Developing an approach to implement green-blue infrastructure networks as an adaptative measure against global change in mountain areas of the Iberian Peninsula

GS 4: How Ecology serves the Society: services and nature-based solutions

1st Meeting of the Iberian Ecological Society and XIV AEET Meeting , 07th February 2019, Barcelona, Spain

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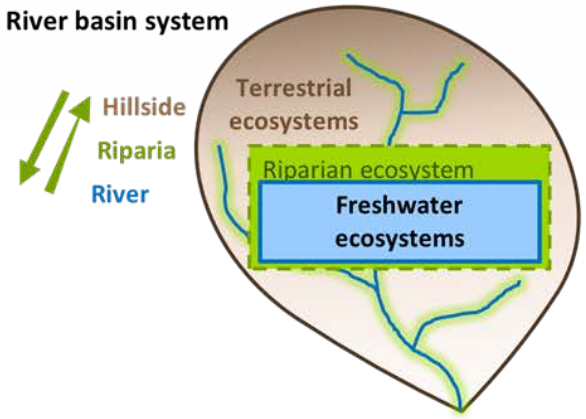
Background

What is Green/Blue Infrastructure Network (BGIN)?

LANDSCAPE STRUCTURE



Biodiversity

Ecosystem Functioning

- Ecosystem Services

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

Green Infrastructure

Environmental — Balance — Socio-economic

Theoretical — *Practical*

Financing

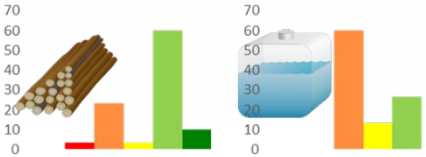
3 base concepts: Connectivity | Multifunctionality | Green

f(approach-framework, discipline, objective)

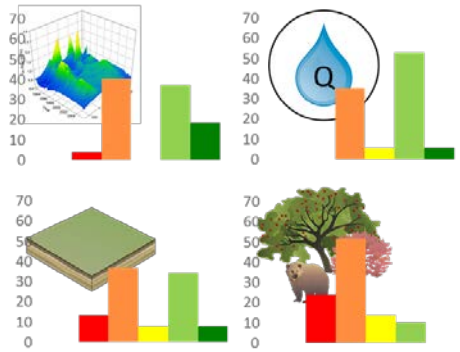
Background

What is Green/Blue Infrastructure Network (BGIN)?

