Universidad de Alcalá

Dinámica y mecanismos de segregación y coexistencia en las principales especies de Quercus *ibéricas*

Miguel Angel de Zavala

Jornada de presentación del libro "Oaks Physiological Ecology"

Zaragoza, 15 de junio de 2018

Conceptos clave

- *Impactos*: efectos específicos y cuantificables atribuibles al cambio climático.

- *Vulnerabilidad*: consta de tres componentes.

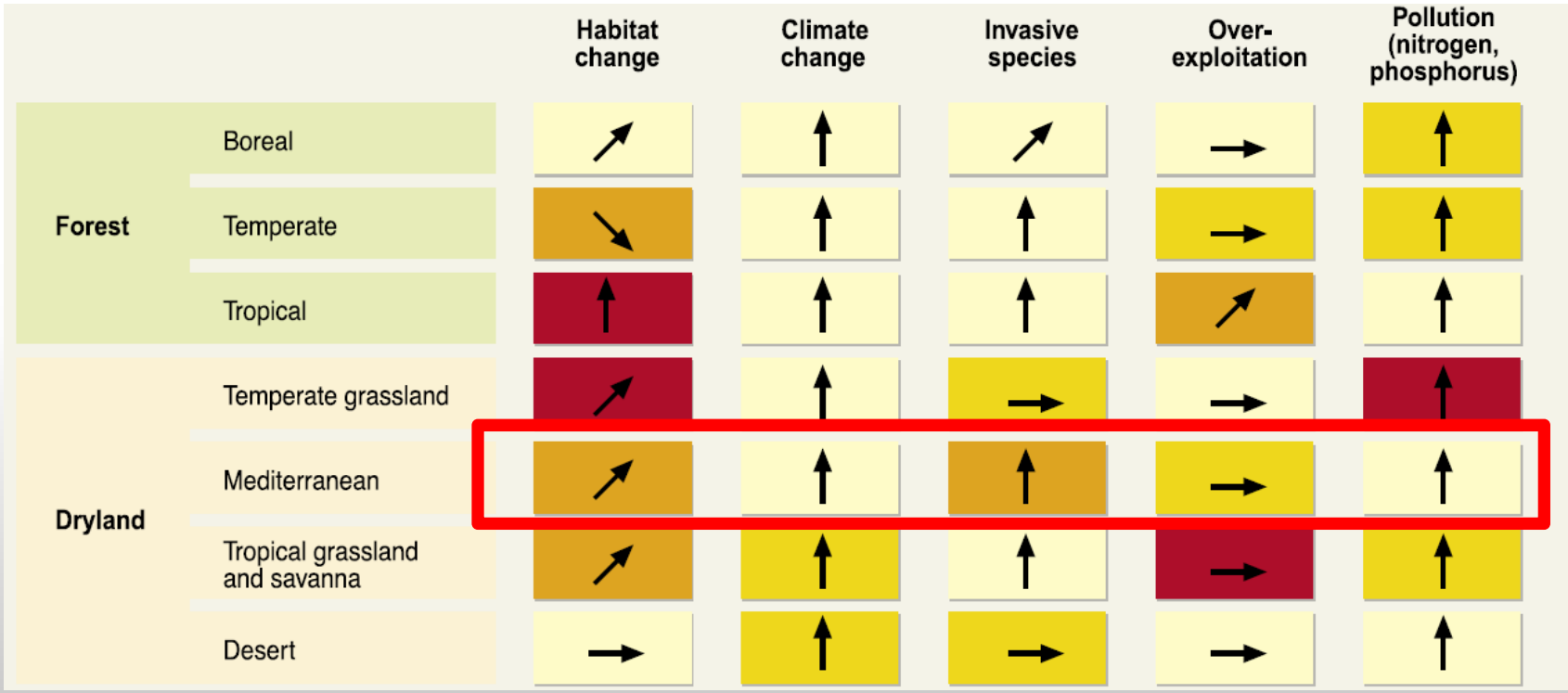
-***Exposición*:** la severidad del cambio climático que es probable que experimente una población o especie en una determinada localidad o región.

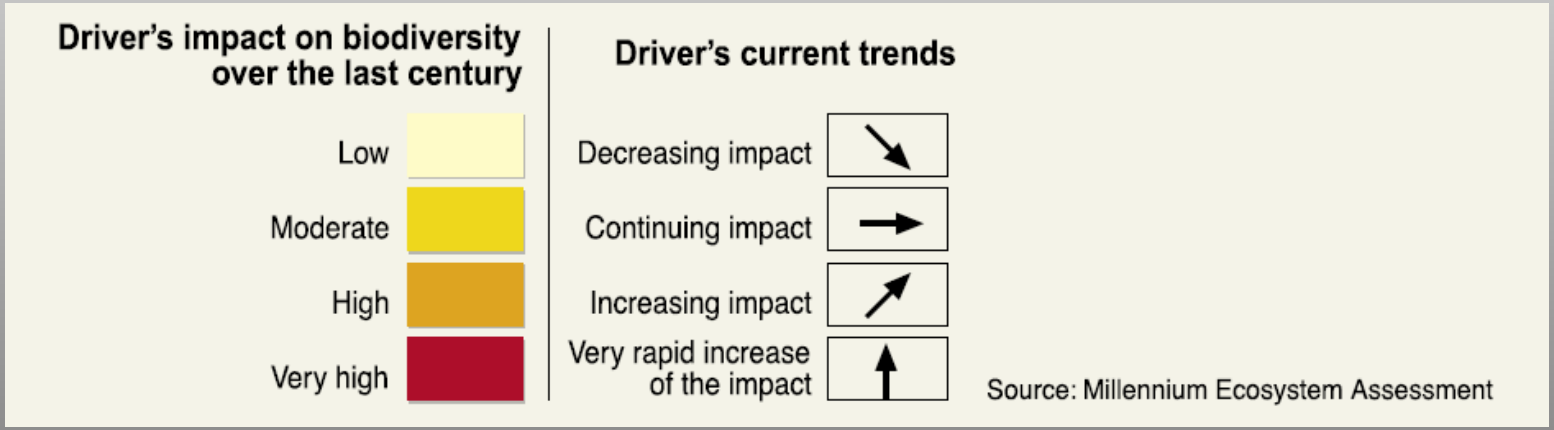
-***Sensibilidad:*** el grado en el que el crecimiento, reproducción, reclutamiento o supervivencia de los individuos de una población (de una determinada especie) dependen del clima predominante.

A nivel de especie es el grado en el que la persistencia de las diferentes poblaciones dependen del clima.

-***Capacidad de adaptación*:** la capacidad de una especie, o de las poblaciones que la constituyen, de hacer frente a los efectos negativos del cambio climático.

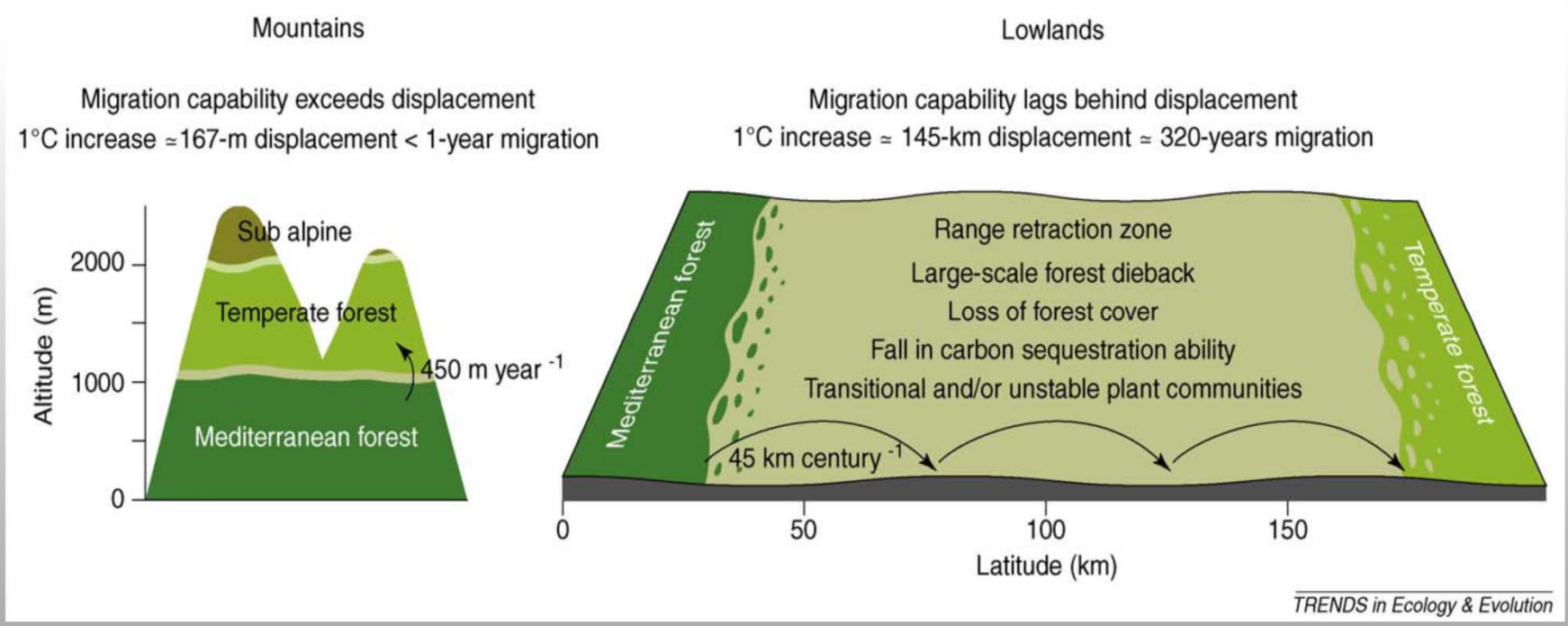
- *Adaptación*: la intervención humana que busca facilitar el ajuste de los sistemas naturales o humanos al clima real o proyectado y sus efectos.





