

Mapping Vulnerability across Europe

Marc Metzger

Dagmar Schröter, Rik Leemans, Bob Bunce



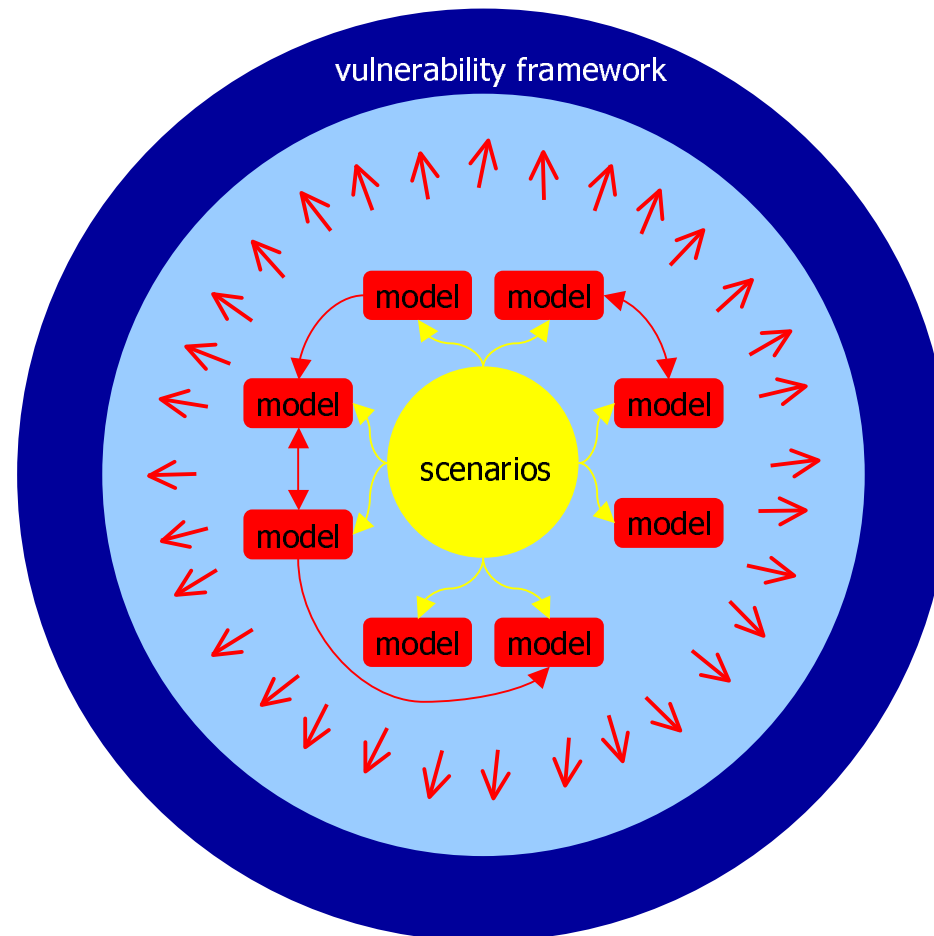
WAGENINGEN UNIVERSITY
PLANT SCIENCES

Presentation plan

- Short recap
- Why vulnerability maps?
- Stratification
- The vulnerability framework
- Some maps



Vulnerability in ATEAM



↑ ecosystem service





The ATEAM modelling framework



multiple GCMs, 4 scenarios
14 models
> 30 ecosystem services
1990, 2020, 2050, 2080
Europe wall to wall in 10' x 10'






ATEAM ecosystem services and indicators - 1

Sectors	Services	Indicators
Agriculture 	farmer livelihood consumer food quality support of rural communities positive externalities negative externalities	<ul style="list-style-type: none">• Profit• Regional product supply• Infrastructure, employment• Landscape attributes, biological resources• Nitrates, N₂O, soil carbon
Forestry	Wood production	<ul style="list-style-type: none">• Above ground biomass
C- storage & Energy 	Carbon storage Power generation (bio fuels)	<ul style="list-style-type: none">• Carbon storage in vegetation• Carbon storage in soil• Suitability for bio fuels



ATEAM ecosystem services and indicators - 2

Sectors	Services	Indicators
Water 	drinking water hydro power Irrigation transport	<ul style="list-style-type: none">• runoff quantity and quality• yearly runoff• summer run off• water level of rivers
Biodiversity & Nature Conservation 	potential for biodiversity: winners potential for biodiversity: losers suitability for endangered species suitability for protected habitats	<ul style="list-style-type: none">• number and types of winners• number and types of losers• suitability for endangered species• suitability for protected habitats
Mountains 	case study looking at water, C-storage and tourism	



Vulnerability Assessment

dictionaries ...open to attack or damage...

ATEAM 'The degree to which an ecosystem service is **sensitive** to global **environmental change** and the degree to which the sector that relies on the service is **unable to adapt** to with the changes.'

Important

In ATEAM Vulnerability (V) comparison current with future time slice!



Vulnerability – an integrator

- Comparisons across time slices and scenarios
 - How will wood production change over time in Sweden?
- Comparisons between ecosystem services
 - Which ecosystems services are vulnerable in Belgium?
- Comparisons between regions
 - Is agriculture in southern France more vulnerable than in central Spain?
- Allows multi-scale assessment

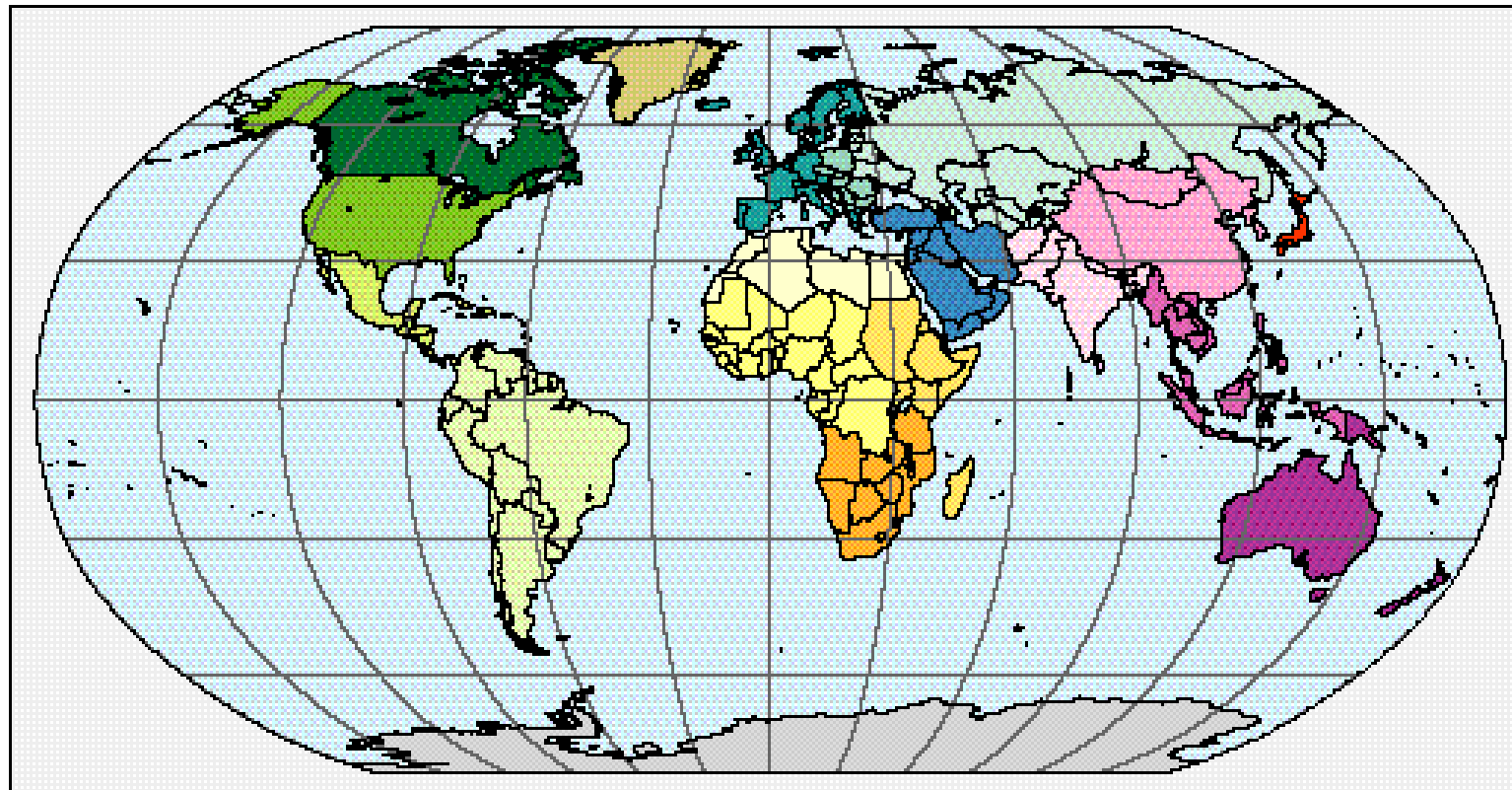


Vulnerability – requirements

- Comparisons between ecosystem services requires a standardized scale, i.e. 0 – 1 range
- Comparisons between regions requires local V measures to be placed in their European environmental context
 - Biodiversity: cannot simply compare Boreal with Mediterranean
 - Crop yield: cannot compare wheat yield in Italy and The Netherlands



