# Selective forest clearing to prevent large forest fires

## Spain - Clareo selectivo para la prevención de incendios (tratamientos selvícolas) (Spanish)

### Selective forest clearing aims in reducing the connectivity and the amount of (dead standing) fuel, as well as reducing the competition between regenerating pines, in order to prevent forest fires and to ensure the growth of a healthy forest.

The forests in the Ayora region experienced a huge disturbance in the past, such as deforestations, removal of key species, land abandonment, dense growth of fire-prone seeder species (high continuity of dead standing fuel), missing management, wildfires and dense afforestations. These disturbances resulted in the degradation of the vegetation, the reduction of the resilience of the ecosystem against fires and thus an increasing risk of wildfires. After fires, many landscapes regenerated with a high and continuous fuel accumulation with few native resprouter species, which made it extremely difficult to control forest fires. The dense growth not only increased the risk of wildfires but also the competition between different species (nutrients, light, space). Therefore appropriate vegetation management to increase the resilience of the ecosystem to fires and to reduce competition is crucial.
These problems are approached by selective forest clearing. The main purposes of thinning dense pine forests are the prevention of fires by reducing the fuel load and its continuity, and to improve pine regeneration by eliminating the competition between different species. As a result, the quality of the plants is improved and the amount of dead or sick plants is reduced, which is essential to ensure a healthy forest. This also leads to a higher resistance to pests which in turn again decreases the risk of fire (less dead plants). Vegetation removal produces fresh vegetation growth, therefore more diverse and nutritious fodder is provided to animals (game and livestock) in the cleared areas which is a benefit for herders. Also wild animals use this fodder supply which in turn hinders them to destroy cultivated fields of the farmers. Furthermore, honey producers make use of the enhanced growth of shrubs and the additional space created by selective clearing to place their beehives and to increase honey production. Especially during the current economic crisis forest management is an important source for jobs - most of the workers were unemployed before working in the selective clearing. Through the clearings, fuelwood is gained and offered to retired people for free for cooking and heating, allowing them to save money. Additionally, almost all villagers like to have a cleared forest due to its high aesthetic and recreational value.
In order to be selective and to preserve desired species, the clearing is done with small machines such as brushcutters and chainsaws. On average the forest is thinned until reaching a density of 800-1200 trees/ha. Species such as Juniperus, Rhamnus al., Quercus rotundifolia, Quercus faginea or Fraxinus ornus are not removed which increases the probability to have a more fire-resistant vegetation composition in future. Dead or sick plants and also a part of fire-prone shrubs such as Ulex parv. and Cistus alb. are removed. If there are both Pinus pinaster and Pinus halepensis. Pinus halepensis is cleared because they compete with each other. The roots are not removed which ensures the stability and productivity of the soil. The remaining species are pruned (“poda”) until a maximum height of 2.5m to improve the conditions of the species. Around each tree they should clear an area of 2m. After felling trees and shrubs a part of the residues is chipped in-situ and covers the soil as mulch, which results in ecological benefits (e.g. increase in soil moisture, prevention from erosion, enhancement of nutrient cycling, reduction of the soil surface temperature). If the slope is steep, it takes more time to do the clearing and it might also increase the risk of erosion afterwards. Under the best conditions (e.g. good access and terrain), 0.8ha per day are cleared (calculated for a group of 9 persons working 7 hours). In this case the costs are paid by the municipal council, which receives a part of the money from the rental fee paid by the wind mill company. The cleared areas have to be maintained depending on the speed of the vegetation growth (which amongst others depends on the soil, slope and humidity). If the clearings are done regularly, it takes less time and it is cheaper than the first clearing. It should be noted that recurrent maintenance is crucial to ensure the effectiveness of the technology.
The region of Ayora is mountainous with a dry subhumid climate (~380 mm annual rainfall). The risk of fire incidence is at its highest from June to September when there are adverse conditions like drought, high temperatures and strong winds (mainly the winds coming from central Spain, called “poniente”). The population density is very low and there are only few job opportunities (e.g. marginal agriculture, grazing, hunting, beekeeping). Most of the inhabitants work in the nuclear power plant. Forest management could be a source for jobs.

**left:** Cleared forest with chipped material applied as mulch and fresh grasses providing fodder to animals. (Photo: Nina Lauterburg)
**right:** The residues generated by forest clearings are chipped in-situ using brushcutters (motodesbrozadoras). The chipped material protects the soil as a mulch layer. Forest management provides jobs - many forest workers were unemployed before. (Photo: Nina Lauterburg)

Location: Spain, Valencia
Region: Ayora/Jarafuel
Technology area: 0.5 km$^2$
Conservation measure: vegetative
Stage of intervention: prevention of land degradation
Origin: Developed externally / introduced through project, recent (<10 years ago)
Land use type:
Forests / woodlands: Natural
Forests / woodlands: Plantations, afforestations
Climate: subhumid, temperate
WOCAT database reference: T_SPA010en
Related approach:
Compiled by: Nina Lauterburg, CDE
Date: 2013-05-11
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CASCADE
Catastrophic shifts in drylands
How can we prevent ecosystem degradation?

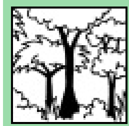
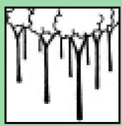
INSTITUTO UNIVERSITARIO CEAM CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRÁNEO

## Classification

### Land use problems:

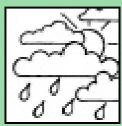
- The prevalent dense shrublands (dominated by seeder species), which resulted from past agricultural land use (changes of the vegetation composition, e.g. removal of key species), land abandonment/rural depopulation and fire occurrence, contain a high fire risk because of both the high fuel loads and their continuity. Also dense forests (either afforestations or natural regeneration) show a high risk for fires. Through the modifications of the vegetation composition in the past (removal of more fire resistant resprouter species, whereas fire-prone seeder species are abundant), the resilience of the ecosystem to fires has decreased. Today a higher fire recurrence can be observed which could still be worsen by future climate change impacts, undermining more and more the ecosystem’s capacity to buffer such shocks. Furthermore, the high density of the forest results in a competition between different species which increases the amount of dead or thin material. (expert's point of view)

**Land use**

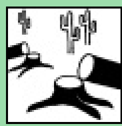
Natural
Plantations, afforestations
selective felling of (semi-) natural forests, plantation forestry

**Climate**



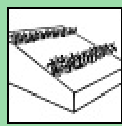
subhumid

**Degradation**



Biological degradation: detrimental effects of fires, quality and species composition /diversity decline

**Conservation measure**



Vegetative: Clearing of vegetation (eg fire breaks/reduced fuel)

**Stage of intervention**

Prevention
Mitigation / Reduction
Rehabilitation

**Origin**

Land users initiative
Experiments / Research
Externally introduced: recent (<10 years ago)

**Level of technical knowledge**

Agricultural advisor
Land user
forest engineer

**Main causes of land degradation:**
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires)
Indirect causes: population pressure, poverty / wealth, labour availability

**Main technical functions:**
- control of fires
- reduction of dry material (fuel for wildfires)
- reduction of fire-prone species

**Secondary technical functions:**
- increase in nutrient availability (supply, recycling,...)
- promotion of vegetation species and varieties (quality, eg palatable fodder)

## Environment

### Natural Environment

**Average annual rainfall (mm)**

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

**Altitude (m a.s.l.)**

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

**Landform**

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

**Slope (%)**

flat
gentle
moderate
rolling
hilly
steep
very steep

**Soil depth (cm)**

0-20
20-50
50-80
80-120
>120

**Soil texture:** fine / heavy (clay)
**Soil fertility:** low
**Topsoil organic matter:** medium (1-3%)
**Soil drainage/infiltration:** medium

**Soil water storage capacity:** medium
**Ground water table:** > 50 m
**Availability of surface water:** poor / none
**Water quality:** good drinking water
**Biodiversity:** medium

**Tolerant of climatic extremes:** temperature increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells
**Sensitive to climatic extremes:** seasonal rainfall increase
**If sensitive, what modifications were made / are possible:** The technology was not modified but it is important to add some notes to the above stated reactions to climatic extremes. The cleared areas are quite resistant against climate change or weather extremes. Only if there will be more rainfall the vegetation might grow faster and the maintenance costs could increase.

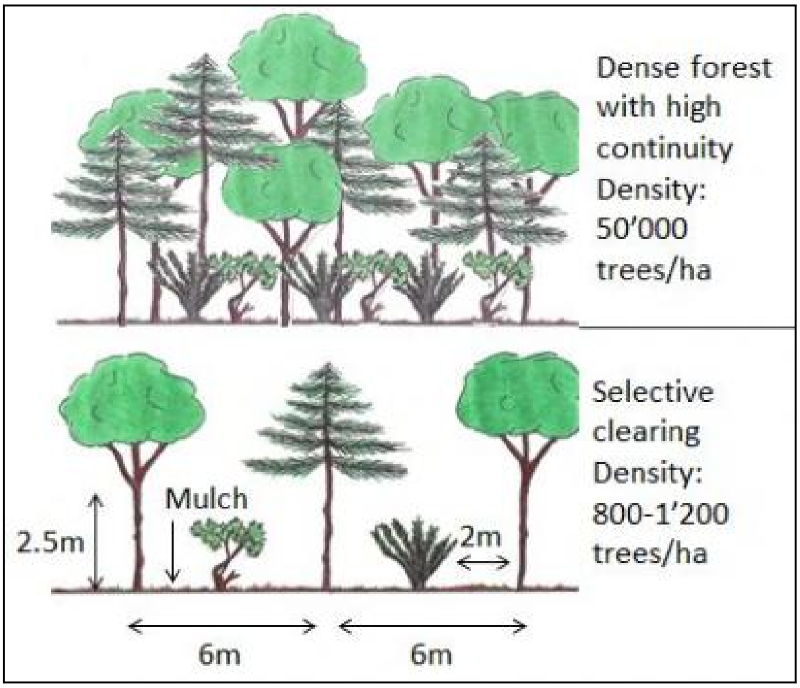
## Human Environment

**Forests / woodlands per household (ha)**

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

**Land user:** employee (company, government), common / average land users, mainly men
**Population density:** < 10 persons/km2
**Annual population growth:** negative
**Land ownership:** state, individual, titled
**Land use rights:** individual, public/open access but organised (e.g. wood, hunting) (There is some public land, controlled by the state. But there is also some private land. The access to the public land is open but organized. Permission is needed from the government to cut trees, to build a house or to hunt. There are some private hunting areas for which the hunting association has to pay a fee.)

**Importance of off-farm income:** : The forest brigade is only working when there is money and a project. If there is no money they have no work and need to look for another job.
**Access to service and infrastructure:**
**Market orientation:** mixed (subsistence and commercial)
**Purpose of forest / woodland use:** timber, other forest products / uses (honey, medical, etc.), recreation / tourism




**Technical drawing**

The main purposes of thinning dense forests (some 50'000 individuals per ha) are the prevention of fires by reducing the fuel load and its continuity (both vertical and horizontal), and to improve regeneration by eliminating the competition between different species. On average the forest is thinned until reaching a density of 800-1200 trees/ha. Species such as Juniperus, Rhamnus al., Quercus rotundifolia, Quercus faginea or Fraxinus ornus are not removed which increases the probability to have a more fire-resistant vegetation composition in future. Dead or sick plants and also a part of fire-prone shrubs such as Ulex parv. and Cistus alb. are removed. The remaining species are pruned ("poda") until a maximum height of 2.5m to improve the conditions of the species. Around each tree they should clear an area of at least 2m but ideally there should be a distance of 6m between different individuals. After felling trees and shrubs a part of the residues is chipped in-situ and covers the soil as mulch, which results in ecological benefits and provides fodder to livestock and game. (Nina Lauterburg)

## Implementation activities, inputs and costs

### Establishment activities

- Cutting and chipping (in-situ) of trees and shrubs (selective clearing)
- Transport of wood (fuel wood)

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 404.00 | 0% |
| Equipment | | |
| - machine use | 2024.00 | 0% |
| **TOTAL** | **2428.00** | **0.00%** |

### Maintenance/recurrent activities

- Cutting and chipping (in-situ) of trees and shrubs (selective clearing)
- Transport of wood (fuelwood)

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Equipment | | |
| - machine use | 446.00 | 0% |
| **TOTAL** | **446.00** | **0.00%** |

**Remarks:**
The costs of selective forest clearing can be affected by numerous factors, such as slope (if the slope is steep, the work is much more difficult and takes more time), vegetation density (it takes more time to clear a dense area) and vegetation type (pine forest or shrubland), distance from a street (people can work less in a day if they have to walk far to clear). Important to note is that maintenance costs could increase with an increase in rainfall because the vegetation will grow faster.
The costs were calculated for the application of the technology (selective clearing) on one hectare. In this case, 9 people are working as a team. If the site is accessible and if the terrain is good for clearing work they can clear 0.8 ha per day. It should be noted that clearing with small machines such as brushcutters and chainsaws is much more expensive than clearing with tractors, but often it is only possible to clear with small machines (e.g. removal of trees is not possible with tractors). A tractor costs more or less 500 Euro per ha (674 Dollar per ha). A clearing of a pine forest with manual machines costs around 1800 Euro per ha (2428 Dollar per ha). The costs of the maintenance activities (e.g. second clearing) are much lower because the area was cleared already some years before. Therefore more ha per day can be cleared. In Jarafuel, a part of the costs are covered by the rental fee paid by the windmill company. The currency rate (Euro-Dollar) was calculated on November 16th, 2013.

## Assessment

### Impacts of the Technology

**Production and socio-economic benefits**

- ++ increased wood production
- + increased fodder production
- + increased fodder quality
- + increased animal production
- + reduced expenses on agricultural inputs
- + increased farm income
- + increased production area
- + increased product diversification

**Production and socio-economic disadvantages**

- ++ high establishment and maintenance costs
- + reduced animal production
- + job uncertainty

**Socio-cultural benefits**

- +++ improved cultural opportunities
- +++ increased recreational opportunities
- ++ improved conservation / erosion knowledge
- ++ improved situation of disadvantaged groups
- + conflict mitigation
- + improved food security / self sufficiency

**Socio-cultural disadvantages**

**Ecological benefits**

- +++ reduced fire risk
- ++ increased soil moisture
- ++ reduced hazard towards adverse events
- ++ increased biological pest / disease control
- + reduced evaporation
- + improved soil cover
- + increased biomass above ground C
- + increased nutrient cycling recharge
- + increased soil organic matter / below ground C
- + reduced emission of carbon and greenhouse gases
- + reduced soil crusting / sealing
- + increased animal diversity
- + reduction of soil surface temperature

**Ecological disadvantages**

- + increased soil erosion locally
- + increased habitat fragmentation

**Off-site benefits**

- ++ reduced risk of wildfires
- + reduced downstream flooding
- + reduced downstream siltation
- + reduced damage on public / private infrastructure

**Off-site disadvantages**

**Contribution to human well-being / livelihoods**

+ Through the clearings it is easier to control fires and protect people. Furthermore it created jobs for the unemployed. In general forest management is not something people want to do, they work in this sector only if there are no other job opportunities. Forest management means a hard job and this kind of work is not well-respected in society.

**Benefits /costs according to land user**

| | Benefits compared with costs | short-term: | long-term: |
|---|---|---|---|
| | **Establishment** | very positive | very positive |
| | **Maintenance / recurrent** | very positive | very positive |

Both the short-term and the long-term benefits are very positive assuming that maintenance is done. It contributes to prevent devastating fires and to guarantee a healthy forest. Together with the creation of jobs, directly after clearing there is firewood and timber available and a reduced risk of wildfires. But it should also be considered that the establishment costs are high. If maintenance is not done the long-term returns will be very negative because an increase in the risk of fire will occur again (without management, there will also be no firewood, no timber and no jobs). The maintenance costs increase the longer you wait because the vegetation will grow again densely.

**Acceptance / adoption:**

There is no trend towards (growing) spontaneous adoption of the technology. Clearings are only done when the state has money. Selective clearing is also applied in other countries/regions, e.g. in California.

#### Concluding statements

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
|---|---|
| Through selective forest clearing the fuel amount and connectivity (vertical/horizontal) is reduced which is crucial for preventing the occurrence and spread of large forest fires. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. Especially the fire-prone seeder species (e.g. Ulex parviflorus, Cistus albidus) should be removed frequently. CEAM suggests to plant more fire-resistant species (late successional stages) within some spots to accelerate the natural succession and to increase the resilience of the ecosystem to fires. Green living plants have a higher humidity content which slows down a fire (oxygen is consumed). By planting late-successional species really densely you don't allow seeders to grow. This measure could also decrease management costs and create Jobs. | The establishment and the maintenance activities are expensive and labour-intensive. Without management the technology is not effective anymore. It would be necessary to extract biomass from the forest to decrease the continuity of the trees and shrubs. In case of a lack of management the risk of fires increases. → Management is crucial. Prevention measures are often less expensive than rehabilitation activities after a fire. The state should therefore invest more money in forest management and fire prevention. Managing the forest would not only decrease the risk of fire but also generate benefits (e.g. wood, biomass, fuelwood). Instead of getting unemployment pay people could get jobs in forest management. Stakeholders mentioned that it would be important to promote the forest as a sustainable economic resource and that the relation between the villagers and the forest should be enhanced. Furthermore it was mentioned that traditional activities (such as grazing, agriculture, wood gathering) should be reactivated and that the villagers should get economic compensation to maintain the forest in a good state. Especially the promotion of grazing was stressed many times. Also planting of more fire-resistant species (late successional stages) in some spots as suggested by CEAM could increase the resilience of the ecosystem and decrease management costs. |
| There is a reduction of competition between plants which is essential to ensure a healthy forest (more nutrients, light, space). This also leads to a higher resistance against pests which in turn again decreases the fire risk (less dead or sick plants). → Recurrent maintenance is crucial to ensure the effectiveness of the technology. | The clearing of forests has potential to prevent fires and therefore degradation. But there are also a lot of highly connected shrublands with a high fuel load which are not addressed by this management practice. → Shrublands need to be cleared as well since they constitute a huge risk for wildfires. |
| Fuel management through vegetation clearing presents some positive aspects with respect to other techniques, e.g. the possibility of being selective in order to preserve desired species or individuals. Furthermore, after felling trees and shrubs a part of the vegetation is chipped in-situ and covers the soil as mulch. This results in ecological benefits (e.g. increase in soil moisture, prevention from erosion, enhancement of nutrient cycling, reduction of the soil surface temperature and evaporation loss). → Recurrent maintenance is crucial to ensure the effectiveness of the technology. | If there is more space after clearing the first shrubs which will grow will be fire-prone early successional species, such as Cistus albidus and Ulex parviflorus. Without management, they will increase the risk of fires. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. Management through grazing could be a simple way to reduce the costs and the risk. By planting resprouter species really densely seeders would not grow anymore in those spots which would also decrease the fire risk and the management costs. |
| The trees/shrubs are cut but the roots are not removed. This ensures the stability and productivity of the soil. → | When the clearing is done on extremely steep slopes there might be an increase in erosion. → Before clearing the soil erosion risk should be calculated. |
| Fewer fires result in a decrease of the destroyed area, less money will have to be invested in restoration or fire extinction. Furthermore, farmers, hunters and honey producers will experience fewer losses. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. | In some areas there will be less shade which could harm some species. → |
| There are both social and economic benefits for local people. The selective clearings provide jobs for rural people, which allows them to increase their livelihood conditions. People do not depend on unemployment pays and are therefore more accepted in society. A part of the extracted wood is used for biomass, fertilizers, pellets, or firewood. Furthermore there would be improved conditions for grazing. Therefore forest management contributes to rural development. → Actually there is still a lot of management required in the forest of this region which would provide jobs in the longer term. Furthermore, many local stakeholders mentioned the importance of reactivating traditional activities (such as grazing, agriculture, wood gathering) and that the villagers should get economic compensation to maintain the forest in a good state. | |
| There are also off-site benefits. Fewer fires will result in a reduction of downstream flooding, downstream siltation and damage on neighbours' fields. When fire removes less vegetation the soil is less vulnerable to erosion. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. | |
| In Jarafuel where most of the land is public retired people receive the firewood gained by forest clearings for free. They can use the wood for cooking and heating and save a lot of money. → People from the region (outside of Jarafuel) like this idea that villagers benefit from what is removed from the forest. More mechanisms like this should be developed so that people recognize that they also benefit from forest management, which in turn would ensure a sustainable forest management. | |
| Almost all villagers like to see a cleared forest. It has a high aesthetic and recreational value (it is possible to walk through the forest). They are also aware that the risk of wildfires is reduced through this technology. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. Villagers and state need to work together to ensure a long-term forest management. | |
| Shepherds, hunters and farmers benefit from forest clearings. Vegetation removal produces fresh vegetation growth, therefore more diverse and nutritious fodder is available for animals (game and livestock) in the cleared areas. Game/wildlife and livestock are better because there is an increase in fodder quantity and quality. Wild animals benefit from this food source which in turn hinders them to destroy cultivated fields of the farmers. Also honey producers benefit from the cleared areas since bees can fly better and there is more place to put the beehives, furthermore the growth of shrubs is enhanced. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. | |

# SELECTIVE CUTTING
**Italy**

## SELECTIVE CUTTING OF FOREST TREES TO PREVENT FIRES AND AVOID THE RISK OF DAMAGED TREES FALLING DOWN.

The technique consists of cutting down and removing damaged trees from the forest (for example those damaged by snow) or dried trees, which tend to fuel fires and increase their spread.
Protection of woods in case of fire and promoting the natural regeneration of forests.
Clearing activities carried out periodically.
The technique is applied in timber forests. The context of production is characterised by a medium level of mechanisation (only the most demanding operations are carried out using mechanical means), the production system is essentially mixed, a small part is destined for personal consumption whilst the bulk of production is destined for local markets. The property is predominantly privately owned but also includes some public land, especially in the case of pasture land. Most farms in the area are livestock farms whilst the agricultural component is destined exclusively for private consumption.

