Assessing postfire conditions in Spain and the Mediterranean

V. Ramón Vallejo & J.A. Alloza

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PROGRAMA PROMETEO
GENERALITAT VALENCIANA
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GRACCIE

UNIVERSITAT DE BARCELONA

FUME

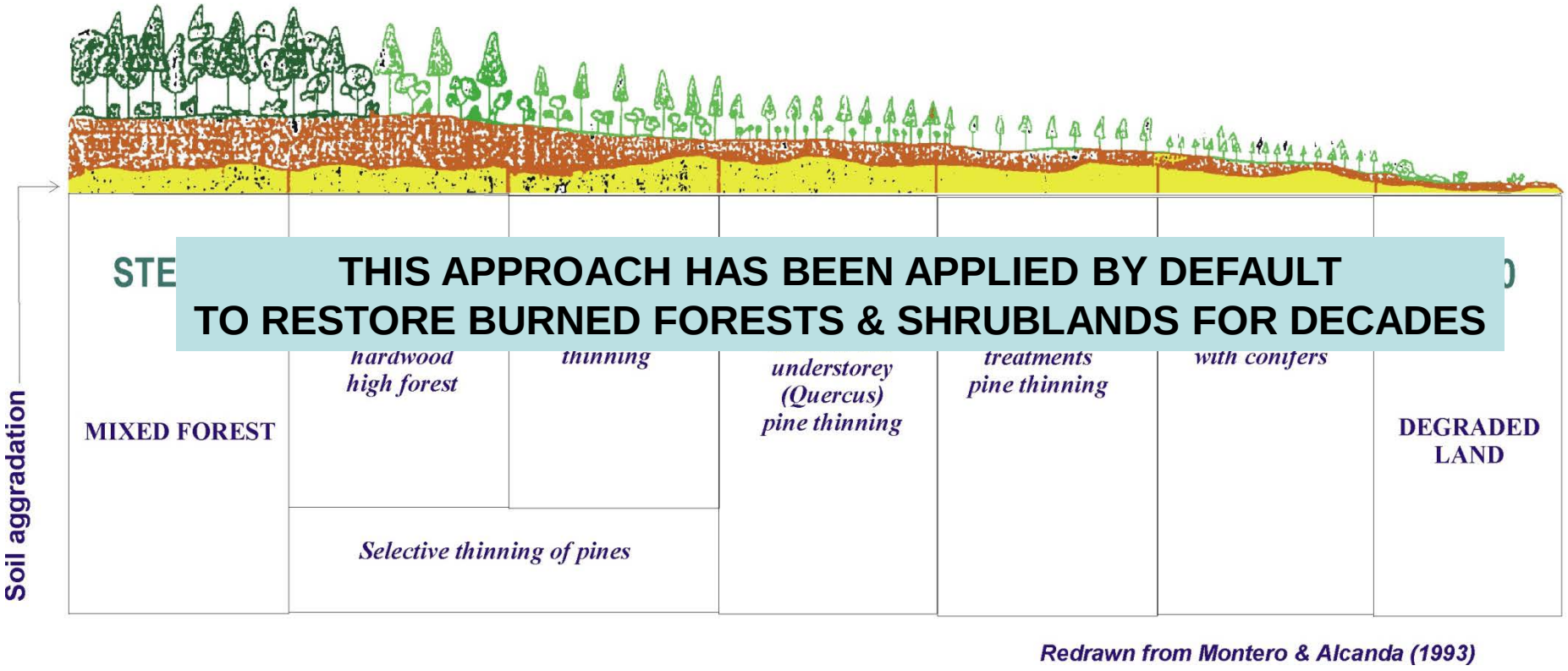
SEVENTH FRAMEWORK PROGRAMME


Long –term over-exploitation
Deforestation
Land degradation
Desertification

Large afforestations since the end of XIX century.

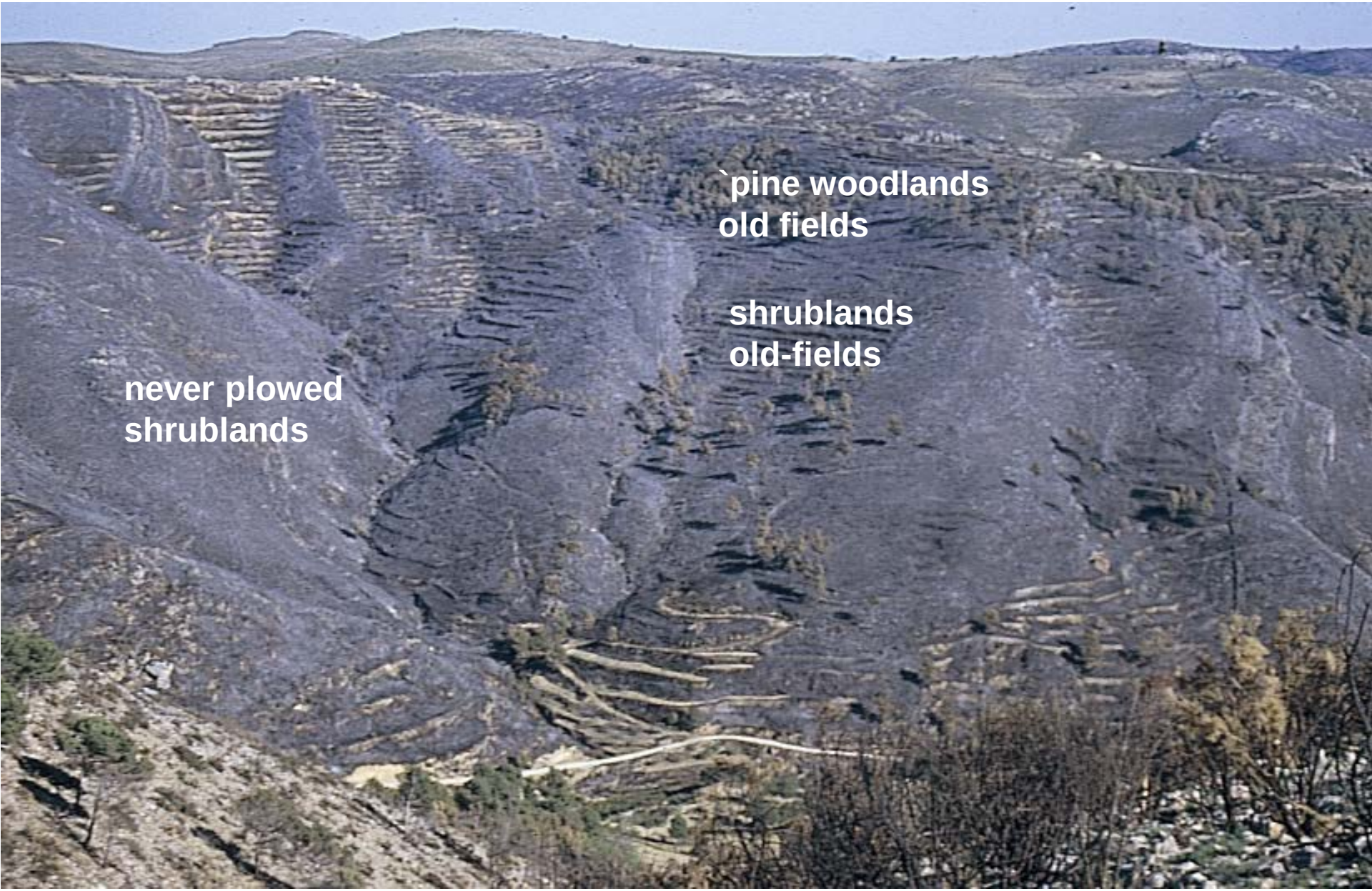
SIERRA ESPUÑA 2004

The traditional approach:



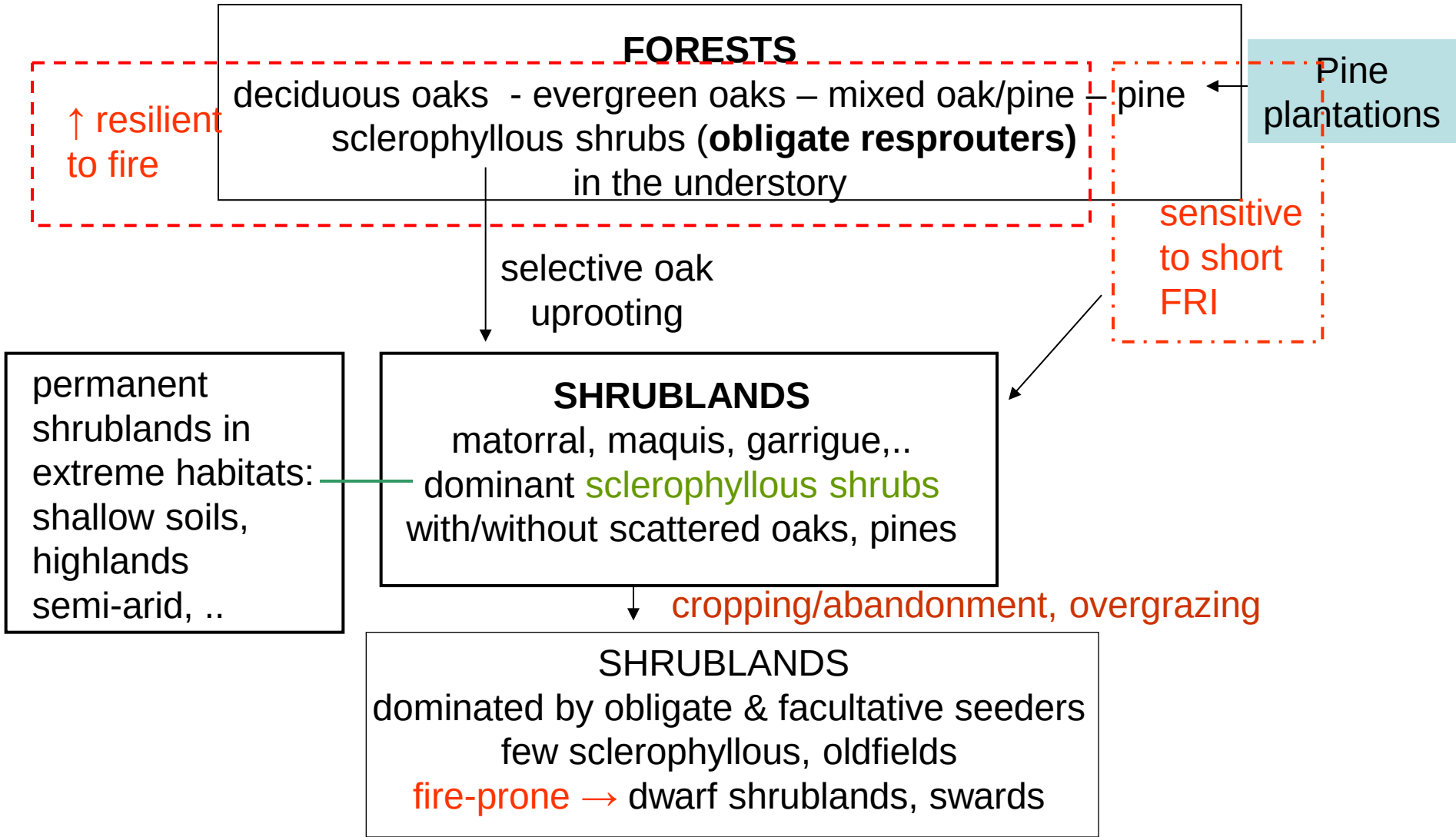
A KEY DRIVER IN THE MED BASIN: LAND USE HISTORY

Useres Fire (Castelló) 2007

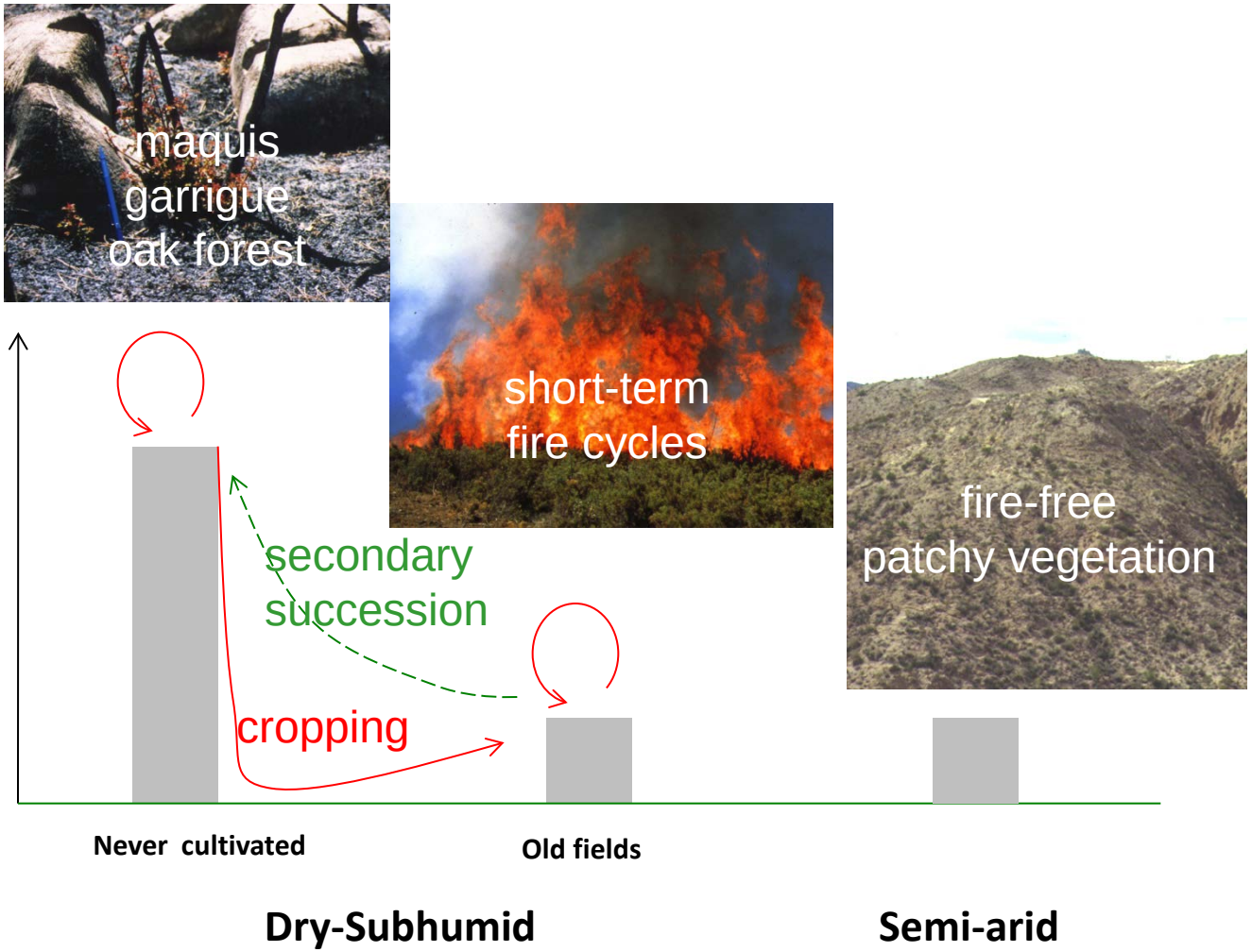

`pine woodlands
old fields
shrublands
old-fields
never plowed
shrublands

THE SHRUBLANDS IN THE MEDITERRANEAN BASIN

CLIMATE RANGE: P: 1000-350 mm (350-200 mm semi-arid) P/PET: 0.75-0.5 (0.5-0.2)
SUBSTRATE: large abundance of calcareous substrates



