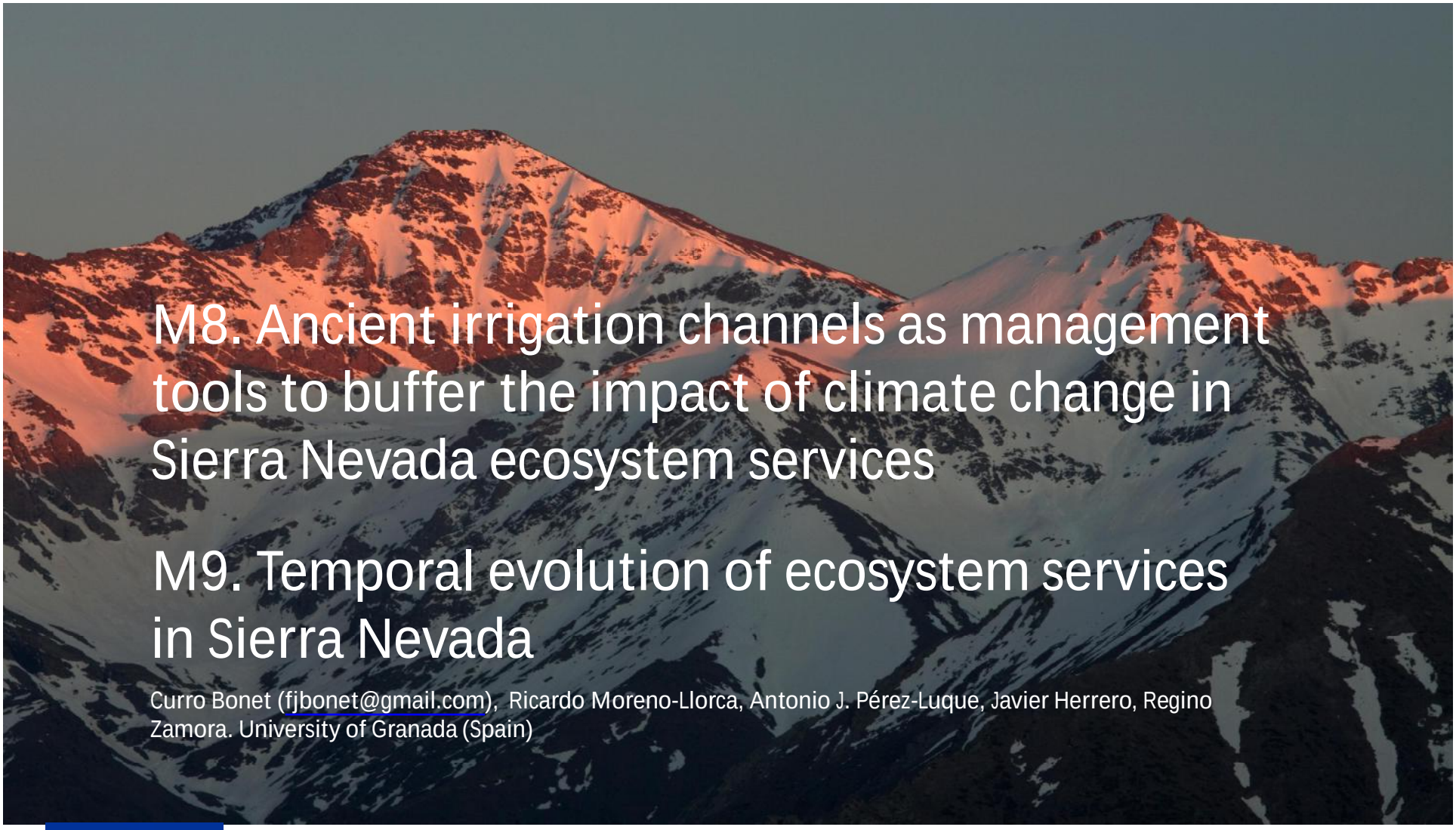


M8. Ancient irrigation channels as management tools to buffer the impact of climate change in Sierra Nevada ecosystem services

M9. Temporal evolution of ecosystem services in Sierra Nevada

Curro Bonet (fjbonet@gmail.com), Ricardo Moreno-Llorca, Antonio J. Pérez-Luque, Javier Herrero, Regino Zamora. University of Granada (Spain)

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

ECOPOTENTIAL General meeting. Texel. 26-30 June 2016

It’s the highest mountain (3482 *m* asl) of south of Europe

One of the most important biodiversity hotspot in the Mediterranean region
(Blanca 1996, Blanca et al. 1998, Cañadas et al. 2014)

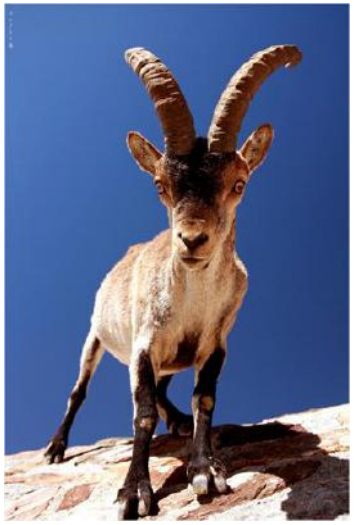
2100 species of vascular plant
(25 % and 20 % of Spanish and European flora, respectively)

High endemicity rate
(80 endemic plant species) (Lorite et al. 2007)

27 habitat types from the Habitat Directive

> 10.000 species of invertebrates

200 species of vertebrates



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

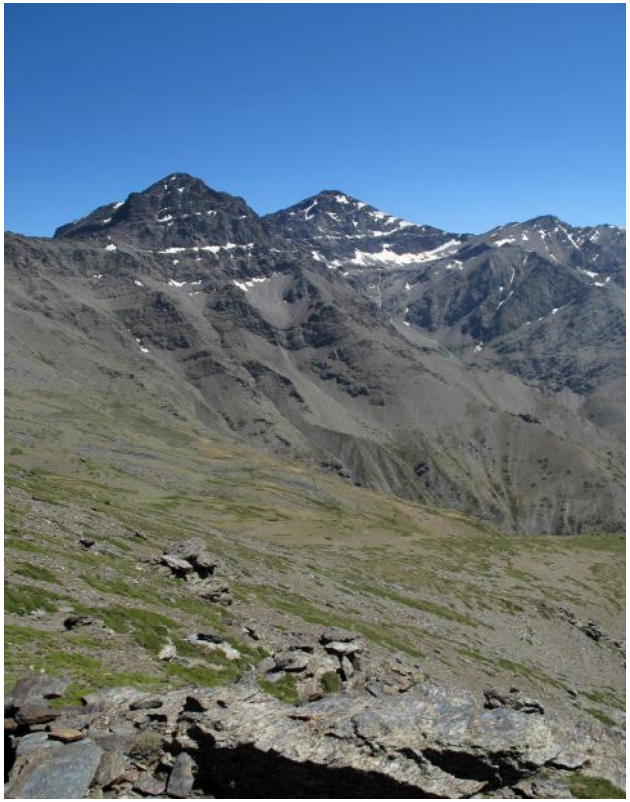
Biosphere Reserve (MAB UNESCO)

Site of Community Importance (Natura 2000 network)

National Park

Natural Park

IUCN Green List of Protected Areas



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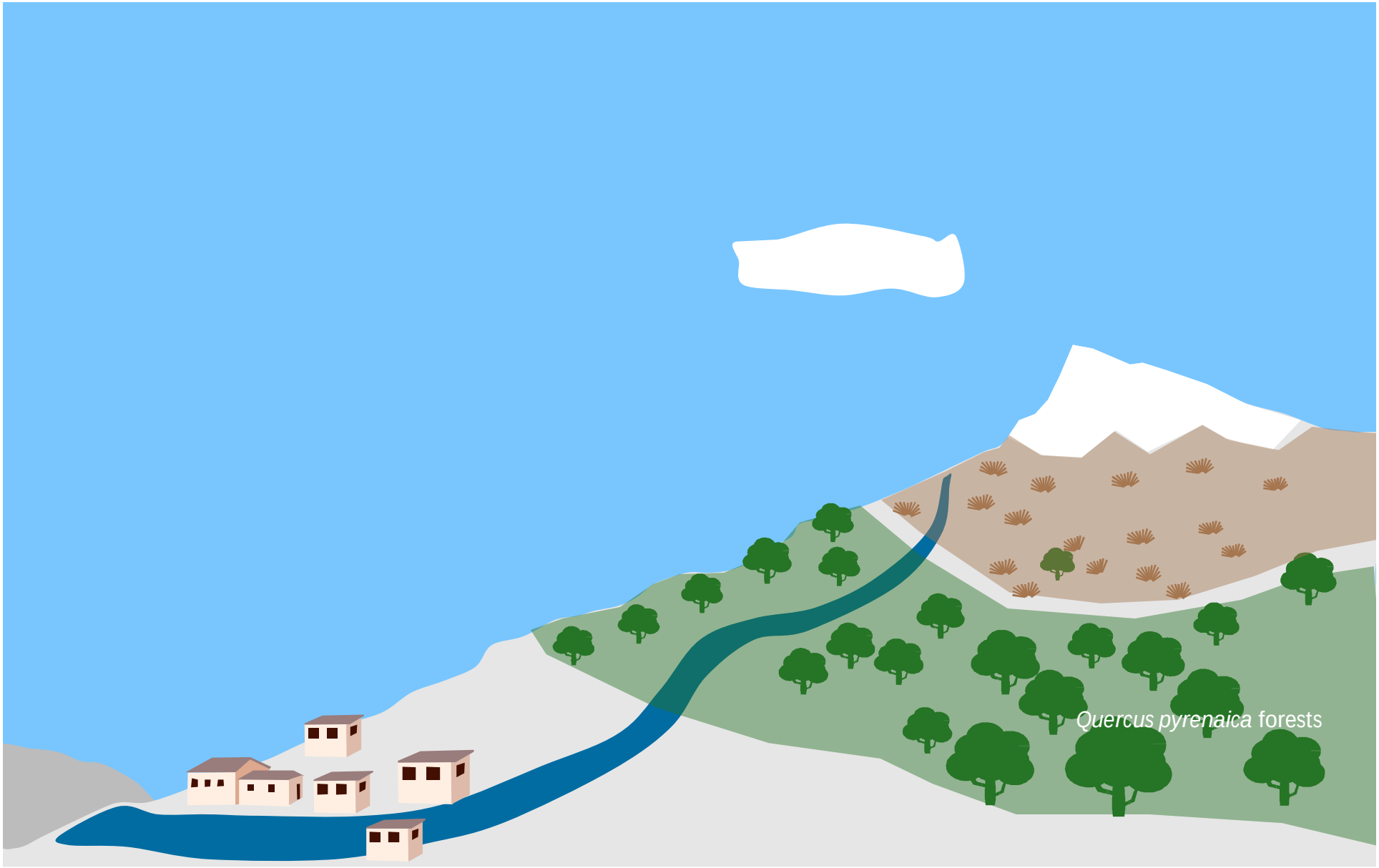
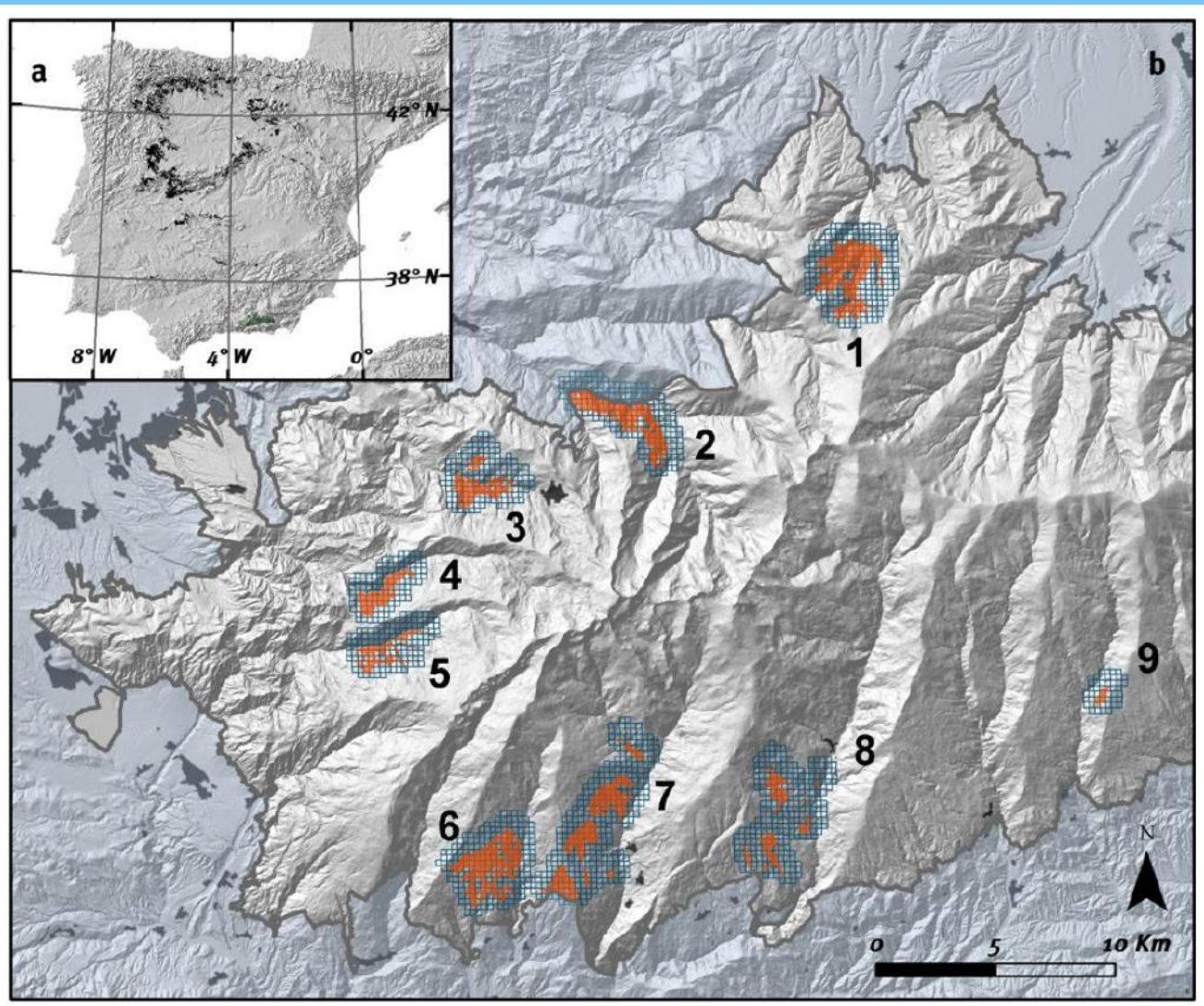
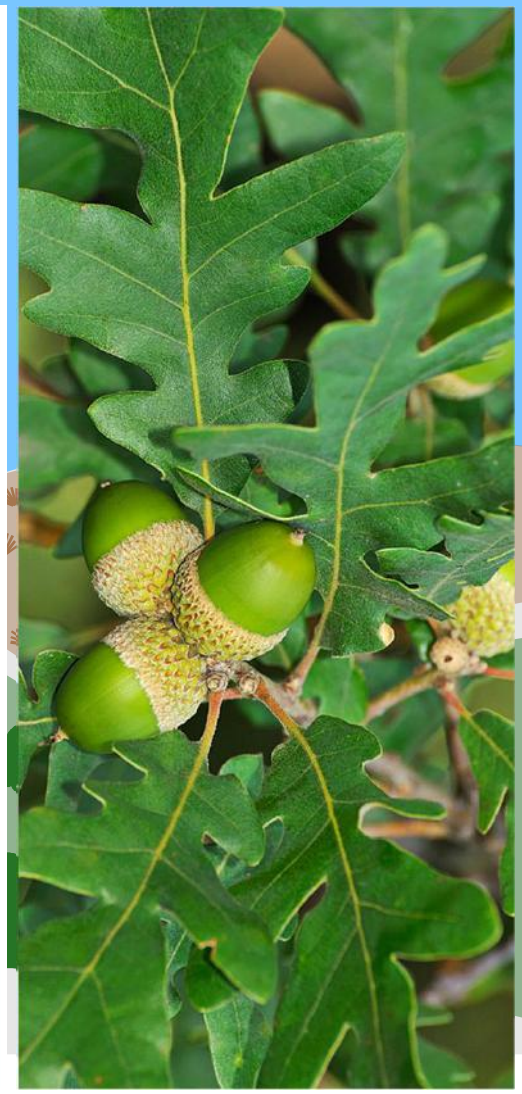
The area includes 61 municipalities (2000 Km^2) with more than 90.000 inhabitants.

