PBL Netherlands Environmental Assessment Agency

Questions of ultimate urgency

biodiversity & ecosystem services in socioeconomic scenarios

Ben ten Brink, PBL

21-10-2013, Paris

Content

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1. The big picture: 10,000 BC up to 2050
2. Global change
3. Approaching local & planetary limits?
4. Questions of ultimate urgence

The big picture:
human development 10,000 BC to 2000 AD

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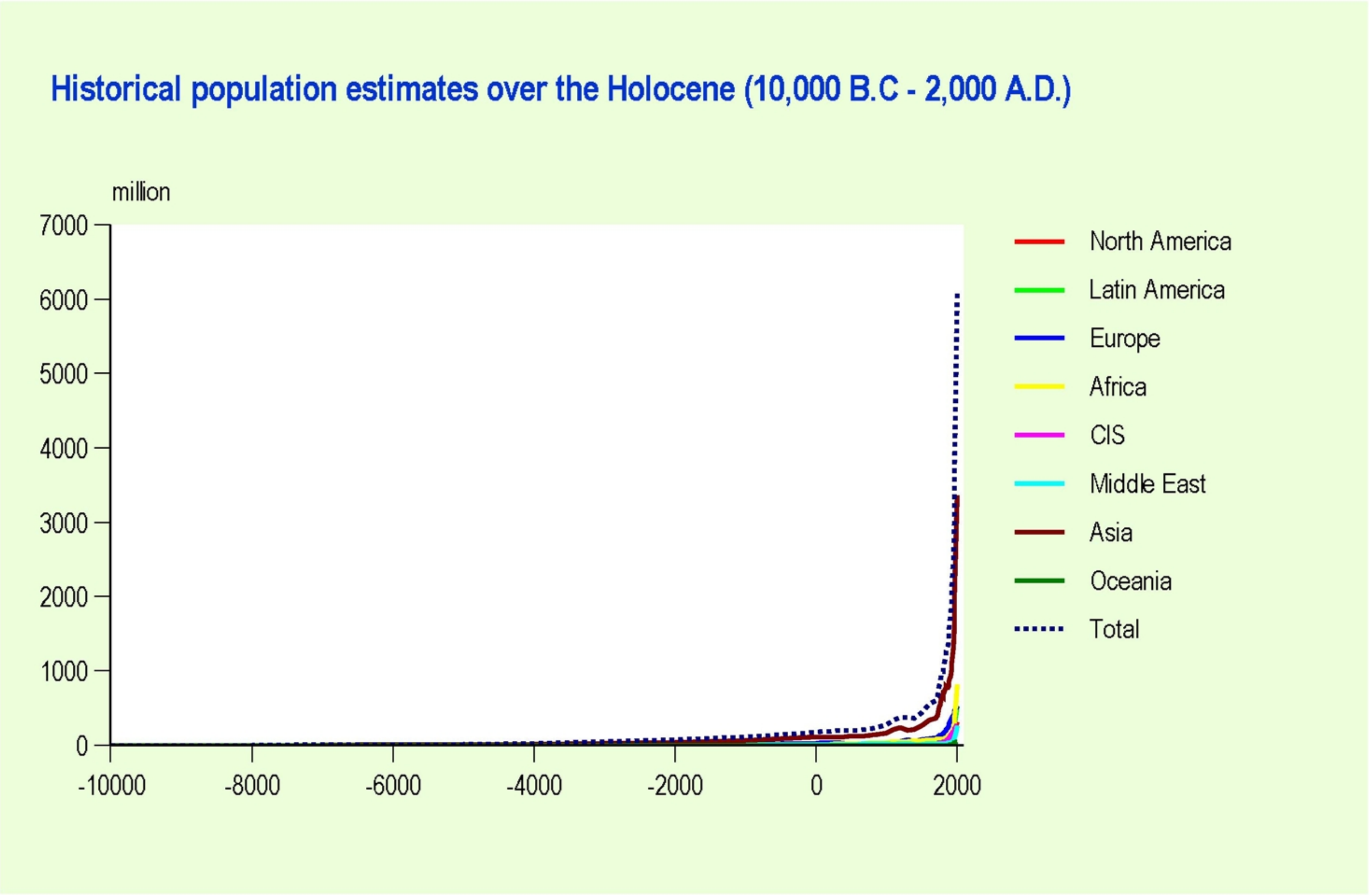
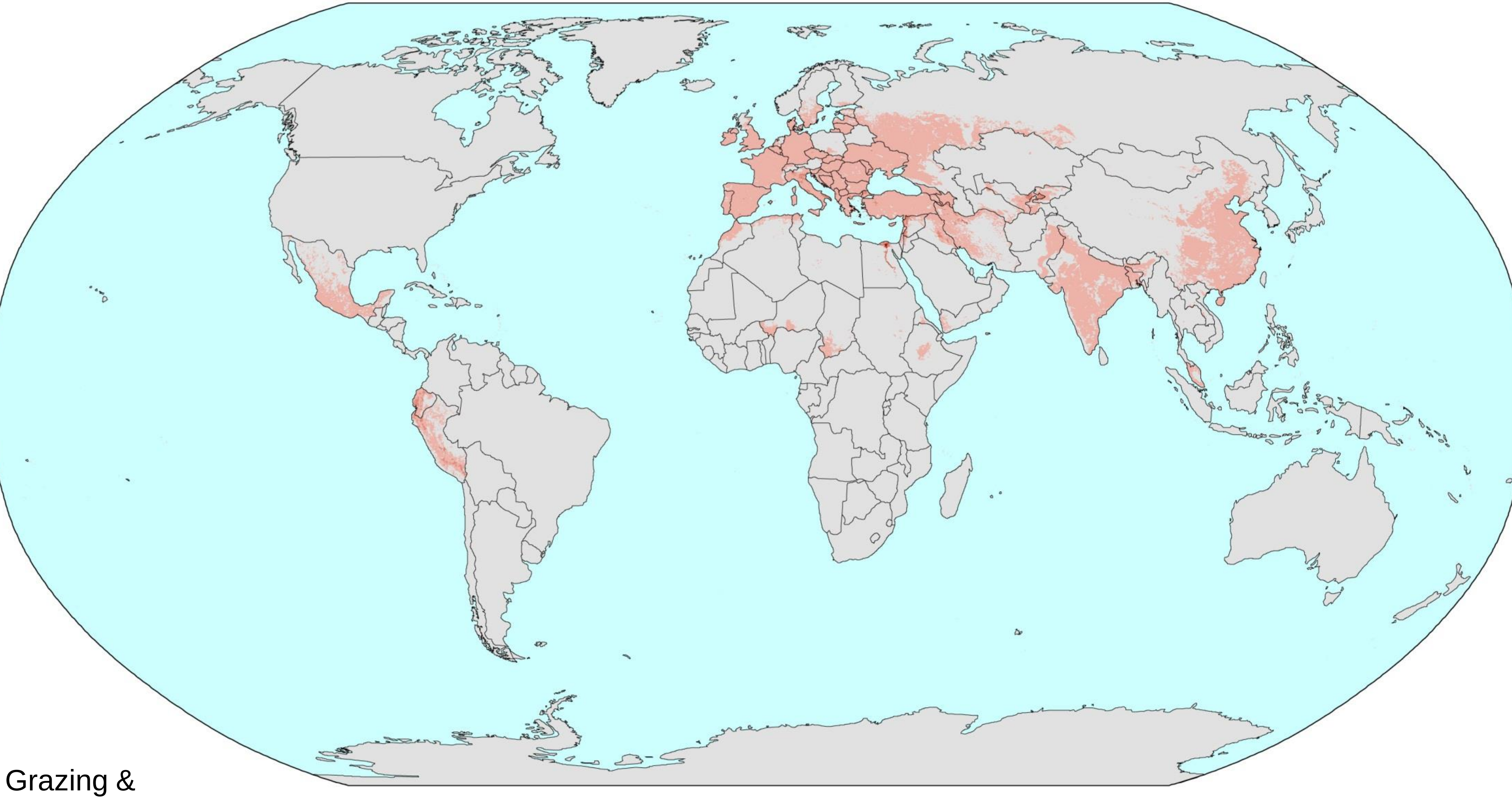


Land use in the past

3000 BC

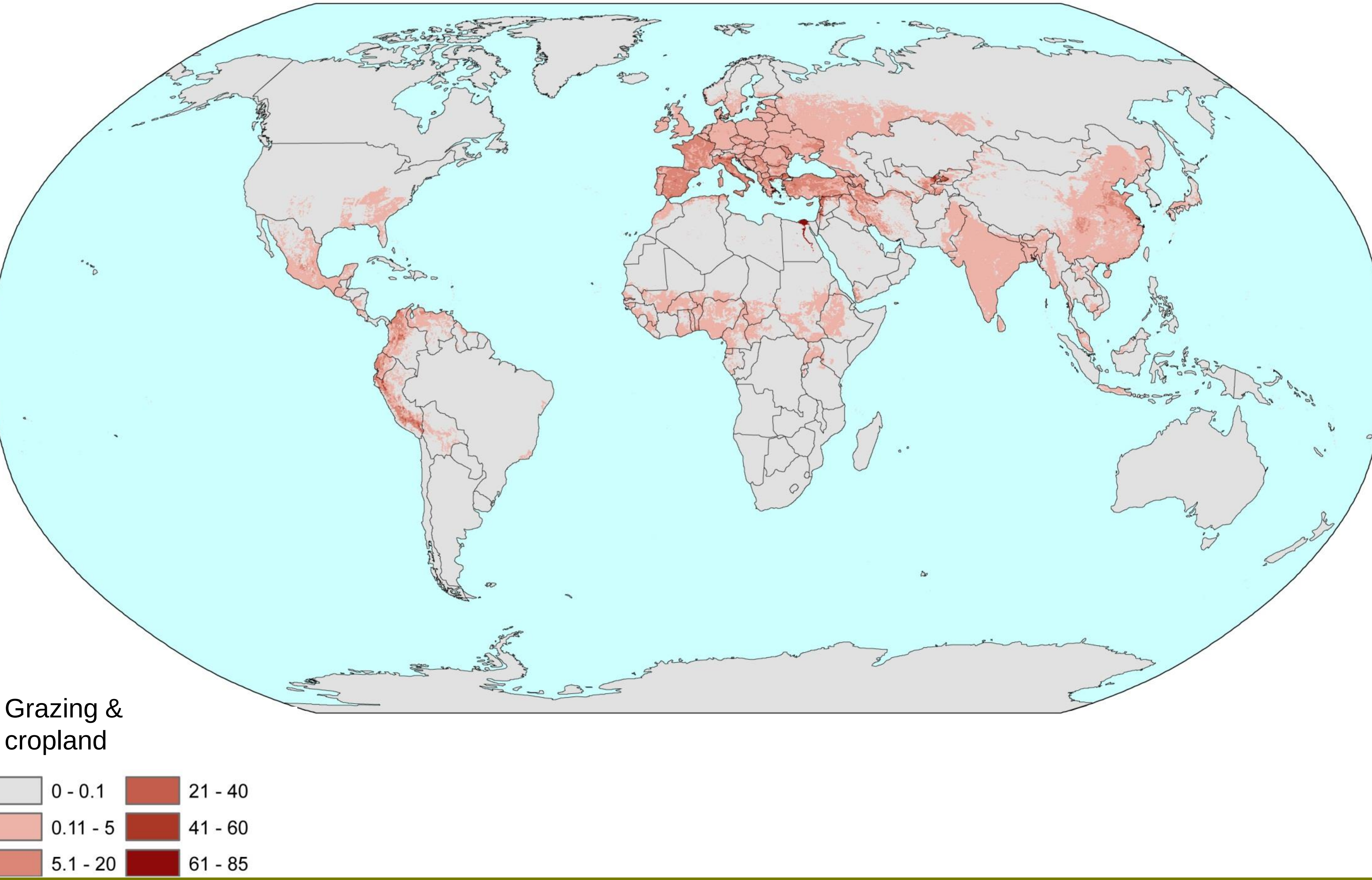


Grazing & cropland

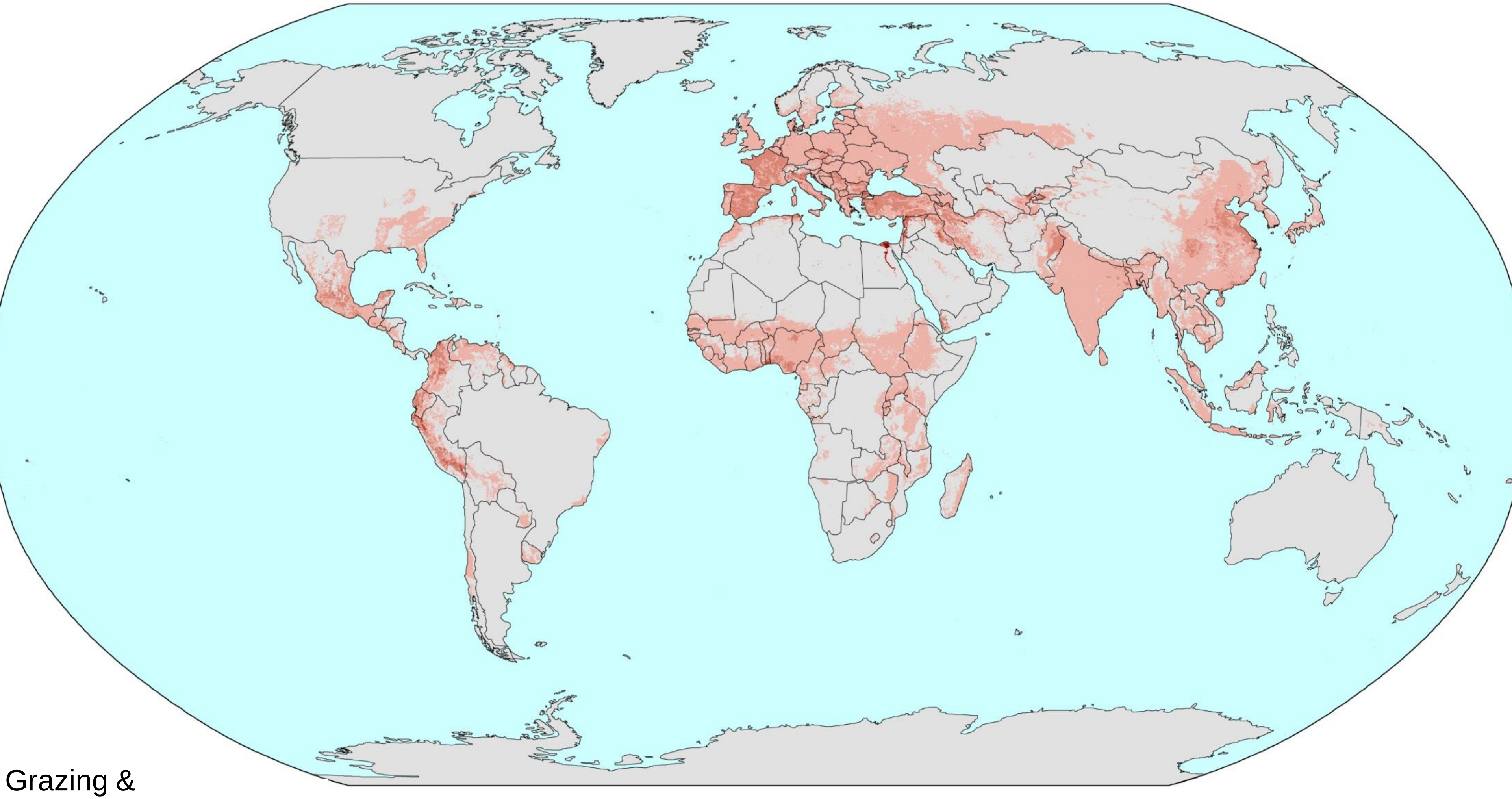
/gridcell)

0 - 0.1	21 - 40
0.11 - 5	41 - 60
5.1 - 20	61 - 85

0 AD



1000 AD



Grazing &
cropland

	0 - 0.1		21 - 40
	0.11 - 5		41 - 60
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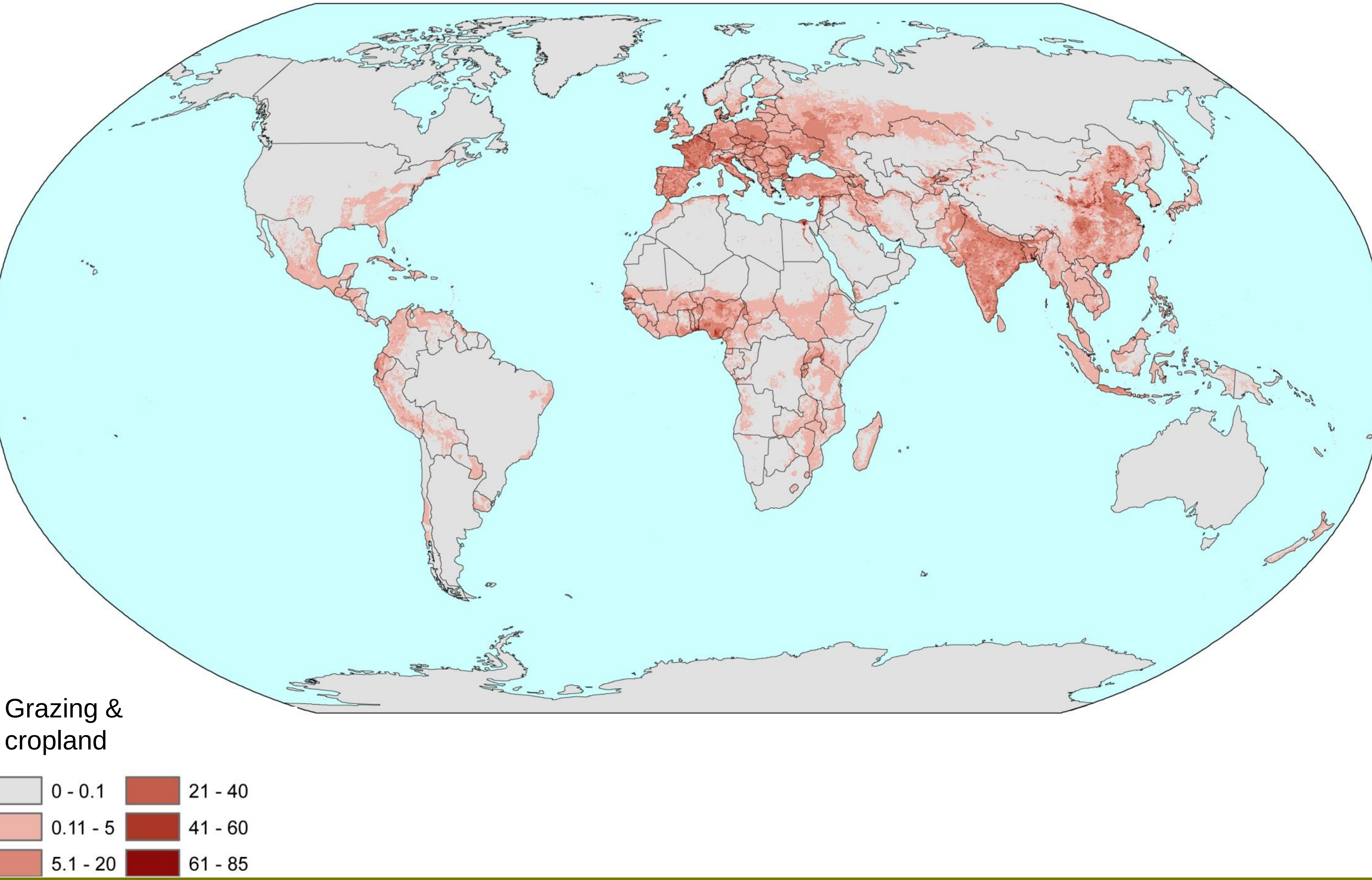
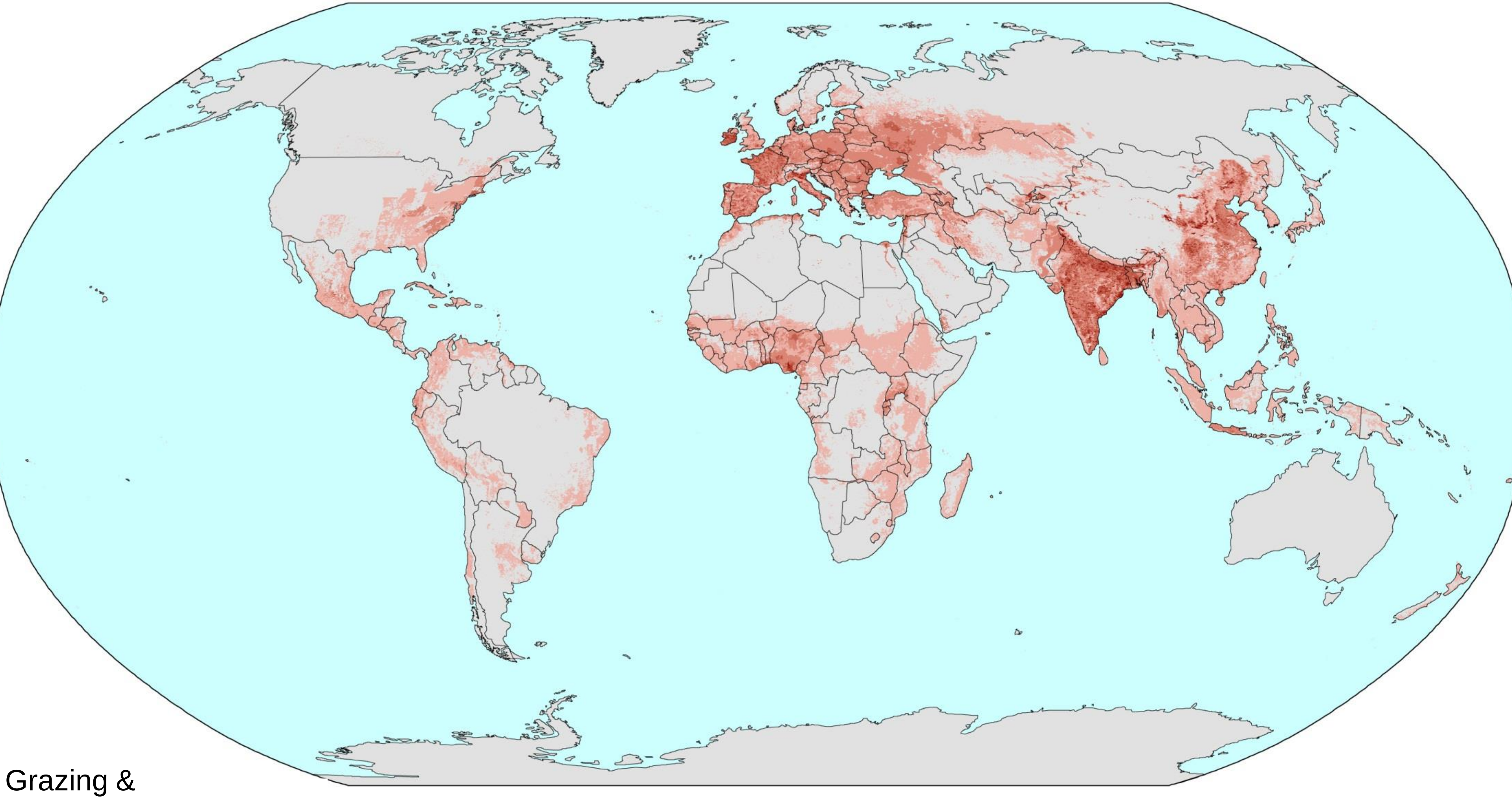
1700 AD



1800 AD



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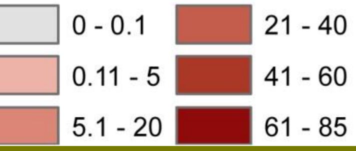
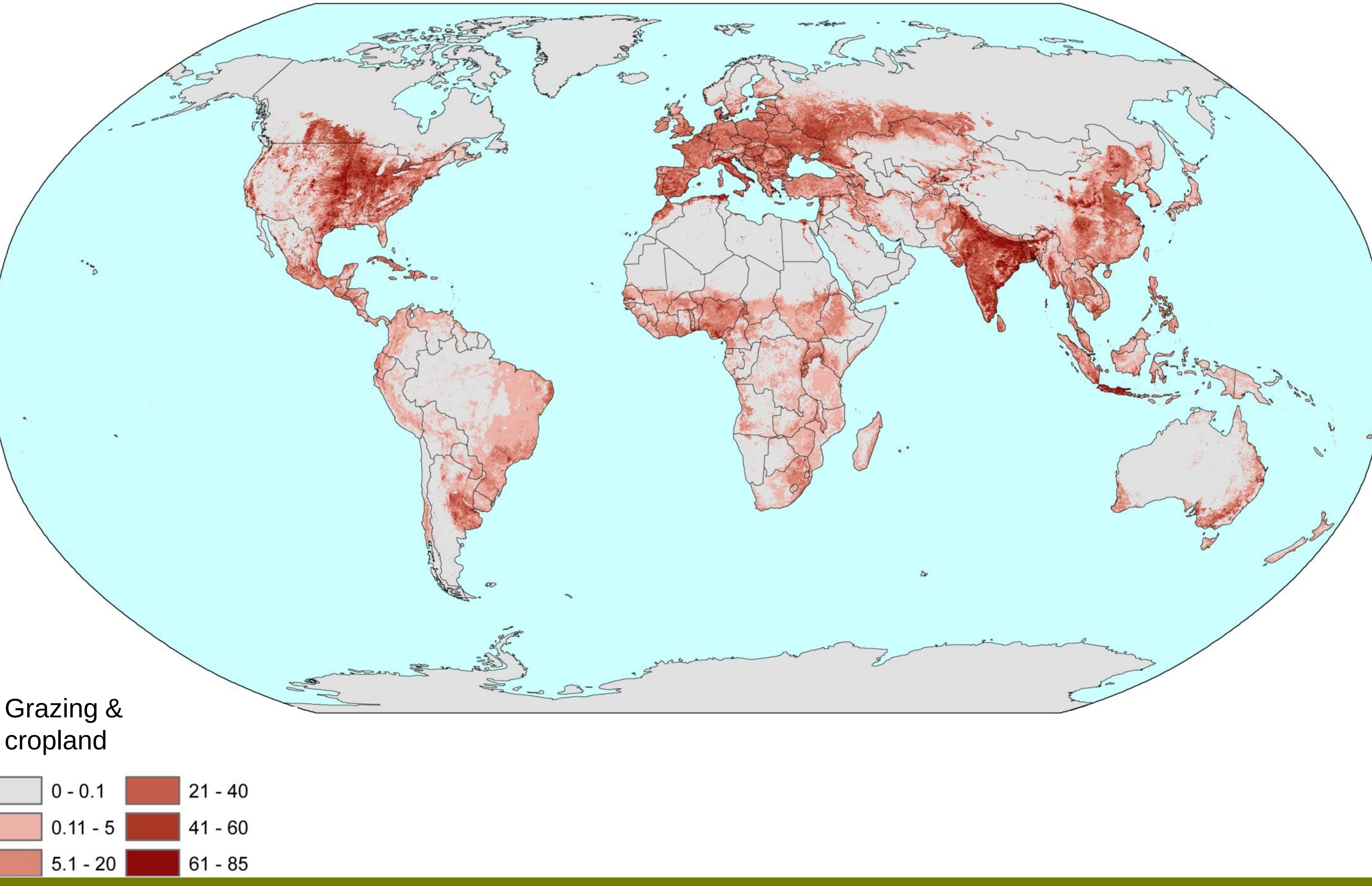
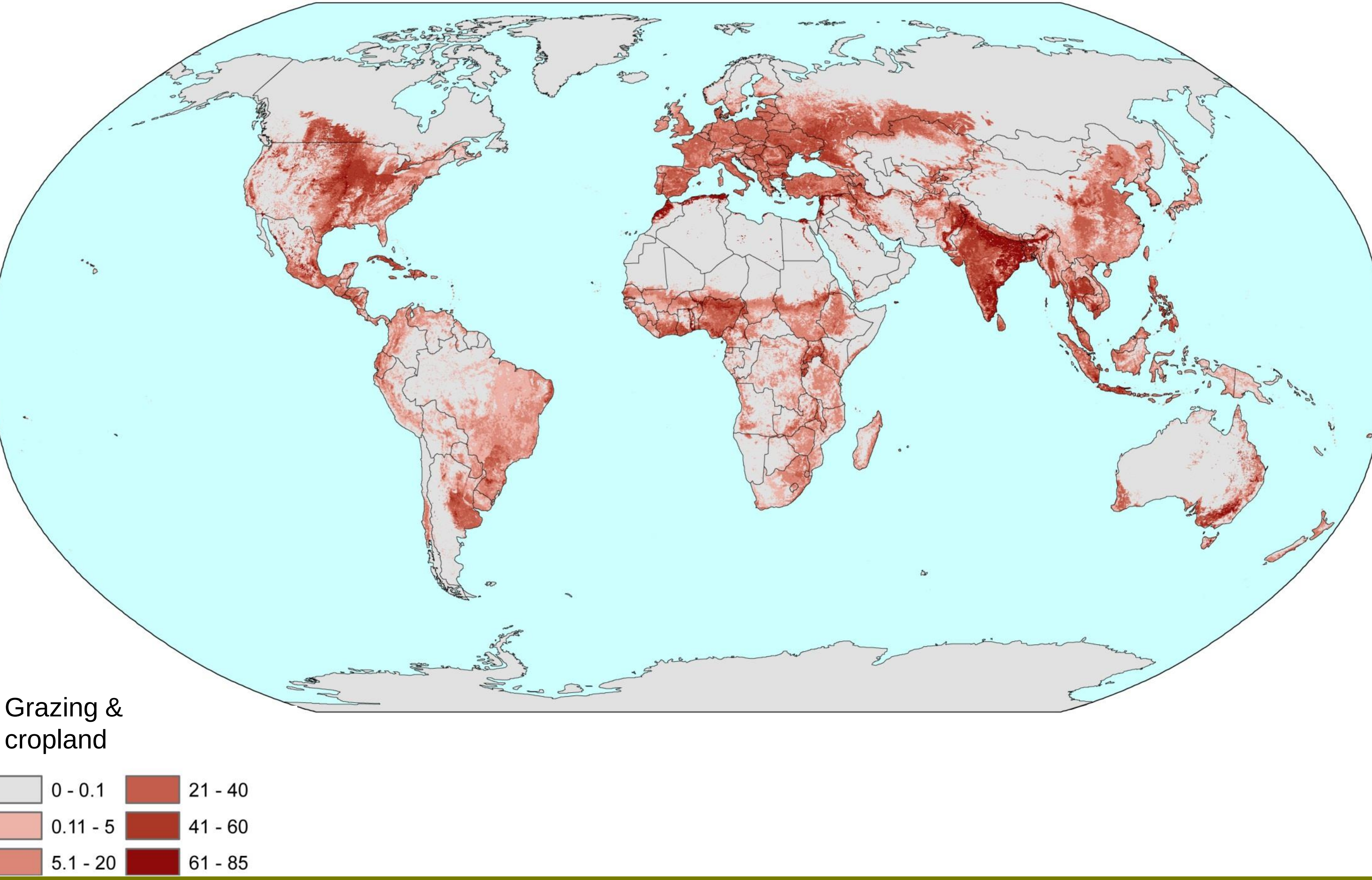


1950 AD

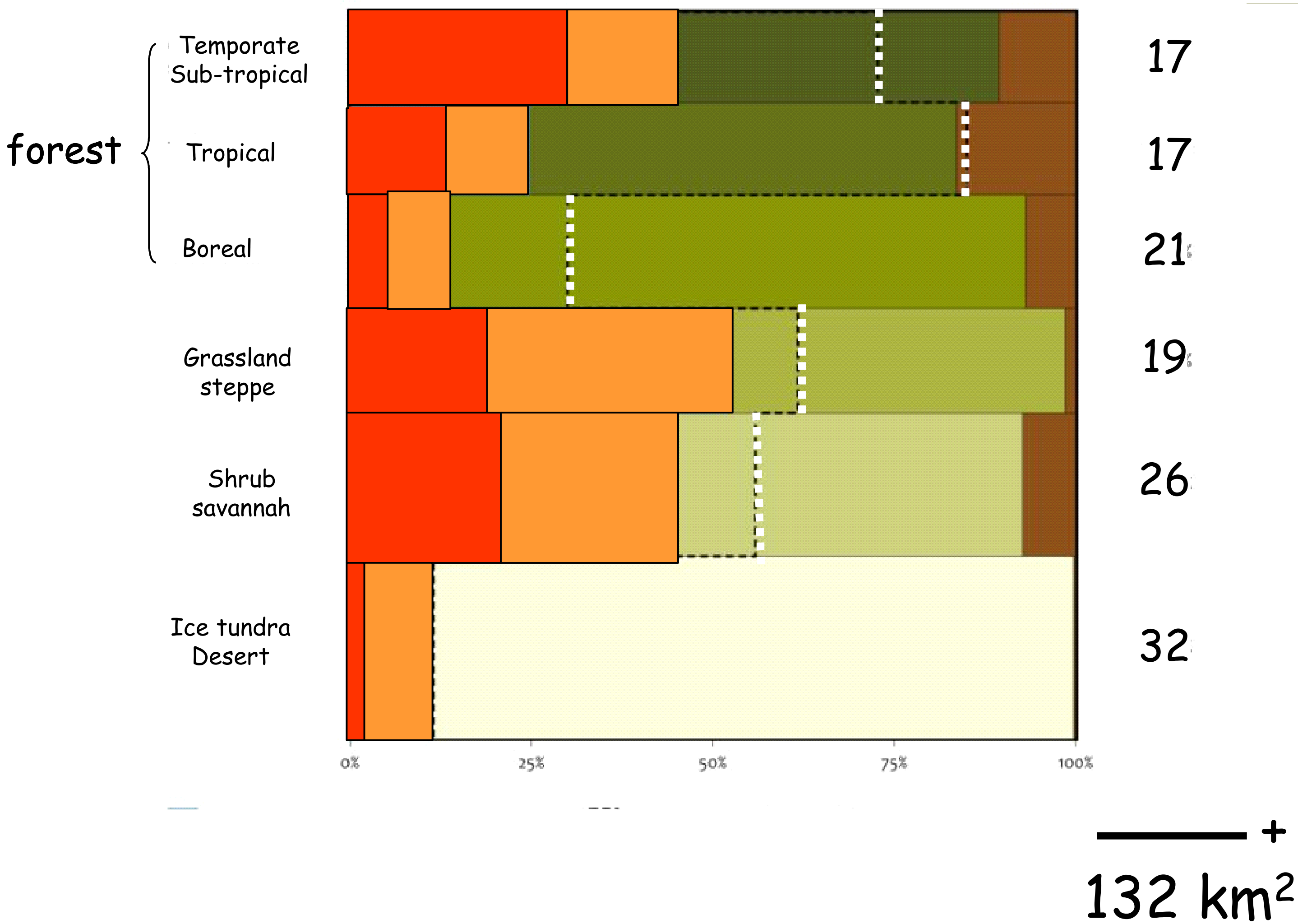


2000 AD



Competing claims on land & assets

2010 Land use per ecosystem type Million km²

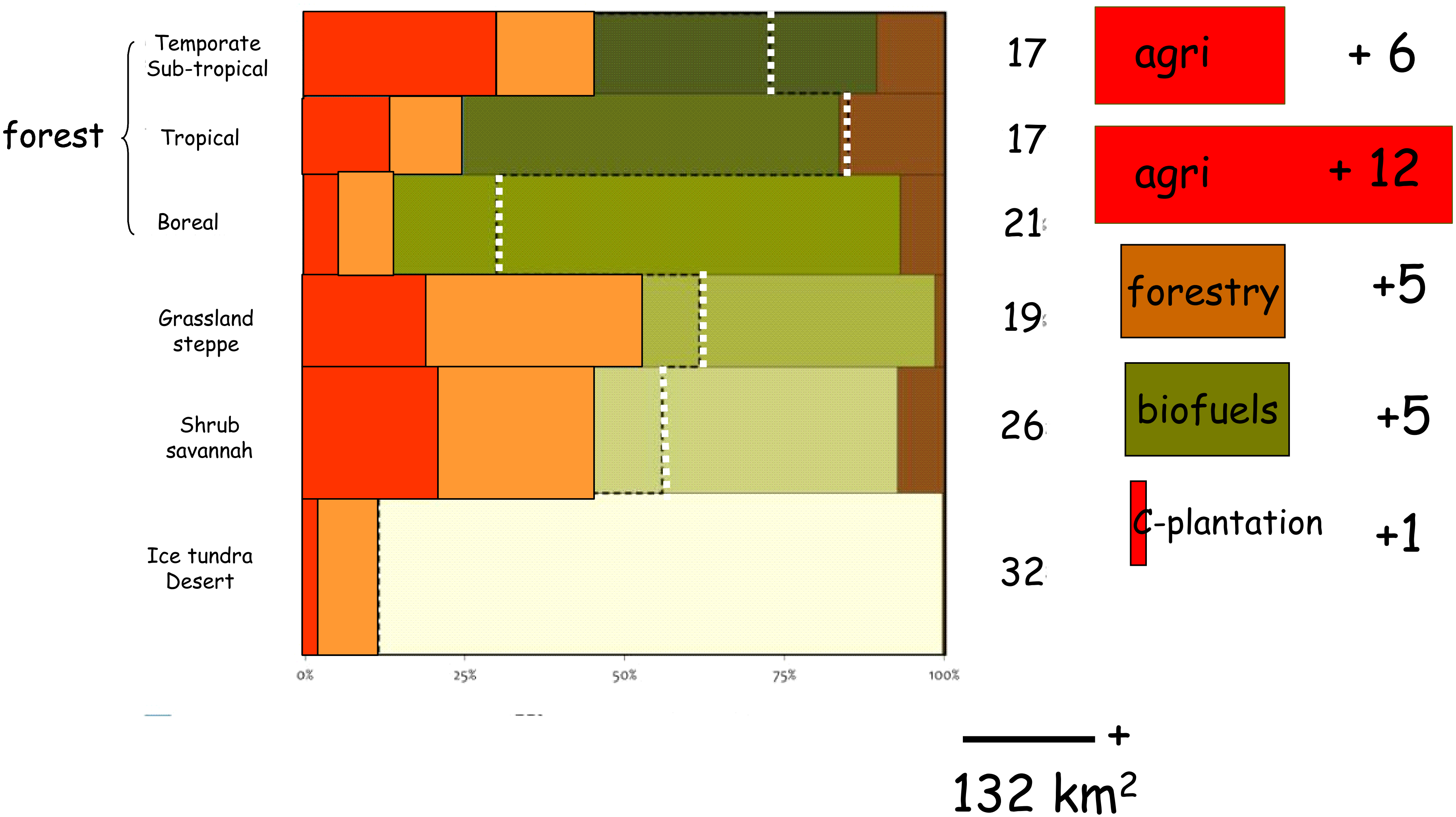


Legend: 5 mln km²

Competing claims on land & assets (baseline scenario)

2050 Land use per ecosystem type

Million km^2



Legend: 5 mln km^2

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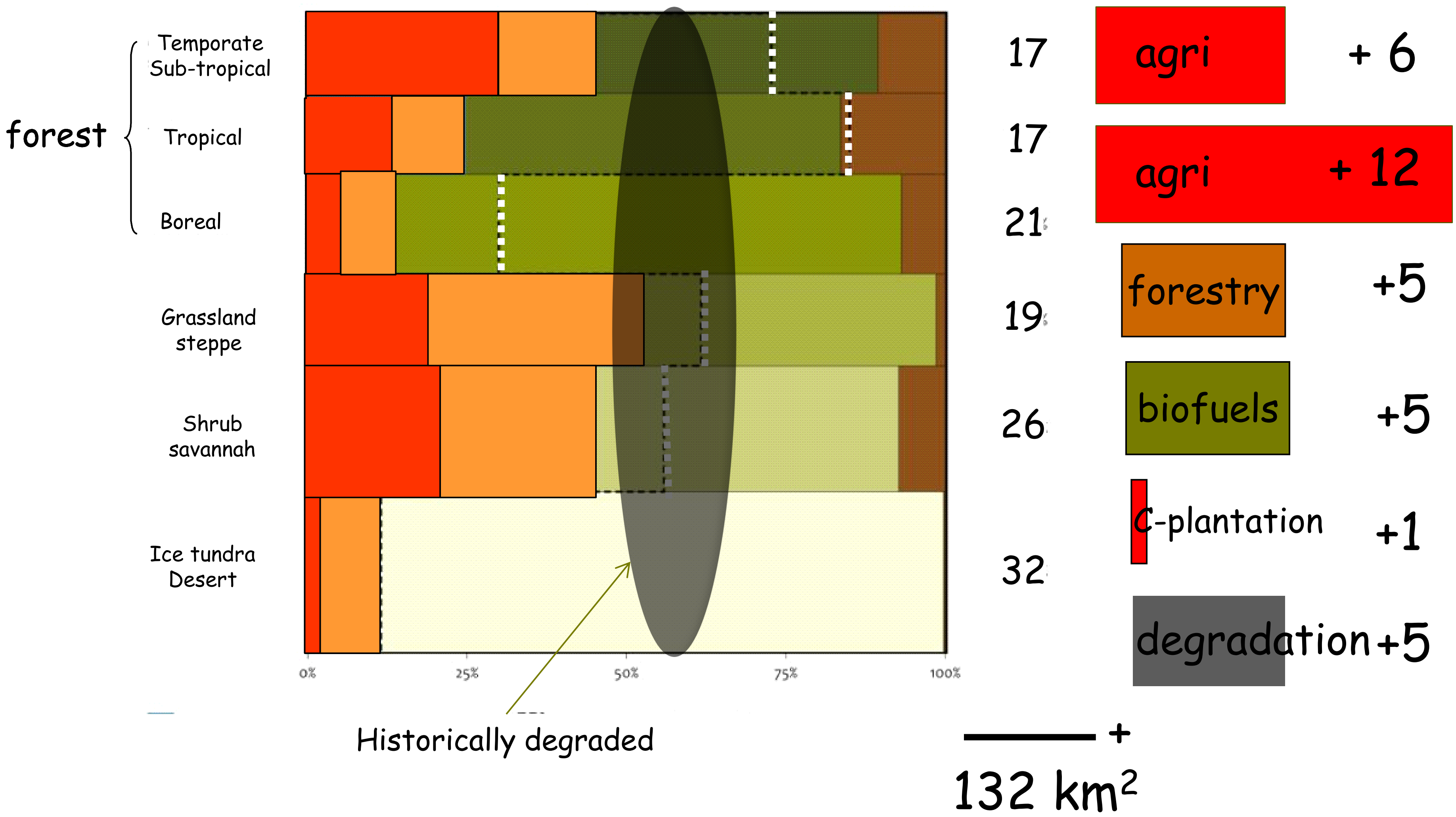

Legend: 5 mln km^2

Zooming in:

South East Asia 1970

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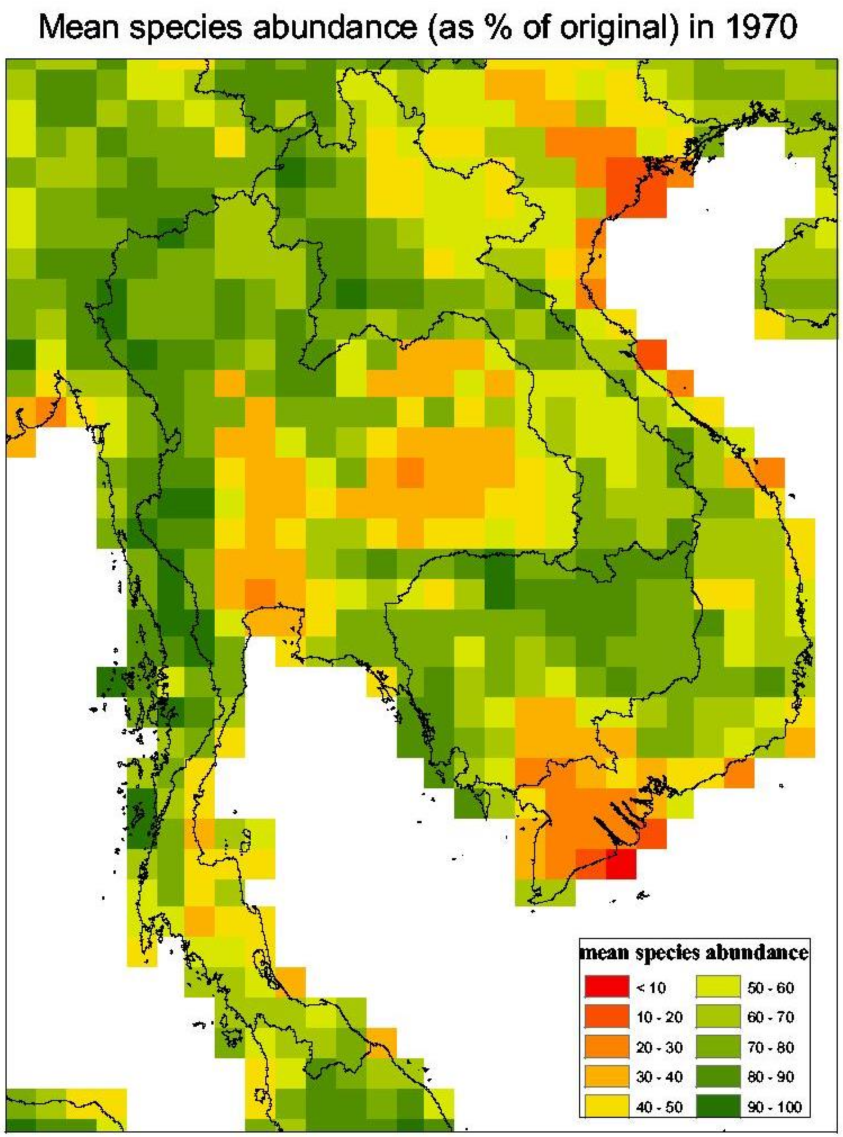

Zooming in:

South East Asia 2000

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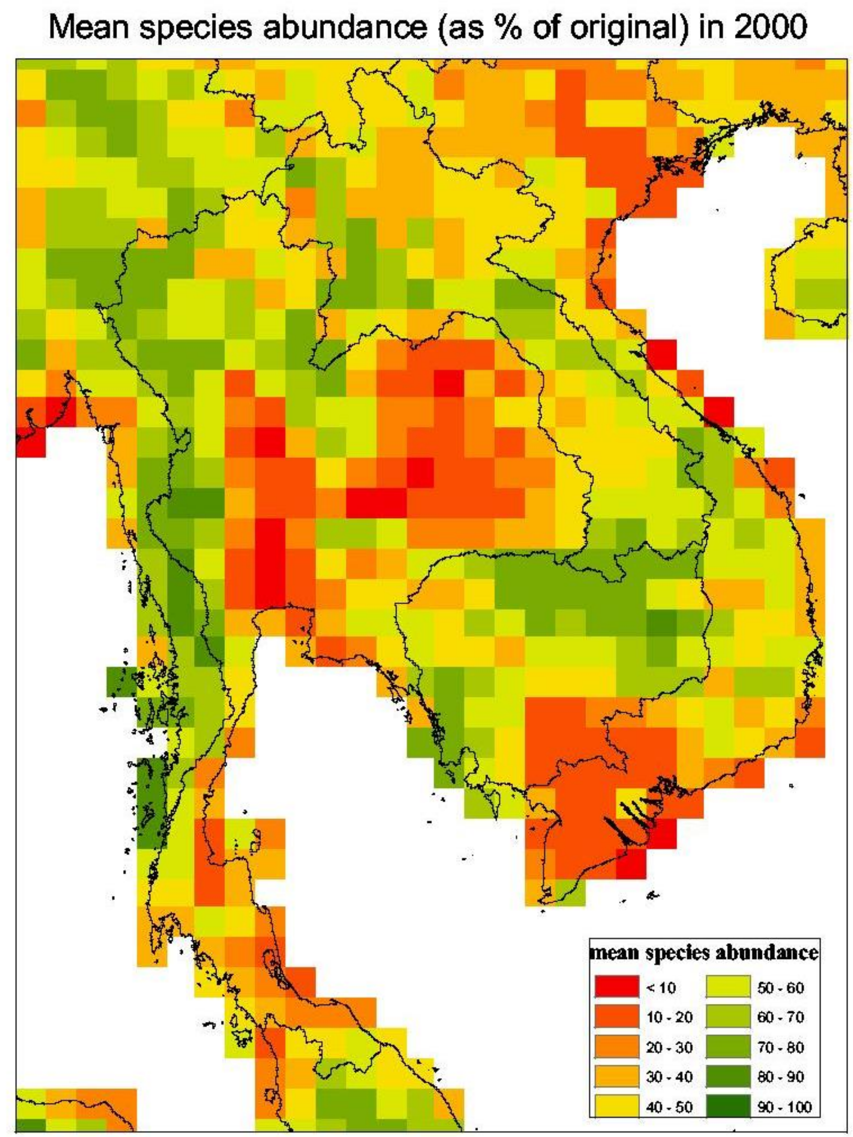

Zooming in:

South East Asia 2030

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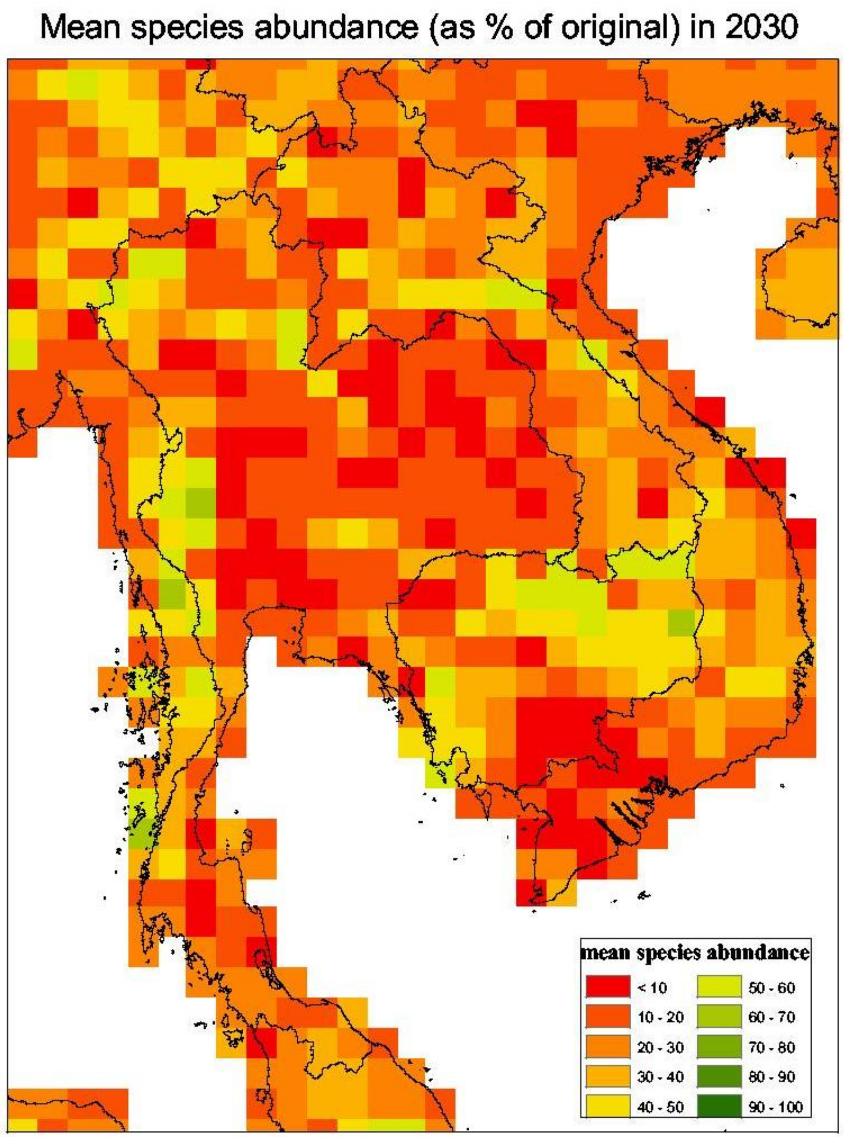
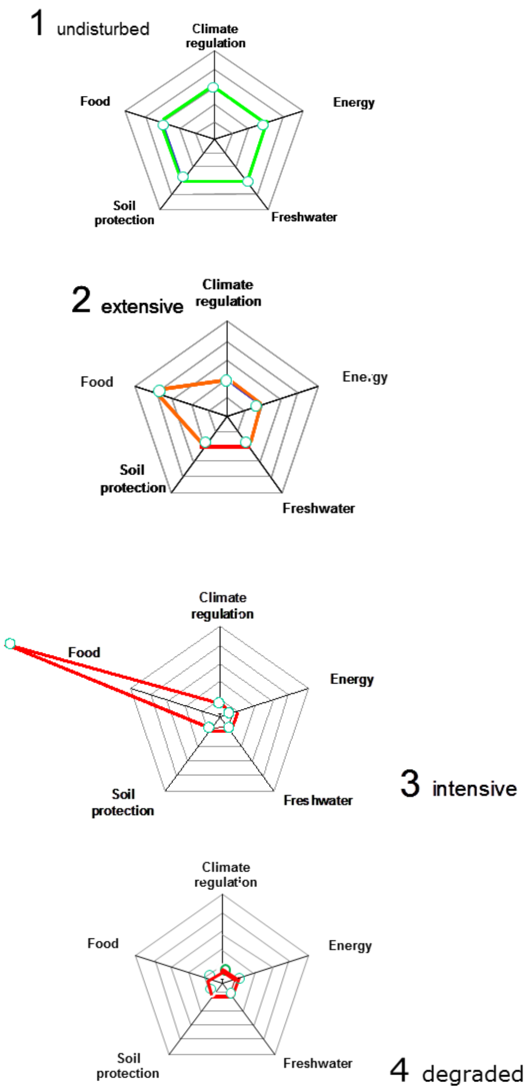
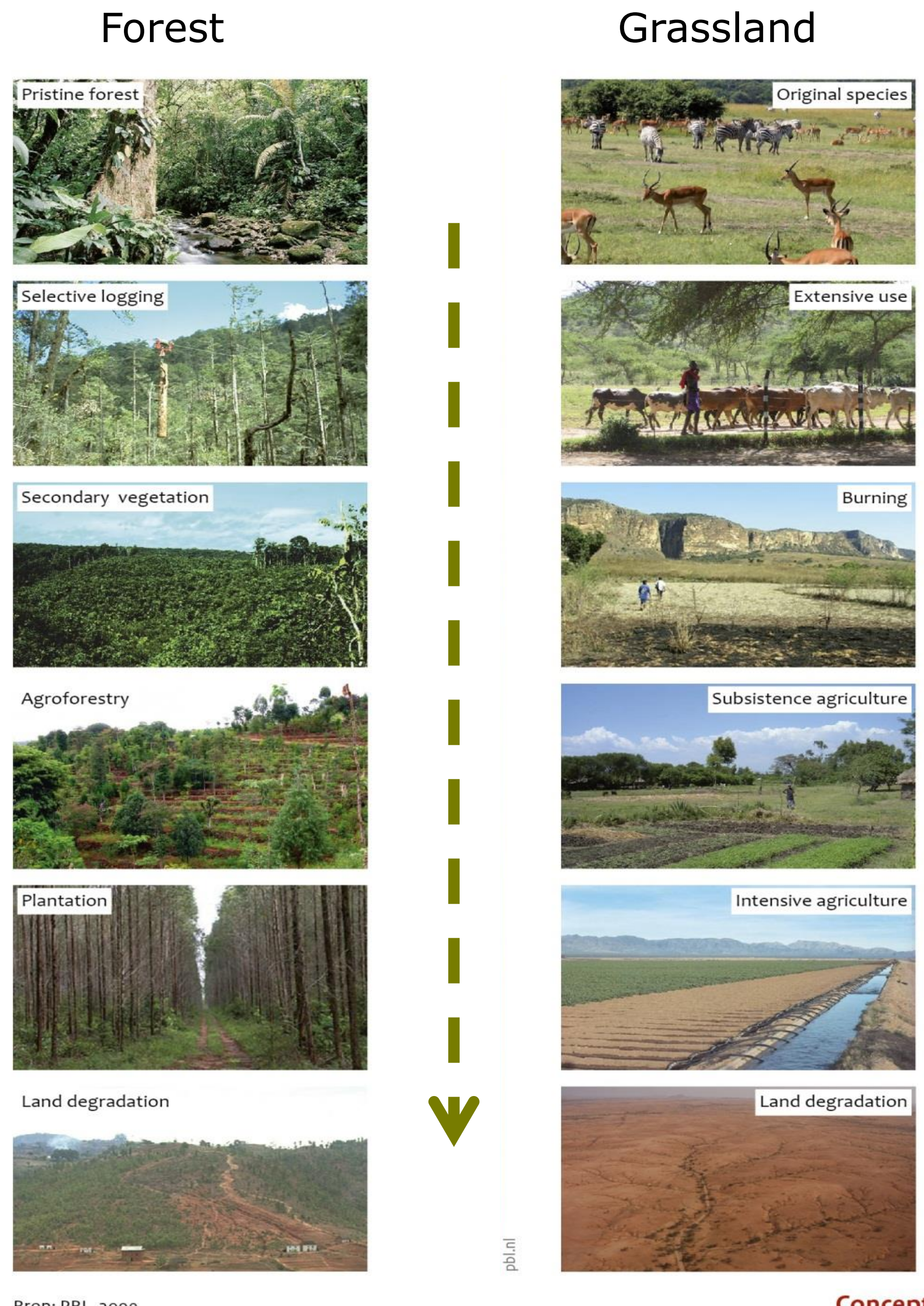
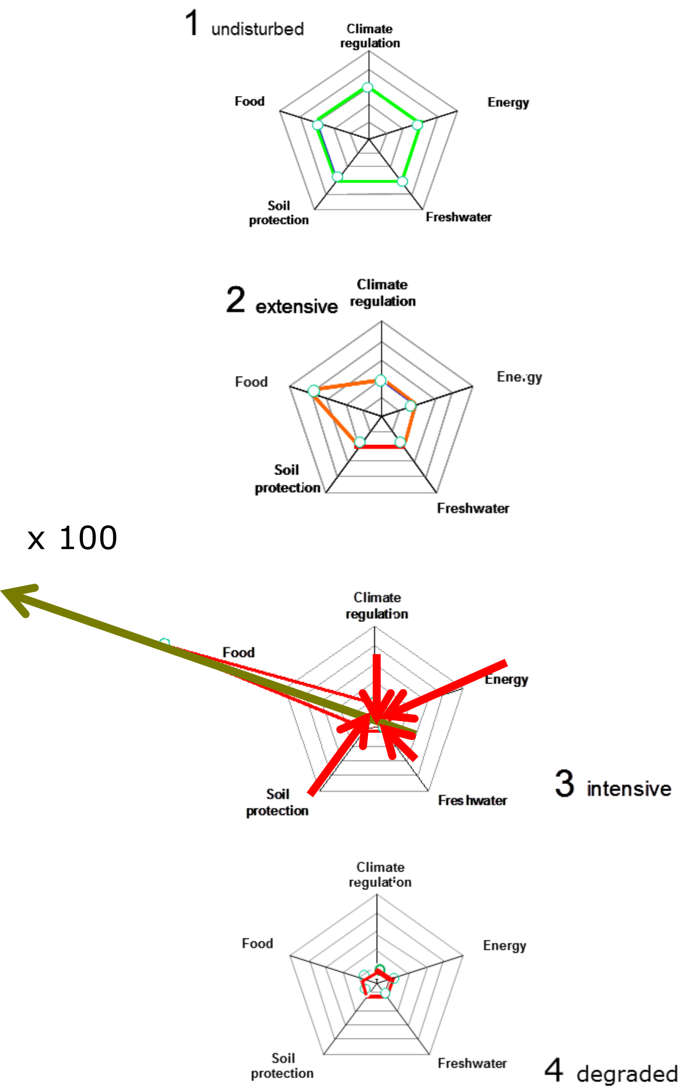


Man transforms lanscape since 8000 BP
Why?



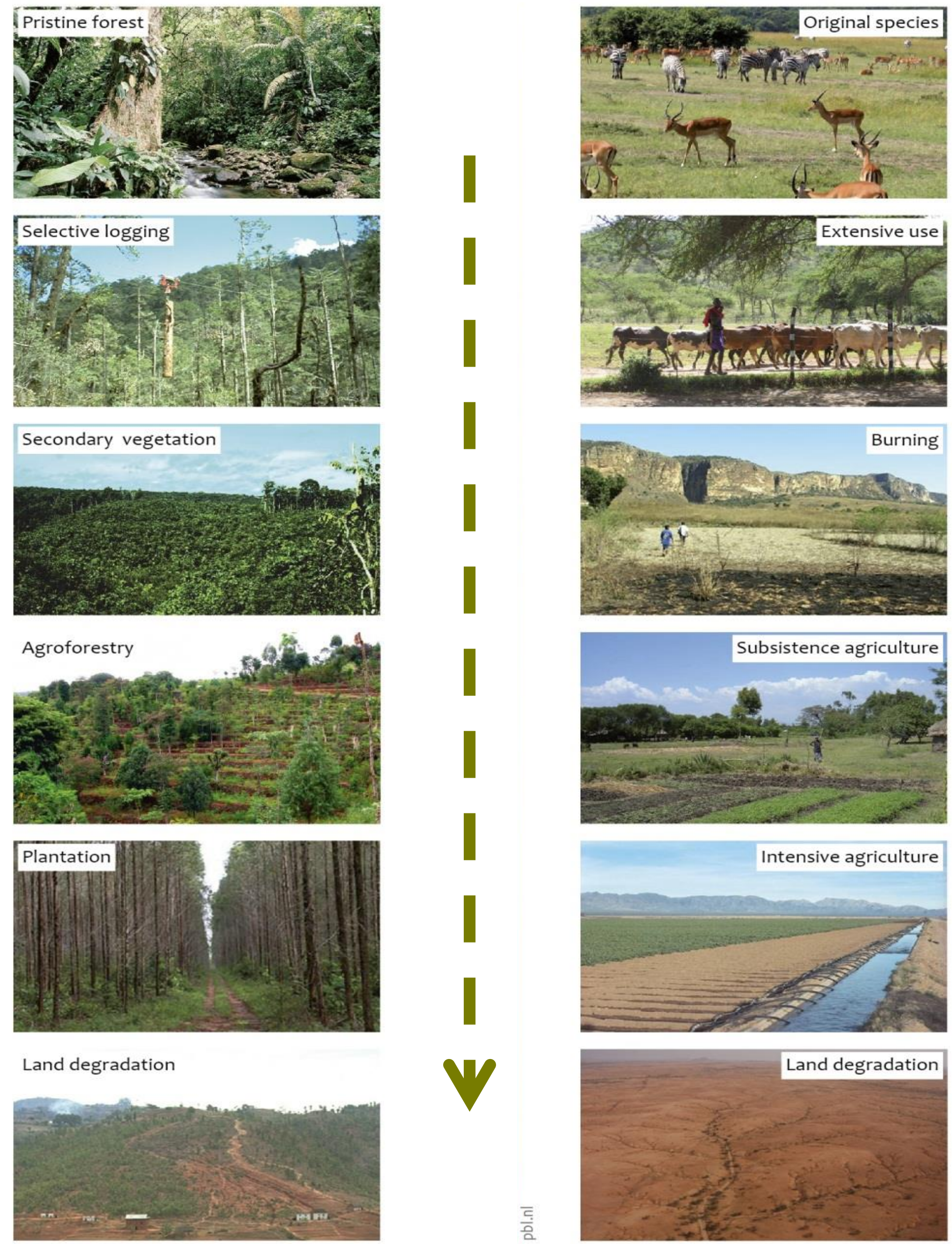


Degradation… or progress?



Forest

Grassland



Bron: PBL, 2009

Concept

Degradation... or progress?

In general we:

de-vegetate

de-carbonate

de-hydrate

de-speciate

de-moderate

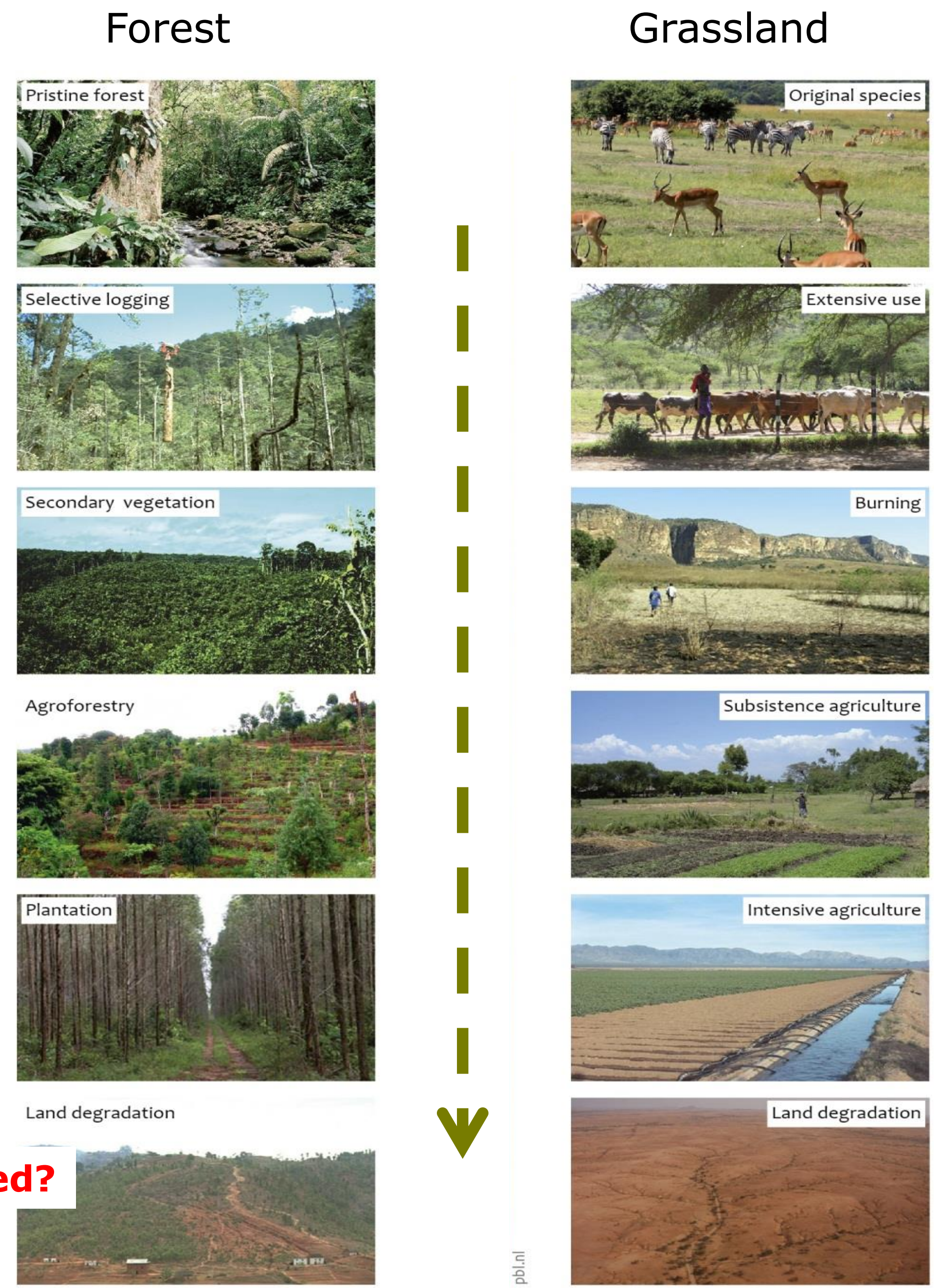
Function change

If badly managed:

de-plete

de-teriorate

Degraded?



