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Priorities for the restoration of semiarid landscapes at different scales

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SER EUROPE SOCIETY FOR ECOLOGICAL RESTORATION

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Priorities for the restoration of semiarid landscapes at different scales

1. Plant
2. Community
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5. Region

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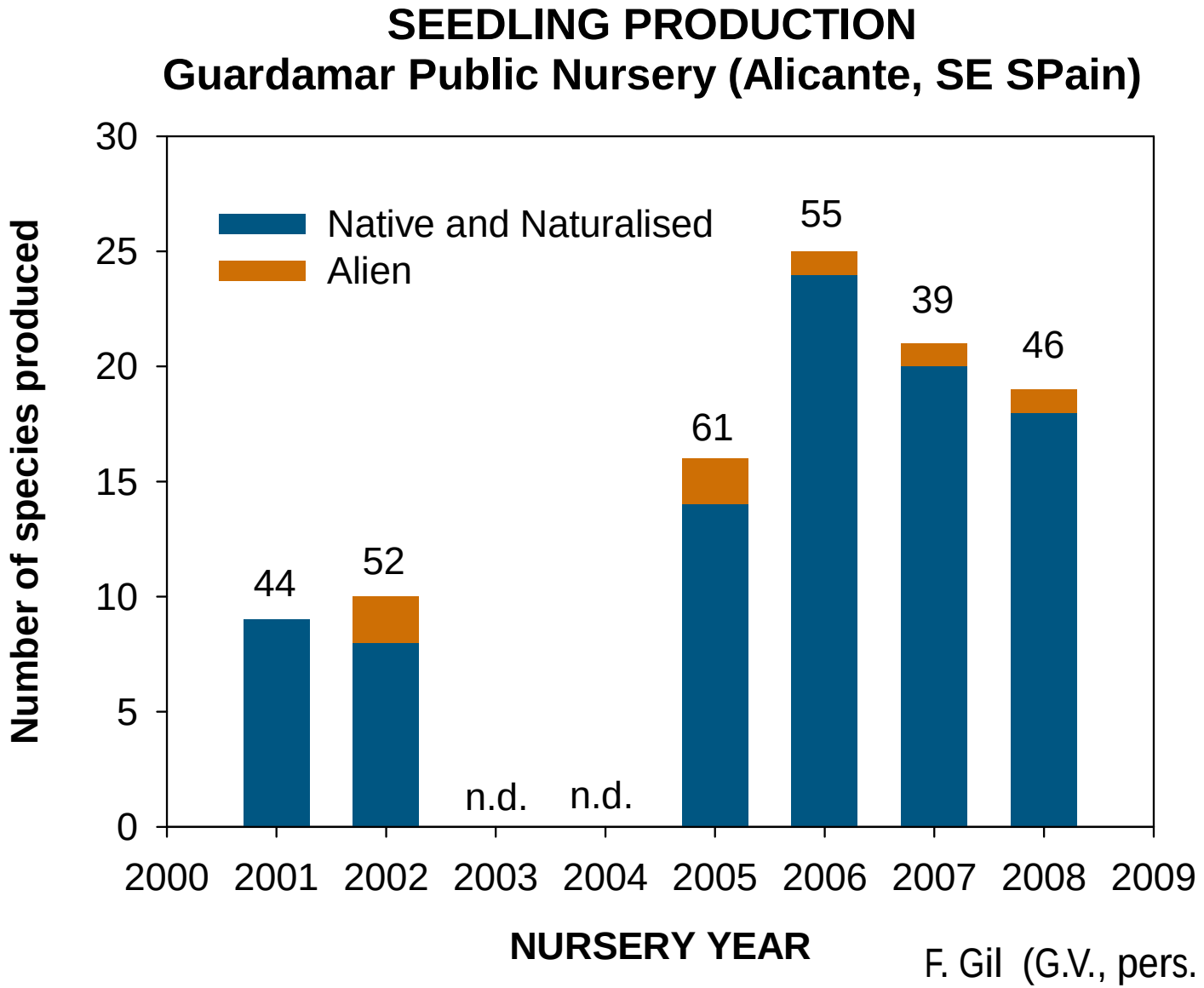
PLANT LEVEL PRIORITIES

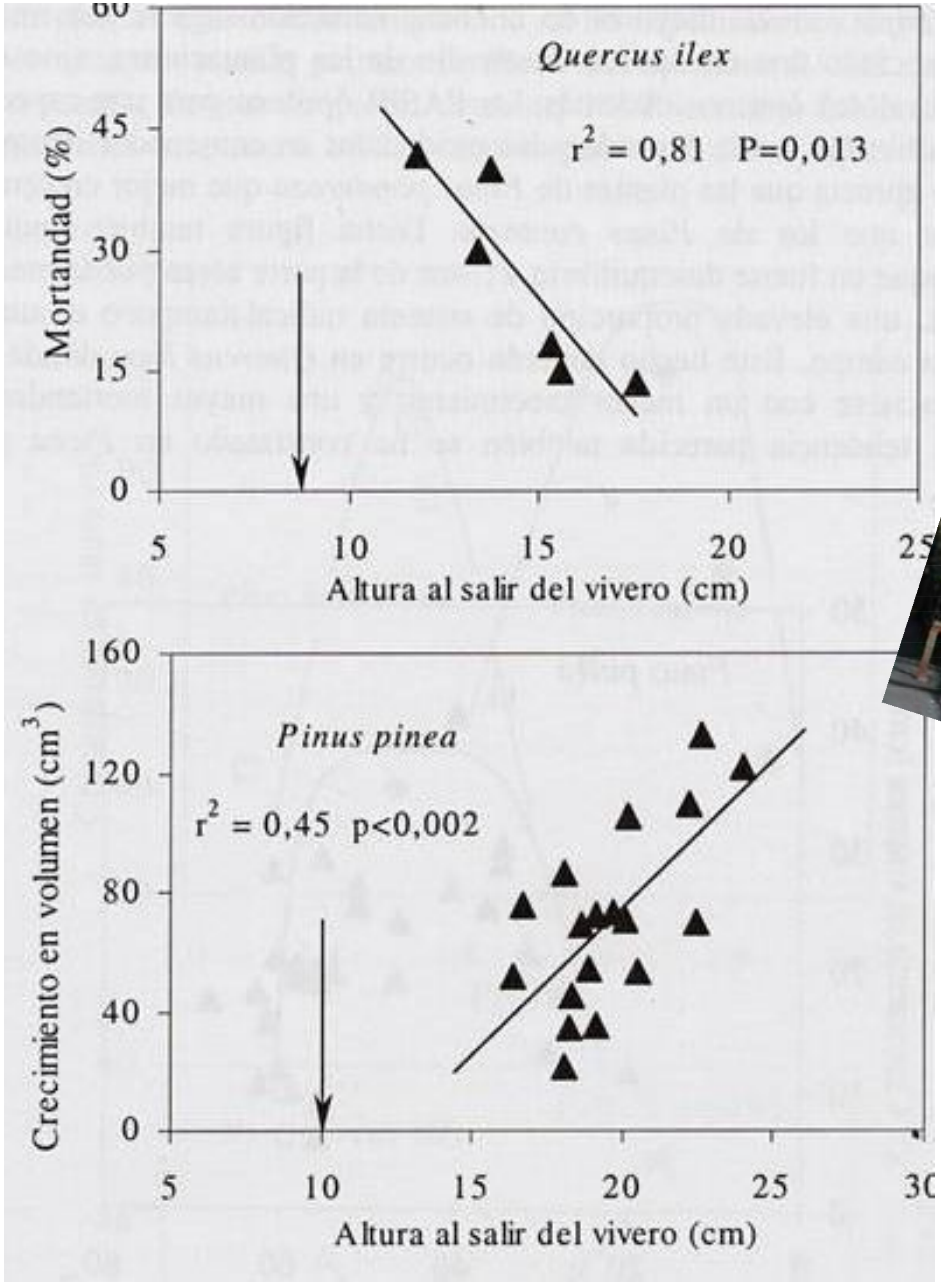
INCREASING NUMBER OF SPECIES PRODUCED; GENOTYPES?



F. Gil (G.V., pers. comm.)

PLANT LEVEL PRIORITIES

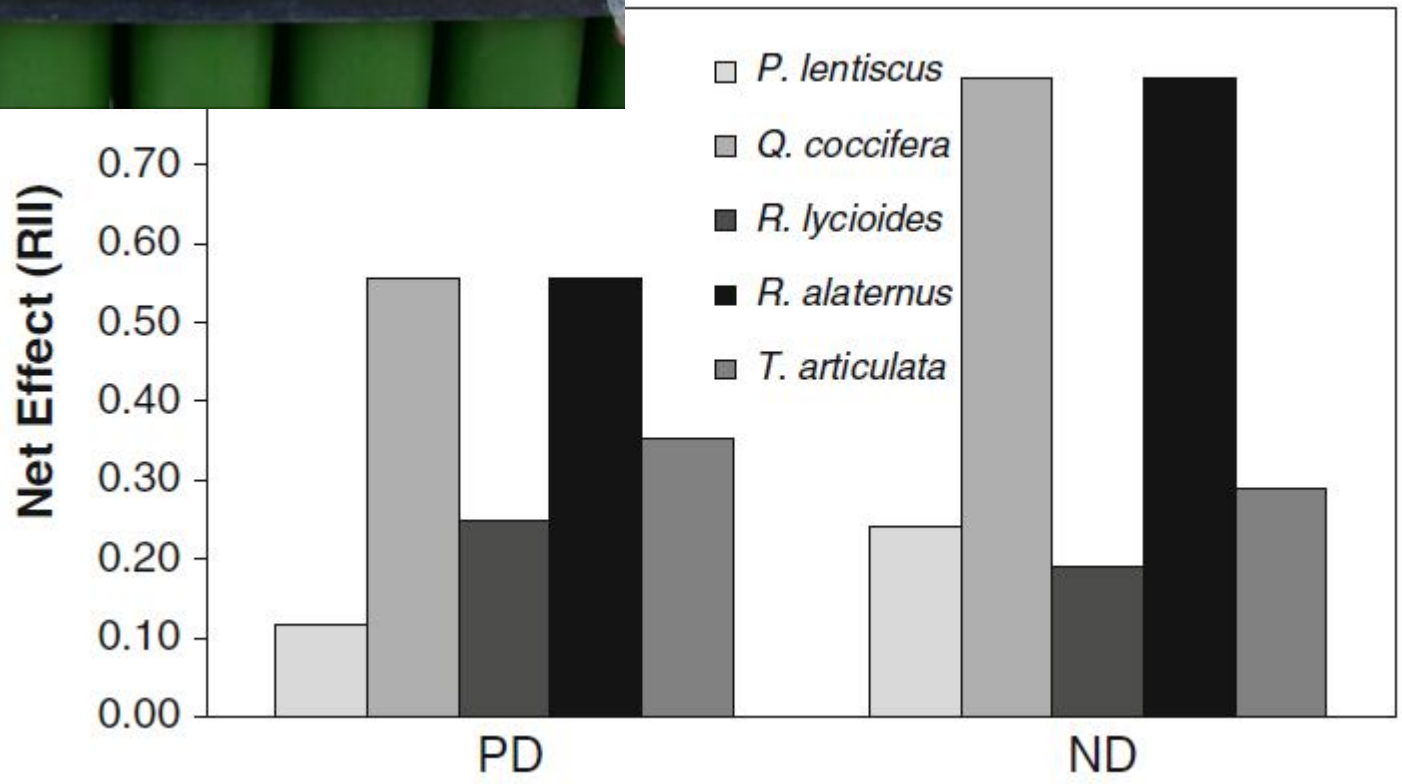
BEST SEEDLINGS ARE BIGGER



Villar (2003)