Stratification human systems - global

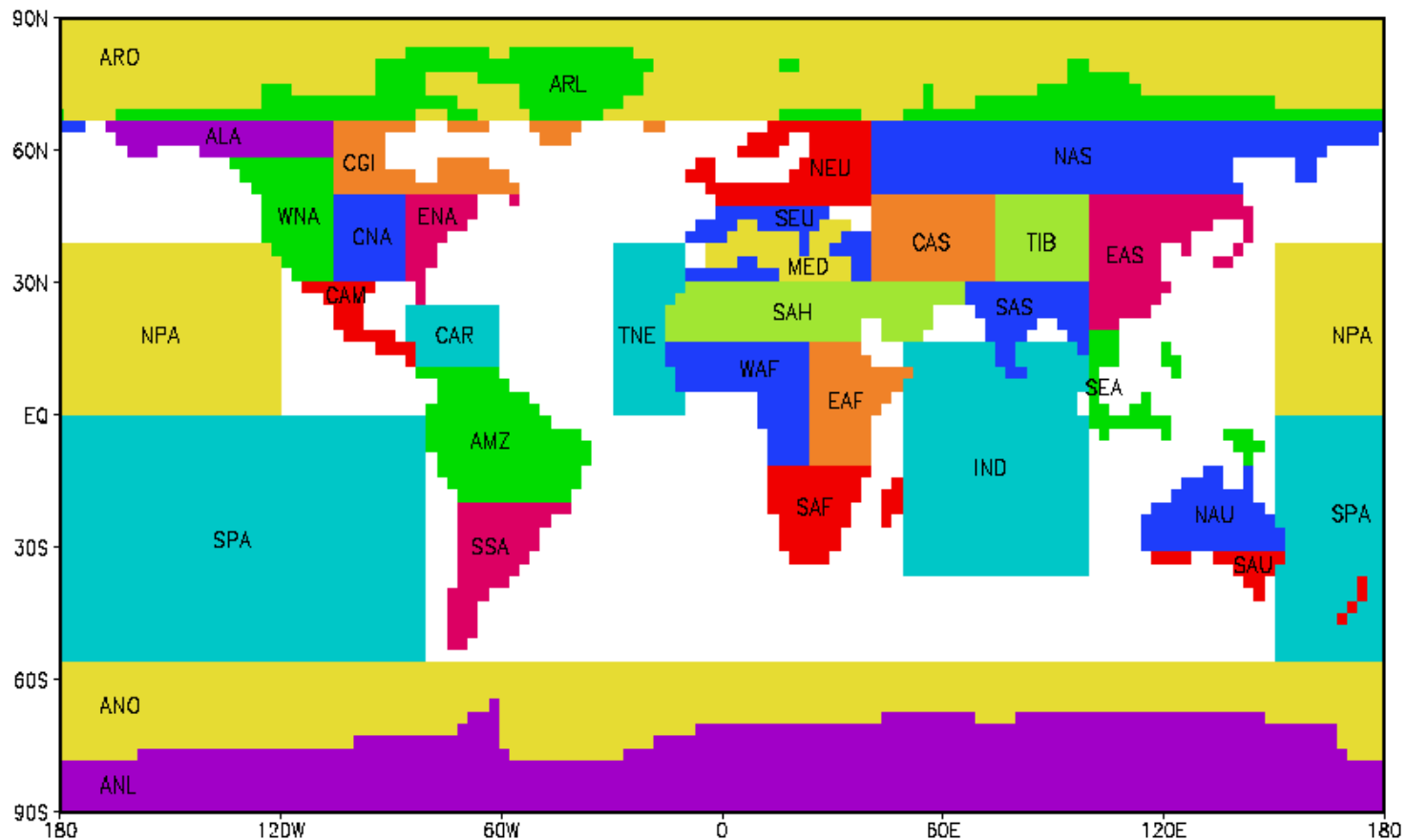


1 Canada	5 Northern Africa	9 OECD Europe	13 South Asia	17 Japan
2 USA	6 Western Africa	10 Eastern Europe	14 East Asia	18 Greenland
3 Central America	7 Eastern Africa	11 Former USSR	15 South East Asia	19 Antarctica
4 South America	8 Southern Africa	12 Middle East	16 Oceania	



Stratification 'natural' systems - global

Regions for which intercomparisons conducted of modelled temperature and precipitation changes under the SRES scenarios

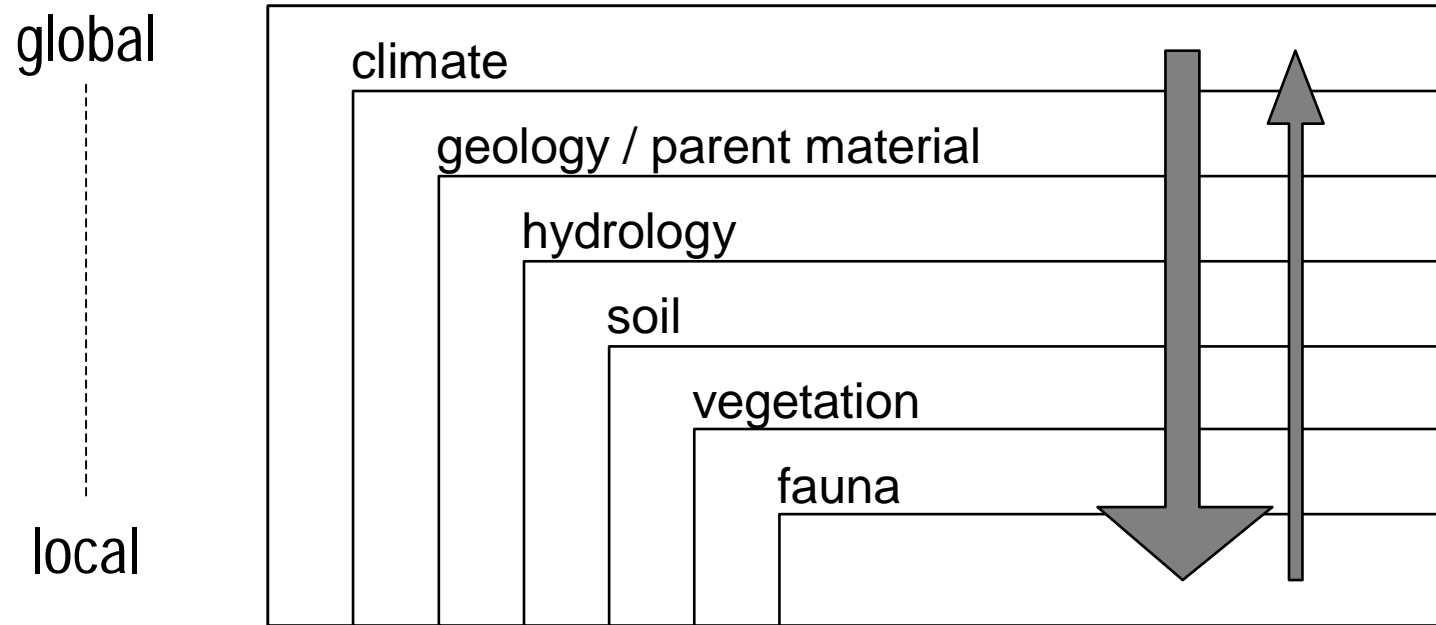


Source: Ruosteenoja *et al.* (2003)



Stratification 'natural' systems - Europe

What would be a suitable European stratification?



(after Klijn, 1997)

reproducible and distinctive



European stratification 1 – Emerald Zones

Biogeographical Emerald Zones



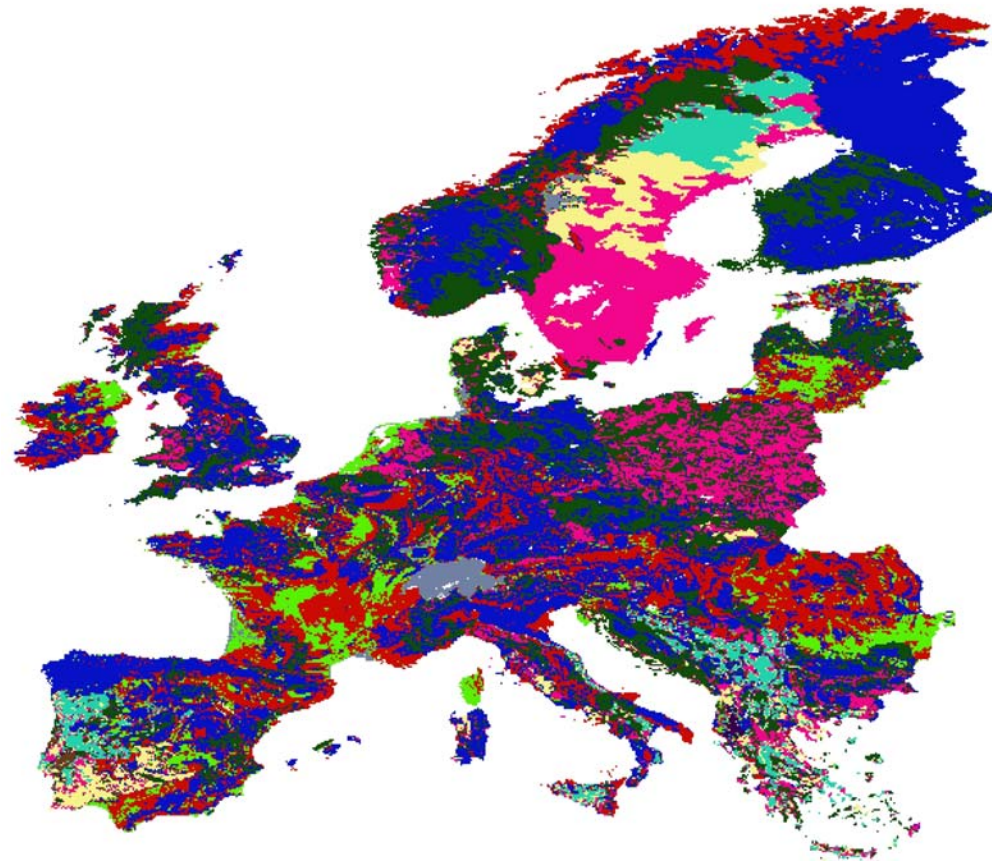
European stratification 2 - PNV

Potential Natural Vegetation (Bohn et al., 2000)



