Góis, Portugal

Study site details

Gois is a municipality situated on the northern slopes of the Lousã Mountains in Central Portugal.

- **Coordinates of central point:**
  Latitude: 40°06’26.28” N
  Longitude: 8°06’57.19” W
- **Size:** 263 km²
- **Altitude:** 145 – 1200 m
- **Precipitation:** ca. 1200 mm
- **Temperature:** na
- **Land use:** pine and eucalyptus forests, arable land, unproductive land and settlements
- **Inhabitants:** 4,499 (2006)
- **Main degradation processes:** forest fires, land abandonment through depopulation
- **Major drivers of degradation:** depopulation and ageing population, land abandonment, monocultural forestry, inadequate laws and lack of enforcement, financial constraints

Figure 1: Study site location

Overview of scenarios

1. Baseline Scenario: PESERA baseline run
2. Technology Scenario: Prescribed fire (POR02)
3. Policy Scenario: Targeted implementation of prescribed fire (POR02)
4. Global Scenario: Food production

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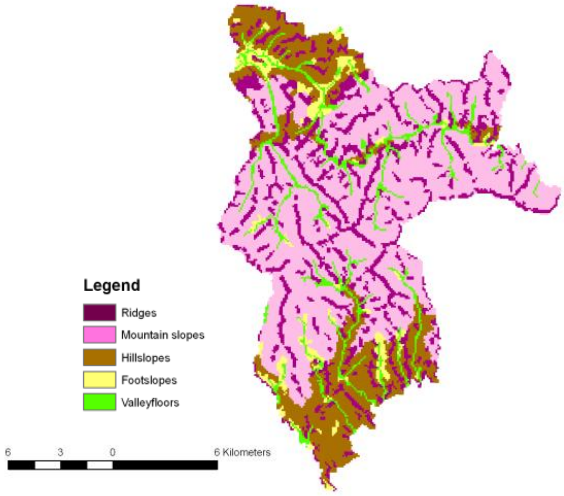
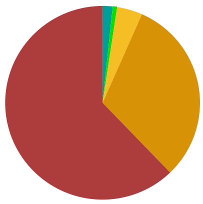
Baseline Scenario
PESERA baseline run

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

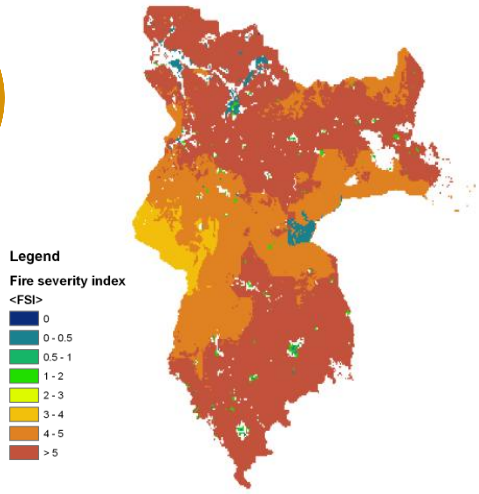
Landforms



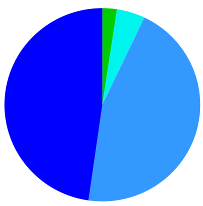
Fire susceptibility



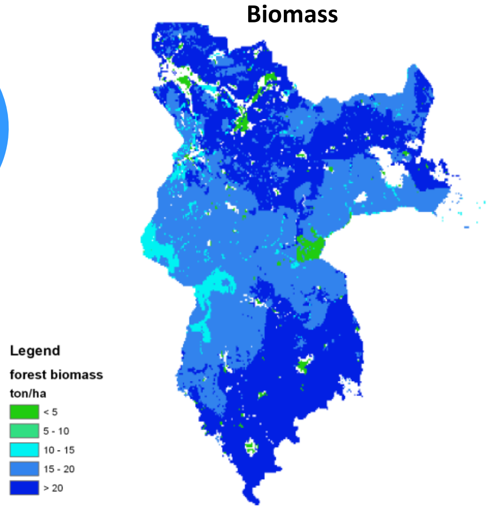
Fire Severity Index (FSI)



