

MASCC – Mediterranean Agricultural Soils Conservation under global Change

- ❖ Mediterranean soils are generally vulnerable to erosion. Climate and land-use changes could increase this problem: sometimes less rainfall, but often stronger storms ; higher aridity with less vegetation cover, more droughts and fires ; and diverse future socioeconomic conditions...
- ❖ MASCC addresses the issue of the vulnerability of Mediterranean agricultural soils to global change. Its conclusions are based on an analysis of the current and future evolution of the vulnerability of agricultural soils to erosion in relation to planned land use, agricultural practices and climate change on a wide range of Mediterranean contexts.
- ❖ MASCC mainly resulted in: a consolidation of the Mediterranean partnership; a framework to evaluate soils vulnerability; guidelines for sustainable conservation strategies under global change, adapted to different Mediterranean agro-ecosystems



Objectives

Soil vulnerability

Erosion

Global change

Agricultural practices

Soil conservation

- ❑ assess the similarities/dissimilarities in dominant factors affecting the current Mediterranean agricultural soil vulnerability by exploring a wide range of Mediterranean contexts;
- ❑ improve the ability to evaluate the impact of extreme events on both the current and projected agricultural soil vulnerability and the sediment delivery at catchment outlet;
- ❑ evaluate the vulnerability and resilience of agricultural production to a combination of potential changes in a wide range of Mediterranean contexts,
- ❑ provide guidelines on sustainable agricultural conservation strategies adapted to each specific agro-ecosystem and taking into consideration both on- and off-site erosion effects and socio-economics issues.

Results & innovation potential

- ✓ Strengthening the partnership through numerous exchanges, data sharing and training on a long-term evolution model of soil properties
- ✓ Synthesis on expected soil conservation techniques and acquisition of new experimental references
- ✓ Better knowledge on the separate and combine impact of climate and land use change on Mediterranean soil vulnerability
- ✓ By 2050, the impact of a change in land use is generally much greater than that of climate change. Land use management, including the implementation of conservation techniques, is therefore the main lever to reduce Mediterranean soil vulnerability to erosion.
- ✓ The soil conservation strategy must be adapted to the conditions of the agroecosystem: there is no single solution.

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METHODOLOGY

I) Present soil degradation

Current soil degradation intensities and processes were analyzed based on an extensive shared database derived from the R_Osmed long-term monitoring catchments network. It aimed to:

- assess the similarities/dissimilarities in dominant factors affecting the current Mediterranean agricultural soil vulnerability in a wide range of Mediterranean contexts
- evaluate the impact of extreme events on present agricultural soil vulnerability and the sediment delivery at the catchment outlet.

II) Scenarios elaboration by 2050

Various scenarios were designed for each studied sites by merging projections of climate and agricultural mitigation strategies.

Climate scenarios

A 20 years period (2040-2060) of ALADIN RCM model projections (RCP4.5 and RCP8.5) were locally bias corrected and timely downscaled from day to sub-hourly time step.

Land use scenarios

Four narrative scenarios for 2050 (Figure 1) were elaborated for each of the studied catchments in MASCC (Figure 2), by combining probable evolutions of landscape management identified through literature review and local experimentation and local expertise.

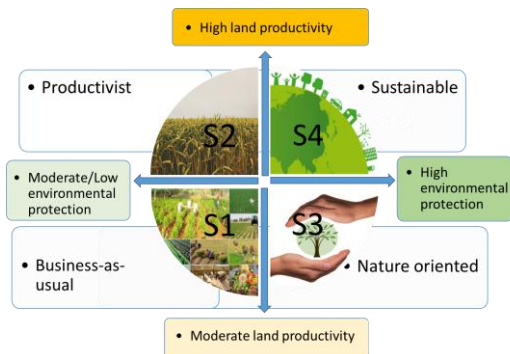


Figure 1. The four land use scenarios tested

III) Numerical modelling

Present and future soil erosion were simulated using the LANDSOIL model, a catchment-scale integrated approach of the soil-landscape system which enables to simulate both sediment fluxes at the catchment outlet and soil evolution anywhere within the catchment area. The extensive database on the current conditions (land uses, agricultural practices and climate) for the studied catchments allows both the parameterization and validation of the model. Separate and combined impact of climate and land use change was then evaluated by comparing each combination of climate and land use scenarios (Figure 3).

