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

CASCADE REPORT series

Report on multi-scale evaluation with policy makers

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University of Leeds

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Catastropic shifts in drylands

Deliverable 8.3

Report on multi-scale evaluation of CASCADE's management principles and grazing model scenarios with stakeholders and policy makers

WP8

Cecilia De Ita, Lindsay C. Stringer,

Luuk Fleskens, Diana Sietz (2017) with input from study sites

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SUMMARY

Land conservation and natural resource management are currently at the forefront of sustainability challenges, particularly due to environmental threats and climate change. Regions like the Mediterranean are particularly vulnerable due to their complex socio-environmental dynamics, which are under pressure from soil erosion, desertification, land abandonment, overgrazing and forest fires.

CASCADE's research has yielded a number of outcomes, including a thorough insight into the physio-environmental ecology of the European Mediterranean Drylands, and a series of tools and measures to improve land management. Stakeholders' resilience and adaptation were also explored in Deliverable 8.1, which presented stakeholders' perceptions of current ecosystem changes and potential opportunities to respond to changes.

The present report evaluates stakeholders' views of the land management measures generated by CASCADE and tailored to each study site, using a participatory multi-scale evaluation process. Assessment followed a participatory approach to capture the wide range of perceptions and views involved in the management of complex socio-environmental landscapes. Six stakeholder workshops were carried out across project study sites. Local stakeholders in each site discussed their perceptions about the land management principles developed by CASCADE, as well as the barriers and opportunities to implement them in the current socio-economic, environmental and policy context. Study sites were differentiated according to the main degradation issues: Overgrazing (Crete, Cyprus and Italy), land abandonment (Spain and Italy), forest fire (Spain and Italy, Portugal). In the grazing sites, Crete and Cyprus, stakeholders also evaluated the scenarios and model outputs that were developed under tasks 8.2 to 8.5.

Stakeholders across all sites agreed with most of CASCADE's management principles, but their perceptions about how challenging or feasible these were to implement diverged for each context. It was found that in grazing areas stakeholders agreed with most of the principles, but mentioned that a number of economic subsidies and incentives were needed for future implementation. In the forest fire context, stakeholders agreed with the effectiveness of the principles, but discussed the socio-economic barriers of implementation and the potential ways to overcome them. In the land abandonment context, the approach to designing principles was discussed. As land abandonment was perceived as a cross-cutting/overarching issue product of a complex socio-environmental dynamic, the feasibility and applicability of the management principles were discussed within the generalities of the perceived socio-economic context of the stakeholders, rather than focusing on the environmental effectiveness or use of the principles. Additional forest fire and post forest fire management principles and recommendations for land management were identified by stakeholders in Italy and Portugal, during the workshop discussions.

To explore CASCADE principles and research input in national and international land management agendas a policy forum was convened involving international, national and selected local stakeholders from the study sites. The policy forum was held in Matera, Italy in February 2017, and included presentations from CASCADE researchers about the project's findings on land abandonment, forest fires and grazing research, presentations by policy makers about relevant policies at EU and international level, and a roundtable discussion on research, policy making and

sustainable land management at the study sites. Overall, the focus on applied research based on solving problems of societal concern, was considered one of CASCADE's strengths by participants. Policy makers also highlighted the importance of the outreach, engagement and dissemination work-packages (WP7, WP8 and WP9). They noted that links to policy and application allowed the project to go beyond the traditional basic science approach and provided the chance to feed into changes that could benefit policy and society. The dialogue also allowed land managers to communicate with policy makers, so they could reflect that the requirements of SLM go beyond direct land management measures. The workshop was overall felt to provide a valuable space for learning and sharing ideas between different stakeholders groups from across the study sites.

1 INTRODUCTION

Due to the complex nature of soil conservation and the multiscale nature of Sustainable Land Management (SLM), research and management approaches need to include the pertinent stakeholders and policy makers (Reed, 2008). Holistic approaches to preserve and manage socio-environmental systems (including those which involve stakeholders) are generally more successful at avoiding land degradation in the future (Acevedo, 2011). However, considering social issues during environmental research and environmental management planning is not enough. Core beliefs and human behaviour, especially behaviours imbedded in group-traditions, can be difficult to modify (Sotirov et al., 2016, Stringer et al., 2014), and as perceptions and values are subjected to cognitive biases, decision making can be belief-driven if goals and institutional efforts do not attend to barriers to change.

Participatory approaches have the potential to engage stakeholders and gather society's support for particular interventions, thus reaching common goals and shared values. Participatory processes can also aid the operationalisation of SLM by delivering a more accurate and contextual assessment of local challenges and drivers of environmental degradation and social issues (Tarrasón et al., 2016), situating scientific assessments within the necessary livelihood contexts. As such, they can provide tailored information able to propel change, and present an opportunity for managing and dealing with the uncertainties and conflicts of socio-environmental systems (Swart et al., 2004). Community participation can also promote communication, cooperation and increase social capital (Stone and Nyaupane, 2014), increasing understanding and leading to shared goals, by building trust and advancing knowledge (de Vente et al., 2016). However, there are a number of reasons why participatory approaches may not be as effective as expected, for example when stakeholder representation is suboptimal, power imbalances exist between stakeholders, and when there are intrinsic issues with the participation and implementation process design (de Vente et al., 2016).

A set of general principles were produced in CASCADE's WP7 in order to inform SLM in contexts experiencing forest fires, grazing and land abandonment. These principles were further translated and relevant principles were selected for each of the six CASCADE study sites. To test the response of stakeholders and policy makers to CASCADE's recommendations in this regard, and to inquire how feasible they consider them to be to apply, the principles and relevant policies were presented and discussed with local stakeholders during a workshop carried out in each study site (total n=6 as although two Spain sites were dealt with together, Cyprus held two workshops involving different stakeholders within each).

To research the effects of potential management decisions for grazing areas, a modelling approach for assessing different management scenarios was developed during Task 8.2 (see Deliverable 8.2 for the modelling process). The scenarios used in the modelling approach represent opportunistic and conservational management considerations directly affecting grazing areas. The scenarios, as with other foresight methods, integrate possible decisions based on observed ecosystem behaviour and environmental conditions that can facilitate the assessment of the future and wider implications of using different strategies, and the identification of policies and strategies that can support particular SLM decisions (Turner et al., 2016). Foresight methodologies have also been considered as relevant

tools to increase stakeholder participation and facilitate decision making as they can help advance knowledge creation and the dissemination of scientific research.

Through the combination of stakeholder engagement and scenario analysis in a participatory framework, we aimed to further test the management principles that were developed in WP7 and discuss the findings derived from the scenario analyses carried out in Task 8.2. The material reported here concludes the iterative process of participatory research, in which CASCADE aimed to assess the local context of the study sites, while testing some of the knowledge produced throughout its duration.

This deliverable first summarises the results from the scenario analysis carried out in Task 8.2. Section 3 presents the methods and results of the workshops with the study site stakeholders, followed by Section 4 which presents the methods and results of the multi-level policy forum held in Italy. It concludes with a general discussion and conclusions of the stakeholder workshops and policy forum.

2 IMPROVING SLM USING LAND MANAGEMENT SCENARIO ANALYSIS

2.1 Modelling approach

Using the modelling strategy outlined in D8.2 (for a summary see Fig. 1), we assessed the socio-ecological effectiveness of selected management scenarios considering non-linear ecosystem dynamics and windows of opportunities and risks (Sietz et al., 2017). These management scenarios capture key management recommendations from WP7 which are mainly based on aspects perceived by stakeholders. We modelled ecological and economic implications of these recommendations as a basis for stakeholder evaluation in Cyprus and Crete. The evaluation particularly revealed insights into the realism of modelled vegetation trends and cash flow series differentiating the usefulness of management principles according to particular study site conditions and stakeholders' perceptions and expectations.

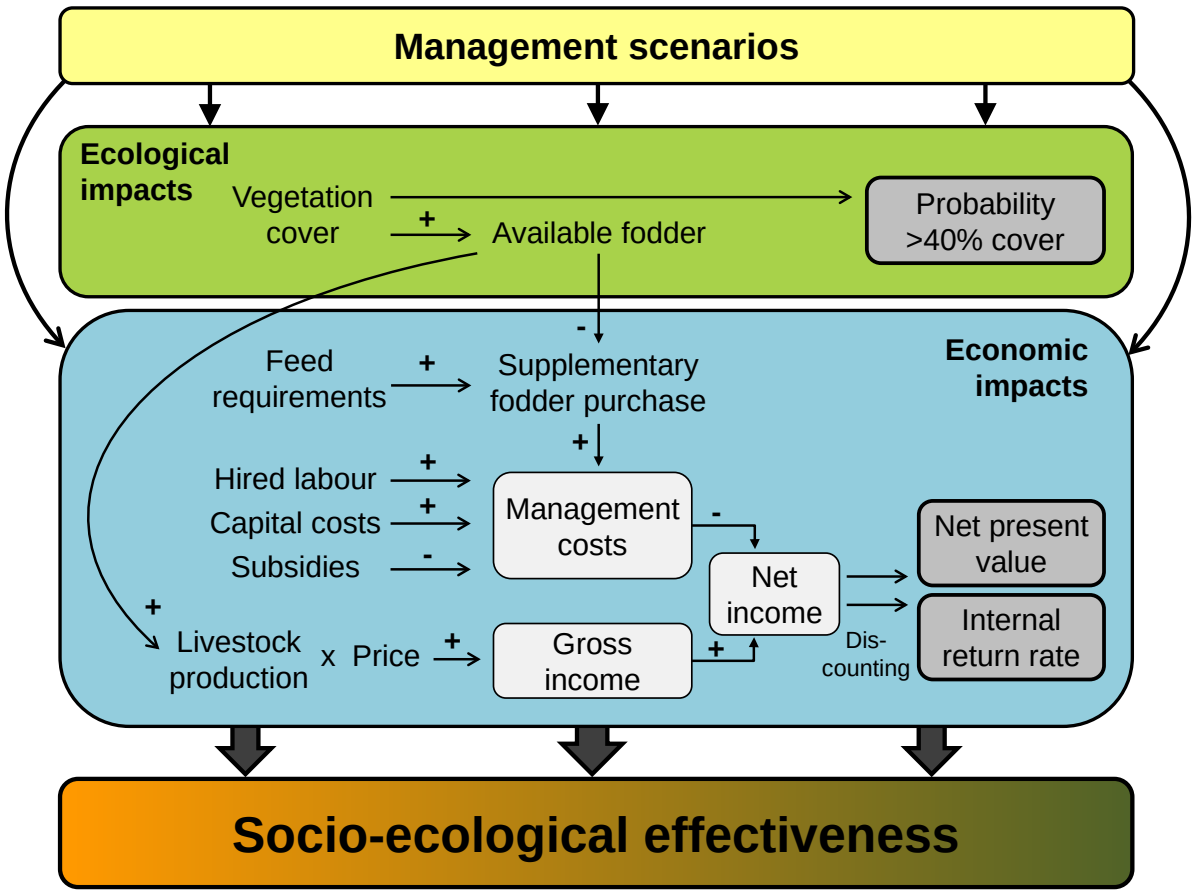

Figure 1. Overview of the socio-ecological modelling approach developed in Task 8.2. (Note: +/- indicated next to arrows symbolise positive and negative effects).

The management scenarios represent adaptive management strategies including opportunistic and conservational grazing management in combination with a varying degree of environmental and economic risk aversion (Table 1, see D8.2). Among these, the baseline scenario depicts a commonly used opportunistic management strategy and least risk aversion. Scenarios S1 and S2 also represent opportunistic management approaches but with higher risk aversion, while scenario S3 captures a conservation management practice, called `resting in wet years`, together with extreme risk aversion. The 'resting' implies that livestock density remains below the grazing capacity in wet years to support the recovery of vegetation allowing potentially higher stocking rates in the near future. Two starting conditions were chosen by the research team, i.e. degraded and restored sites (Table 1), providing a basis to discuss management impacts at various levels of initial vegetation cover. The impacts of scenarios S1-S3 are compared with the implications of the baseline scenario in order to provide an estimate of how far the ecological and economic impacts deviate from the common management situation. This allows us to discuss relative changes in vegetation dynamics and benefits derived from livestock production.

Table 1 Scenarios of adaptive land management. (Note: Start conditions at degraded site are 45% vegetation cover (both Cyprus and Crete) and at restored site 73% (Cyprus) and 52% (Crete)).

Management scenario		Description	Start conditions	
			Degraded sites	Restored Sites
Baseline scenario	Least risk aversion	If vegetation cover smaller 30% → reduce number of animals grazed on pasture to half	X	X
Scenario 1 (S1)	Intermediate risk aversion	If vegetation cover smaller 40% → reduce number of animals grazed on pasture to half	X	X
Scenario 2 (S2)	High risk aversion	If vegetation cover smaller 50% → reduce number of animals grazed on pasture to zero	X	X
Scenario 3 (S3)	Resting in wet years and extreme risk aversion	In wet years and if vegetation cover smaller 60% → reduce number of animals grazed on pasture to half	---	X

2.2 Model Results

Starting with a degraded rangeland, the model results show that S1 causes the vegetation cover to slightly increase compared with the baseline scenario in Cyprus and Crete (Fig. 2). This scenario results in a low probability of reaching >40% vegetation cover but only in the first year (Fig. 2). Vegetation cover remains below 40% in the remaining years. In contrast, S2 induces a more pronounced increase in vegetation cover and high probability of reaching >40% vegetation cover throughout the 10-year period (Fig. 2). Similar to S1, the modelled ecological effects of S2 are alike in Cyprus and Crete.

S1 results in economic gain (positive net income, though very low), while S2 depicts economic loss (negative net income) in both Cyprus and Crete (Fig. 3). Reflecting regional differences in economic costs and benefits of livestock production, S2 resulted in an economic loss of about 1600Euro/ha in Crete but only 25Euro/ha in Cyprus (see Net Present Value in Fig. 3). Regarding socio-ecological effectiveness (Fig. 4), these results indicate that even though S2 is more effective in ecological terms, this scenario is more costly due to the need for alternative fodder provision, and therefore likely to be less attractive to land users.

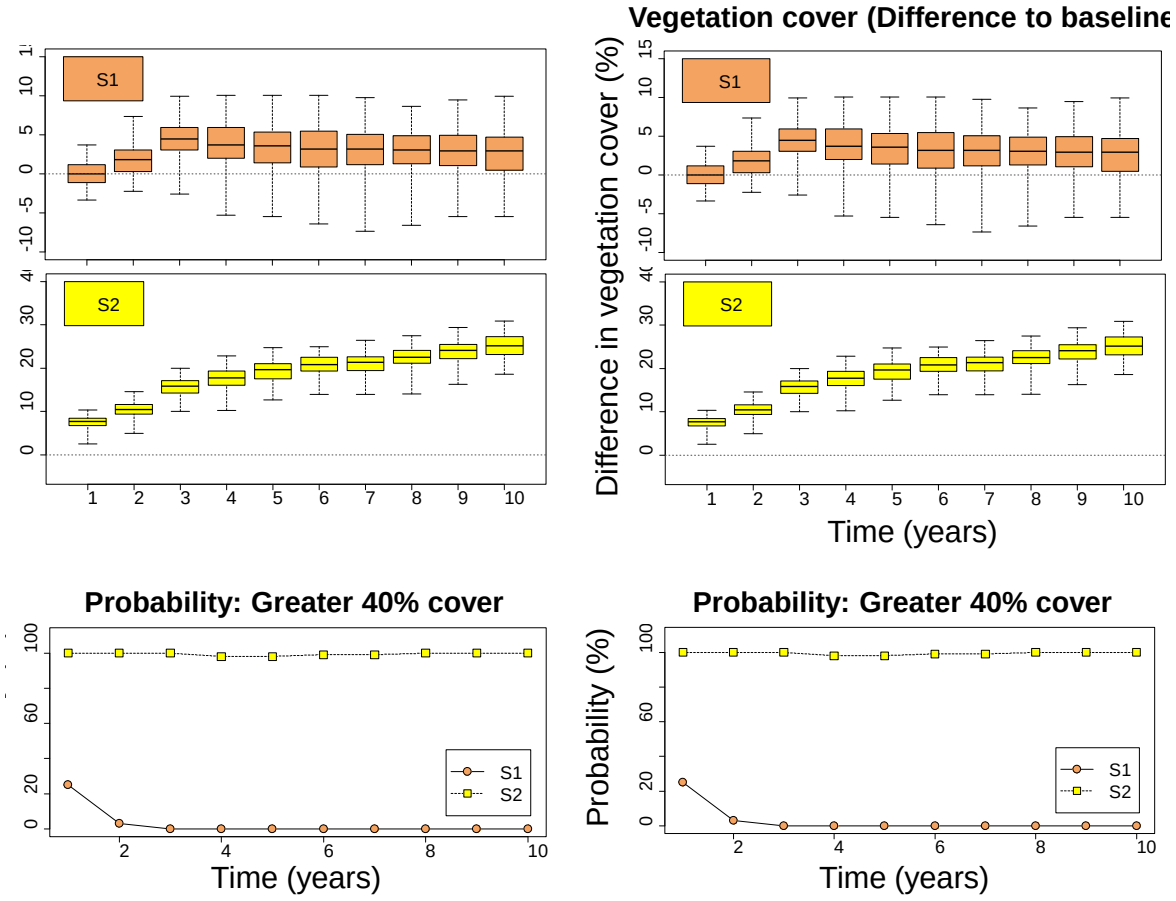

Figure 2 Vegetation cover dynamics and probability of reaching >40% vegetation cover according to scenarios S1 and S2 considering degraded starting conditions. (Note: A = Cyprus, B = Crete. Box boundaries denote the 25th and 75th percentiles of difference in vegetation cover. Whiskers indicate 5th and 95th percentiles. The line near the middle of a box depicts the median value. Colours indicate scenarios referring to the colour code used in Table 1).