Location: Basilicata
Region: Castelsaraceno
Technology area: 0.1 - 1 km2
Conservation measure: management
Stage of intervention: prevention of land degradation
Origin: Developed through land user`s initiative, traditional (>50 years ago)
Land use type:
Forests / woodlands: Natural
Climate: subhumid
WOCAT database reference: T_ITA008en
Related approach: MUNICPAL FOREST MANAGEMNT PLAN (DECADE 2010-2019) (A_ITA001en)
Compiled by: Velia De Paola,
Date: 2014-05-27
Contact person: Giovanni Quaranta, University of Basilicata via dell'Ateneo Lucano 10, 85100 Potenza (IT)
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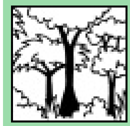
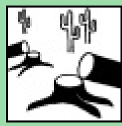
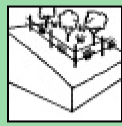
## Classification

### Land use problems:
- In the timber forests the presence of damaged trees promotes the spread of fires and the increase the risk of fallen trees. (expert's point of view)
Fire risk and risk of fallen trees. (land user's point of view)

| Land use | Climate | Degradation | Conservation measure |
|---|---|---|---|
|  |  |  |  |
| Natural<br>clear felling of (semi-)natural forests | subhumid | Biological degradation: detrimental effects of fires | Management: Others () |

**Stage of intervention**

Prevention
Mitigation / Reduction
Rehabilitation

**Origin**

Land users initiative: traditional (>50 years ago)
Experiments / Research
Externally introduced

**Level of technical knowledge**

Agricultural advisor
Land user

**Main causes of land degradation:**

**Main technical functions:**
- control of fires
- reduction of dry material (fuel for wildfires)

**Secondary technical functions:**

## Environment

### Natural Environment

**Average annual rainfall (mm)**

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

**Altitude (m a.s.l.)**

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

**Landform**

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

**Slope (%)**

flat
gentle
moderate
rolling
hilly
steep
very steep

**Soil depth (cm)**

0-20
20-50
50-80
80-120
>120

**Growing season(s):** 120 days(March to august)
**Soil texture:** fine / heavy (clay)
**Soil fertility:** medium
**Topsoil organic matter:** medium (1-3%)
**Soil drainage/infiltration:** good

**Soil water storage capacity:** medium
**Ground water table:** 5 - 50 m
**Availability of surface water:** medium
**Water quality:** good drinking water
**Biodiversity:** medium

**Tolerant of climatic extremes:** temperature increase, seasonal rainfall increase, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells, decreasing length of growing period
**Sensitive to climatic extremes:** seasonal rainfall decrease

### Human Environment

**Forests / woodlands per household (ha)**

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1,000
1,000-10,000
>10,000

**Land user:** Individual / household, Small scale land users, common / average land users, mainly men
**Population density:** 10-50 persons/km2
**Annual population growth:** negative
**Land ownership:** individual, titled
**Land use rights:** individual
**Relative level of wealth:** average, which represents 90% of the land users;

**Importance of off-farm income:** 10-50% of all income:
**Access to service and infrastructure:** low: employment (eg off-farm); moderate: health, education, technical assistance, market, energy, roads & transport, drinking water and sanitation, financial services
**Market orientation:** commercial / market
**Purpose of forest / woodland use:** fuelwood

## Implementation activities, inputs and costs

### Establishment activities

### Maintenance/recurrent activities

- Cutting of trees damaged or dead by mechanical equipment (chainsaw).

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 270.27 | 100% |
| **TOTAL** | **270.27** | **100.00%** |

**Remarks:**
Manual labour and fuel for chainsaw.

## Assessment

### Impacts of the Technology

**Production and socio-economic benefits**

++ increased wood production
++ reduced risk of production failure

**Production and socio-economic disadvantages**

**Socio-cultural benefits**

+++ improved cultural opportunities

**Socio-cultural disadvantages**

**Ecological benefits**

+++ reduced hazard towards adverse events
+++ reduced fire risk
++ increased soil organic matter / below ground C

**Ecological disadvantages**

+ decreased soil organic matter

**Off-site benefits**

++ reduced damage on neighbours fields
++ reduced damage on public / private infrastructure

**Off-site disadvantages**

**Contribution to human well-being / livelihoods**

+

### Benefits /costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| **Establishment** | slightly positive | slightly positive |
| **Maintenance / recurrent** | positive | positive |

The value of the wood harvested is higher than the costs of felling

**Acceptance / adoption:**

50% of land user families have implemented the technology with external material support. Contributions through rural development measure (200 € per hectare)
50% of land user families have implemented the technology voluntary.
There is moderate trend towards (growing) spontaneous adoption of the technology.

### Concluding statements

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
|---|---|
| Selective cutting of damaged trees is a useful tool in preventing the growing spread of wildfires and promotes a more homogenous and regular growth in the forest. → The resources forseen under the RDP to support this action have not led to the its spontaneous adoption. | There are no disadvantages to this technique. → |
| The technique is useful particularly in areas nearest public roads to prevention the spread of wildfires and to decrease risk of damaged trees falling. → | |

# Unvegetated strips to reduce fire expansion
**Italy - Firebreaks**

### Firebreaks are stripes cleared of vegetation that divide a continuous forest in smaller patches to reduce spreading of wildfires and allow intervention.

The technology consists of creating gaps of vegetation of about 5 to 7 meters, every 50 to 75 meters distance contourline large forested areas. These clear strips are connected to main roads having varying length in relation to the size of the area.
Fire breaks act as a barrier to stop or slow the progress of fires and allow firefighters to better position themselves to operate.
Clearing activities which must be carried out annually by specialized workers using minor devices (hand and hedge cutter).
This technology is applied mostly in publicly owned woods (or very large private woods). The network of these fire strips is rather dense as the number of flammable species increases. So it creates patches of 2500 to 5000 meters according to the type of species. The context of production is characterised by a medium level of mechanisation (only the most demanding operations are carried out using mechanical means), the production system is essentially mixed, a small part is destined for personal consumption whilst the bulk of production is destined for local markets. The property is predominantly privately owned but also includes some public land, especially in the case of pasture land. Most farms in the area are livestock farms whilst the agricultural component is destined exclusively for private consumption.

Location: Basilicata
Region: Castelsaraceno
Technology area: 0.1 - 1 km2
Conservation measure: management
Stage of intervention: prevention of land degradation
Origin: Developed through experiments / research, traditional (>50 years ago)
Land use type:
Forests / woodlands: Natural
Climate: subhumid
WOCAT database reference: T_ITA007en
Related approach: MUNICPAL FOREST MANAGEMNT PLAN (DECADE 2010-2019) (A_ITA001en)
Compiled by: Velia De Paola,
Date: 2014-05-27
Contact person: Giovanni Quaranta, University of Basilicata Via dell'Ateneo Lucano 10, 85100 POTENZA (IT)
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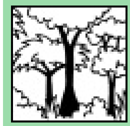
## Classification

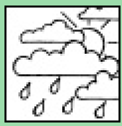
### Land use problems:
- In some wooded areas, especially nearest the roads, there is an excessive amount of undergrowth (with some shrubs reaching a height in excess of two metres) which leaves the area vulnerable to the start and spread of forest fires. (expert's point of view)
The increase in shrubs has increased fire risk. (land user's point of view)

**Land use**



Natural
clear felling of (semi-)natural forests

**Climate**

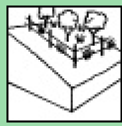


subhumid

**Degradation**

Biological degradation: detrimental effects of fires

**Conservation measure**



Management: Waste Management: includes recycling, re-use or reduce

**Stage of intervention**

- Prevention
- Mitigation / Reduction
- Rehabilitation

**Origin**

- Land users initiative
- Experiments / Research: traditional (>50 years ago)
- Externally introduced

**Level of technical knowledge**

- Agricultural advisor
- Land user

**Main causes of land degradation:**

**Main technical functions:**

- control of fires

**Secondary technical functions:**

## Environment

### Natural Environment

**Average annual rainfall (mm)**

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

**Altitude (m a.s.l.)**

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

**Landform**

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

**Slope (%)**

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

**Soil depth (cm)**

- 0-20
- 20-50
- 50-80
- 80-120
- >120

**Growing season(s):** 120 days(March to august)
**Soil texture:** fine / heavy (clay)
**Soil fertility:** medium
**Topsoil organic matter:** medium (1-3%)
**Soil drainage/infiltration:** good

**Soil water storage capacity:** medium
**Ground water table:** 5 - 50 m
**Availability of surface water:** medium
**Water quality:** good drinking water
**Biodiversity:** medium

**Tolerant of climatic extremes:** temperature increase, seasonal rainfall increase, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells, decreasing length of growing period

### Human Environment

**Forests / woodlands per household (ha)**

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

**Land user:** Individual / household, Small scale land users, common / average land users, mainly men
**Population density:** 10-50 persons/km2
**Annual population growth:** negative
**Land ownership:** individual, titled
**Land use rights:** individual
**Relative level of wealth:** average, which represents 90% of the land users;

**Importance of off-farm income:** 10-50% of all income: Most of the off farm income derives from public sector, i.e. Municipality, Mountain Community, Region and other public bodies. Very few farmer members run local shops or handcraft.
**Access to service and infrastructure:** low: employment (eg off-farm); moderate: health, education, technical assistance, market, energy, roads & transport, drinking water and sanitation, financial services
**Market orientation:** commercial / market
**Purpose of forest / woodland use:** fuelwood

## Implementation activities, inputs and costs

### Establishment activities

### Maintenance/recurrent activities

- Cutting vegetation with the help of device (hedge cutters, usually owned by the specialized workers who are doing the job, and their cost is included in the salary) The hectare is intended to mean the area of cleared vegetation which is usually 5-7metres wide.

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 1351.35 | 100% |
| **TOTAL** | **1351.35** | **100.00%** |

**Remarks:**
Manual labour (including fuel for hedge cutter).

## Assessment

### Impacts of the Technology

**Production and socio-economic benefits**

++ reduced risk of production failure

**Production and socio-economic disadvantages**

+ reduced wood production

**Socio-cultural benefits**

**Socio-cultural disadvantages**

**Ecological benefits**

+++ reduced hazard towards adverse events
+++ reduced fire risk

**Ecological disadvantages**

**Off-site benefits**

++ reduced damage on neighbours fields
++ reduced damage on public / private infrastructure

**Off-site disadvantages**

**Contribution to human well-being / livelihoods**

**Benefits /costs according to land user**

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| **Establishment** | slightly positive | slightly negative |
| **Maintenance / recurrent** | positive | positive |

**Acceptance / adoption:**

100% of land user families have implemented the technology with external material support.
0% of land user families have implemented the technology voluntary.
There is moderate trend towards (growing) spontaneous adoption of the technology.

## Concluding statements

### Strengths and → how to sustain/improve

1) The creation of firebreaks is a very useful method to reduce the spread of fires. → Public funding is needed to ensure this method can continue.

the technique is an important tool in preventing the spread of fires, however, when winds are strong they can make little difference → some as before

### Weaknesses and → how to overcome

Apart from the annual cost of clearing vegetation, it reduces the number of trees per hectare of wooded areas →

# Cleared strip network for fire prevention (firebreaks)

### Spain - Área cortafuegos

### The basic principle of a firebreak network is to split continuous forest areas (where a lot of fuel is built up) into smaller patches separated by vegetation-free strips in order to prevent large forest fires.

In the forest law 3/1993 the declaration of special areas to "Zonas de Actuación Urgente (ZAU)" (zone of urgent actions) through the regional government of Valencia is defined. Objectives are the protection against natural hazards and the promotion of forest restoration within this area. Ayora was declared to a ZAU in 1997 due to its high risk of fires. In the "Plan de Selvicultura Preventiva de Incendios en los Sistemas Forestales de la Comunidad Valenciana" which became operative in 1996 and whose main objective is the reduction of the fire risk, the ZAU is practically addressed for the first time in the establishment of firebreaks (áreas cortafuegos). Based on this plan, the firebreaks were established within a pilot project "Proyecto Piloto de Selvicultura Preventiva" between 1998 and 2002, carried out by the company VAERSA (public company of the Generalitat Valenciana).

A firebreak is a strategically located strip on which the vegetation cover has been partially or totally removed down to mineral soil with the aim of controlling the spread of large forest fires. The main purposes are 1) to interrupt the continuity of hazardous fuels across a landscape to decrease the area affected by fires, 2) to provide areas where fire fighters are protected and can work more efficiently, 3) to slow down a fire, to reduce the fire intensity and caused damages, and 4) to provide strips where fuel management is facilitated. The total surface protected by the firebreaks is 33'851 ha while the management measures are executed on 1944,81 ha. This technology is also applied in other countries, e.g. Portugal, South Carolina or South Africa. The establishment and maintenance are labour-intensive and expensive. Firebreaks can range between a protected area of 2000-6000 ha (first order), 500-1500 ha (second order), and 100-300 ha (third order), together forming a system isolating separate areas by wide strips. This parcelling aims in limiting the burnt area to a maximum of 6000 ha. Each firebreak consists of a bare vegetation-free strip (banda decapado). The width of the bare area ranges between 6m (first order), 3m (second order) and 1.5m (third order). Existing vegetation-free areas (e.g. roads) are used to establish firebreaks to have less visual impact. If there is no road, trees and shrubs have to be cleared and chipped entirely using chainsaws and special tractors. On each side of the bare area there is a totally cleared strip (banda de desbroce total). The width depends on the climatic zone, the order and the hazard of fuel, therefore ranging between 28m (first order), 11m (second order) and 6m (third order). Almost all the existing vegetation is cleared, only some isolated mature trees are not cut if they do not contribute to the propagation of a fire. On both sides of these strips there are auxiliary strips (banda auxiliar) where selective clearing is applied until reaching a desired density. Sick trees are cleared with priority. Species of high ecologic value and low flammability level are not cleared, such as Juniperus phoenicea, Juniperus oxycedrus and Quercus ilex ssp. rotundifolia. The width of these elements can vary according to the prevalent conditions. A part of the wood generated by the clearings is used as fuelwood, the other part is chipped and distributed on the soil as mulch. Firebreaks are often located on mountain ridges and created with 45° to the dominant wind direction (west) to facilitate fire extinction. The maintenance of firebreaks is extremely important. Without clearing, fire-prone species will encroach which decreases the effectiveness of the firebreak. The maintenance is realized depending on the vegetation, usually in firebreaks of first order the maintenance is done every 2 years ("decapado" and "desbroce total") or every 4 years ("banda auxiliar") while firebreaks of second and third order are cleared every 4 years. In the here described project the maintenance was carried out in three phases (2001-2004, 2004-2008 and 2008-2012).

The region of Ayora is mountainous with a dry subhumid climate (~380 mm annual rainfall). The risk of fire incidence is at its highest from June to September when there are adverse conditions like drought, high temperatures and strong winds (mainly the winds coming from central Spain, called "poniente"). The population density is very low and there are only few job opportunities (e.g. marginal agriculture, grazing, hunting, beekeeping, artisanry, wind mill parc). Most of the inhabitants work in the nuclear power plant. Forest management could be a source for jobs.

**left:** Firebreaks are classified in first, second and third order, together forming a system isolating separate areas by wide strips. This parcelling aims in controlling the spread of large forest fires. (Photo: Nina Lauterburg)
**right:** Firebreaks are often located along existing roads to guarantee the access for fire-fighting vehicles and to keep the environmental impact limited. (Photo: Nina Lauterburg)

Location: Spain, Valencia
Region: Region of Ayora (including the municipalities Requena, Cofrentes, Jalance, Jarafuel, Zarra, Ayora)
Technology area: 338.5 $km^2$
Conservation measure: vegetative
Stage of intervention: prevention of land degradation
Origin: Developed externally / introduced through project, 10-50 years ago
Land use type:
Forests / woodlands: Natural
Forests / woodlands: Plantations, afforestations
Climate: subhumid, temperate
WOCAT database reference: T_SPA009en
Related approach: Plan of preventive silviculture (PSP): implementation of firebreak network within a forest intervention area (ZAU) (A_SPA002en)
Compiled by: Nina Lauterburg, CDE
Date: 2013-05-06
Contact person: Jaime Baeza, Fundación Centro de Estudios Ambientales del Mediterráneo (CEAM), Parque Tecnológico Paterna. C/ Charles Darwin 14, 46980 Valencia, Spain. E-Mail: jaime.baeza@ua.es

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

INSTITUTO UNIVERSITARIO CEAM CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRÁNEO

# Classification

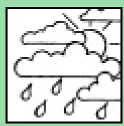
## Land use problems:

- In Ayora, the prevalent dense shrublands (dominated by seeder species), which resulted from past agricultural land use (changes of the vegetation composition, e.g. removal of key species), land abandonment/rural depopulation and fire occurrence, contain a high fire risk because of both the high fuel loads and their continuity. Also dense forests (either afforestations or natural regeneration) show a high risk for fires. Through the modifications of the vegetation composition in the past (removal of more fire resistant resprouter species (mature forest), whereas fire-prone seeder species are now spreading), the resilience of the ecosystem to fires has decreased. Today a higher fire recurrence can be observed which could still be worsen by future climate change impacts, undermining more and more the ecosystem's capacity to buffer such shocks. Before the implementation of firebreaks, it was almost impossible to stop a fire and it was much more dangerous for fire fighters. There was also no access for fire-fighting vehicles. (expert's point of view)

**Land use**

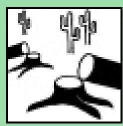
Natural
Plantations, afforestations
selective felling of (semi-) natural forests, plantation forestry

**Climate**



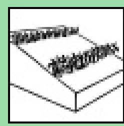
subhumid

**Degradation**



Biological degradation: detrimental effects of fires

**Conservation measure**



Vegetative: Clearing of vegetation (eg fire breaks/reduced fuel)

**Stage of intervention**

Prevention
Mitigation / Reduction
Rehabilitation

**Origin**

Land users initiative: traditional (>50 years ago)
Experiments / Research
Externally introduced: 10-50 years ago

**Level of technical knowledge**

Agricultural advisor
Land user
Engineer

**Main causes of land degradation:**
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires)
Indirect causes: population pressure, poverty / wealth, labour availability

**Main technical functions:**
- control of fires

**Secondary technical functions:**
- reduction of dry material (fuel for wildfires)

# Environment

## Natural Environment

**Average annual rainfall (mm)**

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

**Altitude (m a.s.l.)**

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

**Landform**

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

**Slope (%)**

flat
gentle
moderate
rolling
hilly
steep
very steep

**Soil depth (cm)**

0-20
20-50
50-80
80-120
>120

**Soil texture:** fine / heavy (clay)
**Soil fertility:** medium
**Topsoil organic matter:** low (<1%)
**Soil drainage/infiltration:** medium

**Soil water storage capacity:** high
**Ground water table:** 5 - 50 m
**Availability of surface water:** poor / none
**Water quality:** good drinking water
**Biodiversity:** medium

**Tolerant of climatic extremes:** temperature increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), floods
**Sensitive to climatic extremes:** seasonal rainfall increase, wind storms / dust storms, droughts / dry spells
**If sensitive, what modifications were made / are possible:** The technology was not modified. The firebreaks are quite resistant against climate change or weather extremes. Only if there will be more rainfall the vegetation might grow faster and the maintenance costs could increase. Furthermore, if there are heavy windstorms the effectiveness of firebreaks is undermined because strong winds result in faster spreading fires.

