

Climate impacts: ongoing work with IMAGE 2.2

Tom Kram *et al.*

Workshop on GHG Stabilization Scenarios, NIES, Tsukuba, 22-23 January 2004

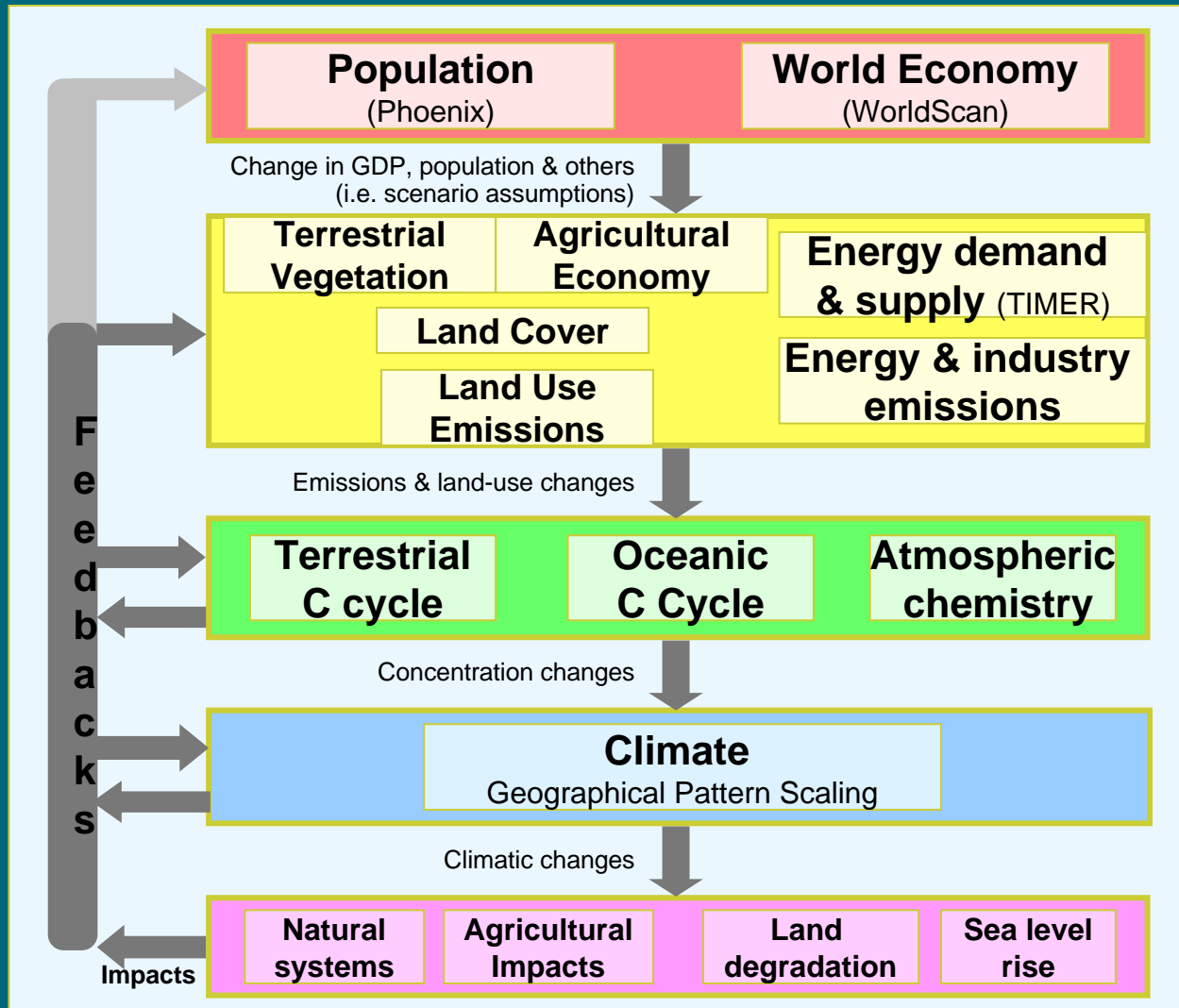


IMAGE

- **Integrated Model to Assess the Global Environment**
 - Combine different themes, investigate interrelations and feedbacks (human and natural), give “complete” picture
- **For specific tasks: scanner models, based on IMAGE**
 - FAIR: cost analyses and exploration of different burden sharing regimes
- **For impacts: IMAGE in conjunction with dedicated modules and separate models**
 - WaterGAP, Euromove, Nutrient-model, etc.



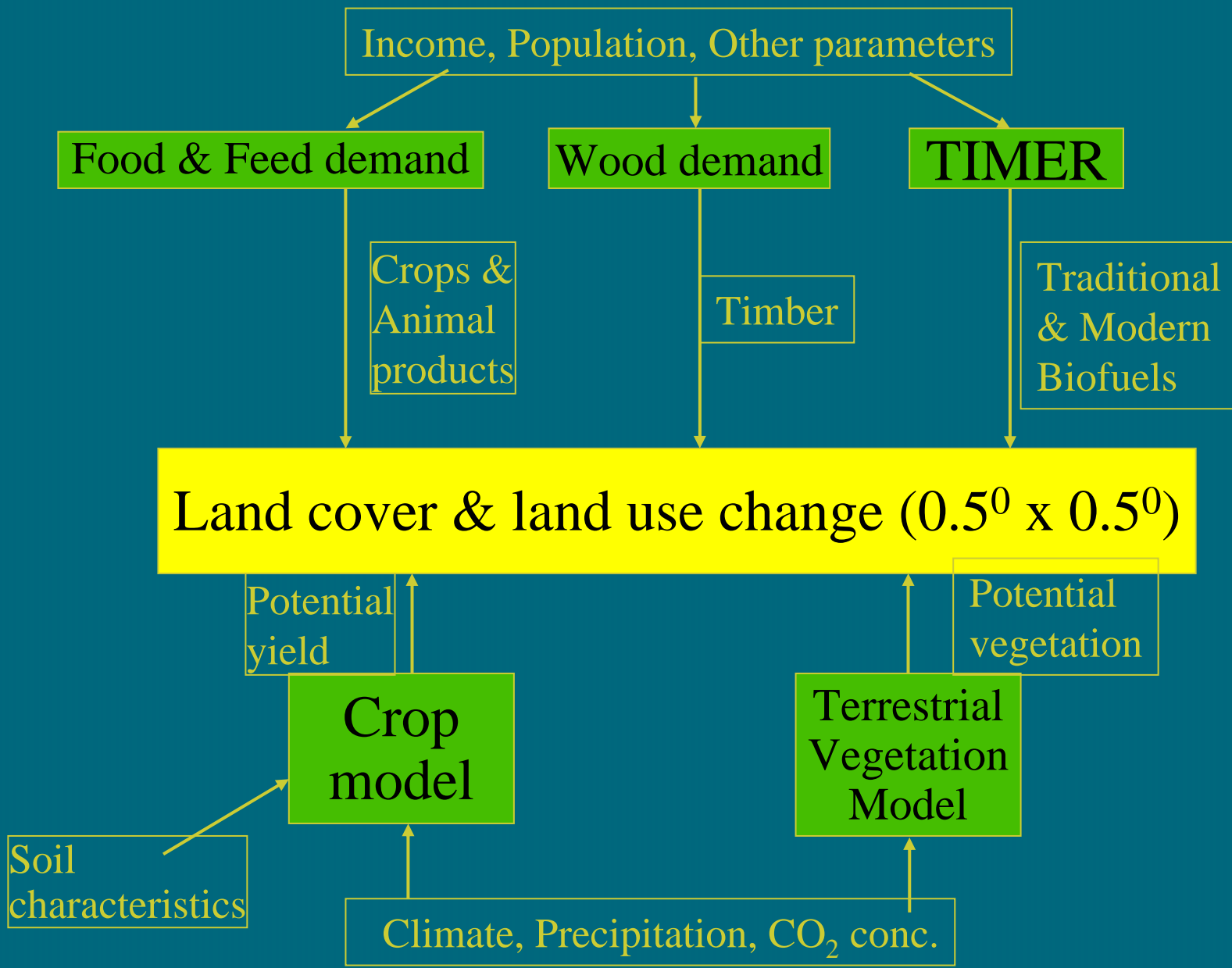
Structure of IMAGE 2.2



The land-use system

- Rule-based allocation mechanism combining physical and human factors
- Output: Land use change geographically explicit