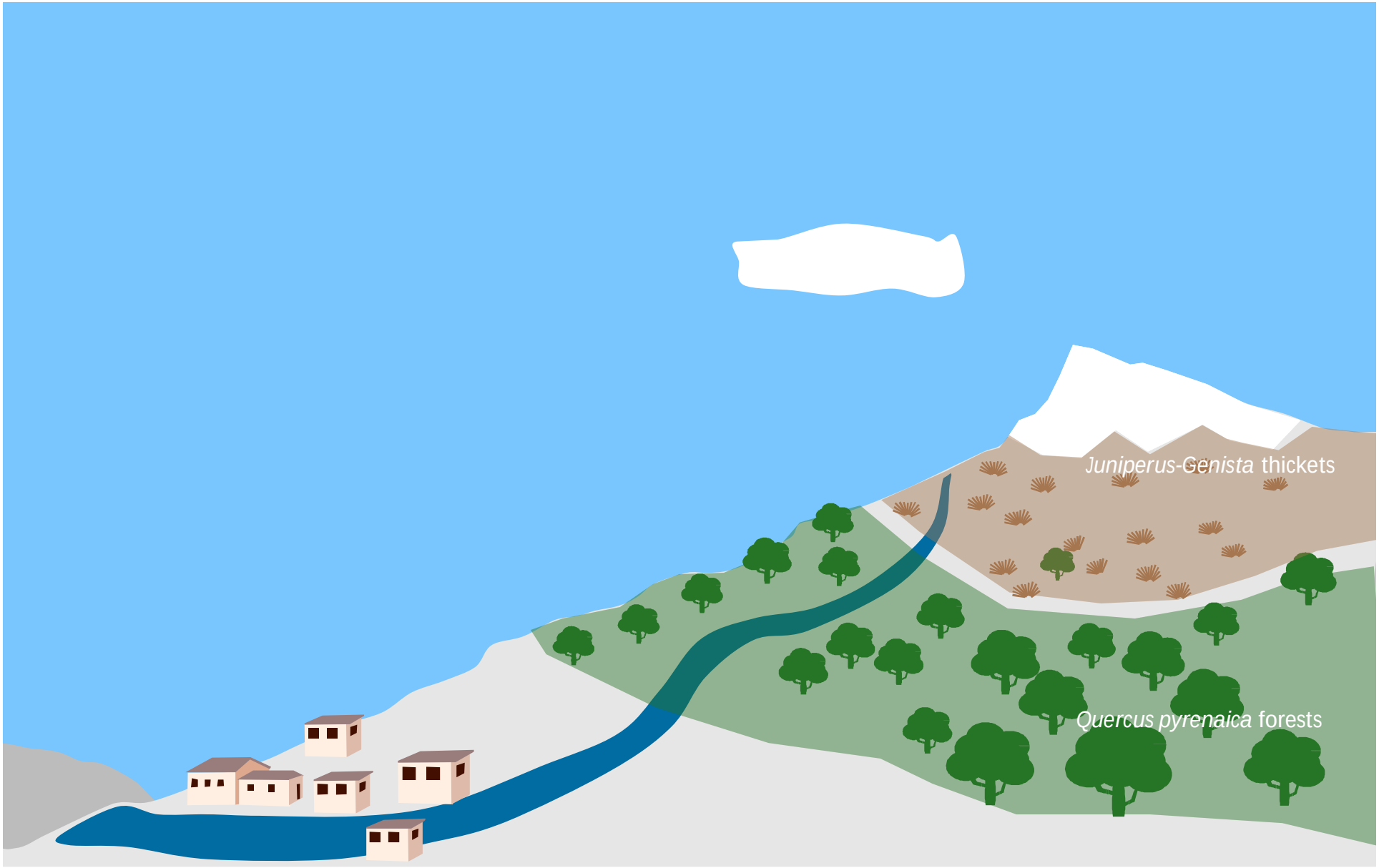
The main economic activities are agriculture, tourism, cattle raising, beekeeping, mining, and skiing

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


Quercus pyrenaica forests


a
42° N
38° N
8° W
4° W
0°
b
1
2
3
4
5
6
7
8
9
N
0
5
10 Km




Juniperus-Genista thickets
Quercus pyrenaica forests

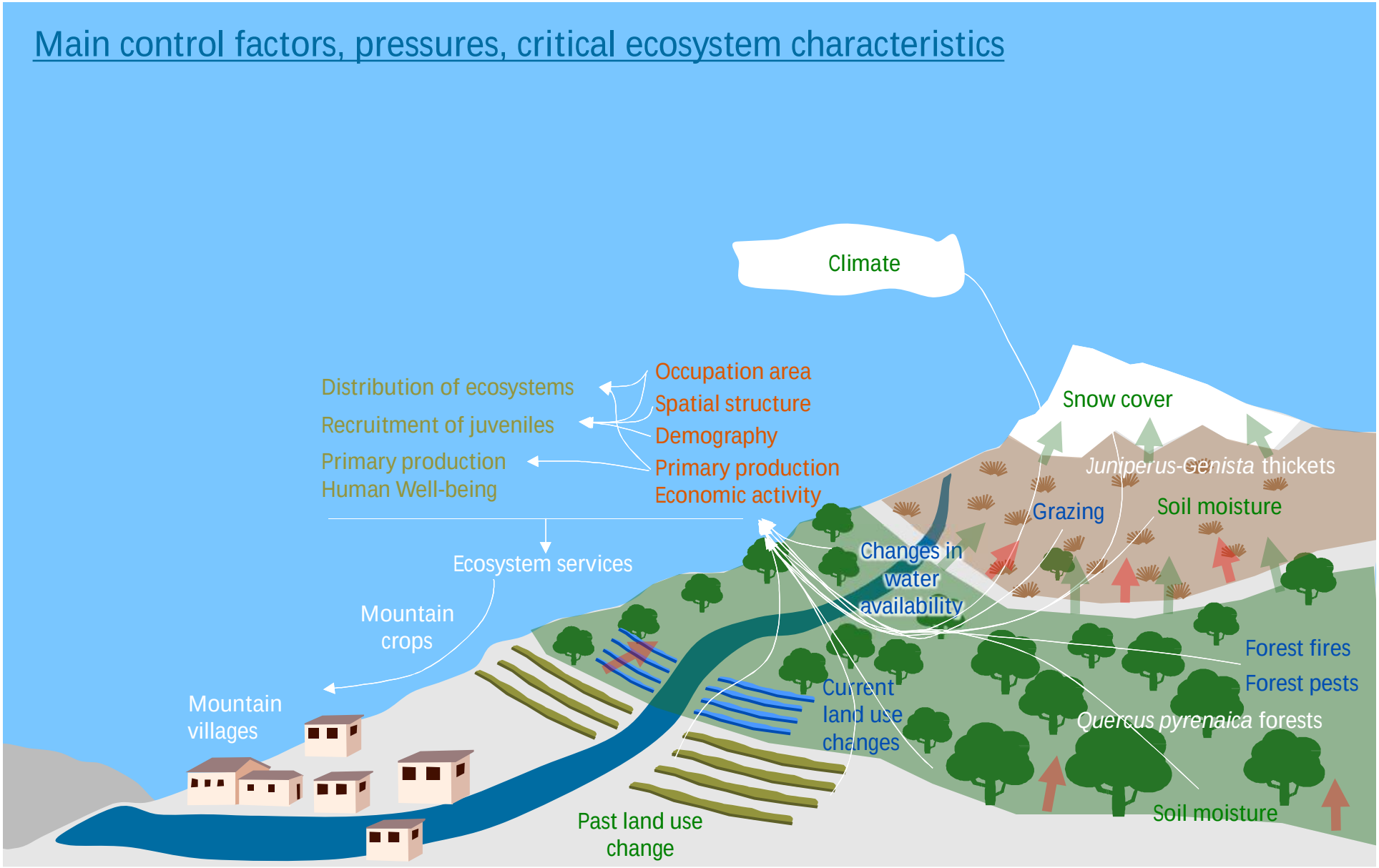
Juniper thickets in Sierra Nevada

Mountain villages

us-Genista thickets

pyrenaica forests

Main control factors, pressures, critical ecosystem characteristics



Legend:

State of the ecosystems

Control factors

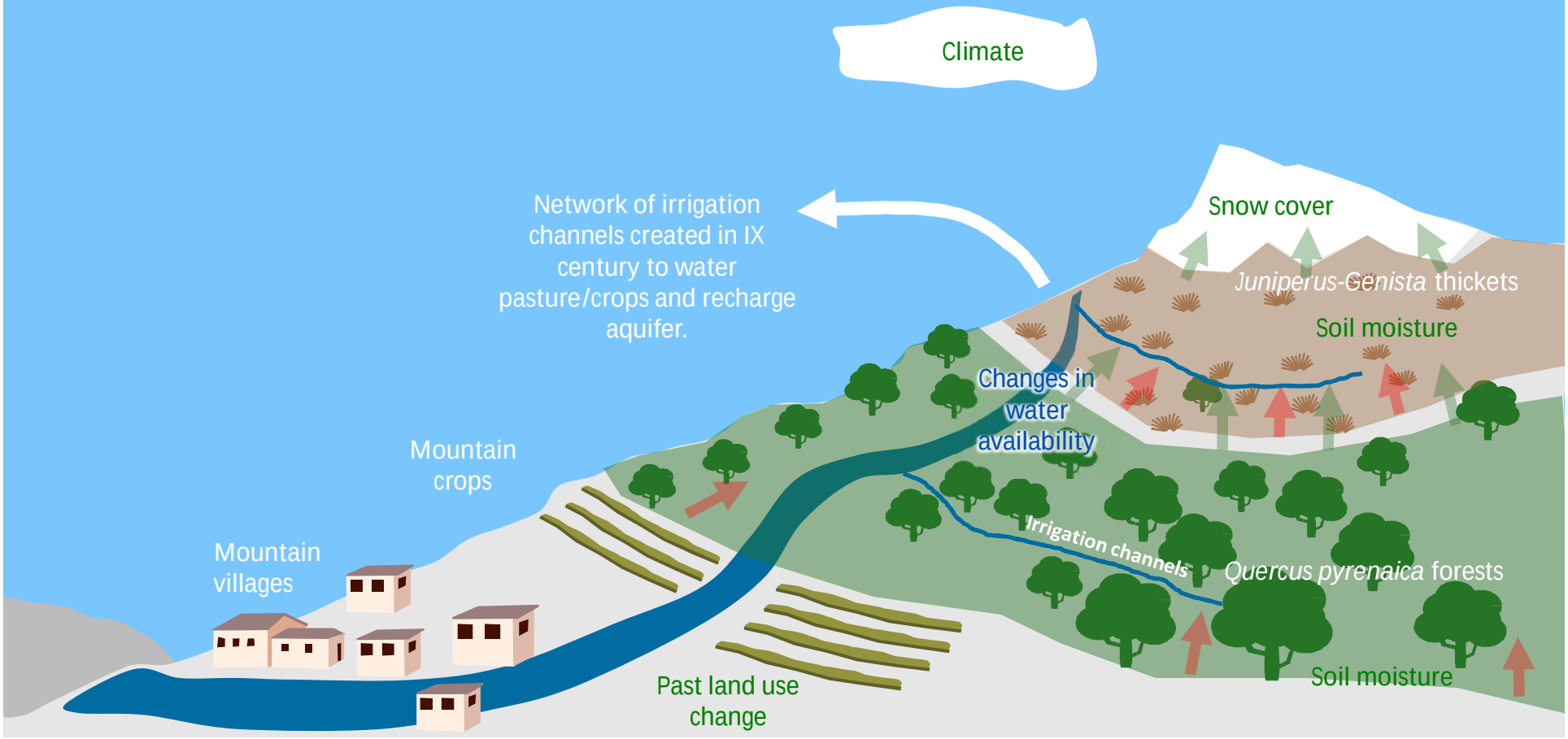
Pressures

Critical ecosystem characteristics

Altitudinal shifts of target ecosystems

M8. Ancient irrigation channels as management tools to buffer the impact of climate change in Sierra Nevada ecosystem services

The network of irrigation channels could help to buffer the impact of global change.



