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. (Nina Lauterburg)

Cleared strip network for fire prevention (firebreaks) (Spain)

Área cortafuegos

DESCRIPTION

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.

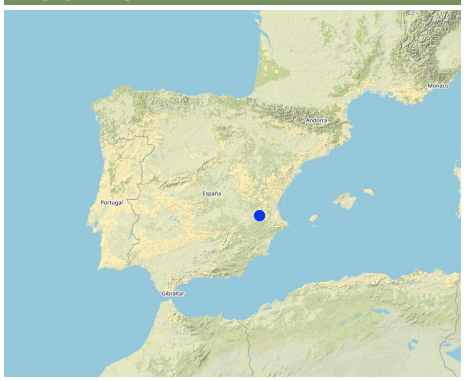
In the forest law 3/1993 the declaration of special areas to "Zonas de Actuación Urgente (ZAU)" (zone of urgent actions) through the regional government of Valencia is defined. Objectives are the protection against natural hazards and the promotion of forest restoration within this area. Ayora was declared 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

LOCATION



Location: Region of Ayora (including the municipalities Requena, Cofrentes, Jalance, Jarafuel, Zarra, Ayora), Spain, Valencia, Spain

No. of Technology sites analysed:

Geo-reference of selected sites
- -1.18, 39.08054

Spread of the Technology: evenly spread over an area (approx. 100-1,000 km2)

In a permanently protected area?:

Date of implementation: 10-50 years ago

Type of introduction
- ☐ through land users' innovation
- ☐ as part of a traditional system (> 50 years)
- ☐ during experiments/ research
- ☑ through projects/ external interventions

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.

The firebreaks identified with a red poster were not realized within the pilot project and are therefore not part of the ZAU. They were established afterwards through the regional government of Valencia. (Nina Lauterburg)

A firebreak is a cleared strip to hinder fires to spread all over the area. (Nina Lauterburg)

CLASSIFICATION OF THE TECHNOLOGY

Main purpose

- [ ] improve production
- [ ] reduce, prevent, restore land degradation
- [ ] conserve ecosystem
- [ ] protect a watershed/ downstream areas – in combination with other Technologies
- [ ] preserve/ improve biodiversity
- [x] reduce risk of disasters
- [ ] adapt to climate change/ extremes and its impacts
- [ ] mitigate climate change and its impacts
- [ ] create beneficial economic impact
- [ ] create beneficial social impact

Land use

Forest/ woodlands Products and services: Timber, Fuelwood, Fruits and nuts, Other forest products, Grazing/ browsing, Nature conservation/ protection, Recreation/ tourism, Protection against natural hazards, wind mill parc, hunting

Water supply

- [ ] rainfed
- [ ] mixed rainfed-irrigated
- [ ] full irrigation

Purpose related to land degradation

- [x] prevent land degradation
- [ ] reduce land degradation
- [ ] restore/ rehabilitate severely degraded land
- [ ] adapt to land degradation
- [ ] not applicable

Degradation addressed

biological degradation - Bc: reduction of vegetation cover, Bf: detrimental effects of fires

SLM group

- natural and semi-natural forest management

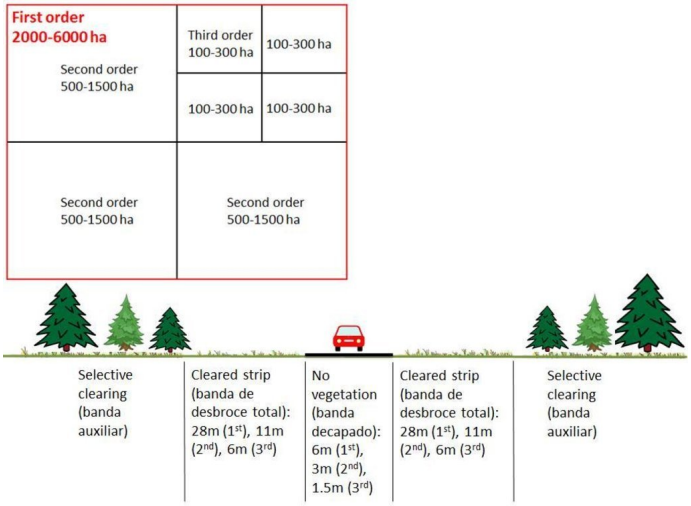
SLM measures

vegetative measures - V3: Clearing of vegetation

TECHNICAL DRAWING

Technical specifications

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.
Location: Ayora. Valencia, Spain
Date: 02-12-2013



