

# ***“Los Bosques Ibéricos frente al Cambio Global “***

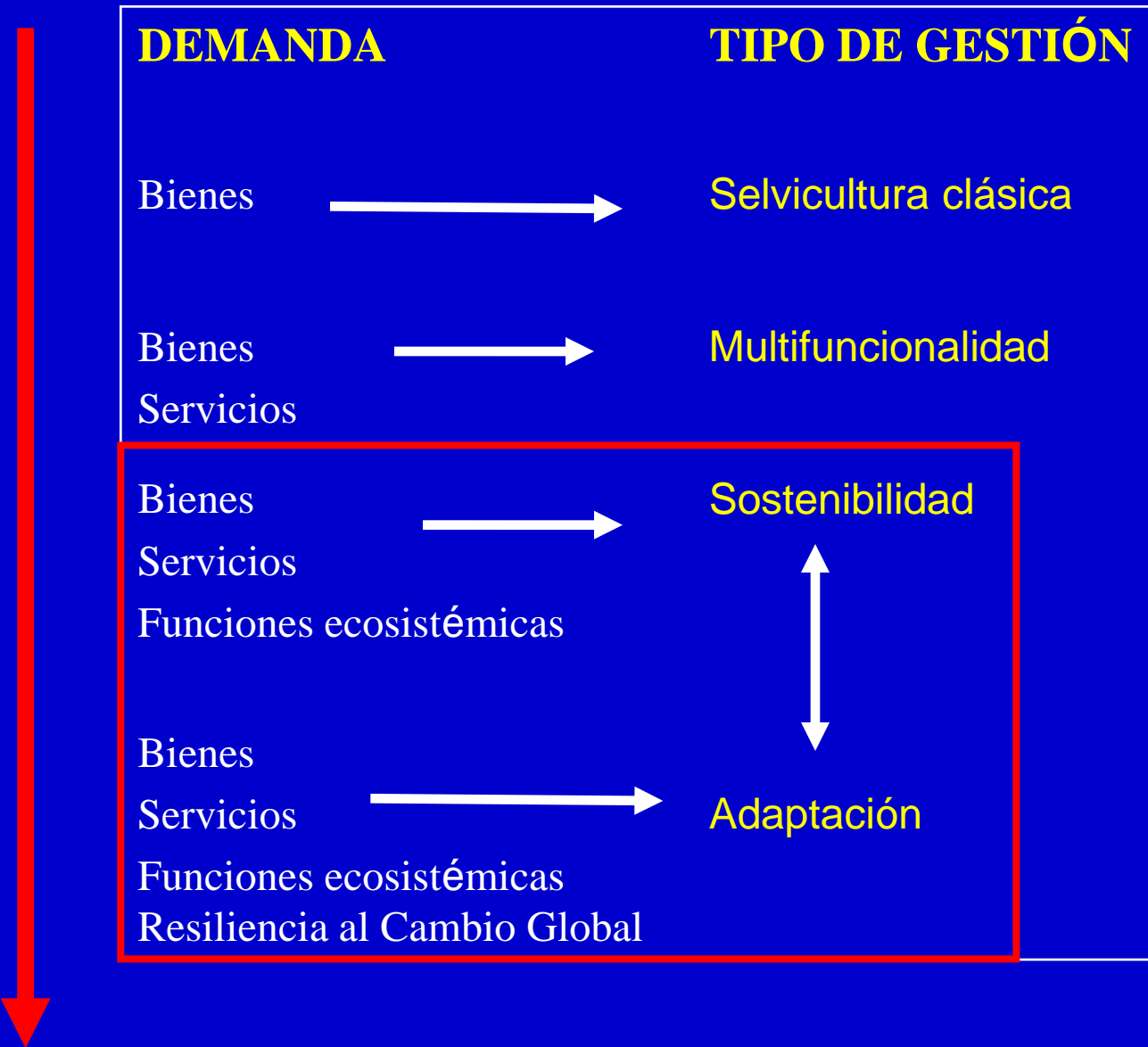
***Miguel Angel de Zavala***

***Grupo de Ecología y Restauración Forestal***

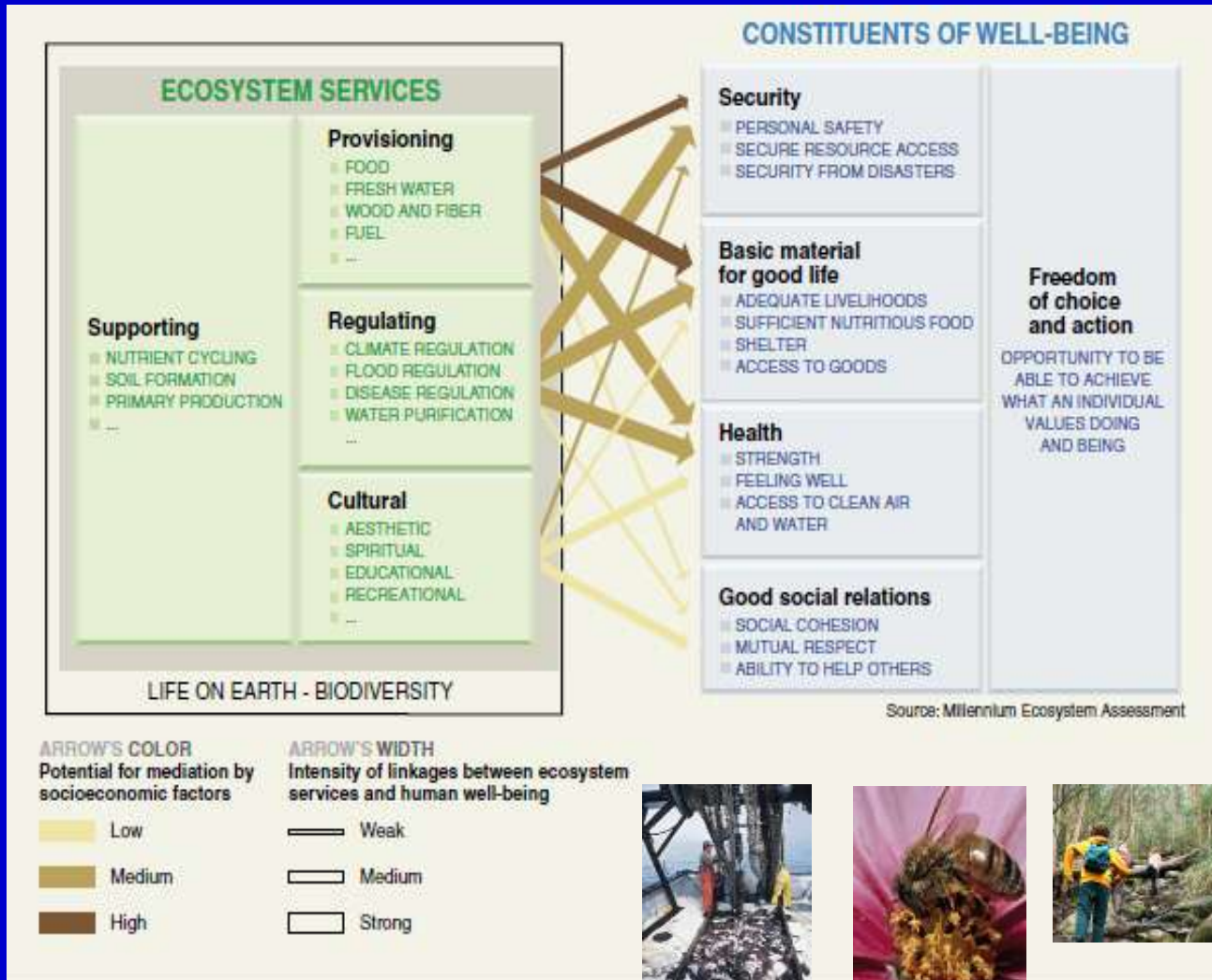
***Seminario Técnico: EUROPARC***

***26 Octubre 2012.***

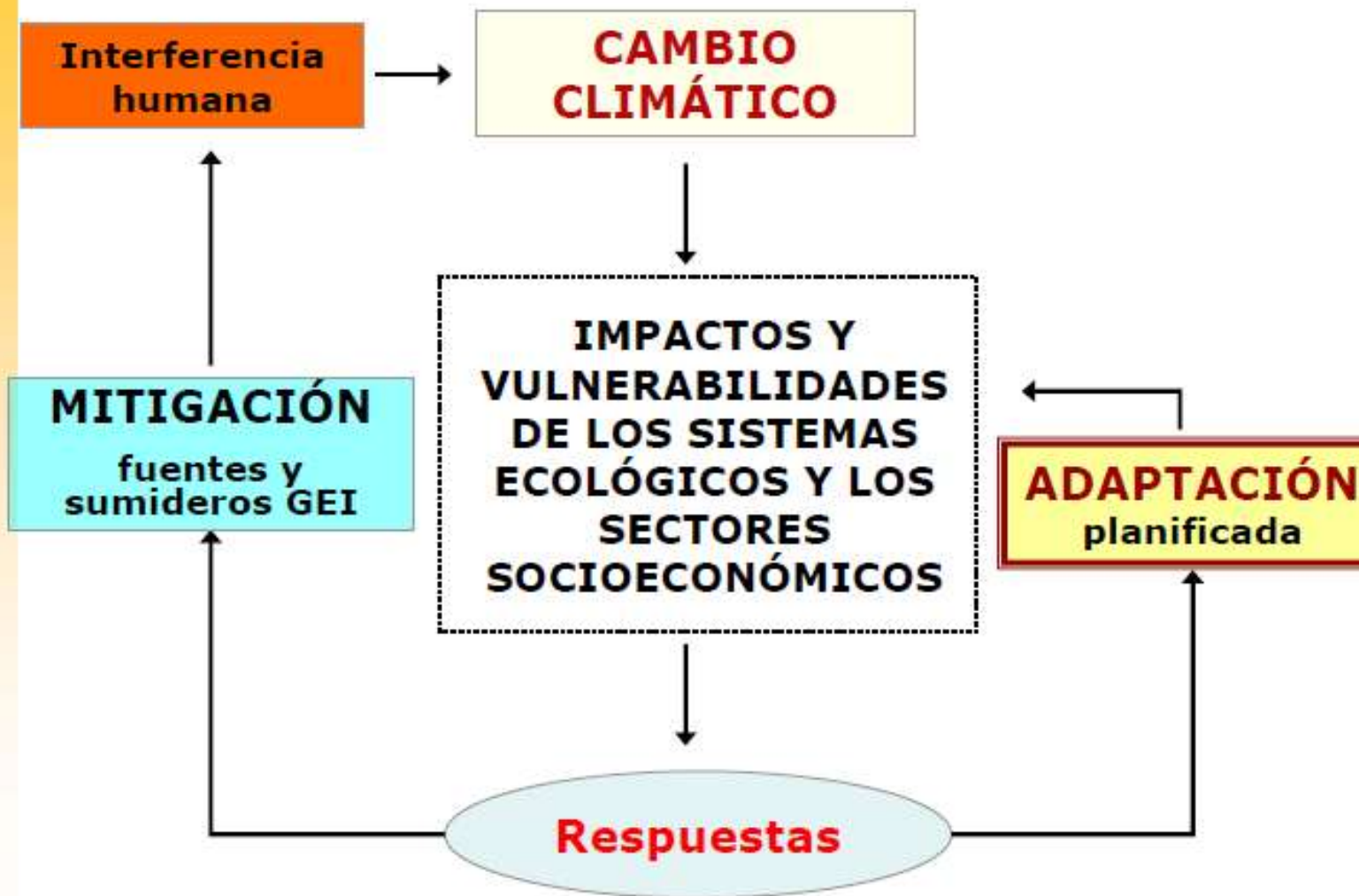




# ¿Por qué los bosques?



# EL CAMBIO CLIMÁTICO COMO PRINCIPAL RETO AMBIENTAL





**IMPACTOS**

		Habitat change	Climate change	Invasive species	Over-exploitation	Pollution (nitrogen, phosphorus)
Forest	Boreal					
	Temperate					
	Tropical					
Dryland	Temperate grassland					
	Mediterranean					
	Tropical grassland and savanna					
	Desert					

### Driver's impact on biodiversity over the last century

Low	
Moderate	
High	
Very high	

### Driver's current trends

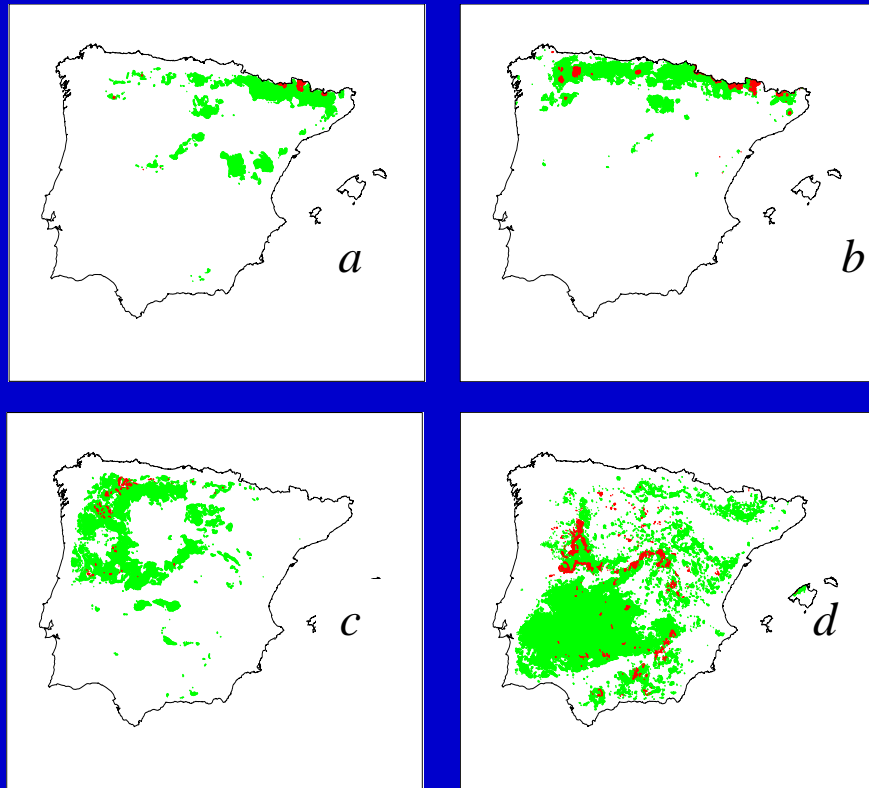
Decreasing impact	
Continuing impact	
Increasing impact	