PLANT LEVEL PRIORITIES

BUT NOT ALWAYS

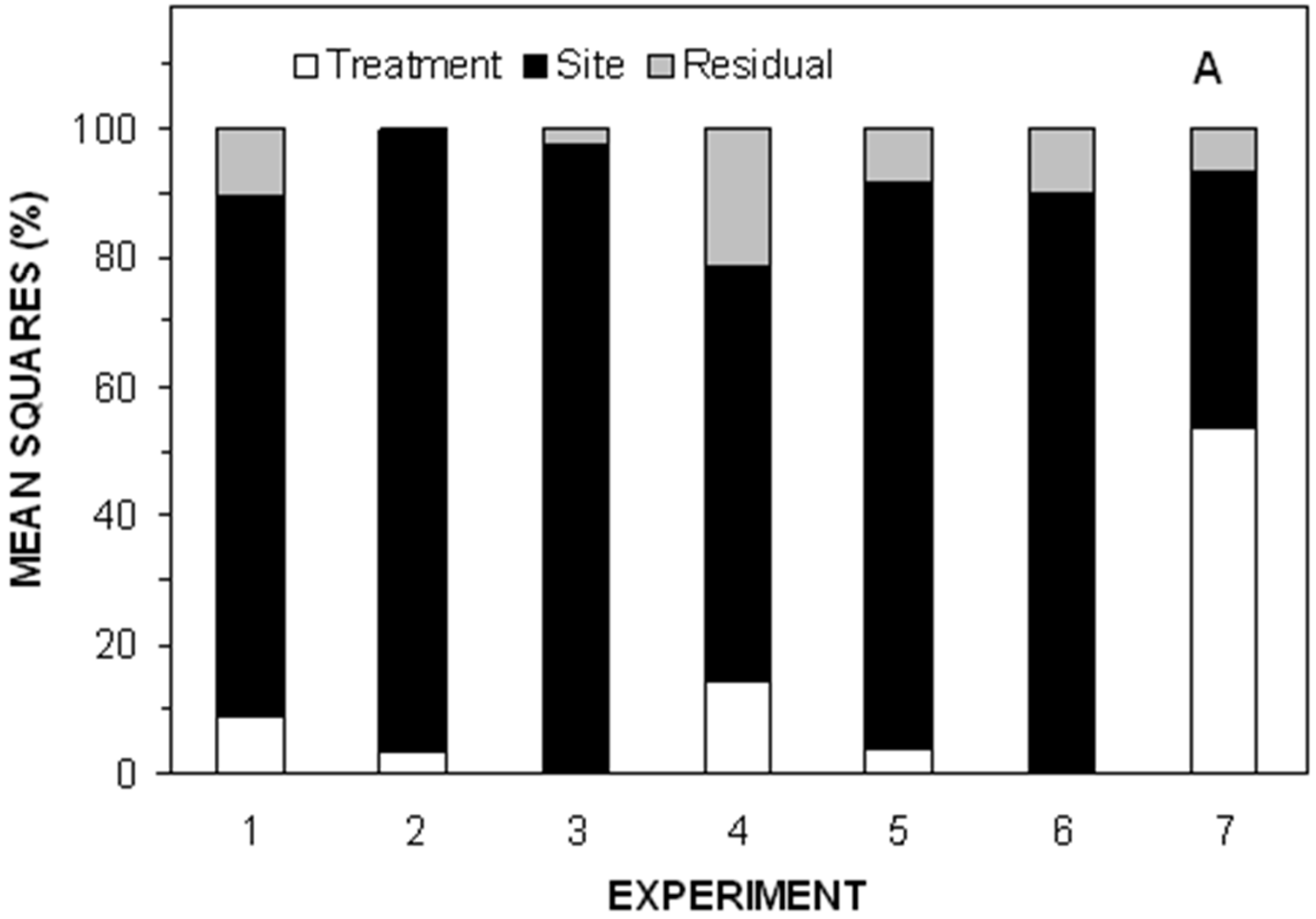


Cortina et al. (2013)

PLANT LEVEL PRIORITIES

PLANT-SITE INTERACTIONS ARE LARGELY UNKNOWN

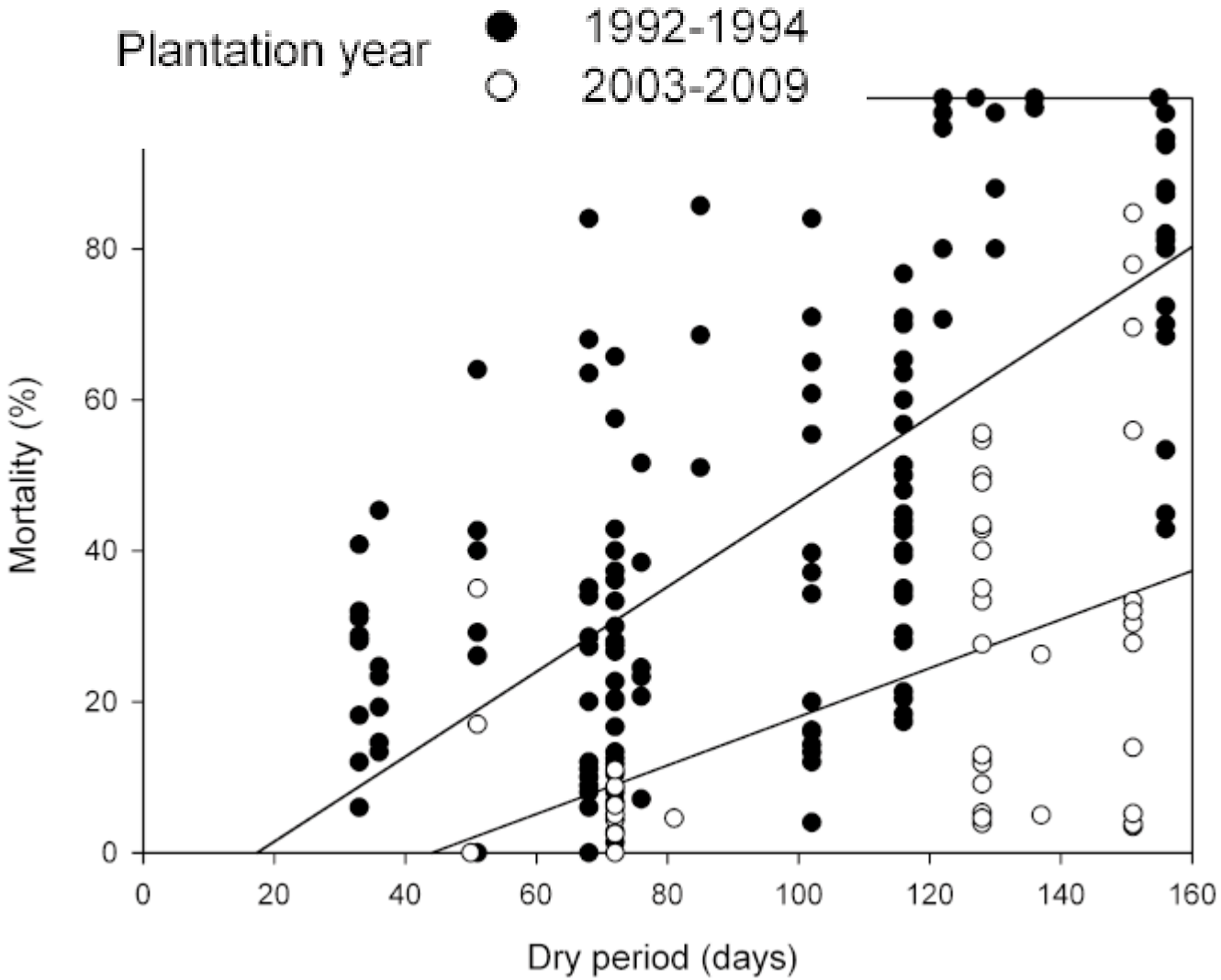
TREATMENT VS. SITE EFFECTS ON PLANT PERFORMANCE



Cortina et al. *J. Arid. Environ*. (2012)

PLANT LEVEL PRIORITIES

SEEDLING QUALITY + FIELD TECHNIQUES HIGHLY IMPROVED



Vallejo et al. (2012)

PLANT LEVEL PRIORITIES

ENOUGH INFO AT THIS SCALE TO CREATE KNOWLEDGE

PLANT LEVEL PRIORITIES

ENOUGH INFO AT THIS SCALE TO CREATE KNOWLEDGE

Recommendations for planting trees in arid areas

https://www.youtube.com/watch?v=tCik5Lco3eM

PLANT LEVEL PRIORITIES

While many scientific questions remain...

seedling quality and site preparation have substantially improved over the last decades

and lack of knowledge may not be a major deterrent of restoration success

Genotypes and plant-soil interactions should be priorities at this scale

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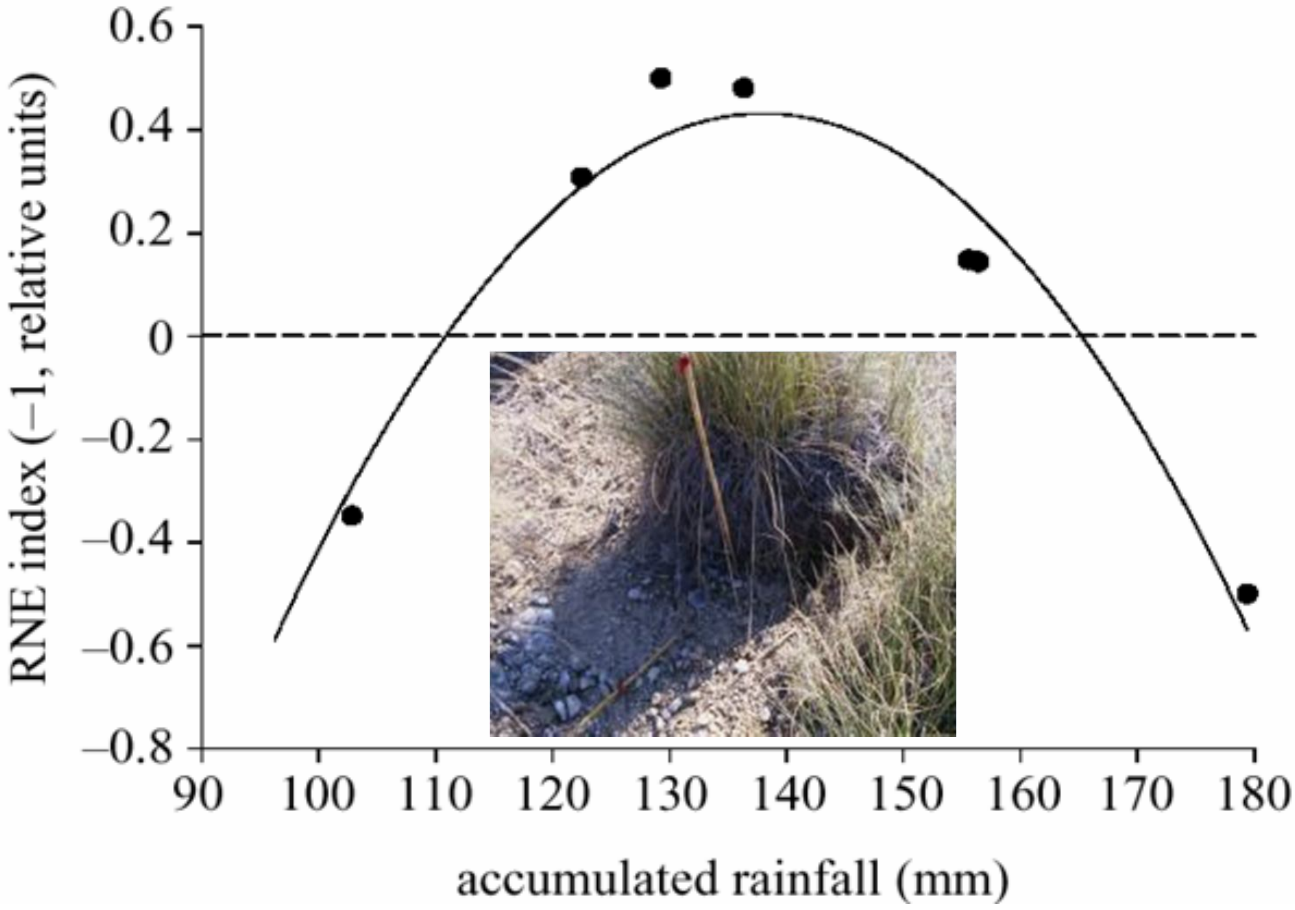
COMMUNITY LEVEL PRIORITIES

