

## SHORT TERM SCIENTIFIC MISSION (STSM) SCIENTIFIC REPORT

This report is submitted for approval by the STSM applicant to the STSM coordinator

**Action number: ES 1306**

**STSM title: Assessment of land use change and climate change on prone-fire site in NW of Portugal**

**STSM start and end date: 03/09/2017 to 03/12/2017**

**Grantee name: Amandine Pastor**

### **PURPOSE OF THE STSM:**

The objective of this STSM is to assess alternative land use practices to limit sediment connectivity and prevent erosion and sediment yield in fire-prone forests of northern Portugal. Via this study, we gathered knowledge from previous projects including stakeholders' involvement to assess alternative management options and their impact on sediment connectivity in the experimental watershed of Macieira. As a joint research between MASCC, RECARE and this STSM, we defined 4 narrative future land use scenarios to be applicable to Macieira by 2050.

Research questions:

- What are the perspectives of local stakeholders about alternative management options to prevent erosion on post-fire prone areas ?
- Which land use and management practices are the most suitable as a prevention to post-fire erosion events (from expert point of view and from soil erosion modeling) ?

### **DESCRIPTION OF WORK CARRIED OUT DURING THE STSMS**

1. Proposed contribution of the scientific objectives of the action

We co-constructed narrative scenarios for the Macieira site with local researchers and stakeholders. The different land uses and management practices were tested in the Macieira fire-prone landscape.

2. Techniques – detail what techniques or equipment you want to use (if applicable)

This STSM included literature review from previous and on-going stakeholder workshops and projects and the elaboration of 2 surveys to design narrative scenarios. First, reports were studied including articles from past-ongoing projects (ERLAND, RECARE, ROSMED and MASCC). With that we designed 2 surveys to co-construct narrative scenarios on Macieira site. Second, we prepared the input datasets to evaluate those scenarios in the LANDSOIL model to compare erosion rates under different land use scenarios. This task implied: improving DEM

representation of Macieira (terraces), classifying latest land use maps and separating rainfall events from 1993 to 2014. Further tasks will be to design future land use maps and downscale climate data.

Preparation of input data for Landsoil included preparation of land use maps pre and post fire by including soil conservation practices into the landscape and crop calendar. Detailed step to achieve our actual work are described below:

1. The first step consists of a literature review and gathering information on land use, climate and perceptions via tables (communication to local researchers).
2. The second step was to design the narrative scenarios from the previous literature review and from the first and second socio-economic surveys sent to local scientists (we received part of the surveys on Dec 20<sup>th</sup> and the rest to be received before Jan 15<sup>th</sup>).
3. The third step is about translating the scenarios into land use maps based on the principles of the LANDSFACT (reprogrammed in R) and validated by an expert community (this step will be established once all surveys have been filled and task 4.a. finished in January 2018)
4. The fourth step is to test different land use scenarios in the erosion model (LANDSOIL) and provide sustainable solutions to post fire prone areas.
  - a. This last step requires first calibration of the model Landsoil and building input data (calibration is done at the moment)
  - b. Running the model and analyses of results (January-February 2018)

The preparation of input data for LANDSOIL consists of:

- Selecting of rainfall events based on 10mm threshold, separated by at least 3h
- Preparing a fine resolution DEM including terraces
- Preparing annual land use calendar for soil crusting, soil roughness and soil cover
- Downscaling future climate input
- Preparing future land use maps from the 2 surveys sent to stakeholders

## **DESCRIPTION OF THE MAIN RESULTS OBTAINED**

From the literature review of the previous projects and on-going workshop such as RECARE (workshop dealing with local stakeholders on soil and water conservation measures in the Caramulo watershed) and the 2 socio-economic surveys (see appendix 1 and 2) that were sent to local scientists. We co-contrast 4 narrative scenarios for the MASCC project: S1 business-as-usual scenario, S2 productivist scenario, S3 nature protection scenario and S4 sustainable scenario.

The Recare project is a 60 months project running from 2013 to 2018 in 17 mediterranean sites. It is entitled: "Preventing and Remediating degradation of soils in Europe through Land". Our study area is Macieira which is located in the Caramulo region (north-central Portugal). The climate is described as Atlantic-Mediterranean with long dry summer periods and high annual rainfall (>1200mm). This climate promotes wildfire ignition and high biomass production. The landscape is dominated by Maritime pines and Eucalyptus (known as highly inflammable species). The main problem of this study area is erosion by water due to high rainfall erosivity and sharp landscape. Post-fire erosion event can reach yield above  $\geq 5 \text{ Mg} \cdot \text{ha}^{-1} \cdot \text{y}^{-1}$  on shallow soils (<40cm). Between 1975 and 2011, at least 70% of the study area have been burnt at least once.