Very rapid increase of the impact	

Source: Millennium Ecosystem Assessment

# El Cambio Global: principales componentes y amenazas.

- Cambio climático.
- Cambios ocupación del suelo
- Fragmentación.

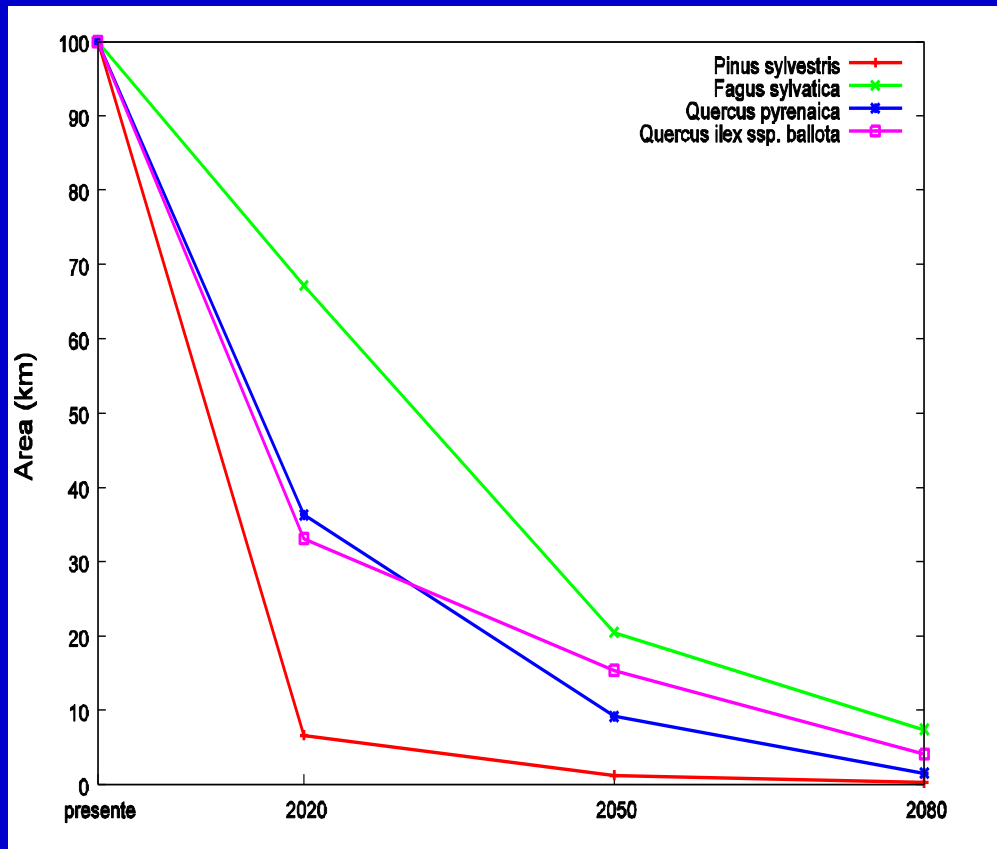
# Cambio climático y distribución potencial



Fuente: Elaborado a partir de Benito Garzón et al. 2009

Area potencial de ocupación el presente (verde) y en 2080 (rojo) en el escenario A2 CSIRO-Mk2 para *Pinus sylvestris* (a), *Fagus sylvatica* (b), *Quercus pyrenaica* (c) y *Quercus ilex* subsp. *ballota* (d)

# Cambio climático y distribución potencial



Fuente: Elaborado a partir de Benito Garzón et al. 2009

Cambios en el tamaño del área de ocupación potencial de cuatro especies forestales representativas de los bosques ibéricos. Área presente = 100%. El área disminuye según las predicciones del escenario A2 CSIRO-Mk2 para 2020, 2050 y 2080.