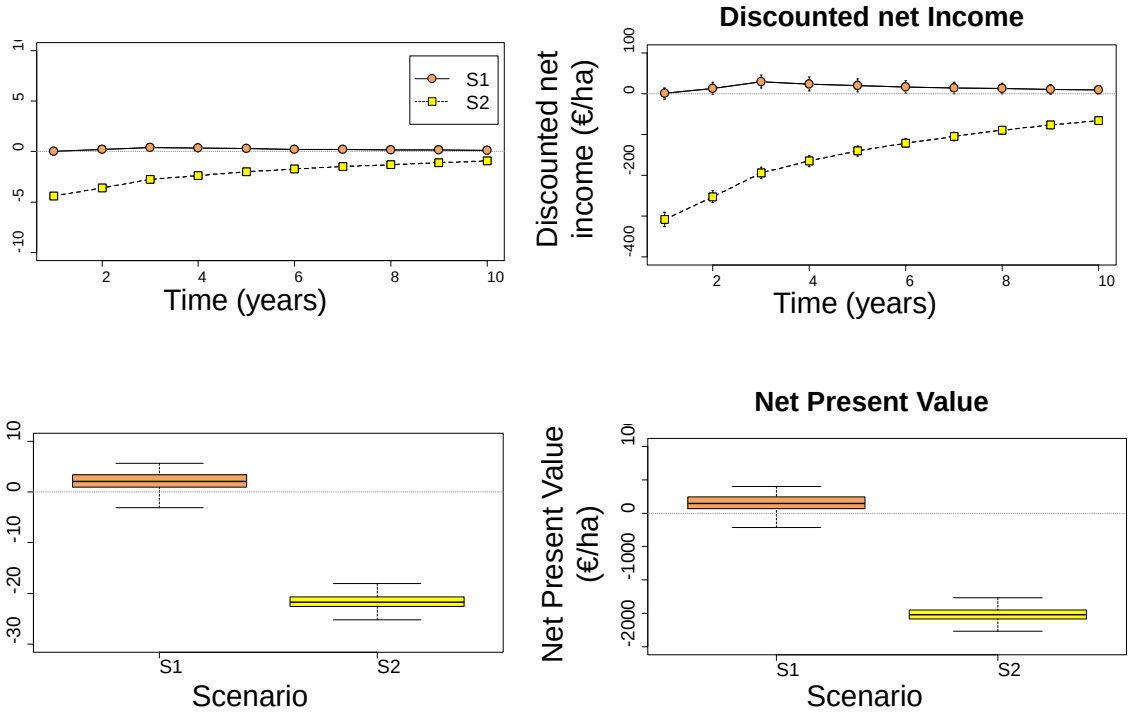

Figure 3. Discounted net income and Net Present Value according to scenarios S1 and S2 considering degraded starting conditions. (Note: A = Cyprus, B = Crete; Net Present Value = sum of discounted net income over the 10-years period. Colours indicate scenarios referring to the colour code used in Table 1).

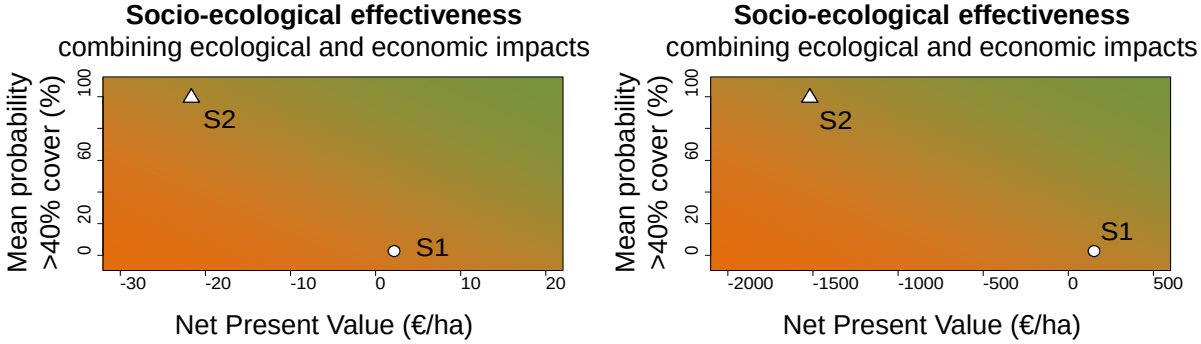

Figure 4. Socio-ecological effectiveness of management scenarios considering degraded starting conditions. (Note: A = Cyprus, B = Crete; S1 and S2 refer to the management scenarios described in Table 1).

Considering a restored site as a starting condition, model results indicate that S1 induces a slight increase in vegetation cover while S2 and S3 yield a significant vegetation cover increase and highest probability of reaching >40% vegetation cover throughout the 10 years in both Cyprus and Crete (Fig. 5). In economic terms, S1 results in a very low economic gain and S2 even in economic loss in both regions (Fig. 6). Due to regional economic costs and benefits of livestock production, S2 results in an economic loss of about 8 Euro/ha in Cyprus and 1400 Euro/ha in Crete (Fig. 6). Only S3 yields a

larger economic gain of about 12 Euro/ha in Cyprus and 600 Euro/ha in Crete (Fig. 6). Together with the vegetation cover increase induced by S3, this economic gain implies best socio-ecological effectiveness among the scenarios considered here (Fig. 7). Although S2 effectively prevents degradation below the critical level of 40% vegetation cover, the economic loss indicates that policy incentives such as subsidies would be useful to increase land users' motivation to implement this type of management.

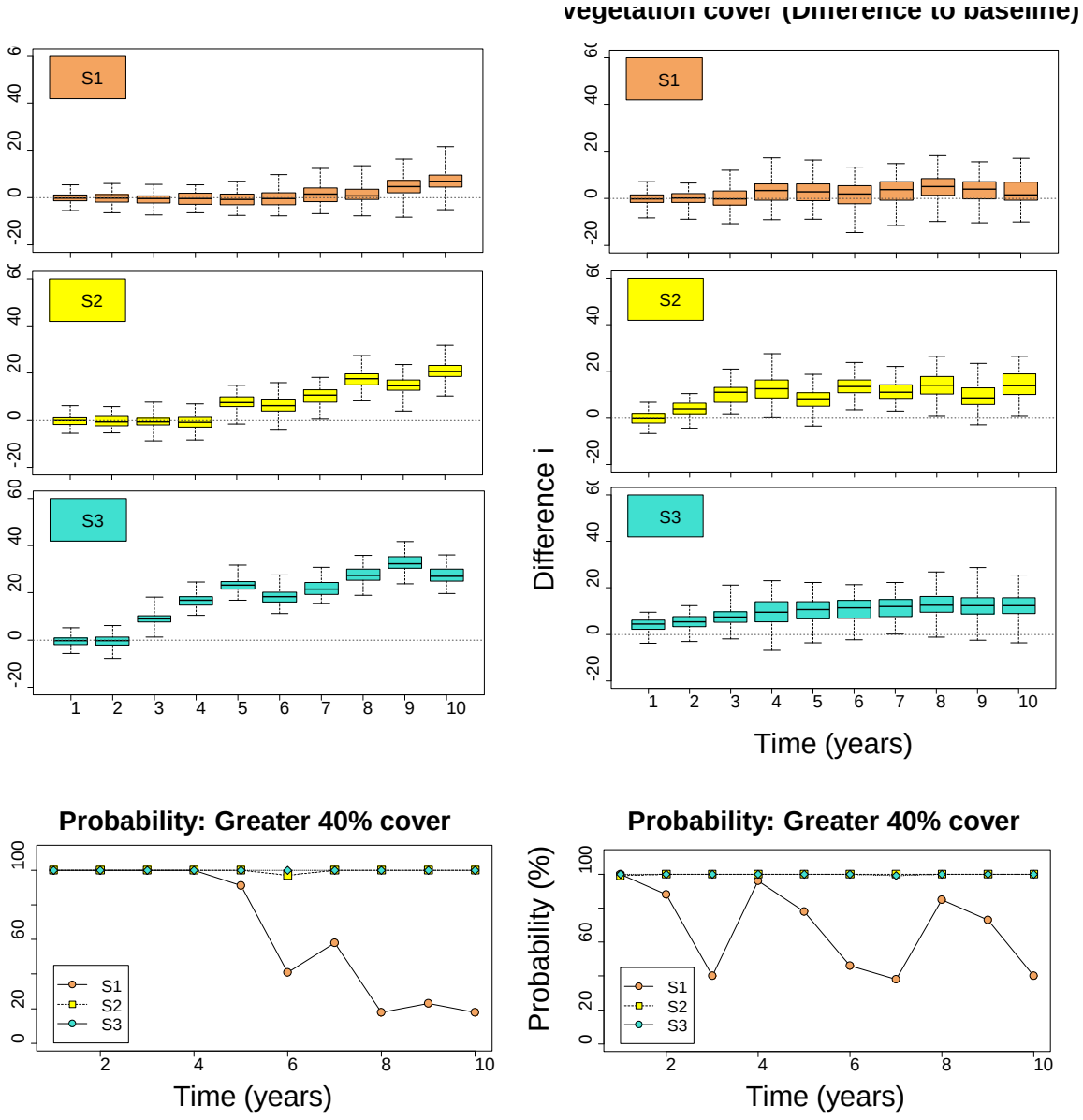

Figure 5. Vegetation cover dynamics and probability of reaching >40% vegetation cover according to scenarios S1 – S3 considering restored site as starting point. (Note: A = Cyprus, B = Crete. Box boundaries denote the 25th and 75th percentiles of difference in vegetation cover. Whiskers indicate 5th and 95th percentiles. The line near the middle of a box depicts the median value. Colours indicate scenarios referring to the colour code used in Table 1).

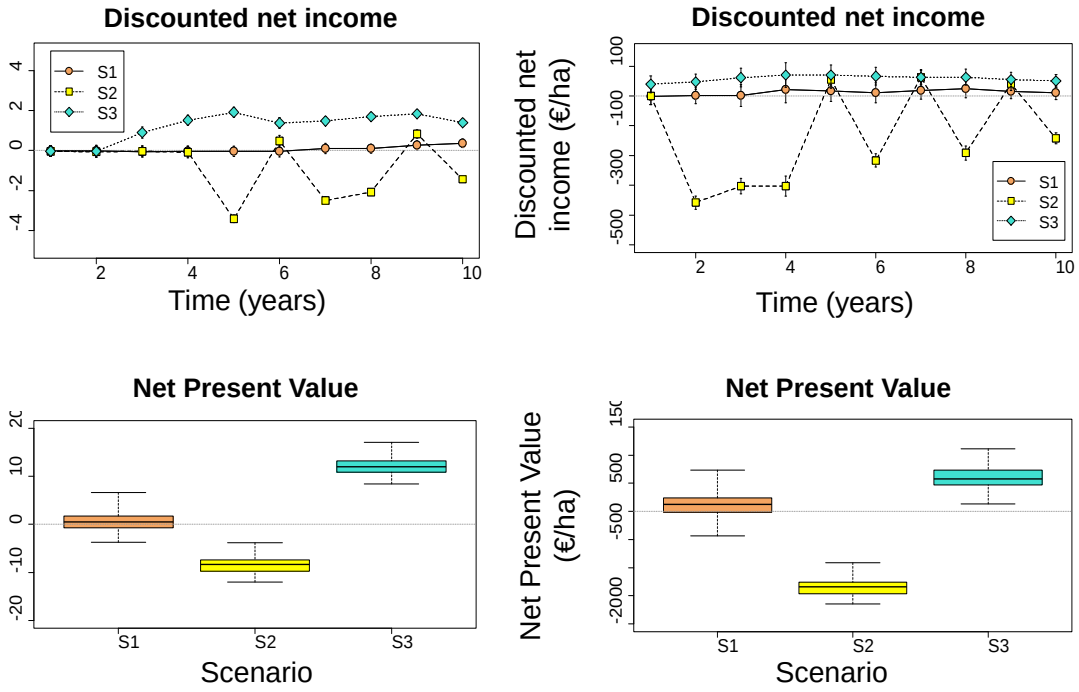

Figure 6. Discounted net income and Net Present Value according to scenarios S1 – S3 considering restored site as starting point. (Note: A = Cyprus, B = Crete; Net Present Value = sum of discounted net income over the 10-years period. Colours indicate scenarios referring to the colour code used in Table 1).

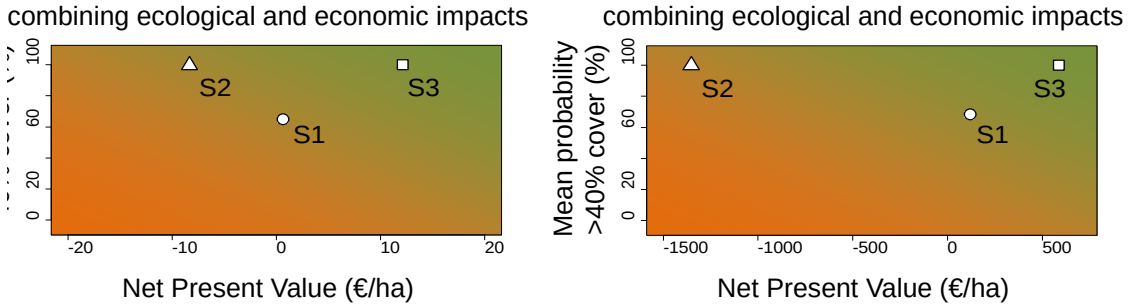

Figure 7 Socio-ecological effectiveness of management scenarios considering restored site as starting point. (Note: A = Cyprus, B = Crete; S1 – S3 refer to the management scenarios described in Table 1).

3 FEEDBACK FROM STAKEHOLDERS ON SLM MANAGEMENT PRINCIPLES AND FINDINGS FROM SCENARIO ANALYSIS

The CASCADE Project (WP7) produced guidelines for land managers in the form of principles and recommendations for SLM. They are simplified and summarised in Deliverable 7.3 "Comprehensive guidelines for natural resource managers" see link http://www.cascade-project.eu/index.php/downloads/project-deliverables. The principles were developed with contributions from land users and land managers (See Annex 1 and Figure 8).

Figure 8. Guidelines for Land Managers produced by CASCADE with contributions from land users and land managers for land abandonment, forest fires and overgrazing, and an example of the principles and their specifications from the post-fire context (see also Annex 1).

The principles and recommendations were discussed with land users and land managers through workshops in each study site. Six stakeholder workshops were carried out by the CASCADE team during the period August 2016 to February 2017. Only one was held in Spain where there were two study sites, but two were held in Cyprus.

3.1 Workshop methodology

Study sites recruited 6-12 stakeholders who were previously engaged with CASCADE activities, many of whom had participated in previous workshops (see Table 2). The first workshop was held in Italy as a pilot workshop, after which the methods and the workshop protocol were further refined. Two workshops were held in Cyprus, as there is mistrust and conflicting stand points between local stakeholders and land managers and decision makers from the government (see section 3.2.2).

Given the nature of the jobs and the traditional gender division of work in pastoralist and farming societies, many of the stakeholders were males. The research aimed to have a representative sample, therefore no especial effort was made towards one gender specifically. Although various government positions in Cyprus and Crete are held by females, they did not attend the workshops, despite being invited. One female was at the Portuguese workshop. As technicians and government representatives were invited to the workshops and there is a more even gender balance in the number of females holding jobs relevant to the stakeholder context in Italy and Spain, three females attended the stakeholder workshop in each of these countries.

Table 2. Principles discussed, date and number of participants of the stakeholder workshops carried out in the study sites.

Study site	Principles on:	Date of workshop	Number of participants
Castelsaraceno, Italy	• Land abandonment • Forest fires • Grazing	31 Aug 2016	10
Valencia, Spain	• Land abandonment • Forest fires	25 Jan 2017	14
Várzea area (Calde-Viseu), Portugal	• Forest-fire (adapted version for Post fire management)	15 Dec 2016	12
Cyprus	• Grazing principles • Grazing Model/Scenarios	28 Jan 2017 6 Feb 2017	13
Crete	• Grazing principles • Grazing Model/Scenarios	10 Feb 2017	5

During the workshops the management principles from the grazing, land abandonment and forest fire guidelines (see Annex 1) were presented, distributed and discussed among the participants according to the specific study site issues under consideration (see Table 3a and 3b).

Table 3a. Overgrazing and land abandonment principles presented in study site workshops. The principles relevant in each study site are shaded under the country's column.