Bron: PBL, 2009

Concept

Preliminary estimation impacts

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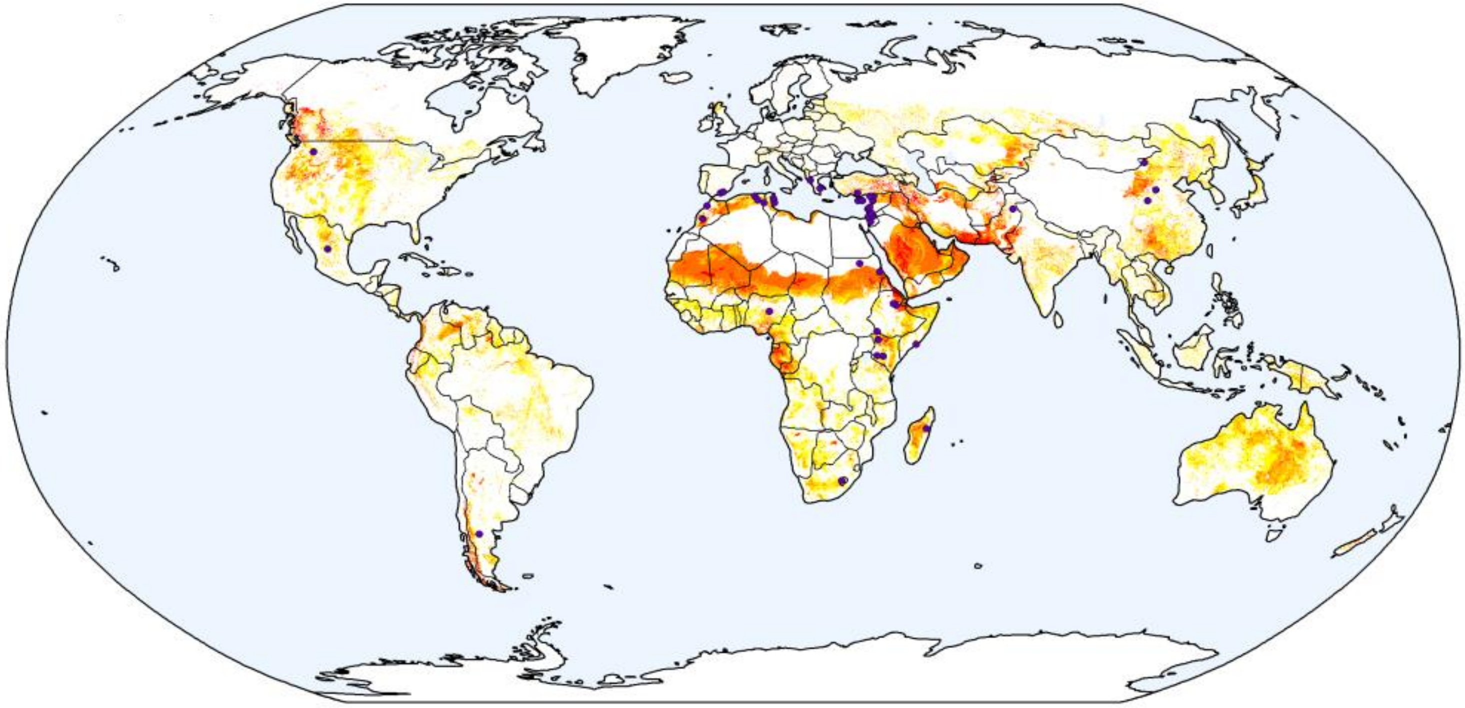
Greenness current/potential (ndvi)

Masked Normalized Difference Vegetation Index (NDVI) ratio



Legend

< 0.5 | 0.5 - 0.6 | 0.6 - 0.7 | 0.7 - 0.8 | > 0.8 | • degraded location

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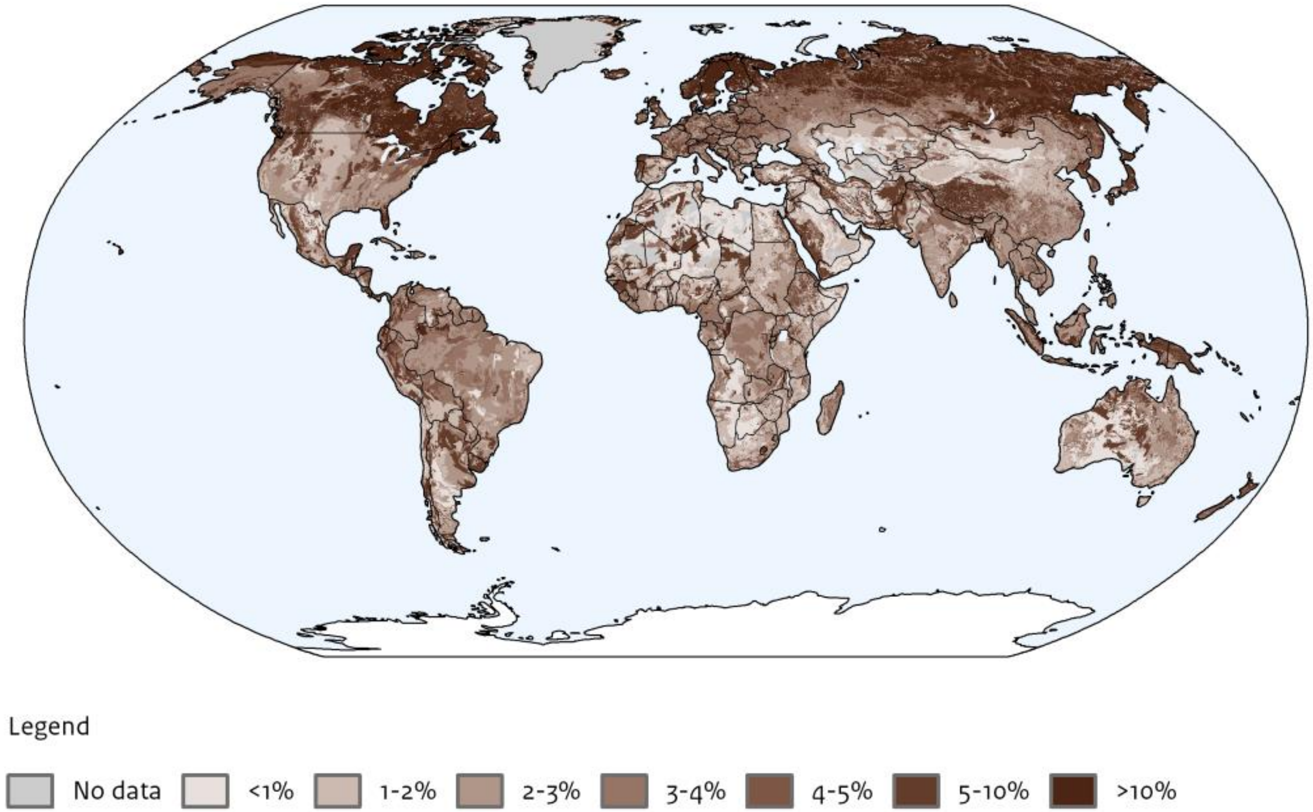
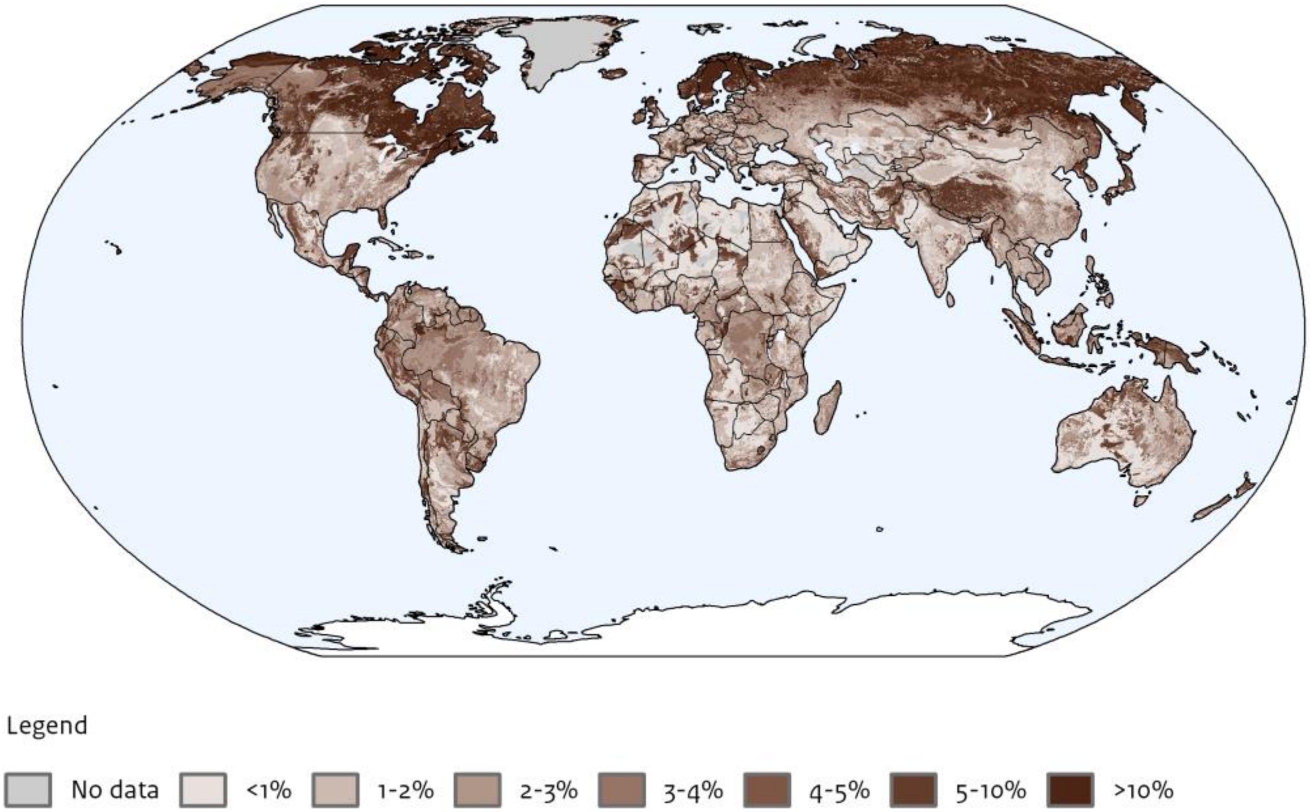
Soil organic Carbon

Modelled potential soil organic matter



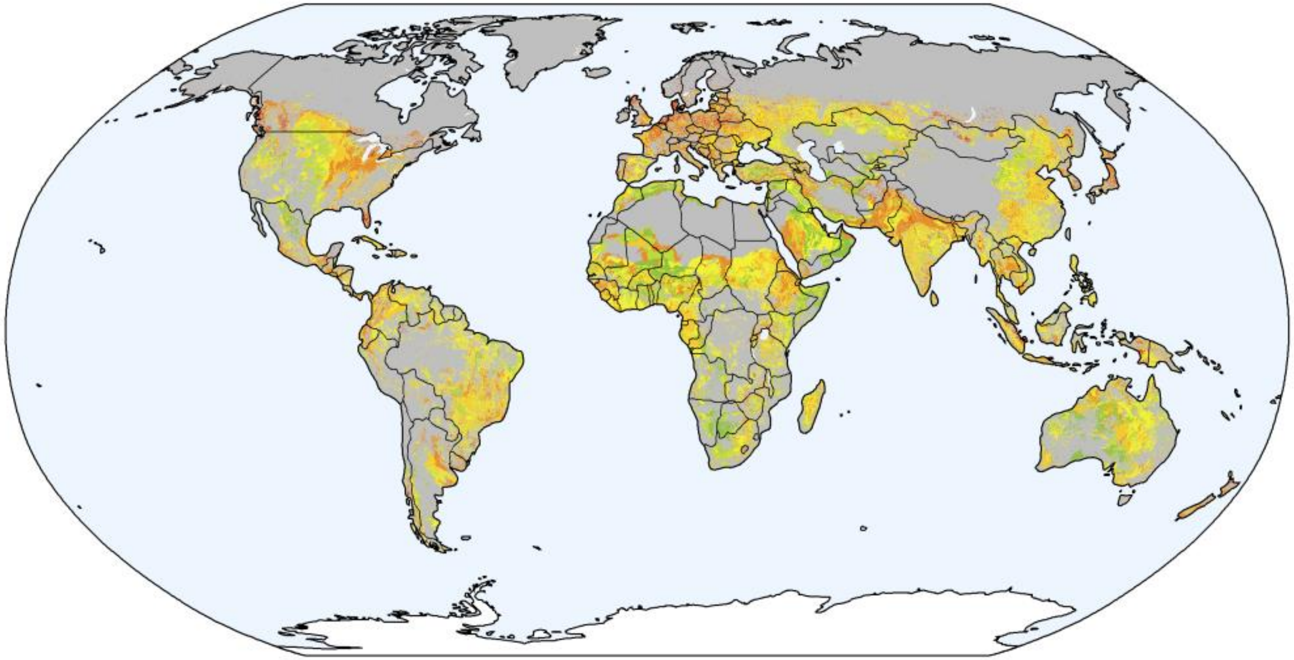
Soil organic Carbon

Modelled current soil organic matter



Soil organic Carbon

Modelled change soil organic matter



Legend

No data | < 0.25% | 0.25-0.5% | 0.05-1% | 1-2% | 2-5% | 5-10% | > 10%

Preliminary estimation impacts

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Carbon sequestration & climate

Biosphere C emissions:

- Pre-1850 : 320 Gt C
- 1850-1998: 136 Gt C +/- 55
- Total : **456** Gt C (401-511) 4 Gt C = 1 ppm CO_2

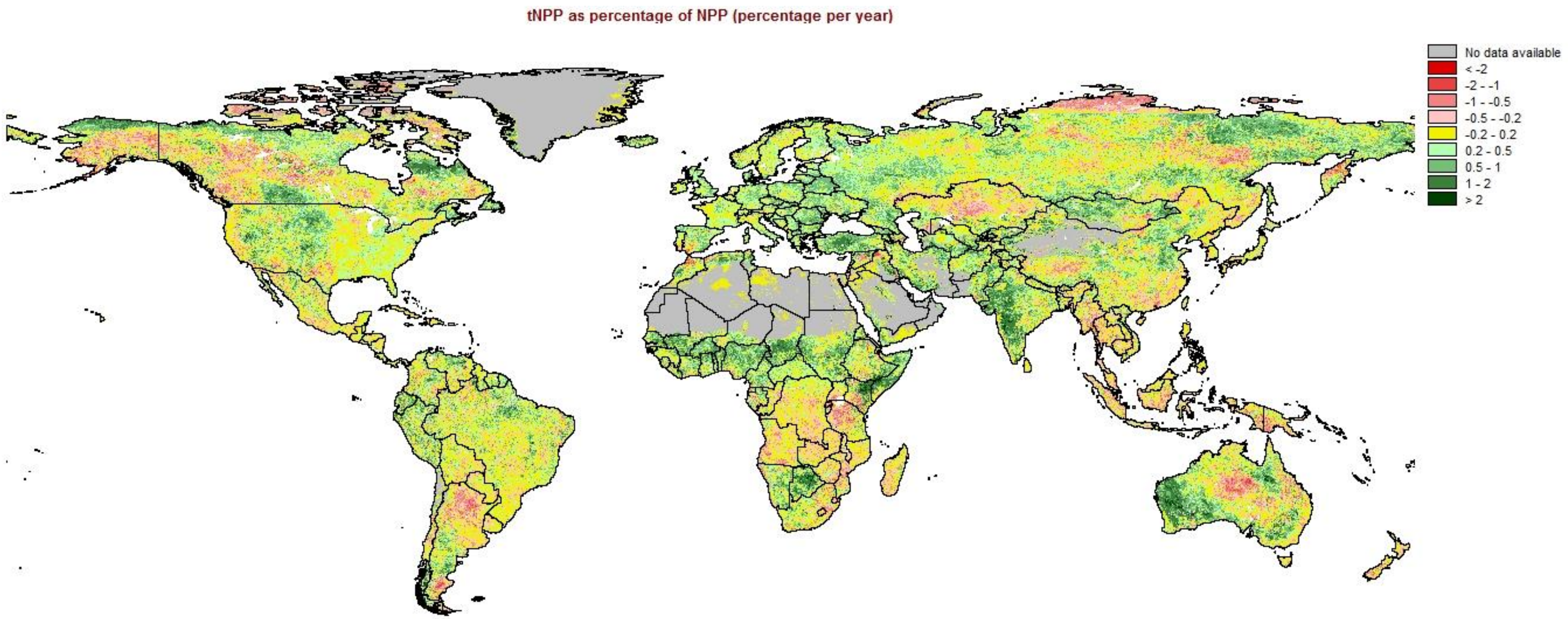
Fossil C emissions 1850-1998 : **270** Gt C +/- 30 (~68 ppm)

Source: Lal (2004, 2008)

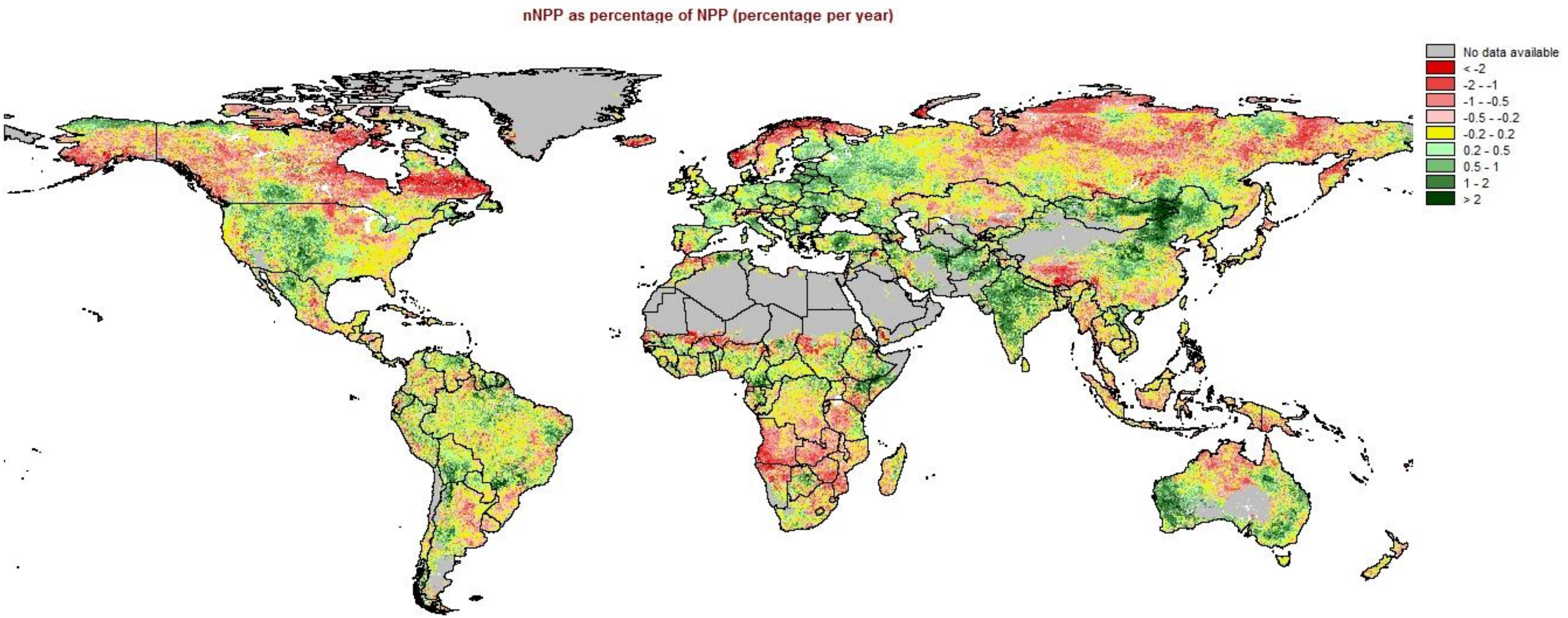
Preliminary estimation impacts

PBL Netherlands Environmental Assessment Agency

Productivity change 1982-2010 (% npp/yr)



Productivity change 1982-2010 climate corrected (% npp/yr)



Preliminary estimation impacts

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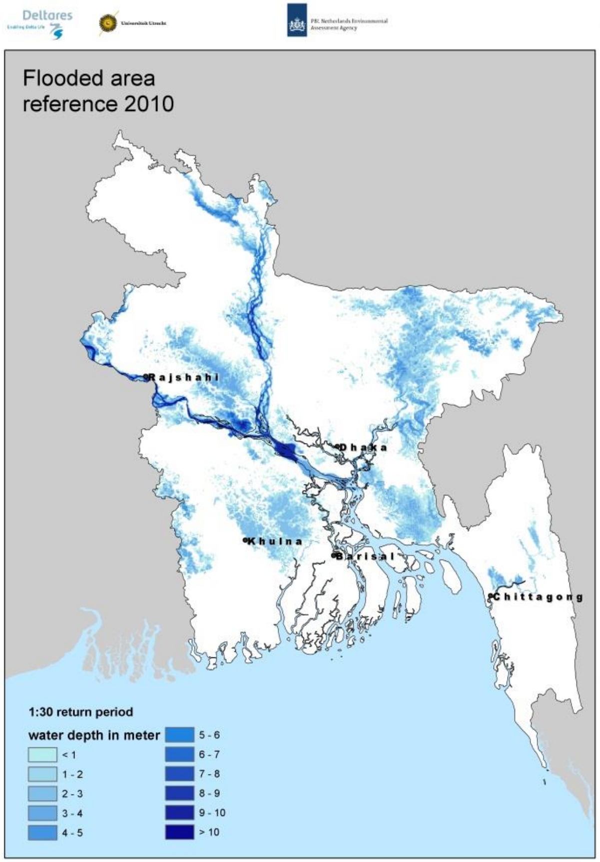
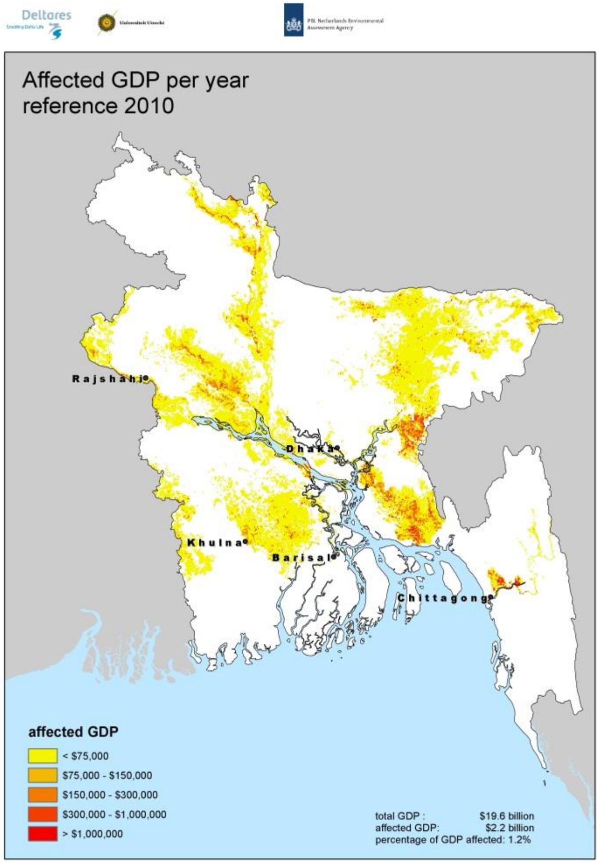
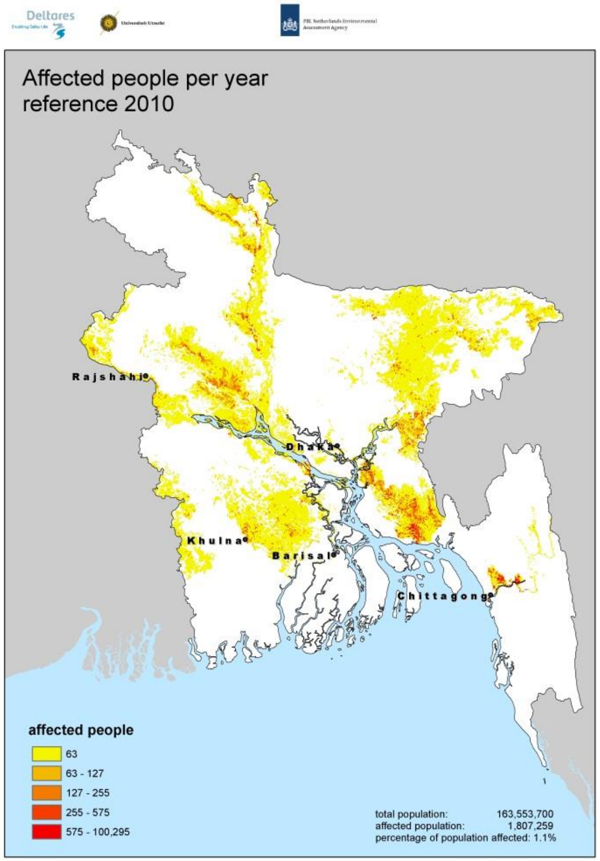
Floods







Once in 30-year flood **Affected GDP per year** **Affected people per year**

Preliminary estimation impacts

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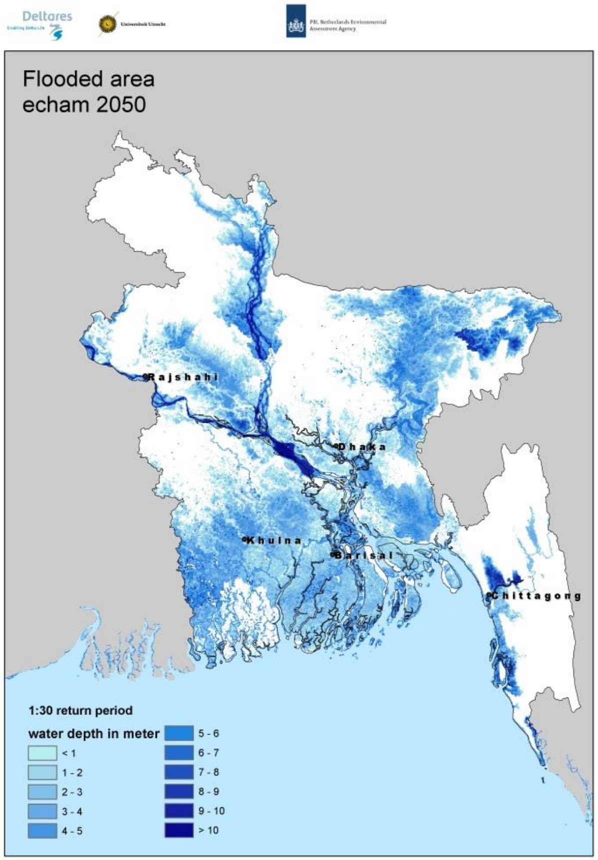
Floods



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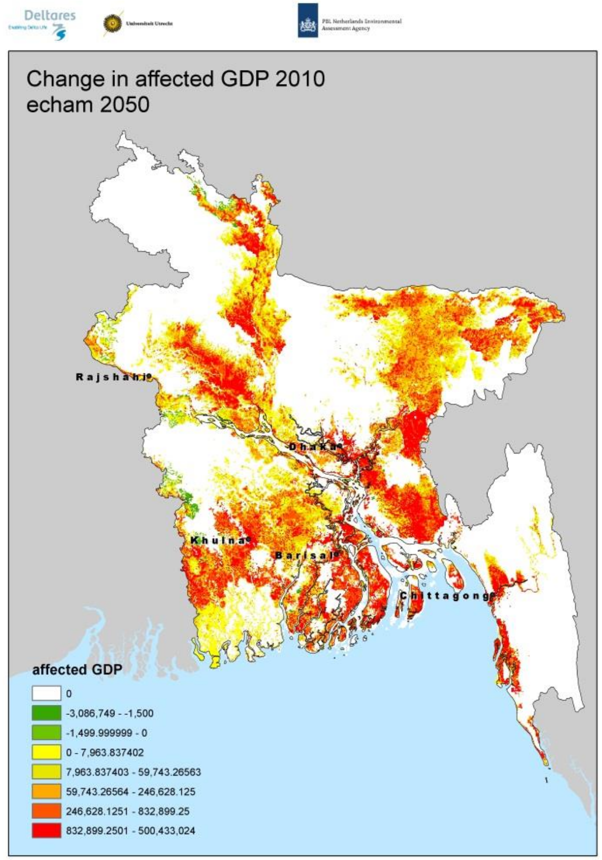
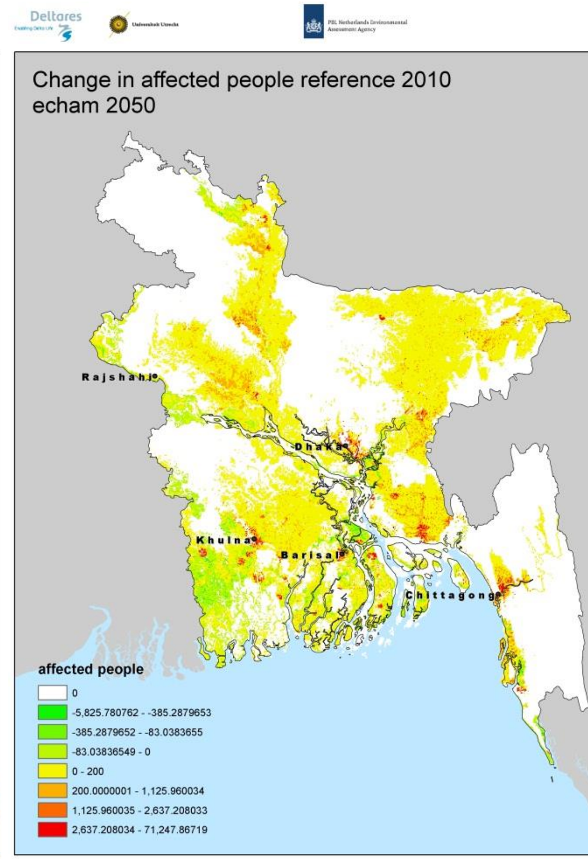


Affected GDP per year



Affected people per year

Planetary bounderies?

to expected socioeconomic development

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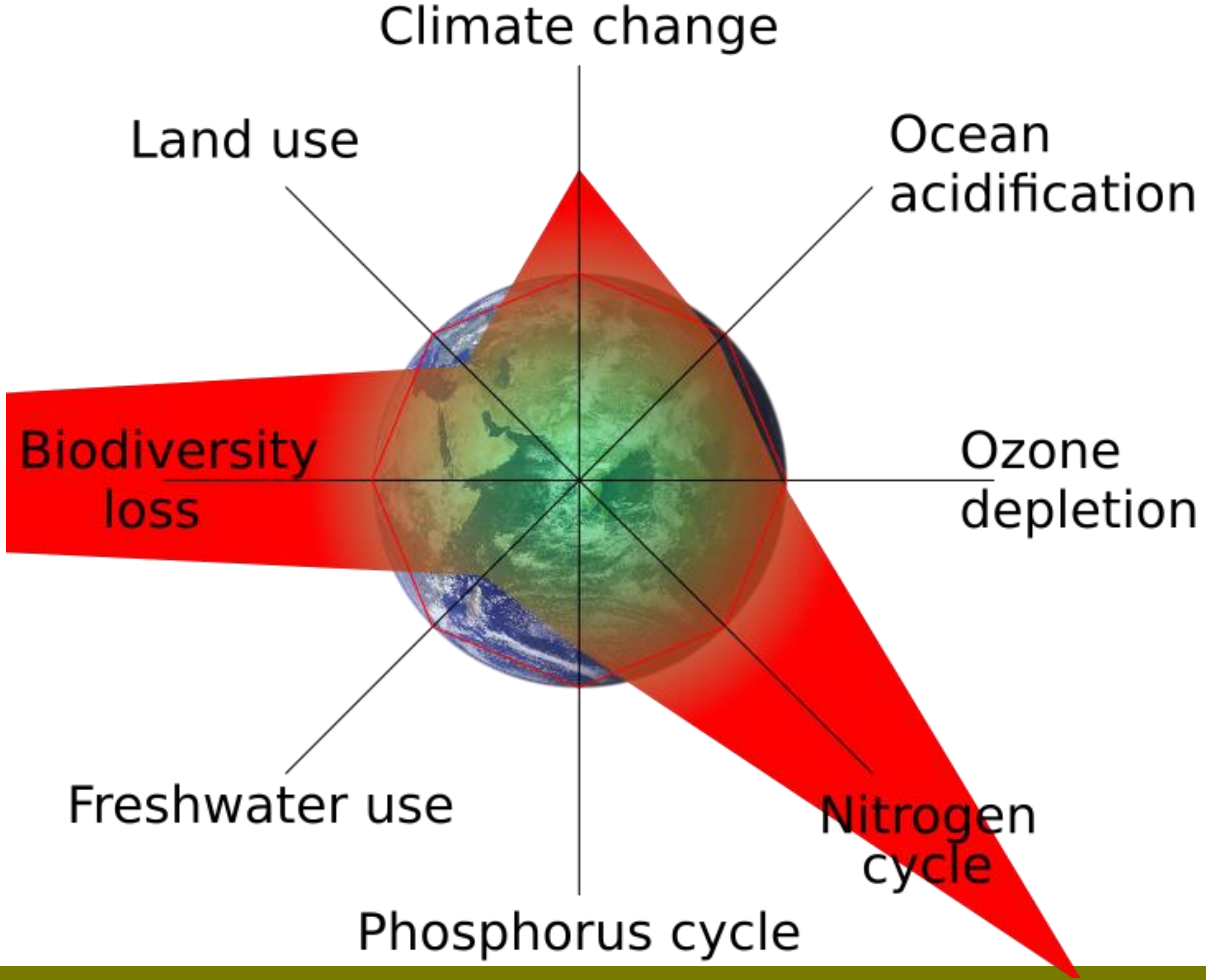
?



Rockstrom et al., 2009

LEITAP – TIMER – IMAGE – GLOBIO - EcoOcean models

Baseline scenario
- Population
- Economic growth
- Technology
- Lifestyle

Options:
1. Closing yield gap
2. Post harvest loss
3. Diet change (meat)
4. Improved forestry
5. Reduced deforest
6. CCM, bio-fuels
7. Protected areas
8. Aqua-culture
9. Liberalisation trade

Indirect drivers
- Food demand
- Energy demand
- Energy mix
- Wood demand
- Food trade

Pressures
- Land use change
- Climate change
- N-deposition
- Forestry
- Infrastructure
- fragmentation

Effects

Biodiversity
- Ecosystem extent
- Ecosystem quality

EGS
- biomass & SOC
- climate
- soil depth & WHC
- NPP
- water availability/quality
- floods & droughts
- food & fish
- timber
- bio-energy

Modelling the future
Planetary bounderies?

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Key policy question:
How far can we stretch global ecosystem transformation?

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EGS-change
&
Tipping points

Modelling the future
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EGS-change & Tipping points

1. Water
2. Food
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4. Economic development
5. Poverty alleviation
6. Migration/conflict

Modelling the future
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Modelling the future
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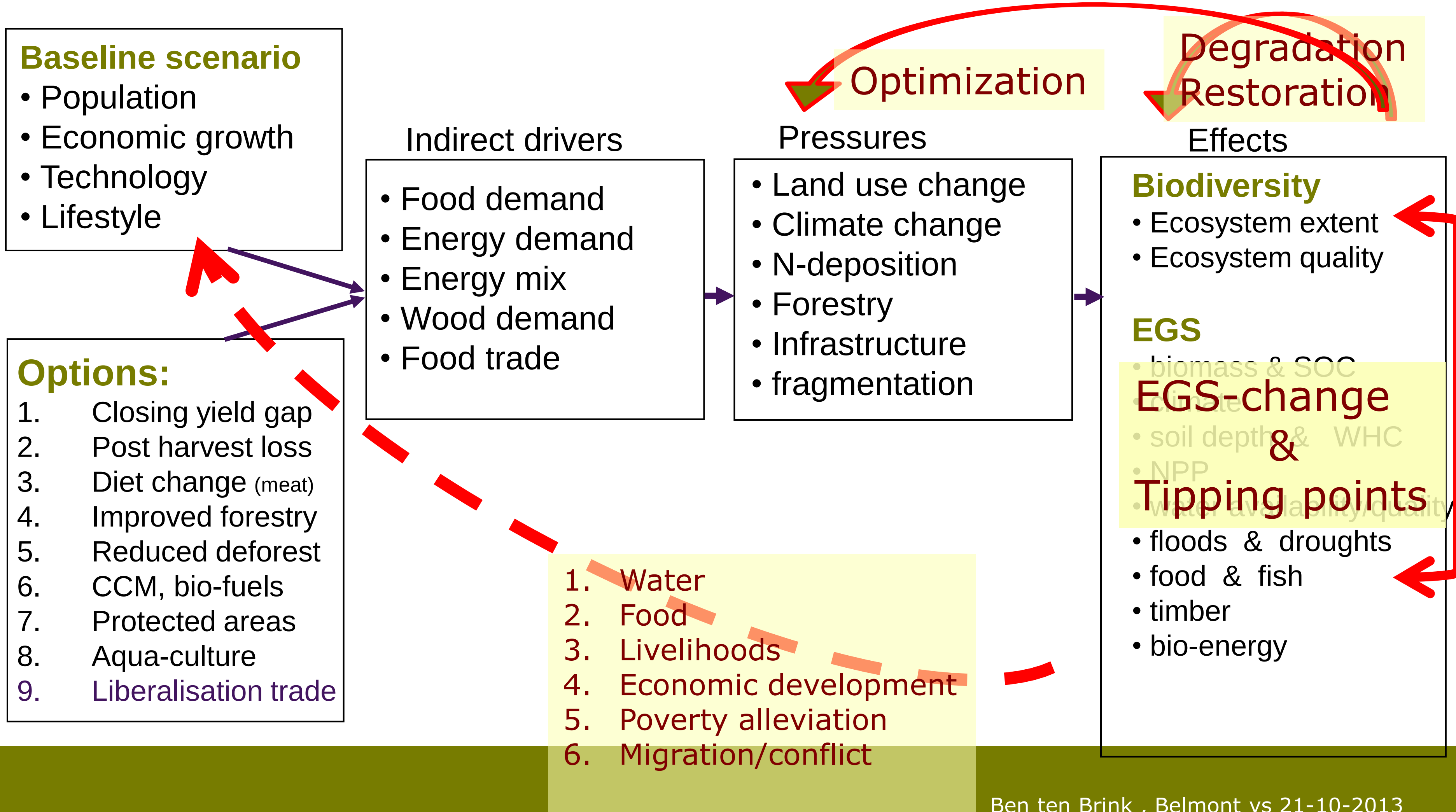

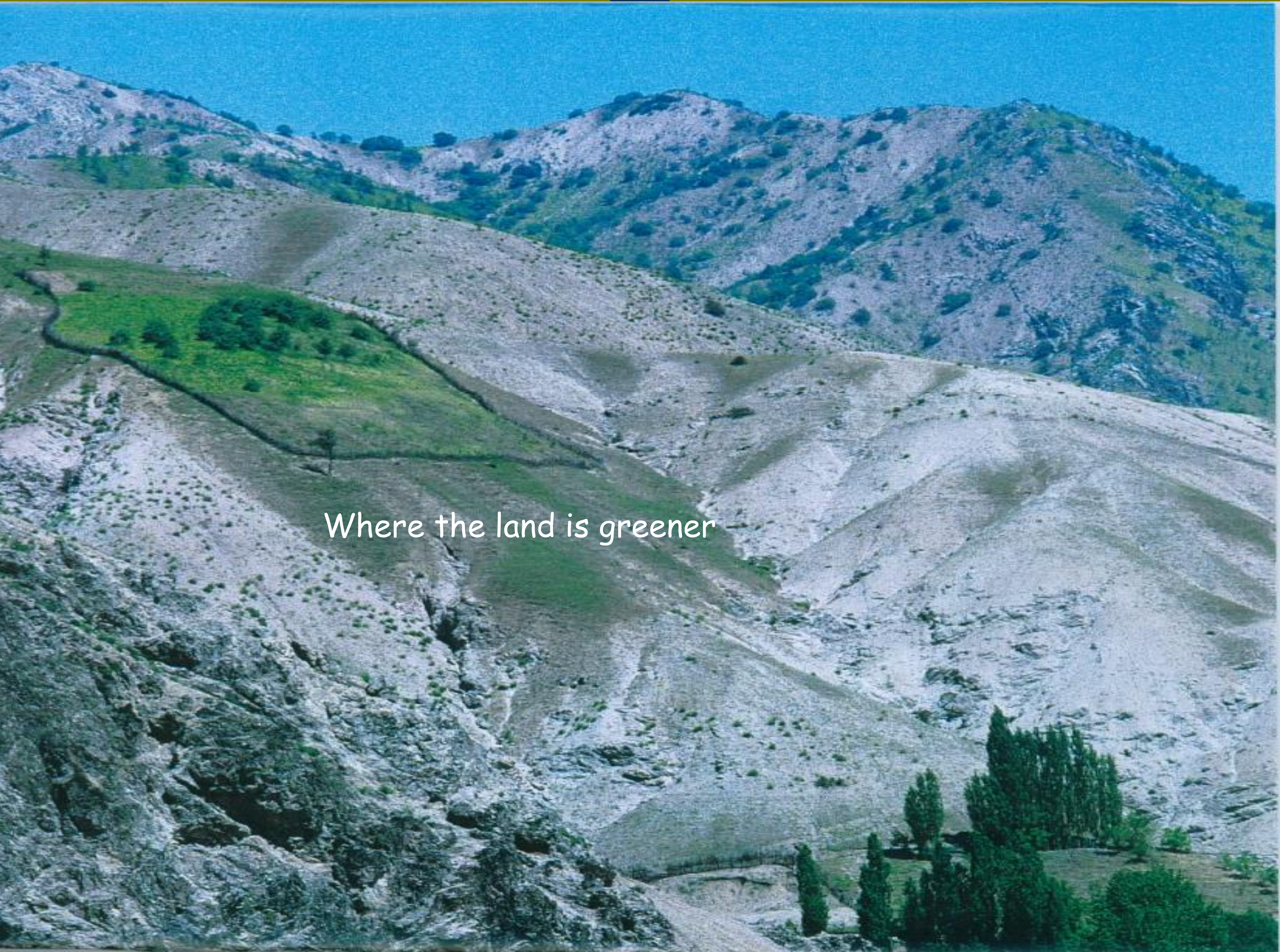
Where the land is greener

Modelling the future
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Human behaviour
politicians, compagnies, people

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EGS-change
&
Tipping points

Economic valuation change
production -> function

1. Deficits
2. Desasters
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Modelling the future
Planetary bounderies?

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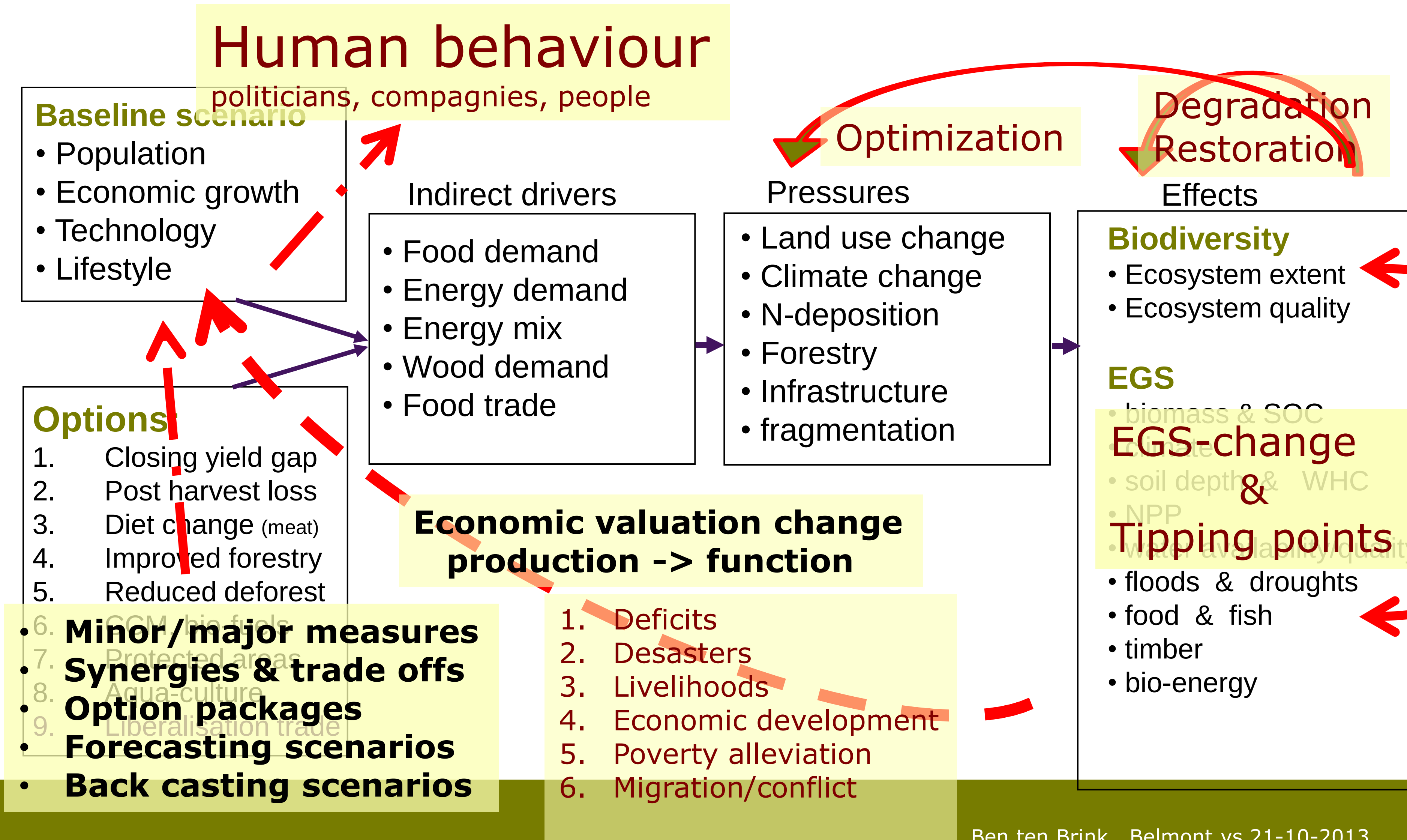

Option trade offs

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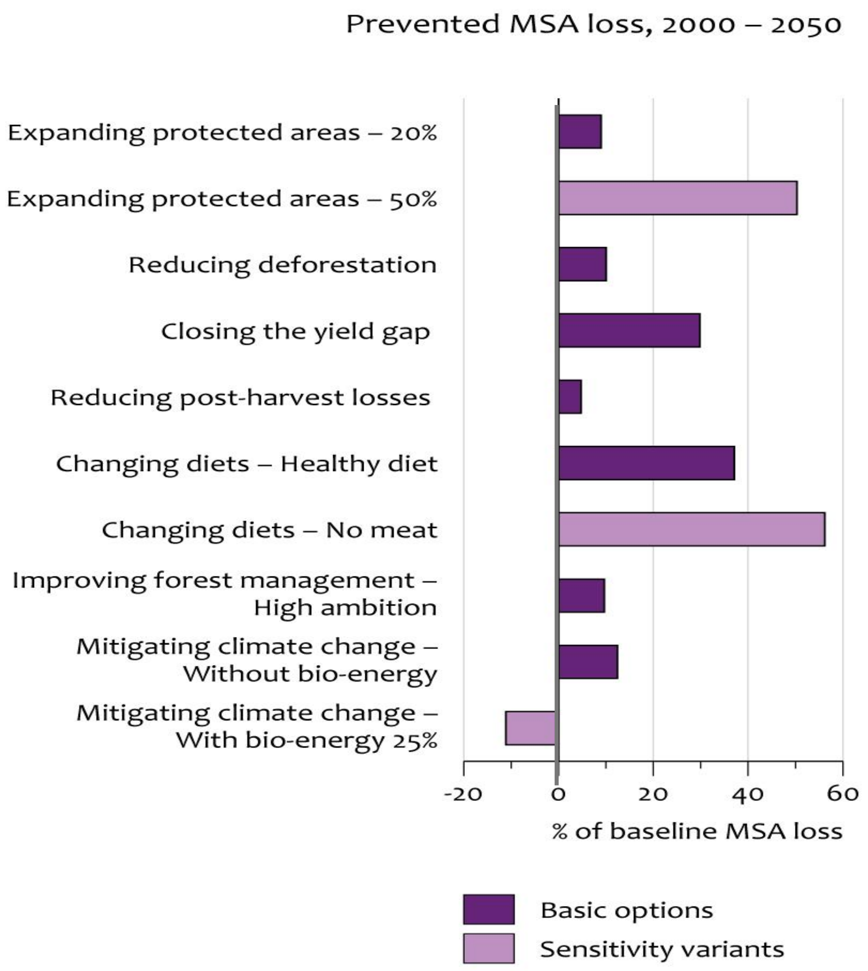
Change in global biodiversity per option compared to baseline scenario



Change in global biodiversity of options expanding protected areas and reducing deforestation by 2030

Option trade offs

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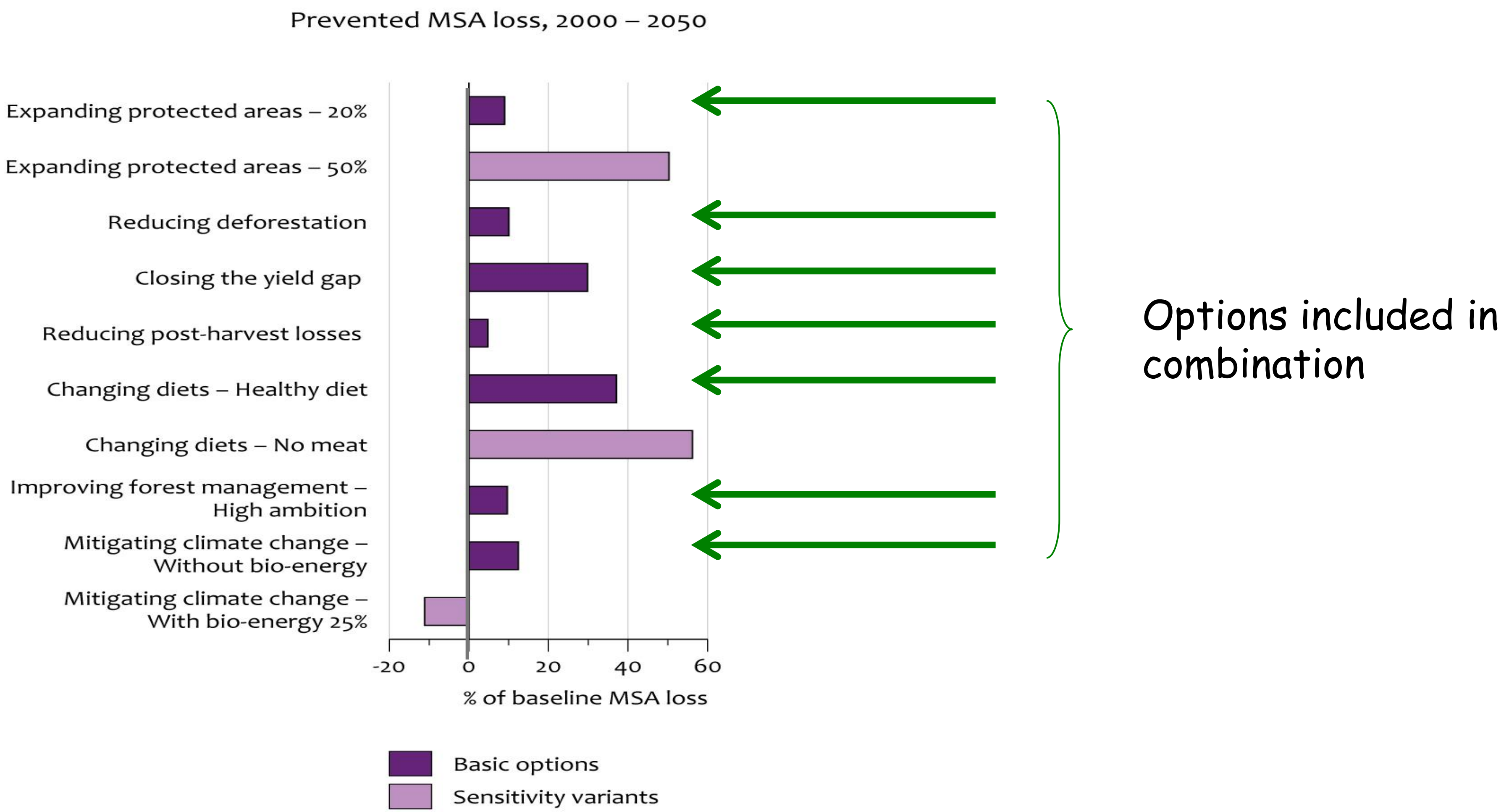

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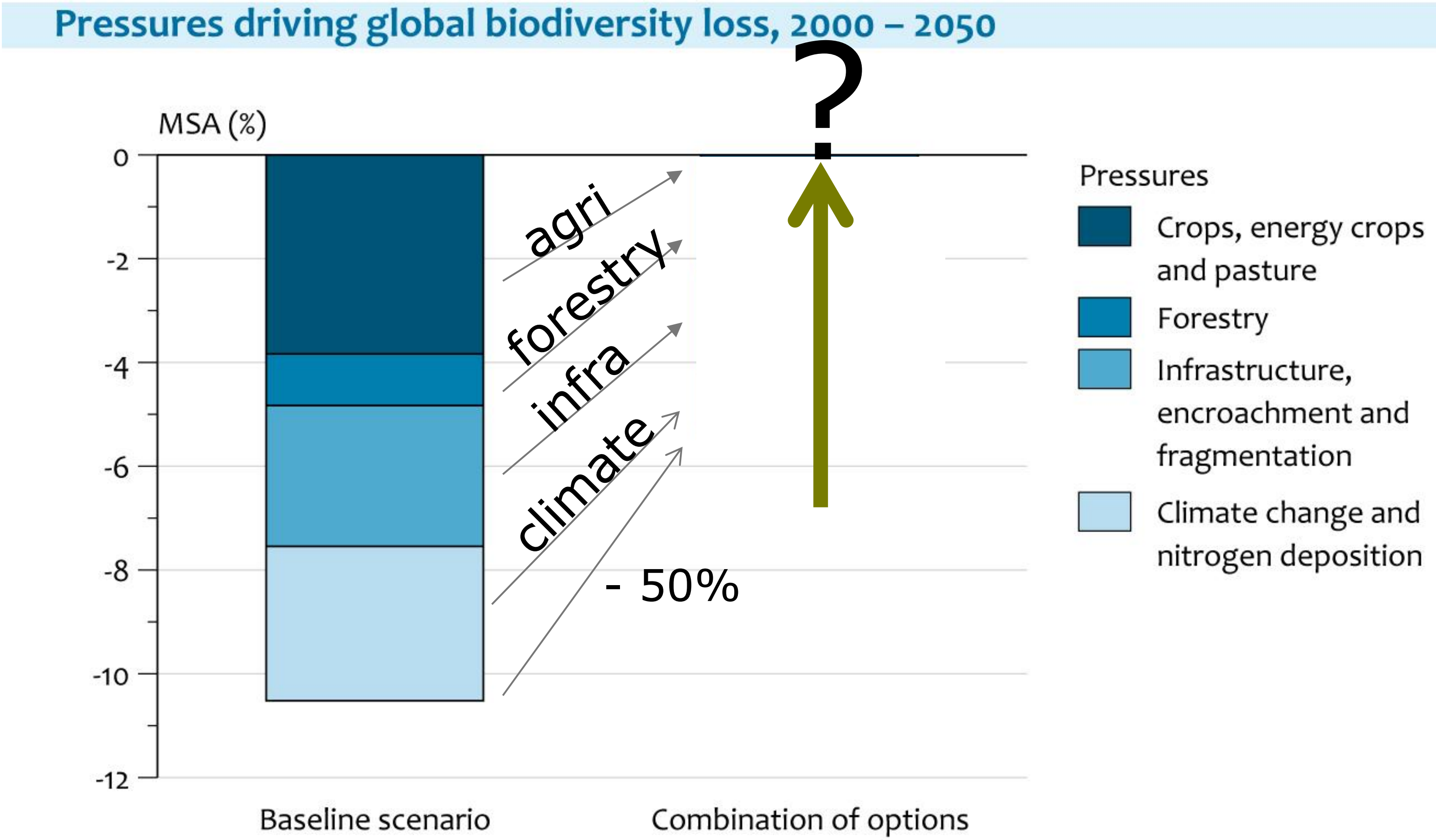

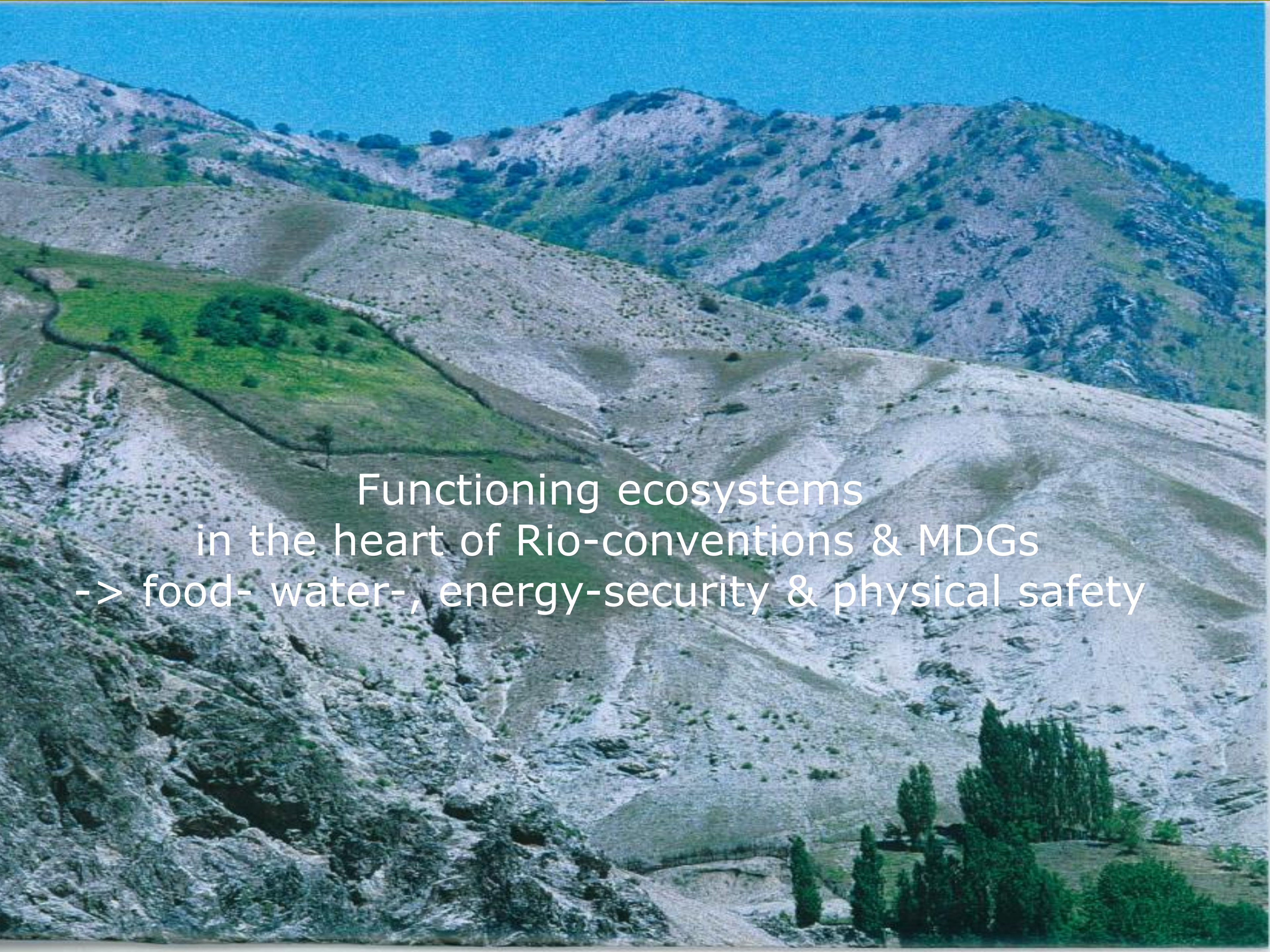
Functioning ecosystems
in the heart of Rio-conventions & MDGs
-> food- water-, energy-security & physical safety


Thank you

Consequences
goods for services

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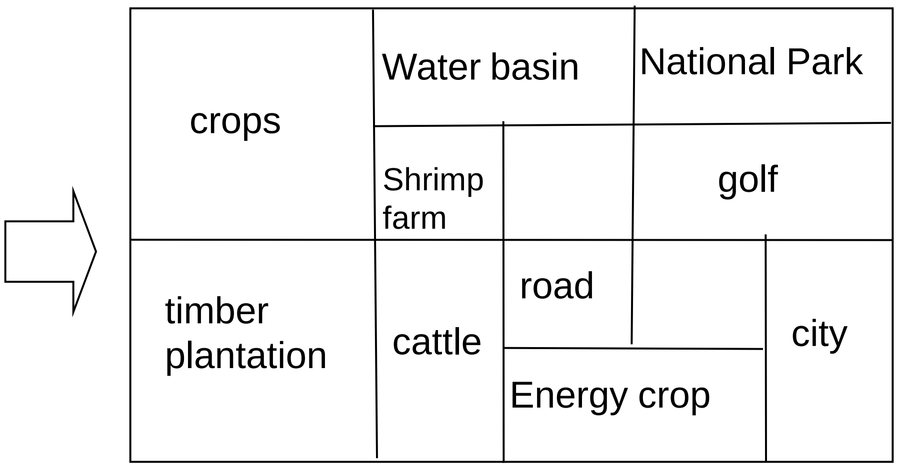
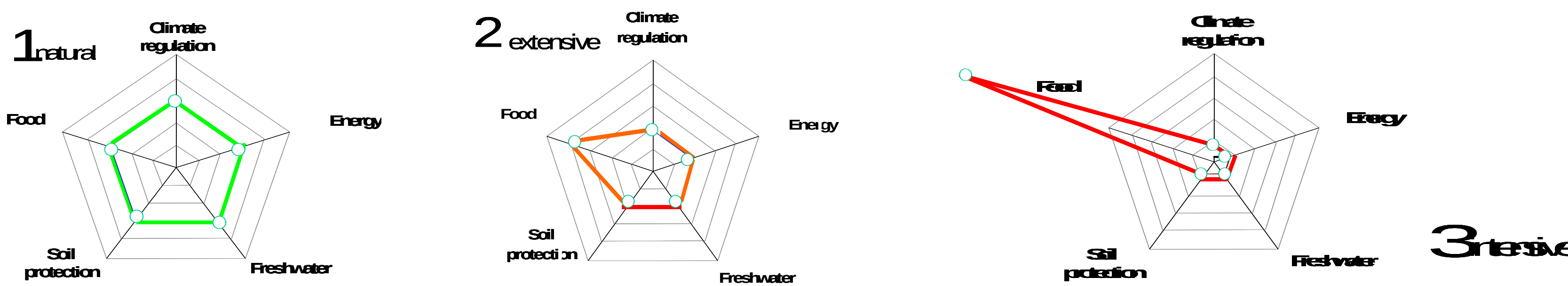
Natural ecosystem





'We parcelate the world'
Swap services for goods

Making multiple maps
function change

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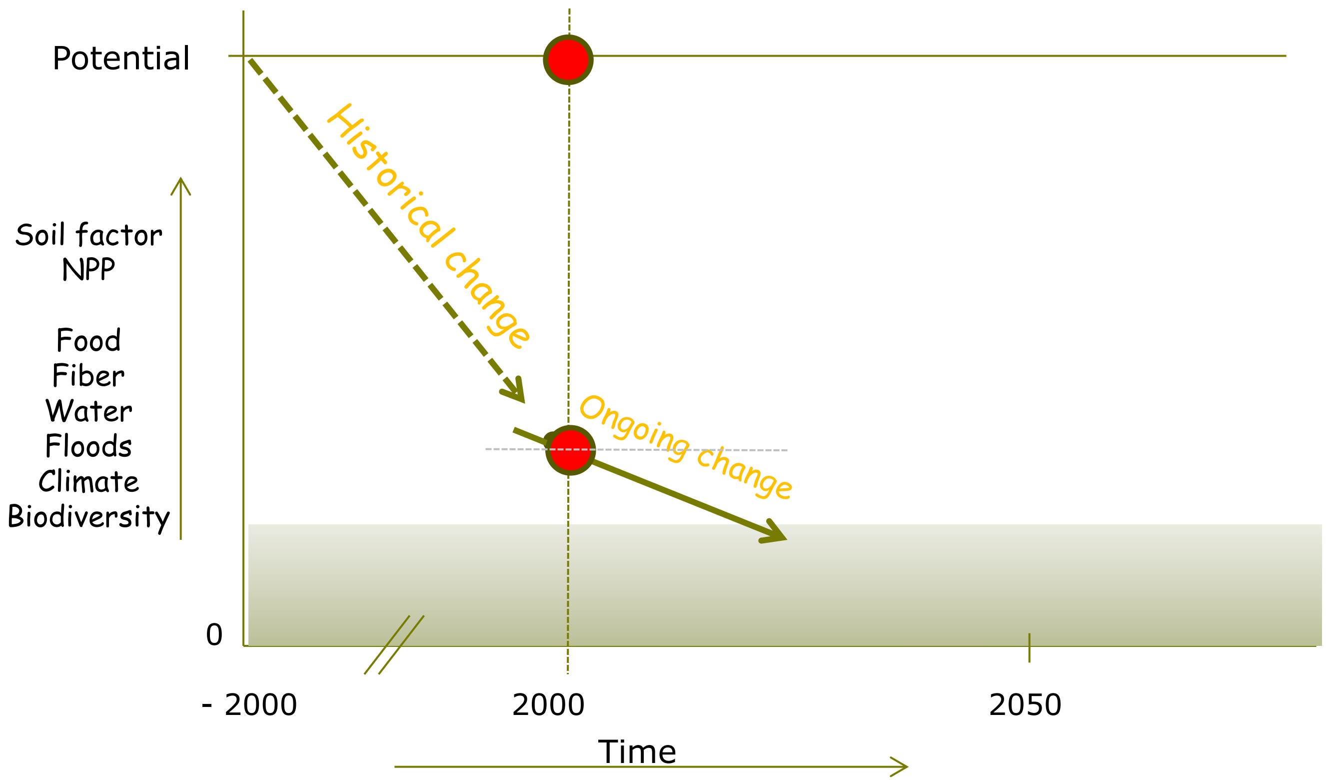