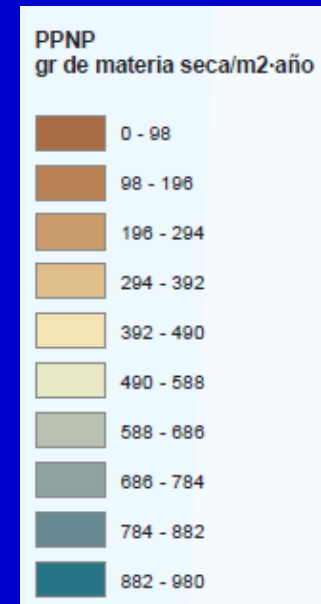
# Cambio climático y productividad potencial (Indice Rosenzweig):



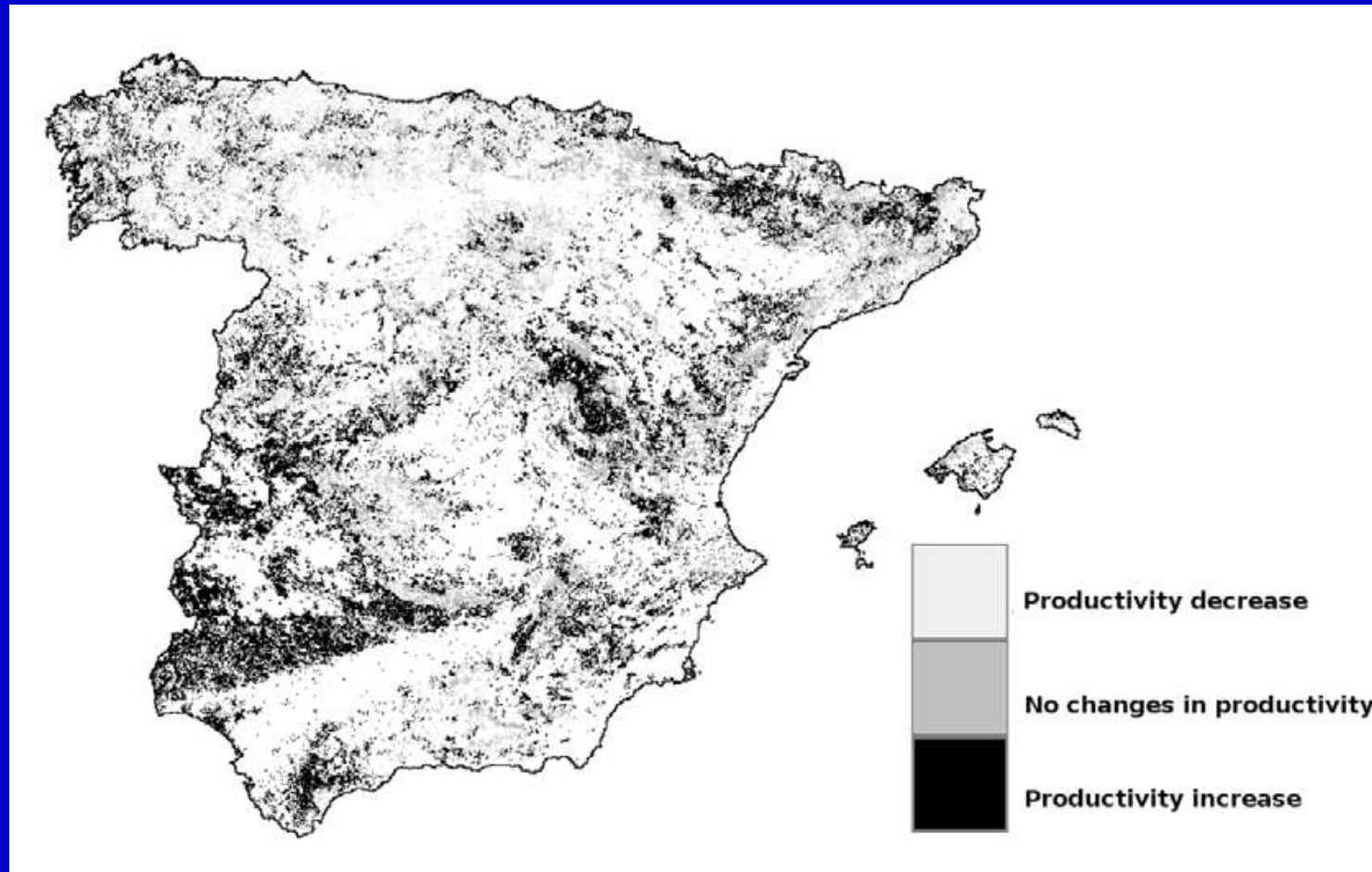
Actual  
(medias 1971-2000)



Futura ECHAM4  
(medias 2011-2040)

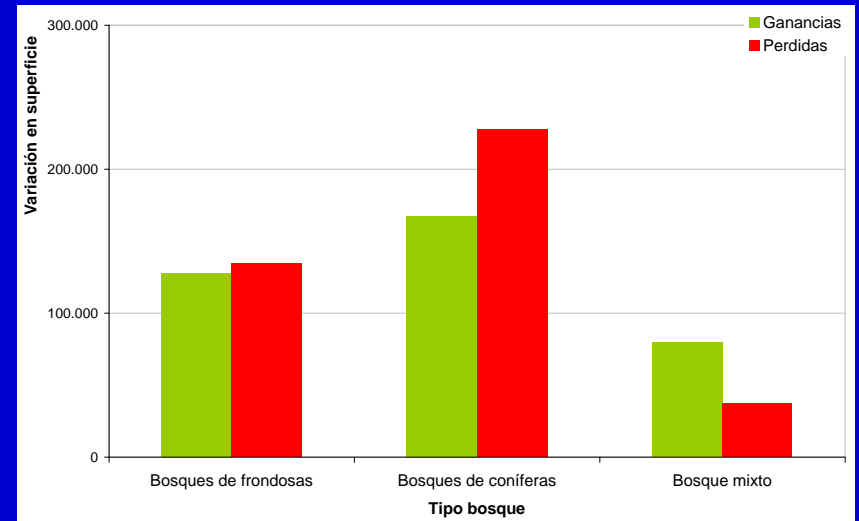
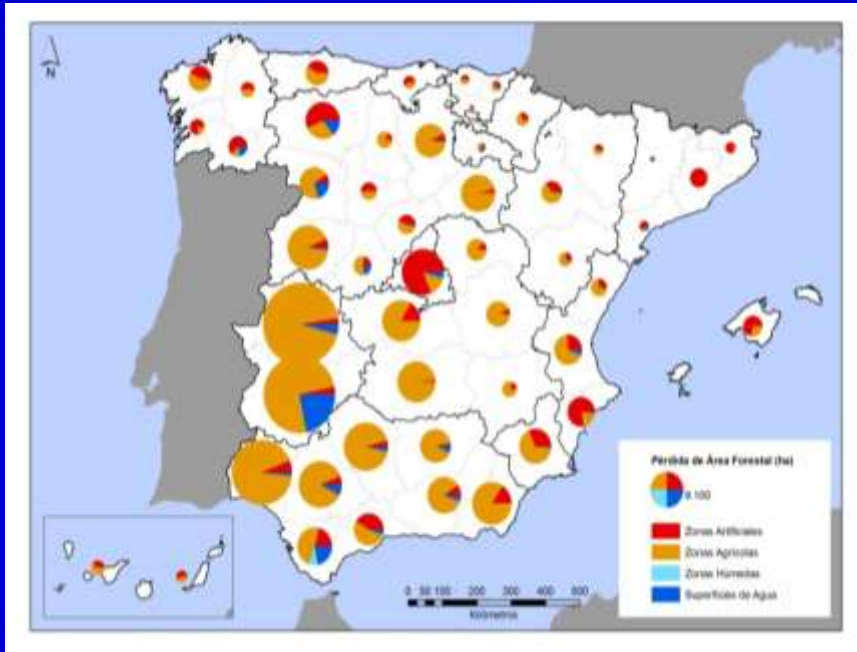


Changes in forest productivity between the present and A2 HadCM3 2080 conditions. Light grey indicates a decrease in productivity under global warming conditions and black indicates an increase in productivity for 2100, whereas grey represents areas where our model predicts no changes in productivity.



Projecting climate change effects on forest productivity: a correlational model calibrated with forest inventory data. 2011. Benito Garzón, m., C. F. Aragón, P. Ruiz Benito, R. García Valdés & Miguel A. Zavala. **Ecological Applications** (submitted).