CONTEXT	CRETE	CYPRUS	PORTUGAL	ITALY	SPAIN
OVERGRAZING					
1. Reduction of vegetation increases soil erosion, leading to less fertile soil and less productive pastures.					
2. Integrating trees and pastures has ecological and socio-economic benefits					
3. Pest management requires an integrated ecosystem approach to promote natural predators					
4. Animal types and herd composition influence plant diversity and health.					
5. Controlled grazing reduces risk of fires, and maintains grass species and productivity of pastures					
6. After a fire or drought continued grazing could lead to a permanent change in pasture productivity and quality					
LAND ABANDONMENT					
1. The environment of abandoned land can change in unexpected and diverse ways: it might not continue to provide the same services, and degraded land might not recover spontaneously					
2.Environmental changes regarding vegetation, soil and water after land abandonment can lead to new risks that require specific management					
3. Land that is not used or economically valuable at present can be used in the future					
4. Labour availability is a constraint in abandonment-prone areas					
5. After a fire or drought continued grazing could lead to a permanent change in pasture productivity and quality					

Table 3b. Fire and post fire management principles presented in study site workshops. The principles relevant in each study site are shaded under the country's column.

CONTEXT	CRETE	CYPRUS	PORTUGAL	ITALY	SPAIN
FIRE MANAGEMENT					
1. Minimizing fuel load and connectivity reduce fire risk					
2. Diversity of species reduces flammability, as well as outbreaks of pests, and thus leads to reduced fire hazards. In particular, promoting re-sprouters facilitates recovery after fire.					
3. Sufficient soil cover shortly after a fire reduces risk of soil erosion					
POST FIRE MANAGEMENT					
1. Ensuring high soil cover, both after fire and after post-fire forestry operations, reduces the risk of erosion and of soil fertility losses					
2. Minimize the impacts of post fire forest operations (logging and extraction of wood and logging residues) on vegetation, litter and soil					
3. Recover degraded areas with lack of spontaneous regeneration of pine trees.					

During the workshops, researchers first presented a brief introduction and update on the CASCADE project's work, followed by presentation of key policies at local/national/EU levels relevant to the study site. If a local policy stakeholder had agreed to participate in the workshop, an invitation was extended to them to give a short presentation on the key policies in their area that addressed the main CASCADE issues being considered. This offer was accepted in Italy where a presentation was given by the representative of the Shepherds' Union, and in Portugal where a national representative from the Institute for the Conservation of Nature and Forests Policies, carried out a presentation about financial programmes for post-fire management and burnt area rehabilitation. A discussion about the stakeholders' views of the principles, the barriers and opportunities for implementing them, and about relevant policies formed the final element of the workshops. In Cyprus and Crete, a discussion about the model results for grazing scenarios was also carried out (see Section 2).

Discussions considered the following questions (which were adapted as necessary by the study site teams) regarding the land management principles, in order to explore opportunities for and barriers to their implementation:

i. Can you apply the principles and recommendations? If not, why not?
ii. Would you include any further principles or recommendations?
iii. Do the policies support the principles and recommendations? If not, where are the gaps? What needs to be done to address the gaps?

The research questions and methods varied slightly among the study sites depending on the characteristics of the stakeholders and principles. Variations in and details of the methods are specified below. To discuss the relevance of the scenario analysis with the potential users of grazing scenarios, the results of the model simulations were tested against the stakeholders' perceptions in Cyprus and Crete. Stakeholders were asked how realistically the model results reflect the vegetation trends, how feasible the management principles are, and potentially if any sites are restored, how grazing interacted with restoration. The following questions were asked during the workshops in Crete and Cyprus (see Section 3.2.1 and 3.2.2 for results).

- Q1 Do the model simulations realistically reflect trends of vegetation degradation and recovery observed in the study sites? If not, why not?
- Q2. Considering the model simulations, do the management principles and recommendations (e.g. 40% critical vegetation cover) make sense for the study sites? If not, why not? What key aspects would need to be changed?
- Q3 In sites where vegetation was successfully restored, how severely was the vegetation degraded (% cover) when restoration started? How many animals per hectare were grazed prior to degradation on these sites?

3.2 Study site stakeholder workshops

3.2.1 Messara Basin, Crete

Based on previous experience, farmers are reluctant to attend stakeholder meetings involving management authorities and are more comfortable to be reached individually, therefore the farmer's representative attended to speak for other shepherds/farmers. Hence, although over 20 stakeholders were invited, only 7 individuals attended (Fig. 9; see Annex 2). Despite this situation, CASCADE study site researchers considered that as the farmers' representative is very well informed on current affairs due to his previous position as head of the pastoralists' union of Heraklion, and long-term involvement of he and his family in the livestock farming profession, the shepherds' views were adequately represented.

In the first part of the meeting, participants were shown the CASCADE movie clip (https://vimeo.com/87468569) in order to demonstrate that problems in drylands are common among CASCADE's study sites. Stakeholders could especially relate to and comment about the overgrazing problems described in Cyprus. Afterwards, TUC researchers gave a short presentation on the CASCADE results for Crete regarding (a) stress gradient experiments, (b) drought stress

experiments, (c) CASCADE grazing principles, and (d) cost-benefit scenarios. Stakeholders were urged to interrupt and discuss any points they wanted to raise during the presentation.

Figure 9. Participants in CASCADE's overgrazing workshop in Crete.

Stakeholders' perceptions of grazing principles in Crete

Every participant in the workshop agreed with criterion 1 "Keep a minimum of 30-40 % soil cover, and criterion 2 "rotate grazing areas and control the amount of animals" of principle 1 *"Reduction of vegetation increases soil erosion, leading to less fertile soil and less productive pastures".* Criterion 1 was seen as feasible by all the participants. However, keeping animals in stables (criterion 3: use stall feeding, especially during the dry season), was considered feasible by non-pastoralists but unrealistic by pastoralists. This is due to current stable installations, as they are rudimentary, and stable construction costs are high.

Regarding principle 2: *"Integrating trees and pastures has ecological and socio-economic benefits",* everyone considered protecting existing trees and planting fruit and fodder trees an effective measure. However, opinions were divided regarding how realistic it is for the stakeholders to apply this. Silvo-pastoralism and market diversification are already applied by a few more educated and open minded farmers who took advantage of financial instruments to plant trees on their land or invest in agro-tourism. To some extent, land tenure was perceived as a barrier: small land owners may not be able to apply such instruments due to the high costs that this implies, and the lack of access to subsidies. Also, small producers are using their products only for subsistence.

Stakeholders agreed with the protection of wildlife and criteria in principles 3.1 and 3.2 *"Protect ecosystem floral and faunal diversity, avoid killing predators",* and stated they already avoid killing predators such as snakes. Measure 3.3 *"Protect trees against rats"* was not relevant for the area.

Regarding 3.4 *"Install fences and traps"* and 3.5 *"Provide nest boxes for birds of prey"*, fencing was not considered realistic, due to the nature of the landscape, while trapping can only be managed at the administration level if such a need arises, otherwise it is illegal. Researchers mentioned that the

use of nesting boxes could be appropriate, but administrators and farmers did not consider it necessary, as indigenous bird populations are not at risk.

Stakeholders agreed with principles 4.1 and 4.4: "*Plan resting periods for pastures",* and "*Increase health and productivity of individual animals instead of increasing the size of the herds*" respectively. However, principle 4.4 was not considered feasible by any stakeholder. Regarding animal types and herd composition from principles 4.2 and 4.3 "*Selectively remove unwanted species, while keeping some for soil protection if necessary"* and *"Diversify animal types",* stakeholders agreed with selectively removing unwanted species, while keeping some for soil protection if necessary. They also agreed with animal diversification, although extensive planning for rotational grazing was considered realistic by non-pastoralists but unrealistic by pastoralists. Animal diversification beyond sheep and goats was not considered feasible by any of the stakeholders. Stakeholders considered that including goats in the herd endangered forested areas, as their efficiency in grazing threaten the viability of the vegetation and limit regeneration. Furthermore, goats can also eat the bark of the trees, leaving them susceptible to diseases. Therefore, diversifying grazing including goats was perceived as a problem.

All stakeholders agreed with principle 5 *"Controlled grazing reduces risk of fires"* the most. This is because they saw that controlling grazing can reduce the risk of fires by reducing the fuel load. Installation of fire breaks and the reduction of bush cover in order to allow grazing and reduce fire risks are already being applied. However, they did not agree with reducing grazing during the dry season, and perceived that grazing should be increased when dry matter increases. Reducing grazing during the wet season makes more sense for stakeholders. Excluding grazing for at least 4 months during the wet season was suggested. This mimics the traditional transhumance pattern of moving to lower grounds during the winter season both for shelter and to allow vegetation to grow before it is grazed. They considered that grazing should be allowed during the dry season when biomass has grown otherwise it would only provide fuel for fires.

All stakeholders agreed with the effectiveness of the measures in principle 6 "*Actions after a fire or drought"*. Burned lands are typically included in a reforestation zone plan. Two years was considered the minimum resting period by farmers; 5-6 years was perceived as adequate.

Stakeholders' perceptions of findings from the scenario analysis in Crete

Stakeholder discussions of findings from the scenario analysis in Crete can be summarised as follows. For degraded sites, participants considered that increasing vegetation cover requires extensive financial resources and the benefit is only environmental. Furthermore, small interventions make little difference. In this sense, the vegetation trends and financial benefits/losses described in the models were considered realistic. In non-degraded/restored sites there is high potential for sustainable management. Excluding grazing during the wet season can be profitable. In order to successfully apply this though, fodder needs to be provided.

The assumption made in management scenarios implying annual decisions on livestock destocking (keeping animals in a stable rather than selling them) or restocking (moving animals from stable to pasture rather than buying new animals) is problematic for degraded initial conditions. Currently stable installations are rudimentary at best and therefore the cost of destocking should include stable construction. Even the traditional model of transhumance (moving animals to higher ground

in the summer and lower grounds in the winter) is currently unfeasible due to labour costs and land fragmentation. Therefore, stakeholders consider that partial animal exclusion in traditional/degraded lands is largely unrealistic. Partial exclusion was however considered realistic in non-degraded or restored lands when lower animal densities are also assumed. Total exclusion is considered unrealistic in all cases.

Contrary to the reactions towards the results of the grazing model, the stakeholders showed some disagreement with the grazing guidelines and recommendations of the grazing principles. As mentioned before, they did not agree with reducing grazing during the dry season. On the contrary, stakeholders considered that grazing should be increased when fresh matter decreases and dry matter increases as vegetation dries out. They felt that reducing grazing during the wet season makes more sense, also in accordance with the "resting in wet season" scenario. Excluding grazing for at least 4 months (wet season) was considered appropriate.

In responding to question 3 (in sites where vegetation was successfully restored, how severely was the vegetation degraded (% cover) when restoration started?), stakeholders could not answer using a simple percentage. This is because the perception of degradation as a function of vegetation cover was not considered entirely realistic. Some participants noted that some sites have been successfully restored after having 0% vegetation cover. Several such examples were discussed and these observations also agree with findings from the CASCADE stress gradient experiments in Deliverable D.6.1 (Kéfi et al., 2016). According to the stress gradient results, degraded sites may be more fertile, with higher amounts of soil organic carbon (SOC) and N, probably as a result of the higher amounts of manure left during grazing. The limiting factor in these cases is soil depth which gradually erodes when vegetation cover is low. Vegetation cover is in some cases a good proxy for degradation but does not depict the permanent loss of other land resources such as soil.

How many animals per hectare were grazed prior to degradation on these sites (=cause of degradation)?

The perception of the number of animals considered as overgrazing varied, and stakeholders were reluctant to set a clear threshold for overgrazing. In their view it is a complex situation that depends on grazing strategies (constant or rotational grazing). E.C. Reg. 1782/2003 suggests livestock density has to be maintained at 1.4 head/ha (Hadjigeorgiou, 2011). The limit for Natura 2000 is 0.2 to 3 LU/ha. Stricter regulations for single areas are possible (Dimopoulos et al., 2006) and indeed necessary (Papanastasis et al., 2002). Current average density is 1-1.4 head/ha. Nevertheless, as much as 4-8 heads/ha can be considered sustainable if rotational grazing is applied. If rotational grazing is not applied over 2 heads/ha may be considered overgrazing.

3.2.2 Randi Forest, Cyprus

In the Pissouri region, the land belongs to and remains under the control of the Forest Department, who commissions its use to shepherds. Workshops in Cyprus were held on two dates with different stakeholders in order to avoid conflict between a) shepherds and local authorities and b) land managers and researchers from governmental departments and academia. Contrasting opinions are held between the two groups and CASCADE researchers were mindful not to exacerbate these positions (see Annex 2). During the two meetings, CASCADE's principles and recommendations for overgrazing were discussed, as well as the different grazing scenarios (see Section 2).

A first meeting was held with the land users from Pissouri including shepherds and local authorities on 28th of January 2017, while on the 6th of February 2017 a second meeting was held with representatives from government departments (Forest, Environment, Agriculture, Wildlife, Fire) and the Faculty of Geotechnical Sciences and Environmental Management at CUT (see Figure 10).

Figure 10. Participants in CASCADE's overgrazing workshop in Cyprus.

Stakeholders' perceptions of grazing principles in Cyprus

The two meetings (see Annex 2) produced different results. In the second meeting, the stakeholders from all departments and the University agreed on the proposed principles, however, in the previous meeting shepherds disagreed with some principles, as outlined below.

During the meetings with both shepherds and government representatives in Cyprus, regarding principle 1 *"Reduction of vegetation increases soil erosion, leading to less fertile soil and less productive pastures"* stakeholders mentioned that they realized the land was being degraded. Shepherds shared the narrative of Randi Forest being greener 100 years ago. They also have a point of comparison of the effect of grazing, as a highway was introduced in the 1990s that divided grazing areas from non-grazed areas. The effects of both kinds of management on the vegetation have helped them to understand the consequences of overgrazing.

Shepherds viewed some principles to be contrary to traditional practices. The discrepancy is mostly due to local beliefs rather than environmental and management evidence. The contentious principles are principles 2 *"Integrating trees and pastures has ecological and socio-economic benefits",* 3 *"Pest management requires an integrated ecosystem approach to promote natural predators"* and 4 *"Animal types and herd composition influence plant diversity and health"* (see Annex 1). The shepherds disagreed with the second principle, regarding integrating trees and pastures. Traditionally olive *(Olea europaea)* and carob *(Ceratonia siliqua)* trees have not been cultivated, and some hold the belief that these species are not easy to grow. However, after a

discussion started by the youngest shepherd present, almost all the participants (with the exception of the eldest shepherd) agreed with the feasibility of the principle. As regards principle 3, all stakeholders disagreed with protecting the snakes, as traditionally they are hunted. Nowadays, shepherds are also hunting other important predators such as foxes, as they believe they destroy partridge eggs.

Stakeholders agreed with principle 5 "*Controlled grazing reduces risk of fires, and maintains grass species and productivity of pastures*" and with the rationale and criteria of principle 6, advocating for stopping grazing after a fire. Some shepherds mentioned that rotational grazing has had positive outcomes, and some suggested to keep some areas closed for longer, i.e. for more than 5 years. Rotating grazing areas was considered feasible by shepherds and government representatives. Some shepherds stated that grazing is not providing any food to herds, due to the degree of desertification on the land, therefore they already have to provide supplementary feed. However the shepherds perceived that they could only use rotational grazing if they are allowed to increase herd numbers, as this would allow them to increase individual income. According to local government representatives, the use of rotational grazing can be useful to prevent fires too. Shepherds also stated that the CASCADE workshops were the first time that any initiative had explained the consequences of overgrazing and the potential impacts on environmental services in the future. This indicates a strength of the participatory approach followed in the project.

In the second meeting, the stakeholders from all departments and the University agreed on the proposed principles. They also suggested the following relating to rotational grazing:

- Keep the animals in specific pasture areas and allow grazing using a rotational pasture system
- Divide the area into 3-5 large zones and allow grazing through rotation to control vegetation.
- Use rotational grazing to avoid fires and make firebreaks

After discussing the management principles, the management scenarios and the management suggestions resulting from the model were discussed with the stakeholders.

Stakeholders' perceptions of findings from the scenario analysis

All the stakeholders agreed with the premise that the model simulations reflect the vegetation trends towards degradation and recovery in the study sites. In Table 4 the answers to the questions and responses of the workshop participants can be seen. The shepherds recalled how 30 years ago, the vegetation cover was around 50%, and 250 animals used to graze the area. Therefore, the model makes sense, as it meant recovering previous conditions. During the second stakeholder workshop with non–pastoralists, the participants were unable to answer questions about how realistic the model simulations are, but suggested looking at past aerial photographs.

Shepherds in the first workshop mentioned that they could comply with using rotational grazing as a measure to allow vegetation to regrow in specific areas. Non-pastoralists in the second workshop agreed with the feasibility of rotational grazing, and even with stopping grazing for a number of years.

Question 3 was not fully applicable in this study site as vegetation has not been successfully restored, and sites with natural regeneration have the thorny shrub *Callicotome vilosa*, which is a potential fire fuel.

Table 4. Responses to questions 1) Do the model simulations realistically reflect trends of vegetation degradation and recovery observed in the study sites and 2) Considering the model simulations, do the management principles and recommendations make sense for the study sites? What key aspects would need to be changed? 13 participants across the two workshops answered the questions. The shepherd answers are in white, non-pastoralists answers are in shaded boxes.