Author: Nina Lauterburg

Technical knowledge required for field staff / advisors: high (The forest agent needs a high technical knowledge. He acts as a link between engineer and forest brigade and controls if the brigade executes what the engineer dictates. He also provides assistance.)
Technical knowledge required for Engineer: high (The forest engineer works for the state and plans where to establish fire breaks and how to construct them (e.g. how much fuel to remove, which machines to use). He needs a high technical knowledge.)
Technical knowledge required for Forest brigade/workers: low (The forest workers only execute what the engineer and the forest agent tell them. They need to know how to handle the machines but don't have to judge where and how to establish the firebreaks.)

Main technical functions: control of fires
Secondary technical functions: reduction of dry material (fuel for wildfires)
Vegetative measure: Clearing to establish strips free of vegetation
Vegetative material: T : trees / shrubs
Trees/ shrubs species: Trees and shrubs are cleared

ESTABLISHMENT AND MAINTENANCE: ACTIVITIES, INPUTS AND COSTS

Calculation of inputs and costs

- Costs are calculated:
- Currency used for cost calculation: **Euro**
- Exchange rate (to USD): 1 USD = 0.74 Euro
- Average wage cost of hired labour per day: 47.00

Most important factors affecting the costs

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.

Establishment activities

1. Project planning and design of firebreak system (Timing/ frequency: 1996)
2. Adaption of the agricultural tractors with forest management machinery (wheels, protection of the machine against stones, clearing machinery with chains) (Timing/ frequency: 1998-2002)
3. Cutting and chipping (in-situ) of trees and shrubs (execution of firebreak network) (Timing/ frequency: 1998-2002)
4. Transport of wood (fuel wood) (Timing/ frequency: 1998-2002)

Establishment inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Euro)	Total costs per input (Euro)	% of costs borne by land users
Labour					
labour	ha	1.0	1095.0	1095.0	
Equipment					
machine use	ha	1.0	675.0	675.0	
Total costs for establishment of the Technology				**1'770.0**	
Total costs for establishment of the Technology in USD				*2'391.89*	

Maintenance activities

1. Clearing of firebreaks of first order (every 2 years) (Timing/ frequency: every 2 years)
2. Clearing of firebreaks of second and third order (every 4 years) (Timing/ frequency: every 4 years)

Maintenance inputs and costs

Specify input	Unit	Quantity	Costs per Unit (Euro)	Total costs per input (Euro)	% of costs borne by land users
Equipment					
machine use	ha	1.0	557.0	557.0	
Total costs for maintenance of the Technology				**557.0**	
Total costs for maintenance of the Technology in USD				*752.7*	

NATURAL ENVIRONMENT

Average annual rainfall
- [ ] < 250 mm
- [x] 251-500 mm
- [ ] 501-750 mm
- [ ] 751-1,000 mm
- [ ] 1,001-1,500 mm
- [ ] 1,501-2,000 mm
- [ ] 2,001-3,000 mm
- [ ] 3,001-4,000 mm
- [ ] > 4,000 mm

Agro-climatic zone
- [ ] humid
- [x] sub-humid
- [ ] semi-arid
- [ ] arid

Specifications on climate
Ayora (383mm)
Thermal climate class: temperate

Slope
- [ ] flat (0-2%)
- [x] gentle (3-5%)
- [x] moderate (6-10%)
- [ ] rolling (11-15%)
- [ ] hilly (16-30%)
- [ ] steep (31-60%)
- [ ] very steep (>60%)

Landforms
- [x] plateau/plains
- [x] ridges
- [ ] mountain slopes
- [ ] hill slopes
- [ ] footslopes
- [ ] valley floors

Altitude
- [ ] 0-100 m a.s.l.
- [ ] 101-500 m a.s.l.
- [x] 501-1,000 m a.s.l.
- [x] 1,001-1,500 m a.s.l.
- [ ] 1,501-2,000 m a.s.l.
- [ ] 2,001-2,500 m a.s.l.
- [ ] 2,501-3,000 m a.s.l.
- [ ] 3,001-4,000 m a.s.l.
- [ ] > 4,000 m a.s.l.