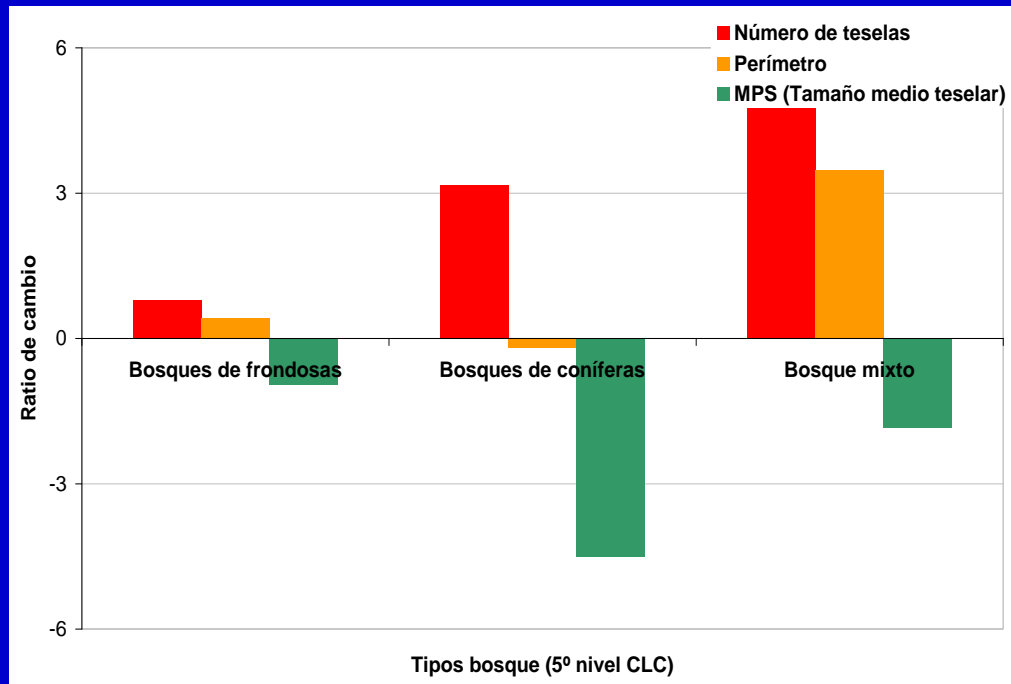
# Cambios de ocupación del suelo



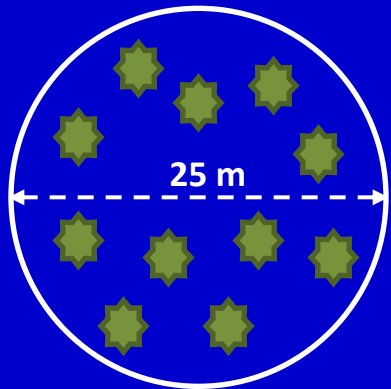
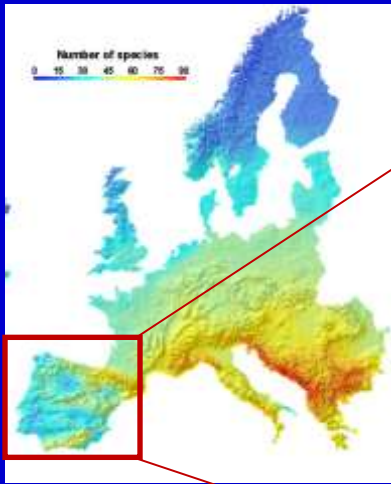
Benito y Zavala 2007. Informe sostenibilidad 2007. OSE. Mundi-prensa. Ministerio de Medio Ambiente.



# Fragmentación



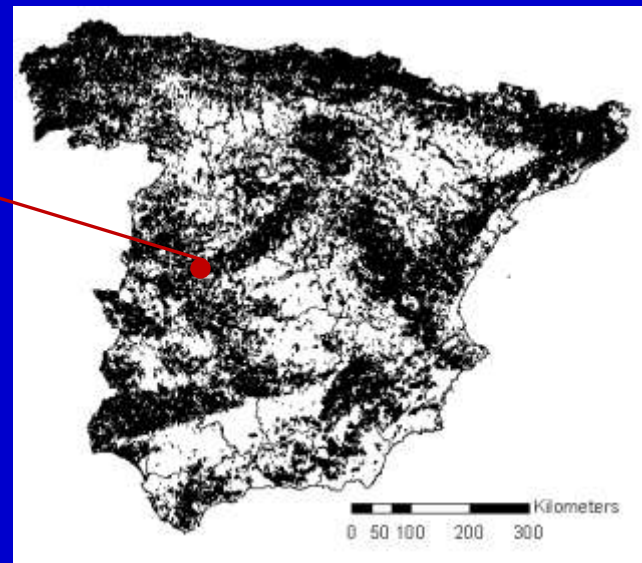
Benito y Zavala (2009). Informe sostenibilidad. OSE. Mundi-prensa. Ministerio de Medio Ambiente.



Presencia / Ausencia  
~90000 puntos (1 punto/Km<sup>2</sup>)



Clima  
Topografía  
Suelo  
Régimen de incendios  
Cobertura forestal



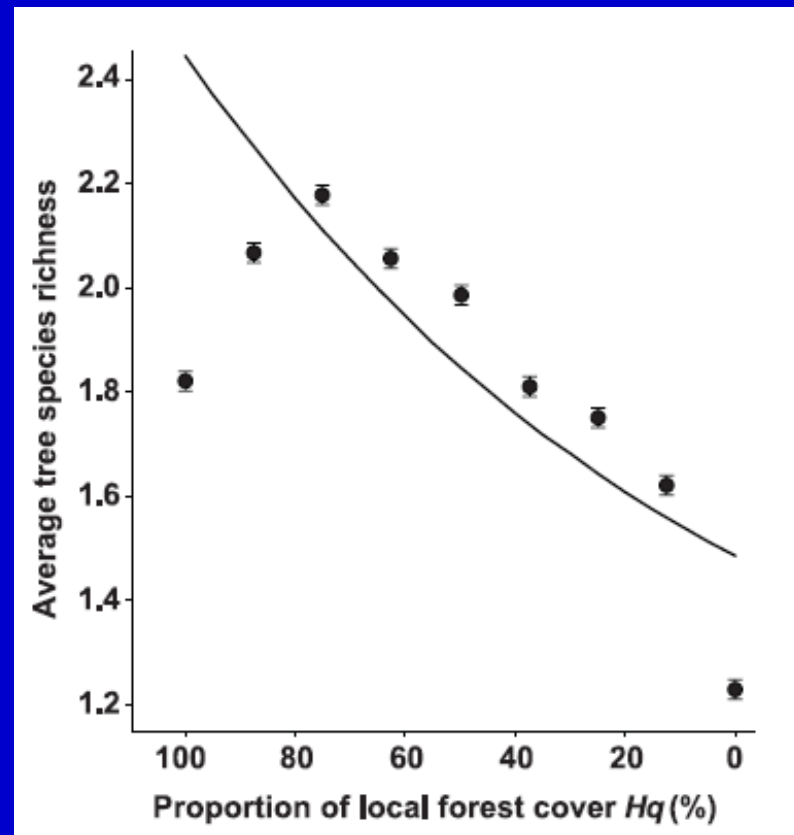
**Inventario Forestal Nacional**



# Riqueza de especies Vs. Pérdida de hábitat

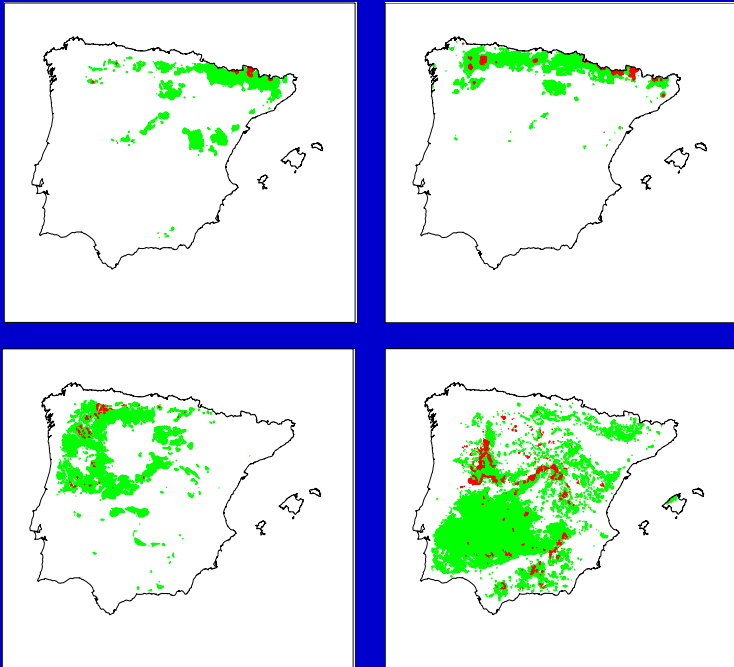
Regresión logística

$$\Omega_j = \ln \{P(j, H_q = 0) / P(j, H_q = 0.75)\}$$



# MODELOS DE VULNERABILIDAD Y RESILIENCIA

# ¿Resilience and adaptation mechanisms?



## Genes

Epigenesis.  
Evolution  
Local adaptation  
Plasticity

## Population and communities

Migration (dispersal)  
Diversity/Stability

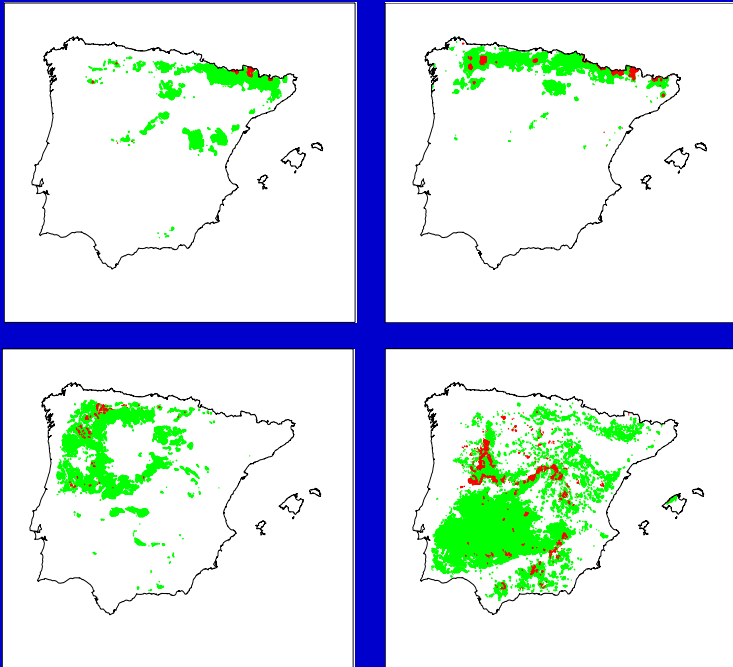
## Humans (Governance)

