M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

Antonio Monteiro
(on behalf of ICETA-InBIO team)

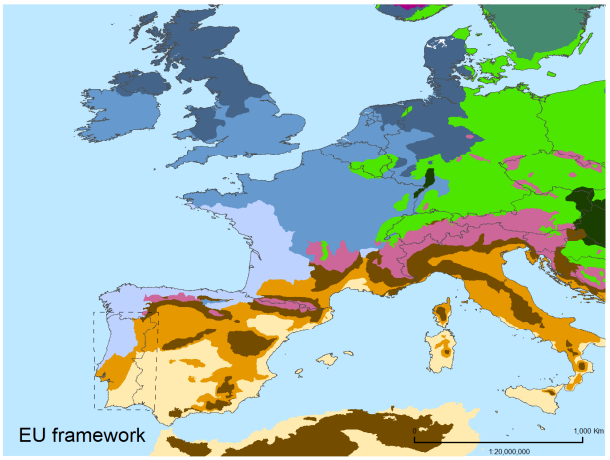
This project is funded by the EU
under the agreement nº 641762

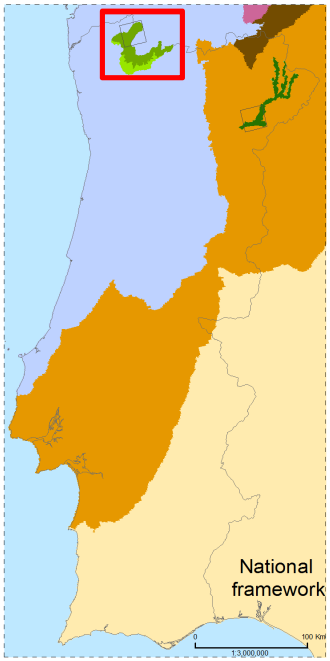
InBIO RESEARCH NETWORK
Biodiversity and Evolutionary Biology

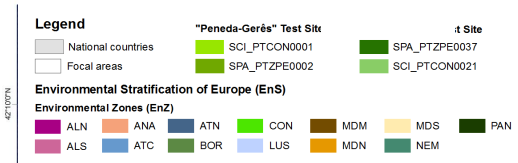
Peneda-Gerês mountain PA (Portugal)

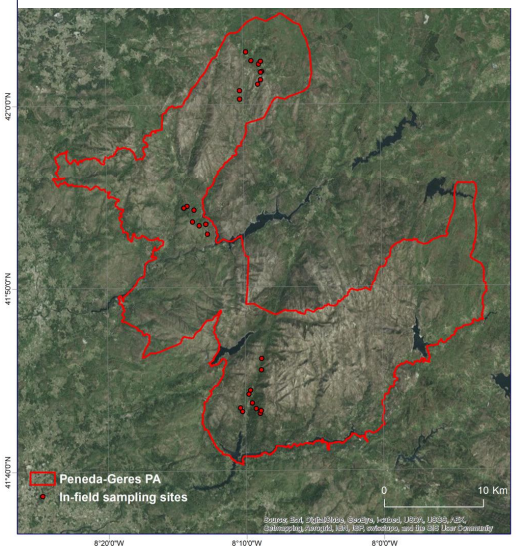
Location: 41.8387° N, 8.2416°W

Area: 702.90 km2









Annual means:

- Temperature: 13.3 °C
- Rainfall: 1272 (2500) mm

PENEDA-GERÊS PA

Drivers and Pressures

- Climate change
- Farmland and pastoral abandonment
- Changes in wildfire regimes
- Expansion of non-native species
- Hydropower infrastructures
- Expansion of tourism pressure

Table XI. Changes in precipitation, and maximum and minimum temperatures, in northwest Portugal, under RCP 4.5 scenario (ensemble of four GCMs), for 2021–2040 and 2041–2060

	2021–2040			2041–2060		
	ΔPrec (%)	ΔTMAX (°C)	ΔTMIN (°C)	ΔPrec (%)	ΔTMAX (°C)	ΔTMIN (°C)
Winter (Jan–Mar)	7.88	0.83	0.39	7.75	1.33	0.83
Spring (Apr–Jun)	−4.85	1.13	0.35	−8.71	1.78	0.85
Summer (Jul–Sep)	−9.73	1.25	0.43	−24.47	2.02	1.10
Autumn (Oct–Dec)	2.63	0.93	0.41	−3.62	1.33	0.78
Annual	1.20	1.03	0.40	−3.86	1.61	0.89

Santos C. et al. (2015)

STORYLINE – Question and motivation

Overarching question:

-How will current and future benefits supplied by mountain PAs be affected by future climate and land management strategies?

Aims:

- To quantify and predict the response of vegetation functions and ecosystem properties to alternative management strategies, considering the expectations of multiple stakeholders in the PA.
- To translate those responses into shifts in societal benefits, namely preservation of natural heritage and supply of water, soil and climate ecosystem services.
- To contribute for further use of instruments (e.g. models) based or fed by EO data in the PA management, including in the timely monitoring of societal benefits.