Participant	Q1	Q2	Notes on Question 1	Notes on Question 2
1	YES	YES	-	Agreed that the vegetation Cover was around 50% 30 years ago and 250 animals used to graze
2	YES	YES	Allow us to increase the number of animals and reduce the amount of grazing animals or do not allow grazing	
3	YES	YES	-	
4	YES	YES	-	
5	YES	YES	Keep the animals in specific pasture areas and allow grazing using a rotational pasture system	
6	YES	YES	Keep the animals in specific pasture areas and allow grazing using a rotational pasture system	*Vegetation Cover was more than 50%, 30 years ago and the British used to allow only 72 goats to graze per livestock in the Randi Forest
7	YES	YES		I do not know

8	YES	YES	Divide the area into 3-5 large zones allow grazing through rotation in order to control vegetation.	The area is overgrazed and the number of animals grazed in 25 ha is three times larger. The animals should continue to graze on a controlled basis in order not to allow the *Callicotome* to expand in the area and convert into biofuel. Also the milk products from the Pissouri area have the advantage of origin[1]. We shouldn't lose that.
9	YES	YES	I agree with 10 years of non-grazing in order for the vegetation to recover. After 8-10 years we should allow controlled grazing in order to prevent possible fires due to the shrubs. Also, if the area is too crowded with animals them some should move elsewhere.	I do not know
10	YES	No	I believe that vegetation will need more than 10 years to recover. Grazing should stop	I do not know
11	YES	YES	Divide the area into zones and allow grazing through rotation in order to control vegetation	I do not know
12	YES	YES	Use rotational grazing	You may find the answer from aerial pictures taken by the British during the 1960s
13	YES	YES	Use rotational grazing in order to avoid fires and make firebreaks	I do not know

[1] With the term advantage of origin, the stakeholder meant that animal produce in the Randi Forest, has a specific quality and flavour due to the presence of specific herbs grazed by animals, therefore milk and cheese have some characteristics (texture and aroma) unique for the Randi area.

3.2.3 Calde Viseu, Portugal

Based on their previous engagement in CASCADE's participatory activities, 14 stakeholders were selected to participate in the final workshop in Portugal (Figures 11 and 12). Twelve stakeholders were able to attend, including representatives of governmental and non-governmental organizations, local forest owners and representatives of the private sector (see Annex 2).

In Portugal the management principles focused on post-fire management, as the study sites were pine forest plantations. Pine trees typically die during or shortly after a fire, therefore, they need to be logged rapidly to recover some of the value of the standing wood. Furthermore, the pines need to be cut because of phytosanitory regulations related with combating the pine nematode. Consequently post-fire principles were tailored to the Várzea region by the Portuguese team (see Annex 1 and Table 2).

Figures 11 and 12. Presentation of the experimental set-up and results developed in the CASCADE Project in Portugal and notes from the workshop discussion.

Stakeholders' perceptions of post-forest fire management principles

In the Portuguese study site land abandonment takes place. The occurrence of land abandonment and forest fires is interlinked and it interacts with other factors. Broadly, land abandonment can occur as a consequence of forest fires, and in turn, large forest fires can be exacerbated due to land abandonment. For this reason CASCADE researchers in Portugal focused on post-fire principles rather than land abandonment *per se.*

Workshop participants believed the absenteeism of land owners from active land management in the Várzea area to be similar to that in the rest of the Portugal. Rural exodus was associated with the search for better living conditions and means that the remaining rural population is generally comprising older people; however, outmigration was also recognised as contributing to more frequent and intense forest fires. Therefore, workshop participants first referred to absenteeism of forest owners as a major constraint when asked about the feasibility of the implementation of the post-fire management principles. This lack of intervention is aggravated in areas where natural regeneration is insufficient.

Regarding principle 1.1 "*Ensuring high soil cover, both after fire and after post-fire forestry operations, reduces the risk of erosion and of soil fertility losses"* the stakeholders recognized the importance of maintaining high soil cover in order to reduce soil erosion. However, a difference was perceived between areas of pine forest that were affected by fire once in 30 years and areas affected by recurrent fires. Stakeholders recognised that areas that have been rarely affected needed less human intervention. In contrast, recurrent fires over short time intervals lead to low rates of spontaneous recruitment, and therefore seeding or planting are needed to maintain forested areas and avoid shrubland expansion.

As a result of CASCADE's experiments regarding mulching effectiveness, stakeholders agreed that application of mulch was desired in areas with a high level of disturbance. According to stakeholders and similar to the situation in Spain, the benefits of mulching are little known by the stakeholders. An awareness campaign regarding its effects, including the minimisation of off-site effects, for example, surface water quality restoration, was proposed. However, it was mentioned that mulching represents high costs, which neither the public sector nor the private sector are prepared for or capable of supporting. Participants agreed that the forest owners would not be willing or able to pay the costs of transport of the organic residues to be applied and the costs of their application. However, in order to minimize the costs of mulching, one of the participants suggested the transfer of forest residues from locations where these residues are in excess to the areas to be mulched. Another alternative to minimize costs of mulching, was to use a local centre for logging residues destined for biomass energy plants, as stakeholders expected that the payments would allow to cover the costs of mulching with the remaining, smaller logging residues.

The second post-fire principle *"Minimize the impacts of post fire forest operations (logging and extraction of wood and logging residues) on vegetation, litter and soil"* raised some controversy among the participants. Two types of logging were presented by CASCADE researchers: traditional logging (logging and removal of wood material over the entire plantation) and conservation logging (logging, and partial removal of wood material, in strips only). Some stakeholders disagreed with the conservation logging technique. One of the reasons indicated was that the machinery used for making piles of forest residues damaged vegetation cover. Other reasons were that these piles were

hiding places for animals that eat pine seeds, thereby limiting natural regeneration, and that the tracks being used were prone to runoff generation and erosion. After discussions, the participants agreed that conservation logging has some benefits over the short term, but that traditional logging is to be preferred in the long term and that it should be the recommended logging practice.

Common forestry operations can have negative effects on vegetation (including pine recruitment) as well as on the soil, especially through soil compaction on tracks. Furthermore, stakeholders perceive that forestry operations can reduce the effectiveness of mulching, so that mulching ought to be postponed till after logging has been completed, when most of the post-fire erosion has already occurred.

Regarding principle 3 *"Recover degraded areas with lack of spontaneous regeneration of pine trees", t*he practical difficulties of seeding raised some discussion. European laws require use of seeds from a known origin when afforestation has a production purpose, which introduces some difficulties when purchasing the seeds. This obligation was unknown to some of the workshop participants, which then ultimately led to the affirmation that forest owners in the Várzea often lacked the knowledge and the technical support from the responsible authorities. Therefore, support to accompany the ongoing technological developments and changes in policy was needed. As a result, even motivated forest owners are not always aware of how to properly take care of their land according to European laws.

During the CASCADE workshops in Portugal a new principle was developed by stakeholders through the participatory approach. The lack of technical support along the multitude of land owners, inspired a new principle *"Increase the scale for forest management (land consolidation, Forest Intervention Area, Forest owners' organization, etc)".* This responds to an issue that came up on various occasions throughout the workshop, and reflects the importance of the predominantly small size of forest properties in constraining forest management and application of the principles in Portugal and in particular, post-fire land management and rehabilitation of degraded burnt areas.

3.2.4 Castelsaraceno, Italy

Eleven stakeholders attended this workshop (Figure 13), including representatives from the farmers'/shepherds' union, local land users and producers, and land managers (i.e. forest managers and agronomists) (see Annex 2).

Available policies regarding agro-environmental incentives in the Castelsaraceno territory were presented by one of the stakeholders. This was followed by presentation of CASCADE's relevant principles by the research team. In Castelsaraceno, land abandonment was the main SLM issue, as the risk of forest fire was very marginal. Unlike other areas in the Mediterranean, it is under-grazing that has had negative impacts as a consequence of land abandonment as it can increase fire risk. The principles presented to the stakeholders as a basis for discussions therefore covered land abandonment (principles 1 to 4), forest fire (3), and grazing (4, 5) (see Annex 1).

Figure 13. Meeting with CASCADE members and stakeholders in the Castelsaraceno Workshop.

Land abandonment

Stakeholders in Italy discussed in detail the challenges and opportunities in stopping land abandonment. They saw it very much as a holistic issue, and discussed the challenges and opportunities for addressing rural out-migration and low productivity.

In Italy, the farmers'/shepherds' union representative agreed with the principles proposed, as he had witnessed the environmental pressure that the land has been facing in the last few decades, and thus the need to prevent future deterioration and safeguard local resources. However, stakeholders had diverse views about the biggest challenges in the region: while the local veterinary officer signalled the lack of, or poor infrastructure, the environmental association representative and the local public administrator recognised depopulation as an important social trend due to the perceived benefits and status of living in urban areas as the biggest challenge. The absence of collective action was also seen as a key theme in the use of SLM and in implementing the principles (see Table 5). Within the discussion the stakeholders differentiated very little and tended to treat the principles as a set without specifying which they were referring to.

Indeed, the representative from the environmental association identified the region of Basilicata's biggest problem as the progressive depopulation of the territory and the absence of collective action. As there are relatively few people spread out across large areas, they considered that the prevailing individualist mind-set needs to be replaced by a greater confidence in the power of building networks, not just agricultural networks but also social networks. He concluded his intervention by describing a very positive model of community collective action he recently saw in Japan in the hope it could be adopted in the region.

Table 5. Main comments and proposals regarding land abandonment principles (treated as a set).

Land abandonment	Land users[1]	Agro-technicians[2]	Government representatives3
Causes	• Low profitability of land and produce • Fragmentation of farms • Unwillingness of land owners to sell land to farmers	• Lack of or deficient infrastructure	• Social trends of migration towards urban concentration, as rurality has had negative connotations • Low profitability of produce • Competition with cheaper imports subjected to lower regulations and production costs • Lack of cooperation among producers
Opportunities for decreasing land abandonment	• Regulate public land to support agricultural and forestry use • Set up farmers' associations • Strengthen local food networks • Regulations for in-farm slaughtering • Provide retirement incentives to older farmers so that the sector can see greater generational change • Mountain farming activities should be linked to niche tourism markets	• Organise collective actions, set-up associations • Regional for in-farm slaughtering. • Designated zones for grazing • Maintaining high quality of produce	• Certification of protected designation of origin for the territory and its products • Cater to niche markets • The branding of this geographic area as synonymous with authenticity, quality and tradition • Development of a "mountain product" label

The local government representative agreed with the general discussion and all the principles, and considered that even small infrastructure investments could reboot rural economies and help incentivise people to return to the community.

Grazing

During the discussions, the stakeholders remembered past measures in Castelsaraceno and agreed with the land management principles identified for pastures. However, only principles 4 and 5 of the overgrazing context (see Annex 1) were considered applicable to Castelsaraceno's current conditions. Principle 4 *"Animal types and herd composition influence plant diversity and health. Overgrazing by uniform livestock species can lead to the spread of invasive/unpalatable species*" encourages land users to plan resting periods for pastures, selectively remove unwanted species and to diversify animal types and Increase health and productivity.

The agronomist stakeholder also mentioned measures to be added: that rotation timetables and grazing loads should be adapted to specific land characteristics; that pasture biomass ought to be considered when calculating grazing loads; and that introducing local indigenous breeds alongside the good practices in place was needed. Equally it was mentioned that to limit grazing during the dry season, careful planning of grazing schedules needed to be in place in order to allow pastures to rest. This is a past practice and was also compatible with principle 5 "*Remove particularly invasive*

shrub either mechanically or with controlled fires to stop the spread of pastures towards woodland". These practices were considered successful at preventing invasive flora when there were a significant number of livestock grazing. It was also mentioned that management plans can be created (at a local town council or regional level) to organise the removal of undesirable flora species.

Regarding mixed grazing, the local veterinarian mentioned that crop rotation, crop selection and the removal of invasive plants should be better incentivised in order to be applied. He mentioned a case in which it was detrimental not to use principle 4 (- in the Park of Pollino in 2004 there was an out-break of anthrax in cattle spread by insect bites and contact between the cattle when all herding around drinking troughs), for which he proposed more drinking troughs in order to avoid the spread of the problem.

3.2.5 Spanish study sites

One workshop was held in Spain covering both study sites. It involved 14 stakeholders, representing environmental NGOs, researchers, land managers and governmental institutions (see Annex 2 and Figure 14). Government representatives worked in conservation, forestry and agricultural areas. The Local Forest Association was invited, however they did not attend.

Discussions focused on forest fires and land abandonment principles (see Annex 1). Land tenure in the study sites is usually held by small proprietaries that do not usually live within the area. Land management is designed and carried out by governmental institutions. Therefore, the workshop focused on bringing together stakeholders representing those institutions relevant to identify the feasibility and barriers of the principles.

Figure 14. Stakeholders from both Spanish study sites in the workshop held in Valencia, Spain.

Comments on the principles for the land abandonment context

The CASCADE team explained to the workshop participants that principles were elaborated mostly for land managers rather than owners. Stakeholders mentioned that implementation of the

principles requires cooperation and legal frameworks, allowing land managers to apply the principles on private property.

Most stakeholders in Spain agreed with most of the land abandonment principles. However, they stated that they could not consider them as guidelines to prevent land abandonment as the principles do not consider a holistic approach to socio-environmental development, taking into account aspects such as social integration, forest use regulation or burning of crop residues. Stakeholders mentioned that a multitude of factors are causing land abandonment in the area, which in turn is linked with an increased risk of forest fires. Furthermore, other socio-economic issues in the region (such as land tenure structures and processes), decrease the feasibility of implementing the principles. Therefore, stakeholders considered that managing these areas is highly complex, from both administrative and spatial perspectives. Stakeholders also mentioned various barriers to implement the principles (Table 6) linked to the land abandonment context.

Table 6. Causes and consequences of land abandonment mentioned by stakeholders.

LAND ABANDONMENT CONTEXT	SPAIN
Causes	Low profitability of land and produce. Lack of or deficient infrastructure. Search for better quality of life in the urban areas.
Barriers for the implementation of land abandonment principles	Smallholdings land tenure (mostly private in many parts of the Valencia Region). Contrasting management goals among private vs common interest. Lack of clear norms of intervening in private lands. Large amounts of funding and subsidies are needed. Labour intensive, there is not enough labour as the area is mountainous.

Stakeholders also expressed disagreement with the terminology used in some of the principles, although not with the principle *per se*. Some of the stakeholders suggested how they could be clarified. For example, an NGO representative suggested using the term “cropland or agriculture abandonment” instead of “land abandonment” in general, as most land abandonment affects croplands.

Comments on the principles for the forest fire context

In Spain, the forest fire principles were clear and stakeholders agreed with them in their context, however they were also perceived as too general (Table 7). In response to principle 2.1 “Avoid afforestation with single or flammable species” the representative of the wildlife department disagreed with not considering species for restoration, due to them being flammable. Some species like *Juniperus spp.* are highly flammable but they are key species in certain ecosystems. Equally,

clarifications were also suggested regarding terminology that seemed too broad to be meaningful to stakeholders. For example, in *"sustain and increase diversity of endemic plants*" (principle 2), the term "endemic" was considered potentially confusing by the Department of Wildlife representative, as most endemic species nowadays are characteristic of degraded environments. The suggestion was therefore made to refer to vegetation as *"Indigenous".* Furthermore, referring to vegetation as "fuel" was perceived to be a broad and potentially confusing use of the term, as it was recognised that although some vegetation can act as fuel in a fire situation, many plant species also have an ecological role.

Between the recommendations under principle 3 *"Sufficient soil cover shortly after a fire reduces risk of soil erosion"*, are mulching and maintaining soil cover in fuel breaks. Stakeholders were dubious about the benefits of mulching due to the scarcity of management experiences, although they recognised the potential benefit of this technique to avoid land degradation. The lack of experience in using or being in contact with this technique meant that they were uncertain about its costs and benefits, as there are few experiences about mulching application as a management technique and these are restricted to small areas especially after forest fires. Different comments were made about these experiences and the type of mulch (hay or forest residues) but there was consensus about the beneficial role of this technique as an emergency land restoration action. Stakeholders also asked the CASCADE team about cheaper options than mulching, and cropland residues were mentioned by stakeholders in this regard. Finally, stakeholders recognised that the term "firebreak" (cortafuegos) is an outdated technical term that fails to reflect the ecological configuration of the area, which presents an array of agricultural and forested patches, rather than a continuous of forest with non-forested sections in a heterogeneous mosaic landscape. Therefore, they felt a holistic view of the forest and the measure was needed for fire management.

In Spain the lack of technical support or information were not seen as a barriers to implementing the principles. Stakeholders however recognised that land tenure is an obstacle both for coordination and implementation of management measures. The small holding sizes of the properties means that there is a multitude of stakeholders that need to agree if measures are going to be taken. In some cases, the owners are not identified by land managers, or it is difficult to contact them, therefore measures cannot be carried out easily as it would involve interfering with private land. This issue is amplified in the case of land abandonment, and in some cases there is opposition to governmental intervention by forest owners. Stakeholders also considered that the needs of the population should be a priority to prevent land abandonment, because if there is a lack of schools, jobs or medical services, land abandonment will continue in the region. They proposed that the management principles for land abandonment should consider social participation in a bottom-up approach, as it is currently happening in the region after large forest fires. Equally, plans should include climate change projections in designing management treatments (prioritization of areas, selection of species and so on). Stakeholders also commented that the role of and impacts on the area's fauna should be included too.