Protected areas network  
Ecological restoration  
Adaptive management

Fuente: *Elaborado a partir de Benito Garzón et al. 2009*

Incorporating adaptation mechanisms into SDM's

# ¿Resilience and adaptation mechanisms?



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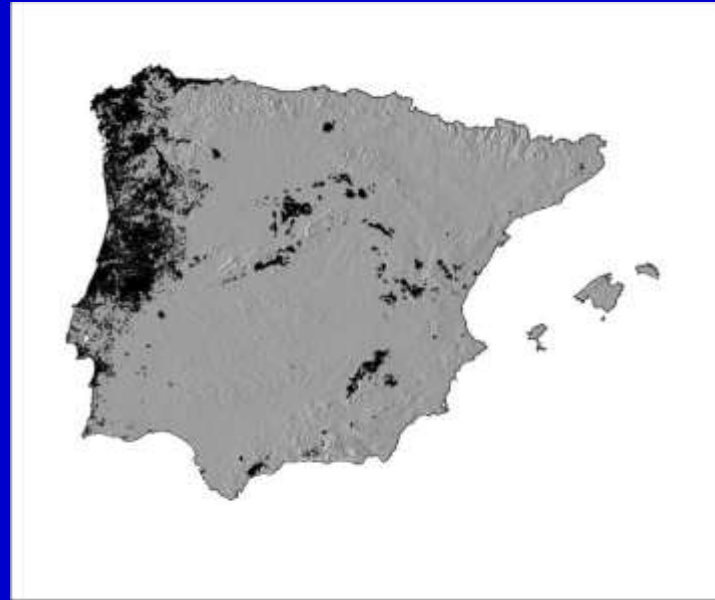
Protected areas network  
Ecological restoration  
Adaptive management

Incorporating adaptation mechanisms into SDM's

# Species distribution

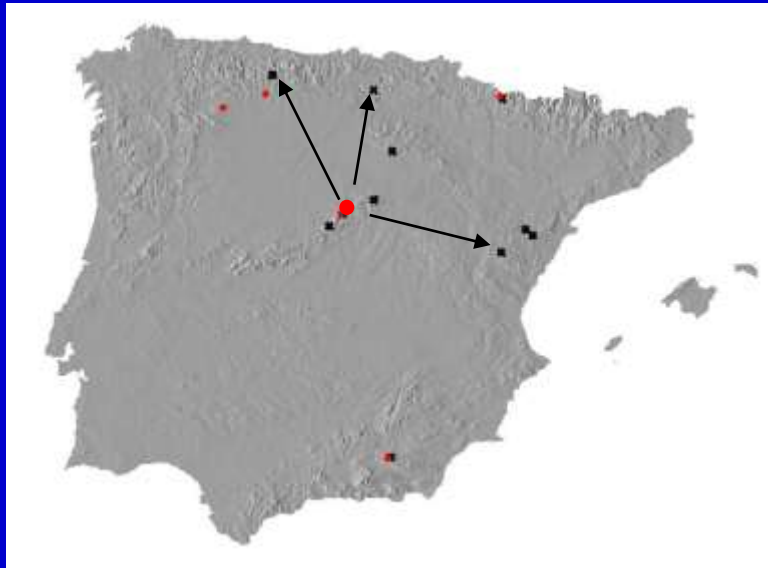


*Pinus sylvestris*



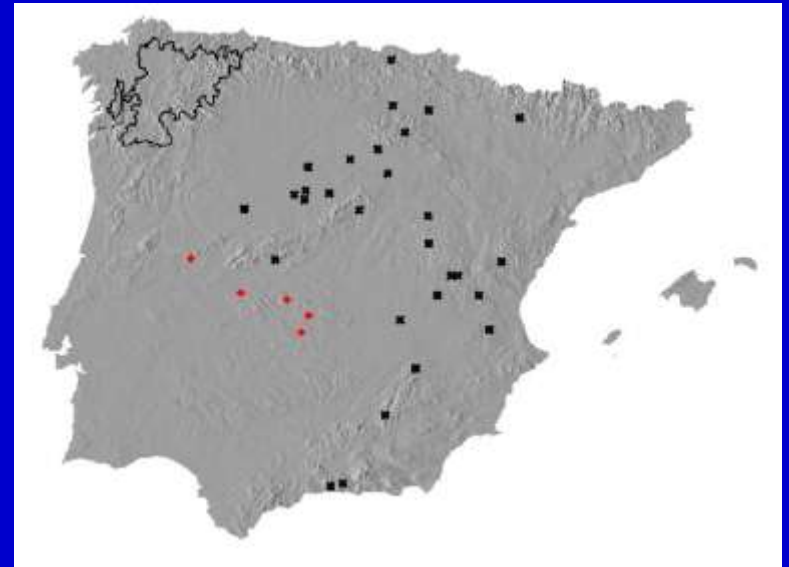
*Pinus pinaster*

# Models of tree survivorship as a function of environmental conditions and climatic distance to origin



*Pinus sylvestris*

Experimental design



*Pinus pinaster*

Provenances

Plantation sites

Alia et al., 1996; 1999; 2001; 2005

# Model parameterization:



selection

CART

random forest

neural networks

**HOLDOUT CROSS-VALIDATION**

Best model

develop

Cut-off threshold (kappa)



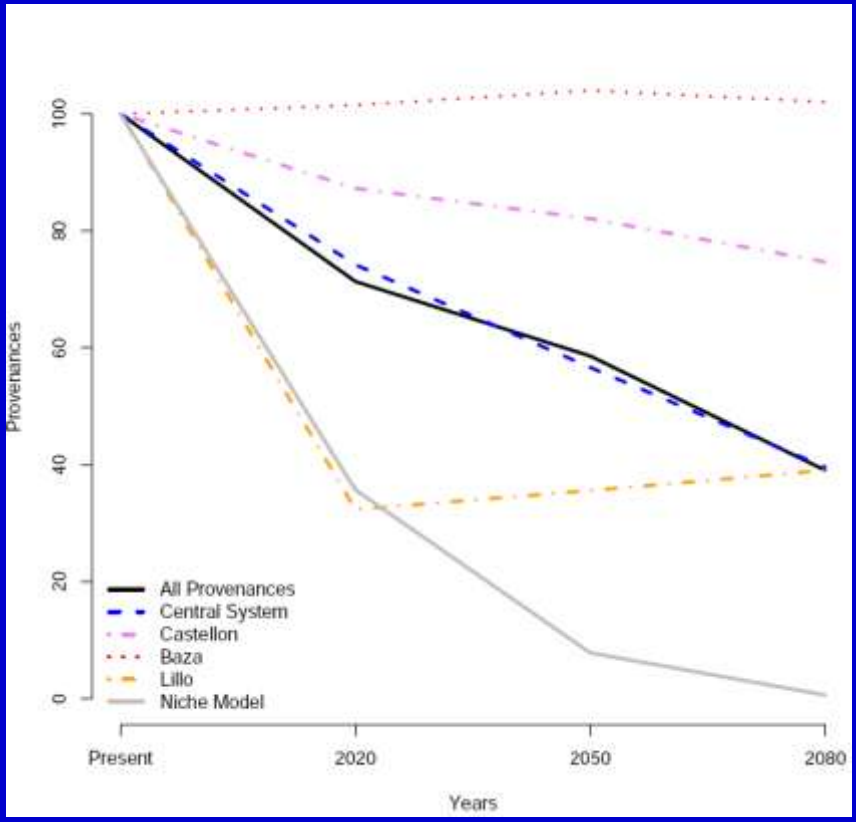
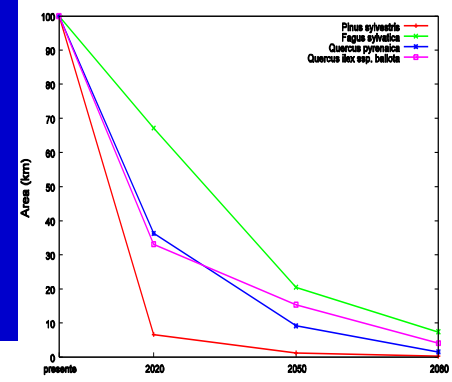
CLIMATE SCENARIOS  
✓ Present  
✓ 2020  
✓ 2050  
✓ 2080

**PRESENCE/AUSENCE** (Ruiz de la Torre, 2001) (Benito Garzon et al., 2006. Ecological Modelling)

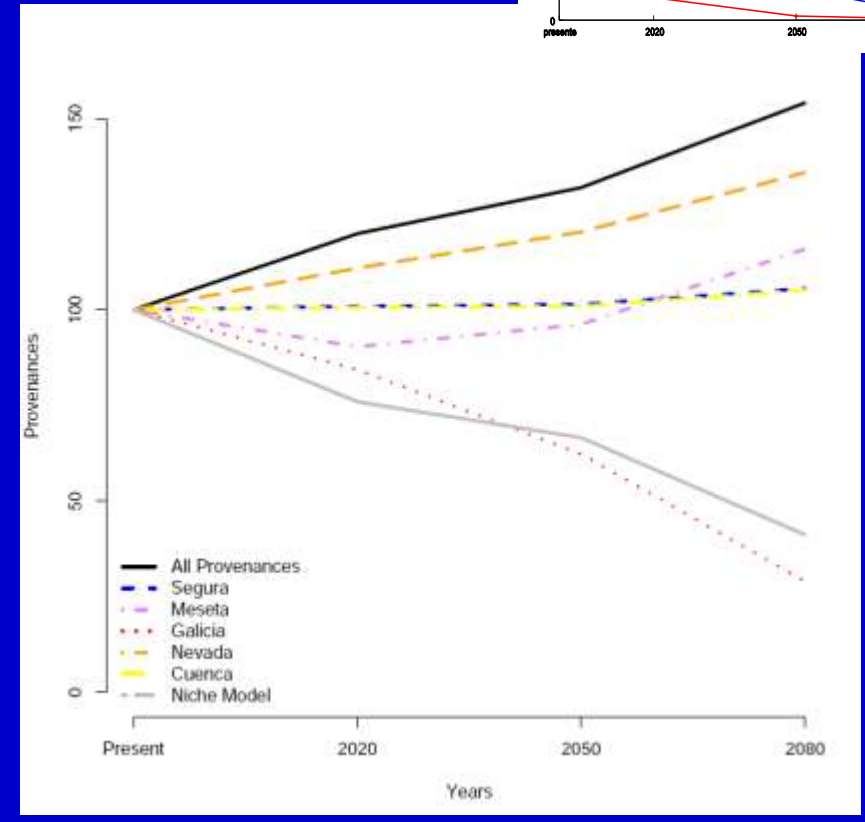
VS.

