CASCADE

Catastrophic shifts in drylands:
How can we prevent ecosystem degradation?

NEWSLETTER 3
June 2016

http://www.cascade-project.eu/

Reporting on our recent Plenary meeting in Ispra, Italy

Photo by E. van den Elsen

The 5th Plenary meeting of the CASCADE Project took place May 24-28 at the EC's Joint Research Centre in Ispra, Italy. The meeting covered research updates from all partners, plans for integration of results, and planning for the final year. In February 2017 there will be a final meeting in Matera, Italy, to share recommendations with stakeholders and policy makers, at both local and EU levels.

CASCADE Project partners are completing experiments and modelling to obtain a better understanding of discontinuous shifts, or tipping points, in dryland ecosystems around the Mediterranean. Our study sites in parts of dryland Portugal, Spain, Italy, Crete and Cyprus have been used to establish more precisely the details of changes to the soil and plant ecosystems due to forest fires, overgrazing and land abandonment.

Research results are presented on our Information System CASCADiS as they become available: http://www.cascadis-project.eu/ The Project Deliverables that have been completed may be viewed or downloaded from the project website: http://www.cascade-project.eu/index.php

Identification of critical changes preceding catastrophic shifts in ecosystems affected by increasing wildfire recurrence (*A.G. Mayor et al*., Work Package 3)

There are many questions to be answered about the effects of fire on soil fertility, and therefore the effects of successional stage of the vegetation and the frequency of fire recurrence were examined on a short term basis (Várzea, Portugal) and a long-term (>5 year) basis (Valencia, Spain). In both cases trends towards soil fertility loss were observed. Labile organic matter fractions were more sensitive than total amounts to fire impact, and could be used as indicators of change in soil functions. The soil surface between shrubs, generally covered by herbaceous plants, showed a particularly high sensitivity to fire occurrence and recurrence. Overall, results suggest that the current trend of increasing fire recurrence in southern Europe may result in losses or alterations of soil organic matter, particularly when fire promotes a transition from pine woodland to shrubland. This shift promotes a trend of soil fertility degradation, that may or may not be reversible. For more details see the paper recently published in Science of the Total Environment: http://dx.doi.org.ezproxy.library.wur.nl/10.1016/j.scitotenv.2016.03.139

General view of the two CASCADE study sites affected by different levels of fire recurrence: Várzea in Portugal (left , J.J. Keizer) and Valencia in Spain (right, A. Valdecantos)

The potential for sudden shifts in dryland ecosystems (*S. Bautista et al*., Work Package 4)

Using a variety of manipulative experiments and observations, researchers tested the main eco-hydrological mechanisms and processes underlying the potential feedback loops that drive dryland dynamics, response to stress, and potential sudden shifts in drylands. It was clear that both plant cover and plant patterns exert a critical role in controlling water and soil conservation in patchy ecosystems. This role relies mainly on the sink capacity of the soils underneath the plant patches, rather than on the capacity of the patches for rainfall interception and physical obstruction to overland flow.

The connectivity of bare-soil emerged as the most critical pattern attribute for explaining the hydrological behaviour of patchy ecosystems, as it reflects and depends on both cover and pattern. Larger bare-soil connectivity implies larger water and sediment losses from semiarid slopes, but it also implies larger inter-patch areas, that can be beneficial for the performance of a downslope patch.

Vegetation patches and inter-patches (S. Bautista et. al)

Results provide critical insights about the control factors of source-sink dynamics in semi-arid lands and help to enhance spatially explicit models that investigate the interactions between spatial vegetation pattern and resource redistribution as well as eco-geomorphic evolution. The control factors that drive plant performance and ecosystem productivity in semiarid lands are needed to help us understand the conservation, management and restoration of these areas. New evidence for a positive relationship between seedling growth and the size of the upslope inter-patch area should be considered when designing conservation and restoration actions in semi-arid lands.

Patch and inter-patch simulation experiments (*S. Bautista et al.*)

In a similar way, treatments that exploit and enhance source–sink dynamics on dryland slopes can improve the re-introduction of native shrubs into areas under strong water–stress conditions. In addition, with the aim of recovering previous landscape processes and minimizing resource leaks, the spatial pattern of the introduced seedlings there can show an optimum functional patchiness and source:sink area ratio, that maximizes both vegetation cover and the amount of water input that can be captured by the vegetation. Further research is needed to define this optimum source:sink ratio more definitely for a number of plant communities and spatial scales.

A gradient of pressures across three plots has been monitored (Bautista et al.)