THE SIGN OF PAIRWISE INTERACTIONS DEPENDS ON SPECIES AND RESOURCE AVAILABILITY



POSITIVE

NEGATIVE

Maestre et al. (2004)

COMMUNITY LEVEL PRIORITIES

AND PAIRWISE INTERACTIONS ARE SIMPLIFIED SYSTEMS

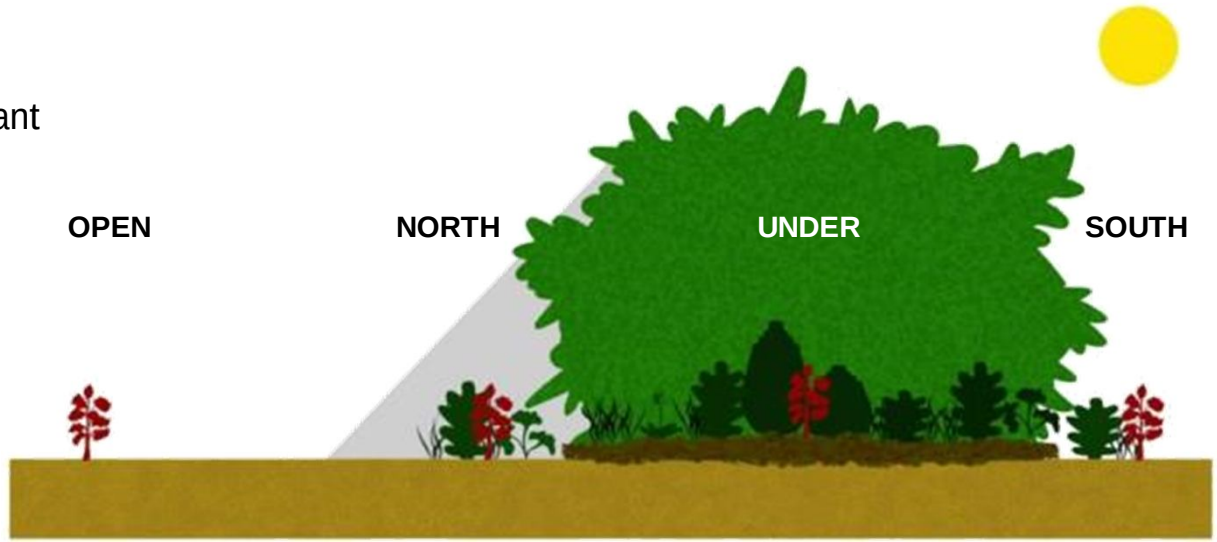
Seedling performance:

- Freezing stress (1st winter)
- Water use efficiency (^{13}C), integrated transpiration rate (^{18}O) and N source (^{15}N)
- Foliar C and N
- Survival and growth (2 years)

- 5 sites *Stipa tenacissima*
- 53 patches
- *Pistacia lentiscus* 1-year-old seedlings in 4 microsites

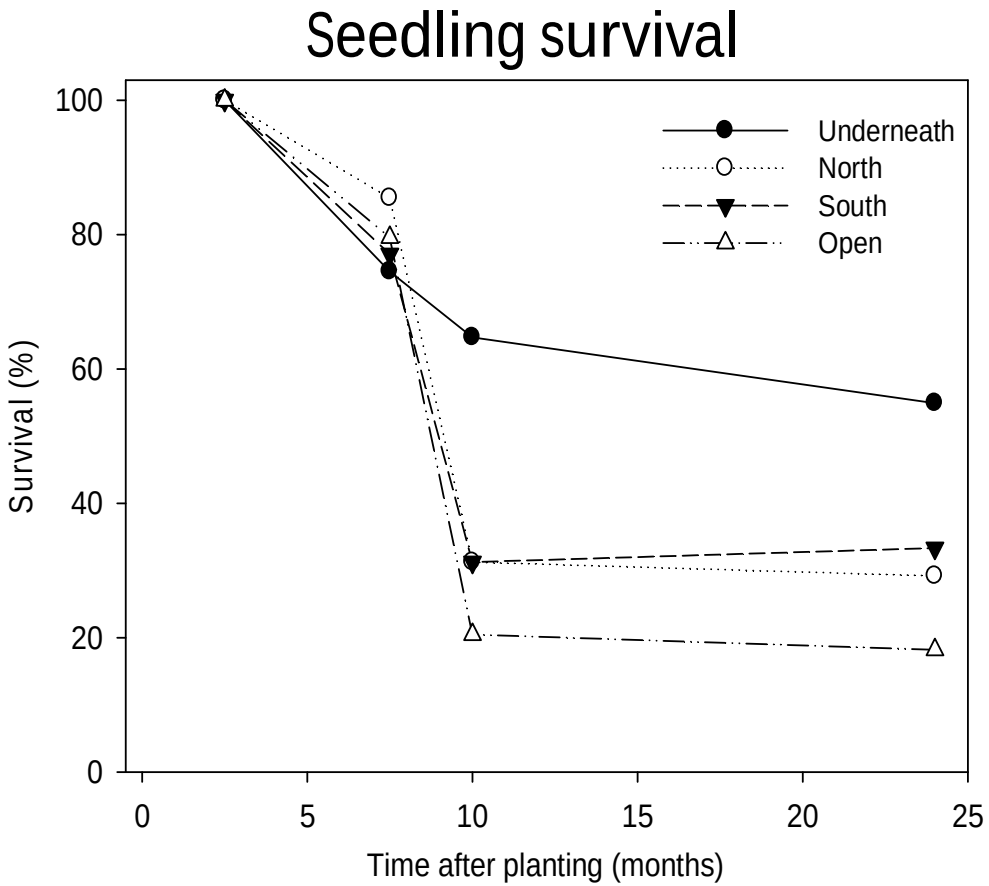
Drivers of seedling <u>survival</u> (GLMM):

- Patch size
- LAI
- Cover and richness of dominant species
- Cover and richness of accompanying species
- Soil organic C and soil total N
- Litter depth
- Phylogenetic distance of the community



COMMUNITY LEVEL PRIORITIES

COMMUNITIES FACILITATE NEW INDIVIDUALS



Underneath vs periphery:

Restricted spatial extent of facilitation

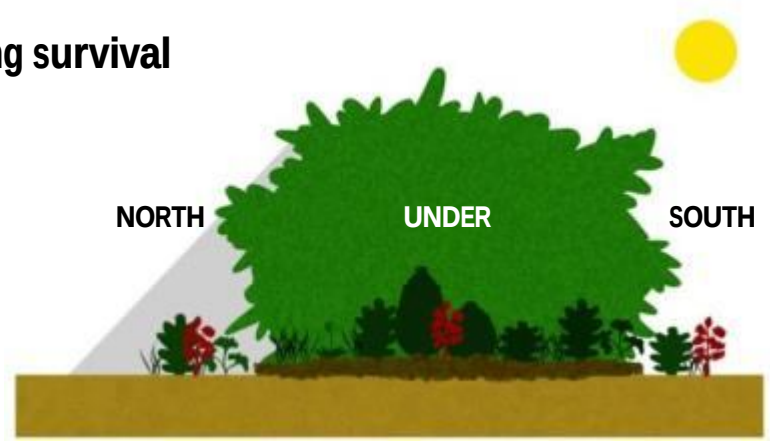
Mechanisms: Improving soil fertility and reducing irradiance stress

Amat et al.(2014)

COMMUNITY LEVEL PRIORITIES

THROUGH COMPLEX INTERACTIONS

Community drivers of seedling survival



↑ Seedling survival

↓ Accompanying species composition (NMDS2)

Competition/facilitation

↑ Accompanying species cover

Protection from excesive radiation

↑ Litter depth

↑ *Soil moisture (mulch)*

↑ Phylogenetic distance

Different niche ↓, *competition*

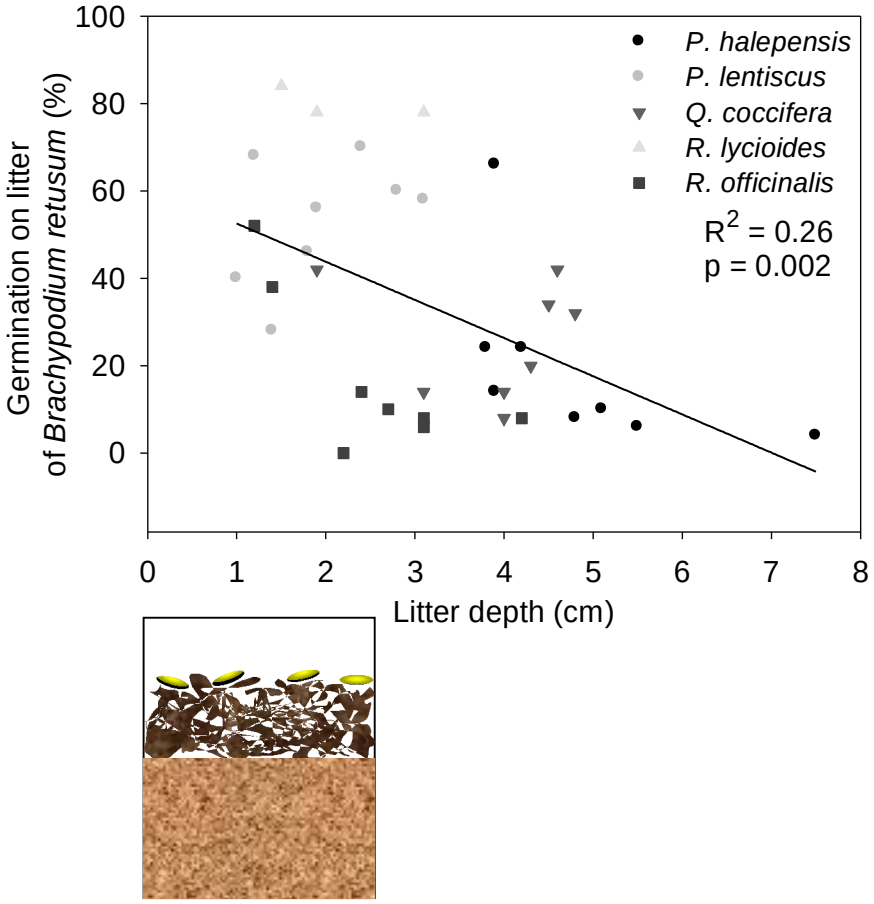
Amat et al.(2014)