STORYLINE – Societal expectations and management strategies

Societal expectations for the PA

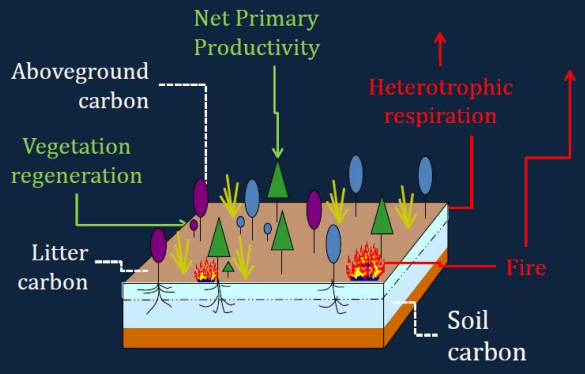
- Conservation of natural heritage (species, habitats)
- Supply of ecosystem services

Future management strategies

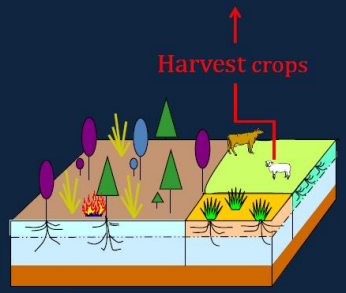
- Business-as-usual
- Economical development
- Ecological rewilding

Management options

Potential Vegetation (PV)
The PA without people



Current vegetation
The current PA



Ecological rewilding
The alternative

Economical development
The alternative

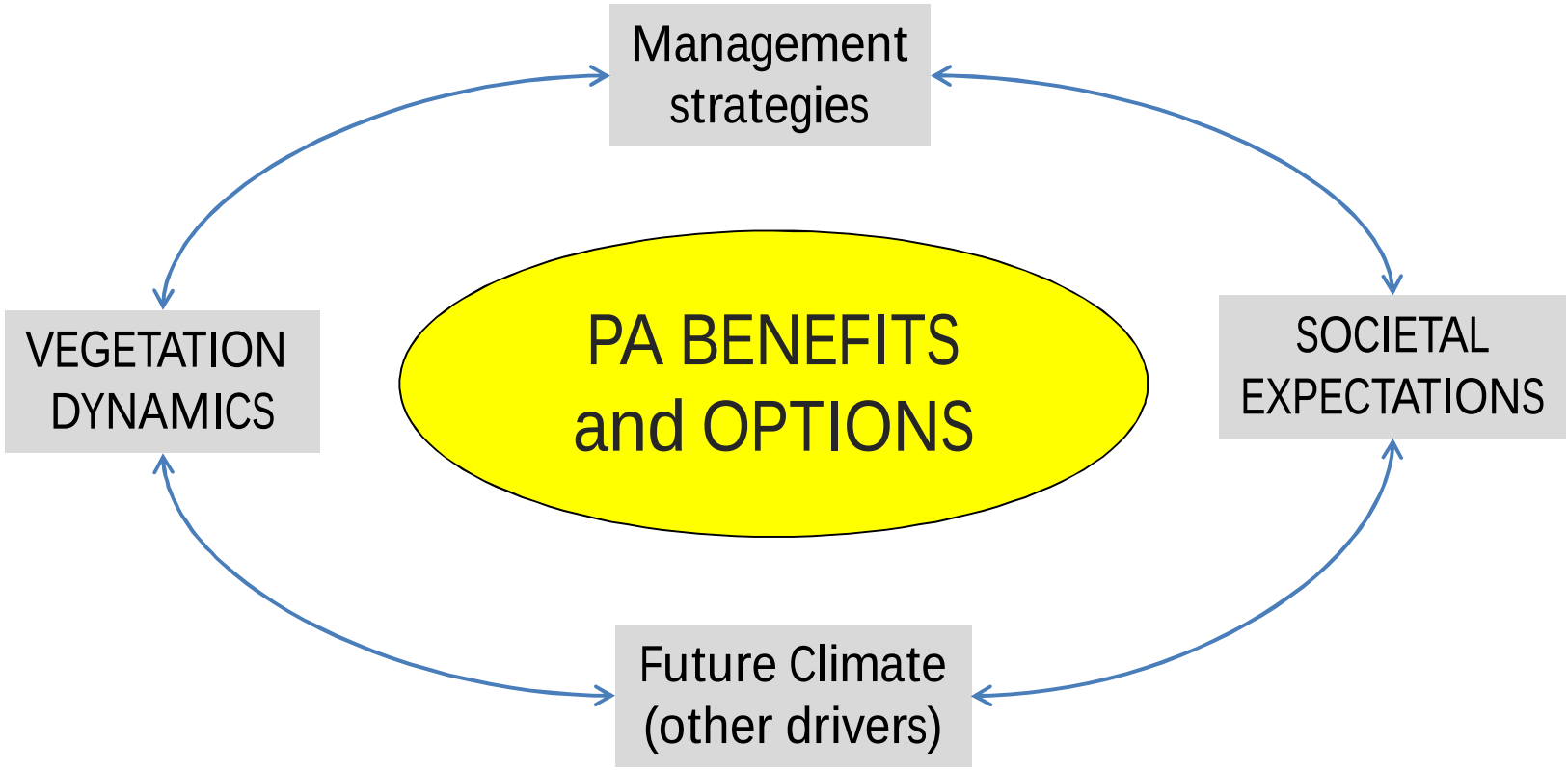
C stock → C uptake → C emissions

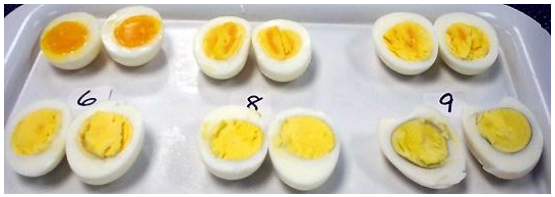
Sitch et al. 2003; Gerten et al 2004; Bondeau et al. 2007

