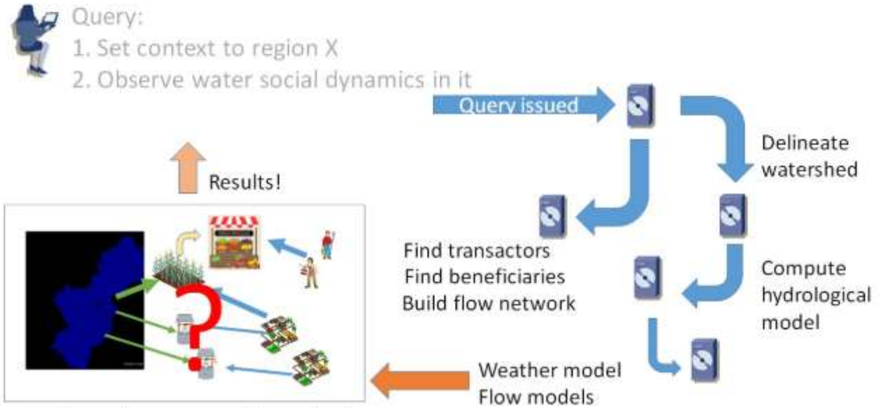
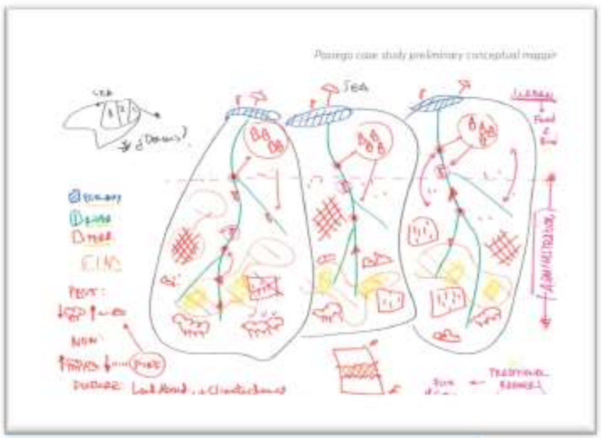
An ecosystem of models