COMMUNITY LEVEL PRIORITIES

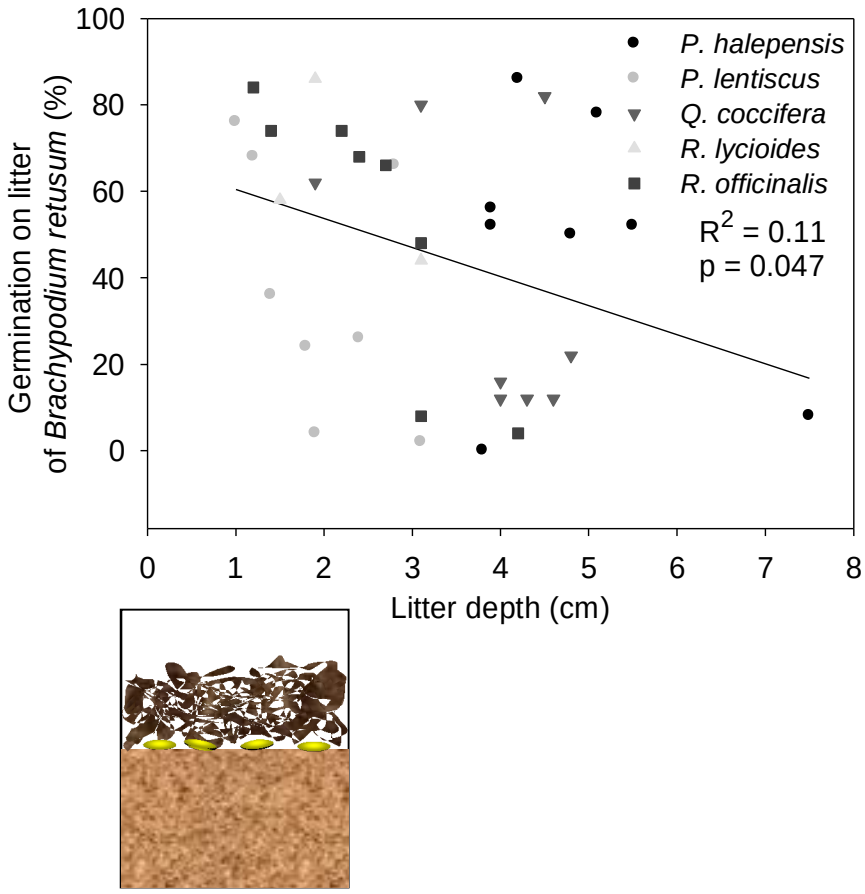
AND THE RESULTS DEPEND ON THE LIFE CYCLE

Relationship between litter accumulation and germination

Germination **on top** of litter layer



Germination **under** litter layer



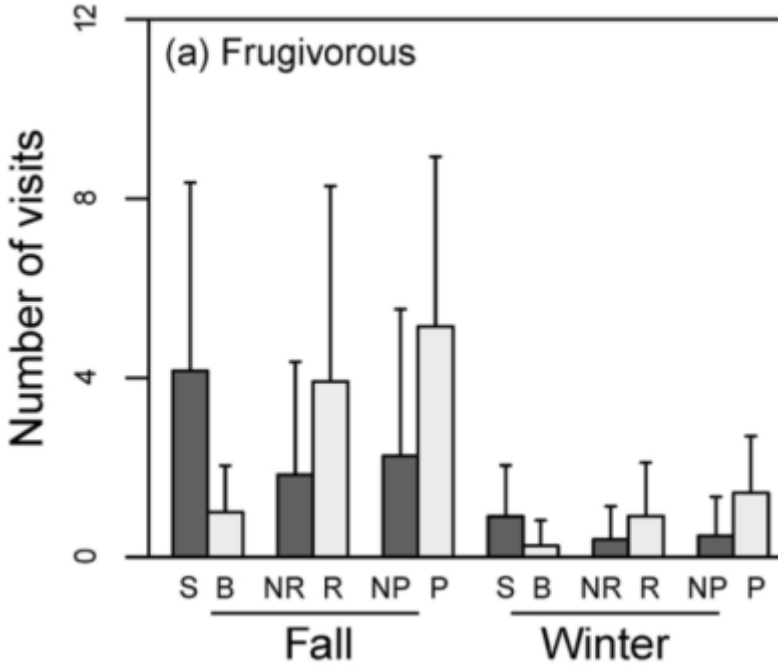
*Similar relationship for *Pistacia lentiscus* seeds and litter weight.

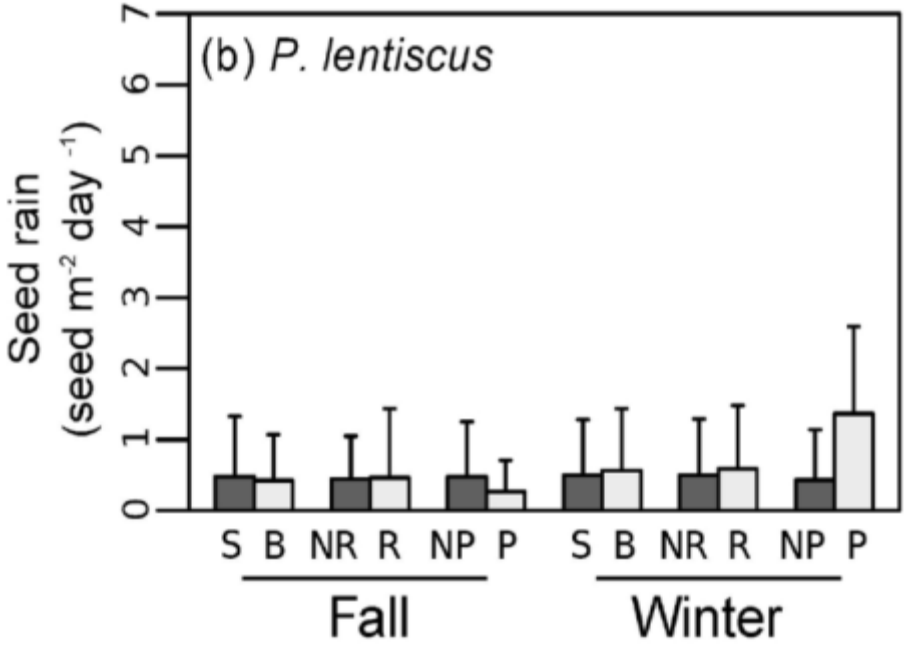
COMMUNITY LEVEL PRIORITIES

BUT THEN THERE IS TECHNICAL AND ECONOMIC FEASIBILITY

09/2012

01/2015





Castillo et al. (submitted)

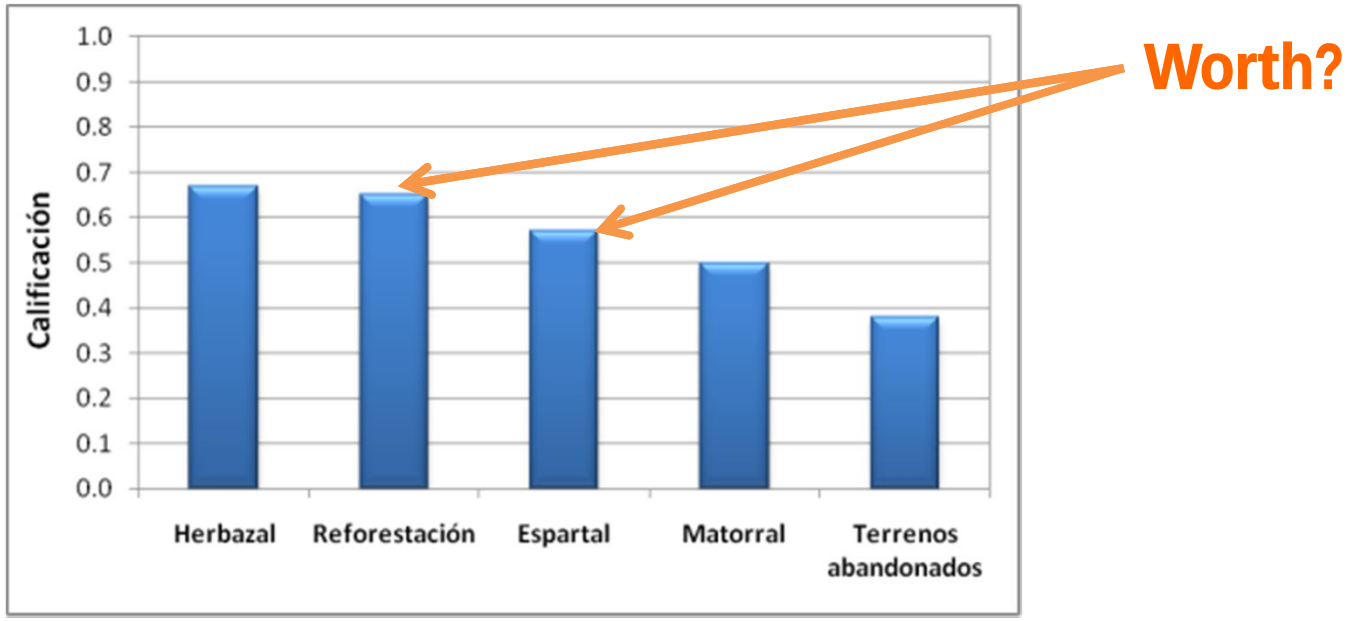
COMMUNITY LEVEL PRIORITIES

ECOLOGICAL SOLUTION THAT CANNOT BE RECOMMENDED

- **Seedling plantation**: 2030-4852 € Ha^{-1} (Cuenca 2014)

- **Branch pile:** 183 € $pile^{-1}$ (46 € pruning-thinning, 38 € slash packaging and 50 km transport, 99 € labor for deploying and building piles; 0.375 labor-days per pile).

  Patch density 179 patches Ha^{-1}: Total cost 32,705 € Ha^{-1} (15,052 Euros Ha^{-1} if freely available branches)



COMMUNITY LEVEL PRIORITIES

Biotic interactions are complex. Challenges to shift from the experimental scale to the management scale include:

- Understanding **interspecific interactions** for a large number of coexisting species

- Understanding **high level interactions**

- Integrating **spatial and temporal changes** in resource availability and ecological conditions