**SURVIVAL BY PROCEDENCE REGION** (In prep.)

# Preliminary results:



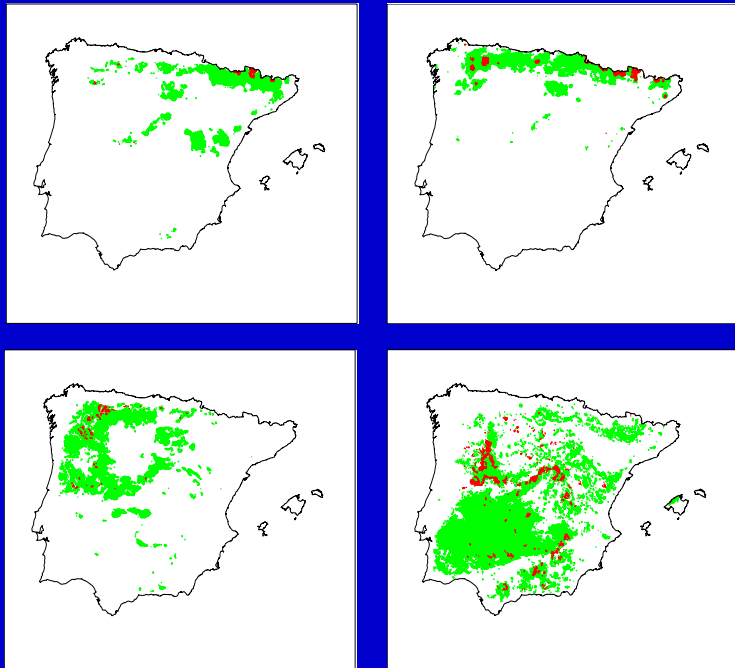
*Pinus sylvestris*



*Pinus pinaster*

Intra-specific variability and plasticity influence potential tree species distributions under climate change. 2011. Benito Garzón, M., R. Alía, M. Robson & M. A. Zavala. *Global Ecol. Biogeogr.* 646: 1-13.

# ¿Resilience and adaptation mechanisms?



Fuente: *Elaborado a partir de Benito Garzón et al. 2009*

## Genes

Epigenesis.  
Evolution  
Local adaptation  
Plasticity

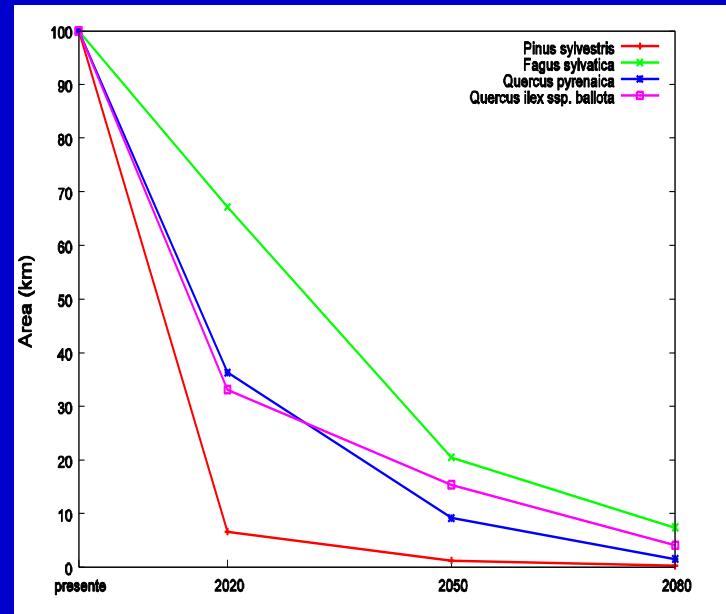
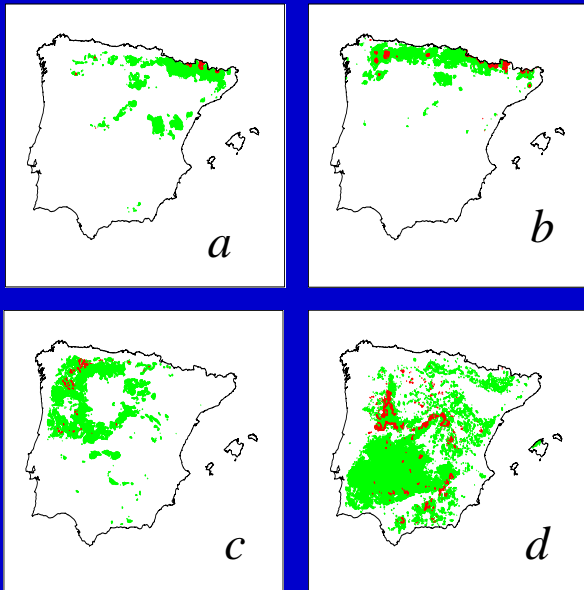
**Population  
and communities**  
Migration (dispersal)  
Diversity/Stability

## Humans (Governance)

Protected areas network  
Ecological restoration  
Adaptive management

Incorporating adaptation mechanisms into SDM's

## Species distribution models (SDM'S): climate change and predicted potential forest distribution

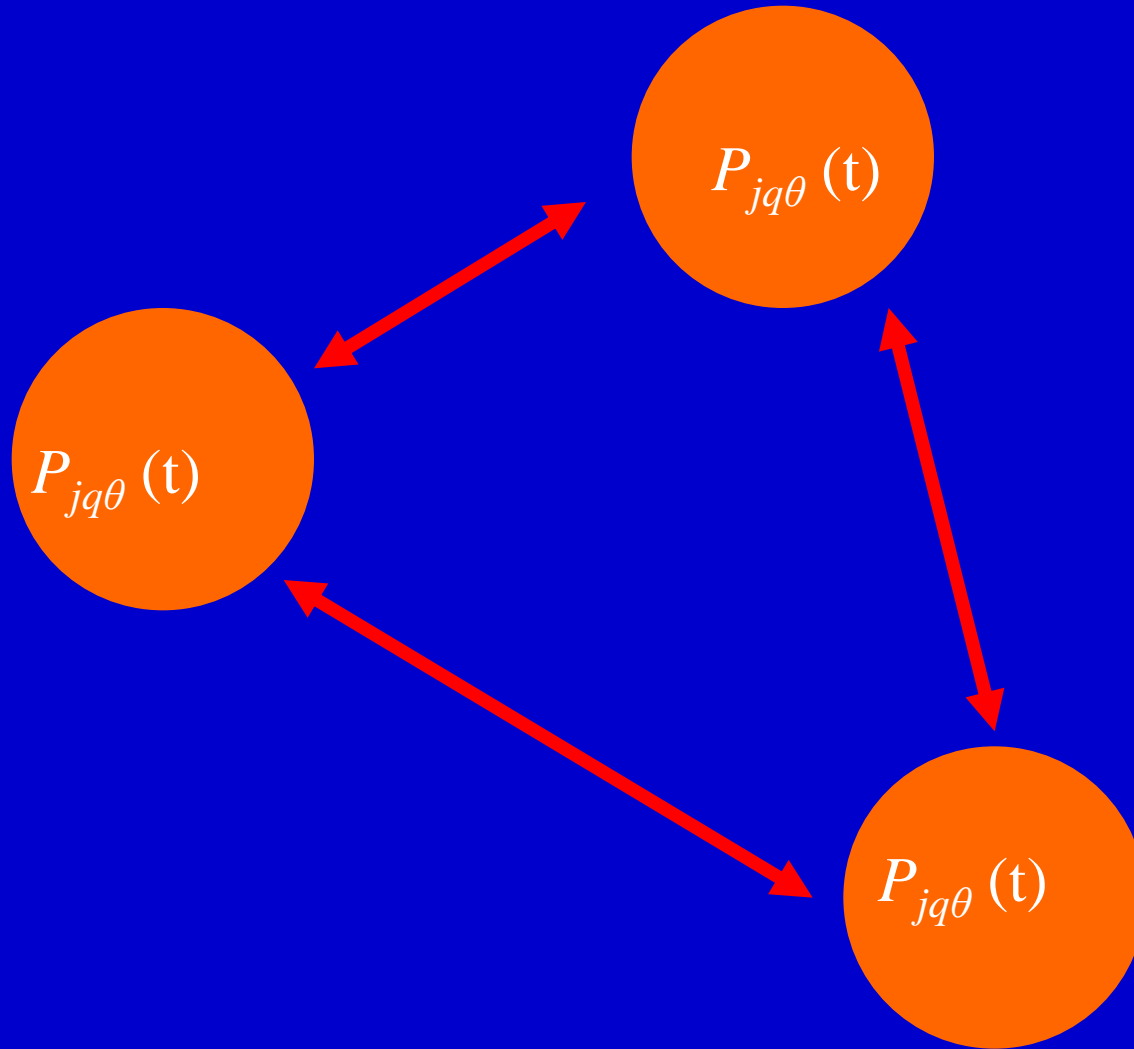


Changes in potential distribution area for selected Iberian forest tree species. Current area = 100%. Area decreases according to climatic predictions from scenario A2 CSIRO-Mk2 for 2020, 2050 and 2080.