C stock → C uptake → C emissions

Sitch et al. 2003; Gerten et al 2004; Bondeau et al. 2007

STORYLINE – Our expectations





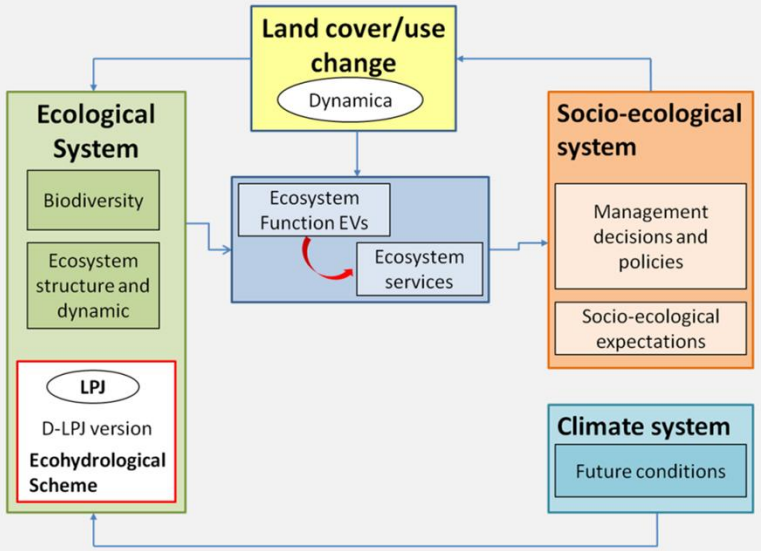
STORYLINE – Activities

SOCIETAL EXPECTATIONS- Supply of ecosystem services

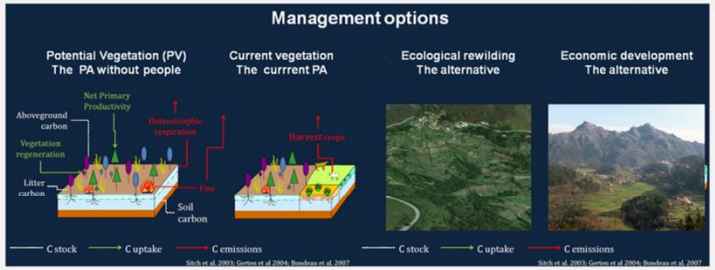
Climate regulation (carbon sequestration)

Hydrological services (e.g. water supply, flood control)

1 Ecosystem functions and services under future management options and climate

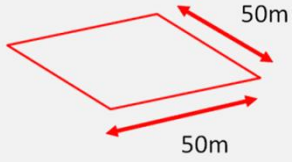


Adapted from Collins et al. 2010, TEEB 2010



Sentinel-1 in-field campaign

Vegetation water content (VWC)
Soil moisture (SM)
Biomass (B)



STORYLINE – Activities

2 Societal expectations- Conservation of natural heritage

Fitting SDM´s

Datasets

Scale

Species records

Multiple predictors

Climate and Land-Use Scenarios

Single models
(Ecological space)

Ensemble models
(Predictive space)