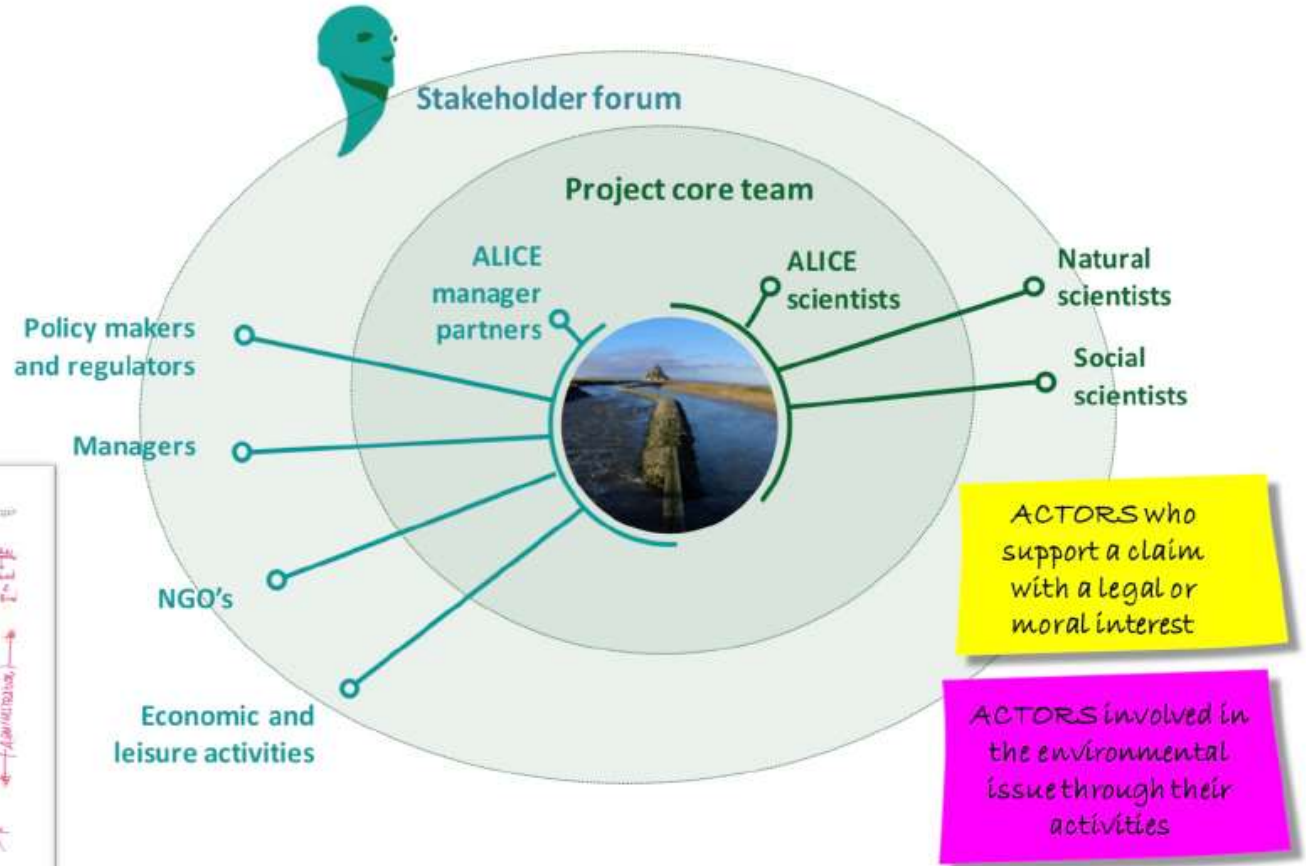


Models and data used in ARIES are stored on an expanding semantic web. While users can provide their own data and models, an extensible network hosts data, models and model services that are assembled according to context. In this kind of *collaborative modelling*:

1. Models and data are developed by the individual, independent experts;
2. Open source technology allows researchers and institutions to add models and data to the network;
3. Models and data can be made available to all users or restricted communities;
4. Artificial Intelligence negotiates the most appropriate models to solve user queries;
5. Transparent documentation can be generated

Stakeholders





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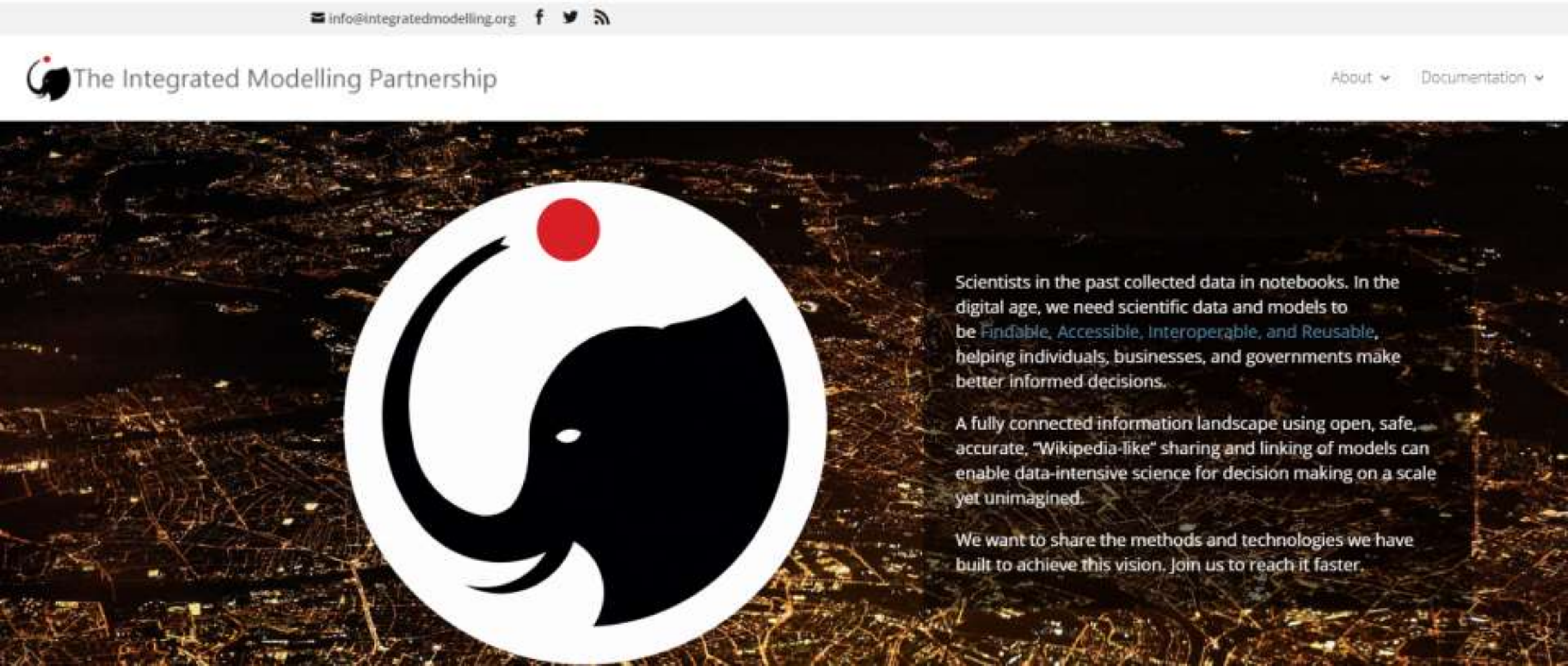