Table 7. Agreements and disagreements with the forest fire principles by Spanish stakeholders. Y = agreement

FOREST FIRE CONTEXT						
SPAIN						
PRINCIPLE	**Agree/Disagree**			**Barriers**		
	NGO	**ACADEMIA**	**GOVERNMENT**	**LEGAL**	**ECONOMIC**	**SOCIAL**
1. Minimizing fuel load and connectivity reduce fire risk	Y	Y	Y	Land tenure in small holdings	Large funding needed as there is governmental responsibility	Land abandonment Lack of social integration
2. Diversity of species reduces flammability, as well as outbreaks of pests, and thus leads to reduced fire hazards. In particular, promoting re-sprouters facilitates recovery after fire.	Y		Y		Low profitability and lack of alternative profitable activities	Lack of communication and organisation between forest owners
3. Sufficient soil cover shortly after a fire reduce risk of soil erosion	Y		Y			Loss of traditional land management knowledge

4 CASCADE'S POLICY FORUM, MATERA, ITALY

4.1 Cascade policy forum methods

CASCADE held a policy forum in Matera, Italy on the 24th of February 2017 (see Annex 3). The Forum aimed to:

a) Identify key policy recommendations according to stakeholders and policy makers, highlighting convergent and divergent priorities between stakeholders and policy makers and among study sites;

b) Establish the entry points to inform relevant policy which could utilise CASCADE's results and data, as well as possible barriers and opportunities for uptake of the project findings according to policy makers at different levels; and

c) Identify remaining knowledge gaps and opportunities for future research regarding SLM.

Overall, the forum consisted of two sections. A short video was presented about CASCADE research at the beginning of the forum. Next, presentations from policy representatives introduced the audience to relevant policies in the EU and internationally that deal with land degradation, tipping points and rural development. Three presentations from CASCADE members, showcased some of the main findings in relation to the important themes within CASCADE: land abandonment, overgrazing and forest fires. Each presentation was followed by questions from the audience, enabling dialogue and clarification on key points.

A roundtable with researchers, policy makers and land managers formed the second section of the policy forum engaging participants and researchers in discussing relevant issues to dryland research and management. Moderators formulated propositions and requested roundtable participants to respond, not only to answer questions from the audience, but also making sure that the objectives of the forum were achieved. The audience was asked to respond to the participants' interventions and to ask further questions to roundtable panellists.

The questions that started off the roundtable discussion were:

1. What were the most surprising findings from CASCADE?
2. How do CASCADE results help inform your work?
3. What enablers do you need, or what is currently missing, which could help you use our CASCADE project results?
4. What knowledge gaps remain?

4.2 Relevant remarks during the policy forum

New insights provided by CASCADE's research, the contribution that the project has made in the study sites and the further potential impact informing policy and land management were the main topics discussed. Local stakeholders, international policy makers and land managers, as well as CASCADE researchers, intervened throughout the forum.

In general, the concept of catastrophic shifts excited attention from the audience, and its meaning and implications conveyed across the different study sites was discussed. Policy makers and land managers mentioned that it is a concept that brought attention to the urgency of improving land management, and to the risk of catastrophic and irreversible damage to environmental resources if poor management practices or inaction are the norm.

Among the results that CASCADE researchers presented were the prospective outcomes of land degradation. They showed that soil erosion and loss is not always the pathway that land degradation takes. Instead, changes in land cover and vegetation can replace existing environments, leaving the landscape less diverse and providing fewer environmental services.

Other relevant results and their potential to be translated into SLM measures were debated. For example, researchers noted that not only the amount of land cover, but also the spatial arrangement of land cover is essential to resource conservation. Discussions considered that these kinds of findings could be translated into better and more accurate management principles and practices, and inform restoration programmes targeting degraded areas.

The remainder of comments and topics are presented here in four sections following the analysis of detailed notes of the interactions between participants. The analysis was undertaken in a thematic way to categorise and group comments and discussions, broadly following the questions that were considered throughout the day. First, participants' perspectives on the participatory research undertaken by CASCADE is explored, followed by presentation of some of the ways that CASCADE has contributed towards land management in the study sites. Entry points for CASCADE's results in relevant policy areas are identified, and finally, the contributions of the forum regarding future opportunities for progressing the SLM agenda (including dissemination and outreach) are considered.

4.3 Participatory research approach within CASCADE

The benefits of using a participatory approach for SLM research within CASCADE was discussed by both stakeholder participants and researchers. Not only policy makers and land managers found the integrated contributions of CASCADE to be novel; researchers also said that they found new information by using a participatory and interdisciplinary approach that extends beyond their usual toolkit of methods.

For researchers, the direct and iterative engagement of CASCADE elements with the study sites, enabled them to highlight relevant issues for land users and provided context to environmental issues. As local researchers with wide experience in the area commented, *"everything was green, everything was excellent…But still people living there were really upset about the environment, about the landscape…Speaking with the shepherds, they said, "Look at this area, it's very bad, there is lot of shrub encroachment""*. By contextualising scientific findings within local perspectives and livelihoods, the danger of providing inappropriate scientific advice and policy recommendations is reduced. This was considered a key strength of CASCADE's approach.

That degradation is not always indicated by losses in vegetation cover is not always an intuitive premise for researchers and non-locals, but for the local population the possibility to carry out traditional activities and livelihoods may not be reflected in the conservation state of the

environment, but in the preservation of specific key resources. For example, vegetation cover increased in the Italian study site following land abandonment as bushes and trees established on previous grazing areas. However, despite the increase in biomass, for livelihoods in the area, the increased vegetation cover introduced new risks of fire and reduced the possibility to make a living from grazing those areas. Thus, for CASCADE researchers, working closely with the stakeholders provided incredibly useful insights not only about land management issues, but also about people's needs from and links with the environment.

For land managers and stakeholders, communication with the researchers was considered beneficial as well. Stakeholders from Cyprus attending the forum mentioned that it was the first time that researchers had opened the dialogue about management practices with the land users. Therefore, combining traditional knowledge from stakeholders with CASCADE's new insights, and furthermore, facing and working with the community's concerns and barriers over new SLM measures, has integrated scientific aspects with local perspectives, innovation and application. Participants valued this integration highly.

4.4 How CASCADE has informed stakeholders' work and influenced policy

Not only novel knowledge generated by the project was regarded as useful by land managers. According to policy makers in Portugal, some of the management principles were not new. However, CASCADE's post-fire management principles were based on rigorous scientific research, and the results concurred with the empirical perceptions of local resource managers. Consequently, it provided validation and data to support the management principles being proposed by the policymakers, as well as a better evidence base with which to refine previous approaches to management.

In some cases, CASCADE principles reinstated old practices that were sustainable, which stakeholders had stopped using in recent years. For example, policy makers from Cyprus mentioned that prior to CASCADE, there was inaction from both policy makers and land managers in addressing degradation. However, the project brought attention to drylands and the risks of overgrazing, and to relevant management measures. Management principles identified by CASCADE and mentioned by stakeholders as past practices were maintaining carob trees and practicing rotational grazing. Furthermore, CASCADE principles and recommendations modified and refined management practices that were in place or were about to be carried out at the suggestion of resource managers. For example, in Cyprus, managers were considering stopping grazing to prevent land degradation, however, as CASCADE's results pointed out the benefits of grazing, they are now revising their grazing plans so that it does not stop entirely.

That CASCADE provided well-researched information was also considered to empower land managers, as the information that they can convey is endorsed by the project. A representative from Portugal mentioned "*In Portugal, only 3% of the forest area is managed only by the state. In the last 40 years, 2.5 million ha have been burned in Portugal, and 5,000 of them were burned more than 10 times in the same period. This project it is very important for us because the results gave us the knowledge we needed to transmit to the owners of the 92% of the forest".*

4.5 Entry points in relevant policies

International policies relevant to CASCADE and into which the project findings could feed were discussed extensively during the policy forum. Suggestions of key policies and frameworks from participants include the Sustainable Development Goals (SDGs), the Paris Agreement (on climate change), and a new Intergovernmental Panel on Climate Change (IPCC) special report on the links between land degradation and climate change. The Common Agricultural Policy (CAP) was considered particularly relevant as it has a large budget in the EU and it comprises targets to reduce soil erosion and keep soil organic carbon at certain levels. The interlinkage between development policies and the climate change agenda was also agreed to be important, with CASCADE results offering potential to inform both, as well as more sustainable natural resource use in general. One participant from the United Nations Convention to Combat Desertification (UNCCD) noted that *"In the SDGs there is now the Land Degradation Neutrality as a clear target, plus other targets need to consider soil conservation in order to be met. Equally, in order to meet the 2° target of the Paris Agreement and reach negative emissions we need to take into consideration the role of land and soil management in climate change mitigation and adaptation"*. This view of the articulation of soil conservation with other major agreements was shared, with the ecosystem approach being proposed by the Food and Agriculture organisation (FAO) representative as a way to harness synergy between the various policies.

The research provided by CASCADE can provide better time frames of natural events and ecology. The importance of considering the time frame for grazing subsidies and designing programmes and policies was highlighted. It was mentioned that the temporality of policies, programmes and subventions, can create management issues and increase inefficiency, as expectations from land users can differ from estimated results. It is vital to manage stakeholders' expectations in terms of how long it will take before the benefits of particular practices start to be seen. This can help to reduce disillusionment.

The different time frames over which policy makers, stakeholders and researchers operate creates challenges for creating entry points for research to inform policy. As one researcher noted: "*The policy cycle has its own timeframe which doesn't necessarily fit with the scientific provision of results. I think that is a really key issue that comes up time and time again. It's just the nature of science and the nature of policy making."* Furthermore, applying the principles technically at a land management level was recognised to be different from changing policies as part of a supportive institutional environment.

Given the urgency of SLM, using the precautionary principle in policy making and planning regarding land use and land management was considered relevant to prevent further negative environmental impacts, even if there is inadequate evidence and when more research is still needed. Precautionary measures that need to be in place to prevent serious damage were discussed as a gap between policy and knowledge based measures. Risk reduction measures and a precautionary approach can also be applied to the planning of subsidies. Legislation regarding subsidies has largely focused on emergency measures during disasters, such as providing fodder in drought years. However measures to prevent environmental damage, such as designated resting of grasslands during wet seasons and in extremely wet years to allow regrowth, may prevent those catastrophes and result in more cost-effectiveness in the long term**.** Furthermore, in view of the risk of catastrophic shifts and other

environmental damages (e.g. the increased risk of landslides due to land erosion), concerns spread beyond just environmental factors. Policy actions that sought to ensure human safety under environmental change and degradation conditions were also mentioned.

The importance of linking the management principles derived in CASCADE with wider agendas was mentioned as key to advancing SLM. To further propel the operationalisation of CASCADE's principles, the FAO representative suggested the dissemination of the findings should be linked directly with the SDGs, or other initiatives such as FAO's climate smart agriculture programme. That way, it can be included in the agendas of international policy makers and inform their paradigms and policies. Internationally, the importance of lobbying and disseminating the results was noted. Highlighting SLM priorities and the urgency of action to the EU in Brussels was mentioned as one of the next steps that could be adopted by CASCADE researchers. It was mentioned that in order to be operationalised, policy recommendations needed to be developed in form of specific objectives and guidelines proposed to Brussels. However, discussions also noted the fine line between the provision of scientific information to policy makers and engagement in advocacy and lobbying. Therefore, participants disagreed on the desired roles of scientists within these activities, and their ideal degree of participation.

4.6 Future opportunities and outreach

During the forum, participants discussed not only how researchers can feed their findings into policy, but also how to increase engagement with land managers. It was agreed that the dissemination of the principles and other land management measures benefitted from the participatory approach taken throughout much of the research. It was also highlighted that outreach mechanisms need to use appropriate language and channels of communication to be effective. *"Make the results known to the decision makers but in a way they can understand and can transmit easily",* as an international policy maker stated.

Collaboration and cooperation between organisations was seen by international policy makers as one of the best opportunities to drive changes and improvements in land management, not only at national level but also internationally. As an international policy maker highlighted, outreach can increase social interest and thus the pressure for improving policies: *"Probably the best way for policy makers to take into account what the scientific community is finding is for the scientific community to explain quite well to society about the change of paradigm, not only to the policy makers."*

Knowledge management and databases available to policy makers and land managers, were seen as an area that can facilitate or set back research dissemination, due to the lack of availability of the data or its accessibility. Often although the information can be available, the information is spread out across various specialized databases, thus restricting the accessibility to policy makers. Nevertheless, the UNCCD representative stated that his organisation has been considering the localisation of knowledge, and they are working on the development of a "knowledge hub" to facilitate access to relevant information. He suggested that CASCADE could collaborate and participate in their initiative to help increase the dissemination of project findings.

Furthermore, collaboration and communication was mentioned by policy makers as an opportunity to reach agreements and actions by a land manager from Cyprus*, "We are taking some decisions at*

the technical level. Politicians, ministers see things differently… definitely try to convince them and I hope that the answer will be positive….Further research in the study sites, to monitor CASCADE's measures will in fact add to policy making and pro-intervention."

Soil conservation education at different levels was also considered as a priority area of action, both for land users and policy makers. CASCADE's land management scenarios for analysing grazing impacts were regarded as a potential tool for transformative action, as they can not only guide management practices but also help to convey possible outcomes to a wider audience. CASCADE researchers in Spain found that a local government using a participatory bottom-up approach was more successful at managing fire risks, compared with traditional methods of education, such as awareness campaigns. However, education and social awareness were also cited to be incorporated in long-term management plans.

The contributions of CASCADE can go beyond providing new technical information. As the UNCCD participant stated *"a project like CASCADE can provide more insightful understanding of the socio-economic dynamics- that is quite important. It helps to better plan interventions…because one of the things policy makers hate is uncertainty, so we can provide them with better evidence of what it is going to happen, or is very likely to happen, so it will help a lot to take up the measures and to promote intervention".*

The link between science, legislation and governability were also examined by the participants. The responsibility of local and international policy makers to use knowledge that has been supported by EU funding was questioned by a policy maker. He noted the knowledge gathered by scientific research may fail to reach relevant policy makers, thus failing to permeate key discussions, meaning that the knowledge produced by European funded projects may not be used for policy elaboration. Potentially, a considerable evidence base for policy making is thus being missed. Regarding dissemination, CASCADE has developed an information hub that includes relevant information regarding sudden ecosystem shifts, soil and plant processes, the study sites and management information in the form of videos and documents directed to the general public (See http://www.cascadis-project.eu/better-management).

5 DISCUSSION

Although advanced tools for SLM in drylands such as WOCAT (World Overview of Conservation Approaches and Technologies; www.wocat.net) have been developed, tailoring measures to particular socio-environmental systems is necessary, as conditions vary within sites and over time (Schwilch et al., 2012), and the effectiveness of programmes and measures depend on their capacity to address particular local and external issues affecting land degradation. The close contact of CASCADE researchers with land users and policy makers allowed the project to develop more insightful results and propel a practice of knowledge sharing and learning, appropriate to advance SLM.

However, stakeholders' involvement in the research does not guarantee the identification of appropriate management measures (Schwilch et al., 2012) or the adoption of new technologies. There are various barriers to the adoption of new and innovative land management measures (Fleskens et al., 2014, Sietz and Van Dijk, 2015). Policy research and literature state that decision making is mainly driven by beliefs, values and experience, which in turn can interact with particular

sets of goals and perceptions of issues and challenges (Sotirov et al., 2016, Hall, 1993). These can affect the ways in which research is used.

It is suggested that when the participation process is led by non-state representatives, it is more likely that participants would share and learn information from each other, and solutions would be reached (de Vente et al., 2016). CASCADE researchers were perceived as a third party by stakeholders, able to communicate with them and policy makers without conflicts of opinion. Such perceived objectivity can be useful, particularly if stakeholders are seeking evidence to continue with particular practices. Equally, stakeholders' access to sound information can further foster shared perceptions and goals.

Thus, the learning and knowledge sharing process was considered particularly important by the project, especially where land users and land managers have dissenting positions, such is the case in Crete, where policy makers and shepherds were not able to attend the same workshop due to conflicting views (Sotirov et al. 2016). As shared goals are more feasible to be pursued, participatory approaches can be key in identifying common ground, connecting long and short-term ways of thinking through improved understanding. Using stakeholder engagement throughout, it was possible not only to share information, but also to share priorities, visions, and barriers. This was recognised as a tool to further design and elaborate outreach and management programmes. It also opened new channels of communication between researchers and stakeholders.