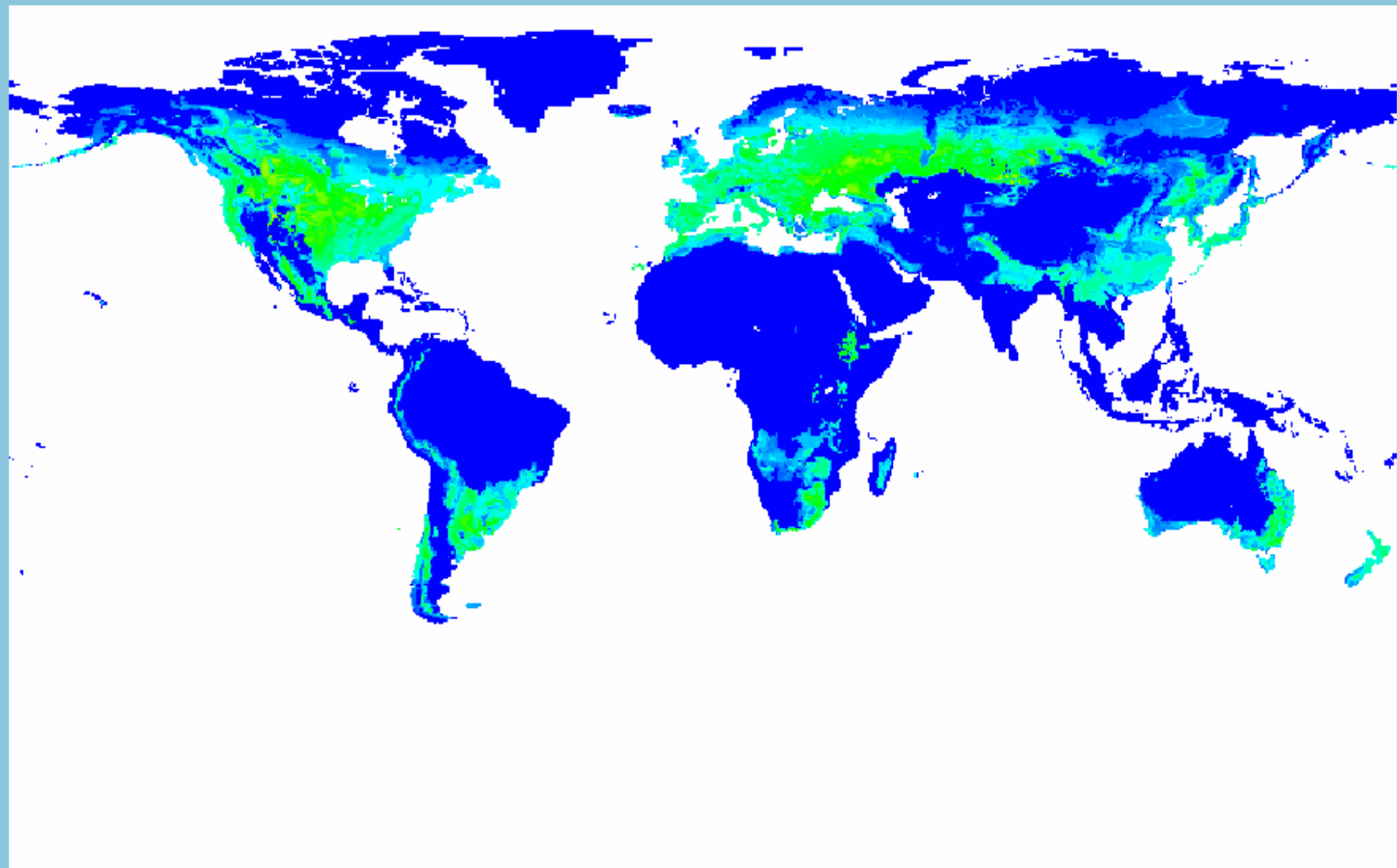


Information used in land use model

- Population density
- FAO data for arable area in each country
- FAO data for land productivity
- Potential productivity maps for each crop



Potential Productivity of Crops



Food & fodder crop (1)
Temperate cereals

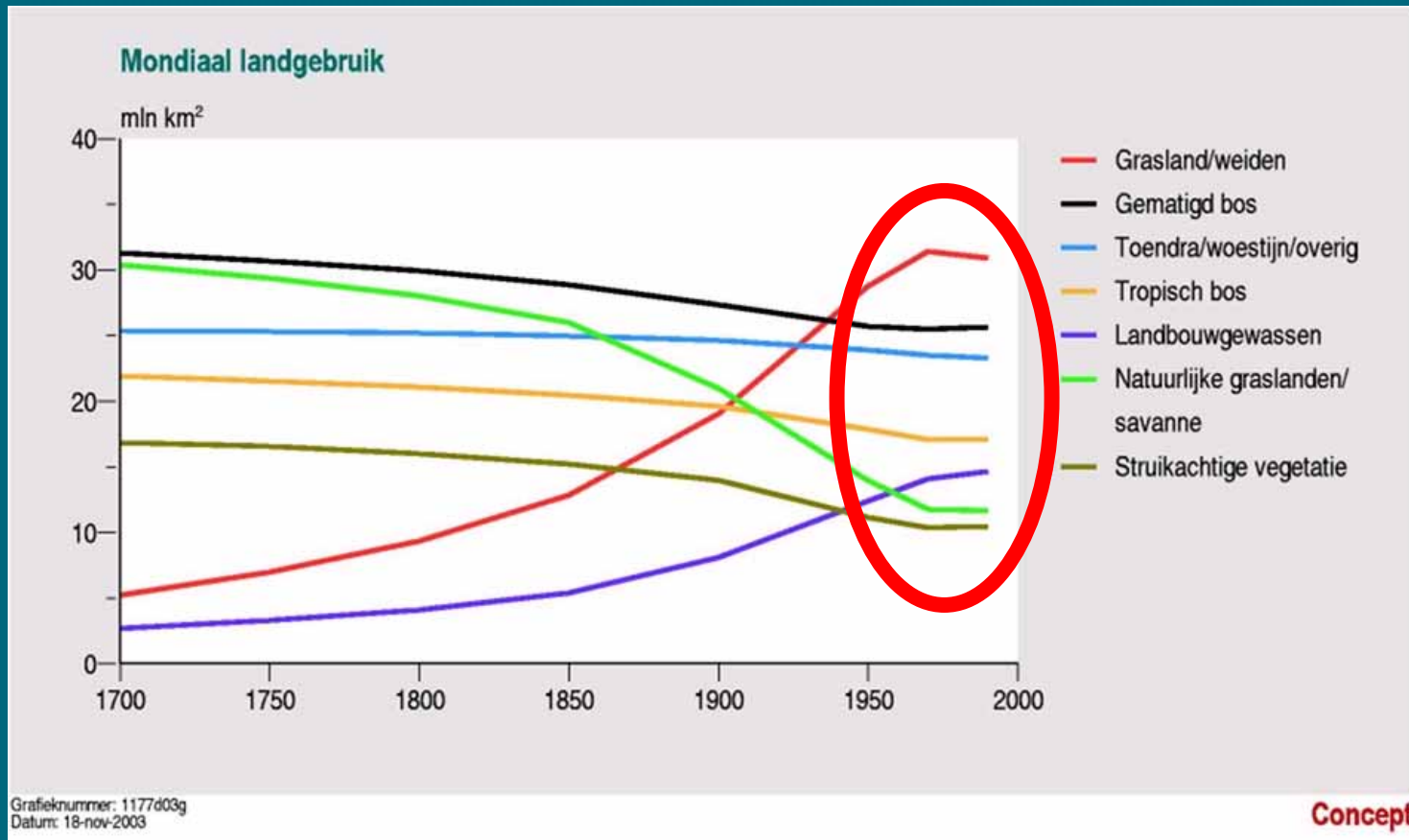


Agricultural land requirements

- Regional demand for animal products (beef, milk, pork, mutton, eggs and poultry) and crops (cereals, maize, rice, pulses, oil crops and roots & tubers)
- Trade flows between regions (agro-economic models)
- Yield increase due to technological development
- Shifts in livestock production systems