Legend:

Control factors

Pressures

Altitudinal shifts of target ecosystems

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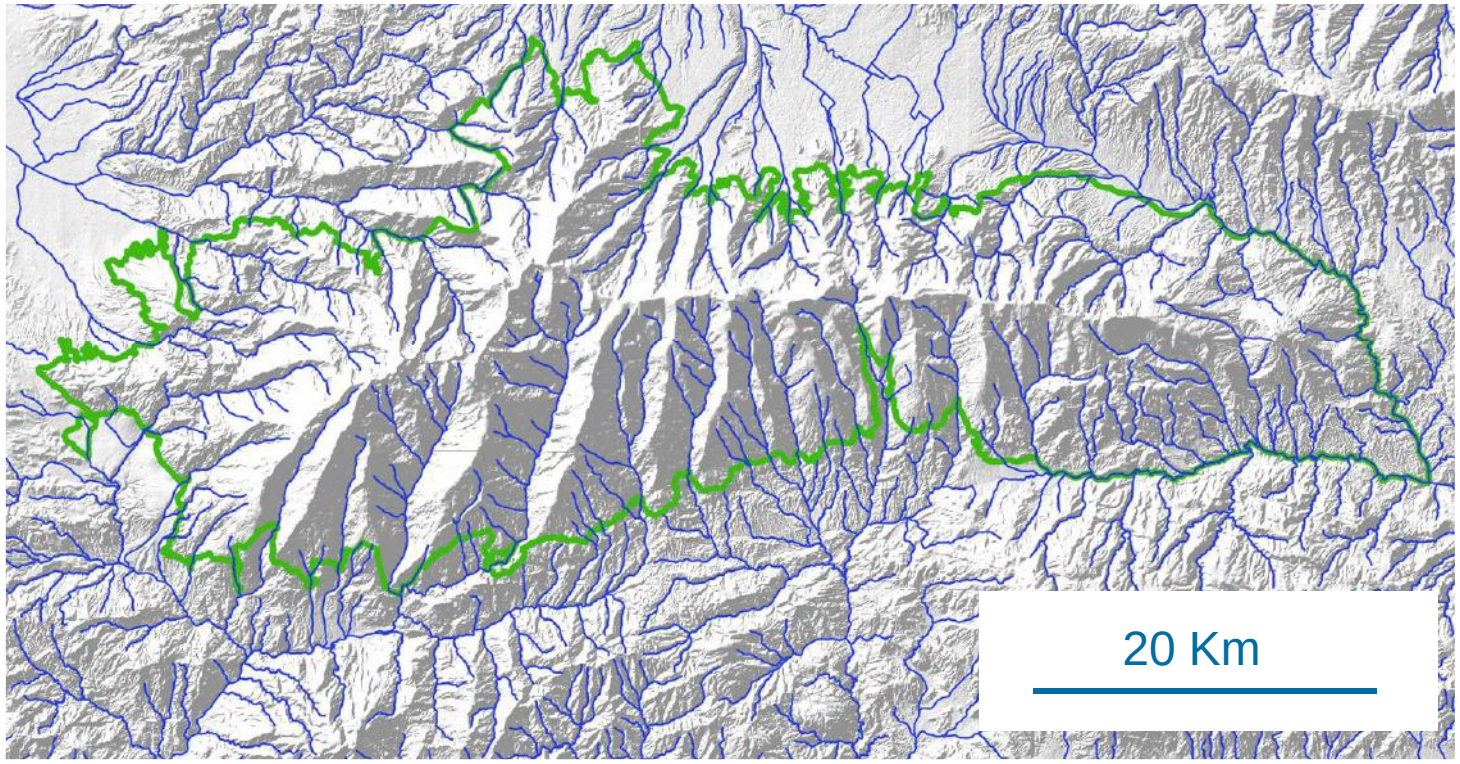
The network of irrigation channels could help to buffer the impact of global change.

Natural hydrological network



nista thickets

oisture

aica forests

oisture

change

Legend:

Control factors

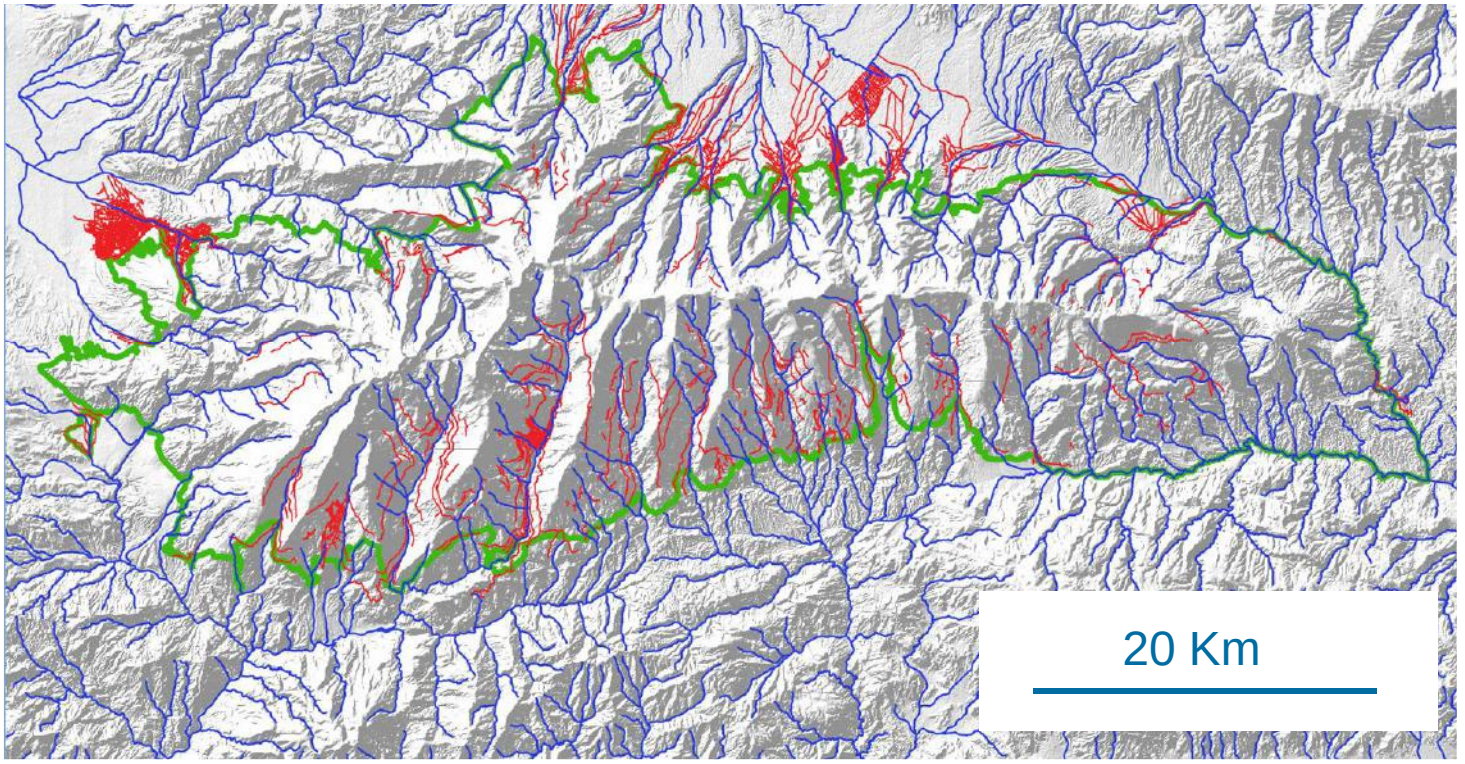
Pressures

Altitudinal shifts of target ecosystems

M8. Ancient irrigation channels as management tools to buffer the impact of climate change in Sierra Nevada ecosystem services

The network of irrigation channels could help to buffer the impact of global change.

3000 Km of ancient irrigation channels



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change

Legend:

Control factors

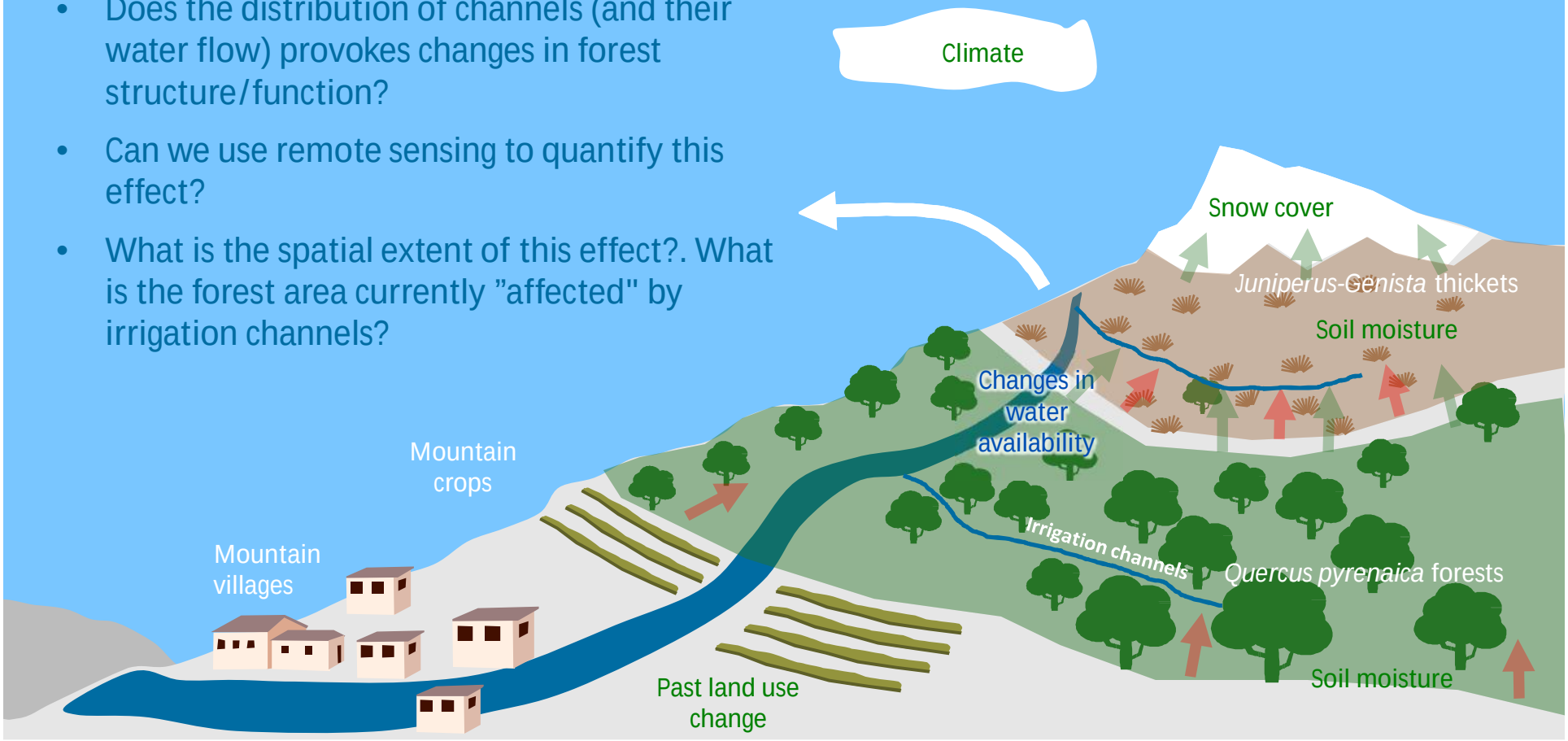
Pressures

Altitudinal shifts of target ecosystems

M8. Ancient irrigation channels as management tools to buffer the impact of climate change in Sierra Nevada ecosystem services

The network of irrigation channels could help to buffer the impact of global change.

- Does the distribution of channels (and their water flow) provokes changes in forest structure/function?
- Can we use remote sensing to quantify this effect?
- What is the spatial extent of this effect?. What is the forest area currently "affected" by irrigation channels?



Legend:

Control factors

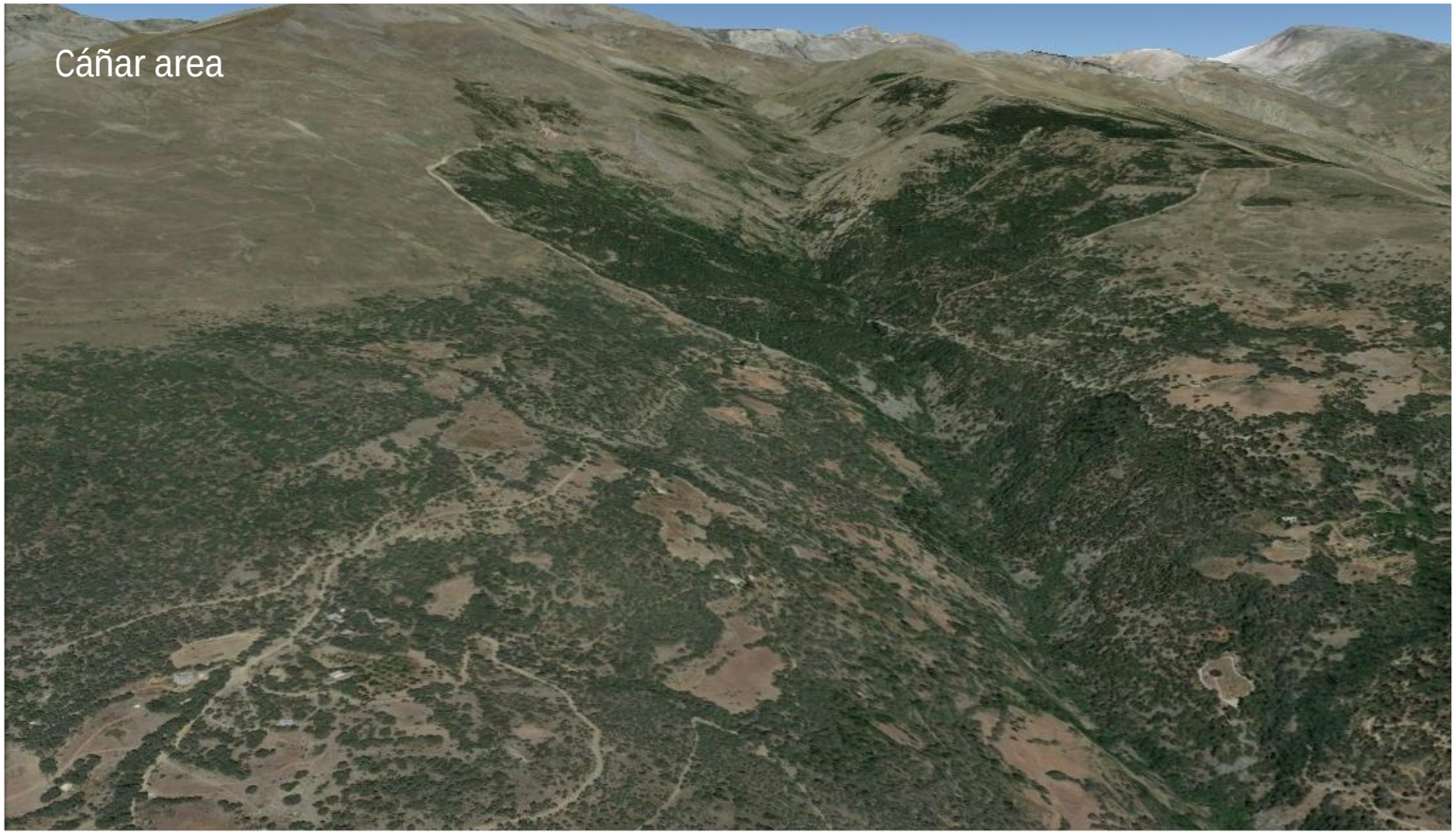
Pressures

Altitudinal shifts of target ecosystems

M8. Ancient irrigation channels as management tools to buffer the impact of climate change in Sierra Nevada ecosystem services

Material and methods (ongoing work)* We focus on *Q. pyrenaica* forests.