Although plant cover and biomass are the most common vegetation properties used for hydrological modeling, results suggest that other patch metrics like patch number and/or size distribution might be better hydrological indicators than patch cover. Integrated indexes based on capturing the connectivity of the bare-soil matrix in patchy ecosystems, such as the Flowlength index, have great potential as surrogates for the hydrologic functioning in semiarid landscapes. These indices can be obtained easily from aerial photographs and incorporated into hydrologic and erosion models at the hillslope and catchment scales.

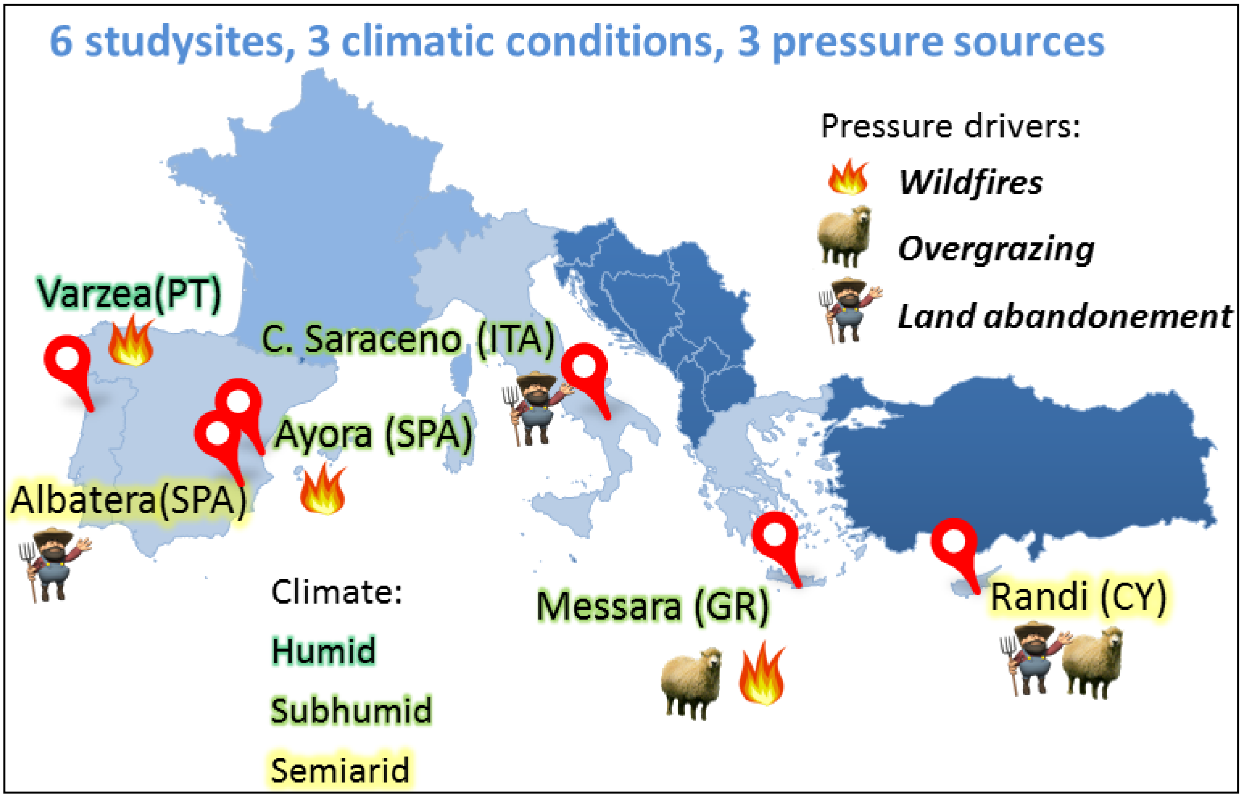
Overall, the results reported here from a first set of experiments support the idea of eco-hydrological processes and feedbacks as potential inside mechanisms underlying sudden shifts in drylands. New, on-going experiments will test how increased pressure on dryland systems could trigger sudden shifts towards degraded states, and how this degradation can be reverted by manipulating plant cover and diversity.

Regime shifts in the CASCADE dryland sites (*A. Valdecantos et al.,* Work Package 5)

Common indicators have been established for assessing major structural and functional changes in vegetation composition and (spatial) structure and related ecosystem services that result in regime shifts. For a selection of dryland ecosystems in which several restoration actions have been applied, potential tipping points and thresholds for restoration success were identified. Two reports have been produced: Deliverable 5.1 on structural and functional changes associated with regime shifts in Mediterranean dryland ecosystems; and Deliverable 5.2 on restoration potentials for preventing and reversing regime shifts.

Main Results:

- Ecosystem Services have been improved by restoration actions in all the field sites
- Randi (in the long term) and Albatera (in the short term) are the most sensitive sites Traditional logging after wildfire released a positive net balance in the very short term
- In more stable/mature states, restoration benefits are lower



Drivers of land degradation in the study sites (Schwilch et al.)