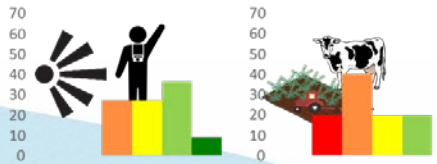
Provisioning



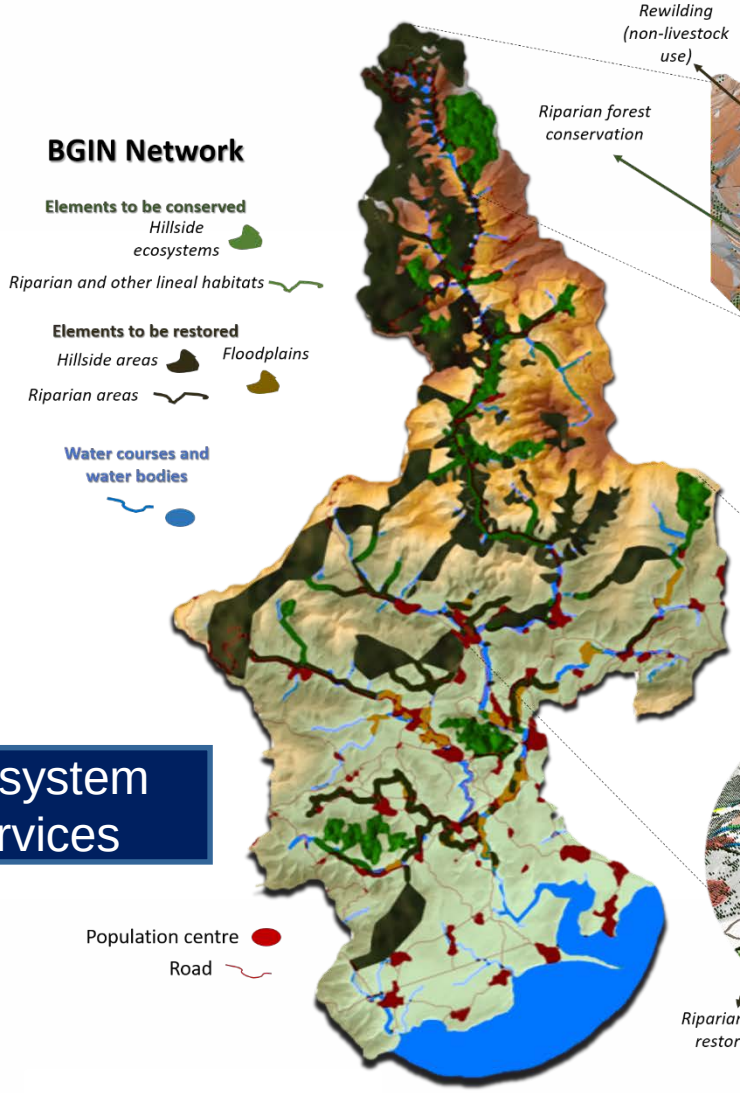
Regulation and Maintenance

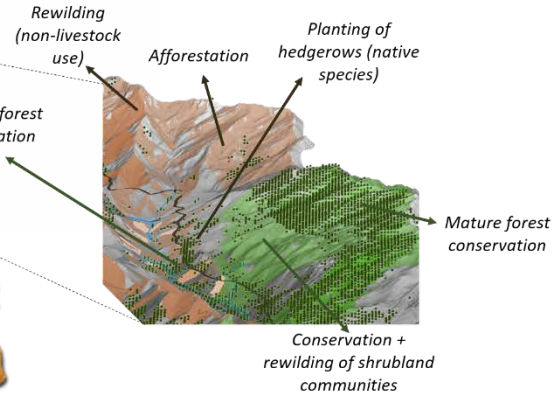


Cultural

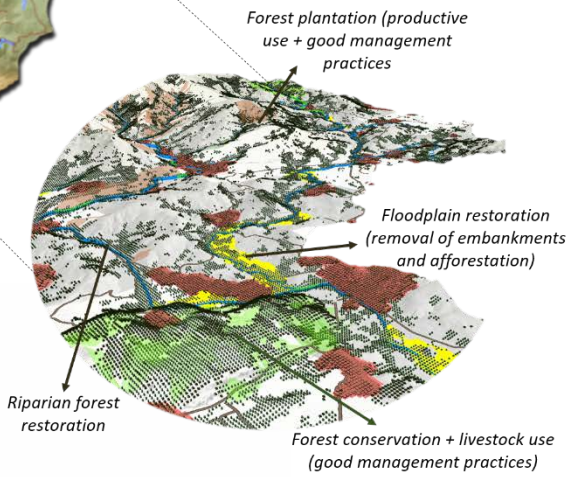


Ecosystem services





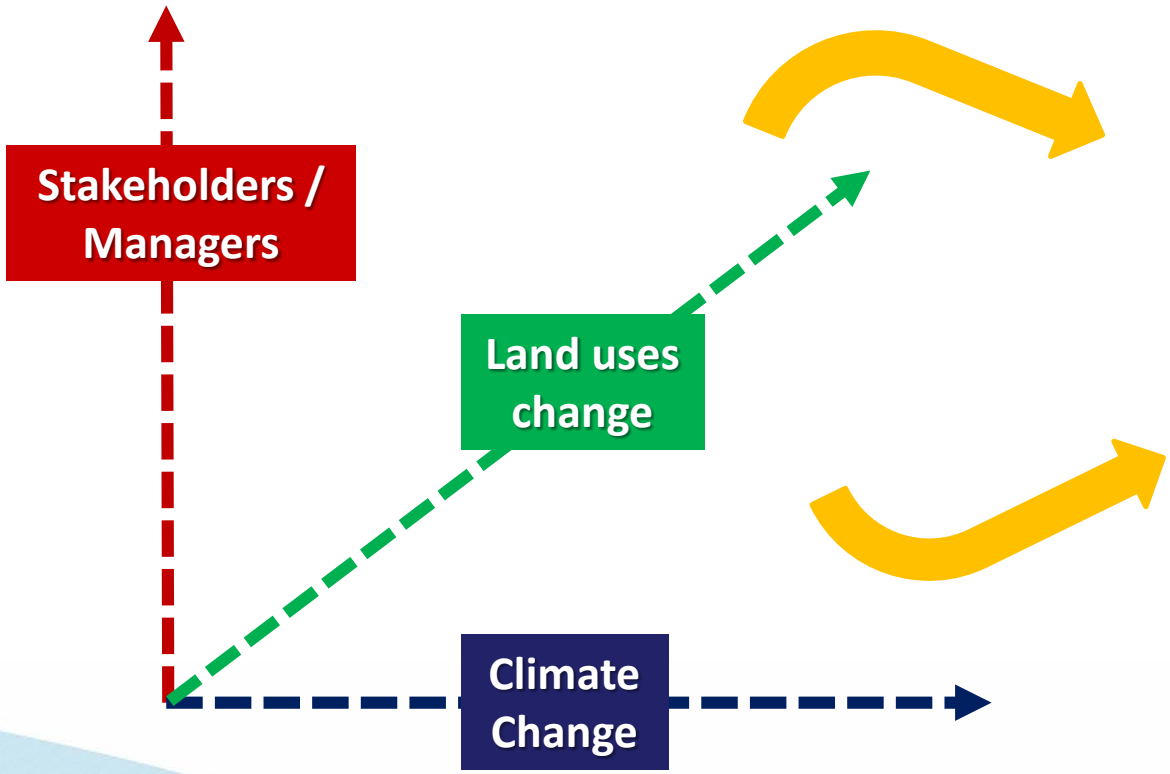
Some examples of BGINs elements



Background

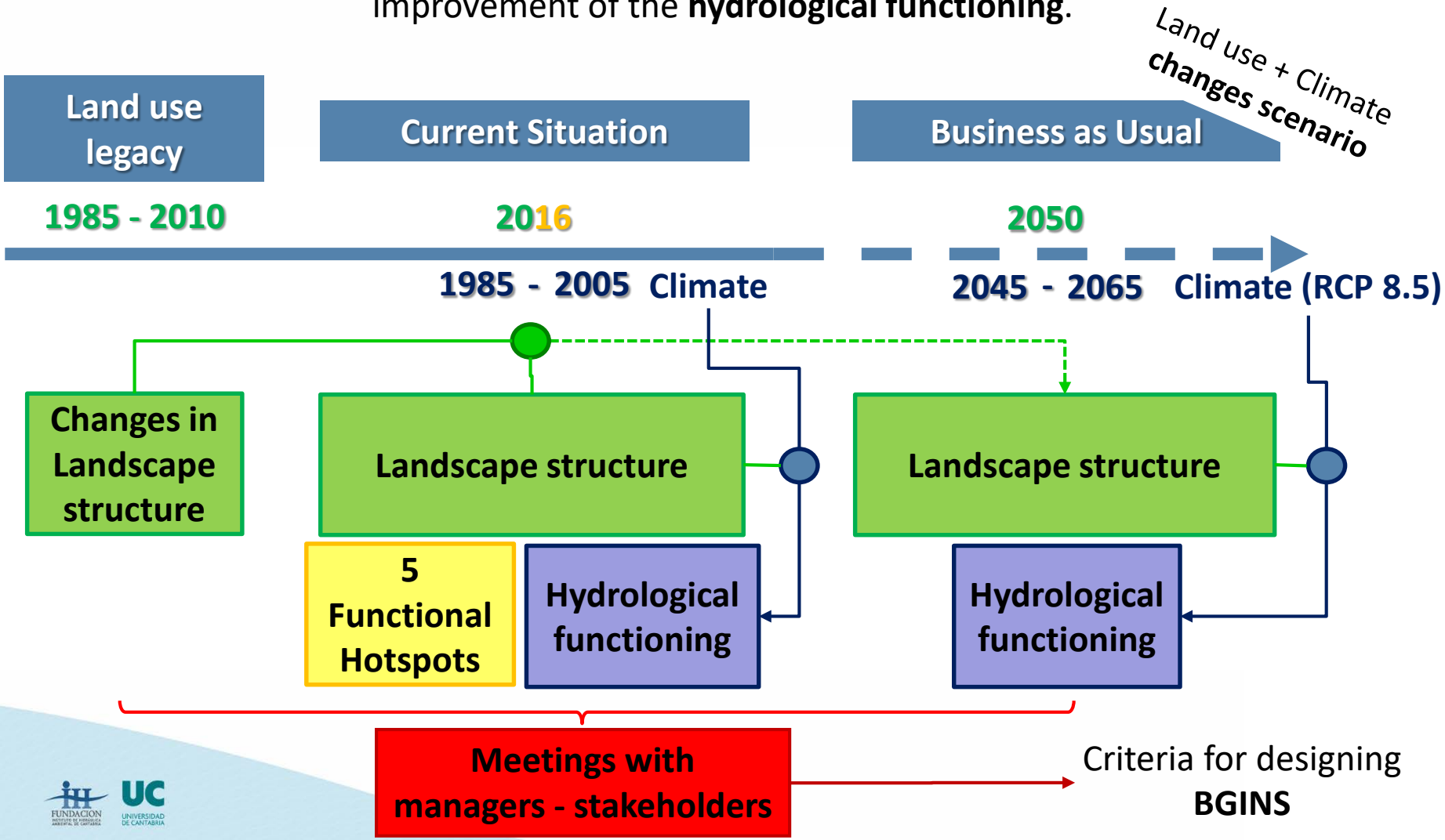
Blue/Green Infrastructures Networks: towards an adaptative territorial management