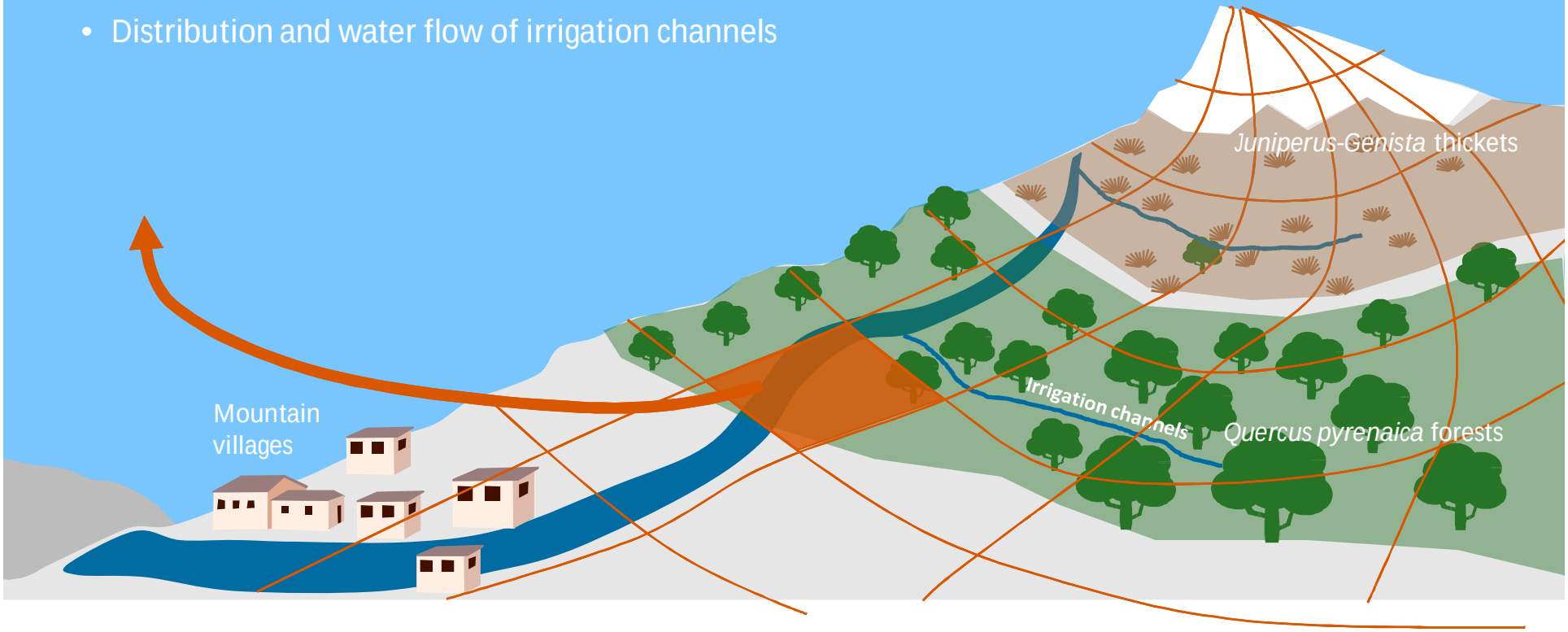
- Selection of areas of interest.



M8. Ancient irrigation channels as management tools to buffer the impact of climate change in Sierra Nevada ecosystem services

Material and methods (ongoing work)* We focus on *Q. pyrenaica* forests.

- Selection of areas of interest.
- Data matrix
- Independent variables:
  - Distribution and water flow of irrigation channels



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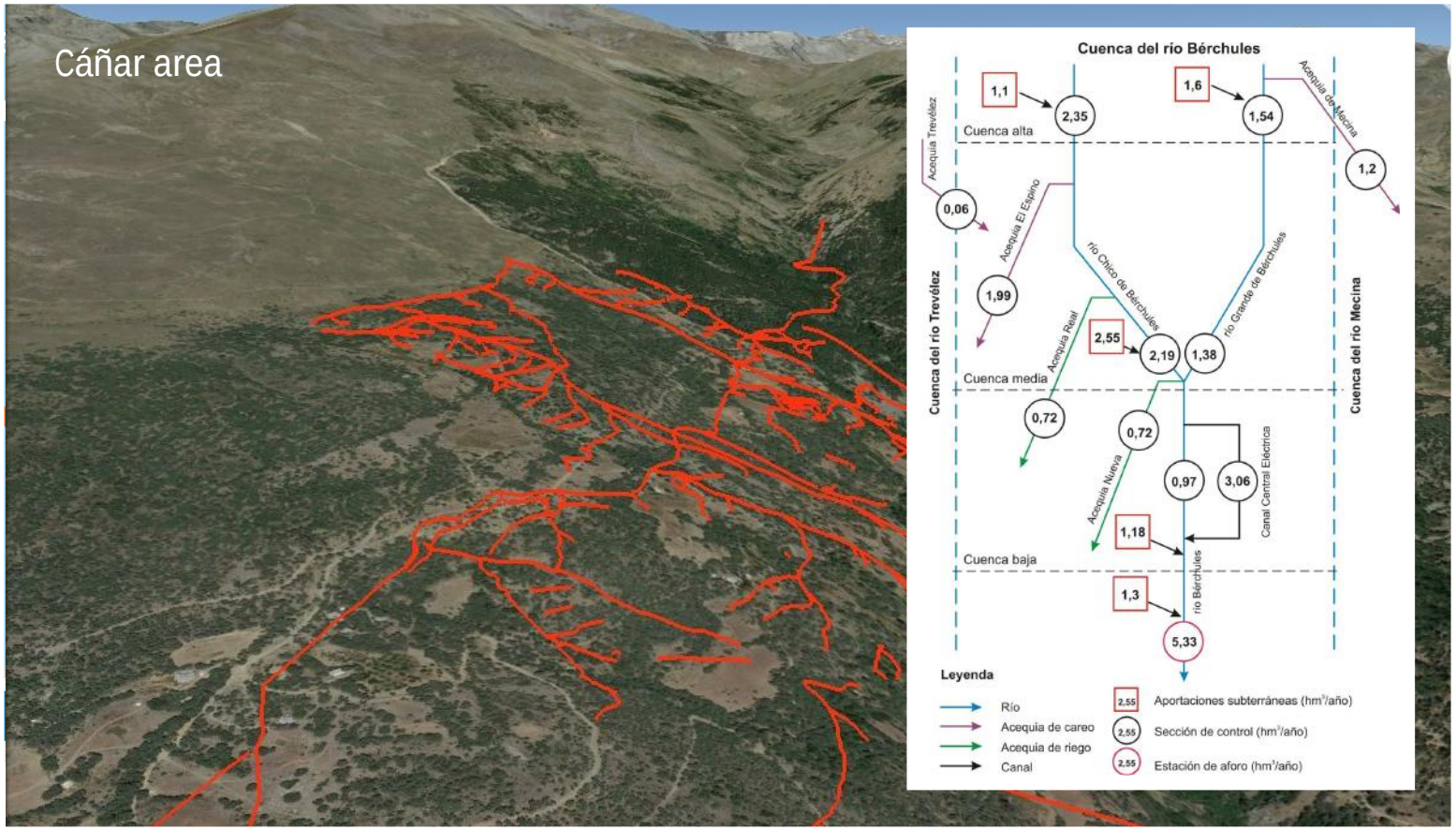

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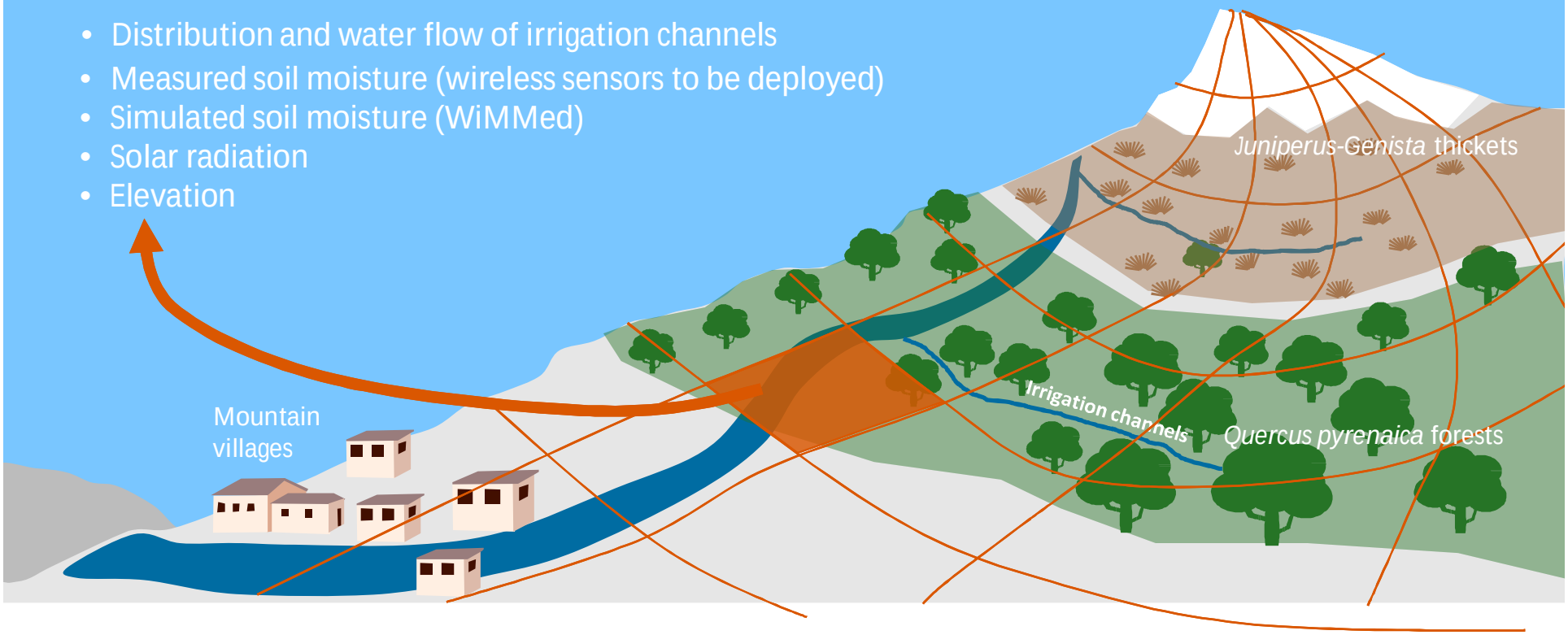
Material and methods (ongoing work)* We focus on *Q. pyrenaica* forests.

- Selection of areas of interest.
- Data matrix
- Independent variables:
  - Distribution and water flow of irrigation channels
  - Measured soil moisture (wireless sensors to be deployed)
  - Simulated soil moisture (WiMMed)
  - Solar radiation
  - Elevation



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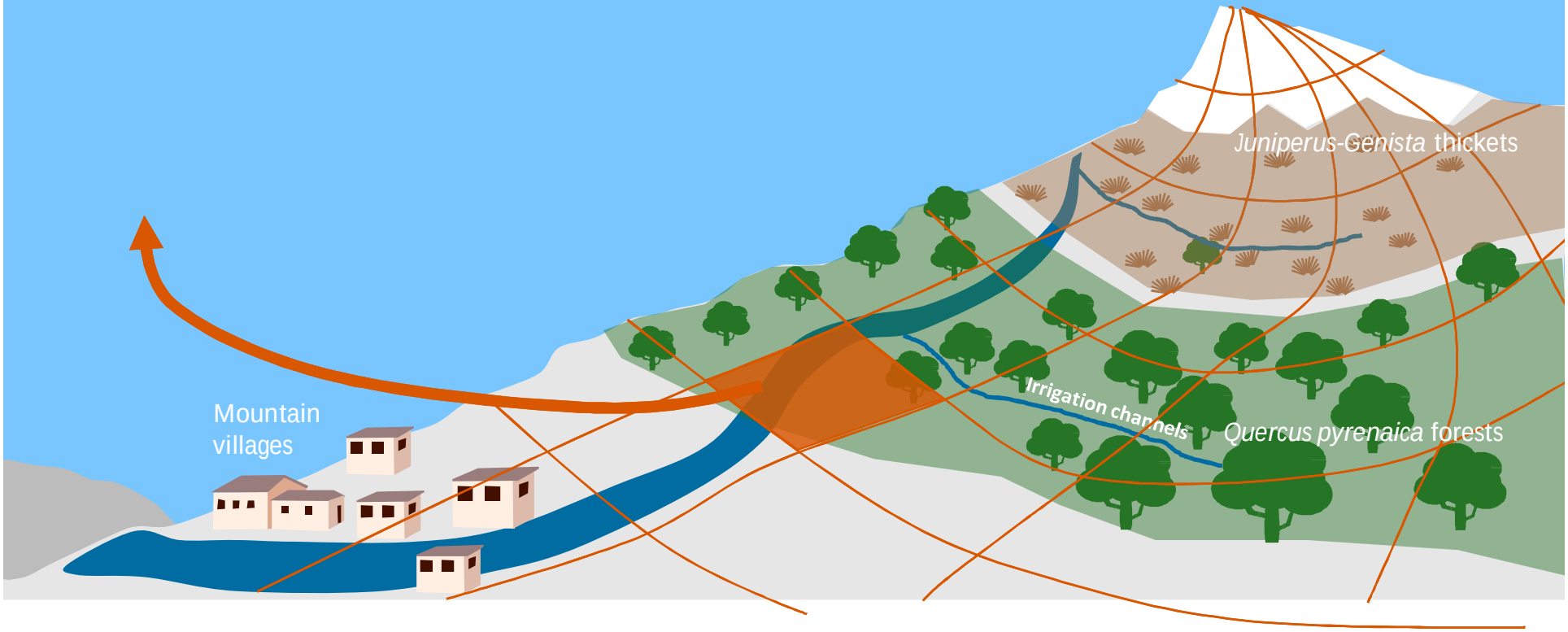