Restoration scenarios
SOC increase over time

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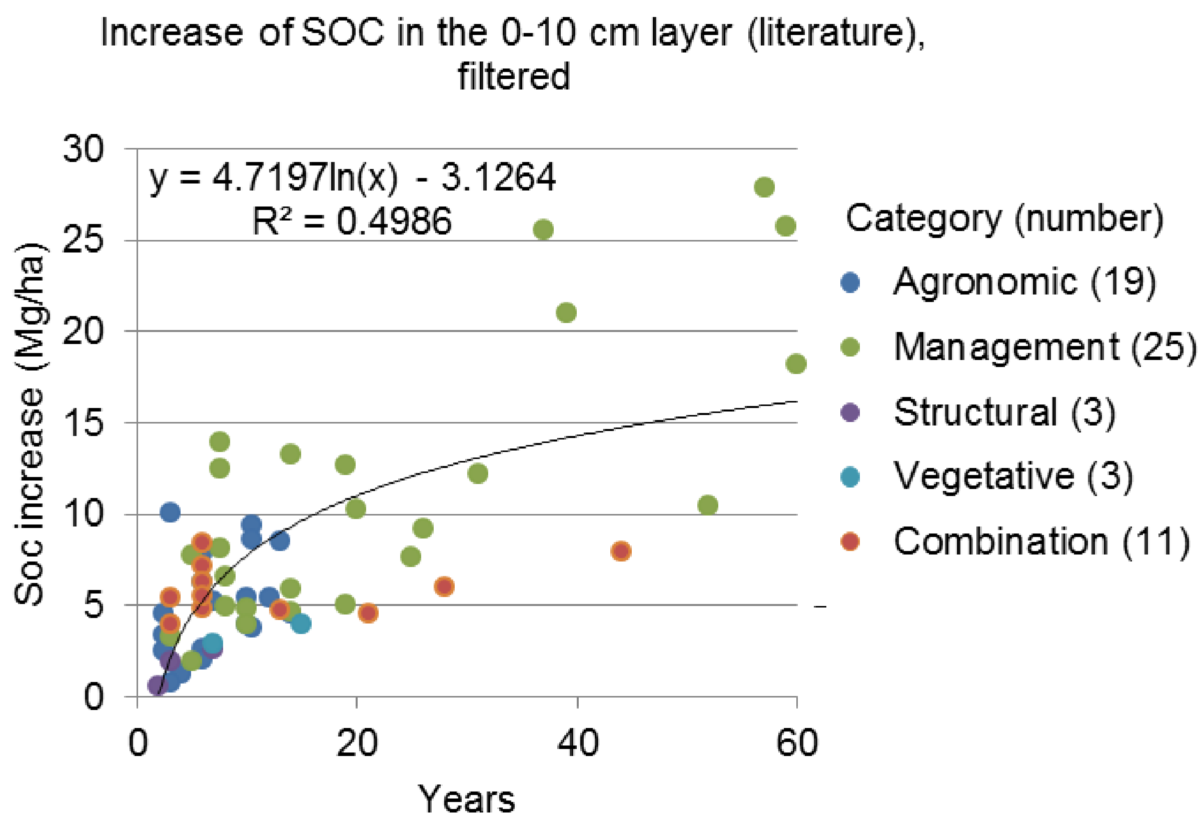

Legend:
sequestration > 0.25 Mg/ha
total dSOC > 7.5 Mg/ha

Source: WUR, WOCAT

Future scenarios

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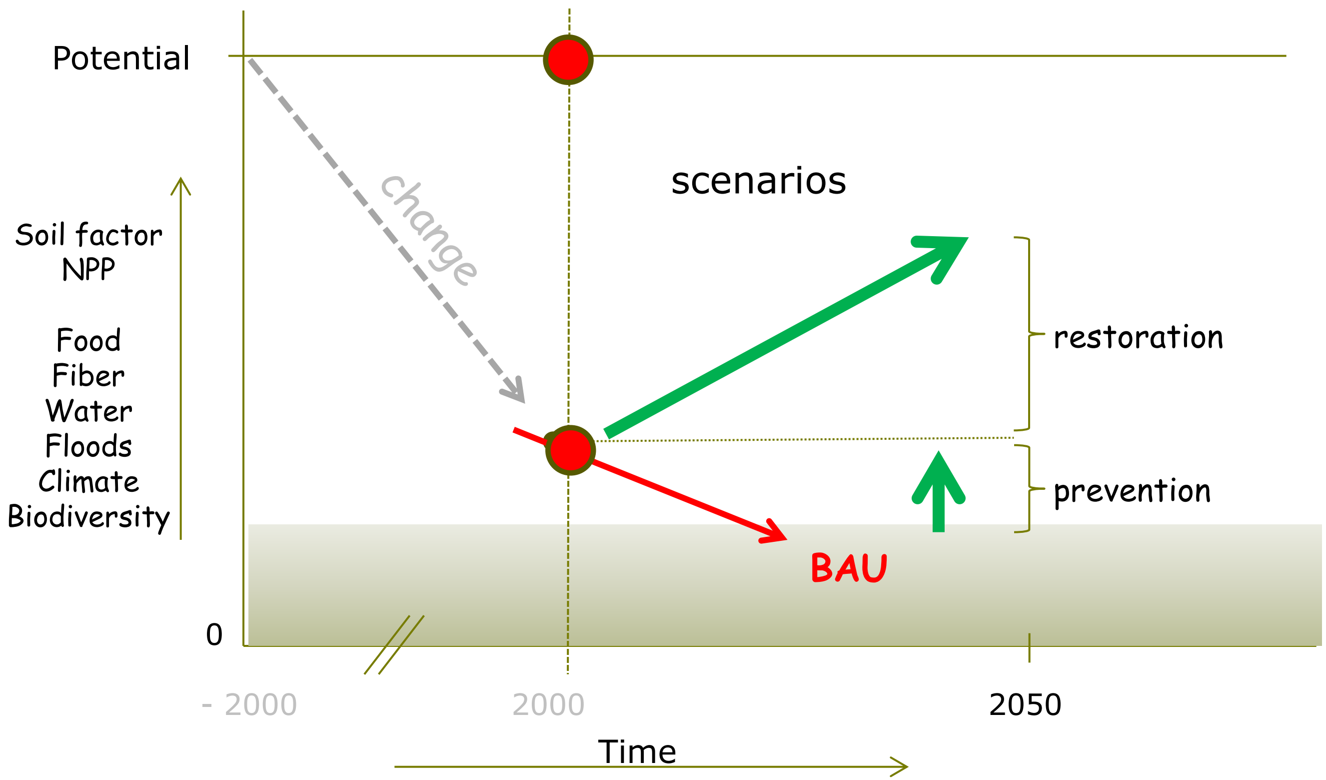
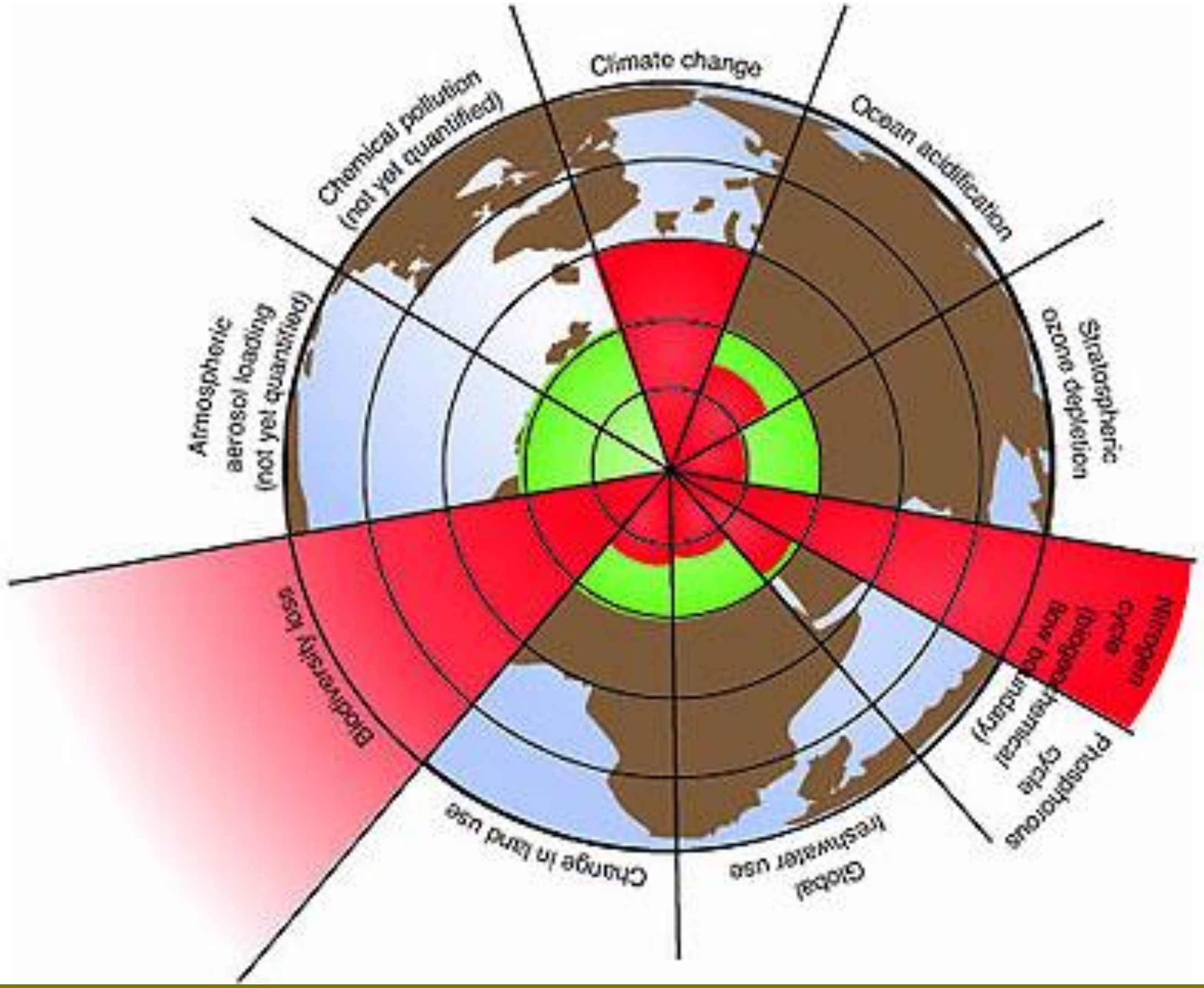
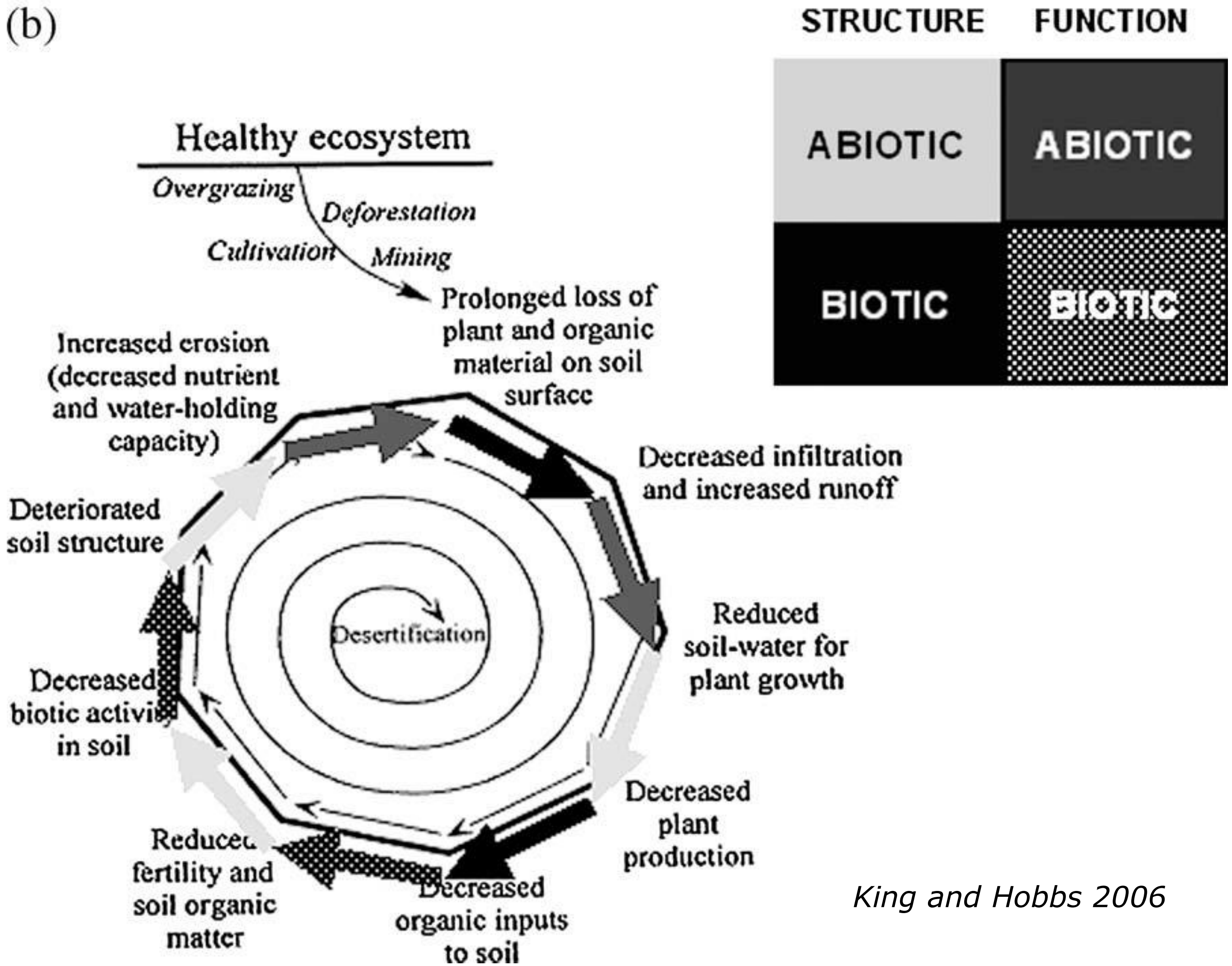



Climate change
Ocean acidification
Stratospheric ozone depletion
Nitrogen cycle (biogeochemical flow boundary)
Phosphorous cycle
Global freshwater use
Change in land use
Biodiversity loss
Atmospheric aerosol loading (not yet quantified)
Chemical pollution (not yet quantified)

Key process

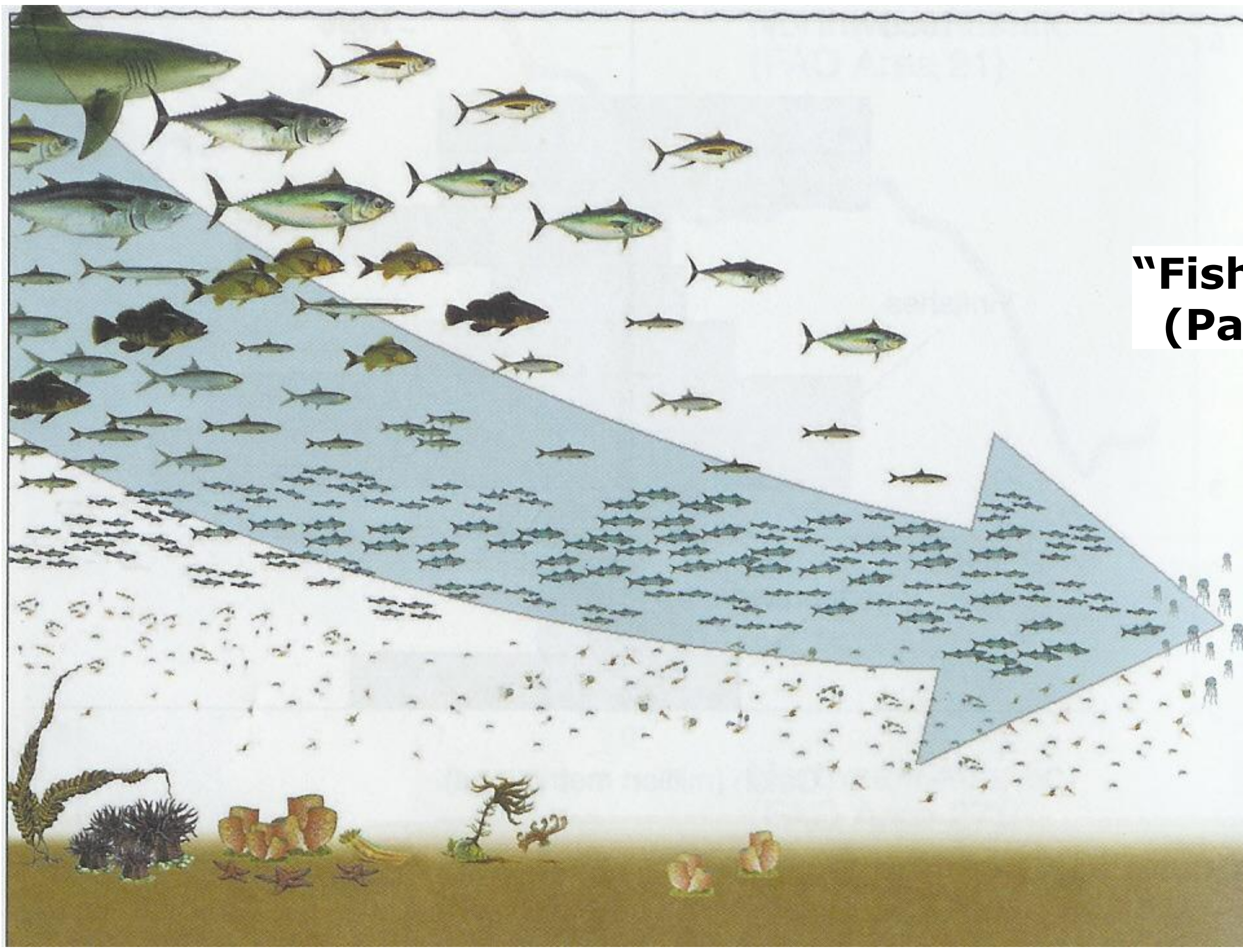
De-vegetate
De-corbonate
De-hydrate
De-speciate
De-plete
De-teriorate
De-sertificate

-> Ecosystem engine stops



King and Hobbs 2006

How do we measure biodiversity loss? → homogenisation



"Fishing down the foodwe
(Pauly, 2001)"

We also convert, plough, burn, log, hunt and pollute down

Global biodiversity loss: 70% -> 60% (MSA)

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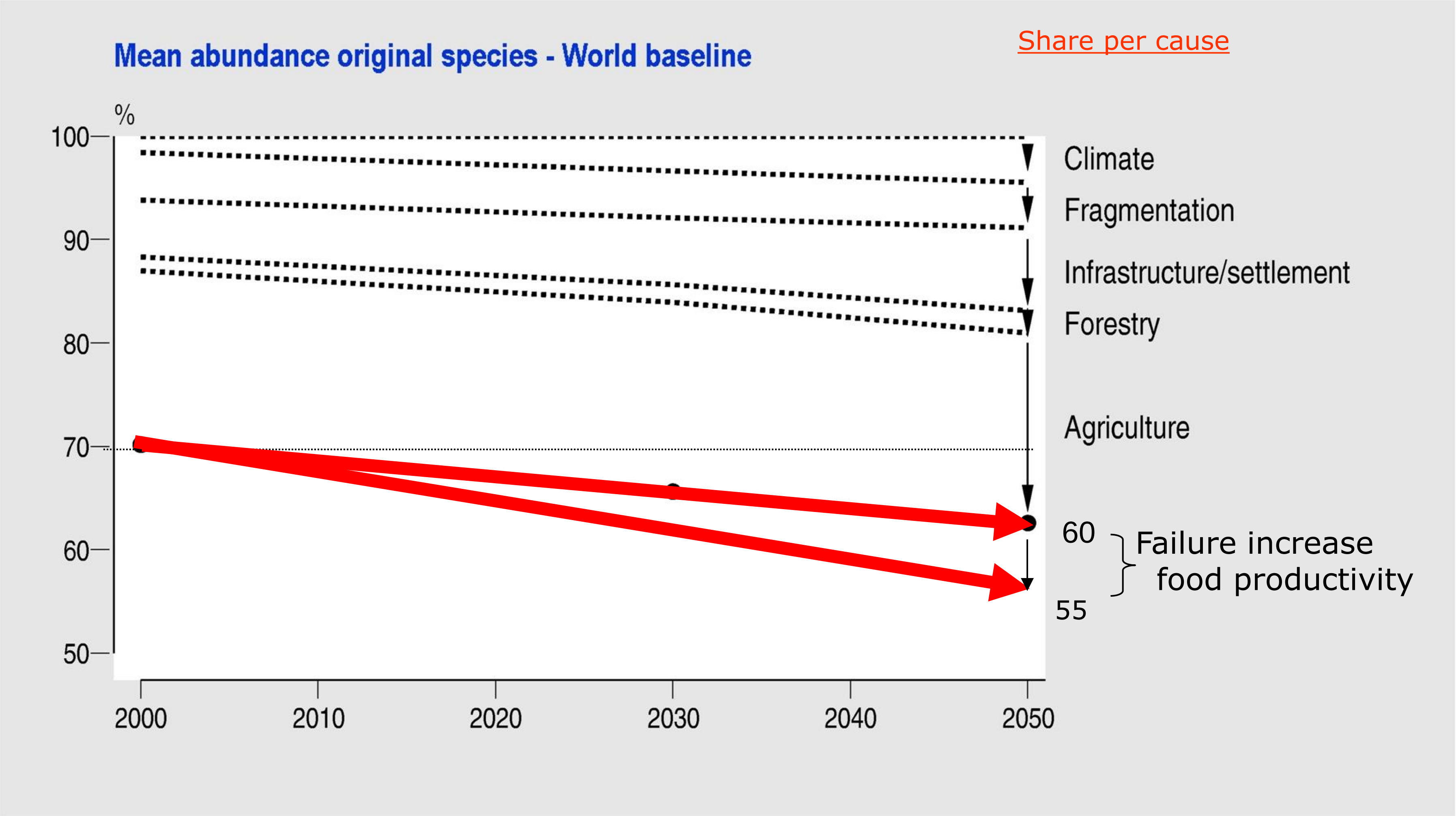

Datum: 20-dec-2005

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Rethinking global biodiversity strategies

Sector-based options to reduce biodiversity loss

as a contribution to TEEB

A cooperation between PBL, LEI and UBC

Ben ten Brink PBL, 20-10-2010

Conclusions

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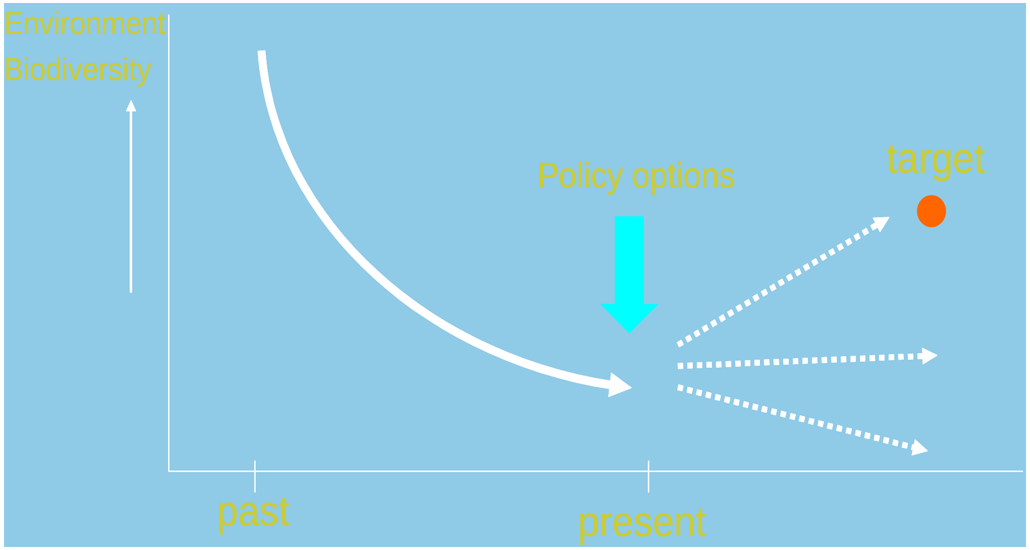
1. By 2050, global biodiversity further declines from 70%->60%
2. many sub-systems to **lower** levels
3. individual options reduce loss a little
4. a combination of options **halves** the loss, and
5. has **positive** effects on climate change, water quality, and food availability
6. **more** options are possible -> further reduce

Governmental institute

Independent

Contribute to:

- –IPCC
- –MA
- –**GBO2**
- –**GEO** 1, 3,**4**
- –FAO outlook
- –**OECD outlook 2008**
- –TEEB1



- –**Contribution to TEEB -> Bio-physical effects Cost of Policy Action**
- –...

Global Biodiversity Outlook 3 concluded:

1. 2010-target not achieved at any level
2. loss proceeds at unchanged pace
3. risk at passing tipping points

Recommends measures on:

- agricultural efficiency
- forestry
- climate mitigation
- fisheries
- consumption
- ……………

How much?
Do they halt loss?

We assessed 8 options and 1 combination

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8 single options:

1. Closing yield gap (efficiency)
2. Reducing post harvest loss (50%)
3. Diet change (less meat - no meat)
4. Climate mitigation & biofuels (max + 2°C)
5. Wood plantations + RIL
6. Reduced deforestation
7. Protected areas (20%-50% per biome)
8. Restoring marine stocks & aquaculture

\+ Option package (ambitious but feasible)

Compared to no new policie
scenario (BAU)

Indicator: mean species abundance

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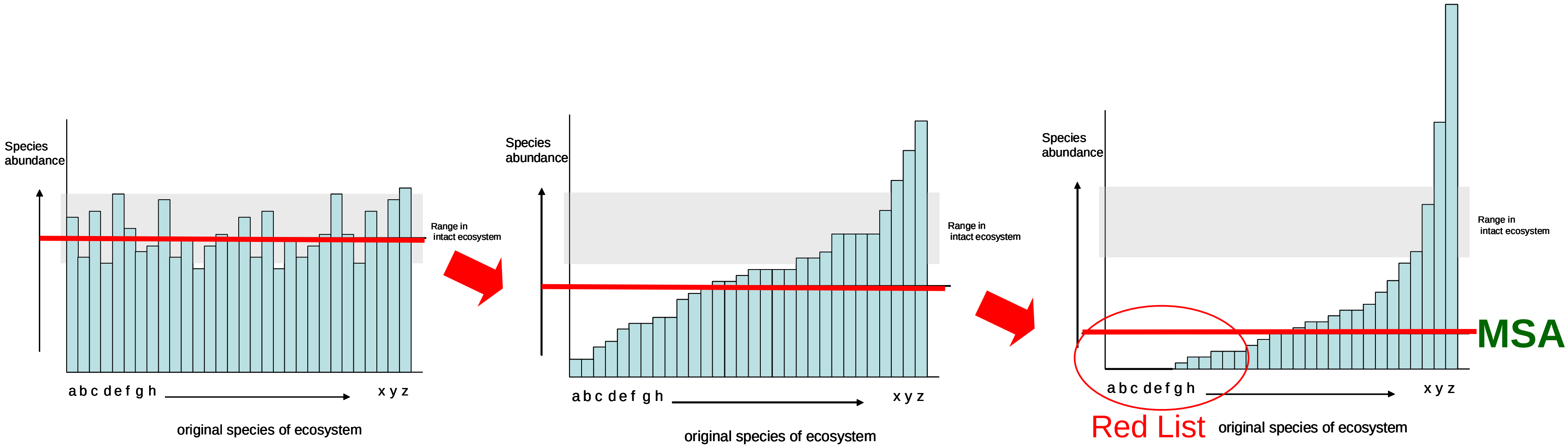
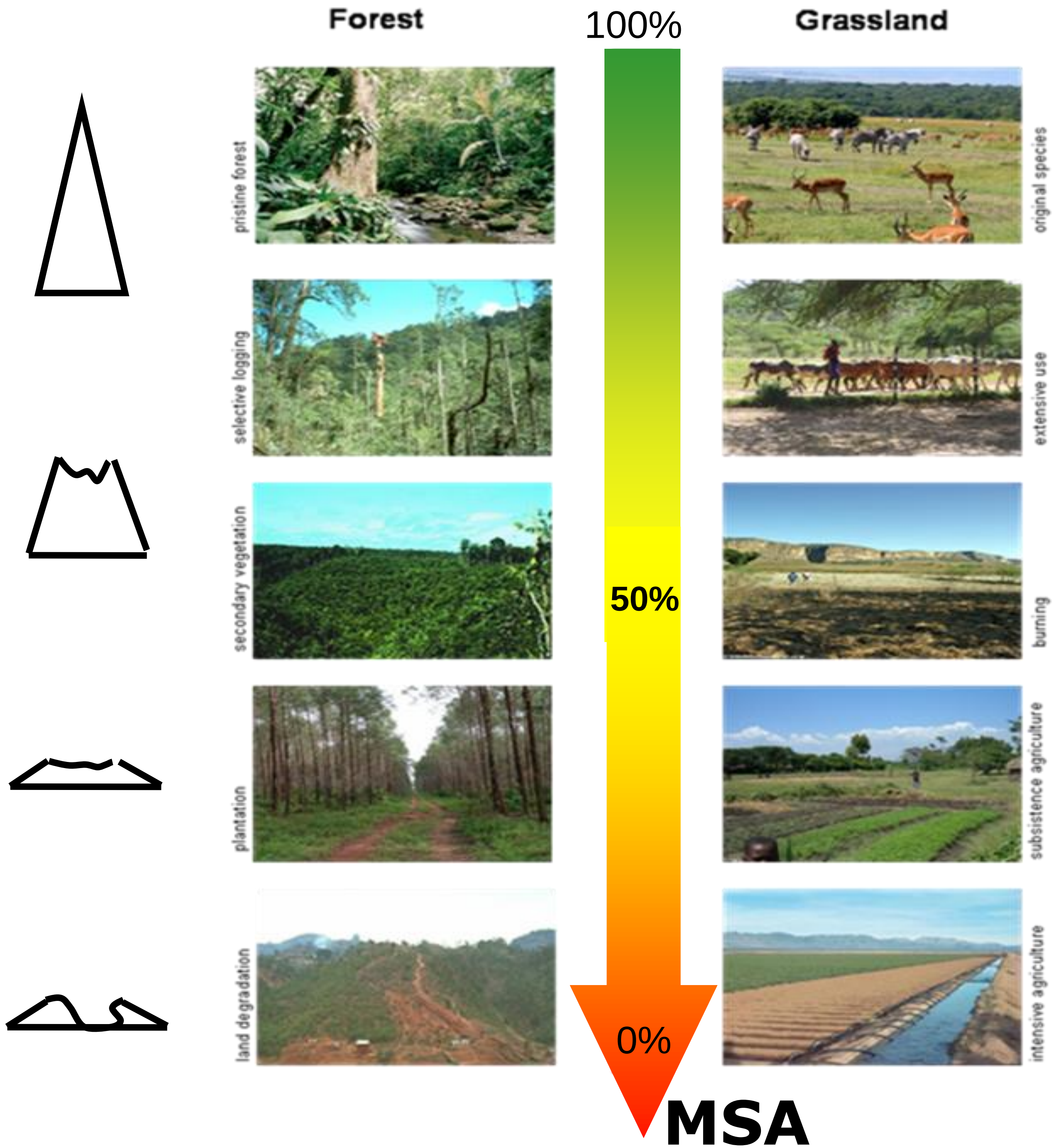


Mean Species Abundance (MSA)

MSA
A landscape view



Baseline scenario: no new policies

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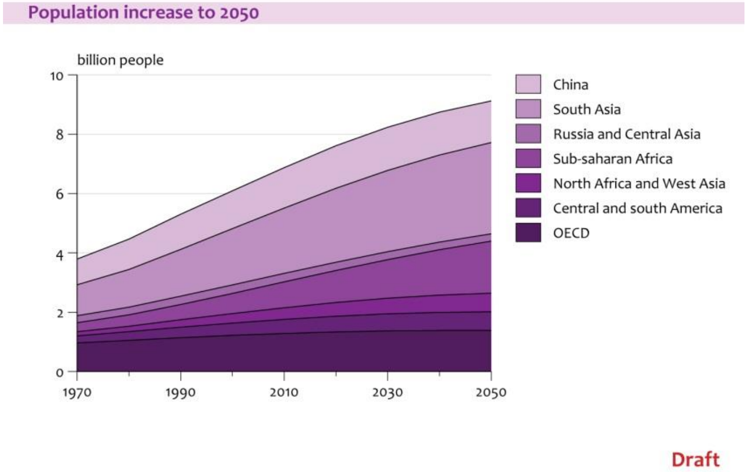
Characteristics 2000-> 2050:

1.5 x global population
1.6 x food productivity
1.6 x fish demand
1.4 x wood demand
2.5 x global energy use
3 x income per person

Kyoto implemented



Sources: OECD, IEA, FAO,

Cork et al,

Baseline 1970

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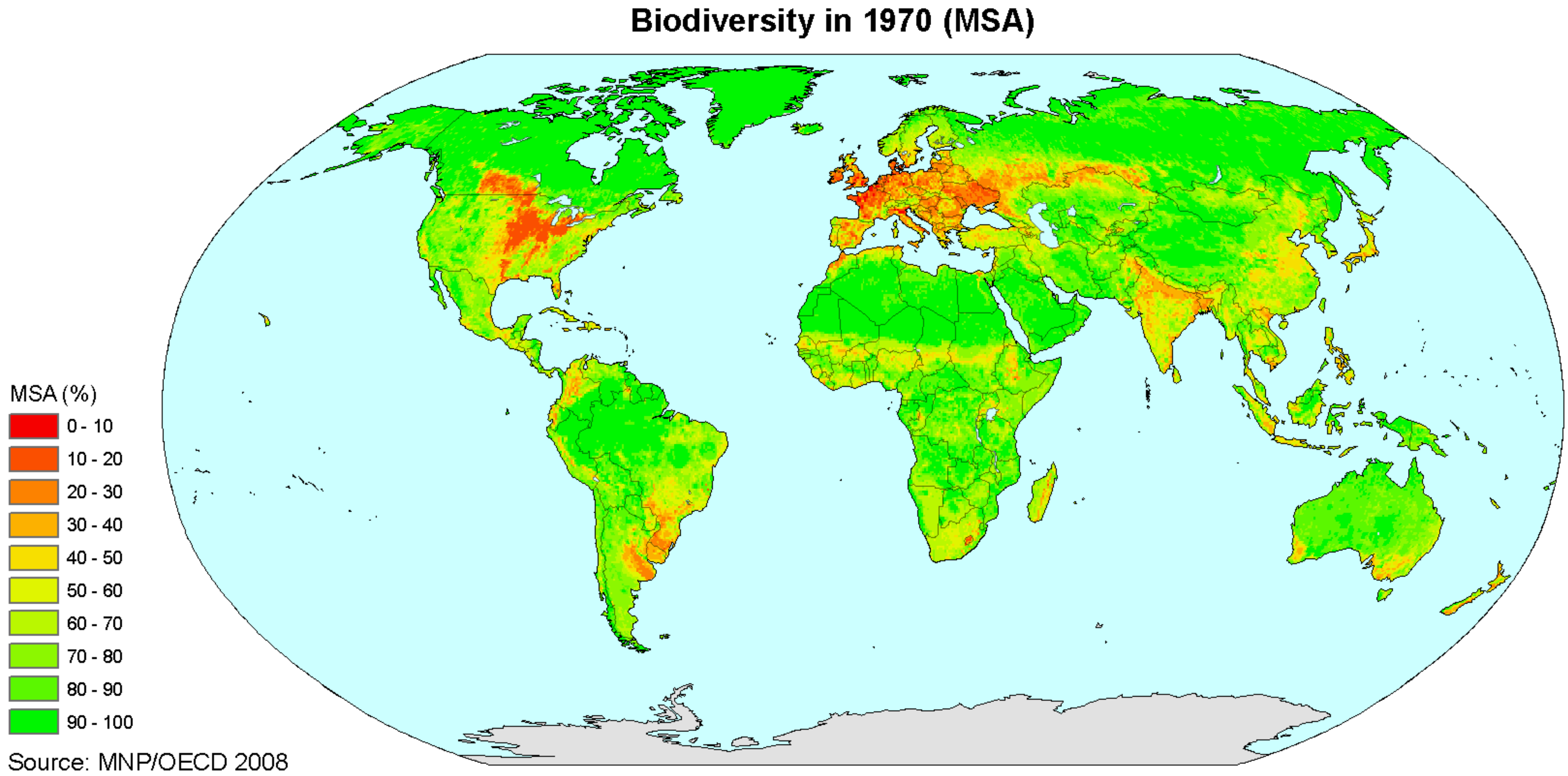

Baseline 2000

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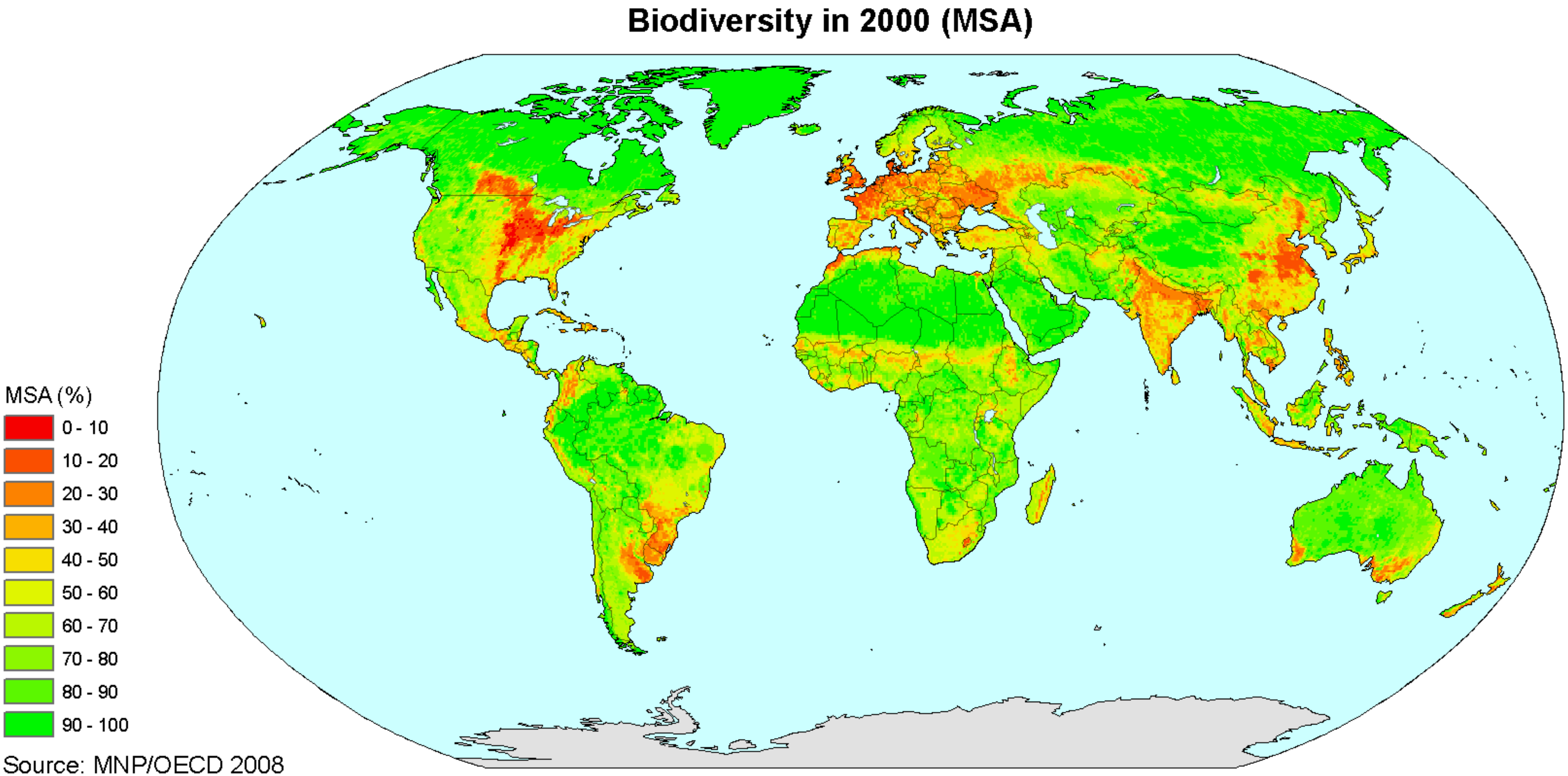

Baseline 2010

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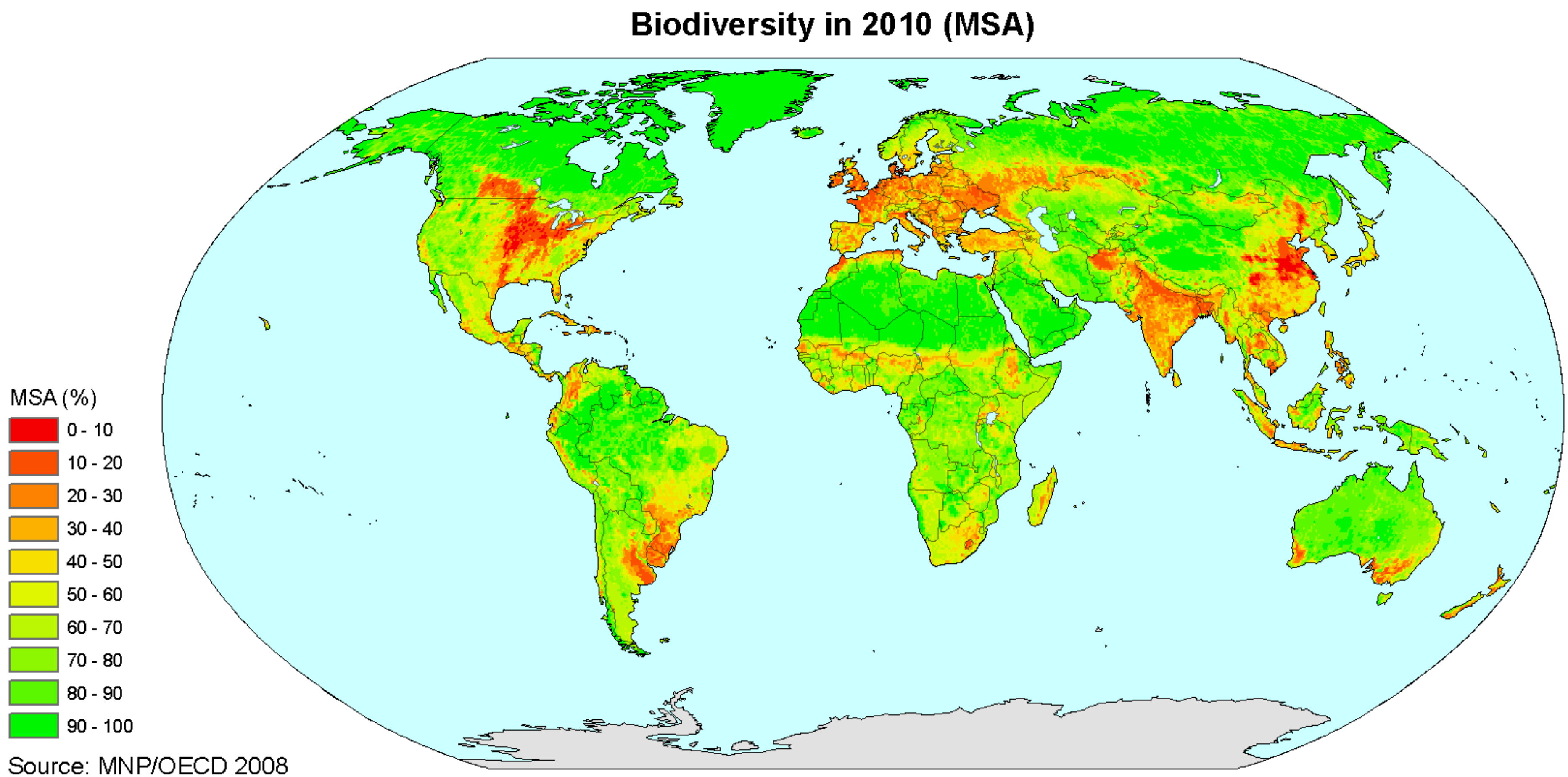

Baseline 2030

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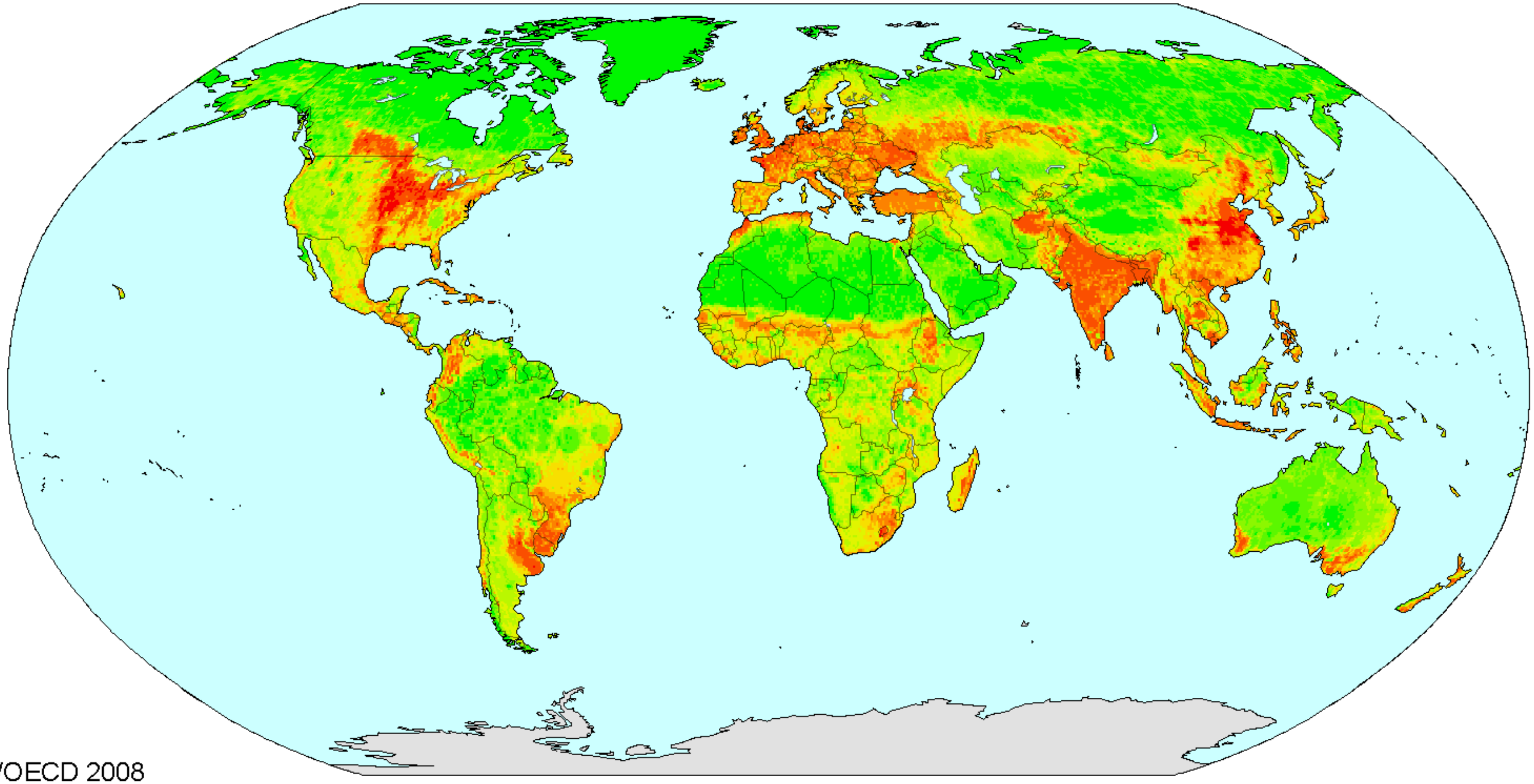
Biodiversity in 2030 (MSA)



MSA (%)
0 - 10
10 - 20
20 - 30
30 - 40
40 - 50
50 - 60
60 - 70
70 - 80
80 - 90
90 - 100

Source: MNP/OECD 2008

Baseline 2050

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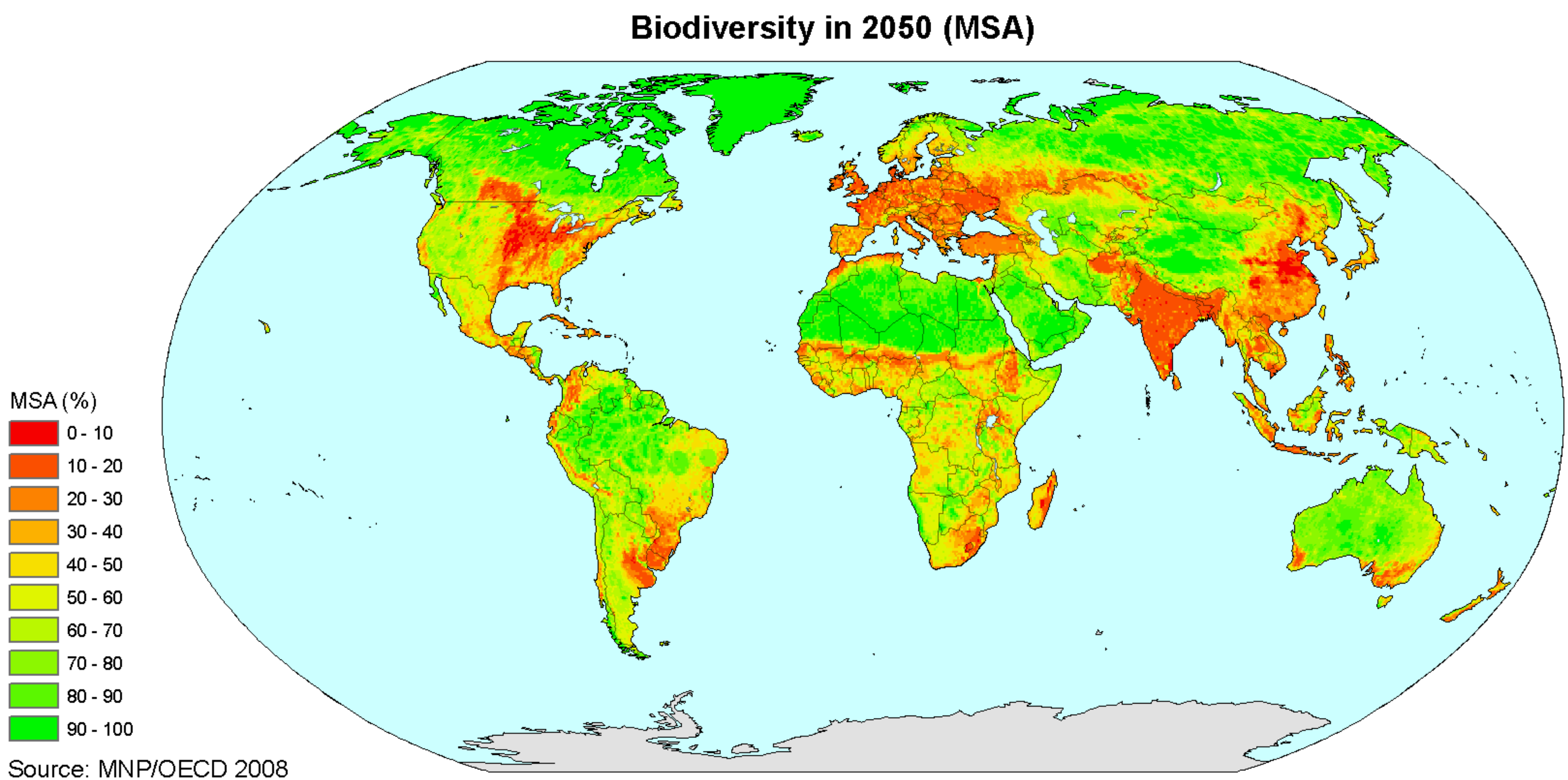

Biodiversity loss continues (MSA)

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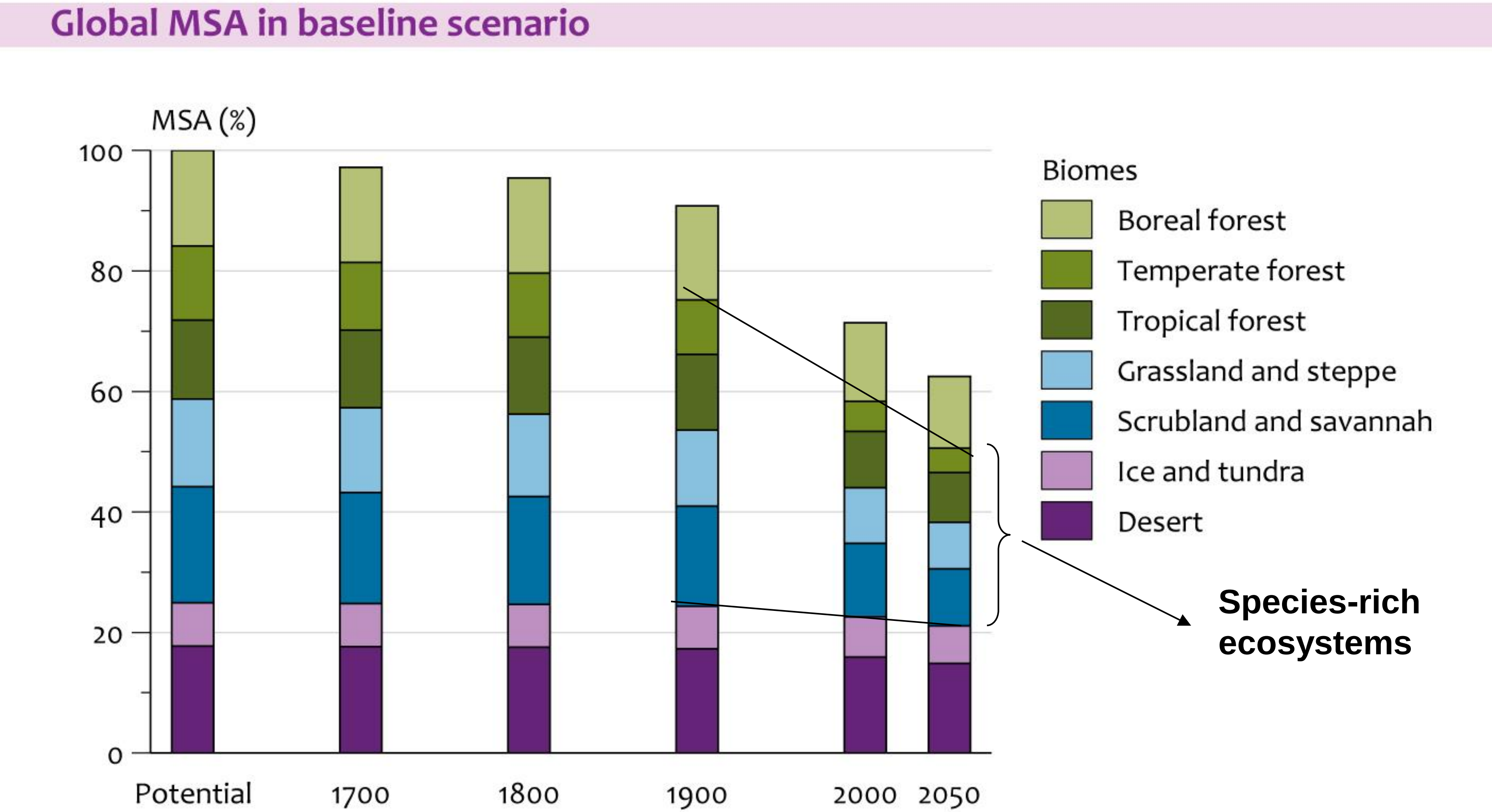

Methods

We will be synthesizing a wide variety of scenarios and models as the basis of our analysis. Some of these will be new analyses undertaken for the GBO4.

Types of models and scenarios used:

- **Extrapolations from current trends – statistical**
- **Extrapolations from current trends – with hypotheses or probablistic**
- **Socio-economic storylines - e.g. MA, GEO, IPCC storylines.**
- **Storylines + policy options - e.g., Rethinking scenarios**
- **Backcasting analyses: working backwards from sustainable endpoints - e.g., Rio+20 scenarios**

‘Backcasting’ as an innovative way to explore alternative pathways for reaching agreed upon objectives

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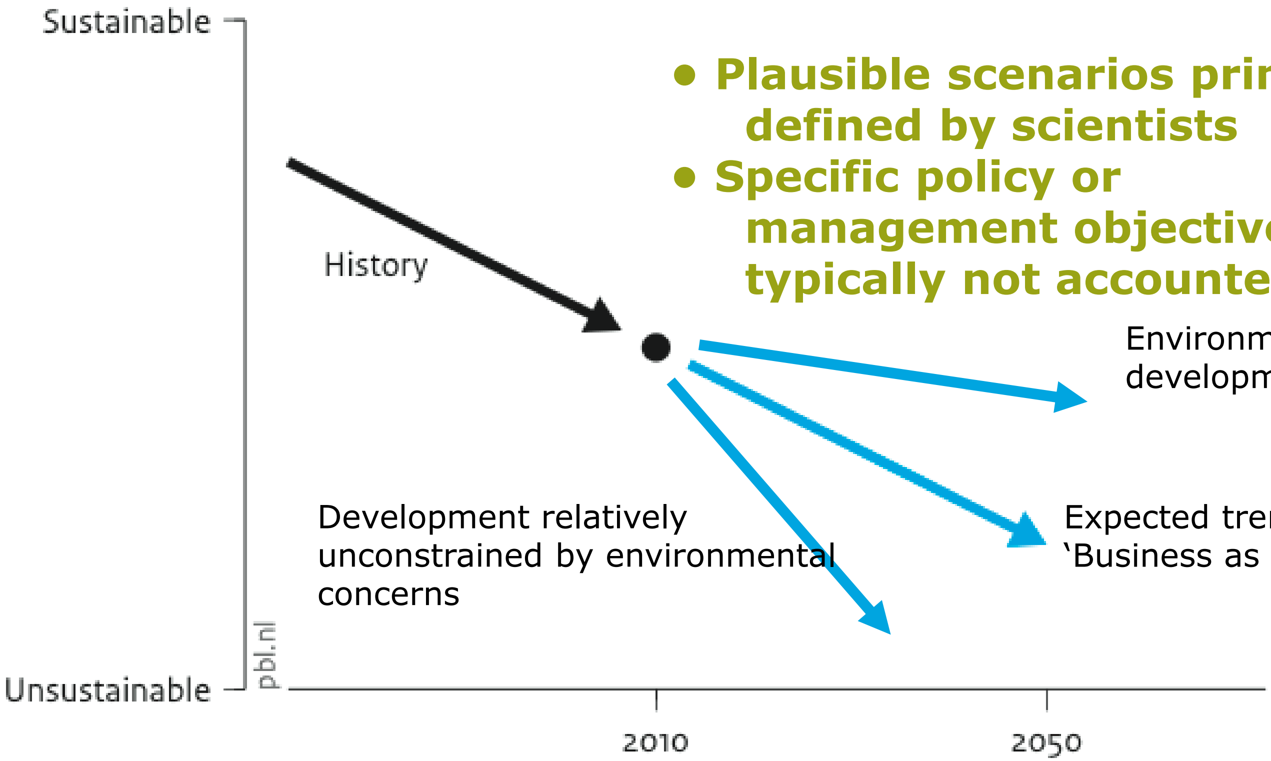
The ‘Storyline’ approach to developing plausible socio-economic scenarios

Roads from Rio+20

Pathways to achieve global sustainability goals by 2050

- **Plausible scenarios primarily defined by scientists**
- **Specific policy or management objectives typically not accounted for**



'Backcasting' as an innovative way to explore alternative pathways for reaching agreed upon objectives

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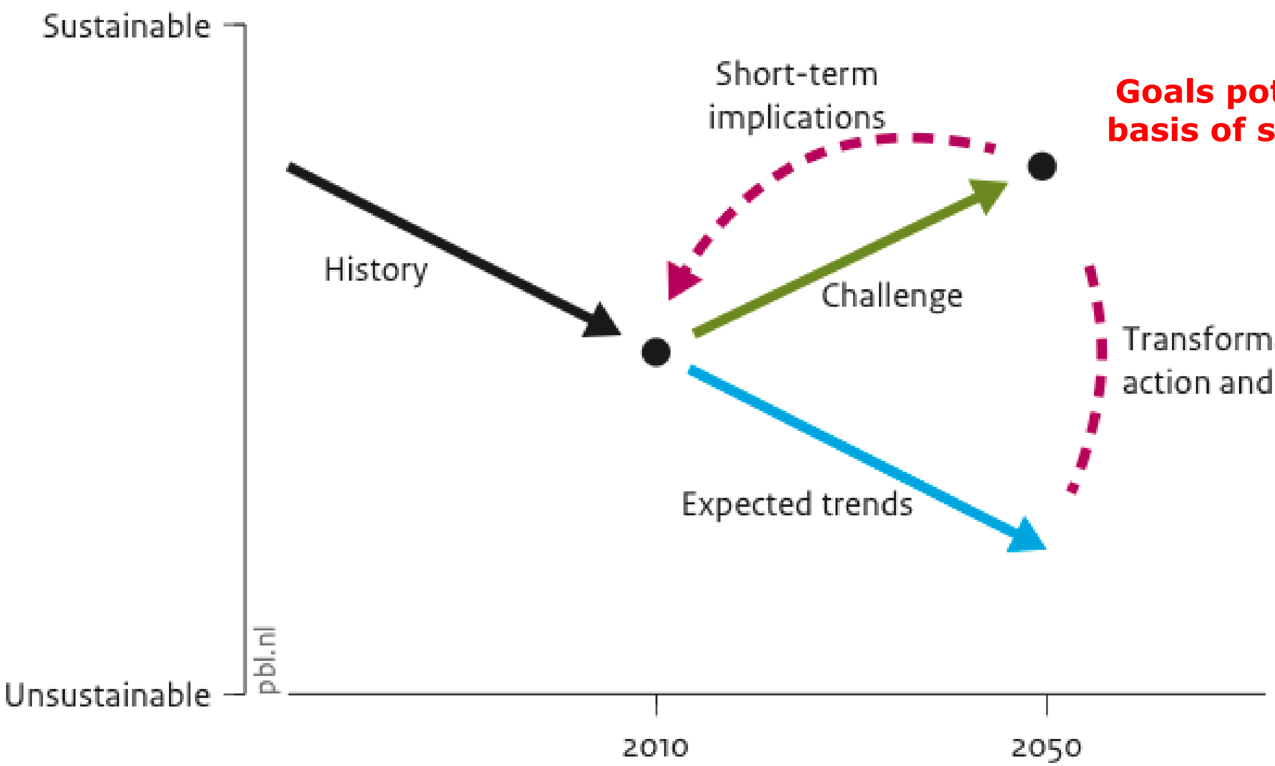
Roads from Rio+20

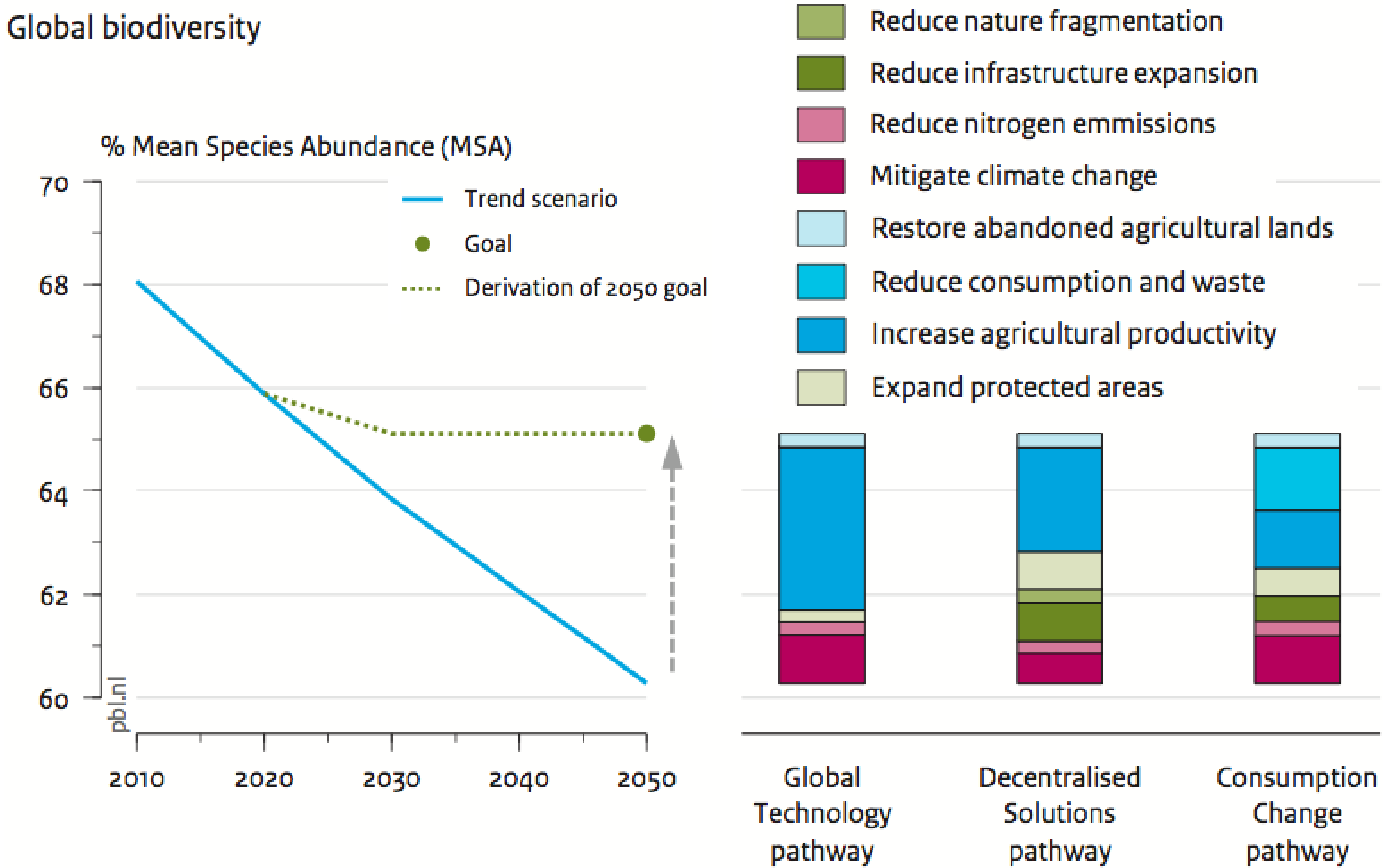
Pathways to achieve global sustainability goals by 2050

Backcasting analysis, working back from a sustainable end point to determine actions for today