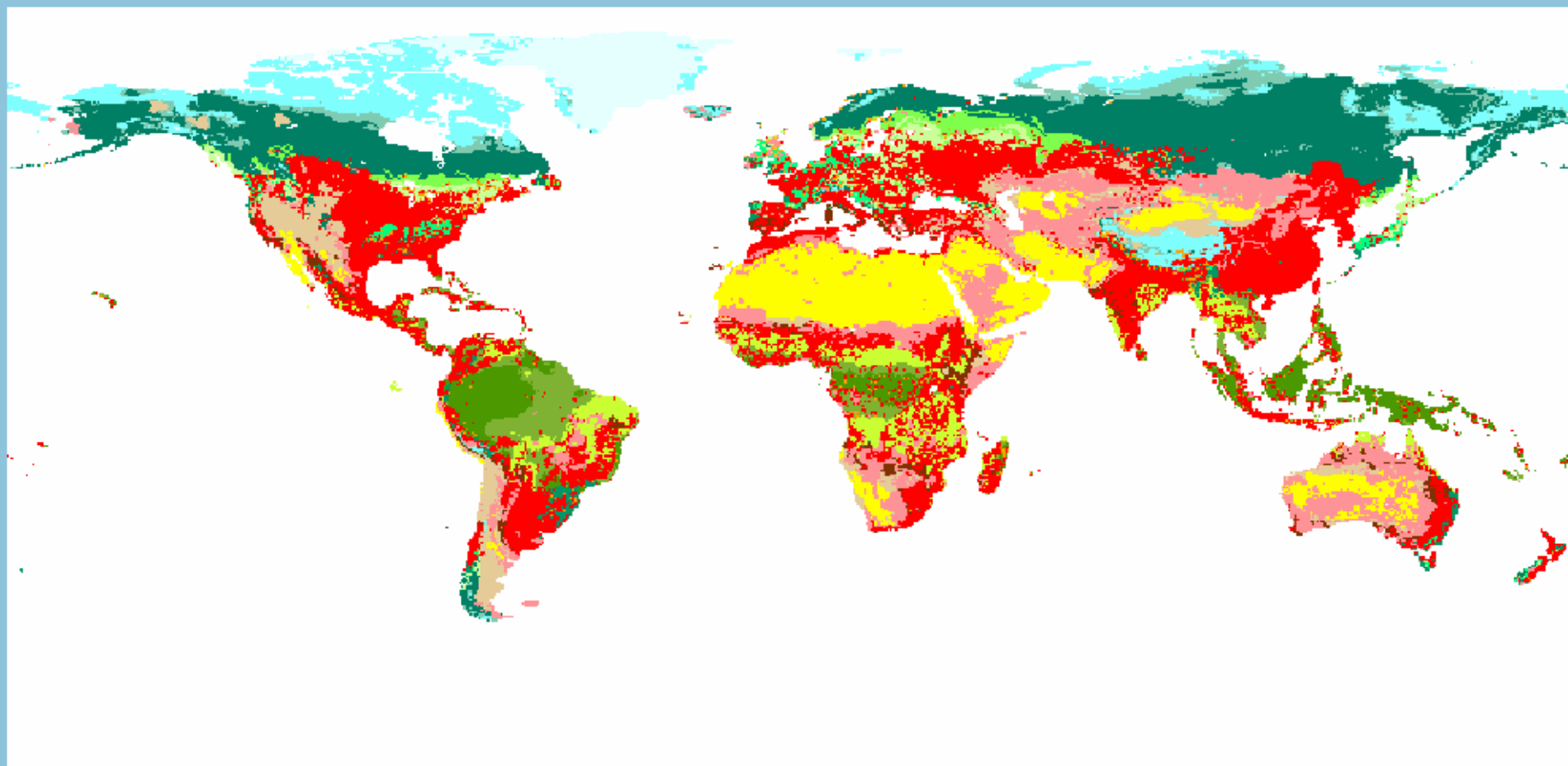


Historical trends in land-use



Results for FAO scenario (Agriculture towards 2030)

Land Cover - 2030 - B2_FAO2



Model results

- Nutrient input due to change in arable land and fertilizer use
- Productivity per hectare due to climate change (temperature, precipitation and CO₂)
- Land-use emissions from deforestation, fertilizer use and cattle (diet and size)



Integrated Assessment: tackling the interrelations between environmental issues

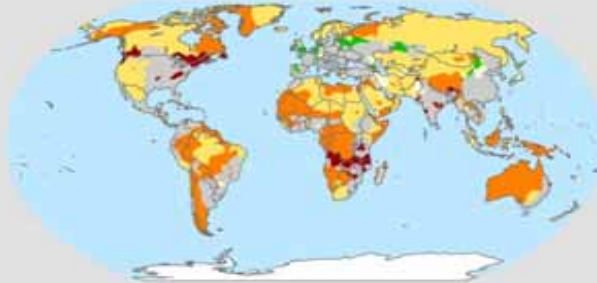
- Increased pressure on the land use system affects ecosystems and LU emissions
- Compounded effects from simultaneous (multiple) environmental stress on ecosystems



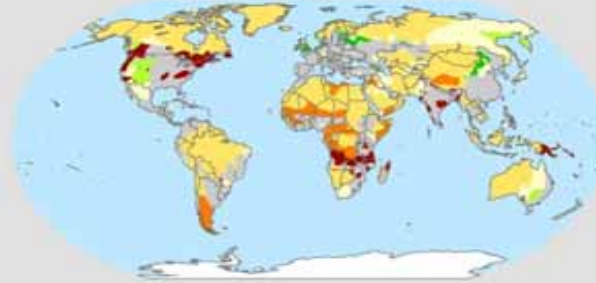
Natural Capital Index

Verandering natuurlijkgebied en milieudruk 2002 - 2032

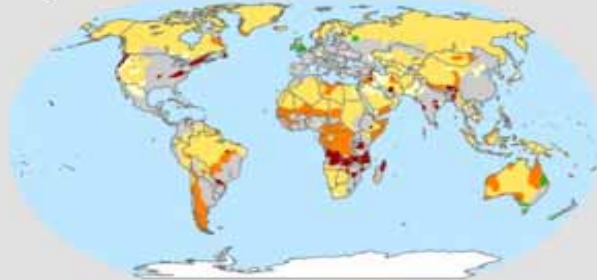
Mondiale Markt



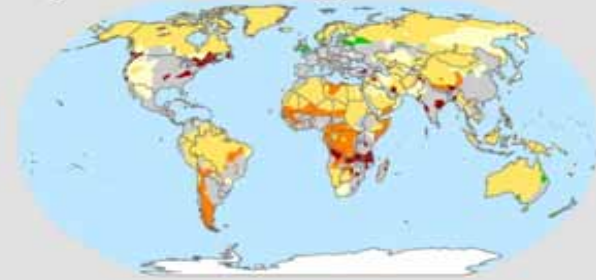
Mondiale Samenwerking






Regionale Markt



Regionale Samenwerking



Legenda

-  Van gedomesticeerd naar natuurlijk gebied
-  Afname milieudruk
-  Geen verandering
-  Toename milieudruk
-  Van natuurlijk naar gedomesticeerd gebied
-  Blijft gedomesticeerd gebied
-  Water