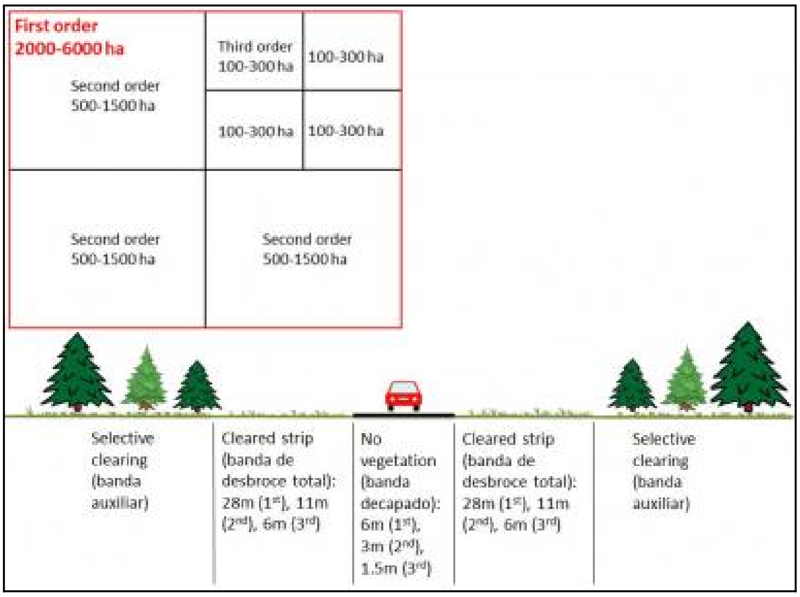
## Human Environment

**Forests / woodlands per household (ha)**

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

**Land user:** employee (company, government), common / average land users, mainly men
**Population density:** < 10 persons/km2
**Annual population growth:** negative
**Land ownership:** state, individual, titled
**Land use rights:** individual, open access but organised (e.g. wood, hunting)
(There is some public land, controlled by the state. But there is also some private land. The access to the public land is open but organized. Permission is needed from the government to cut trees, to build a house or to hunt. There are some private hunting areas for which the hunting association has to pay a fee.)

**Importance of off-farm income:** : The forest brigade is only working when there is money and a project. If there is no money they have no work and need to have a look for another job.
**Access to service and infrastructure:**
**Market orientation:** mixed (subsistence and commercial)
**Purpose of forest / woodland use:** timber, other forest products / uses (honey, medical, etc.), recreation / tourism




**Technical drawing**

Firebreaks can range between a protected area of 2000-6000 ha (first order), 500-1500 ha (second order), and 100-300 ha (third order), together forming a system isolating separate areas by wide strips. This parcelling aims in limiting the burnt area to a maximum of 6000 ha. Each firebreak consists of a bare strip (banda decapado) ranging between 6m (first order), 3m (second order) and 1.5m (third order). On both sides of the bare area there is a totally cleared strip (banda de desbroce total) whose width ranges between 28m (first order), 11m (second order) and 6m (third order). On both sides of these strips there are auxiliary strips (banda auxiliar) where selective clearing is applied. The width of these elements can vary according to the prevalent conditions. (Nina Lauterburg)

# Implementation activities, inputs and costs

## Establishment activities

- Project planning and design of firebreak system
- Adaption of the agricultural tractors with forest management machinery (wheels, protection of the machine against stones, clearing machinery with chains)
- Cutting and chipping (in-situ) of trees and shrubs (execution of firebreak network)
- Transport of wood (fuel wood)

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 1095.00 | 0% |
| Equipment | | |
| - machine use | 675.00 | 0% |
| **TOTAL** | **1770.00** | **0.00%** |

## Maintenance/recurrent activities

- Clearing of firebreaks of first order (every 2 years)
- Clearing of firebreaks of second and third order (every 4 years)

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Equipment | | |
| - machine use | 557.00 | 0% |
| **TOTAL** | **557.00** | **0.00%** |

**Remarks:**
The costs of the establishment of firebreaks can be affected by numerous factors, such as slope (if the slope is steep, the work is much more difficult and takes more time, because machines cannot be used on steep slopes), vegetation density (it takes more time to clear a dense area), stone content of the soil (if there are many stones the work is much more difficult for the machines and more dangerous for the workers), availability of a road (where a firebreak can be established, costs can be saved). Important to note is that maintenance costs could increase with an increase in rainfall because the vegetation will grow faster (otherwise firebreaks are quite resistant against climate change or weather extremes). Furthermore, modifying a normal tractor for forest management can be extremely expensive.
The total costs of the firebreaks (establishment and maintenance) were calculated for the application of the technology on one hectare, based on the indications given in the official project documents of the regional government (Generalitat Valenciana) and information from different stakeholders (e.g. forest agent, university staff, employee of VAERSA). The whole project costs were around 3 Mio Euro for the establishment and around 1.5 Mio Euro for the maintenance phase. The maintenance costs refer to the third maintenance phase taking place from 2008 to 2012. The costs of the execution of the project were 1312 Euro/ha (1770 Dollar) and the costs of the maintenance were 82.03 Euro/ha (110 Dollar, after 2 years) and 331.37 Euro/ha (446 Dollar, after 4 years). The currency rate (Euro-Dollar) was calculated on November 16th, 2013.

## Assessment

### Impacts of the Technology

**Production and socio-economic benefits**

- ++ increased wood production
- \+ increased fodder production
- \+ increased fodder quality
- \+ increased animal production

**Production and socio-economic disadvantages**

- ++ high establishment and maintenance costs
- \+ loss of land
- \+ job uncertainty

**Socio-cultural benefits**

- ++ improved conservation / erosion knowledge
- ++ improved situation of disadvantaged groups
- ++ Increase of the security for fire fighters
- \+ conflict mitigation
- \+ improved food security / self sufficiency

**Socio-cultural disadvantages**

- \+ loss of recreational opportunities
- \+ socio cultural conflicts
- \+ increased health problems

**Ecological benefits**

- ++ reduced hazard towards adverse events
- ++ reduced fire risk
- \+ reduced emission of carbon and greenhouse gases

**Ecological disadvantages**

- \+ increased surface water runoff
- \+ decreased soil cover
- \+ decreased soil organic matter
- \+ increased soil erosion locally
- \+ increased habitat fragmentation

**Off-site benefits**

- ++ reduced risk of wildfires
- \+ reduced downstream flooding
- \+ reduced downstream siltation
- \+ reduced damage on neighbours fields
- \+ reduced damage on public / private infrastructure

**Off-site disadvantages**

**Contribution to human well-being / livelihoods**

\+ Through the establishment and the maintenance of firebreaks it is easier to control fires and protect people. Furthermore it created jobs for the unemployed. But it seems that in general forest management is not something people want to do, they work in this sector only if there are no other job opportunities. Forest management means a hard job and this kind of work is not well-respected in society

### Benefits /costs according to land user

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| **Establishment** | very positive | very positive |
| **Maintenance / recurrent** | very positive | very positive |

Both the short-term and the long-term benefits are very positive assuming that maintenance is done. Together with the creation of jobs, directly after establishing the firebreaks there is firewood and timber available and a reduced risk of wildfires. But it should also be considered that the establishment costs are high. If maintenance is not done the long-term returns will be very negative because an increase in the risk of fire will occur again (without management, there will also be no firewood, no timber and no jobs). The maintenance costs increase the longer you wait because the vegetation will grow again densely.

**Acceptance / adoption:**

There is little trend towards (growing) spontaneous adoption of the technology. The existing firebreak network system was established within the pilot project. Other firebreaks were created afterwards by the regional government of Valencia or already existed before. Maybe the network is enlarged in some areas from time to time. This technology is also applied in other countries/regions, amongst others in Portugal, South Carolina and South Africa.

## Concluding statements

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
|---|---|
| There is a reduction of fuel load within the firebreaks and therefore they contribute to fire prevention. → The maintenance of firebreaks is crucial | Firebreaks are a strong disturbance of the natural environment. People often criticise the negative aesthetic/visual impact which results in a decline of the recreational value. → This problem is difficult to overcome, but the technology helps to prevent an even bigger disturbance of the forest caused by a fire. Even though criticising the firebreaks due to its visual impact people know about the importance of this measure and are also concerned with the devastating effects of a forest fire. There is always the question of what is better: to establish firebreaks and disturb nature, or to experience a large fire. |
| A firebreak does not stop a fire but facilitates the access for fire fighters (and vehicles) and guarantees a higher security for people, thus increasing the possibility to control/slow down a fire. By arranging the territory in different parcels (firebreaks of first, second and third order) the spread of large forest fires is less probable → The maintenance of firebreaks is crucial. Furthermore, there must be a good coordination and organisation within the fire fighter staff in case of an emergency. | The establishment and the maintenance activities are expensive and labour-intensive. Without management the firebreaks are not effective anymore. It would be necessary to extract biomass from the forest to decrease the continuity of the trees and shrubs. In case of a lack of management the risk of fires increases. → Management is crucial. It should be noted that prevention measures are often less expensive than rehabilitation activities after a fire. More investment in forest management and fire prevention is required. Managing the forest would not only decrease the risk of fire but also generate benefits (e.g. wood, biomass). Furthermore, jobs would be generated which is especially important during the current economy crisis in Spain. There are some good practices found in other regions to cover the maintenance costs: In Jarafuel (next to Ayora) a part of the rent paid by the wind mill company to the state is reinvested in forest management. Or in Andalucia, the government launched a project to invest subventions in maintenance of firebreaks through grazing and this was very successful. This could be a good alternative to expensive management measures. It was also mentioned by many stakeholders that traditional activities (such as grazing, agriculture, wood gathering) should be reactivated and that the villagers should get economic compensation to maintain the forest in a good state. |
| There are both social and economic benefits for local people. The establishment and the maintenance of firebreaks provide jobs for rural people which allows them to increase their livelihood conditions. A part of the extracted wood is used for biomass, fertilizers, pellets, or firewood. Furthermore there would be improved conditions for grazing. → More investment in forest management is required to sustain these benefits. Furthermore, many local stakeholders mentioned the importance of reactivating traditional activities (such as grazing, agriculture, wood gathering) and that the villagers should get economic compensation to maintain the forest in a good state. | Firebreaks are not that efficient because after clearing, the first plants which grow are Ulex parviflorus and Cistus albidus which are fire-prone species. Furthermore, if you cut them each 4 or 5 years there will only be grassland which is not natural in Mediterranean region. A fire could be caused more easily due to the high amount of thin and dead material. → CEAM suggests to plant more fire-resistant species (late successional stages) within some spots in the firebreaks to increase the resilience of the ecosystem. Green living plants have a higher humidity content which slows down a fire (oxygen is consumed). The issue is not to cover the whole firebreaks with plants but to establish some green spots. By planting late-successional species densely you don't allow seeders to grow. This measure could also decrease management costs. People keep in their minds the idea of having to clear all the vegetation in order to not have fires or to stop them, but it is not really the most sustainable one. The idea of green firebreaks is already common in some other countries but you need to ensure water availability for irrigation. |
| Vegetation removal produces fresh vegetation growth, therefore more diverse and nutritious fodder is available for animals (game and livestock) in the cleared areas. Game/wildlife and livestock are better because there is an increase in fodder quantity and quality. → The maintenance of firebreaks is crucial. | In some areas, the implementation of firebreaks can occupy productive land which means a loss of land → The main objective of this technology is to provide protection from forest fires instead of creating productive land. |
| Due to the high stone content of the soil, and due to mulching through in-situ brush-chipping of the cleared material, the firebreaks are not that prone to erosion as in other regions/countries (e.g. Portugal). → | The work is dangerous and there is a high risk to harm oneself when clearing and chipping the vegetation. It is also a physical stress due to the exhausting work → |
| Improvement and maintenance of the forest paths and streets to establish firebreaks and to guarantee access for fire fighter vehicles but also for recreational activities (rural tourism). → Establishment and maintenance of the firebreaks can improve the forest track network. | When there is a strong and dry wind from the inland (poniente) the smaller firebreaks are useless because the fire just passes over. It should also be noted that without human intervention the firebreaks do not stop a fire → Establish big firebreaks and ensure maintenance. |
| Fewer fires result in a decrease of the destroyed area, less money will have to be invested in restoration or fire extinction. Furthermore, farmers, hunters and honey producers will experience fewer losses. → The maintenance of firebreaks is crucial. | |
| In Jarafuel where most of the land is public retired people receive the firewood gained by forest clearings for free. They can use the wood for cooking and heating and save a lot of money. → People from the region (outside of Jarafuel) like this idea that villagers benefit from what is removed from the forest. More mechanisms like this should be developed so that people recognize that they also benefit from forest management, which in turn would ensure a sustainable forest management. | |
| There are also off-site benefits. Fewer fires will result in a reduction of downstream flooding, downstream siltation and damage on neighbours' fields. When fire removes less vegetation the soil is less vulnerable to erosion → The maintenance of firebreaks is crucial. | |


**left:** Reduction of the density of trees and or vegetation removal using machinery (Photo: João Soares)
**right:** Primary strip network system for fuel management. (Photo: João Soares)

# Primary strip network system for fuel management

### Portugal - Primary strip network system for fuel management

**Linear strips are strategically located in areas where total or partial removal of the forest biomass is possible. This technology contributes towards preventing the occurrence and spread of large forest fires and reducing their consequences for the environment, people, infrastructures, etc.**

There are three types of strip for fuel management in forest areas: primary, secondary and tertiary, defined by the Law 17/2009. The most important differences between them are in terms of size (primary being the widest and the tertiary the narrowest) and scale (primary referring to the district level, secondary to the municipal level and tertiary to the parish level). The primary strip network system for fuel management (RPFGC) is integrated in the National System to Prevent and Protect Forest against Fires and it is defined by the National Forest Authority (AFN).
The RPFGC aims to re-arrange landscape elements, through the establishment of discontinuities in the vegetation cover, in forest areas and in the rural landscape (for example using water bodies, agricultural land, pasture, rocky outcrops, shrubland and valuable forest stands). Land tenure is private in most of the areas covered by the RPFGC. The main objectives of this technology are: to decrease the area affected by large fires; to enable direct access by fire fighters; to reduce fire effects and protect roads, infrastructures and social equipment, urban areas and forest areas of special value; and to isolate potential fire ignition sources.
These primary strips are ≥ 125 metres wide and preferably between 500 and 10,000 ha in area. The tree cover should be less than 50% of the area and the base of the tree canopy should not be lower than 3 metres. The RPFGC concept should include the adoption of a maintenance programme. The implementation and maintenance operations can be performed through different agro-forest technologies, such as clearance of bushes and trees, pruning, prescribed fire, harrowing and cultivation of the ground beneath the trees. Timber products can be sold and the removed litter can be used in a biomass power plant or applied to the fields to improve soil fertility, using mulching technology.
This SWC Technology needs considerable financial resources in terms of labour and equipment at the implementation phase. Costs, however, undergo considerable reduction thereafter. The implementation of this infrastructure to prevent and protect the land from forest fire is entirely funded by the government and implemented by the forest municipal services.

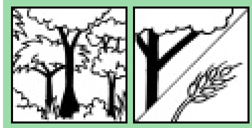
Location: Portugal
Region: Santarém / Mação
Technology area: 400 km$^2$
Conservation measure: structural
Stage of intervention: prevention of land degradation
Origin: Developed externally / introduced through project, recent (<10 years ago)
Land use type:
Forests / woodlands: Natural
Mixed: Agroforestry
Climate: subhumid, temperate
WOCAT database reference: T_POR001en
Related approach: Forest Intervention Area (QA | POR01)
Compiled by: Celeste Coelho, University of Aveiro
Date: 2011-10-16
Contact person: Celeste Coelho, Centre for Environmental and Marine Studies University of Aveiro 3810 - 193 Aveiro Portugal Tel.: +351 234 370 349 Fax: +351 234 370 309 E-mail: coelho@ua.pt

## Classification

### Land use problems:

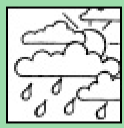
- Forest fires increase due to rural depopulation and to land management abandonment. (expert's point of view)

**Land use**



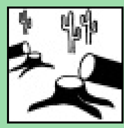
Natural
Agroforestry
rainfed
silvo-pastoralism
rainfed
selective felling of (semi-) natural forests, clear felling of (semi-)natural forests

**Climate**



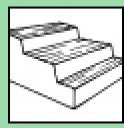
subhumid

**Degradation**



Biological degradation: detrimental effects of fires

**Conservation measure**



Structural: Others ()

**Stage of intervention**

- Prevention
- Mitigation / Reduction
- Rehabilitation

**Origin**

- Land users initiative
- Experiments / Research
- Externally introduced: recent (<10 years ago)

**Level of technical knowledge**

- Agricultural advisor
- Land user

**Main causes of land degradation:**
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires)
Indirect causes: Property size

**Main technical functions:**
- control of fires

**Secondary technical functions:**
- reduction of dry material (fuel for wildfires)

# Environment

## Natural Environment

**Average annual rainfall (mm)**

- > 4000 mm
- 3000-4000 mm
- 2000-3000 mm
- 1500-2000 mm
- 1000-1500 mm
- 750-1000 mm
- 500-750 mm
- 250-500 mm
- < 250 mm

**Altitude (m a.s.l.)**

- > 4000
- 3000-4000
- 2500-3000
- 2000-2500
- 1500-2000
- 1000-1500
- 500-1000
- 100-500
- <100

**Landform**

- plateau / plains
- ridges
- mountain slopes
- hill slopes
- footslopes
- valley floors

**Slope (%)**

- flat
- gentle
- moderate
- rolling
- hilly
- steep
- very steep

**Soil depth (cm)**

- 0-20
- 20-50
- 50-80
- 80-120
- >120

**Growing season(s):** 1 days(1 per year)
**Soil texture:** medium (loam)
**Soil fertility:** low
**Topsoil organic matter:** low (<1%)
**Soil drainage/infiltration:** poor (eg sealing /crusting)

**Soil water storage capacity:** low
**Ground water table:** 5 - 50 m
**Availability of surface water:** medium
**Water quality:** good drinking water
**Biodiversity:** medium

**Tolerant of climatic extremes:** temperature increase, seasonal rainfall increase, seasonal rainfall decrease, decreasing length of growing period
**Sensitive to climatic extremes:** heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells

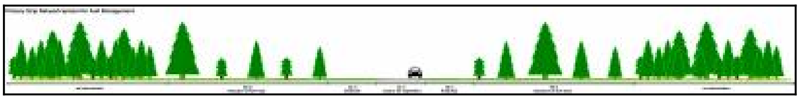
## Human Environment

**Forests / woodlands per household (ha)**

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

**Land user:** groups / community, Small scale land users, common / average land users, men and women
**Population density:** 10-50 persons/km2
**Annual population growth:** negative
**Land ownership:** individual, not titled
**Land use rights:** individual
**Water use rights:** open access (unorganised)
(Individual, not titled: Usually, legal documents for the property are missing.)
**Relative level of wealth:** average, which represents 50% of the land users; 50% of the total area is owned by average land users
poor, which represents 50% of the land users; 50% of the total area is owned by poor land users

**Importance of off-farm income:** > 50% of all income:
**Access to service and infrastructure:** low: employment (eg off-farm); moderate: education, technical assistance, telecommunications; high: health, market, energy, roads & transport, drinking water and sanitation, financial services
**Market orientation:** mixed (subsistence and commercial)



**Technical drawing**

This technical drawing indicates the technical specifications, dimensions and spacing for the Primary Strip Network System for Fuel Management. The figure shows a road as the axis of the RPFGC, but it can also be a river or a ridge, amongst other breaks in the forest cover. (João Soares)

## Implementation activities, inputs and costs

### Establishment activities

- Primary System design
- Shrubs cleaning + Thinning (reduction of fuel load) + Pruning
- Removing the cut waste material
- Litter Shredding
- Transport to the Biomass Plant

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 1076.00 | 0% |
| Equipment | | |
| - machine use | 568.00 | 0% |
| - Transport | 100.00 | 0% |
| **TOTAL** | **1744.00** | **0.00%** |

### Maintenance/recurrent activities

**Remarks:**
The costs include the activities to ensure the vertical and horizontal discontinuity of the fuel load and also the activities needed to manage the waste produced from the shrubs cleaning and thinning.
The costs calculation was made for the implementation of the first section of the RPFGC. The implementation phase lasted for 2 or 3 months during the dry season. This section included 28 ha and 4 teams of forest sappers were involved.