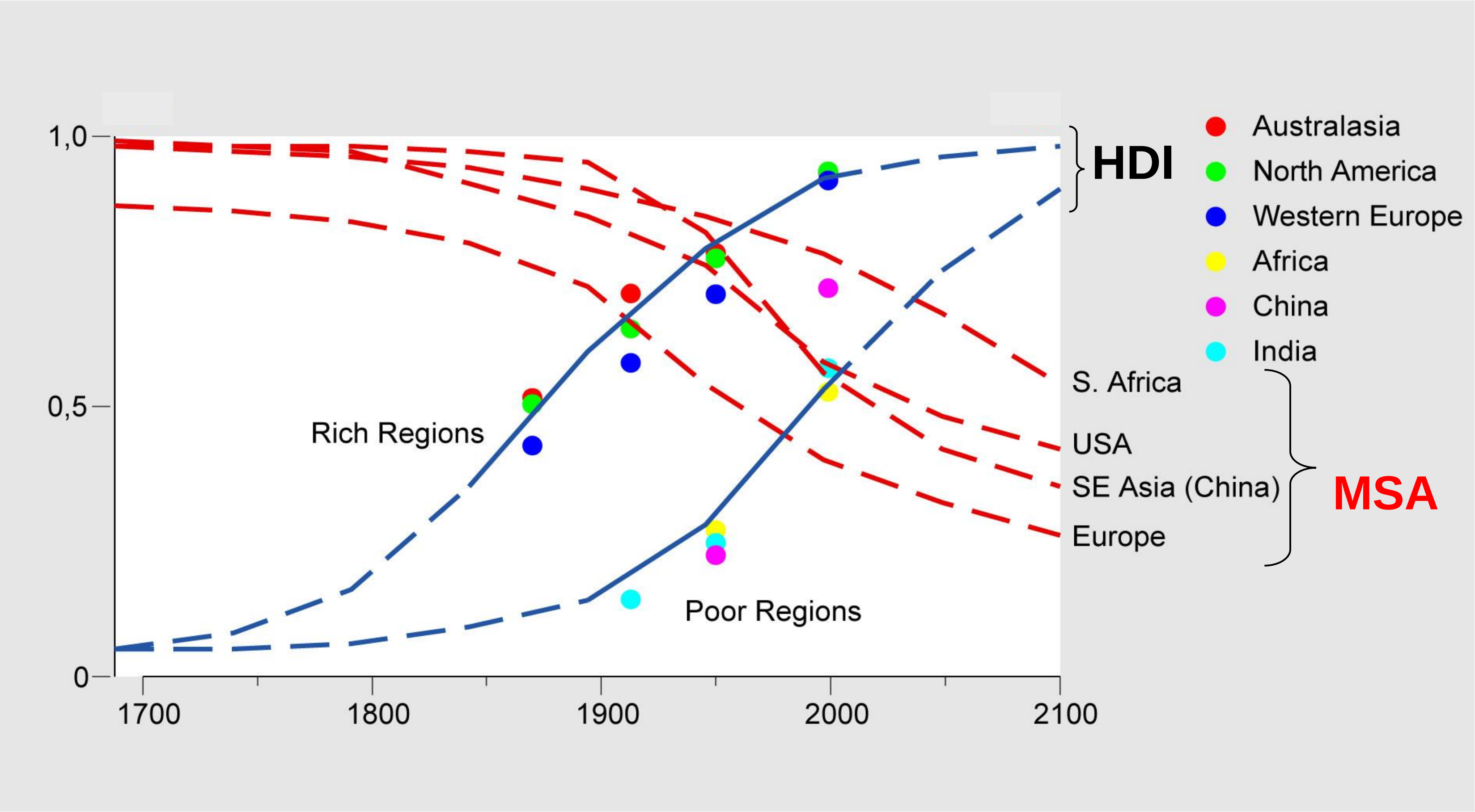


Goals potentially set on the basis of science-stakeholder dialogs

Global biodiversity and options to prevent biodiversity loss



Development & biodiversity inversely related



3. Why is it important?

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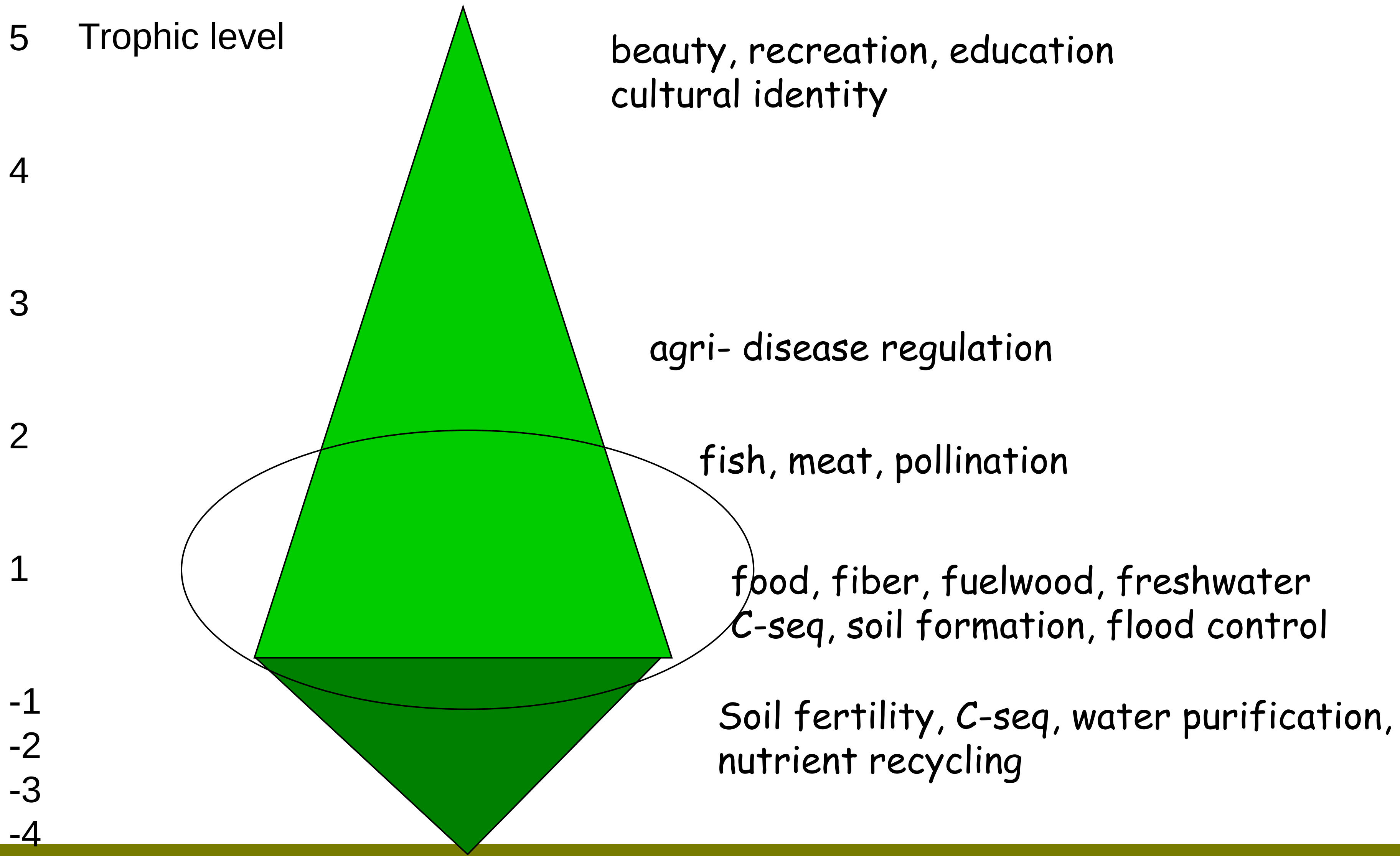
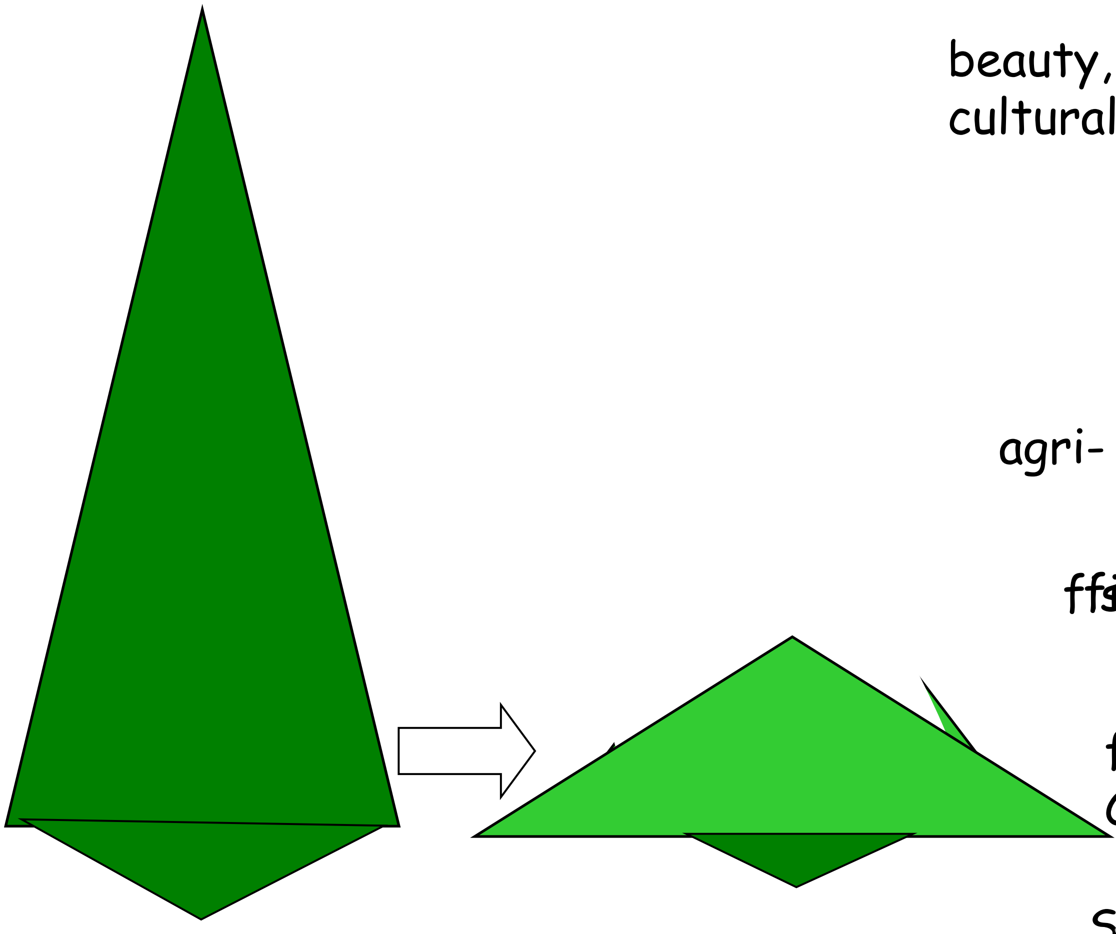


Avoid a lose-lose



beauty, recreation, education
cultural identity

agri- disease regulation

fish, meat pollination

food, fiber, fuelwood, freshwater
C-seq, soil formation, flood control

Soil fertility, water purification,
nutrient recycling
Soil fertility, water purification,
nutrient recycling

original

intensive use
deteriorated

Global forest area 2000-2050 (source GBO3)

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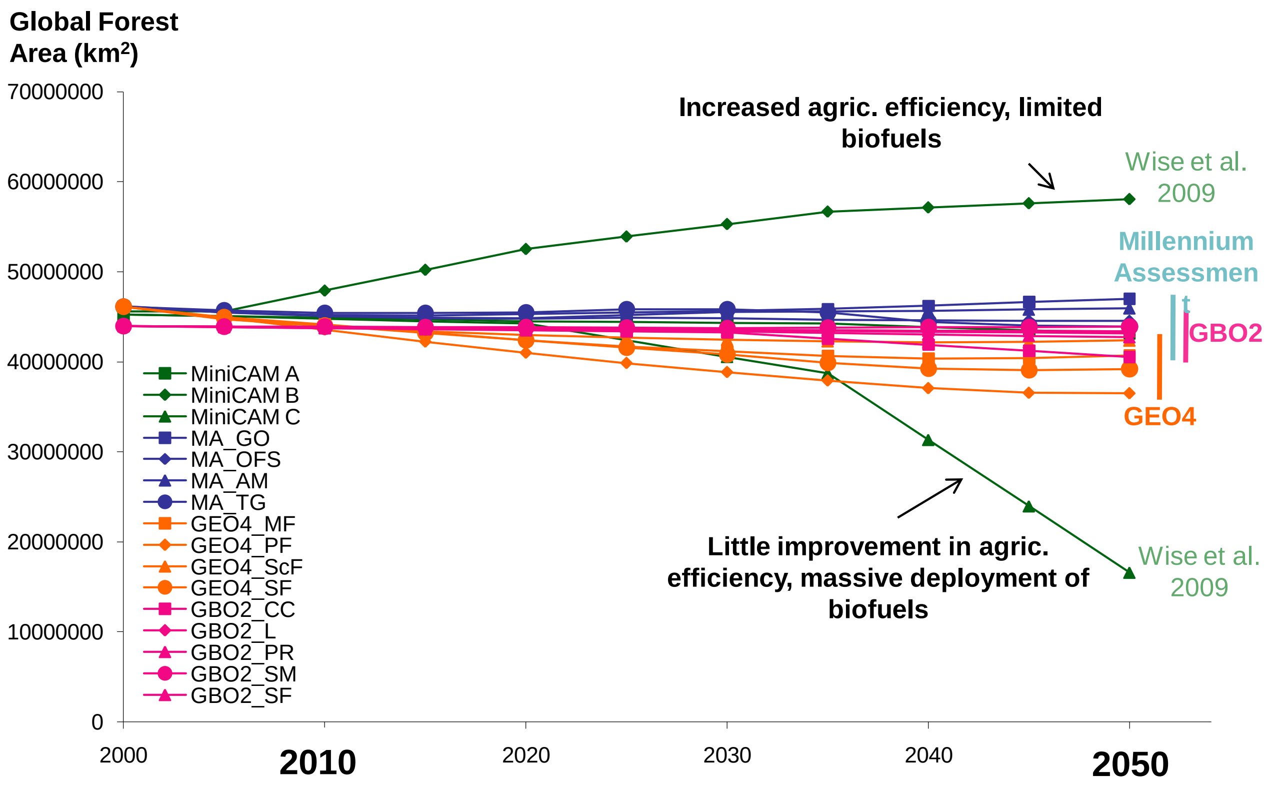
Biodiversity Futures for the 21st Century

Global Biodiversity Outlook 3

HABITAT LOSS



Current protected areas, and expansion to 20% and 50%

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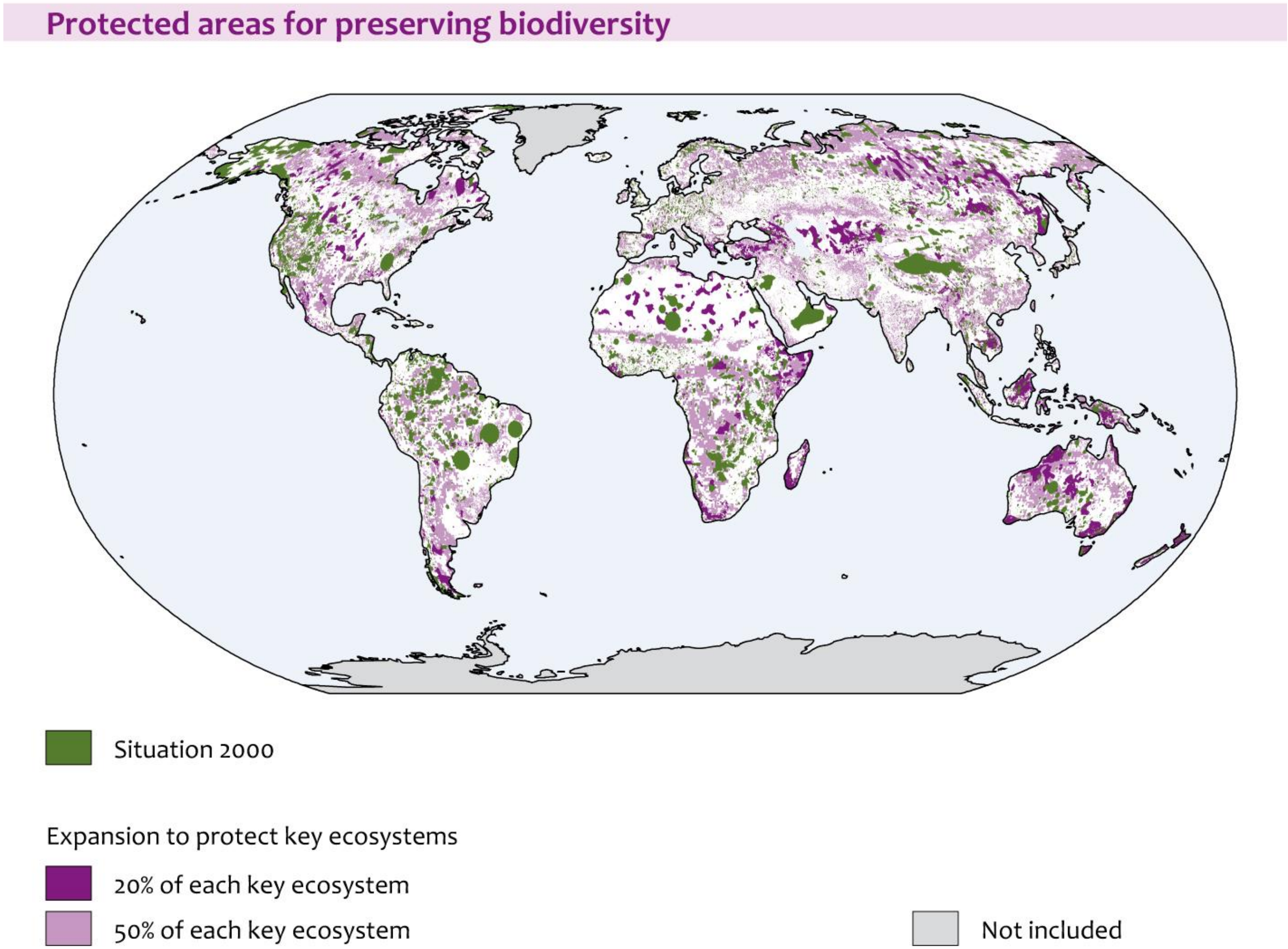

Species extinction past- future(source GBO3)

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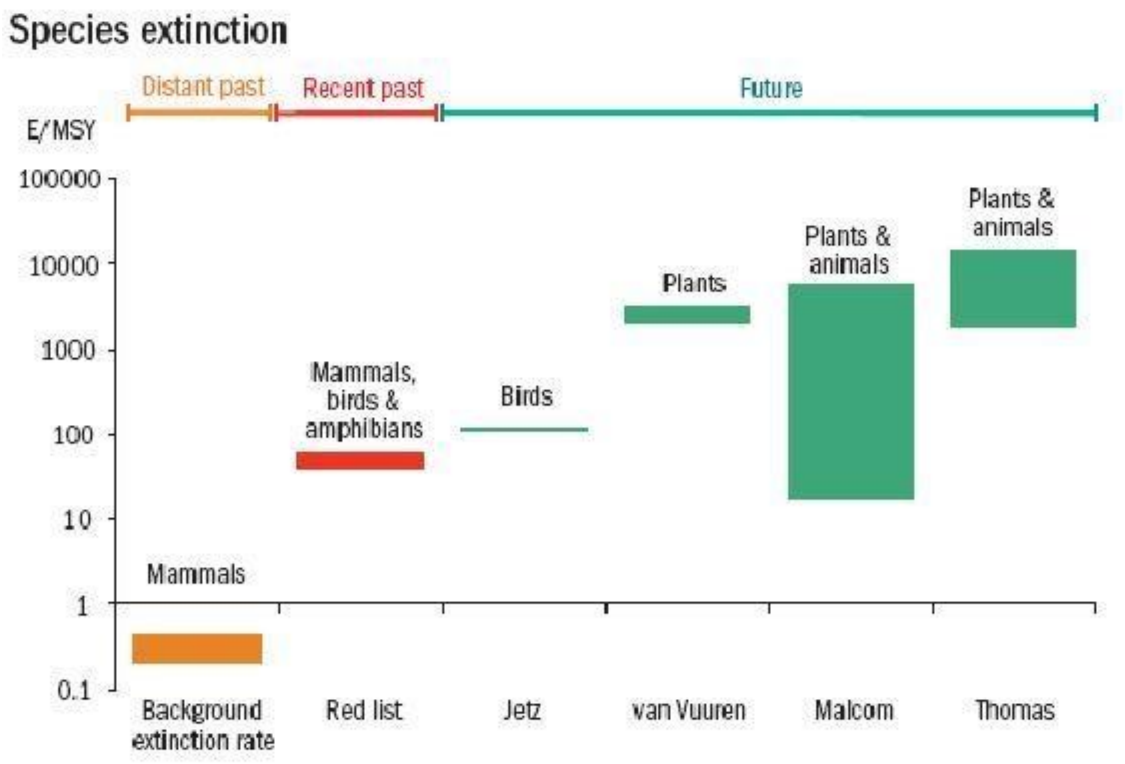
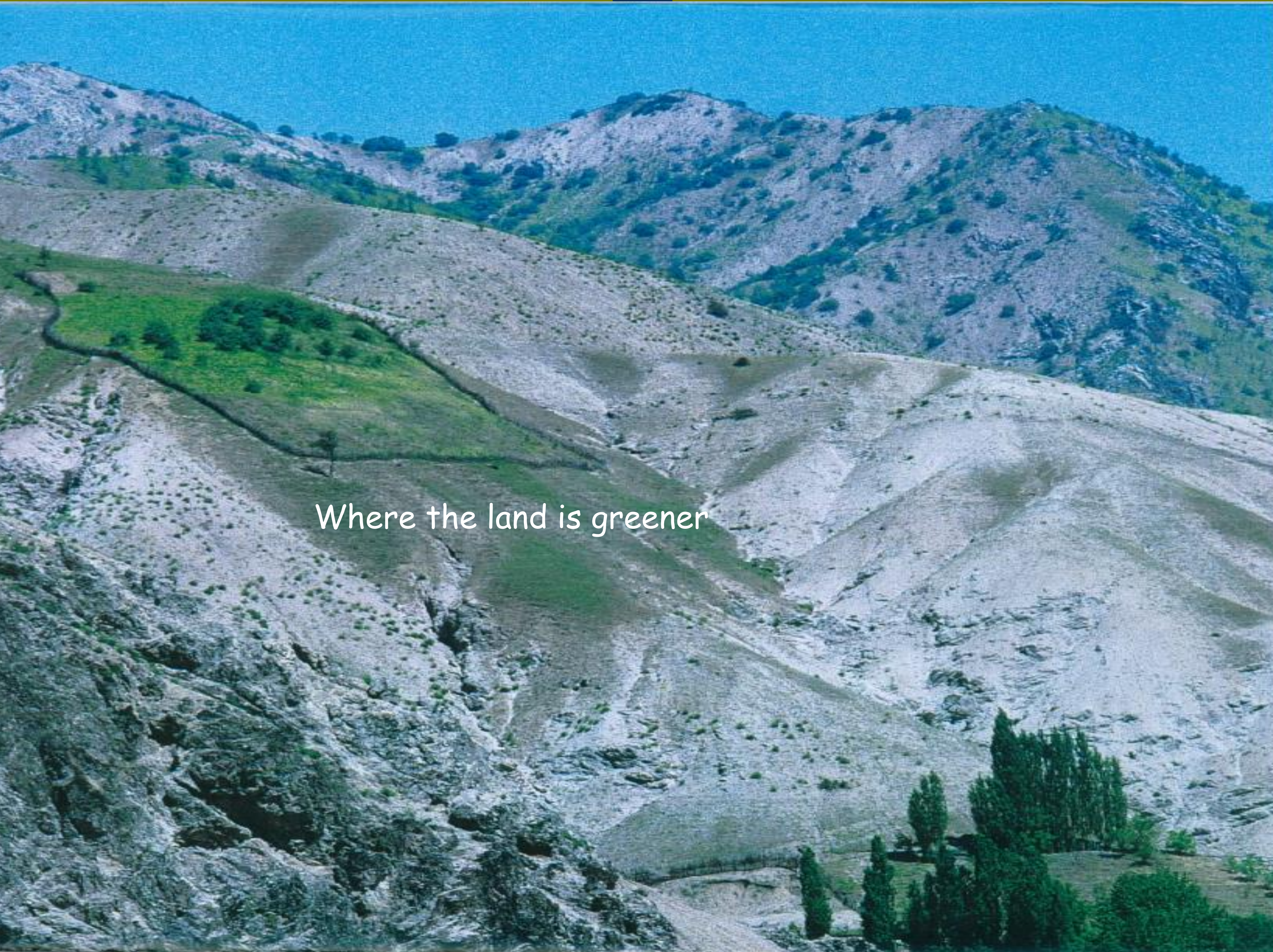
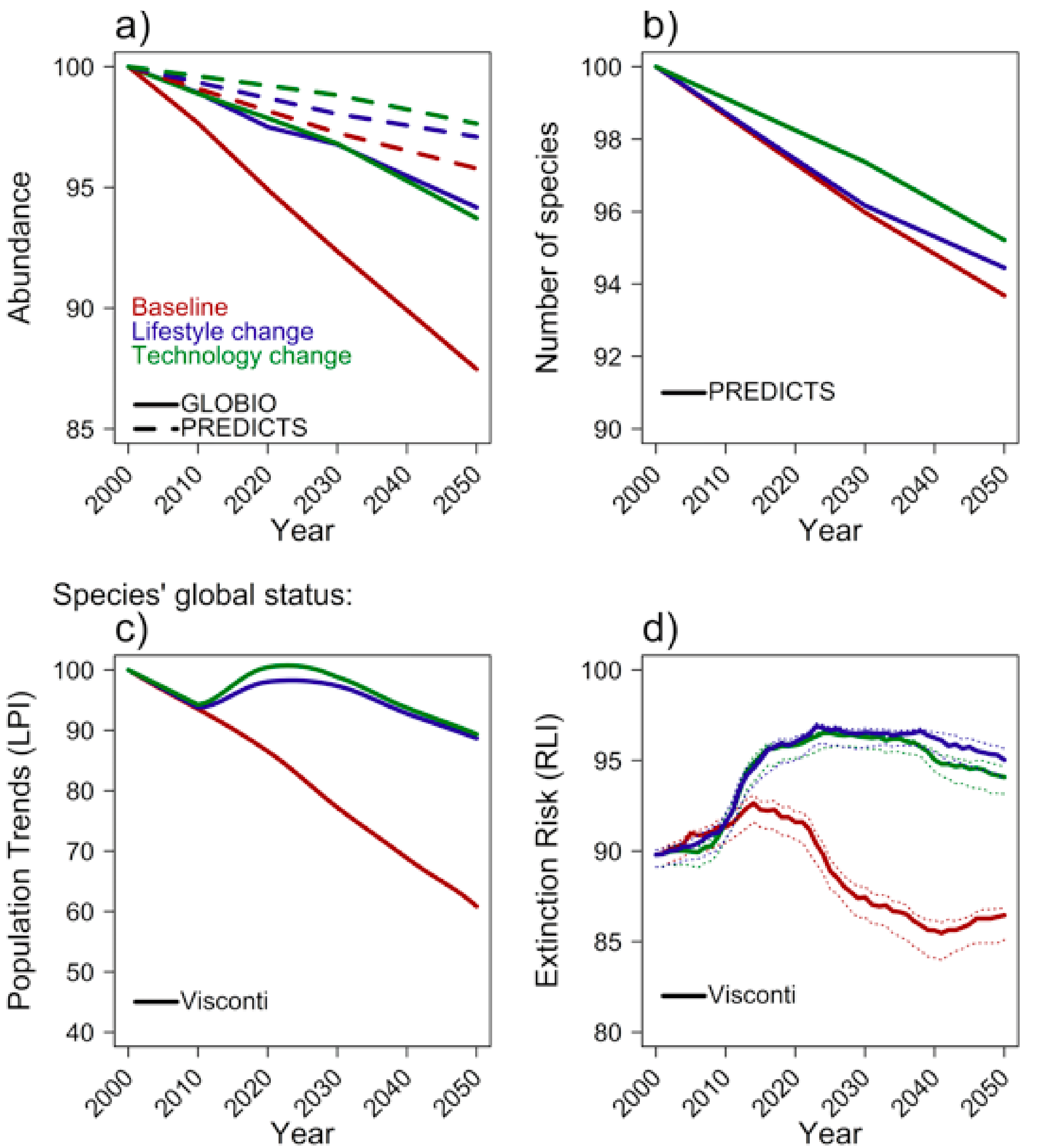


Ben ten Brink
COP10 side event 20-10-2010


Where the land is greener



Target 12 (and beyond)

Comparing multiple indicies of impacts using the Rio+20 socio-economic scenarios

Note: PREDICTS results provisional!

Biodiversity protection, climate mitigation and improving human well being

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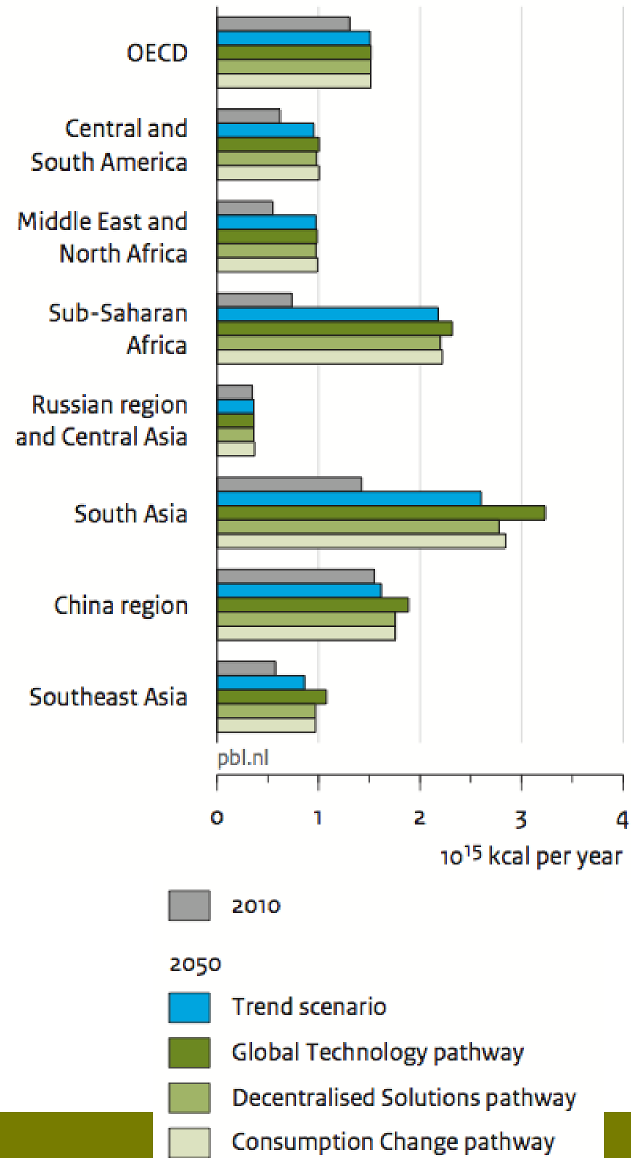
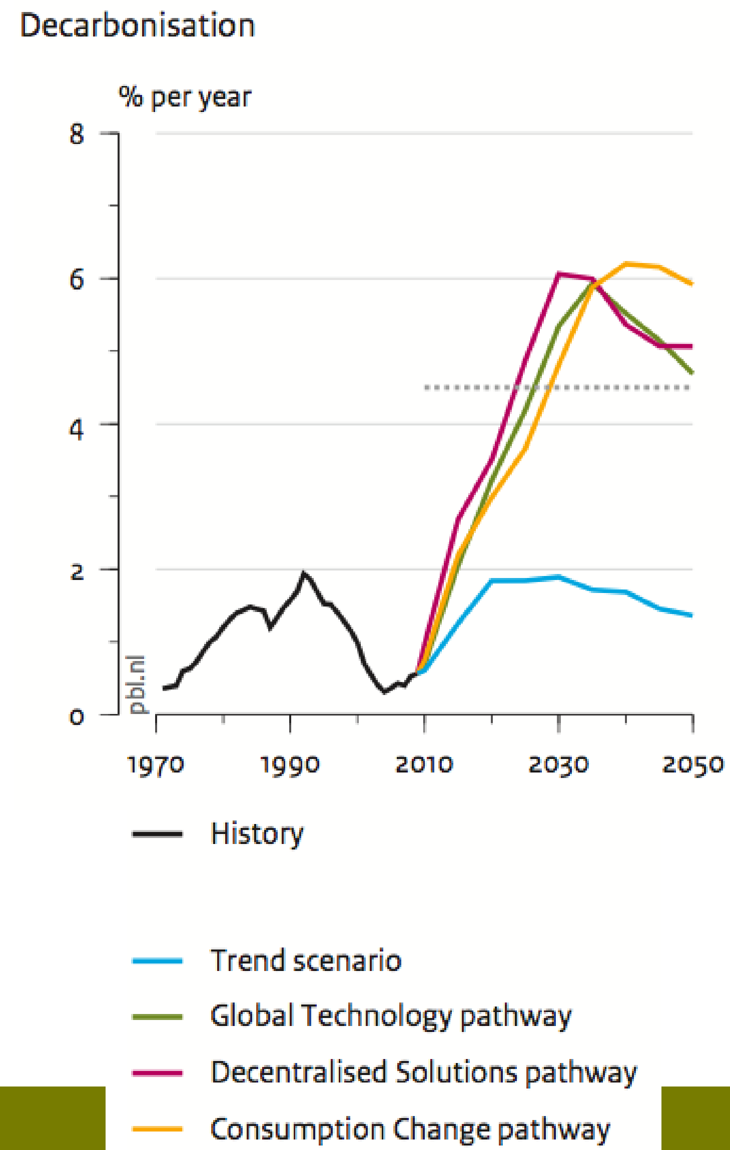
Global calorie consumption



Global decarbonisation rate



Zoming in:
Grasslands - 2000

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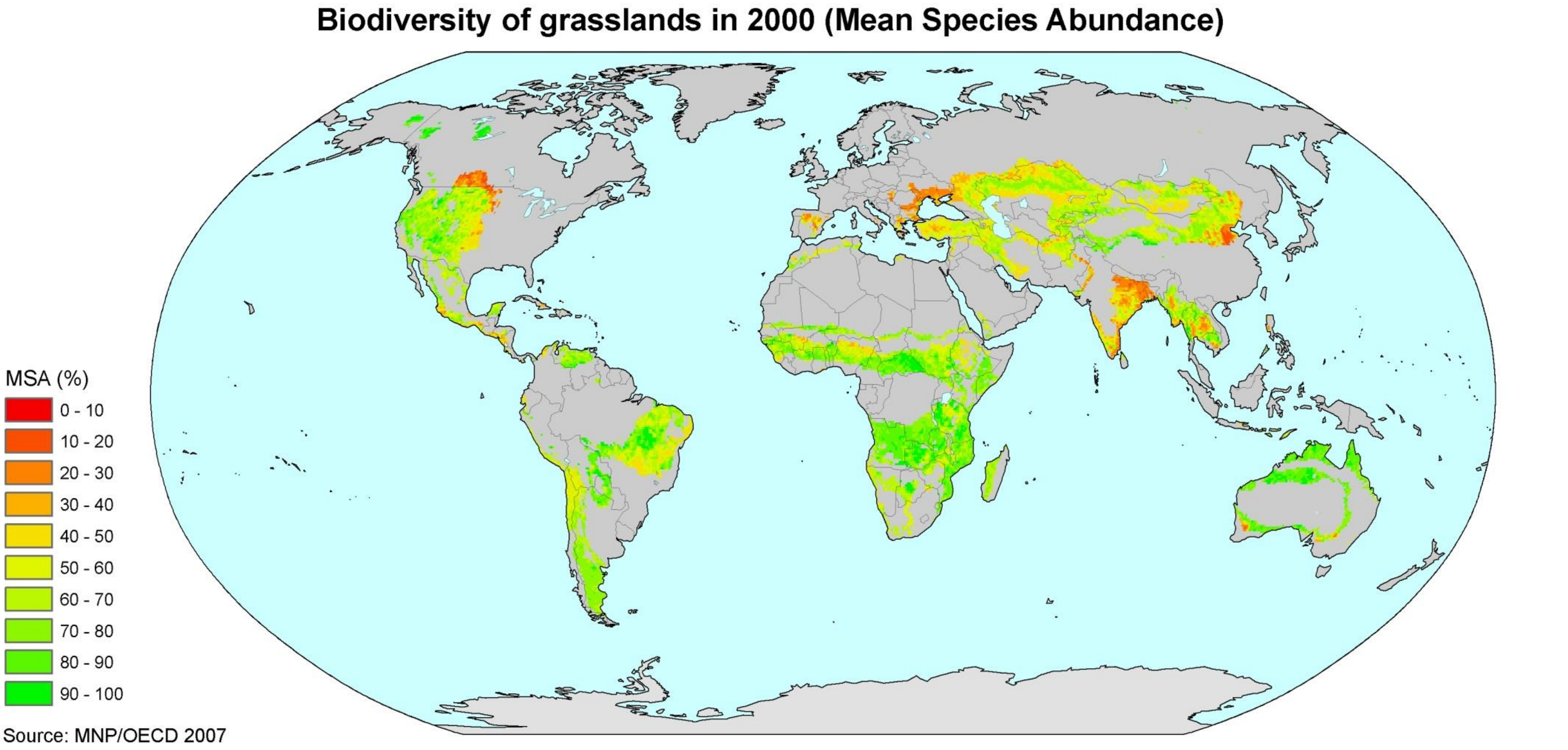

Zooming in:

Grasslands baseline - 2050

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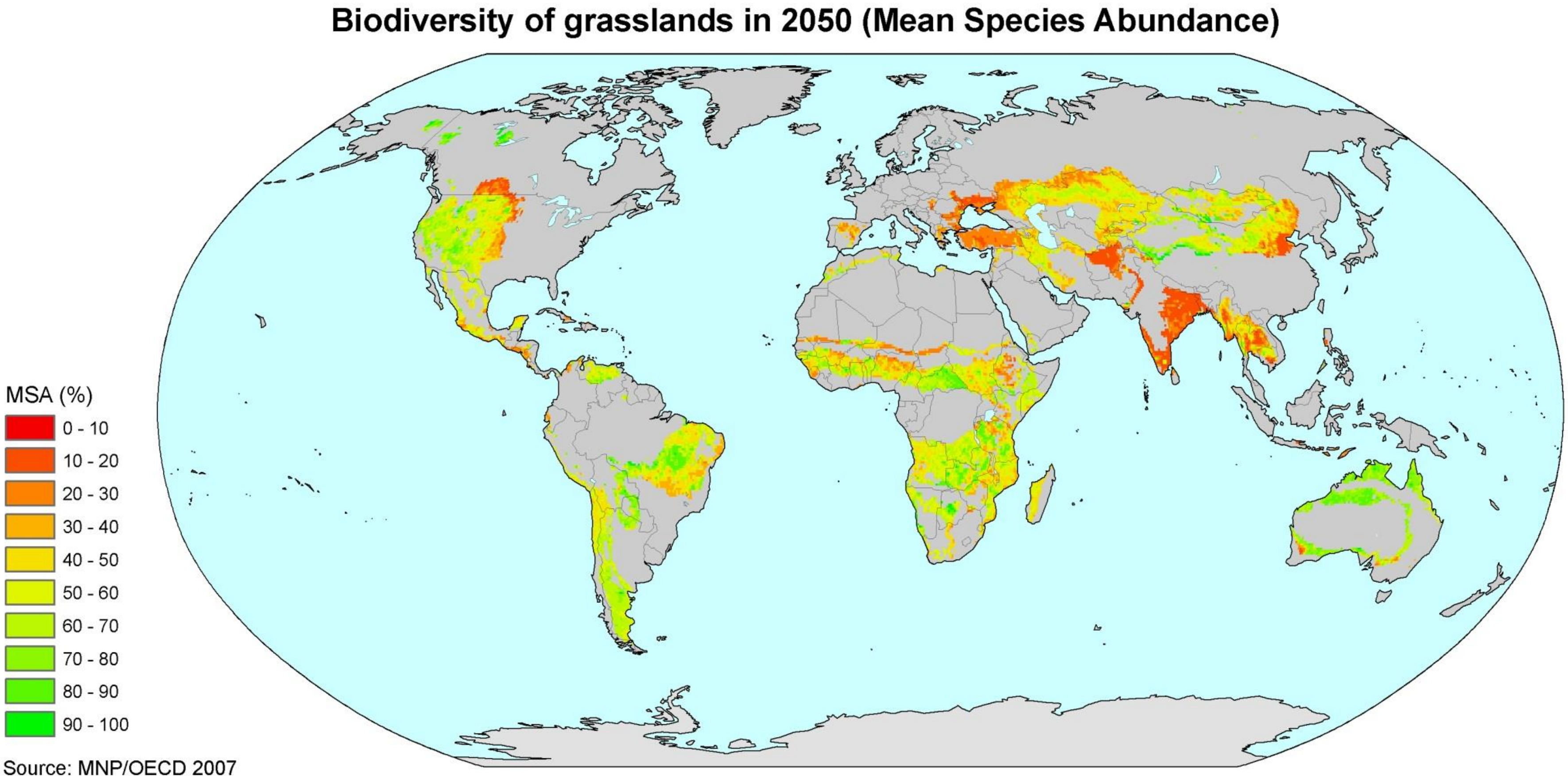

Zooming in:

Temperate & tropical forests - 2000

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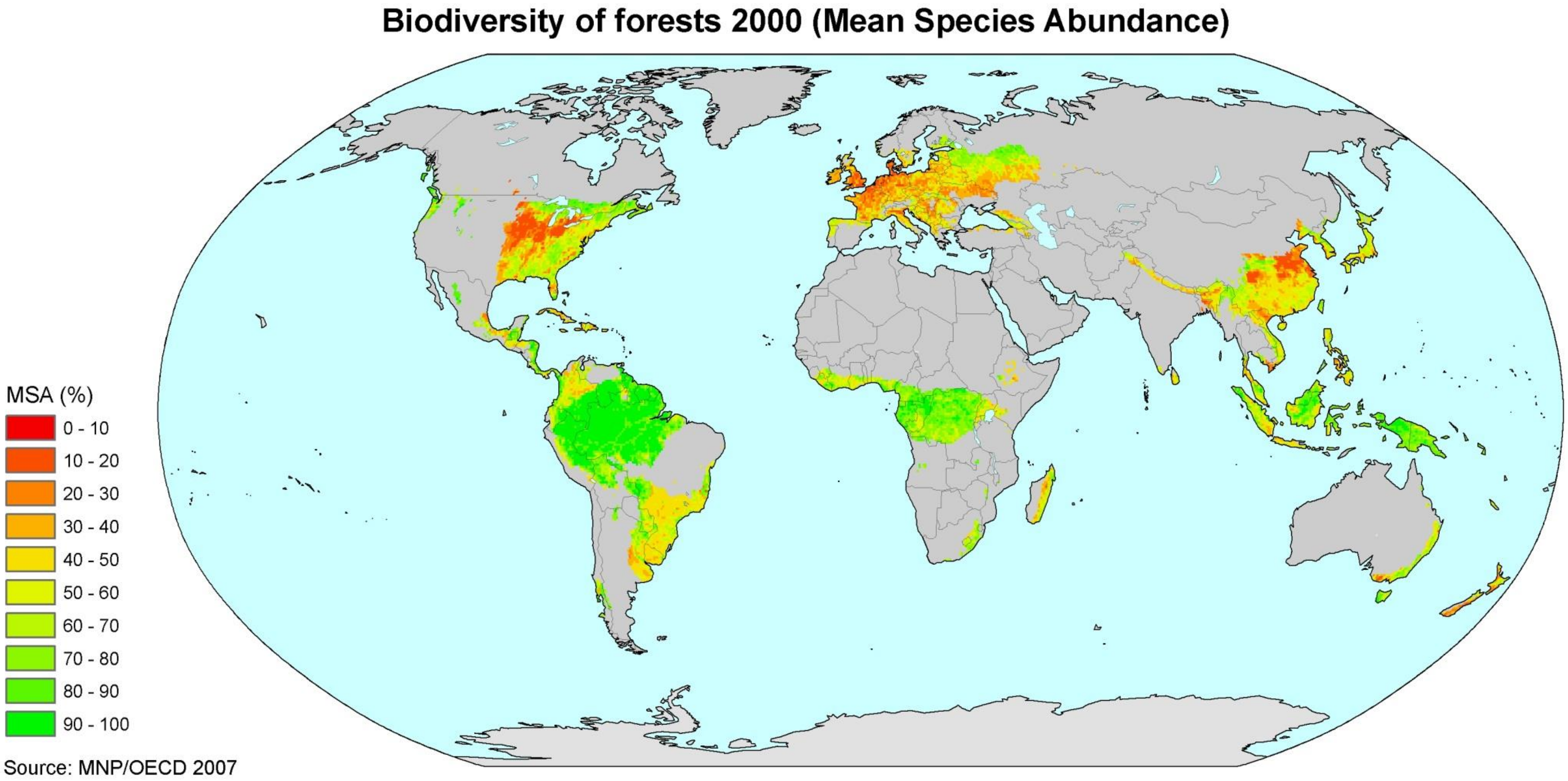
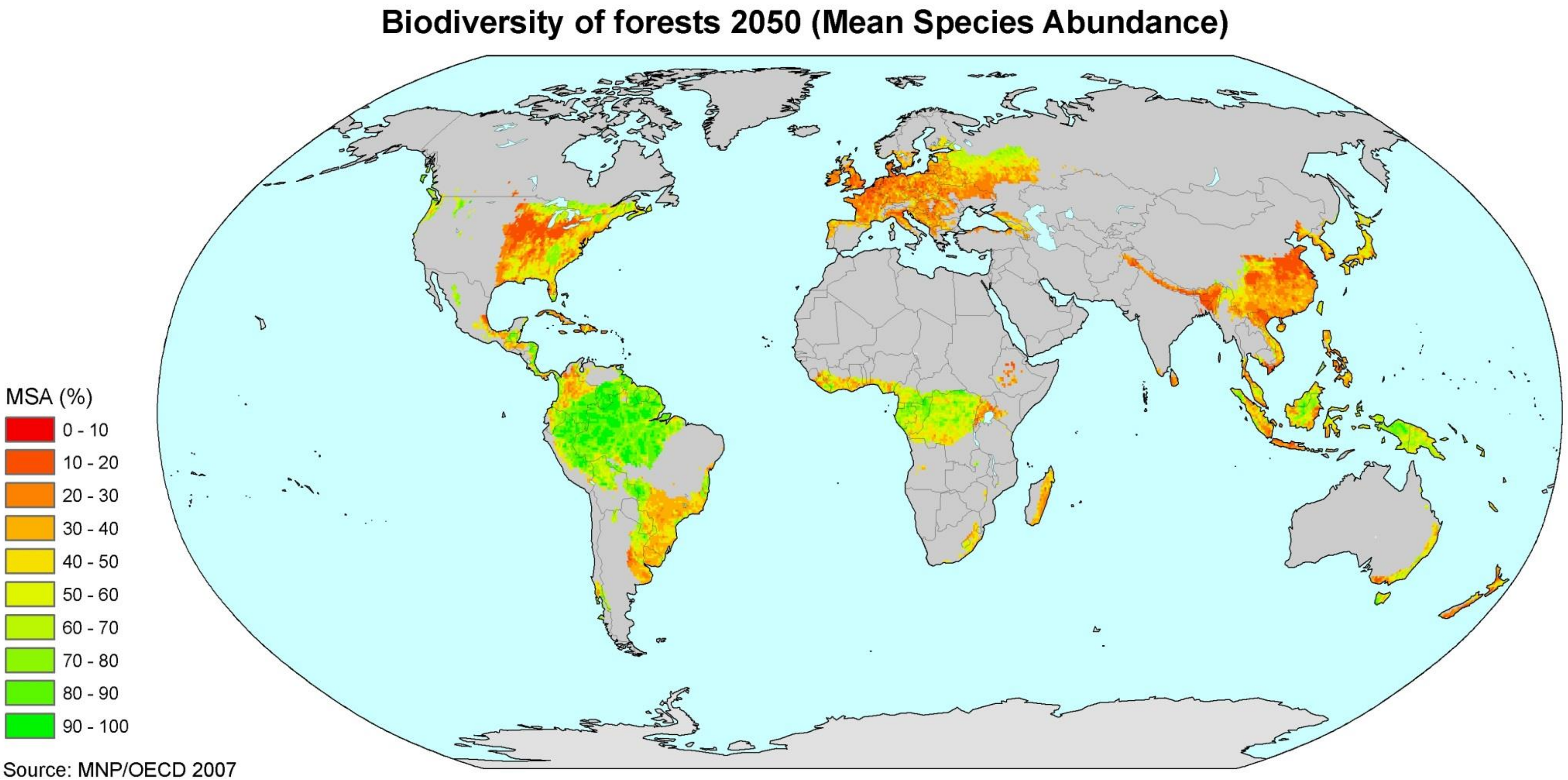
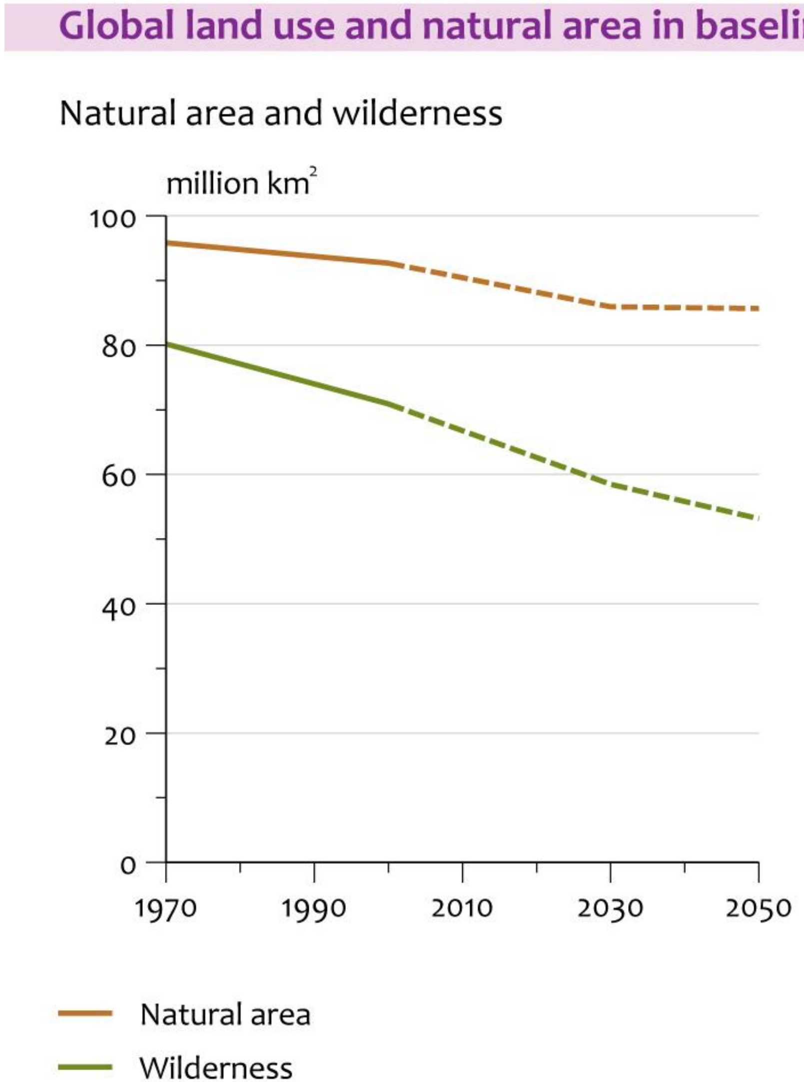


Zooming in:

Temperate & tropical forests baseline - 2050



Baseline: natural area & wilderness



(Earth total: 130 million km²

8 options

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1. Closing yield gap (production efficiency)
2. Reducing food chain losses
3. Diet: Less meat (healthy, none)
4. Climate mitigation & biofuels (max + 2°C)
5. Improving forest management (wood plantations + RIL)
6. Reduced deforestation
7. Expanding protected areas (20%-50% per biome)
8. Restoring marine fish stocks & aquaculture

+ Option combination (ambitious but feasible)

Effects in Prevented Loss (Pl
of baseline loss (10%)

Overview prevented loss per option (MSA, NA, wilderness)

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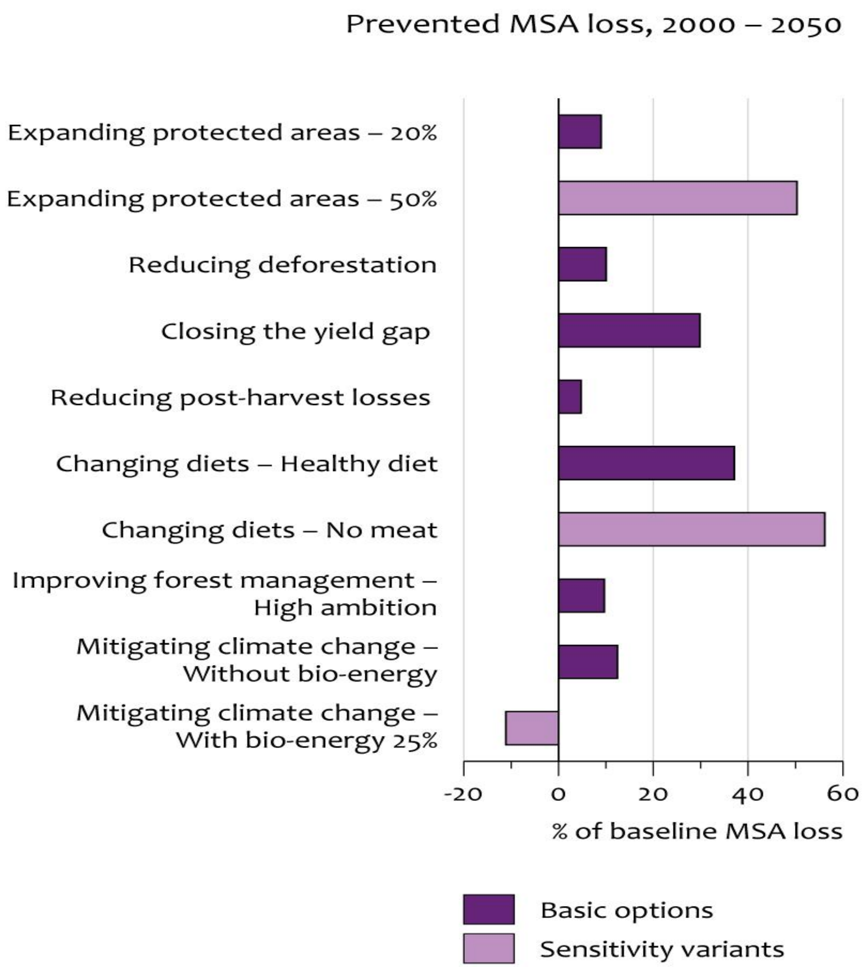
Change in global biodiversity per option compared to baseline scenario



Change in global biodiversity of options expanding protected areas and reducing deforestation by 2030

Option combination

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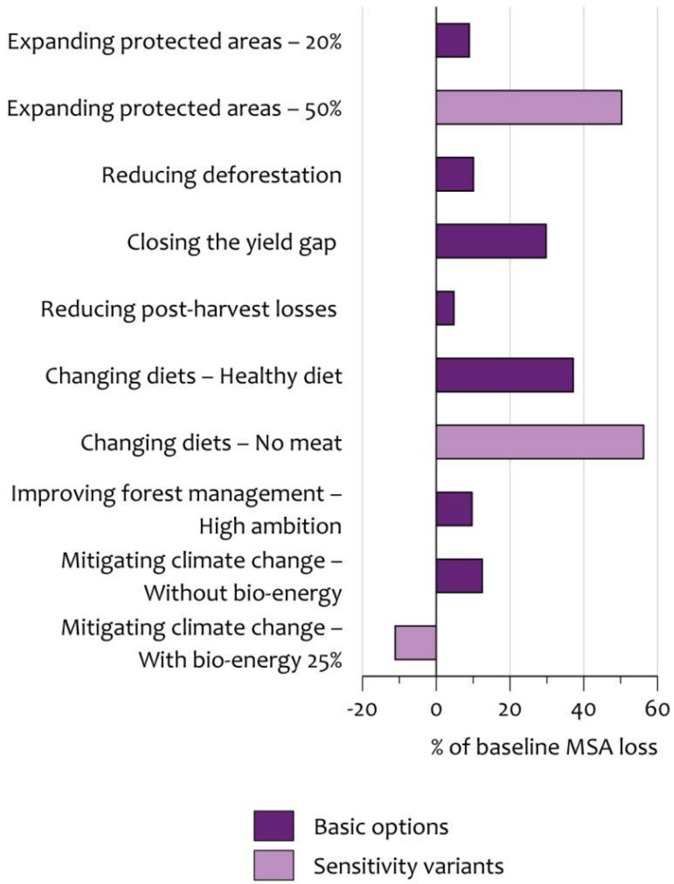
Change in global biodiversity per option compared to baseline scenario

Prevented MSA loss, 2000 – 2050



Options included in combination

Change in global biodiversity of options expanding protected areas and reducing deforestation by 2030

Option combination: halving the loss (MSA)

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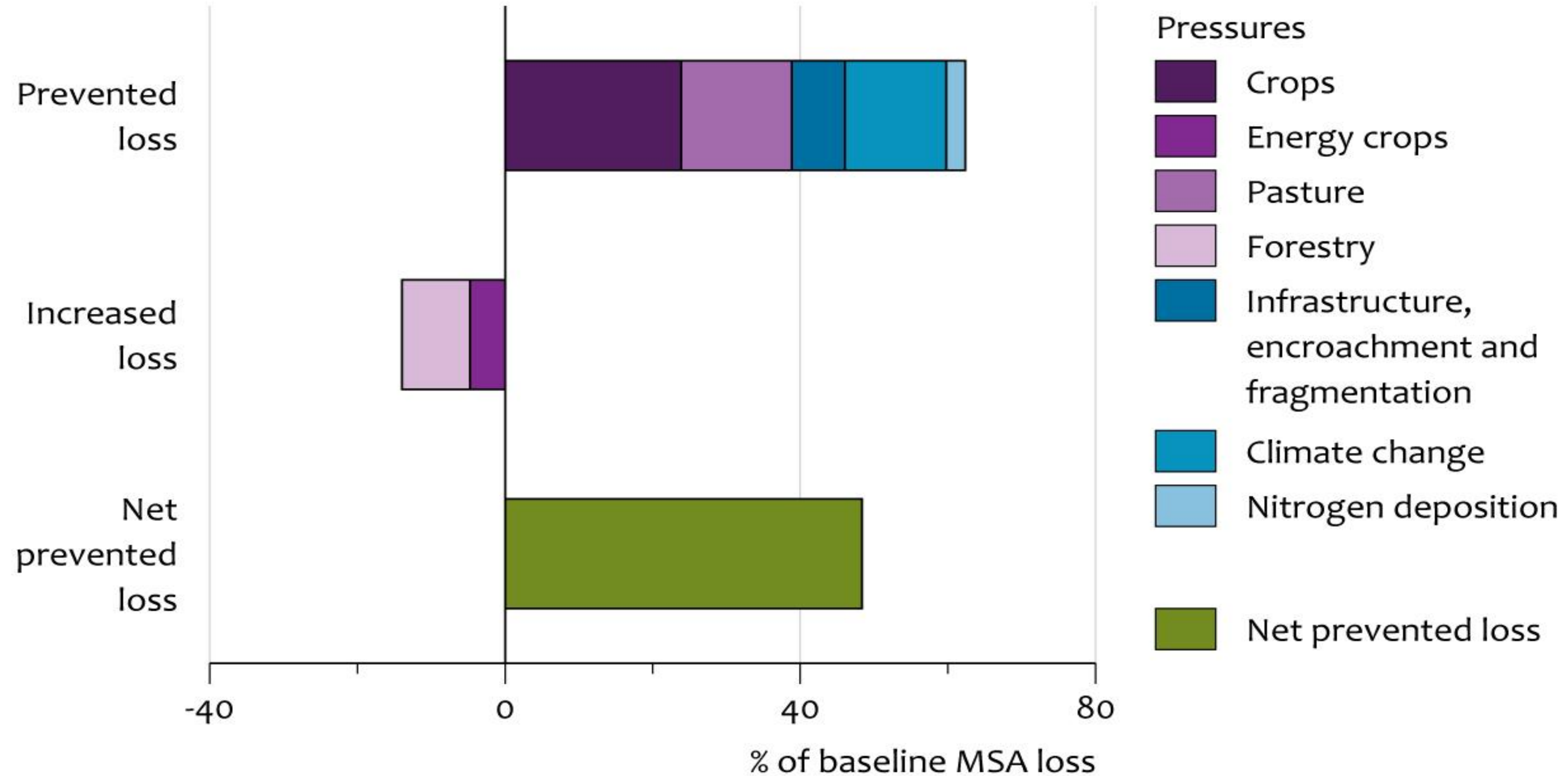
Prevented global MSA loss compared to baseline scenario, 2000 – 2050

Combination of options



Option combination: natural area and wilderness

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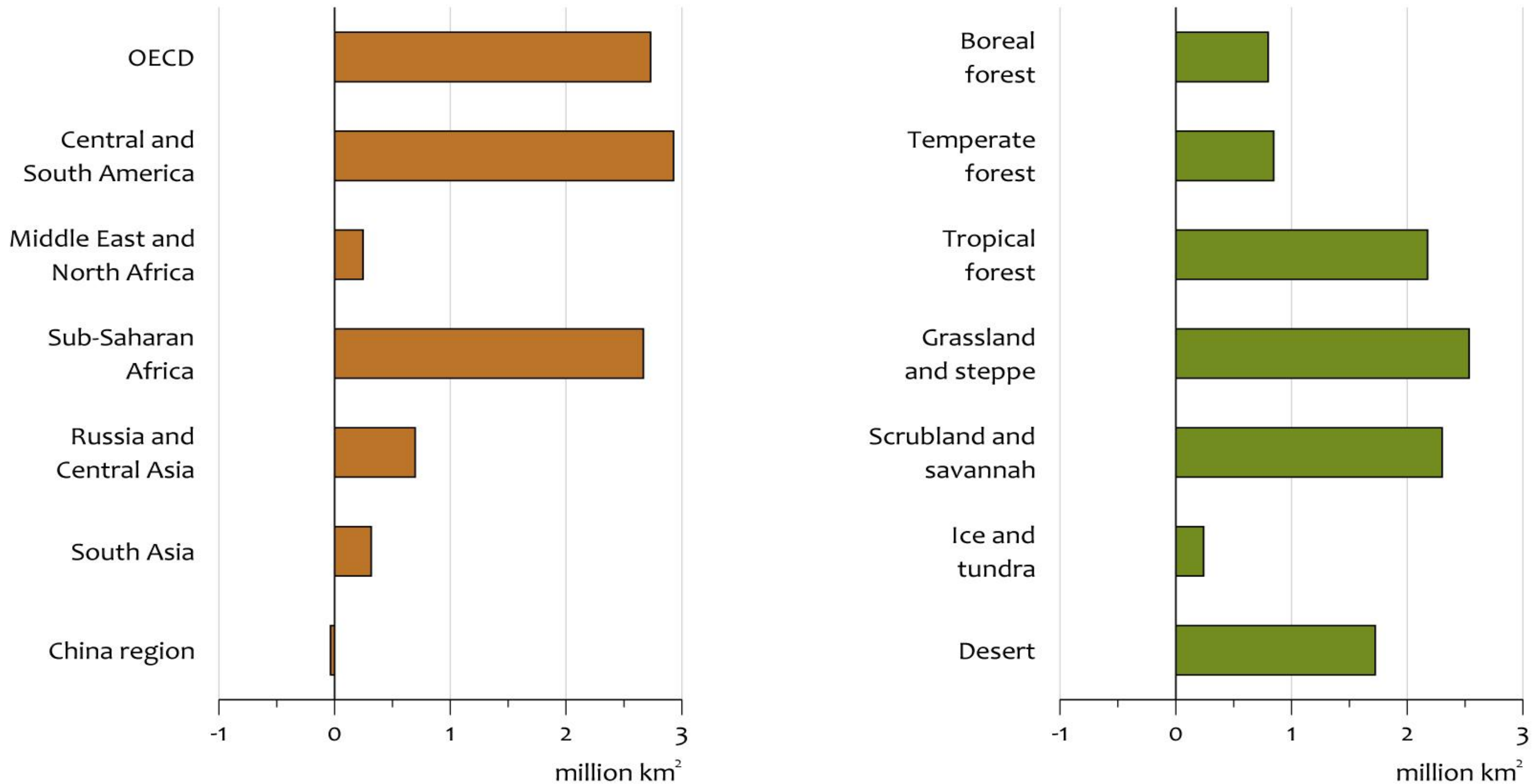
Change in natural area and wilderness compared to baseline scenario, 2050