- Overcoming **technical and economic** limitations

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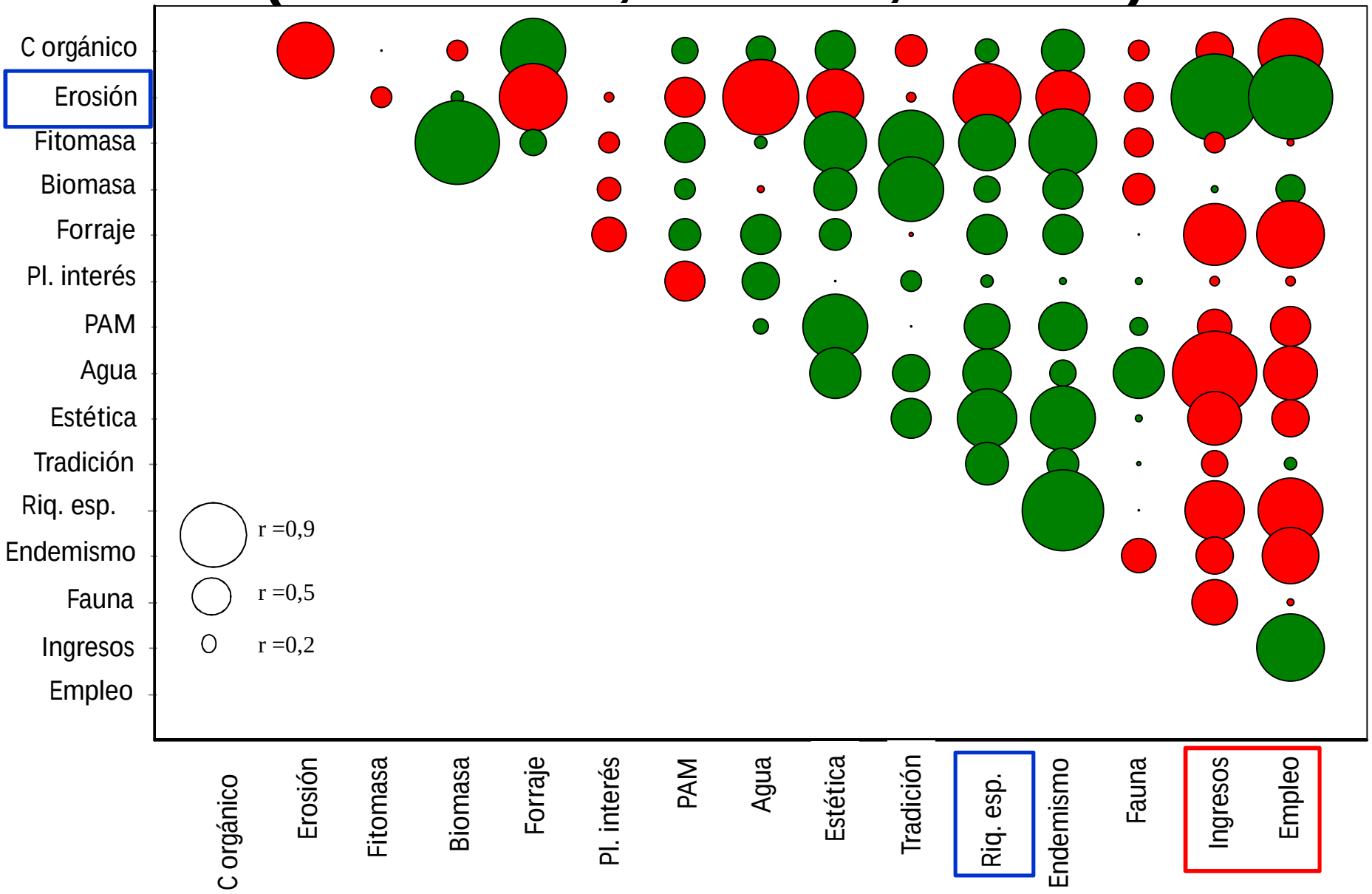
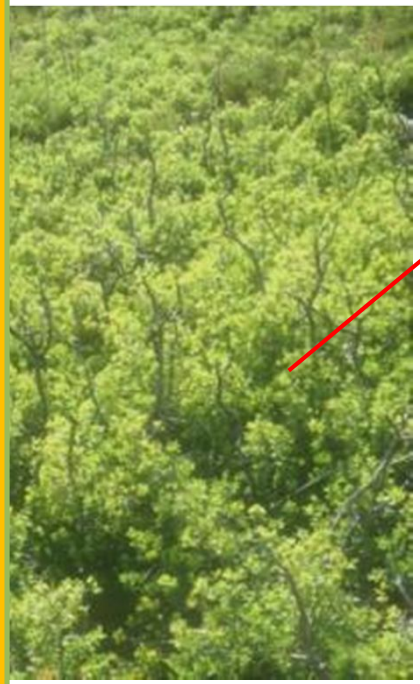
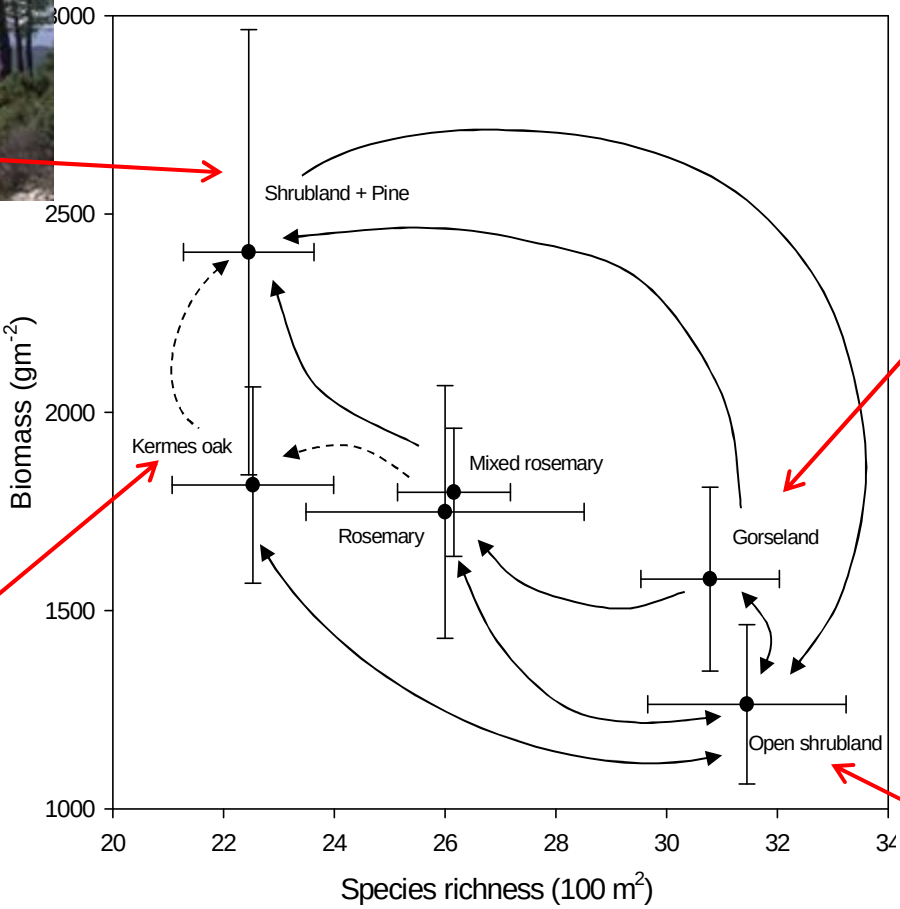
ECOSYSTEM CAN BE CHARACTERIZED BY A SUIT OF TRAITS (COMPOSITION, FUNCTION, SERVICES)



ECOSYSTEM LEVEL PRIORITIES

BUT ECOSYSTEM TRAITS NOT ALWAYS COVARY





Cortina et al., *J. Nat. Cons.* 2006, Baeza et al., *J. Veg. Sci.* 2007

ECOSYSTEM LEVEL PRIORITIES

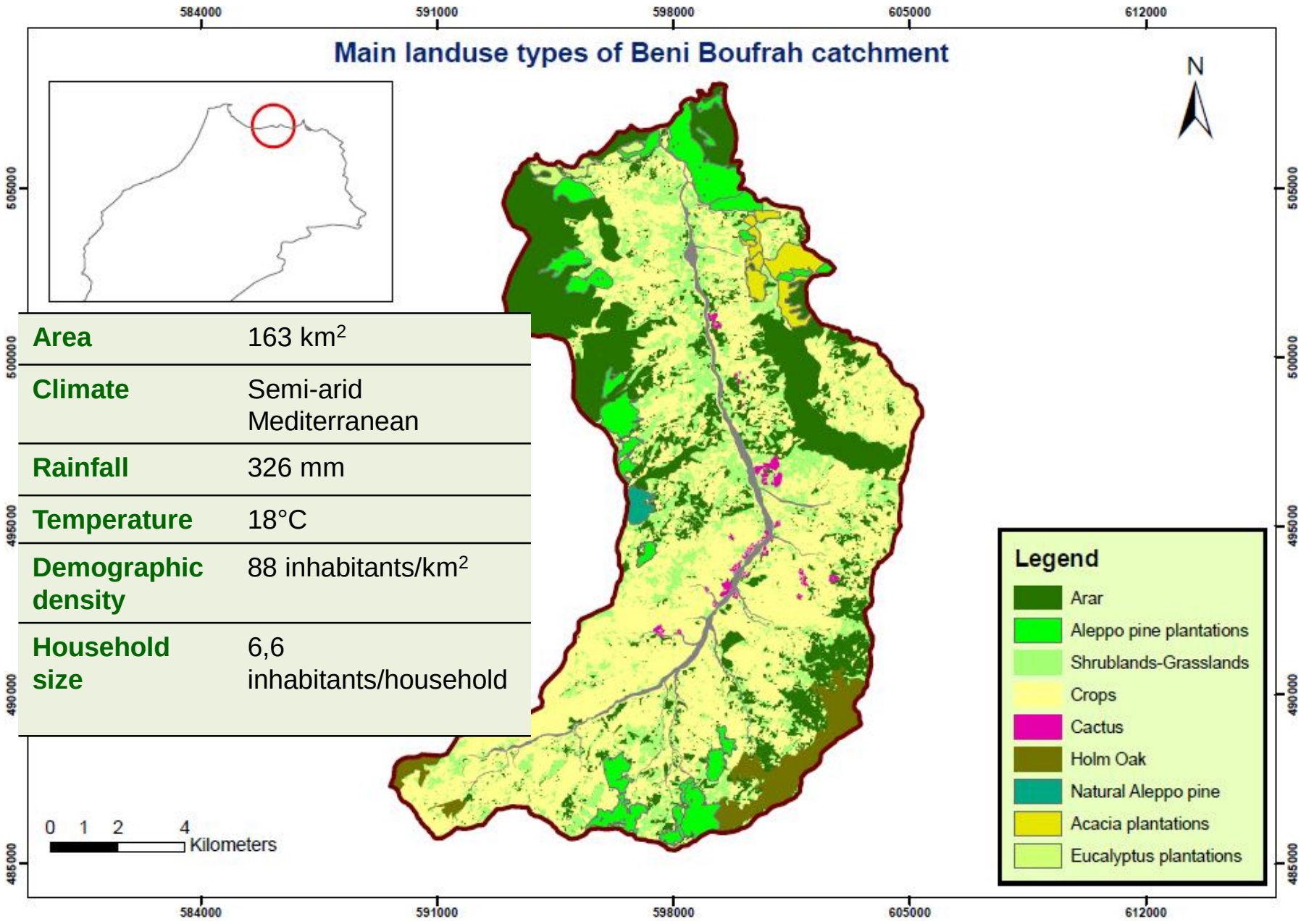
HOW TO DECIDE?