Post-fire management include ploughing, logging and bench terracing of which ploughing was

proved to increase soil water erosion. One effective post-fire management treatment is mulching with logging residues. However the measure needs to be tested and compared with other methods such as rate of mulch used, use of application schemes at landscape level, combination with PAM, impact of soil erosion measures against other services (e.g. C sequestration). Soils are mainly characterized by cambisols on granite and schist base. Soils are usually shallow, stony, coarse-textured and with high organic matter content (5-10 % in the topsoils). From a socio-economic point of view, 90% of the forest area in Northern Portugal is owned privately which gives low margin of manoeuvre for post-fire management. Fires have been exacerbated by eucalyptus plantations including logging, bench terracing etc. and land abandonment. One important problem is that the government promoted the PRODER sub-action 2.3.2.1 “Planning and recovery of forest plantations for emergency stabilization” but without a systematic evaluation of its performance. Moreover, long-term post-fire management does not include the restoration of heavily degraded ecosystems at the moment.

The stakeholders of RECARE project were composed of private and public forest owners, research institutes of forestry, owners and workers of paper industry and water-related services companies.

The second workshop of RECARE proposed the following post-fire erosion measures:

1. Plowing according to fire level contours (incorporating forest residues into the soil) | 20 votes;
2. Construction of erosion control barriers | 11 votes;
3. Soating, incorporating vegetable waste after fire | 9 votes
4. Conservationist removal of firewood after fire (keeping some forest residues scattered around the area) | 9 votes;
5. Tillage according to the contour lines after sowing after fire | 6 votes;
6. Technical removal of firewood after fire | 3 votes.

“



Based on these results the first technique to be selected was:

1. Mulching, with incorporation of vegetal residues after fire (implementation and monitoring already in course in Semide, Miranda do Corvo).

After some discussion, the participants stated that they would like to see a standard post-fire management technique tested, especially to understand the real effects on soil erosion. As such it was selected:

2. Plowing according to fire level contours (monitoring planned for next year, depending on

intervention by a forest owner).

### Results from Survey 1

From the first survey, we identified the socio-economic characteristics of Macieira to be able to design appropriate scenario.

First, we described the socio-economic context of Macieira between 1985 and 2015 with:

- Economy driven by out-migration and ageing population and the rest of the people living from subsistence forestry, farming and ecotourism.
- Governance: strengthening of local government through agglomeration with other villages
- Agriculture management: strong forestry management, maintenance of terraces and agriculture fields declining
- Urbanization: increase of 10%
- Possible break-down: wild fires, pine nematode, eucalyptus plague and diseases

Then we ranked the driving factors of the actual landscape from the most important to the less important: economy (farm abandonment), governance (centralization of decisions), migration, distance to city, access to natural resources, R&D, climate (for details: see appendix 1)

Third, we gathered information of emergent facts:

- Ageing of population and incentives for ecotourism

Fourth, we gathered information about plausible futures:

- Wood production
- Biomass production for bioenergy
- Ecotourism and re-migration of young population with different lifestyles

Fifth, we described the actual land use with past and possible trends

Table 1. Evolution of land use (past, present, future): 0 = equal trend, - = negative trend, + = positive trend

Land use	X1 (corn/pasture rotation, vine hedges)	X2 (pasture, vine hedges)	X3 (pine forest)	x4 (eucalypt forest)	Emergent LU: natural oak forest (replanted)	Abandoned LU: potatoes/vegetables
Economic profit for export	-, -, -(0)	-, -, -(0)	-, 0, -	+, 0, +	?, ?, -	-, ?, ?
Food Self- sufficiency	0, -, -	0, -, -	-, -, -	-, -, -	?, ?, -	-, ?, ?
Impact on Environment (biodiversity, use of pesticides)	+, 0, 0	+, 0, 0	+, 0, 0	+, +, +	?, ?, -	+, ?, ?
Actual Erosion rate (here only define for present)	0	0	+	+	?	?
LU abandonment	0, +, +	0, 0, +	+, 0, +	-, -, -	?, ?, -	+, ?, ?
Shift to another LU (only define for present)	To x2	To x4	To x4		?	?