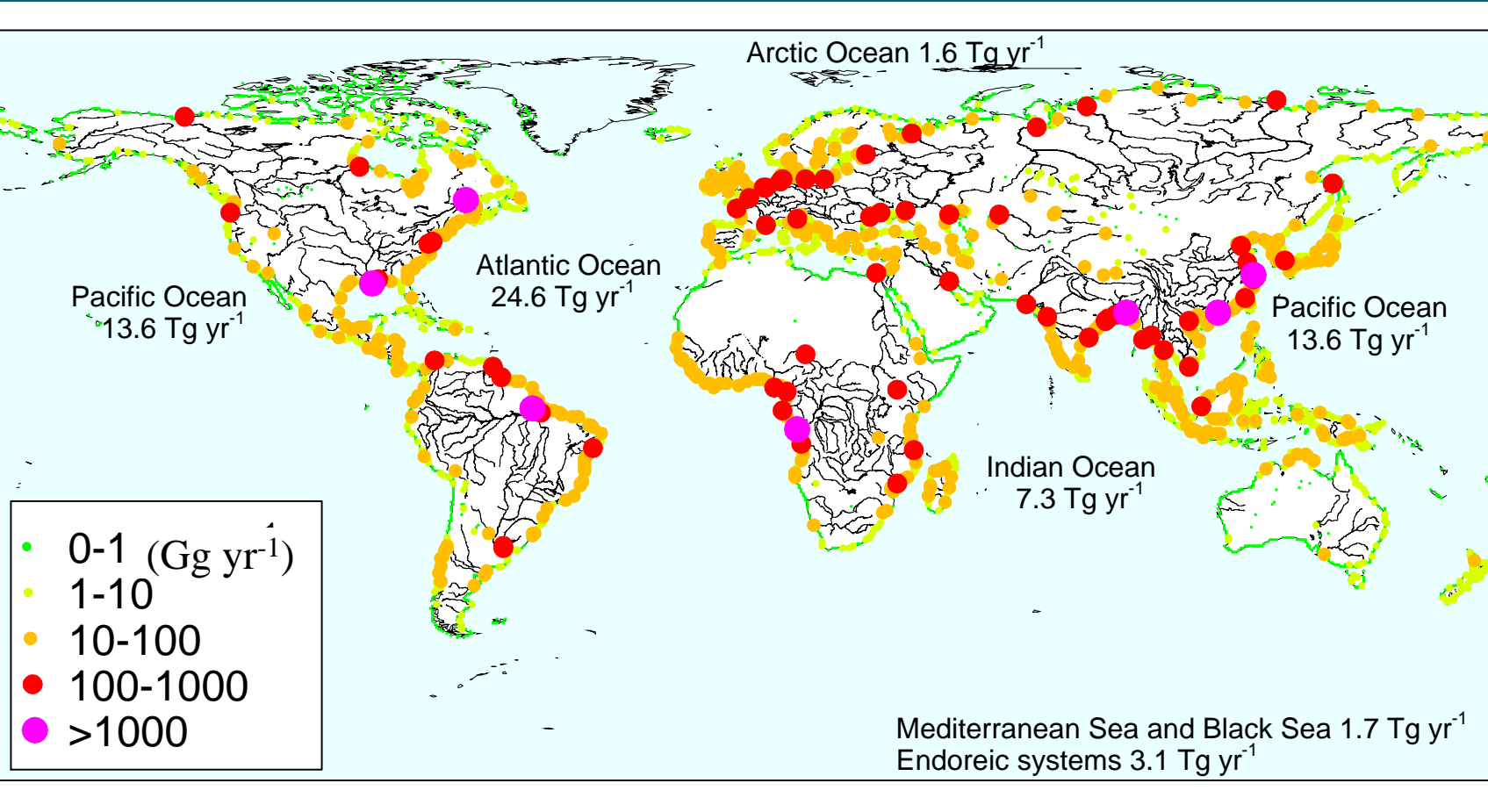


Integrated Assessment: Nitrogen

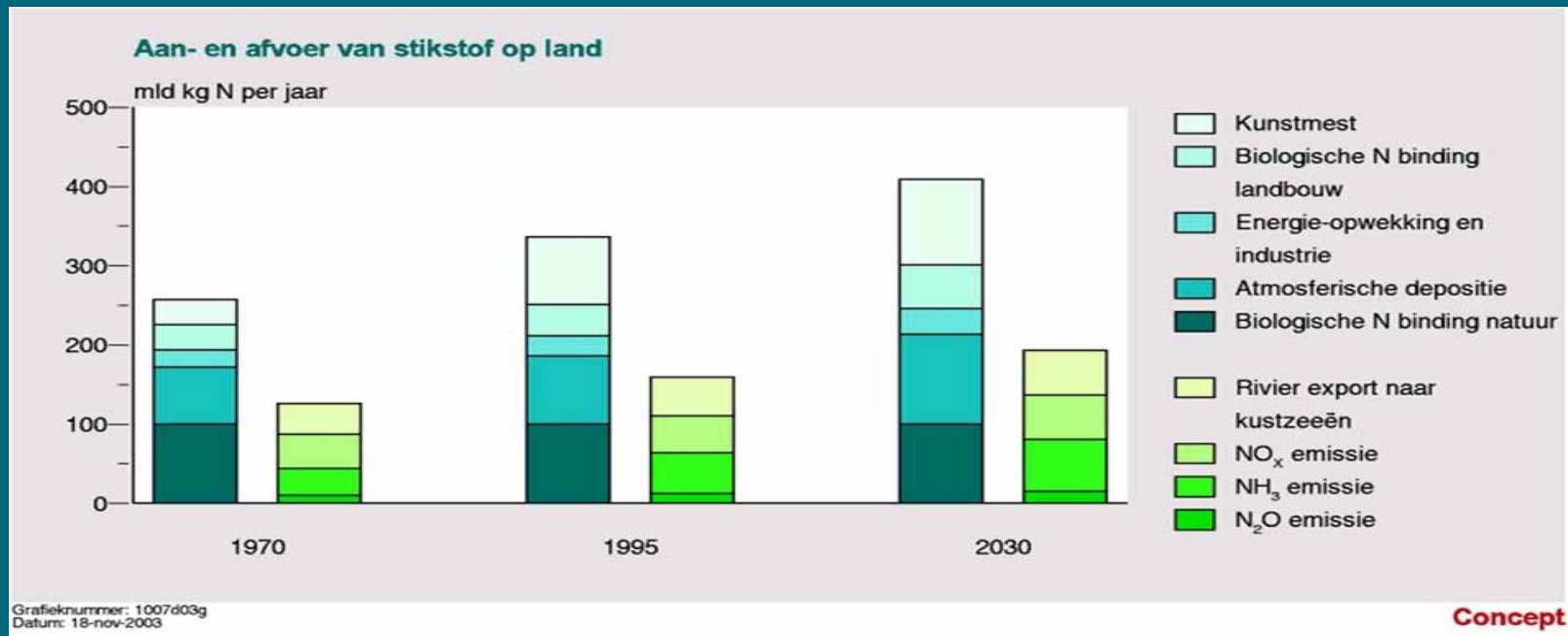
- Nitrogen cycle issues: nutrients and emissions