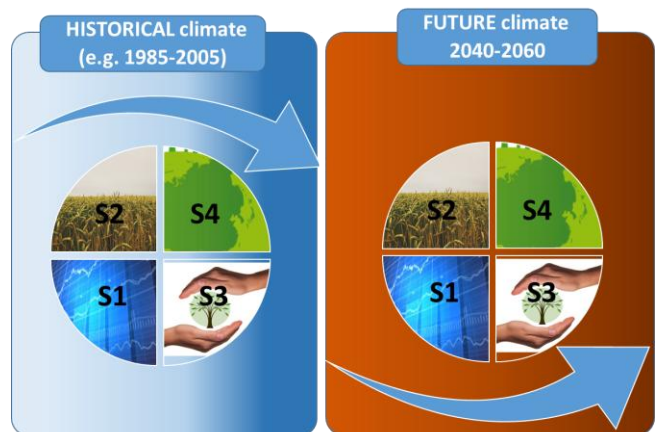


Figure 3. Simulation design

IV) Assessment of mitigation strategies

For each studied site, evolution and durability of natural resources used by agriculture were evaluated from LANDSOIL simulation results by including both on-site and off-site impacts of soil erosion. They were compared to durability derived from the baseline business-as-usual scenario in order to identify site-specific tailored conservation measures that benefit for soil preservation and agricultural sustainability. Finally, best mitigation strategies in western Mediterranean countries in relation to the environmental and socio-economic context were derived from inter-sites comparison.

Why collaborating?

Most activities implied close collaborative works and synergies among partners. Transnational cooperation provided remarkable added value, allowing for:

- Sharing a extensive rainfall-runoff-erosion database required for the analysis of the variability of factors and processes involved and for the analyse of extreme events impact.
- Apply a common framework for the comparative analysis of the impact of global change on the sustainability of Mediterranean agricultural soils
- Better understanding of the diversity of the context and the need for site-specific conservation strategies.
- strengthening long-term cooperation.

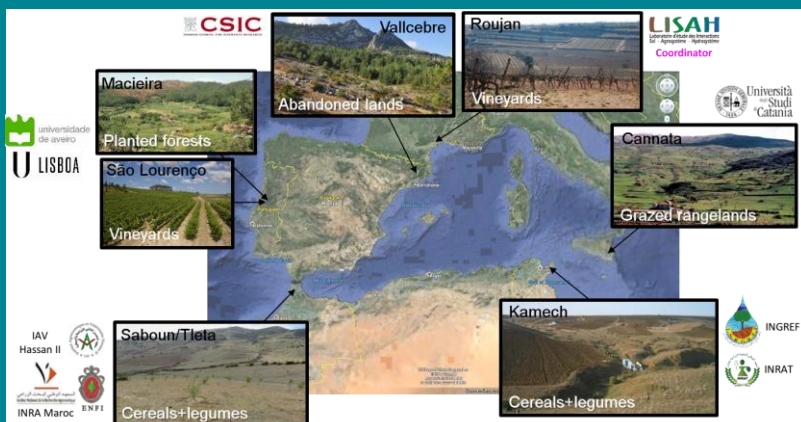


Figure 2. Studied catchments representing a range of various western Mediterranean agro-ecosystems

ACHIEVEMENTS

I) Present soil degradation

- The analysis of runoff and erosion time series over periods ranging from 3 to 29 years at the outlet of 10 small Mediterranean catchment basins spread over 5 countries (Portugal, Spain, France, Italy and Tunisia) made it possible to characterize the extreme variability of flows within the Mediterranean environment (Figure 4).

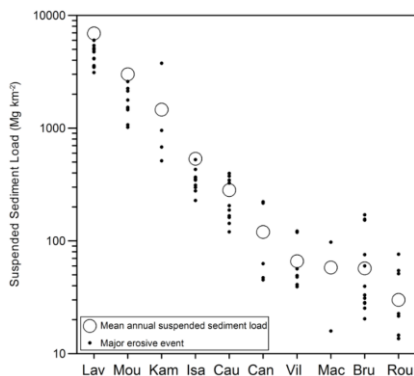


Figure 4. High variability of inter-annual average erosion rates in 10 Mediterranean catchments and contribution of the erosive events with a return period > 2 years.

- A combined analysis of seasonality, intensity and frequency of events was proposed to analyze the hydro-erosive response of a watershed and guide the selection criteria for soil conservation measures tailored to the watershed under study [Smetanova et al., 2019b].

II) Scenarios elaboration by 2050

- A review of the traditional and innovative soil conservation techniques has been produced for each main agro-ecosystems studied in MASCC. Some of them have been disseminated as talks or posters during conferences, or scientific papers [e.g., Moreno-de-las-Heras et al., 2019]
- New experimental data sets related to the impact of innovative practices on runoff and sediment have been produced during the MASCC project (Figure 5).



Figure 5. Field experiments with biochar application in vineyards – Portugal

- Four land use and management scenarios have been produced for each study site (Figure 6)

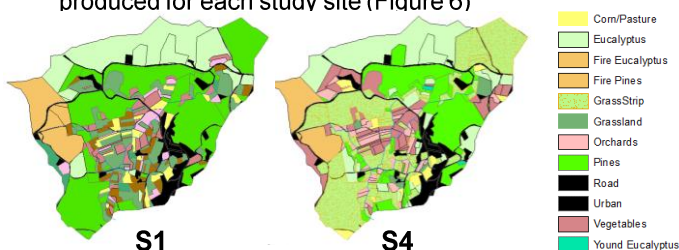


Figure 6. Example of scenarios S1 and S4 elaborated for the Macieira catchment (planted forest in Portugal)

III) Numerical modelling

- The different combinations between climate and land use and management scenarios were simulated using LANDSOIL model, and a first analyse was provided in respect to mean soil erosion rate average at catchment scale (Figure 7).