http://www.youtube.com/watch?v=MaKKKdoLc2g

Importancia ecotonos

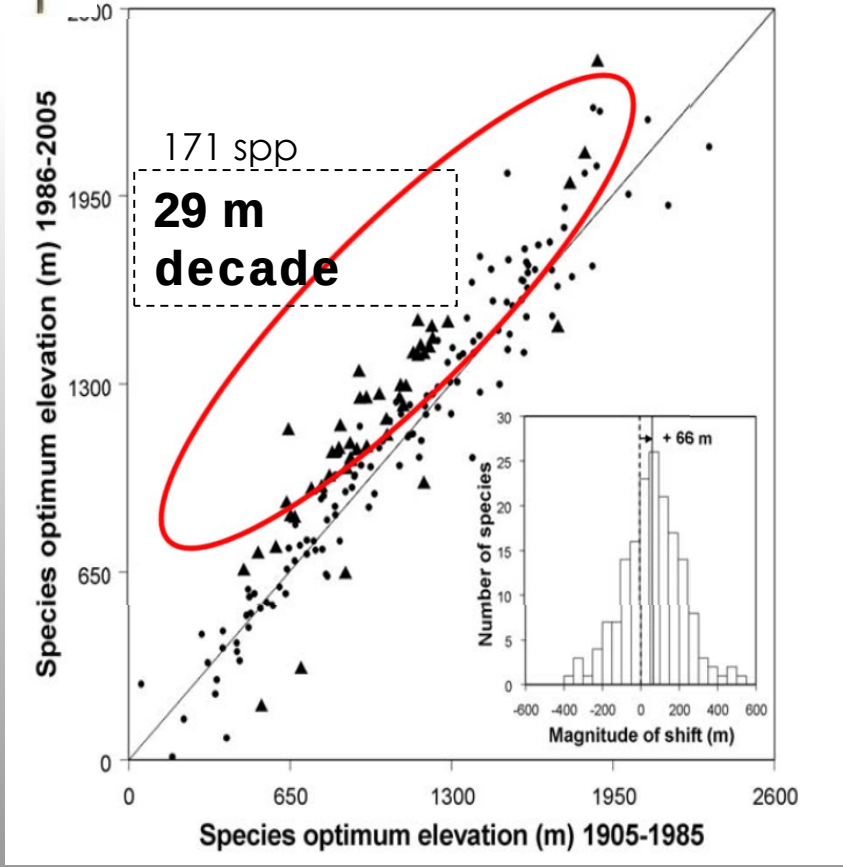


Jump *et al.* 2006

Gradientes altitudinales

171 spp

29 m decade

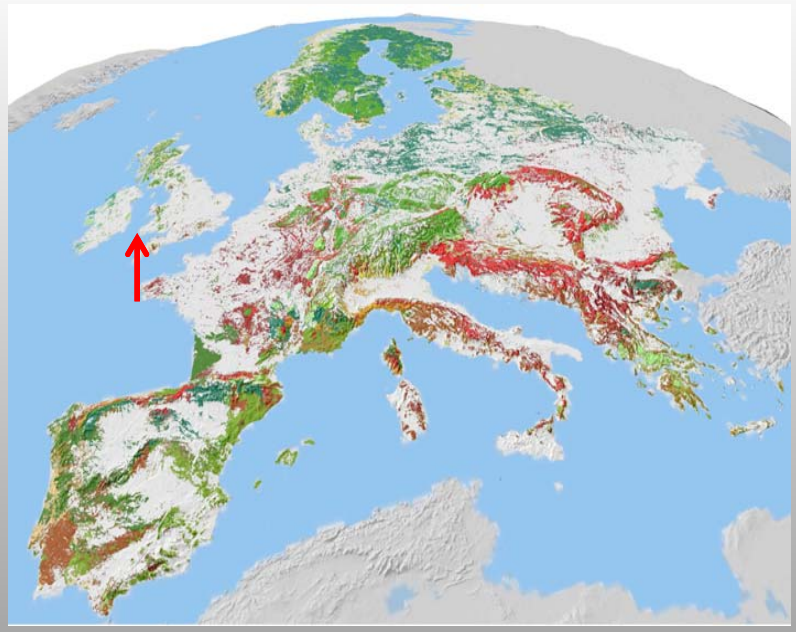


Lenoir *et al.* 2008, Science

Gradientes latitudinales

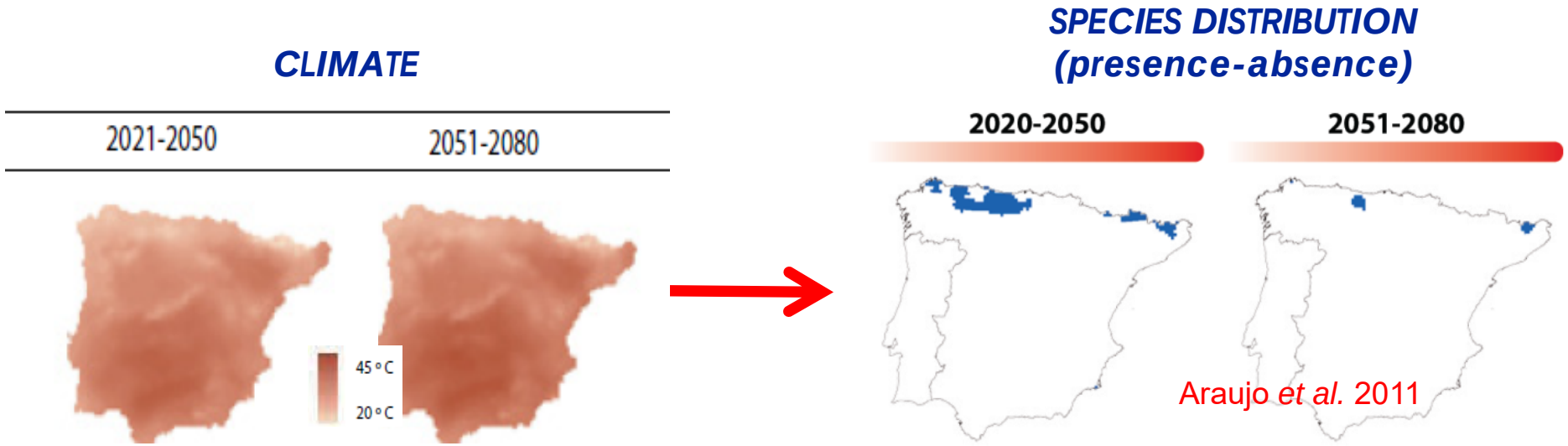
6 km decade

1,700 spp

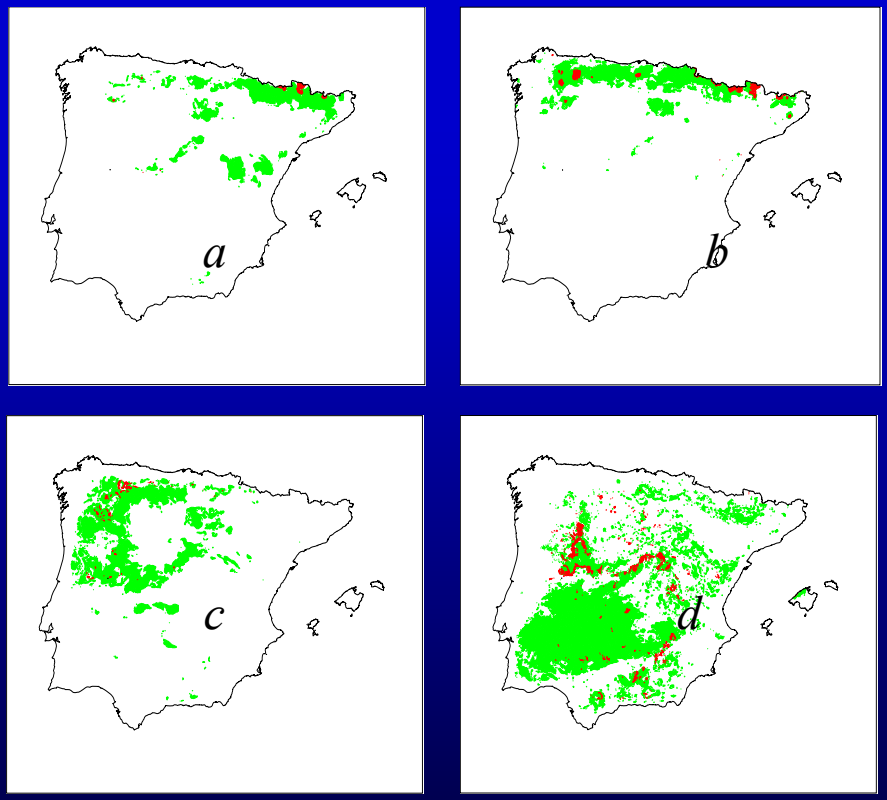


Parmesan & Yohe 2003, Nature

Classical Species Distribution Models (SDM)



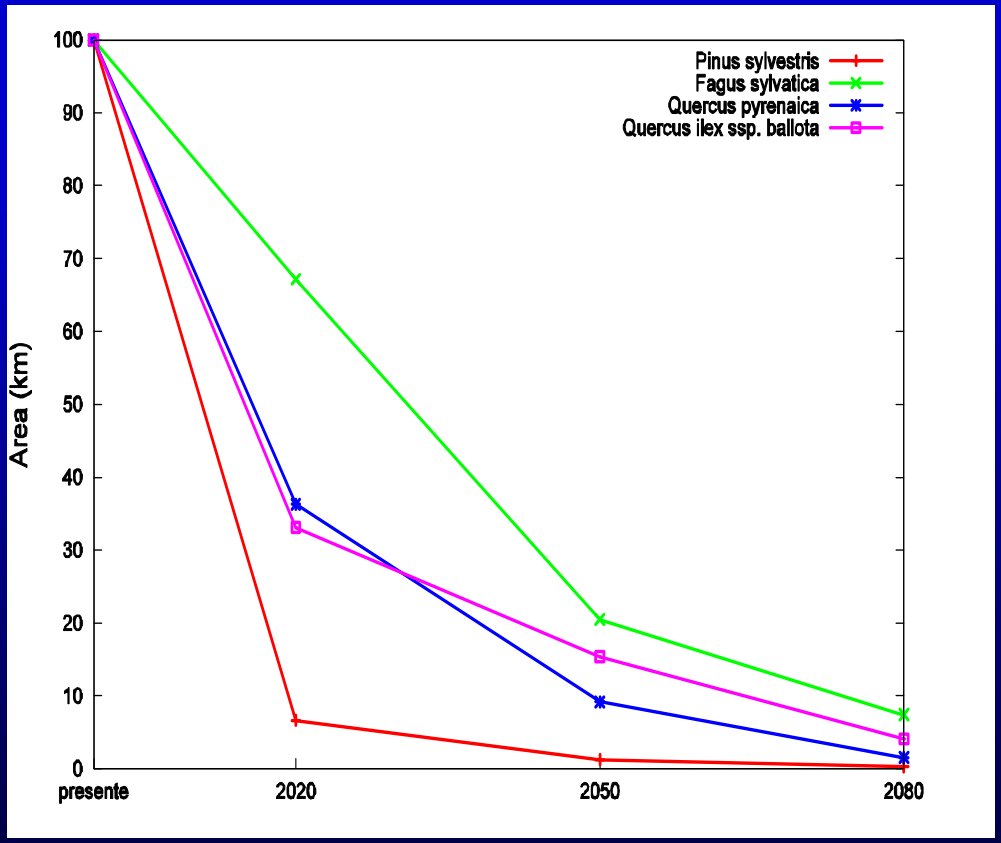
Vulnerability to climate change: potential tree species distributions