Nitrogen loading of coastal water



Nutrient consequences of FAO scenario: global N-fluxes

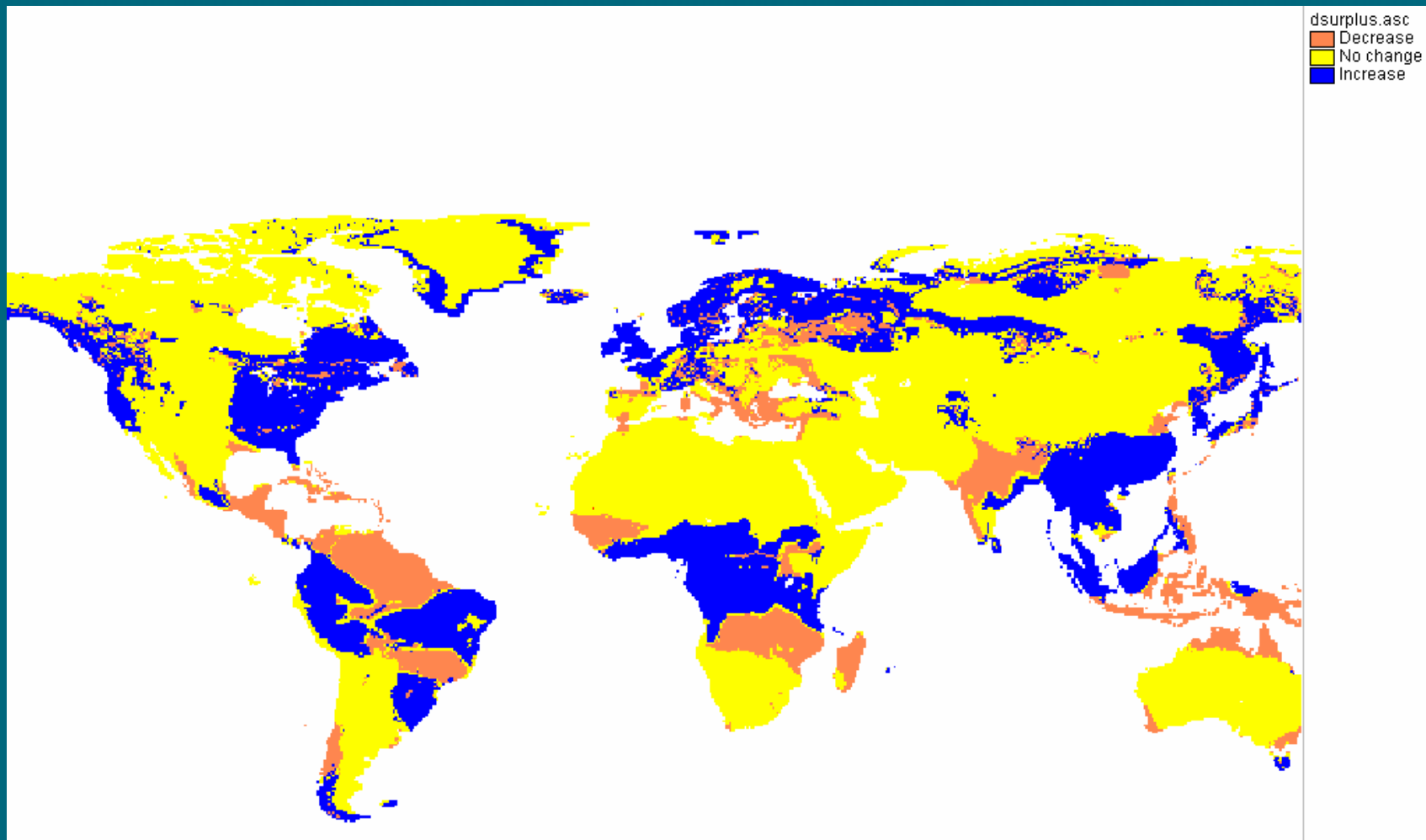


Integrated Assessment: Water

- Consequences for water availability (co-operation with University of Kassel - WaterGAP model)
- Growing demand and (regional) water stress
- Water induced soil degradation



Change in precipitation surplus between 2000 and 2030



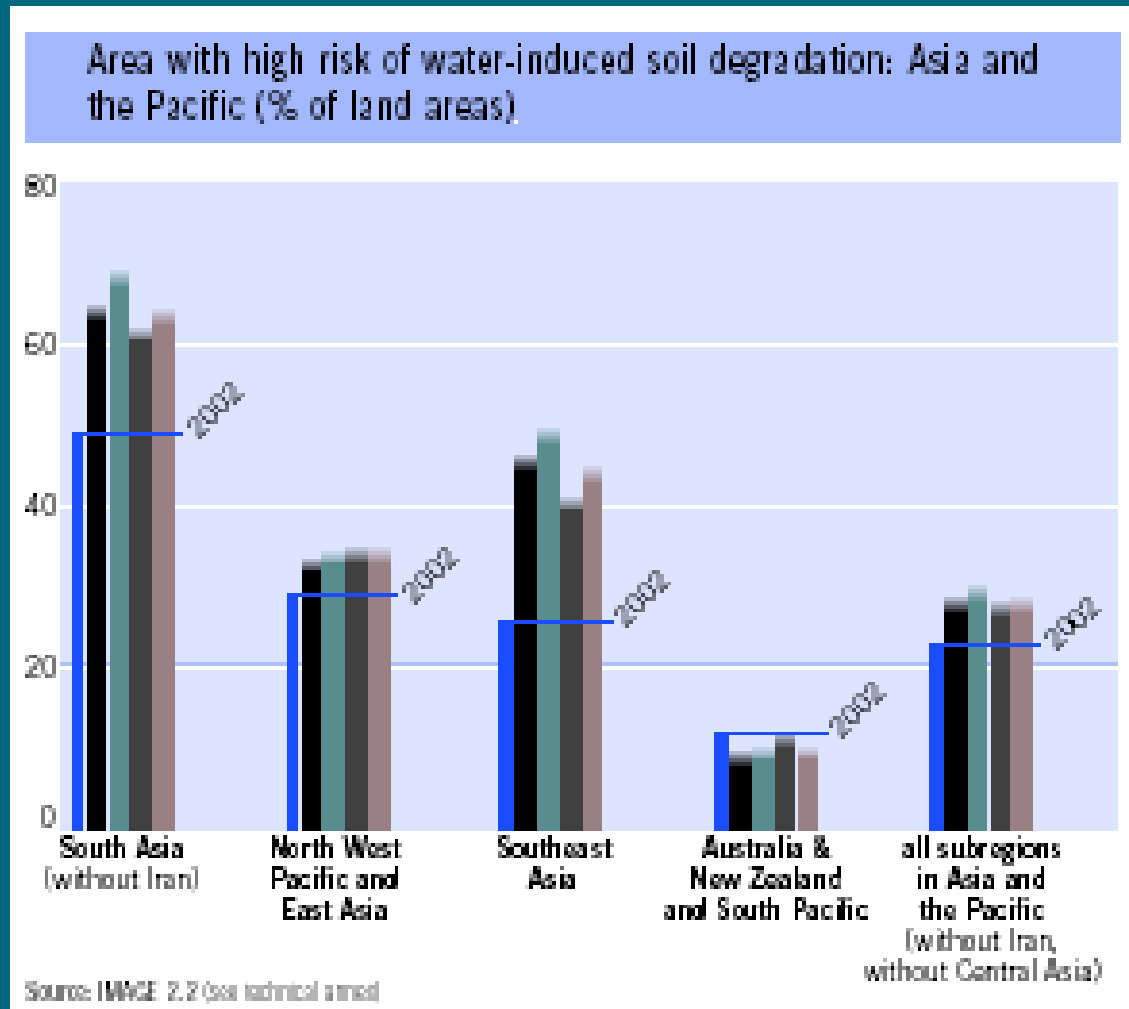
Not only change in supply...

- The growth of water demand by households and industries (% aagr 2000-2040)

	Strong Europe	Transatlantic Market	Regional Communities	Global Economy
EU-15	-1.6	0.3	-1.0	-1.2
OECD	-1.3	0.5	-0.5	-1.1
non Annex I	0.7	2.6	1.4	2.0
World	-0.3	1.6	0.5	0.6