5.1.1 FOREST SITES

Stakeholders' perceptions of land abandonment, forest fires and grazing in forested areas of Spain, Portugal and Italy differed. Mainly, stakeholders agreed with post fire and forest fire principles that linked to abandonment, as well as the grazing principles. Yet while they did not disagree with the land management principles, the approach to managing land abandonment was controversial. The causes and consequences of land abandonment are complex and encompass multidimensional factors (Renwick et al. 2013), so its management was perceived beyond the reach of CASCADE. In the views of stakeholders, it was necessary to situate the guidelines within a socio-environmental context. Spanish stakeholders saw this as key to their usefulness and applicability, especially in the land abandonment and forest fire context. In Spain and Portugal living in the region may become difficult due to the lack of services and general economic climate, alongside other externalities. At the same time, the management of the land for forest fires was closely related to land tenure, as the availability and interest of stakeholders to engage in land management varies depending on their stake and the perceived land value.

The key barriers in Spain and Portugal related to land tenure and the lack of laws that allow land managers to apply forest fire measures on private land. Private and public sectors can have different goals, which can also change over time, as values and socio-economic conditions change (Cubbage et al., 2007), while private management may respond to shorter term needs and values.

Land tenure in the hands of multiple land owners with small sized plots was perceived to be hampering land management, as land owners of smallholdings may not be involved in land management. In Portugal stakeholders stated that successful operationalization of forest fire prevention is restricted by the predominantly small-scale forest land parcels. Here, abandonment links to forest fire management.

In Italy, given that land tenure is held in larger land plots, the representative of the farmers'/shepherds' union considered that the best option would be to set up an agency to oversee the management of publicly owned land that favoured agricultural and forestry use. This could help to preserve and better maintain publicly owned lands which are currently at risk of abandonment.

Given the complexity of managing the land when land tenure is distributed in smallholdings, stakeholders in Spain considered focusing on individual and localised productive projects as the best opportunity to boost conservation and development. Even if such projects are held at a small scale, they could work as a network. Small successful projects in the region could in turn spark development at a local level, as well as recover interest in the land once other proprietors realize its potential. Furthermore, land owners could form cooperatives to boost local production, as well as their incomes. The strategy of localised sources of production would help to concentrate on the commercialisation of valuable resources such as honey production, agrotourism and ecologic agriculture, plus they considered it more feasible as it is at a small scale and it would be possible for technicians to support owners. Stakeholders would expect that these projects could stabilise the population. Such development was seen as requiring simultaneous efforts towards creating schools for farmers. This was a novel and unexpected insight, that land users can be engaged in revitalising an area by making localised efforts, especially as more conservative or traditional strategies were expected.

Fire awareness campaigns in Spain have been ineffective according to a stakeholder from the forest fire prevention department, as many are a consequence of badly-managed stubble burning by farmers, rather than the result of accidental or negligent actions. Fire prevention campaigns were considered as top-down approaches to increase awareness. Instead, a bottom-up approach through boards and owners organisations was considered necessary by the forest fire department representative. Local stakeholders in Spain are nevertheless exploring legal means to move forward fire prevention strategies on private property. Lessons from Spain could be usefully tested in other study sites.

In general, Spanish stakeholders did not complain about the lack of technical information and documentation as a barrier to improve SLM. The Centre of Forest Research and Experimentation (CIEF) (Conselleria de Agricultura, Medio Ambiente, Cambio Climático y Desarrollo Rural) works as a governmental research centre in charge of providing GIS information and there are local technicians working within the region. Land managers and decision makers are usually affiliated to governmental or academic institutions, therefore they can access the information if necessary. In other study sites however, information is sometimes lacking or difficult to access.

In Italy, rural tourism was seen as a good alternative to boost the region's development and to sell local produce. The tourism authority stated that there have been actions to support and promote tourism in the region, however, this was hampered by a lack of cooperation as local farmers try to sell produce independently. Direct trade with the consumer is also commonly seen as the best way to increase produce revenues and maintain production, as mentioned by the beekeeper representative in Italy. There is a common belief that tourism increases economic revenues, can improve infrastructure and promote general community development, however, to ensure that tourism development meets community expectations appropriate planning and community collaboration is necessary (Presenza et al., 2013).

Additionally, in Portugal and Spain stakeholders mentioned the need to develop farmer schools in order to maintain and transmit traditional knowledge, in shepherding, ethnobotany and ethnozoology courses, as well as to learn new SLM technologies. These kinds of ideas support many of the suggestions made at the policy forum regarding making information available to stakeholders in different ways and ensuring SLM interventions are linked to wider environment and development debates and challenges.

5.1.2 GRAZING SITES

In Cyprus and Crete, stakeholders generally agreed with the grazing principles that CASCADE proposed. Shepherds also mentioned that it was the first time that any institution approached them to talk about dryland management, and showed interest in their information and measures. Thus, it is important to maintain these kinds of efforts. Low levels of contact with dryland farmers can lead to their alienation as they can see how traditional land uses have devaluated under government indifference, which can lead them to refuse to engage with conservation efforts (Onate and Peco, 2005). Given the value of stakeholder engagement noted at both study site workshops and the policy forum, it will be vital to ascertain how best to keep in touch with the stakeholders after the end of the CASCADE project.

In Cyprus the oldest shepherds disagreed about the feasibility of integrating olive trees and carob trees in grazing areas. As mentioned before, when perceptions of traditional values are challenged by new information, there is also the risk that stakeholders reject facts in order to protect their core beliefs, thus stakeholders are more open to information that doesn't challenge their beliefs and values (Sotirov et al., 2016). Nevertheless, through participation during the study site workshop the youngest shepherd was able to convince almost all of the rest that it was in fact feasible. Equally, they were reluctant to stop killing predators, due to traditional practices rather than environmental reasons. It is clear that such traditional practices should not be overlooked but rather, engaged with and explained in order to better understand them. Stakeholders are not however totally closed to new opportunities. Nevertheless, given the current situation in Cyprus and the wider Greek economy, market diversification in a sustainable way is considered even more unrealistic in the current socioeconomic context unless incentives are provided.

In Crete while all stakeholders considered actions after fire or drought effective, in practice this is not always the case. For many measures stakeholders saw the potential benefit of the principle, but lack the motivation for applying a new measure, thus, further efforts and incentives to reap benefits and start a wave of action are needed. Bridging the gap between knowledge and action remains a challenge.

Policy makers from Cyprus also requested more information regarding new knowledge about soil management and overgrazing, which is particularly encouraging. Policy makers often concentrate their environmental conservation efforts on protected areas, thus local CASCADE researchers considered that attention to drylands and farmland areas is a step forward to prevent further land degradation. This suggests the new information provided by CASCADE can broaden policy makers' horizons and interests.

5.1.3 Using and sharing knowledge for SLM in the Mediterranean, opportunities for dissemination

Stakeholders welcomed the information given by CASCADE both in the policy forum and in the stakeholder workshops. Strategies to improve the land management agenda were noted by policy makers, such as the potential uses of management scenarios, identifying pathways for management and appreciating the benefits of stakeholder engagement and institutional collaboration.

There is still nevertheless a lack of evidence for decision makers to make an informed decision about SLM investments. Using techniques such as scenarios still offer great untapped potential. It was considered that the development and explanation of management scenarios can be particularly useful for dissemination and planning. For example an Agriculture NGO representative in Spain considered that land change scenarios could be used to demonstrate the future impact of guidelines for forest and land management in the Mediterranean region. Indeed, the use of scenario analysis and other foresight methodologies has been found to aid development of common understandings of the near future, and the challenges and opportunities for stakeholder participation (Sotirov et al., 2016). This approach can also raise awareness of the resources at stake in case of inaction, therefore is useful to promote the urgency and importance of the principles proposed by CASCADE. To deliver scenario information to a general audience can be key to convey support and engagement, for which scenarios and modelling should aim to be flexible and less complicated able to convey a narrative of future pathways (Kok and van Delden, 2009). Through the use of scenarios it is possible not only to convey a message (Kok and van Delden, 2009); scenarios can be key to appraise best measures and practices, particularly for mitigating land degradation (Fleskens et al., 2014).

During the policy forum various participants stressed the importance of the dissemination of CASCADE work and results to support policy and practices at different levels. As an international policy maker from UNCCD envisaged it "…*CASCADE can take one additional step which is expanding collaboration and cooperation nationally and internationally, for different areas, and other countries and regions. But also with different entry points, sometimes for forest fire management, sometimes for forest landscape restoration*…". Equally, CASCADE's approach and findings can be applied and tested for their applicability in other areas of the world.

Effective SLM needs a coherence across socio-economic, legal and institutional approaches and measures (WOCAT, 2007). International initiatives to coordinate and share knowledge on advances towards SLM in the Mediterranean were mentioned as potentially beneficial by stakeholders in Portugal. Sharing knowledge and alternative histories of success was deemed potentially useful, as it could be replicated throughout the region. At a regional level, there are already international collaboration initiatives that share knowledge and efforts towards land management and productive enterprises. These initiatives are promoted by governmental entities but only work to link local partners in both countries. Stakeholders in Portugal mentioned that there is a current collaboration project, with the Basilicata region in Italy. Such cooperation could be vital for exchanging expertise. More could nevertheless be done in this regard to enhance knowledge sharing.

The role of researchers in SLM was also discussed, the ethical and professional implication of staying as a distant non-participant spectator were regarded as by a resource manager who noted that "*Sometimes it's our fault as scientists, too much science and we could not clearly convey the message to the policy makers [about] what exactly needs to be done…. I mentioned the Four per Thousand*

initiative… a group of soil scientists said -Yes but this cannot be implemented because you cannot do this, you don't have data for that-So that's our part?". Therefore a wider discussion over the use of pragmatic approaches to improve land management and the role of scientists therein may be beneficial. There is also still a lack of evidence for decision makers to make an informed decision about SLM investment. To decide when and where to invest, it is necessary to gain an understanding of the non-linear behaviour of the ecosystem dynamics, as environmental conditions varied and the windows of opportunity for specific measures can be critical (Sietz 2017). Together, these aspects highlight that despite important advances within CASCADE, much research remains to be done.

5.1.4 Laws and Incentives

Local

Due to issues arising from land tenure, one of the most commonly discussed options for improving coordination and collaboration in Spain was organisation schemes to congregate stakeholders around specific objectives. Such efforts have been working in other areas of Spain, such as the "mesa de concertación" (agreement boards) working in the Valencia region, or the "Mesas forestales" (Forestry table) or "Juntas Rectoras" (governing board of Natural Parks), where boards or organisations are generally grouping multiple local stakeholders with the aim of managing the land.

In Spain there is currently an initiative to carry out a census of abandoned lands, with the aim of fomenting legal means that allow the administration of them for environmental conservation efforts. This is known in the region as *"Custodia del territorio".* Such legal means and the formalisation of collective efforts could be usefully assessed in further research as to their effectiveness and appropriateness across other forest sites.

National

In Italy, improving poor infrastructure e.g. through improved road maintenance was considered by the stakeholders as one of the biggest challenges in order to boost development in the area. Lack of services can boost land abandonment if quality of life is perceived as low, and even small investments in infrastructure can boost the rural economy. Nevertheless, stakeholders considered that in a future scenario, the territory could be in a condition where land values stabilise. Therefore, existing infrastructure should be maintained (road maintenance, keeping access roads open, maintenance of irrigation networks etc.), in order to guarantee its future use. In the same way intangible assets must be preserved, such as skills and know-how (e.g. knowledge exchange about edible wild plants, methods for making bread etc.). Such efforts require policy actions and appropriate legal and institutional frameworks.

In Italy during the stakeholder workshops, it was mentioned that some legislation was hampering the production of local farmers, such as regional legislation halting on-farm slaughtering. Legislation allowing farmers to cut production costs by slaughtering and selling their produce independently (as farmers slaughtering animals on site are doing it illegally under this law) was seen as beneficial by stakeholders. Thus, farmers' associations were seen as an option to strengthen local food networks and promote on-farm food processing of niche products. Organisation was also seen as key, as farm cooperatives could set-up a small number of collective processing plants that all farmers would have access to.

In Italy cooperation features heavily in the new policy planning period. Due to land abandonment, there is a strong consensus on the need for policies that address not only economic development but also social and environmental needs. However, although in Italy farm fragmentation is rare, it can also be a problem for SLM, as small scale owners can have less capacity to implement costly measures, plus efforts are fragmented and less effective if coordination and compromises are not achieved between owners.

In Spain the current land management directives are under study to allow actions in private lands especially in areas with high (fire) risk. Most of those areas are set aside agricultural lands (pseudoforests) with high density of pines and very low or no successional progress. The Forest Law established in 1993 already tried to permit actions in private properties affected by the design of Areas of Urgent Action (ZAUs) (mainly firebreaks) but it failed as it required one individual agreement per piece of land. Supporting this with subsidies is not feasible due to the huge number of properties and unknown land owners in many cases.

EU

In Portugal, stakeholders perceived access to EU funds as key to implement mulching as an emergency measure for stabilization. Another possibility for increasing the viability of mulching, would be the existence of a local biomass power plant, so that the costs of handling the logging residues and their application as mulch, after shredding, would, at least partially, be covered by the economic valorisation of the larger woody parts delivered to the power plants. Again, these options require institutional support.

In Italy stakeholders mentioned that providing retirement incentives to older farmers could promote greater generational change, and the farmers'/shepherds' union representative mentioned that the EU's measure on minimum tillage should be implemented in order to incentivise conservation agriculture.

In Basilicata, 87% of the territory is classified as mountainous, therefore, certifications such as the "Mountain Product Certification" (Regulation EU No. 665/2014) gives the region the opportunity to uniquely brand its products. Local producers in Italy saw policies on certification and designation of origin (Regulation EU No. 1151/2012) as an alternative to add value to the production, and improve resilience, as produce prices could withstand price fluctuations and continue activities if prices of a determine good fall dramatically at a given point.

However, designation of origin can also have undesired consequences if demand surpasses the supply capacity. Cypriot Halloumi cheese gained the origin denomination in 2016. Therefore, there is an ongoing campaign to boost milk production to satisfy the demand.

In synthesising the proposals from the study sites and considering them in conjunction with those from the policy forum, big gaps are apparent between the large-scale initiatives at the international level and the smaller scale efforts at local levels that can help movement towards SLM. Further work is needed to bridge these gaps if international initiatives such as the UNCCD's Land Degradation Neutrality target setting programme are to resonate with local land managers.

6 CONCLUSIONS

The global importance of land degradation and its negative impacts on agriculture goes beyond the loss of environmental services. Humanitarian crises worldwide are arising due to the loss of land productivity as tipping points are reached. The urgency of improving SLM stresses the importance of advancing CASCADE goals and the dissemination of its work. Reaching SLM requires transformative change. One important strategy for this involves research allied with participation, collaboration with broader institutional efforts and steps to foster permanent cooperation. CASCADE aimed to provide new and relevant information not only to manage the present and project future scenarios, but also to create the bridges necessary between stakeholders, policy makers, researchers, land users and land managers. Further dissemination process will close the circle of social engagement. By learning from each other, CASCADE researchers were able to build trust and share common goals, and is a job that will prove essential in oncoming years due to climate change. Furthermore, the role of the moderator is also important, a further review and compilation of the methods used by CASCADE's team when delivering the principles, and a discussion about the particular reception in each study site, could yield interesting results.

The forest fire and post fire principles proposed in Spain and Portugal reached a high level of approval from stakeholders, although various barriers were perceived to limit their applicability. Between the perceived barriers for applying forest fires and land abandonment principles were land tenure in both countries and individual and tailored technical support for private owners in Portugal. In Cyprus and Crete, stakeholders agreed with the overgrazing principles, although shepherds were resistant to stop hunting predators, and some challenged those principles different to their traditional practices.

Highlighting the relevance of new knowledge and linking it to relevant national and international policies was one of the most frequently mentioned ways to include CASCADE's findings in future planning.

CASCADE's contributions are not restricted to innovative information. The research and experiments carried out also confirmed and concurred with empirical information, supporting some traditional practices that have been lost. Thus they not only highlighted the effectiveness and importance of some of the traditional local land management practices, they also provided more detailed guidelines and support for their application. This may be particularly important in the case of traditional knowledge that may have been lost, as traditional knowledge is generally less valued in policy making than scientific studies (Stringer and Reed 2007). Furthermore, during the policy workshop it was mentioned that it is more feasible to include knowledge-based regulations in policy, as it can help to deal with uncertainty.

The importance and soundness of scientific concepts, as well as how unanimous theory and practices are within the scientific community has serious implications in advancing the policy agenda and agreements, as incorporating measures in evidence based policy making require scientific support. On the other hand stakeholders 'on site' are dealing with tipping points and the loss of environmental services, therefore, urgency of action may require more pragmatic approaches. It is therefore vital that both kinds of stakeholders work in collaboration with scientists.

Finally, the information presented in this report further advances our knowledge about stakeholders' views and their perceived challenges in applying SLM measures. This information can in turn, be used to foster agreements between stakeholders, as they can identify common ground and thus move forward and agreed on shared goals. Policy makers recognized that CASCADE's research and new insights from controlled experiments and modelling scenarios, can also help them design programmes and act as a roadmap for actions for improving land management and conservation. This reiterates the importance of integrating knowledge across disciplines, stakeholders, scales and timeframes in order to reach decisions and practices that can really advance SLM.