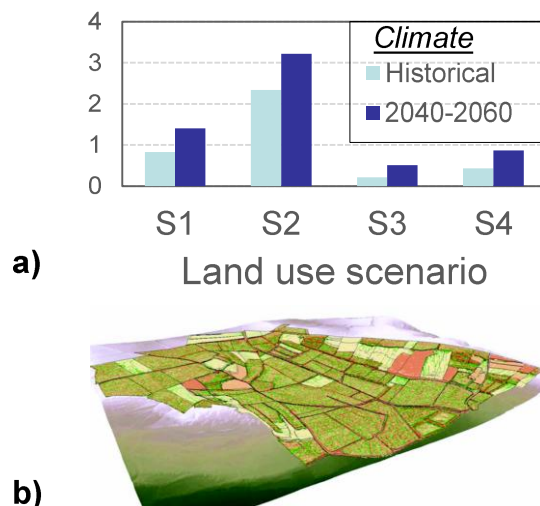


Figure 7. a) Simulated soil erosion rates for the Roujan catchment (vineyard, France); b) relief changes after 20 years of simulation with S2 scenario and 2040-2060 rainfall datasets.

IV) Assessment of mitigation strategies

- An in-depth analysis of the effect of conservation techniques on both on-site and off-site impacts of soil erosion are derived for each agro-ecosystem (Figure 8).

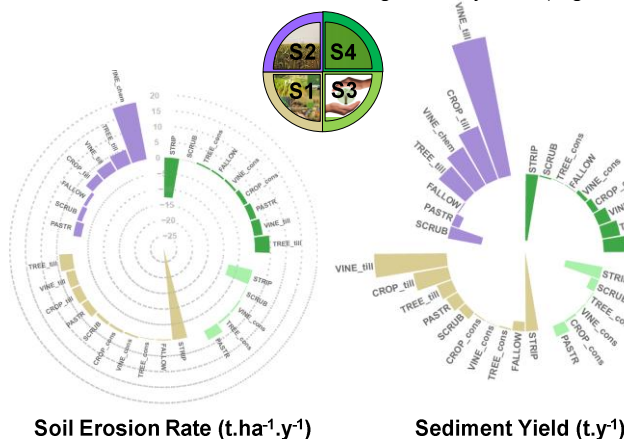


Figure 8. Simulated impact of conservation practices in terms of on-site impact (soil erosion rates) or off-site impact (contribution to sediment yield at catchment outlet) for the Roujan catchment

- A method for evaluation cost of soil degradation has been proposed and tested in the Moroccan catchment [El Mokkadem et al., 2019].
- Additional field work was also carried out on a few catchments to better link soil losses and agronomic properties.



Stakeholder engagement & training

- ❑ MASCC project strengthened a network of researchers with different expertise to help guiding Mediterranean soil conservation strategies tailored for a wide range of Mediterranean agro-ecosystems.
- ❑ Different stakeholders participated to the project to help in the elaboration of the narrative scenarios of land use change including conservation measures adapted to the context considered. Restitutions were also organized in some countries to discuss the land use scenario maps.
- ❑ The list of stakeholders varies from country to country and mainly includes national, regional and local actors of rural development planning and as well as academic experts.
- ❑ Some field trips were organized during each plenary meetings of the project to promote exchanges with local actors and build a shared vision of the diversity of situations in the Mediterranean area.
- ❑ Results were disseminated via scientific papers, talks and posters in major international conferences. It included the coordination of sessions in EGU conference and the organization of a dedicated conference in Morocco; Rabat, on 2019, November 19-20th.
- ❑ Several modelling trainings sessions were organized by and for the MASCC participants. Most of the students and young researchers involved in MASCC have benefited from a common transnational experience.



Figure 9. Illustration of stakeholder engagement and training during the MASCC project: a) field trip in Portugal; b) field trip in Italy; c) modelling training session in Portugal, d) conference in Rabat.

Next steps

- ❖ The analysis of the best mitigation strategies in the Western Mediterranean countries will continue with the progressive consideration of the results on new agro-ecosystems.
- ❖ Future research needs include:
 - studies to better understand and model the link between soil losses by water erosion and changes in soil fertility (i.e., loss of agronomic potential).
 - works on the acceptability of conservation measures in each context
 - socio-economic studies to better assess the impacts of erosion and identify trade-offs between scenarios and on-site and off-site impacts (e.g., cost of soil erosion).

Do you want to know more?

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For more information on the ARIMNet2 Network

www.arimnet2.net

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Reference: RACLOT D. and the MASCC team, 2019. MASCC – Mediterranean Agricultural Soils Conservation under global Change. *ARIMNet2 Highlights Series*

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The views and opinions expressed in this publication are purely those of the writers and may not in any circumstances be regarded as stating an official position of the European Commission

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