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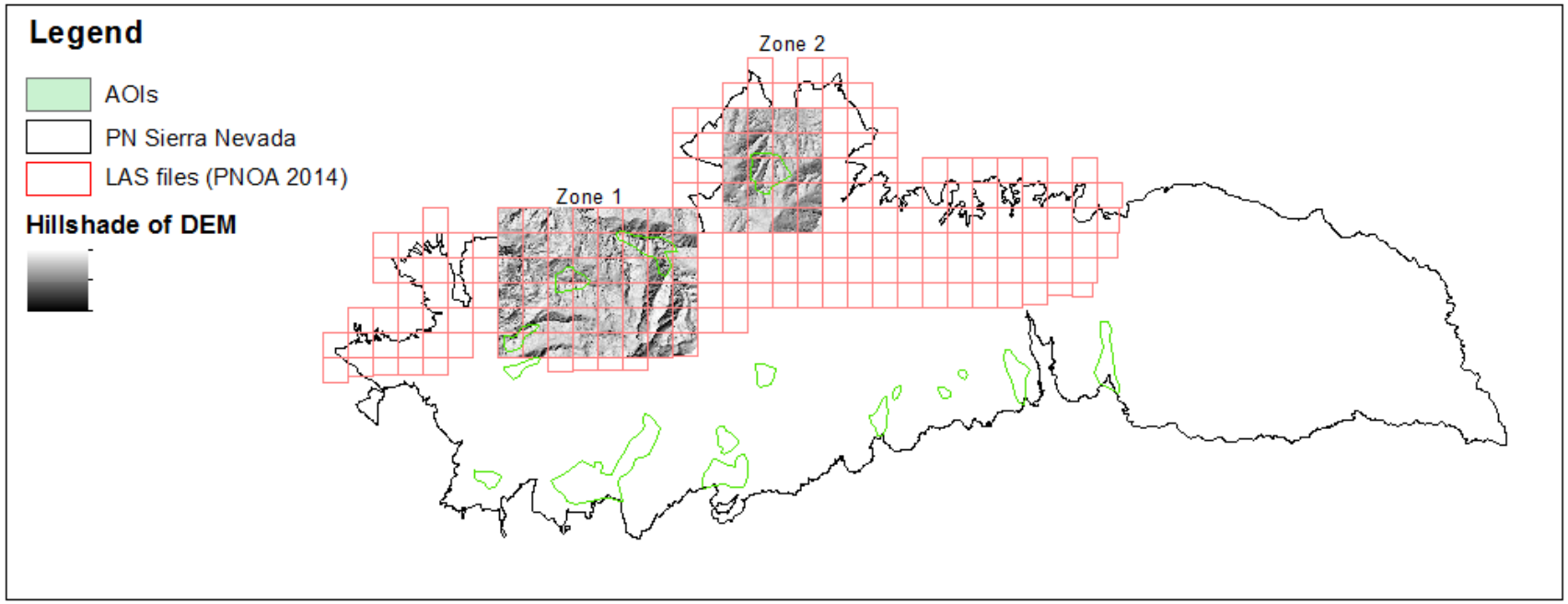

- DEM (2-3m)
- Individual identification of trees
- Canopy height model (10m)
- Coverage at different tree heights (10m)
- Density of vegetation (10m)
- Volume below trees (related to total biomass)

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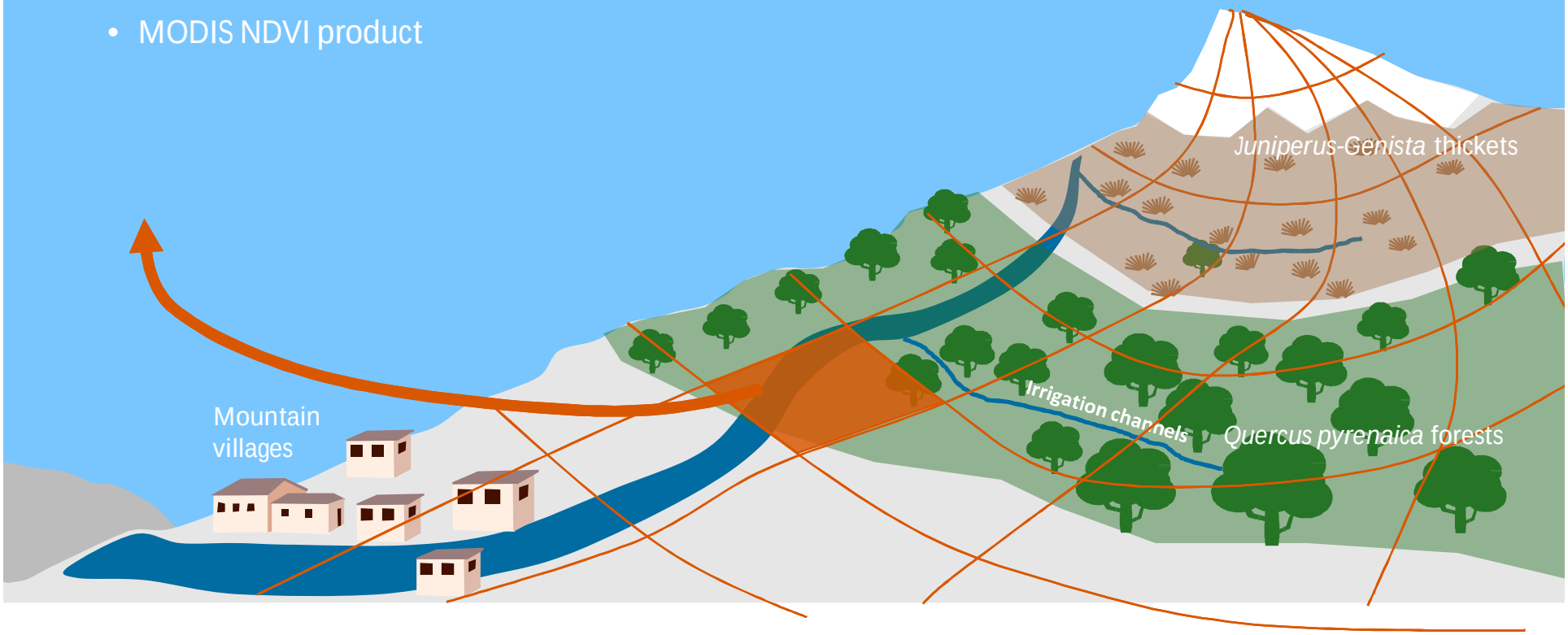
Material and methods (ongoing work)* We focus on *Q. pyrenaica* forests.

- Dependent variables:
  - Forest structure (LIDAR analysis by Mihai Tanase)
  - Forest functioning at several spatial scales:
    - MODIS NDVI product

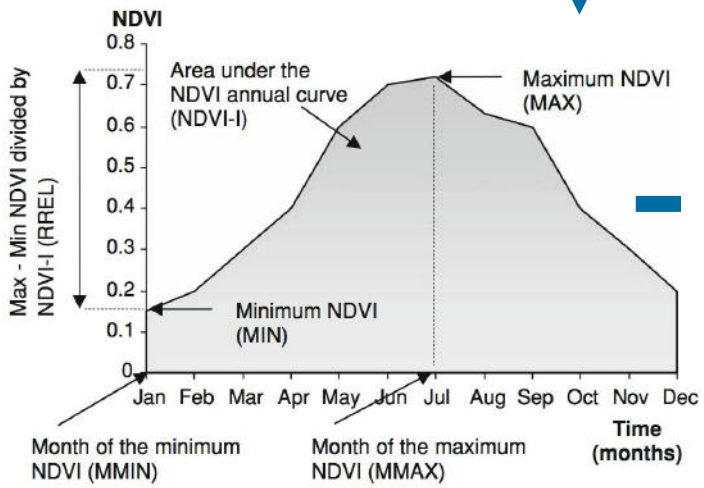


M8. Ancient irrigation channels as management tools to buffer the impact of climate change in Sierra Nevada ecosystem services

Material and methods (ongoing work)* We focus on *Q. pyrenaica* forests.

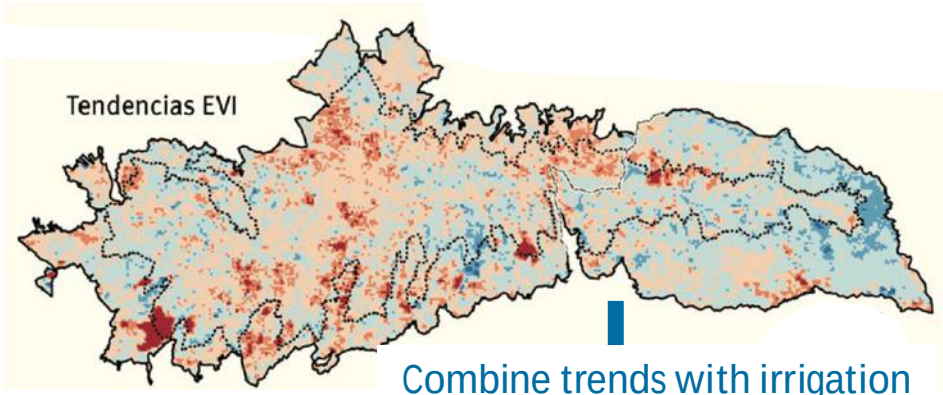
MODIS NDVI/EVI time series (2000-2014)

Compute yearly indicators

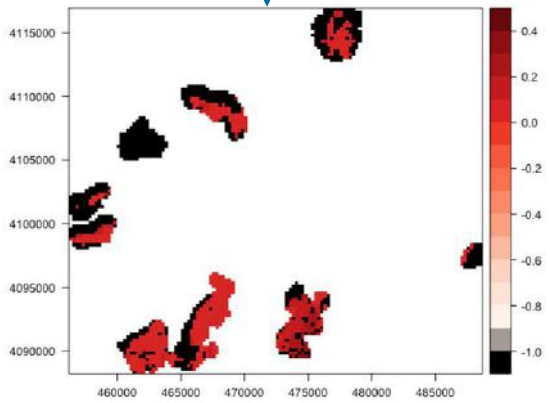


Alcaraz-Segura et al. 2009

Compute trends (Mann-Kendall)



Combine trends with irrigation channels distribution



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Material and methods (ongoing work)* We focus on *Q. pyrenaica* forests.

- Dependent variables:
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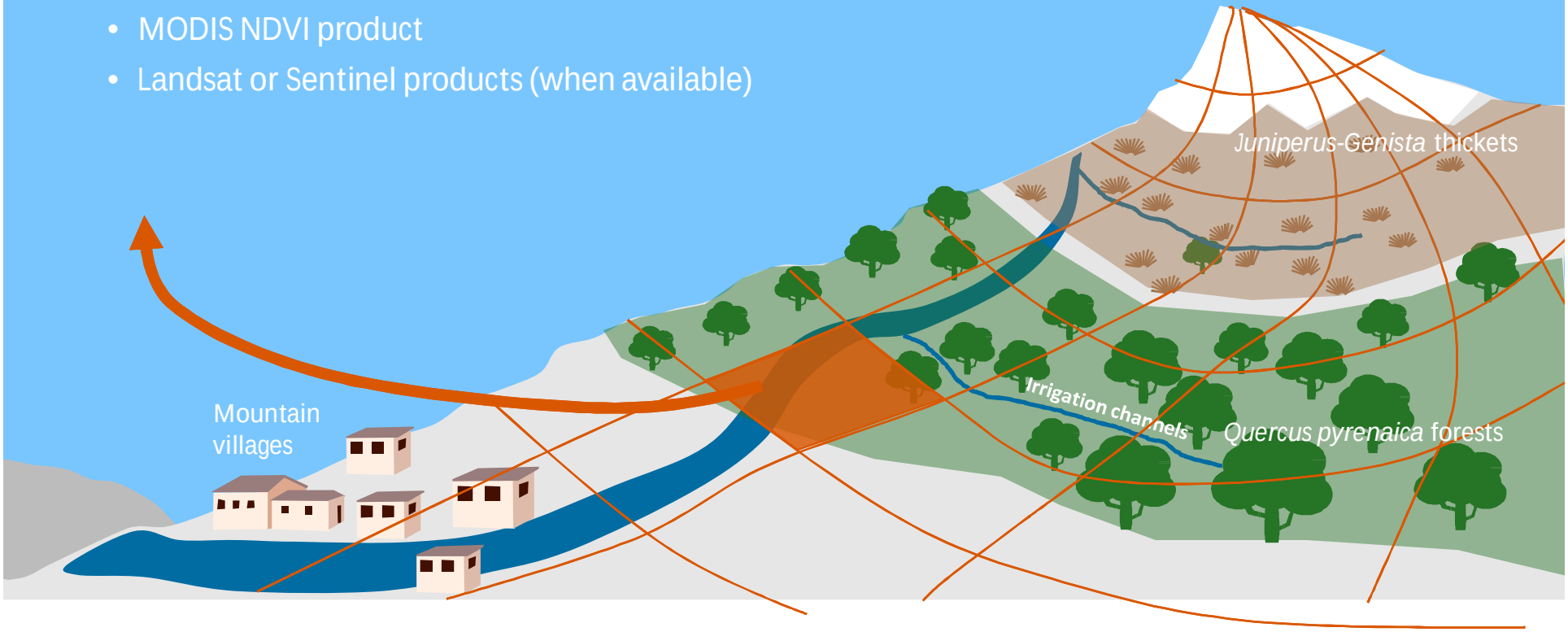
  - Forest functioning at several spatial scales:
    - MODIS NDVI product
    - Landsat or Sentinel products (when available)



M8. Ancient irrigation channels as management tools to buffer the impact of climate change in Sierra Nevada ecosystem services