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

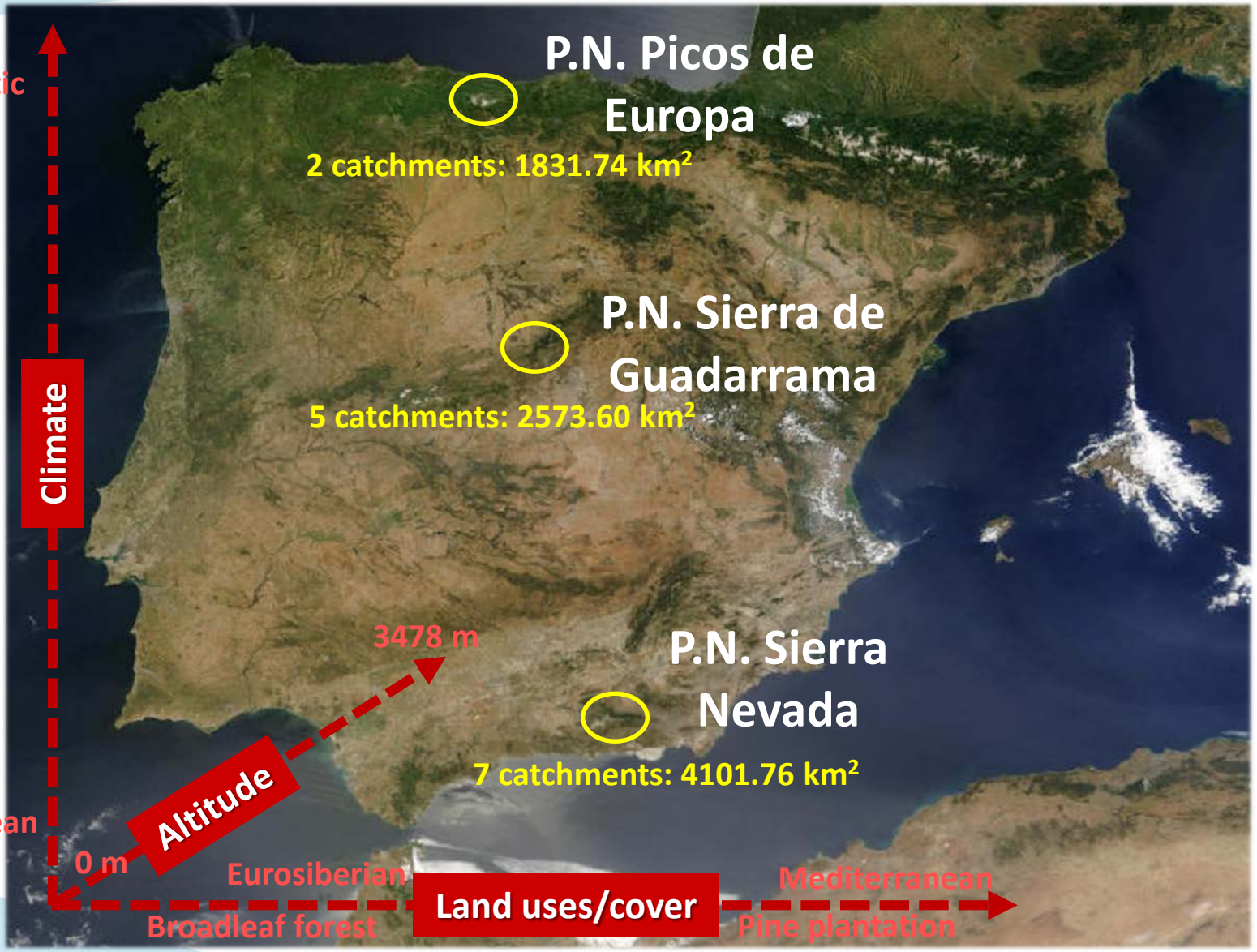


Objectives

Developing a **methodology to design BGINs** for **mountain catchments** of the Iberian Peninsula following two main **criteria**: the optimization of the **landscape structure** and the improvement of the **hydrological functioning**.



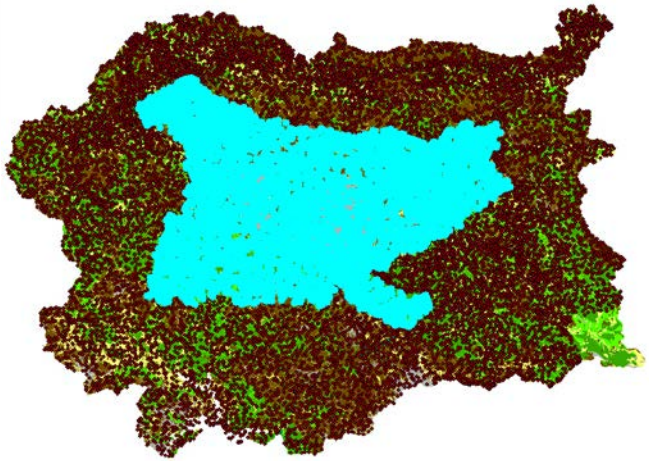
Study area


P.N. Picos de Europa
2 catchments: 1831.74 km²
P.N. Sierra de Guadarrama
5 catchments: 2573.60 km²
P.N. Sierra Nevada
7 catchments: 4101.76 km²
Atlantic
Climate
Mediterranean
3478 m
Altitude
0 m
Eurosiberian
Broadleaf forest
Land uses/cover
Mediterranean
Pine plantation

Methods

Landscape structure

Current Situation



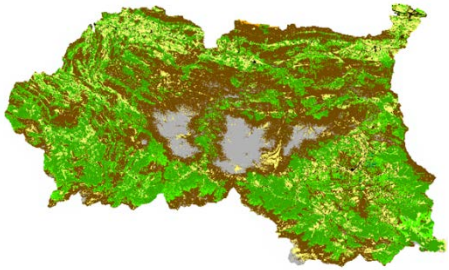
Vegetation occurrence points:
SIOSE
Vegetation map of PP.NN

Spatial modelling algorithm:
Support Vector Machine
(SVM)

Environmental variables
Slope, altitude and soil properties

Abiotic variables
Sentinel and LiDAR

Spatial resolution:
20m



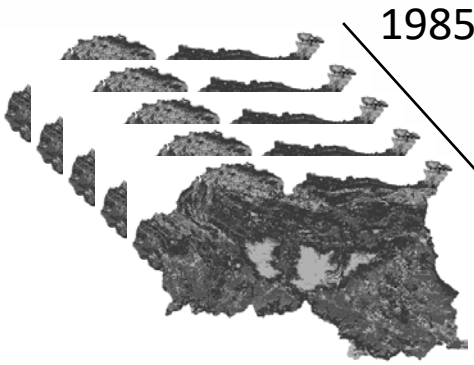
Land cover/use legend

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

Methods

Landscape structure

Business as Usual

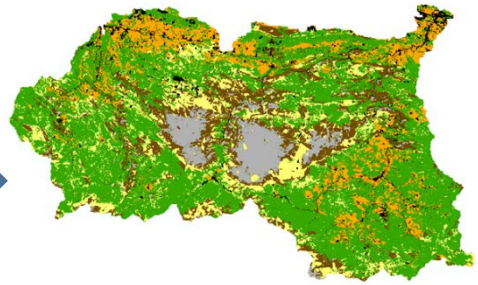


LANDSAT (1985 – 2010)
Land uses changes (píxel)