European stratification 3 - soil

European Soil Bureau Soil Map



European stratification 3 - soil

European Soil Bureau Soil Map



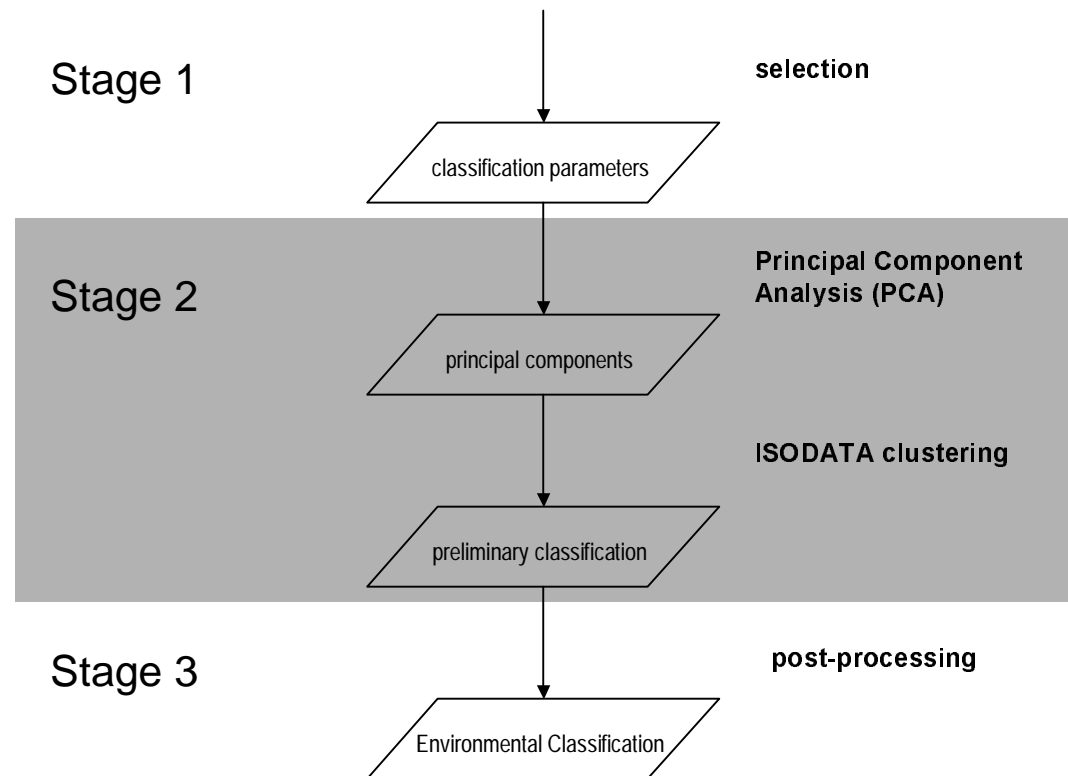
existing stratifications...

... form a useful description, but

- Class divisions are not quantified
- Are not easily related to global change scenarios
- Have unequal distances in environmental space



statistical stratification for Europe



climate

- minimum temperature
- maximum temperature
- precipitation
- sunshine

geomorphology

(substitutes)

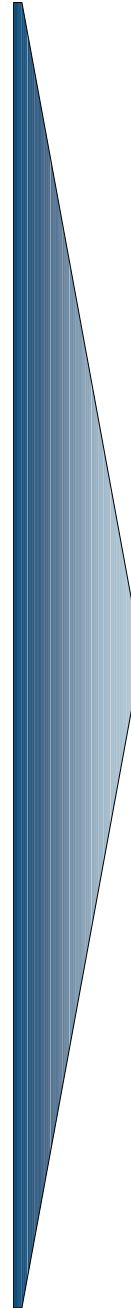
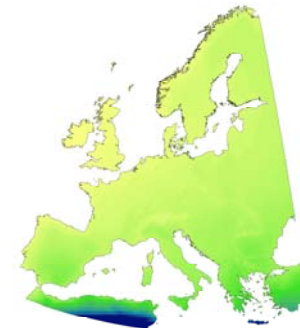
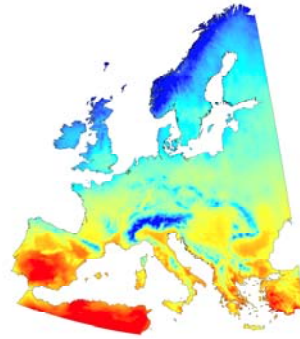
- altitude
- slope

oceanicity

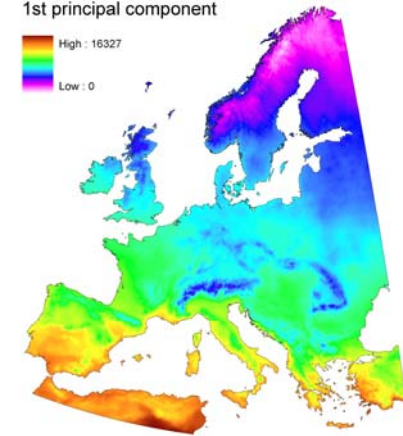
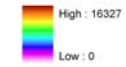
- annual temperature range divided by latitude

northing

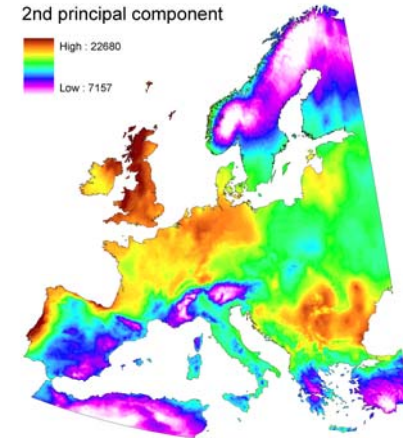
- latitude



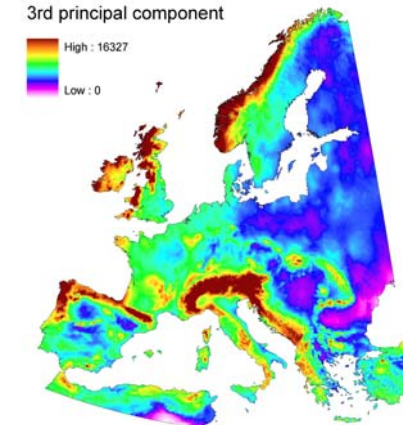
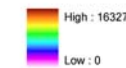
1st principal component