Source *Benito Garzón et al.* 2009

Changes in potential distribution of tree species; current (green) and 2080 (red) under scenario A2 CSIRO-Mk2 for *Pinus sylvestris* (a), *Fagus sylvatica* (b), *Quercus pyrenaica* (c) and *Quercus ilex* subsp. ballota (d)

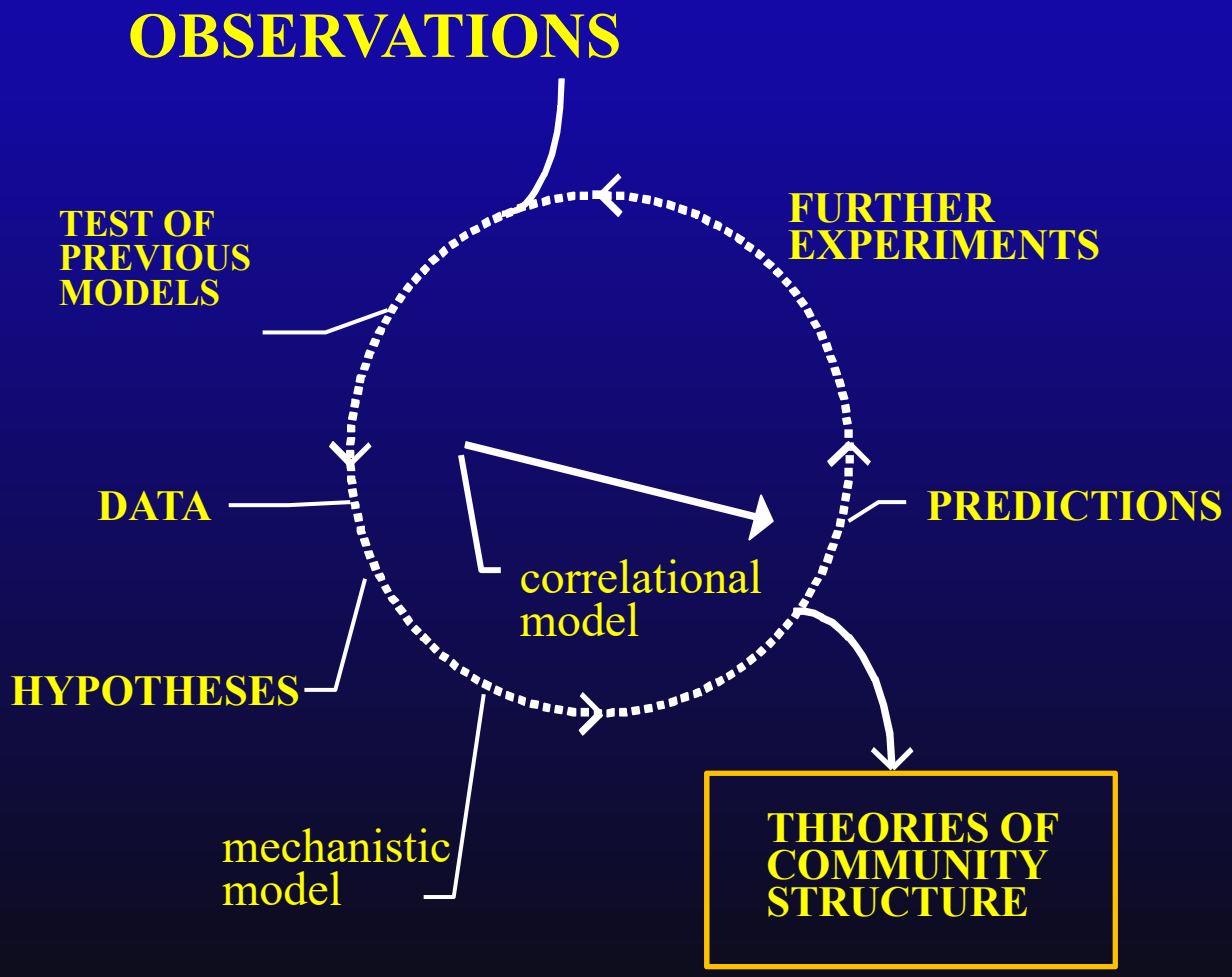
Vulnerability to climate change: potential tree species distributions



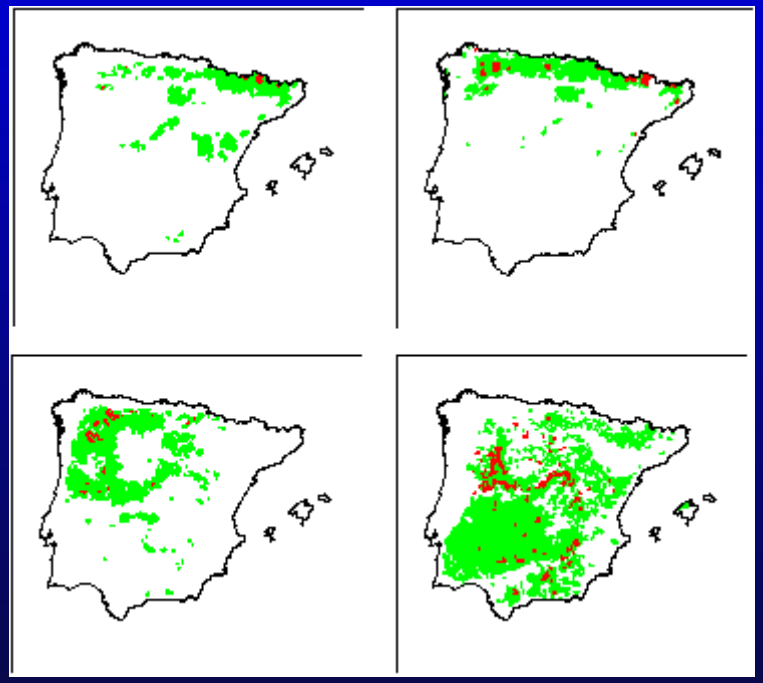
Source *Benito Garzón et al.* 2009

Changes in potential distribution of tree species. Current = 100%. Potential area decreases according to A2 CSIRO-Mk2 for 2020, 2050 and 2080.

The Role of Models in Global Change Research



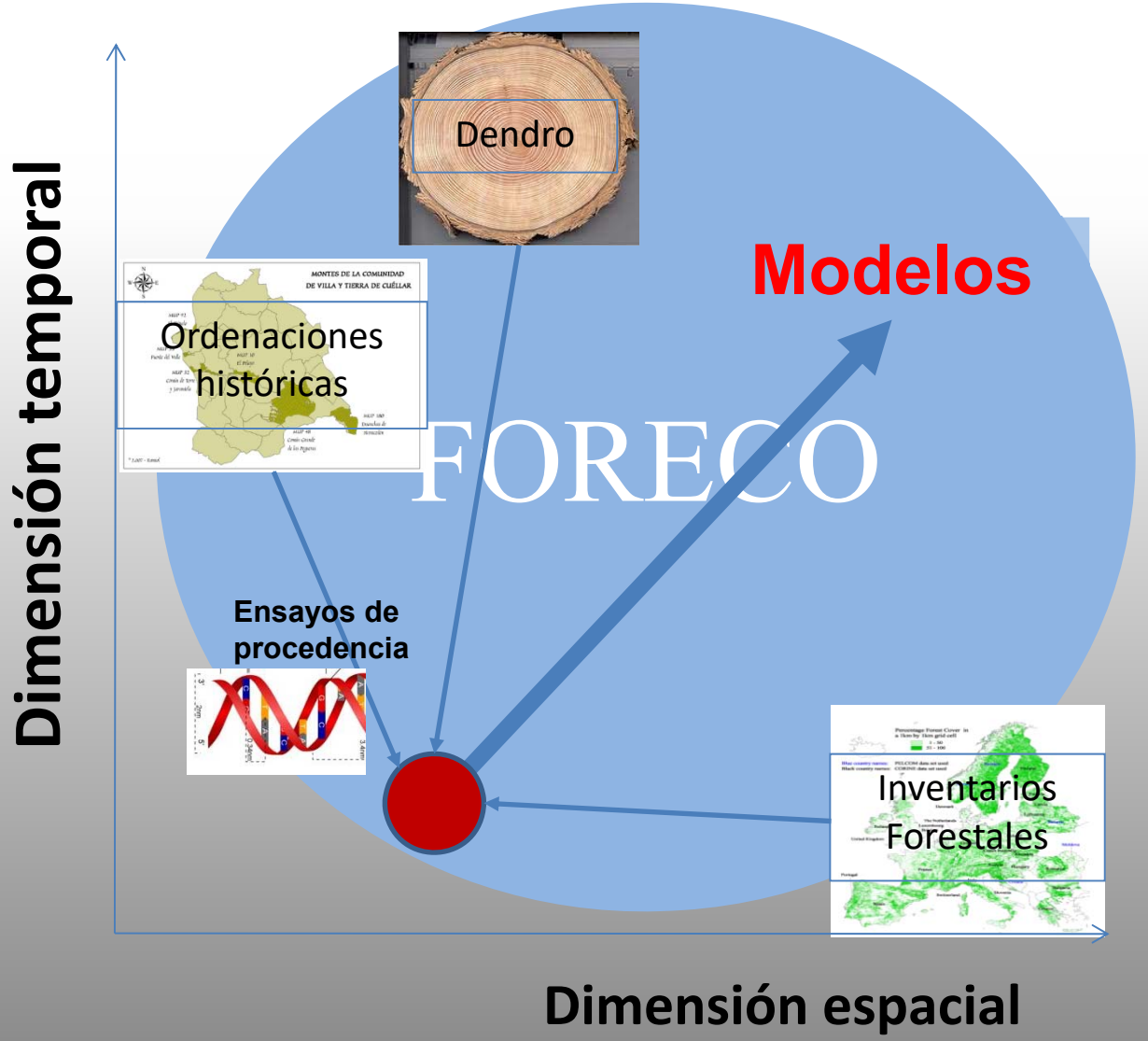
Including ecological and adaptive mechanisms in vulnerability models.