Scientists in the past collected data in notebooks. In the digital age, we need scientific data and models to be Findable, Accessible, Interoperable, and Reusable, helping individuals, businesses, and governments make better informed decisions.

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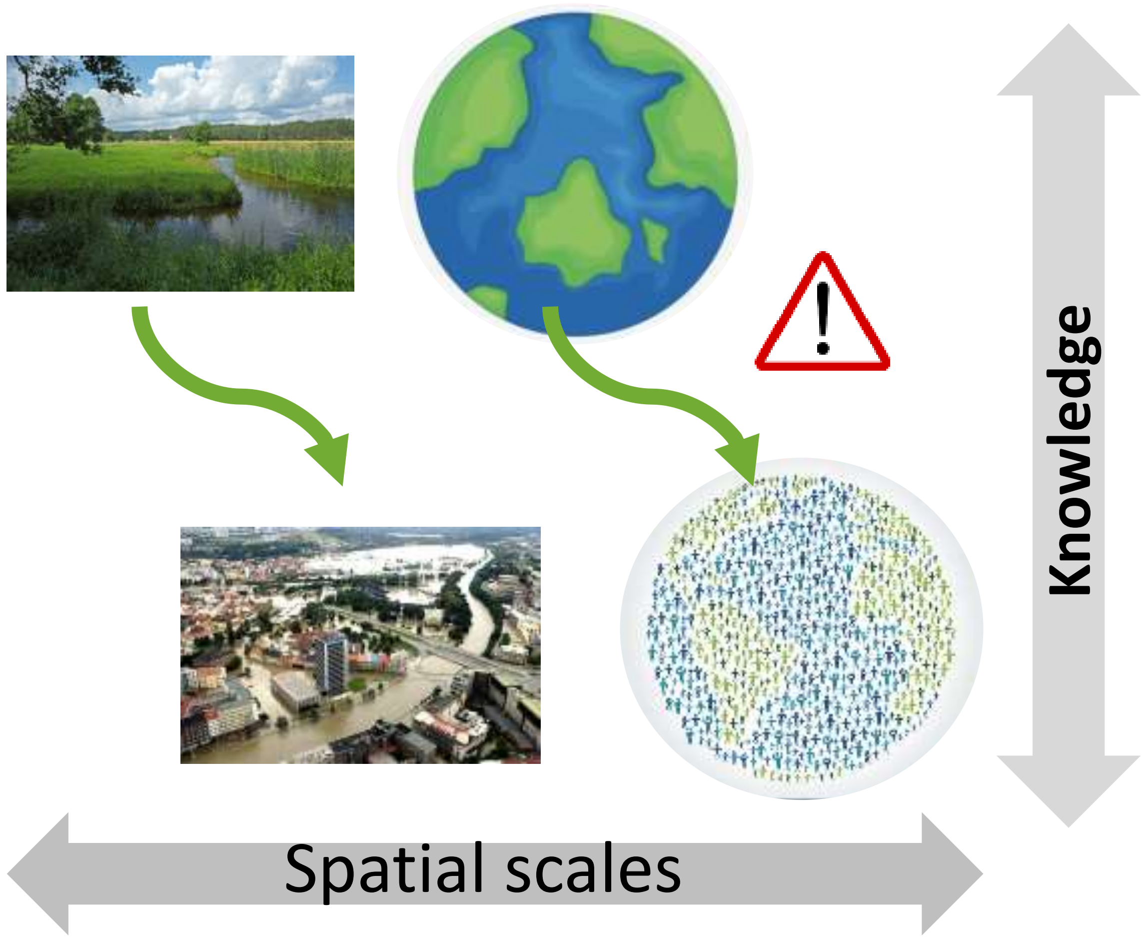
BGIN POLICY ISSUES