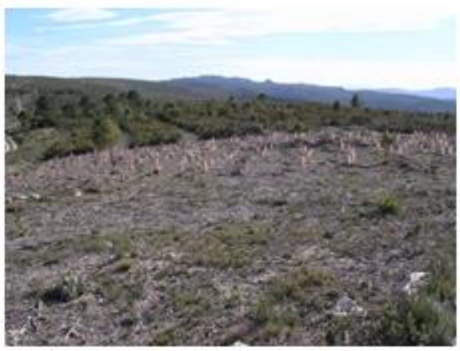
Restoration approaches in the study sites

Várzea

- Standard or traditional logging: all wood was removed from the site

- Conservation logging: logging residues were left on the ground organized in piles

Ayora



- Selective clearing of fire-prone shrubs
- Planting resprouter seedlings

Castelsaraceno

Fencing

Clearing woody vegetation

Restoration in the Randi, Messara and Albatera study sites

Randi

Grazing exclusion

Messara

- Grazing exclusion
- Planting carob trees

Albatera

Traditional restoration: planting pines in terraces

Ecotechnological restoration: multispecies plantations with updated techniques

Recommendations for management practices (*G. Schwilch et al.,* Work Package 7)

The primary aims were to identify and evaluate natural resource management practices regarding their resilience towards change and their sustainability over time and scale. Guidelines are being prepared on best practices for natural resource managers.

In order to achieve these, an inventory and assessment of natural resource management was made, and a questionnaire tool to explore the resilience of natural resource management practices with stakeholders was compiled.

20 technologies and 3 approaches were identified and described using WOCAT methodology https://www.wocat.net/en/knowledge-base.html See examples below.

Graze land forestation with Ceratonia siliqua (carob trees) in the Mediterranean
Greece - Φύτευση βοσκότοπου με Ceratonia siliqua (χαρουπιές) στη Μεσόγειο (EL)

Graze land forestation with Ceratonia siliqua (carob trees)

left: Mature plantation of Ceratonia siliqua (Photo: I. Daliakopoulos)
right: Pruned stand of Ceratonia siliqua (Photo: I. Daliakopoulos)

Location: Heraklion
Region: Melidochorion/Kastriotis
Technology area: 0.05 km²

Post-fire Forest Residue Mulch
Portugal - acolchoado, aplicação de restos vegetais

Forest residue mulch is spread immediately after a wildfire in order to prevent soil erosion and reduce overland flow.

left: Forest residue mulch being scattered in a recently burnt area.
right: Detail of a forest residue mulch composed by eucalypt chopped bark mulch.

CASCADE
Catastrophic shifts in drylands

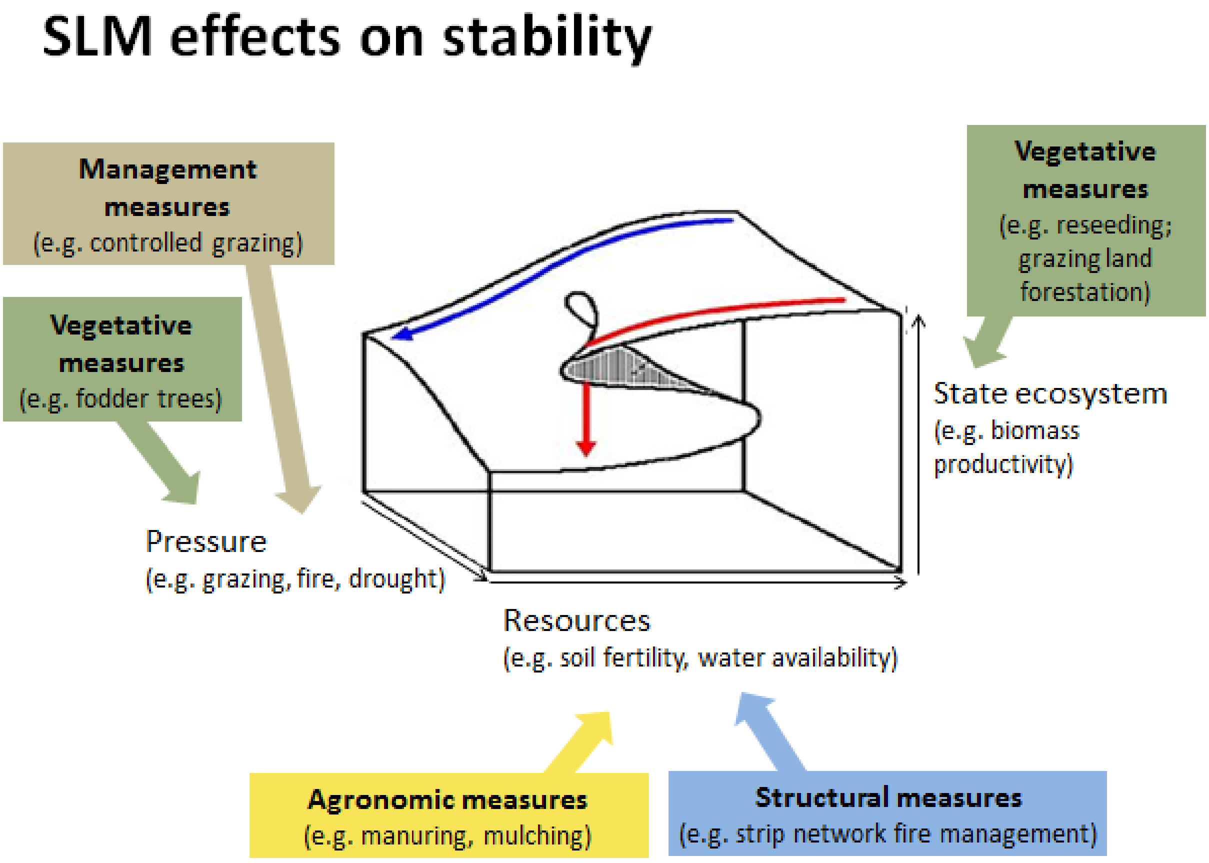
Modeling grazing, fire and aridity in drylands (*Kéfi et al.,* Work Package 6)