2nd principal component



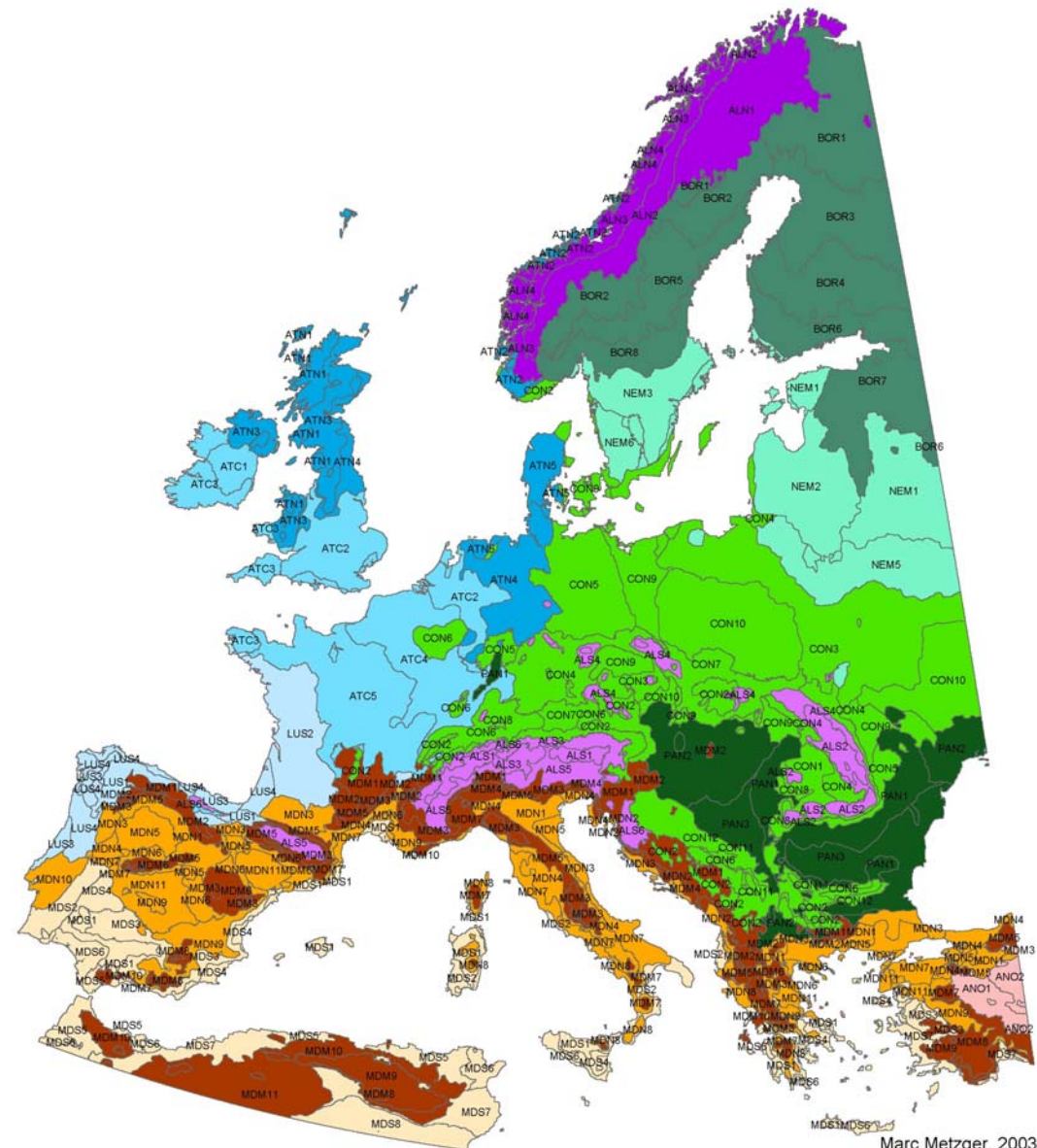
3rd principal component



The Environmental Classification of Europe

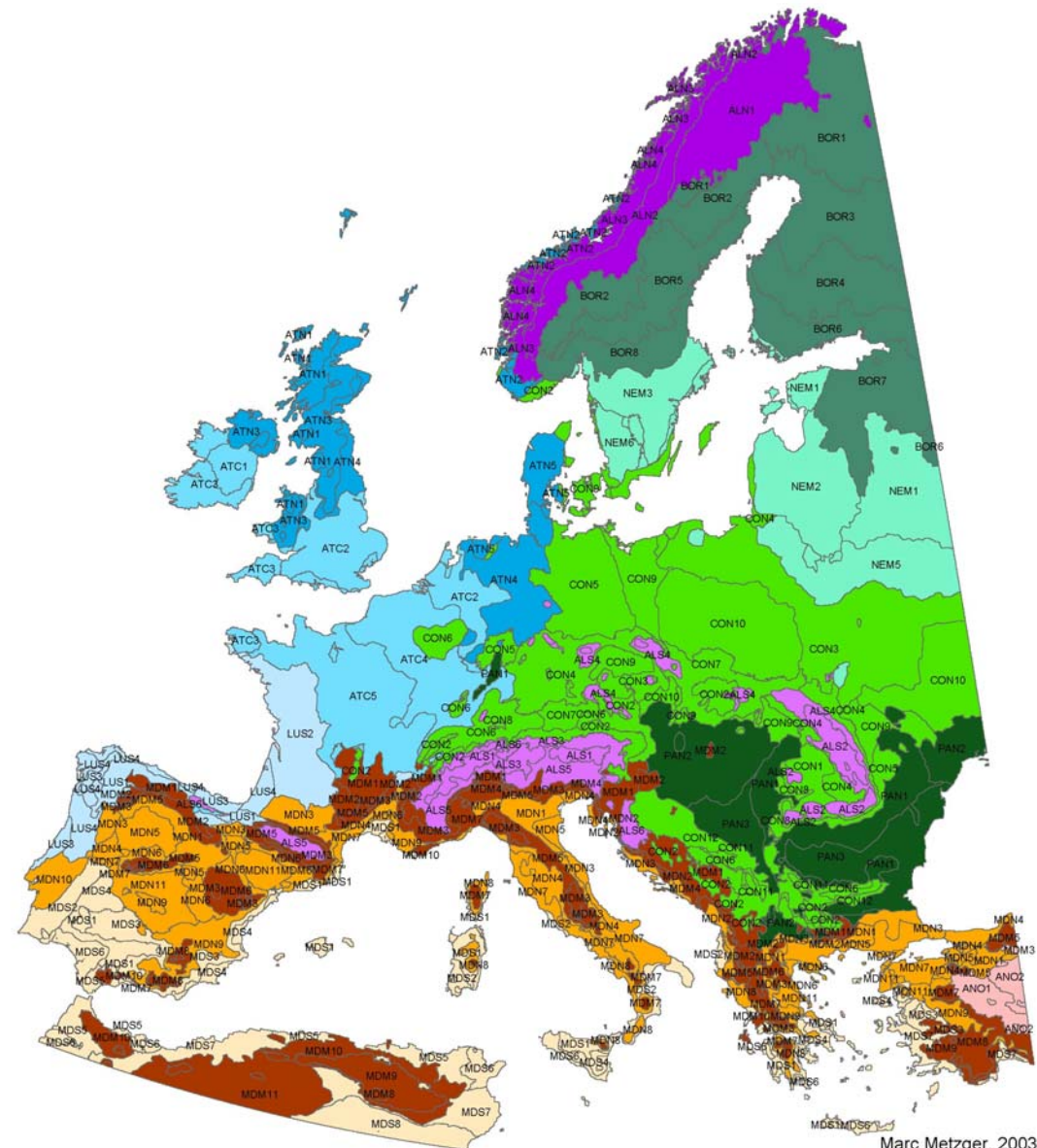
Environmental Zone

- Alpine North
- Boreal
- Nemoral
- Atlantic North
- Alpine South
- Continental
- Atlantic Central
- Pannonian
- Lusitanian
- Anatolian
- Mediterranean Mountains
- Mediterranean North
- Mediterranean South

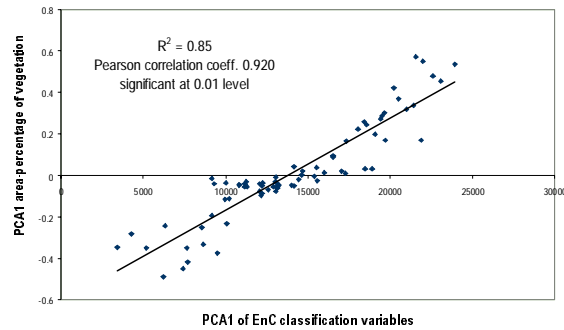


The Environmental Classification of Europe

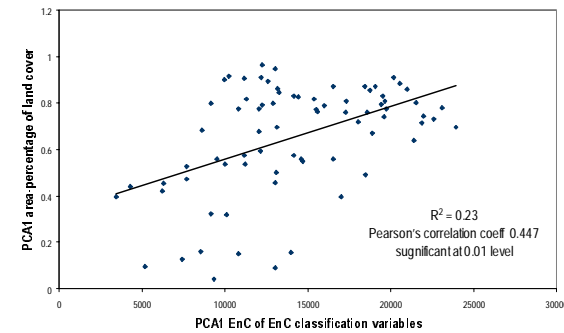
- statistically derived
- explicit classes
- 1km² resolution
- 84 classes
- 3 aggregation levels
- core classification
- easily adapted to user's need



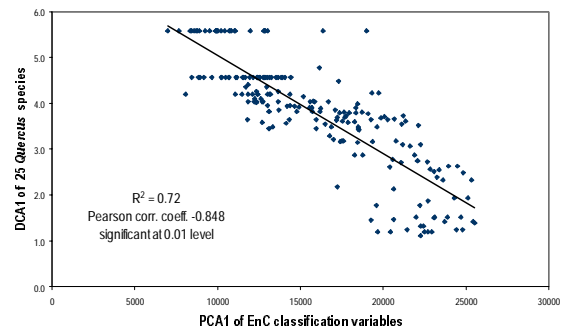
The Environmental Classification of Europe