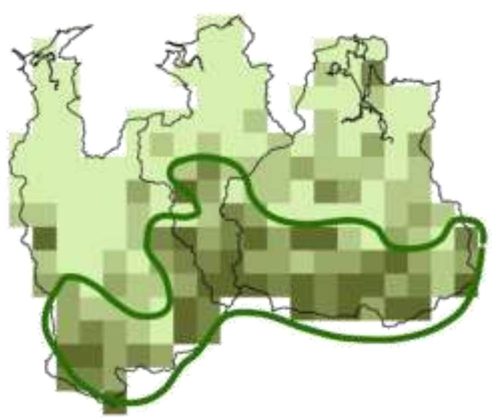
Source areas

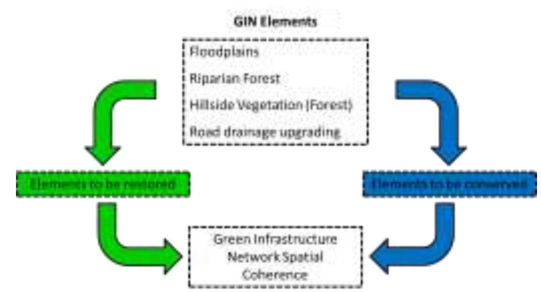
Flows

Beneficiaries



Stakeholders





Stakeholders

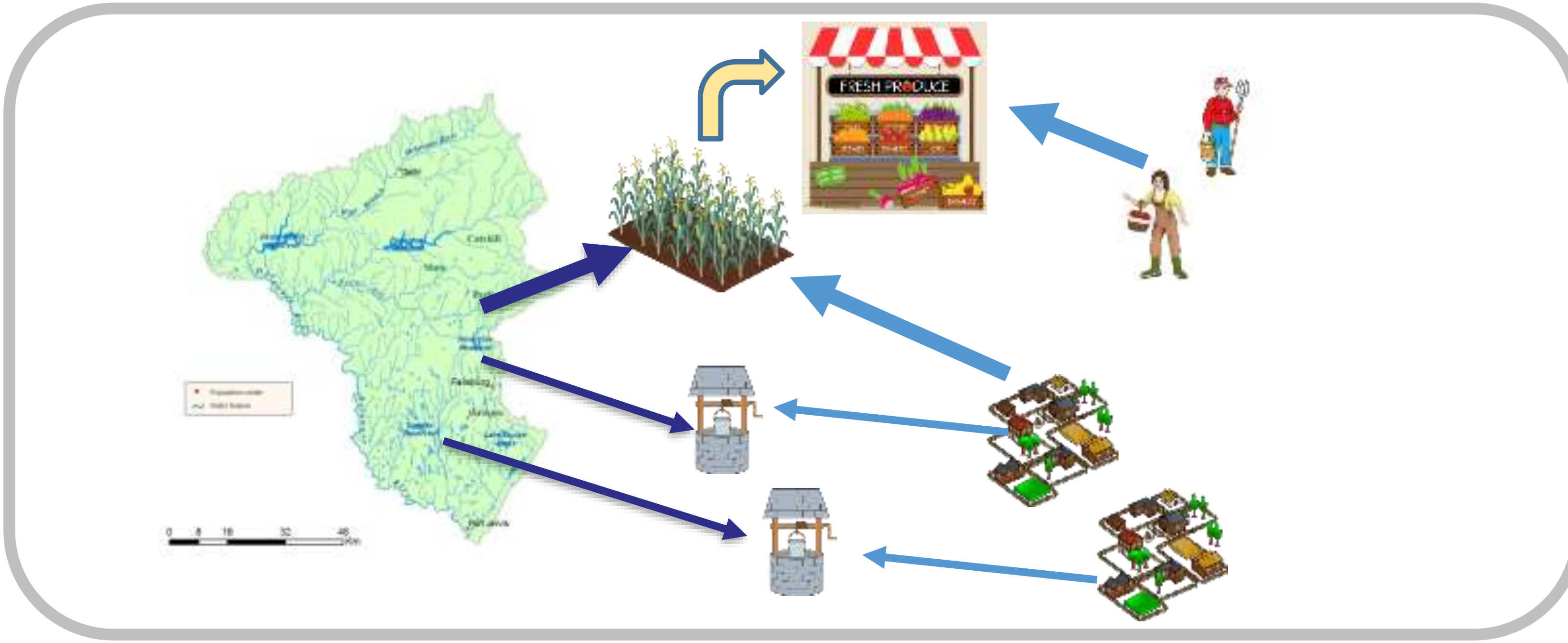
February 2019 → **Surveys:** collect the impressions of the agents.

March 2019 → **First Workshop:** Recognize Strengths and Weaknesses in the territory for adaptation to Climate Change and the main environmental problems.