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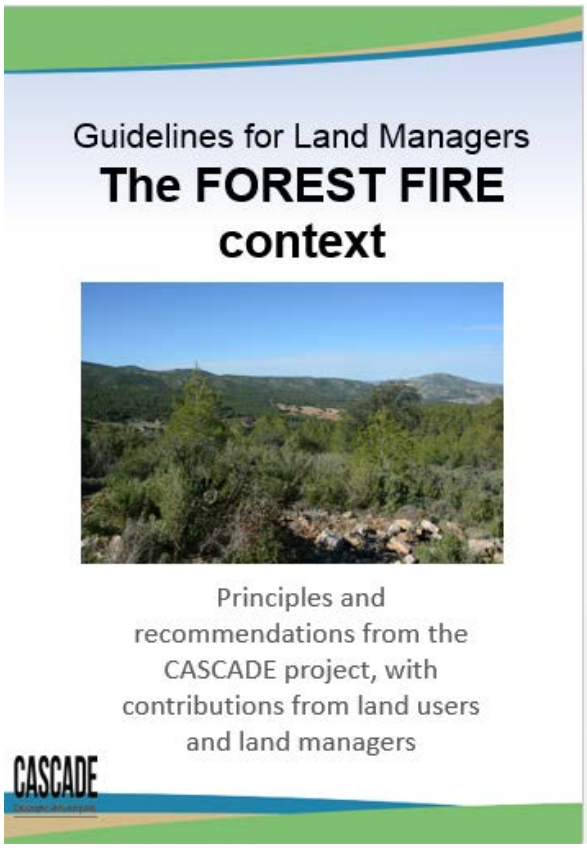
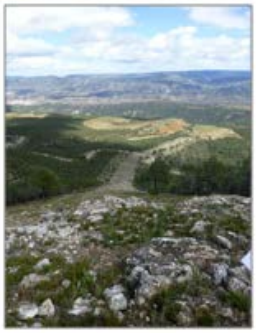
8 ANNEX. I CASCADE's management principles

9 I.I FOREST FIRE PRINCIPLES



**Cropland (top) and fuel breaks (right) decrease the connectivity of the forest, reducing the fire spread and facilitating access for fire fighters



Sources:
(1) Selective forest clearing to prevent large forest fires (SPA010). Selective cutting (ITA008)
(2) Fuel breaks (ITA007, SPA009, POR001)
(3) Preventive forest intervention approaches (A_POR001, A_SPA002)

CASCADE

3

Guidelines for Land Managers

The FOREST FIRE context

Principle 2: Diversity of species reduces flammability, as well as outbreaks of pests, and thus leads to reduced fire hazards. In particular, promoting resprouters facilitates recovery after fire.

- ✓ **Avoid afforestation with single or flammable species**
- ✓ **Sustain and increase diversity of endemic plants**
- ✓ **Avoid removing resprouters**
- ✓ **Plant resprouters in favourable places (northern slopes, humid spots)**

Mediterranean forests in fire prone areas are at present dominated by seeder species (those regrowing from seeds after fire), especially where afforestation with Pines was implemented*. These are very flammable.

Resprouters (those regrowing from the roots after fire) are less resistant to drought and germinate with more difficulties than seeders. But they increase the capacity of the forest to recover after fire, especially if conditions in the first year are not favourable for seed germination.

*Typical seeder (left) and resprouter (right) species of the Mediterranean

CASCADE

4

Promoting a diversity of tree species and understory cover reduces forest flammability, because each reacts differently to fire. Increasing diversity of vegetation also reduces the impact of plant specific diseases that can in turn increase flammability, because sick and dead plant material are drier and thus more flammable.

Whenever removing vegetation (e.g. during logging, clearing, firebreak creation) beneficial species (e.g. resprouters) should be maintained (5, 6).

Land management options include **afforestation with diverse species** (4)** and **selective forest clearing** (1) ***

**Diverse afforestation area with Holm Oak and other resprouter species (left)

***Forest with reduced density of trees after selective clearing (right)

Sources:
(4) Selective clearing and planting experiment to promote shrubland fire resilience (SPA011)
(5) Shrubland under selective clearing and planting for fire risk reduction

CASCADE

5

Guidelines for Land Managers

The FOREST FIRE context

Principle 3: Sufficient soil cover shortly after a fire reduces risk of soil erosion

- ✓ **Keep or reach a minimum of 50-60% of soil cover**

Vegetation has an important role in preventing soil erosion* thereby retaining nutrients and thus maintaining soil fertility (7). CASCADE studies have also highlighted that a reduction in vegetation promotes a long-term decrease in soil fertility (8). Avoiding soil and fertility loss is also important for recovery of vegetation after fire.

*Plant holding the soil through its root system

Soil cover can consist of living vegetation or dead plant residues**, (e.g. from logging) However, there is a risk that this material may spread plant and animal diseases and pests such as nematodes, and also increase the fuel load (9).

**Dead plant residues increase soil cover but also the risk of pest and fire

CASCADE

6

To simultaneously reduce the risk of fire and avoid soil erosion, a vegetation cover of 50-60% should be maintained, especially in fuel breaks or cleared areas.

Land management options include **mulching after fire** (10) and maintaining soil cover in **fuel breaks** (2)***.

***Forests managed to reduce density of vegetation (top) and connectivity (right) while keeping a minimum of soil cover

Sources:
(7) Afforestation with Pinus Halepensis after the fire of 1979 (La Molinera) (SPA012)
(8) Mayor A. G. et al. (2016). Fire-induced pine woodland to shrubland transitions in Southern Europe may promote shifts in soil fertility. Science of The Total Environment.
(9) Traditional post-fire logging
(10) Mulching after fire (POR003, POR004)

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Photos: *Matteo Jucker Riva*
Layout: *Nichola Geeson, (MEDES Foundation, Italy)*

We thank Vicente Calomer (Spain), Eng. Rui Melo and Eng. Rui Pedro Ferreira (Portugal) for the contributions

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10 I.II GRAZING PRINCIPLES

Guidelines for Land Managers

The OVERGRAZING context

Principles and recommendations from the CASCADE project with contributions from land users and land managers

CASCADE

Guidelines for land managers
OVERGRAZING context

Principle 1: Reduction of vegetation increases soil erosion, leading to less fertile soil and less productive pastures

- ✓ **Keep a minimum of 30-40% soil cover**
- ✓ **Rotate grazing areas and control the amount of animals**
- ✓ **Use stall feeding, especially during the dry season**

Vegetation cover is important to protect soil against erosion and to maintain soil nutrients and soil water content*, which in turn guarantee that plants remain healthy and continue growing (1). If the surface cover falls below 30-40%, soil erosion increases sharply. At such low cover, connectivity of bare patches facilitate loss of water and nutrient resources, resulting in possibly irreversible changes**.

**Temporary (right) and permanent degradation (bottom) caused by overgrazing

*Healthy (darker) soil from a vegetated area placed on a degraded (white) soil from an overgrazed area

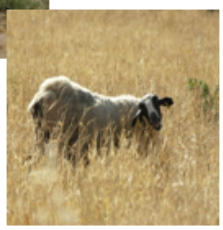
CASCADE

2

If grazing is too intense, the proportion of bare soil increases and hence permanently degrades the pasture (2). This is particularly relevant during droughts (2) or in summer, where the vegetation is most under pressure. During these periods, alternative sources of fodder** should be provided to animals (3), and care should be taken to maintain a vegetation cover of at least 40 % (1,4).

Land management options include **fodder provision** (3), rotational grazing and area closure.

** Cultivating and storing fodder, hay making, cut and carry systems, and excluding some areas from grazing can help maintain the environment even during the driest periods



Sources:
(1) CASCADE Deliverable 4.2
(2) CASCADE Deliverable 6.1 page 3
(3) Fodder provision to reduce grazing pressure on natural vegetation (CYP001)
(4) Mayor A. G. et al. (2016). Fire-induced pine woodland to shrubland transitions in Southern Europe may promote shifts in soil fertility. Science of The Total Environment

CASCADE

3

Guidelines for land managers
OVERGRAZING context

Principle 2: Integrating trees and pastures has ecological and socio-economic benefits

- ✓ **Protect existing trees**
- ✓ **Plant fruit and fodder trees such as carob**
- ✓ **Diversify pasture land products to explore new market opportunities**

Livestock production allows only relatively low gains, especially if competition from markets elsewhere is high and the productivity of pastures is low. Introducing fruit trees in pastoral lands can improve pastures*, provide additional fodder and shade for the animals, decrease soil erosion and improve soil fertility. Products from olive or carob trees can create additional income from alternative markets** (4, 5).

Land management options include **planting carob trees on grazing land** (5).

**Carob trees are particularly adapted to dryland pastures and provide valuable products

*Trees in pastures help retain the soil and provide shade

Source:
(5) Planting Carob trees in degraded grazing land (GRE008)

CASCADE

4

Guidelines for land managers
OVERGRAZING context

Principle 3: Pest management requires an integrated ecosystem approach to promote natural predators

- ✓ **Protect ecosystem floral and faunal diversity**
- ✓ **Avoid killing all snakes, wolves or other predators**
- ✓ **Protect trees against rats**
- ✓ **Install fences and traps**
- ✓ **Provide nest boxes for birds of prey**

Animal pests such as rats and boars, beyond a certain number, can damage the vegetation, increase soil erosion and thus reduce the value of pastures. Long term improvement has to consider the ecosystem as a whole, in order to increase the number of wolves, snakes, and eagles.

Short term land management options include **tree protection from rats*** (6) and **fences to prevent damage from wild boars** ** (7).

**Fence to keep wild boars out

*Measures to protect trees and pastures from pests

Sources:
(6) Carob tree protection from rats (CYP003)
(7) Metallic fences to prevent damages to pastures from wild boars (ITA005)

CASCADE

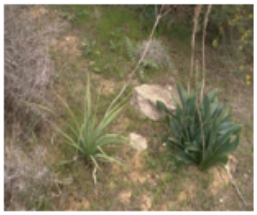
5

Guidelines for land managers
OVERGRAZING context

Principle 4: Animal types and herd composition influence plant diversity and health. Overgrazing by uniform livestock species can lead to the spread of invasive/unpalatable species

- ✓ **Plan resting periods for pastures**
- ✓ **Selectively remove unwanted species, while keeping some for soil protection if necessary**
- ✓ **Diversify animal types**
- ✓ **Increase health and productivity of individual animals instead of increasing the size of the herds**

Animals tend to eat the plants that they prefer (e.g. annual grasses or large-leafed plants) and avoid the unpalatable or less tasty species* (e.g. perennial grasses or thorny shrubs).



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*Unpalatable species colonize overgrazed areas, reducing productivity and changing the ecosystem

6

*Shift (from left to right) from annual grasses To perennials caused by prolonged grazing

Continued and heavy grazing changes the vegetation and can decrease pasture productivity*. If the unpalatable species have a competitive advantage over the more palatable ones, this process can lead to a permanent change in the ecosystem.

*Fencing to exclude livestock temporarily helps the "good" plants to recover

**Unpalatable species like ferns (left) can be cut and used as litter for stables, and the fields can be ploughed and seeded (top) to restore them

Pasture degradation can be prevented by allowing the pastures to rest, especially during the growing season, favouring the recovery of more palatable species*.

Land management options include having different types of livestock (e.g cows, sheep and goats), **manuring pastures** (8) and **ploughing and seeding of fodder species to recover degraded pastures** (9).

Sources:
(8) Pasture manuring (ITA003)
(9) Ploughing and seeding of fodder species to recover degraded grazing areas (ITA004)

CASCADE

7

Guidelines for land managers
OVERGRAZING context

Principle 5: Controlled grazing reduces risk of fires, and maintains grass species and productivity of pastures

- ✓ **Avoid completely abandoning an area for a long period**
- ✓ **Limit grazing during the dry season as much as possible**
- ✓ **Remove woody/thorny bushes mechanically once they are abundant**
- ✓ **Install fuel breaks or reduce bush cover into hedge rows to (re-)allow grazing and thus decrease fire risk**

CASCADE

*Abandoned agricultural terraces and pastures in Cyprus

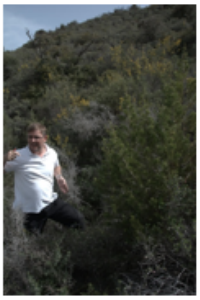
8

In dry areas, wildfires can occur whenever there is sufficient vegetation to burn*. Grazing reduces the amount of fuel, and has an important effect in reducing the occurrence of fire (4).

If pastures are not grazed anymore, they can become much more vulnerable to fire. If the vegetation includes thorny shrubs, once it is too thick, animals will not be able to enter it, generating a vicious circle that leads to loss of productive pastures and increased fire risk.

Thus pastures should not be completely abandoned for long periods, but should be grazed at moderate intensity and rested occasionally.

Land management options include controlled and rotational grazing.



*Abandoned pastures with too great a bulk of vegetation can easily catch fire

Sources:
(10) Carpio afforestation on grazing land

Guidelines for land managers
OVERGRAZING context

Principle 6: After a fire or drought continued grazing could lead to a permanent change in pasture productivity and quality

- ✓ **Reconsider management immediately after a fire or during a drought by reducing grazing, allowing a minimum of 2 years for resting, and providing supplementary fodder**
- ✓ **In case of a permanent loss of vegetation cover or quality, actively revegetate/regenerate/restore**

Even if grazing is sustainable during "normal" periods, it can degrade the land irreversibly during or immediately after a disturbance, such as a drought or a fire*.

*Allowing grazing after a fire prevents regrowth of palatable vegetation (left) and increases the presence of invasive species (right)

To ensure that the land recovers from disturbance and returns to productivity rapidly, it is important to modify the land management immediately after a disturbance and not to wait until it is evident that it is not recovering**.

Land management options include grazing exclusion, irrigation, **revegetation** (11, 12).

*Examples of grazing exclusion (left) and revegetation (right) in arid rangelands

Sources:
(11) Restoration options CASCADE Deliverable 5.2
(12) Multi-specific plantation of semiarid woody species (SPA013)

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11 I.III LAND ABANDONMENT PRINCIPLES

Guidelines for Land Managers

The LAND ABANDONMENT context

Principles and recommendations from the CASCADE project with contributions from land users and land managers

CASCADE
Catastrophic shifts in drylands

RECOMMENDATIONS FOR LAND MANAGERS
The LAND ABANDONMENT context

Principle 1: The environment of abandoned land can change in unexpected and diverse ways: it might not continue to provide the same services, and degraded land might not recover spontaneously

- ✓ **Adapt to the changes in the environment to exploit new ecosystem services**
- ✓ **Maintain a certain level of use of the land if you want to avoid radical changes to the landscape and a decrease of productivity**

The environment of abandoned land can evolve following diverse pathways depending on the limiting conditions (e.g. soil type, water availability, topography).

The vegetation can shift to a different type of community (e.g. from grassland to shrubland or to forest)*(1).

* Cropland and pastures turned into shrubland (left) and forest (right) after abandonment

CASCADE
Catastrophic shifts in drylands

2

If the land was particularly degraded before the abandonment, or if the environmental conditions are limiting spontaneous recovery, the land degradation might increase even after the land use has stopped.**

This means that the services provided by the land will change, and without substantial investment it might not be possible to revert back to using the land as it was before abandonment.

Thus it might be more desirable to plan for some areas to adapt the land use*** and for others to maintain the previous use (e.g. rotational grazing to maintain pasture, cultivating with longer fallow periods).

Abandoned land can also be specifically managed for its biodiversity.

Land management options include **revegetation of abandoned land** (2), rotational grazing, or some alternative use of the land.

**Land abandonment does not always increase the bulk of vegetation. Lack of management can sometimes lead to severe land degradation

***Bee-keeping, tourism and wind energy are possible alternative uses of abandoned land

CASCADE
Catastrophic shifts in drylands

Sources:
(1) CASCADE Deliverable 2.1 Italian study site
(2) Multi-specific plantation of semiarid woody species (SPA013, SPA016)

3

RECOMMENDATIONS FOR LAND MANAGERS
The LAND ABANDONMENT context

Principle 2: Environmental changes regarding vegetation, soil and water after land abandonment can lead to new risks that require specific management

- ✓ **Monitor the environment and adapt management to new risks**
- ✓ **Actively regenerate and revegetate abandoned areas to prevent soil erosion, flooding or further land degradation**

Environmental changes on abandoned land, combined with an interruption in the management of the area, can produce new disturbances like fire, soil erosion or floods with relevant on-site as well as offsite impacts.

Observing and monitoring the environment* should continue despite land abandonment, and management should consider new risks such as fire (related to increased biomass), landslides (related to abandonment of terraces and roads) or increased flooding and erosion.

Land management options include **fuel breaks** (3) and **revegetation of abandoned land** (2), especially in case of heavy degradation to re-naturalize the area and prevent further negative impact.

*Examples of revegetation and monitoring of vegetation growth

CASCADE
Catastrophic shifts in drylands

Sources:
(3) Fuel breaks (ITA007, SPA009, POR001), Forest Management Plan (A_ITA001)

4

RECOMMENDATIONS FOR LAND MANAGERS
The LAND ABANDONMENT context

Principle 3: Land that is not used or economically valuable at present can be used in the future

Recommendations:

- ✓ **Maintain infrastructure (e.g. roads, terraces, irrigation networks)**
- ✓ **Maintain knowledge for future generations**
- ✓ **Explore new emerging market opportunities**

Even if the land is not economically valuable or productive at the moment, it might still be culturally important. Changes in subsidies, market or in the environment may change the situation and increase the demand for land, previous land uses or new ones.