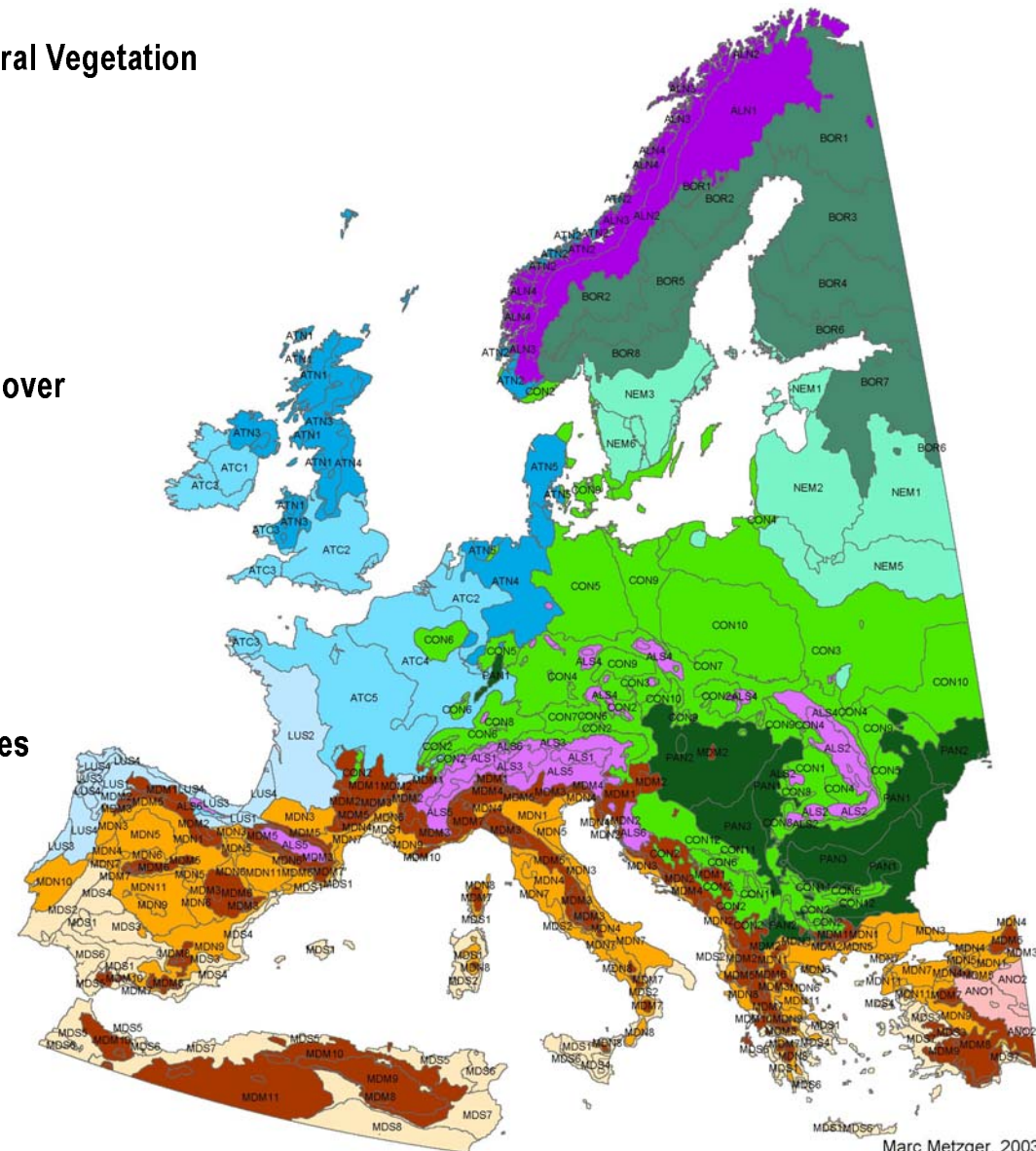
Potential Natural Vegetation



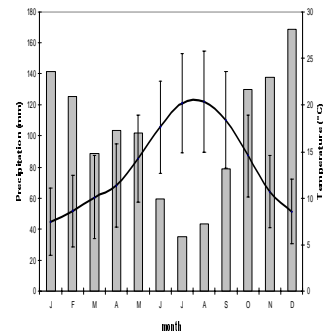
CORINE land cover



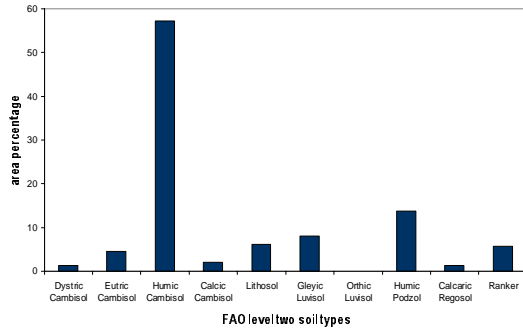
Quercus species



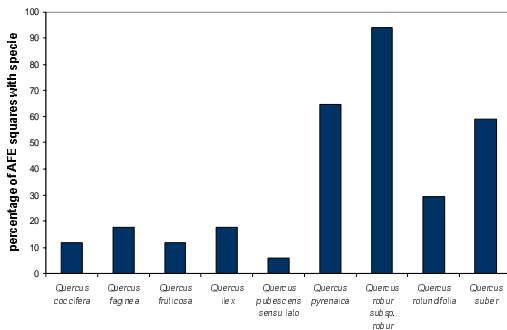
The Environmental Classification of Europe



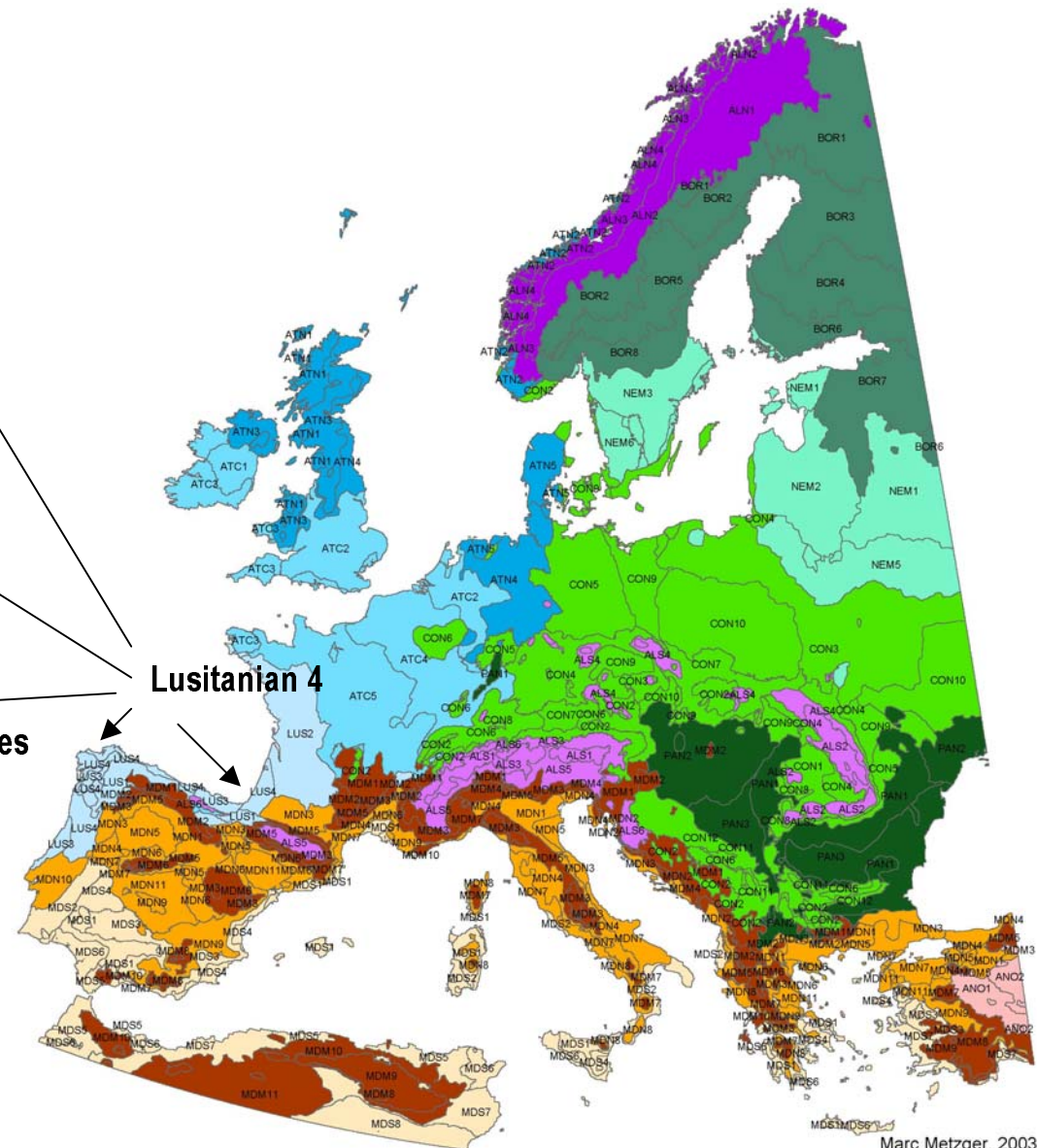
climate



soil



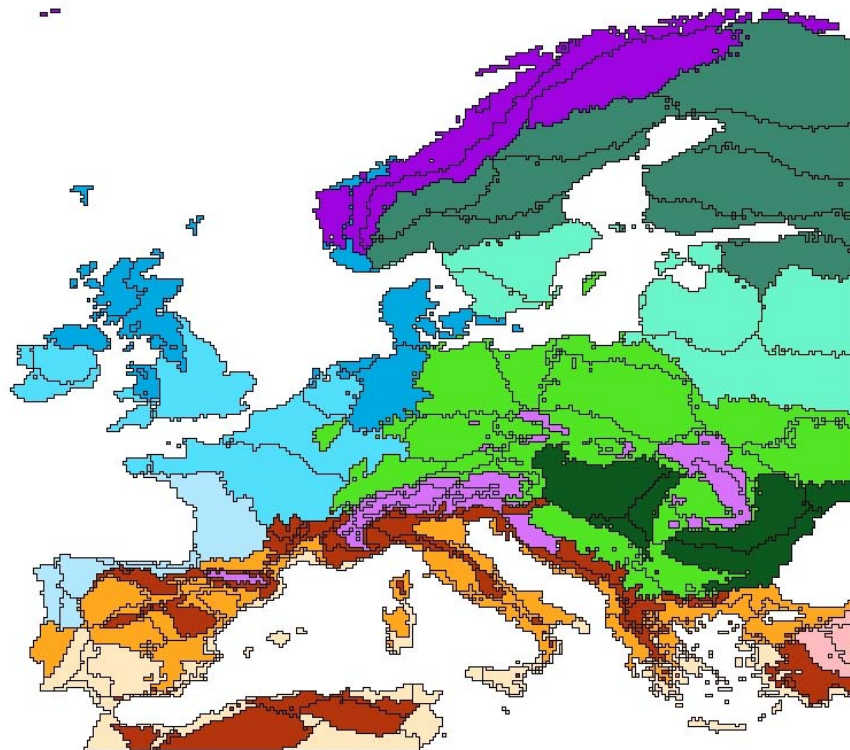
Quercus species



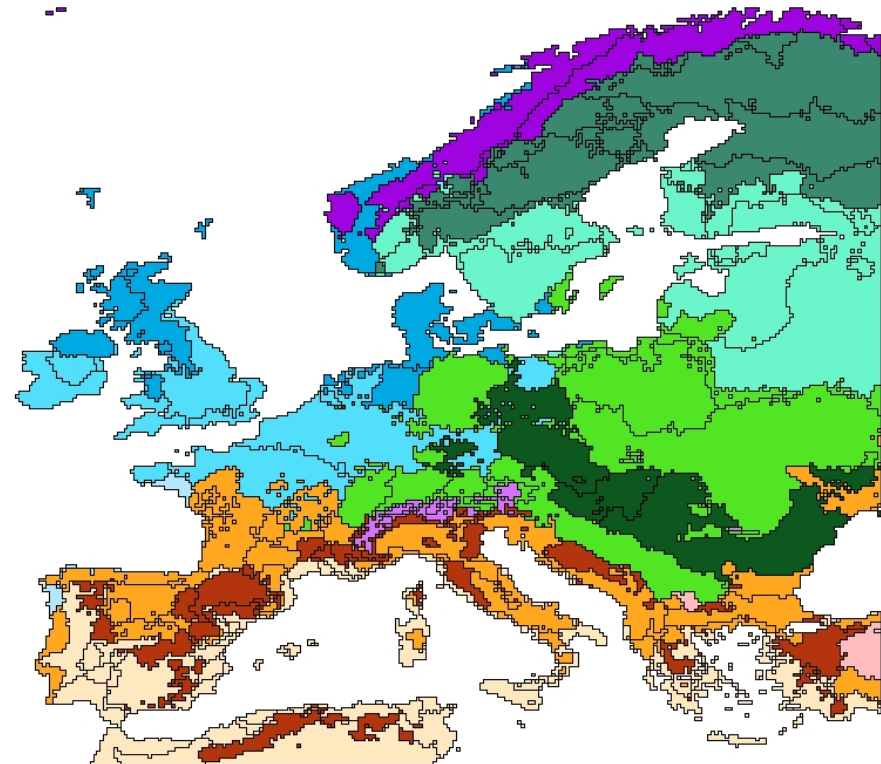
Lusitanian 4

Shifting classes

Baseline (2000)