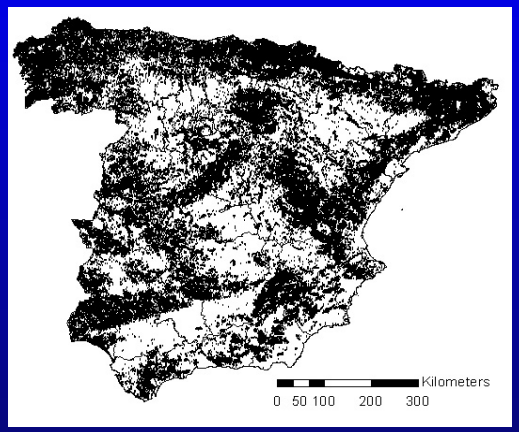
Genes & organismic
Epigenesis.
Evolution/Local adaptation
Plasticity

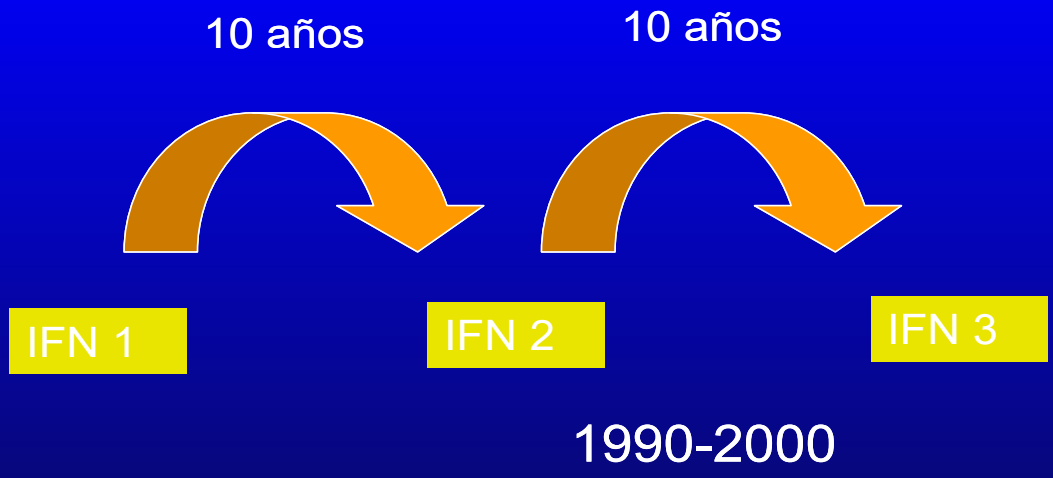
Population and communities
Demographic compensation
Migration (dispersal)
Diversity/Stabiilty

Ecosystem & landscape.
CO_2 fertilization
Land use governance


Dendro
Modelos
Ordenaciones históricas
FORECO
Ensayos de procedencia
Inventarios Forestales
Dimensión temporal
Dimensión espacial

Temporal **sampling**





Forest plot distribution IFN (89365 plots) in continental Spain (1 plot per Km^2).

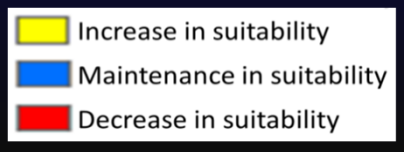
Benito-Garzón et al. (2013). Inter-specific differences in tree growth and mortality responses to climate determine potential species distribution limits in Iberian forests. Global Ecology and Biogeography). DOI: 10.1111/geb.12075

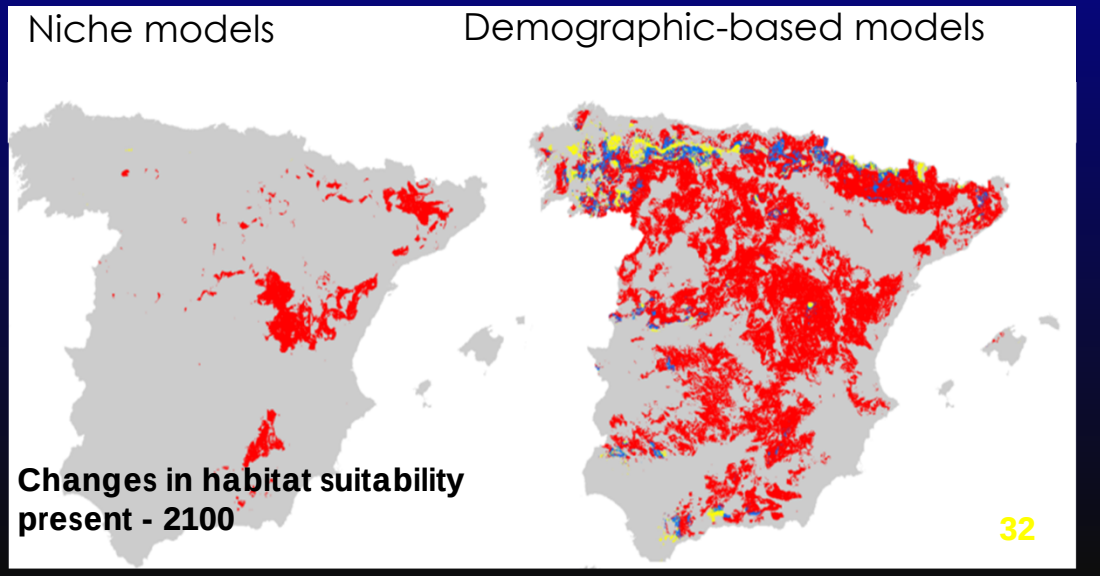
Species	Growth	Mortality
Pinus halepensis	↗	↗
P. pinea	↗	↗
P. pinaster	↗	↗
P. nigra	↗	↗
P. sylvestris	↗	↗

Species	Growth	Mortality
Quercus suber	↗	↘
Q. petraea	↘	↗
Q. robur	↗	↗
Abies alba	↗	↗
Castanea sativa	↗	↗
Fagus sylvatica	↗	↗

Compare to classical niche models

- Habitat reductions: Rear-edge Iberian Peninsula
- Habitat expansion: Mediterranean species





Changes in habitat suitability present - 2100

Ruiz-Benito et al (2013). Patterns and drivers of tree mortality in Iberian forests: climatic effects are modified by competition. PLoS ONE 8: e56843. doi: 10.1371/journal.pone.0056843

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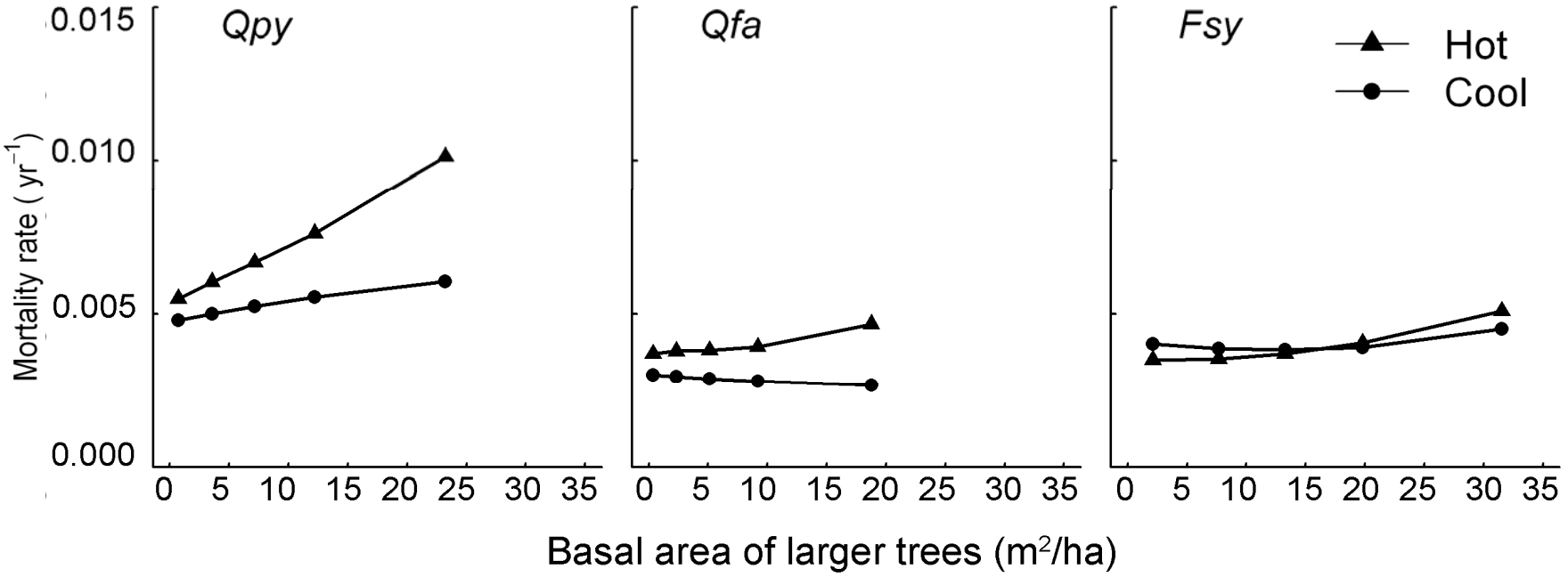
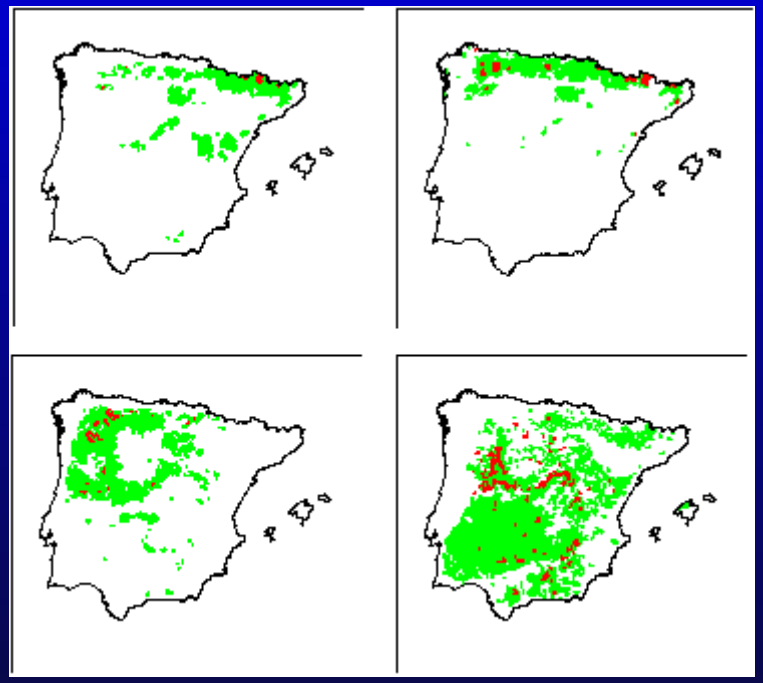
↑ mortality rates in hot sites at high competition levels



Pinus halepensis
Pinus pinea
Pinus pinaster
Pinus nigra
Pinus sylvestris
Pinus uncinata
Quercus ilex
Quercus suber
Quercus pyrenaica
Quercus faginea
Fagus sylvatica

Including ecological and adaptive mechanisms in vulnerability models.