biophysical tolerance						
Slope tolerance	low slope or terrace	low slope or terrace	High slope	High slope	High slope	low slope or terrace

Finally, local researchers were asked to evaluate the use of terraces in Maciera landscape

Table 2. Evaluation of Terraces in Macieira

Conservation Practices	SWC1 (terrace)
On which land use	X1, X2
Environment (biodiversity, use of pesticides and herbicides)	no difference from unterraced fields
Impact on Erosion	+ : terraces allow the development of pasture in the humid season (by preventing frost), keeping soil cover
Social acceptance (labour, cost)	social pressure to maintain terraces
Rate of adoption of SWC for past, present, future	50%,50%,50%
Risk	abandonment due to population age (already ongoing)
New potential	permanent pasture

## Results from Survey 2

We present some estimates of potential future land use occupation in the Caramulo mountain range in the middle of the 21st century (2050), according to four scenarios of socioeconomic development in the coming decades:

- S1: continuation of the current situation ("business-as-usual")
- S2: agroforestry production
- S3: environmental protection
- S4: sustainable agroforestry production

The Águeda river basin occupies about 400 km<sup>2</sup>, in an area dominated by eucalyptus and pine plantations. An important part of this area is in the Caramulo mountain range where Maciera belongs (Figure 1).

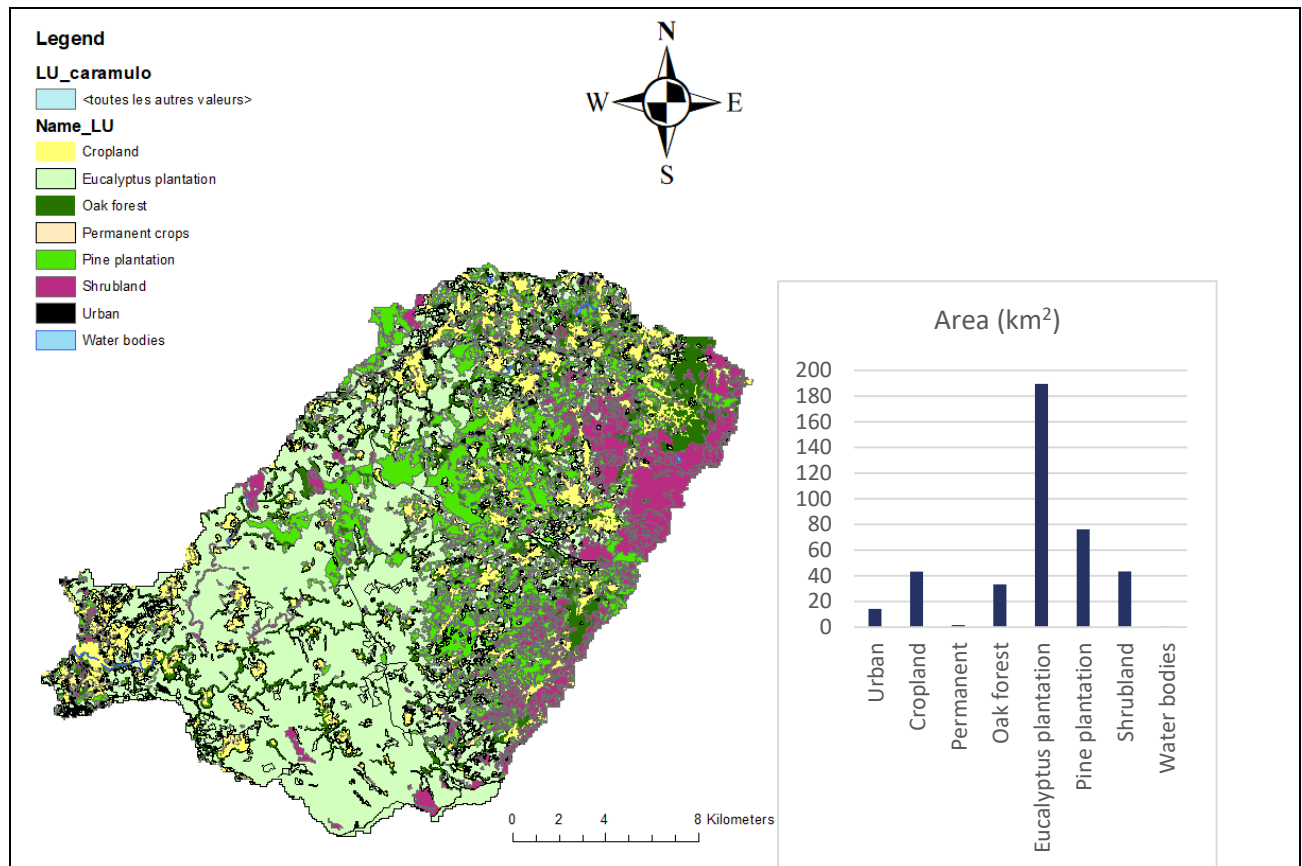


Figure 1. Land use occupation of Caramulo in 2010

### Description of the scenarios

#### S1: Continuation of the current situation ("business-as-usual")

This scenario follows the evolution trends of recent and present past land use, thus considering the continuity of current government policies and the current business and socio-economic structure. Water and soil conservation measures are considered to be stable, unless in the current context they are undergoing a strong evolution.

#### S2: Agroforestry production (focused on economic returns)

In this scenario the Caramulo mountain range follows a trend of a highly competitive world, where farmers and foresters have to increase production to supply regional, national and export markets. Consequently, the emphasis is on the production of profitable species at the expense of the degradation of natural resources.

#### S3: Environmental protection

In this scenario, European, national and regional subsidies are given to farmers, foresters and landowners to maintain a harmonious and environmentally sustainable landscape. New legislation requires the application of measures that prevent soil degradation and maintain natural habitats, such as natural hedges, ecological corridors, fallow land, etc. All agroforestry production includes water and soil conservation practices.