THE ROLE OF CROPPING/ABANDONMENT

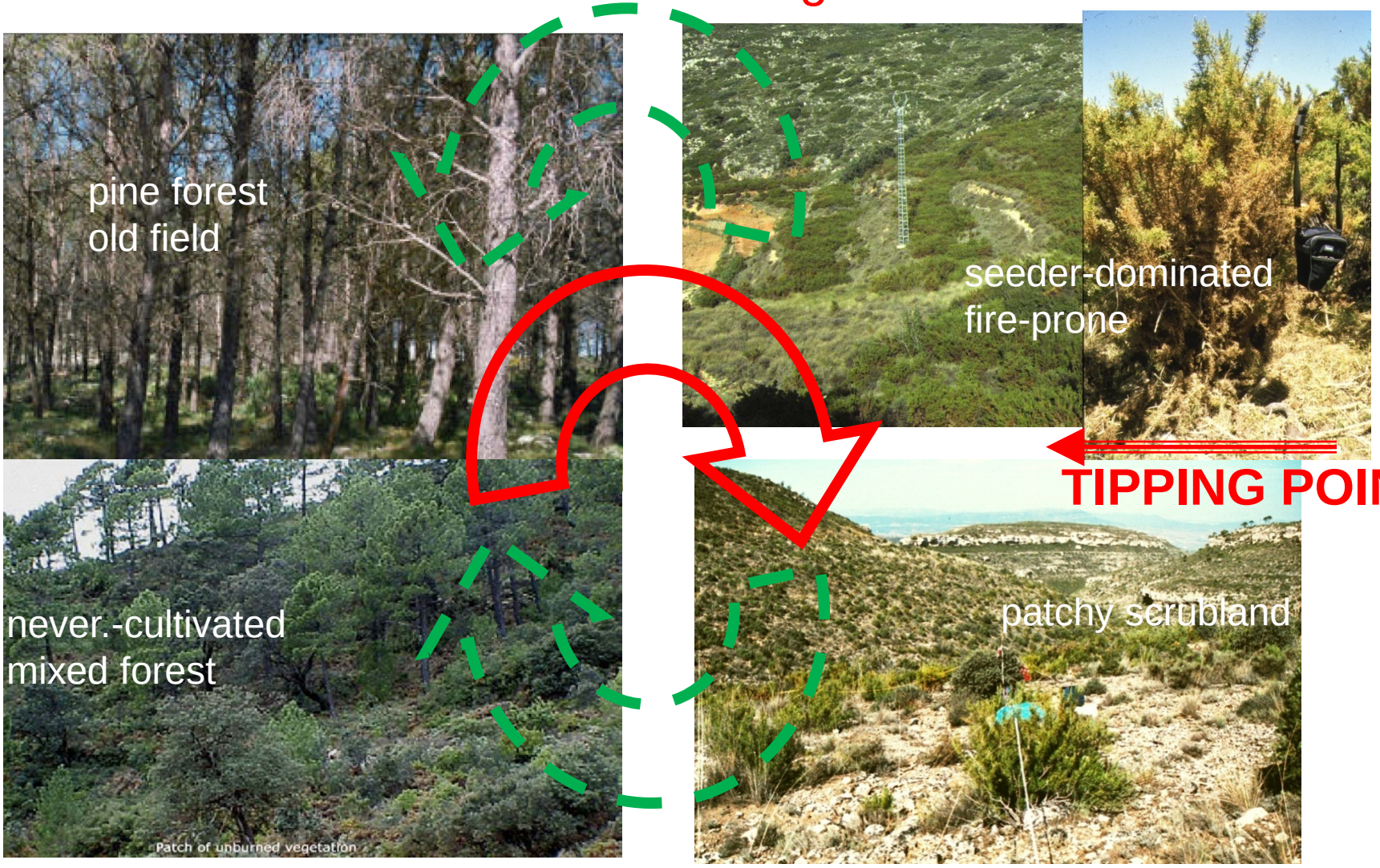


Cropping ⇒ woody resprouter uprooting

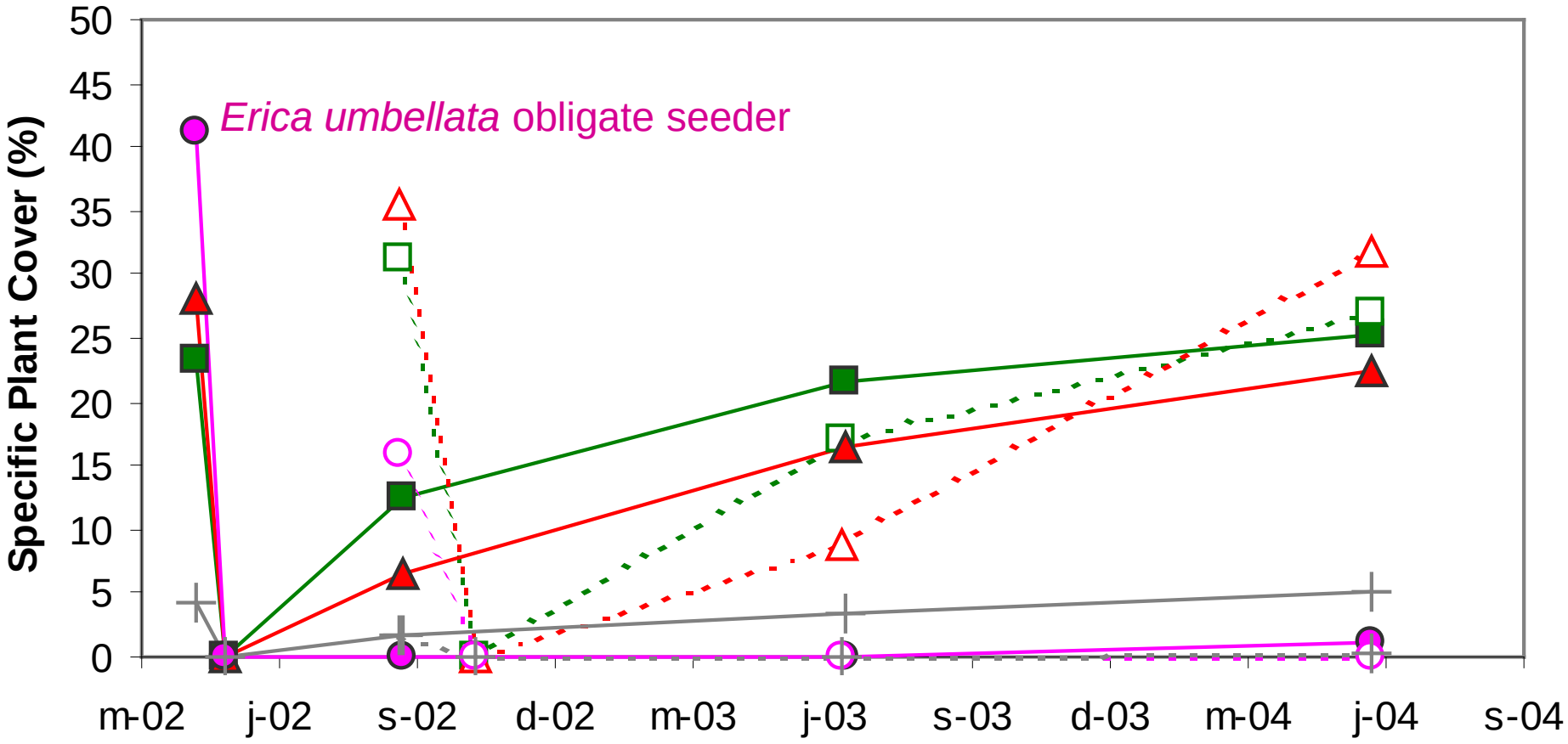
Secondary succession = *f* (landscape structure, i.e.,
fine/coarsed grained oldfield/uncropped patches)

WHAT REFERENCE FOR ECOLOGICAL RESTORATION?

RECURRENT FIRES MAY TRIGGER CATASTROPHIC SHIFTS …



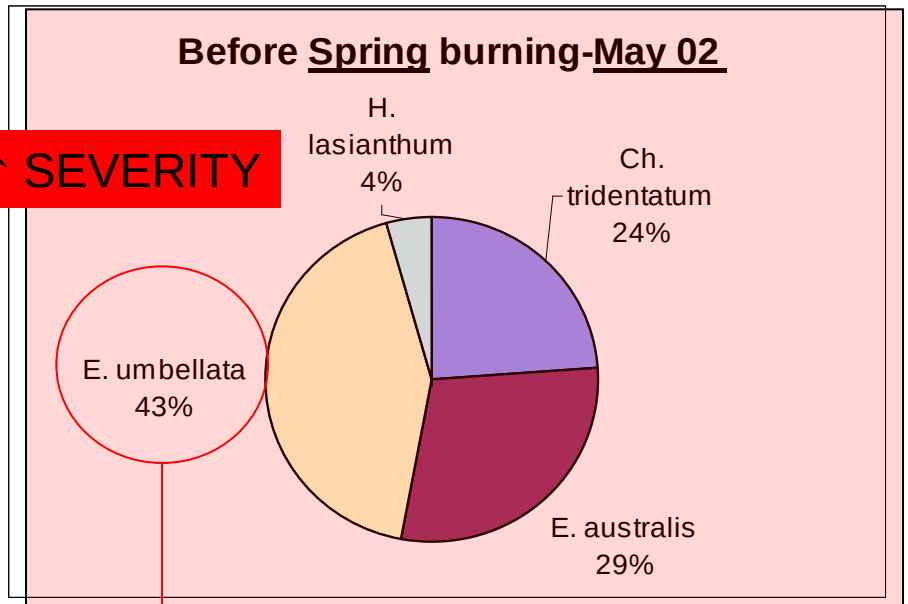
Plant regeneration after burning – heathlands central Portugal

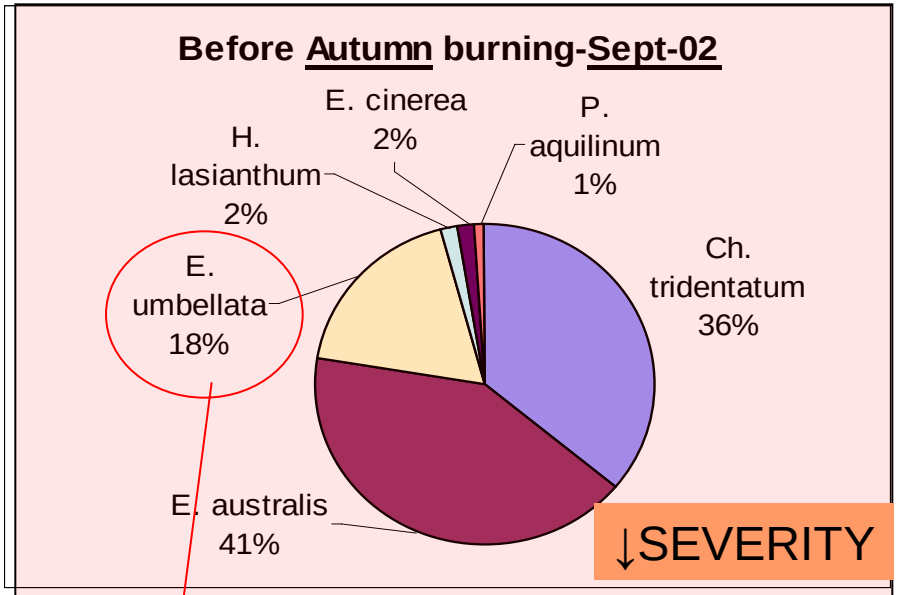


Serrasolses pers. Comm. SPREAD project

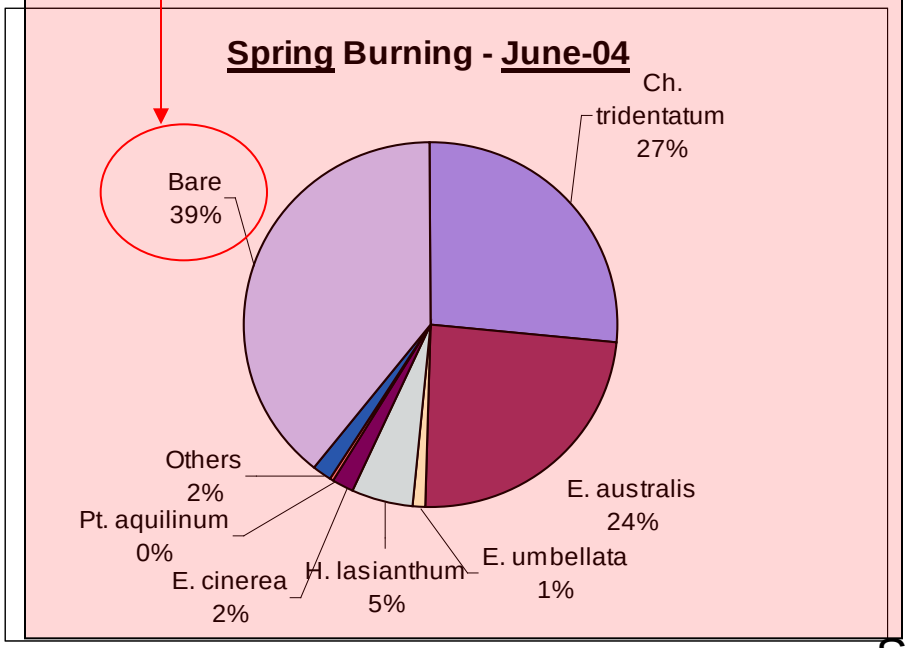
Plant regeneration after burning: Specific Plant Cover

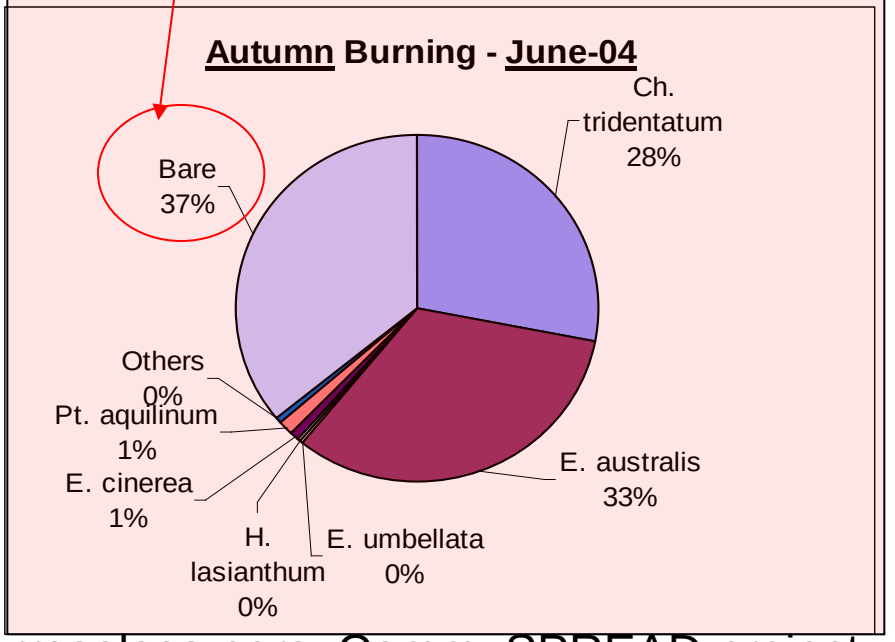
↑↑ SEVERITY





↓SEVERITY





Serrasolses pers. Comm. SPREAD project

RESPROUTING VIGOUR COULD BE VERY DIVERSE …

Table 3. PFRT detected in Atlantic vegetation, indicating the different intensities of each species and examples of the species included in each group.

PFRT	Stimulation degree: High	Medium	Low
Fire Dependent (Germination and resprouting stimulation)	*U. europaeus, U. gallii, U. minor, C. multiflorus*	*A. lainzii, P. tridentatum, G. berberidea, E. vagans, E. ciliaris, H. alyssoides*	*U. micranthus, C. scoparius, G. triacanthos, T. globulariifolia*
Resprouting Dependent (Resprouting stimulation only)	*A. curtisii, E. erigena, E. scoparia, E. tetralix, P. longifolium, Q. robur, Q. pyrenaica*	*D. decumbens, H. lanatus, B. pendula A. marginata, D. cantabrica*	*C. vulgaris, B. media*
Germination Dependent (Germination stimulation only)	*C. striatus*	*T. guttata*	*E. umbellata*
Fire Sensitive (No modification of germination nor resprouting)	*P. sylvestris, P. uncinata, P. nigra, B. maxima*	*P. pinaster*	*P. radiata*

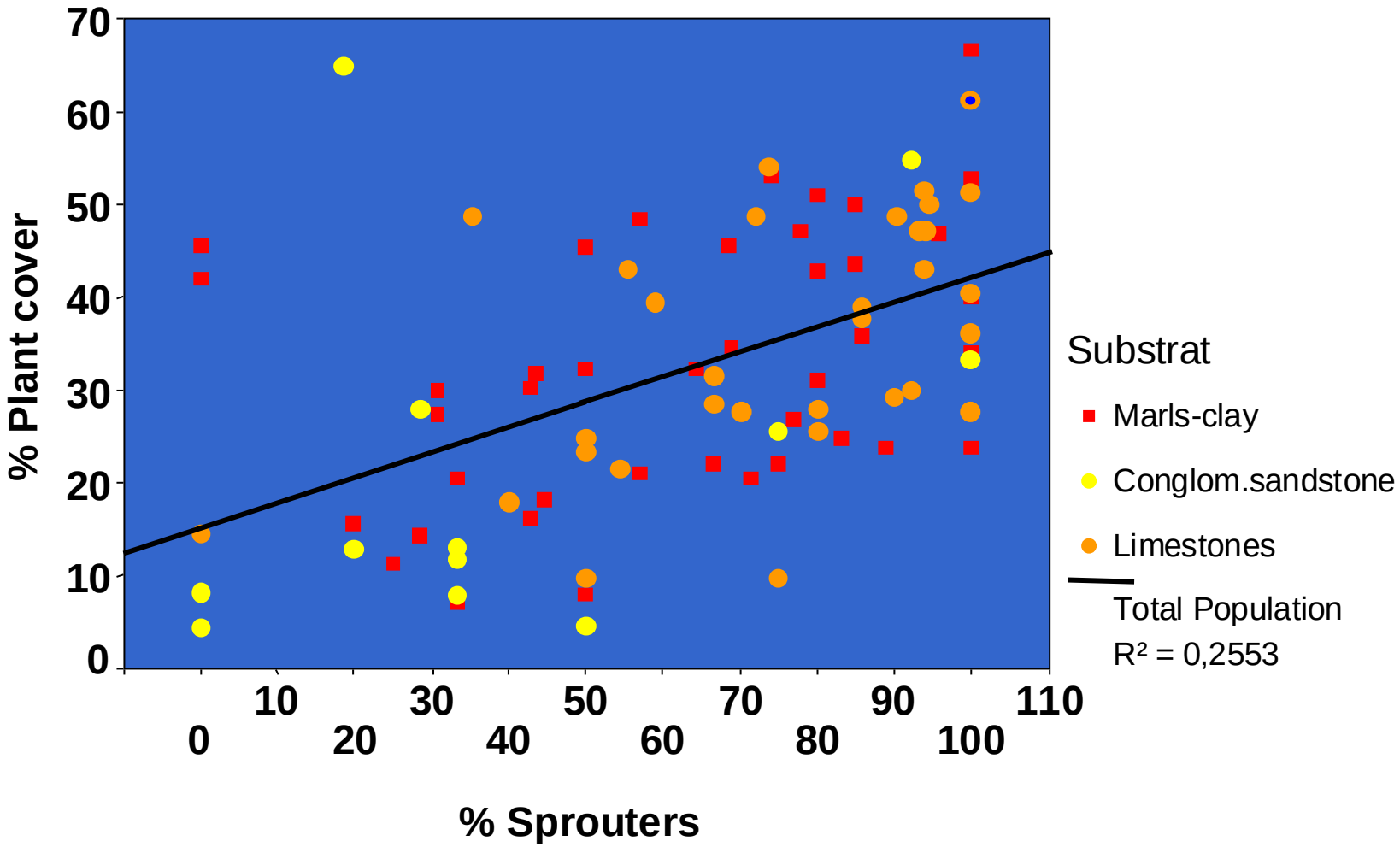
PFRT: Plant Functional-Regenerative Traits
Reyes & Casal, 2008

