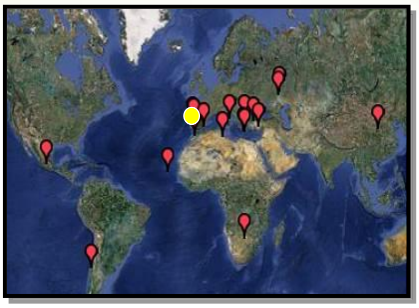
Mação study site, Portugal

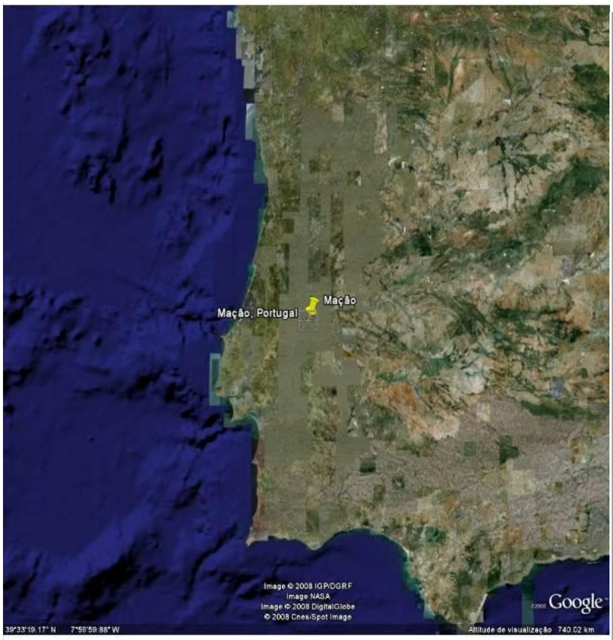
Highlights of work carried out in the DESIRE Project
Based on work by the University of Aveiro, Portugal

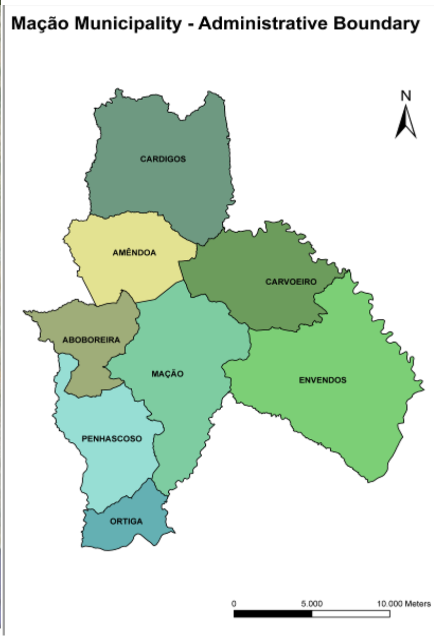


The study site

Mação lies in a transition zone between the Atlantic and the Mediterranean climate types, and is located on the northern bank of the lower Tejo River, central Portugal.

- Coordinates of central point: Latitude: 39°33’19.17’’N; Longitude: 7°59’59.88’’W
- Size: 400 km²; Altitude: 28 – 640m
- Precipitation: <600 – 1000 mm (South to North transect)
- Main degradation processes: drought, compounded by catastrophic forest fires
- Major drivers of degradation: depopulation and ageing population, land abandonment, monocultural forestry, inadequate laws and lack of enforcement, financial constraints
- Land use: Agro-silvo-pasture systems in the middle 20th /at the present forestry of *Pinus pinaster* and*Eucalyptus globulus* and shrubland arable land, unproductive land and settlements. Soils very shallow and stony, - Humic cambisols, on schists and metamorphic rocks. Step slopes (> 20º)
- Inhabitants: 7,419 (2006) 6919 inhabitants and 17.7 inhabitants/km^2 (2009)
- Huge investments in fire fighting equipment and measures