Iris boissieri

Taxus baccata

Climatic data

EO data

Climatic + EO

Ecosystem functional types

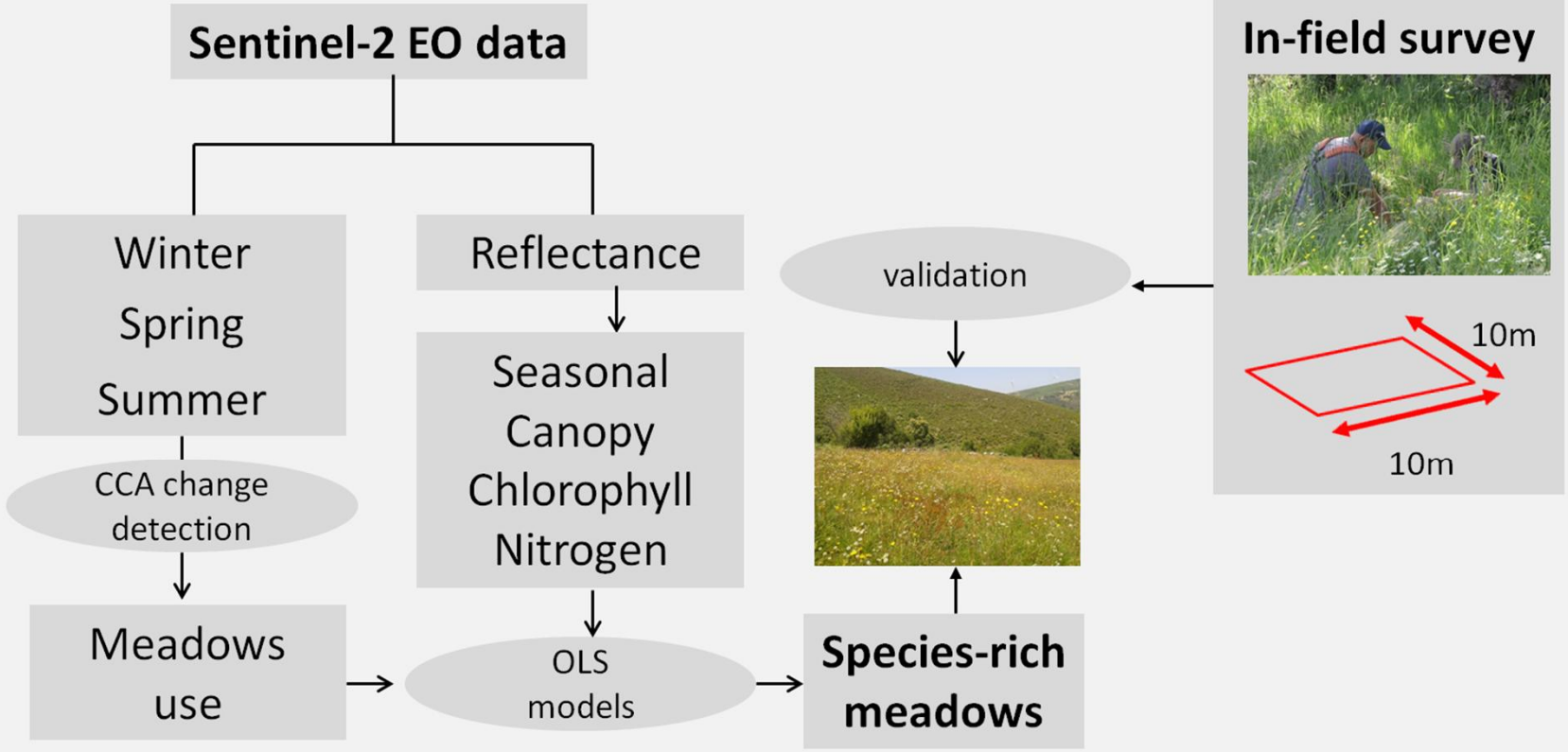
Essential variables

Regional

Local

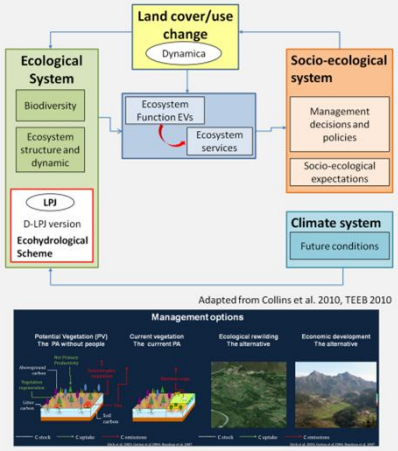
STORYLINE – Activities

3 EO-based prediction of species-rich meadows in a context of land abandonment and vegetation succession



STORYLINE – Activities

1 Ecosystem functions and services under future management options and climate

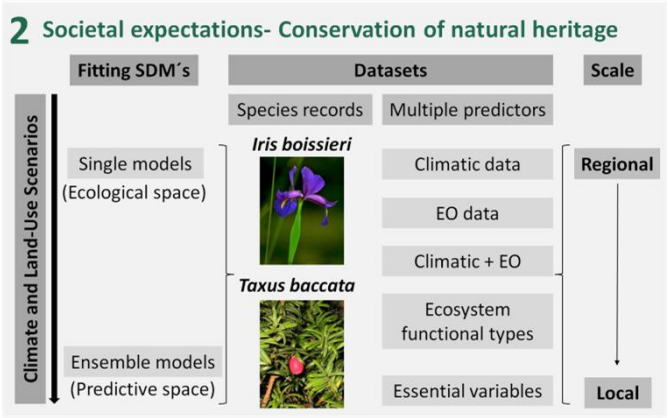


Sentinel-1 in-field campaign

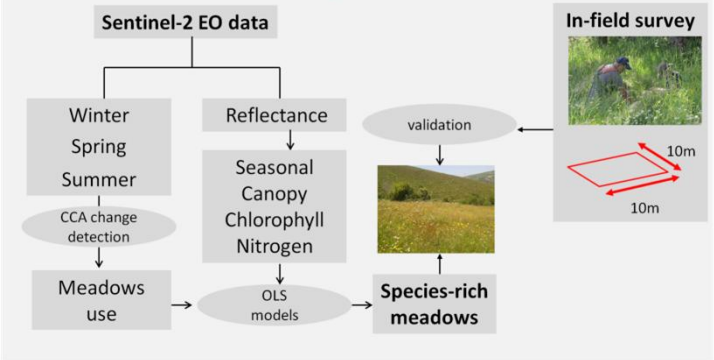
Vegetation water content (VWC)
Soil moisture (SM)
Biomass (B)