Biomass production



Biomass



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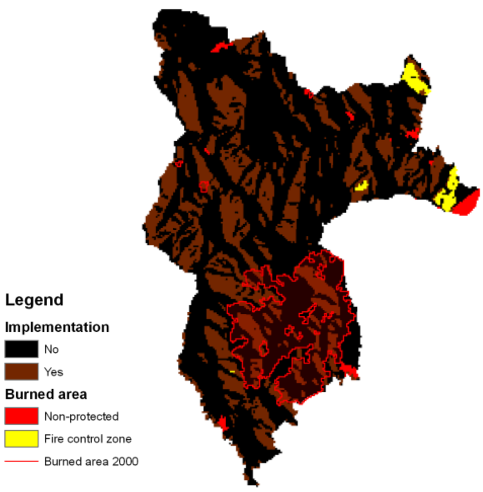
Technology Scenario:
Prescribed fire (POR02)

- Areas burned in a controlled way are assumed to act as a 100% effective fire break. Repeated burning every 2 years is assumed.
- The cost of prescribed fire is assumed to be fixed at €270/ha; planning and fire brigade stand-by are the main cost factors.
- A discount rate of 10% has been applied
- Analysis is carried out for an implementation period of 10 years, with the benefits derived from analysis of avoidable damage from observed fire-affected areas over the period 2001-2009.

Applicability

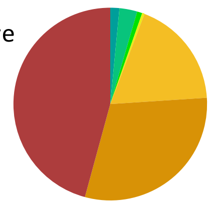
- Prescribed fire needs to be carefully planned in relation to wind speed, humidity and temperature. Slope aspect is another important aspect to take into account. Shown here is the area with NE-E facing slopes, which was assessed to have the highest potential impact on forest fire reduction.

Applicability

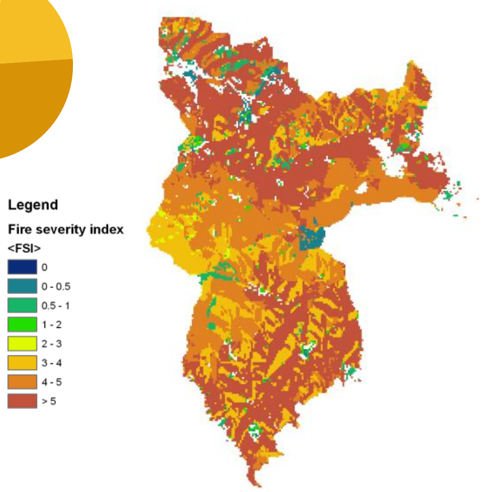


Biophysical impact: fire susceptibility

- Fire severity index is reduced when prescribed fire is implemented. The FSI values shown here are representative for the situation 2 years after controlled burning of NE-E facing slopes (FSI values in other slope aspects are not affected).



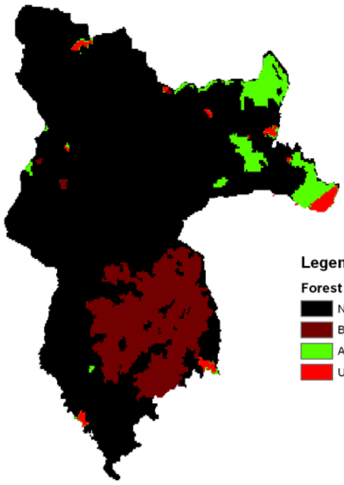
Fire Severity Index (FSI)

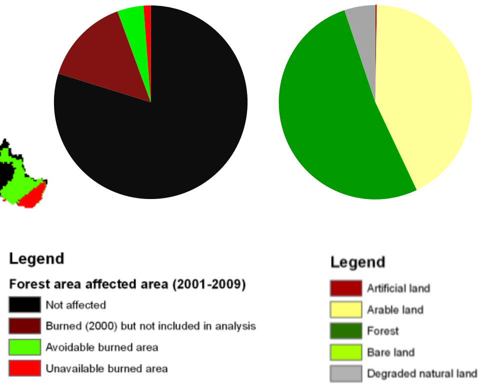


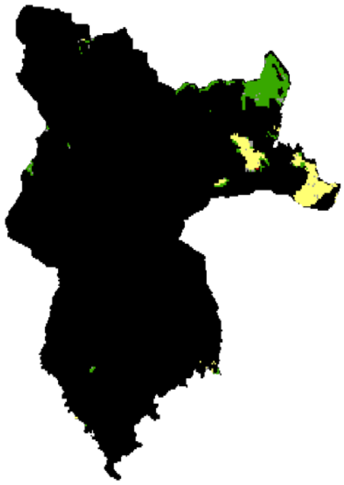
Biophysical impact: forest fire prevention