Combination of options;
Natural area per region

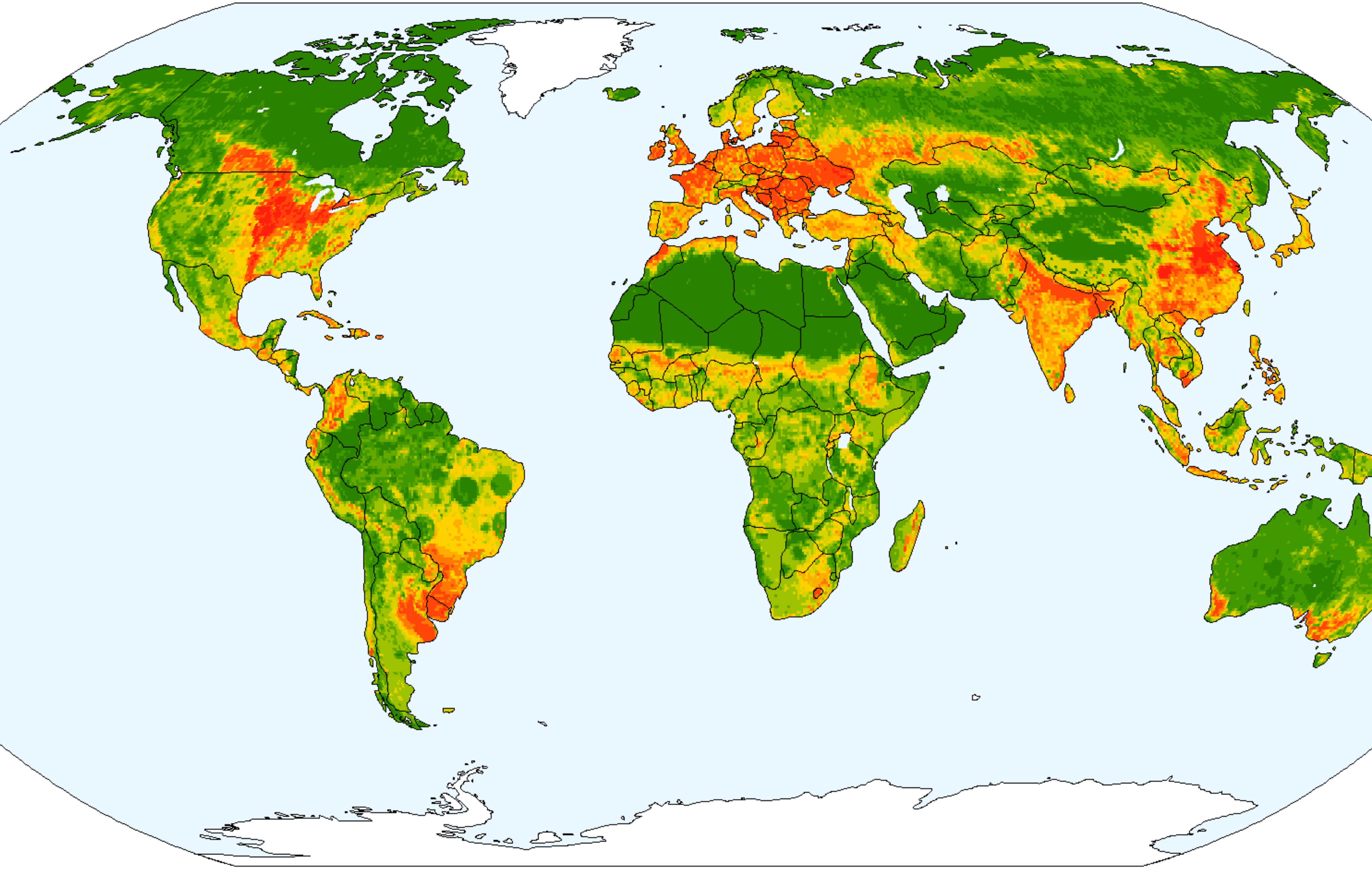
+ 10 mln km²

Combination of options;
Wilderness per biome

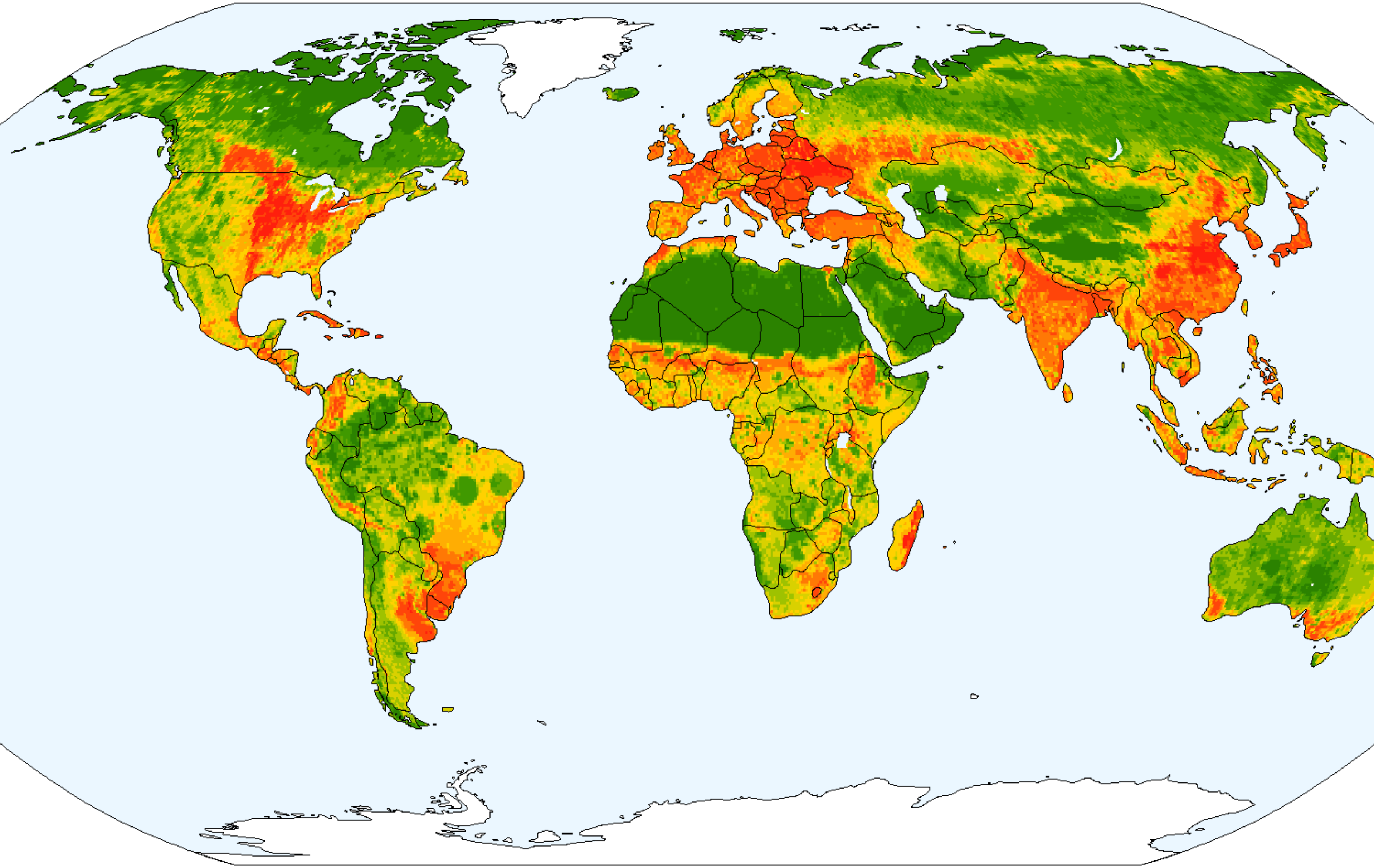
+ 11 mln km²



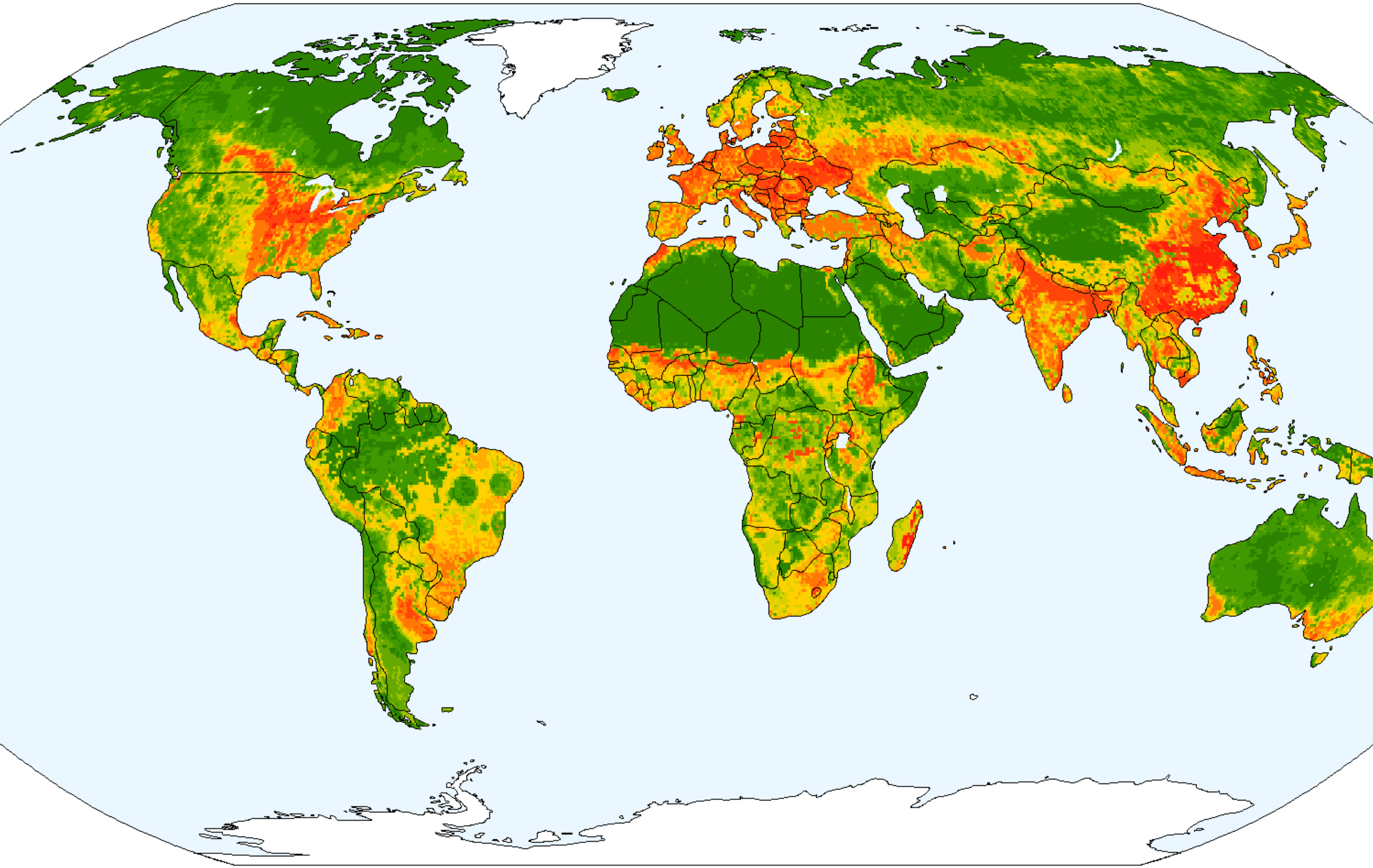
2010



2050 baseline

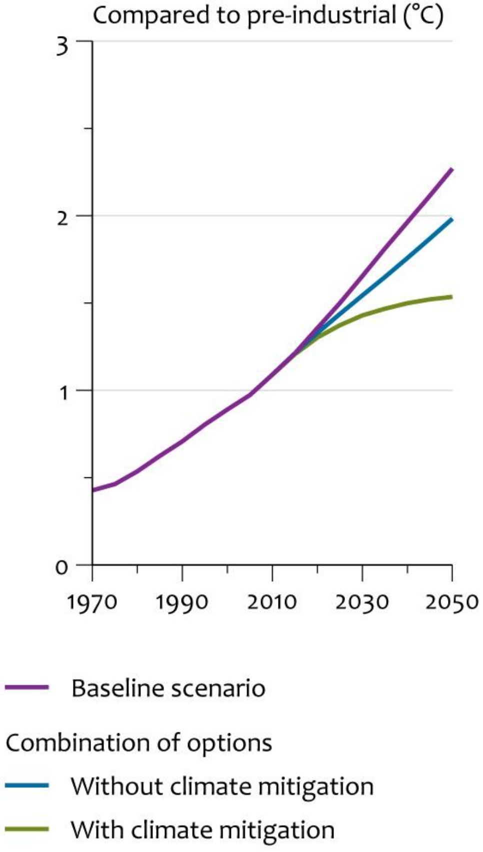


2050 option combination



Global greenhouse gas emissions, concentration and temperature change

Temperature change



Less conversion effect

Energy change effects

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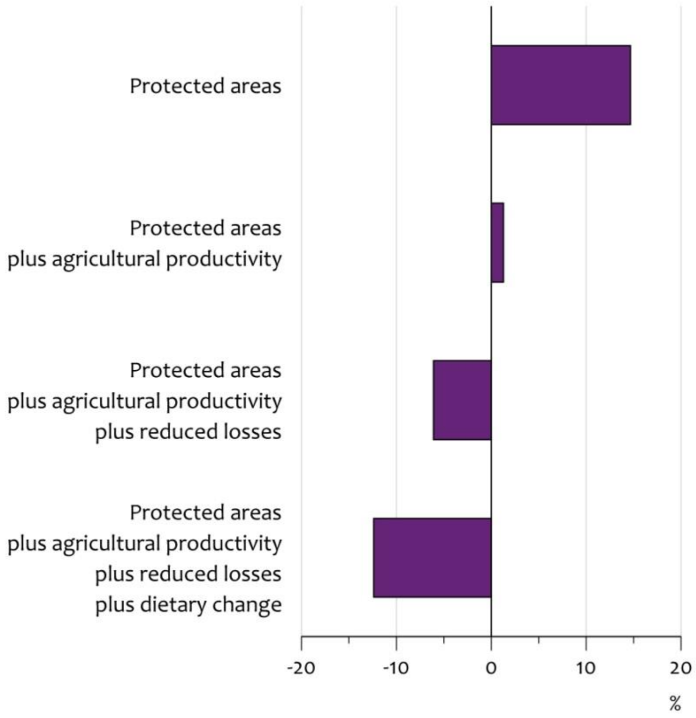
Assessment Agency

Change in land prices and food consumption compared to baseline scenario, 2030

Stepwise introduction of options;
Global land prices



Conclusions

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1. Ambitious option package can half loss by 2050, but not halt

2. Autonomous socio-economic growth is huge:
   - PA alone not sufficient to significantly reduce loss
   - Integrated sector-based approach required

3. Productivity increase is key (if not..)

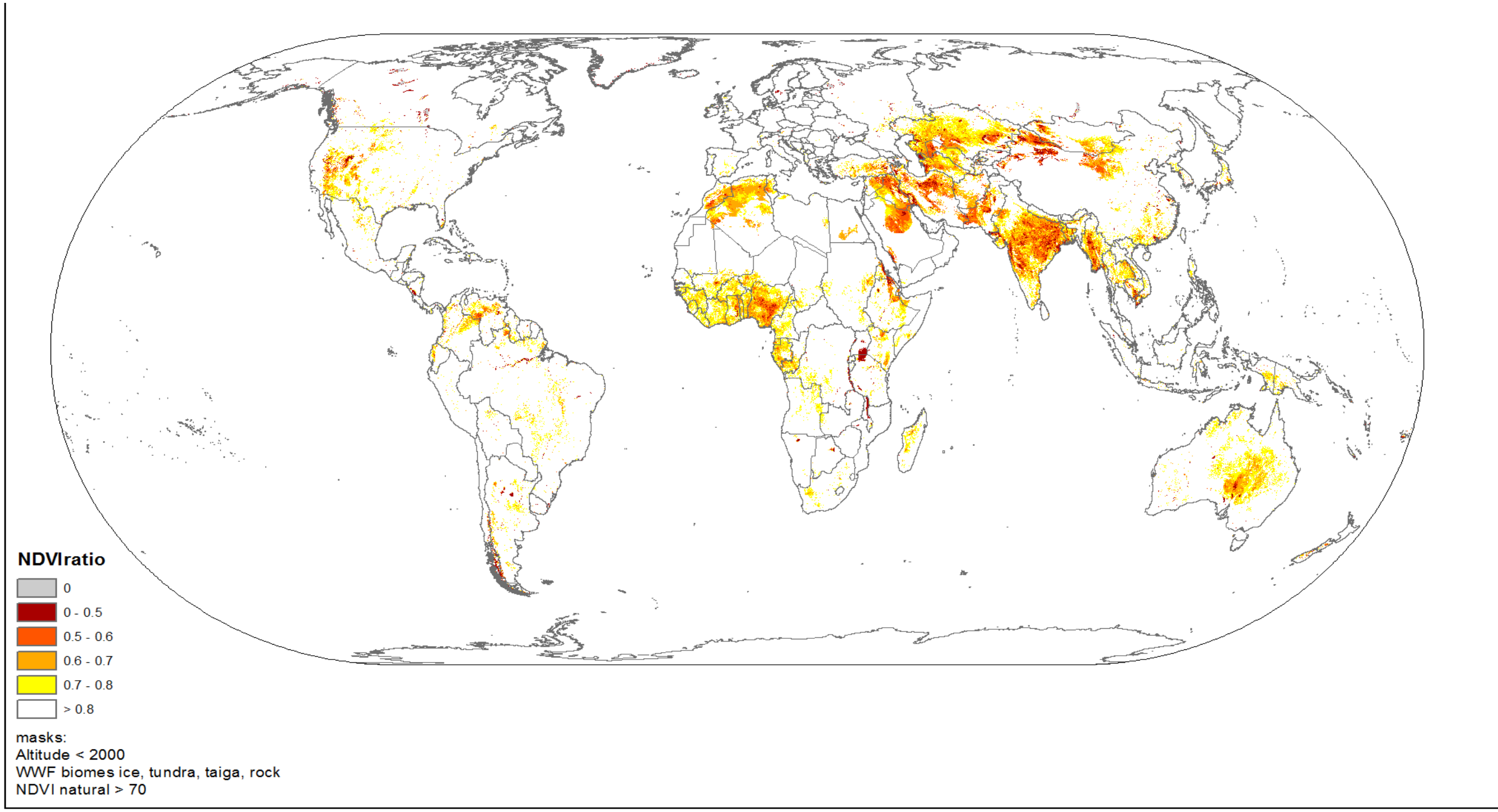
4. Combine land demanding with land relieving options (price effects)

   (PA, plantations, bio fuels, REDD) (productivity, reduce food loss, diet)

5. Align with climate change, MDGs, food & wood & energy policies

Greenness change Current/Potential method B

Masked Normalized Difference Vegetation Index (NDVI) ratio



Global biodiversity loss: natural area & wilderness

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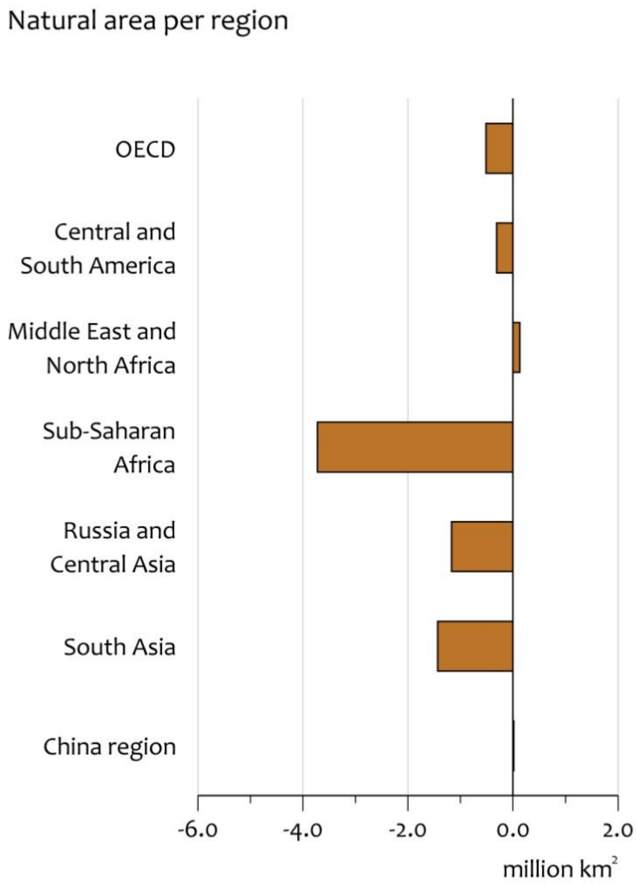
Change in natural area and wilderness in baseline scenario, 2000 – 2050



Biodiversity loss: per biome

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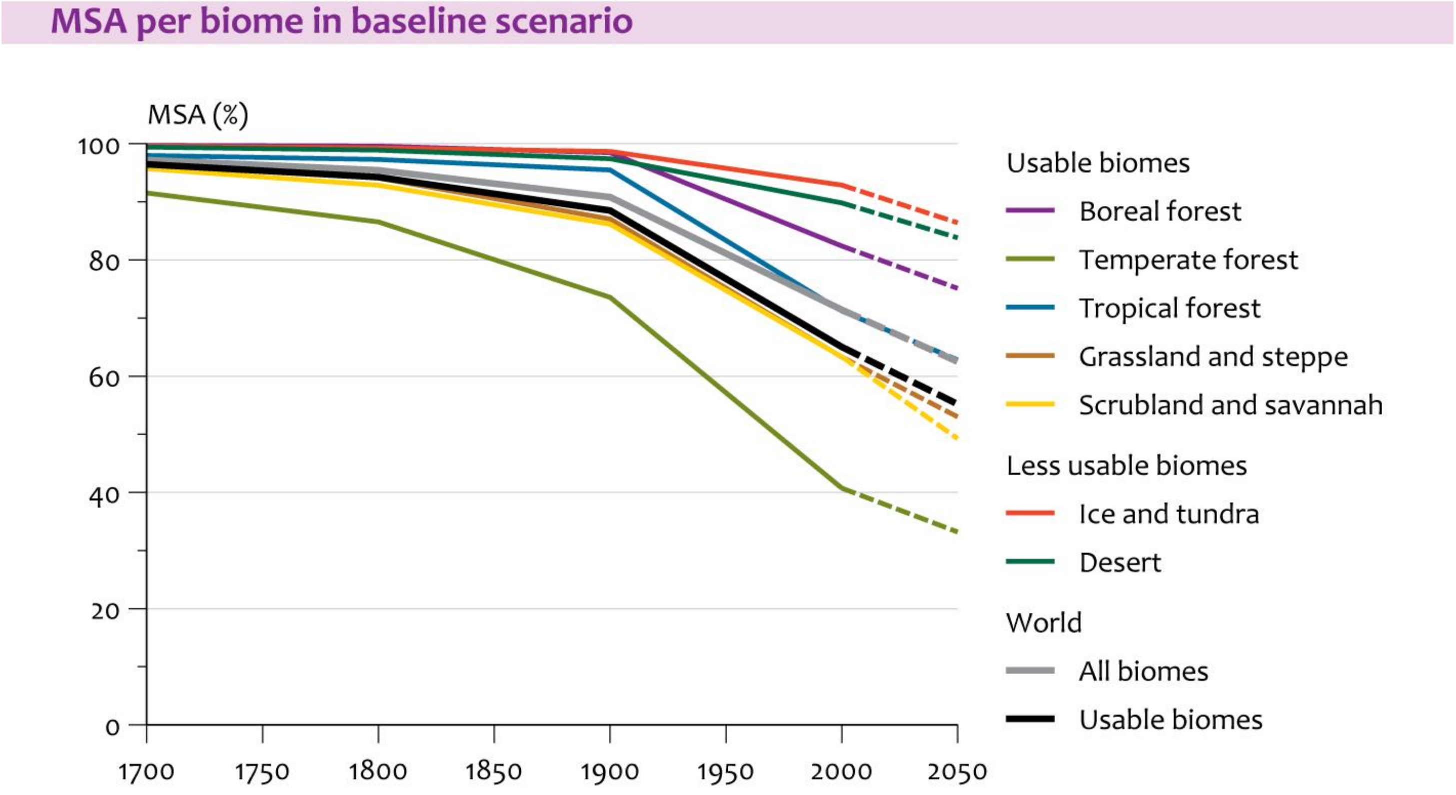

Biodiversity loss: per region

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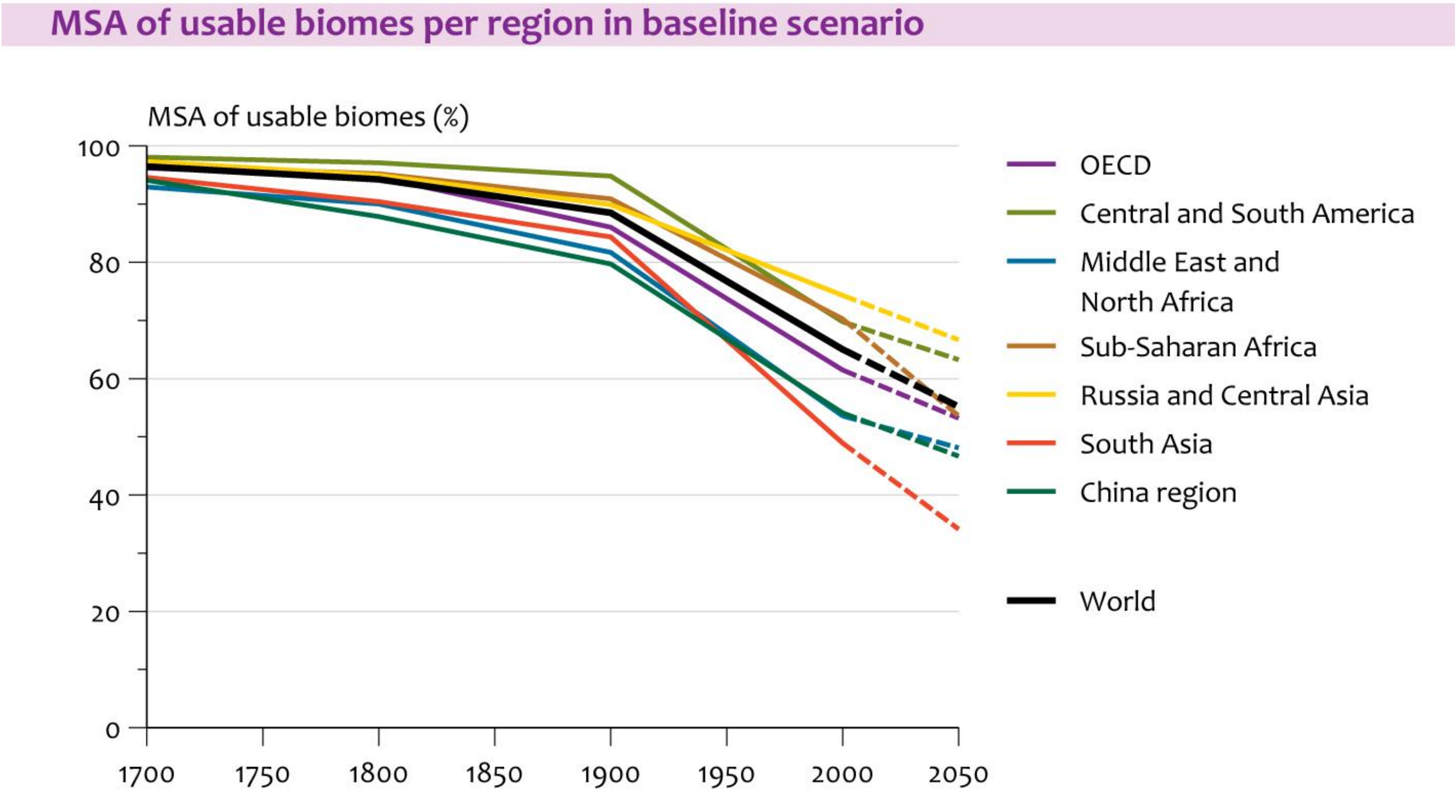

Yield gap for various staple foods, in baseline and option

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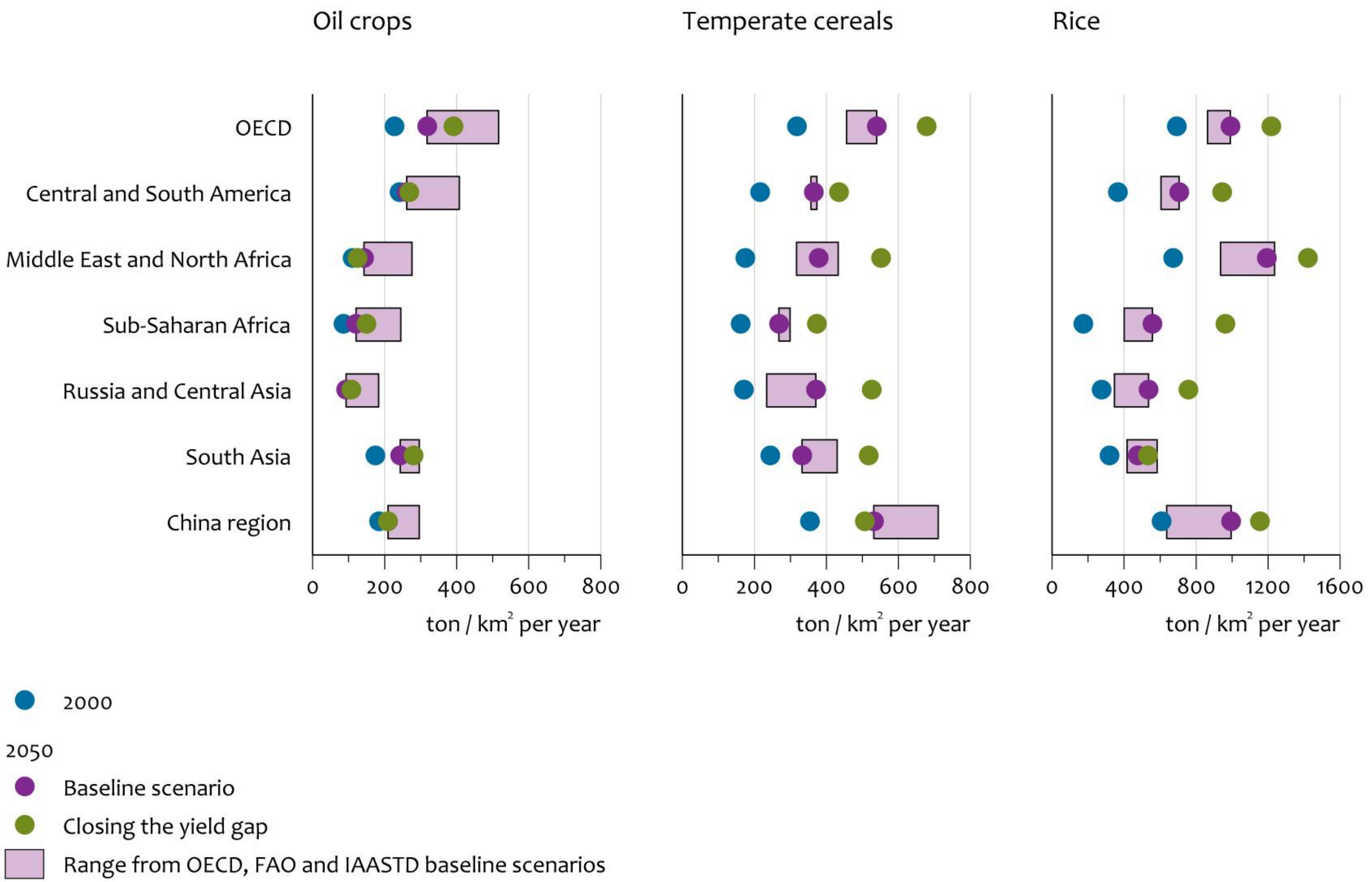
Regional yields



Timber and pulp demand over time

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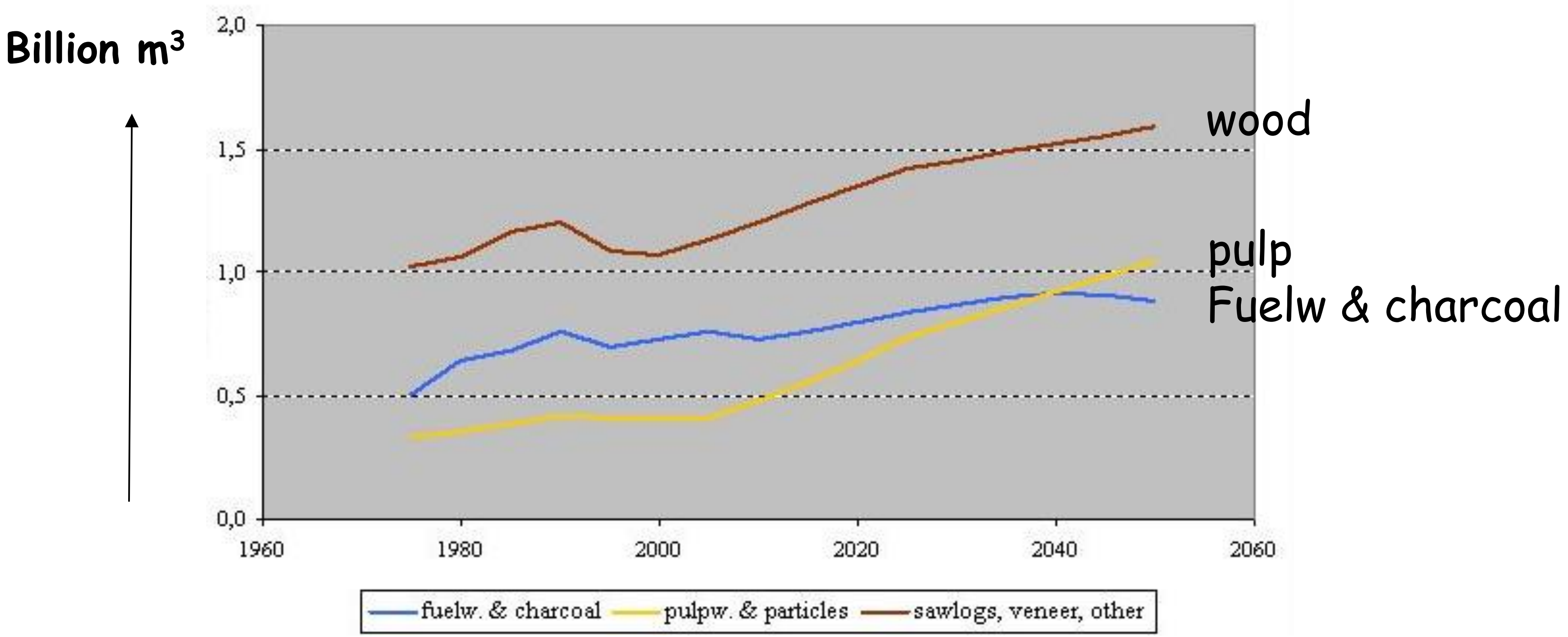
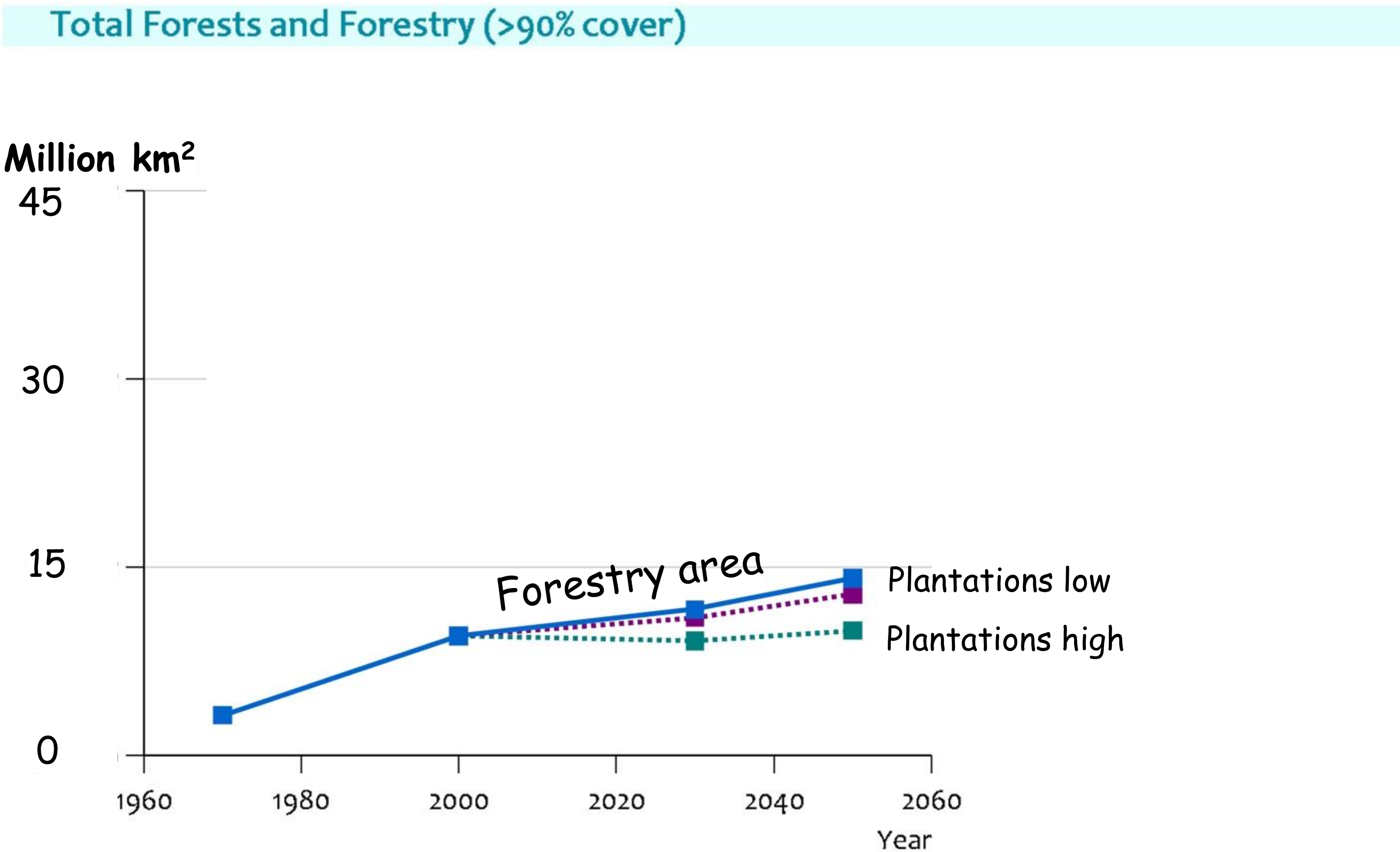
- Global wood demand increase from 2.5 -> 3.5 billion m^3/yr



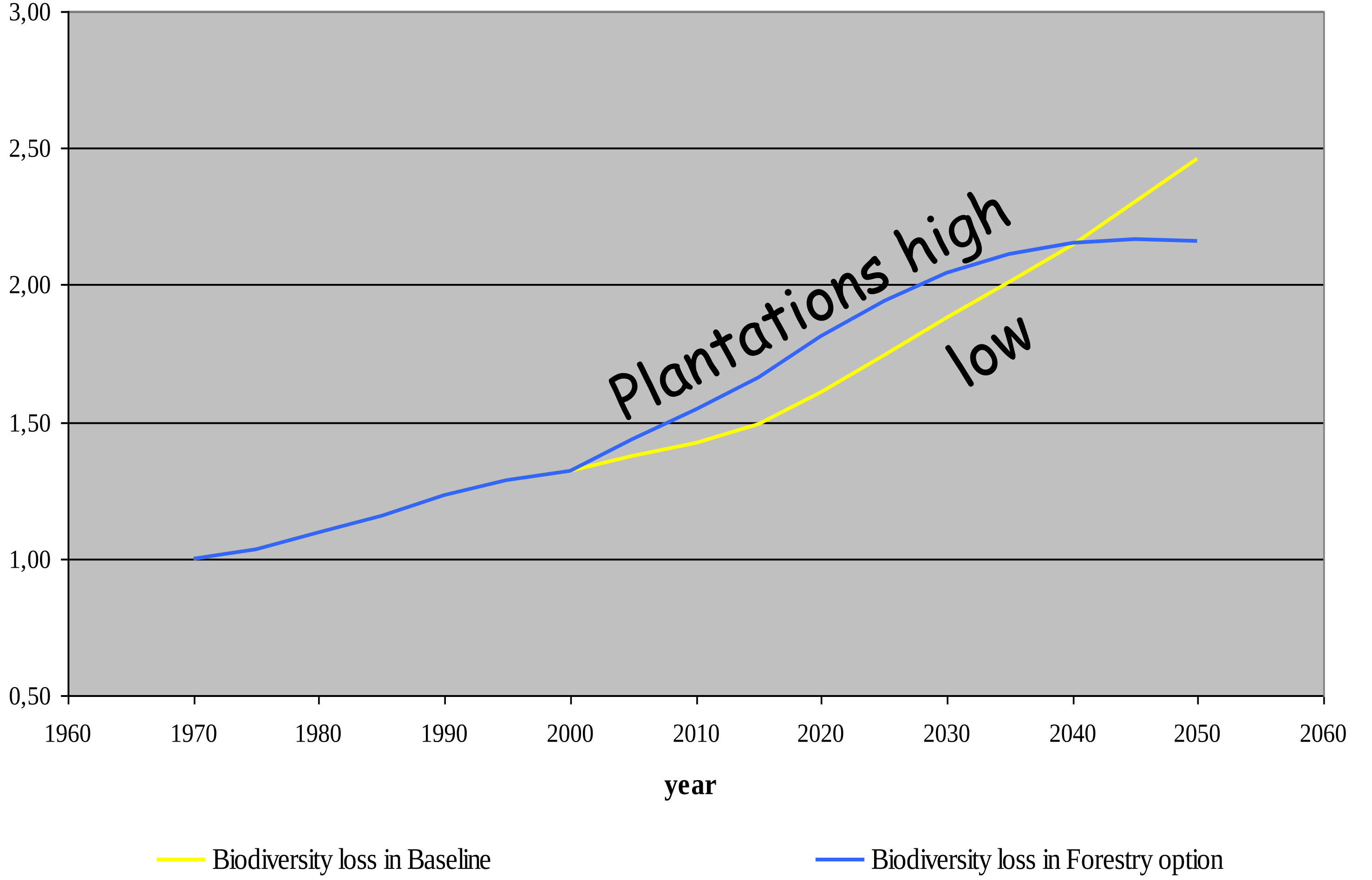
Plantations produce 40% demand by 2050 + RIL



Grafieknummer: VIB-Option 4 SFM Forest-areas
Datum: 09-apr-2010

Concept

Biodiversity loss (msa)



High biodiversity footprint

Zooming in

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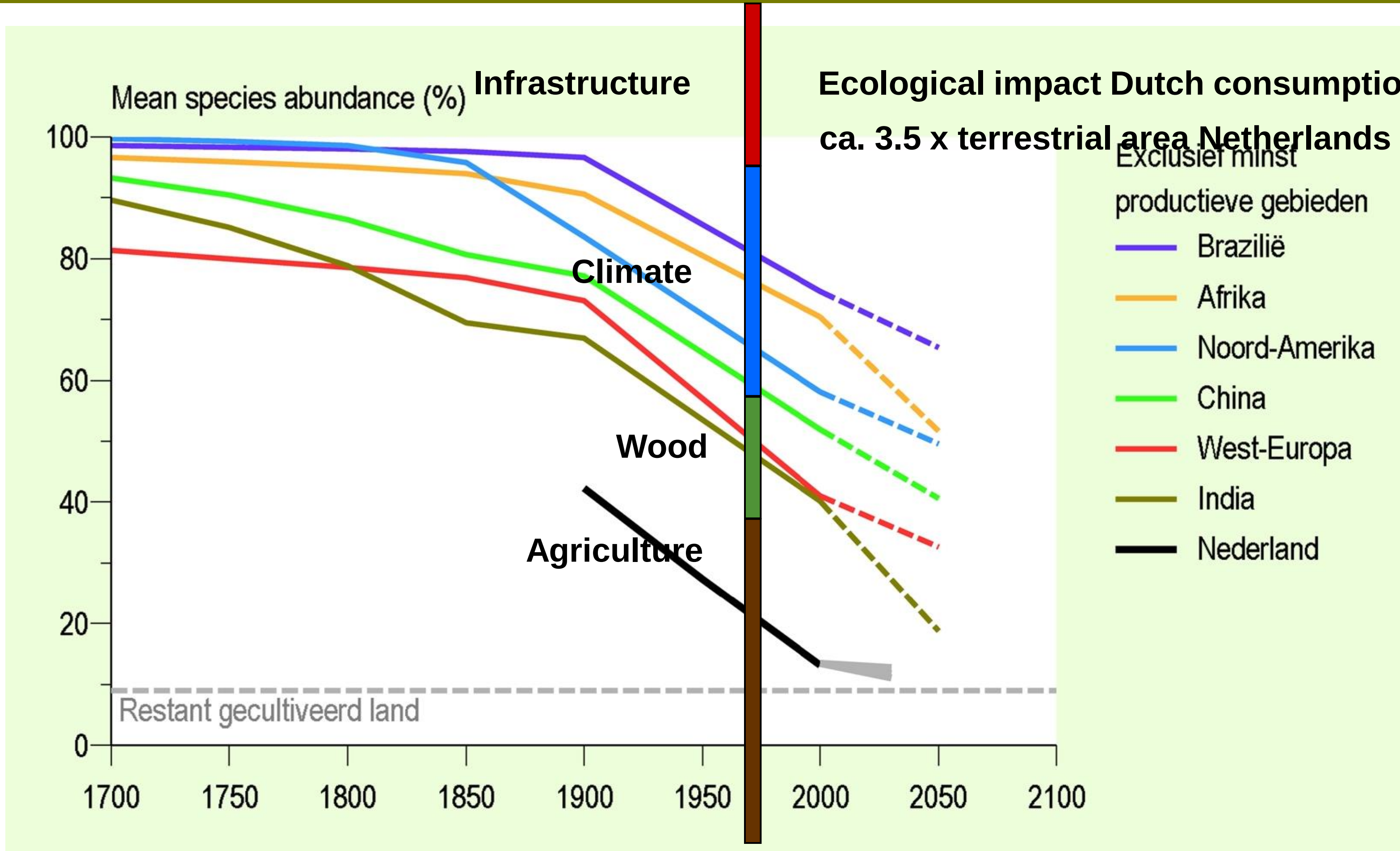

Conclusions

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1. Ambitious but feasible option package can half the rate of loss by 2050
2. But not halt the loss

3. Sector-based policies far more effective then PA alone
4. Directly effective: diet change, closing yield gap, PA, RIL and lowering catch
5. Long term effective: forest plantations
6. Biofuels & unguided trade liberalisation would lead to net loss

7. Options in multiple sectors behave in cumulative way
8. Options in one sector behave in a multiplicative way (½ x ½ = ¼)

9. Efficiency increase is key
10. Combine land demanding with land relieving options (price effects)
11. Climate policies beneficial, without biofuels
12. Align with climate change, MDGs, food & wood & energy policies

Towards a smart option-package

1. Technical high ambitious potential
2. Policy oriented package (survey)

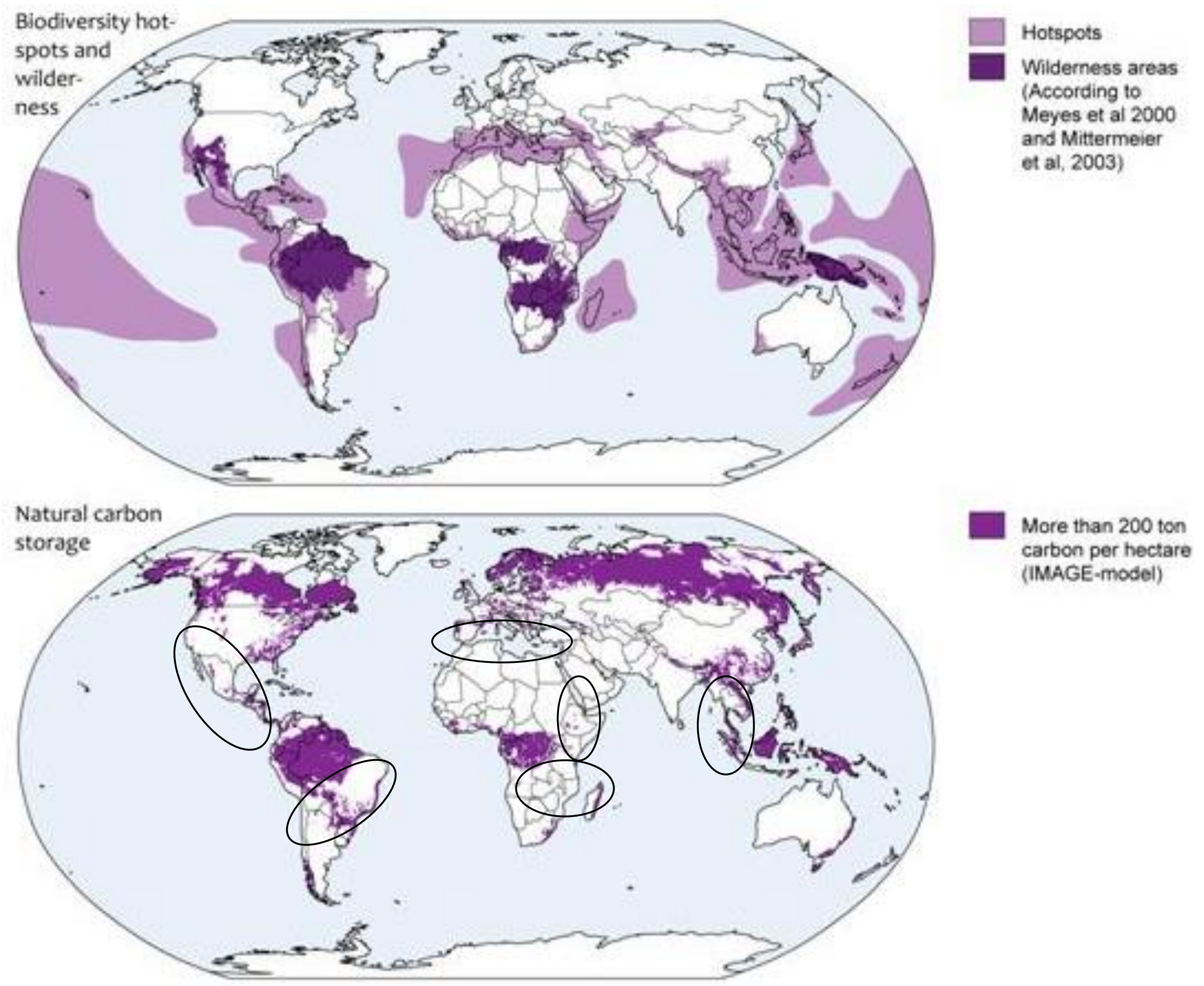
*
under development

Combine:

- Carbon-rich area protection (forest, grassland and peat)
- with biofuels on degraded grounds plus waste utilization
- with protection of EGS in brittle ecosystems (sub-humid and mineral soils)
- with effective protection of 25% per eco-region incl. biodiv hot spots
- with eco-efficient production increase in agriculture & forestry & aquaculture in current under performing production systems
- as a means to alleviate poverty
- With micro-finance, capacity building, law and law inforcement, technology transfer, better redistribution of food, ……
- strong efficiency increas in energy and water use
- temporary reduction of fisheries
- guided trade libealization
- taxation on land conversion and meat
- Fair distribution of cost and benefits of global public goods (biodiv) by GDM
- Introduction of healthy diet consumpion patterns
- …….

REDD: limited match with hot spots

PBL Netherlands Environmental Assessment Agency



Causes and what can we do about it?
Competing claims

PBL Netherlands Environmental
Assessment Agency

Potential losses from growing demand of commodities

Growing habitat loss from:
- food, feed, forestry plantations, bio-fuel,
- Carbon plantation, built up area

Growing quality loss from
- climate change, eutrophication,
- exploiting fish and wood in natural ecosystems
- ongoing land degradation

Options

Baseline BAU future development

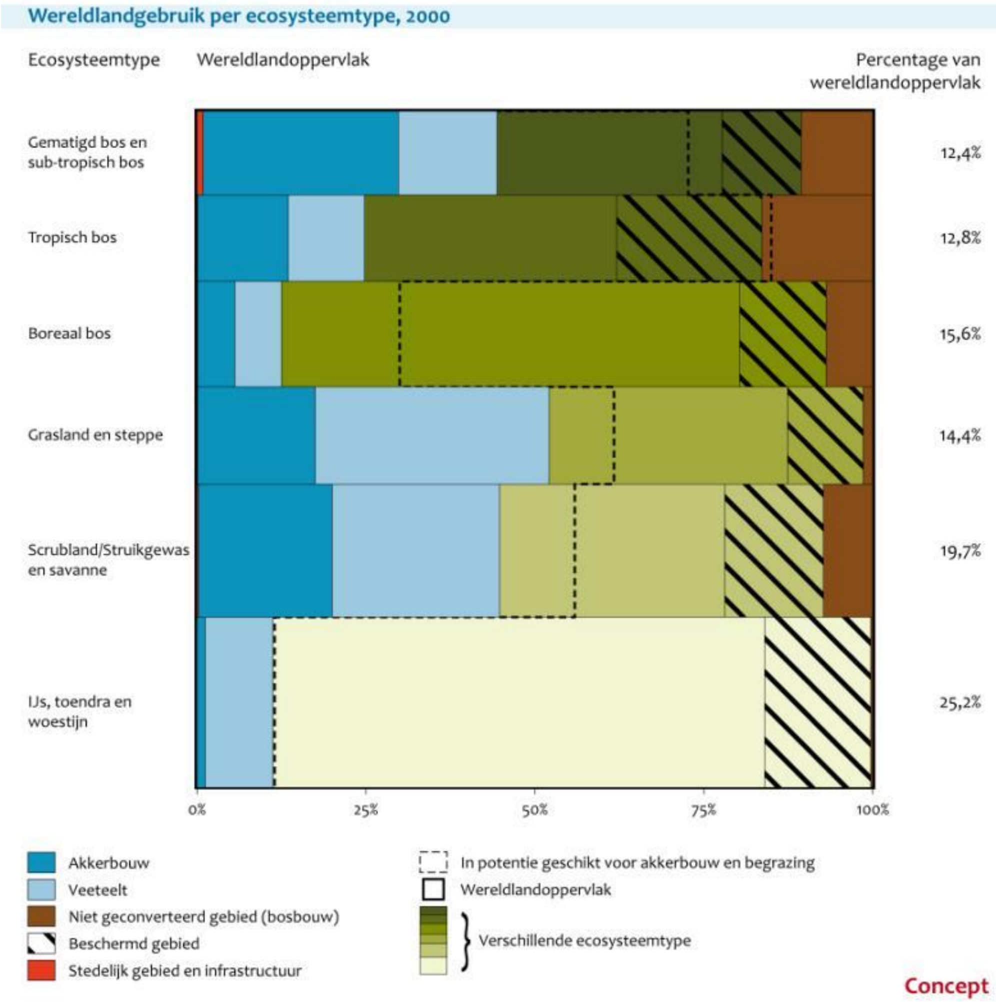
1. Food production efficiency
    1. higher increase than BAU scenario
    2. Failure to increase future yields as in BAU scenario
2. Reducing post-harvest loss
3. Diet change
    1. Reduction in meat consumption
    2. Increase in meat consumption
4. Timber production efficiency
    1. Efficiency increase through forest plantation
    2. No forest plantation
5. REDD protect high-carbon forest areas & reduced impact techniques
6. Climate objective in alternative 450 ppm scenarios
    1. by 2nd generation bio fuels
    2. by food crops
7. Expansion of protected areas incl. substitution effects outside PAs

Additional:

1. Liberalization of trade in agricultural products
2. Aquaculture replacing partly marine capture fisheries (needs UBC)

Land use in 2000 arable land + extensive grazing + forestry

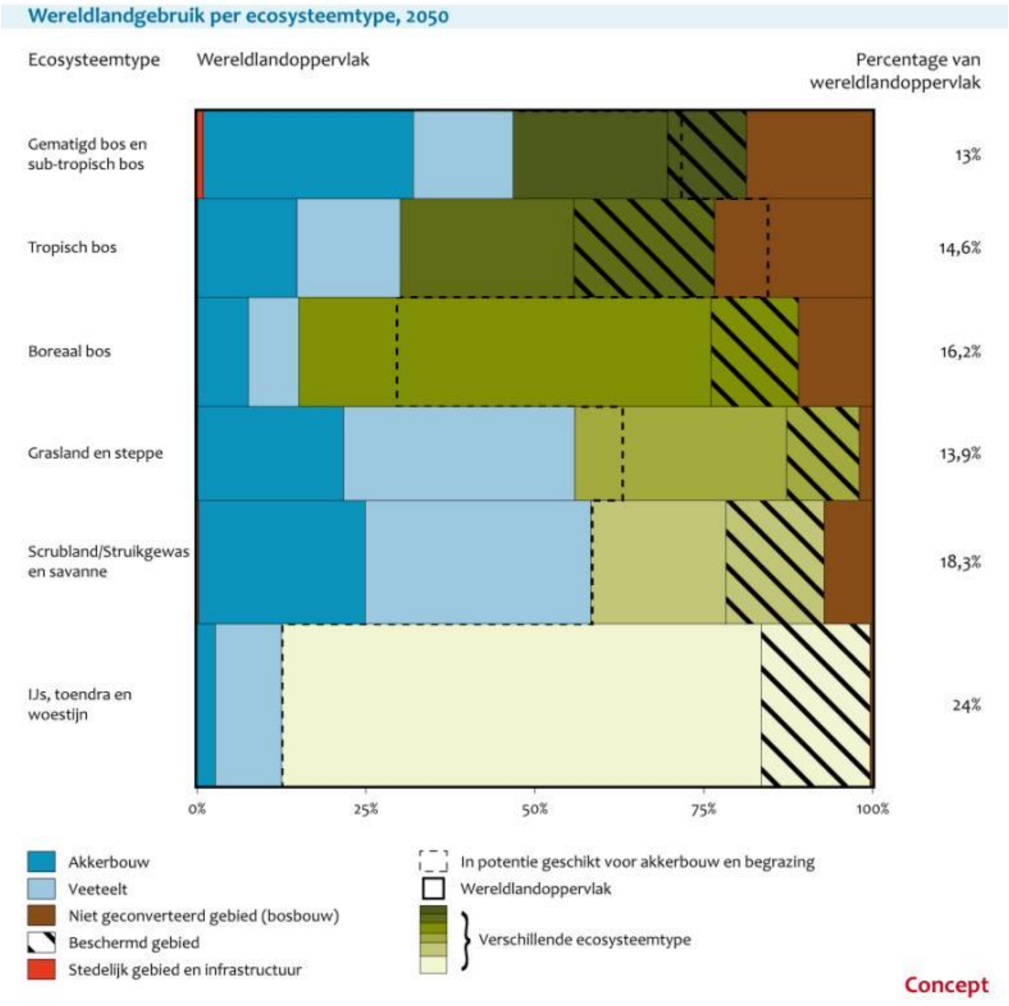
Netherlands Environmental Assessment Agency



+ 10% protected area per biome

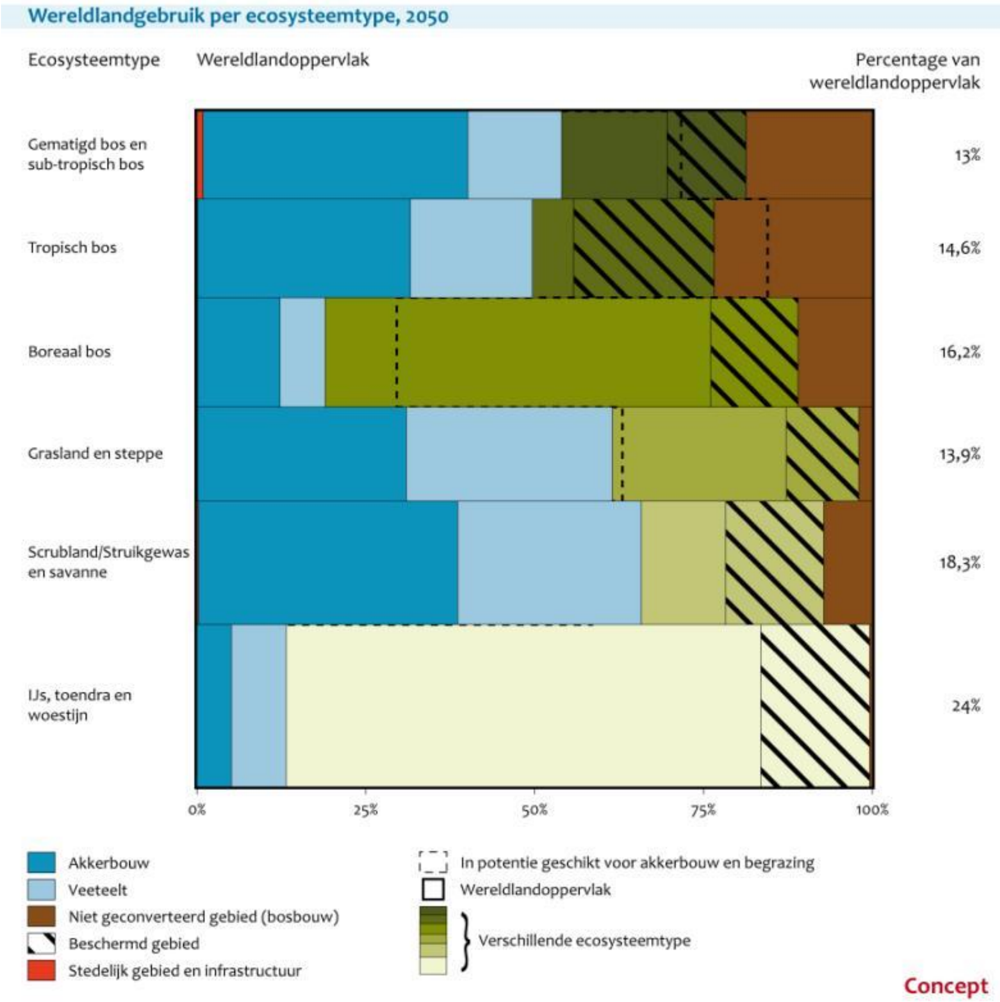
Land use in 2050 arable land + extensive grazing + forestry

Netherlands Environmental Assessment Agency



1.8 x Δ production

Land use in 2050 (arable land + extensive grazing + forestry)



In million km²

Failure: additional agriculture

forestry

biofuel 5

C plantation

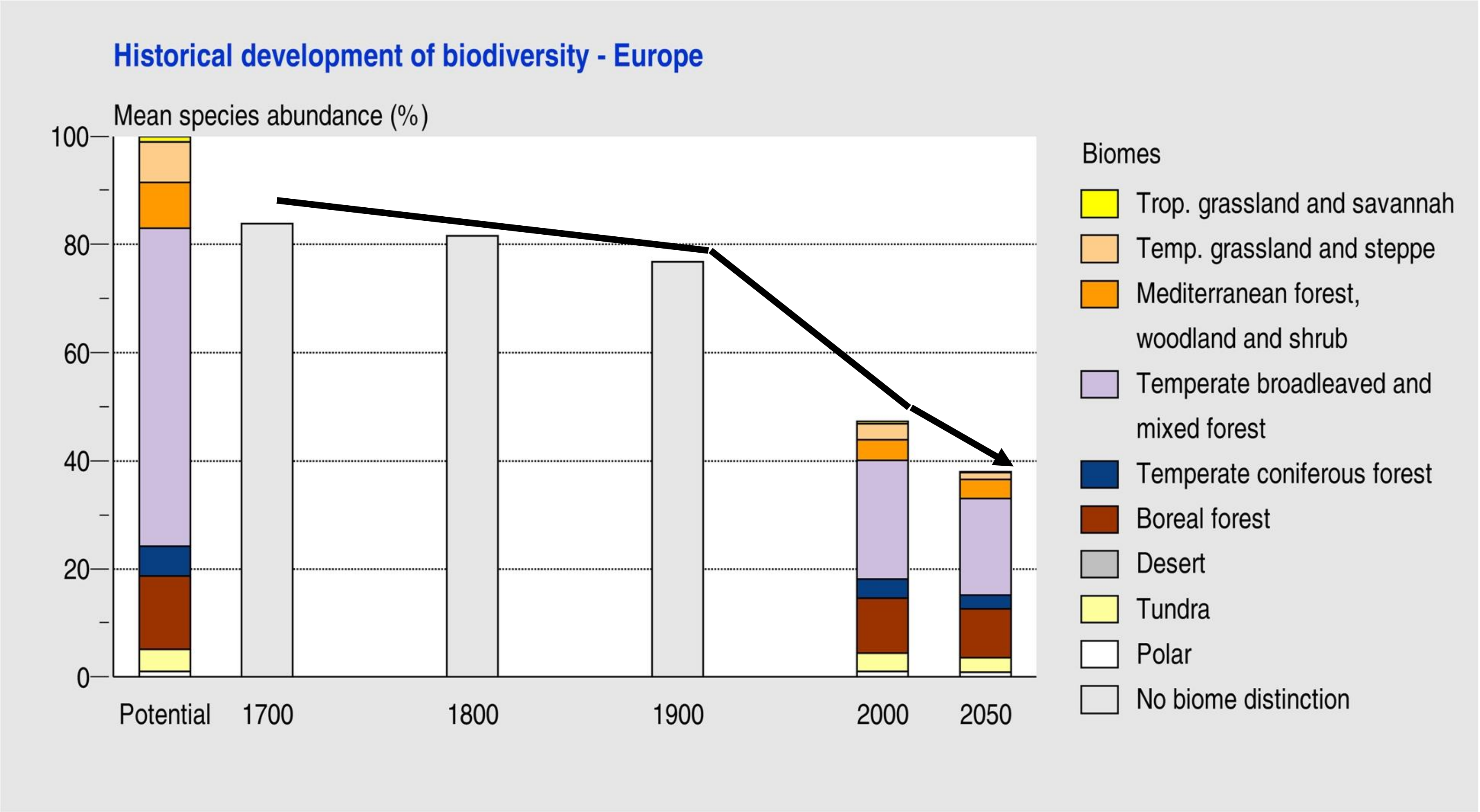
Degradati 4-8

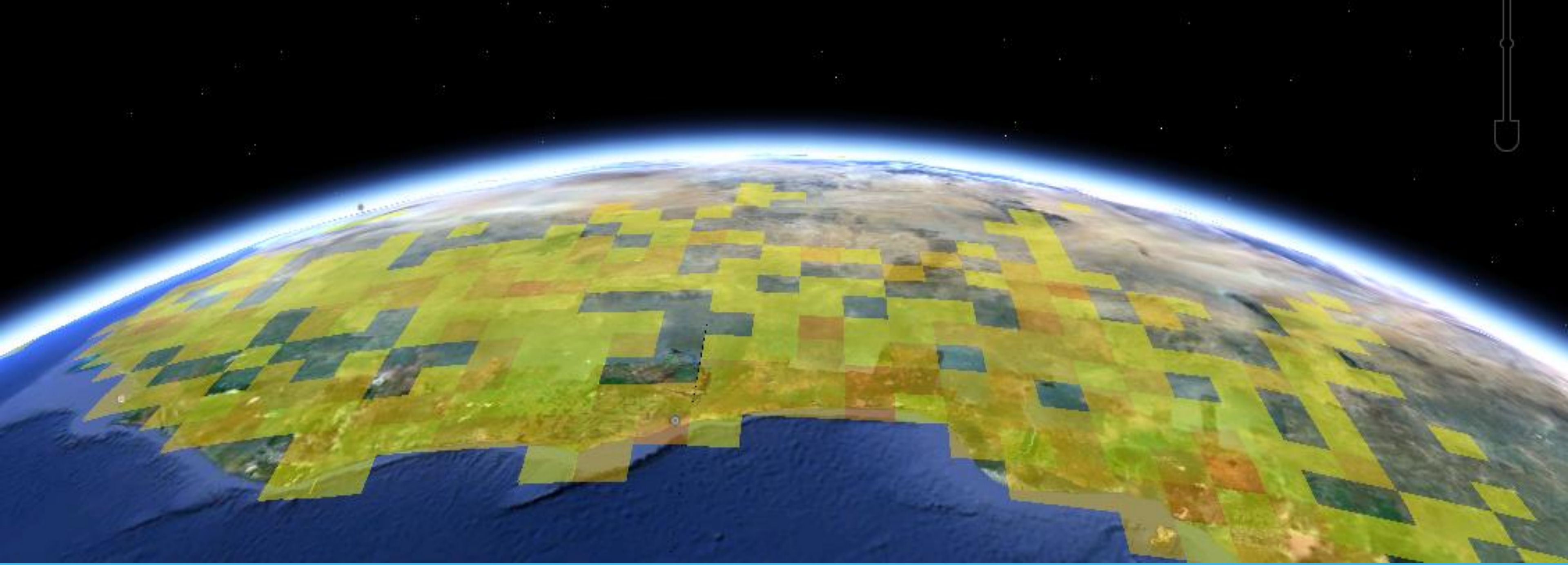
Abandonm

Zooming in:

Europe

PBL Netherlands Environmental Assessment Agency





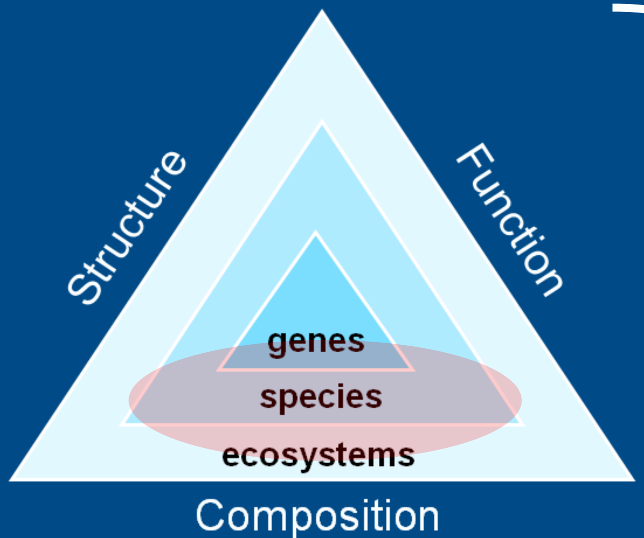
Using models of biodiversity as policy support tools to anticipate, avoid and manage impacts of global environmental change

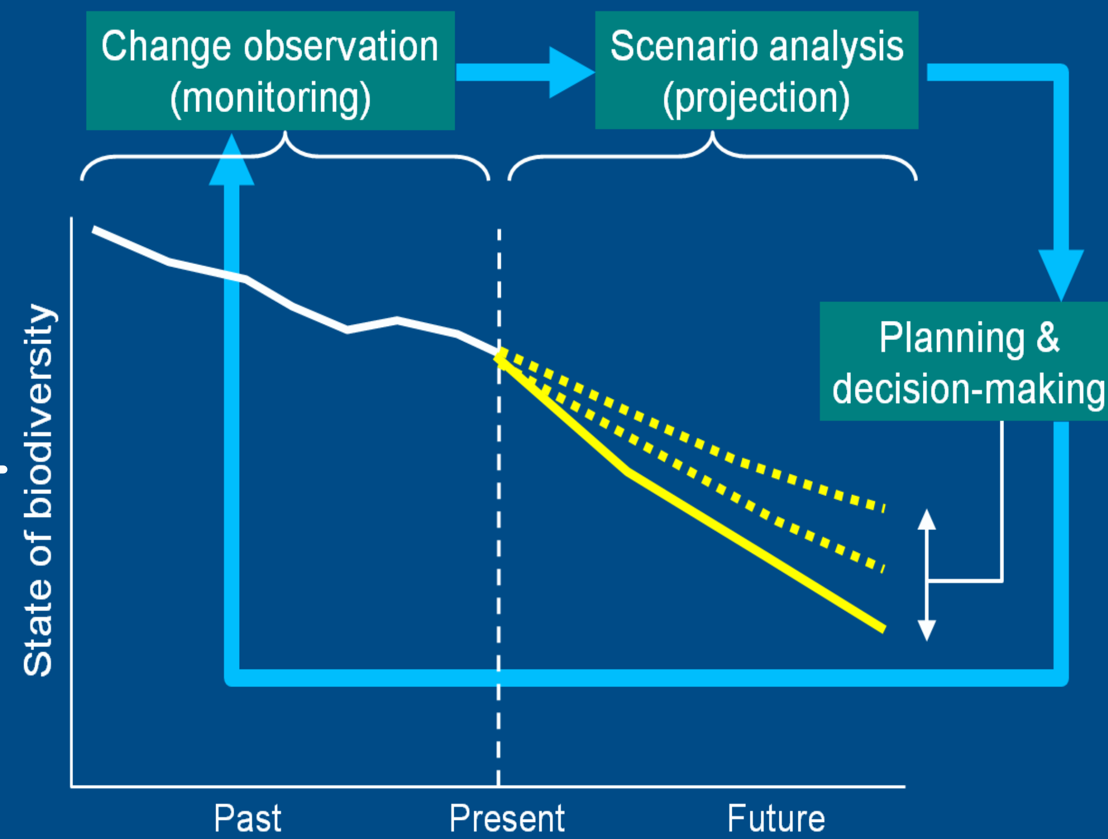
Simon Ferrier, CSIRO Ecosystem Sciences

Belmont Forum Scoping Workshop on Biodiversity & Ecosystem Services
21 October 2013

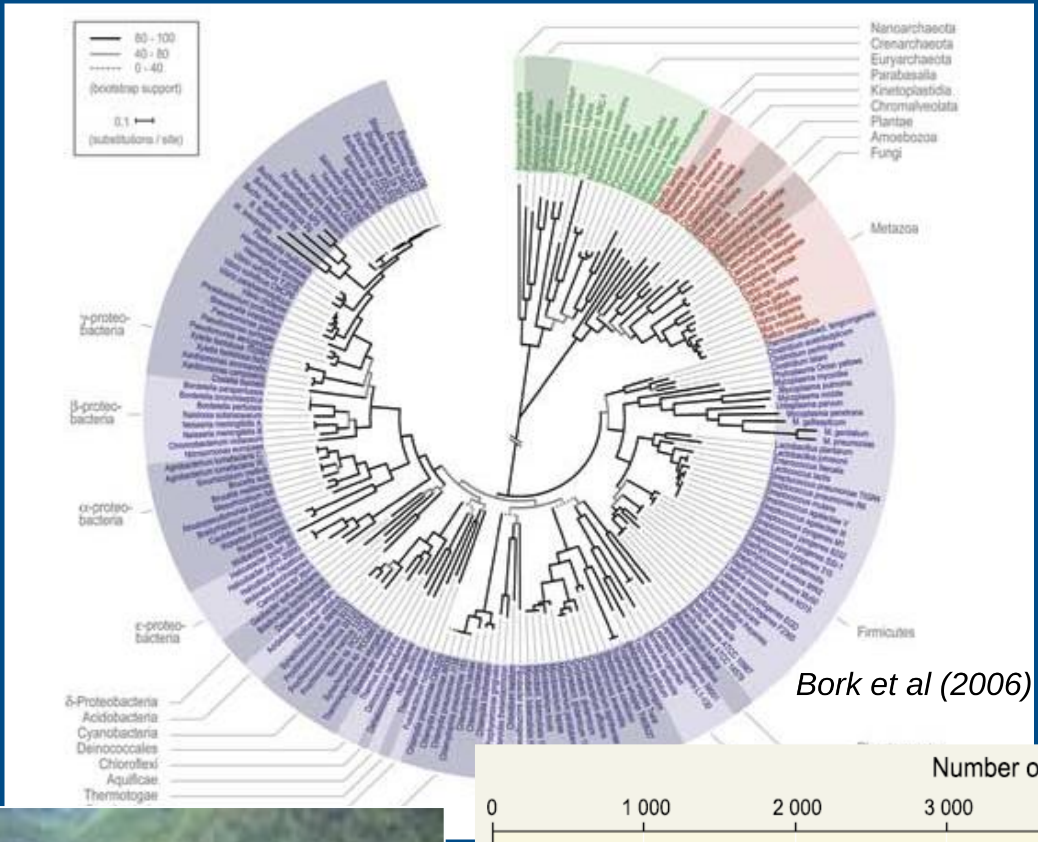
BELMONT FORUM

Models inform multiple scales & modes of assessment addressing multiple dimensions & levels of biodiversity

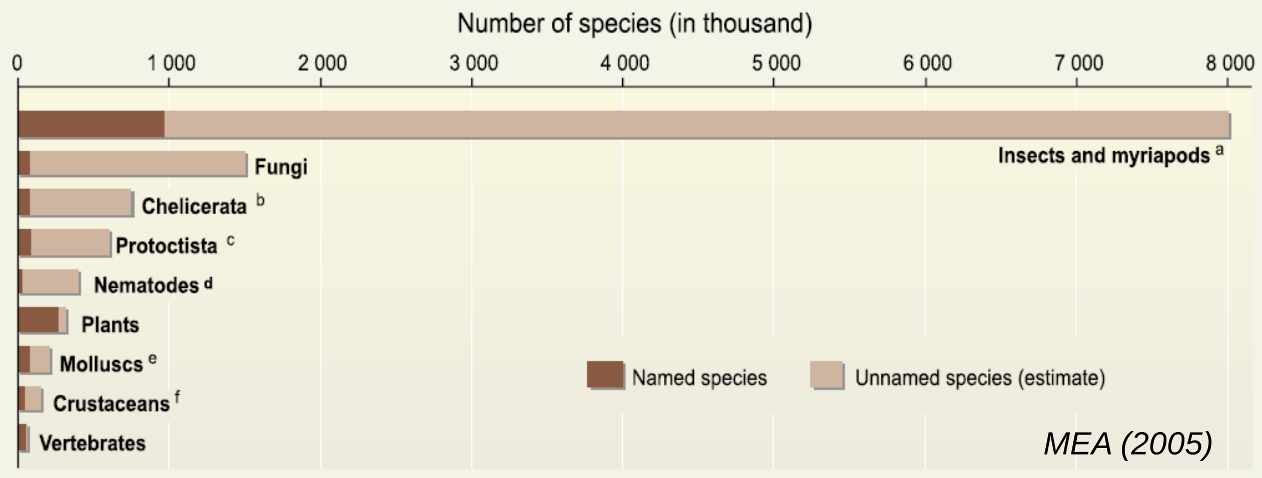




The challenge of the compositional dimension - biodiversity really is diverse, and poorly known

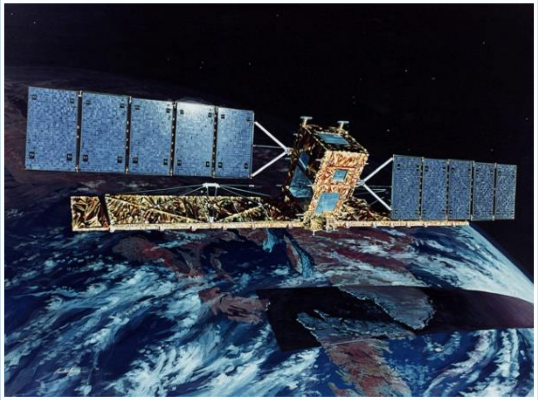


Bork et al (2006)



MEA (2005)

Two major sources of information on the state of biodiversity, with complementary strengths



Remote sensing

• complete spatial coverage

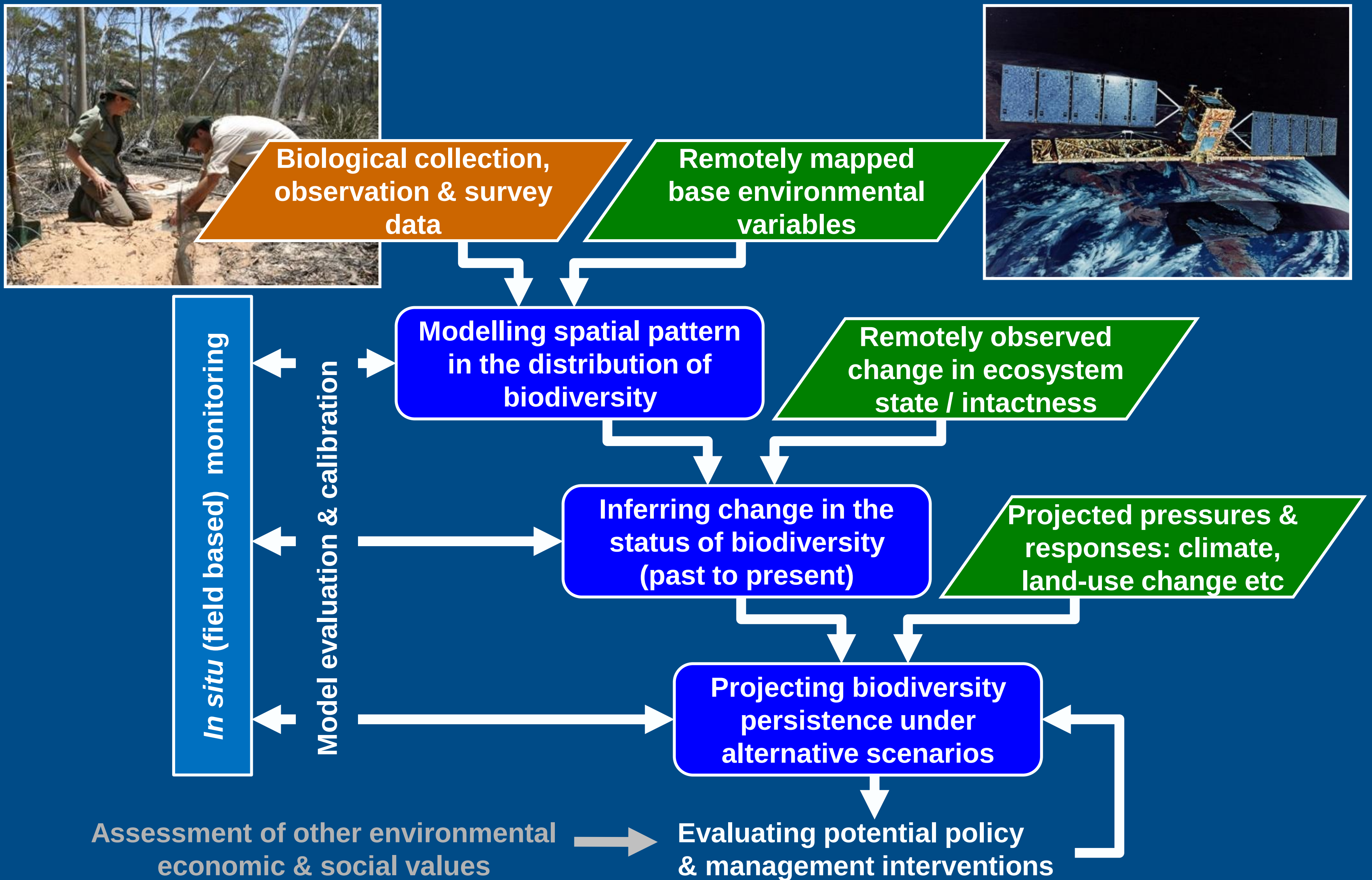
• reasonable detection of ecosystem structure & function, but not of biodiversity composition at species/gene level

• direct detection of structure, function <u>and</u> composition

• but sparse, and uneven, spatial coverage

In situ (field based) observation

Therefore need integration through modelling, laying the foundation for change observation & projection



Spectrum of distributional modelling strategies

Ferrier & Guisan (2006) *Journal of Applied Ecology*

- interested in individual species of particular concern
- reasonable number of records per species

Individual species distribution (niche) modelling

"Predict first, assemble later" techniques

Simultaneous multi-response modelling of multiple species

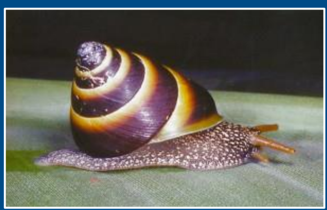
"Assemble first, predict later" techniques

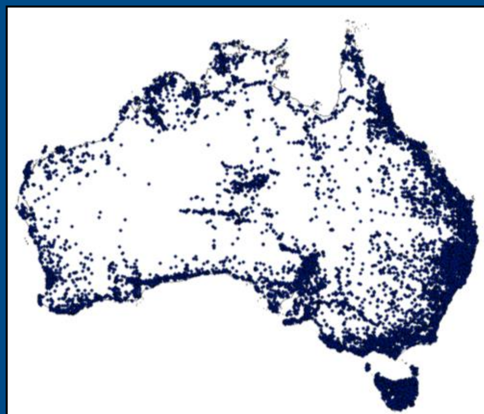
Macroecological modelling of collective biodiversity properties (richness, compositional turnover etc)

- interested in biodiversity as a whole
- huge number of species, each with few (or no) records

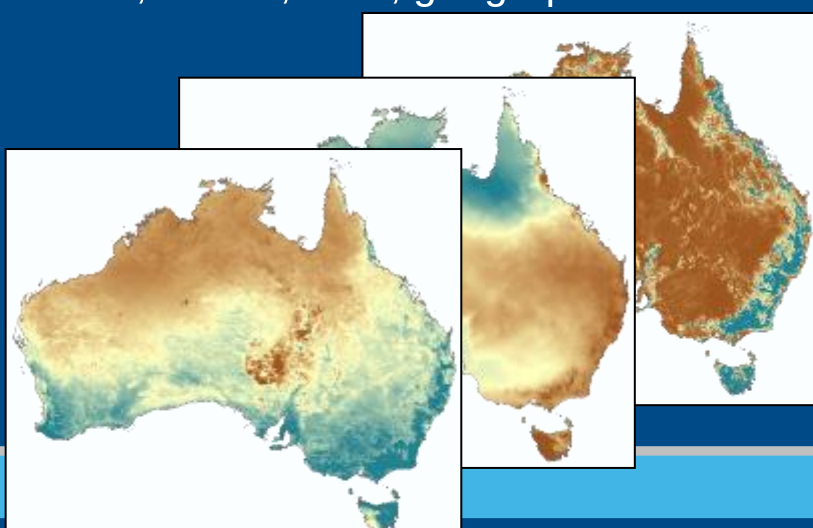
- e.g. modelling spatial turnover in biodiversity composition using generalised dissimilarity modelling

77,000 records of 2,700 land-snail species



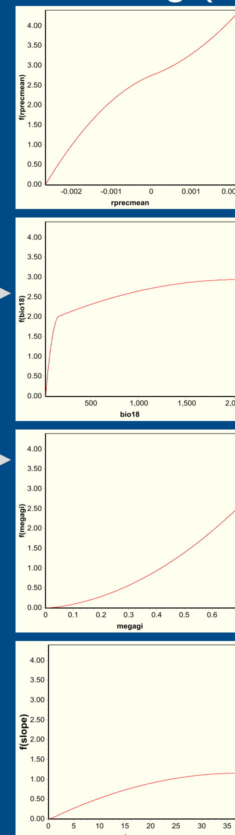


Remotely derived environmental variables:
climate, terrain, soils, geographic isolation etc



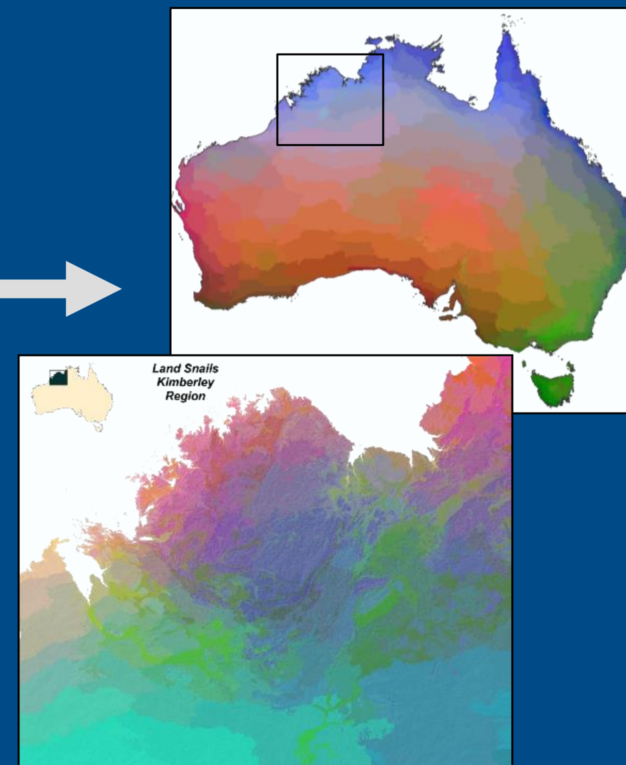
etc ...

Generalised dissimilarity modelling (GDM)



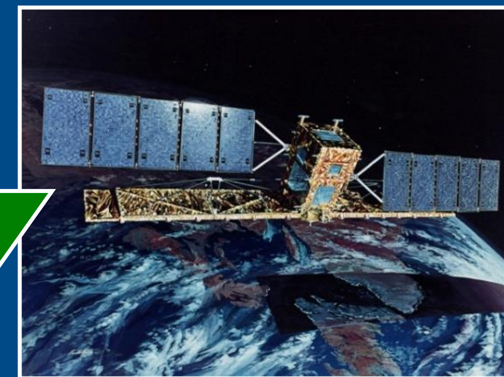
etc ...

Spatial pattern in compositional turnover



Funded by Aust. Dept of Sustainability, Environment, Water, Population & Communities

Adding the temporal dimension – projecting biodiversity persistence under alternative scenarios



Biological collection, observation & survey data

Remotely mapped base environmental variables

Modelling spatial pattern in the distribution of biodiversity

Remotely observed change in ecosystem state / intactness

Inferring change in the status of biodiversity (past to present)

Projected pressures & responses: climate, land-use change etc

Projecting biodiversity persistence under alternative scenarios

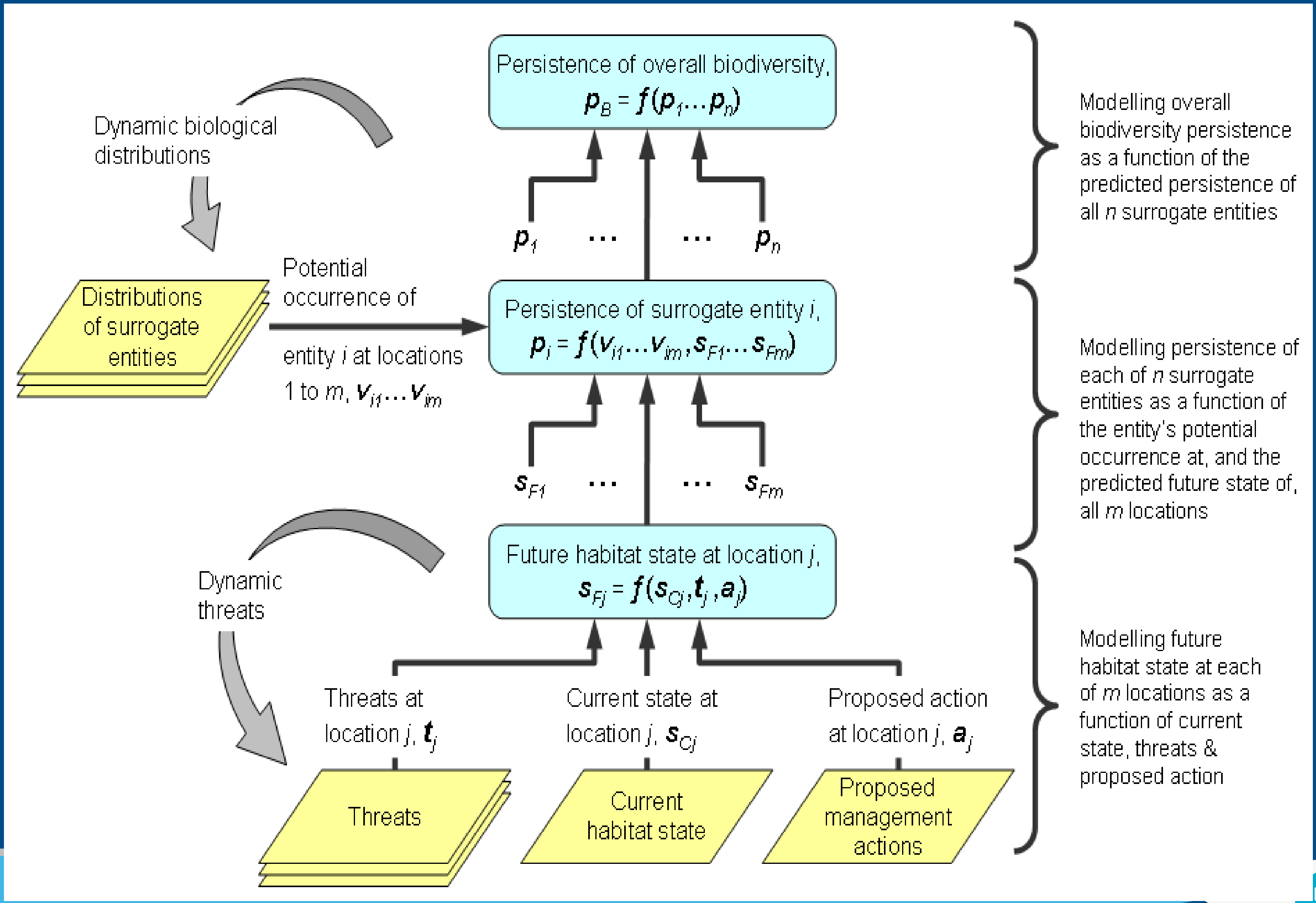
In situ (field based) monitoring

Model evaluation & calibration

Assessment of other environmental economic & social values

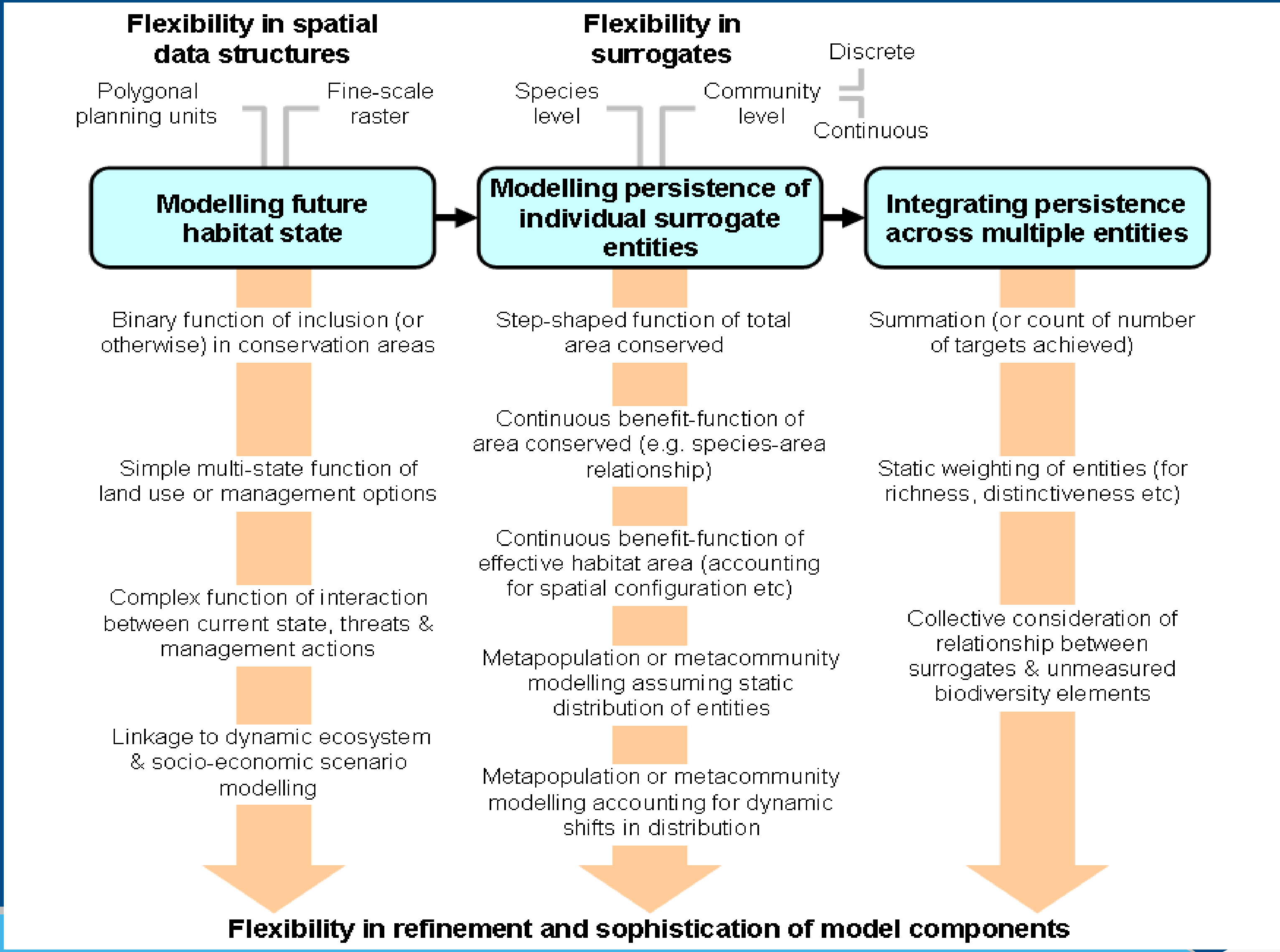
Evaluating potential policy & management interventions

A general framework for modelling persistence of compositional diversity – three broad components



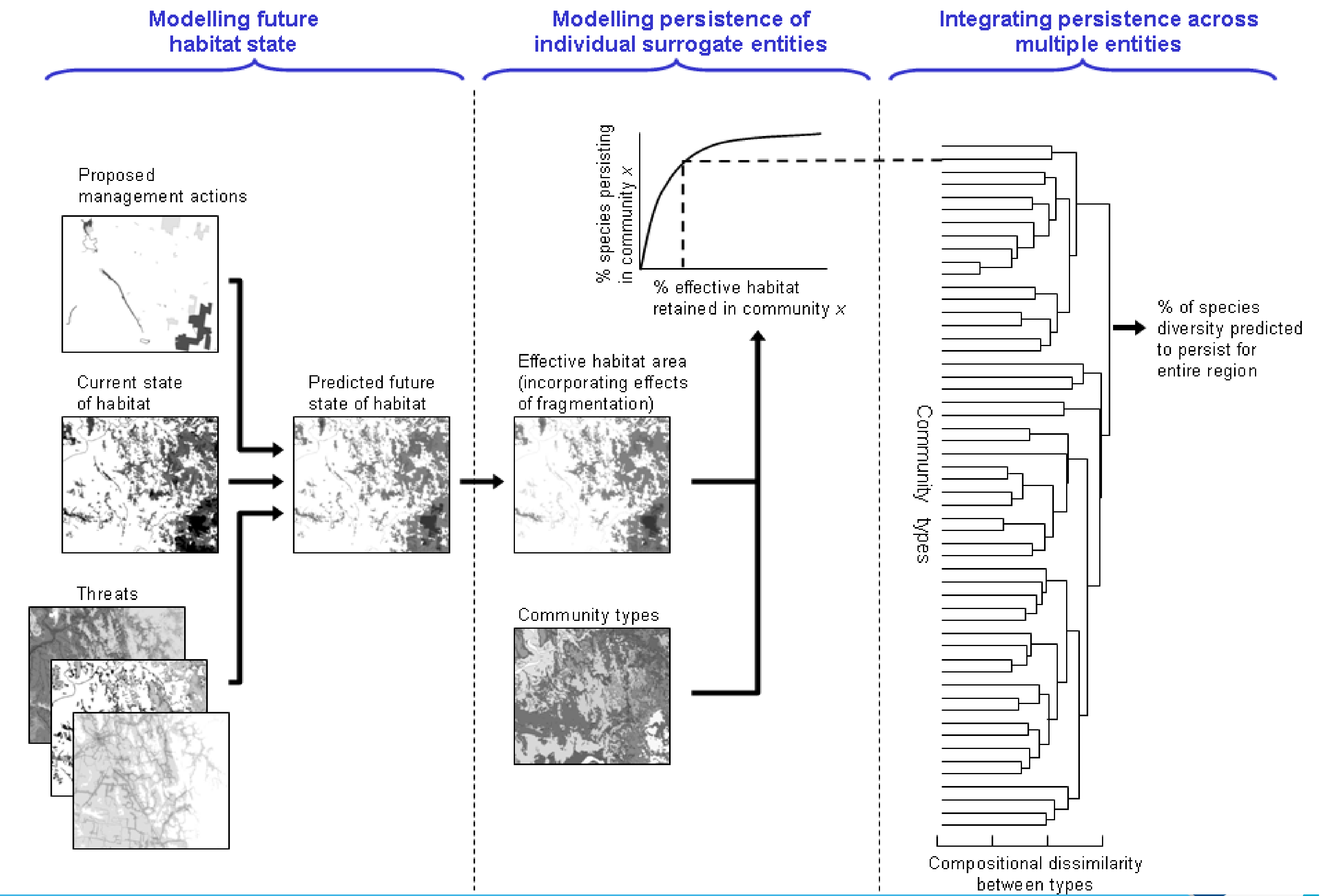
Ferrier, S & Drielsma, M (2010) *Diversity & Distributions* 16: 386-492

Flexibility in implementing these components ...



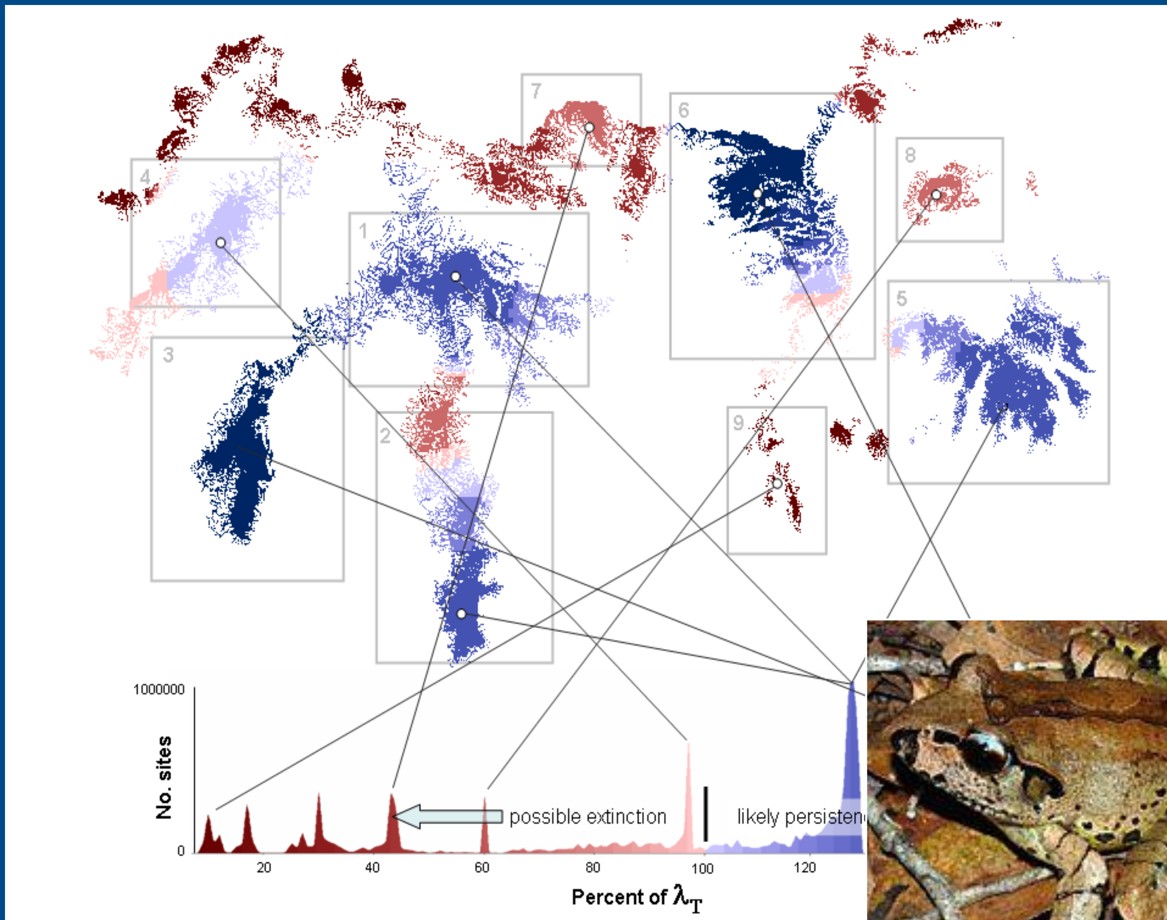
Ferrier, S & Drielsma, M (2010) *Diversity & Distributions* 16: 386-492

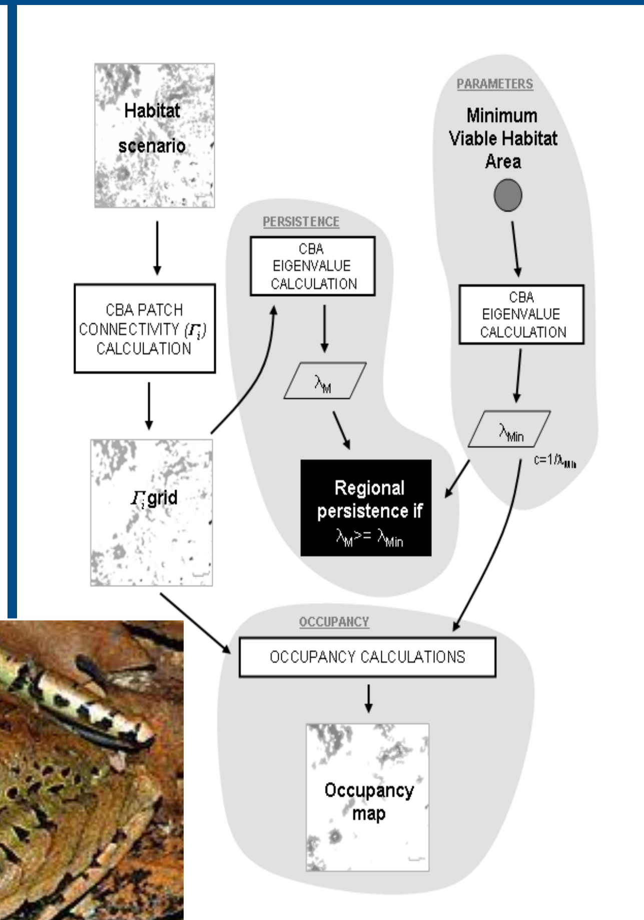
... from simple pattern-based approaches ...



Ferrier, S & Drielsma, M (2010) *Diversity & Distributions* 16: 386-492

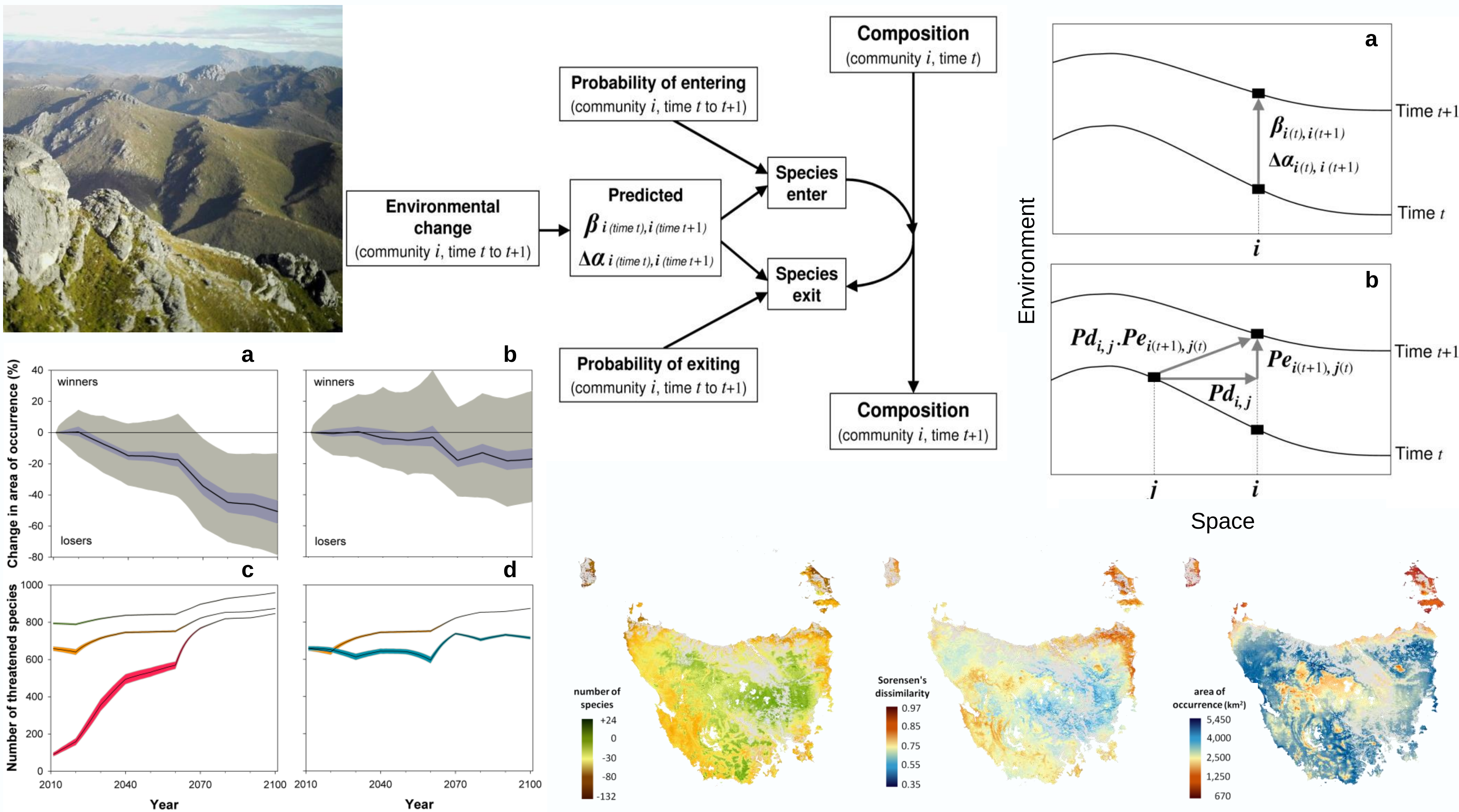
... to more complex process-based approaches, e.g. metapopulation-capacity modelling ...





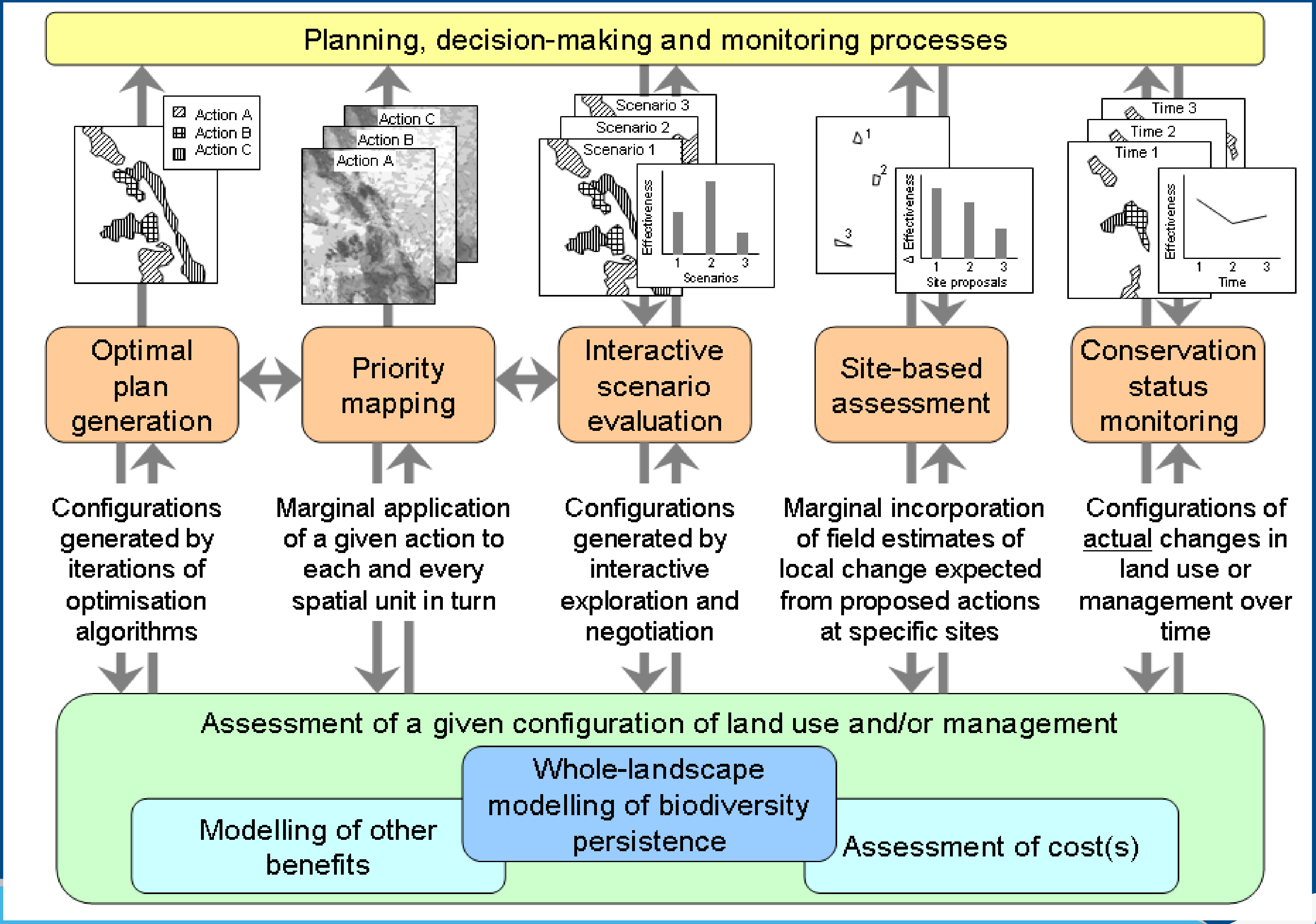
Drielsma, M & Ferrier, S (2009) *Biological Conservation* 142: 529-540

... dynamic macroecological modelling of metacommunity persistence (accounting for climate change)



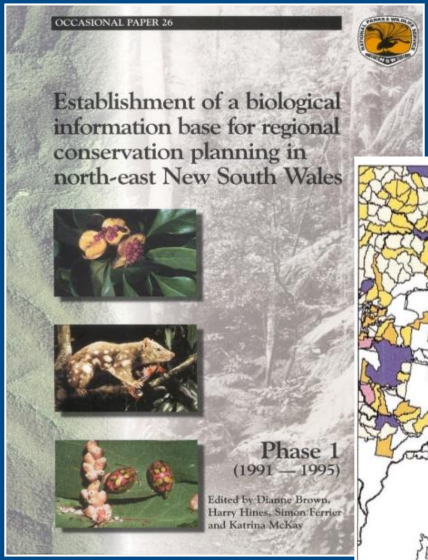
Mokany, K *et al* (2012) *Global Change Biology* 18: 3149-3159

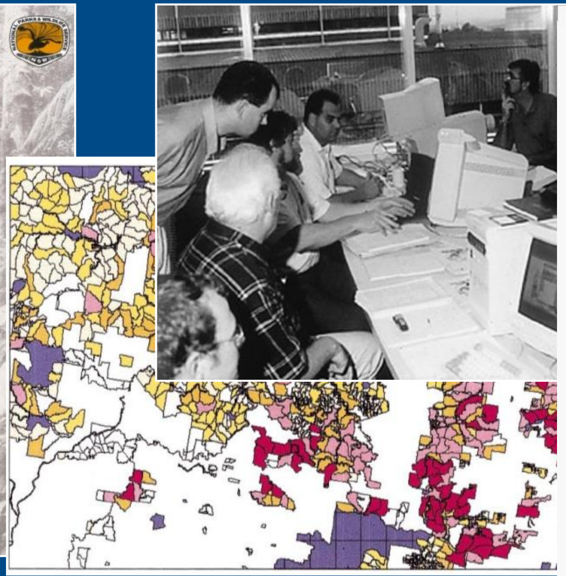
A common foundation for multiple forms of higher-level assessment across multiple scales

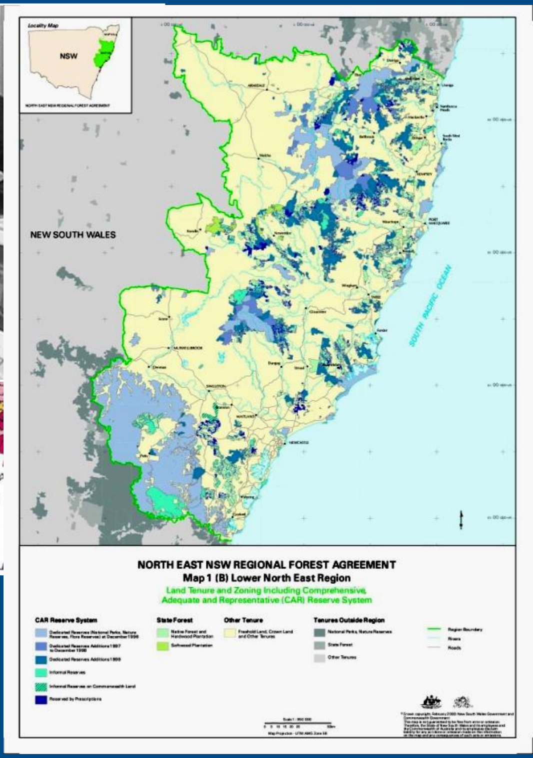


Ferrier, S & Drielsma, M (2010) *Diversity & Distributions* 16: 386-492

Landscape / regional scale applications – e.g. conservation planning in north-east NSW forests in the 1990s ...







Modelled species distributions & vegetation communities

Protection targets

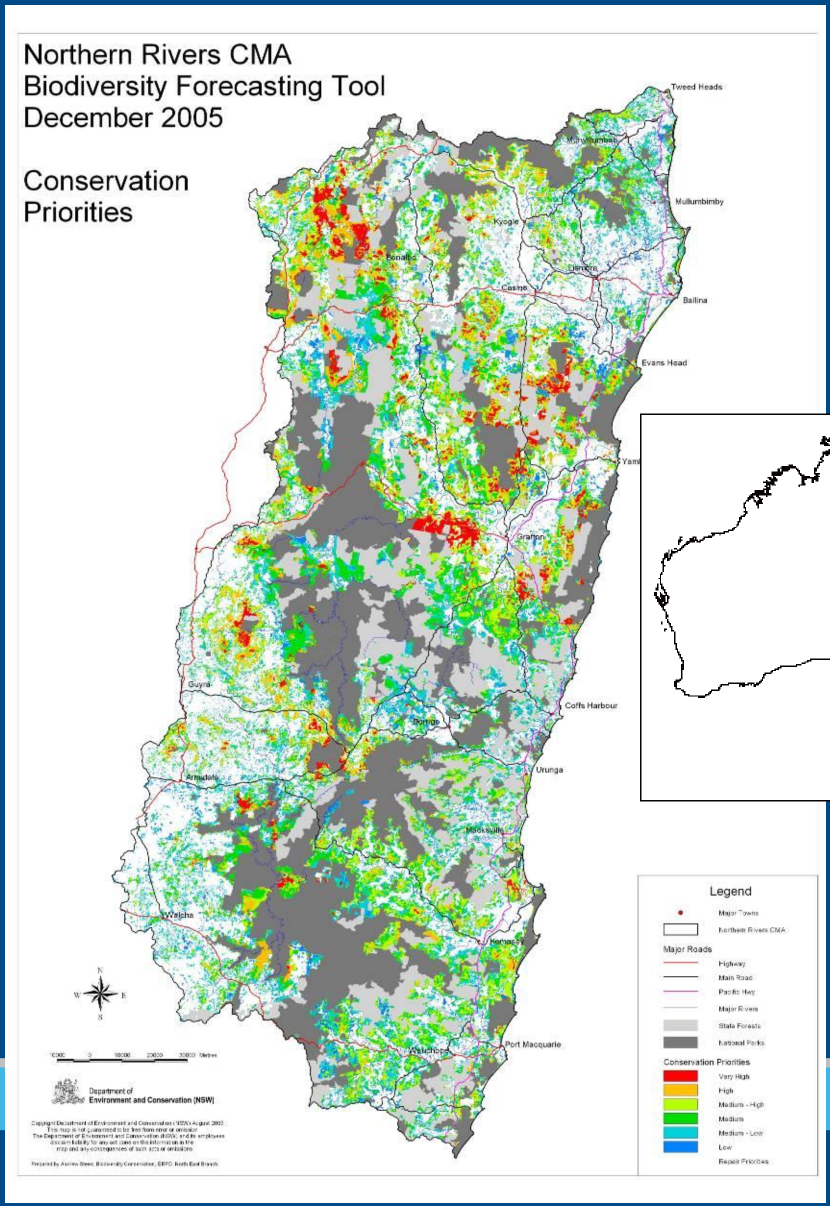
Conservation prioritisation (irreplaceability analysis)

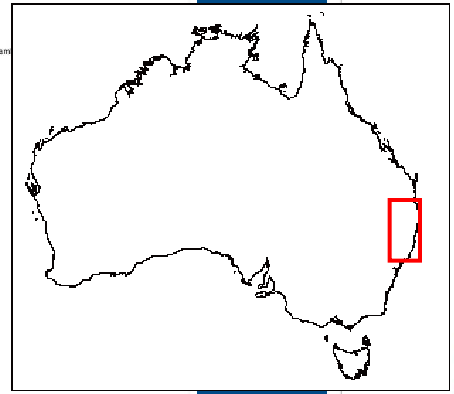
Timber resource assessment

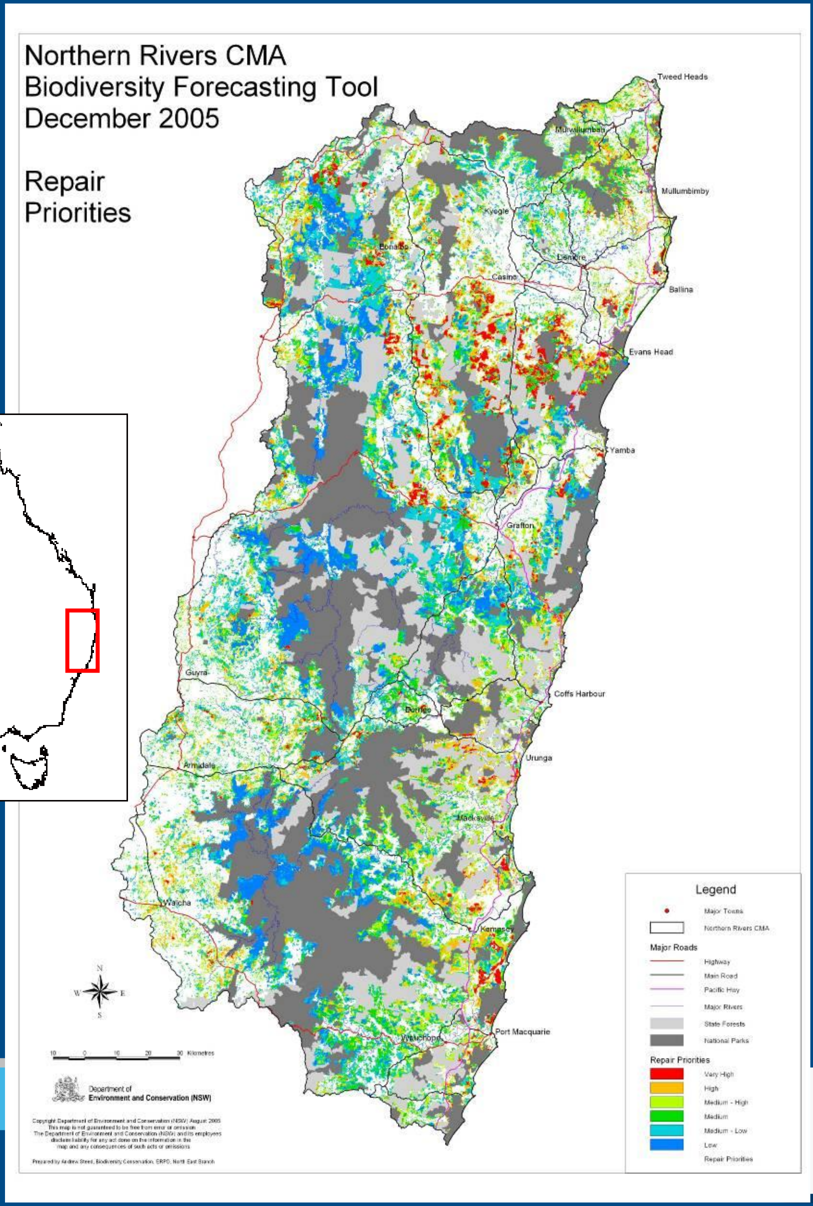
Negotiation & selection of new reserves

Ferrier, S, Pressey, R & Barrett, T (2000) *Biological Conservation* 93: 303-325

... whole-landscape prioritisation of protective and restorative management actions ...



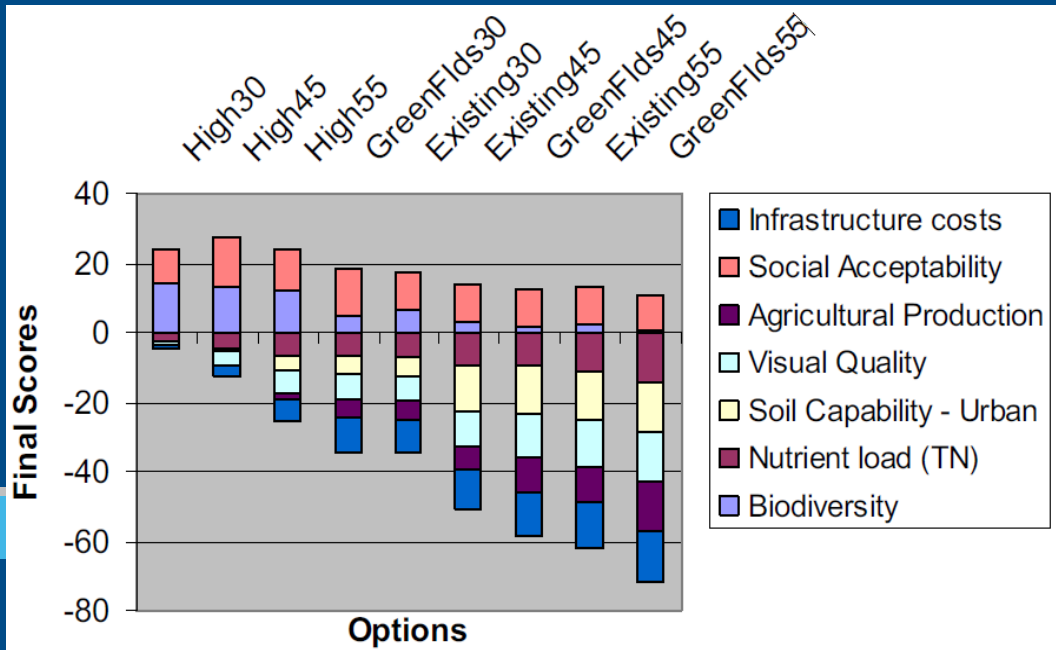




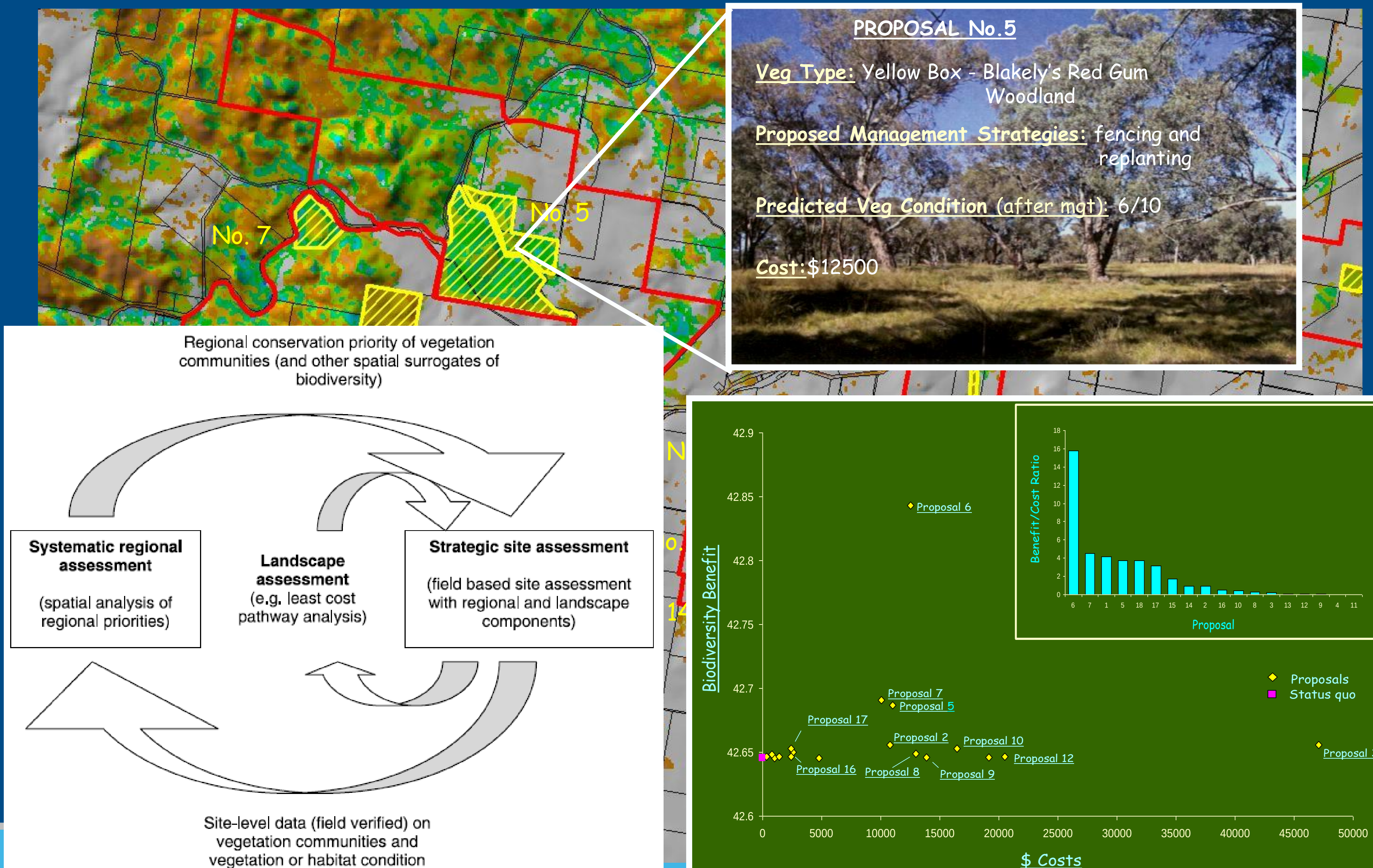
... multi-objective environmental / social / economic evaluation of alternative land-use scenarios ...

NSW GOVERNMENT
Department of Planning

Comprehensive Coastal Assessment
Better Planning for Coastal NSW

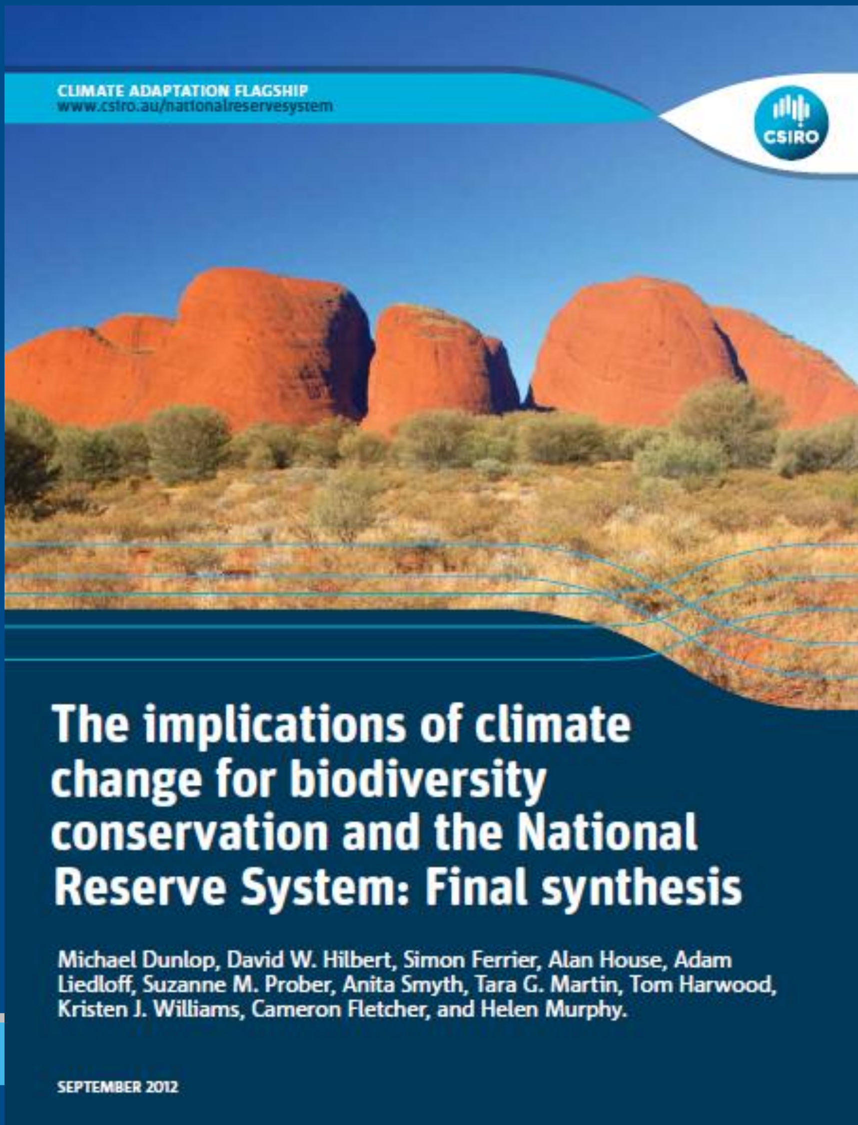


... site-based assessment of environmental stewardship proposals within a whole-landscape context



Seddon JA *et al* (2010) *Conservation Letters* 3: 415-424

National / continental scale applications – e.g. climate change impact & vulnerability assessment ...