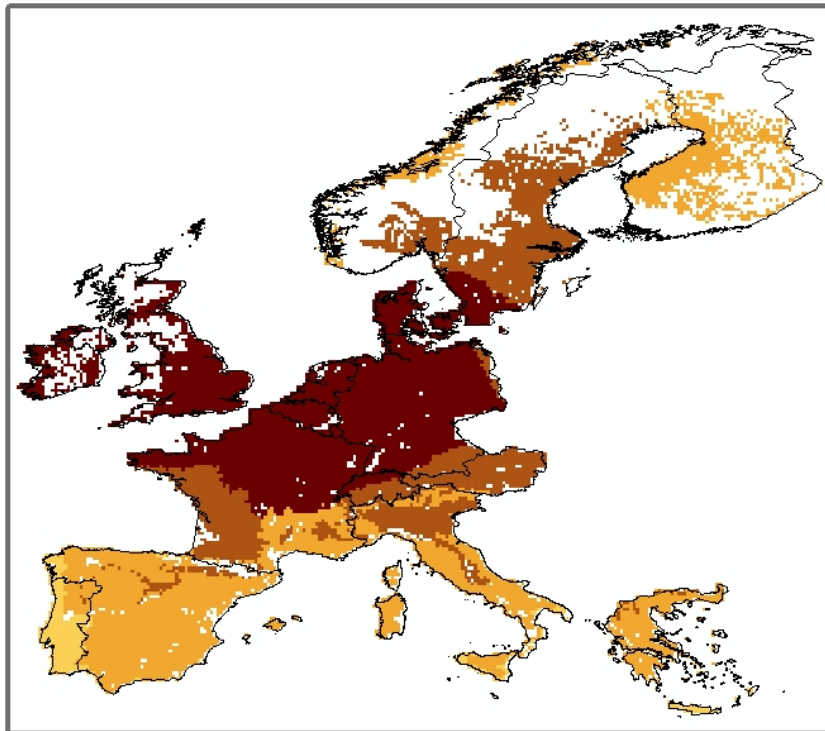


A1 (2080), HadCM3

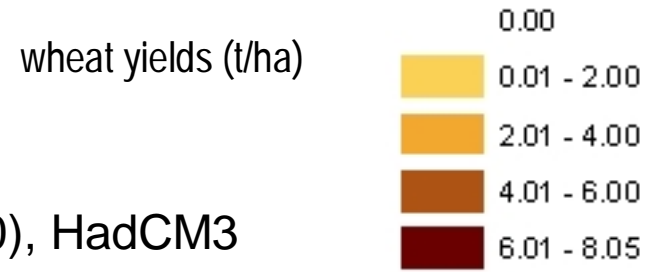
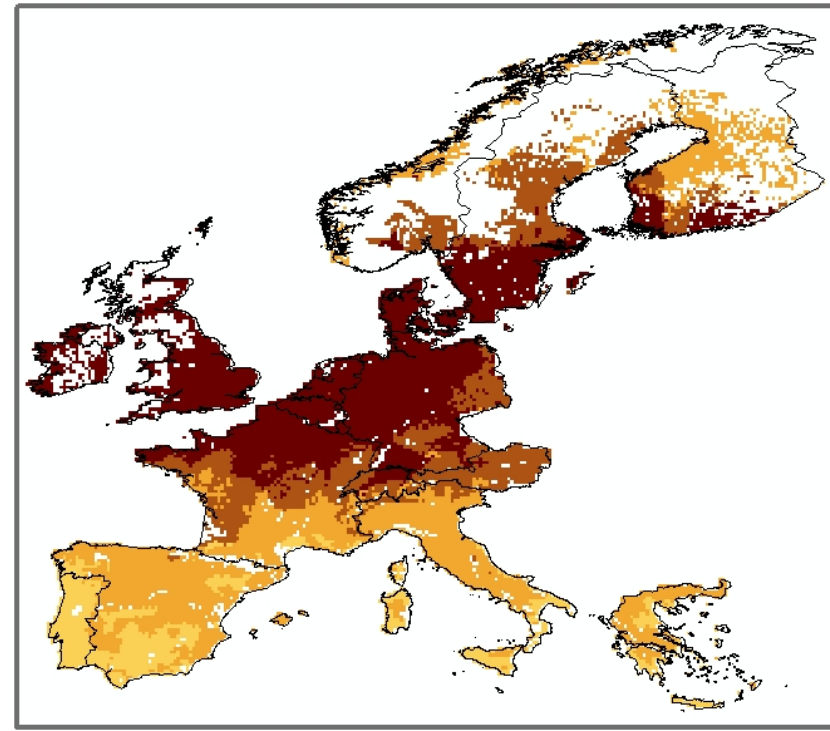


One application...

Baseline (2000)