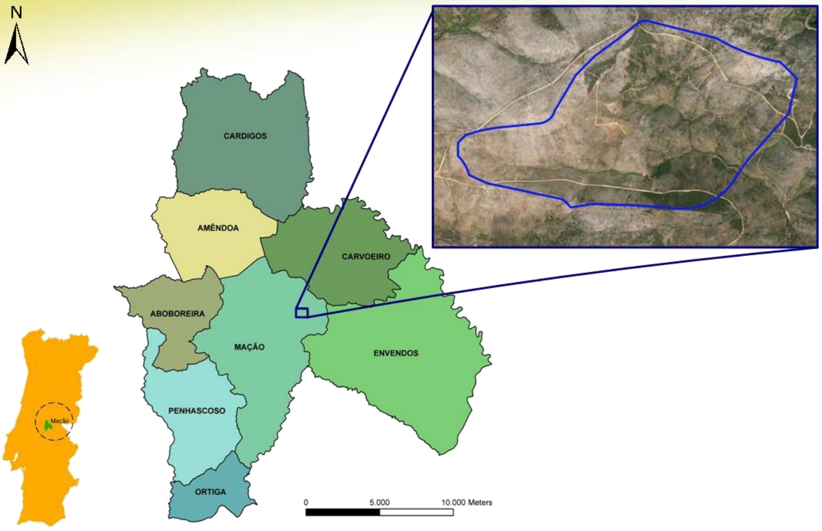


Location of Macao study site in Portugal

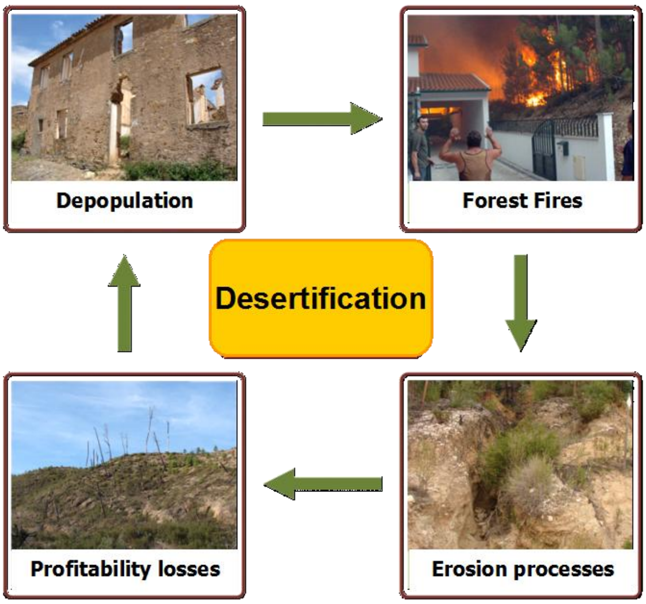
Mação has undergone severe drought periods during the past decade, made worse by catastrophic forest fires that destroyed most of the forest area and led to severe degradation of vegetation and soil. The population is predominantly elderly, and younger people move away from the area, since it is difficult to earn a living. The DESIRE framework has been used to investigate the degradation processes and assess the efficiency of measures to avoid fire damage and reverse those degradation processes.

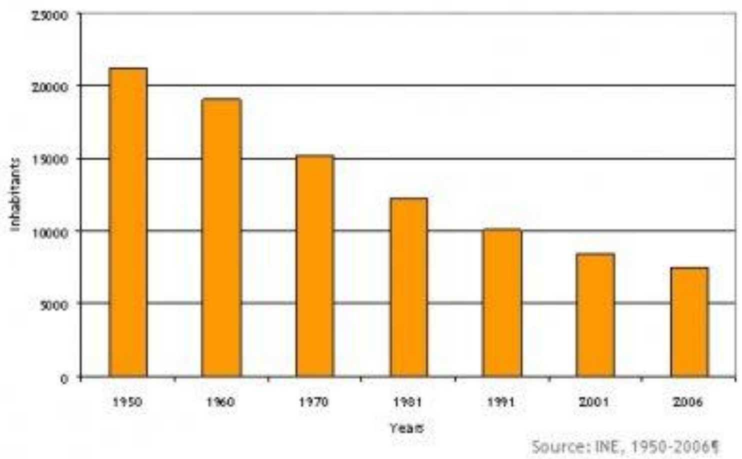
Sustainability goals	
Goal 1	Conservation of biological diversity;
Goal 2	Maintenance of productive capacity of forest ecosystem;
Goal 3	Maintenance of forest ecosystem health and vitality;
Goal 4	Conservation and maintenance of soil and water resources;
Goal 5	Maintenance of forest contribution to global carbon cycles and climate change mitigation;
Goal 6	Maintenance and enhancement of long-term multiple social and economic benefits;
Goal 7	Streamlining and simplification of policy and legal instruments;
Goal 8	Provide agricultural lands to balance opportunities with the protection of ecological systems;

Sustainability goals focus on what can be done to improve sustainable land management