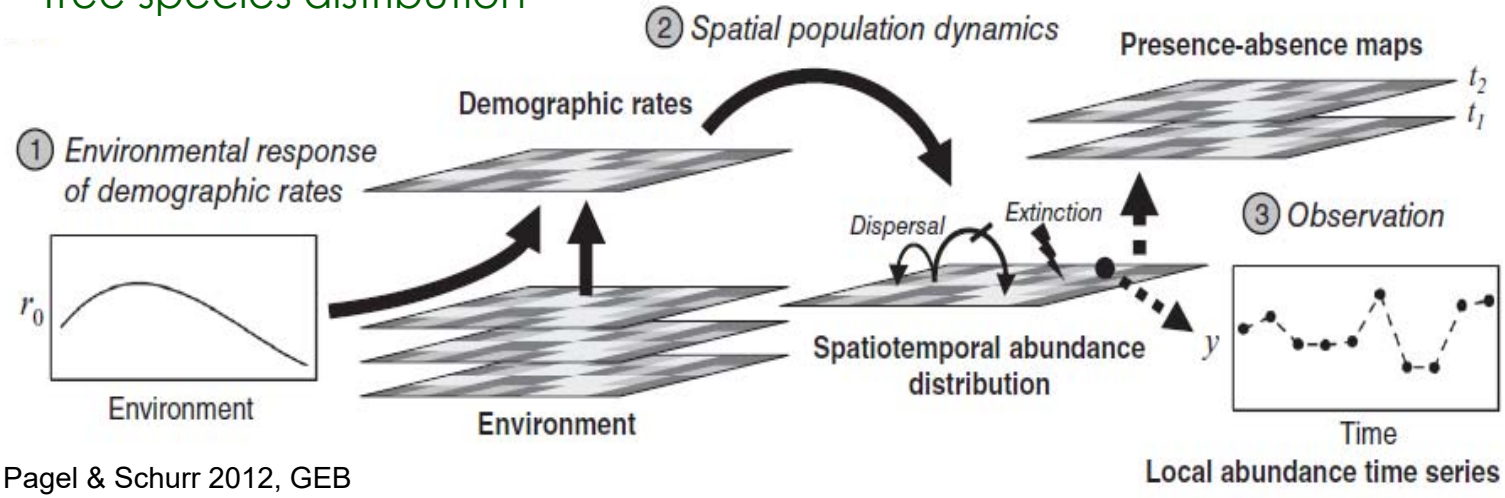
Genes & organismic
Epigenesis.
Evolution/Local adaptation
Plasticity

Population and communities
Demographic compensation
Migration (dispersal)
Diversity/Stabiilty

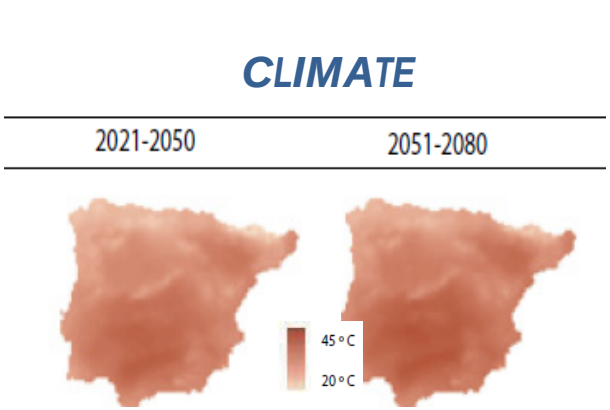
Ecosystem & landscape.
CO_2 fertilization
Land use governance

Hypothesis: *"Source-sink dynamics"*

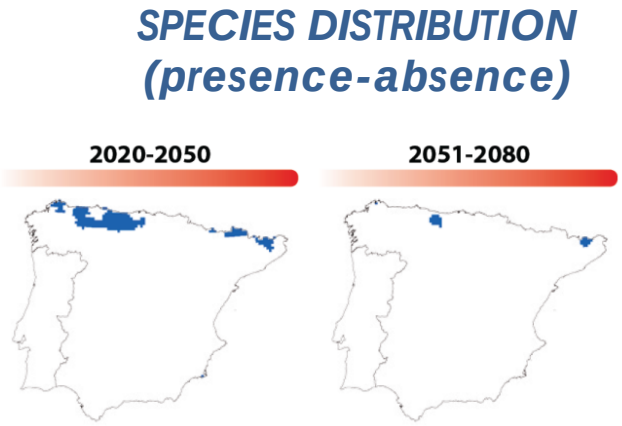
Tree species distribution



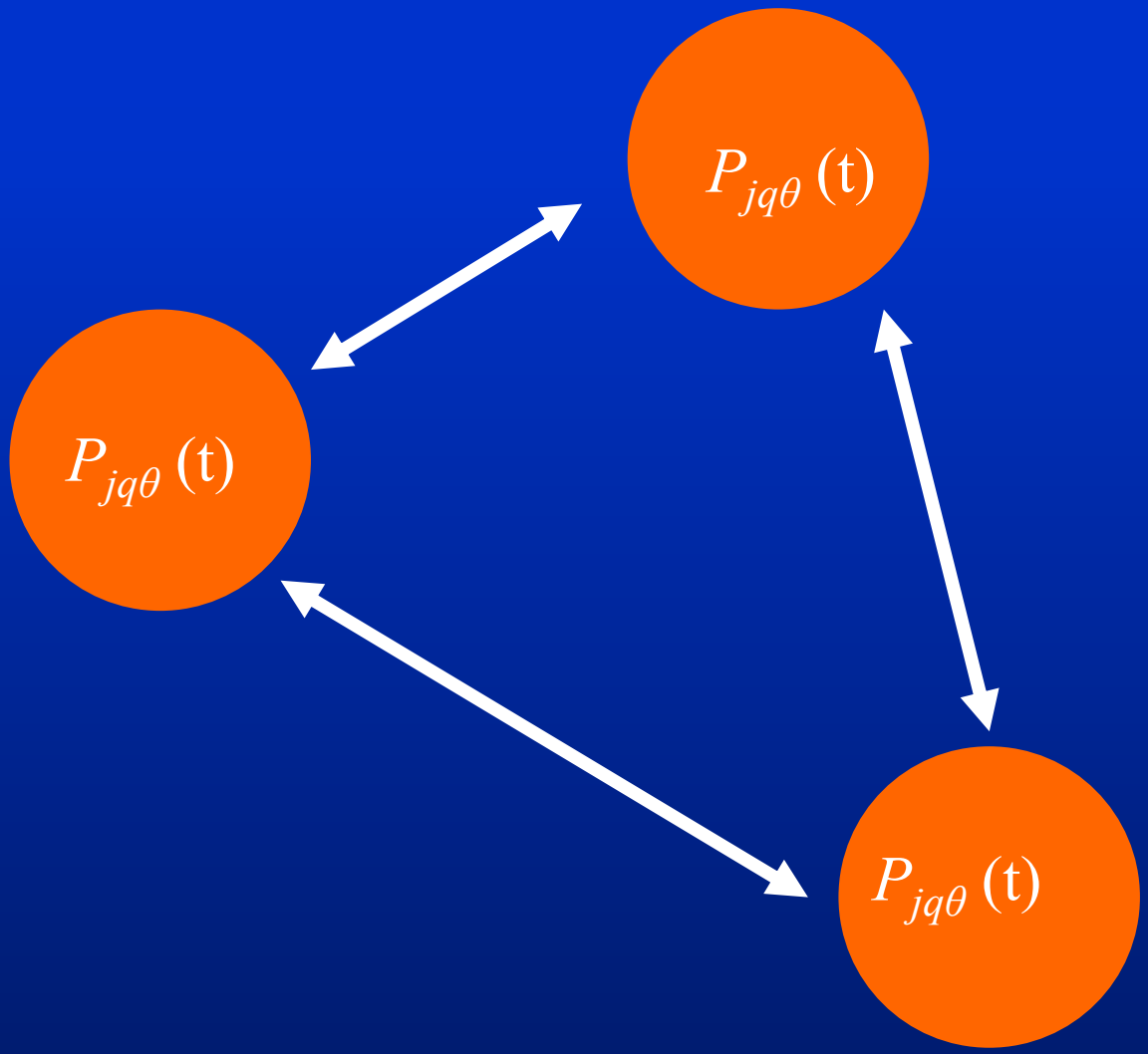
Pagel & Schurr 2012, GEB



Classical Species Distribution Models (SDM)

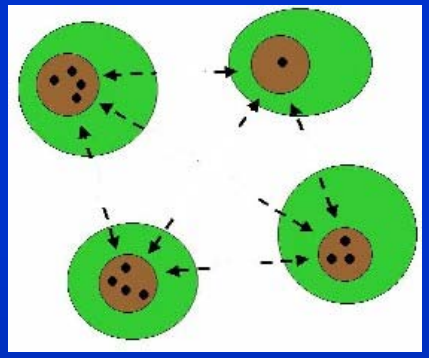


SPOM ("Stochastic Patch Occupancy Model")



Vulnerability to Climate Change

Model fitting



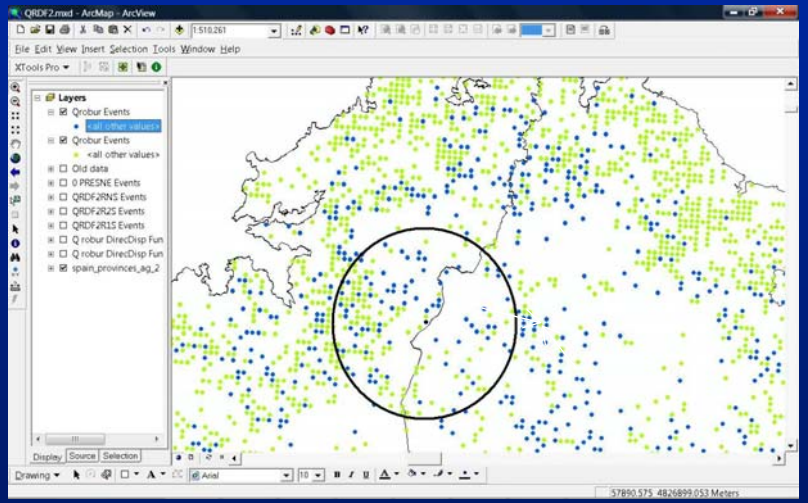
1990 2000 inside the forest

Quercus robur

0 → 1
1 → 0

$P_{j,q,\theta}$ (1→0) = f (P, T)

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



Neighborhood

Random dispersal - Mediated dispersal

SPOM ("Stochastic Patch Occupancy Model")

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

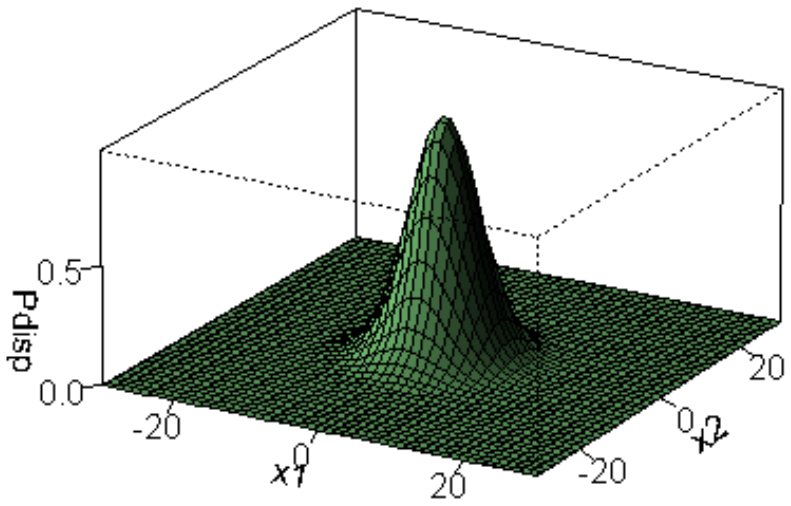
1) Distance to seed source.