CASE STUDY

THE BENI BOUFRAH CATCHMENT

ECOSYSTEM LEVEL PRIORITIES

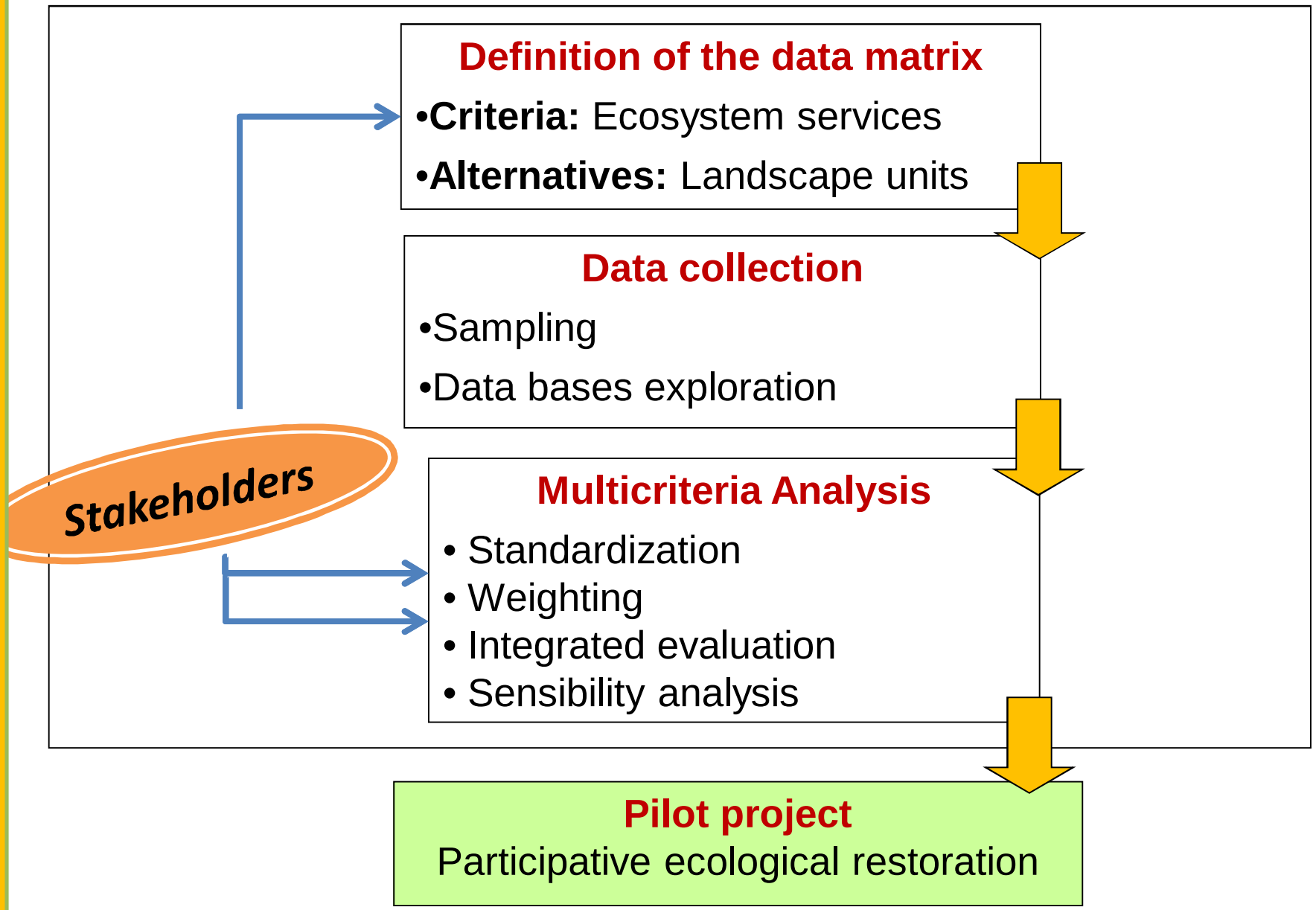
STUDY AREA



Area	163 km^2
Climate	Semi-arid Mediterranean
Rainfall	326 mm
Temperature	18°C
Demographic density	88 inhabitants/km^2
Household size	6,6 inhabitants/household

ECOSYSTEM LEVEL PRIORITIES

METHODOLOGY



Landscape units

Crops

Shrublands

Arar

Pine plantations

Cactus

ECOSYSTEM LEVEL PRIORITIES

Stakeholder platform

Stakeholders	Categories	Number of stakeholders	Subtotal
Experts	Researchers, University professors	8	19
	Forest Administration	6	
	Agricultural Administration	4	
	Hydrological department	1	
Collaborators	Local authority	2	20
	Municipal representatives	3	
	NGOs members	6	
	Touristic facilitators	2	
	Professors Primary	1	
	Local developers	2	
	Other functionaries	4	
Direct users	Farmers	6	28
	Cooperatives members	8	
	Fishermen	5	
	Hunters	1	
	Loggers	1	
	Other inhabitants	7	
Total			67

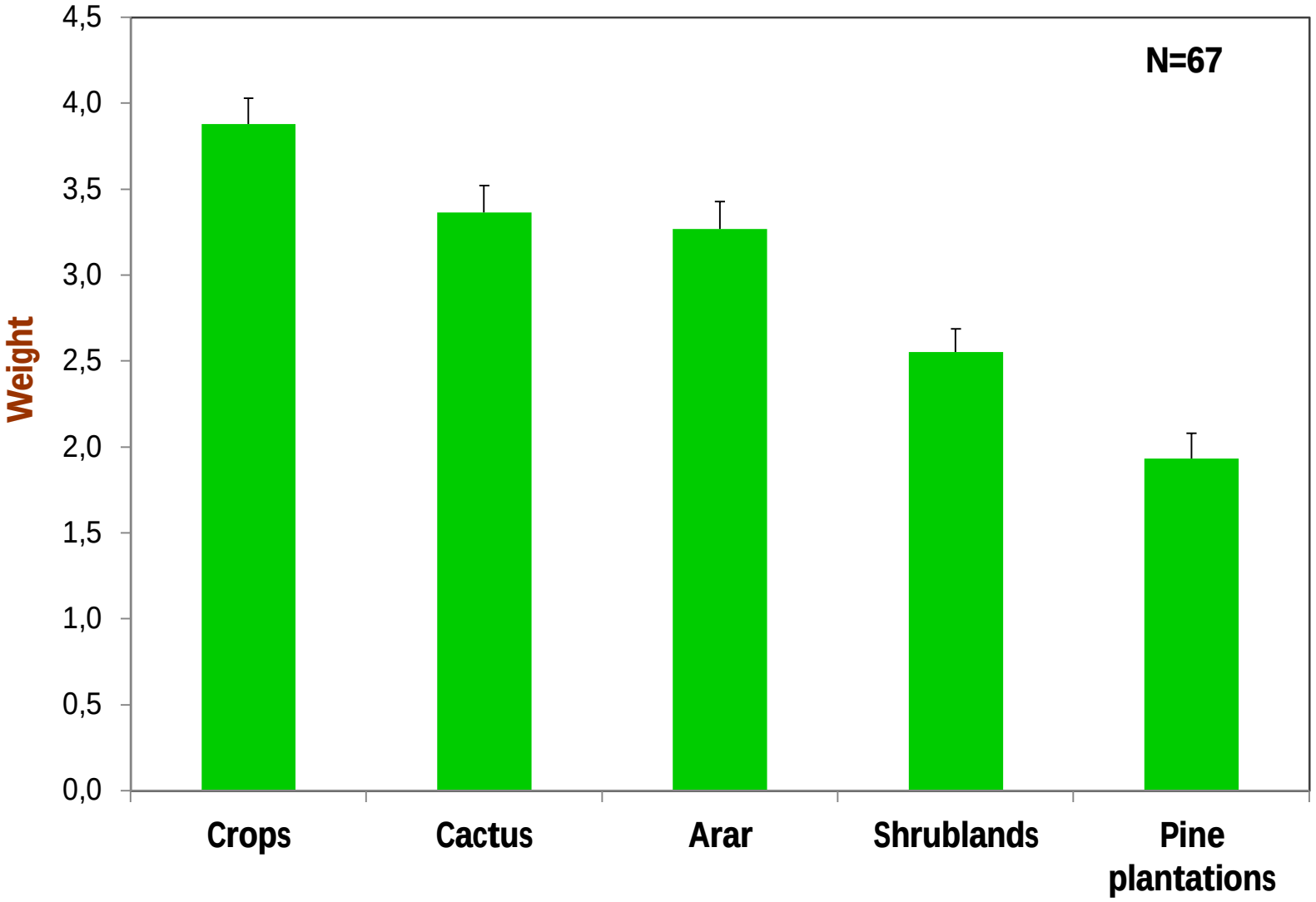
ECOSYSTEM LEVEL PRIORITIES

Criteria & indicators of ES

Category	Criteria	Indicator	Measurement Unit
Supporting services	Soil fertility	Organic soil carbon	%
	Primary production	Annual production	kg ha^{-1} $year^{-1}$
Regulating services	Erosion control	Erosion rate	g m^{-2} $year^{-1}$
	Flood control	Runoff coefficient	%
	Climatic regulation	Phytovolume	m^3 m^{-2}
Provisioning services	Biomass production	Total biomass	kg ha^{-1}
	Forage productivity	Total forage	UF ha^{-1} $year^{-1}$
	Food supply	Amount of food	kg ha^{-1}
	Aromatic and medicinal plants	Percentage of aromatic and medicinal plants	%
	Water retention	Retained water	%
Cultural services	Aesthetic beauty	Aesthetic value	RU
	Traditional appeal	Traditional value	RU
Biodiversity	Specific richness	Total number of plants	N
	Endemism	Number of rare and endemic plants	N
	Game abundance	Small and big game preferences for habitats	UR
Economical benefits	Employment	Labour offer	Days ha^{-1} $year^{-1}$
	Incomes	Products incomes	Dh ha^{-1} $year^{-1}$

ECOSYSTEM LEVEL PRIORITIES

Landscape units ranking by stakeholders



ECOSYSTEM LEVEL PRIORITIES

Feedback workshop (11/06/2013)

ECOSYSTEM LEVEL PRIORITIES

- Educational materials and announcements
- Workshop with secondary school students
- Call to participate

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LANDSCAPE LEVEL PRIORITIES

WHICH ACTION IS PRIORITAIRE?

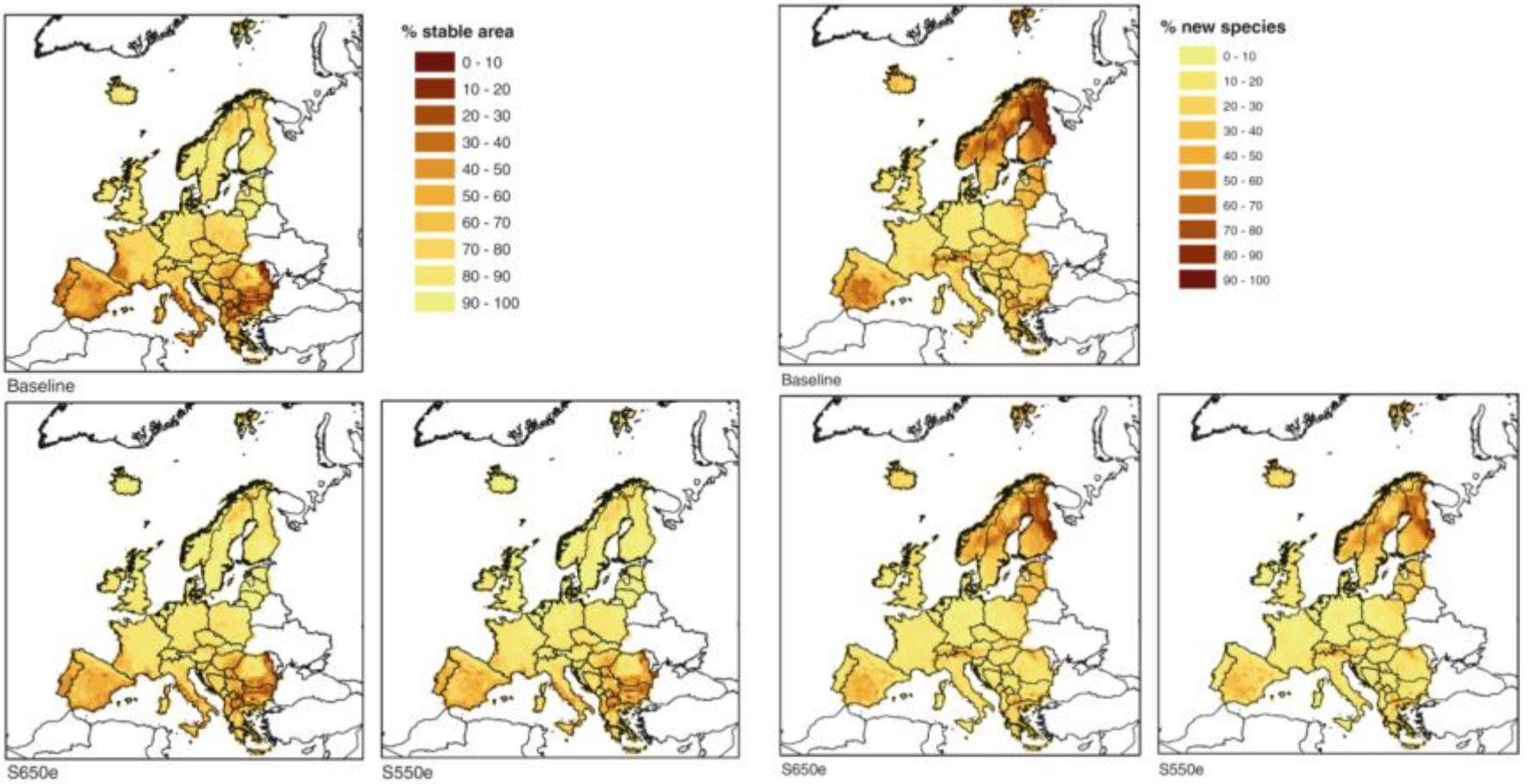
LANDSCAPE LEVEL PRIORITIES

BETTER TO FOCUS ON SMALL OR LARGE INTERVENTIONS?