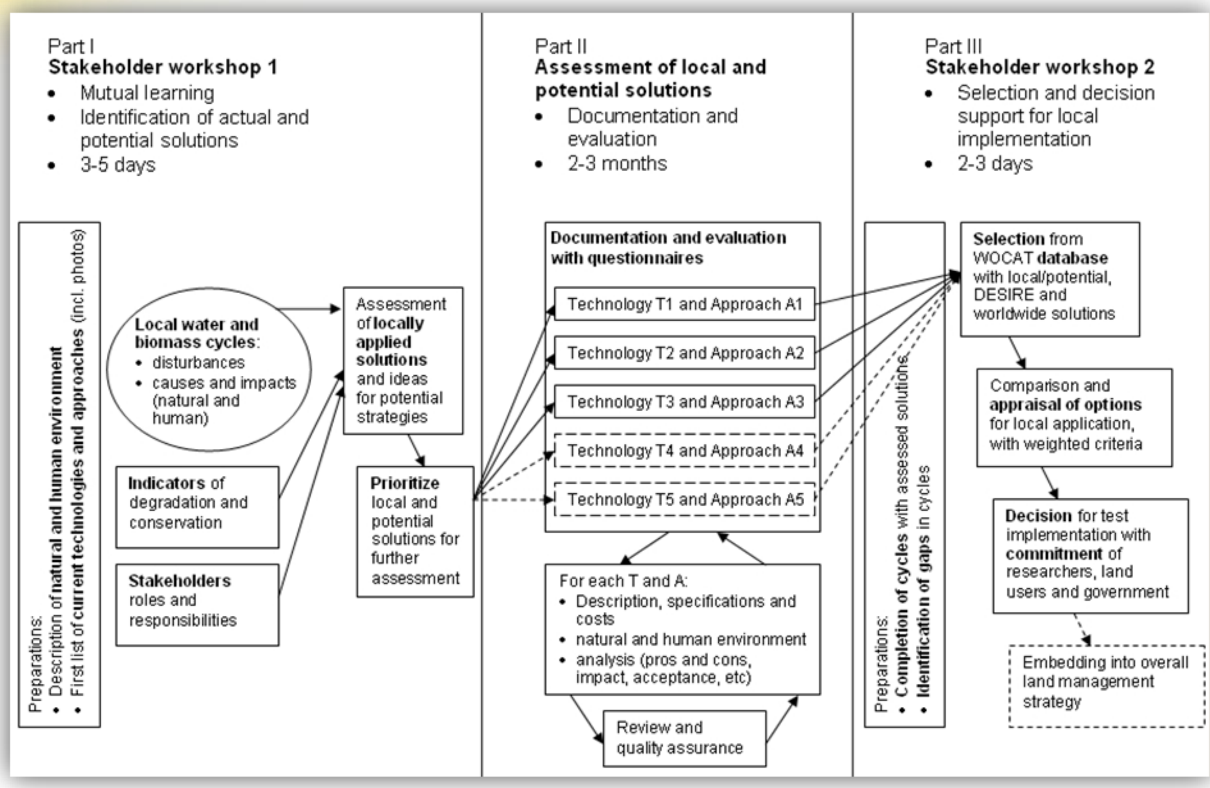
Detail of study site





Decrease in population since 1950

Workshops for researchers and stakeholders to select sustainable land management technologies



Researchers talked with local people and policy makers, and together they decided on the best options for sustainable land use. In the DESIRE Project the three Parts to WOCAT methodology were developed as outlined above. This provides decision support for choosing technologies suited to the local environment that includes social, cultural and economic factors as well as physical science.

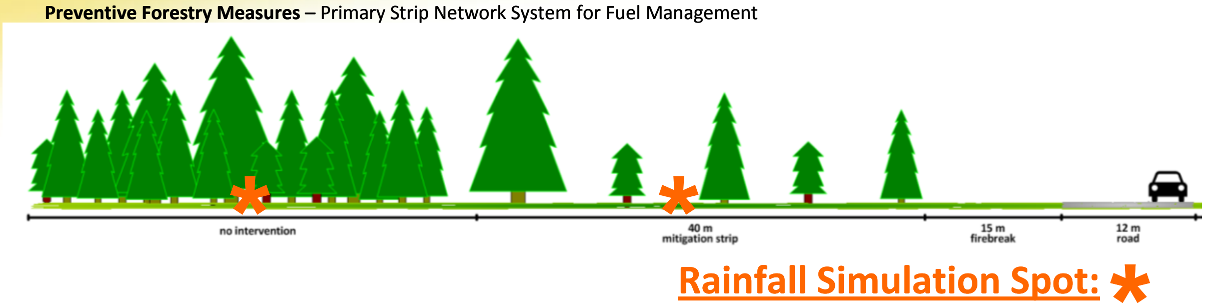
In every DESIRE study site researchers and stakeholders held two workshops to arrive at their selection of approaches and technologies. At the first workshop stakeholders learned about how degradation happens, and how to avoid it.

Meetings of researchers with stakeholders were used to help break the cycle of desertification. Together they discussed and tried out suggestions to find the best ways of reducing the incidence and impact of forest fires while addressing goals for sustainability. If forest fires become less of a problem and do less damage, then 1)erosion will be decreased, 2)it will be easier to make a living off the land, and 3)land users will be less likely to abandon their farms and look for more reliable employment prospects in the towns.

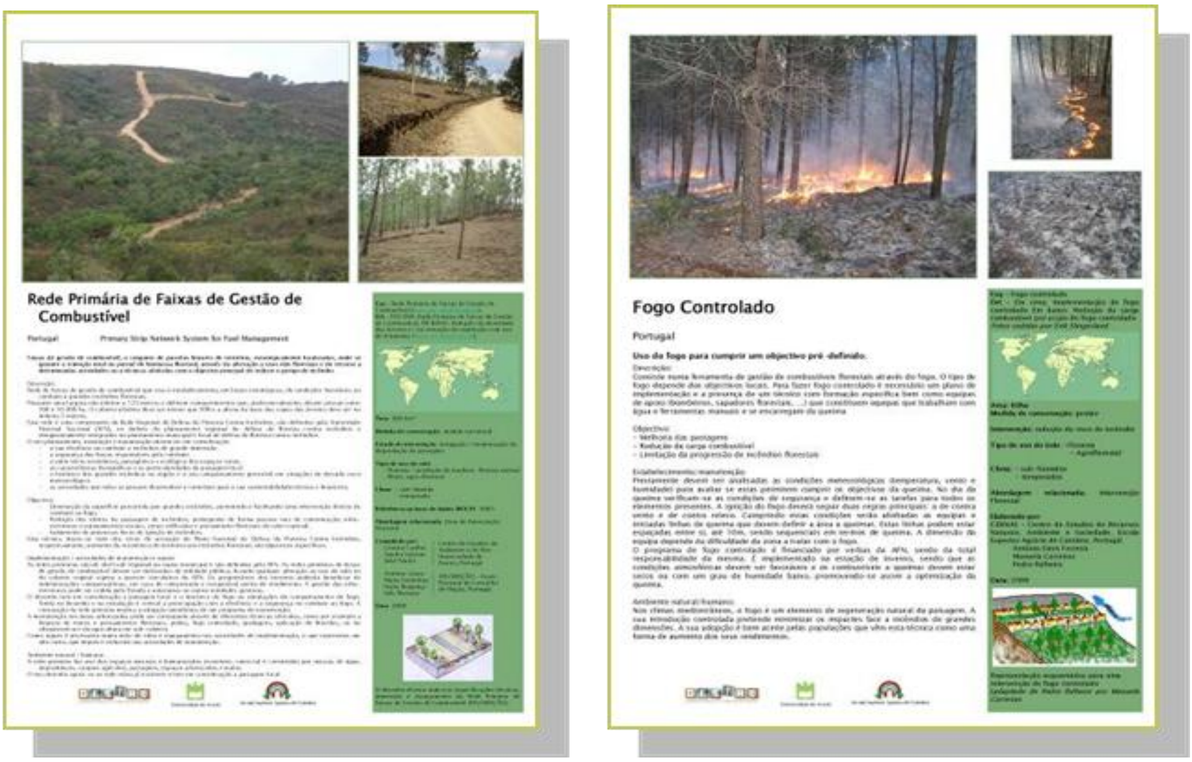
Technologies to improve sustainable land management