The models that have been developed in CASCADE can be used for a variety of purposes. In particular they can be used to run simulations of changing conditions or pressures. For example, a model may indicate how the vegetation biomass might decrease with increased aridity. The models can be used to explain changes or potential tipping points with stakeholders, and for teaching, and can be accessed at https://github.com/cascade-wp6 See also the Early Warning Signals Toolbox at http://www.early-warning-signals.org/

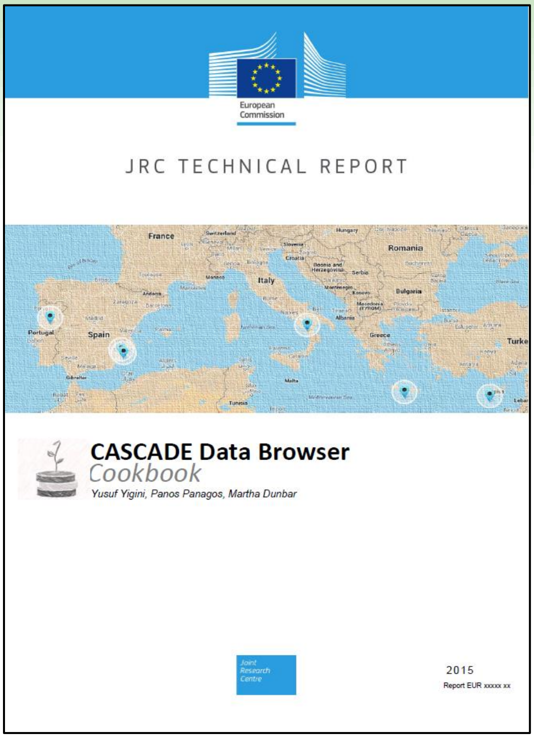
Modeling sustainable land management scenarios (*Fleskens et al.,* Work Package 8)

In order to provide policy recommendations for preventive and restorative dryland management, the following tasks will be completed in 2016/17.

1. Inventory of stakeholders' adaptation strategies to regime shifts in study sites
2. Developing a point-based integrated model to assess preferable timing of measures
3. Integrated regional modelling of SLM strategies
4. Multi-scale evaluation of scenario analyses with policy makers and land managers



Measures that affect the stability of sustainable land management technologies (Fleskens et al.)



The CASCADE database (*Yigini et al.)*

Data compilation and sharing is essential to optimise the integration of different strands of research, and provide a lasting legacy for potential use in future research. At the EC's Joint Research Centre in Ispra, Italy, a tailored design for a CASCADE data base has been prepared and documented in a "Cookbook" so that the data will become and remain easily accessible.

As CASCADE Deliverables are completed, they will be made available for download on the CASCADE website http://www.cascade-project.eu/index.php/downloads/project-deliverables and be described in the information system CASCADiS http://www.cascadis-project.eu/sudden-ecosystem-shifts

Read more about the general aims and work plan in the CASCADE flyer, (downloadable from http://www.cascade-project.eu/index.php/downloads/category/1-public-documents in 5 languages)

Compiled and edited by Nichola Geeson, June 2016

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