January 2020 → **Second Workshop:** Presentation of results of the models for the current time and approach of solutions.

June 2020 → **Third Workshop:** Presentation of results of the scenarios and approach of alternatives.

Sociecological networks



Providers (e.g. forests, watersheds) are first identified and built by the AI engine.

The ontologies define types of Transactors (e.g. wells, crops, atmosphere), identified last.

Beneficiaries (e.g. farmers, coastal dwellers) are identified next.

The model for the system then creates and classifies all relationships, starting with *provision* (provider->transactor)…

…and following with use (beneficiary <- transactor), building a (potentially) different scaled model for each flow.

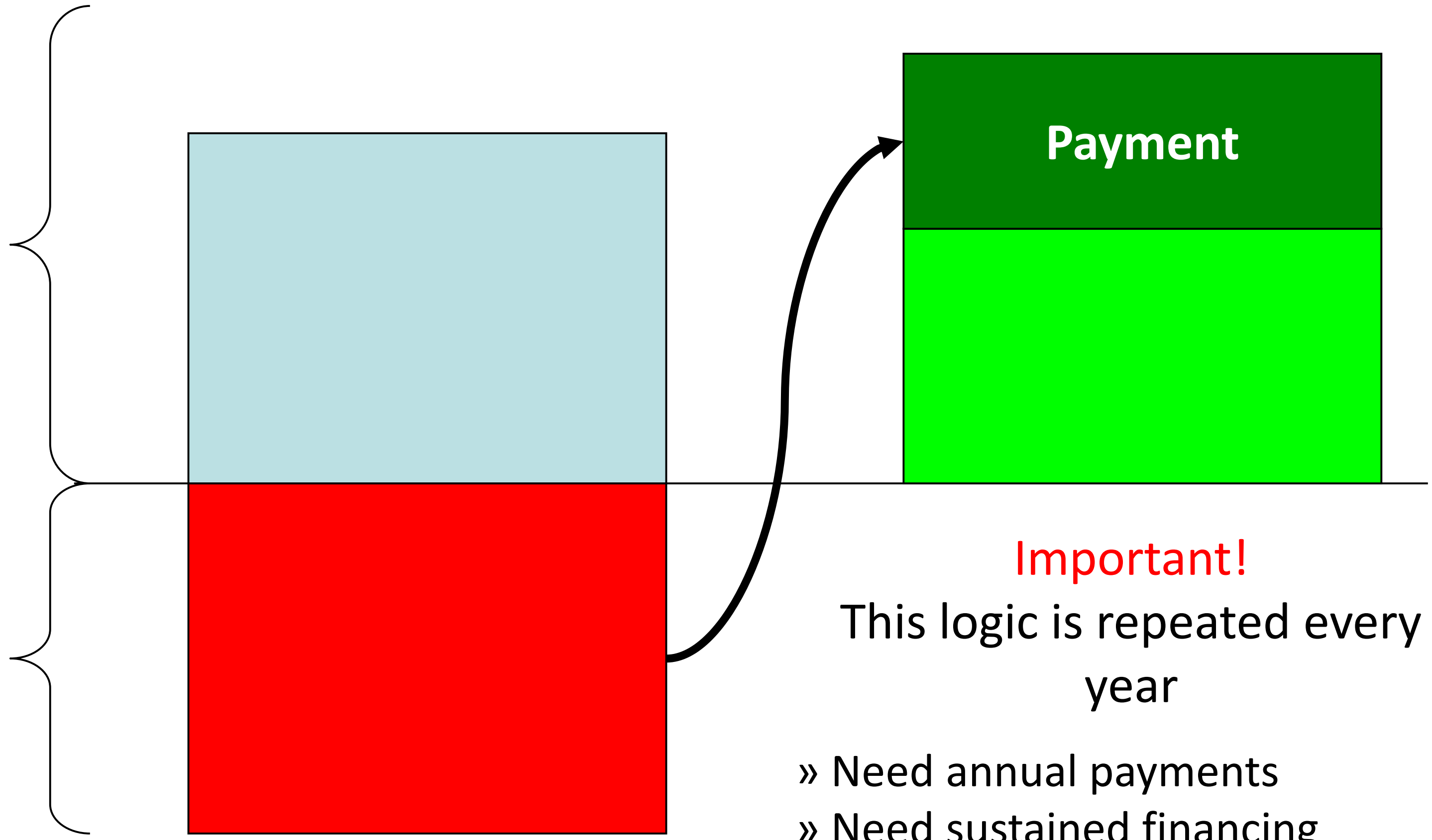
Intermediate transactors (e.g. markets) are brought in according to the ontologies. They can be local or remote.