MED. BASIN SCLEROPHYLOUS SPECIES

- **vigorous** post-fire obligate resprouters
- recruitment during inter-fire intervals

Genera/sp	Family
Arbutus	Ericaceae
Olea	Oleaceae
Phillyrea	Oleaceae
Pistacia	Anacardiaceae
Quercus coccifera	Fagaceae
Q. ilex	Fagaceae
Q. suber	Fagaceae
Viburnum	Caprifoliaceae
Rhamnus	Rhamnaceae

The key factor in ecosystem recovery in the Mediterranean: the abundance of resprouter species



Data: 6 month afetr fire

Ecology, 90(5), 2009, p. 1420

Fire-related traits for plant species of the Mediterranean Basin

Ecological Archives E090-094

S. Paula,[1] M. Arianoutsou,[2] D. Kazanis,[2] Ç. Tavsanoglu,[3] F. Lloret,[4] C. Buhk,[5] F. Ojeda,[6] B. Luna,[7] J. M. Moreno,[7] A. Rodrigo,[8] J. M. Espelta,[8] S. Palacio,[9] B. Fernández-Santos,[10] P. M. Fernandes,[11] and J. G. Pausas[1,12,13]

- life form
- height
- rooting depth
- S:R
- leaf phenology

- leaf shape
- leaf size
- resprouting ability
- bud source
- heat-stimulated germination
- other cues

- seed bank longevity
- seedling emergence
- age at maturity of resp.
- age at maturity seedling
- seed mass
- propagule
- dispersal mode

Global Change Biology

Global Change Biology (2011) **17**, 2905–2935, doi: 10.1111/j.1365-2486.2011.02451.x

TRY – a global database of plant traits

J. KATTGE*, S. DÍAZ†, S. LAVOREL‡, I. C. PRENTICE§, P. LEADLEY¶, G. BÖNISCH*,

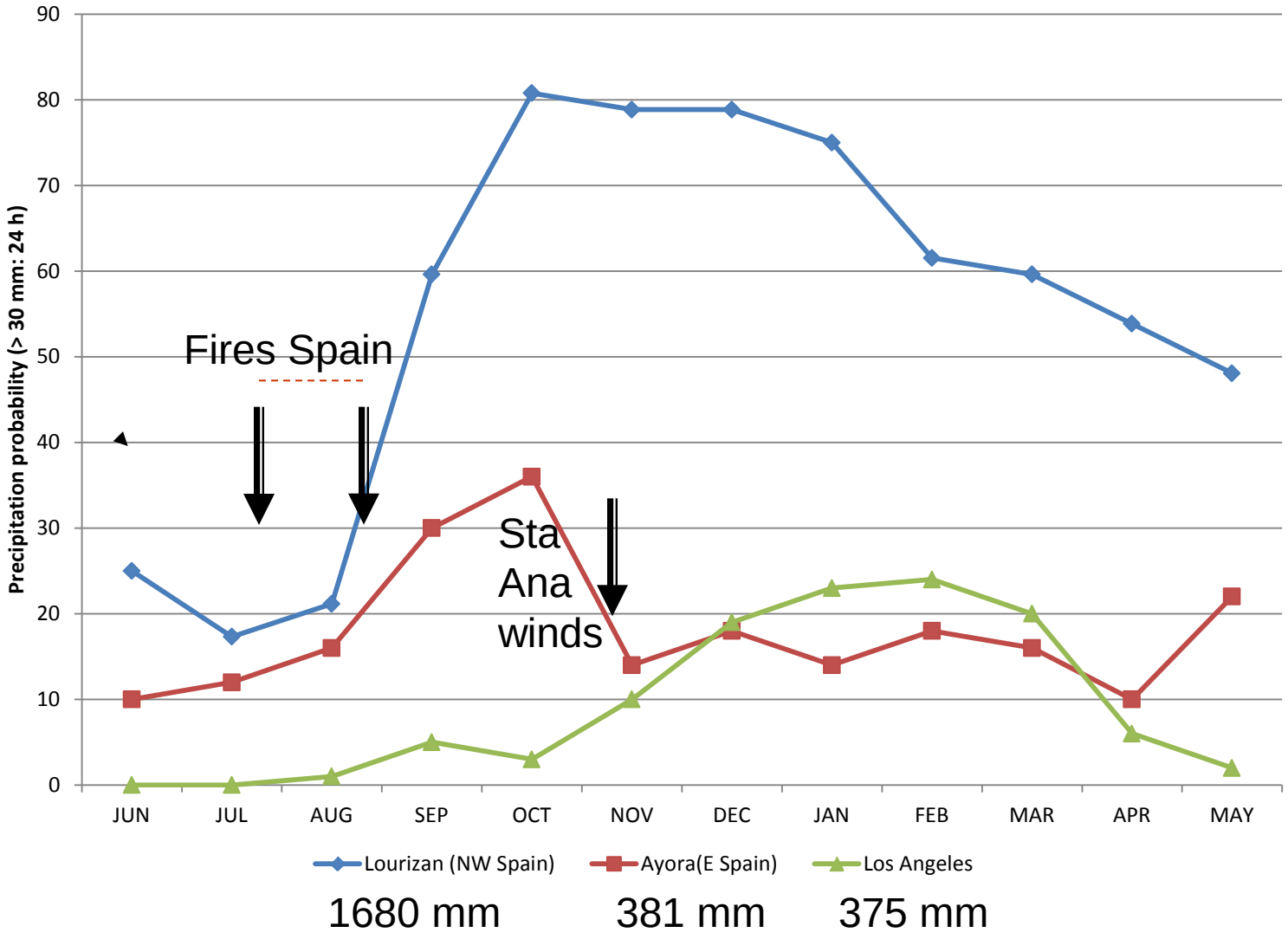
NEW APPROACHES IN POSTFIRE RESTORATION

- To face the dramatic changes in fire regime
- To accomodate to the new social perception of natural areas → ecosystem services
- To make use of advances in fire and restoration ecology

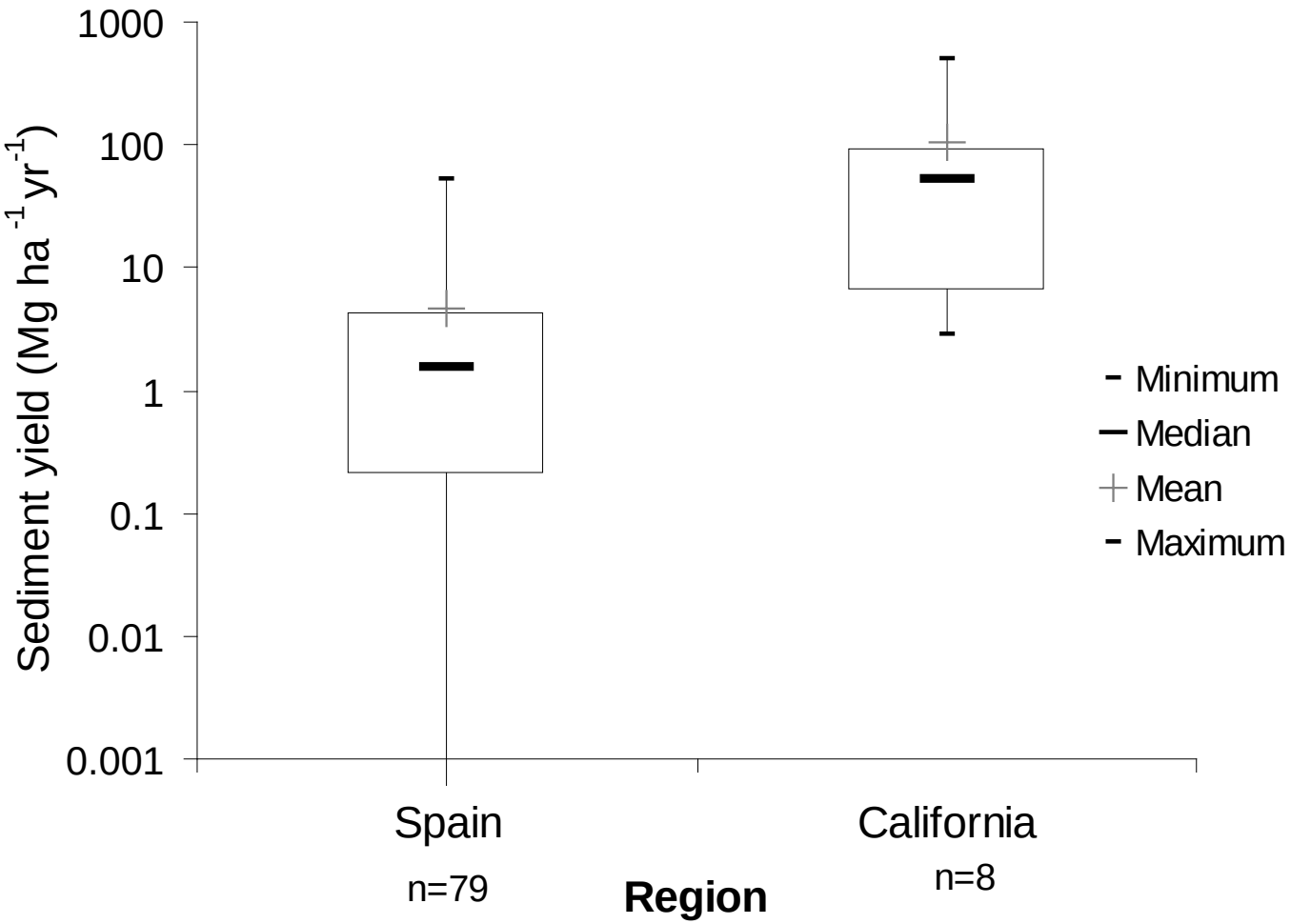
An approach to assess post-fire restoration needs

- **Definition of management objectives for burned areas:**
  - Avoid damages (erosion, flash floods)
  - Increase resiliencia & biodiversity
  - Prevent new fires
- **Identification of fire-vulnerable ecosystems**
  - ⇒ Prediction of runoff & soil erosion risk
  - ⇒ Prediction of dominant species regeneration capability (resilience, regeneration rate) as a ***f***(fire severity & land and ecosystem characteristics)
- **Timely application of specific techniques to mitigate degradation and assist regeneration**

RAIN EROSIVITY AFTER FIRE



Sediment yields from burned plots in Spain and California: First 2 years after burning



Lee H. MacDonald, personal comm.

POSTFIRE RESTORATION ASSESSMENT

Identification of vulnerable areas

Definition of management objectives

Fire severity & Impact evaluation dNBR & field survey

Action Plan

Short term

Long term

Charred wood management

Post-fire rehabilitation

Restoration

Fire prevention

STRATEGIES FOR POST-FIRE REHABILITATION/ RESTORATION

Objectives

- Soil and water conservation
- Increasing ecosystems resilience (and fire prevention)
- Increasing ecosystem and landscape quality
  - promoting biodiversity
  - (often) increasing ecosystems maturity

POST-FIRE ACTIONS
(why, where, when, how)

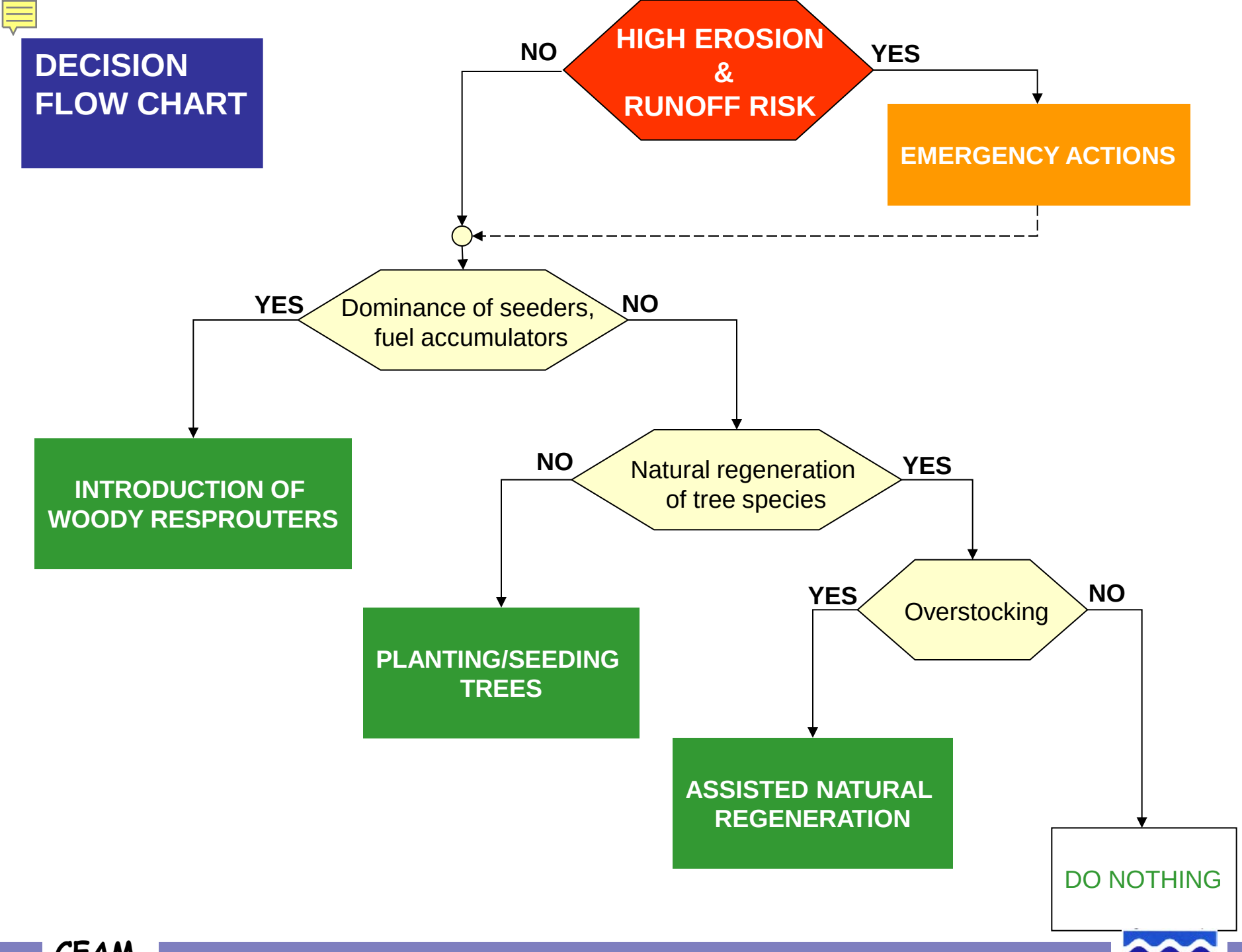
According to:

Degradation risk

Objectives ⇒

Assuming general ecological objectives

DECISION FLOW CHART



1) Do nothing:

fast and complete natural regeneration

low erosion & runoff risk

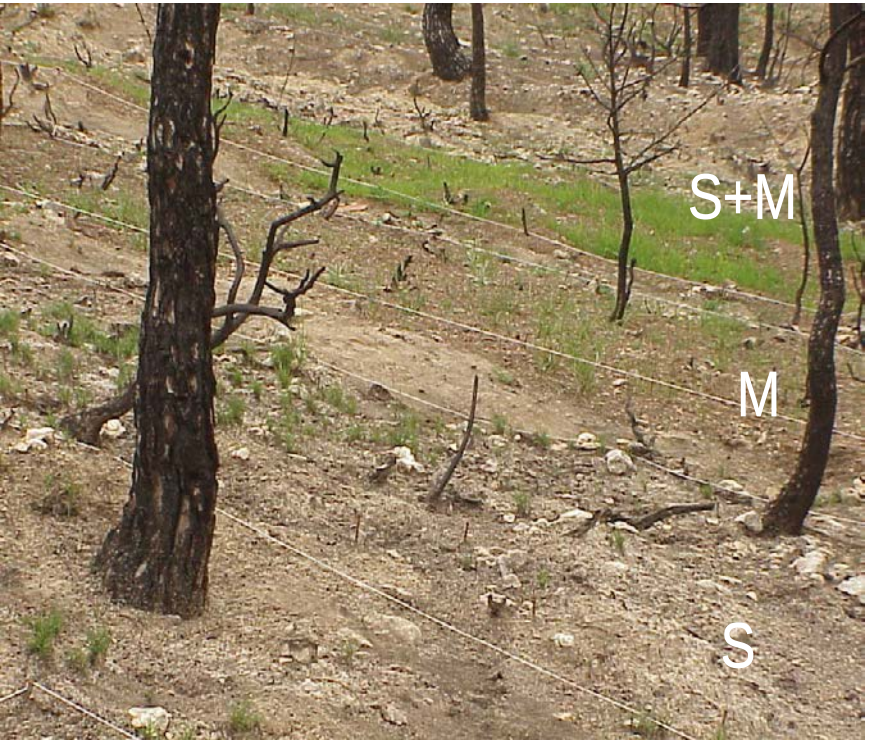
Serra Caldeirao, Algarve Portugal
Fire July 2004 – foto June 2006