Preventive forestry and Primary Strip Network System for Fuel Management (PSNSFM)

Preventive Forestry is a set of measures applied to forest stands, shrubs and other local species to protect forest against fires. These measures deal with composition of the forest stands, structure and location, aiming to reduce fire risk and to increase vegetation resilience to fire. Preventive Forestry measures represent an important instrument against forest fires, but the removal of vegetation tends to expose bare soil to the erosive effects of rainfall. Rainfall simulations were used to assess erosive processes, such as runoff and sediment loss.

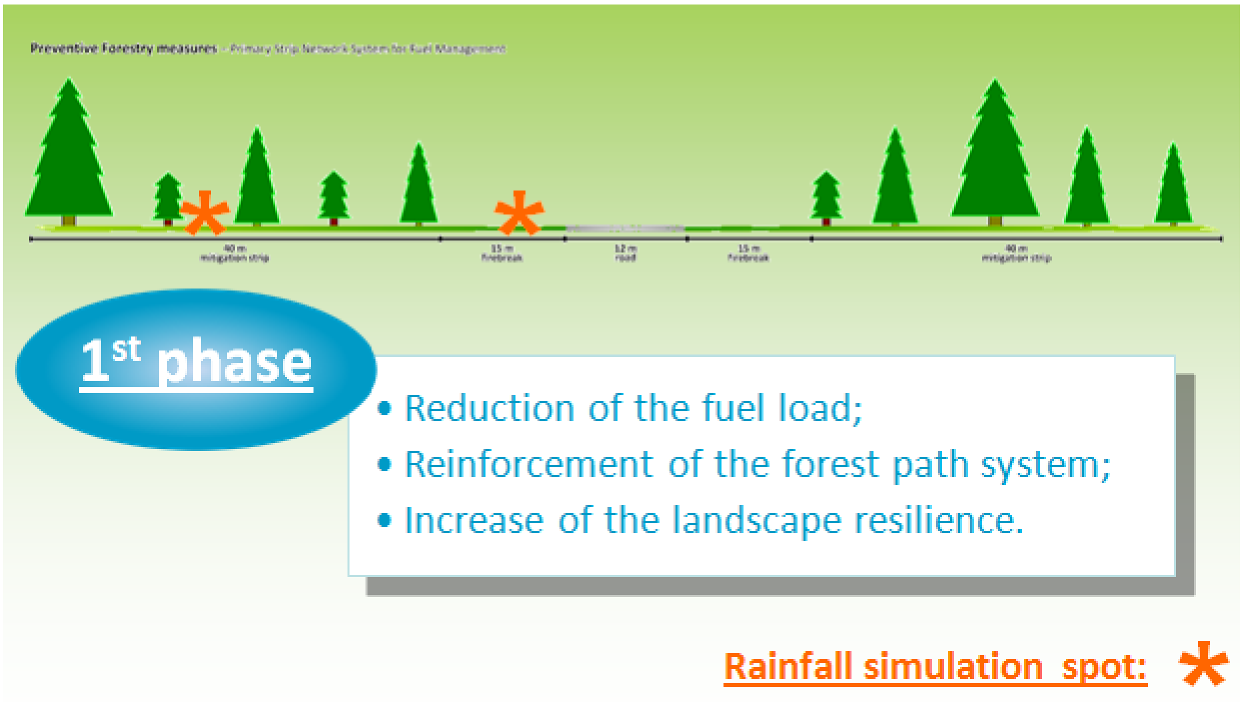


Rainfall simulation spots

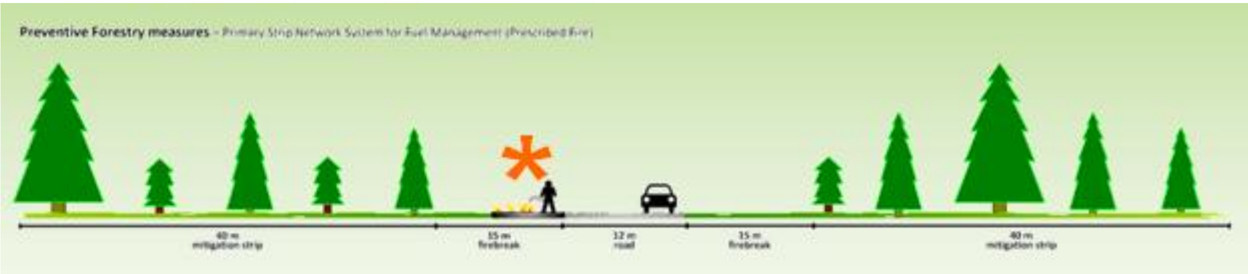


Primary Strip Network System for Fuel Management, Prescribed Fire

The implementation of the Primary Strip Network System for Fuel Management is currently being developed by the Municipal Civil Protection of Mação.