Fire-affected area

Avoided burning

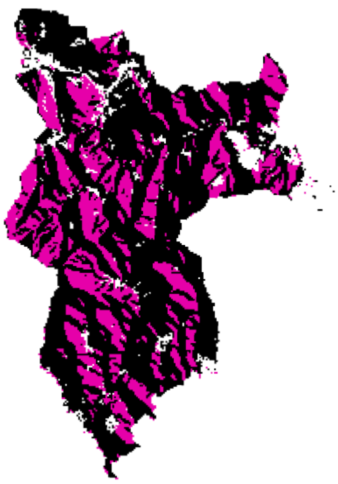


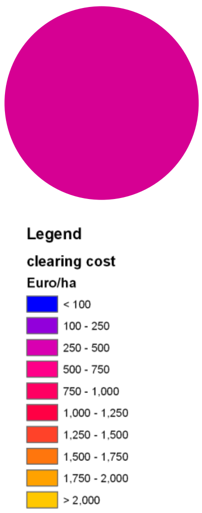




Economic viability

Clearing costs



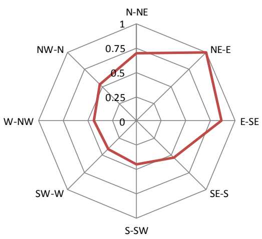


Net Present Value

Year	Clearing cost	Avoided damage
0	€ 1,886,220	
1		€ 238,744
2	€ 1,886,220	€ 238,744
3		€ 238,744
4	€ 1,886,220	€ 238,744
5		€ 238,744
6	€ 1,886,220	€ 238,744
7		€ 238,744
8	€ 1,886,220	€ 238,744
9		€ 238,744
10		€ 238,744
Total	€ 9,431,100	€ 2,387,444

Discount factor	10%
Net present value	€ -6,398,302

Scenario analysis of implementation zone



Relative effectiveness of slope aspect for fire containment

Implementation area	Size of area (ha)		NPV (Euro)		
	Preventive	Avoided fire	Clearing cost	Avoided damage	Nett
1. N-NE Aspect	5412	930	€ 6,093,174	€ 975,416	-€ 5,117,758
2. NE-E Aspect	6986	1332	€ 7,865,284	€ 1,466,981	-€ 6,398,302
3. E-SE Aspect	6425	1139	€ 7,233,674	€ 1,269,604	-€ 5,964,070
4. SE-S Aspect	5360	702	€ 6,034,629	€ 698,569	-€ 5,336,060
5. S-SW Aspect	6223	589	€ 7,006,250	€ 735,163	-€ 6,271,086
6. SW-W Aspect	6851	541	€ 7,713,292	€ 634,324	-€ 7,078,968
7. W-NW Aspect	5763	579	€ 6,488,352	€ 483,031	-€ 6,005,321
8. NW-N Aspect	4626	706	€ 5,208,245	€ 743,015	-€ 4,465,231
9. Ridges	4560	1121	€ 5,133,938	€ 1,090,797	-€ 4,043,141

An economic analysis of prescribed fire is difficult due to lack of clarity over the optimal scale of implementation. Clearing costs if indiscriminately applied across areas of similar slope aspect (or ridges) appear to be too high to justify investment based on damage by forest fires in the period 2001-2009. However, the damage in this time frame has been limited, and extending the analysis with the year 2000, when 15% of the municipality was burned would give a different picture. That said, more informed application of prescribed fire could decimate the clearing (burning) costs without compromising effectiveness. Slopes with N-NE aspects appear to be the most effective in terms of containing wildfires but might not be the most cost-effective.