Technology is applied in
- [ ] convex situations
- [ ] concave situations
- [ ] not relevant

Soil depth
- [ ] very shallow (0-20 cm)
- [x] shallow (21-50 cm)
- [ ] moderately deep (51-80 cm)
- [ ] deep (81-120 cm)
- [ ] very deep (> 120 cm)

Soil texture (topsoil)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [x] fine/ heavy (clay)

Soil texture (> 20 cm below surface)
- [ ] coarse/ light (sandy)
- [ ] medium (loamy, silty)
- [ ] fine/ heavy (clay)

Topsoil organic matter content
- [ ] high (>3%)
- [ ] medium (1-3%)
- [x] low (<1%)

Groundwater table
- [ ] on surface
- [ ] < 5 m
- [x] 5-50 m
- [ ] > 50 m

Availability of surface water
- [ ] excess
- [ ] good
- [ ] medium
- [x] poor/ none

Water quality (untreated)
- [x] good drinking water
- [ ] poor drinking water (treatment required)
- [ ] for agricultural use only (irrigation)
- [ ] unusable

Water quality refers to:

Is salinity a problem?
- [ ] Yes
- [ ] No

Occurrence of flooding
- [ ] Yes
- [ ] No

Species diversity
- [ ] high
- [x] medium
- [ ] low

Habitat diversity
- [ ] high
- [ ] medium
- [ ] low

CHARACTERISTICS OF LAND USERS APPLYING THE TECHNOLOGY

Market orientation
- [ ] subsistence (self-supply)
- [x] mixed (subsistence/ commercial)
- [ ] commercial/ market

Off-farm income
- [ ] less than 10% of all income
- [ ] 10-50% of all income
- [ ] > 50% of all income

Relative level of wealth
- [ ] very poor
- [ ] poor
- [ ] average
- [ ] rich
- [ ] very rich

Level of mechanization
- [ ] manual work
- [ ] animal traction
- [ ] mechanized/ motorized

Sedentary or nomadic
- [ ] Sedentary
- [ ] Semi-nomadic
- [ ] Nomadic

Individuals or groups
- [ ] individual/ household
- [ ] groups/ community
- [ ] cooperative
- [x] employee (company, government)

Gender
- [ ] women
- [x] men

Age
- [ ] children
- [ ] youth
- [ ] middle-aged
- [ ] elderly

Area used per household
- [ ] < 0.5 ha
- [ ] 0.5-1 ha
- [ ] 1-2 ha
- [ ] 2-5 ha
- [ ] 5-15 ha
- [ ] 15-50 ha
- [ ] 50-100 ha

Scale
- [ ] small-scale
- [ ] medium-scale
- [ ] large-scale

Land ownership
- [x] state
- [ ] company
- [ ] communal/ village
- [ ] group
- [ ] individual, not titled
- [x] individual, titled

Land use rights
- [ ] open access (unorganized)
- [ ] communal (organized)
- [ ] leased
- [x] individual
- [x] open access but organised (e.g. wood, hunting)

- 100-500 ha
- 500-1,000 ha
- 1,000-10,000 ha
- > 10,000 ha

Water use rights
- open access (unorganized)
- communal (organized)
- leased
- individual
- ✓ open access but organised (e.g. wood, hunting)

Access to services and infrastructure

IMPACTS

Socio-economic impacts

fodder production

decreased — increased (✓)

Vegetation removal produces fresh growth. More grasses available for animals (game and livestock) in the cleared areas.

fodder quality

decreased — increased (✓)

The new growth provides more diverse and nutritious fodder. Animals (especially goats) eat everything but they like more young grasses than shrubs

animal production

decreased — increased (✓)

Game/wildlife and livestock are better because there is an increase in fodder quantity and quality

wood production

decreased — increased (✓)

The wood/timber generated by the clearing can be used for biomass, fertilizers, pellets, firewood. A part of the wood is chipped in-situ and applied as mulch

production area (new land under cultivation/ use)

decreased (✓) — increased

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

energy generation (e.g. hydro, bio)

decreased — increased (✓)

In some areas, the cleared ground on mountain ridges is used for wind mills. A part of the cleared vegetation is used for bioenergy (biomass).

expenses on agricultural inputs

increased (✓) — decreased

The establishment and the maintenance of fire breaks is expensive.

job uncertainty

increased (✓) — decreased

If there is no money provided by the state the maintenance of fire breaks cannot be executed. This constitutes a high risk for forest workers because they never know if they will loose their job.