## Assessment

### Impacts of the Technology

**Production and socio-economic benefits**

+++ reduced risk towards adverse events (droughts, floods and storms)
++ increased fodder production
++ increased fodder quality
++ increased animal production
+ increased energy production: biomass

**Production and socio-economic disadvantages**

++ costs of implementation
+ reduced wood production
+ increased maintenance costs

**Socio-cultural benefits**

++ community institution strengthening
+ national institution strengthening
+ conflict mitigation
+ improved conservation / erosion knowledge

**Socio-cultural disadvantages**

+ socio cultural conflicts

**Ecological benefits**

+++ reduced hazard towards adverse events
+++ reduced fire risk
+ improved soil cover

**Ecological disadvantages**

++ decreased soil cover
+ increased surface water runoff
+ decreased soil organic matter
+ increased soil erosion locally
+ increased habitat fragmentation

**Off-site benefits**

+++ reduced damage on public / private infrastructure
++ reduced damage on neighbours fields

**Off-site disadvantages**

**Contribution to human well-being / livelihoods**

+ reduced risk of wildfire

**Benefits /costs according to land user**

| | Benefits compared with costs | short-term: | long-term: |
|---|---|---|---|
| | **Establishment** | neutral / balanced | positive |
| | **Maintenance / recurrent** | neutral / balanced | positive |

The maintenance will only start 2 or 3 years after the technology implementation, so no returns are expected at short-term.

**Acceptance / adoption:**

There is strong trend towards (growing) spontaneous adoption of the technology. After the implementation period there was a high local acceptance of the technology. It is also expected that grazing activities contribute to the technology maintenance

## Concluding statements

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
|---|---|
| Fuel load reduction → This will be achieved using prescribed fire and specialised machinery. The efficacy of prescribed fire depends on the collaboration of technicians and forest sapper teams. To guarantee the effectiveness of RPFGC implementation, long-term maintenance has to be ensured. | Soil erosion increase → Forestry good practices should be used in the RPFGC implementation, especially concerning the use of machinery and avoiding disturbance of soil at depth. Soil cover after the removal of the existing vegetation should be promoted (by seeding, mulching or creating a low intensity pasture). |
| Reinforcement of the forest path system → Clearing the strips of the RPFGC can enhance the forest track network. | Soil cover reduction → Soil cover after the removal of the existing vegetation should be promoted (by seeding, mulching or creating a low intensity pasture). |
| Forest fire prevention and fighting → The know-how of the local stakeholders and communities will contribute to the design of the RPFGC . This information should be integrated into the Municipal Plans to Prevent and Protect Forest Against Fires (PMDFCI). Any further information should be provided to the Civil Protection Agencies and to the Forest Technical Office and also to the local fire-brigade team. | Runoff increase → Soil cover after the removal of the existing vegetation should be promoted (by seeding, mulching or creating a low intensity pasture). Excessive vegetation removal should be avoid, especially near water courses where the removal should be nil or minimum. |
| Increase in landscape resilience → This will only be effective if the RPFGC is continuous and without gaps. The acceptance of the RPFGC by the landowners is fundamental to widespread the use of this technology. Information and awareness about the need to change vegetation cover is also very important, in order to avoid extensive areas of monoculture. | Budget for implementation and maintenance → European and national funds. Collaboration of the local government providing equipment and labour force. Information and awareness to the landowners about the importance of this technology. Campaigns of national awareness and definition of this technology as 'public use' to overcome some potential social conflicts concerning the land rights. |

# Forest Intervention Area (ZIF)

### Portugal - Zona de Intervenção Florestal (Portuguese)

**Forest Intervention Area (ZIF) is a territorial unit, where the main land use is forestry. This approach assembles and organizes small forest holders and defines a joint intervention for forest management and protection. Defined by law in 2005, and revised in 2009, each ZIF of private forest has to include at least a contiguous area of 750 ha, 50 landowners and 100 forest plots, and has to be managed by a single body, defined by ZIF members.**

Aim/objectives: The ZIF overall objective is to promote the efficient management of forest and to mitigate current constraints of forest intervention (e.g. land size and tenure). Other objectives are to develop structural measures for fire prevention, to integrate local and central administration actions and to implement the national and regional forest management policy at the local level. The final purpose of ZIF areas is to improve productivity in rural forest areas, contributing to rural development

Methods: The idea emerged after the catastrophic wildfires of 2003 and was developed and presented by a group of stakeholders (landowners, forest associations, City Council, among others) to the Ministry of Agriculture, Rural Development and Fisheries. The ZIF approach was legislated by Law 127/2005, and revised under Law 15/2009. Each ZIF assembles small properties, which will be jointly managed by a single entity, which can be a non-profit-making and voluntary organization or some other group of people approved by the forest owners. Each ZIF will have a Forest Management Plan (PGF), where the forestry operations and activities for ZIF area are defined accordingly to the guidelines of the Regional Plan for Forestry Management and Planning (PROF), and a Specific Plan to Forest Protection (PEIF), which includes actions to protect forest against biotic and abiotic risks. The management entity should have a team with qualifications and experience in forestry and with technical ability to design these plans.

Stages of implementation: The legal constitution of ZIF includes six mandatory steps, namely the constitution of the founding group (group of landowners with at least 5% of a continuous area inside the ZIF), the prior consultation meeting, the public consultation, the final audience meeting, the proposal submission to the National Forest Authority (AFN) and legal publication of each ZIF (already done). After these procedures, the PGF and PEIF of each ZIF will be designed by the management entity and evaluated and approved by AFN. The implementation activities can then be implemented by the management entity or by individual landowners following the rules described on the plans. PEIF validity is five years and PGF validity is 25 years (still in preparation). [See figure below].

Role of stakeholders: The founding group is mainly composed of forest owners and producers and is the starting point for creating a ZIF. The management entity administers the ZIF in order to achieve their main purposes and the aims defined on the plans. AFN will support and monitor ZIF activities. ZIF non-supporting landowners are obliged to have a PGF for their land, as well as to accomplish the PEIF of the ZIF.

The landowners inside the ZIF who are non-supporters do not have a clear role. Based on PROF - Plano Regional de Ordenamento Florestal (Regional Plan for Forestry Management and Planning), for ownerships of > 25 ha, the owners are obliged to have a PGF - Plano de Gestão Florestal (Plan for Forestry Management) for their property.

**left:** ZIF Information Session (Photo: AFLOMAÇÃO)

**right:** Forest Intervention Areas in Mação Municipality (Photo: João Soares)

Location: Santarém, Mação
Approach area: 400.00 km$^2$
Type of Approach: project/programme based
Focus: mainly on other activities
WOCAT database reference: A_POR001en
Related technology(ies): Prescribed Fire (POR02), Primary Strip Network System for Fuel Management (POR01)
Compiled by: Celeste Coelho, University of Aveiro
Date: 2009-02-01
Contact person: Celeste Coelho, Department of Environment and Planning, Centre for Environmental and Marine Studies, University of Aveiro, 3810-193 Aveiro, Portugal; coelho@ua.pt

## Problem, objectives and constraints

### Problems

- lack of forest planning and management, forest fires, land structure and tenure, land abandonment, rural depopulation and ageing.

### Aims/Objectives

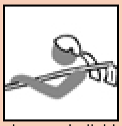
- To promote the sustainable management of forest; - To coordinate the protection of forest and natural areas; - To reduce the conditions to fire ignition and spread; - To coordinate the recovery of forest and natural areas affected by forest fires; - To give territorial coherence and effectiveness to the action of local administration and others actors.

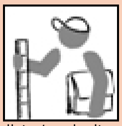
### Constraints addressed

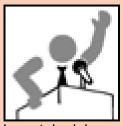
| | Constraint | Treatment |
|---|---|---|
| social / cultural / religious | Social resistance to this approach. Landowners fear to lose tenure rights. Difficult to reach and find owners due to inheritance and out-migration. Rural depopulation occurred in the last decades. | Financial support, creation of new job opportunities in rural areas. |
| institutional | Scepticism about the practical effects of this approach. Very high costs for implementation and lack of private investment | ZIF pilot areas will motivate implementation and investment into other ZIFs. |
| financial | High implementation cost. | Governmental incentives |
| legal / land use and / water rights | Land structure and tenure (private holdings) | Minimum area to constitute a ZIF is 750 ha |

## Participation and decision making

### Stakeholders / target groups


land users, individual


SLM specialists / agricultural advisors


politicians / decision makers

### Approach costs met by:

| | |
|---|---|
| government (Permanent Forest Fund) | 100% |
| local community / land user(s) (ZIF implementation activities: National Strategic Reference Framework (60%), Land users (40%)) | 0% |
| **Total** | **100%** |

Annual budget for SLM component: US$ > 1,000,000

**Decisions on choice of the Technology(ies)** mainly by SLM specialists with consultation of land users

**Decisions on method of implementing the Technology(ies):** by SLM specialists alone (top-down)

**Approach designed by:** national specialists

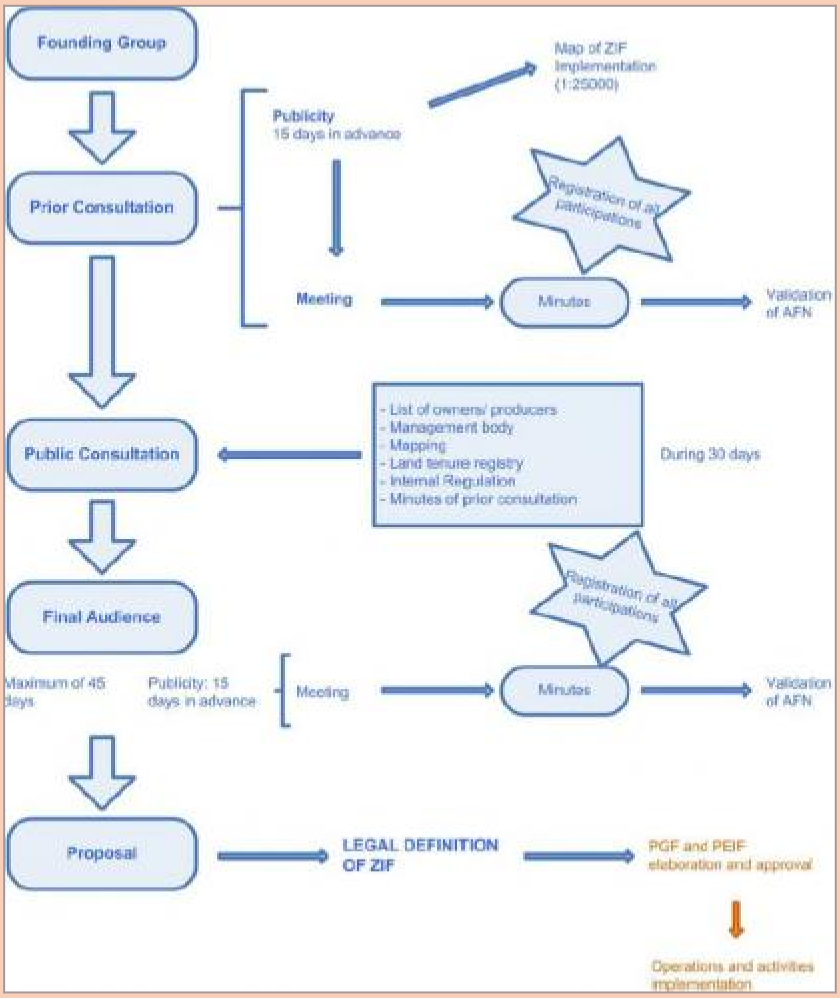
**Implementing bodies:** other (Private organizations), local community / land users, local government (district, county, municipality, village etc)

### Land user involvement

| Phase | Involvement | Activities |
|---|---|---|
| Initiation/motivation | Interactive | Balance alternatives and take decision to test the agave forestry information sessions about ZIF approach; informal contacts, door-to-door approaches and formal agreement of the landowners to become ZIF members. |
| Planning | Passive | information sessions to present the ZIF plans (PGF and PEIF). |
| Implementation | Interactive | management activities can be made by the land owners or by the ZIF management entity. Regular meetings with ZIF members |
| Monitoring/evaluation | Interactive | not defined yet |
| Research | Interactive | on-farm research, good practice demonstration and collaboration with research projects. |

**Differences between participation of men and women:** No

**Involvement of disadvantaged groups:** Yes, moderate
Yes (in the sense that the majority of forest owners are usually pensioners, with low incomes)




**Organogram:** Legal process related with the ZIF constitution (blue) Elaboration and approval of the ZIF plans (orange) Implementation of the plans (orange)

## Technical support

### Training / awareness raising:
Training provided for opinion leaders
Training focused on information sessions and individual contacts with opinion leaders

### Advisory service:
Name: Information sessions
Key elements:
1. ZIF process
2. Explaining rational of ZIF for specific municipality and its conditions like depopulation, forest fires, etc
3. Elaboration of the ZIF plans

The extension system is well set up to ensure follow-up activities
The extension system is very adequate to ensure continuation of activities.

### Research:
Yes, great research. Topics covered include sociology, economics / marketing, forestry, politics, ecology
Mostly on station and on-farm research.
The approach includes technical and local knowledge. The idea was prepared and presented by a group of stakeholders (landowners, forest associations, among others) to the Ministry of Agriculture, Rural Development and Fisheries and legislated by the Law n. º 127/2005, 5 August.

## External material support / subsidies

**Contribution per area (state/private sector):** Yes. through FFP (Permanent Forest Fund) and QREN (National Strategic Reference Framework).

**Labour:** Voluntary. landowners can work on their properties or can be substituted by the ZIF management entity. Some activities, such as the implementation of the Primary Strips Network System for Fuel Management can be supported by the municipality services.

**Inputs:**
- Equipment (machinery, tools, etc): Printer, toners, map production.. Fully financed

**Credit:** n. a.

**Support to local institutions:** Yes, great support with
City council supports the forest association activities.

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|

**Changes as result of monitoring and evaluation:**
(* The monitoring procedures are not structured yet) (* The monitoring procedures are not structured yet)

## Impacts of the Approach

**Improved sustainable land management:** Yes, great; Reduction of the number and likelihood of forest fires.

**Adoption by other land users / projects:** Yes, many; The initial social resistance to the approach will diminish through the existence of a successful ZIF.

**Improved livelihoods / human well-being:** Yes, moderate

**Improved situation of disadvantaged groups:** Yes, moderate; It is expected that the increase in land productivity through the implemented technologies will help to improve the socio-economic situation of these rural groups.

**Poverty alleviation:** Yes, moderate; It is expected that the implementation of this approach will contribute to the improvement of rural socio-economic conditions through productivity increase, creation of employment and promotion of local products.

### Training, advisory service and research:

- Training effectiveness
  SLM specialists: good
- Advisory service effectiveness
  Land users*: good
  Information sessions; Dissemination

### Land/water use rights:
Hinder - greatly in the implementation of the approach. The ZIF join small properties and their management is undertaken as a single property, guide by a forest management plan. This entity can be a non-profit and voluntary organization or an other group of people approved by the forest owners and/or producers.
The approach did reduce the land/water use rights problem (greatly).

### Long-term impact of subsidies:
Positive long-term impact: Greatly

## Concluding statements

### Main motivation of land users to implement SLM:

Rules and regulations (fines) / enforcement

Affiliation to movement / project / group / networks

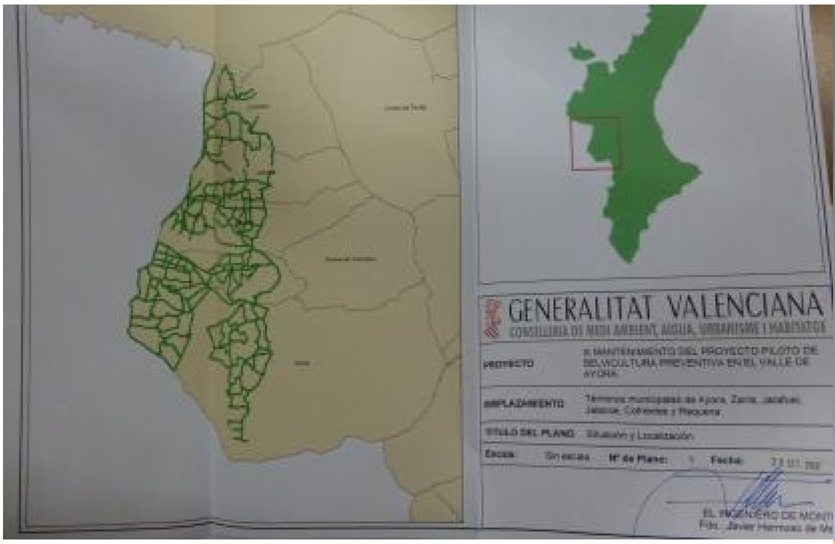
Aesthetic

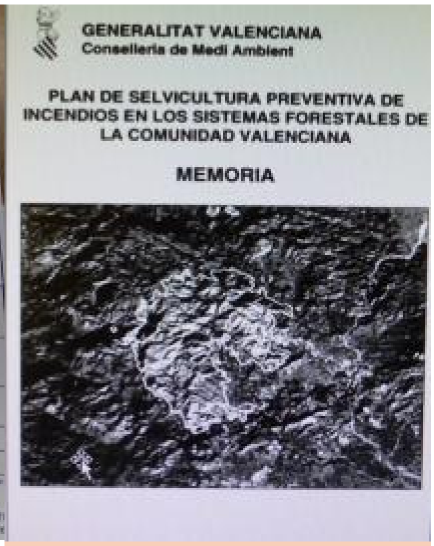
Forest fires

### Sustainability of activities:

No the land users can`t sustain the approach activities without support.
The forest owners do not have the financial capacity to apply and support these activities by themselves.

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
| --- | --- |
| Social conscience → through awareness campaigns and information sessions provided at national and local level. | Unattractive investment (low public support and lack of private support) → the need to review and reform the existing QREN or provide others means of support. Incentives to private initiative or donors should be found. |
| Prevention of forest fires → the increase of forest management will contribute to the decrease of large forest fires. The implementation of integrated and global measures to fire prevention will be suitable within the ZIF approach. | Highly bureaucratic nature of the ZIF approach → simplification of the bureaucratic process |
| Restoration of burnt areas → The use of forest species to enable the protection and recovery of degraded soils or soils with high erosion risk has a very positive influence on the rehabilitation of burnt areas. However, many of these species are not economically attractive at short or medium term. The management of the land using ZIF model will allow the definition of the most affected areas for an urgent intervention. | Rather complex process: unclear role for the non-adherent landowners within the ZIF; ZIF has to follow many laws and plans; control and monitoring activities still not defined → clarification and simplification of the bureaucratic process of the ZIF |
| Increase productivity → present land tenure and structure of forest holdings constitute a bottleneck for forest productivity. The integrated management of the ZIF will allow a better management and use of the land, increasing the exploitation of timber and non-timber products and also increasing the resilience to wildfires. | Costs related to the approach → major financial support from the government needs to be provided. |
| Improve forest management → promotion of the planting of more fire-resilient species which are better adapted to the local conditions. AFN should: (i) provide information about the guidelines; (ii) develop new policies and tools, which are more suitable to the local level; (iii) support and implement public awareness campaigns about forest values and services, and (iv) provide financial support to ZIF constitution and implementation activities. | |




# Plan of preventive silviculture (PSP): implementation of firebreak network within a forest intervention area (ZAU)

## Spain - Plan de selvicultura preventiva de incendios en los sistemas forestales de la Comunidad Valenciana (Spanish)

## Through the declaration of Ayora to a forest intervention area (ZAU) and the implementation of the pilot project of the PSP, a preventive silviculture was promoted through the establishment of a firebreak network.

**left:** Third maintenance of the firebreaks established through the pilot project of the plan of preventive silviculture (Photo: Generalitat Valenciana)

**right:** Project documents of the plan of preventive silviculture (Photo: Generalitat Valenciana)

Location: Spain, Valencia, Los Serranos, Utiel-Requena, Valle de Ayora-Cofrentes, Sierra de Mariola
Approach area: 838.61 km$^2$
Type of Approach: project/programme based
Focus: mainly on conservation with other activities
WOCAT database reference: A_SPA002en
Related technology(ies): Cleared strip network for fire prevention (firebreaks) (T_SPA009en)
Compiled by: Nina Lauterburg, CDE
Date: 2013-05-06
Contact person: Jaime Baeza, Fundación Centro de Estudios Ambientales del Mediterráneo (CEAM), Parque Tecnológico Paterna. C/ Charles Darwin 14, 46980 Valencia, Spain. / Departamento de Ecología, Universidad de Alicante, Ap. 99, 03080 Alicante, Spain. jaime.baeza@ua.es

Aim/objectives: Forest fire is the main degradation driver in Ayora. In the article 24 of the forest law 3/1993 the declaration of special areas to forest intervention areas, so-called "Zonas de Actuación Urgente (ZAU)" through the regional government of Valencia is defined. Objectives are the protection against natural hazards and the promotion of conservation/restoration within a area which is degraded, affected by a forest fire (and natural regeneration is not probable), adverse climatic conditions, pests, severe ecological change, or fauna or flora of special value. If the use of the resources is not compatible with the conservation objectives within a ZAU, the administration has the right to enforce restrictions. The Ayora region was declared to a ZAU in 1997 due to its high risk of fires. In the "Plan de Selvicultura Preventiva de Incendios en los Sistemas Forestales (PSP)" ("plan of preventive silviculture to prevent forest fires") which became operative in 1996 and whose main objective is the reduction of the fire risk, the ZAU was practically addressed for the first time in the establishment of a firebreak network (áreas cortafuegos). The PSP constitutes an important part of the "plan de protección contra incendios forestales" ("plan of protection against forest fires") and has the following main objectives: The analysis/mapping of historic forest fires in Valencia (1984-1994) to support decision-making in silvicultural issues, the classification of the forest by quality and fire risk to establish local/regional plans to prevent fires (through silvicultural actions), selection of areas (province level) for the establishment of pilot projects (to apply silvicultural actions), decision on periodic investment and level of employment.