2) Post-fire genet mortality.

Purves, D., M. A. Zavala, K. Ogle, F. Prieto, y J.M. Rey Benayas. 2007. Environmental heterogeneity, bird-mediated directed dispersal, and oak woodland dynamics in Mediterranean Spain. Ecological Monographs 77:77–97.

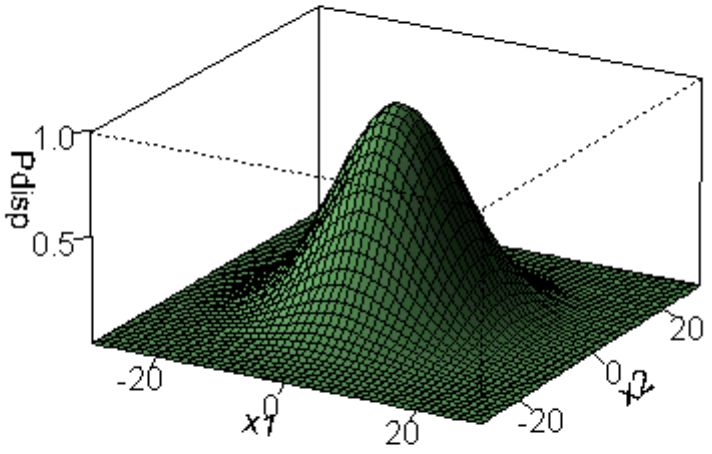
Vulnerability to Climate Change

Pinus sylvestris dispersal kernel



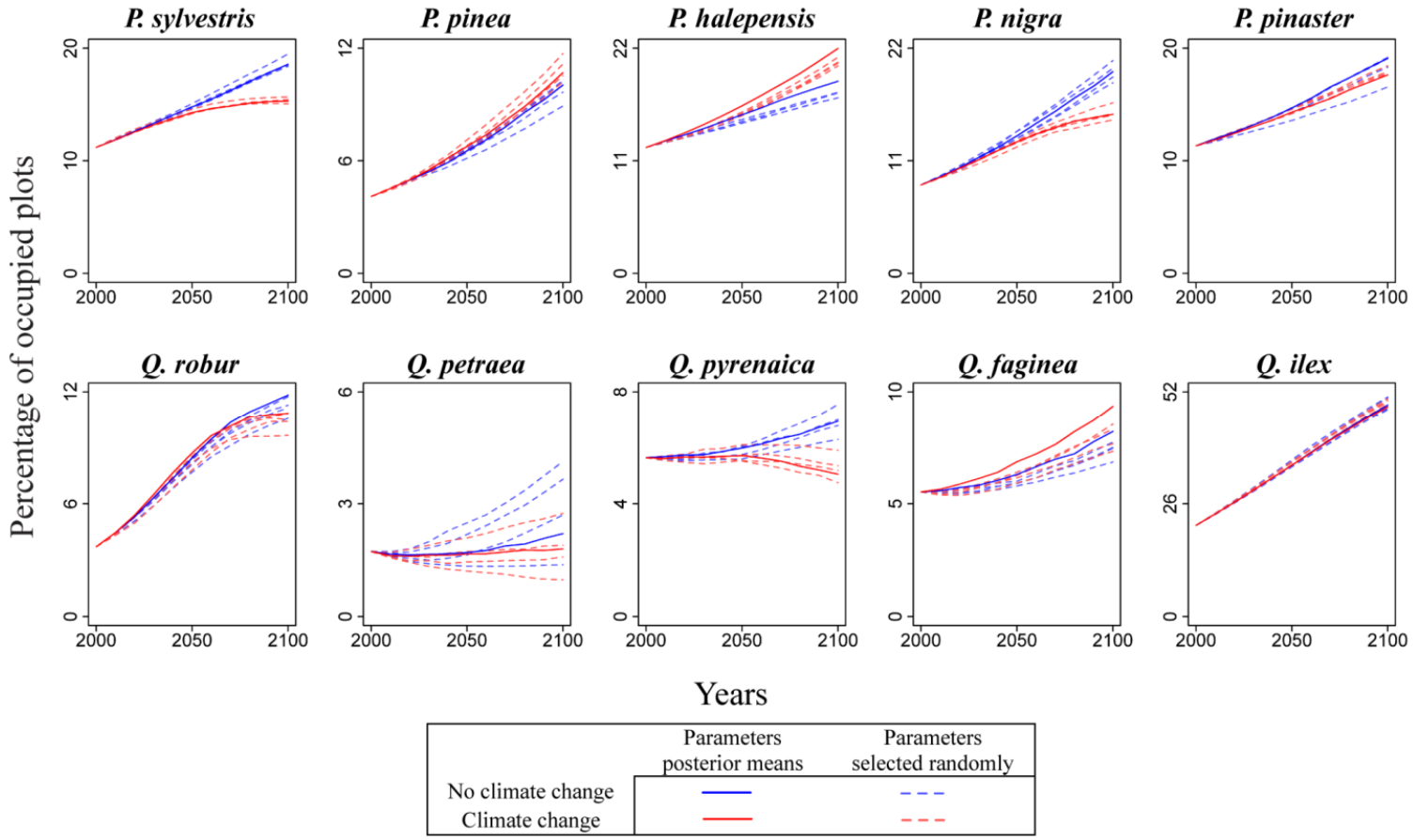
$$f(\mathbf{x}) = \exp\left(-\left[\frac{\sqrt{x1^2 + x2^2}}{\sigma}\right]^2\right) \qquad \sigma = 6.19$$

Quercus faginea dispersal kernel



$$f(\mathbf{x}) = \exp\left(-\left[\frac{\sqrt{x1^2 + x2^2}}{\sigma}\right]^2\right) \qquad \sigma = 12.54$$

Vulnerability to Climate Change



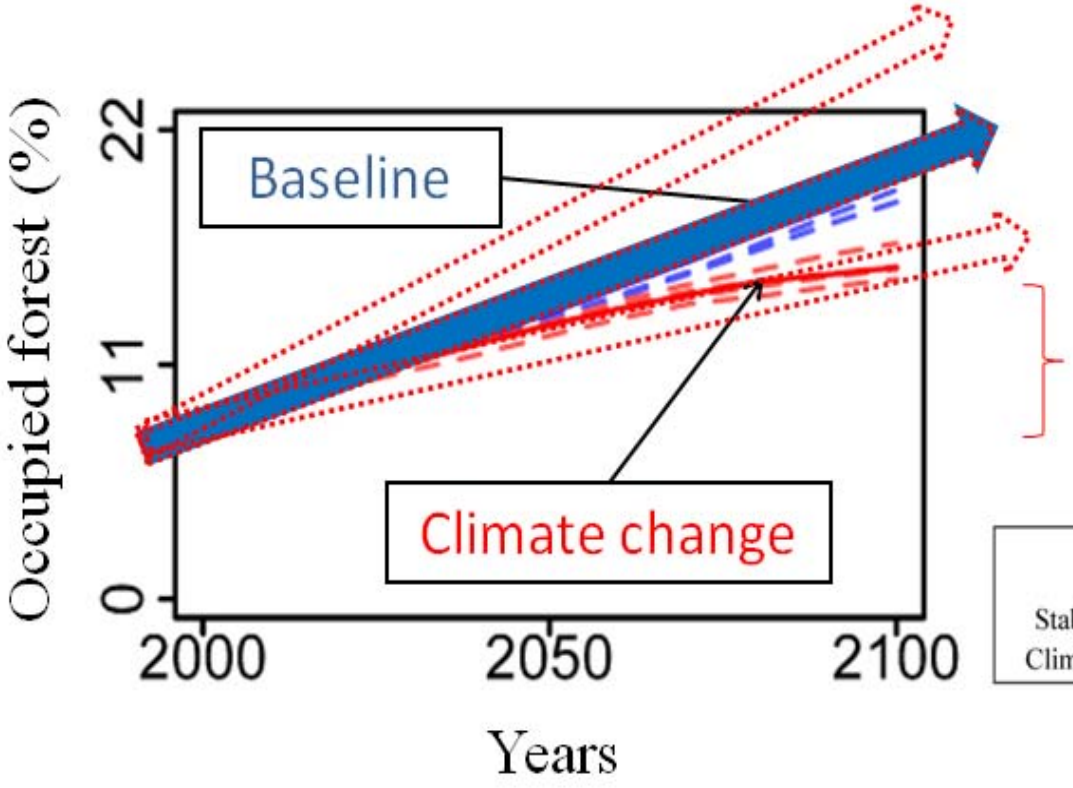
Species fraction of occupied plots from year 2000 to year 2100. One simulation using the posterior means for the parameter values, and four simulations using parameter sets drawn randomly from the samples generated by the MCMC algorithm.

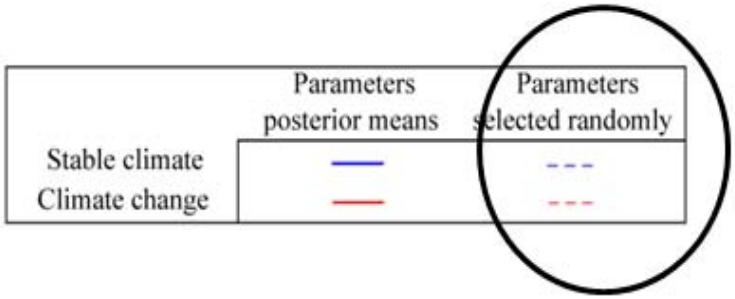
García-Valdés, R., **M. A. Zavala**, M. B. Araújo & D. W. Purves. 2011. Chasing a moving target: projecting non-equilibrial tree species responses to climate change .Journal of Ecology 2013).