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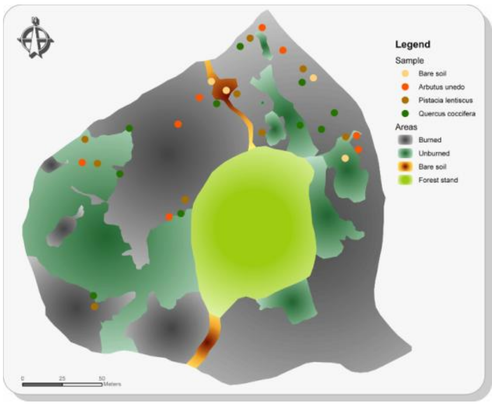
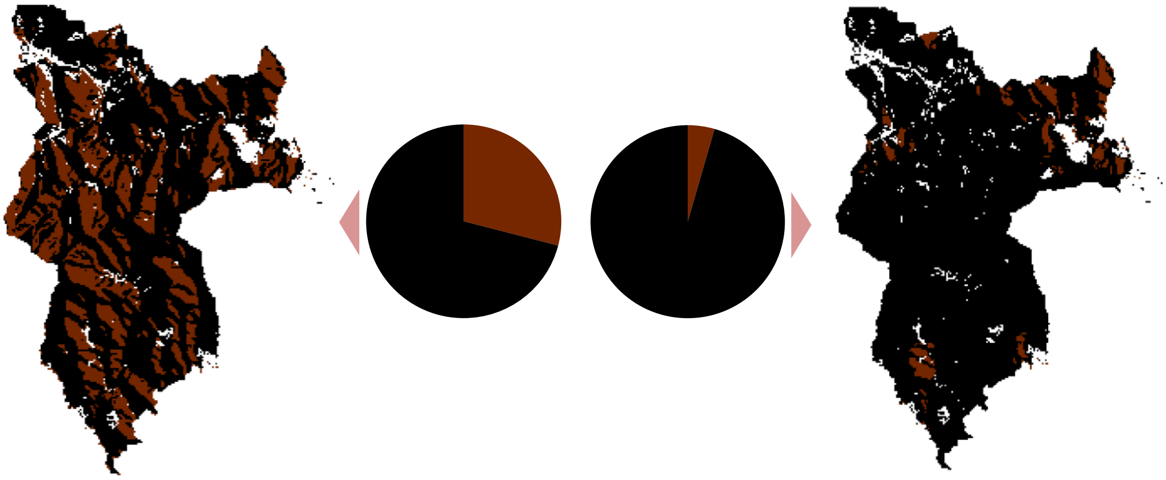
Policy Scenario:
Targeted implementation of prescribed fire (POR02)

The extent of application of prescribed burning analysed in the Technology Scenario is exaggerated, with ratios of preventively burned to protected areas ranging from 4.1 – 12.7. If areas most at risk of wildfires are better known and the prescribed fire technology more restrictively applied, costs can be reduced while maintaining high level of wildfire control. In this policy scenario we consider only implementing prescribed fire with 1km from burned areas on land with high susceptibility to fire (FSI > 5).



Profitability:

Implementation area: A. Slopes NE-E aspect **B. Idem, with SFI > 5 and burned area < 1km**



Net Present Value

Implementation area	Size of area (ha) Preventive	Avoided fire	NPV (Euro) Clearing cost	Avoided damage	Nett
I. Targeted application with calculated effect (reduced effectiveness due to patchy application)					
N-NE Aspect	745	488	€ 838,768	€ 672,489	-€ 166,280
NE-E Aspect	1177	944	€ 1,325,142	€ 1,213,962	-€ 111,180
NW-N Aspect	613	453	€ 690,154	€ 495,730	-€ 194,424
II. Targeted application with assumed micro-management to retain effectiveness					
N-NE Aspect	745	930	€ 838,768	€ 975,416	€ 136,647
NE-E Aspect	1177	1332	€ 1,325,142	€ 1,466,981	€ 141,840
NW-N Aspect	613	706	€ 690,154	€ 743,015	€ 52,860

Targeted implementation reduces the implementation area (and hence costs) by 83% (for NE-E slope aspect). Two analyses are performed: in the first (calculated) analysis the annual area avoided from burning is reduced from 133 to 94 ha due to more patchy application; in the second the same cost is assumed to suffice to safeguard the originally protected area (i.e. more micro-management). The NPV is slightly negative in the first but positive in the second analysis. In applying prescribed fire, there is a trade-off between targeting high-risk areas and accepting wildfire risk in remaining areas.

Cost-effectiveness indicators:

- The cost per hectare of land where burning is avoided is between €902 and €1720.
- The cost per inhabitant would be between €37 and €71 per year.

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Global Scenario:
Food production

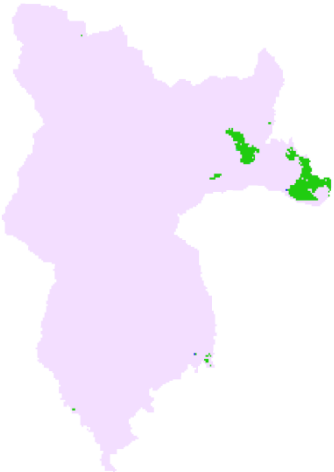
The food production scenario selects the technology with the highest agricultural productivity (biomass) for each cell where a higher productivity than in the baseline scenario is achieved. The implementation costs for the total study area are calculated and cost-productivity relations assessed. To facilitate comparison between different study sites, all costs are expressed in Euro.