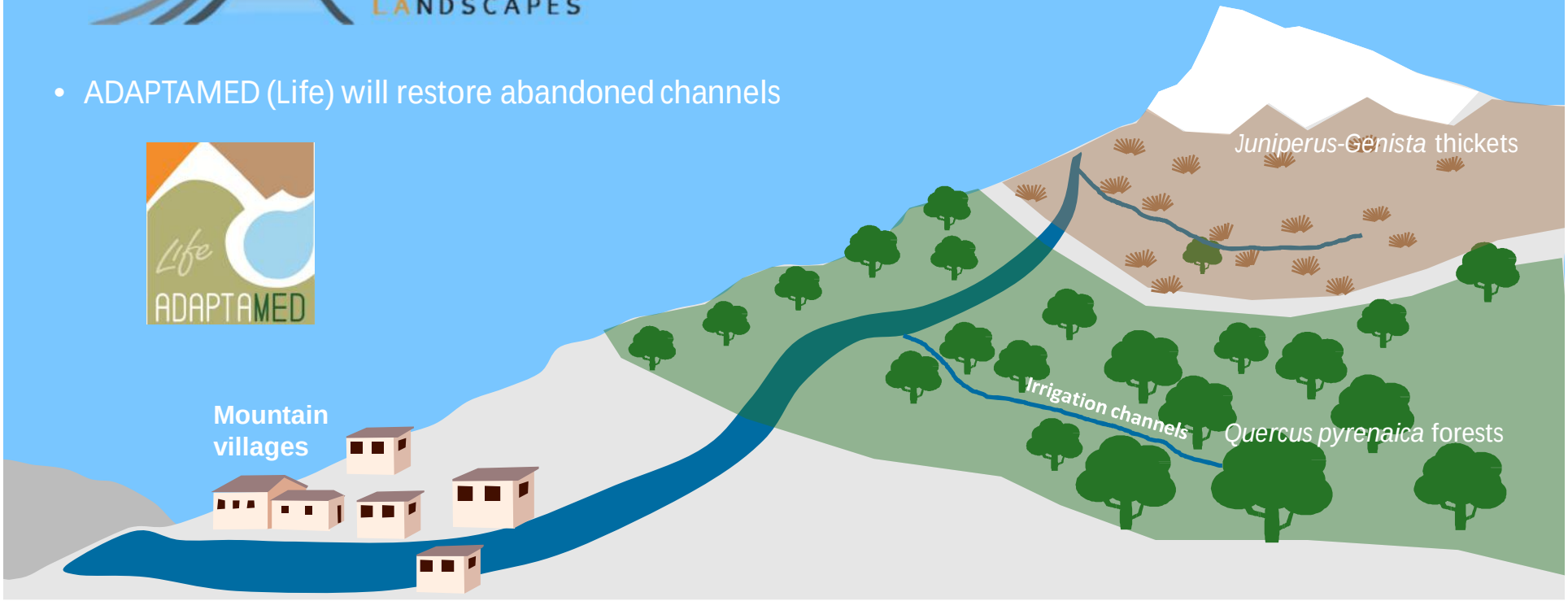
Links with other EU projects

- MEMOLA (FP7) provides distribution/flow of channels

MEDITERRANEAN MOUNTAINOUS LANDSCAPES

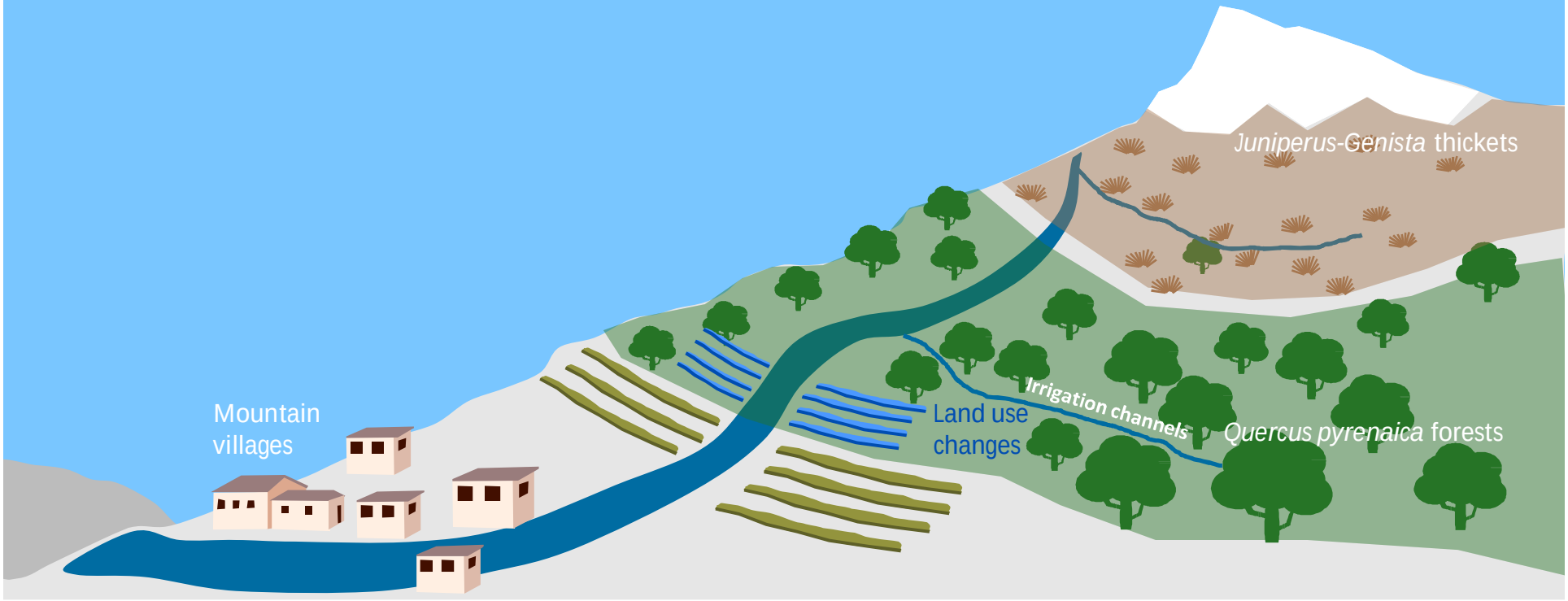
- ADAPTAMED (Life) will restore abandoned channels

Life ADAPTAMED



M9. Temporal evolution of ecosystem services in Sierra Nevada

Land use change is a key driver of ecosystems structure/functioning.



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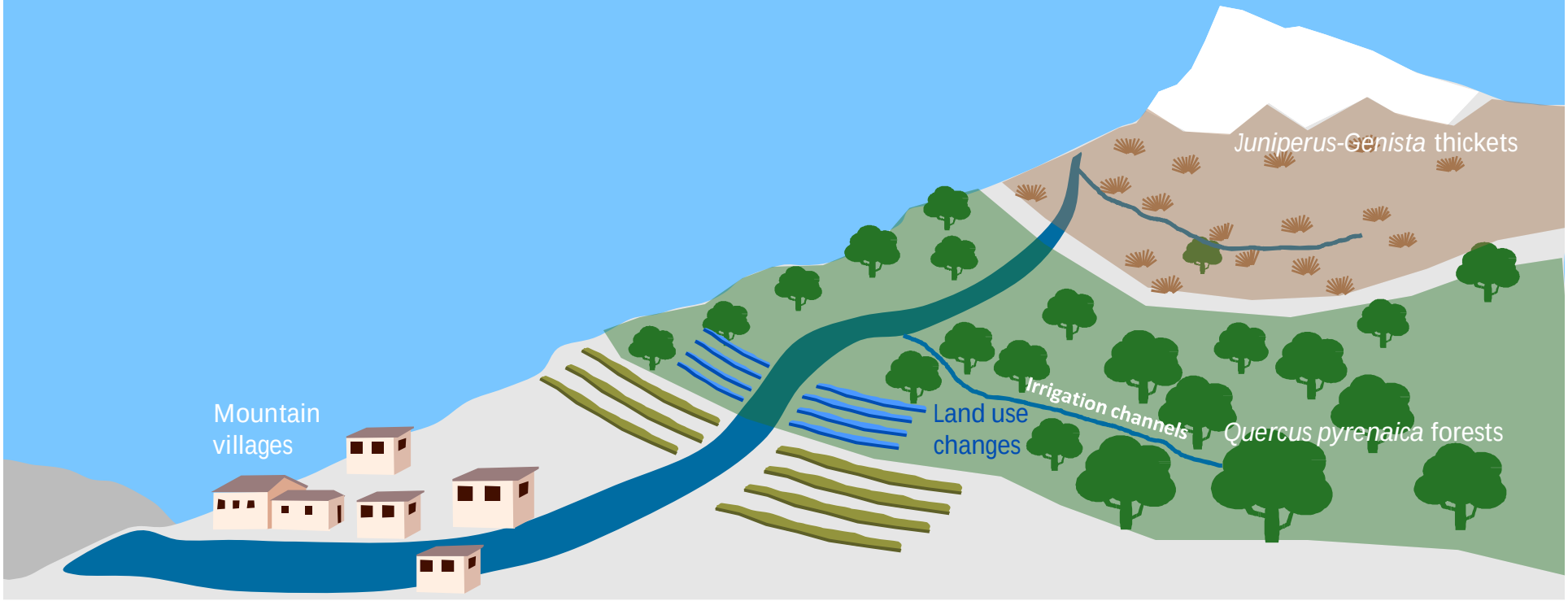

Present

M9. Temporal evolution of ecosystem services in Sierra Nevada

Land use change is a key driver of ecosystems structure/functioning.

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M9. Temporal evolution of ecosystem services in Sierra Nevada

Land use change is a key driver of ecosystems structure/functioning.

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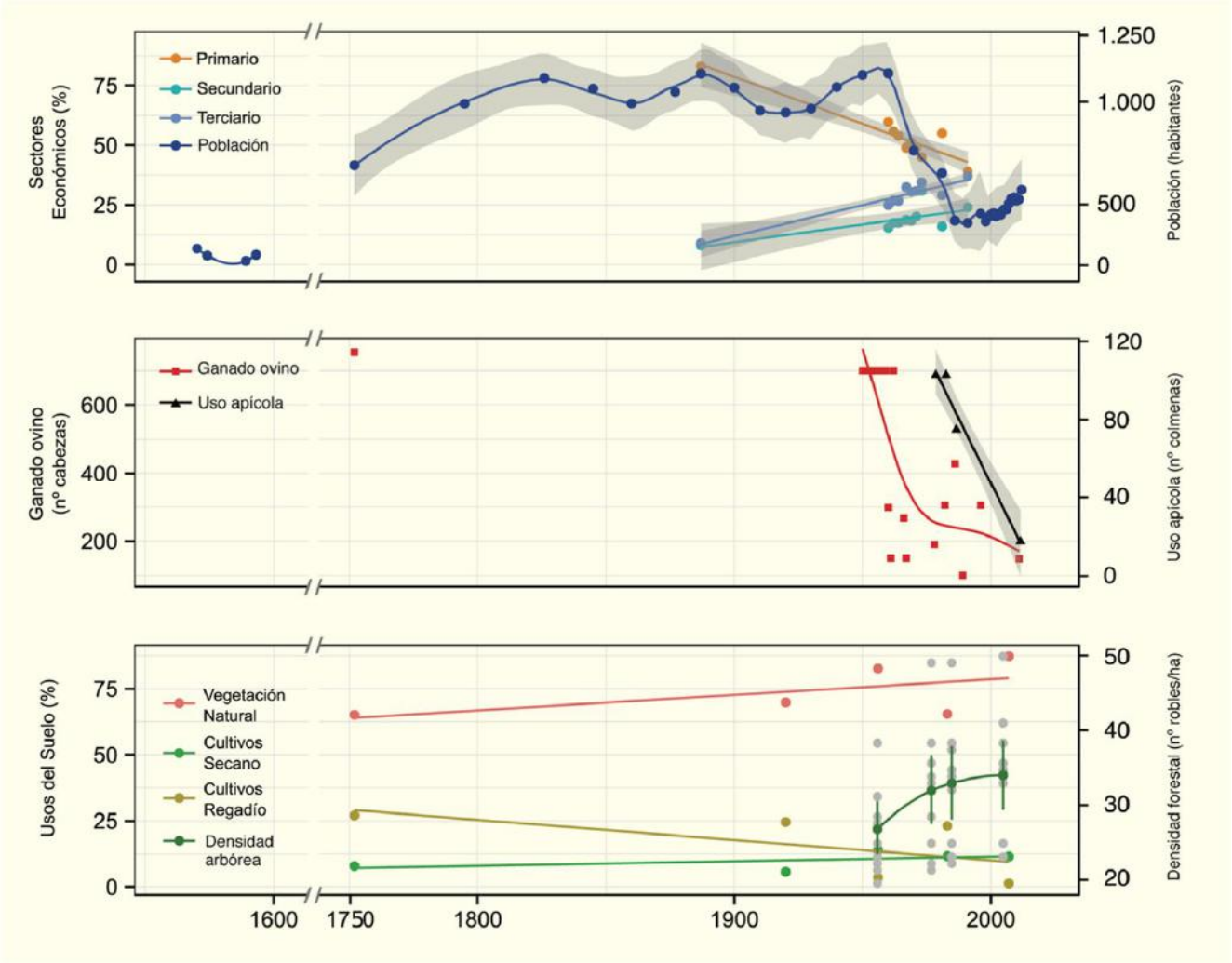
M9. Temporal evolution of ecosystem services in Sierra Nevada

Land use change is a key driver of ecosystems structure/functioning.

We have collected in situ information to describe temporal changes in land use patterns.



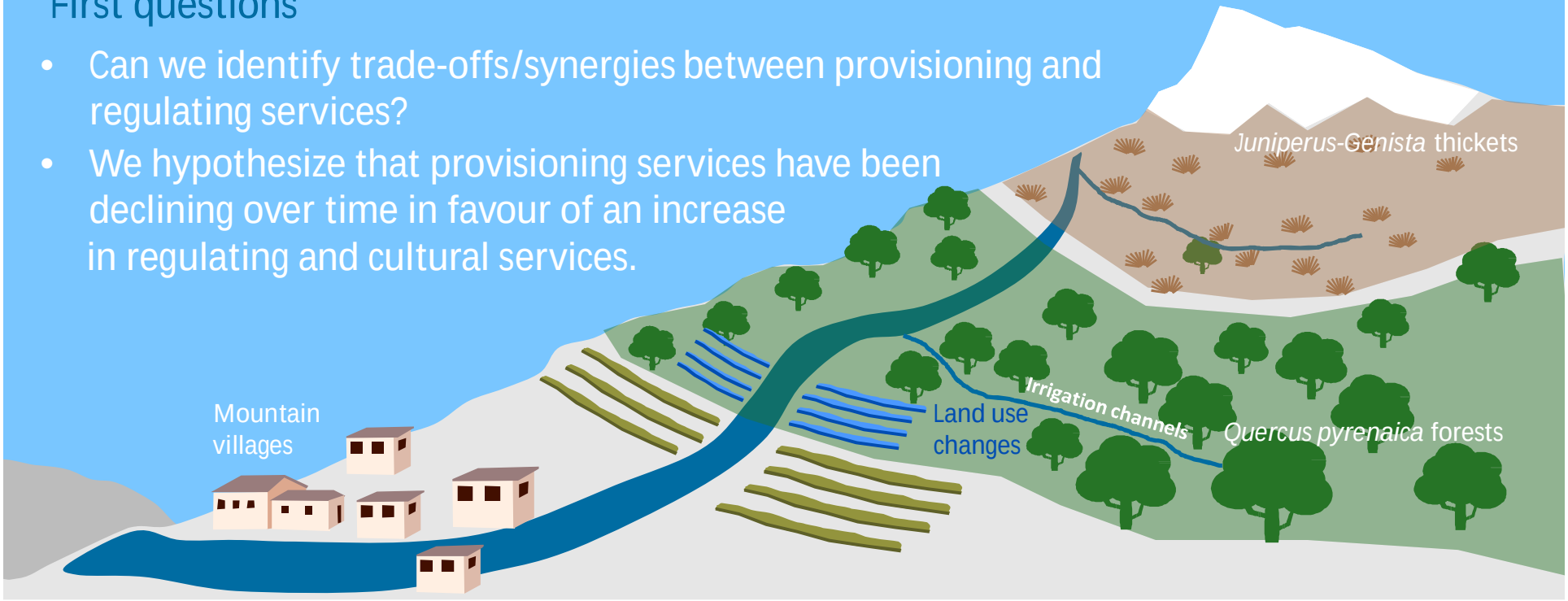
M9. Temporal evolution of ecosystem services in Sierra Nevada

Objectives

- Quantify the changes in the landscape using the concept of ecosystem services
- Understand synergies and trade-offs among ecosystem services
- Build future land use scenarios useful for managers

First questions

- Can we identify trade-offs/synergies between provisioning and regulating services?
- We hypothesize that provisioning services have been declining over time in favour of an increase in regulating and cultural services.