Non-equilibrium and climate change

Pinus nigra

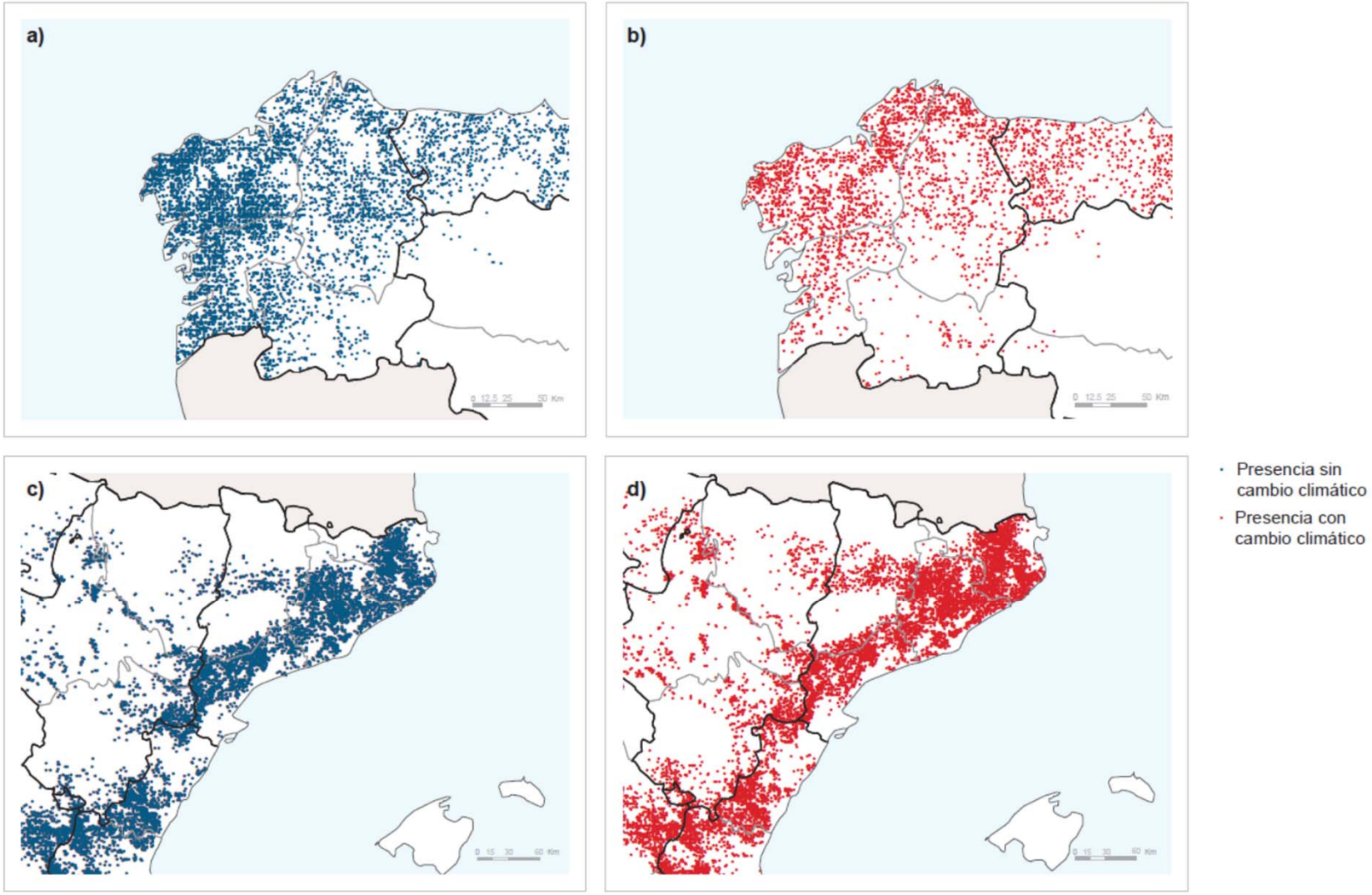
Simulation results





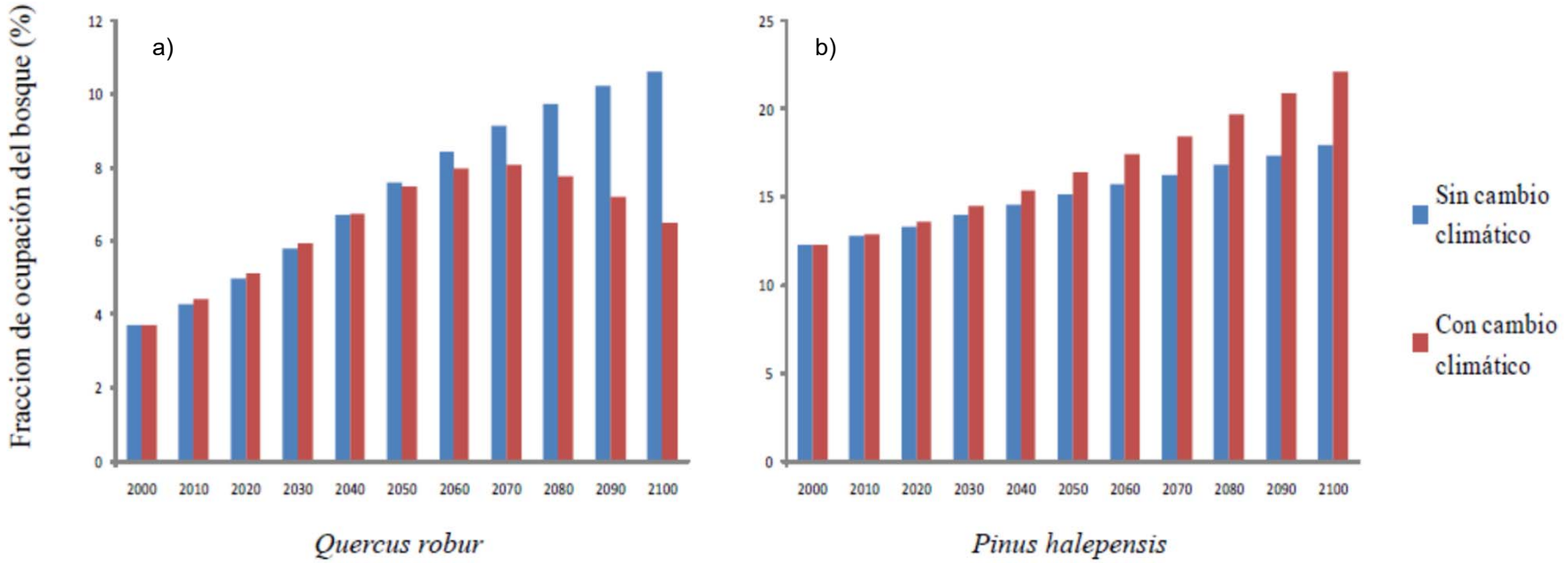
Error propagation

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)[18]. Nota: las Islas Baleares no se incluyeron en el análisis.

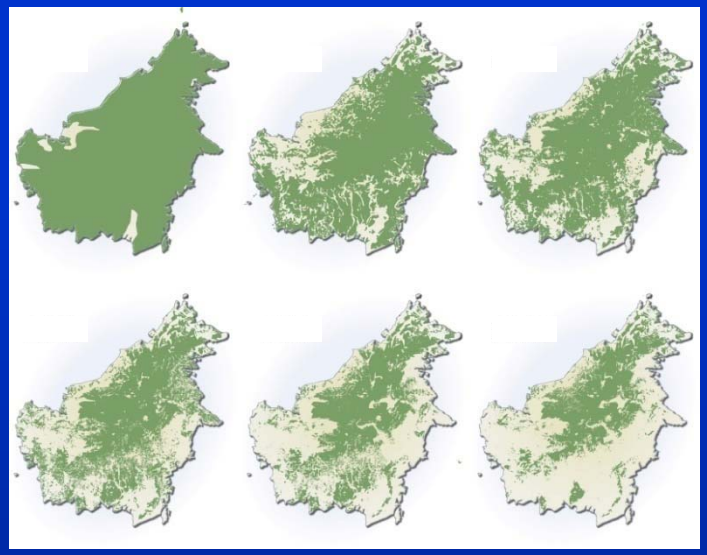
Vulnerability to Climate Change



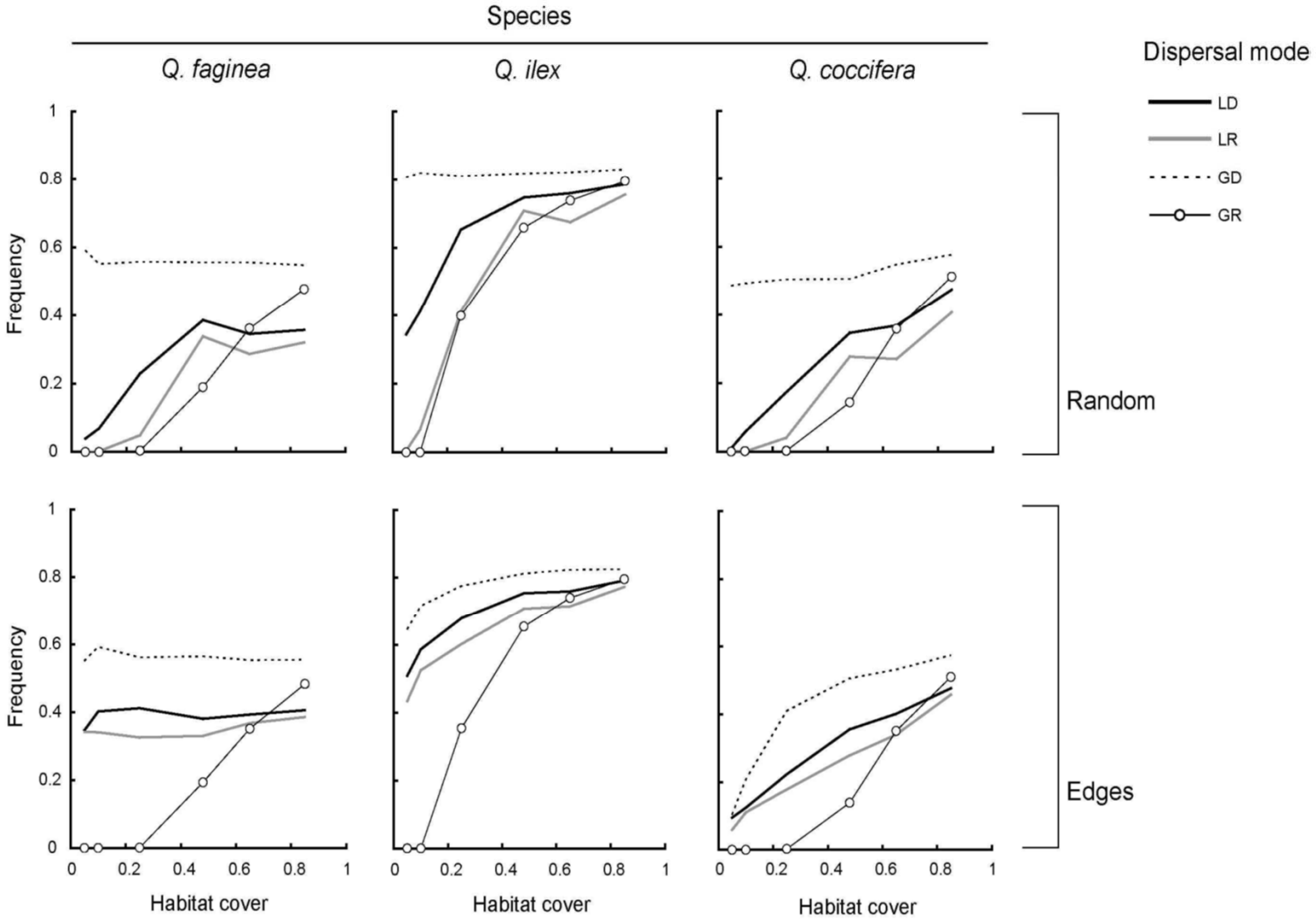
Proyecciones de la fracción de ocupación del bosque, número de parcelas en las que está presente la especie respecto al total de parcelas de bosque, en 2100 con y sin cambio climático para (a) el roble común (*Q. robur*) y (b) el pino carrasco (*P. halepensis*)