Socio-cultural impacts

food security/ self-sufficiency

reduced — improved (✓)

Forest workers earn money to buy food, otherwise they would depend on unemployment pay and thus put pressure on the state.

health situation

worsened (✓) — improved

Improved air quality by reducing forest fires.

recreational opportunities

reduced (✓) — improved

People often criticise the aesthetic impact of fire breaks. But this impact is smaller than if the whole forest is burnt

SLM/ land degradation knowledge

reduced — improved (✓)

Local people know about the importance of conservation of the area and really like to have the forest protected of wildfires

conflict mitigation

worsened — improved (✓)

Less fires result in a decrease of the destroyed area, less money will have to be invested in restoration or fire extinction. Farmers, hunters,honey producers will experience fewer losses. Wild animals remain in the forest (more grasses after clearing).

situation of socially and economically disadvantaged groups (gender, age, status, ehtnicity etc.)

worsened — improved (✓)

More jobs for unemployed, this is especially important during the current economic crisis

Ecological impacts

surface runoff — increased / decreased: On the cleared strips, associated with the vegetation removal

soil moisture — decreased / increased: On the cleared strips, associated with the vegetation removal

soil cover — reduced / improved: On the cleared strips, but not too bad because of the mulch layer (removed vegetation is chipped in-situ)

soil organic matter/ below ground C — decreased / increased: On the cleared strips, associated with the vegetation removal

emission of carbon and greenhouse gases — increased / decreased: If the fire is stopped more quickly there will be less emissions

fire risk — increased / decreased: The firebreaks prevent the occurrence and spread of large forest fires by providing access for fire fighters

Off-site impacts

downstream flooding (undesired) — increased / reduced: When fire removes less vegetation then the soil is less prone to flooding

downstream siltation — increased / decreased: When fire removes less vegetation then the soil is less vulnerable to erosion

damage on neighbours' fields — increased / reduced

damage on public/ private infrastructure — increased / reduced: Forest fire frequency and intensity and the associated damages are reduced

COST-BENEFIT ANALYSIS

Benefits compared with establishment costs

Short-term returns: very negative / very positive

Long-term returns: very negative / very positive

Benefits compared with maintenance costs

Short-term returns: very negative / very positive

Long-term returns: very negative / 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.

CLIMATE CHANGE

Gradual climate change

annual temperature increase: not well at all / very well

Climate-related extremes (disasters)

local rainstorm: not well at all / very well

local windstorm: not well at all / very well

drought: not well at all / very well

general (river) flood: not well at all / very well

ADOPTION AND ADAPTATION

Percentage of land users in the area who have adopted the Technology

- single cases/ experimental
- 1-10%
- 11-50%
- > 50%

Of all those who have adopted the Technology, how many have done so without receiving material incentives?

- 0-10%
- 11-50%
- 51-90%
- 91-100%

Has the Technology been modified recently to adapt to changing conditions?

- Yes

☐ No

To which changing conditions?

☐ climatic change/ extremes
☐ changing markets
☐ labour availability (e.g. due to migration)

CONCLUSIONS AND LESSONS LEARNT

Strengths: land user's view

- 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).
- 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.
- 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.
- 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

Strengths: compiler's or other key resource person's view

- There is a reduction of fuel load within the firebreaks and therefore they contribute to fire prevention.
- 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
- 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.
- 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.
- 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).

Weaknesses/ disadvantages/ risks: land user's viewhow to overcome

- 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.
- 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 Establish big firebreaks and ensure maintenance.
- 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

Weaknesses/ disadvantages/ risks: compiler's or other key resource person's viewhow to overcome

- 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.
- 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.
- 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.

REFERENCES

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Resource persons
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Full description in the WOCAT database
https://qcat.wocat.net/en/wocat/technologies/view/technologies_1592/

Linked SLM data
Approaches: Plan of preventive silviculture (PSP): implementation of firebreak network within a forest intervention area (ZAU)
https://qcat.wocat.net/en/wocat/approaches/view/approaches_2590/
Approaches: Plan of preventive silviculture (PSP): implementation of firebreak network within a forest intervention area (ZAU)
https://qcat.wocat.net/en/wocat/approaches/view/approaches_2590/

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