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

Socio-economic inputs

Spatial resolution: 30m



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Methods

Hydrological functioning

Current Situation

P.N Picos de Europa
P.N Sierra de Guadarrama

Hydrological model

TETIS v9.0

Grupo de Investigación de Modelación Hidrológica y Ambiental

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

P.N Sierra Nevada

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…

Methods

Hydrological functioning

Business as Usual

P.N Picos de Europa
P.N Sierra de Guadarrama

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P.N Sierra Nevada

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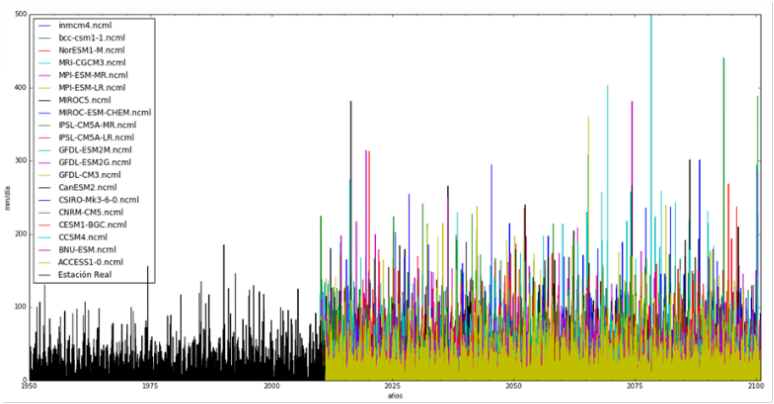
Climate INPUT: 2045 – 2065 (RCP8.5)
(precipitation and temperatura)



$$Serie_{Futuro} = DeltaREA \times Serie_{Presente}$$

$MF \rightarrow Modelo\ Futuro$
$MP \rightarrow Modelo\ Pesente$

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

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

Vegetation INPUT:

Landscape structure

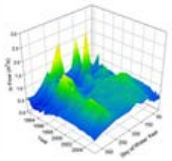
Business as Usual

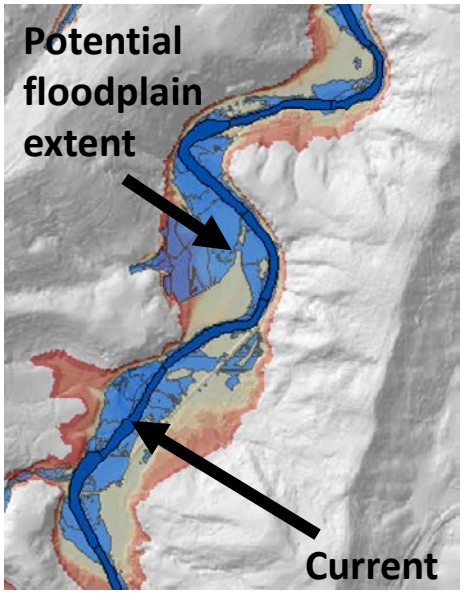
Methods

Functional Hotspots

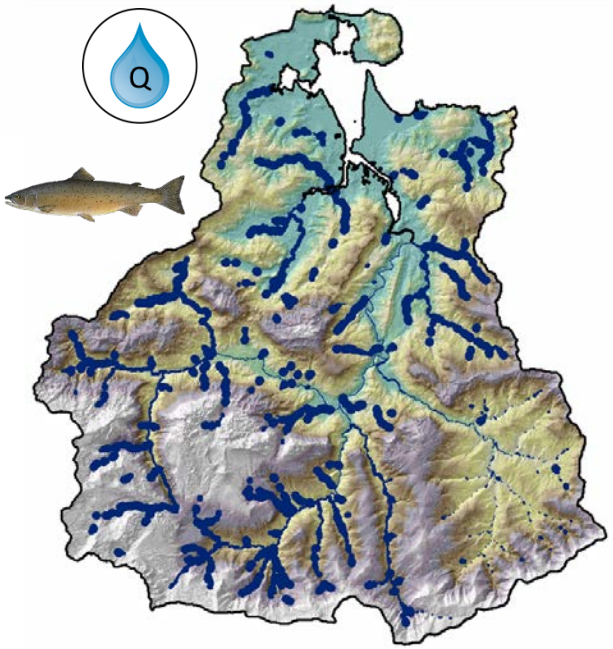
Current Situation

1- Floodplain extent





2 - Thermal loading

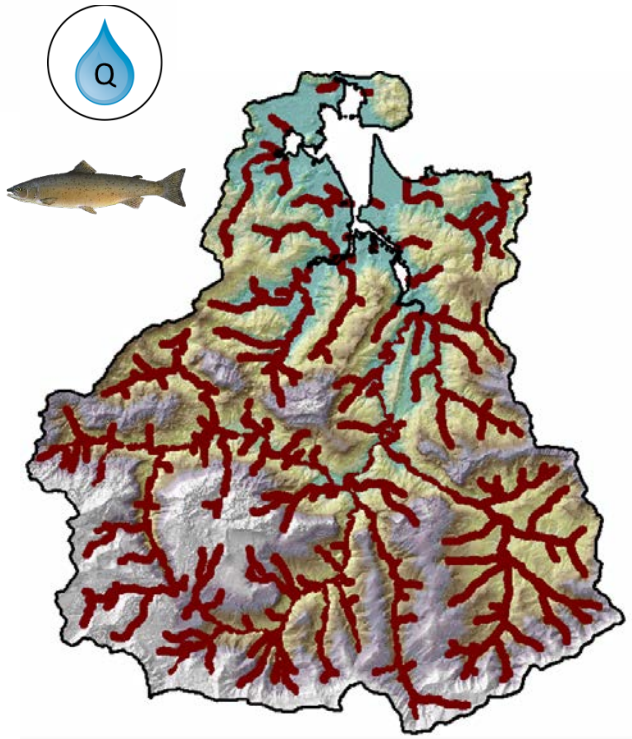


Maximum potential Shade-Thermal Energy
(watt . hour / m²)