LANDSCAPE LEVEL PRIORITIES

AND LANDSCAPES ARE ALARMINGLY CHANGING

SPECIES POOL AND CLIMATE CHANGE



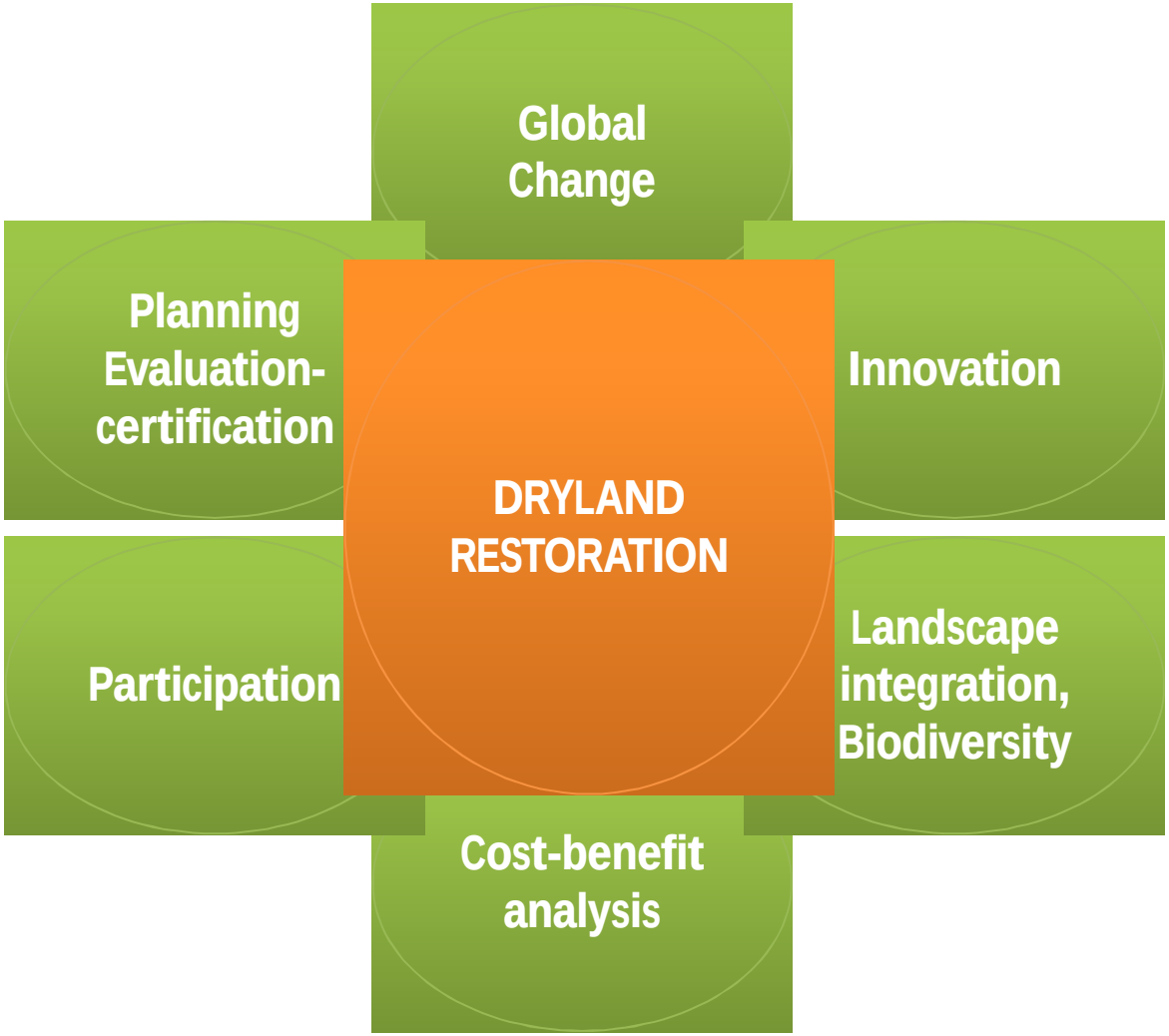
"…in Southern Europe, where up to 25% of the species now present will have disappeared under the climatic circumstances forecasted for 2100"

Alkemade et al. (2011)

LANDSCAPE LEVEL PRIORITIES

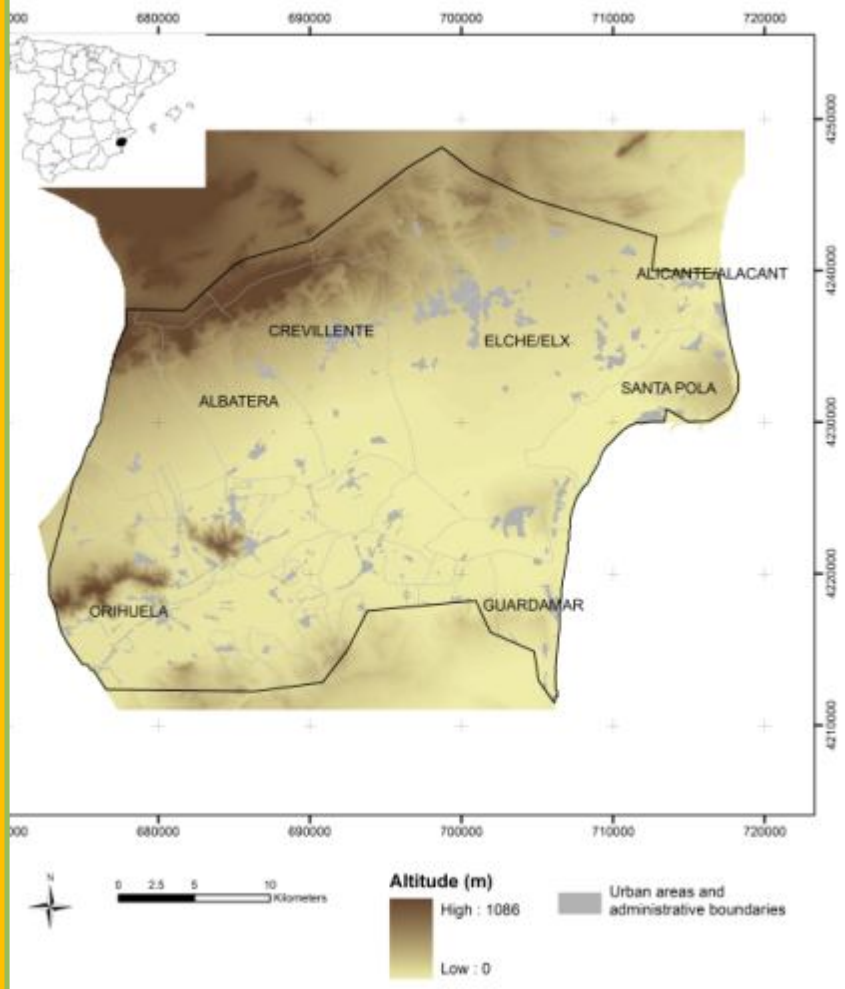
INTEGRATING PEOPLE VALUES AND ASPIRATIONS

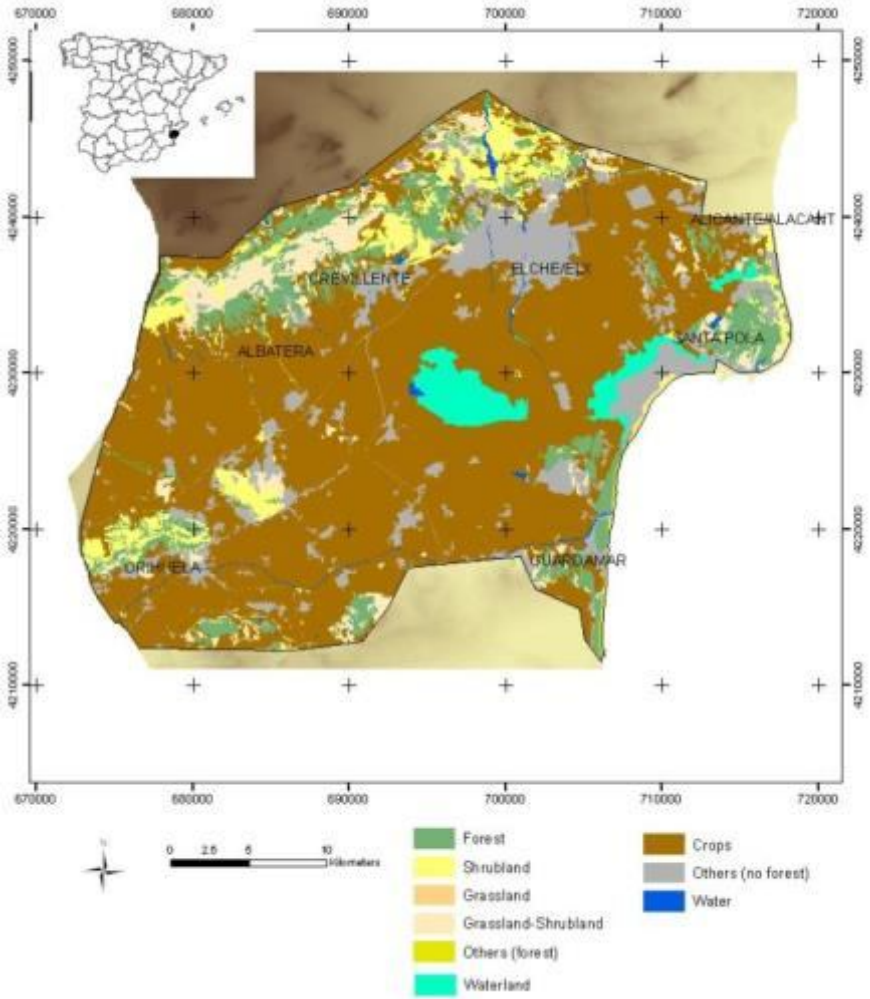
Tools for planning ecological restoration in the Region of Valencia (TERECOVA)