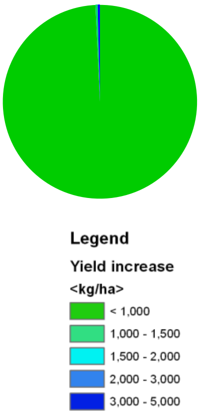
+958 kg/ha

+130 kg/inhabitant

Scope for increased (i.e. not lost) production

Yield increase





Biophysical impact: yield increase

- Yield increase in 39% of applicable area (all arable land)
- Average absolute yield increase: 958 kg/ha
- Average yield increase: na (avoided burning)

Economic indicators

Average costs (arable land as share of total):
- Investment cost: €1,571/ha*
- Unitary cost year 1: €1,640/ton(yr)*
- Unitary cost lifetime: €820/ton*

Aggregate indicators:
- Study site: €0.96 million*
- Augmented annual production: 583 ton
- Augmented total production: 5,833 ton

* Note that costs can be reduced with more targeted application of the technology (see Policy scenario), to: Investment cost: €216/ha; unitary cost year 1: €226/ton(yr); unitary cost lifetime: €113/ton; Aggregate investment study site: €0.13 million.

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Concluding remarks

- The baseline simulation shows very high fire susceptibility in about 70% of the forest and unmanaged area. Biomass production is more than 15 ton/ha in 90% of the forest area.
- Prescribed fire was prioritised by scientists and local stakeholders to control wildfires. Field experiments were conducted to assess the effects of controlled fire in comparison to wildfires. The analyses included post-fire hydrology, measuring erosion and nutrient losses. It was concluded that prescribed fires result in less degradation effects than wildfires, confirming it can be used as a landscape planning tool. Modelling concentrated on an analysis of the potential of using prescribed fire as a fire break at landscape scale, using data on burned areas and ignitions over the period 2001-2009. Slope aspect was considered as a basic management factor, as fire is more easily controlled on relatively homogeneous slopes. Applying controlled fire on slopes with NE-E aspect was found to result in the highest reduction of wildfire. The average annual area burned by wildfires could be reduced from 1703 to 317 ha (a 78% reduction). From an economic point of view a crucial factor is how much area should be burned in a controlled fashion to achieve this effect. Indiscriminate application is too expensive but there is likely to be much room for improvement, which was explored as a policy scenario. It should also be pointed out that the rate of burning was relatively low over the period assessed (e.g. wildfires in the year 2000 burned 3842 ha, or 15% of the municipality).
- In the workshop to evaluate monitoring and modelling results, stakeholders confirmed their preference for prescribed fires (and the fuel strips network), evaluating it slightly higher than in the second workshop – perhaps because of increased knowledge derived from pilot implementation of the technology. In order to promote the technology, recommended actions in four domains (regulation, awareness, forest intervention areas, and funding) were agreed by the participants.
- A policy scenario explored whether the benefit-cost ratio could be improved by more contextual knowledge leading to a more targeted application of the technology. Two additional management factors were taken into account: the fire severity index (FSI) in the baseline situation and the distance from burned areas over the past decade. Both factors could potentially weaken the firebreak effect of prescribed fires: the FSI because introducing a threshold FSI creates a more scattered pattern of areas with low susceptibility, and proximity to known fire hotspots because there is no guarantee that ignitions would not occur in an area where no recent wildfires occurred. The patchiness due to FSI threshold was modelled to reduce protection against wildfires. Due to less effective firebreak function, the greatly reduced investment costs were still too high to warrant application of prescribed fire. However, if we assume field knowledge is sufficient to avoid reduction of effectiveness, the technology turned positive. Application across NW-N slopes was most cost-effective in this analysis.
- The global scenario for food production shows that although the technology is not primarily intended to protect cropland (which is a limited land use in the area), its impact in avoiding the burning of crops is noticeable. For simplicity the analysis assumes that all fires would affect crops in the field (i.e. occur before harvesting). The investment costs to protect crop production, when attributed equally to all areas where burning would have been avoided, range from €1,640 to potentially €113/ton grain.
- The analyses show that the required scale of application of prescribed fire is a crucial factor in assessing its economic viability. Targeted application is essential in order not to apply the technology too widely, perhaps introducing degradation impacts that are not serving to offset more devastating wildfires. Results obtained were based on several assumptions and based on an analysis of areas burned in the period 2001-2009. While the long-term average area burned could deviate from the observed burned areas in this period, it is under future climate change likely that wildfires will increase rather than decrease, in which case the viability of implementing prescribed fire could be improved. For example, would the 2000 burned areas have entered the analysis and the effectiveness of prescribed fire would have been the same as observed over the period 2001-2009, even the large scale application of wildfires across all ridges would have been economically attractive.