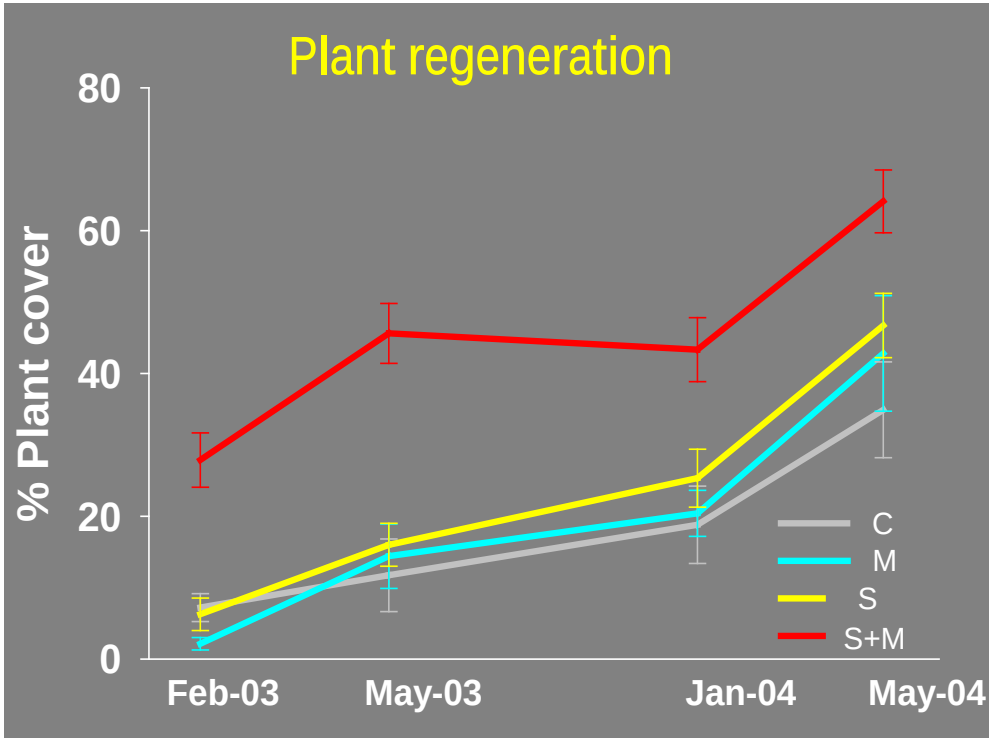
2) Emergency rehabilitation:

degraded land
high erosion & runoff risk
low plant cover recovery rate
high values at risk

muching, seeding + mulching, soil amendments for immediate soil protection

Emergency seeding



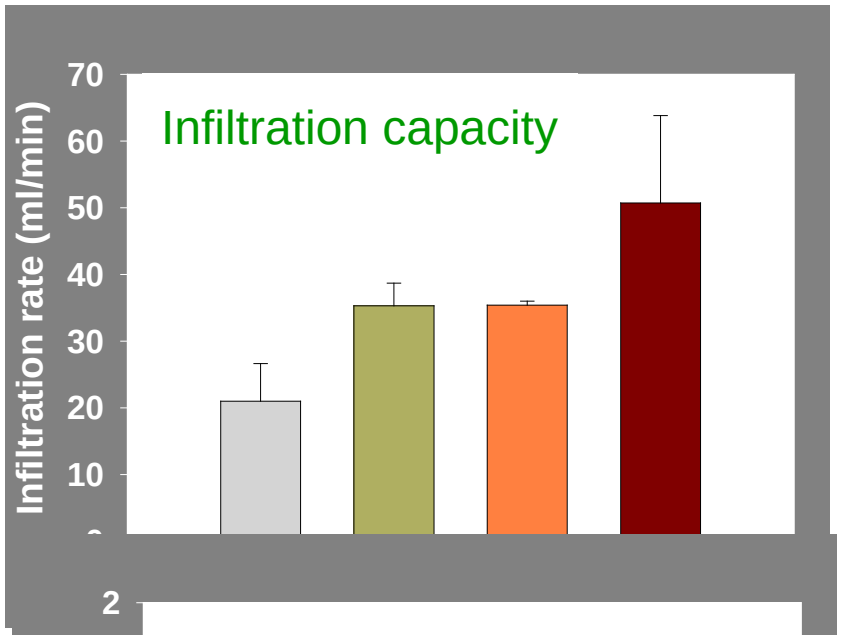


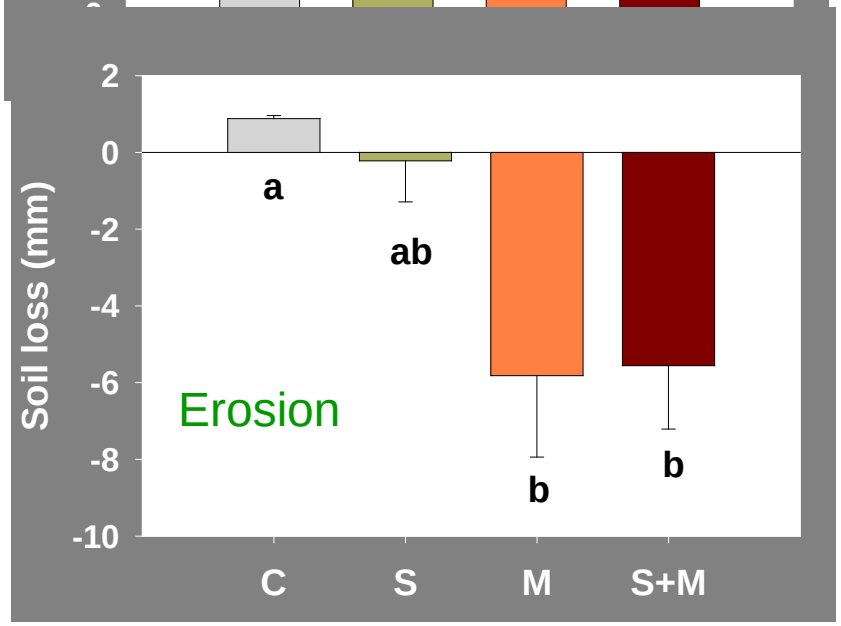
May 2003, 7 months after fire and after treatment aplication

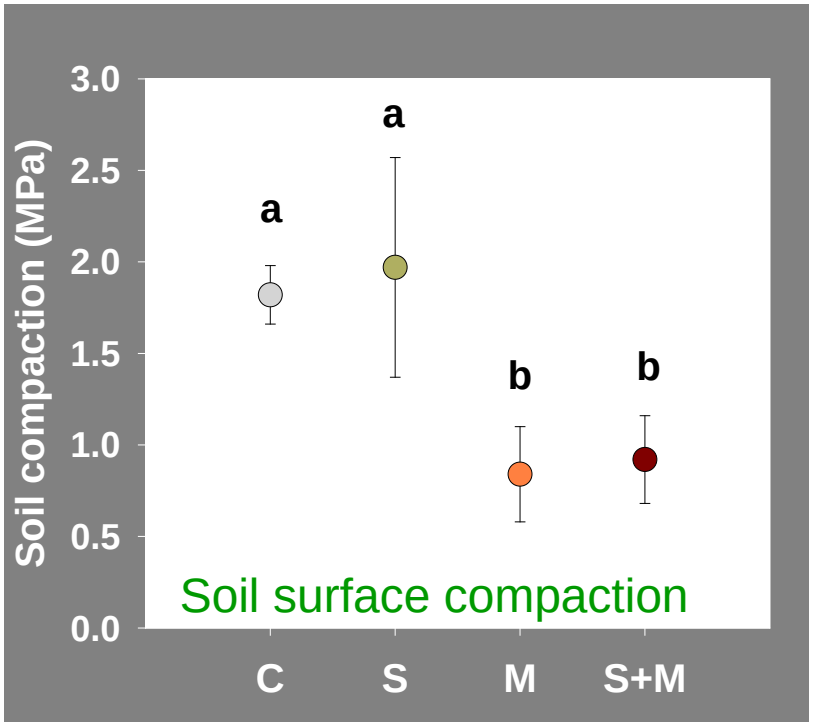
S+M: Seeding + Mulch
S: Seeding
M: Mulch without seeding

Emergency seeding

Soil protection







S+M: Seeding + Mulch
S: Seeding
M: Mulch without seeding
C: Control

2b) Emergency rehabilitation:

high erosion & runoff risk

low plant cover recovery rate

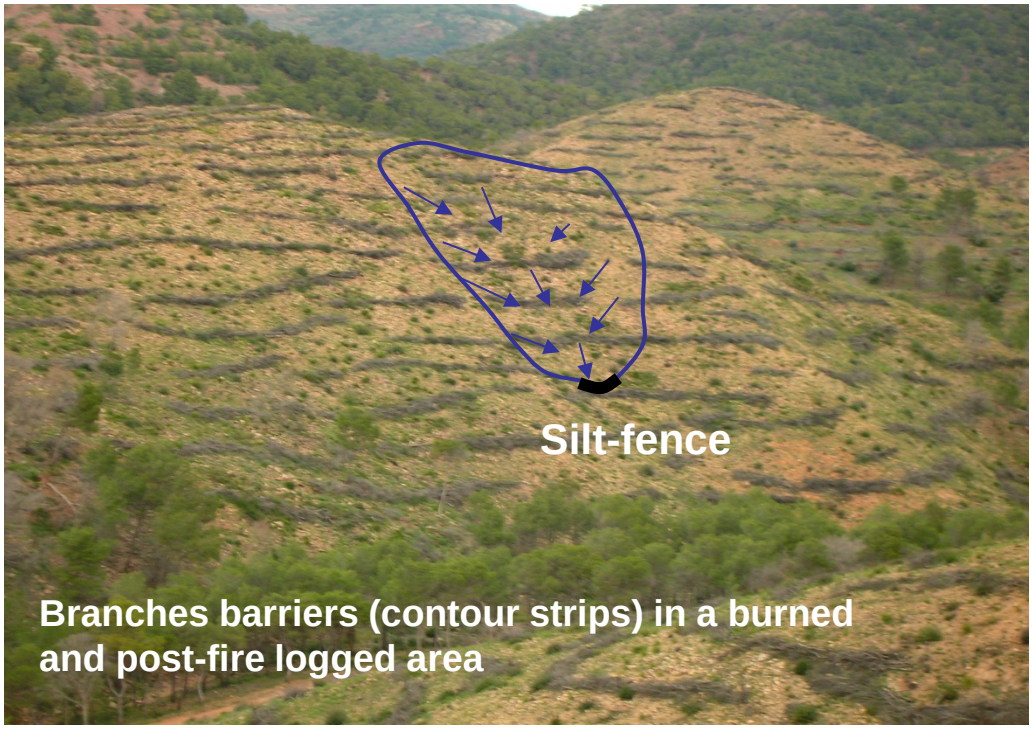
high values at risk

economic interest in logs & pest control (?)

Salvage logging → log dams, branch barriers (contour felling)

Charred logs extraction

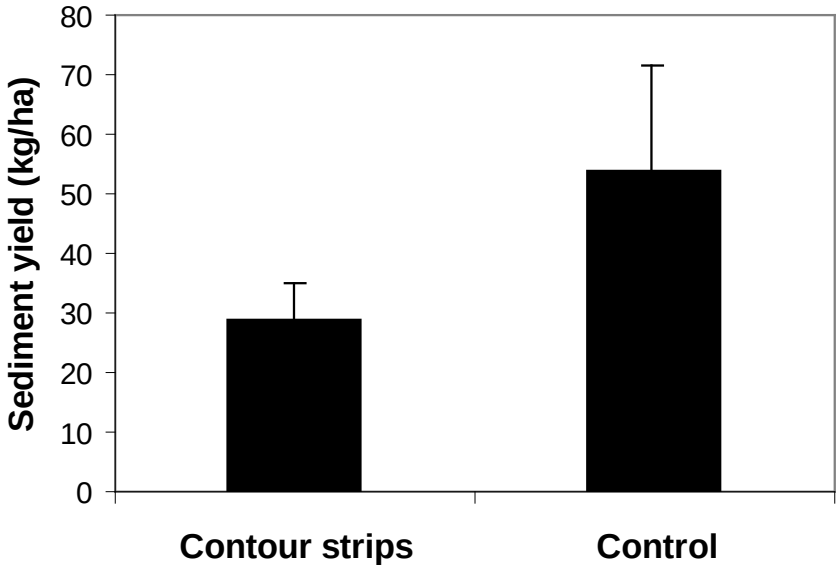
Up to 51 Mg ha year^{-1} soil loss



Branches barriers (contour strips) in a burned and post-fire logged area

Silt-fence used to monitor sediment yield

Total sediment yield produced in control and treated areas during the monitoring period: July 2005-April 2006




Aliaga Mayo 2013

3) (re)Introduction of woody resprouters (to increase fire resilience):

understory dominated by woody seeders - colonizers - high fuel accumulators

oldfields (often)

Planting resprouters tall shrubs & trees

Fire-prone shrublands: Clearing + introduction of fire-resilient species

Clearing & Planting

clearing

Clearing + planting

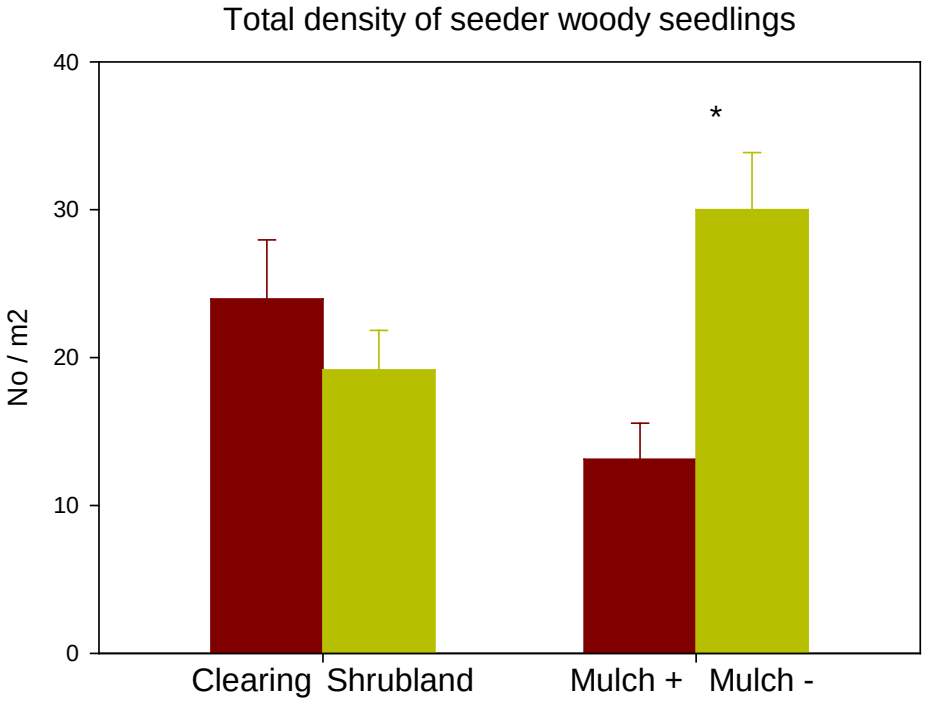
Control plot

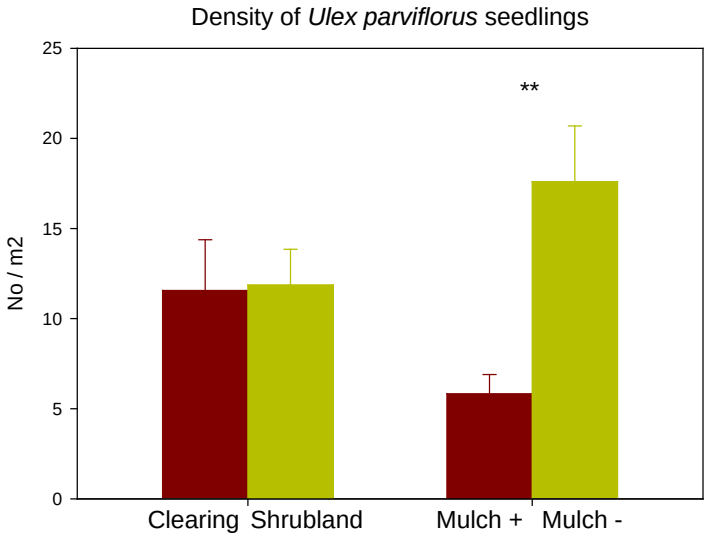
Planting
Quercus ilex
Rhamnus alaternus

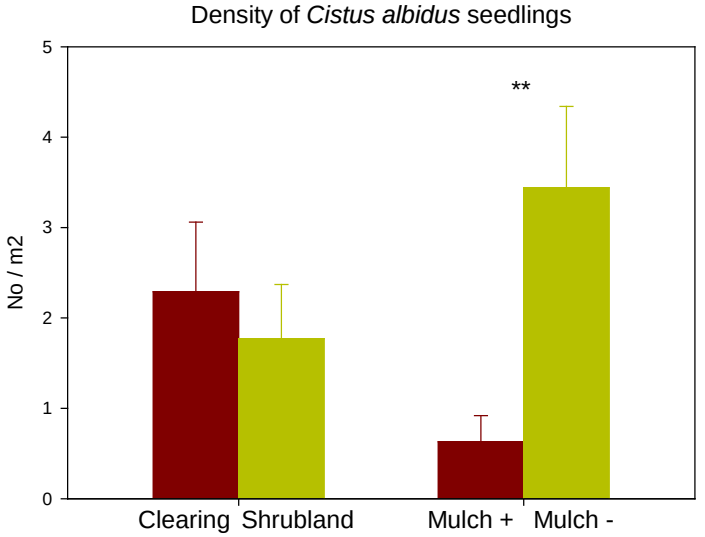
Experiments conducted in 2003 → medium-term analysis