# Species Distribution Models

- Presence / absence
- Assume equilibrium
- No dispersal
- No population dynamics

# *SPOM (“Stochastic Patch Occupancy Model”)*



# *SPOM (“Stochastic Patch Occupancy Model”)*

$$P[z_{j,i}(t+1) | z_{j,i}(t)] = \begin{cases} \phi_i & \text{if } z_{j,i}(t) = 1 \text{ and } z_{j,i}(t+1) = 0 \\ 1 - \phi_i & \text{if } z_{j,i}(t) = 1 \text{ and } z_{j,i}(t+1) = 1 \\ 1 - (1 - \alpha_{j,i})^{S_{j,i}(t)} & \text{if } z_{j,i}(t) = 0 \text{ and } z_{j,i}(t+1) = 1 \\ (1 - \alpha_{j,i})^{S_{j,i}(t)} & \text{if } z_{j,i}(t) = 0 \text{ and } z_{j,i}(t+1) = 0 \end{cases}$$

- 1) Distance to seed source.
- 2) Post-fire genet mortality.



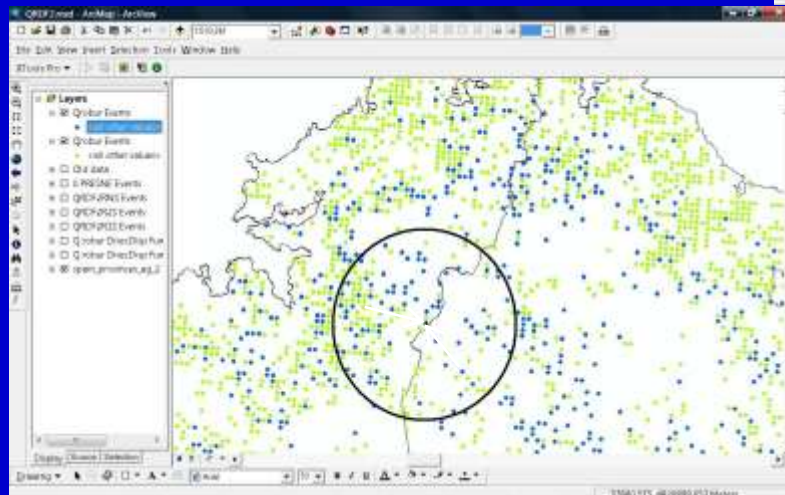
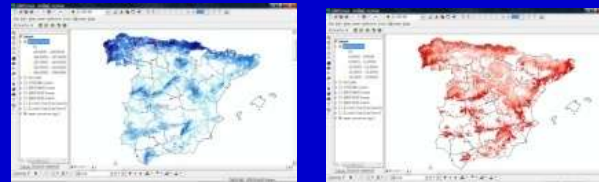
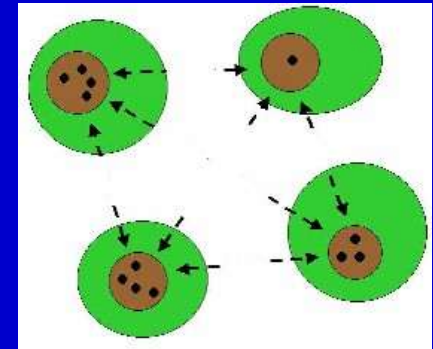
# Model fitting

1990 → 2000 inside the forest

*Quercus robur* 0 → 1  
1 → 0

$$P_{j,q,\theta} (1 \rightarrow 0) = f(P, T)$$

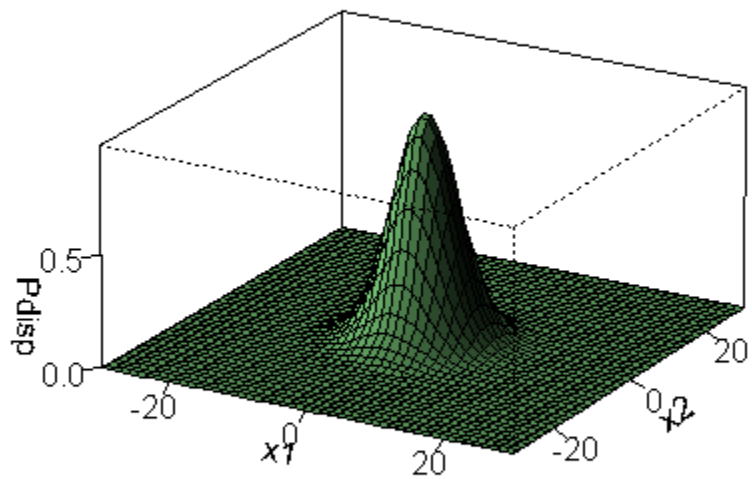
$$P_{j,q,\theta} (0 \rightarrow 1) = f(P, T, \text{DistF}, \text{DistSp})$$



## Neighborhood

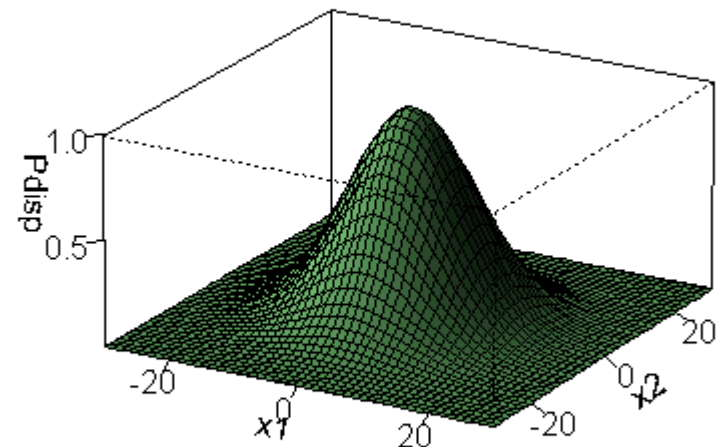
Random dispersal - Mediated dispersal

### Pinus sylvestris dispersal kernel

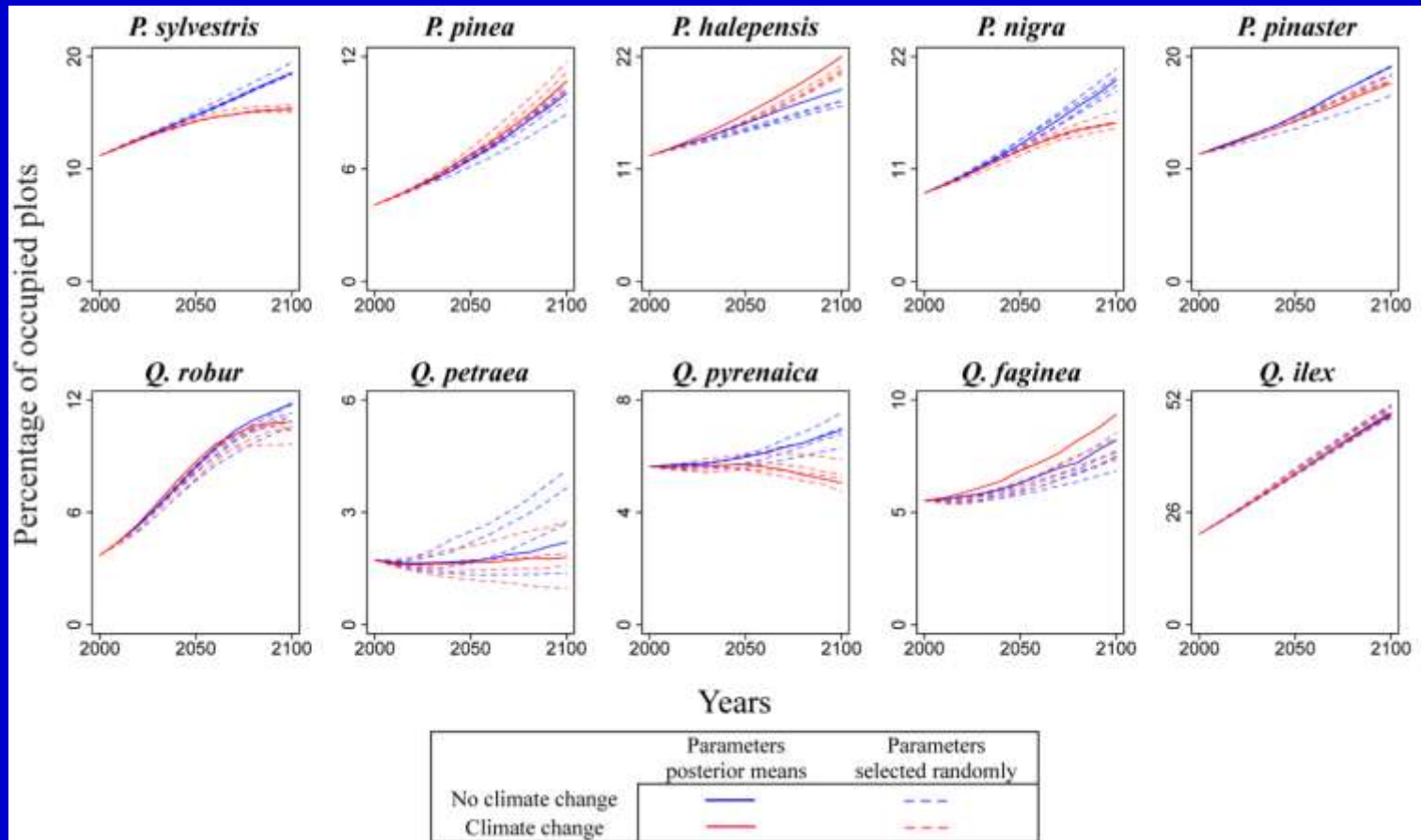


$$f(\mathbf{x}) = \exp\left(-\frac{\sqrt{x_1^2 + x_2^2}}{\sigma}\right)^2 \quad \sigma = 6.19$$