During the monitoring phase the firebreak on the Primary Strip Network System for Fuel Management can also be done using Prescribed Fire.



Results of research carried out in the field site

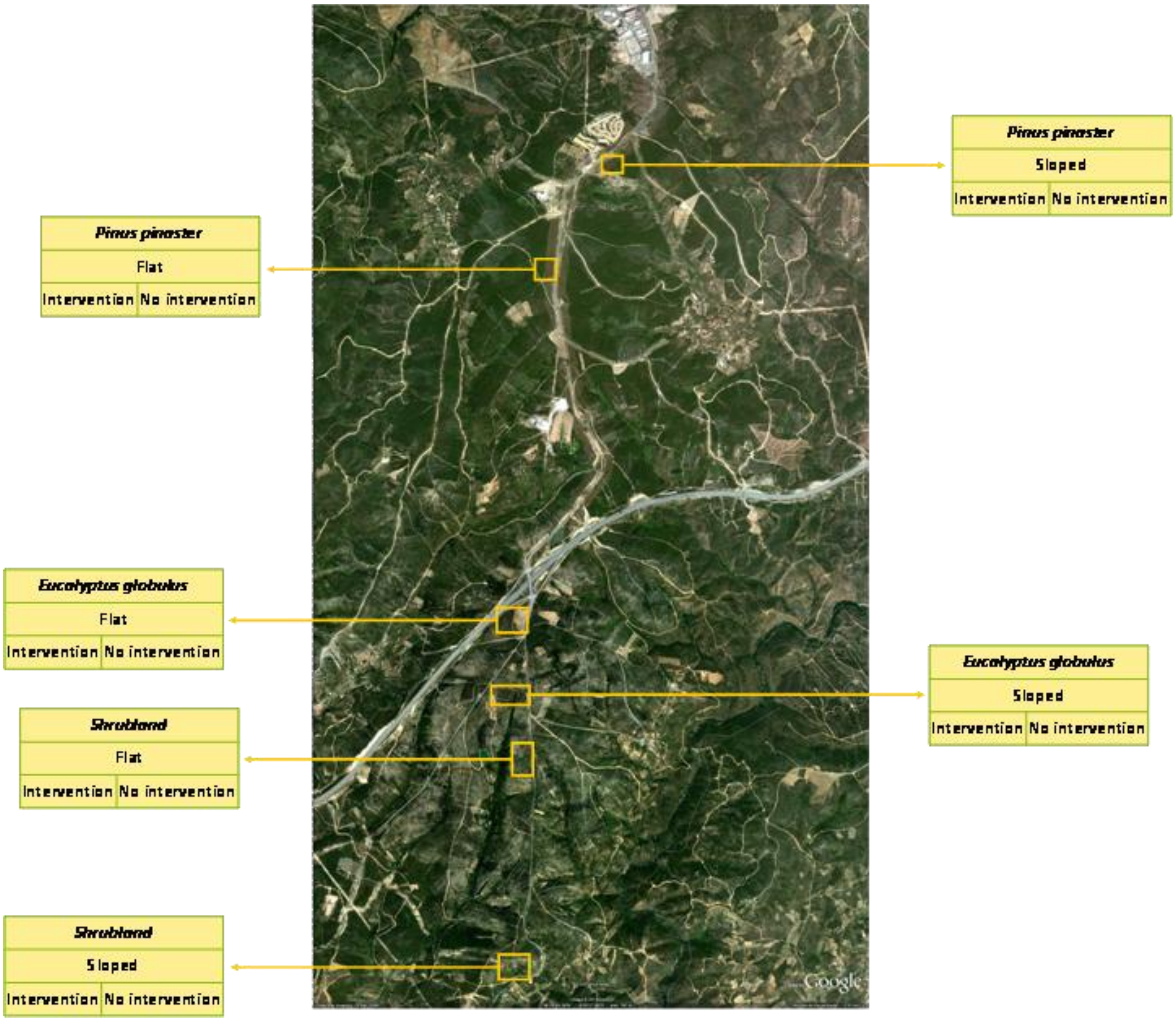
Monitoring in the Caratão catchment:

Monitoring equipment:

- small flume;
- water level recorders;
- meteorological station;
- rainfall gauge network.

The Mação Region suffered massive fires in 2003 and 2005, and by 2011 more than 70% of the municipality had been burnt. Natural degradation and regeneration, together with mitigation techniques were assessed at this location. A large part was burned recently and gave way to regeneration stands and shrubs, where the regeneration failed.

Description of the setup of the experimental trials with description of instrumentation if applicable:
For the rainfall simulation experiments, a Sprinkler Rainfall Simulator developed by Cerdá *et al.* (1997) was used. The rain was produced at an intensity of 45 mm/h (local extreme event type). Run off was measured from a 0.26 m^2 plot in the centre of the target area. A rainfall simulation event was carried out in the dry season and also at the end of the wet season.