LANDSCAPE LEVEL PRIORITIES

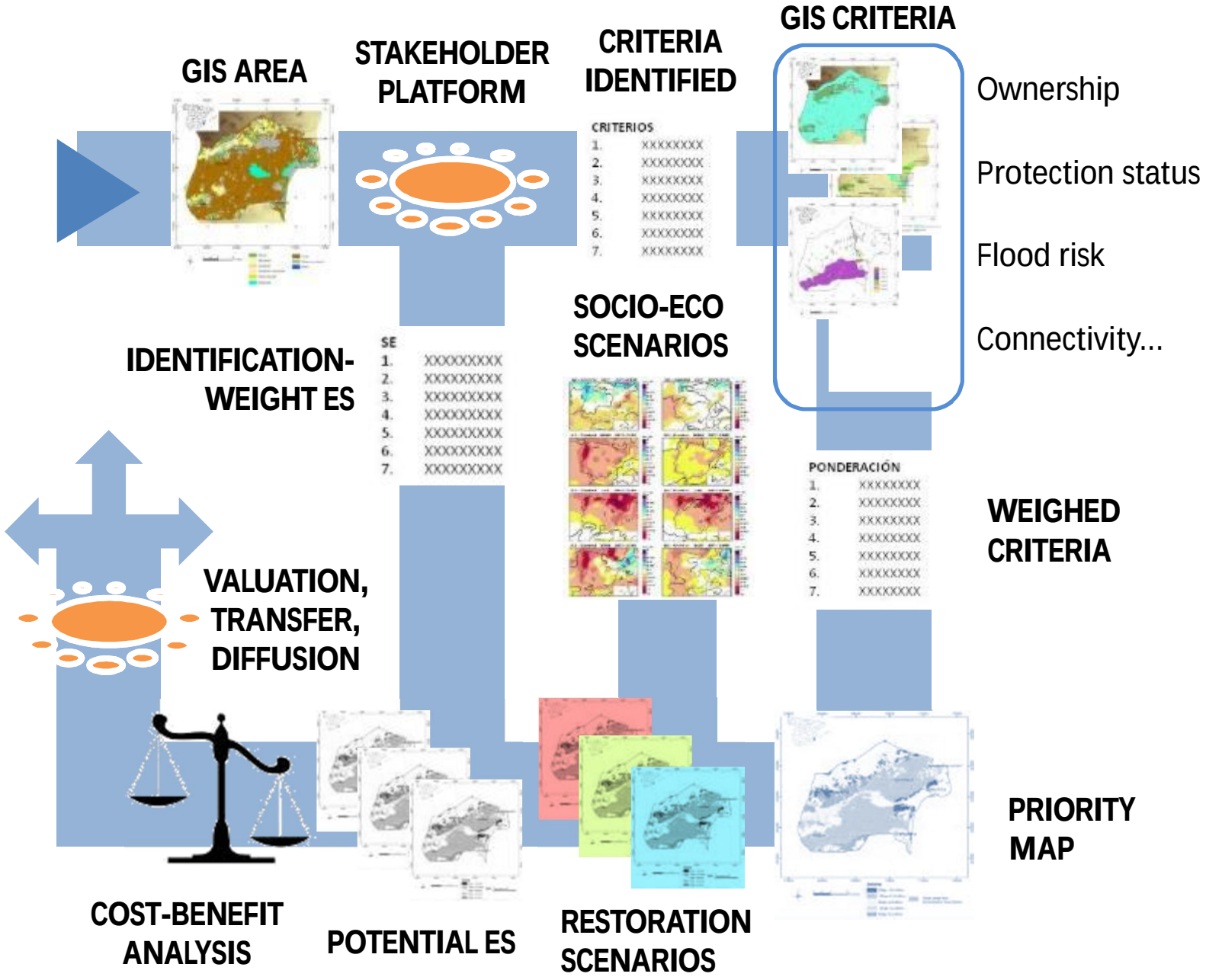
INTEGRATING PEOPLE VALUES AND ASPIRATIONS





LANDSCAPE LEVEL PRIORITIES

INTEGRATING PEOPLE VALUES AND ASPIRATIONS



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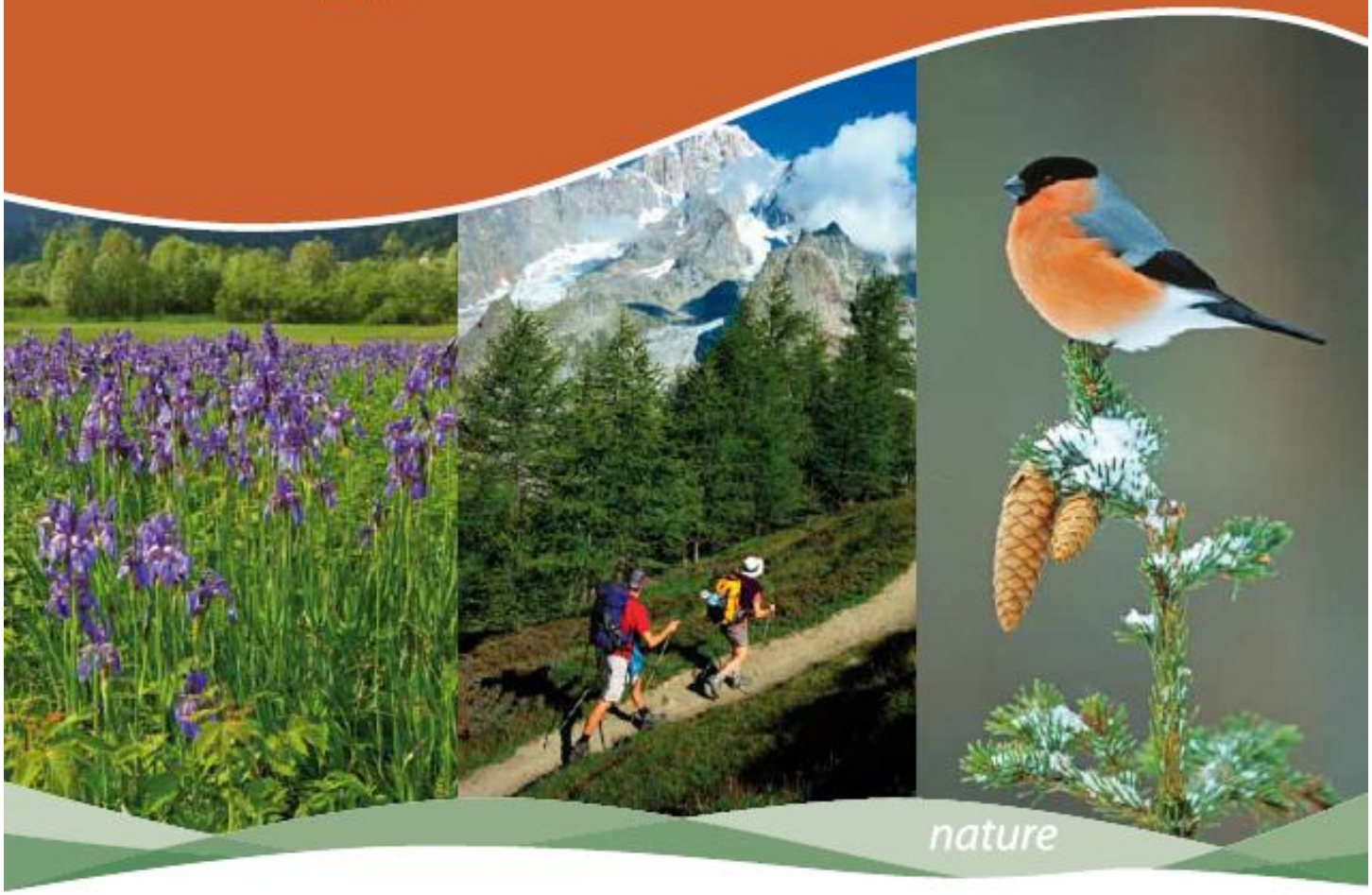
REGIONAL LEVEL PRIORITIES

The EU Biodiversity Strategy to 2020



EUROPEAN COMMISSION

environment

REGIONAL LEVEL PRIORITIES

TARGET 2. MAINTAIN AND RESTORE ECOSYSTEMS AND THEIR SERVICES

Ecosystems and their services are maintained and enhanced by:

- Green infrastructure by end 2012
- **Restoring at least 15% of degraded ecosystems. By 2014: each member state has developed a strategic framework to set priorities for ecosystem restoration!**
- By 2015: no net loss of ecosystems and their services ‘biodiversity proof’ policy at all levels

REGIONAL LEVEL PRIORITIES

ACTION 6a: "**By 2014, Member States, with the assistance of the Commission, will develop a strategic framework to set priorities for ecosystem restoration at sub-national, national and EU level".**

REGIONAL LEVEL PRIORITIES

ILLUSTRATIVE EXAMPLE FOR A MEMBER STATE WITH HIGH COVERAGE OF NATURAL AREAS					
		Types of areas	**Base-line**	**By 2020 (and net gain)**	**By 2050**
LEVEL 1	Satisfactory abiotic conditions. Key species, properties and processes of ecosystem patches and their functions, at site level and at landscape level, are in good to excellent condition.	a.o. 'wilderness' areas and N2000 habitats and species in FCS, rivers and lakes in good ecological status (GES), marine ecosystems in GES, ...	30%	32% (+ 2% from L2)	40% (+ 8% from L2)
LEVEL 2	Satisfactory abiotic conditions, some disrupted ecological processes and functions, either at site level or at landscape level or at both levels. Reduced or declining diversity and key species, compared to L1 but retains stable populations of some native species.	a.o. N2000 habitats and species not in FCS, ...	15%	28% (+ 15% from L3; - 2% to L1)	35% (+15% from L3; - 8% to L1)
LEVEL 3	Highly modified abiotic conditions, many disrupted ecological processes and functions, either at site level or at landscape level or at both levels. Dominated by artificial habitats but retains some native species and stable populations.	a.o. non-protected rural areas, not including intensive agriculture	30%	16% (+ 1% from L4; - 15% to L2)	10% (+ 9% from L4; - 15% to L3)
LEVEL 4	Highly modified abiotic conditions, severely reduced ecological processes and functions, both at site level and at landscape level. Dominated by artificial habitats with few and/or declining populations of native species; traces of original ecosystem hardly visible.	'heavily modified ecosystems' (e.g. intensive agriculture, build urban areas, roads, airports, brownfield areas, heavily modified water bodies); heavily degraded 'natural' and 'semi-natural' ecosystems	25%	24%	15%
TOTAL SURFACE			100%		
TOTAL 'RESTORABLE' SURFACE			70%		
TOTAL 'RESTORED' SURFACE (cumulative starting from baseline, and calculated on the basis of 'restorable surface')				25,7%	71,4%

REGIONAL LEVEL PRIORITIES

STILL TOO MANY QUESTIONS

- What is degraded?
- What is restored?
- Descriptors/threshold values?
- Why past restoration efforts do not account? (baseline 2010)
- Why transformation within a given level do not account?
- Must prioritization be done at national or European level?
- Does the 15% target apply at a European or national level?
- How will be funded?
- Why not adopting a true landscape aproach?
- Why only Forests, Grasslands, Croplands, Wetlands, Urban?

REGIONAL LEVEL PRIORITIES

INNOVATIVE FINANCING INSTRUMENTS

- Potential of private non-profit sources to fund actions under Target 2
- Philanthropic donations by companies from private for-profit sources to fund actions under Target 2
- Public private partnerships and bonds for green infrastructure
- Insurance sector mitigating of environmental risk
- Payments for ecosystem services (PES)
- Tax Relief on capital assets in good environmental management
- Hypothecated tax funds
- Risk-sharing investment structures (first-loss loans, subordinated debt, etc.)
- Pro-biodiversity business (PBB) models - investment funds & funding platforms
- Product labelling and certification
- Bio-Carbon markets
- Biodiversity Offsets and Habitat Banking

CONCLUSIONS

1. Priorities depend on scale
2. The larger the scale, the higher the uncertainty
3. The largest the scale, the higher the need to incorporate society → new challenges, new responsibilities
4. These are complex issues, international collaboration is a must

José Huesca

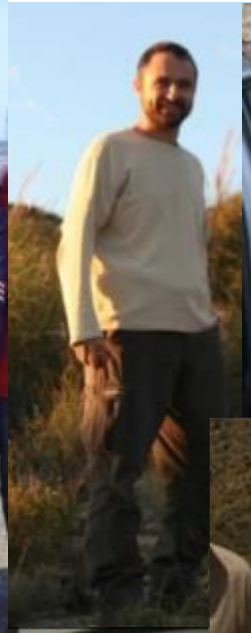
Karen Disante

Roman Trubat

Santiago Soliveres

Fernando Maestre

Jaume Tormo



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TERECOVA – *Tools for integrating ecological restoration into land planning in the Region of Valencia* (CGL2014-52714-C2-1-R)

SEMER – *Optimización de la Provisión de Bienes y Servicios en Paisajes Forestales Degradados de Marruecos Mediante la Restauración Ecológica (AECI AP/040315/11)*)