Tradeoff analysis

2 Societal expectations- Conservation of natural heritage



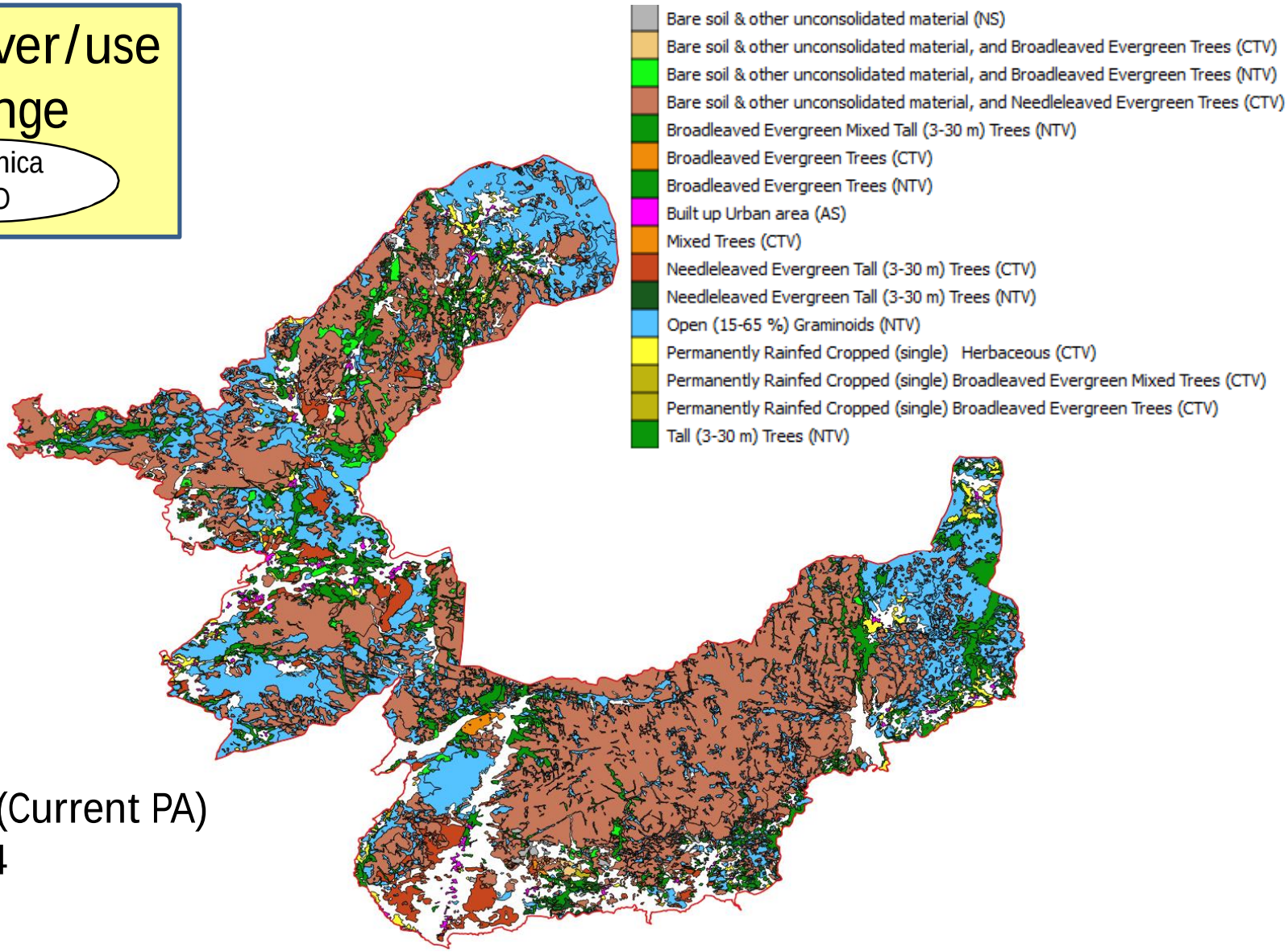
3 EO-based prediction of species-rich meadows in a context of land abandonment and vegetation succession



STORYLINE – Preliminary outputs

Land cover/use change

Dynamica EGO

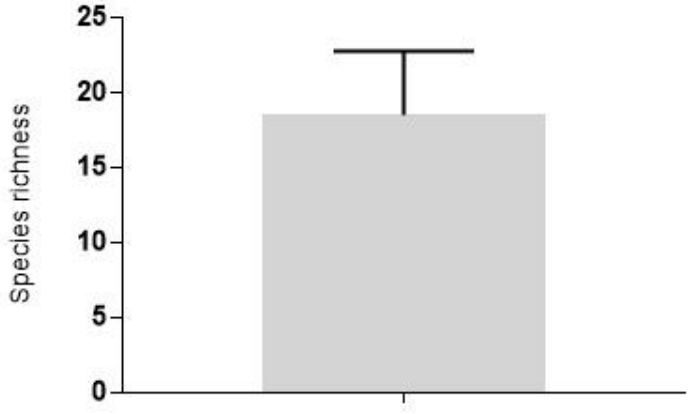


Year: 2014 (Current PA)
LCCS level 4

STORYLINE – Preliminary outputs

In-field data (plant diversity)

- Species-richness meadows (n=24)
- Recent management influences plant diversity



M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

TEAM WORKING IN THE STORYLINE DEVELOPMENT AND IMPLEMENTATION

A Monteiro[a], C Santos[a], S Arenas[a], J Gonçalves[a], A Buchadas[a], P Alves[a], J Alonso[a], P Castro[a], R Lucas[b], M Tanase[c], S Mermoz[c], A Bouvet[c], C Notarnicola[d], F Greifeneder[d] and J Honrado[a]

a) ICETA-InBIO
b) UNSW
c) CESBIO
d) EURAC

Thank you for your attention!

Antonio Monteiro

Contacts: jhonrado@fc.up.pt / amonteiro@fc.up.pt

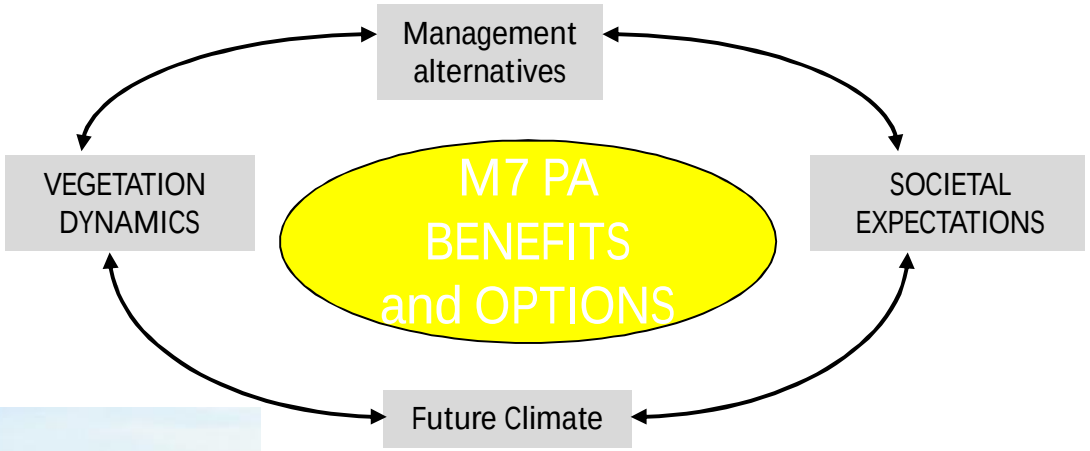
This project is funded by the EU
under the agreement nº 641762