Location of plots

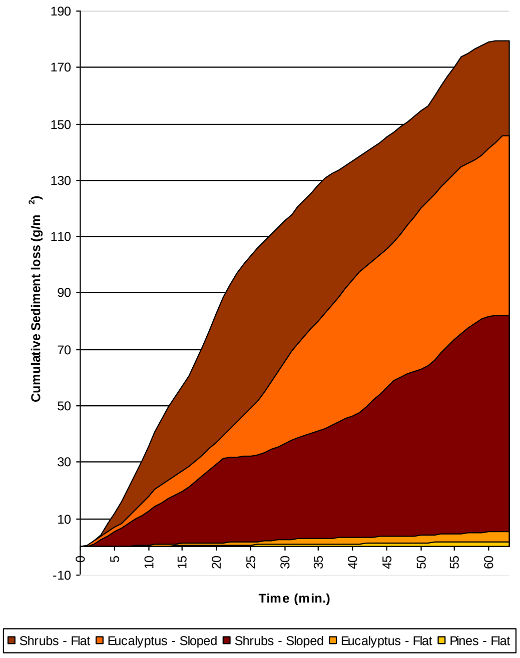
Pinus pinaster				Eucalyptus globulus				Shrubland			
Mitigation strip		No intervention		Mitigation strip		No intervention		Mitigation strip		No intervention	
Sloped	Flat	Sloped	Flat	Sloped	Flat	Sloped	Flat	Sloped	Flat	Sloped	Flat
3 replicates	3 replicates	3 replicates	3 replicates	3 replicates	3 replicates	3 replicates	3 replicates	3 replicates	3 replicates	3 replicates	3 replicates

Description of cover type, slope at rainfall simulations sites

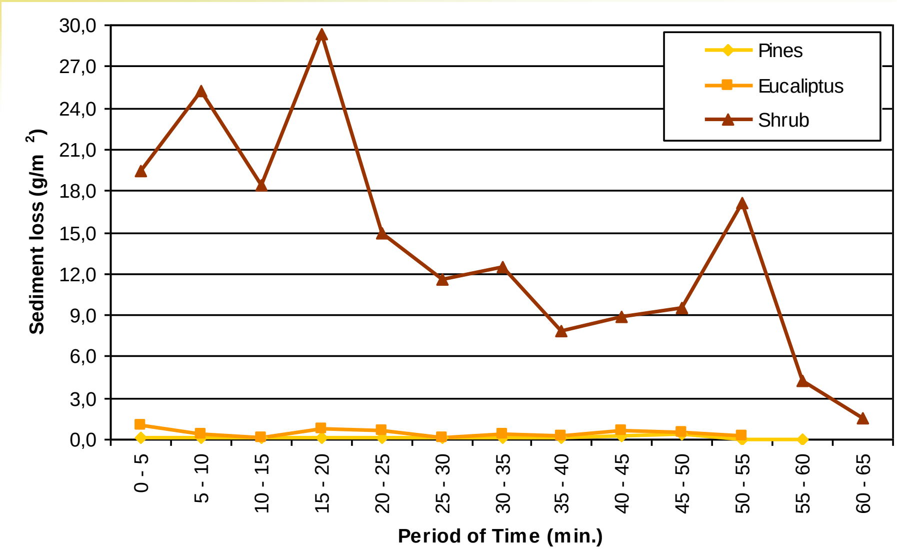
Bio-physical results

Dry_Season:

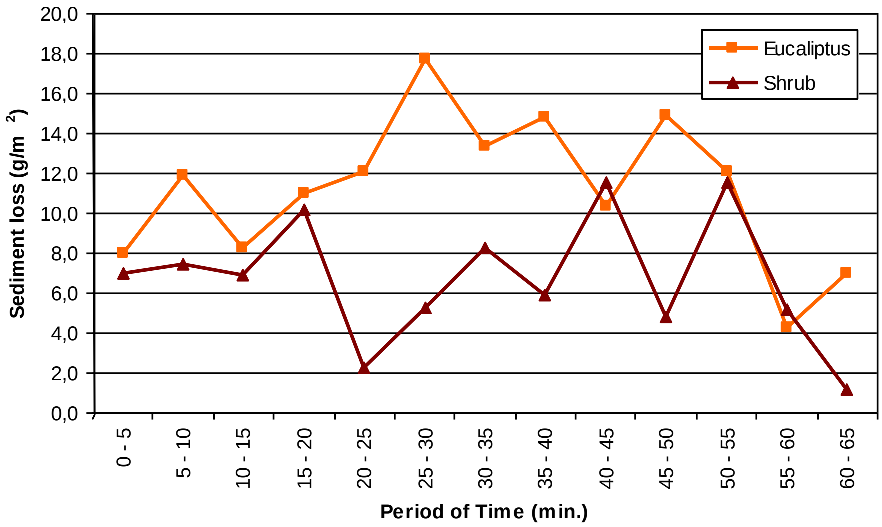
- Rainfall simulations in flat shrubland and sloped *Eucalyptus* sites resulted in the highest cumulative sediment losses; shrubland did not have vegetation cover and *Eucalyptus* is located on stony ground (>90%).
- Flat *Eucalyptus* and Pine sites led to insignificant soil losses.
- The influence of slope only had a significant impact in *Eucalyptus* sites.
- Sediment loss on flat shrubland was higher than on sloped shrubland.
- There was a small variation of sediment loss on flat Pine and *Eucalyptus* sites throughout rainfall simulations.
- Sediment loss on the flat shrubland site was higher in the first 20 min but decreased significantly until the end of the simulations; the presence of high peaks may be explained by water accumulation in the micro relief.