Infrastructure such as roads, irrigation networks and terraces should be maintained at a basic level, as they are essential to allow future access and use of the land*. Also, their destruction could lead to enhanced risks of landslides, flooding and erosion.

Knowledge related to the land and the former land uses should also be maintained, as a basis for a sustainable use of the land in the future.


* Unused infrastructure such as terraces and waterpoints should be maintained

RECOMMENDATIONS FOR LAND MANAGERS
The LAND ABANDONMENT context

Principle 4: Labour availability is a constraint in abandonment-prone areas

- ✓ **Focus on activities requiring low labour for land management / maintenance**
- ✓ **Promote cooperation and participation among land users, to make the most of current use and management**

In areas where there is outmigration or land abandonment, the former land management or land use may become difficult to maintain because of the lack of labour.

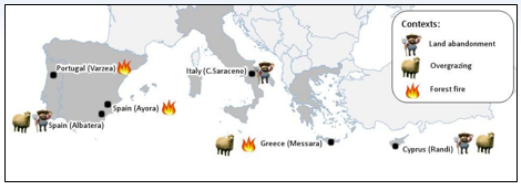
In order to preserve the land and to keep the possibility to return back to former land uses, management should concentrate on activities that are not labour intensive (e.g. from agriculture to silviculture; from sheep to cattle farming)*.


*Examples of fodder cultivation on former cropland (left) and silviculture (right)

Labour requirements for land management can also be reduced by increasing cooperation among the remaining land users. They can reduce costs , inputs and labour requirements by sharing tools and machinery, and cooperating for major works such as restoring land or increasing access to land.

Participation of land users in management decisions, and exchange between land users, local administrators and land managers * can lead to new land uses and adaptation measures, requiring less labour, such as golf or hiking areas.

*Cooperation and exchange of knowledge with land users



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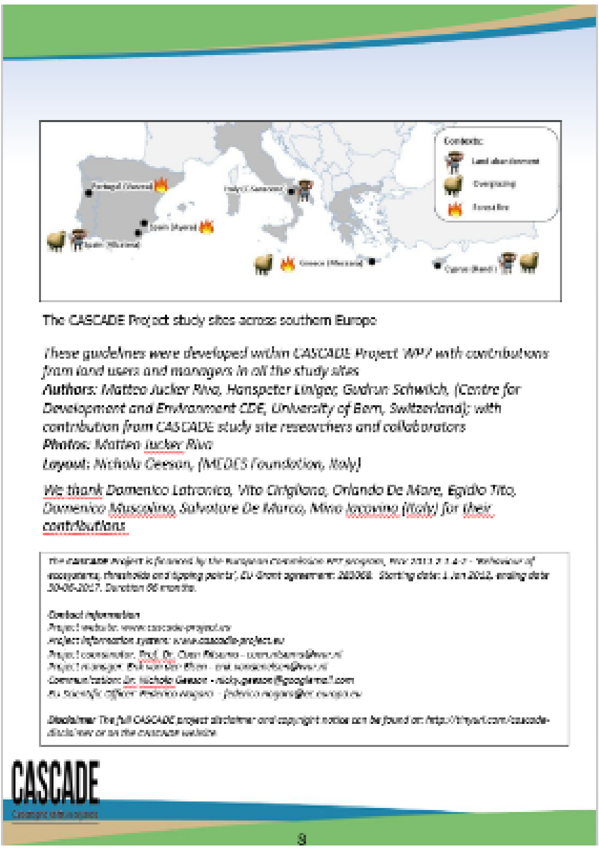

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12 I.IV PORTUGAL POST FIRE MANAGEMENT PRINCIPLES

Recomendações para gestores florestais

Após Incêndios Florestais

Princípio 1: Assegurar uma cobertura do solo elevada, tanto após o incêndio como após as operações florestais pós-fogo, **reduz o risco de erosão e a perda de fertilidade do solo.**

Recomendações

- ✓ **Manter ou aumentar um mínimo de 50-60 % de cobertura do solo**
- ✓ **Aplicar um acolchoado de resíduos florestais *(mulching)* para aumentar a cobertura**

Aplicação de mulching

Mulching natural

A vegetação e a manta morta têm um papel importante na prevenção da erosão e da perda de fertilidade do solo. Estudos realizados no âmbito do CASCADE evidenciaram que um incêndio, através dos seus impactos na vegetação, na manta morta e no próprio solo, pode aumentar substancialmente as perdas de solo e a sua fertilidade. É importante minimizar estas perdas, quer para facilitar a recuperação do ecossistema após o incêndio, quer para reduzir a poluição de cursos de água a jusante, com sedimentos e, em particular, com cinzas erodidas.

Cobertura do solo pós-fogo suficiente

Cobertura do solo pós-fogo insuficiente

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Recomendações para gestores florestais

Após Incêndios Florestais

A cobertura protetora do solo consiste, em primeiro lugar, na cobertura providenciada pela vegetação que resiste (seja ela viva ou morta) e pelos seus resíduos na superfície do solo (designada de manta morta). Por exemplo, os resíduos do corte ou as agulhas caídas das copas de pinheiros chamuscados pelo incêndio. No entanto, existem constrangimentos na deposição dos resíduos resultantes do corte de pinheiro por razões fitossanitárias, como a disseminação do nemátodo. Também existe alguma preocupação relativamente ao contributo destes resíduos para o risco de incêndios futuros.

Cobertura do solo com mulching natural

Retenção do solo e das cinzas

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Recomendações para gestores florestais

Após Incêndios Florestais

Princípio 2: Minimizar os impactos das operações florestais pós-fogo (corte e extração do material lenhoso) **na vegetação, na manta morta e no solo.**

- ✓ **Acompanhar as operações florestais pós-fogo de forma a minimizar os seus impactos nos pinheiros, na cobertura protetora do solo e nos trilhos criados pela maquinaria**
- ✓ **Avaliar e monitorizar os impactos das medidas de mitigação, para manter uma atualização regular das boas práticas de gestão florestal pós-fogo**

O corte e a extração do material lenhoso após o incêndio é a operação típica e prioritária na gestão florestal pós-fogo, do ponto de vista económico (comercialização da madeira), das boas práticas de silvicultura (regeneração da vegetação) e do ponto de vista legal (combate ao nemátodo).


Corte de conservação pós-fogo

No entanto as operações florestais, nomeadamente as que envolvem máquinas pesadas, podem ter impactos negativos:

- na recuperação da vegetação (inclusive na regeneração espontânea dos pinheiros);
- na cobertura protetora do solo promovida pela manta morta (designadamente pela remoção dos resíduos do corte);
- na erosão do solo (através de compactação do solo bem como pela criação de trilhos pela maquinaria, que podem transformar-se em "autoestradas" para a escorrência superficial).

É ainda de realçar que a extração tanto da madeira como dos resíduos de corte representam uma diminuição do carbono armazenado no ecossistema, bem como uma redução da fertilidade do solo disponível para a recuperação da vegetação.

Recomendações para gestores florestais

Após Incêndios Florestais

Na área de estudo do CASCADE (Várzea, Calde) foi testada uma abordagem inovadora no corte e extração do material lenhoso e dos sobrantes, em áreas geridas pelo ICNF. Esta abordagem visava minimizar os impactos na regeneração espontânea dos pinheiros, através do condicionamento da movimentação das máquinas pesadas. Os resultados alcançados no CASCADE não confirmaram que esta nova abordagem altere substancialmente o recrutamento dos pinheiros. No entanto, existem motivos suficientes, documentados na literatura científica, que justificam que o corte e a extração da madeira e resíduos sejam acompanhados de perto pelos proprietários e gestores florestais.

Este acompanhamento parece fundamental para que se sugiram atempadamente medidas de mitigação para os impactos das práticas correntes na gestão florestal pós-fogo, sobretudo em zonas de reduzida regeneração espontânea dos pinheiros e da vegetação em geral e/ou de elevado risco de erosão.


Corte pós-fogo tradicional

Recomendações para gestores florestais

Após Incêndios Florestais

Princípio 3: Recuperar áreas degradadas com insuficiente regeneração espontânea de pinheiros.

- ✓ **Avaliar o potencial de regeneração, tendo em conta a idade do povoamento, histórico de incêndios e o tipo e a severidade do fogo**
- ✓ **Monitorizar a regeneração, especialmente em zonas com baixo potencial, após as operações florestais pós-fogo e após período de seca prolongado**

A elevada capacidade de regeneração espontânea do pinheiro-bravo justifica que, em muito casos, esta seja a opção privilegiada na gestão pós-fogo, pelo menos até ao restabelecimento da função produtiva numa área florestal. No entanto, esta capacidade pode ser influenciada por um conjunto alargado de fatores, com especial destaque para a quantidade e qualidade do banco de sementes da plantação. Por sua vez, o banco de sementes depende em grande escala da idade da plantação, ou seja não existirá um banco de sementes até os pinheiros terem 10 a 15 anos. Assim, plantações que ardem duas vezes em poucos anos não terão uma regeneração espontânea adequada. Isto foi comprovado em várias parcelas estudadas pelo CASCADE na área de Várzea. Similarmente, plantações que sofreram um fogo de copas de alta severidade podem ter a sua capacidade de regeneração espontânea muito limitada pela queima das pinhas ou por danos irreversíveis causados às suas sementes.


Menor densidade arbustiva


Maior densidade arbustiva

Recomendações para gestores florestais

Após Incêndios Florestais

Não são apenas os fatores ligados ao regime de incêndios que determinam a regeneração espontânea de plantações de pinheiro-bravo. Entre os outros fatores destacam-se as operações florestais pós-fogo, nomeadamente o corte e a extração do material lenhoso e dos sobrantes, como foi referido no princípio anterior. No entanto, também a aplicação de um acolchoado *(mulching)* poderá afetar, positivamente como negativamente, a regeneração dos pinheiros. Verificou-se na área de Várzea que a regeneração de pinheiro foi muito deficiente em zonas ocupadas por grandes pilhas de resíduos de corte. É também provável que a regeneração espontânea de pinheiro seja comprometida por uma seca severa e prolongada após o incêndio, nomeadamente durante os primeiros dois a três anos após o incêndio.

De um modo geral, é ainda difícil prever com elevada exatidão a regeneração espontânea do pinheiro-bravo após incêndio. Neste sentido, é relevante assegurar a monitorização desta regeneração, nomeadamente em zonas de maior risco de regeneração inadequada.

13 ANNEX II. Lists of stakeholders in CASCADE's study sites' workshops

*The tables with names of participants were **removed** in this version of the Deliverable, in order to respect privacy laws. The names can be obtained from the CASCADE coordination team if needed.*

Table 1. List of participants/stakeholders in the CASCADE workshop in Crete

Table 3: List of participants in the final CASCADE workshop in Castelsaraceno Italy.

Table 4: List of participants in the CASCADE workshop in Portugal

Table 5: List of participants in the CASCADE workshop in Spain (from Ayora and Albaterra).

14 ANNEX III. Table 1. CASCADE Matera Policy Forum Programme

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Catastropic shifts in drylands

CASCADE Policy Forum programme

Friday 24th February 2017 - Matera, Italy.

Programme item	Time	Responsibility
Registration and coffee	8.30-9.00	*Erik van den Elsen*
Welcome	9.00-9.10	*Gianni Quaranta* and *Luca Braia*
Short video and overview of CASCADE project	9.10-9.30	*Erik van den Elsen*
Presentation and discussion on relevant policies at EU and international level and insights for prevention of catastrophic shifts	9.30-10.30	Up to 4 policy representatives from European and international levels
Questions	10.30-10.45	Moderated by *Panos Panagos*
Coffee break	10.45-11.15	UNIBAS
(1) Land abandonment in CASCADE – findings	11.15-11.30	*Matteo Jucker Riva*
Questions	11.30-11.40	Moderated by *Panos Panagos*
(2) Overgrazing in CASCADE – findings	11.40-11.55	*Ioannis Tsanis*
Questions	11.55-12.05	Moderated by *Panos Panagos*
(3) Fires in CASCADE– findings	12.05-12.20	*Ramon Vallejo*
Questions	12.20-12.30	Moderated by *Panos Panagos*
Lunch	12.30-13.45	UNIBAS
Group photo	13.45-14.00	*Erik van den Elsen*
Roundtable introduction	14.00-14.10	*Lindsay Stringer*
Roundtable (with questions pre-set but also interactions with audience)	14.10-15.20	Moderated by *Lindsay Stringer* and *Panos Panagos*. Up to 10 roundtable participants: • Stakeholder from Cyprus (grazing) - *George Papadavid.* • Stakeholder from Portugal (fire) - *Rui Pombo.* • Stakeholder from Italy (land abandonment) - *Donato Di Stefano* • CASCADE member: *Luuk Fleskens.* (integrated modelling) • CASCADE member: *Susana Bautista.* (Ecology) • International policy - *Victor Castillo.* (UNCCD) • International policy (FAO) - *Sergio Zelaya.*
Video message from Gianni Pittella	15.20 – 15.35	*Gianni Pittella*
Wrap up and closing	15.35-15.45	*Gianni Quaranta* and *Angelica Saggese*
Drinks	15.45-16.15	UNIBAS

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15 Table 2. Participants at the CASCADE Policy Forum, Matera, Italy.

INVITEES	NAME	INSTITUTION
ITALY	Sergio ZelayaBonilla	Senior officer of Land and Water division AGL - FAO
	Victor Castillo	Knowledge Management, Science and technology, UNCCD
	Pandi Zdruli	IAMB (Mediterranean Agronomic Institute of Bari)
	Gianni Pitella	VP of the EU parliament
	Angelica Saggese	Italian Senate Agriultural commission
	Luca Braia	Basilicata Agricultural assessor
	Donato Di Stefano	President of Basilicata farmers association
	Domenico Muscolino	From Castelsaraceno (Mayor of the village in the last 10 years)
	Salvatore de Marco	Transient large livestock breader from Castelsaraceno
SPAIN	Antoni Marzo	General Director of Environment. Regional Government of Valencia, Spain
GREECE	Marinos Kritsotakis	Director Decentralized Administration of Crete, Directorate of Water
PORTUGAL	Rui Pombo	Institute for Forest and Nature Conservation – ICNF
	João Pinho	consultant ICNF, former vice-president of ICNF, responsible for the National Council for Reforestation
CYPRUS	Dr Papadavid	Agricultural Research Institute
	Costas Michael	Ministry of Agriculture, Rural Development and Environment
CASCADE PROJECT	Erik Van den Elsen	WENR
	Jane Brandt	UNIBAS
	Rudi Hessel	WENR
	Diana Sietz	WUR
	Victoriano Ramon Vallejo Calzada	Universitat de Barcelona
	Matteo Jucker Riva	Centre for Development and Environment CDE, University of Bern, Switzerland

INVITEES	NAME	INSTITUTION
	Gianni Quaranta	UNIBAS
	Rosanna Salvia	UNIBAS
	Velia de Paola	UNIBAS
	Susana Bautista	University of Alicante
	Alejandro Valdecantos	CEAM
	Nichola Geeson	UNIBAS
	Cecilia De Ita	University of Leeds
	Panos Panagos	European Commission - Joint Research Centre
	Lindsay Stringer	University of Leeds
	Ioannis Tsanis	Technical University of Crete
	Michalakis Christoforou	Cyprus University of Technology
	Christiana Papoutsa	Cyprus University of Technology
	Jan Jacob Keizer	University of Aveiro
	Sandra Valente	University of Aveiro
	Lia Hemerik	WUR

16 ANNEX IV. POLICIES MENTIONED DURING CASCADE WORKSHOPS

STUDY SITE	POLICY	DESCRIPTION	REFERENCE	COMMENT
Spain	Wind Energy Plan in the Region of Valencia	Wind energy outcome has to be invested in forest management	Wind Energy Plan in the Region of Valencia: http://www.dogv.gva.es/portal/ficha_disposicion_pc.jsp?sig=3151/2001&L=1	The reference to compensations appears in Article 11.5.c
Portugal	Forest owners association	Forest owners association allows land users to coordinate forest management and fire prevention interventions	https://www.dropbox.com/s/730you16yqemm6n/portugal-ForestOwnerAssociations.pdf?dl=0	
Greece	Subsidies for afforestation	Subsidies for land owners to plant carob trees on degraded land	https://www.dropbox.com/s/hyjqeeqz8bkg9os/120_48arabatzis.pdf?dl=0	The carob afforestation was funded through the "First forestation of agricultural lands" action of the "Agricultural and Rural Development Programme 2000-2006" which was the Greek adaptation of the CAP. For that specific CAP this was the "priority axis 4 under article 31 of the European regulation 1257/99". For subsequent CAPs the action "First forestation of agricultural lands" still exists but under different coding (Action 221 and Action 8.1 for 2007-2013 and 2014-2020, respectively
Cyprus	Protection of Carob trees from rats	State enables farmer to combat pest directly by providing materials and traps	http://www.moa.gov.cy/moa/da/da.nsf/page09_gr/page09_gr?OpenDocument&Start=1&Count=1000&Expand=16	