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

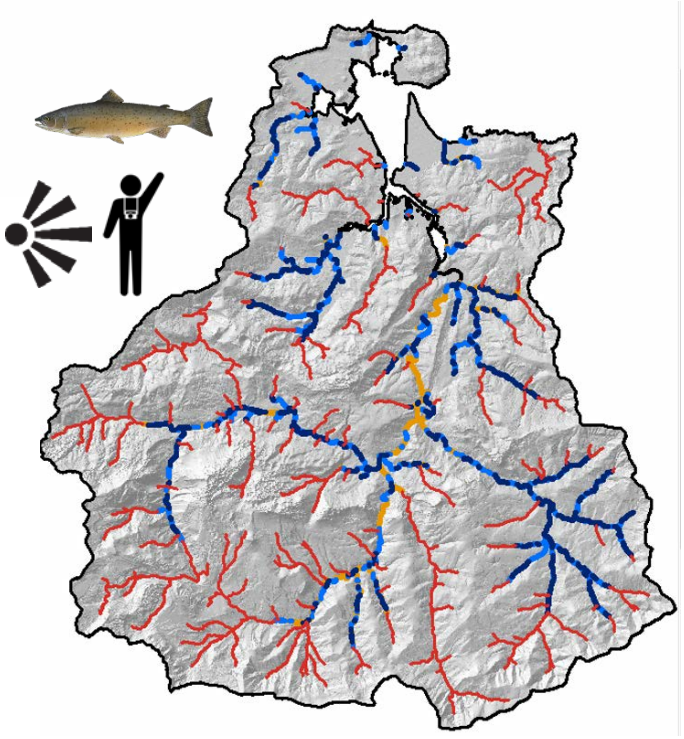
Increasing benefit

Methods

Functional Hotspots

Current Situation

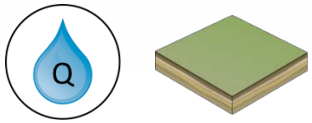
4 - Potential habitat for salmonids



Habitat quality

- < 0.1
- 0.4
- 0.5
- > 0.5

5 - Hillslope surface erosion

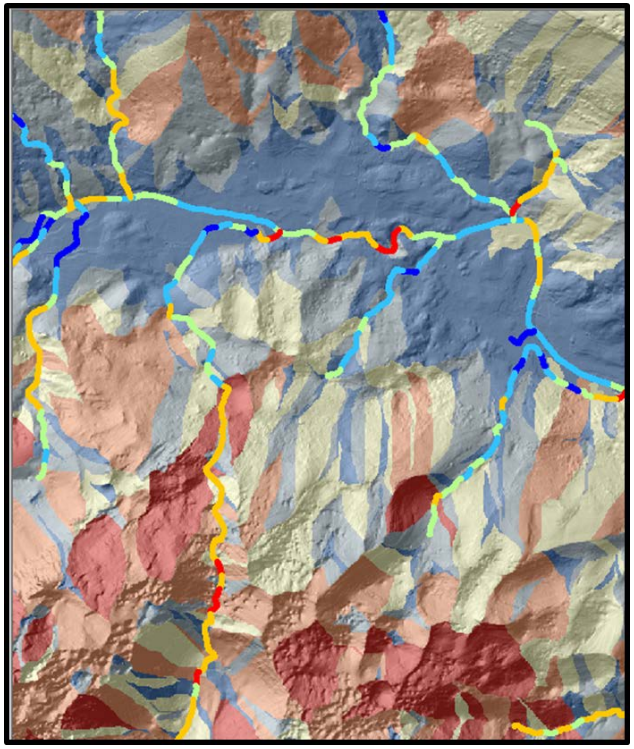


Erosion potential

- 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

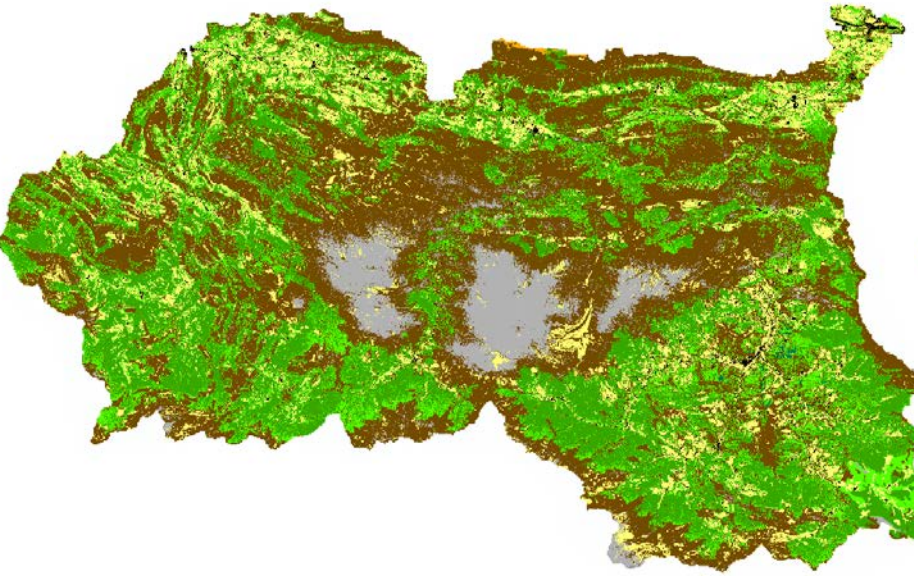


Results

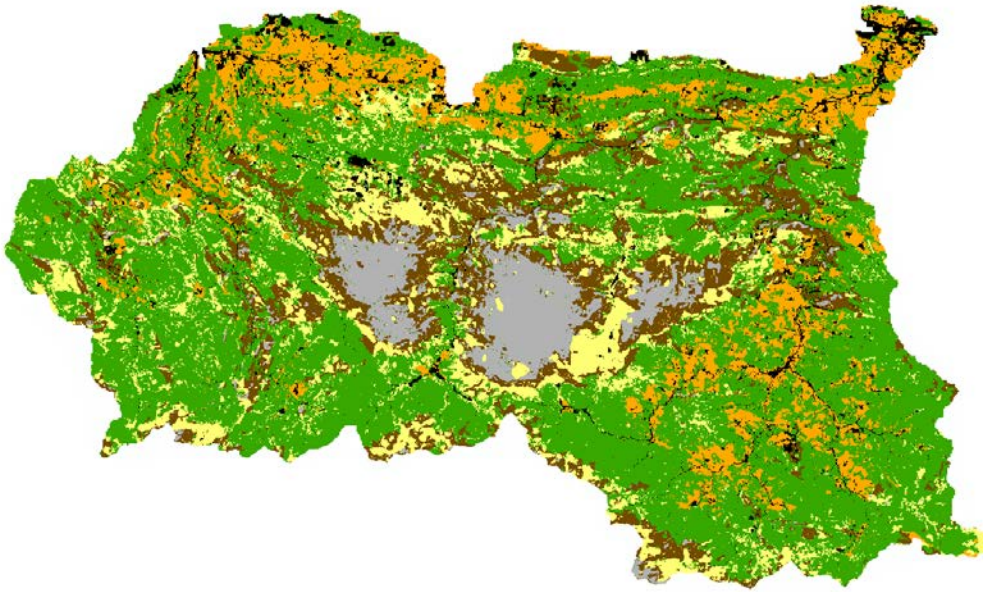
Landscape structure

P.N Picos de Europa P.N Sierra de Guadarrama P.N Sierra Nevada

Current Situation



Business as Usual



Mature broadleaf forest
Young broadleaf forest
Coniferous forest/plantation
Shrubland
Pastures
Agrarian
Rocks
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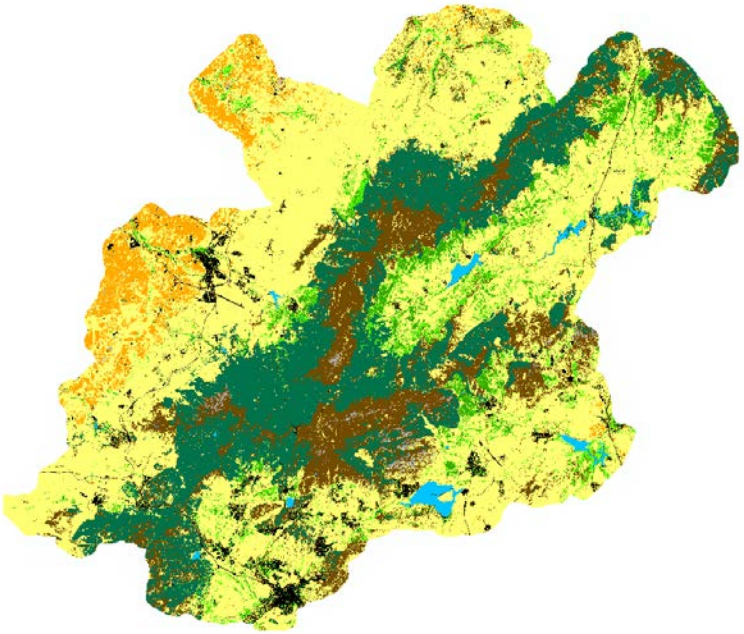
Water