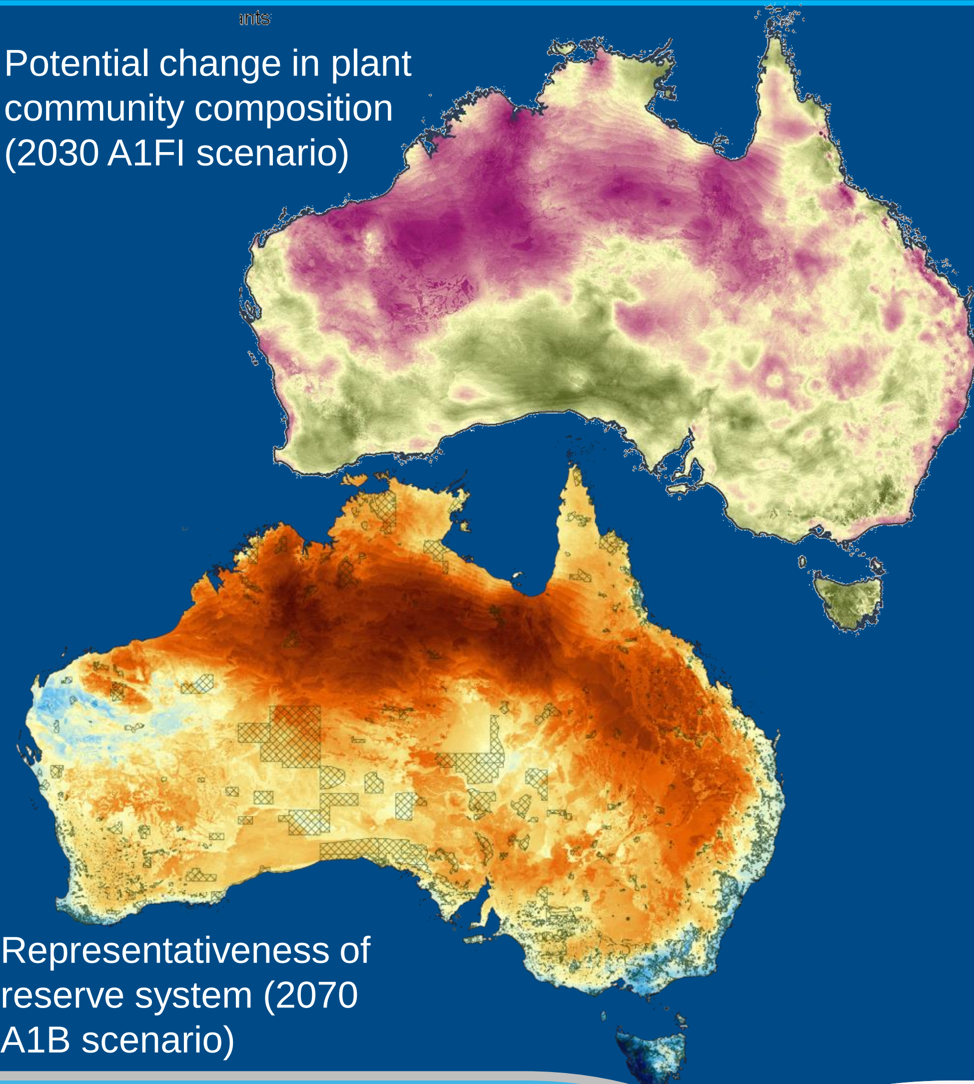

CLIMATE ADAPTATION FLAGSHIP
www.csiro.au/nationalreservesystem

CSIRO

The implications of climate change for biodiversity conservation and the National Reserve System: Final synthesis

Michael Dunlop, David W. Hilbert, Simon Ferrier, Alan House, Adam Liedloff, Suzanne M. Prober, Anita Smyth, Tara G. Martin, Tom Harwood, Kristen J. Williams, Cameron Fletcher, and Helen Murphy.

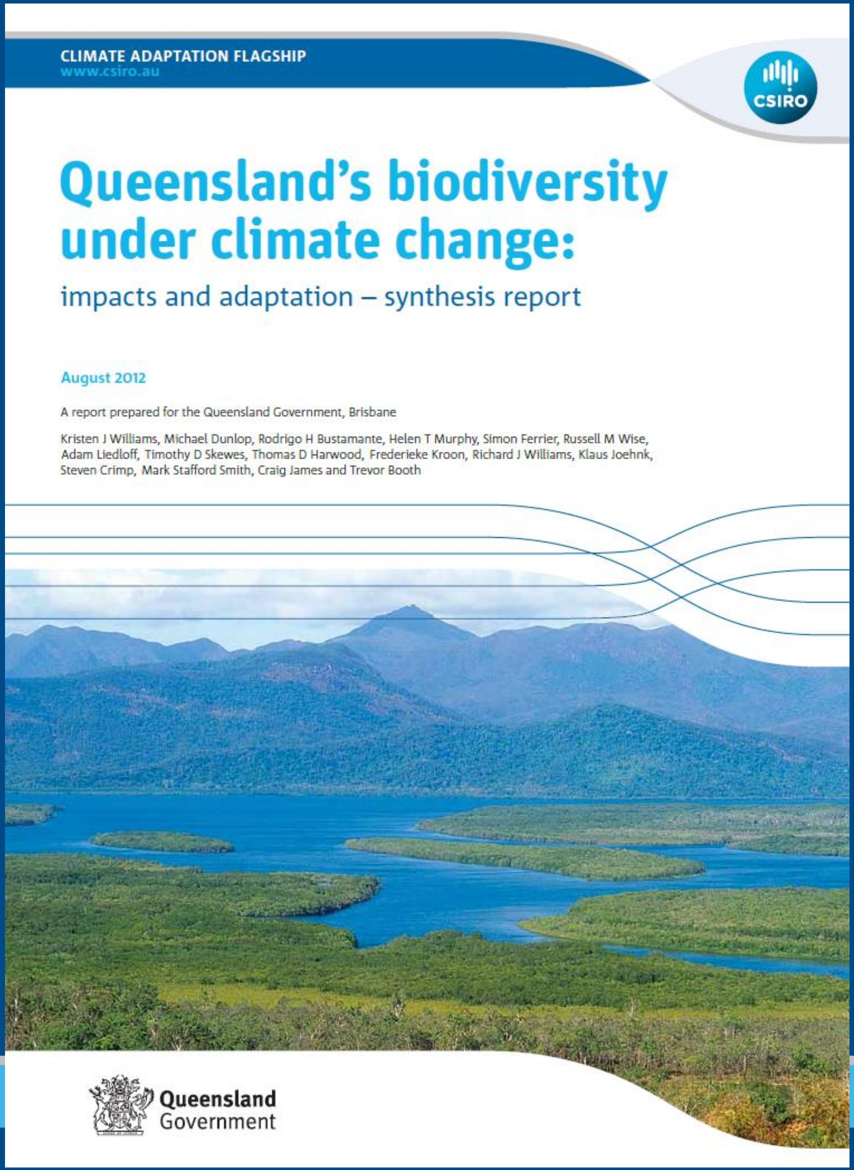
SEPTEMBER 2012



Potential change in plant community composition (2030 A1FI scenario)

Representativeness of reserve system (2070 A1B scenario)

... also informing policy & planning at state (provincial) scale ...


CLIMATE ADAPTATION FLAGSHIP
www.csiro.au

Queensland's biodiversity under climate change:

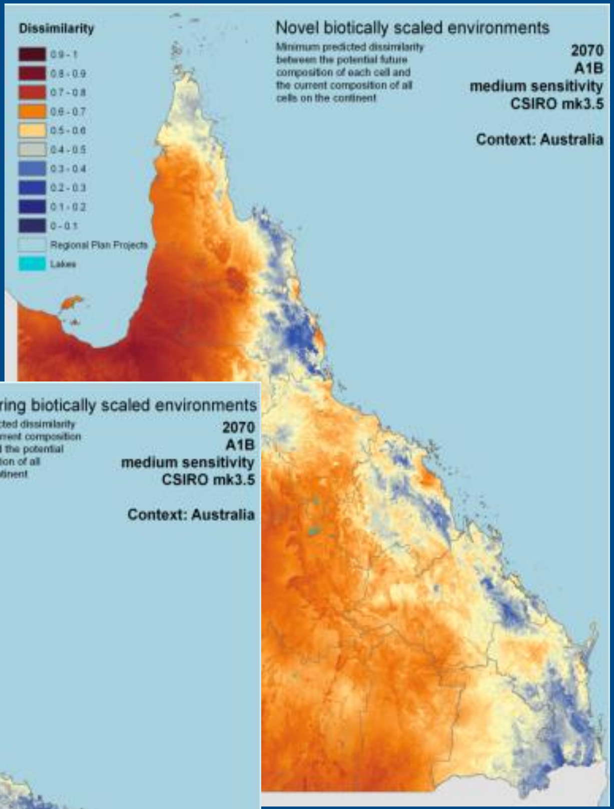
impacts and adaptation – synthesis report

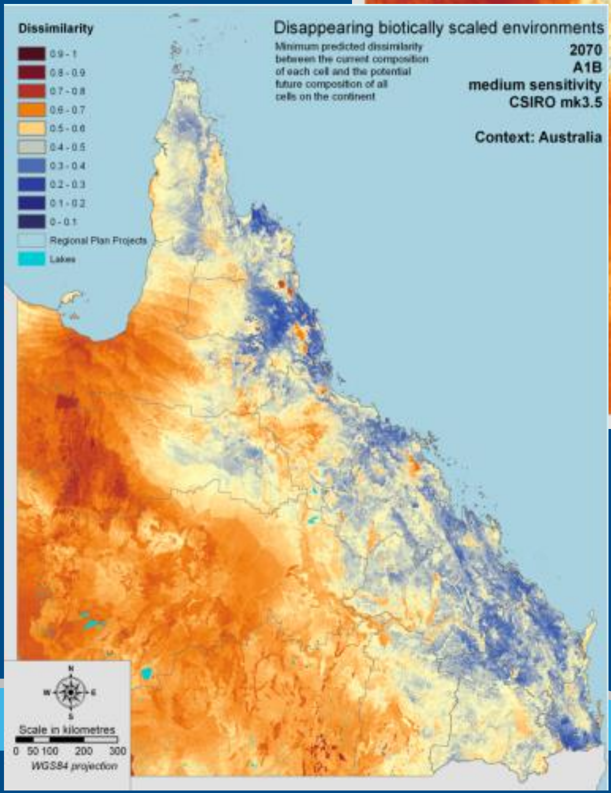
August 2012

A report prepared for the Queensland Government, Brisbane

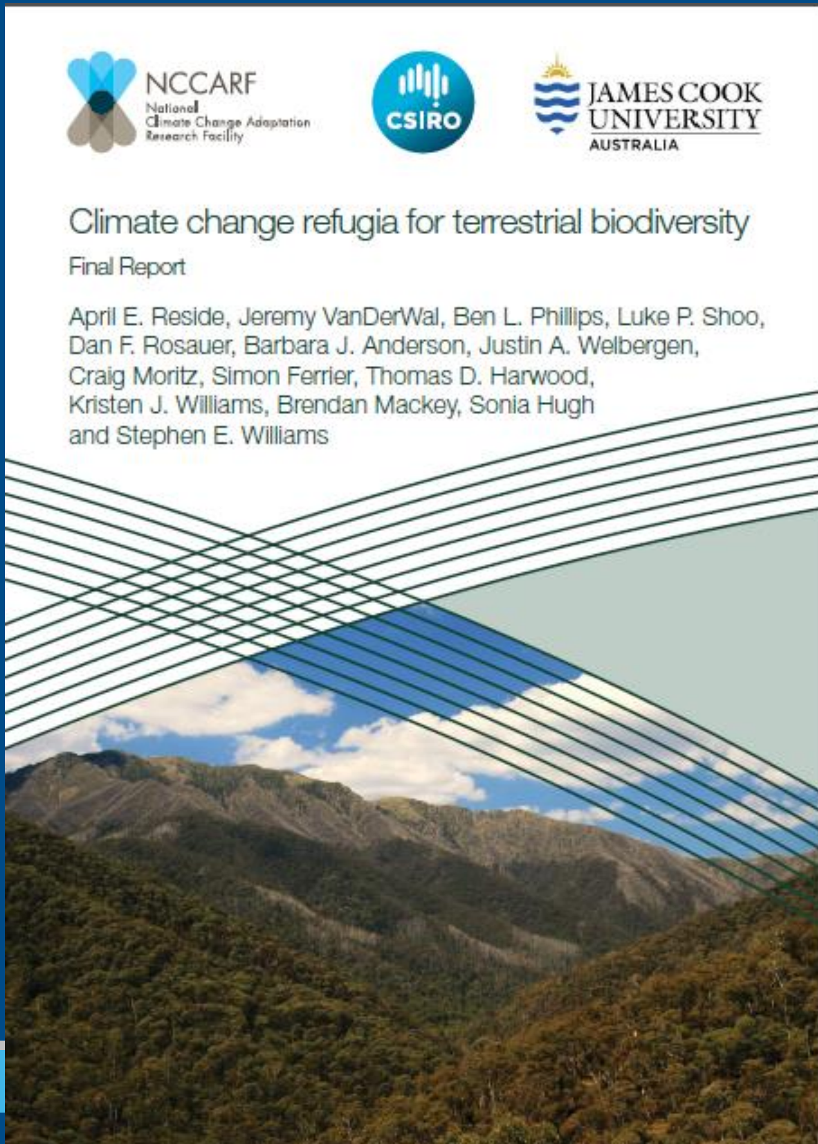
Kristen J Williams, Michael Dunlop, Rodrigo H Bustamante, Helen T Murphy, Simon Ferrier, Russell M Wise, Adam Liedloff, Timothy D Skewes, Thomas D Harwood, Frederieke Kroon, Richard J Williams, Klaus Joehnk, Steven Crimp, Mark Stafford Smith, Craig James and Trevor Booth

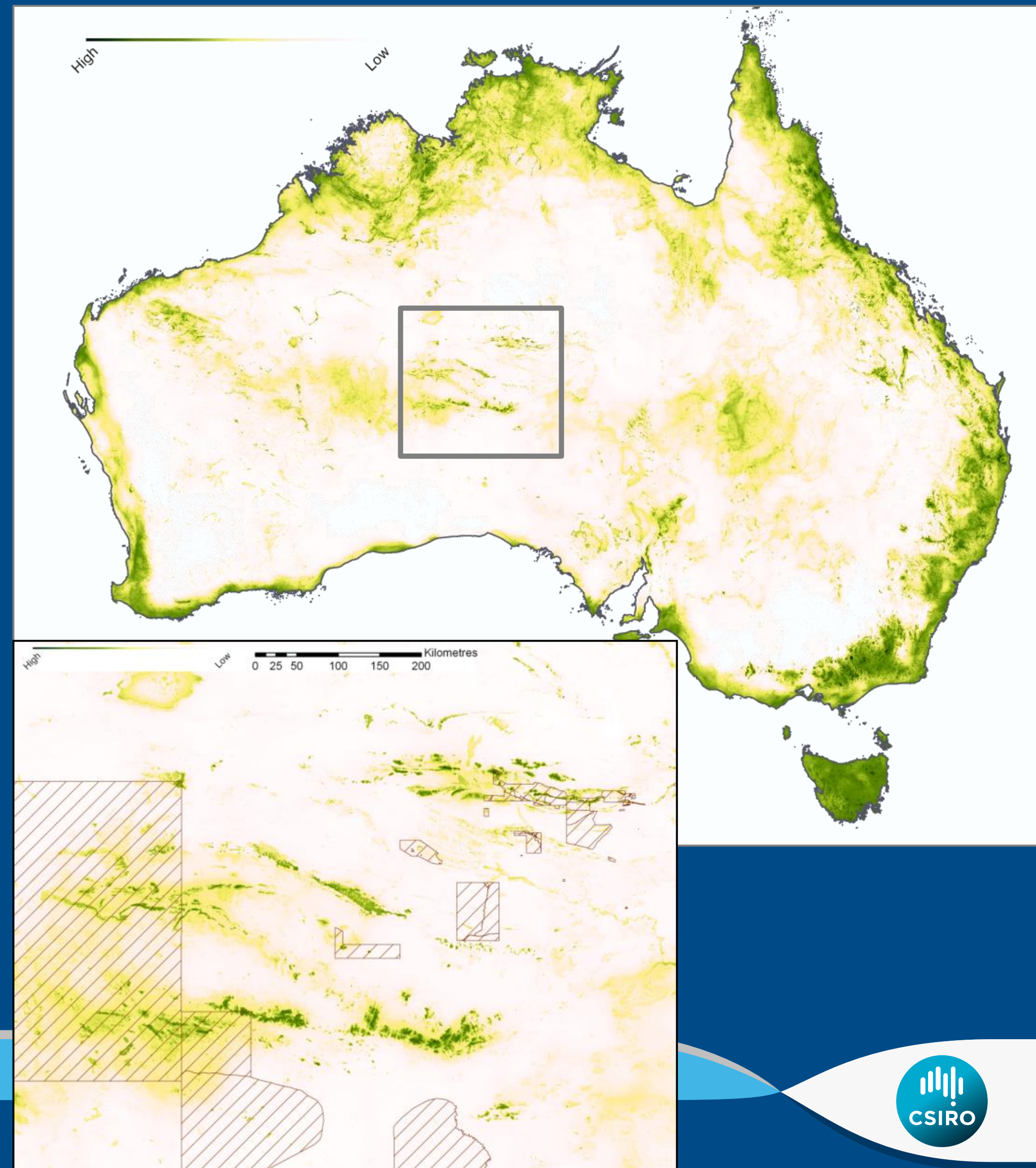
Queensland Government



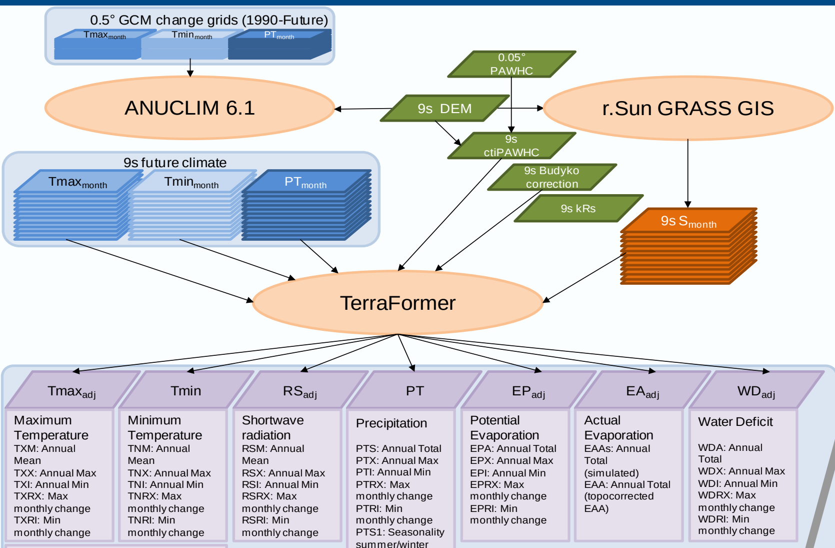


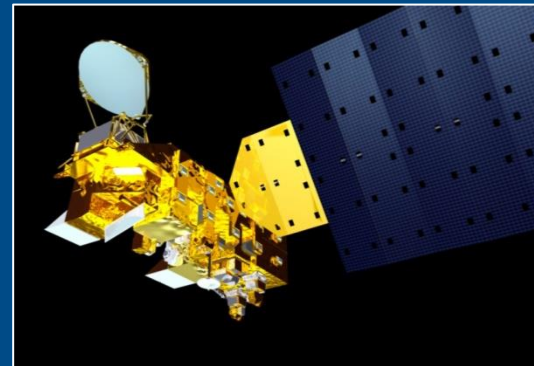
... and recently applied at much finer spatial resolution to identify potential climate refugia for biodiversity ...

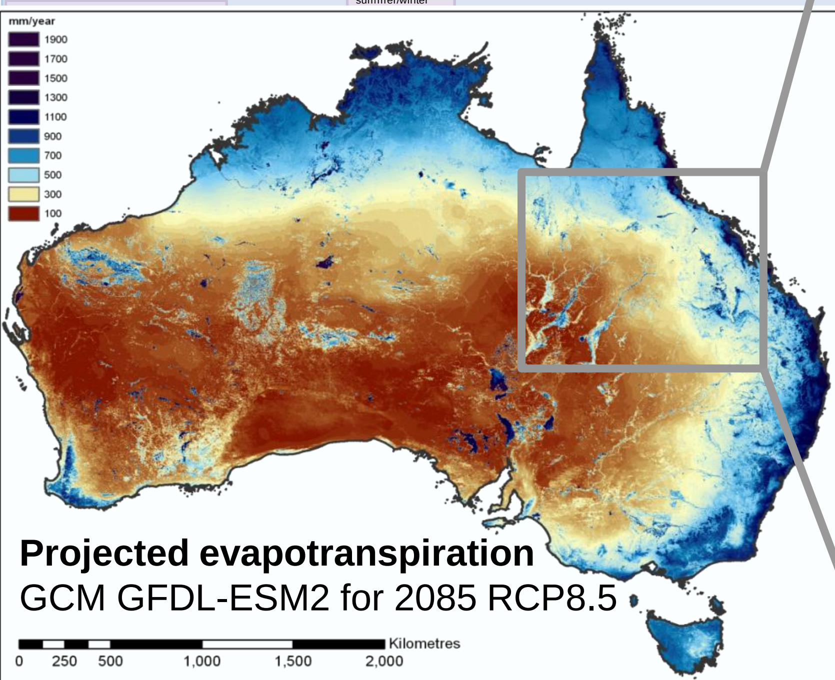




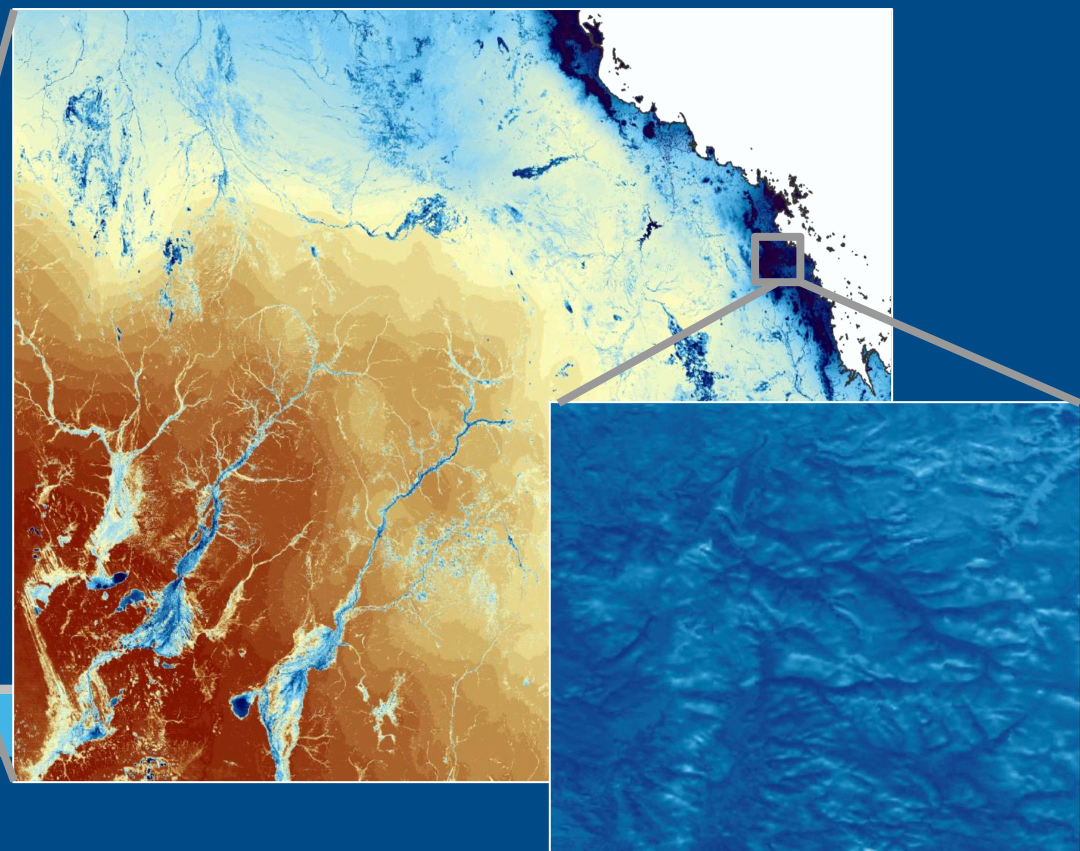
... employing a new generation of fine-scaled environmental variables & high-performance computing



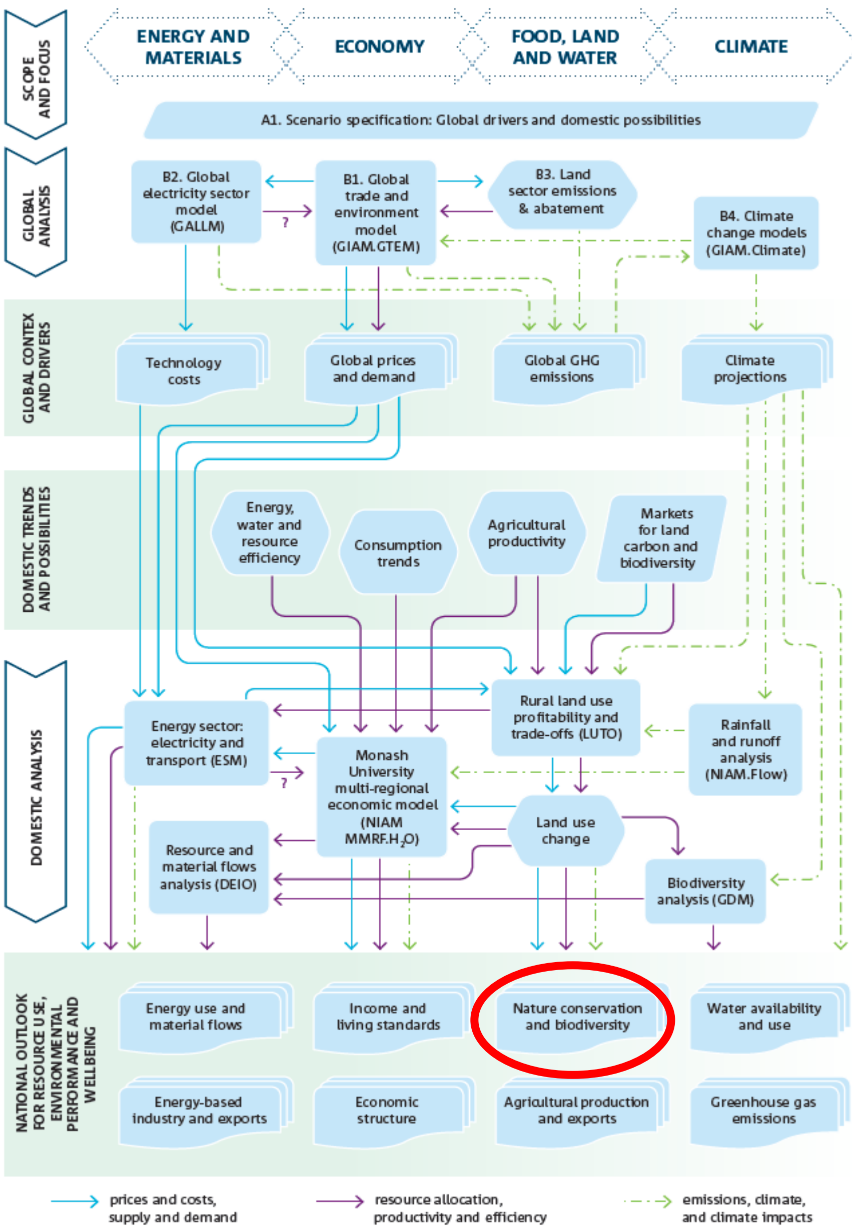


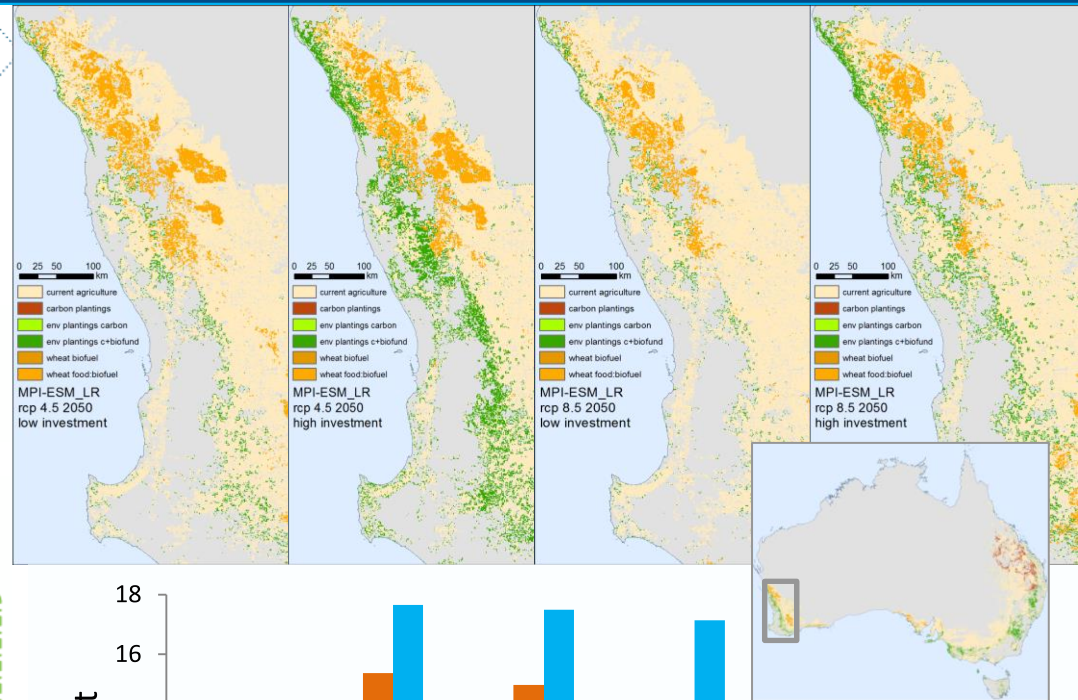


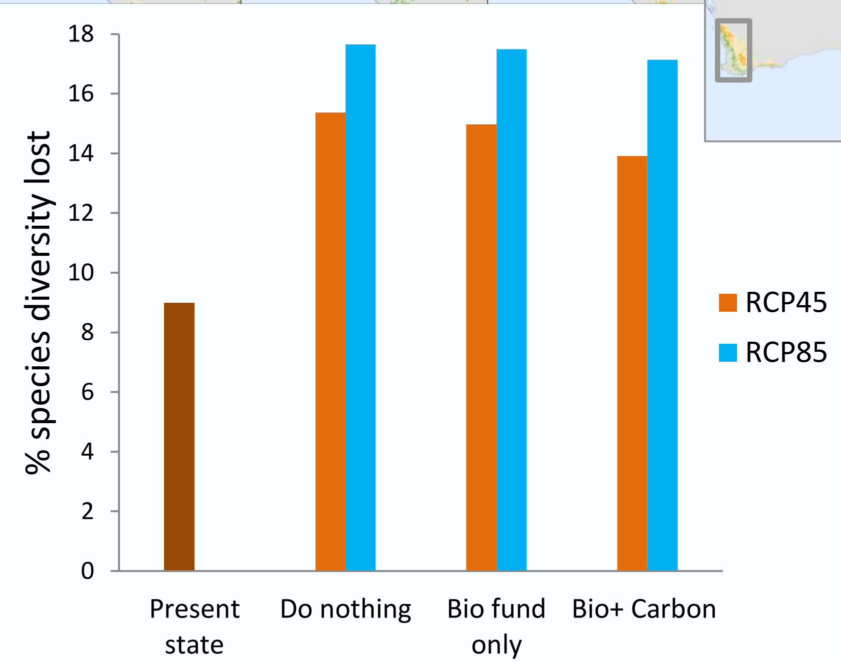
Projected evapotranspiration
GCM GFDL-ESM2 for 2085 RCP8.5



… CSIRO Australian National Outlook project – integrated assessment of natural-resource use scenarios (land, water, energy, ecosystem services)





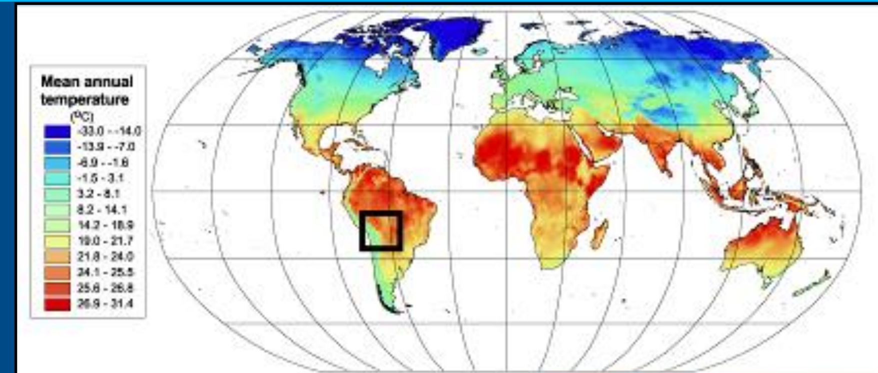


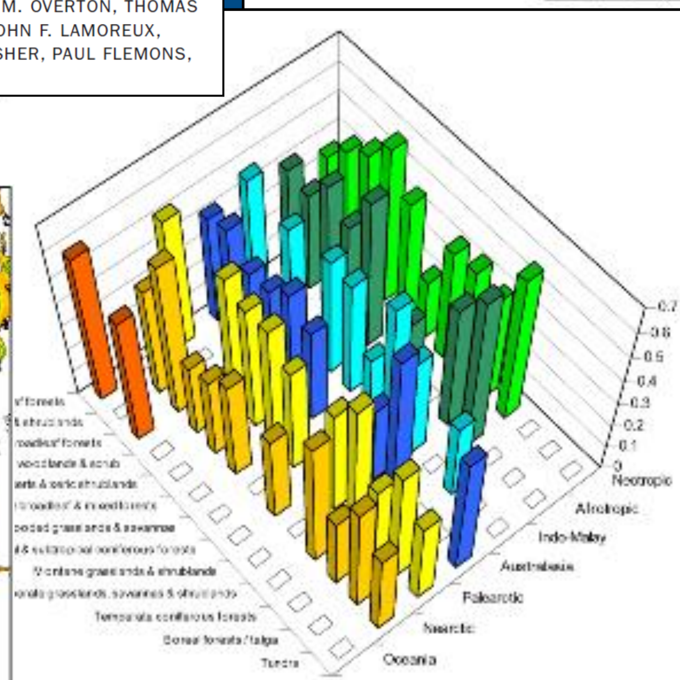
Global scale applications – e.g. proof-of-concept assessment of protected areas for 5th World Parks Congress (2003) …

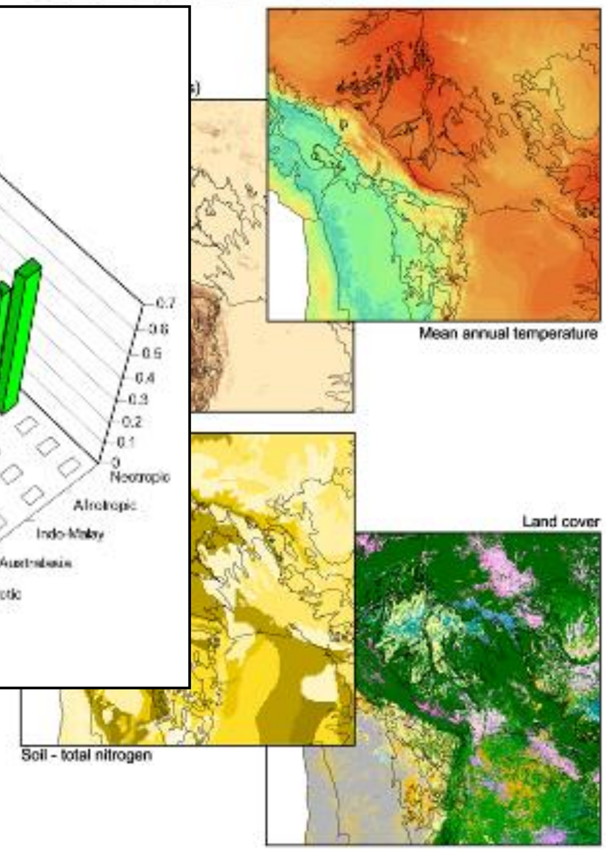
Articles

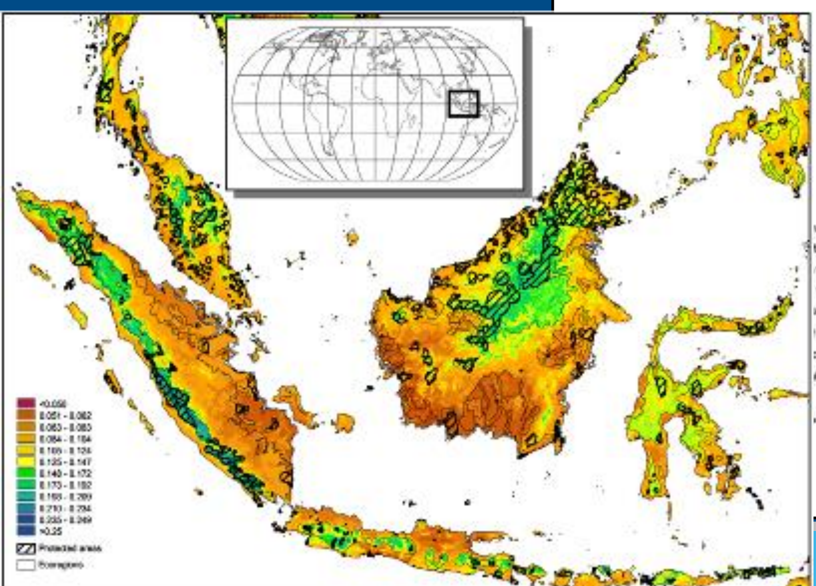
Mapping More of Terrestrial Biodiversity for Global Conservation Assessment

SIMON FERRIER, GEORGE V. N. POWELL, KAREN S. RICHARDSON, GLENN MANION, JAKE M. OVERTON, THOMAS F. ALLNUTT, SUSAN E. CAMERON, KELLIE MANTLE, NEIL D. BURGESS, DANIEL P. FAITH, JOHN F. LAMOREUX, GEROLD KIER, ROBERT J. HIJMANS, VICKI A. FUNK, GERASIMOS A. CASSIS, BRIAN L. FISHER, PAUL FLEMONS, DAVID LEES, JON C. LOVETT, AND RENAAT S. A. R. VAN ROMPAEY









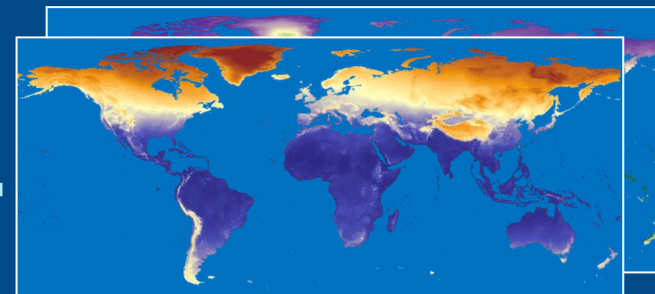
Ferrier et al (2004) BioScience

... major new opportunities have opened up over past 10 years through various global initiatives & activities ...

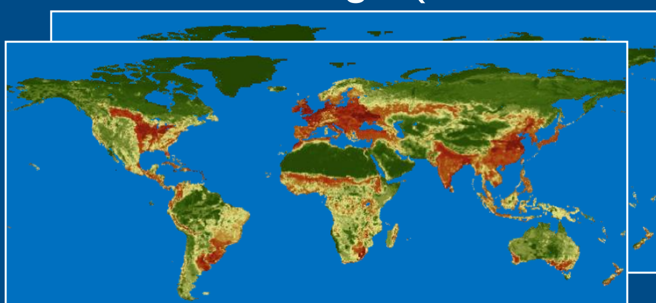
A recent proof-of-concept example – based on modelling of all GBIF data for ferns (>1.3 million records for >10,000 species)

Fern species records (GBIF)

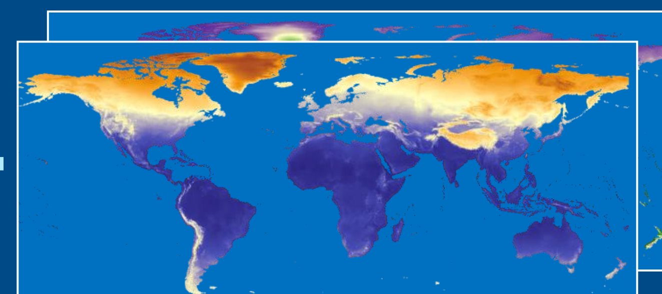
Base environment (WorldClim etc)



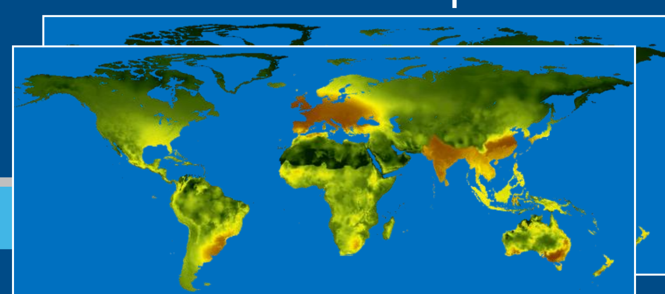
Land-use change (IMAGE etc)



Climate change (IPCC etc)

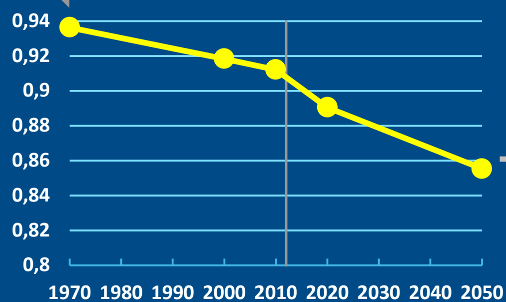


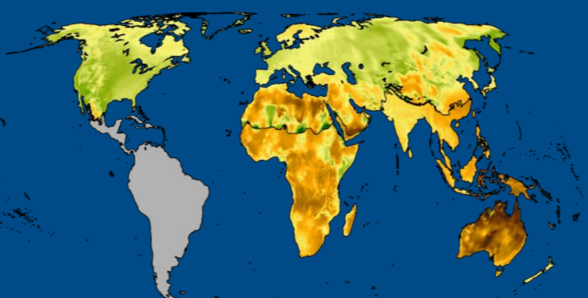
Modelled retention of compositional diversity



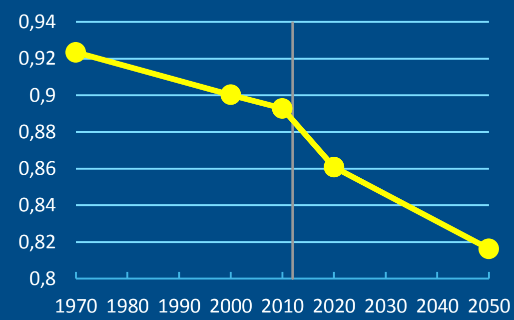
Thereby able to report change in retention of compositional diversity at any required level of spatial aggregation

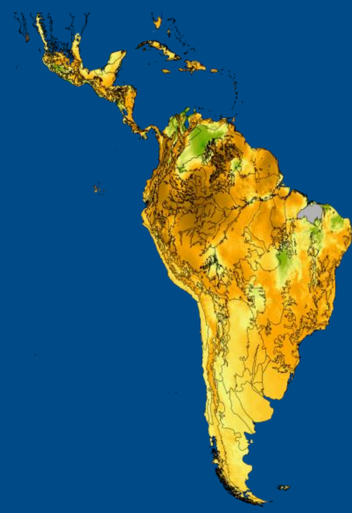
Whole planet | **Realm (or continent)** | **Ecoregion**



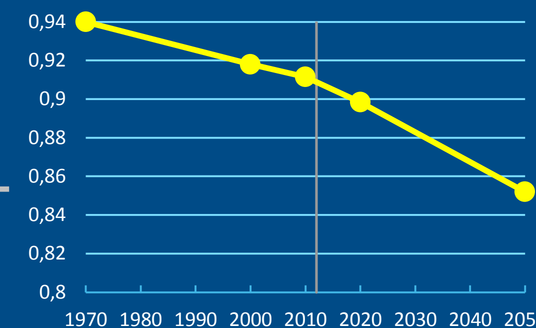


Neotropics

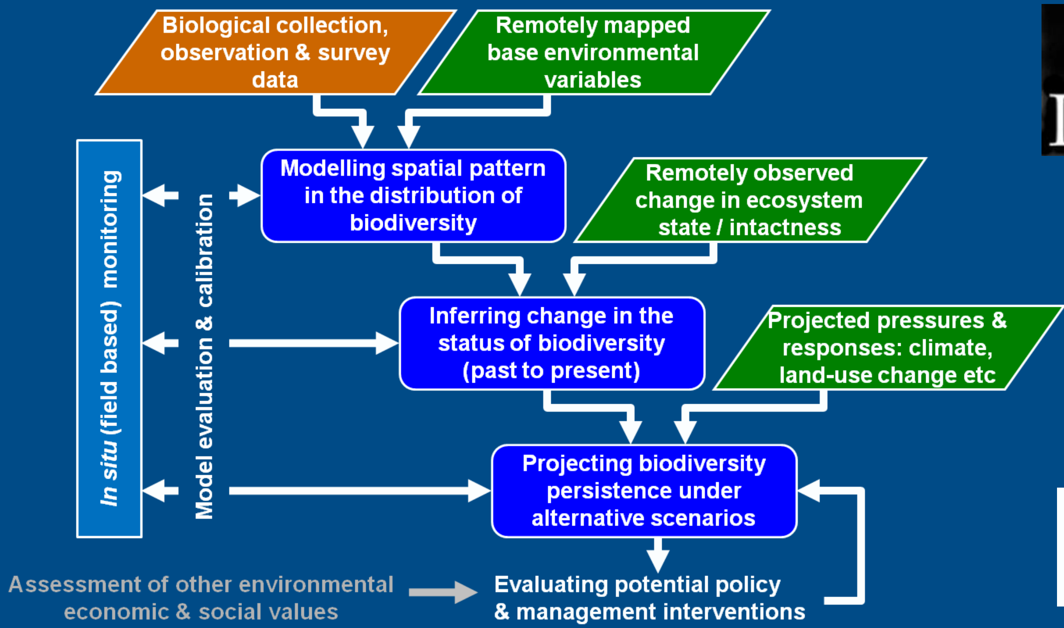




Maranhao Babaçu Forest



6th World Parks Congress (Nov 2014) serving as a catalyst for first full implementation of this approach



6th World Parks Congress (Nov 2014) serving as a catalyst for first full implementation of this approach

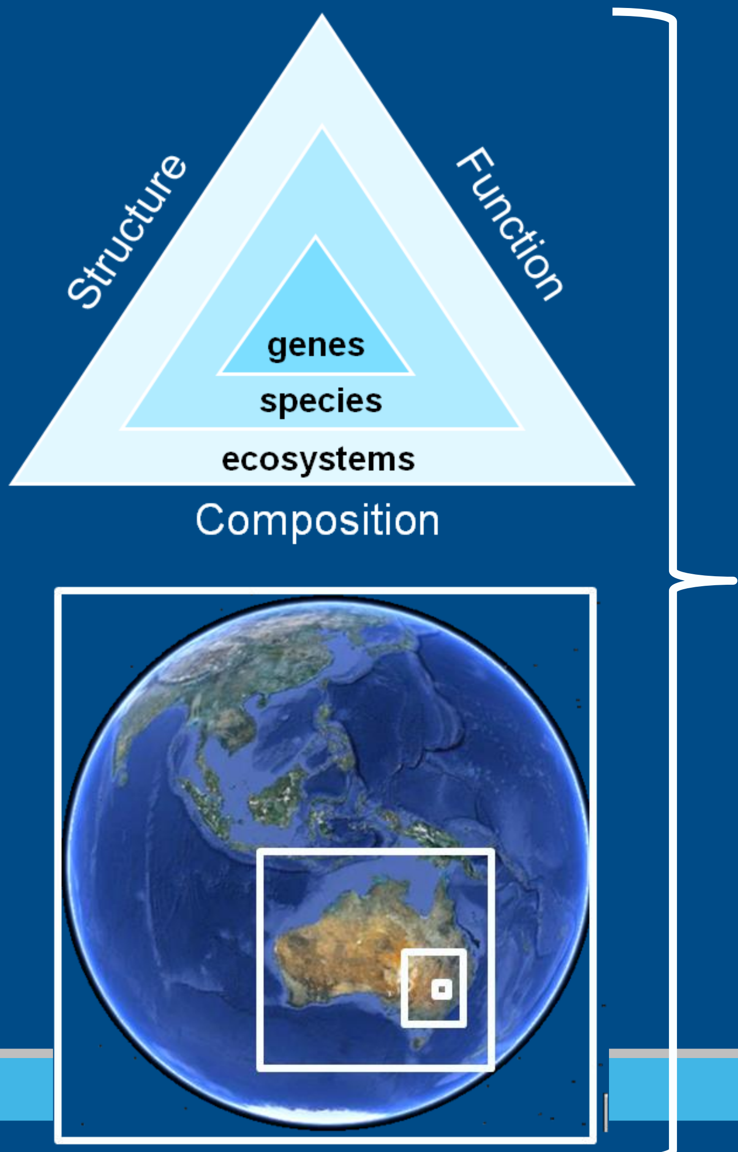
IUCN WORLD PARKS CONGRESS SYDNEY 2014

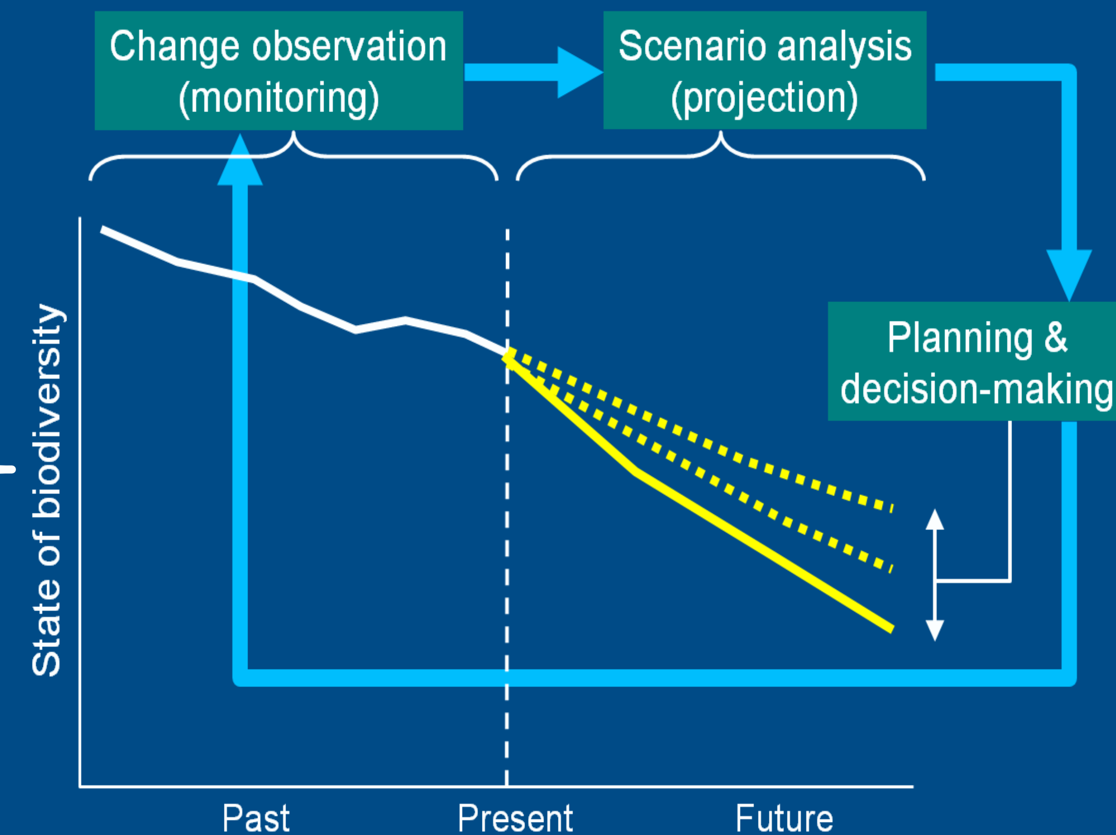
CSIRO

GEO GROUP ON EARTH OBSERVATIONS

- How adequately does the world's protected-area system represent current patterns of compositional diversity across a wide range of highly diverse biological groups?
- How is this level of representation expected to change given projected velocities of climate change?
- Which existing protected areas are most vulnerable to turnover and/or loss of compositional diversity under climate change?
- Where are the gaps in existing protected-area coverage that could be most critical to maximising overall whole-landscape retention of compositional diversity, in the face of ongoing climate and land-use change?

The challenge ahead - integration & harmonisation across scales, biodiversity dimensions, & assessment modes





The challenge ahead - integration & harmonisation across scales, biodiversity dimensions, & assessment modes

COMMENT

COMMUNICATION Sally Rockey reflects on two years of blogging at the NIH p.298

ECOLOGY Zoological travelogue tracks rare species worldwide p.300

WOMEN Calls to root out sexism in journals, conferences and experiments p.305

OBITUARY Rita Levi-Montalcini, nerve growth factor pioneer and science advocate p.306

A hyena surveys a flock of flamingos in South Africa.

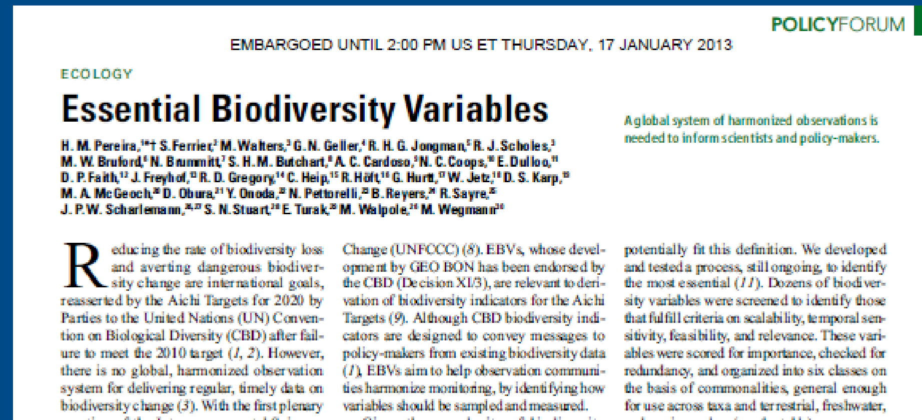
Time to model all life on Earth

To help transform our understanding of the biosphere, ecologists — like climate scientists — should simulate whole ecosystems, argue **Drew Purves** and colleagues.

No report from the Intergovernmental Panel on Climate Change would fail to mention global climate models. Yet the international bodies that are charged with addressing global challenges in conservation — including the Intergovernmental Platform on Biodiversity and Ecosystem Services, which holds its first plenary meeting next week in Bonn, Germany — cannot refer to analogous models of the world's ecosystems. Why? Because ecologists have not yet built them.

General circulation models, which simulate the physics and chemistry of Earth's land, ocean and atmosphere, embody scientists' best understanding of how the climate system works and are crucial to making predictions and shaping policies. We think that analogous general ecosystem models (GEMs) could radically improve understanding of the biosphere and inform policy decisions about biodiversity and conservation. Currently, decisions in conservation are based on disparate correlational studies, such as those showing that the diversity of bird species tends to decline in deforested landscapes. GEMs could provide a way to base conservation policy on an understanding of how ecosystems actually work.

Such models could capture the broad-scale structure and function of any ecosystem in the world by simulating processes — including feeding, reproduction and death — that drive the distribution and abundance of organisms within that ecosystem. Ecologists could apply a GEM to African savannas, for instance, to model the total biomass of all the plants, the grazers that feed on the plants, the carnivores that feed on the grazers and so on. Over time, the flows of energy and nutrients could be mapped between them. All of the organisms would be grouped not by species, but according to a few key traits such as



EMBARGOED UNTIL 2:00 PM US ET THURSDAY, 17 JANUARY 2013

ECOLOGY

Essential Biodiversity Variables

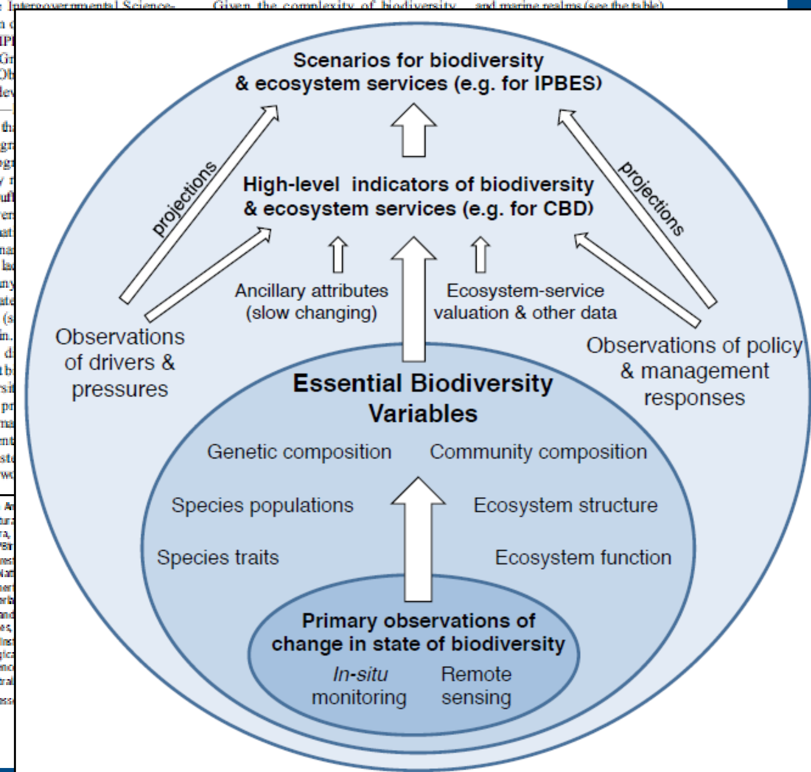
A global system of harmonized observations is needed to inform scientists and policy-makers.

H. M. Pereira,[1*†] S. Ferrier,[2] M. Walters,[3] G. N. Geller,[4] R. H. G. Jongman,[5] R. J. Scholes,[3] M. W. Bruford,[6] N. Brummitt,[7] S. H. M. Butchart,[8] A. C. Cardoso,[9] N. C. Coops,[10] E. Dulloo,[11] D. P. Faith,[12] J. Freyhof,[13] R. D. Gregory,[14] C. Heip,[15] R. Höft,[16] G. Hurtt,[17] W. Jetz,[18] D. S. Karp,[19] M. A. McGeoch,[20] D. Obura,[21] Y. Onoda,[22] N. Pettorelli,[23] B. Reyers,[24] R. Sayre,[25] J. P. W. Scharlemann,[26,27] S. N. Stuart,[28] E. Turak,[29] M. Walpole,[26] M. Wegmann[30]

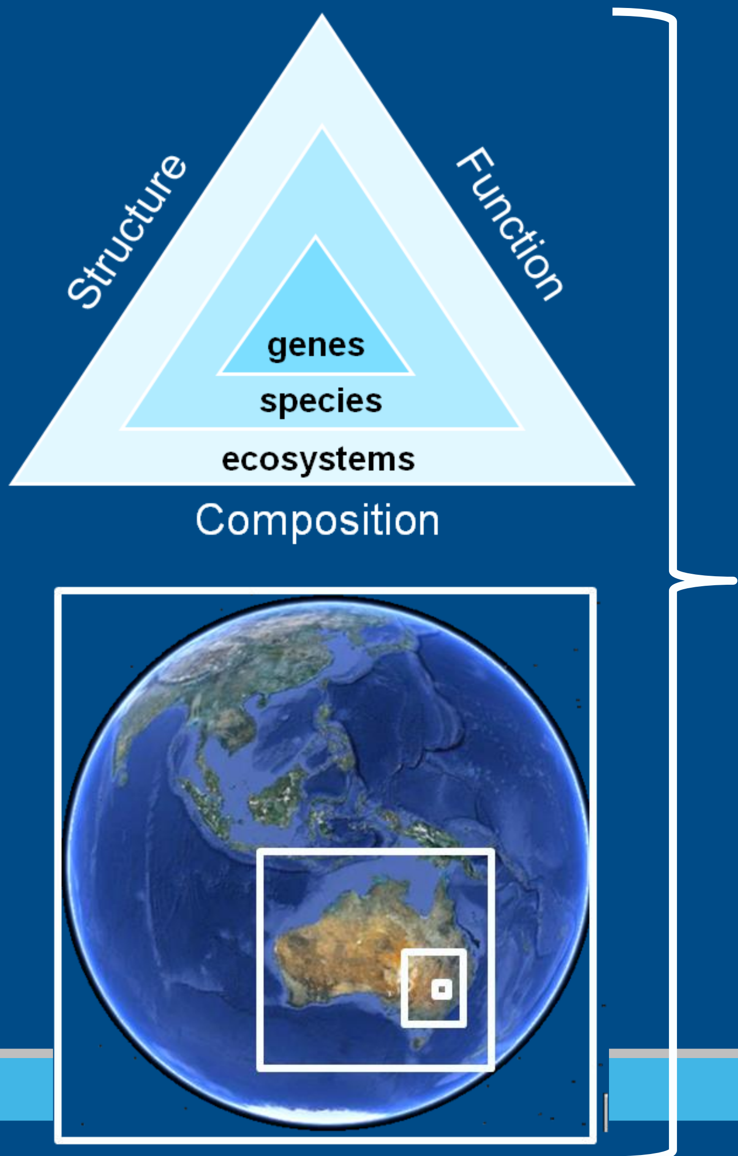
Reducing the rate of biodiversity loss and averting dangerous biodiversity change are international goals, reasserted by the Aichi Targets for 2020 by Parties to the United Nations (UN) Convention on Biological Diversity (CBD) after failure to meet the 2010 target (*1*, *2*). However, there is no global, harmonized observation system for delivering regular, timely data on biodiversity change (*3*). With the first plenary meeting of the Intergovernmental Science-Policy Platform …

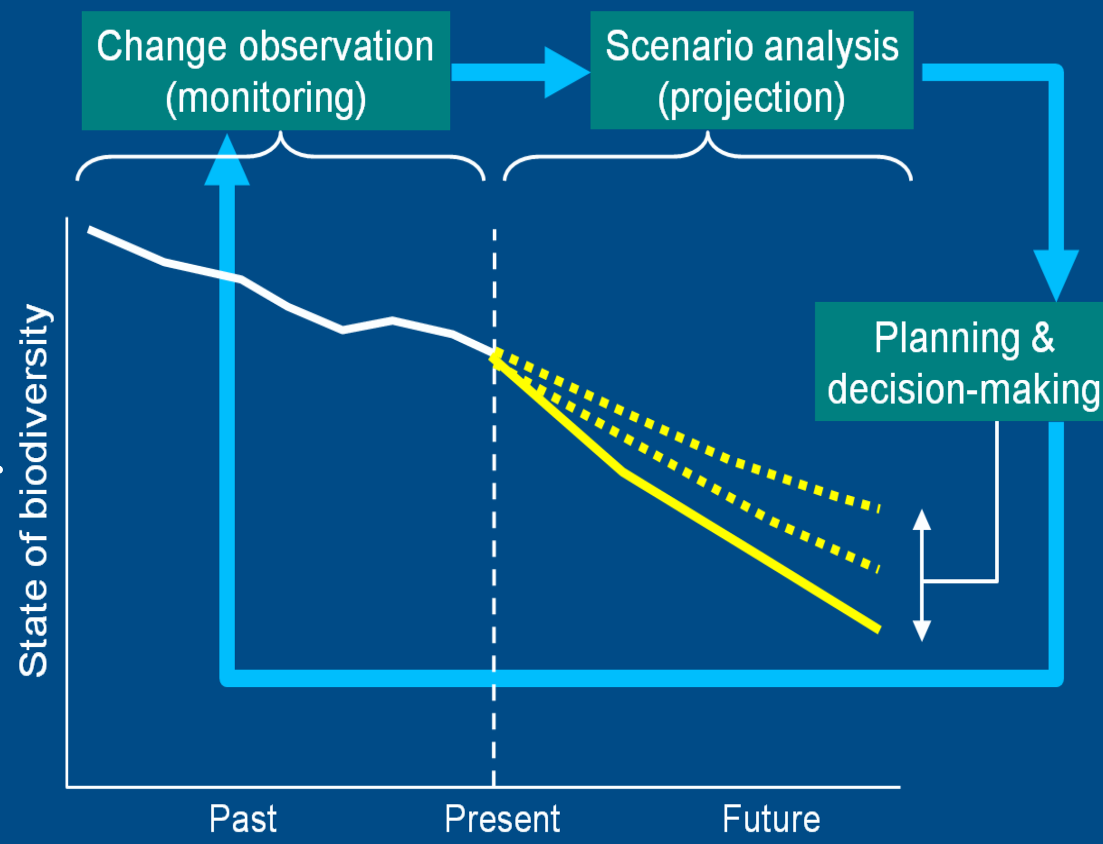
Change (UNFCCC) (*8*). EBVs, whose development by GEO BON has been endorsed by the CBD (Decision XI/3), are relevant to derivation of biodiversity indicators for the Aichi Targets (*9*). Although CBD biodiversity indicators are designed to convey messages to policy-makers from existing biodiversity data (*1*), EBVs aim to help observation communities harmonize monitoring, by identifying how variables should be sampled and measured.

… potentially fit this definition. We developed and tested a process, still ongoing, to identify the most essential (*11*). Dozens of biodiversity variables were screened to identify those that fulfill criteria on scalability, temporal sensitivity, feasibility, and relevance. These variables were scored for importance, checked for redundancy, and organized into six classes on the basis of commonalities, general enough for use across taxa and terrestrial, freshwater, and marine realms (see the table).