InBIO RESEARCH NETWORK
Biodiversity and Evolutionary Biology

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

STORYLINE- SETUP

Societal Expectations
1) Conservation of natural heritage
2) Supply of ecosystem Services



SOCIETAL EXPECTATIONS

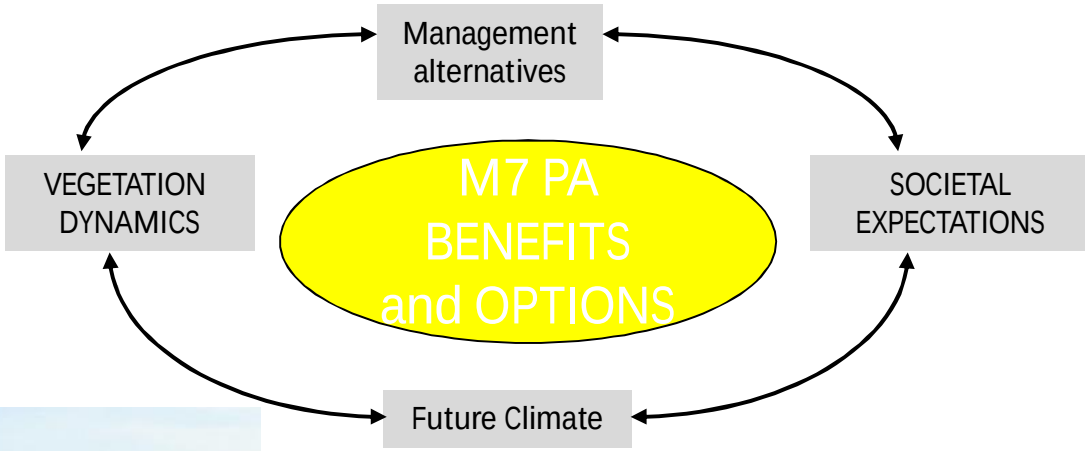
1) Conservation of natural heritage
   Iris boissieri (narrow endemic)
   Iberian wolf
   Species-rich meadows

2) Supply of ecosystem services
   Climate regulation
   Water provision and flood control
   Soil protection
   Eco-tourism

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

STORYLINE- SETUP

Management alternatives
1) Business-as-usual
2) Economic development
3) Ecological rewilding
4) The PA master plan



Management alternatives

1) Business-as-usual – recent and current trends will continue (e.g - farmland)

2) Economic development - economic activities (agriculture, cattle raising, forestry, tourism) will be promoted

3) Ecological rewilding (Ceausu et al. 2015)- Vegetation succession and other natural processes are promoted after land abandonment

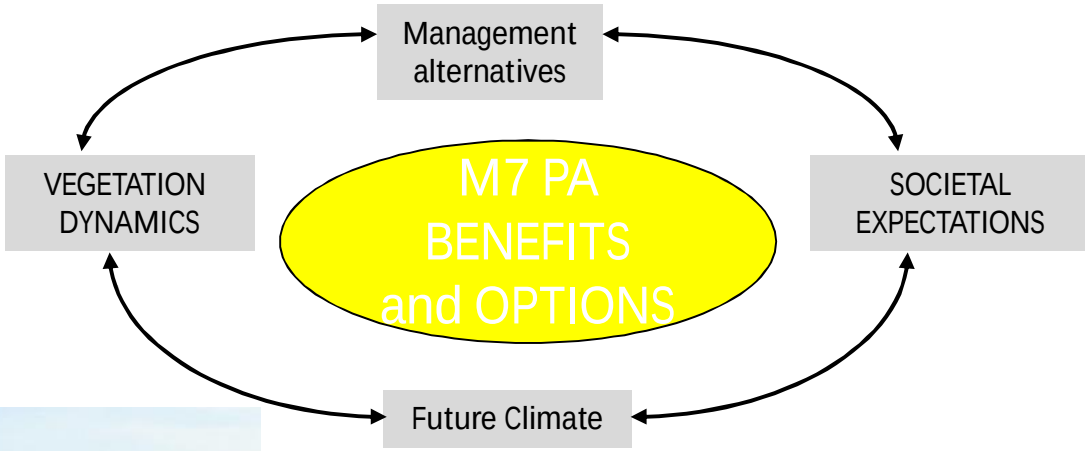
4) The PA management plan- the conservation management strategy of the PA master plan will be implemented

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

STORYLINE- SETUP

Future climate

1) > winter precipitation and < summer precipitation
2) > min and average temperature



FuTURE CLIMATE

1) CMIP-5 experiment: RCP 4.5 (intermediate changes)
   RCP 8.5 (strong changes)

STORYLINE – Conceptual Framework

Good points

- Explicit incorporation of local-scale heterogeneities (Pappas et al. 2015)

- Coupling climate change scenarios with land use/land cover change scenarios

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

DVM simulations (e.g. Carbon)

Research questions (e.g. Carbon)