#### S4: Sustainable agroforestry production (mix of S2 and S3)

In this scenario, governments help farmers and foresters maintain or increase their agroforestry production, while respecting new legislation on environmental sustainability. Cultivation requires greater application of water and soil conservation practices, and farmers and foresters are encouraged to increase the diversity of their crops.

Table 1. Probable evolution of the use of future soil in Caramulo according to the socioeconomic scenarios to be filled as indicated above: ++ (>50%), + (0 to 50%), - (-50% to 0%), -- (<-50%).

LU occupation	Área	Percent of	Scenarios
---------------	------	------------	-----------



	(km2) Área (km2)	total	S1 Business as usual	S2 Productivist	S3 Nature protection	S4 Sustainable
Urban	14.20	4%	-	-	+	+
Cropland	43.29	11%	-	-	+	+
Permanent	1.62	0.4%	+	+	+	+
Oak forest	33.25	8%	-	-	++	++
Eucalyptus plantation	189.51	47%	++	++	-	-
Pine plantation	76.22	19%	-	-	+	+
Shrubland	43.44	11%	+	+	+	+
Water bodies	0.29	0.1%	+	+	+	+

Table 2. Management practices to prevent soil erosion

Erosion control measures	vote 1 to 6 (1 being the best measure)
Plowing according to fire level contours	1
Construction of erosion control barriers	2
Soating, incorporating vegetable waste after fire	5
Conservationist removal of firewood after fire	6
Tillage according to the contour lines after sowing after fire	4
Technical removal of firewood after fire	3

Appendix/Survey 1 was filled and reviewed by Joao Pedro Nunes, Jan Jacob Keizer, Frank Verheijen, Sandra Cristina Marques Valente, João Rocha, Dalila Serpa, Nelson Abrantes, João Puga, Ana Caetano

Appendix/Survey 2 was sent to:

We upscaled the study area to the entire Caramulo mountain range (1 Ha to 100 Ha), and invited different researchers to fill out the form:

- From the University of Coimbra and Aveiro: Carmen Ferreira, António Dinis Ferreira, Prof. Celeste (geographers), Peter Roebeling (env. economist), Fátima Alves (env. planning & management), Jan Jacob Keizer (biologist) and Sandra Cristina Marques Valente (social sciences).

Calibration and simulation of the current and future land use of soil erosion in Maciera are carried out at the moment and will be presented in 2 coming conferences in February and April in Lisbon and Venice.

#### Future collaborations

Following this research we have increased our collaboration with the mascc project team of the university of Aveiro. We have built collaborations with the community expert from the 2nd survey, involved students and professor from SLM from WUR (Msc student)

This work is also part of the mascc project and will be finalized in February 2018. (To achieve our future task, we need to downscale climate change data (already downloaded and downscaled for other mascc sites) and we need to translate land use scenario to produce land use maps with a method developed for the site of Roujan from the Mascc project using LANDSFACT model.)

The main results of this work will be presented in a couple of conferences in February and April 2018 in Lisbon and Venice.