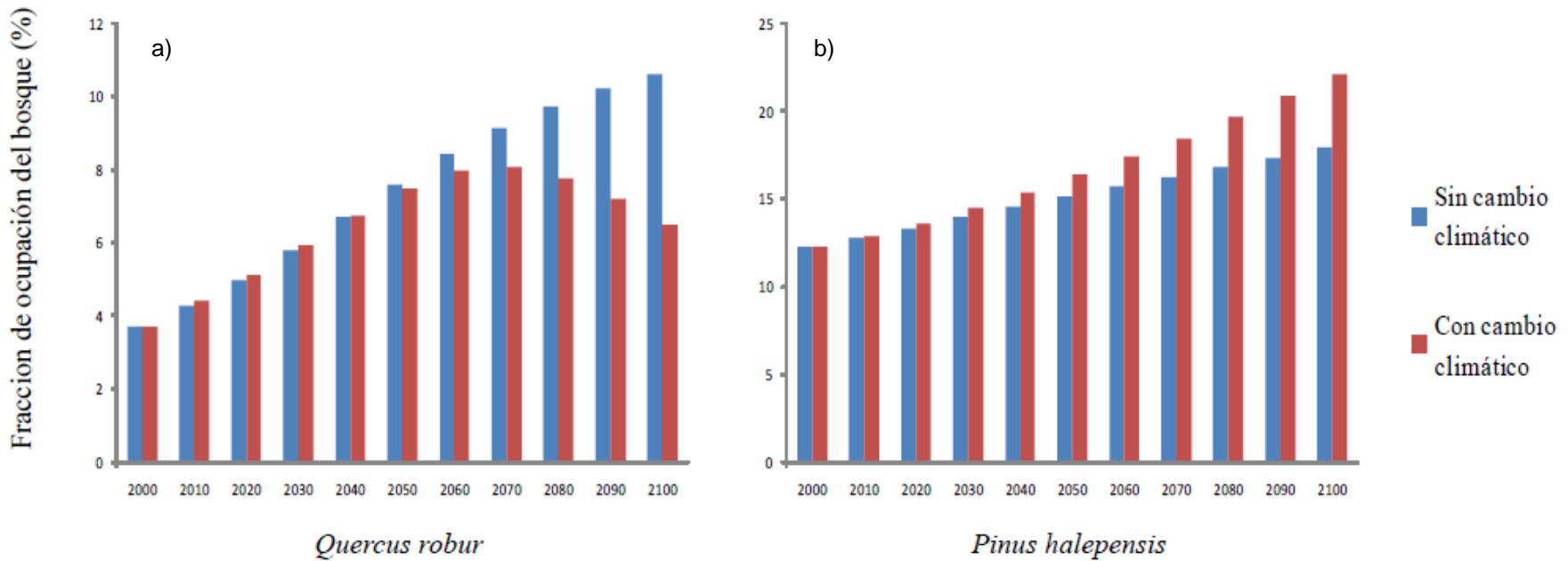
### Quercus faginea dispersal kernel



$$f(\mathbf{x}) = \exp\left(-\frac{\sqrt{x_1^2 + x_2^2}}{\sigma}\right)^2 \quad \sigma = 12.54$$

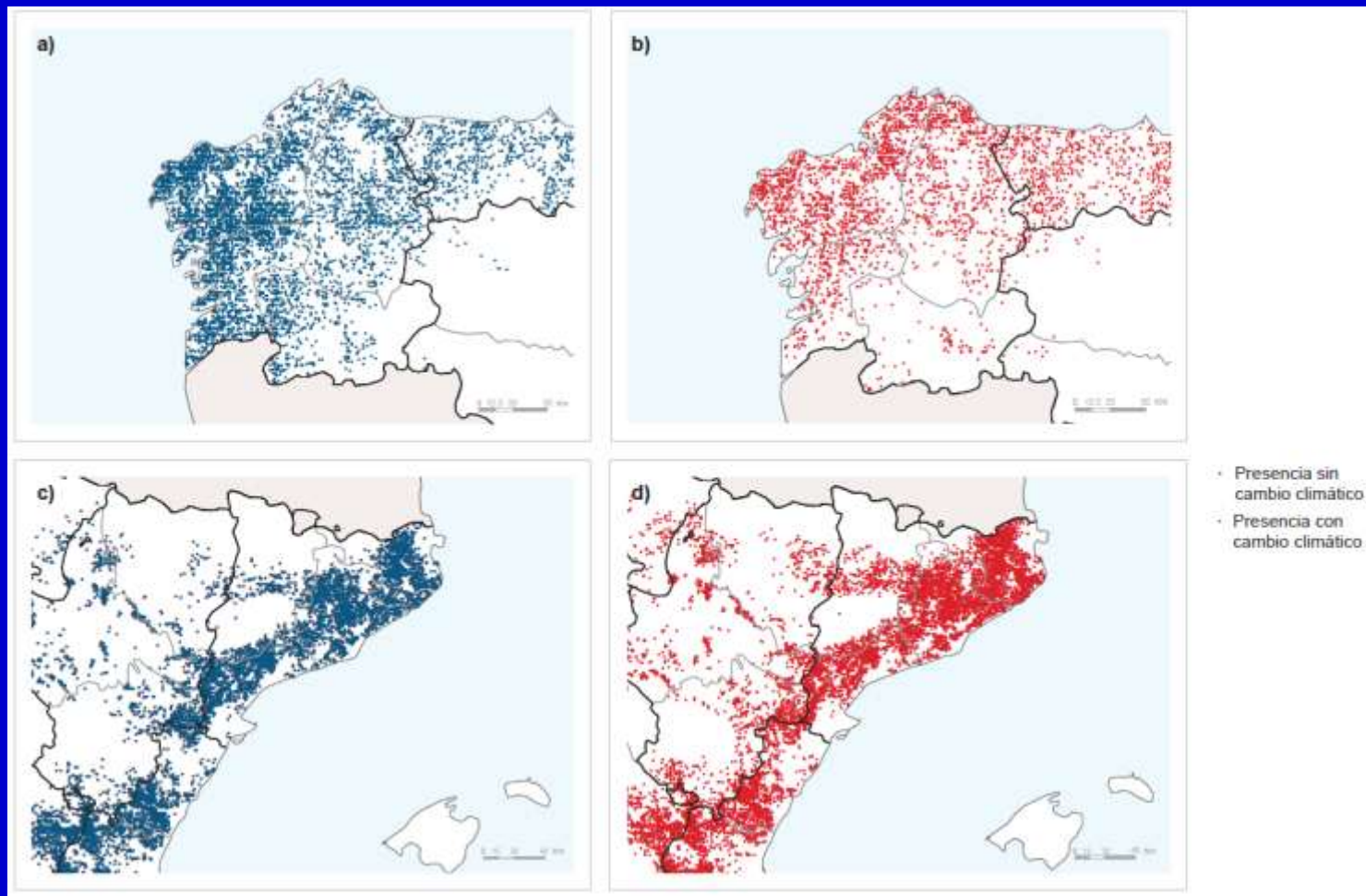


Species fraction of occupied plots from year 2000 to year 2100. One simulation using the posterior means for the parameter values, and four simulations using parameter sets drawn randomly from the samples generated by the MCMC algorithm.



Proyecciones de la fracción de ocupación del bosque, número de parcelas en las que está presente la especie respecto al total de parcelas de bosque, en 2100 con y sin cambio climático para (a) el roble común (*Q. robur*) y (b) el pino carrasco (*P. halepensis*)

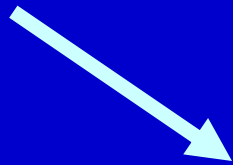
Proyecciones de la fracción de ocupación del bosque de *Q. robur* en 2100 sin y con cambio climático (a y b respectivamente) y para el *P. halepensis* (c y d respectivamente).



Fuente: Elaboración OSE a partir de García-Valdés et al. (2010)<sup>18</sup>. Nota: las Islas Baleares no se incluyeron en el análisis.

# Líneas futuras:

MODELOS  
DATOS



SOSTENIBILIDAD / ADAPTABILIDAD