Methods: Within the PSP, 4 pilot projects were initiated in Los Serranos (17'470 ha), Utiel-Requena (20'966 ha), Valle de Ayora-Cofrentes (33'851 ha) and Sierra de Mariola (11'574 ha) to promote a preventive silviculture which aims in modifying the amount of fuel in the forest through the establishment of a firebreak network and to limit the burnt area. The pilot areas were selected (in collaboration with the forest administration of Valencia) by the following criteria: representativity for the whole province, high value for the population, high potential risk of fire. In T_SPA009en the pilot project of Ayora-Cofrentes (Cofrentes, Jalance, Jarafuel, Zarra, Ayora) is described in detail and this approach focuses on the Ayora site as well. The firebreak network was established between 1998 and 2002, carried out by the company VAERSA and executed on both public and private land. Since the old firebreaks (established before the project) had a strong visual and ecological impact, the PSP designed a new type called "área cortafuego". The continuous maintenance of the firebreaks is required which is also included in the pilot project. The total area protected by the firebreak network amounts to 33'851 ha while the management measures were executed on 1944,81 ha. The costs of the execution were 1312 Euro per ha, the maintenance 82.03 Euro per ha (all 2 years) and 31.37 Euro per ha (all 4 years).

Stages of implementation: After the establishment of the PSP (1996) and the declaration of Ayora to a ZAU (1997) the implementation of the pilot project was realized in the following phases: 1) splitting up of the territory based on the quality and the potential risk (using maps and aerial pictures), 2) field work (to examine the first draft of the firebreak network elaborated in the office), 3) office work (digitizing), 4) final map, 5) estimation of costs, 6) combination of firebreak plan with the cadastral land register.

Role of stakeholders: The PSP, the ZAU and the pilot projects were set up by the regional government of Valencia, in collaboration with the forest services. The PSP is put into operation each year by the forest services to plan the maintenance of the firebreak network. The effect on the local population is the creation of jobs in forest management.

## Problem, objectives and constraints

### Problems

High amount of continuous fuel due to lack of management which increases the risk of vast and devastating fires, lack of fire prevention and extinction measures, ecological and visual impact of old firebreaks.

### Aims/Objectives

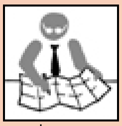
Research on historic fires to support decision-making in silvicultural practices, fire risk reduction, reducing the burnt area through splitting up the forest, improvement of fire prevention and extinction measures (e.g. improvement of access for fire-fighting vehicles and protection of fire fighters), establish local/regional plans to prevent fires (through silvicultural actions), promote conservation of the forest on a large scale

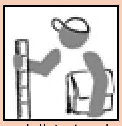
### Constraints addressed

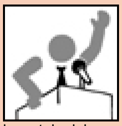
| | Constraint | Treatment |
|---|---|---|
| institutional | Laws on forest management existed already before the implementation of the PSP but the idea of establishing a firebreak network was not available | With the pilot project of the PSP the firebreak network was carefully assessed and implemented |
| financial | There was a lack of money to implement silvicultural measures | The pilot project of the PSP was fully financed by the government |

## Participation and decision making

### Stakeholders / target groups


planners


SLM specialists / agricultural advisors


politicians / decision makers


land users, groups

### Approach costs met by:

| | |
|---|---|
| government (government of Valencia ) | 100% |
| **Total** | **100%** |

Annual budget for SLM component: US$ 100,000-1,000,000

**Decisions on choice of the Technology(ies)** Politicians in collaboration with SLM specialists

**Decisions on method of implementing the Technology(ies):** Politicians in collaboration with SLM specialists

**Approach designed by:** national specialists

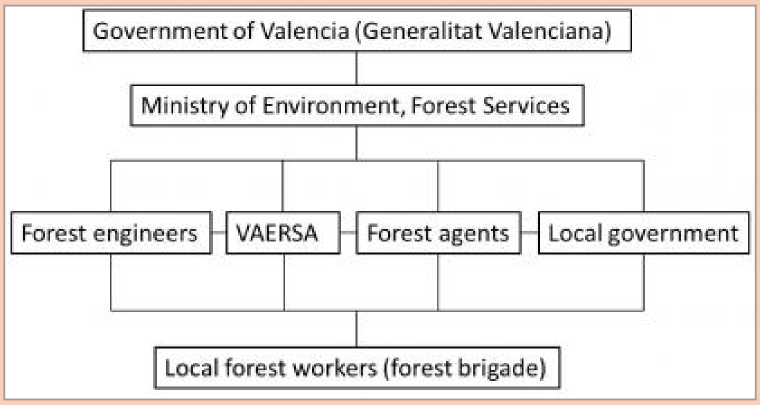
**Implementing bodies:** government (Regional government of Valencia (Generalitat Valenciana), forest services), local government (district, county, municipality, village etc) (Probably the local governments helped in the implementation of the pilot projects, e.g. provision of maps. )

### Land user involvement

| Phase | Involvement | Activities |
|---|---|---|
| Initiation/motivation | None | By government of Valencia |
| Planning | None | By government of Valencia |
| Implementation | Payment/external support | local people working in the execution and maintenance of the firebreak network, led by forest agents and forest engineers of the government of Valencia |
| Monitoring/evaluation | None | By government of Valencia |
| Research | None | By government of Valencia |

**Differences between participation of men and women:** Yes, moderate
Usually men are involved in the forest sector

**Involvement of disadvantaged groups:** Yes, little
In the execution and the maintenance of the firebreak network unemployed local people were/are included. But in the development of the PSP this was not the case.




**Organogram:** The PSP and the pilot projects were set up by the regional government of Valencia in collaboration with the forest services. Forest engineers and forest agents are employed at the forest services and helped to design the projects. VAERSA, a public company of the Generalitat Valenciana, executed the pilot projects and was supported by forest engineers, forest agents and the local governments. Local forest workers were contracted (by VAERSA) for execution and maintenance work and controlled by forest agents. (Nina Lauterburg)

## Technical support

### Training / awareness raising:
Training provided for land user
Training was on-the-job
Training focused on Training of local people in the use of machinery in forest management (execution and maintenance of firebreaks)

### Advisory service:

The extension system is quite adequate to ensure continuation of activities.  The maintenance of the pilot projects is included in the PSP and is planned and executed by the government of Valencia. Already three maintenance projects followed after the execution of the pilot projects (2000-2004, 2004-2008, 2008-2012). Future funding of activities is not clear.

### Research:
Yes, moderate research. Topics covered include technology, economics / marketing, ecology
Mostly on station and on-farm research.
analysis/mapping of historic forest fires in Valencia (1984-1994) to support decision-making in silvicultural practices, classification of the forest by quality and fire risk, research on causes of forest fires

## External material support / subsidies

**Contribution per area (state/private sector):** Yes. state (government of Valencia)

**Labour:** Paid in cash. execution and maintenance of firebreak network (forest management)

### Inputs:
- Equipment (machinery, tools, etc): machinery for forest management.  Fully financed
- Infrastructure (roads, schools, etc): roads .  Fully financed

**Credit:** Credit was not available

**Support to local institutions:** No

## Monitoring and evaluation

| Monitored aspects | Methods and indicators |
|---|---|
| technical | Regular observations by project staff, government: Observations of built-up of fuel to decide when and where maintenance is required |

### Changes as result of monitoring and evaluation:
There were no changes in the approach.

There were few changes in the technology.  The technology is the same since the execution of the project but maintenance (e.g. clearing of firebreaks) is applied. Some more firebreaks were established where it was still required and not covered by the pilot project.

## Impacts of the Approach

**Improved sustainable land management:** Yes, moderate; Improvement of fire extinction and prevention

**Adoption by other land users / projects:** Yes, few; Within the PSP they carried out 4 pilot projects, and after the projects more firebreaks were established

**Improved livelihoods / human well-being:** Yes, little; Reduction of the risk of fire and the loss of land through fires. Furthermore jobs were created by this project.

**Improved situation of disadvantaged groups:** Yes, little; More jobs provided through this approach of forest management

**Poverty alleviation:** Yes, little; More jobs provided through this approach of forest management

### Training, advisory service and research:

- Training effectiveness
  Land users*: good
- Research contributing to the approach`s effectiveness: Moderately
  The development of the firebreak network is a complex process and was planned in detail.

### Land/water use rights:

None of the above in the implementation of the approach.  The firebreak network was implemented on both public and private land and the government of Valencia is allowed to establish a ZAU by law.

### Long-term impact of subsidies:

Once the government will not be able to continue paying the maintenance of the firebreaks the technology will probably not be managed anymore

## Concluding statements

### Main motivation of land users to implement SLM:

Fire prevention and extinction

### Sustainability of activities:

No the land users can`t sustain the approach activities without support.
The maintenance is expensive and has to be financed by the state. Furthermore, forest services need to provide technical assistance.

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
|---|---|
| There are both social and economic benefits for local people. The establishment and the maintenance of firebreaks provide jobs for rural people, which allows them to increase their livelihood conditions. People do not depend on unemployment payments and are therefore more accepted in society. → The government should sustain its investment in forest management and include the local population | Land users cannot continue the SLM approach/ technology on their own. The maintenance is expensive and has to be financed by the state. Once the government will not continue paying the maintenance of the firebreaks the technology will probably not be managed anymore. Furthermore, forest services need to provide technical assistance → The government should sustain its investment in forest management. More trainings could be provided to local land users by the government of Valencia |
| There are also firebreaks which were not established within the pilot project but due to a request of forest agents. The project was important to upscale this technology and to get people's attention for the problem of forest fires. → Public awareness raising. | Little involvement of the local population. The projects were designed by the government without including local land users → Include local land users in the planning of forest management. Work in a transdisciplinary way. |
| The firebreak network facilitates the access for fire fighters (and vehicles) and guarantees a higher security for people, thus increasing the possibility to control/slow down a fire. By arranging the territory in different parcels (firebreaks of first, second and third order) the spread of large forest fires is less probable → The maintenance of firebreaks is crucial. Furthermore, there must be a good coordination and organisation within the fire fighter staff in case of an emergency | Firebreaks do mainly work in fire extinction and less in fire prevention → Investigation of other management practices and approaches. An integrative way of forest management could be the clearing of fire-prone species and the planting of more fire-resistant species as suggested by CEAM. |
| The maintenance of the firebreak network is included in the PSP. → The government should sustain its investment in forest management. | |
| Before the implementation of the pilot projects of the PSP there was a lack of money and no institutional base. The pilot project allowed to establish a firebreak network (fully financed by the government of Valencia) → The government should sustain its investment in forest management. | |

WOCAT


# Selective clearing and planting experiment to promote shrubland fire resilience

### Spain - Experimento para aumentar la resiliencia del matorral contra incendios (Spanish)

### The combination of clearing of fire-prone seeder species and planting of more fire resistant resprouter species directs the vegetation to later successional stages which increases the resilience to fires.

The forests and shrublands in Ayora experienced a series of disturbances in the past (such as deforestation and land use), which resulted in the degradation of the vegetation and the reduction of the resilience to fires. At present, there is a high fire incidence. Post-fire landscapes regenerated with a high and continuous fuel accumulation with few native resprouter species. Therefore appropriate vegetation management is crucial. For management the major goals are to reduce the fuel load and its continuity and to increase the resilience of the vegetation to fires. Within this experiment carried out by CEAM (Centro de Estudios Ambientales del Mediterráneo, University of Valencia) different fuel management techniques were examined. They selected three study sites (Morera, Roñoso, Gachas) with a similar history of land use, vegetation composition, soil characteristics, and a typical post-fire scenario whith scarce occurrence of resprouter species. In each site, four plots were established to test the effect of the following management techniques: 1) control (no action), 2) clearing, 3) planting (within the shrubland) and 4) the combination of clearing and planting.
The main purpose of this experiment was to find out which management technique is the most appropriate to prevent fires and it was shown that the combination of selective clearing of fire-prone shrubs (fuel control) and planting of more resistant resprouter species can increase the resilience to fires and is therefore a suitable management practice. Compared to the other management techniques, there are some advantages. Clearing the vegetation (either by hand or mechanically) reduces the fire risk and enhances seedling establishment and growth. Furthermore, the cleared vegetation is chipped and applied in-situ as mulch, which protects the soil from erosion, reduces soil temperature and moisture loss, and enhances carbon conservation. Additionnally, selective clearing allows to preserve desired species and by planting resprouter species the natural processes can be accelerated. Once established, resprouter species persist for a long time which promotes an increase of the vegetation resilience. In this documentation, only the combination of clearing and planting is evaluated since this action is considered as the most appropriate management practice.
In each study site, the experimental area covered about 5000m2 (3 plots of 1000m2 each, one plot of 2000m2). To test the effect of the combination of clearing and planting, a clearing machine was used to clear a plot of 1000 m2 in all three sites. The few resprouting individuals such as Juniperus oxycedrus and Quercus ilex and also some seeder trees such as Pinus halepensis and Pinus pinaster were left standing. The planting holes (0.35 m2) were created with a tractor using a backhoe. The slash and brush chips generated by the clearing were reused in the planting holes as mulch which resulted in ecological benefits. In February 2003, native resprouters of late successional stages with a low amount of dead fuel were planted, such as Quercus ilex, Rhamnus alaternus and Pistacia lentiscus, all protected by a plastic tree shelter to prevent browsing. The seedlings were grown for 8 months in a nursery in Santa Faz (Alicante) and then transferred to a nursery in La Hunde (Ayora) one month before planting. The Regional Forest Services of Valencia provided seeds as well.
The region of Ayora is mountainous with a dry subhumid climate (~380 mm annual rainfall). The risk of fire incidence is at its highest from June to September when there are adverse conditions like drought, high temperatures and strong winds (mainly the winds coming from central Spain, called “poniente”). The population density is very low and there are only few job opportunities (e.g. marginal agriculture, grazing, hunting, beekeeping). Most of the inhabitants work in the nuclear power plant. Forest management could be a source for jobs.

**left:** Different vegetation treatments were examined on four plots in three study sites. 1)Control (no action), 2)clearing, 3)clearing and planting, and 4)planting within the shrubland. (Photo: CEAM)
**right:** The combination of clearing fire-prone and planting more fire resistant species is an appropriate management practice of fire-prone shrubland. (Photo: CEAM)

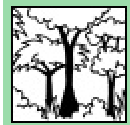
Location: Spain, Valencia
Region: Ayora
Technology area: 0.015 km$^2$
Conservation measure: vegetative
Stage of intervention: prevention of land degradation, mitigation / reduction of land degradation
Origin: Developed through experiments / research, recent (<10 years ago)
Land use type:
Forests / woodlands: Natural
Forests / woodlands: Plantations, afforestations
Climate: subhumid, temperate
WOCAT database reference: T_SPA011en
Related approach:
Compiled by: Nina Lauterburg, CDE
Date: 2013-04-26
Contact person: Alejandro Valdecantos, Fundación Centro de Estudios Ambientales del Mediterráneo (CEAM), Parque Tecnológico Paterna. C/ Charles Darwin 14, 46980 Valencia, Spain. Phone: +34 609 183 599 E-Mail: a.valdecantos@ua.es

## Classification

### Land use problems:

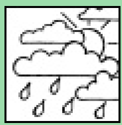
- In Spain the prevalent dense shrublands (dominated by seeder species), which resulted from agricultural land abandonment and fire occurrence, contain a high fire risk because of both the high fuel loads and their continuity. Resprouter species have been removed in the past and are therefore scarce, whereas seeder species are abundant and increase the risk of fires. (expert's point of view)

**Land use**



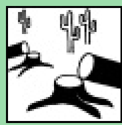

Natural
Plantations, afforestations selective felling of (semi-) natural forests, plantation forestry

**Climate**



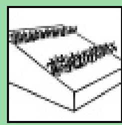
subhumid

**Degradation**



Biological degradation: detrimental effects of fires, quality and species composition /diversity decline

**Conservation measure**



Vegetative: Tree and shrub cover
Vegetative: Clearing of vegetation (eg fire breaks/reduced fuel)
Vegetative: Others (Introduction of fire resistant species)

**Stage of intervention**

Prevention
Mitigation / Reduction
Rehabilitation

**Origin**

Land users initiative
Experiments / Research: recent (<10 years ago)
Externally introduced

**Level of technical knowledge**

Agricultural advisor
Land user

**Main causes of land degradation:**
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires), other human induced causes, change of vegetation composition to fire-prone shrubland
Indirect causes: population pressure, poverty / wealth, labour availability

**Main technical functions:**
- control of fires
- reduction of dry material (fuel for wildfires)
- Promotion of vegetation species and varieties (more fire resistant vegetation composition)

**Secondary technical functions:**
- increase / maintain water stored in soil

## Environment

### Natural Environment

**Average annual rainfall (mm)**

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

**Altitude (m a.s.l.)**

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

**Landform**

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

**Slope (%)**

flat
gentle
moderate
rolling
hilly
steep
very steep

**Soil depth (cm)**

0-20
20-50
50-80
80-120
>120

**Soil texture:** fine / heavy (clay)
**Soil fertility:** medium
**Topsoil organic matter:** medium (1-3%)
**Soil drainage/infiltration:** medium

**Soil water storage capacity:** medium
**Ground water table:** 5 - 50 m
**Availability of surface water:** poor / none
**Water quality:** good drinking water
**Biodiversity:** medium

**Tolerant of climatic extremes:** seasonal rainfall decrease, heavy rainfall events (intensities and amount), wind storms / dust storms, floods, droughts / dry spells
**Sensitive to climatic extremes:** temperature increase, seasonal rainfall increase, temperature decrease, snow, frost

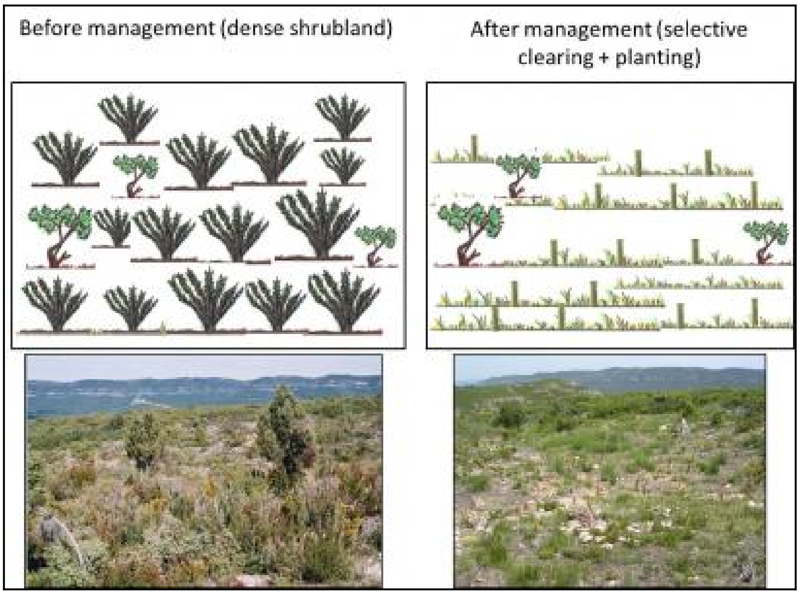
## Human Environment

**Forests / woodlands per household (ha)**

- ☐ <0.5
- ☐ 0.5-1
- ☐ 1-2
- ☐ 2-5
- ☐ 5-15
- ☐ 15-50
- ☐ 50-100
- ☐ 100-500
- ☐ 500-1,000
- ☐ 1,000-10,000
- ☐ >10,000

**Land user:** employee (company, government), mainly men
**Population density:** < 10 persons/km2
**Annual population growth:** negative
**Land ownership:** state, individual, titled
**Land use rights:** individual, public/open access but organised (e.g. wood, hunting)
(There is some public land, controlled by the state. But there is also some private land. The access to the public land is open but organized. Permission is needed from the government to cut trees, to build a house or to hunt. There are some private hunting areas for which the hunting association has to pay a fee.)