Present

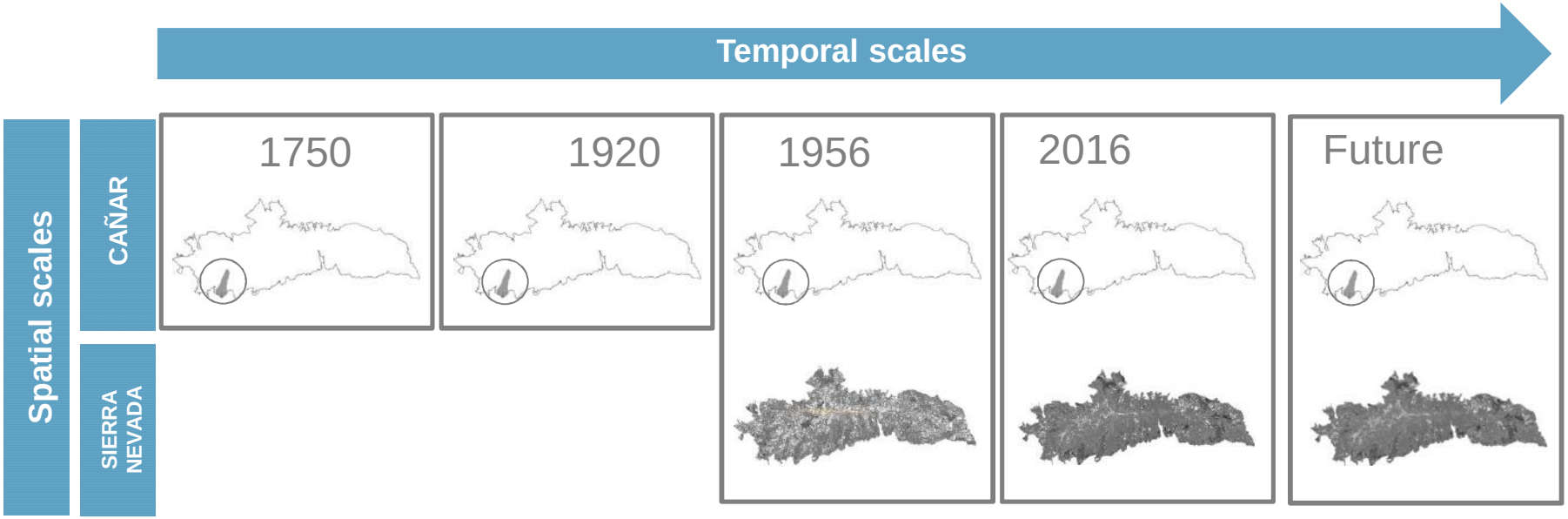
M9. Temporal evolution of ecosystem services in Sierra Nevada

Material and methods (ongoing work)

- Identify ecosystem services and spatial-temporal scales

Provisioning services: crop production, livestock production

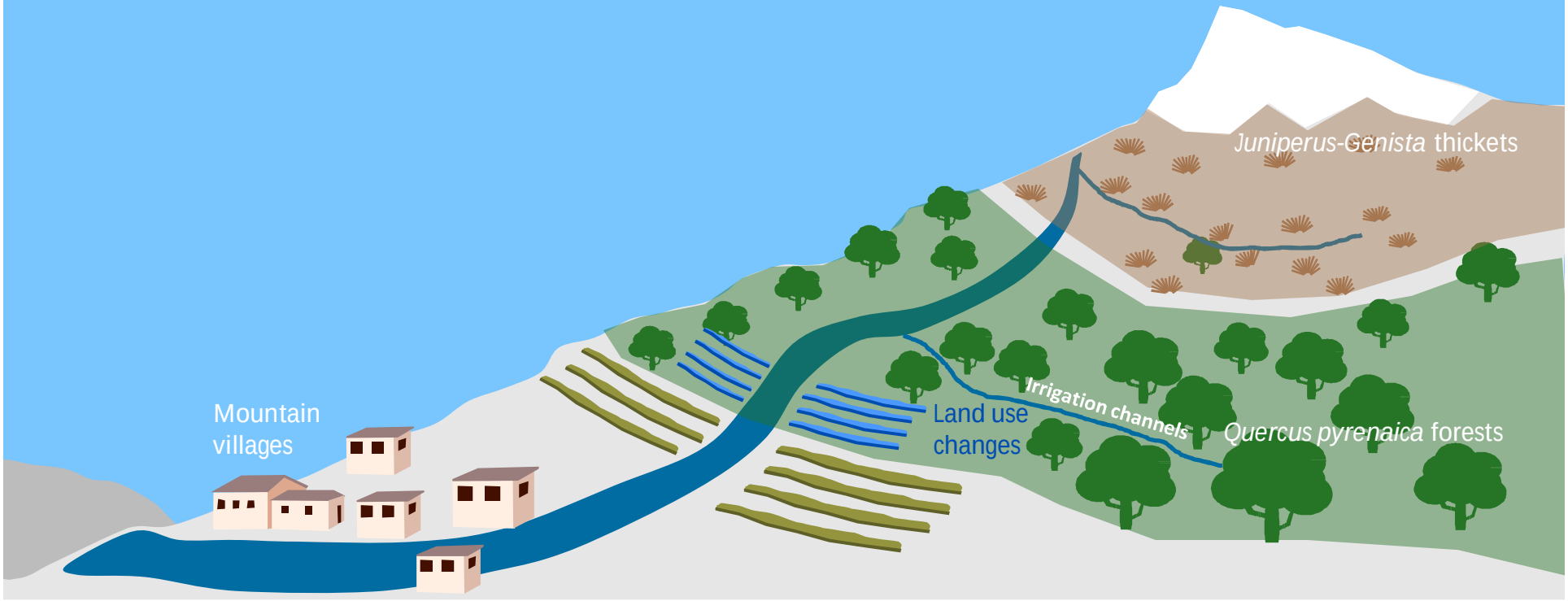
Regulating services: soil loss avoidance, flood prevention



M9. Temporal evolution of ecosystem services in Sierra Nevada

Material and methods (ongoing work)

- Identify ecosystem services and spatial-temporal scales
- Quantifying provisioning ecosystem services
  - Historical Land use maps: area occupied by crops and pastures



M9. Temporal evolution of ecosystem services in Sierra Nevada

Material and methods (ongoing work)

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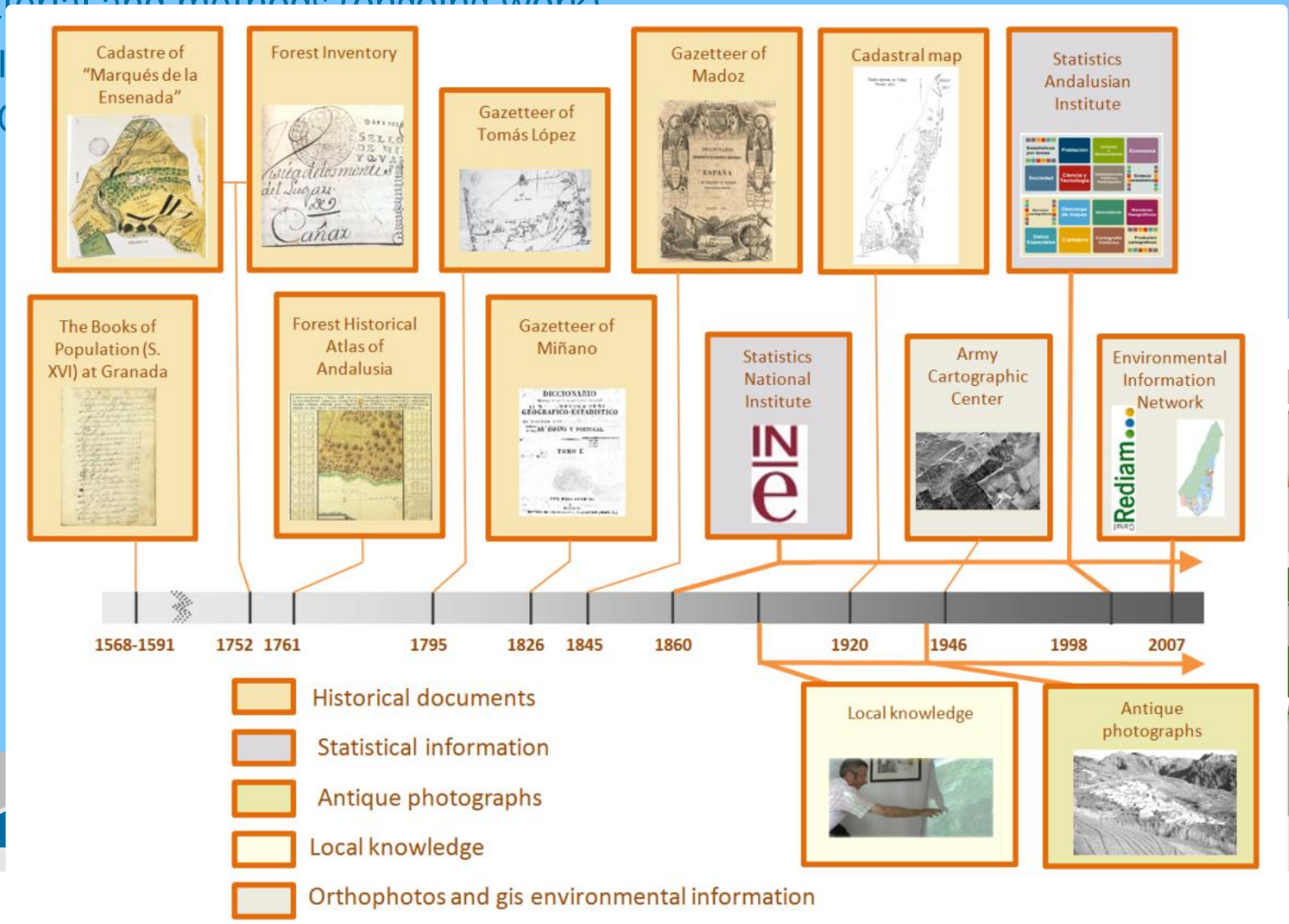

nista thicketts

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Material and methods (ongoing work)

- Identify ecosystem services and spatial-temporal scales
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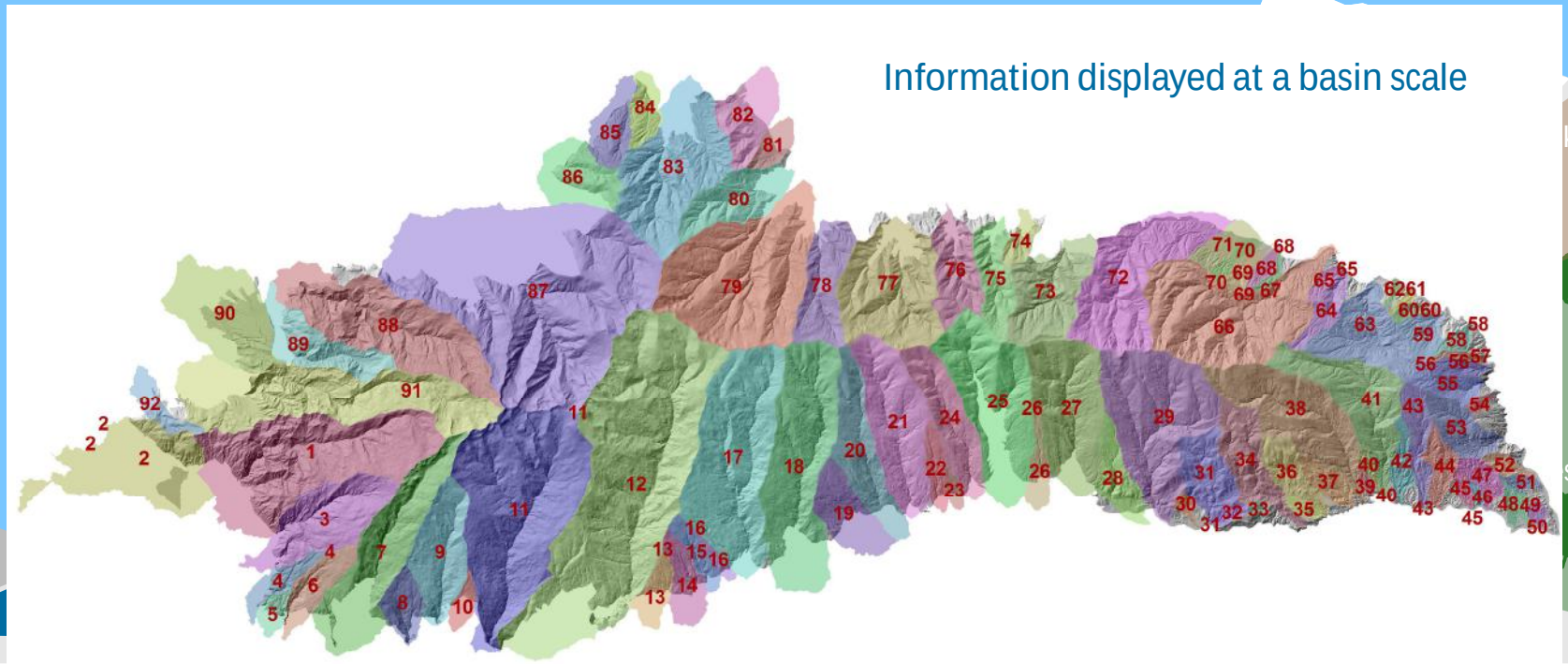
  - Historical Land use maps: area occupied by crops and pastures
  - Statistics describing crop yields.