2005 7 23

RESULTS
3. Germination of seeder species







Data taken in 2008

4) Recovery of forest

stand-replacing fires

lack of seed sources in unburned patches

shrublands, oldfields

management objective

Pinus pinaster

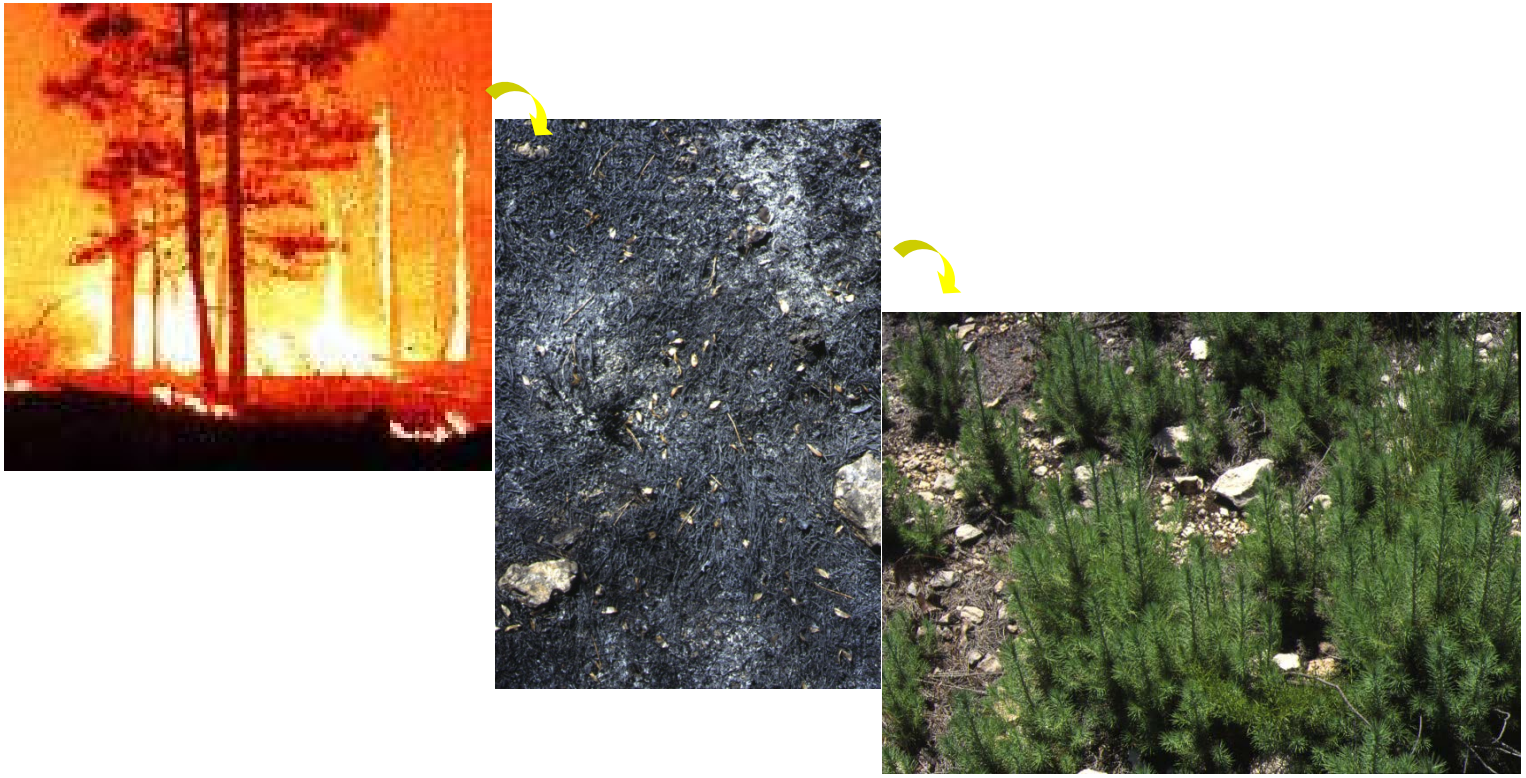
Quercus ilex

Plantation of tree species: conifers + hardwoods combined

4b) Recovery of forest (assisted natural regeneration)

overstocking → thinning ,....

cleaning of stools in coppices



Excessive post-fire pine regeneration
Pinus halepensis

CLEARING & PLANTING ALICANTE (AUTUMN 2010)

MAIN ECOSYSTEMS DESERVING POSTFIRE RESTORATION IN THE MEDITERRANEAN BASIN

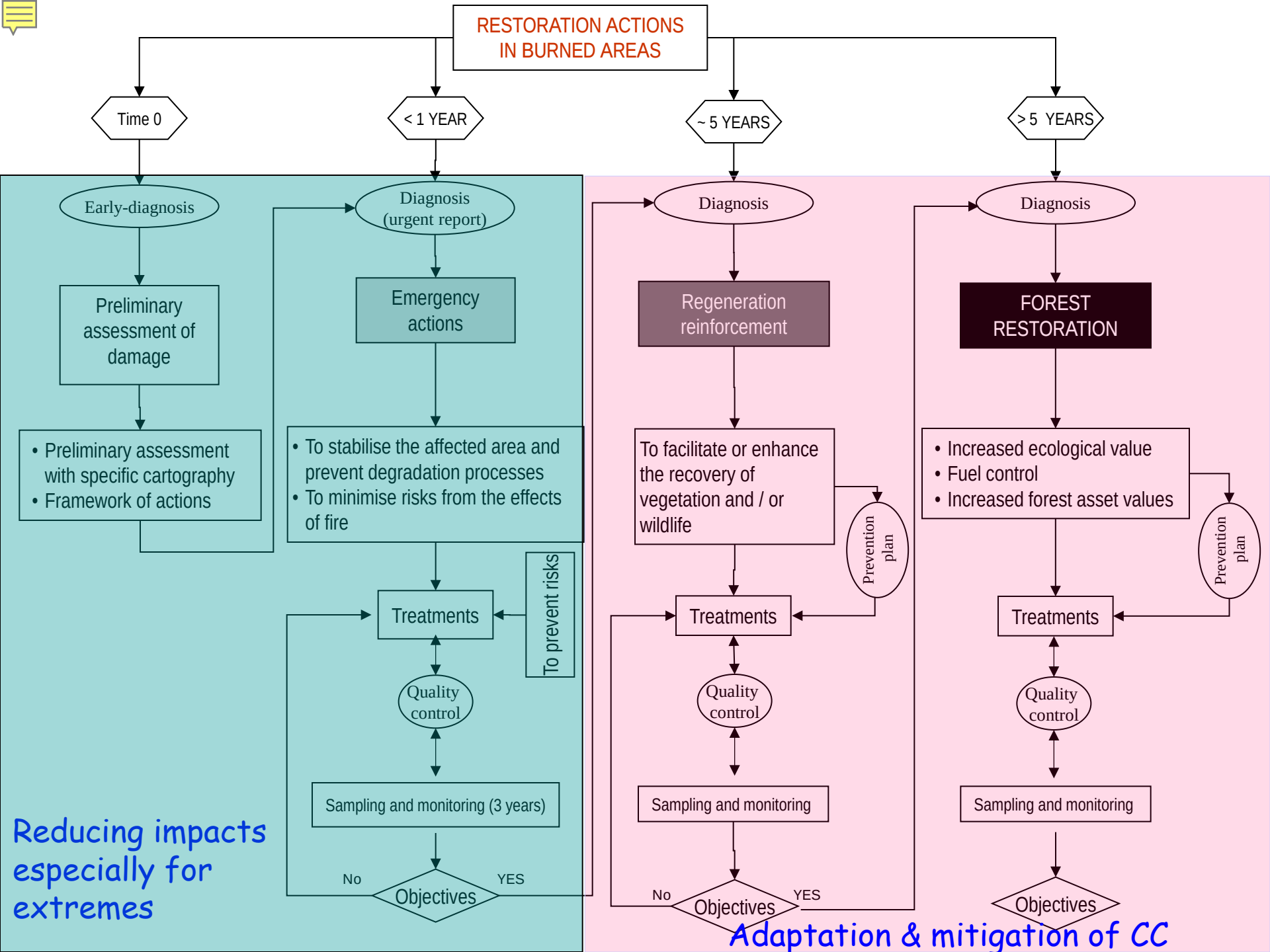
- **Previously degraded lands by other pressures**
(overgrazing, cultivation-abandonment, fuelwood & timber exploitation, charcoal production – including uprooting of sclerophyllous species)

- **Oldfields**

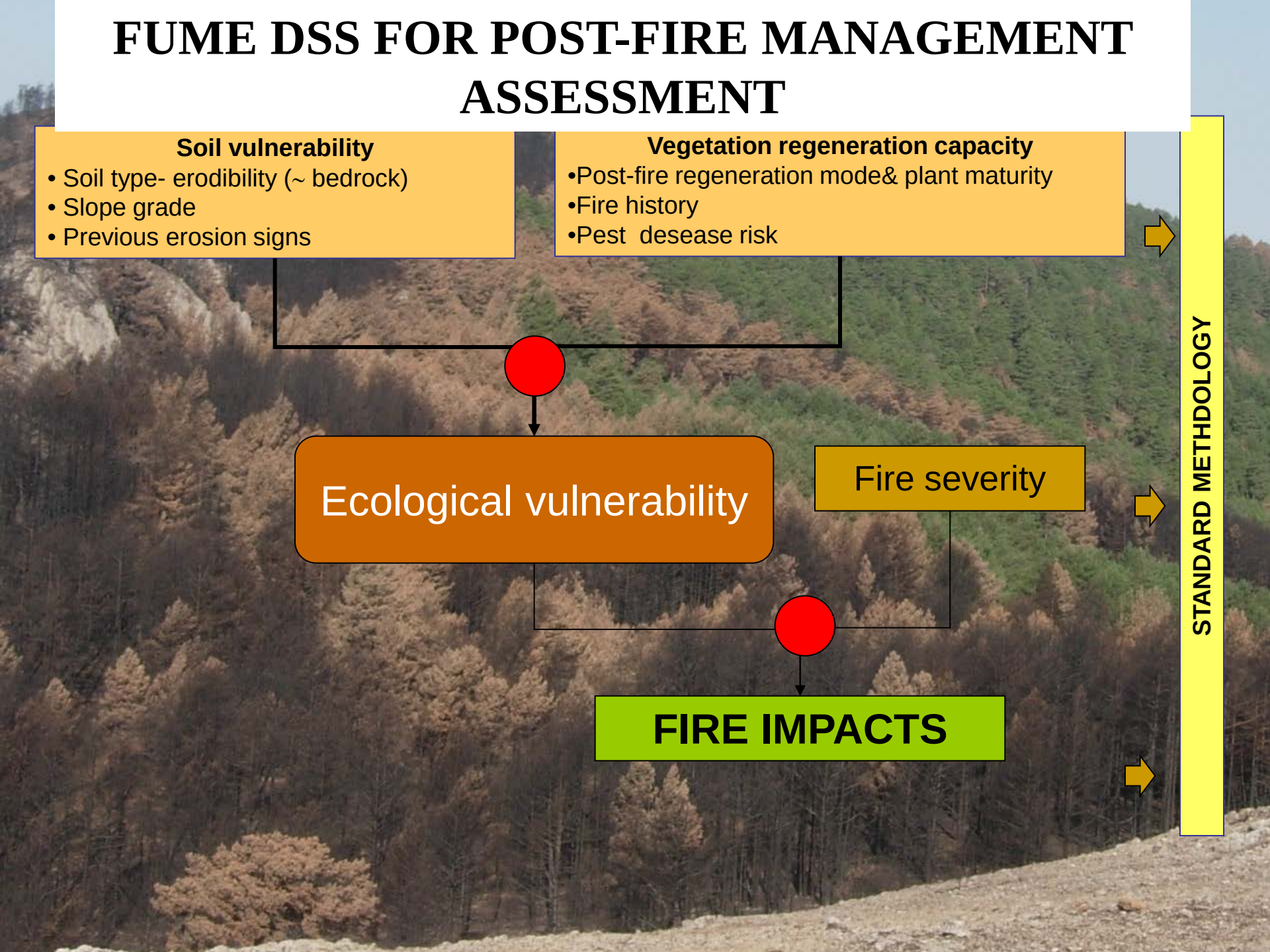
- **Plant communities dominated by obligate seeders**

- **Erodible soils & steep slopes**
Often developed on soft substrates: marls, granites, shales,..

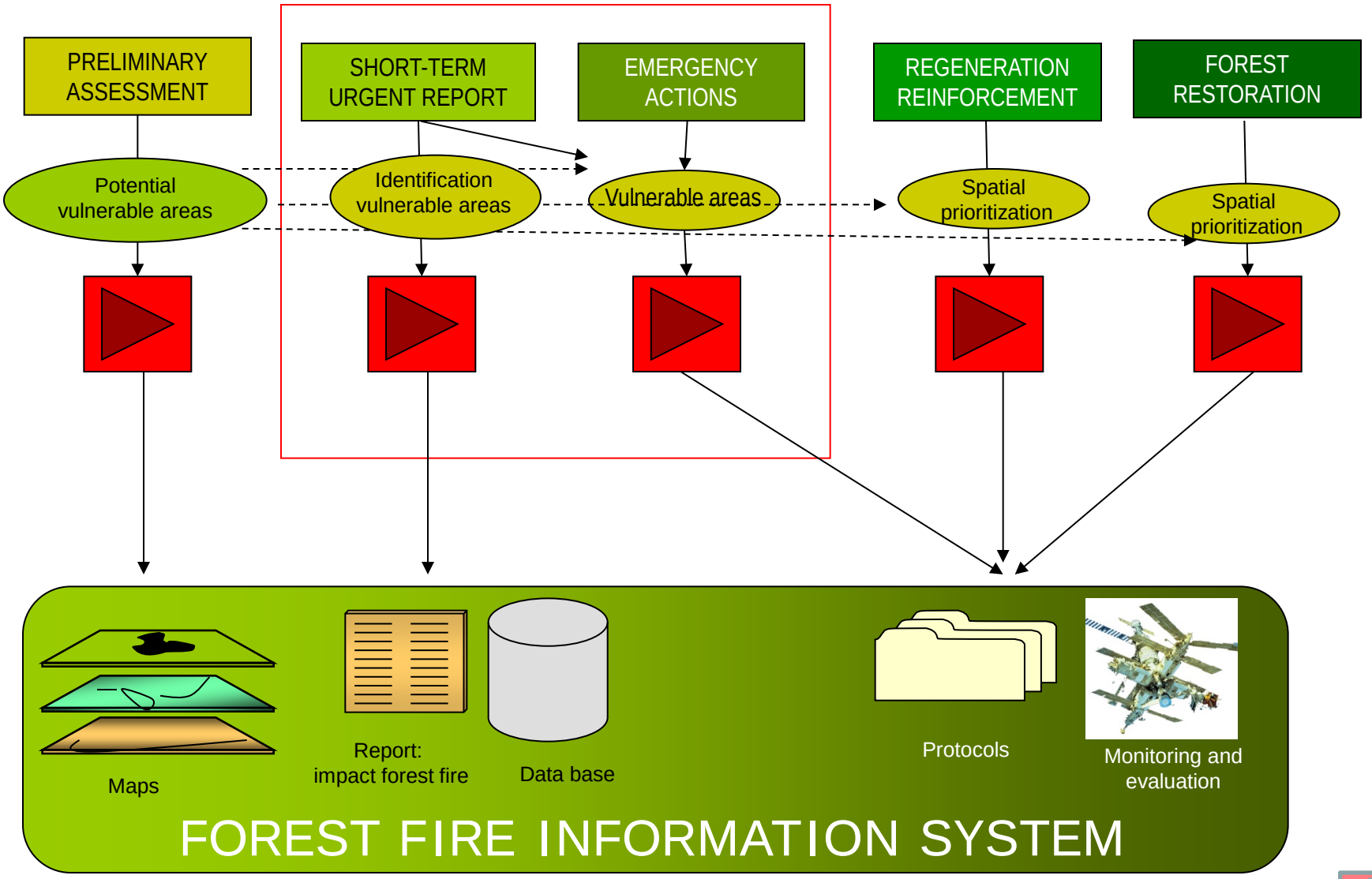
- **Areas suffering recurrent, short-interval fires**


RESTORATION ACTIONS IN BURNED AREAS
Time 0
< 1 YEAR
~ 5 YEARS
> 5 YEARS
Early-diagnosis
Preliminary assessment of damage
• Preliminary assessment with specific cartography
• Framework of actions
Diagnosis (urgent report)
Emergency actions
• To stabilise the affected area and prevent degradation processes
• To minimise risks from the effects of fire
To prevent risks
Treatments
Quality control
Sampling and monitoring (3 years)
No
Objectives
YES
Reducing impacts especially for extremes
Diagnosis
Regeneration reinforcement
To facilitate or enhance the recovery of vegetation and / or wildlife
Prevention plan
Treatments
Quality control
Sampling and monitoring
No
Objectives
YES
Diagnosis
FOREST RESTORATION
• Increased ecological value
• Fuel control
• Increased forest asset values
Prevention plan
Treatments
Quality control
Sampling and monitoring
Objectives
Adaptation & mitigation of CC

FUME DSS FOR POST-FIRE MANAGEMENT ASSESSMENT

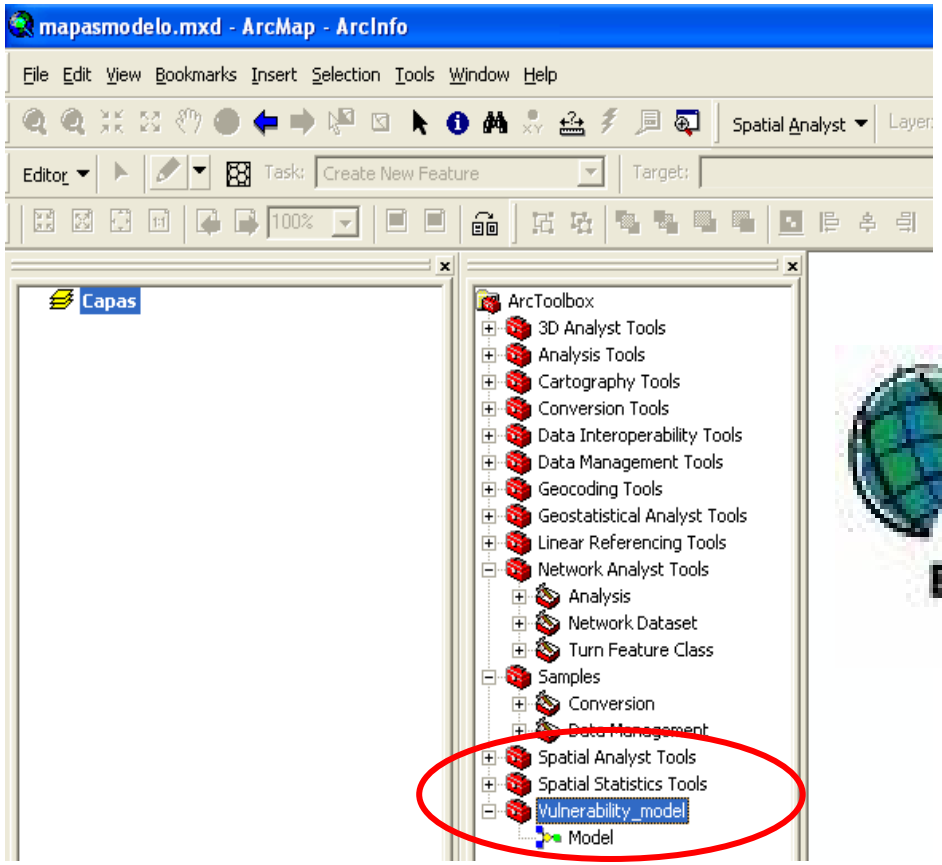


POST-FIRE DECISION SUPPORT SERVICE



PRELIMINARY ASSESSMENT OF POTENTIAL ECOLOGICAL IMPACTS

MAPPING EVALUATION[1]