**Importance of off-farm income:** :
**Access to service and infrastructure:**
**Market orientation:** mixed (subsistence and commercial)
**Purpose of forest / woodland use:** timber, other forest products / uses (honey, medical, etc.), recreation / tourism




**Technical drawing**

On the left, the situation before management is illustrated. Dense shrublands contain a high fire risk due to their high fuel amount and continuity. On the right, the situation after management is shown. The combination of selective clearing of fire-prone seeder species and planting of more fire resistant resprouter species (illustrated by tree shelters in the drawing) promotes shrubland resilience to fires. (Nina Lauterburg)

## Implementation activities, inputs and costs

### Establishment activities

- Cutting and chipping (in-situ) trees and shrubs (removed species: ulex parviflorus, rosmarinus officinalis, cistus albidus. Natural regenerated species which are not cleared: pinus halepensis, pinus pinaster, quercus ilex, juniperus oxycedrus)
- Planting (planted species: pistacia lentiscus, quercus ilex, rhamnus alaternus)

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Equipment | | |
| - machine use | 3089.00 | 0% |
| - tree shelters | 945.00 | 0% |
| Agricultural | | |
| - seedlings | 4587.00 | 0% |
| **TOTAL** | **8621.00** | **0.00%** |

### Maintenance/recurrent activities

- There is no maintenance, but in case of maintenance they would do selective clearings (using machines)

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Equipment | | |
| - machine use | 446.00 | 0% |
| **TOTAL** | **446.00** | **0.00%** |

**Remarks:**
Slope (if the slope is steep, the work is much more difficult and takes more time), distance from a street (people can work less in a day if they have to walk far to clear/plant), vegetation density (it takes more time to clear a densely vegetated area).
The costs were calculated for the application of the technology (combination of clearing and planting) on one hectare. The costs can vary depending on the amount of vegetation which has to be cleared (site specific). The costs of the clearing amount to 1090 Euro per ha (1470 Dollar). The costs of the plantation (both labour and machines) are approximately 5300 Euro per hectare (7150 Dollar). But it should also be noted that the application of the selective clearing and planting on a vast continuous area is not the aim of this technology, but rather to apply the treatments on some selected spots to reduce the continuity of fire-prone seeder species and to increase the probability of dispersal of resprouter species (e.g. by birds). Therefore the costs would be lower than indicated here. The currency rate (Euro-Dollar) was calculated on November 16th, 2013.

## Assessment

### Impacts of the Technology

**Production and socio-economic benefits**

- + increased fodder production
- + increased fodder quality
- + increased animal production
- + increased wood production

**Production and socio-economic disadvantages**

- + reduced animal production

**Socio-cultural benefits**

- ++ improved cultural opportunities
- ++ increased recreational opportunities
- ++ improved conservation / erosion knowledge
- ++ improved situation of disadvantaged groups
- + conflict mitigation

**Socio-cultural disadvantages**

**Ecological benefits**

- +++ reduced fire risk
- ++ increased soil moisture
- ++ increased plant diversity
- ++ increased biological pest / disease control
- ++ reduction of germination of competing seeds
- ++ reduction of soil surface temperature
- + reduced evaporation
- + improved soil cover
- + increased biomass above ground C
- + increased nutrient cycling recharge
- + increased soil organic matter / below ground C
- + reduced emission of carbon and greenhouse gases
- + reduced soil loss
- + reduced soil crusting / sealing
- + increased animal diversity

**Ecological disadvantages**

**Off-site benefits**

- ++ reduced risk of wildfires and damage of villages

**Off-site disadvantages**

**Contribution to human well-being / livelihoods**

Not applicable since it was only an experiment, but for sure it would contribute to improve livelihoods and human well-being, forest and shrubland management could provide jobs and would also decrease the risk of fires.

**Benefits /costs according to land user**

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| Establishment | slightly negative | very positive |
| Maintenance / recurrent | very positive | very positive |

Short term returns are slightly negative because the management practice is expensive and until the trees reach a mature state, there are not many returns (in terms of wood and biomass). In the long term this management practice has very positive results because it increases the resilience to fires and can be seen as a sustainable management of fire-prone areas. Additionally, wood and biomass can be extracted. The idea is not to apply any maintenance in the first 10 years after the establishment.

**Acceptance / adoption:**

There is no adoption trend since this was only an experiment, but maybe there will be the possibility to upscale this technology in a regional project.

## Concluding statements

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
|---|---|
| After fires, the natural landscape regenerated with a high and continuous fuel amount and a scarce occurrence of native resprouter species. It is crucial to apply management actions to reduce the fire hazard. The experiment demonstrated that it is possible to accelerate the post-fire vegetation response (which promotes ecosystem resilience). → Clearing of fire-prone species and planting of late-successional species. The management of these areas is crucial – the clearings must be repeated from time to time. | The management activities are expensive and labour-intensive. The state does not invest much money in prevention of forest fires but focuses more on fire extinction. → More investment in prevention of forest fires is required and this management practice could increase the ecosystem resilience against fires in the long term in a sustainable way. This would also generate jobs. This technology implies a combination of techniques (selective clearing and planting). Costs may be reduced by implementing individual techniques but positive results may also be reduced. |
| Planting of resprouting species in post-fire areas can accelerate the natural process. Clearing of the vegetation reduces the fire risk, but this treatment may also enhance seedling establishment and growth. → | The technology could result in a reduction of the animal production because grazing should be restricted after planting to ensure the growth of the planted seedlings. → Since the technology would not be applied over vast areas but only locally on some plots, the fodder supply would probably still cover the needs of the animals. |
| The slash and brush chips generated by the clearings can be reused in the planting holes. This mulch layer protects the soil surface and reduces both the soil surface temperature and the germination of competing seeds while increasing the soil moisture content, especially in the driest periods. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. | Depending on the site, some soil may be exposed to erosion due to mechanical clearing. → Mulching with brush chipping can minimize or even solve this problem. |
| The combination of clearing and planting resprouting species seems to be an appropriate option for managing these areas because, once established, the resprouting species persist for a long time and lead to an increase of the ecosystem resilience. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. | After clearing, an increase in wind velocity might occur. → The planted trees will grow which will again result in the reduction of this problem. |
| Social and economic benefits for the locals. Especially during the economic crisis the forest management is an important source for jobs. → Actually there is still a lot of management required in the forest of this region which would provide jobs in the longer term. | |
| Almost all villagers prefer a managed forest. It has a high aesthetic and recreational value. Through the application of this technology the awareness of the risk of wildfires would probably increase. → Recurrent maintenance is crucial to ensure the effectiveness of the technology. Villagers and state need to work together and ensure a long-term forest management. | |
| Shepherds and farmers benefit from forest clearings. There are more young grasses in the forest which provides fodder for livestock. Also wild animals benefit from this food supply which in turn hinders them to destroy cultivated fields of the farmers. → Recurrent maintenance is crucial to ensure the effectiveness of the Technology. | |

# Resilience analysis Tool

Result summary

***About this Resilience Assessment***


***Authors:***
Baeza, Jaime


***Date of Submission:***
11/01/2016

***Main sources of information:***
scientific knowledge

***References in the WOCAT database:***
SPA 11;

Spain
Spa_3

## *Shrubland under selective clearing and planting for fire risk reduction and resilience increase*

## Disturbances affecting the land management system:

The following disturbances affect the land management system, and could change dramatically the environment making it unusable for land users:

| | | |
|---|---|---|
| Type of disturbance: |  fires |  droughts |
| Frequency: | **Between 1 and 5 years** | **Between 5 and 10 years** |
| Risk of permanent changes to the environment after a disturbance: | **High** | **High** |

## Impact of land management on resilience to disturbances:

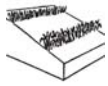
This is the impact that the land management practices have in preventing, mitigating and fostering recovery after. All together they indicate which effect the land management has on the resilience of the system to disturbances:

| | | |
|---|---|---|
| Land Management practice 1: ***Clearing of fire-prone seeder species.*** | ++ | ++ |
| Land Management Practice 2: ***Planting of fire resistant resprouter shrubs and trees*** | ++ | 0 |
| ***Overall impact of land management on resilience to disturbances*** | Very positive | Very positive |

*Legend: ++ Very positive; + Positive; 0 Neutral; - Negative; -- Very negative

## Human and natural environment of the land management system:

A brief description of the features of the land management system assessed

| Land use type | | Environment | | Management | |
|---|---|---|---|---|---|
|  | Present land use(s):<br>***Fo: Other; Fp: Plantations;*** |  | Climate:<br>***subhumid*** |  | Main measure:<br>***Vegetative*** |
| | Past land use(s):<br>***Ca: Annual cropping; Fn: Natural forests; Ca: Annual cropping*** | | Land forms:<br>***plateau / plains, valley floors*** | | Land managers:<br>***employee (company, government), , ,*** |

## Current state of the land management system:

We have asked ***Land users, Land managers, and local experts*** to assess the provision of benefits and the state of the environment in the land management system. These are the most important benefits / services that the environment should provide:

***(P1) Animal and plant productivity***

***(E6) greenhouse gas absorption***
***(E8) Protection from extreme events***

And these are the most important environmental properties that allow the land management system to remain valuable:

Category ***Soil and Water:***

***Availability/protection of springs / water sources***

***Low soil erosion***

Category ***Fauna:***

***High number of wild grazers***

***High number of domestic grazers***

Category ***Vegetation:***

***Low presence of alien/ dangerous species (specify)***

***Presence of a specific plant or group(e.g resprouters, palatables)***

Category ***Landscape:***

***Presence of one specific habitat/land use/land cover***

***Presence of different landscape elements and vegetation patterns***

***Land users, Land managers, and local experts*** have provided the following evaluation of the state of the environment and the provision of benefits/services:

| State of the environment: | | Provision of benefits /Services: | |
|---|---|---|---|
| Category | Evaluation | Category | Evaluation |
| ***Soil and Water:*** | **Healthy** | | |
| ***Fauna:*** | **Degraded** | Productive benefits /services: | **Insufficient** |
| ***Vegetation:*** | **Degraded** | Ecological benefits/Services: | **Insufficient** |
| ***Landscape:*** | **Healthy** | Socio-cultural benefits /Services: | **Undecided** |

## Concluding remarks

### External factors affecting the resilience of land management system:

What external factors ***increase the pressure*** on the environment of the land management system? How they are likely to evolve in the future?*

**Removal of natural vegetation (-)**

What external factors *enable sustainable land management* ? How they are going to evolve in the future?*

**Subsidies for land use activity (-)**

**Land tenure(=)**

**Laws and regulations prescribing land management(=)**

*Forecasted evolution of ext. Factors in the next 10 years: (+) increase, (=) Stable, (-) Decrease

### Under what conditions can the disturbances induce a permanent  change to the land management system?

Fire:
If more than 2 fires occur within 20 years woodland to shrubland transitions are expected. Higher recurrences can drive the system to non-return stable states

Drought:
If severity of drought is higher than tolerance limit for most shrub species re-established in the area, general dieback could be expected, with consequences on ecosystem functioning.

### What are the conditions for a positive evolution of the land management system?

I further maintenance is applied and other treatments of preventive silviculture are applied to reduce fire risk with these land management practices

### Sources used to compile the questionnaire:

*M.J. Baeza , J. Raventos , A. Escarre and V.R. Vallejo. Fire risk and vegetation structural dynamics in Mediterranean shrubland. Plant Ecology, 187:189–201. ;*

*A. Valdecantos,M. J. Baeza,and V. R. Vallejo. Vegetation Management for Promoting Ecosystem Resilience in Fire-Prone Mediterranean Shrublands. Restoration Ecology 17:414–421;*

*M. Jaime Baeza, Alejandro Valdecantos and V. Ramón Vallejo. Management of Mediterranean Shrublands for Forest Fire Prevention. In: New research on Forest Ecosystems A.R. Burk (Ed.) Nova Science Publishers. New York*

# Afforestation with Pinus Halepensis after the fire of 1979 (La Molinera)

### Spain - Repoblación “La Molinera” con Pino Halepensis después del incendio del año 1979 (Spanish)

## Post-fire afforestation with Pinus Halepensis to reduce soil erosion and to enhance forest growth.

As a consequence of the devastating fire of the year 1979 which destroyed 33’000 ha of forest, strong erosion processes occurred on the bare soil and hindered the vegetation to regrow. Furthermore, this region was already abandoned (rural exodus) and missing management practices increased the problem of erosion. Therefore the government mandated to afforest the burnt areas in 1985.
The main purpose of the afforestation was to reduce the soil erosion (which was severe at that time) by planting trees, which increases soil stability and enables forest growth again. But the state also wanted to ensure wood extraction in the future. Furthermore, the visual impact was an important driver for afforesting this area.
The afforestation was executed in the winter of 1985 (November-February/March) by the regional forest services (Conselleria de agricultura). Forest engineers, who worked for the state and planned the project, collaborated with forest agents whereas the involved forest agents contracted local villagers to help afforesting these areas. The forest agent acted as a link between engineer and forest brigade and controlled if the brigade executed what the engineer proposed. He also provided assistance to the workers. The forest brigade was paid by day-if it was raining, people did not work and did not get any salary. Nobody could provide direct information on the afforestation process in 1985 but there are not many differences of how they did it in the past and how it works today. The planting holes (60cm x 60cm x 60cm) were created with a machine (Caterpillar) using a “spoon” to open a hole and cover it again. This process loosens the soil (only possible in soils which are free from big stones). It should be noted that they did not use a ripper, they knew that the soil is destroyed using this technique. The seedlings were planted manually by the forest workers and arranged linearly because this facilitated the handling of the machines. Since the soil had a low stone content, it was suitable for the establishment of a forest. The afforested area covered around 100 ha (not continuously). Today, the costs of an afforestation are around 1500 Euro per ha, but in the past it was less expensive. They only planted Pinus Halepensis. Today, a seedling of this tree species costs between 20 and 60 Cents. If the regional forest services have their own nurseries, they do not need to spend money to buy seedlings. The success of an afforestation depends on numerous factors such as aspect and humidity (better on north-facing slopes), soil amount/fertility (better conditions on former cultivated fields), origin of the seedlings (adapted to the local climatic conditions), variability/uncertainty of the weather conditions (e.g. droughts, freezing). Usually a plantation is done in October/November and therefore especially the first summer determines the success. If it is too dry the plant will not grow (roots are too short to reach the humidity deeper in the ground). Further, the availability of trained people and the selection of appropriate machines are crucial. The documented afforestation is one of a few examples of afforestation trials which succeeded. Today there is a forest where young pines are growing naturally ("children" of the planted ones), but also resprouter species (e.g. Quercus) can be found, which regenerated without having been planted and apparently were dispersed by birds. But there are also some problems related to this afforestation. The forest agent explained that there is a high pest risk since monoplantations are less resilient to diseases (sick or dead plants in turn increase the fire risk). Another problem is that the trees were planted too densely (800-1000 plants per ha with a spacing of 5-10m) which requires recurrent management of the forest. Knowing about this problem, around the year 2003 they managed the area doing a selective clearing to reduce both the continuity and the competition between the species and thus also reduced the fire risk (“ayuda regeneración”). But the forest has become extremely dense again, thus increasing the risk of fires. There is a need to manage this area again and to extract biomass (selective clearing), but unfortunately no management project is planned for the near future.
The region of Ayora is mountainous with a dry subhumid climate (~380 mm annual rainfall). The risk of fire incidence is at its highest from June to September when there are adverse conditions like drought, high temperatures and strong winds (mainly the winds coming from central Spain, called “poniente”). The population density is very low and there are only few job opportunities (e.g. marginal agriculture, grazing, hunting, beekeeping). The plantation provided jobs for rural people. Also today forest management could be a source for jobs.

**left:** The Pinus Halepensis seedlings were planted linearly which is still visible from the distance. (Photo: Nina Lauterburg)
**right:** The success of this Pinus Halepensis afforestation is not only proved by the occurence of healthy old pines, but also by the growth of young pines and resprouter species such as Quercus which have not been planted. (Photo: Nina Lauterburg)

Location: Spain, Valencia
Region: Ayora, La Molinera
Technology area: 1 $km^2$
Conservation measure: vegetative
Stage of intervention: rehabilitation / reclamation of denuded land
Origin: Developed externally / introduced through project, 10-50 years ago
Land use type:
Forests / woodlands: Natural
Forests / woodlands: Plantations, afforestations
Land use:
Other: Other: wastelands, deserts, glaciers, swamps, recreation areas, etc (before), Forests / woodlandsrests / woodlands: Plantations, afforestations (after)
Climate: subhumid, temperate
WOCAT database reference: T_SPA012en
Related approach:
Compiled by: Nina Lauterburg, CDE
Date: 2013-06-01
Contact person: Vicente Colomer, Forest Agent Generalitat Valenciana (Conselleria de infraestructura, territorio y medio ambiente). Phone: +34 669 819 522 E-mail: colomer.vju@gmail.com

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

INSTITUTO UNIVERSITARIO CEAM CENTRO DE ESTUDIOS AMBIENTALES DEL MEDITERRÁNEO

## Classification

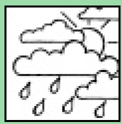
### Land use problems:

- The past land use resulted in a change of the vegetation composition (e.g. through removal of resprouter species). Due to rural exodus and land abandonment, the natural succession took place and fire-prone early-successional species colonized the abandoned fields. The vegetation grew without any control which seems to have caused the devastating fire of the year 1979 which destroyed 33’000 ha of forest. As a consequence of this fire, strong erosion processes occurred on the bare soil and hindered the vegetation to regrow. Furthermore, people which still lived there lost their properties after the fire and moved away as well. A consequence of the depopulation was a lack of management practices which increased the problem of post-fire erosion. (expert's point of view)

**Land use**

Natural
Plantations, afforestations
Other: Other: wastelands, deserts, glaciers, swamps, recreation areas, etc (before)
Forests / woodlandsrests / woodlands: Plantations, afforestations (after)
plantation forestry

**Climate**

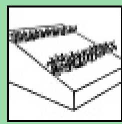


subhumid

**Degradation**

Soil erosion by water: loss of topsoil / surface erosion, Biological degradation: detrimental effects of fires

**Conservation measure**



Vegetative: Tree and shrub cover

**Stage of intervention**

Prevention
Mitigation / Reduction
Rehabilitation

**Origin**

Land users initiative
Experiments / Research
Externally introduced: 10-50 years ago

**Level of technical knowledge**

Agricultural advisor
Land user
Engineer

**Main causes of land degradation:**
Direct causes - Human induced: deforestation / removal of natural vegetation (incl. forest fires)
Indirect causes: population pressure, land tenure, labour availability, inputs and infrastructure

**Main technical functions:**
- control of raindrop splash
- control of dispersed runoff: retain / trap
- control of dispersed runoff: impede / retard
- control of concentrated runoff: retain / trap
- control of concentrated runoff: impede / retard
- improvement of ground cover
- stabilisation of soil (eg by tree roots against land slides)
- sediment retention / trapping, sediment harvesting
- increase of biomass (quantity)

**Secondary technical functions:**
- increase of surface roughness
- increase in organic matter
- increase in nutrient availability (supply, recycling,…)
- increase of infiltration
- promotion of vegetation species and varieties (quality, eg palatable fodder)

## Environment

### Natural Environment

**Average annual rainfall (mm)**

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

**Altitude (m a.s.l.)**

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

**Landform**

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

**Slope (%)**

flat
gentle
moderate
rolling
hilly
steep
very steep

**Soil depth (cm)**

- 0-20 (selected)
- 20-50
- 50-80
- 80-120
- >120

**Soil texture:** fine / heavy (clay)
**Soil fertility:** low
**Topsoil organic matter:** medium (1-3%)
**Soil drainage/infiltration:** medium

**Soil water storage capacity:** medium
**Ground water table:** 5 - 50 m, > 50 m
**Availability of surface water:** poor / none
**Water quality:** good drinking water
**Biodiversity:** medium

**Tolerant of climatic extremes:** temperature increase, seasonal rainfall increase, heavy rainfall events (intensities and amount)
**Sensitive to climatic extremes:** seasonal rainfall decrease, droughts / dry spells, decreasing length of growing period, fires, temperature decrease, hail/snow
**If sensitive, what modifications were made / are possible:** The technology was not modified but it is important to add some notes to the above stated reactions to climatic extremes. If the temperature is decreasing to -15°C the pines are sensitive because they freeze. But they are tolerant against temperature increase always when there is water available (Pinus Hal. is more tolerant to temperature increase than Pinus Pinaster). Afforestations are more sensitive to droughts than natural forests because the afforested trees are not used to these hard conditions. If the pines are mature, they are more tolerant than young pines because their roots are longer and reach deeper into the ground. If there is a drought when pines are still young it can increase the risk of a fire. The pines are also sensitive to hail and snow.