High risk of water-induced soil degradation

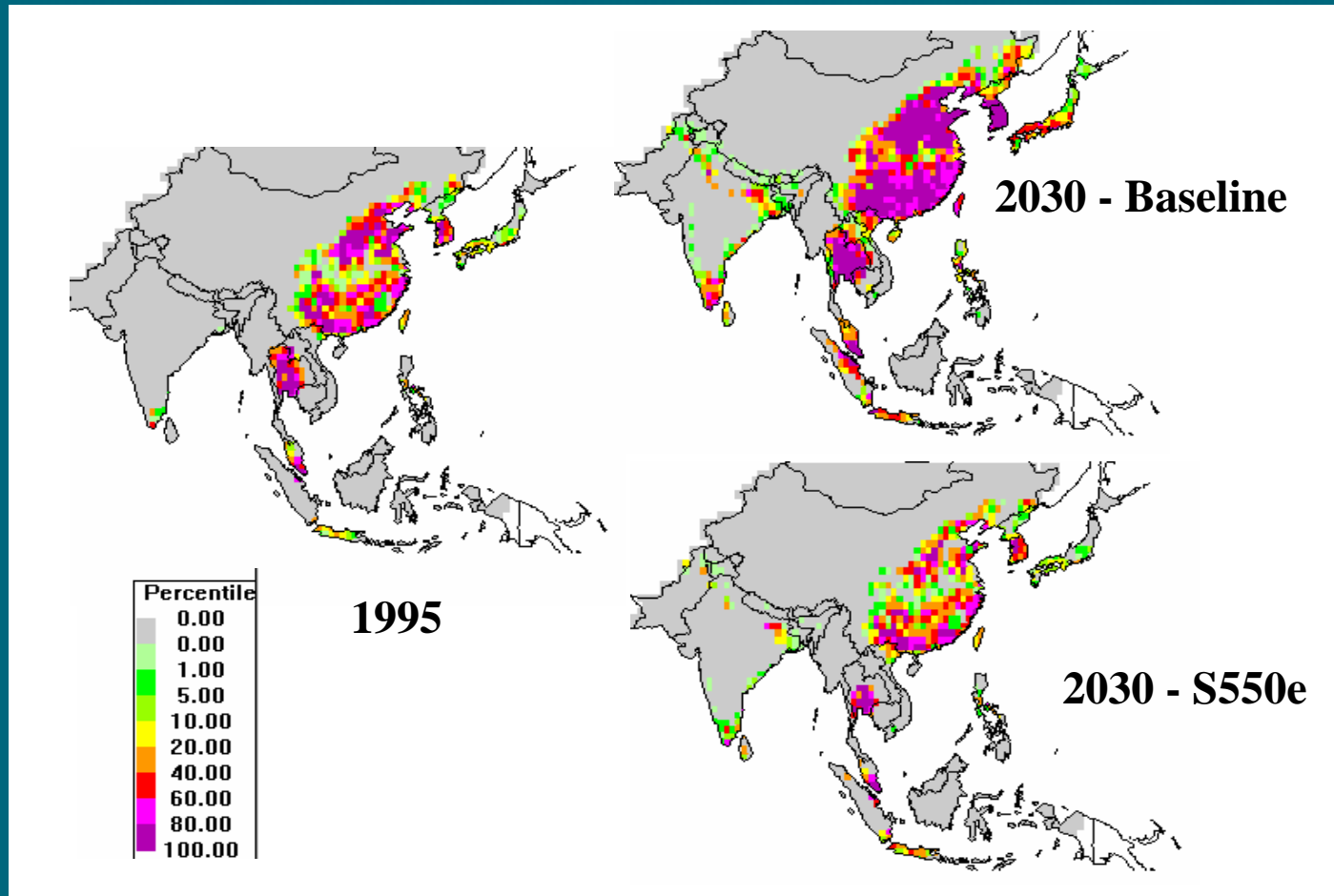


Integrated Assessment:

- Linking climate and air quality: IMAGE + RAINS



Air quality gains from climate policy



TIMER-RAINS/Asia

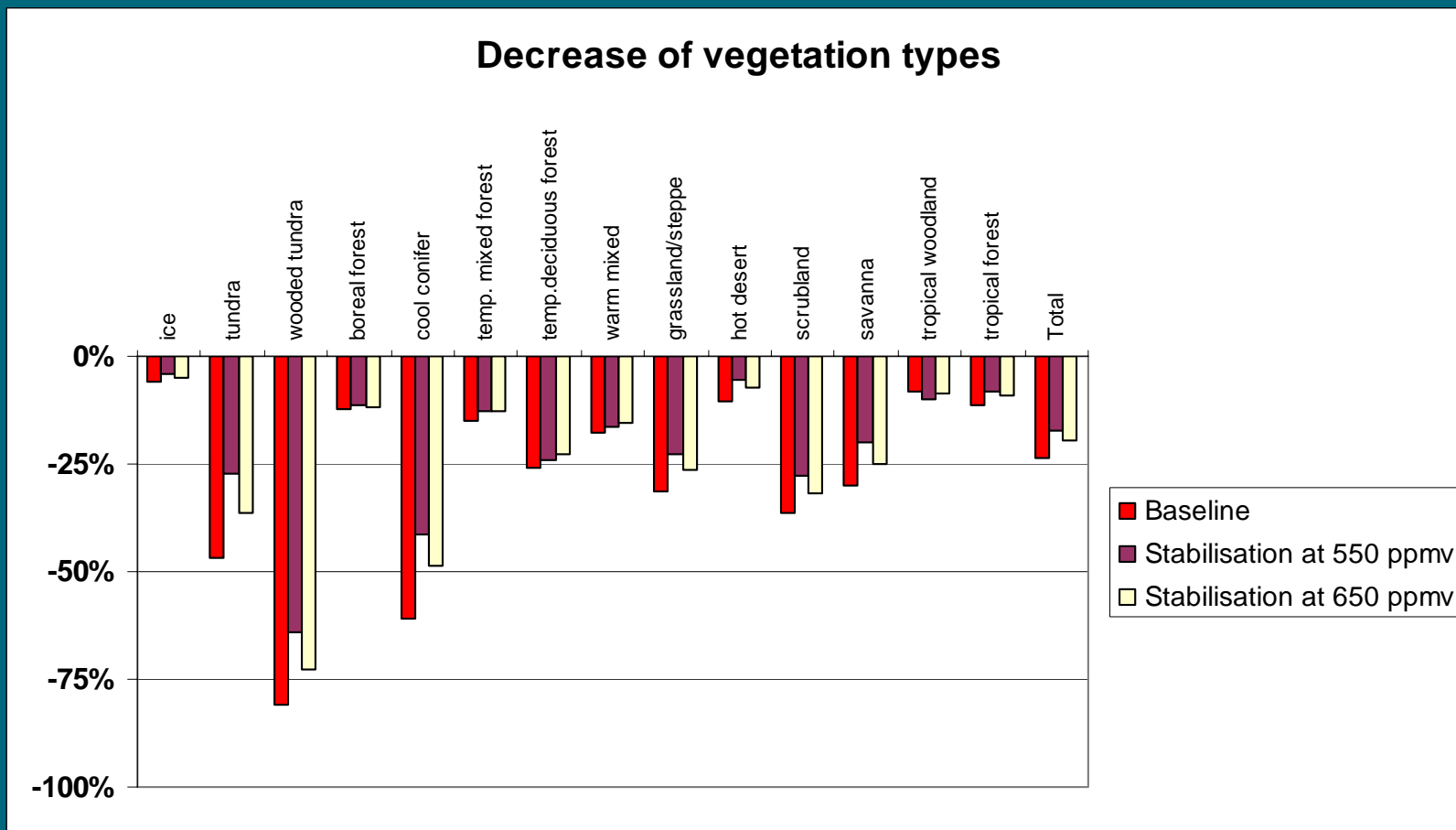


Integrated Assessment: Biodiversity

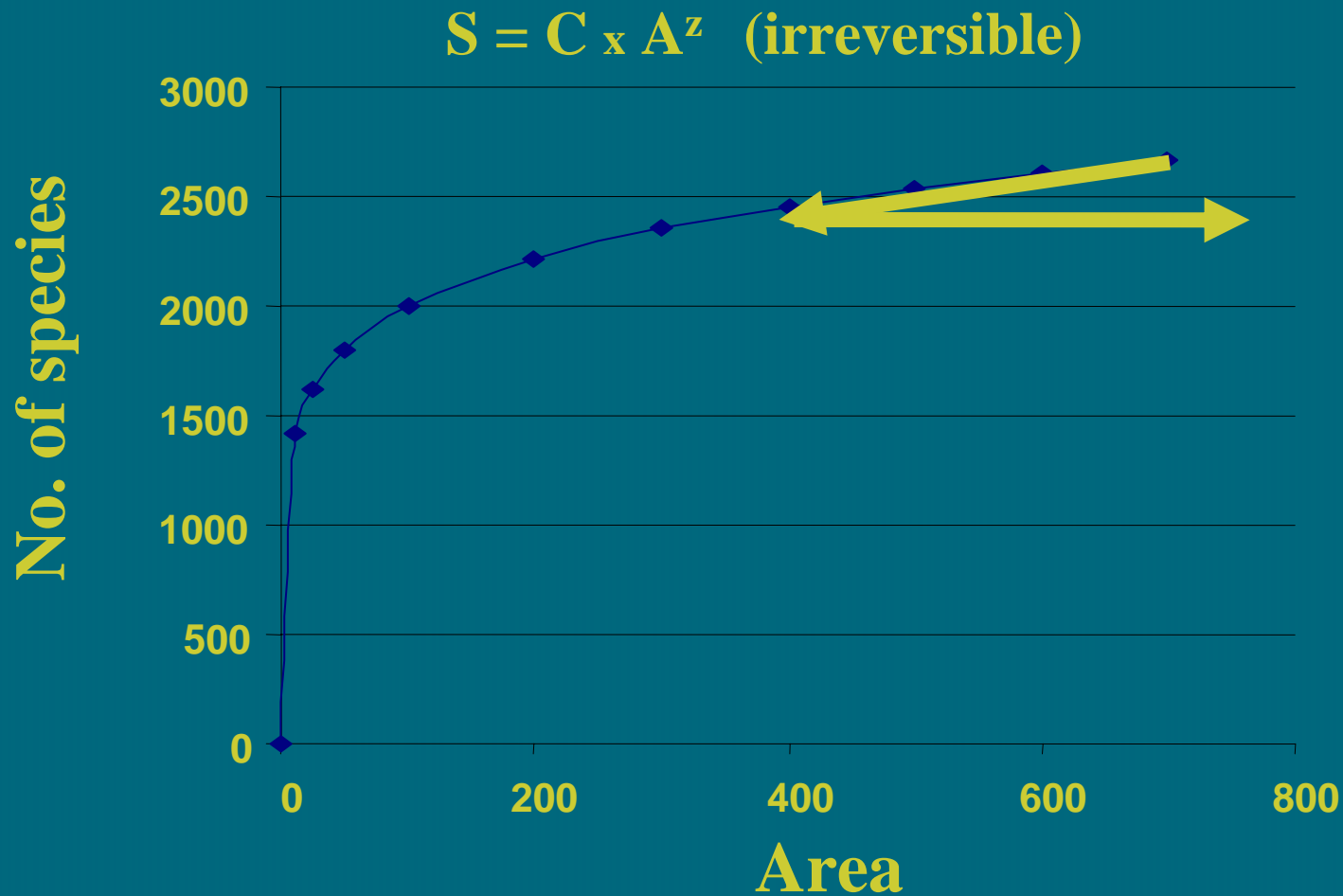
- Biodiversity impacts from LU change, climate and other environmental factors
- loss of vegetation by type (IMAGE)
- loss of species (IMAGE + species-area curves)
- climate effect on European ecosystems (IMAGE + EUROMOVE)



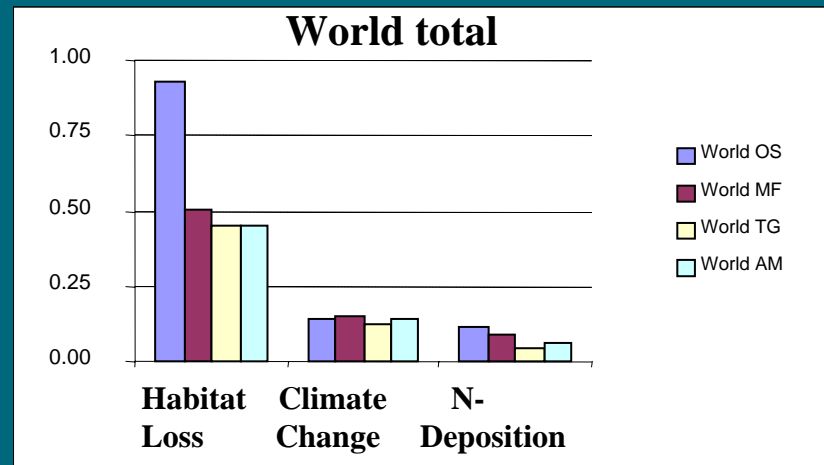
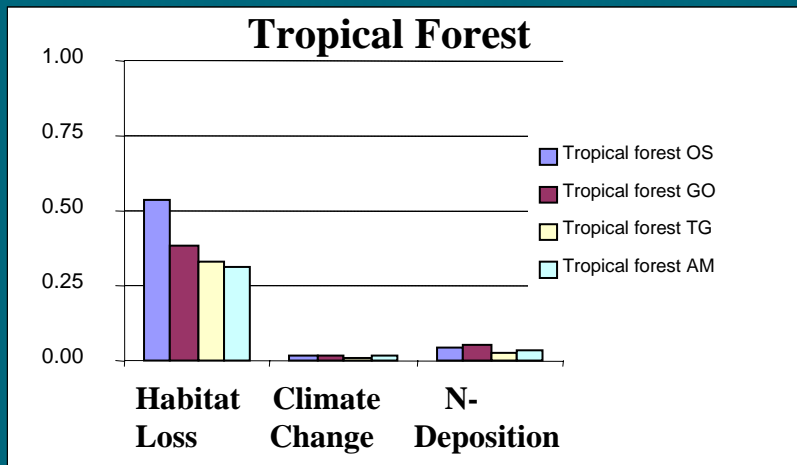
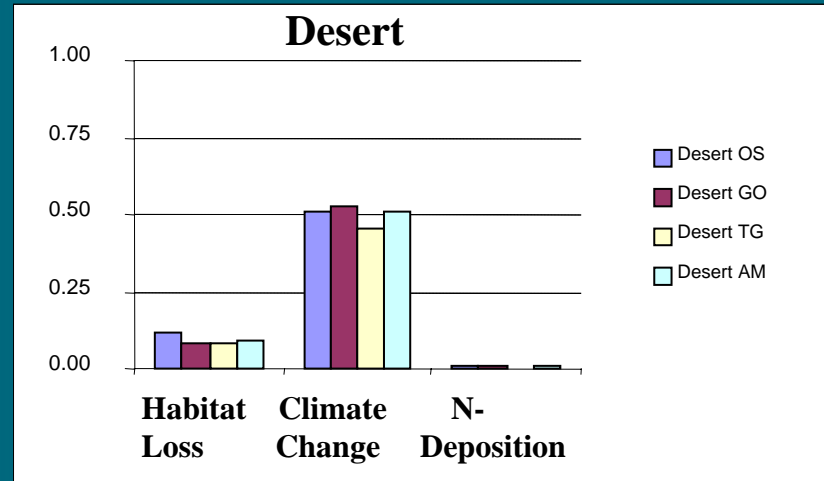
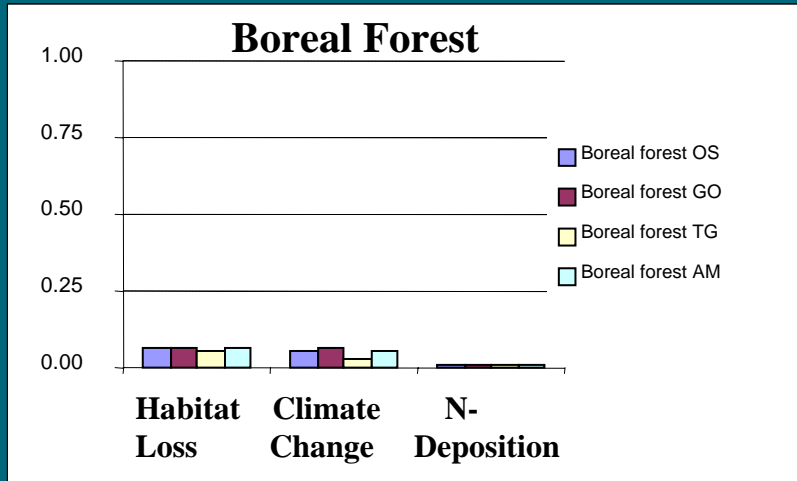
Consequences for natural vegetation



Millennium Ecosystem Assessment: species - area curves



MA: loss of species by stress factor



Biodiversity: EUROMOVE/IMAGE

(Note: RIVM contribution to Nature article)

- EUROMOVE estimates presence of 1400 vascular plant species in gridcells from 6 climate variables
- Calibration with Atlas Flora Europaeae (1989)
- Aggregated to 20 European regions
- Climate variables from IMAGE + GCM patterns
- Baseline (CPI) and stab.scenarios (S550, S450)
- Sensitivity to different GCM patterns



Biodiversity indicators from EUROMOVE

1. Stable area:

percentage of grid cells in which a species occurs both in 1995 and in the future