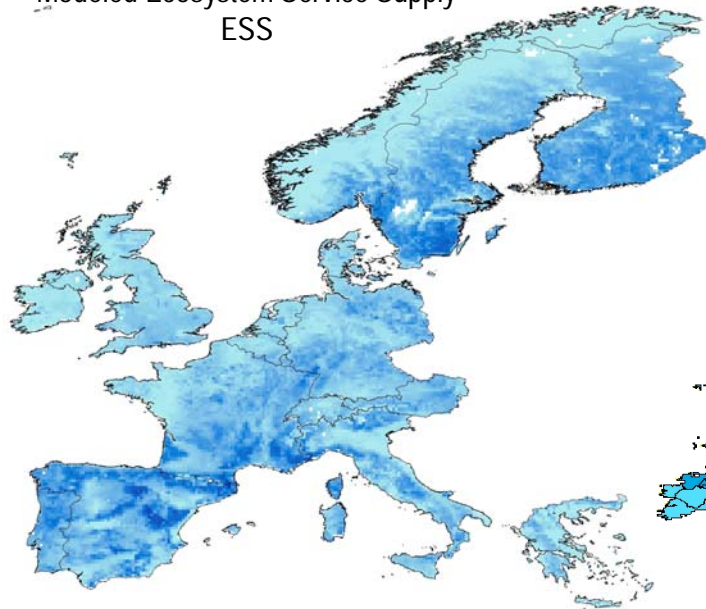


A1 (2080), HadCM3

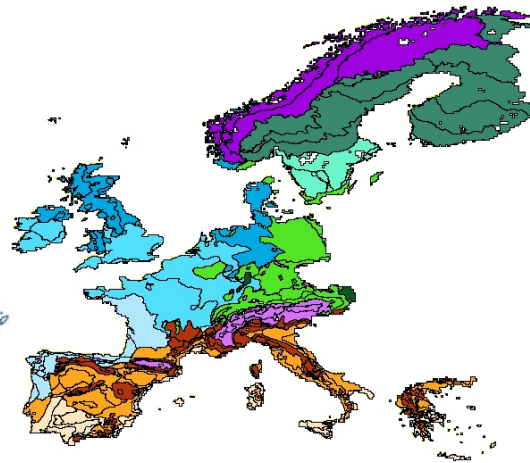


But main purpose... stratification of ecosystem services

Modeled Ecosystem Service Supply
ESS

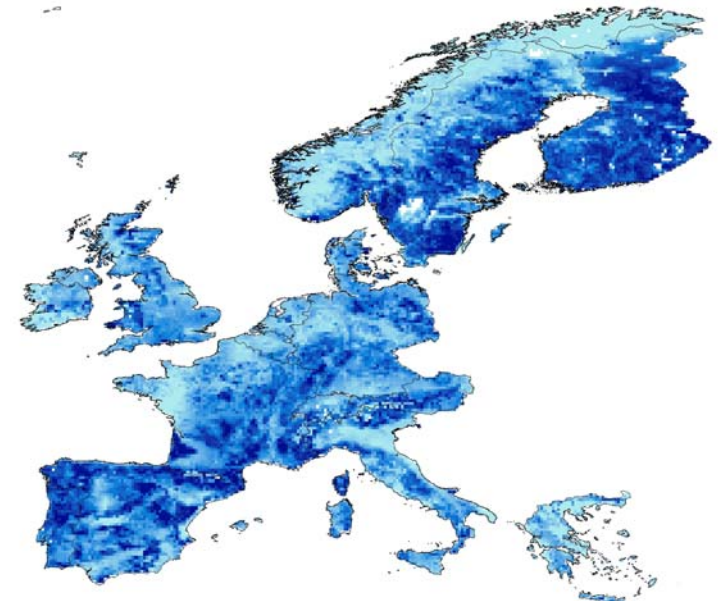


stratification
EnC



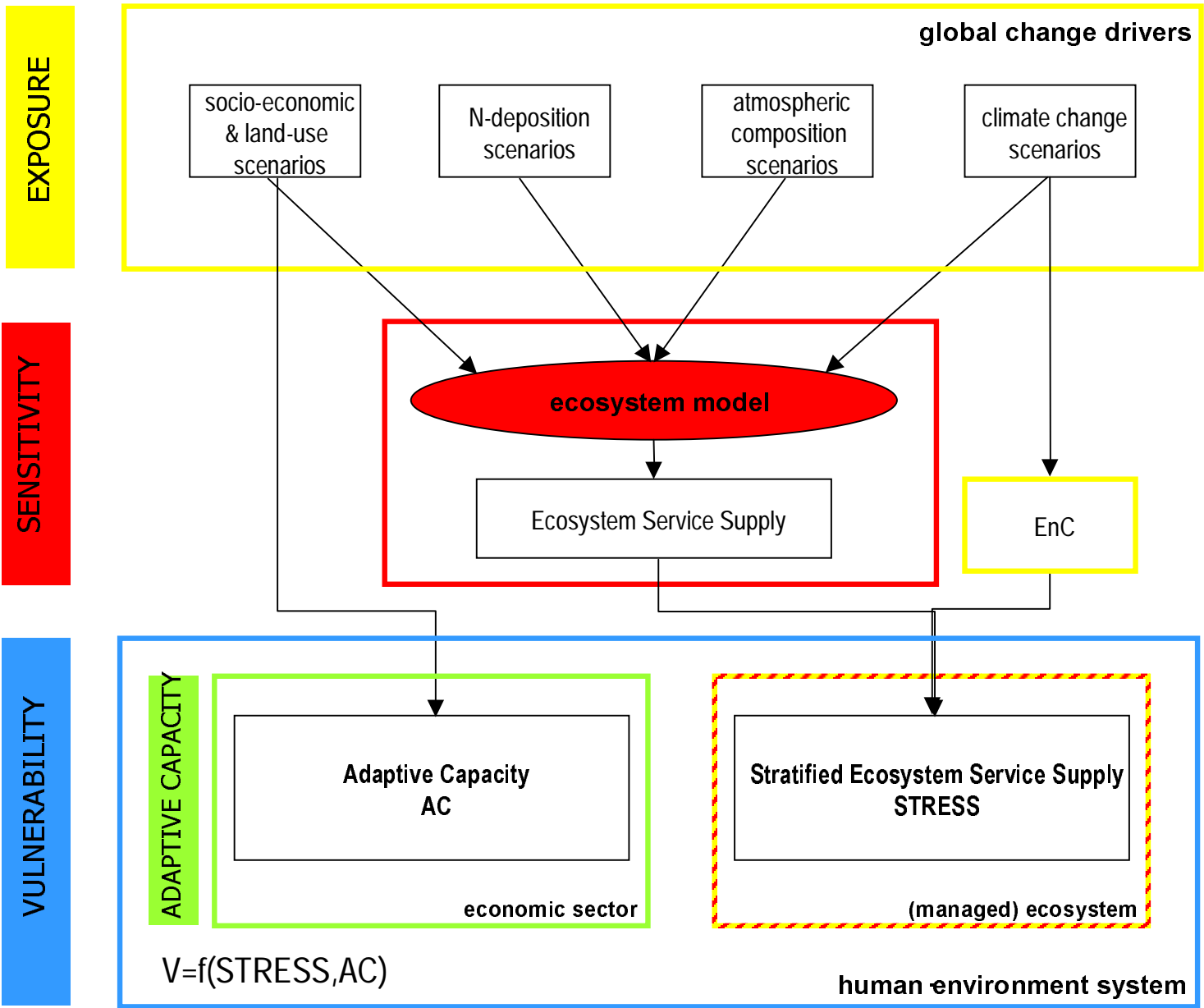
$$\text{STRESS} = \text{EES} / \text{class max}$$