Mitigation Strips Area – Cumulative Sediment Loss



Mitigation Strips Area – Sediment Loss in Flat Sites



Mitigation Strips Area – Sediment Loss in Sloped Sites

Simulation Plot (flat Shrubland)

Sprinkler Rainfall Simulator developed by Cerdà

Soil layers in pine site - no runoff occurred

The results:

- increase knowledge among researchers and local stakeholders about the effects of the mitigation strips technology on soil erosion and/or conservation.
- promote future opportunities for dissemination and further developments about the suitability of this technology.
- show that due to high implementation and maintenance costs, this technology requires full support from public entities (as well as specific technology capacity).

Involvement of stakeholders

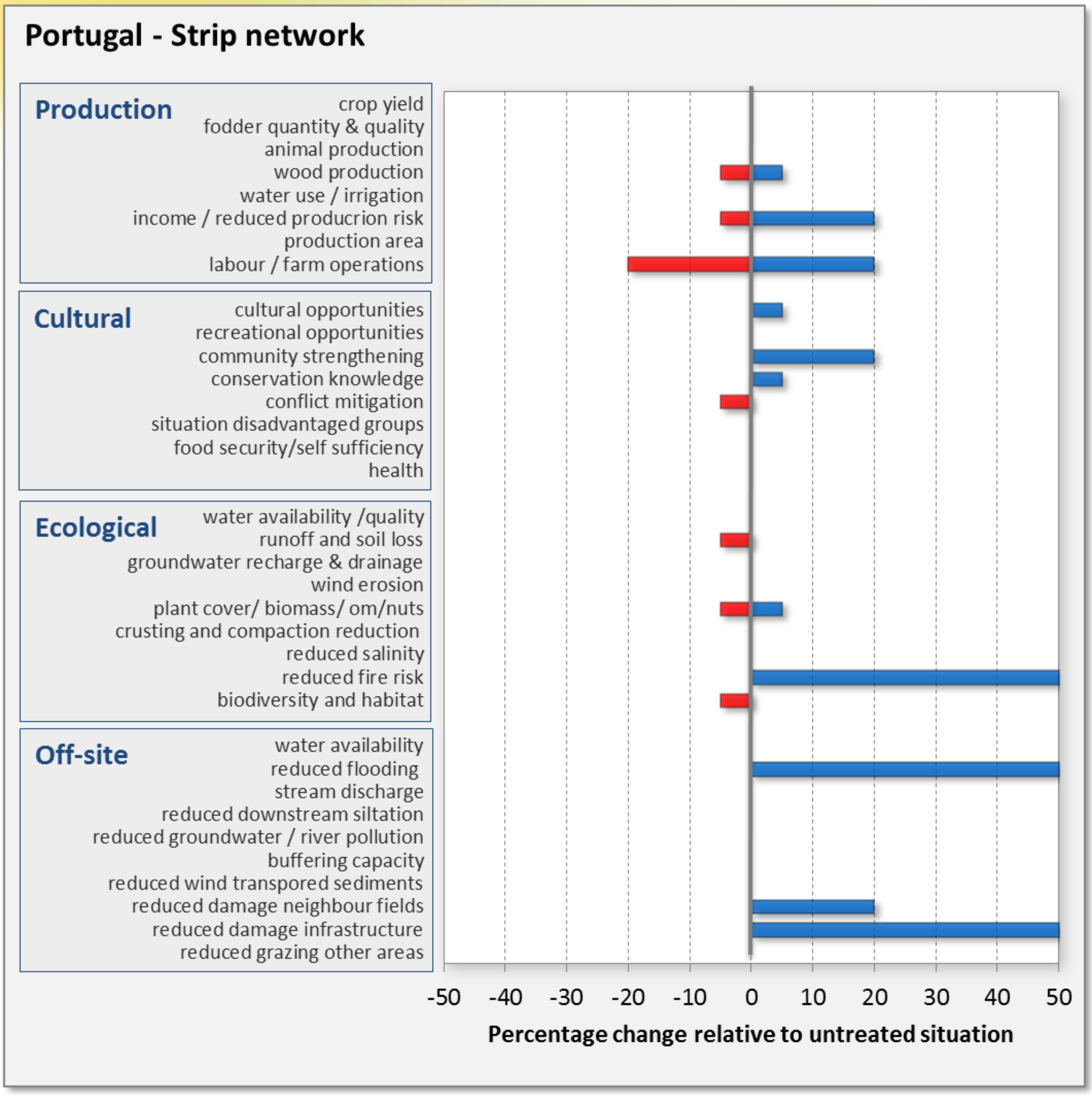
Field work was carried out in close collaboration between researchers of University of Aveiro and local technicians from GTF (Forestry Technical Office of the Municipality of Mação) and Aflomação (Forestry Association of Mação) – selection and assessment of field-test areas.