2. Disappearance fraction:

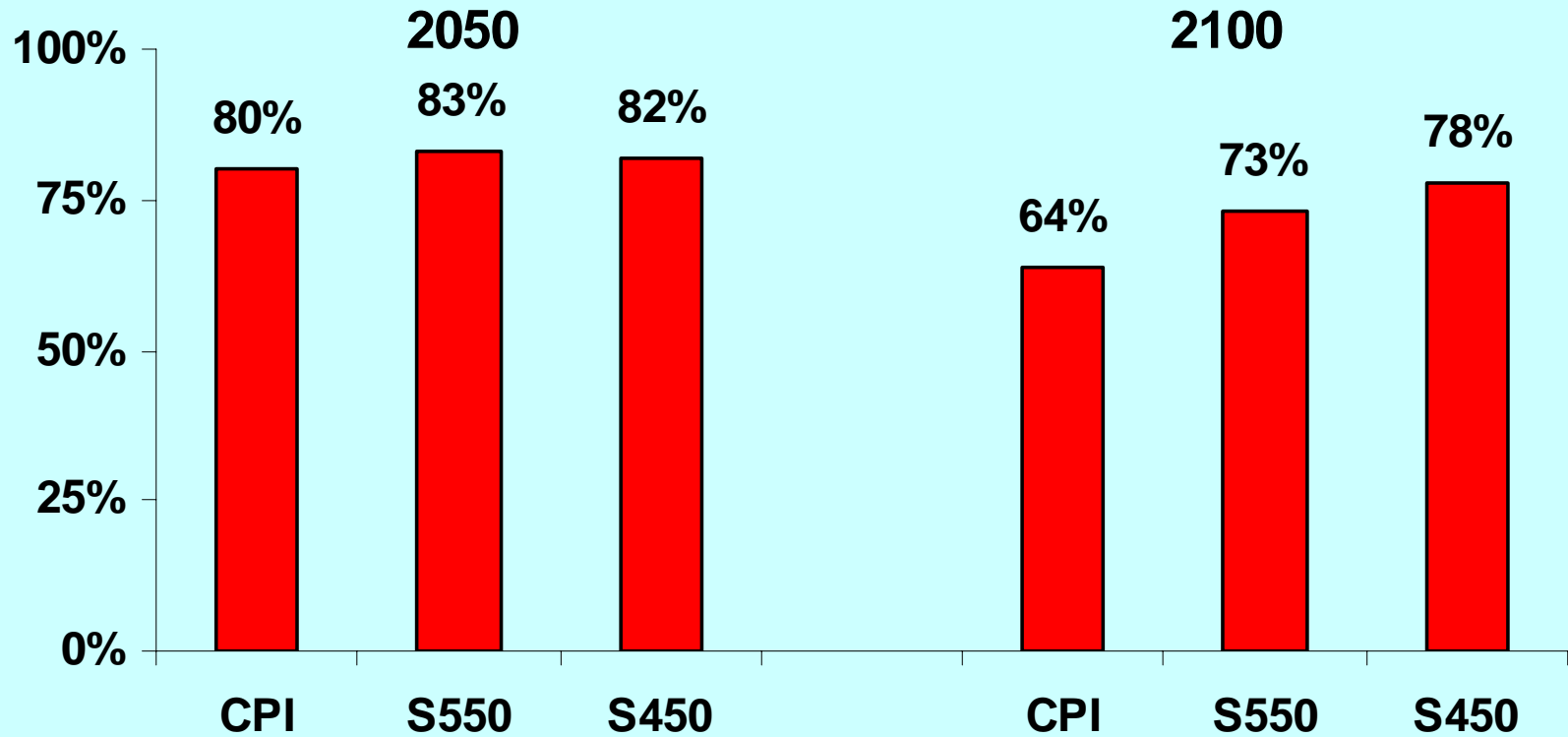
fraction of species present today in region, that are no longer there in the future

3. Species flux:

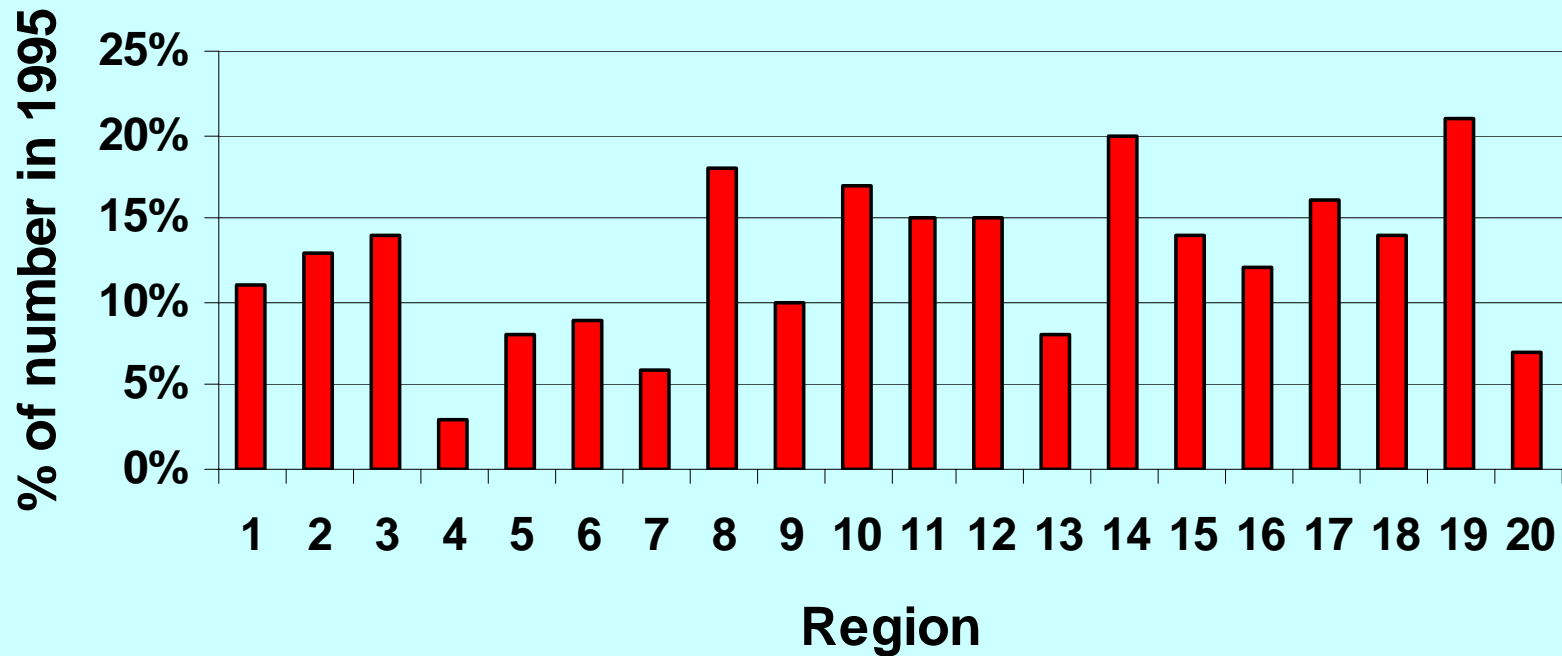
difference between the number of appearing and disappearing species as fraction of the number of species in 1995



Stable Area in Europe



Species disappearing (CPI-2100)



- **Lowest: Norway & Sweden**
- **Highest: Germany, Ukraine, Greece**



Sensitivity of stable area in 2100 to GCMs

CPI	HADCM2	CGCM1	CSIRO-MK2	ECHAM4
Lowest	39% Ukraine	55% Spain	61% Russia	44% Spain
Average	64%	72%	72%	65%
Highest	89% Baltics	94% Iceland	87% Benelux	89% Iceland
S550				
Lowest	55% Ukraine	65% Spain	70% Russia	55% Spain
Average	73%	79%	79%	74%
Highest	93% Baltics	95% Iceland	92% Benelux	92% Iceland
S450				
Lowest	62% Ukraine	70% Spain	74% Spain	74% Spain
Average	78%	82%	82%	78%
Highest	94% Baltics	95% Iceland	93% Benelux	93% Benelux



For more information

www.rivm.nl/ieweb
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