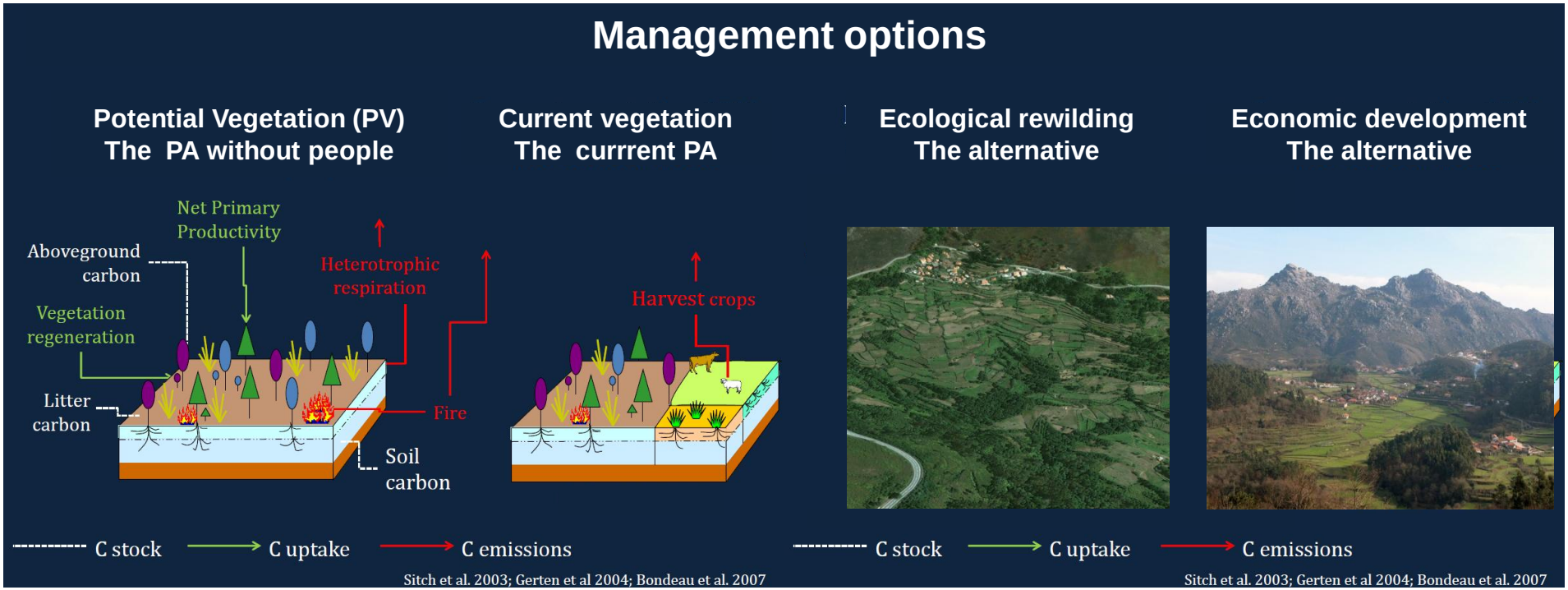
Q1. How much carbon is stored and sequestered under current land use?

Q2. What is the change in carbon storage and sequestration as a result of land use changes?

Q3. How is this relevant for the design of public policies related to carbon storage and sequestration ?

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

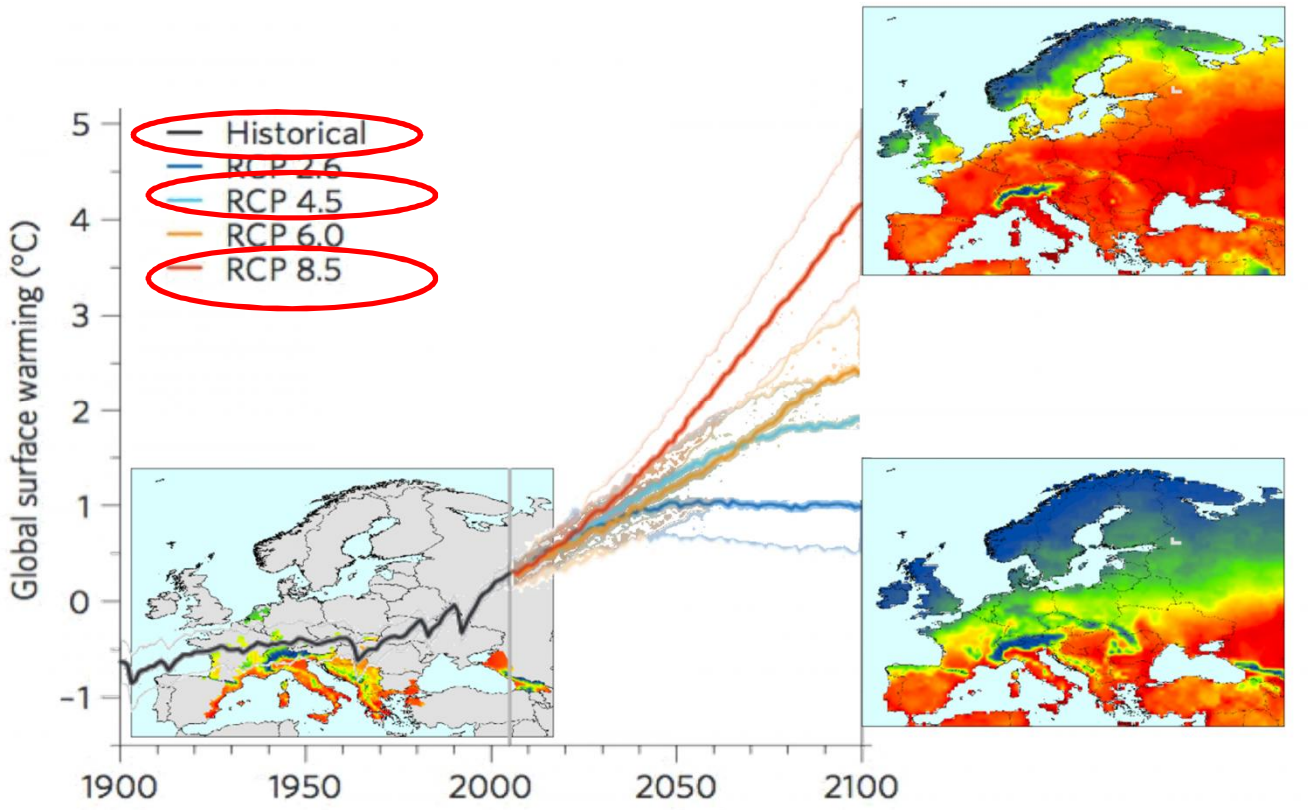
DVM simulations (e.g. Carbon)