Eng.º António Louro (Vice-President of Mação Municipality) said: "What happened here was the consequence of a large number of forest fires. It was related to a new landscape that we created during the last century which resulted in the death of agriculture and invasion by forest. This landscape, together with the climate conditions typical for this region was completely unsustainable. It ended in an enormous tragedy and huge waste of resources. The tragedy is related to the loss of income and livelihood of the local population which in the last decades was the forest. And along with that loss we are now losing the population. DESIRE creates a strong link between the academic world and local reality. For us that's very good because it brings knowledge from the academic world straight to the field."

Stakeholders & scientists involvement: selection and assessment of field-test areas

Evaluation

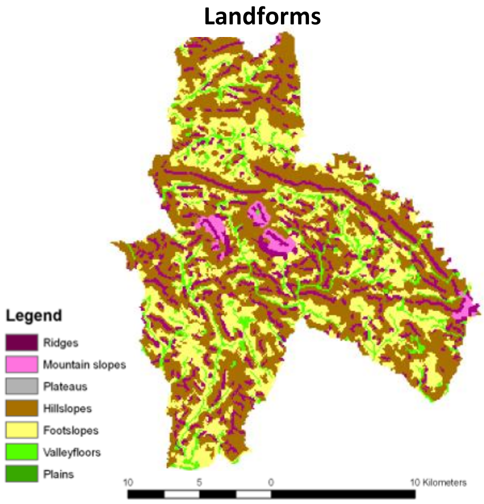
The results are evaluated from a production, socio-cultural and economic point of view. The bars express the estimated or measured percentage of change with respect to the reference situation. This change can be positive (blue) or negative (red). Note that this evaluation is based on the experiments, on the long term experience of the coordinating team in this area and on consultations with the farmers.



Conclusions from scenario modelling

PESERA model baseline run

Two baseline indicators were calculated, the fire severity index as a measure of fire susceptibility and biomass production as a measure of fuel load. The main influencing variable controlling both indicators is land use. Output shown is limited to forest areas as these are the areas where fire ignitions occur. The fire severity index is very high in 90% of the study area. Three-quarters of the forest area contains more than 20 tons of biomass per ha, followed by ca. 20% having between 15-20 ton per ha.



The baseline simulation shows a very high fire susceptibility in over 90% of the area. Biomass production is more than 15 ton/ha in 95% of the area (corresponding to *Pinus pinaster* and *Eucalyptus globulus* forests).

The primary strip network system for fuel management (PSNSFM) was prioritised by scientists and local stakeholders to control wildfires. Whereas this preventive forestry measure represents an important instrument against forest fires, the removal of vegetation tends to expose bare soil to the erosive effects of rainfall. In field experiments, rainfall simulations were used to assess erosive processes, such as runoff and sediment loss.

Modelling of the PSNSFM showed that on average 958 ha of land (under various land uses, but mostly forest) can be protected from burning annually. Over a decade, this is 9578 ha. This is realised by implementing a strip network of 1287 ha. Experimental findings can help optimize management of the strips to minimize soil erosion, but it is clear that the vast area saved from burning also avoids the increased soil erosion problems following wildfires. Economic evaluation of the technology with the model was very positive.

In the workshop to evaluate monitoring and modelling results, stakeholders confirmed their preference for the PSNSFM (and prescribed fires), evaluating it slightly higher than in the second workshop – perhaps because of increased knowledge derived from pilot implementation of the technology. In order to promote the technology, recommended actions in four domains (regulation, awareness, forest intervention areas, and funding) were agreed by the participants.

A policy scenario excluding the 2003 forest fire damage from the cost-benefit analysis resulted in slightly negative net present value. However, fire extinguishing and replanting costs were not considered and could tip the balance. Also, establishing and maintaining the PSNSFM for a period longer than 10 years could make it economically viable even if the structure could not prevent catastrophic wildfires from occuring.

The global scenario for food production shows that although the technology is not primarily intented to product cropland (which is a limited land use in the area), its impact in avoiding the burning of crops is noticeable. For simplicity the analysis assumes that all fires would affect crops in the field (i.e. occur before harvesting). The investment costs to protect crop production are, when attributed equally to all areas where burning would have been avoided, low at €39/ton grain.

The analyses show that investing in a strip network is viable. As the model analyses were performed for a single strip network system, it is not necessarily the best lay-out or may not have the most economic strip density. Results obtained were based on several assumptions and based on an analysis of areas burned in the period 2001-2009. While the long-term average area burned could deviate from the observed burned areas in this period, it is under future climate change likely that wildfires will increase rather than decrease, in which case the impacts of implementing strip networks can be even more important. Results from experimental research should be taken into account to reduce erosion risk in strips, and could also help devise management strategies for burned areas (which to some extent will always be unavoidable).

Final conclusions on the success of chosen technologies

Forest fire prevention using strip network is a useful technique but it can cause increased runoff and soil losses since the area along the strips will be bare and exposed to erosive rain. Villagers were very interested in the technique and will attempt to maintain the strips themselves. Currently the main infrastructure is protected but not the side roads. Possibly the stripnet work will extend to those as well. Where trees are cut at the strip there is a risk of erosion. Sediment loss from the strip area depends on tree species and terrain slope gradient. The erosion risk appears to be relatively low.

Due to the testing activities, the erosion risk is now better integrated into the strip construction.

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➜ This project has been funded by the European Commission DG Research-Environment Programme
Unit of Management of Natural Resources
Head of Unit *Pierre Mathy*, Project officer *Maria Yeroyanni*

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See: http://www.desire-his.eu/en/macao-portugal for full details of DESIRE research