Deforestation and use for pasture

Conservation with payment for service

Benefits to land users

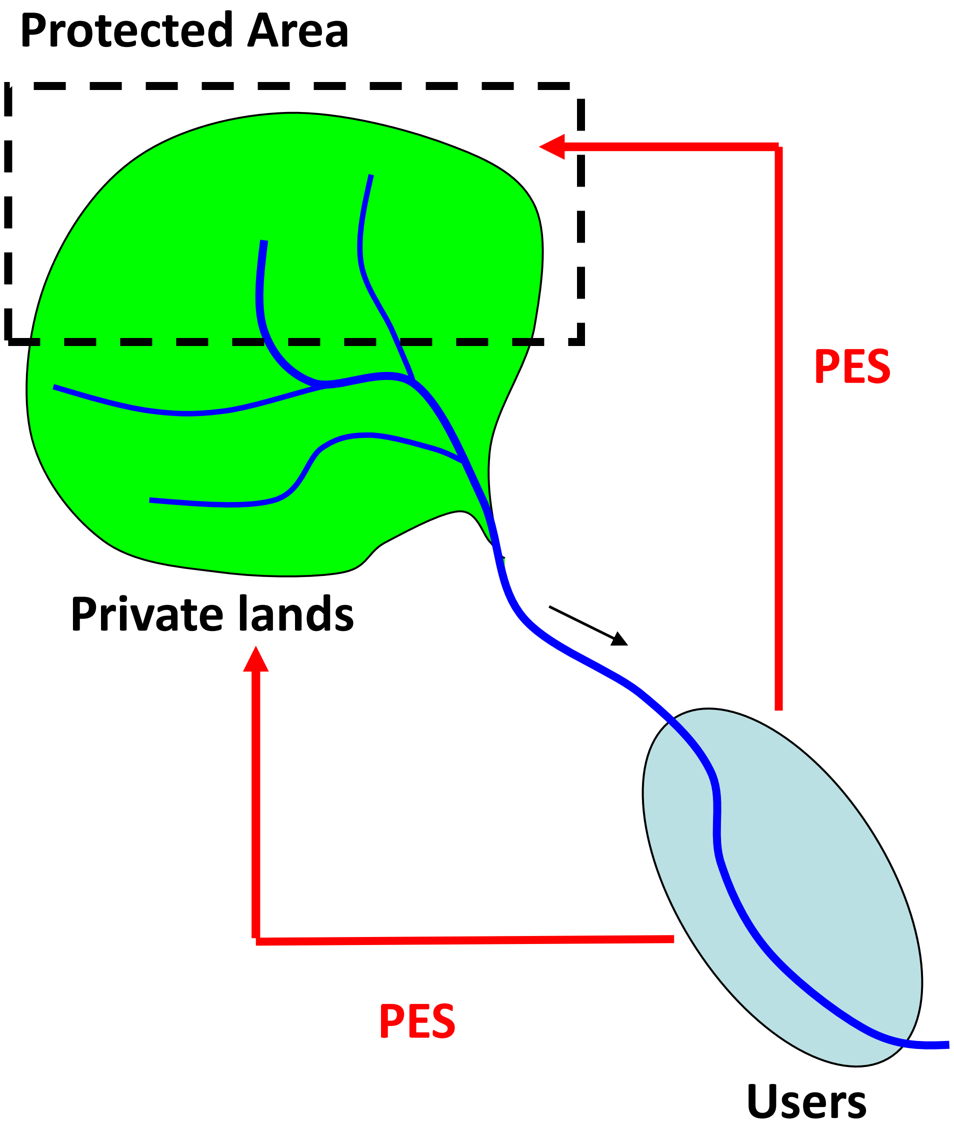
Costs to downstream populations



Important!