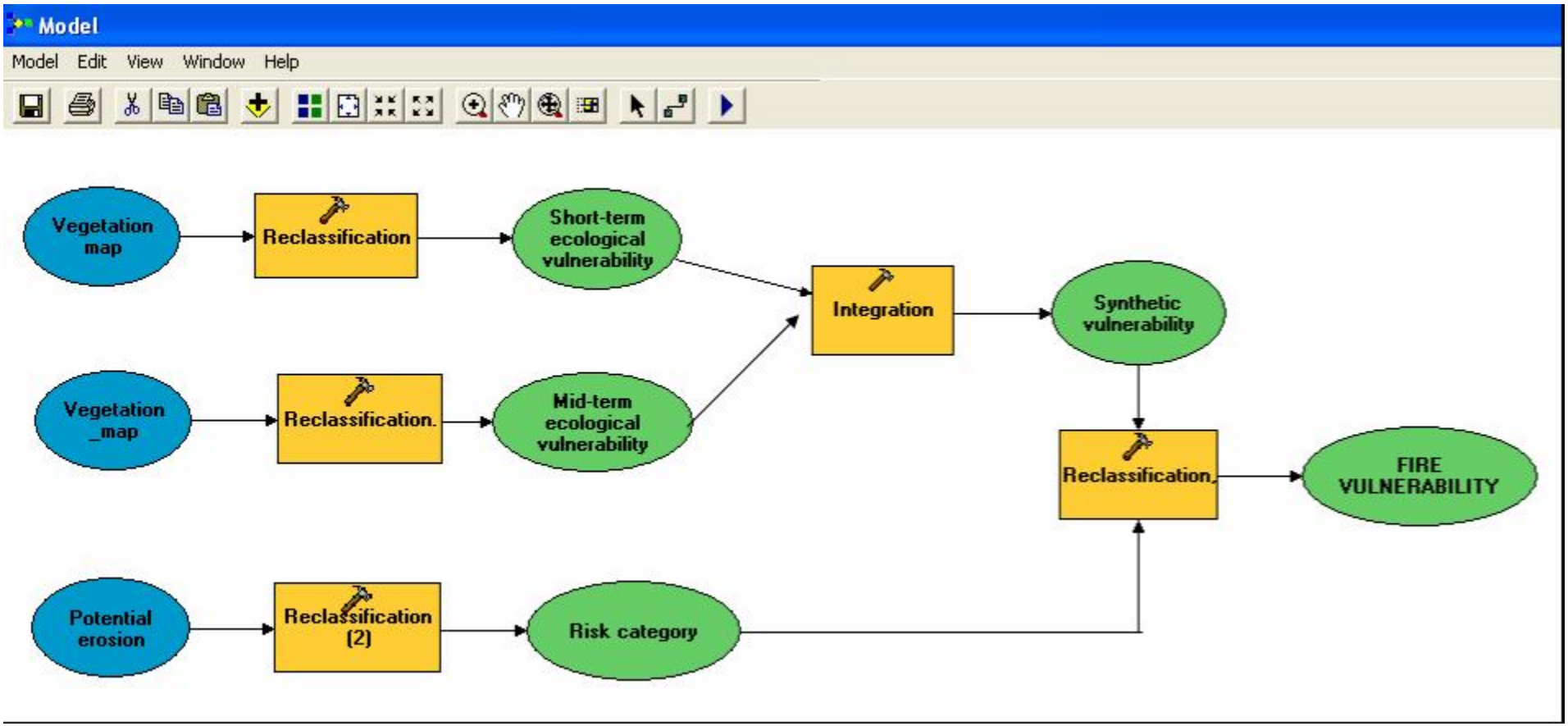


in ArcGis

ESRI ArcGIS

[1]Adapted from Duguy, B., Alloza, J. A., Baeza, M. J., De la Riba, J., Echeverría, M. T., Ibarra, P., Llovet, J., Pérez-Cabello, F., Rovira, P., and Vallejo, V. R., 2012. Modelling the ecological vulnerability to forest fires in Mediterranean ecosystems using geographic information technologies. Environmental Management, doi 10.1007/s00267-012-9933-3: 1-15.

Example in ArcGis Model Builder



First step: Reclassification vegetation types according to their physiognomy (forest/shrubland), tree canopy cover (if present), tree layer maturity and the post-fire reproductive strategy (resprouters/seeders)

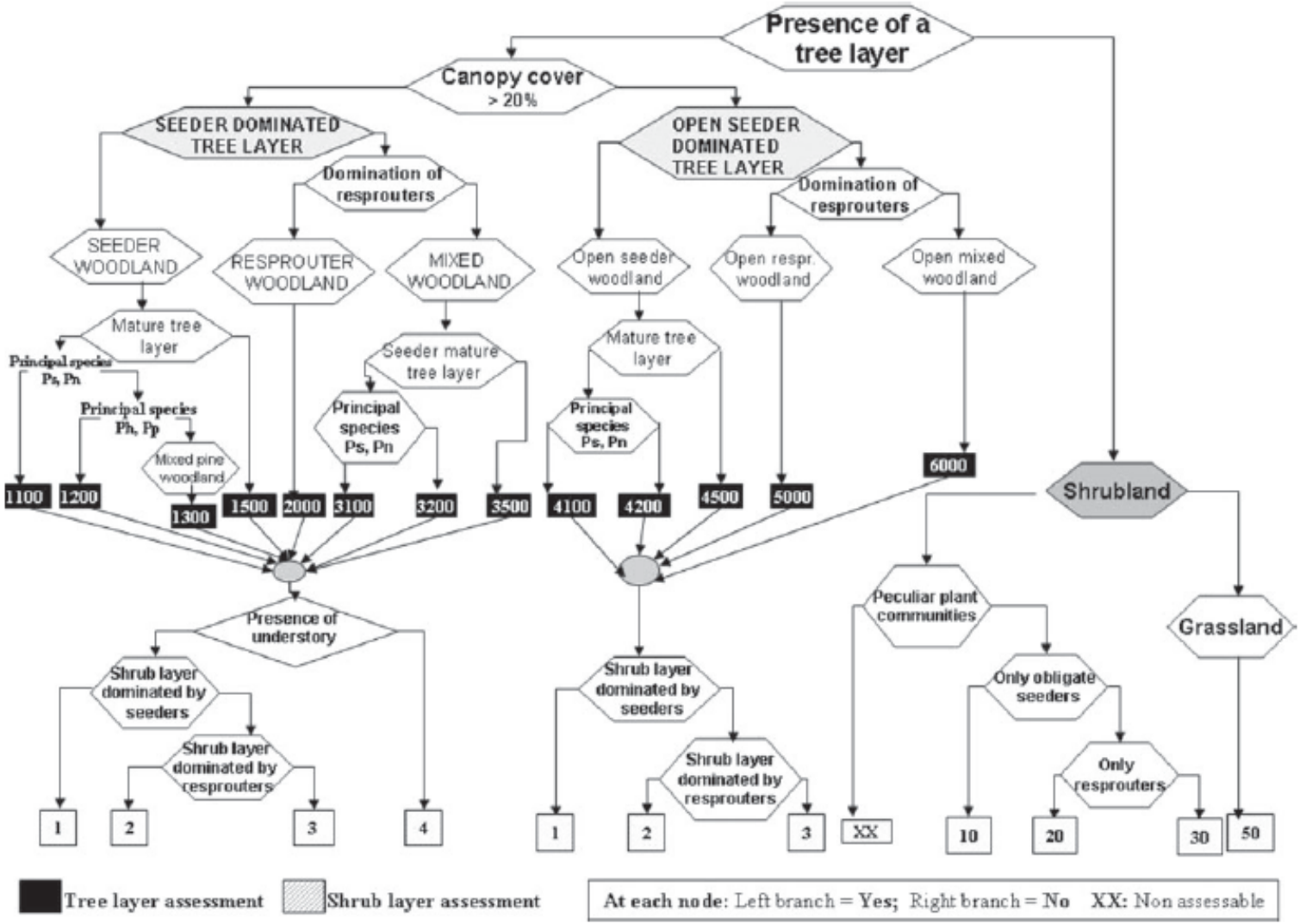


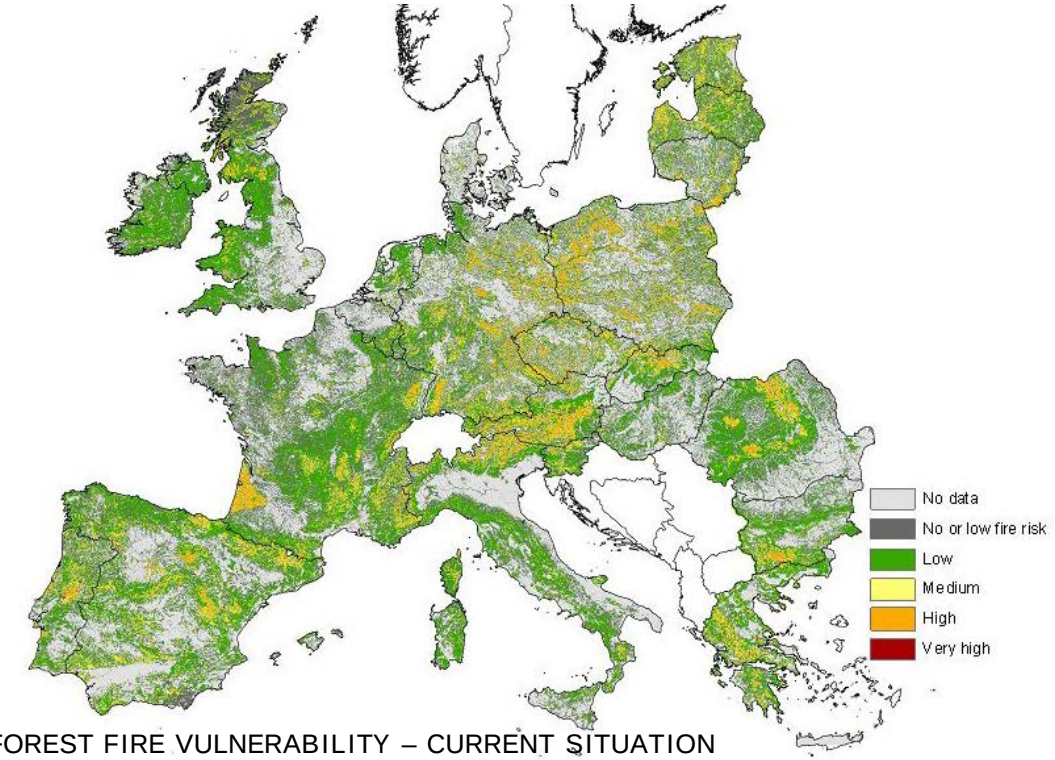
Fig. 2 Scheme for the classification of plant communities into vegetation types. (Ps: *Pinus sylvestris*; Pn: *Pinus nigra*; Ph: *Pinus halepensis*; Pp: *Pinus pinaster*) The codes attributed to the vegetation types correspond to those given in Appendices B and C (Electronic supplementary material). *For shrublands*: 10: seeder-dominated; 20: resprouter-dominated; 3: mixed *Vegetation types with a tree layer*: The first 3 digits of the code appear in the black boxes; the 4th digit, informing about the shrub layer (1: seeder-dominated; 2: resprouter-dominated; 3: mixed), appears in the last row

Duguy et al 2012

Third step: Environmental risk integration

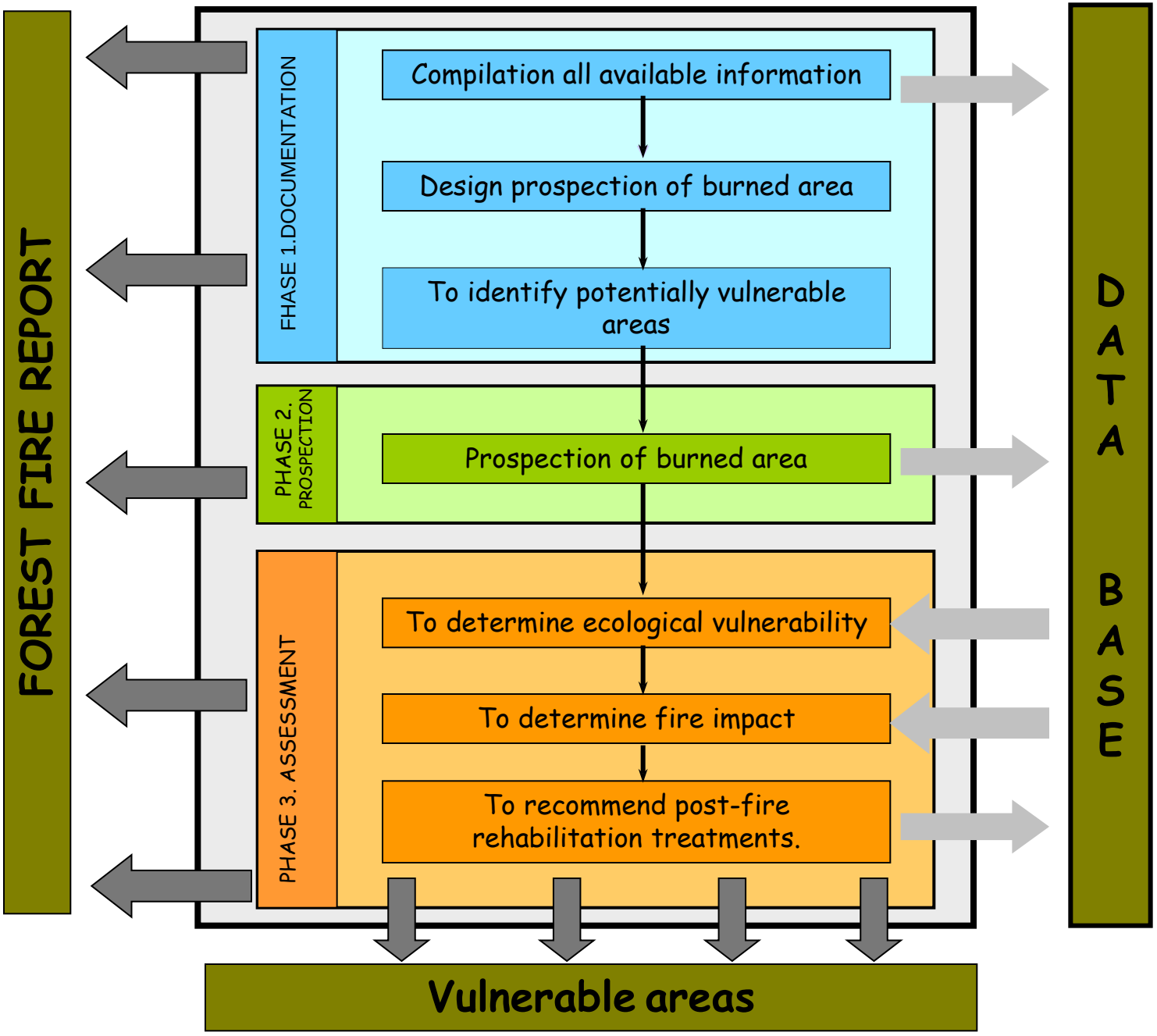
Fire vulnerability

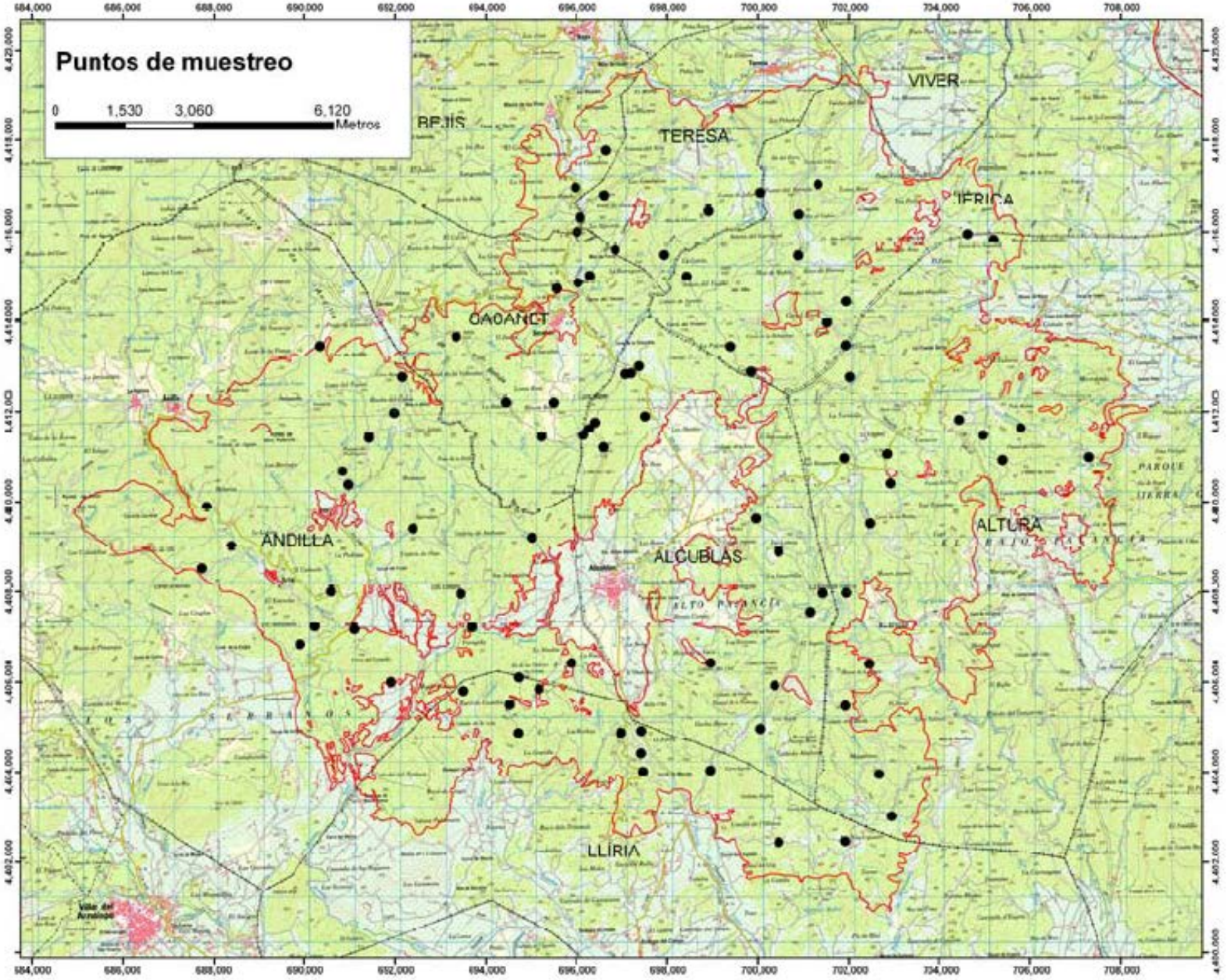
		Erosion risk			
		Very high	*High*	*Medium*	*Low*
Synthetic Vulnerability	*Very high*	*Very high*	*Very high*	*High*	*High*
	High	*Very high*	*High*	*High*	*Medium*
	Medium	*High*	*High*	*Medium*	*Medium*
	Low	*High*	*Medium*	*Medium*	*Low*