Fuente: Elaboración OSE a partir de García-Valdés *et al.* (2010).

Vulnerability to habitat change

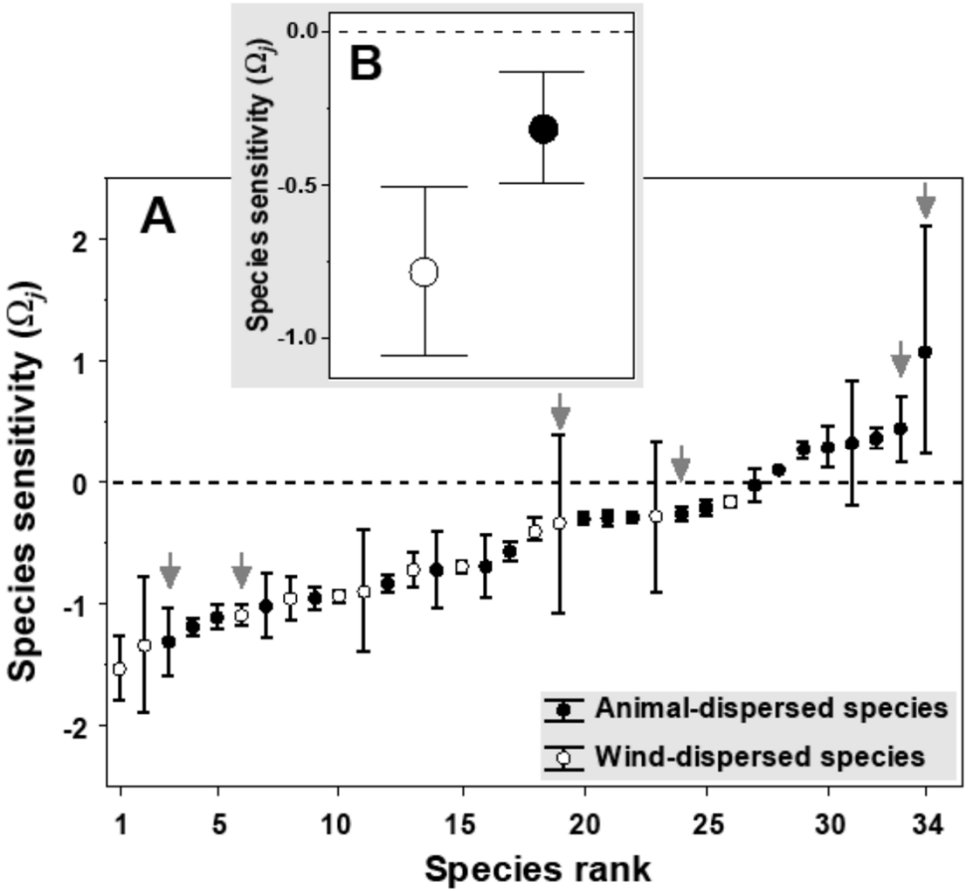


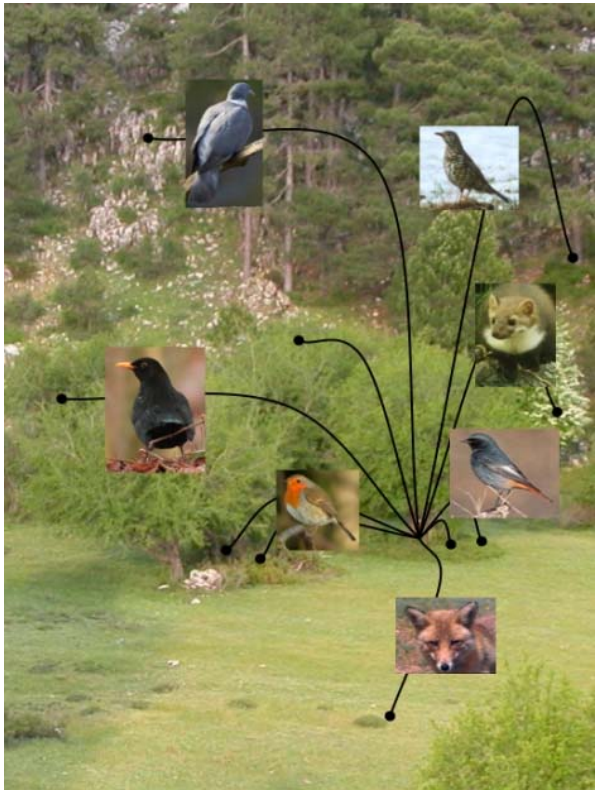
Vulnerability to habitat change



Purves, et al. 2007. Ecological Monographs 77:77–97.

Vulnerability to habitat change





Montoya et al. (*Science* 2008)

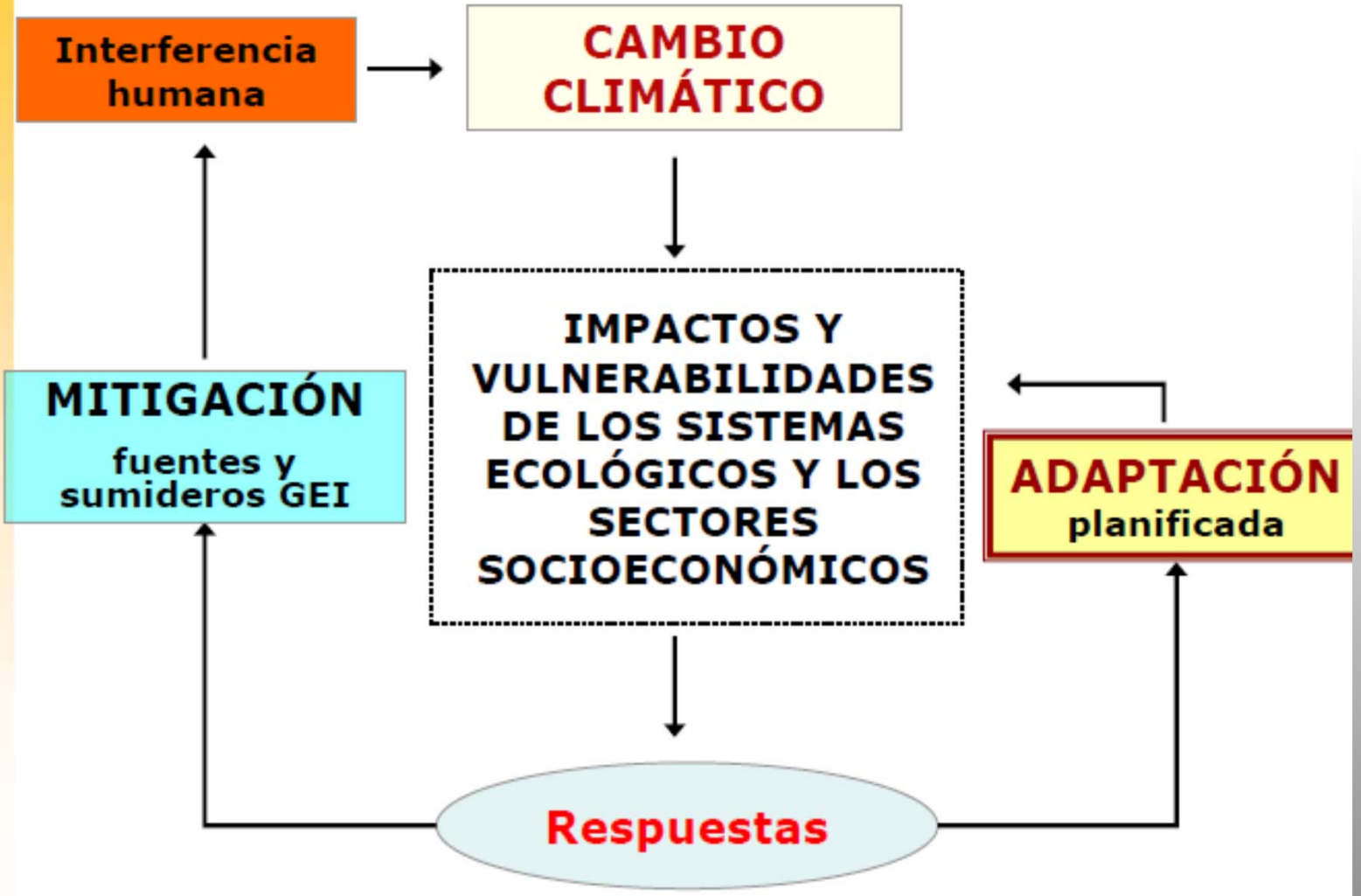
MINISTERIO DE MEDIO AMBIENTE Y MEDIO RURAL Y MARINO

Ciclo de Seminarios de Análisis y Prospectiva

I Seminario 2009 / 26 de Febrero

Implicaciones del Cambio Climático sobre el medio ambiente, el medio rural y el medio marino

EL CAMBIO CLIMÁTICO COMO PRINCIPAL RETO AMBIENTAL



oecc

"Cuando creíamos que teníamos todas las respuestas, de pronto, cambiaron todas las preguntas".

Mario Benedetti