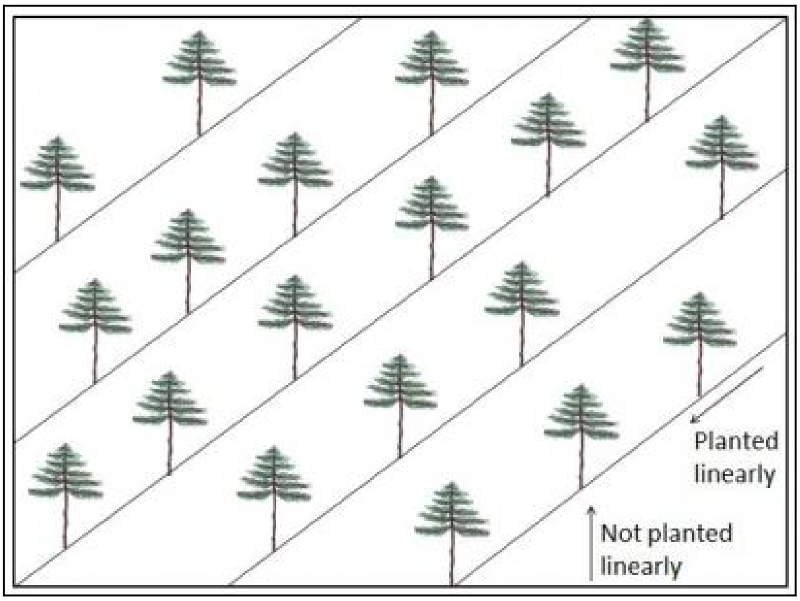
## Human Environment

**Forests / woodlands per household (ha)**

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

**Land user:** employee (company, government), common / average land users, mainly men
**Population density:** < 10 persons/km2
**Annual population growth:** negative
**Land ownership:** state, individual, titled
**Land use rights:** individual, public/open access but organised (e.g. hunting)
(In the region, there is some public land, controlled by the state. But there is also some private land. The access to the public land is open but organized. Permission is needed from the government to cut trees, to build a house or to hunt. There are some private hunting areas for which the hunting association has to pay a fee.)

**Importance of off-farm income:** :
**Access to service and infrastructure:**
**Market orientation:** mixed (subsistence and commercial)
**Purpose of forest / woodland use:** nature conservation / protection, protection against natural hazards




**Technical drawing**

The Pinus Halepensis seedlings were planted on a line in order to facilitate the operation of machines. The linear arrangement is still visible when observing the plantation from the distance, but when finding oneself within the forest this alignment is not visible anymore since the forest grew very densely. A part of today's forest grew naturally after planting the trees - some young pines but also some resprouters (e.g. Quercus) can be found which is pleasant and shows the success of this plantation effort. However, it would have been better to plant less trees with a bigger distance between the individuals. To reduce the high density and continuity of the forest (and thus to reduce the fire risk) a selective clearing would be required but currently the state does not invest money in forest management practices. Without extraction of biomass this dense forest contains a high risk of fire. (Nina Lauterburg)

## Implementation activities, inputs and costs

### Establishment activities

- Digging holes (60cm x 60cm x 60cm)
- Plantation of the seedlings (pinus halepensis)

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Equipment | | |
| - machine use | 4857.00 | 0% |
| **TOTAL** | **4857.00** | **0.00%** |

## Maintenance/recurrent activities

- Selective clearing "ayuda regeneración" (only done once in 2003 but should be done again to decrease the risk of fires and competition between species)

### Maintenance/recurrent inputs and costs per ha per year

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Equipment | | |
| - machine use | 2428.00 | 0% |
| **TOTAL** | **2428.00** | **0.00%** |

**Remarks:**
The costs of a plantation can be affected by numerous factors, such as slope (if the slope is steep, the work is much more difficult and takes more time, also because machines cannot be used on steep slopes), distance from a street (people can work less in a day if they have to walk far to plant), stone content of the soil (if there are many stones the work is much more difficult for the machines), soil type (plantations work much better on previous cropland because the soil is more fertile), origin of the seedlings (adapted to the local climatic conditions), variability/uncertainty of the weather conditions (e.g. droughts, freezing). If there are adverse climatic conditions or other negative circumstances the afforestation will not work well and this might cause higher costs.
The costs were calculated for the application of the technology on one hectare. Furthermore, the total costs of the afforestation were calculated with today's costs because the costs at the time it was implemented are not known. The currency rate (Euro-Dollar) was calculated on November 16th, 2013.

# Assessment

## Impacts of the Technology

### Production and socio-economic benefits

- +++ increased wood production
- ++ increased product diversification

### Production and socio-economic disadvantages

- ++ loss of land
- + reduced animal production

### Socio-cultural benefits

- ++ improved conservation / erosion knowledge
- ++ improved situation of disadvantaged groups
- + increased recreational opportunities

### Socio-cultural disadvantages

### Ecological benefits

- ++ improved harvesting / collection of water
- ++ increased soil moisture
- ++ reduced surface runoff
- ++ improved excess water drainage
- ++ improved soil cover
- ++ increased biomass above ground C
- ++ increased nutrient cycling recharge
- ++ increased soil organic matter / below ground C
- ++ reduced soil loss
- ++ Reduction of soil surface temperature
- + reduced evaporation
- + recharge of groundwater table / aquifer
- + reduced wind velocity
- + reduced soil crusting / sealing
- + increased animal diversity
- + increased plant diversity
- + Increase in shade

### Ecological disadvantages

- ++ increased fire risk
- ++ increased niches for pests

### Off-site benefits

- + reduced downstream flooding
- + reduced damage on neighbours fields
- + reduced damage on public / private infrastructure
- + Reduced amount of sediments in the water ponds for fire extinction

### Off-site disadvantages

### Contribution to human well-being / livelihoods

+ In the year 1985 the afforestation created jobs for the unemployed. But it seems that in general forest management is not something people want to do, they work in this sector only if there are no other job opportunities. Until today this attitude did not change much. Forest management means a hard job and this kind of work is not well-respected in society.

**Benefits /costs according to land user**

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| **Establishment** | negative | positive |
| **Maintenance / recurrent** | neutral / balanced | neutral / balanced |

Short-term returns are negative because the management practice is expensive and until the trees reach a mature state, there are not many returns (in terms of wood and biomass). In the long-term this management practice shows a positive result because compared to bare soil or shrubland it has ecological benefits such as the reduction of soil erosion, and it also provides wood and biomass which could be extracted. Currently there is no management project because the state does not invest money but it would actually be required in order to maintain the healthy state of this forest patch and to control the fire risk. If there is money invested by the state they can do a selective clearing which will result in short-term returns, e.g. wood (but also in the long-term they will be able to extract wood).

**Acceptance / adoption:**

There is no trend towards (growing) spontaneous adoption of the technology. In Spain a lot of afforestation trials have been realized in the past but only a few of them succeeded.

## Concluding statements

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
|---|---|
| The afforestation allowed the rehabilitation of an area affected by a devastating wildfire. It is an example out of many afforestation trials which succeeded. The success of this Pinus Halepensis afforestation is not only shown by the occurrence of healthy old pines, but also by the growth of young pines and resprouter species such as Quercus which were not planted. → Recurrent management, e.g. selective clearing, is crucial to ensure a healthy forest | It would be necessary to extract biomass from the forest to decrease the continuity of the trees and shrubs. Due to the lack of forest management (the management activities are expensive and labour-intensive) there is an increased risk of fires. → More investments in forest management such as selective forest clearings are required. Managing the forest would not only decrease the risk of fire and the competition between the species but also generate benefits such as timber or biomass for bioenergy production. Furthermore, jobs would be generated. In general, after afforestations, it would be required that people manage the forest. Nowadays, there is only limited use of the forest – in the past people lived of the land, but today this is not the case anymore. E.g. grazing is almost not existing anymore but in fact this would be really important for the reduction of the fire risk. |
| Through the plantation of pines, the soil cover and stability was improved which in turn led to a decrease of soil erosion. The reduction in soil erosion (less transported sediments) also resulted in a decrease of damages of the infrastructure (such as streets or water ponds for fire extinction). → There is no need to plant more trees or shrubs because the ecosystem regenerated well. But recurrent management, e.g. selective clearing, is crucial to ensure a healthy forest | It is not fully clear whether Pinus Halepensis plantations are a useful tool for restoration and it is also questioned whether it is sustainable to plant only Pinus Halepensis. Monoplantations result in the simplification of the landscape and alterations of habitats. One of the reasons why they used this species is that planting pines is kind of a tradition: it was always used for economic purposes because in earlier times the wood had a higher value. Furthermore, Pinus Halepensis seedlings grow faster and show a higher survival rate than other species, and since the aim of the afforestations was to have forest again in a short period of time, this species seemed to be the most suitable. But often in Pinus Halepensis Monoplantations other species do not grow (which is not the case in the documented afforestation). → Research carried out on this topic showed that it would be good to increase the diversity (e.g. with carrasca, sabina, enebros, madroños), to combine the plantation of pines with the plantation of broad-leaved resprouting species (such as holm oak), in order to take advantage of both the fast-growth features of pines and the high resilience of oaks. This also provides higher diversity and landscape heterogeneity |
| There are also economic benefits for local people. The afforestation provided jobs for rural people. Furthermore, Pinus Halepensis seedlings grow faster and show a higher survival rate than other species, therefore the natural process of forest growth is increased which in turn results in the possibility to use the forest after some years again, e.g. extraction of wood/biomass for bioenergy or timber. But unfortunately this is not done frequently because it is expensive to clear the forest (located in a remote area). → Also today forest management could be a source for jobs. It was also mentioned by many stakeholders that traditional activities (such as grazing, agriculture, wood gathering, selective clearings) should be reactivated and that the villagers should get economic compensation to maintain the forest in a good state | Monoplantations are more vulnerable to perturbations such as forest fires or pests. If there is a high amount of one specific species the spread of a pest is facilitated. Sick or dead trees in turn increase the fire risk. → It would be good to increase the diversity (e.g. with carrasca, sabina, enebros, madroños), to combine the plantation of pines with the plantation of broad-leaved resprouting species (such as holm oak), in order to take advantage of both the fast-growth features of pines and the high resilience of oaks. |
| Many stakeholders mentioned the positive visual impact. They prefer to have a forest instead of bare soil or shrubland, and it reminds them of how the state of the forest was before the fire. Trees have a higher value for them than shrubs. They supported the fact that the afforestation helped the environment to regenerate. → Recurrent management, e.g. selective clearing, is crucial to ensure a healthy forest. | Additional information: The here documented afforestation was successful, but usually many plantations of Pinus Halepensis failed (low seedling survival rate) → Seedling survival can in some cases (has also be questioned) be enhanced through preconditioning, water harvesting techniques (micro-catchments), tree-shelters (protective tubes), fertilisation, application of mulch, using facilitating effects (planting close to a resource island or a nurse plant, to benefit from shade, change in soil properties, retention of soil and nutrients, protection from grazers), perch effect (providing bird perches e.g. dead trees, artificial woody structures, in old fields to accelerate colonisation rates (bird-mediated restoration)) |
| Compared to the situation after the fire there is a higher biodiversity due to the afforestation. → Recurrent management, e.g. selective clearing, is crucial to ensure a healthy forest. | The area which was afforested is now not available anymore for agriculture. There is therefore a loss of agricultural land, but it is not sure either whether there would be a farmer using this land since it is located in a remote area. → |
| The afforestation contributed to rural development → | The area is now less accessible for hunters because of the density of the forest which allows animals to hide themselves → Local hunters are cultivating cereals next to the forest to attract the animals. This is also important for the animals because without these fields, they would probably have to leave this area due to the scarce fodder supply |
| | Some stakeholders criticized the linear planting. This is not like nature “would do it”. → |
| | There are many stakeholder who said that it was an error to do so many afforestations with Pinus Halepensis because in many regions nature would have regenerated by itself. It would have been possible to save a lot of money. A plantation causes high costs. → |
| | Due to the lack of management and because there is almost no use of the forest by the local population, there is a high amount of shrubs which increases the fire risk and hinders from walking through the forest → In the opinion of the villagers it would be important to promote the relationship between humans and nature and to find a balance between forest use and natural processes. The consciousness of the patrimonial value of the forest should also be promoted. |

# Resilience analysis Tool

Result summary

***About this Resilience Assessment***

***Authors:***

Keizer, Jan Jacob
Cristina Ribeiro, Sandra Valente, Oscar González-Pelayo, Victor Santana

***Date of Submission:***

01-11-2015

***Main sources of information:***

other knowledge

Portugal

Por_2

***Recently burnt maritime pine plantation subjected to traditional logging following the fire, with extraction of all the woody material and use of heavy machinery***

## Disturbances affecting the land management system:

The following disturbances affect the land management system, and could change dramatically the environment making it unusable for land users:

| | | |
|---|---|---|
| Type of disturbance: |  fires |  pests / diseases |
| Frequency: | **Between 5 and 10 years** | **Once per year or less** |
| Risk of permanent changes to the environment after a disturbance: | **High** | **Low** |

## Impact of land management on resilience to disturbances:

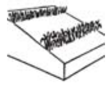
This is the impact that the land management practices have in preventing, mitigating and fostering recovery after. All together they indicate which effect the land management has on the resilience of the system to disturbances:

| | | |
|---|---|---|
| Land Management practice 1: ***Traditional logging using heavy machinery for extraction all woody material*** | 0 | + |
| ***Overall impact of land management on resilience to disturbances*** | **Neutral** | **Positive** |

*Legend: ++ Very positive; + Positive; 0 Neutral; - Negative; -- Very negative

## Human and natural environment of the land management system:

A brief description of the features of the land management system assessed

| Land use type | | Environment | | Management | |
|---|---|---|---|---|---|
|  | Present land use(s):<br>***Fp: Plantations;*** |  | Climate:<br>***subhumid*** |  | Main measure:<br>***Vegetative*** |
| | Past land use(s):<br>***Ge: Extensive grazing land;*** | | Land forms:<br>***hill slopes*** | | Land managers:<br>***employee (company, government), Small scale land users, Leaders / privileged, mainly men*** |

## Current state of the land management system:

We have asked ***Land users, Land managers, and local experts*** to assess the provision of benefits and the state of the environment in the land management system. These are the most important benefits / services that the environment should provide:

***(P1) Animal and plant productivity***

***(S2) Cultural services (e.g maintaining traditional landscape)***

And these are the most important environmental properties that allow the land management system to remain valuable:

Category ***Soil and Water:***

***Low soil erosion***

***High soil cover (including vegetation, litter, rocks and mosses)***

Category ***Vegetation:***

***Presence of a mixture of grasses, shrubs and trees (complex vegetation structure)***

***High number of different species (vegetation diversity)***

Category ***Landscape:***

***Presence of different landscape elements and vegetation patterns***

***Connectivity between healthy areas***

Category ***Fauna:***

***High soil fauna***

***High number of birds***

***Land users, Land managers, and local experts*** have provided the following evaluation of the state of the environment and the provision of benefits/services:

| State of the environment: | | Provision of benefits /Services: | |
|---|---|---|---|
| Category | Evaluation | Category | Evaluation |
| ***Soil and Water:*** | **Degraded** | | |
| ***Vegetation:*** | **Degraded** | Productive benefits /services: | **Undecided** |
| ***Landscape:*** | **Healthy** | Ecological benefits/Services: | **Insufficient** |
| ***Fauna:*** | **Degraded** | Socio-cultural benefits /Services: | **Sufficient** |

## Concluding remarks

### External factors affecting the resilience of land management system:

What external factors ***increase the pressure*** on the environment of the land management system? How they are likely to evolve in the future?*

**Removal of natural vegetation (+)**

**Unsustainable soil management(+)**

**disturbance of water cycle (+)**

What external factors *enable sustainable land management* ? How they are going to evolve in the future?*

**Subsidies for land management or nature conservation(=)**

**Market prices of goods produced from the land (-)**

**Land tenure(=)**

*Forecasted evolution of ext. Factors in the next 10 years: (+) increase, (=) Stable, (-) Decrease

### Under what conditions can the disturbances induce a permanent change to the land management system?

Fire:
If recurrent fires occur before the pine stand has been able to create a viable seed bank (typically 10-15 years).
If the influx of pine seeds from neighboring unburnt areas is limited
If post-fire logging produces massive mortality of the pine seedlings.

Pests / diseases:
Not possible to define--

### What are the conditions for a positive evolution of the land management system?

Ecosystem regeneration, and in particular natural pine recruitment is sufficient. Ecosystem regeneration can be reduced by soil degradation, which is caused by fire and the following soil erosion, and can also be increased by post-fire logging with machinery . Pine recruitment can be reduced by the lack of a viable seed bank, at the time of the fire or elevated rates of mortality of pine seeds and seedlings due to high fire severity, post-fire forestry operations and, possibly, post-fire drought and phytosanitary problems (especially pine nematode);
If fire events are avoided for 15 years

### Sources used to compile the questionnaire:

*Prats S.A., MacDonald L.H., Monteiro M., Ferreira A.J.D., Coelho C.O.A., Keizer J.J., 2012. Effectiveness of forest residue mulching in reducing post-fire runoff and erosion in a pine and a eucalypt plantation in north-central Portugal. Geoderma 191, 115-125;*

*Maia P., Pausas J., Vasques A., Keizer J.J., 2012. Fire severity as a key factor in post-fire regeneration of Pinus pinaster (Ait.) in Central Portugal. Annals of Forest Science 69, 4, 489-498;*

*Prats S.A., Malvar, M.C., Vieira, D.C.S, MacDonald L.H., Keizer J.J., 2013. Effectiveness of hydro-mulching to reduce runoff and erosion in a recently burnt pine plantation in central Portugal. Land Degradation & Development (doi: 10.1002/ldr.2236)*

# Post-fire Forest Residue Mulch

**Portugal - acolchoado, aplicação de restos vegetais**

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

In two areas of eucalypt plantations affected by wildfires in central Portugal in 2007 and 2010, the research team of the University of Aveiro set up two experiments in order to test the effect of forest residue mulching as a soil erosion mitigation technique. Forest residues such as chopped eucalypt bark mulch was spread over a group of erosion plots, and was compared to an untreated group of plots. The mulching was applied at ratios of 8.7 and 10.8 Mg ha-1 provided an initial ground cover of 70 to 80%, and was found to reduce post-fire runoff by 40-50% and soil erosion by 85-90%, respectively.
The increase in ground cover will decrease post-fire soil erosion by reducing raindrop impact over the ashes and bare soil, and decrease the runoff amount by increasing water surface storage, decreasing runoff velocity, and increase infiltration. Ideally, post-fire mulching must be carried out immediately after the fire, in order to prevent that the first autumn rainfall events fall over the bare and unprotected burnt soils. It is intended for places in which burnt severity was moderate to high and where there are important values at risk, such as water reservoirs, populations, industries, human and wild life.
The chopped bark mulch was obtained at a depot 20 km from the burnt area, where eucalypt logs are debarked and then transported to a paper pulp factory. The bark is chopped into fibers and are typically transported to a biomass energy plant. We used these 10–15 cm wide 2–5 cm long bark fibers as the source for our mulching experiment. The chopped bark mulch decays very slowly (around 20% less ground cover per year) which was very useful in cases of low re-growth of natural vegetation.
The eucalypt trees in the region are typically planted as monocultures for paper pulp production, and harvested every 7-14 years. The landscape reflects a long history of intense land management, with a mosaic of (semi-)natural and man-made agricultural and afforested lands. Since the 1980´s, however, wildfires have increased dramatically in frequency and extent, aided by a general warming and drying trend but driven primarily by socio-economic changes.

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

Location: Portugal/Beira Litoral
Region: Sever do vouga/ Pessegueiro do Vouga, Ermida
Technology area: 1.0E-5 km$^2$
Conservation measure: agronomic
Stage of intervention: prevention of land degradation, mitigation / reduction of land degradation
Origin: Developed through experiments / research, recent (<10 years ago)
Land use type:
Forests / woodlands: Plantations, afforestations
Climate: subhumid, temperate
WOCAT database reference: T_POR003en
Related approach: not applicable ()
Compiled by: Sergio Prats Alegre Prats, Universidad de Aveiro
Date: 2013-04-25
Contact person: Jan Jacob Keizer /Jacob, Assisstant Researcher CESAM –Centro de Estudos do Ambiente e do Mar, Universidade de Aveiro. Phone: + 351 234 370200 ext. 22612. e-mail: jjkeizer@ua.pt.