FOREST FIRE VULNERABILITY – CURRENT SITUATION

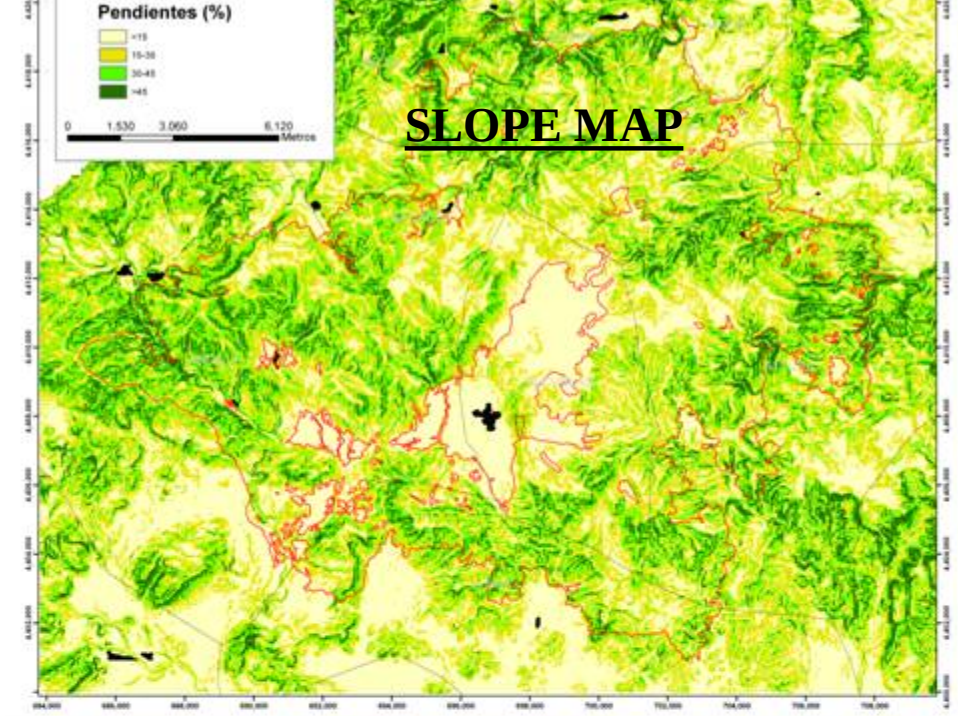
Fire impact protocol



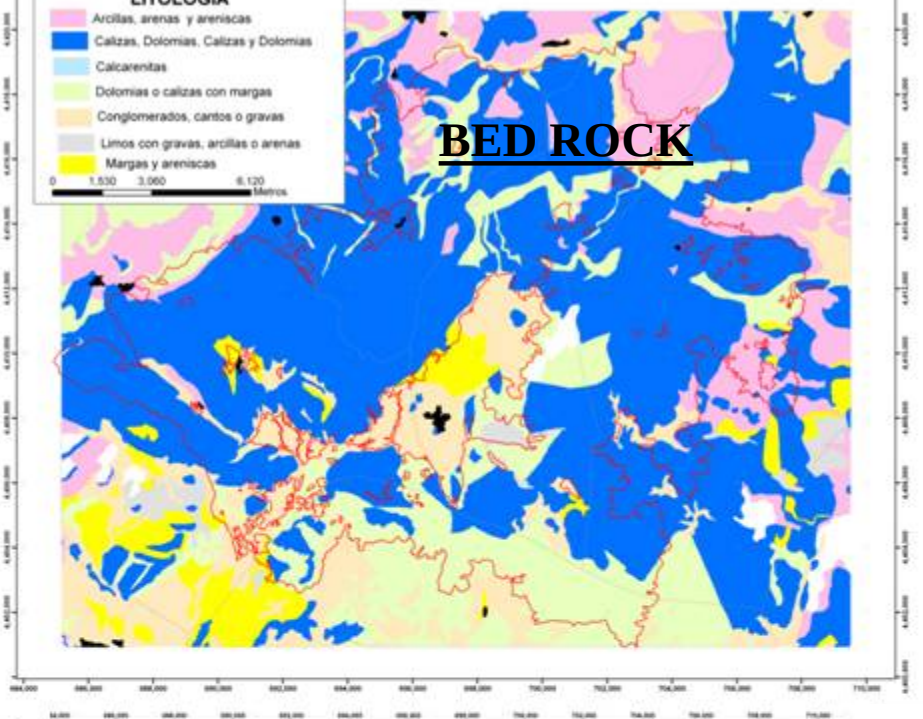


Andilla fire: 29 june 2012, 20,000 ha

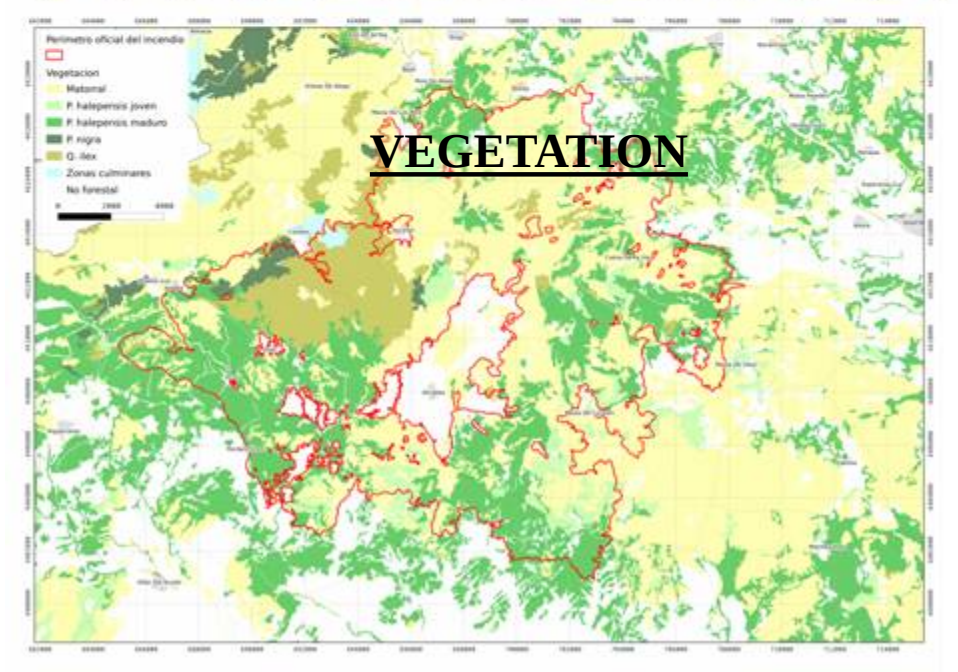
Sampling points



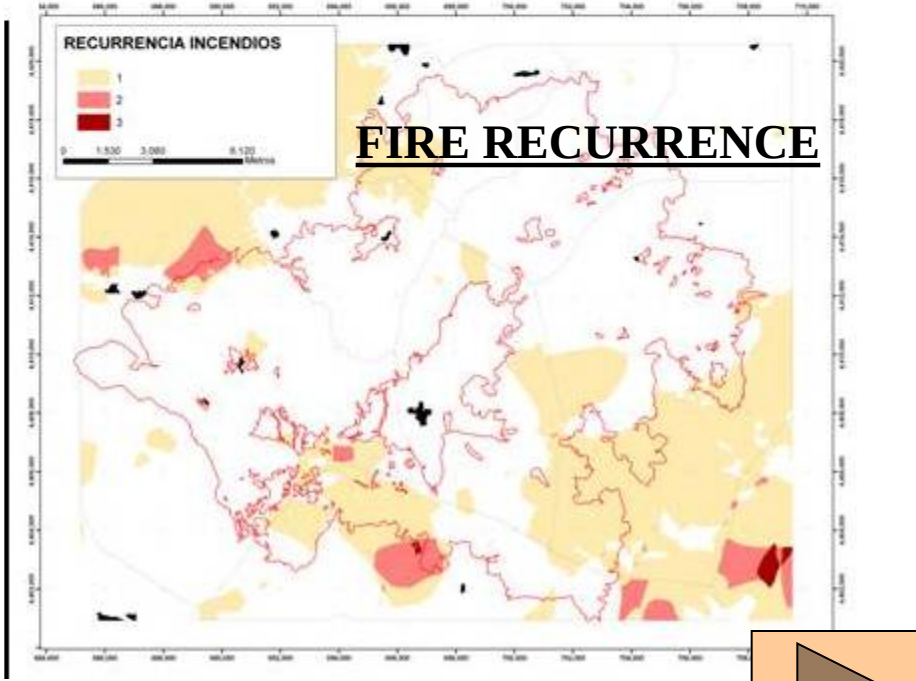
SLOPE MAP



BED ROCK



VEGETATION



FIRE RECURRENCE

Scale 1:50.000

POSTFIRE-DSS

VEGETATION REGENERATION CAPACITY

Presence of non serotinuos pines	Abundance of young serotinuos pines	Recovery rate of resprouster species	Nº of fires in the last 20 years
Low Medium Height	Low Medium Height	Low Medium Height	0 1 >=2

ENVIRONMENTAL RISKS

Soil erosion

- ☐ Risk of intense precipitation
- ☐ Steep slopes
- ☐ Erodible soils
- ☐ Dominance of seeders

Other risks

- ☐ Tree failing
- ☐ Pest propagation
- ☐ Others

FIRE SEVERITY

Soil severity

- ☐ Consumption organic horizon
- ☐ White ash

Vegetation severity

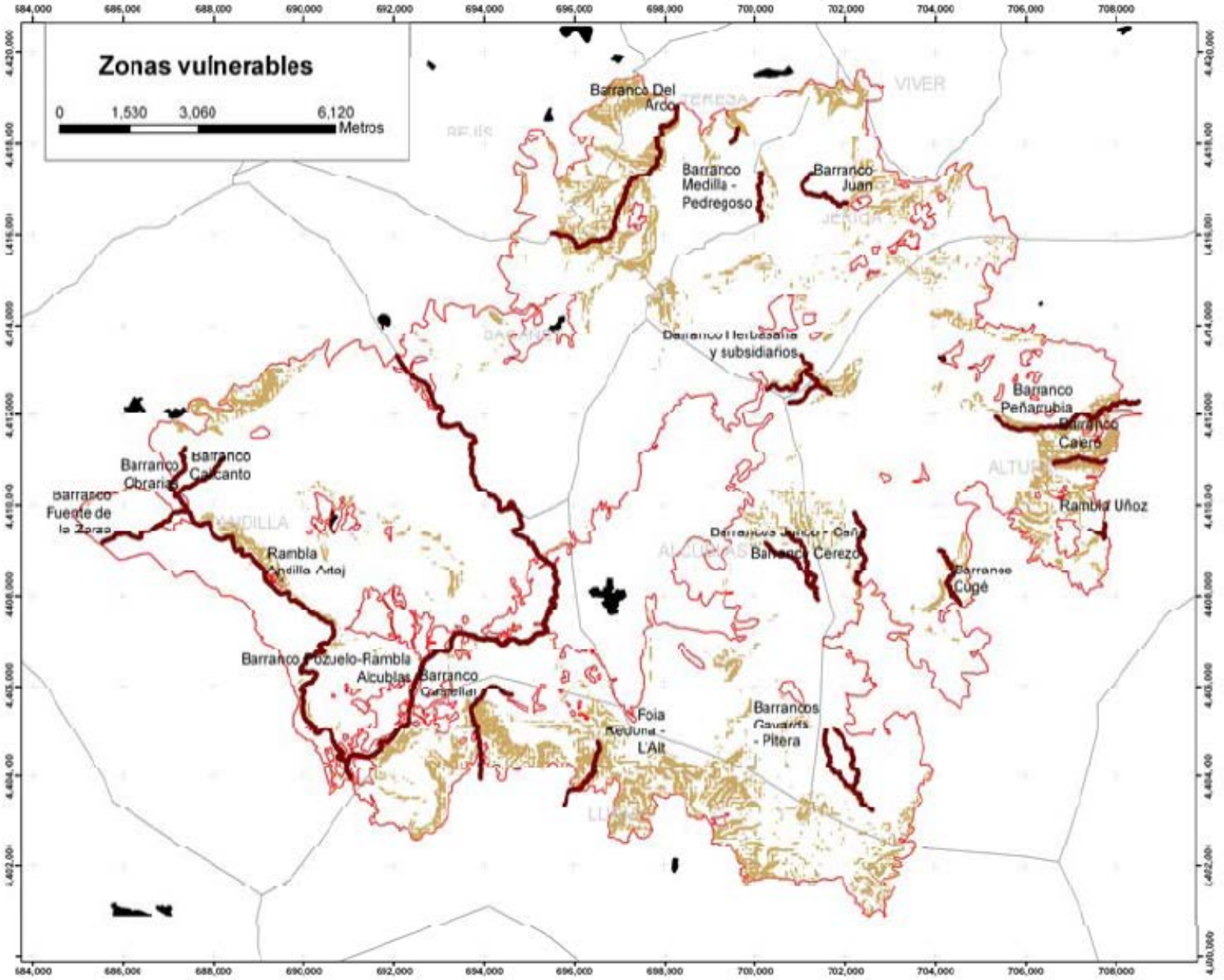
- ○ Unaltered (remains green)
- ○ Partially affected (dry)
- ○ Consumed