INPUT DATA: Land cover/use data for the current world and alternatives
Source Data: Landsat imagery based classification
Scheme: LCCS-Level 4

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

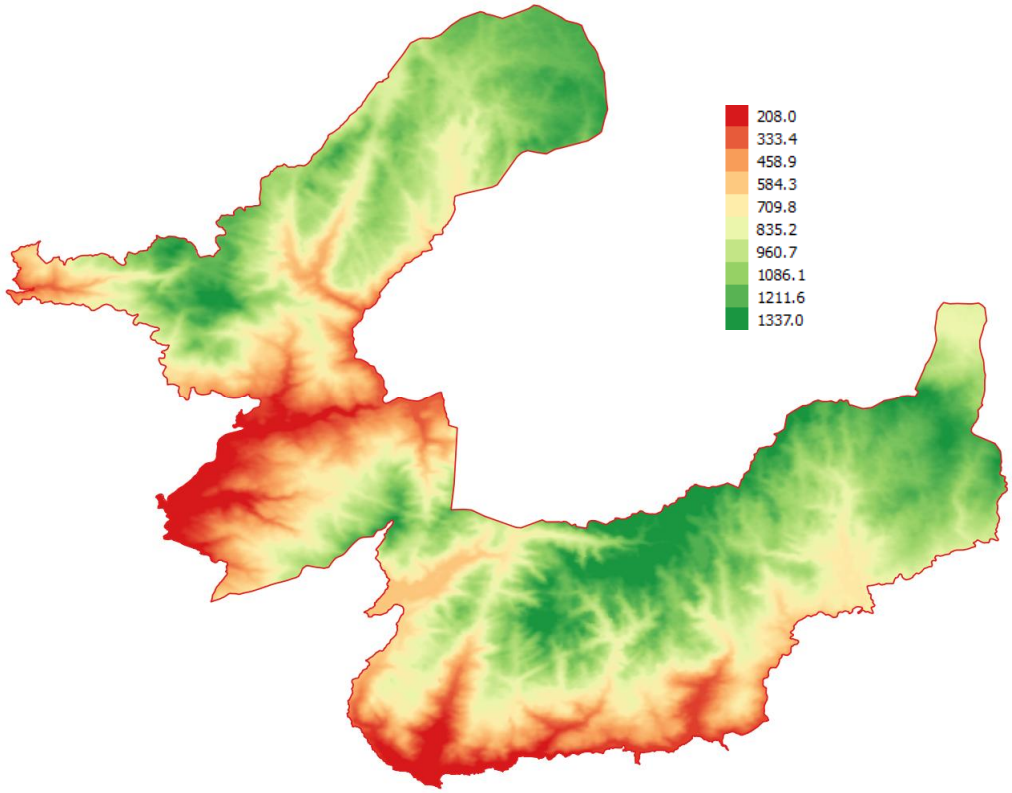
DVM simulations (e.g. Carbon)



INPUT DATA: Precipitation, temperature and radiation – DAILY Values
Source Data: Historical:interpolated observed dataset; Future: precipitation (Rainfarm); temperature and radiation (discussion is open in the consortium)

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

DVM simulations (e.g. Carbon)



OTHER INPUT DATA: Topography (DEM 30m); Soil properties (FAO soil map)
Annual values of Atmospheric CO2 (ice cores as in Frank et al. 2010)
Species-based parameterization of European Biomes (Hickler et al. 2012)

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

DVM simulations (e.g. Carbon)

Spin-up period: 500 years (to reach a state of equilibrium of carbon pools and vegetation cover
with historical climate conditions)- unavoidable step in DGVM applications

Runnings:
Potential Natural Vegetation simulation (since bare land until 2050)- The world without people

Historical simulation (1980-2014)- Current world scenario

Management alternatives (2016-2050)- The alternatives (Ecological rewilding; economic development)

Management alternatives + Future climate (2016-2050)- The alternatives (Ecological rewilding; economic development) + Current world scenario (BAU)

M7 Vegetation dynamics as a proxy of Socio-ecological Transitions and future Societal benefits in Mountain PAs Peneda-Gerês

DVM simulations (e.g. Carbon)

Q1. How much carbon is stored and sequestered under current land use ?

C storage = amount of carbon stored in a pixel

$$C\ storage = C_{aboveground} + C_{soil} + C_{litter}$$

Q2. What is the change in carbon storage and sequestration as a result of land use changes?

$$Changes\ in\ C_{storage} = \Delta\ Current\ vegetation - Potential\ vegetation$$