CESAM

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

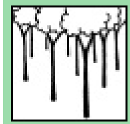
RECARE

## Classification

### Land use problems:

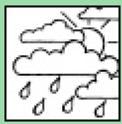
- Increased runoff and soil erosion, resulting in a decrease of on-site fertility and derived off-site effects such as loss of water quality, reservoirs water volume storage, higher risk of flooding and human beings damage. (expert's point of view)
Loss of wood resources and productivity. (land user's point of view)

**Land use**



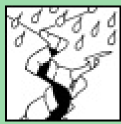
Plantations, afforestations
plantation forestry

**Climate**



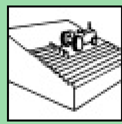
subhumid

**Degradation**



Soil erosion by water: loss of topsoil / surface erosion, Water degradation: change in quantity of surface water, decline of surface water quality

**Conservation measure**



Agronomic: Vegetation/soil cover

**Stage of intervention**

Prevention
Mitigation / Reduction
Rehabilitation

**Origin**

Land users initiative
Experiments / Research: recent (<10 years ago)
Externally introduced

**Level of technical knowledge**

Agricultural advisor
Land user

**Main causes of land degradation:**
Direct causes - Human induced: crop management (annual, perennial, tree/shrub), deforestation / removal of natural vegetation (incl. forest fires), disturbance of water cycle (infiltration / runoff)
Direct causes - Natural: Heavy / extreme rainfall (intensity/amounts), other natural causes, Sediment deposition can decrease the storage volume of reservoirs.

**Main technical functions:**
- control of raindrop splash
- control of dispersed runoff: retain / trap
- control of concentrated runoff: retain / trap
- control of concentrated runoff: impede / retard
- control of concentrated runoff: drain / divert
- improvement of ground cover
- improvement of water quality, buffering / filtering water
- sediment retention / trapping, sediment harvesting

**Secondary technical functions:**
- control of dispersed runoff: impede / retard
- increase of infiltration
- increase / maintain water stored in soil

## Environment

### Natural Environment

**Average annual rainfall (mm)**

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

**Altitude (m a.s.l.)**

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

**Landform**

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

**Slope (%)**

flat
gentle
moderate
rolling
hilly
steep
very steep

**Soil depth (cm)**

0-20
20-50
50-80
80-120
>120

**Soil texture:** medium (loam)
**Soil fertility:** high
**Topsoil organic matter:** high (>3%)
**Soil drainage/infiltration:** medium

**Ground water table:** 5 - 50 m
**Availability of surface water:** good
**Water quality:** good drinking water
**Biodiversity:** medium

**Tolerant of climatic extremes:** temperature increase, seasonal rainfall increase, seasonal rainfall decrease, heavy rainfall events (intensities and amount), wind storms / dust storms, droughts / dry spells
**Sensitive to climatic extremes:** floods

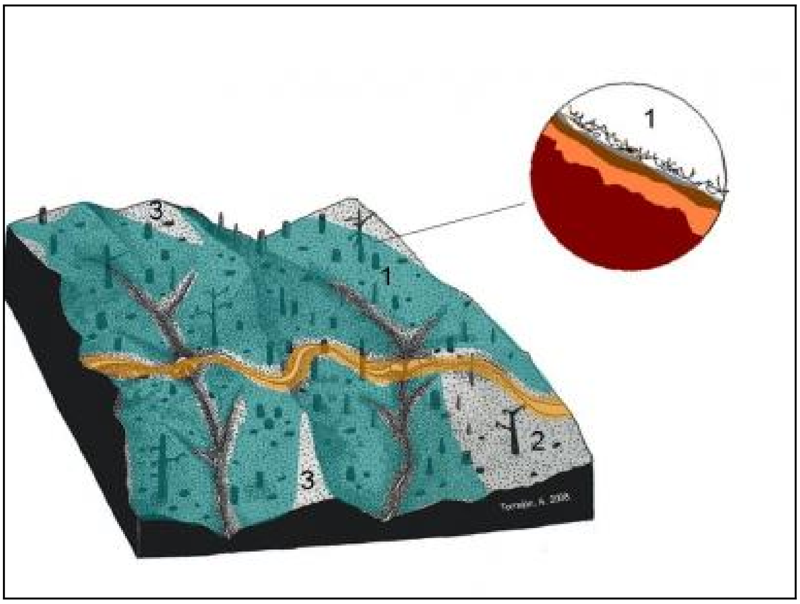
## Human Environment

**Forests / woodlands per household (ha)**

- <0.5
- 0.5-1
- 1-2
- 2-5
- 5-15
- 15-50
- 50-100
- 100-500
- 500-1,000
- 1,000-10,000
- >10,000

**Land user:** employee (company, government), Small scale land users, common / average land users, men and women
**Population density:** 50-100 persons/km2
**Annual population growth:** negative
**Land ownership:** communal / village
**Relative level of wealth:** average, which represents 50% of the land users;

**Importance of off-farm income:** less than 10% of all income:
**Access to service and infrastructure:** low: employment (eg off-farm), market, energy; moderate: health, education, technical assistance, roads & transport, drinking water and sanitation, financial services
**Market orientation:** commercial / market
**Purpose of forest / woodland use:** timber




**Technical drawing**

Forest residue mulch is spread as homogeneous as possible over steep areas (steeper than 15º) burnt at high fire severity (represented in green and 1). Other areas which are flat (2) and burnt at low severity or only partially burnt (3) must be avoided.

# Implementation activities, inputs and costs

## Establishment activities

- Manpower
- Transportation (small truck for carrying persons and material)
- Eucalypt chopped bark mulch
- Others

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 192.00 | 100% |
| Equipment | | |
| - machine use | 51.20 | 100% |
| Agricultural | | |
| - forest residue mulch | 307.60 | 100% |
| Other | | |
| - | 64.10 | 100% |
| **TOTAL** | **614.90** | **100.00%** |

## Maintenance/recurrent activities

-

**Maintenance/recurrent inputs and costs per ha per year**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 0.00 | 0% |
| Equipment | | |
| - machine use | 0.00 | 0% |
| **TOTAL** | **0.00** | **NaN%** |

**Remarks:**
Accessibility and steepness will raise the costs, but selecting forest residues with lower densities as well as applying them in horizontal strips along the slope can reduce the application rates and the costs. For large and inaccessible areas some researchers indicated that helicopters can reduce the costs.
The prices were determined in winter 2012 for central Portugal. It is intended that mulch is applied only once, and thus maintenance is not needed. In other regions other forest residues can have a higher availability. Straw, needles, deciduous leaves or chopped shrubs are lighter compared to eucalypt chopped bark, slash stems or wood chips, and thus, can be easier to apply and transport. However, the lighter the material, the easier it can be blown away in windy areas.

## Assessment

### Impacts of the Technology

**Production and socio-economic benefits**

- ++ increased irrigation water availability quality
- \+ reduced demand for irrigation water

**Production and socio-economic disadvantages**

- \+ increased expenses on agricultural inputs

**Socio-cultural benefits**

- +++ improved conservation / erosion knowledge
- \+ conflict mitigation

**Socio-cultural disadvantages**

**Ecological benefits**

- +++ improved soil cover
- +++ reduced soil loss
- ++ increased water quality
- ++ reduced surface runoff
- \+ increased soil moisture
- \+ reduced evaporation
- \+ recharge of groundwater table / aquifer
- \+ reduced hazard towards adverse events
- \+ increased soil organic matter / below ground C
- \+ increased beneficial species

**Ecological disadvantages**

**Off-site benefits**

- ++ reduced downstream siltation
- ++ reduced groundwater river pollution
- ++ improved buffering / filtering capacity
- ++ reduced wind transported sediments
- ++ reduced damage on neighbours fields
- ++ reduced damage on public / private infrastructure
- \+ increased water availability
- \+ reduced downstream flooding

**Off-site disadvantages**

**Contribution to human well-being / livelihoods**

Public awareness of the technology is very limited. It is necessary to show it to landowners and stakeholders and increase dissemination.

**Benefits /costs according to land user**

| Benefits compared with costs | short-term: | long-term: |
|---|---|---|
| **Establishment** | positive | neutral / balanced |
| **Maintenance / recurrent** | slightly positive | slightly positive |

**Acceptance / adoption:**

0% of land user families (0 families; 0% of area) have implemented the technology with external material support. The technology has been tested by scientific researchers and it is very effective, but not broadly implemented.
0% of land user families (0 families; 0% of area) have implemented the technology voluntary. The technology has been tested by scientific researchers researchers and it is very effective, but not broadly implemented.
There is no trend towards (growing) spontaneous adoption of the technology.

## Concluding statements

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
| --- | --- |
| It is a technology very easy to apply, with low failure possibilities and a strong soil erosion control → Some researchers found better performance by grinding the mulch and selecting only the longest fibres. | When applying high density mulches the application labour requirements and costs will be higher → Distribute the mulch in strips, use lighter mulches, grind to remove the fine fibres or maybe try to reduce the application rate. It is also possible to use in-situ chopping tree machines or to use aerial application methods, such as helicopters to reduce the application costs. |
| The material is readily available (residues from the main forest specie affected by the wildfire) → | The costs are not very high, but enough to discourage the landowners to cover the expenses. → Look for Government funding, educate land owners about soil erosion conservation techniques. |
| It will prevent sediment movement and accumulation over roads and downslope properties → | |

WOCAT


# Post-fire Natural Mulching

### Portugal - No intervention, needle carpet, caruma (Portuguese)

### In certain situations, the leaves from the burnt trees created a natural carpet that protect the soil from being eroded.

In the 2007 summer a wildfire affected the locality of Pessegueiro do Vouga, municipality of Sever do Vouga, north-central Portugal. The area was afforested with eucalypt and pine plantations. The research team of the University of Aveiro checked that in some burnt areas the crown damage was very small, despite the litter and underground vegetation were totally consumed by fire. The pine site presented a markedly lower fire severity, with the canopies only partially consumed by the fire, so it allow to study the effect of fire severity on soil erosion by comparison with adjacent slopes burned a high severity.
In a wildfire that affected a pine plantation in central Portugal in 2007, the research team of the University of Aveiro set up an experiment in order to test the effect of forest residue mulching as a soil erosion mitigation treatment. However, the low fire severity resulted in an elevated litter cover prior any technique was applied. The objective is to determine were "no action" in post-fire management will still result in low soil erosion values.
The high litter cover will decrease post-fire soil erosion by reducing raindrop impact over the ashes and the bare soil, and decrease the runoff amount by increasing water surface storage, decrease of runoff velocity, and increase infiltration. As the needle litter cover was natural, no action was needed. After a simple assessment of the remaining ground cover in the burnt area, the "no intervention" option should be selected if the soil is covered by litter, leaves or needles. The benefits of this are not only the mitigation of soil erosion (and associated soil fertility losses) immediately after forest fires, but also the long-term conservation of the soil resources without additional costs.
The landscape reflects a long history of intense land management, with a mosaic of (semi-)natural and man-made agricultural and afforested lands. Since the 1980´s, however, wildfires have increased dramatically in frequency and extent, aided by a general warming and drying trend but driven primarily by socio-economic changes.

**left:** Natural needle carper protecting the soil from soil erosion (Photo: Sergio Prats Alegre)
**right:** Leaves protecting the soil in a burned slope

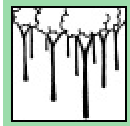
Location: Portugal, Aveiro
Region: Sever do Vouga, Pessegueiro de Vouga
Technology area: 1.0E-5 km$^2$
Stage of intervention: prevention of land degradation, mitigation / reduction of land degradation
Origin: Developed through experiments / research, recent (<10 years ago)
Land use type:
Forests / woodlands: Plantations, afforestations
Climate: subhumid, temperate
WOCAT database reference: T_POR004en
Related approach:
Compiled by: Sergio Prats Alegre Prats, Universidad de Aveiro
Date: 2007-10-04
Contact person: Sergio Prats Alegre- Post-doc fellow, Centre for Environmental and Marine Studies (CESAM) - Department of Environment and Planning-University of Aveiro, Campus de Santiago, 3810-193 Aveiro, Portugal Phone: + 351 234 370200
e-mail: sergio.alegre@ua.pt

## Classification

### Land use problems:

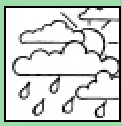
- Strong increases in runoff and erosion should be a main land management concern following wildfires, as they constitute a serious threat to land-use sustainability and downstream aquatic habitats and human infrastructures. The forest owners and managers need to establish target areas to apply cost-effective post-fire soil erosion mitigation treatments, included the "no action" option. (expert's point of view) Loss of wood resources and productivity. (land user's point of view)

**Land use**



Plantations, afforestations
plantation forestry

**Climate**



subhumid

**Degradation**

Soil erosion by water: loss of topsoil / surface erosion

**Conservation measure**

**Stage of intervention**

Prevention
Mitigation / Reduction
Rehabilitation

**Origin**

Land users initiative: recent (<10 years ago)
Experiments / Research: recent (<10 years ago)
Externally introduced

**Level of technical knowledge**

Agricultural advisor
Land user

**Main causes of land degradation:**
Direct causes - Human induced: soil management, deforestation / removal of natural vegetation (incl. forest fires)
Indirect causes: population pressure

**Main technical functions:**
- control of raindrop splash
- control of dispersed runoff: retain / trap
- control of concentrated runoff: retain / trap
- improvement of ground cover
- increase of surface roughness
- increase of infiltration
- sediment retention / trapping, sediment harvesting
- increase of biomass (quantity)

**Secondary technical functions:**
- control of dispersed runoff: impede / retard
- control of concentrated runoff: impede / retard
- improvement of surface structure (crusting, sealing)
- improvement of topsoil structure (compaction)
- increase in organic matter
- increase in nutrient availability (supply, recycling,...)

# Environment

## Natural Environment

**Average annual rainfall (mm)**

> 4000 mm
3000-4000 mm
2000-3000 mm
1500-2000 mm
1000-1500 mm
750-1000 mm
500-750 mm
250-500 mm
< 250 mm

**Altitude (m a.s.l.)**

> 4000
3000-4000
2500-3000
2000-2500
1500-2000
1000-1500
500-1000
100-500
<100

**Landform**

plateau / plains
ridges
mountain slopes
hill slopes
footslopes
valley floors

**Slope (%)**

flat
gentle
moderate
rolling
hilly
steep
very steep

**Soil depth (cm)**

0-20
20-50
50-80
80-120
>120

**Growing season(s):** 270 days(September to May)
**Soil texture:** medium (loam)
**Soil fertility:** medium
**Topsoil organic matter:** high (>3%)
**Soil drainage/infiltration:** medium, poor (eg sealing /crusting)

**Soil water storage capacity:** low
**Ground water table:** > 50 m
**Availability of surface water:** medium
**Water quality:** good drinking water
**Biodiversity:** low

**Tolerant of climatic extremes:** temperature increase, seasonal rainfall increase, wind storms / dust storms
**Sensitive to climatic extremes:** heavy rainfall events (intensities and amount)

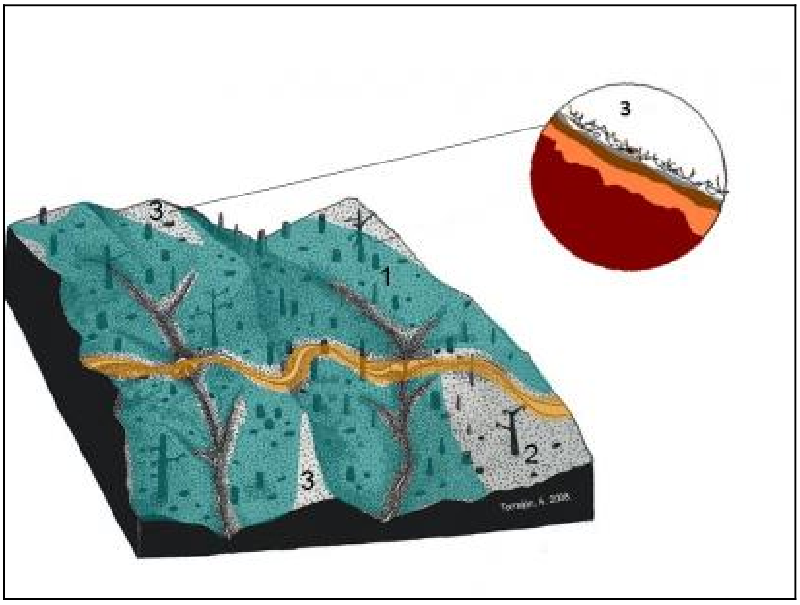
## Human Environment

**Forests / woodlands per household (ha)**

<0.5
0.5-1
1-2
2-5
5-15
15-50
50-100
100-500
500-1,000
1,000-10,000
>10,000

**Land user:** groups / community, Small scale land users, common / average land users, men and women
**Population density:** 50-100 persons/km2
**Land ownership:** individual, not titled
**Relative level of wealth:** poor, which represents 60% of the land users; 70% of the total area is owned by poor land users

**Importance of off-farm income:** 10-50% of all income:
**Access to service and infrastructure:** moderate: health, technical assistance, employment (eg off-farm), financial services; high: education, market, energy, roads & transport, drinking water and sanitation
**Market orientation:** commercial / market
**Purpose of forest / woodland use:** timber




**Technical drawing**

Natural mulch is often present in areas burnt at low severity or only partially burnt (3). This areas as well as planar areas (2) must be areas for no mitigation treatment or “no action” after forest fires.

## Implementation activities, inputs and costs

### Establishment activities

- Natural cover

**Establishment inputs and costs per ha**

| Inputs | Costs (US$) | % met by land user |
|---|---|---|
| Labour | 0.00 | % |
| Equipment | | |
| - machine use | 0.00 | % |
| - animal traction | 0.00 | % |
| - tools | 0.00 | % |
| Construction material | | |
| - stone | 0.00 | % |
| - wood | 0.00 | % |
| - earth | 0.00 | % |
| Agricultural | | |
| - seeds | 0.00 | % |
| - seedlings | 0.00 | % |
| - fertilizer | 0.00 | % |
| - biocides | 0.00 | % |
| - compost/manure | 0.00 | % |
| Other | | |
| - | 0.00 | % |
| - | 0.00 | % |
| - | 0.00 | % |
| - | 0.00 | % |
| **TOTAL** | **0.00** | **0.00%** |

### Maintenance/recurrent activities

**Remarks:**
No cost are envisaged for this technology. Visual assessment of the soil cover can be susceptible for costs, for example consulting, but we think it is not eligible.

## Assessment

## Impacts of the Technology

| Production and socio-economic benefits | Production and socio-economic disadvantages |
| --- | --- |
| | +□□ reduced wood production |

| Socio-cultural benefits | Socio-cultural disadvantages |
| --- | --- |
| +++ improved conservation / erosion knowledge | |

| Ecological benefits | Ecological disadvantages |
| --- | --- |
| +++ improved soil cover | |
| +++ reduced soil loss | |
| ++□ reduced surface runoff | |
| ++□ reduced soil crusting / sealing | |
| ++□ reduced soil compaction | |
| +□□ increased soil moisture | |
| +□□ reduced evaporation | |

| Off-site benefits | Off-site disadvantages |
| --- | --- |
| ++□ reduced damage on public / private infrastructure | |
| +□□ reduced downstream flooding | |
| +□□ reduced damage on neighbours fields | |

**Contribution to human well-being / livelihoods**

**Benefits /costs according to land user**

| Benefits compared with costs | short-term: | long-term: |
| --- | --- | --- |
| **Establishment** | very positive | very positive |
| **Maintenance / recurrent** | very positive | very positive |

As natural mulching has no cost, any benefit is always very positive

**Acceptance / adoption:**

0% of land user families (0 families; 0% of area) have implemented the technology voluntary. The land users are not aware about the advantages of natural mulching, but in fact they apply it when they have not economic resources.
There is moderate trend towards (growing) spontaneous adoption of the technology. Some times logging after fire reduces the natural mulching capacity to prevent post-fire erosion

## Concluding statements

| Strengths and → how to sustain/improve | Weaknesses and → how to overcome |
| --- | --- |
| It is a technology with no associated cost and with low failure possibilities and a strong soil erosion control. → Inform land owners and forest managers to avoid post-fire logging in areas with natural mulching and therefore avoid the decrease in the technology effeciency. Some times logging after fire reduces the natural mulching capacity to prevent post-fire erosion. | Some people argue that can increase fire risk → Fire risk will not be probably increase as the surrounded areas were frequently also burned |
| No cost → | No possible to harvest the logs during the first period after the fire → Assume the cost of selective felling |