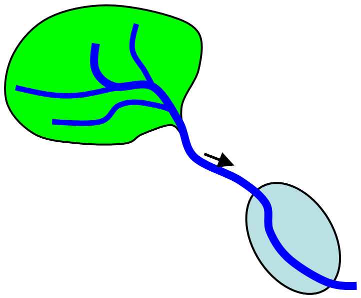
This logic is repeated every year

» Need annual payments
» Need sustained financing

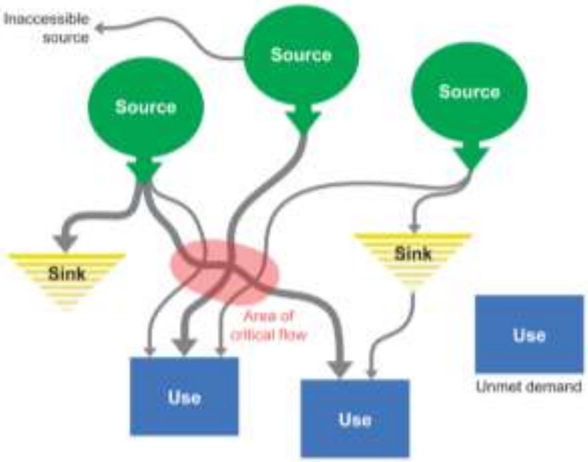


Payments can go to:

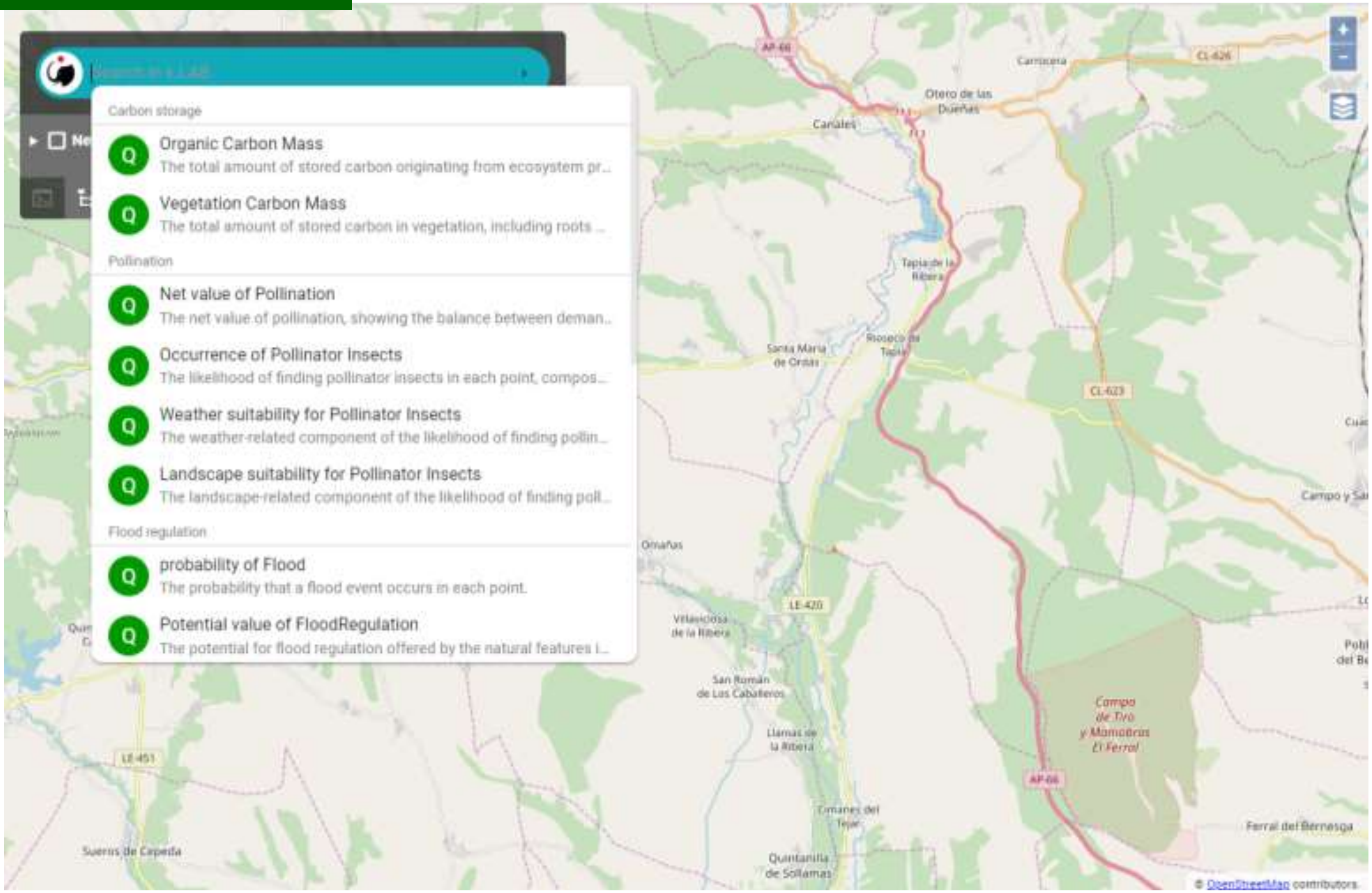
- Private landowners: including buffer zones and biological corridors, among others
- Protected Area budgets