Results

Landscape structure

P.N Picos de Europa | **P.N Sierra de Guadarrama** | P.N Sierra Nevada

Current Situation



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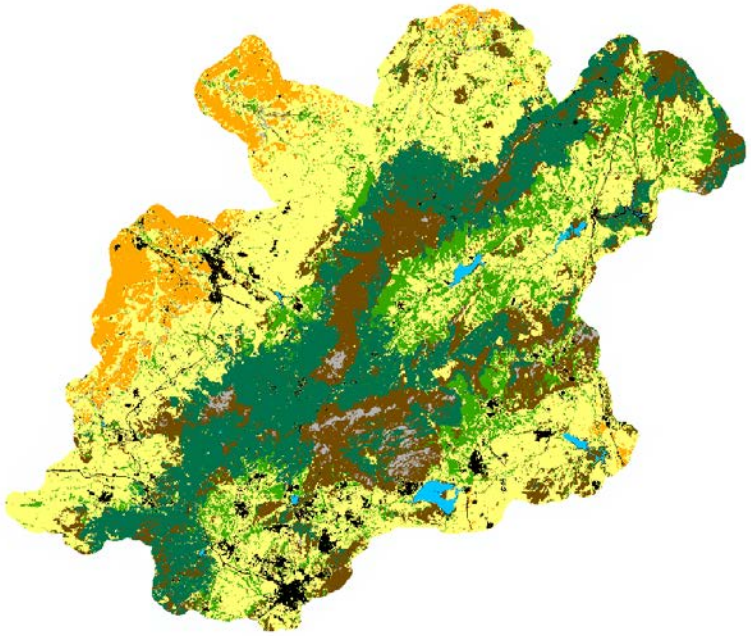

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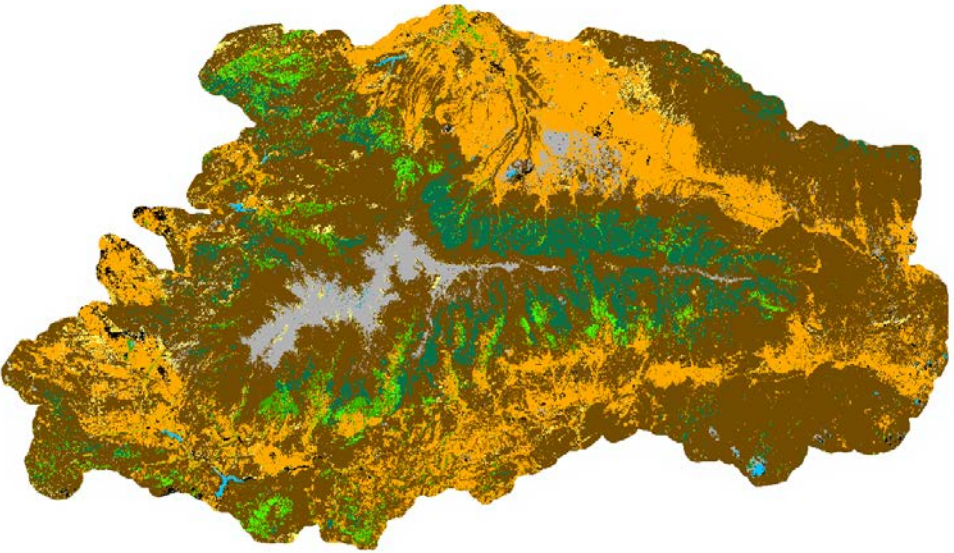
Results

Landscape structure

P.N Picos de Europa | P.N Sierra de Guadarrama | **P.N Sierra Nevada**

Current Situation



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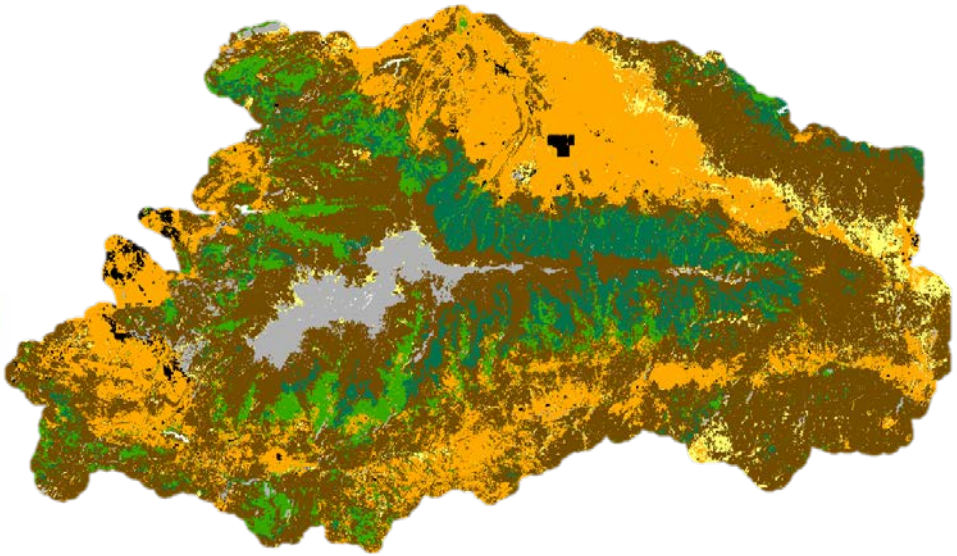

Mature broadleaf forest
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Results