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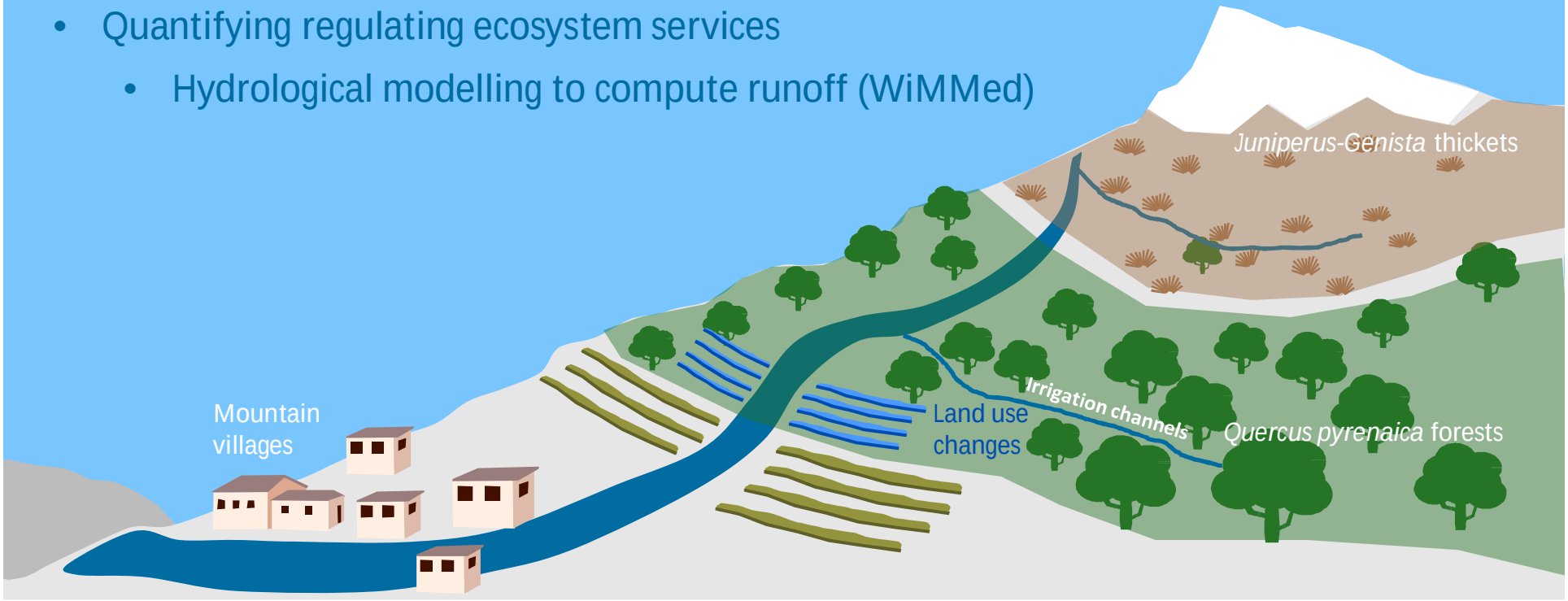
Material and methods (ongoing work)

- Identify ecosystem services and spatial-temporal scales
- Quantifying provisioning ecosystem services
  - Historical Land use maps: area occupied by crops and pastures
  - Statistics describing crop yields.
- Quantifying regulating ecosystem services
  - Hydrological modelling to compute runoff (WiMMed)



M9. Temporal evolution of ecosystem services in Sierra Nevada

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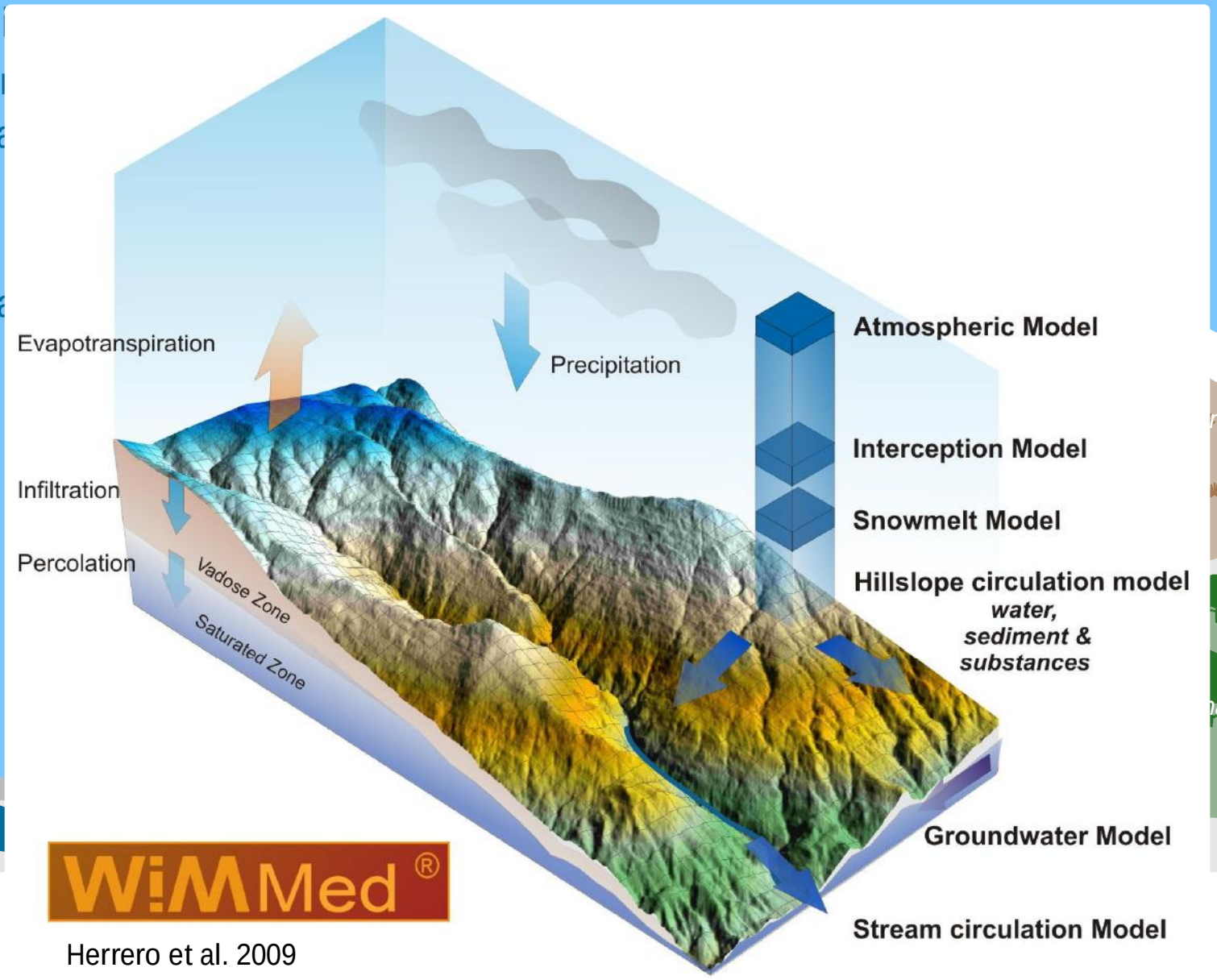

WiMMed®

Herrero et al. 2009

nista thickets

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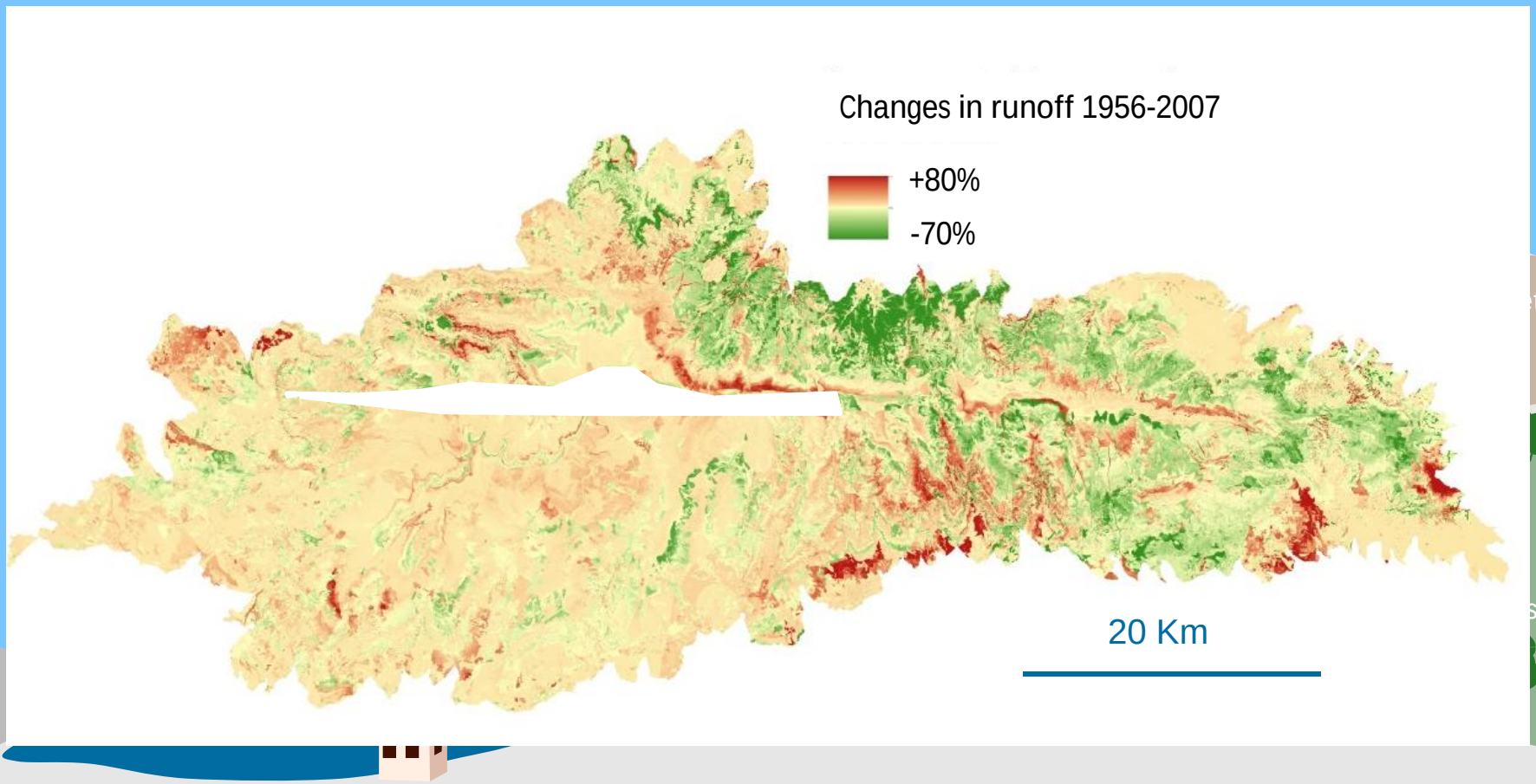
M9. Temporal evolution of ecosystem services in Sierra Nevada

Preliminary results

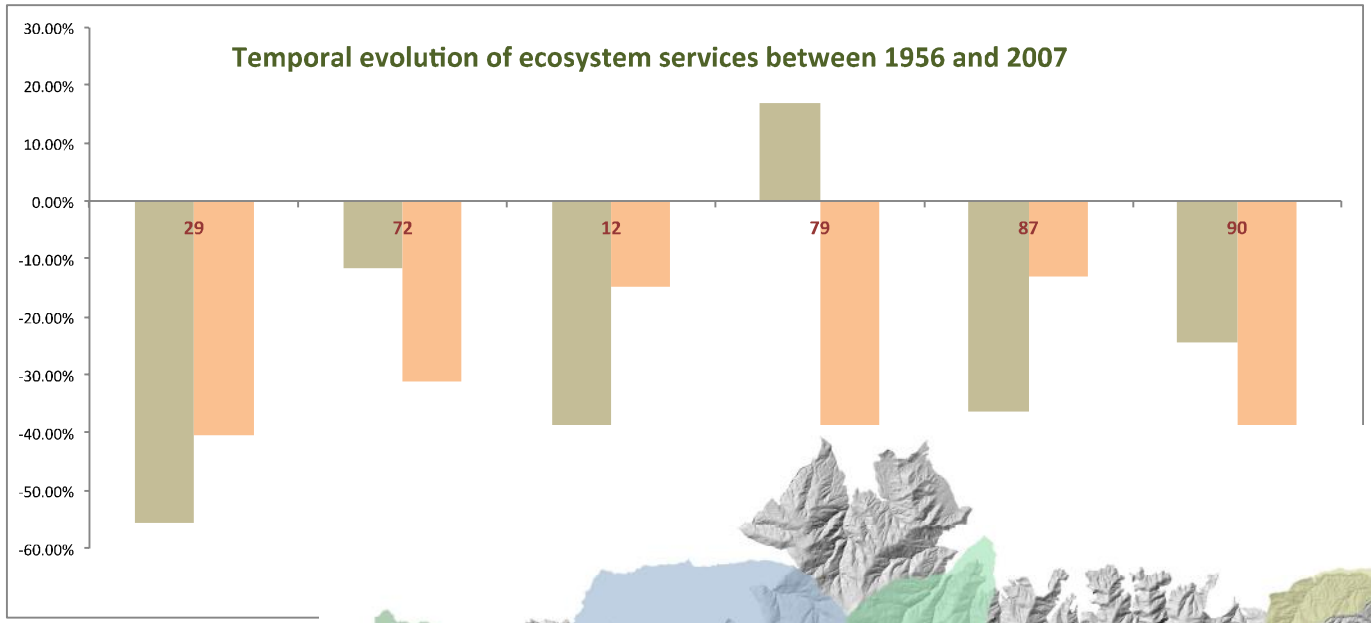
- Spatial distribution of changes in runoff

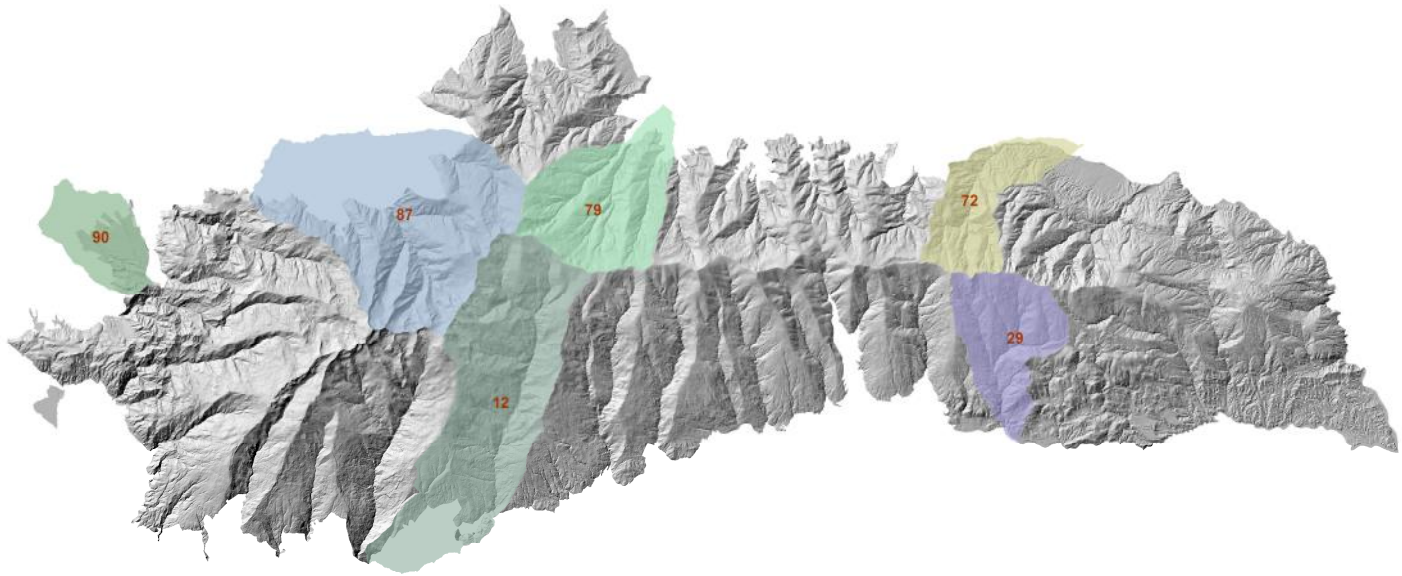


M9. Temporal evolution of ecosystem services in Sierra Nevada

Preliminary results

- Spatial distribution of changes in runoff
- Preliminary quantification of livestock and crop production





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