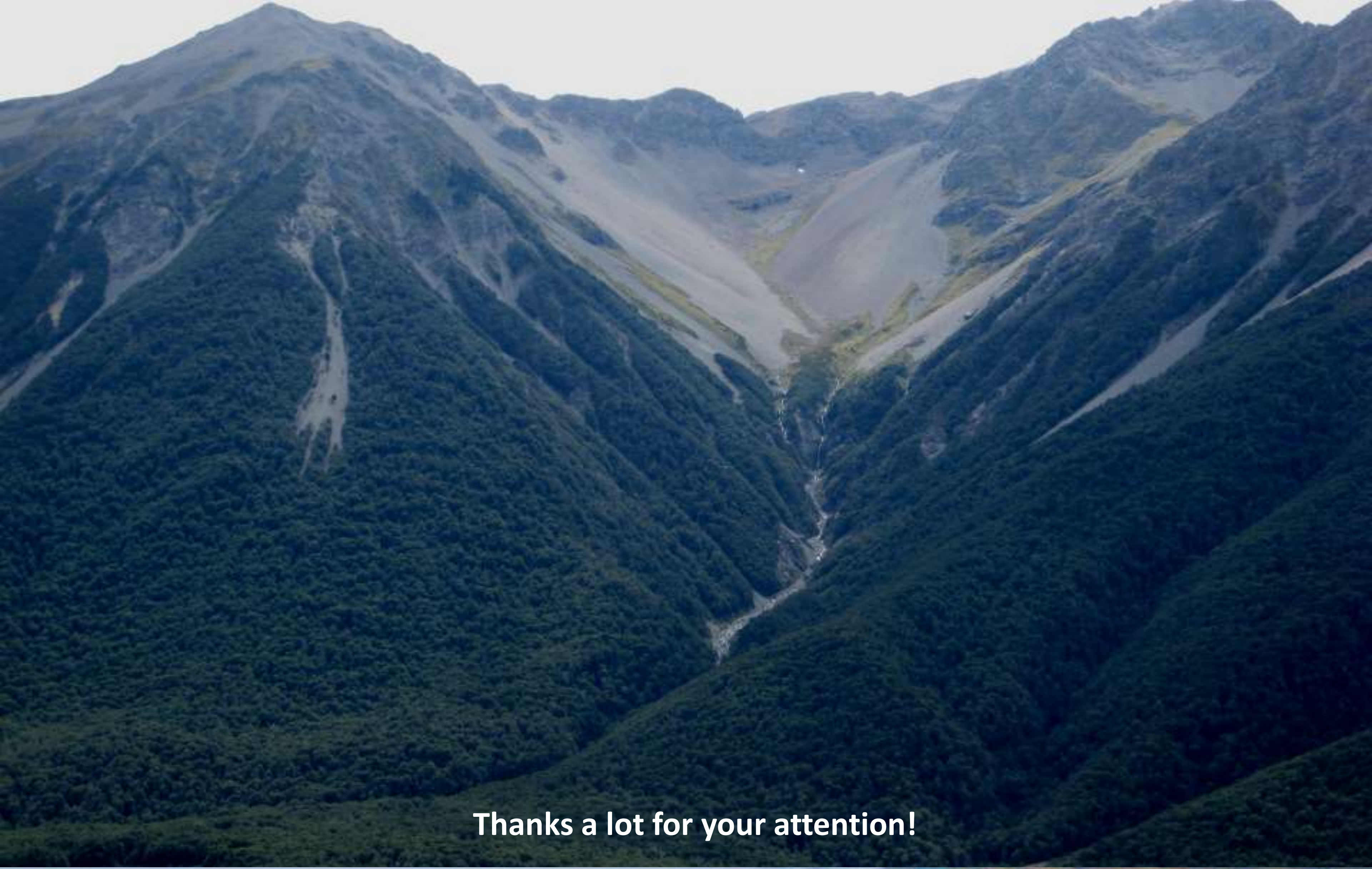


- Not a universal solution
- One size does not fit all
- Identify the services being provided clearly
- Understand and document the links between ecological processes and services
- Include the demand side, not only the supply side
- Monitor effectiveness
- Design flexible mechanisms
- Mix and match with other mechanisms
- Getting the science and institutions right



GUI - k.EXPLORER





Thanks a lot for your attention!

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