Hydrological functioning

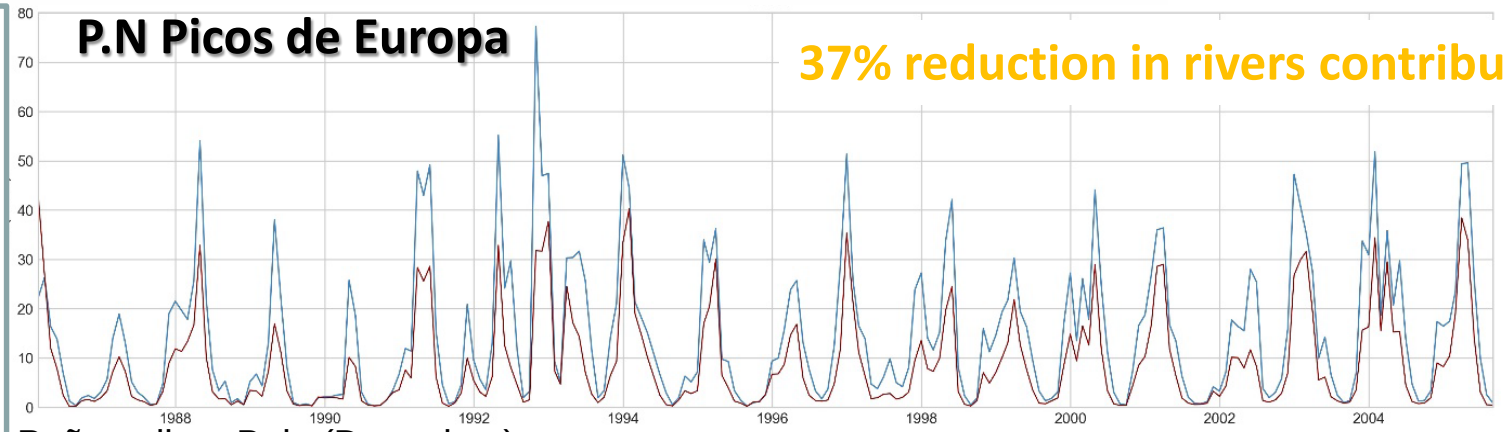
Current Situation

Business as Usual

Q (m^3/s) mensual average

P.N Picos de Europa

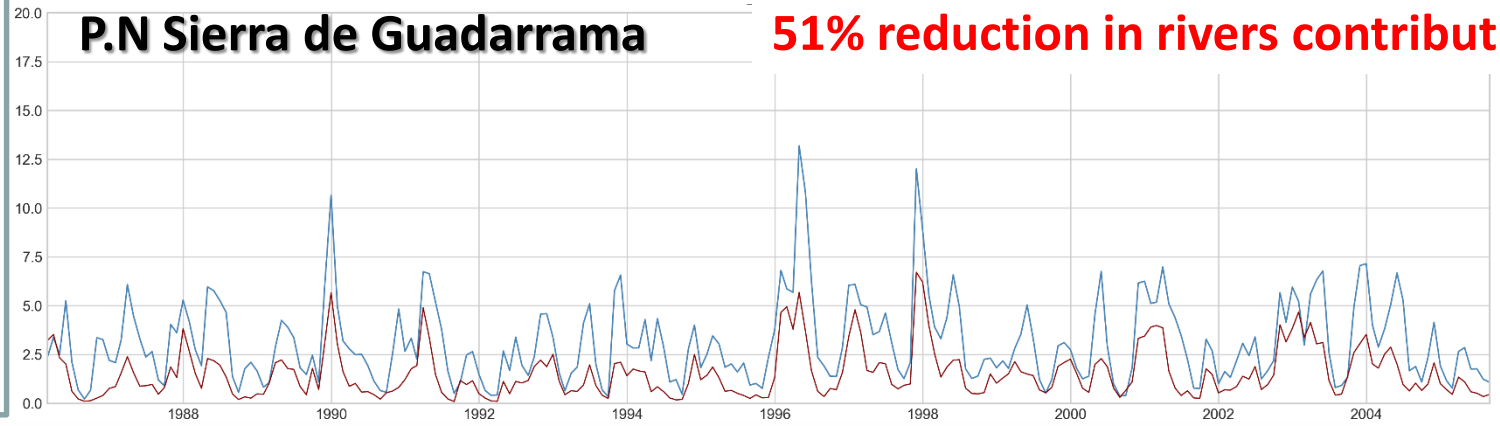
37% reduction in rivers contribution



Peñamellera Baja (Deva river)

P.N Sierra de Guadarrama

51% reduction in rivers contribution



Segovia (Eresma river)

Results

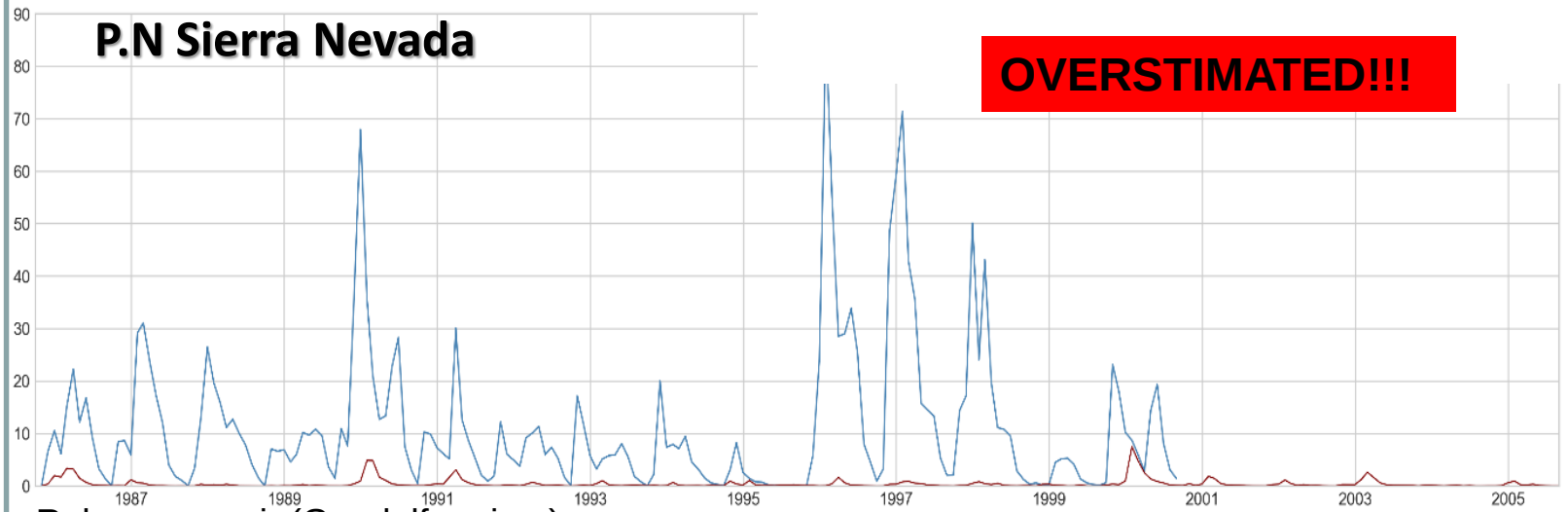
Hydrological functioning

Current Situation

Business as Usual

Q (m^3/s) mensual average

P.N Sierra Nevada



Rules reservoir (Guadalfeo river)

90% reduction in rivers contribution

OVERSTIMATED!!!