Evaluation

Exit

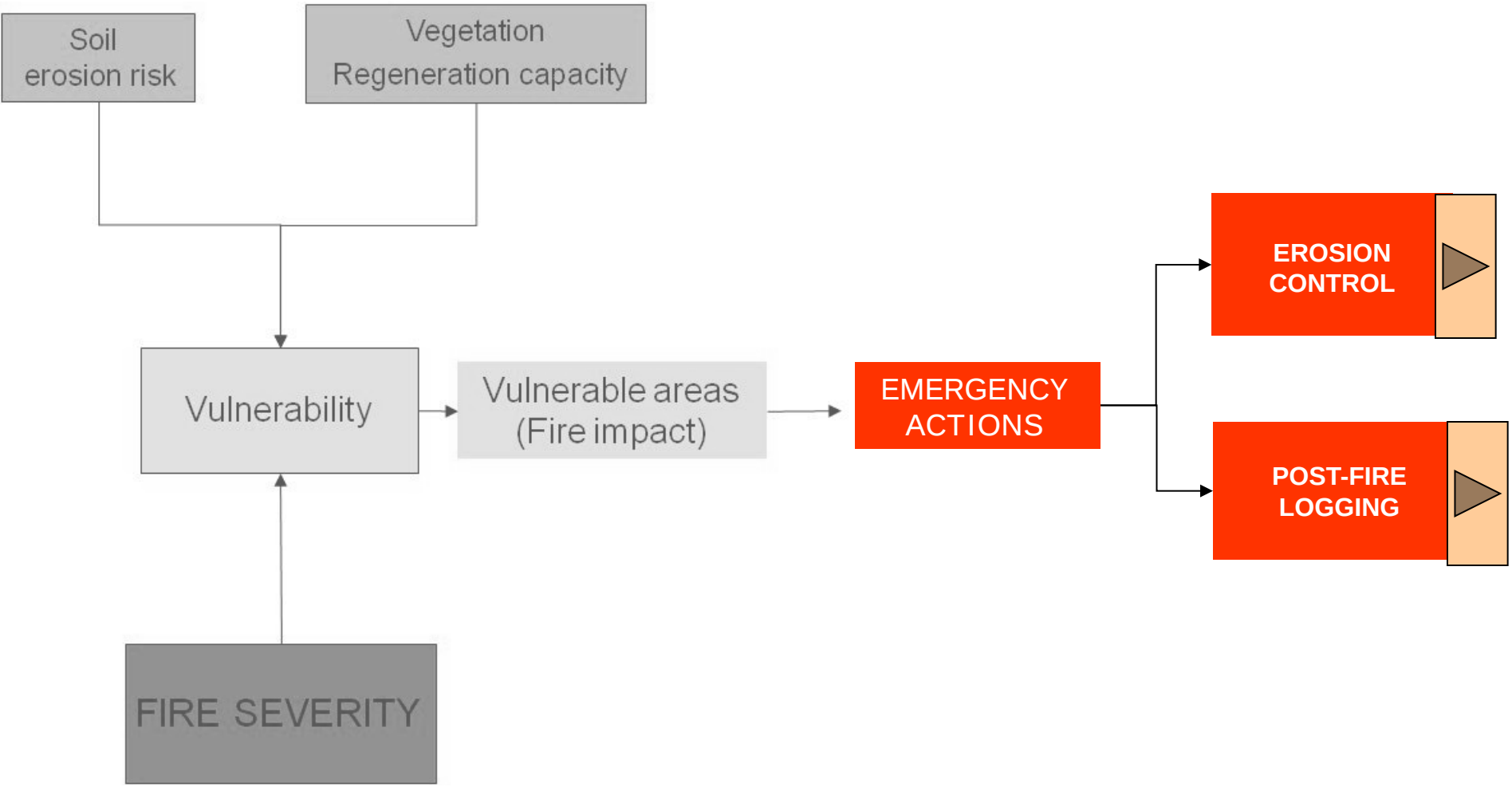
FUME

SEVENTH FRAMEWORK PROGRAMME

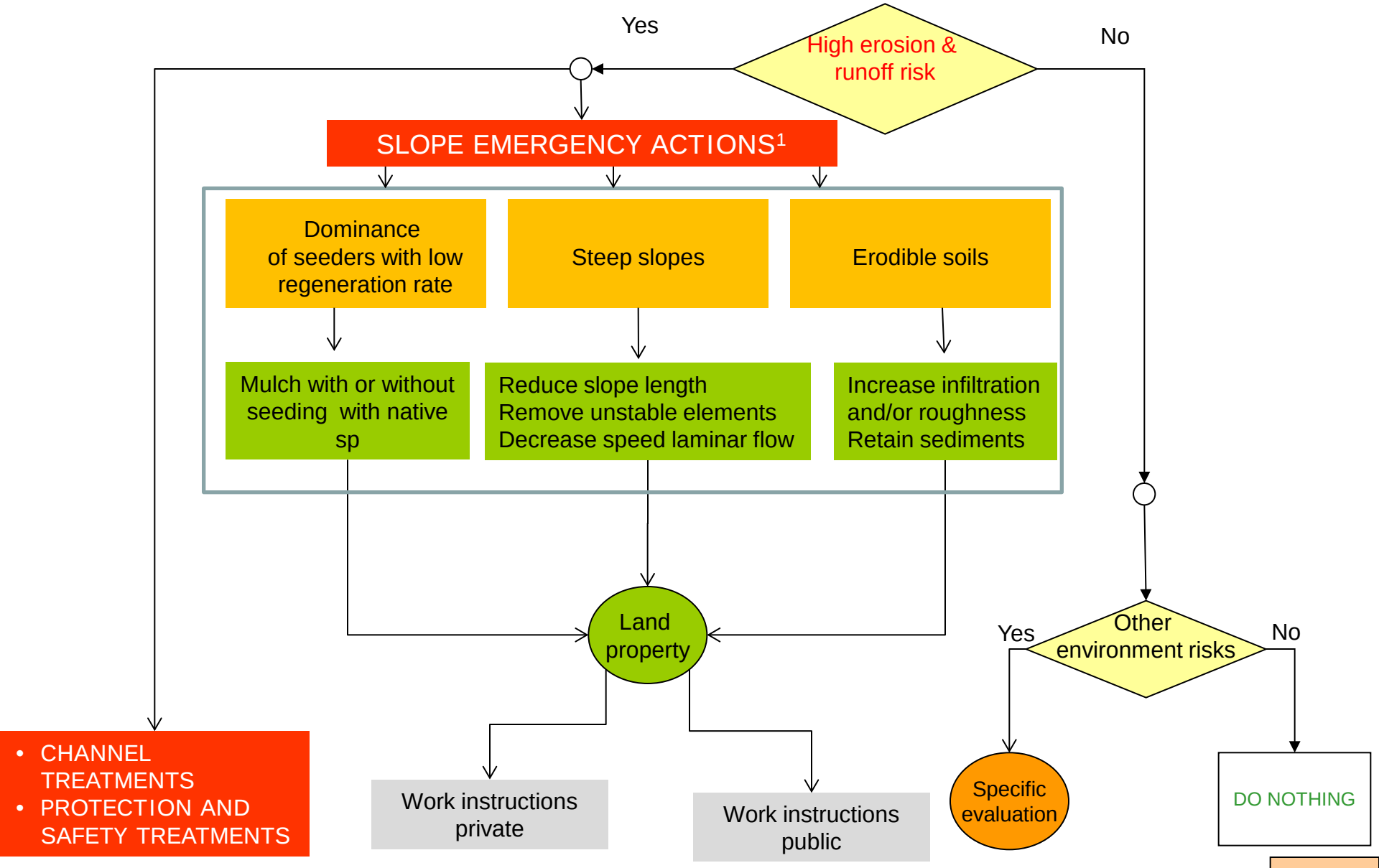


LOCATION OF MOST VULNERABLE AREAS

Fire impact protocol

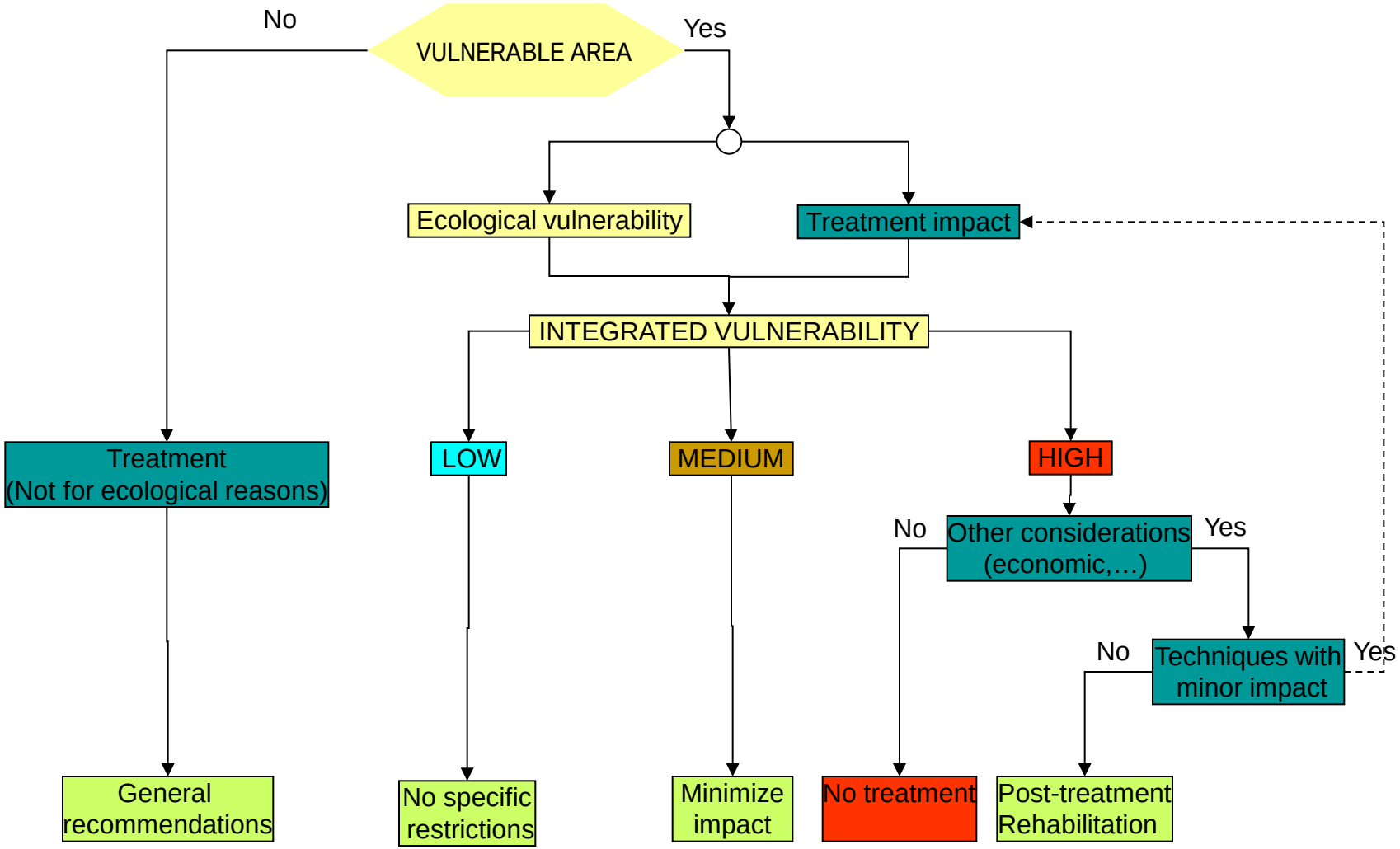


EMERGENCY ACTIONS

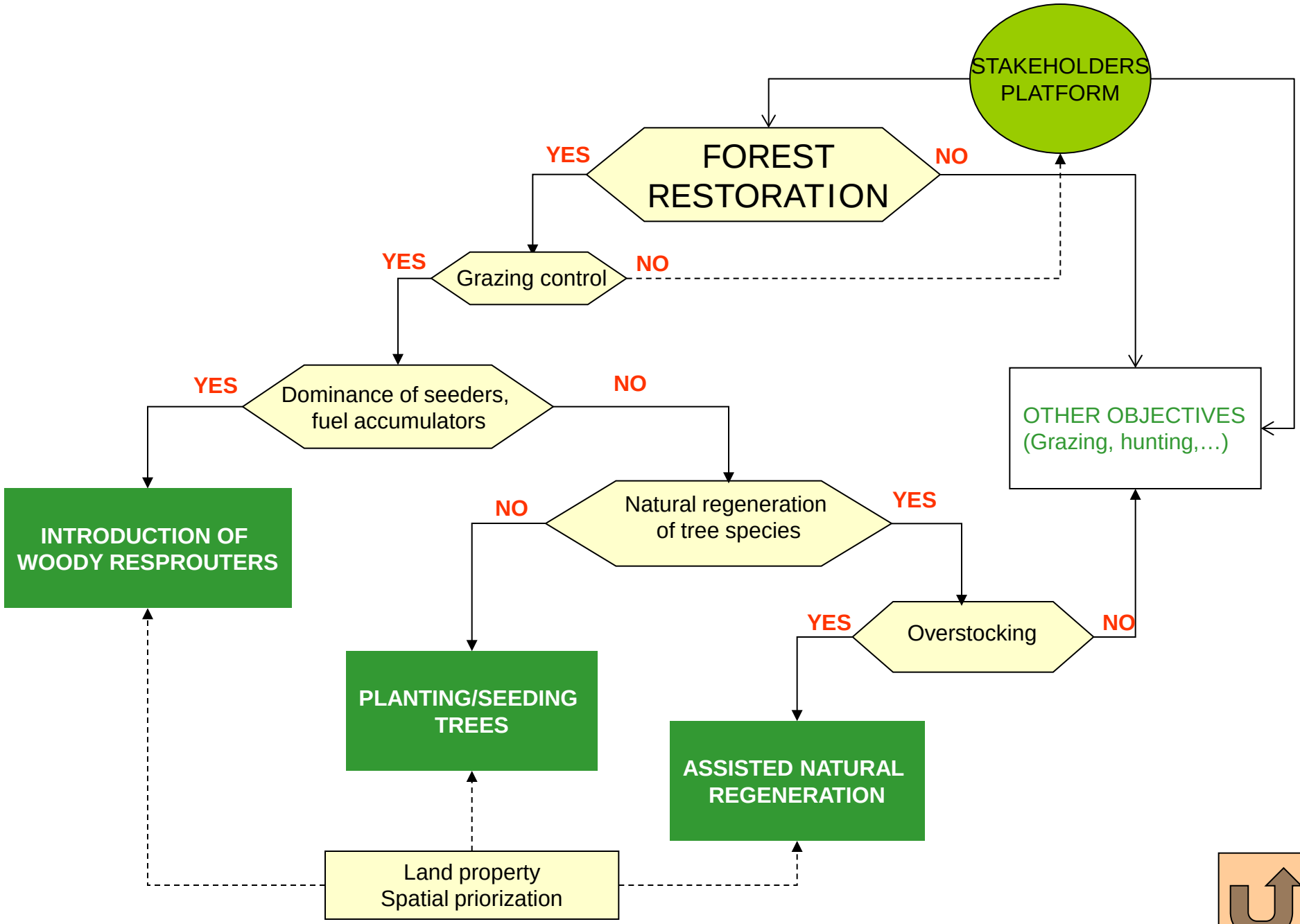


[1] Burned Area Emergency Response Treatments Catalog
http://www.fs.fed.us/eng/pubs/pdf/BAERCAT/lo_res/TOContents.pdf

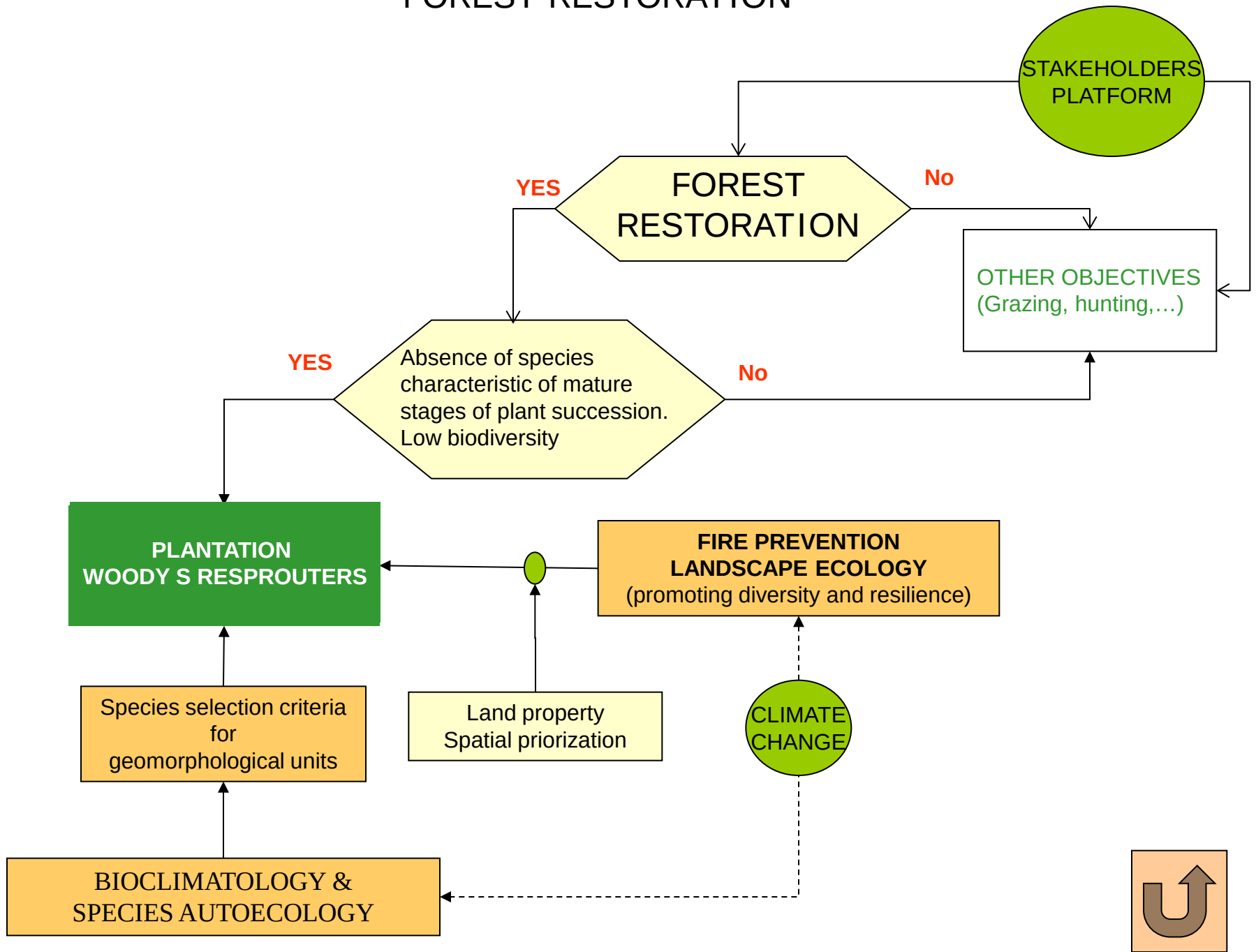
POST-FIRE LOGGING



REGENERATION REINFORCEMENT



FOREST RESTORATION



SPECIFIC REGULATION ON POST-FIRE MANAGEMENT

European & Mediterranean Basin Countries

Country	Interdiction of land use change	Salvage logging	Soil erosion mitigation and flood prevention	Forest regeneration (planting or seeding)	Management of natural regeneration	Grazing control
Bulgaria	x			x		x
Cyprus				x		
Estonia				x		
France	x	x	x	x		
Greece	x	x	x	x		x
Israel						x
Italy	x	x		x		x
Latvia				x	x	x
Lithuania	x	x		x	x	x
Morocco	x		x			x
Poland	x			x	x	x
Portugal	x*	x	x	x		x
Romania	x	x	x	x	x	
Spain	x	x	x		x	x
Slovenia				x		
Switzerland (Ticino)	x					
Tunisia						x
Turkey	x					

* for selected forest types (e.g. cork oak forest)

Mavsar et al., *2012*