Stratified Ecosystem Service Supply
STRESS

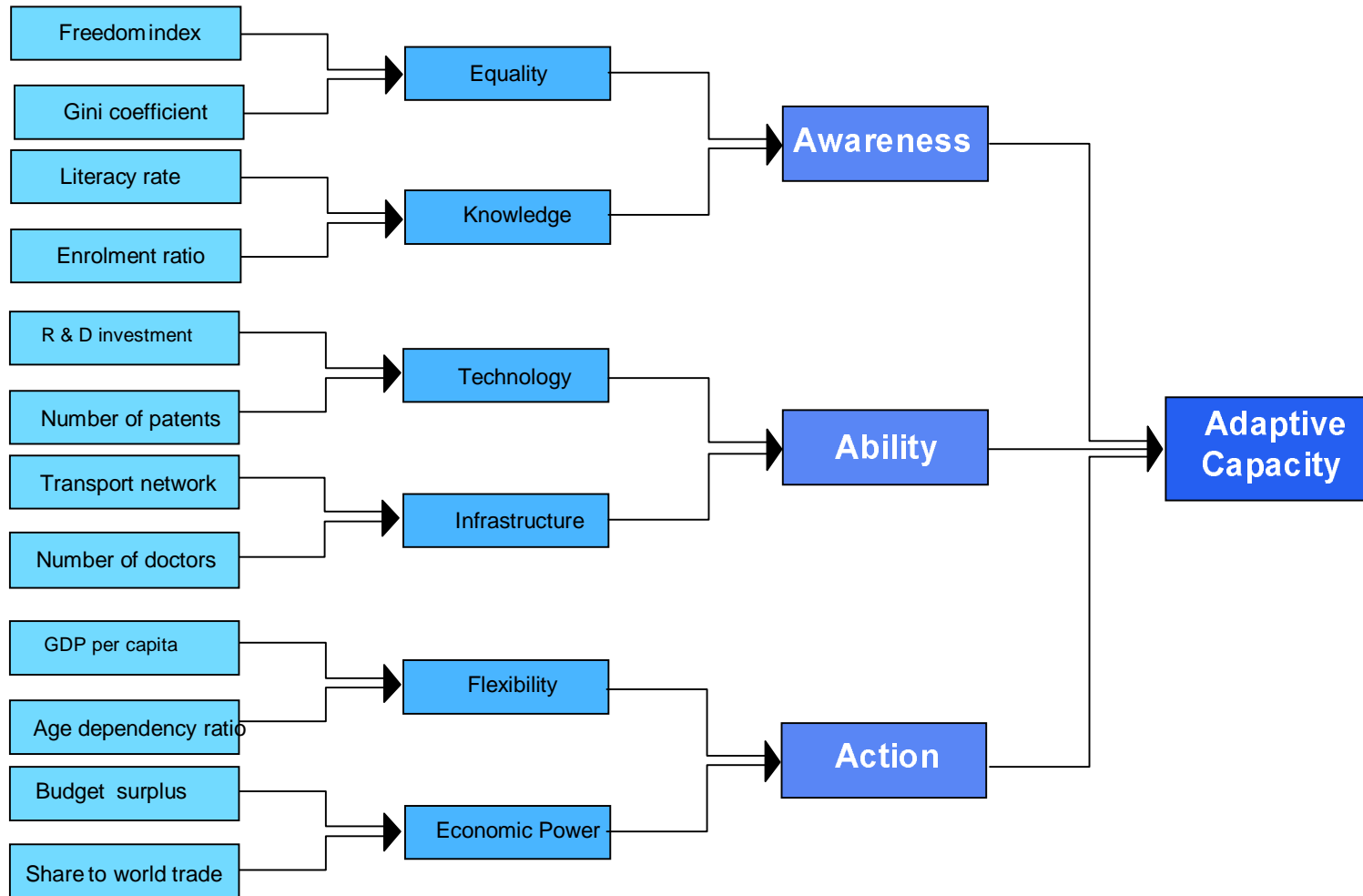


- ES placed in environmental context
- STRESS value in 0 – 1 unitless range



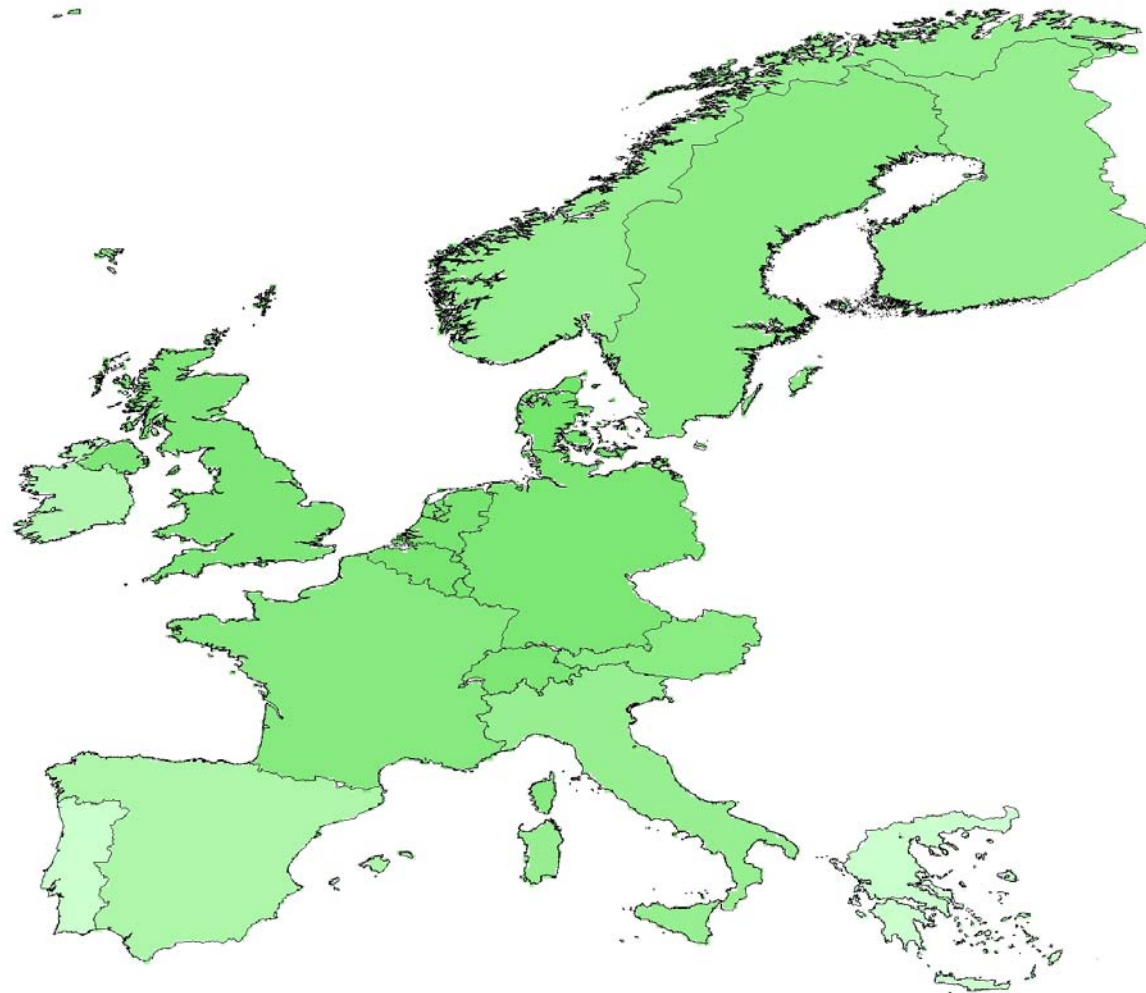


Top-down AC framework



Top-down AC framework

1990

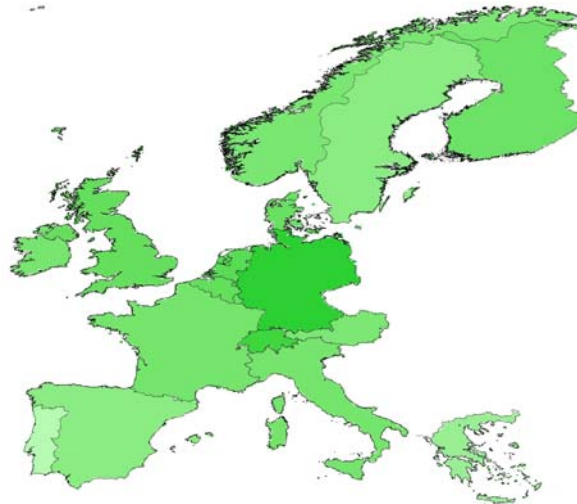


Top-down AC framework

1990



2050



2080



Modeled Ecosystem Service Supply
ESS

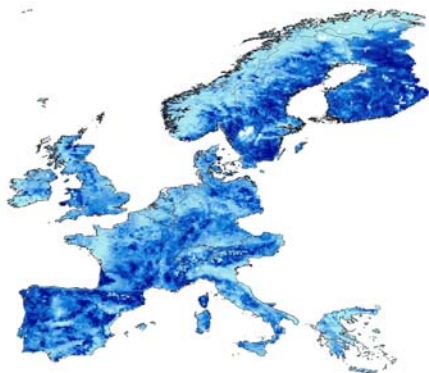
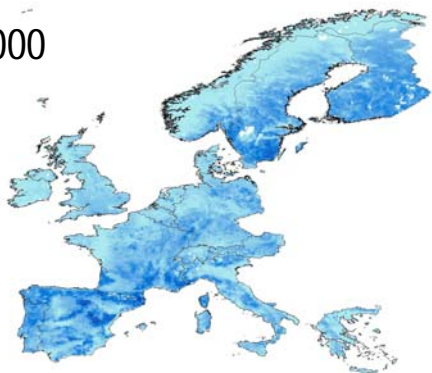
Stratified Ecosystem Service Supply
STRESS

Adaptive Capacity
AC

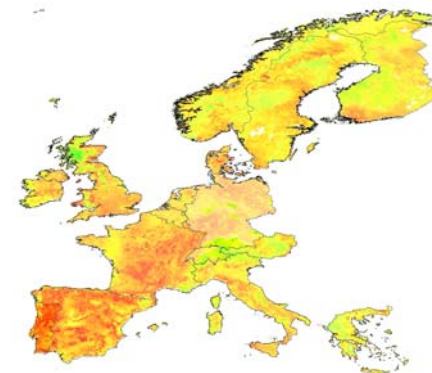
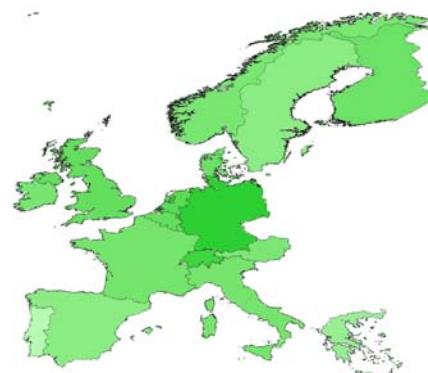
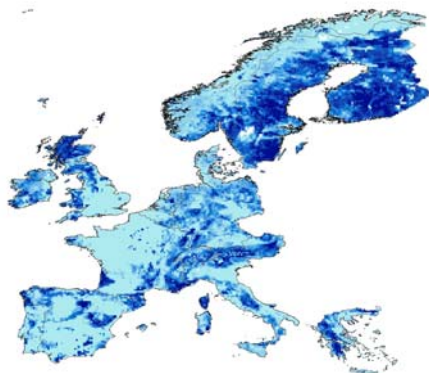
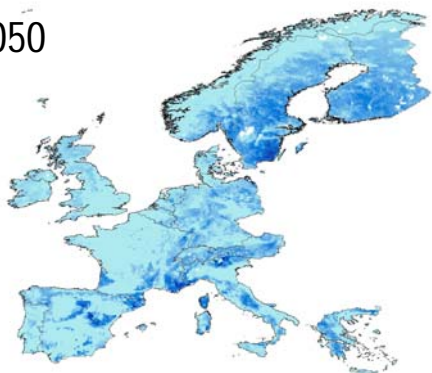
Vulnerability

$$V=f(\text{STRESS}, \text{AC})$$

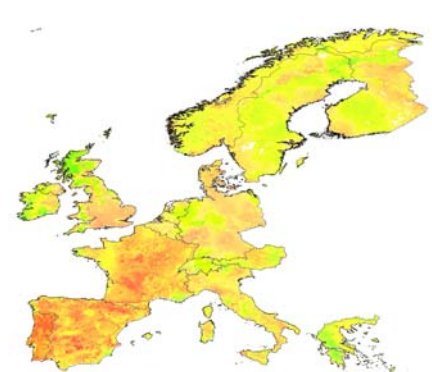
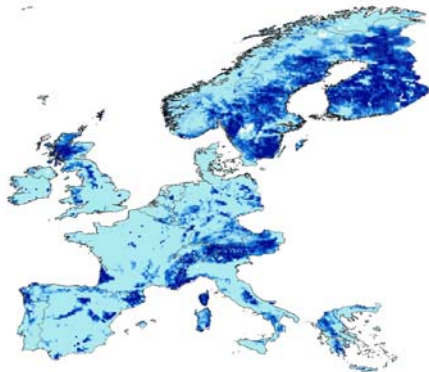
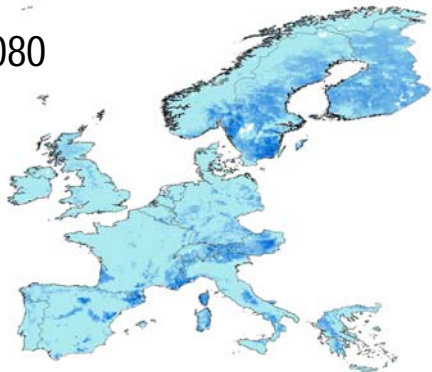
2000



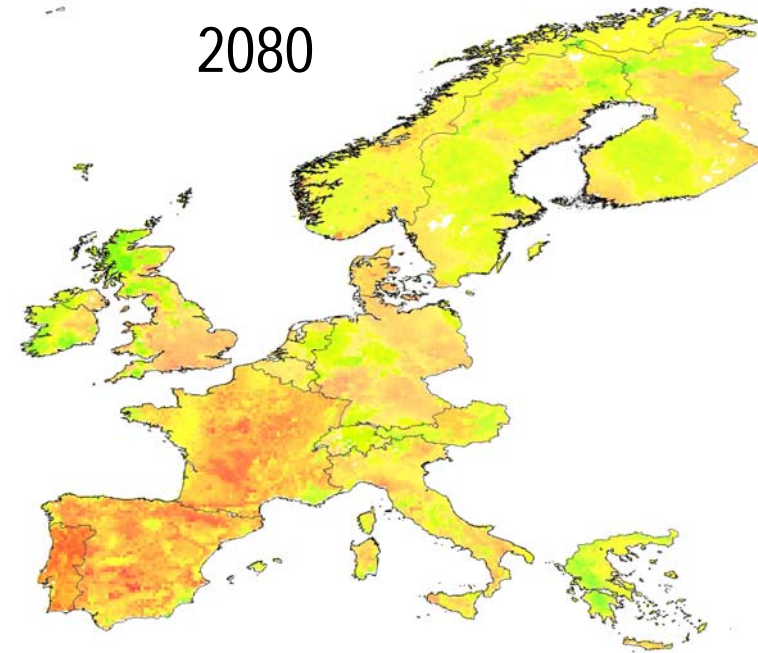
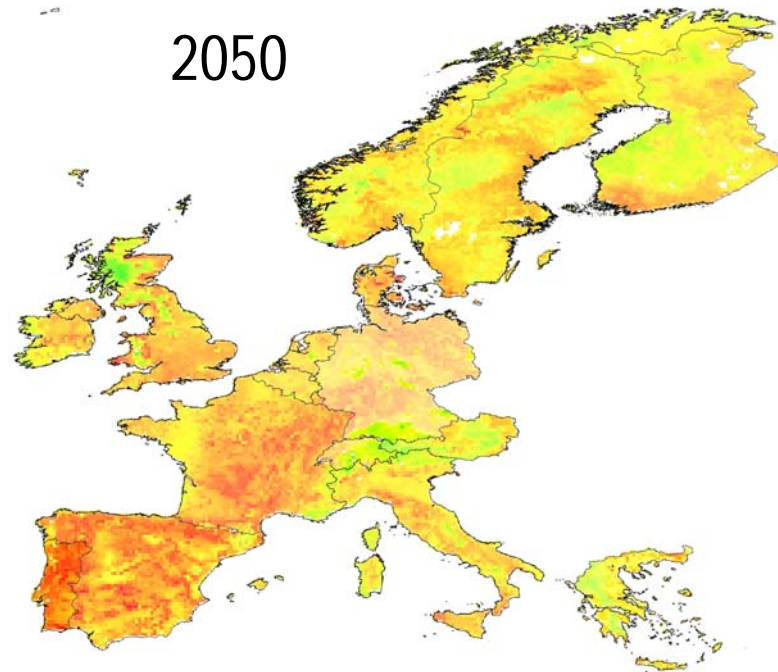
2050



2080



Vulnerability maps



consistent framework for
multiple GCMs, 4 scenarios
14 models
> 30 ecosystem services
1990, 2020, 2050, 2080

mapping tool
maps for V, ESS, STRESS, AC
comparison between regions
robust and vulnerable areas
pre-defined road maps