Bias of -50% in the hydrological model (current situation)

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INSTITUTO DE HIDRÁULICA AMBIENTAL
UNIVERSIDAD DE CANTABRIA

Results

Hydrological functioning

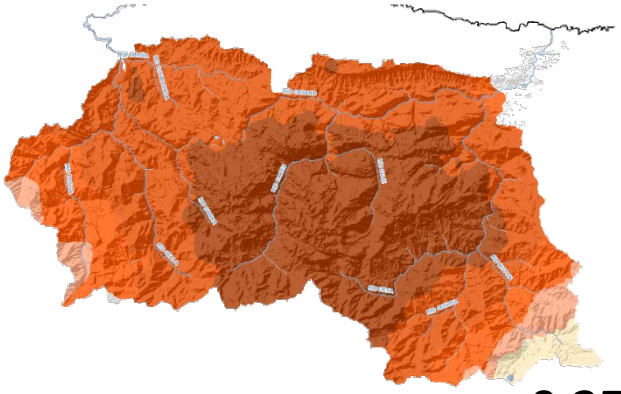
Business as Usual – Current Situation

Mean annual rain	Mean annual temperature	Daily mean ETR

P.N Picos de Europa

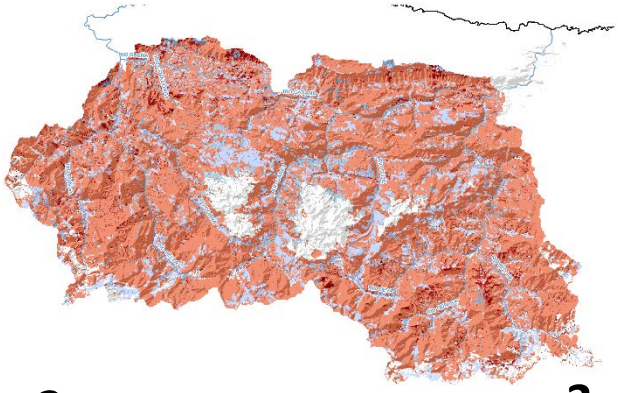
-225 175

mm/year



2.25 0.25

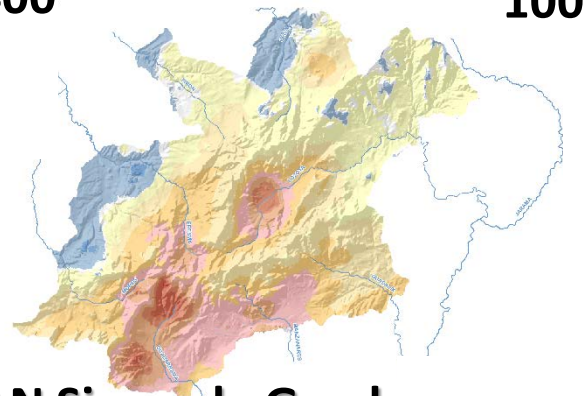
ºC



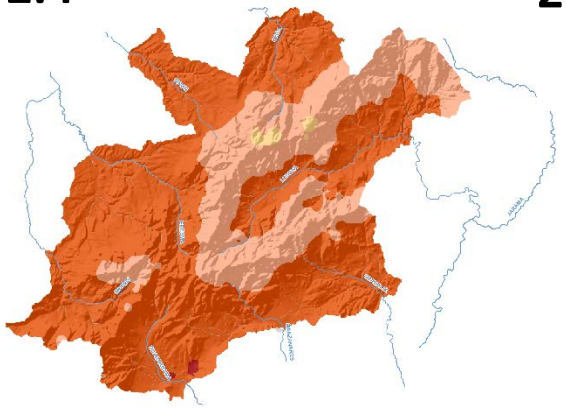
2 -3

mm/day

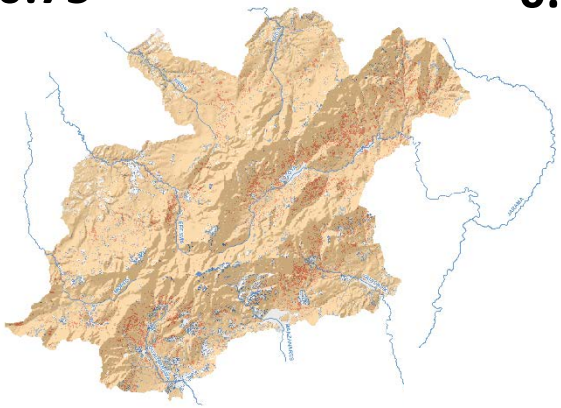
-400 100



2.4 2.8



0.75 -0.5



P.N Sierra de Guadarrama

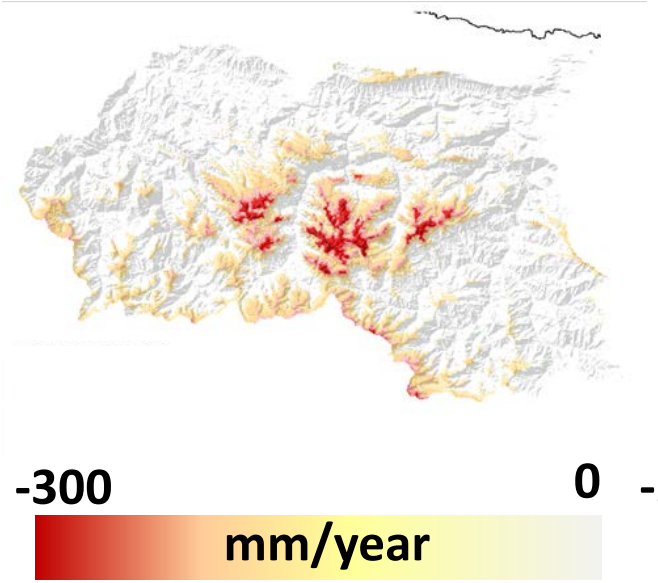
Results

Hydrological functioning

Business as Usual – Current Situation

Snow-water equivalent annual average

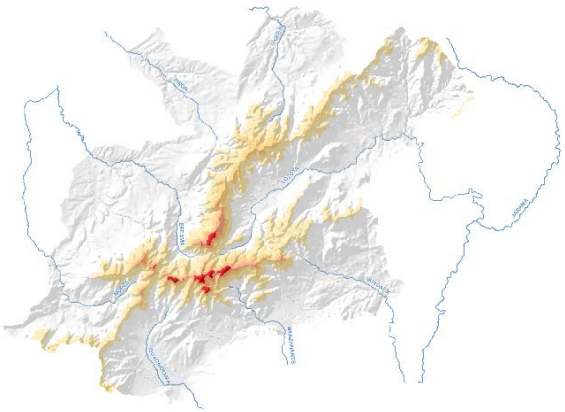
P.N Picos de Europa



-300 0

mm/year

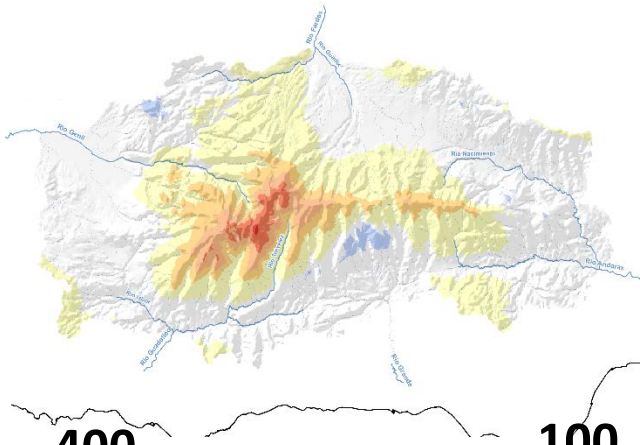
P.N Sierra de Guadarrama



-250 0

mm/year

P.N Sierra Nevada



-400 100

mm/year

Conclusions and next steps

Meetings with managers - stakeholders

Products from modelling	Criteria for designing BGINs (from managers)
1. Probable areas of **forest expansion/regression**	***Picos de Europa***
2. Localization of **mature native forests**	**Rewilding** Protection of the most **productive pastures** **Riparian buffers** in headwaters
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)	***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

ALICE

Improving the management of Atlantic Landscapes accouting for biodiversity and ecosystem services

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Thanks a lot for your attention!