The challenge ahead - integration & harmonisation across scales, biodiversity dimensions, & assessment modes





Thank you

CSIRO Ecosystem Sciences
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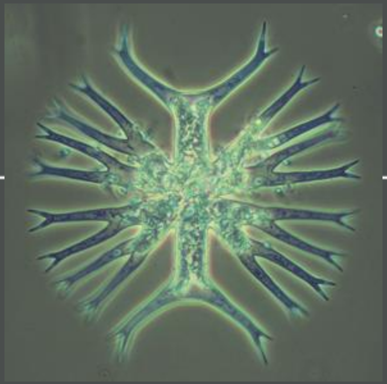
e simon.ferrier@csiro.au
w www.csiro.au

DIVERSITAS
an international programme
of biodiversity science

A contribution to IPBES:
Improving our capacity to predict global changes in biodiversity and ecosystem services

Anne Larigauderie

Paris, 21-22 October 2013



DIVERSITAS

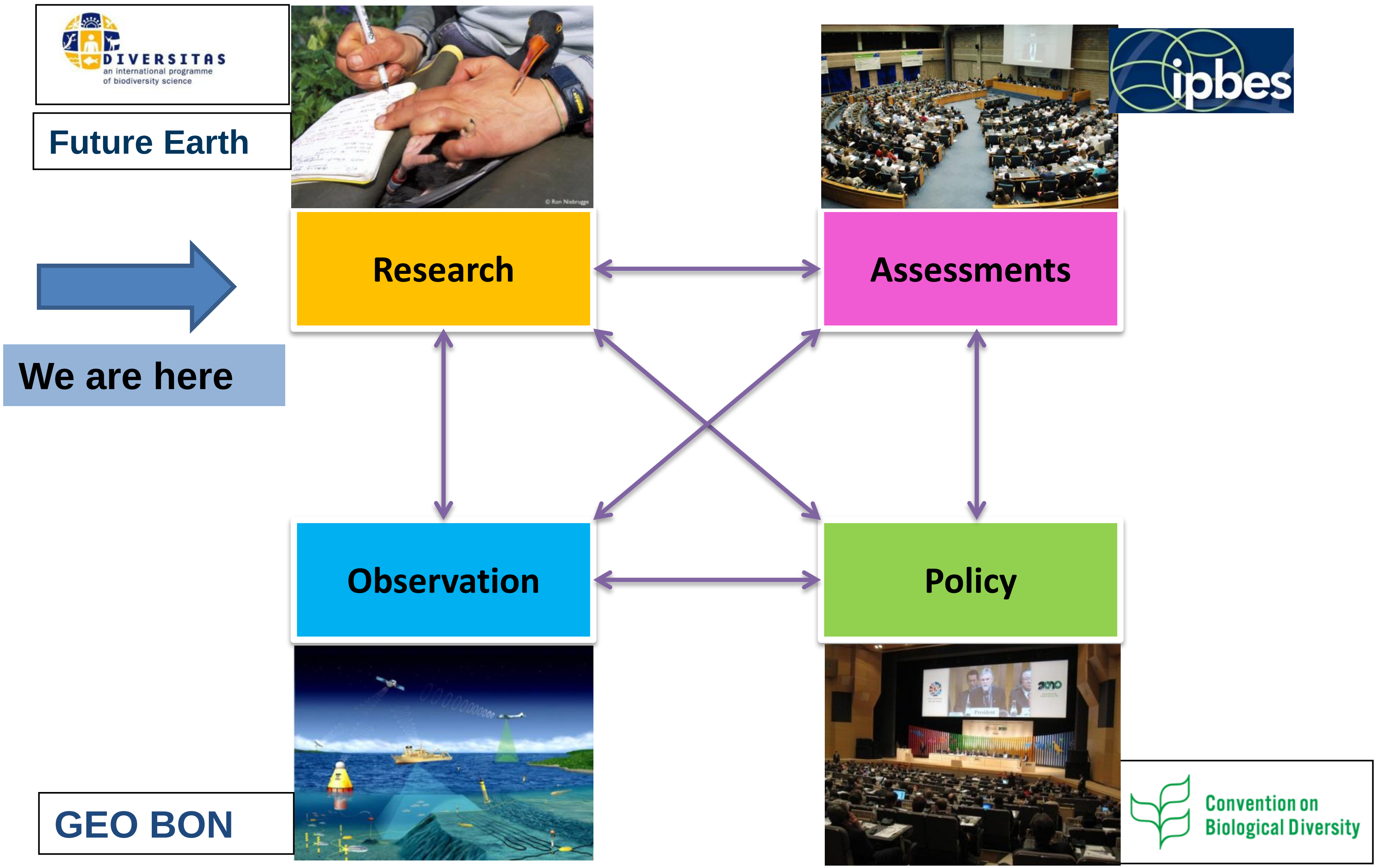
Outline

- Overall context for the call
  - Policy context (IPBES, CBD)
  - Scientific context (Future Earth)

- Draft research questions




Policy context: Biodiversity science-policy interface



BELMONT FORUM

ICSU
International Council for Science

UNITED NATIONS UNIVERSITY

futurearth
research for global sustainability

ISSC
international social science council

UNESCO
United Nations Educational, Scientific and Cultural Organization

IGFA
International Group of Funding Agencies for Global Change Research

UNEP

WMO as observer

The mission of Future Earth

- To provide societies with the knowledge required to face the risks posed by global environmental change and
- To seize opportunities in the transition to global sustainability

photos: www.dawide.com

photos: www.dawide.com

Examples of questions Future Earth will need to answer

- How and why is the global environment changing?
- What are likely future changes?
- What are the implications for human wellbeing and other species?
- What choices can be made to reduce harmful risks and vulnerabilities, enhance resilience & create prosperous and equitable futures?


photos: www.dawide.com


photos: www.dawide.com

Need for a new approach

The challenges of global environmental change and sustainable development require a new approach which is:

- More integrated
- More international
- More collaborative
- Co-designed with users, funders
- More responsive to society's needs
- And which builds on the success of current international research programmes

Proposed integrated research themes

- Dynamic Planet
  - Understanding how the system works & predicting how it will change
- Global Development
  - Addressing the most pressing needs of human development (food, water, health, energy); Short term
- Transformation towards Sustainability
  - Focusing on long term transformations needed to move to a sustainable future (Long term)

Proposed cross cutting capabilities

- Observing systems
- Data systems
- Earth system models

  Build the next generation of models that better capture the dynamics of human environment interactions, feedbacks and thresholds in the Earth system and that allow for predictions of risks and change on longer time and more detailed regional scales.
- Theory development

A Collaborative Research Action

Proposed by:

- DFG (Germany)
- ANR (France)
- DIVERSITAS

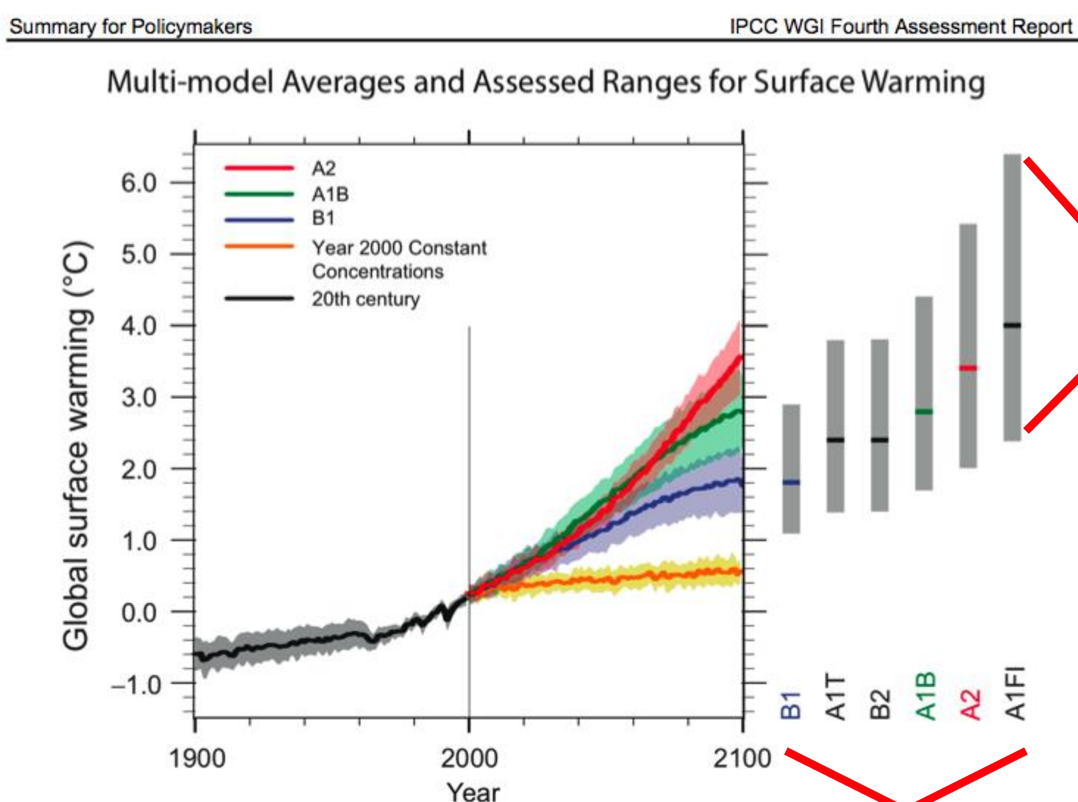
Supported by:

- IHDP
- IGBP
- IPBES
- Convention on Biological Diversity

Overall goal of proposed CRA

Stimulate international collaboration to improve our capacity to model changes in biodiversity and ecosystem services as a response to various socio-economic scenarios

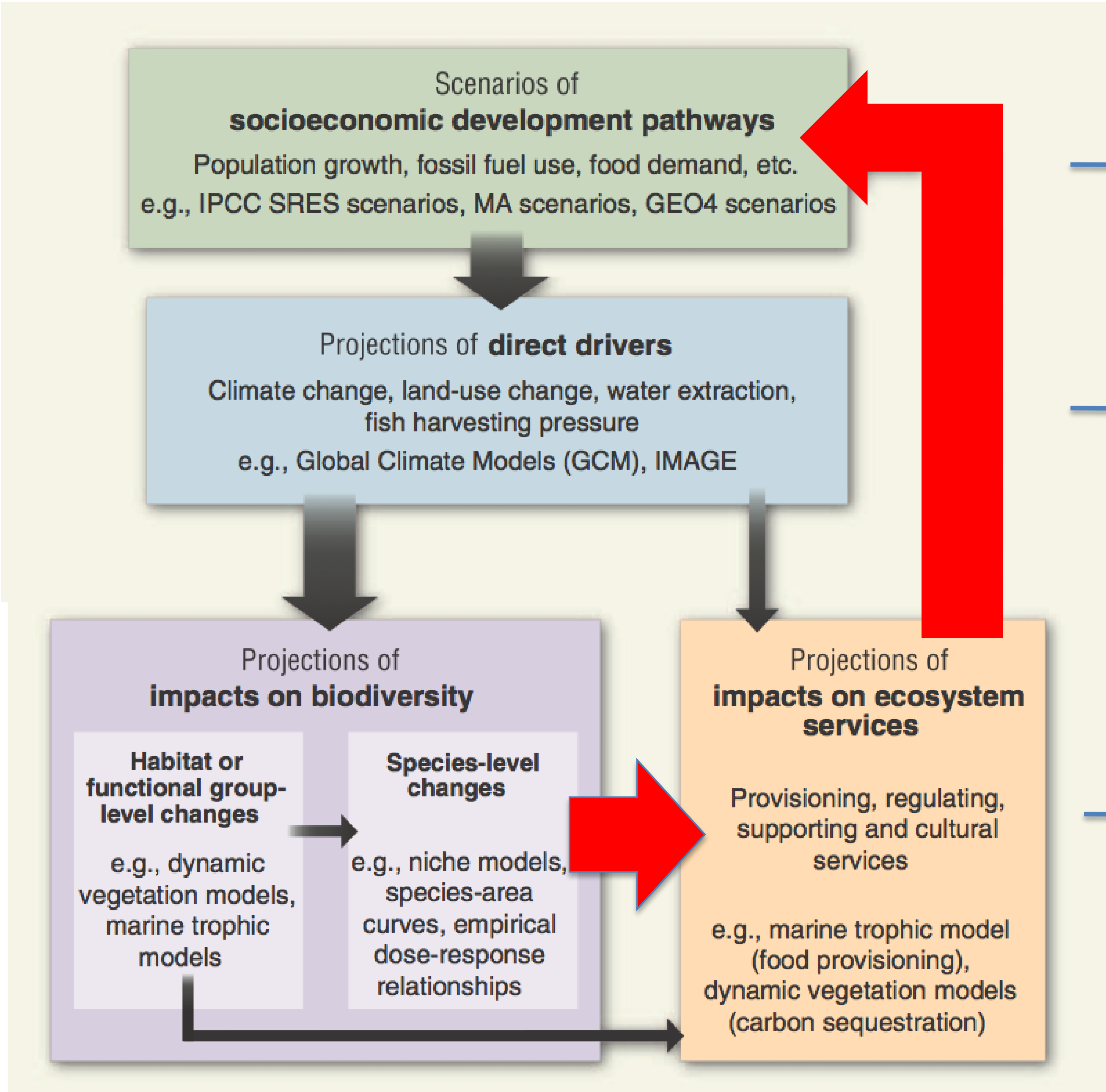
Projecting future changes according to several socio-economic scenarios & climate models: the IPCC approach



Uncertainty due to range of climate models for IPCC

Uncertainty due to range social-economic development scenarios (SRES for IPCC, MA for MA)

IPBES Terminology



'Scenarios' of socioeconomic development

'Models' of direct drivers

'Models' of biodiversity And ES

'Scenarios + Models' *(= Scenarios)*

Pereira, Leadley et al. 2010. Science.

What needs to be done in terms of knowledge generation for IPBES? Intensify work on scenarios & models

• **Socioeconomic <u>Scenarios</u>**

- Create scenarios that explicitly take into account biodiversity
- Generate scenarios based on policy maker & stakeholder input
- Develop a framework for cross-scale consistency between regional & global scenarios

• **<u>Models</u> of biodiversity and ecosystem services**

- Define common metrics for models and data
  (parameterization, validation, policy relevance)
- Intercomparison of models to better understand models & quantify uncertainty
- Couple biodiversity and ecosystem services in models
- Link and harmonize regional and global analyses
- Account for a wide range of drivers
- *Include species interactions*

• **<u>Scenarios + Models</u>** - Develop models with **dynamic feedbacks** between scenarios, models of drivers, models of biodiversity & models of ecosystem services
- Evaluate tipping points in coupled human-environment systems

Leadley et al. 2010, Pereira et al. 2010, Dawson et al. 2011, Bellard et al. 2012, EU COST Harmbio, Tokyo IPBES workshop 2011, etc.

Proposed objectives of CRA (initial proposal)

- Making socio-economic scenarios more relevant for decision making
- Improving confidence in and the usefulness of projections of biodiversity and ecosystem services and their impacts on human well-being
- Using scenarios and models of biodiversity and ecosystem services to help anticipate, avoid, and manage disruptive global environmental change
- Using scenarios and models to provide insights into the institutional, economic, and behavioral changes to enhance the capacity of social–ecological systems to adapt and support biodiversity and ecosystem services under global change

Complementary objectives (pre-scoping)

- Incorporating community and ecosystem level interactions into models
- The need to link local, regional and global levels for ecological, economic and social models
- Being explicit about model uncertainties
- Increase understanding of feedbacks, tradeoffs and co-benefits
- Integrating marine and terrestrial biodiversity/ecosystem models
- Incorporating up-to-date observations and monitoring data into ecological, economic and social models

To conclude

Models & scenarios of BES changes represent a strategic & timely topic for a Belmont CRA:

- There is a high demand: policy context
- There is a need for collaboration across disciplines, countries, etc.

Thank you!


Intergovernmental Science-Policy Platform
on Biodiversity and Ecosystem Services (IPBES)

Contributing to IPBES

Belmont Forum, 21 Oct 2013

Anne Larigauderie

Outline

- What is IPBES?
- Draft programme of work of IPBES

What is IPBES?

IPBES-1 (January 2013)

- Intergovernmental Platform on Biodiversity and Ecosystem Services
- Inspired from IPCC: Provide policy relevant scientific knowledge to inform decision making
- Established in April 2012, Panama City
- 113 Members (Sept 2013)

A long process

Negotiation	Nov. 2008 - Putrajaya, Malaysia Oct. 2009 - Nairobi, Kenya June 2010 - Busan, Republic of Korea
Modalities of operation and establishment	Oct. 2011- Nairobi, Kenya April 2012 - Panama City, Panama
Operation--alisation	Jan. 2013 - First plenary meeting Dec. 2013 - Second plenary meeting

Current status

- UNEP, UNESCO, UNDP & FAO
- Secretariat hosted by Germany (Bonn)
- Governance: Bureau (H Zakri); interim Science Panel (co-chairs: M Lonsdale, C Joly)
- Rules and Procedures for IPBES
- Initial work programme (submitted to IPBES-2)
  - Draft Conceptual Framework
  - Draft Work Programme for 2014-18
  - Draft Stakeholder Engagement Strategy (ICSU & IUCN)
- Initial Budget approved (3.1 Million for 2013)

IPBES Draft Work Programme 2014-18

- **Objective 1:** Strengthen the **capacity and knowledge foundations** of the science-policy interface to implement key functions of the Platform
- **Objective 2:** Strengthen the science-policy interface on biodiversity and ecosystem services at and across **sub-regional**, **regional** and **global levels**
- **Objective 3:** Strengthen the science-policy interface on biodiversity and ecosystem services with regard to **thematic** and **methodological issues**
- **Objective 4:** **Communicate** and evaluate Platform activities, deliverables and findings

Future Earth recognised as a partner of IPBES

Objective 1 Strengthen the **capacity and knowledge foundations**

1(d): Catalyse efforts to generate new knowledge

IPBES will **catalyse efforts to generate new knowledge in dialogue with scientific organizations**, policymakers and funding organizations, while not directly undertaking new research.

The generation, access to and management of knowledge and data will be supported through a thematically widespread network of institutions and initiatives, including GEO, GBIF, **Future Earth** and other relevant initiatives.

Scenarios & models recognised as a priority in the IPBES Draft Work Programme

Objective 3 (Thematic and methodological assessments):

(a) One fast-track thematic assessment on pollination and food production *(March 2015)*;

(b) One thematic assessment on land degradation and restoration and/or one thematic assessment on invasive alien species *(March 2016)*;

(c) **Policy support tools and methodologies for scenarios analysis and modelling of biodiversity and ecosystem ser**vices *(March 2017)* based on a fast-track assessment *(March 2015)* and a guide *(August 2015)*;

(d) Policy support tools and methodologies regarding value, valuation and accounting of biodiversity and ecosystem services *(March 2017)* based on a fast-track assessment *(March 2015)* and a guide *(August 2015)*.

In summary

The proposed Belmont CRA would generate highly policy relevant new knowledge for scenario analysis and modelling of biodiversity and ecosystem services (IPBES Objective 3).

Thank you!

ICSU
International Council for Science

Reinforcing research to develop scenarios of biodiversity, ecosystem services and the usage of natural resources

-

BiodivERsA's view

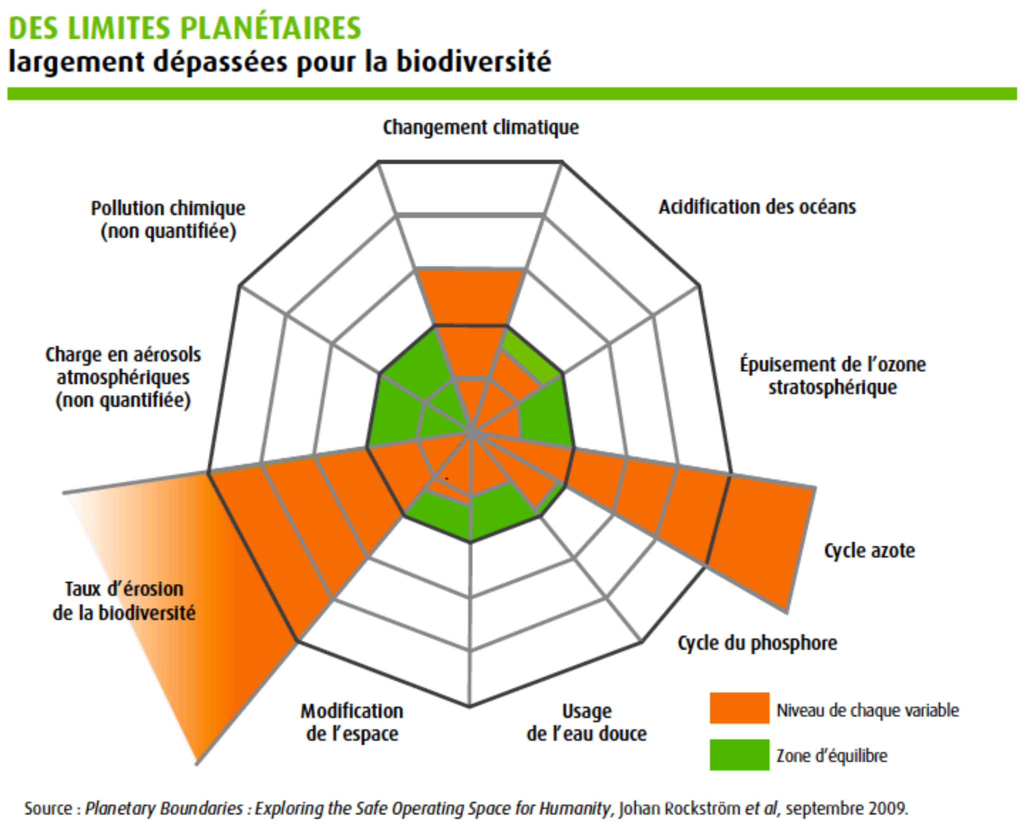
Dr. Xavier Le Roux
BiodivERsA Coordinator (FRB)

Belmont Forum workshop, 21-22 October 2013

Scientific and societal challenges:

Human societies and ecological systems interact and mutually determine each other's trajectories

In the 21st Cen … nges, socio-
economic de … vill have a
major imp … services



Much inv … urrent
trajectories an … investment
to dev … erm

Scenarios of the changes in usages of ecosystems and natural resources, access to these resources, and fate of biodiversity are increasingly needed for:

- decision making
- anticipating the consequences of decisions taken
- evaluating the impacts of policies and management practices on biodiversity and ecosystem services
- evaluating the impacts of governance mechanisms for biodiversity and services

Horizon: a few decades

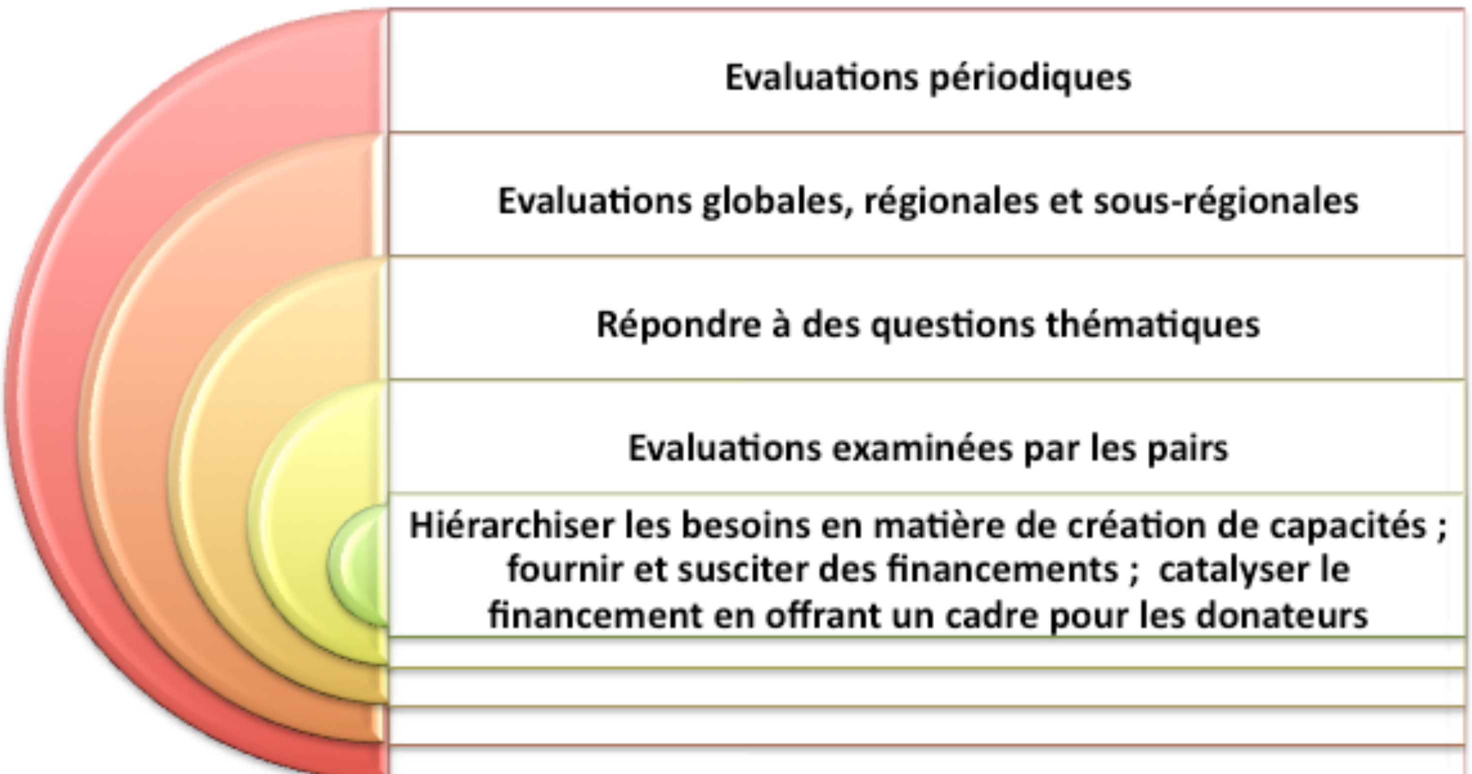
Main gaps identified:

- explore a wider range of possible futures (beyong enrgy-oriented scenarios)
- integrate humans-environment feedbacks + roles of adaptation, migration, etc.
- better coupling scenarios of biodiversity and services
- characterise uncertainties
- reinforce the relevance of scenarios
- use and develop indicators that may be used by policy makers

Need of research programs mobilising a range of disciplines, in particular social sciences, to tackle these issues

Urgent to support this research topic:

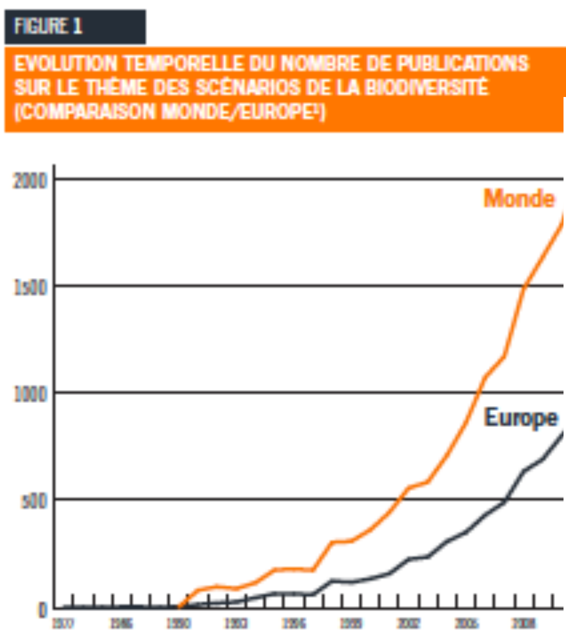
<u>Creation of IPBES, with an increasing need of biodiversity scenarios:</u>

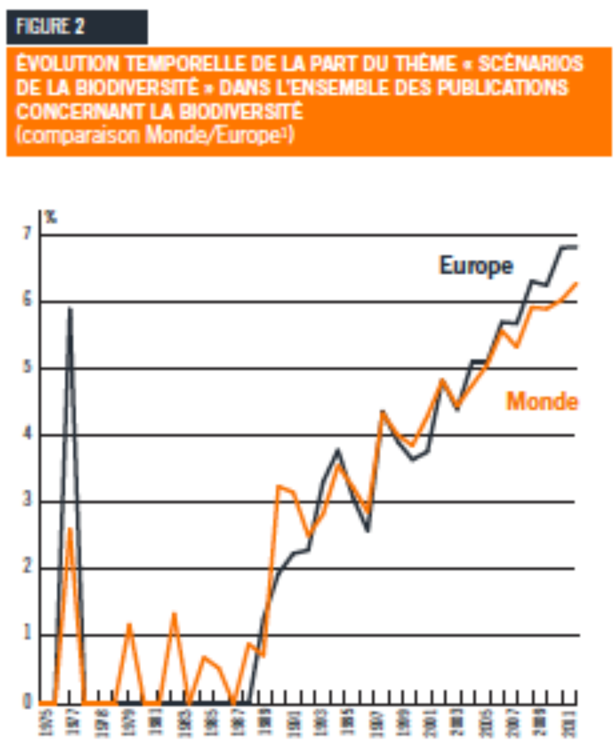


In particular:
Scenarios of biodiversity & services

An increasingly important research topic for the scientific community:

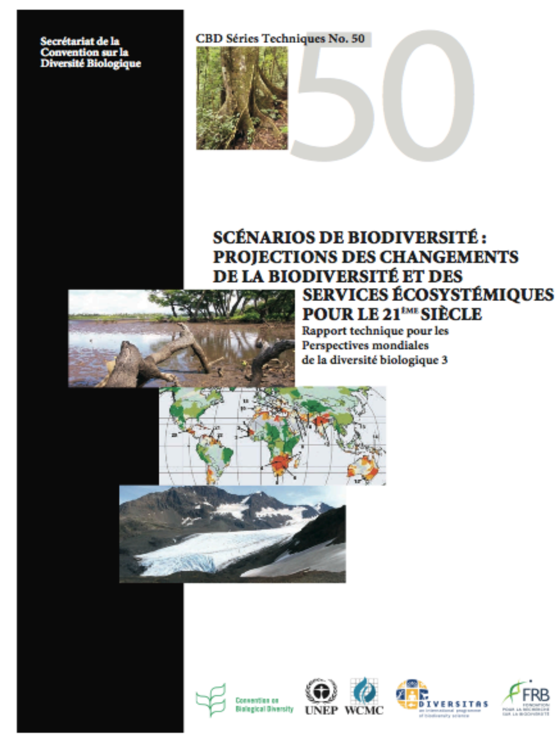
<u>Increasing part of biodiversity research linked to scenarios:</u>





FRB report (2012)

<u>Key articles and syntheses during the last decade:</u>



GBO3 – Leadley et al. (2010)

A research topic that just begins to be strategically promoted by funders:

At the national scale in France: the FRB flagship programme « Biodiversity Modelling and Scenarios »

FRB
FONDATION
POUR LA RECHERCHE
SUR LA BIODIVERSITÉ

Developing innovative research projects

↓

Calls for proposals ➔ ca. 12 projects funded (200 000 Euros each)

Strenghtening links between national initiatives and actors

↓

- construction of a national network
- project building workshop(s)
- etc.

Evaluating research potential and stakeholders' needs

↓

- overview of scenario-building tools, types of scenarios developed
- Dialog with stakeholders

A research topic that just begins to be strategically promoted by funders:

At the European scale by BiodivERsA:

A call launched in 2011-2012: *Biodiversity scenarios; identifying tipping points; improving resilience*
(€8.8M ; 9 European countries)

<u>Great success</u>
But broad topic makes it harder to specifically support research on biodiversity scenarios

MAIN RESEARCH PRIORITIES

- **Analyse & compare different plausible futures**
- **Evaluate dynamics & interactions of socio-ecosystems (1 to a few decades**)

- Explicit the issue of uncertainty
- Account for all biodiversity dimensions (genes → ecosystems ; including intra-species diversity)
- Do not forget North-South relations
- Terrestrial ecosystems, fresh water, coastal and marine

MAIN RESEARCH PRIORITIES

- Develop and use scenarios to analyse the relationships between global change, biodiversity and ecosystem services:
- **Ultimately, guide management and policies…**
- **…as an emergency, support key fondamental issues** to be tackled for improving biodiversity scenarios

MAIN RESEARCH PRIORITIES

- Use different socio-economic scenarios to test a range of management and policy options for mitigating or adapting to global change (account for main socio-economic activities!)
- Retroactions of ecosystems on human societies should be explored
- Priorities in terms of services or ecosystems to be protected?

Better mobilisation of both natural and social sciences!
Stronger link with stakeholders!

Laboratoire d'Ecologie, Systématique et Evolution
Belmont Forum – CRA – Oct 2013

BELMONT FORUM

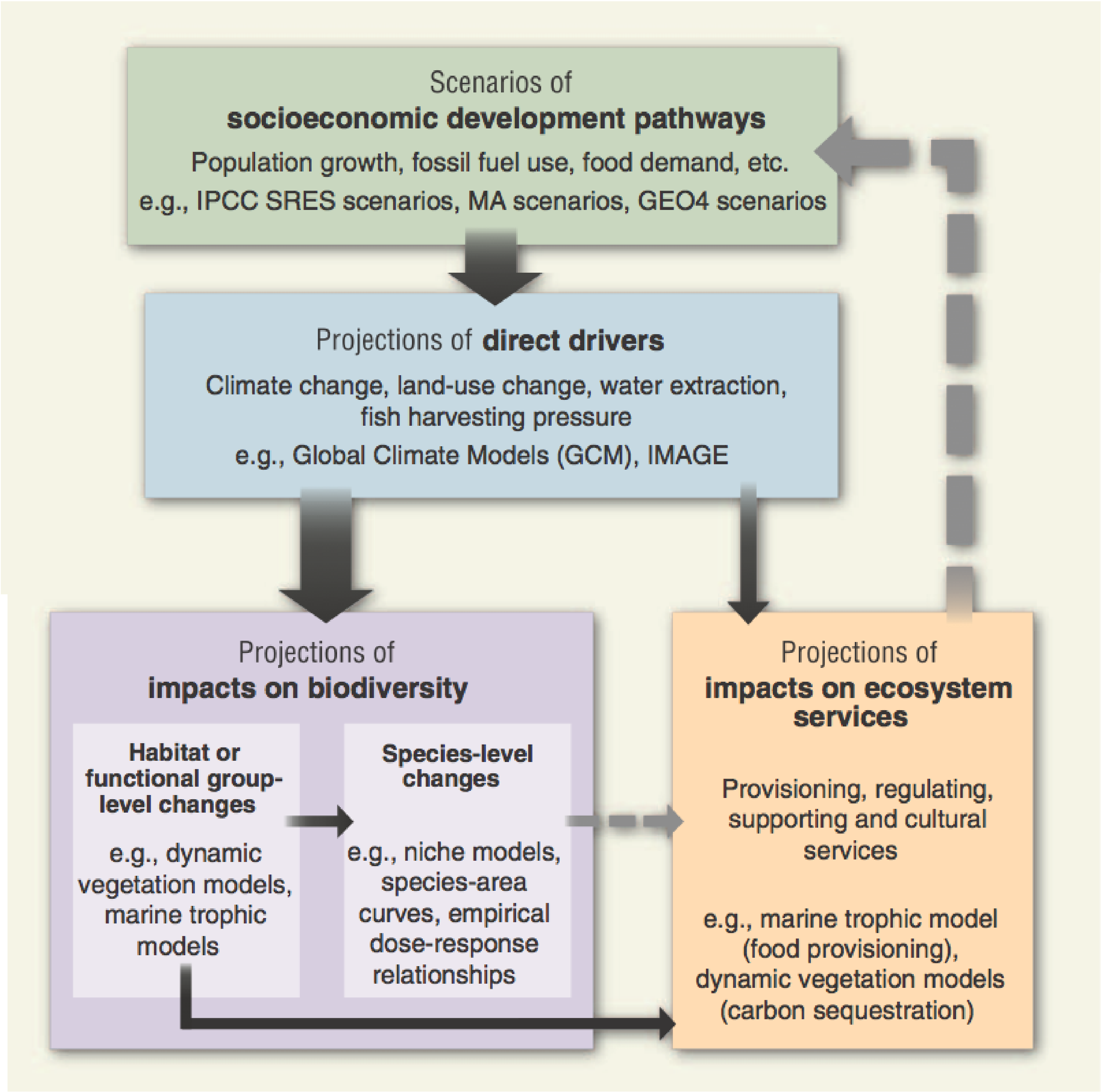
Overview of socio-economic scenarios and models of their impacts on biodiversity and ecosystem services

Paul Leadley
Univ. Paris-Sud

DIVERSITAS
an international programme of biodiversity science

Future Earth
research for global sustainability

bioDISCOVERY
a core project of DIVERSITAS



Scenarios & Models of Global Change, Biodiversity and Ecosystem Services

Pereira, Leadley et al. 2010. Science.

Overview of scenarios and models of biodiversity and ecosystem services

- Making socio-economic scenarios more relevant for decision making.

- Improving confidence in and the usefulness of projections of biodiversity and ecosystem services and their impacts on human well-being.

- Using scenarios and models of biodiversity and ecosystem services to help anticipate, avoid, and manage disruptive global environmental change.

- Using scenarios and models to provide insights into the institutional, economic, and behavioural changes to enhance the capacity of social–ecological systems to adapt and support biodiversity and ecosystem services under global change.

•

Socio-economic scenarios:

Developing policy relevant scenarios
and
Harmonizing across spatial and temporal scales

Methods for looking into the future

- **Qualitative scenarios – e.g., based on case studies and national commitments**

- **Extrapolations from current trends – statistical**

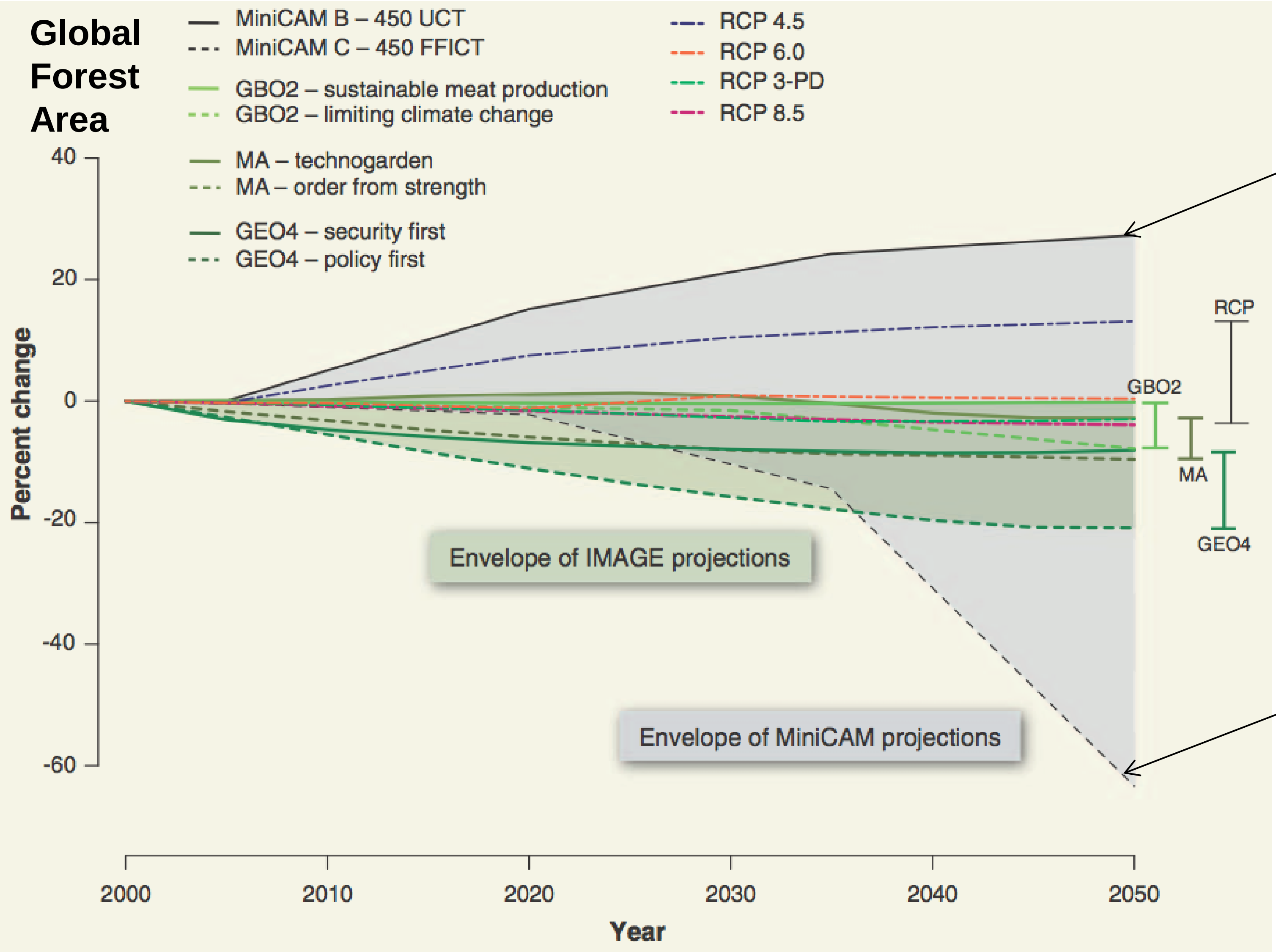
- **Extrapolations from current trends – with hypotheses or probablistic**

- **Socio-economic storylines - e.g. MA, GEO, IPCC storylines.**

- **Storylines + policy options - e.g., Rethinking scenarios**

- **Backcasting analyses: working backwards from sustainable endpoints - e.g., Rio+20 scenarios**

Socioeconomic scenarios

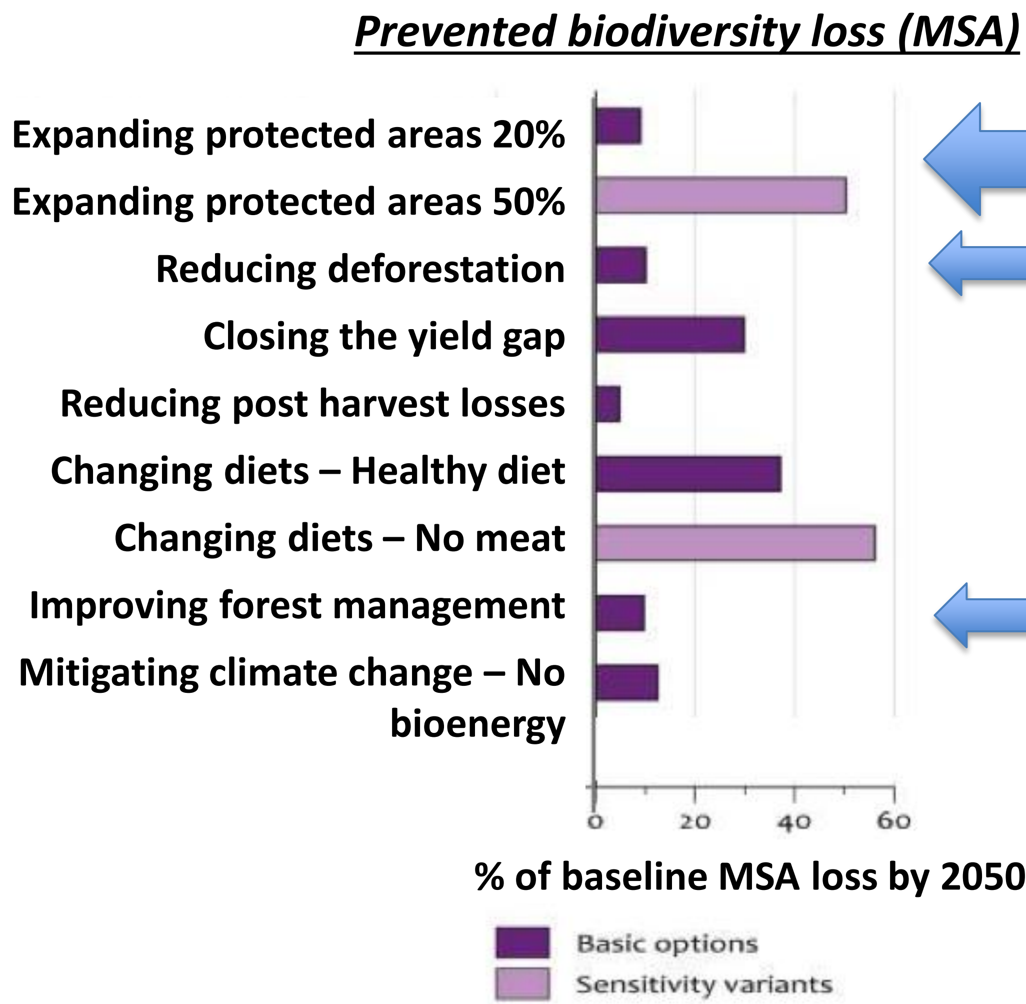


Tax on all sources of C emissions: Limited biofuels, Increased agric. efficiency,

Tax only on fossil fuel C emissions: Massive deployment of biofuels; Little improvement in agric. efficiency,

Pereira, Leadley et al. 2010 Science

Testing impacts of changes in development pathways that are 'Aichi relevant'



Target 11. Protected areas

Target 5. Habitat loss

Target 7. Sustainable mgmt

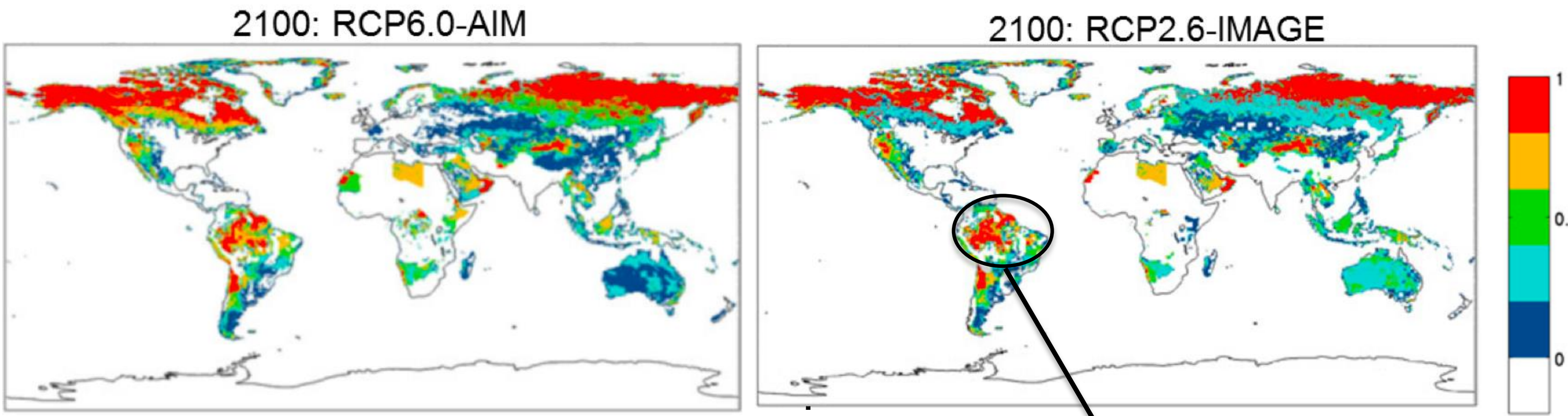
+ broadly Target 4: Sustainability

From B. ten Brink

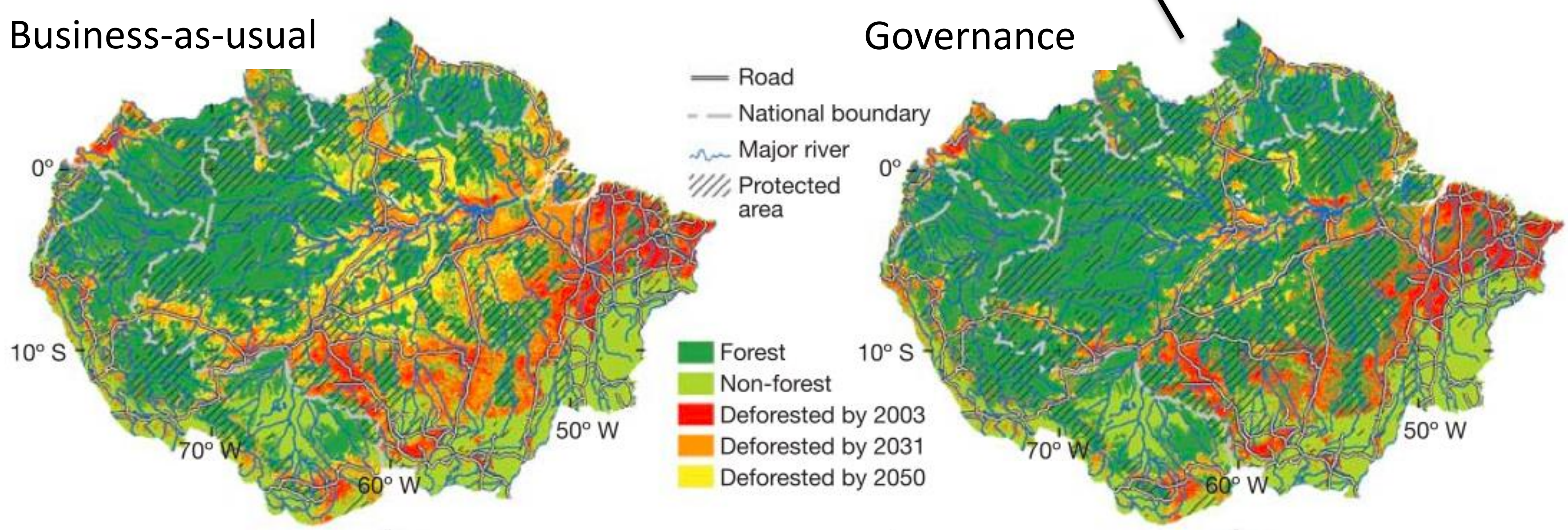
PBL Netherlands Environmental Assessment Agency

Scaling and harmonizing socio-economic scenarios

IPCC AR5 RCP land use



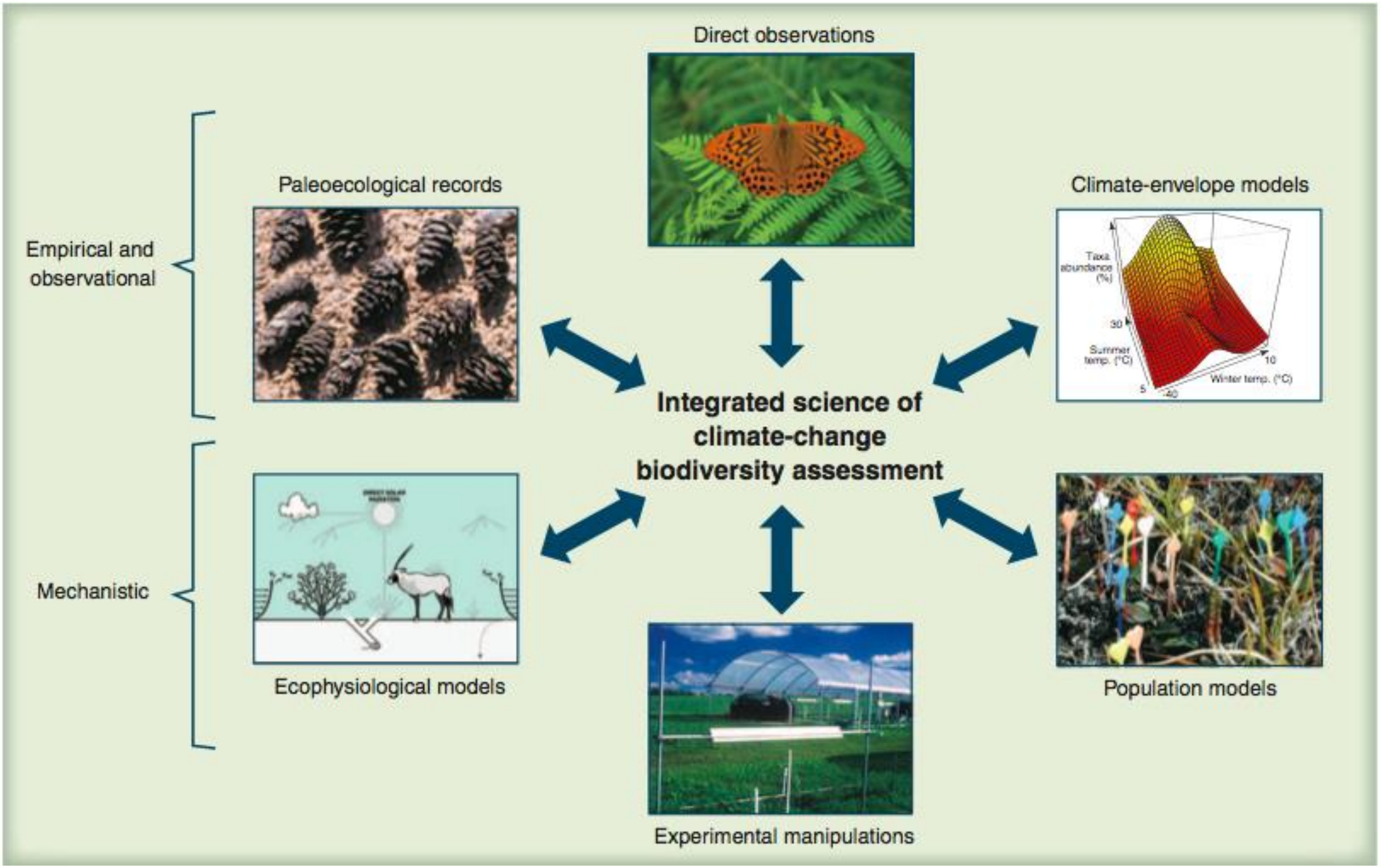
Amazon basin scenarios 2050



Soares-Filho et al. 2006 Nature

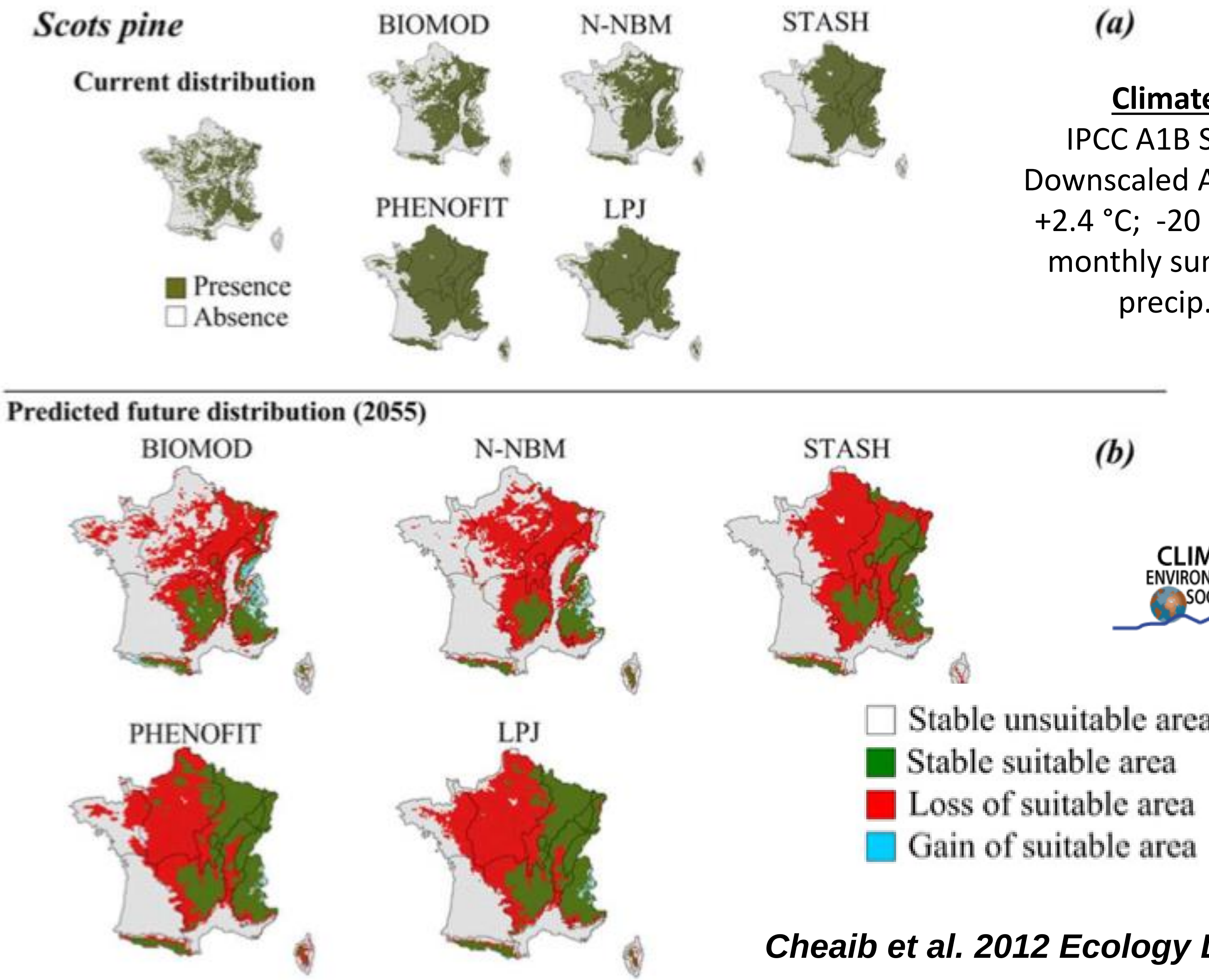
Models of global change impacts on biodiversity and ecosystem services

Models of climate change impacts on biodiversity & ecosystems: a need for better integration of models and data



Dawson et al. 2011 Science

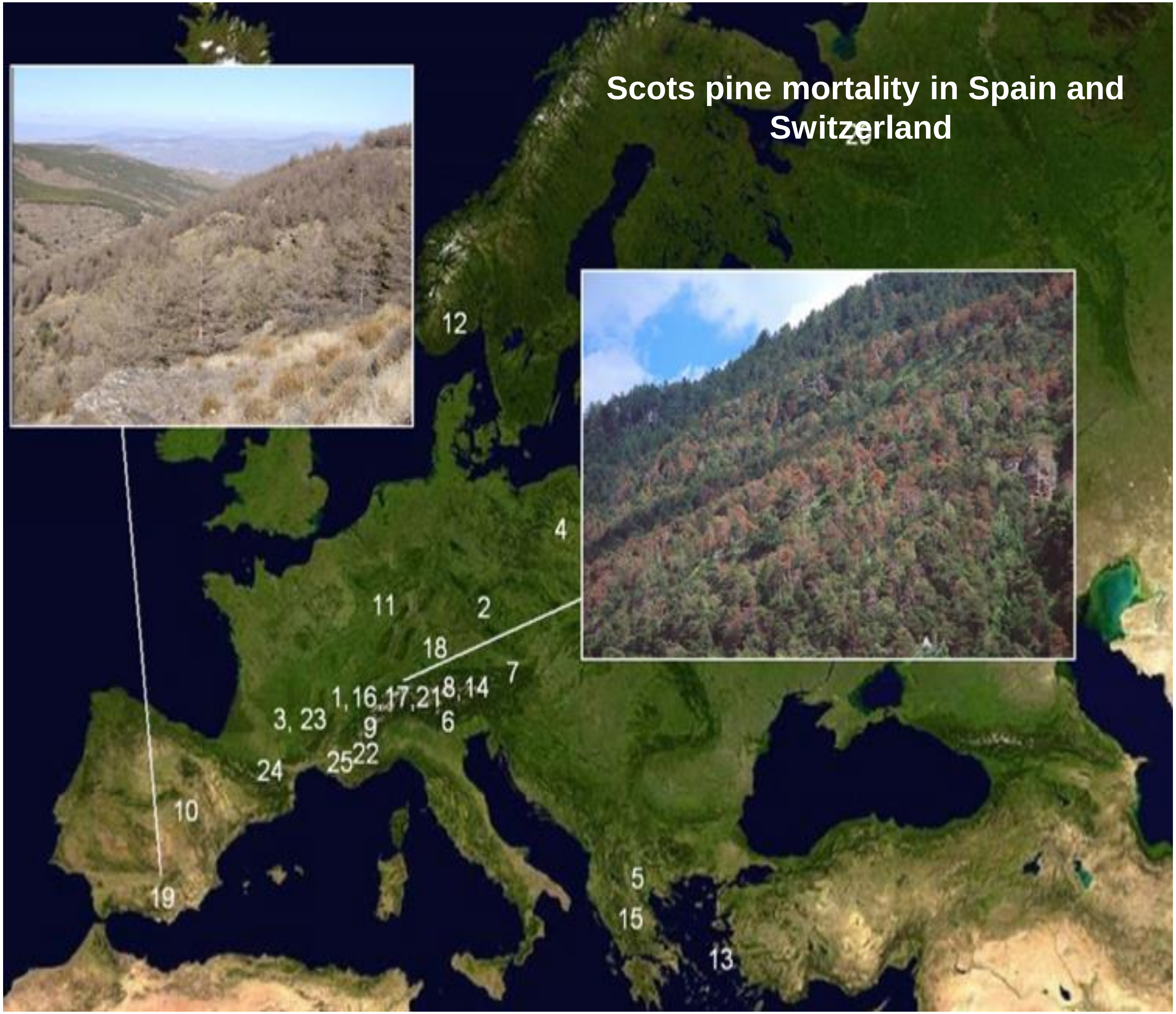
Model intercomparison to help quantify uncertainty in climate change impacts on trees: Scots pine in 2055



Climate
IPCC A1B SRES
Downscaled ARPEGE
+2.4 °C; -20 mm in monthly summer precip.

Cheaib et al. 2012 Ecology Letters

Evidence of a global scale increase in tree mortality



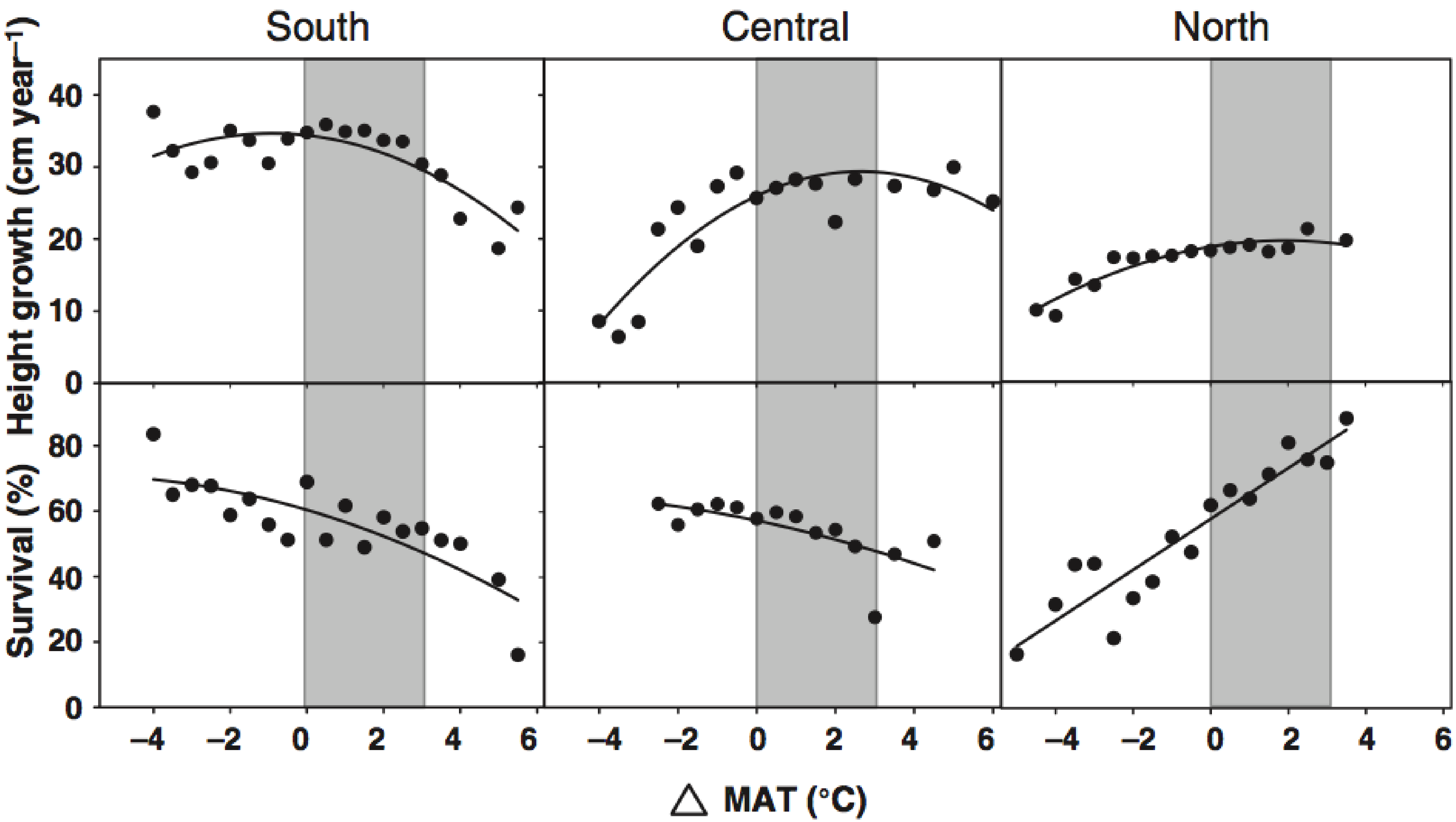
Allen et al. 2010

Ecology Letters, (2008) **11**: 588–597 doi: 10.1111/j.1461-0248.2008.01172.x

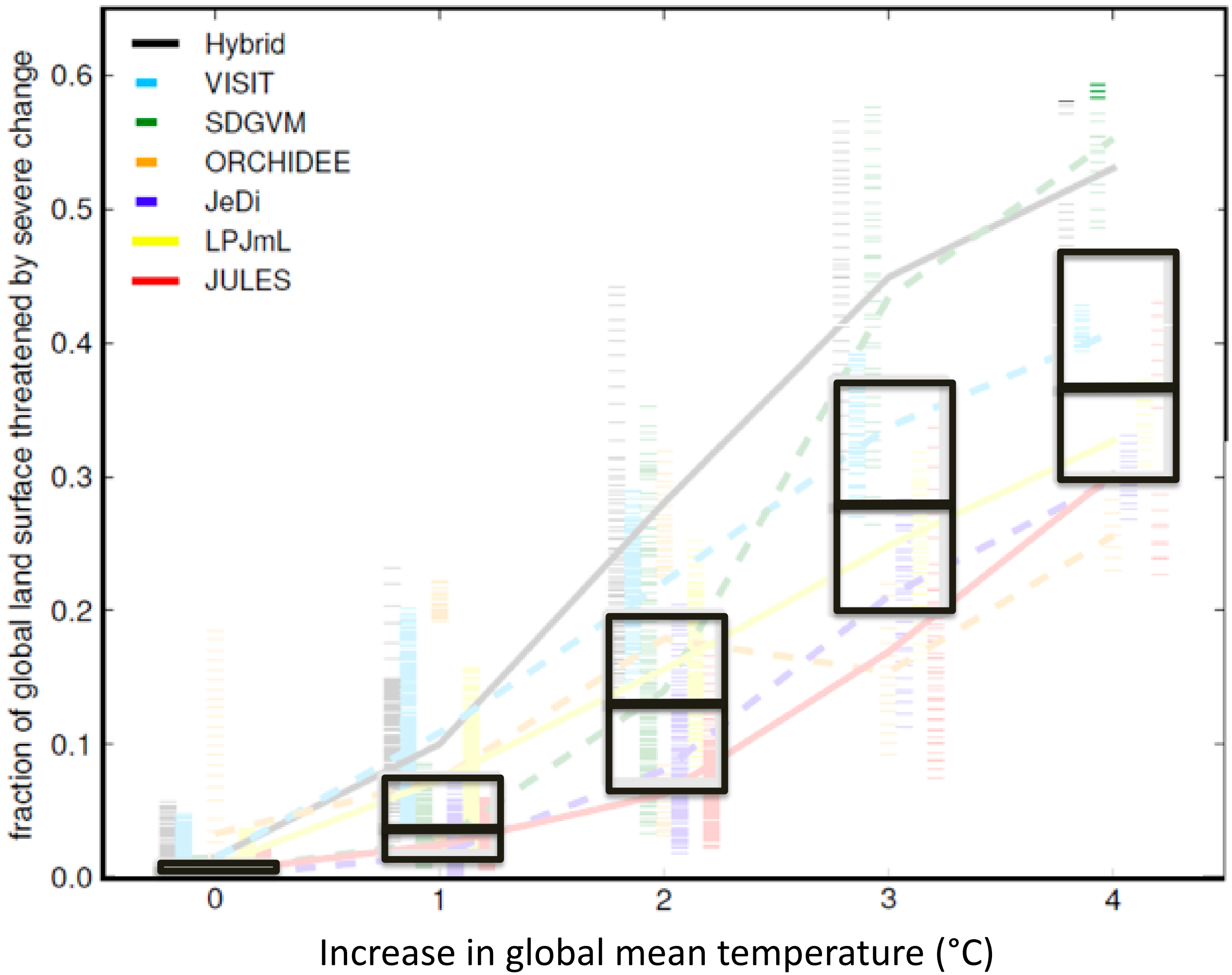
LETTER

Climate warming will reduce growth and survival of Scots pine except in the far north

P. B. Reich[1]* and J. Oleksyn[1,2]

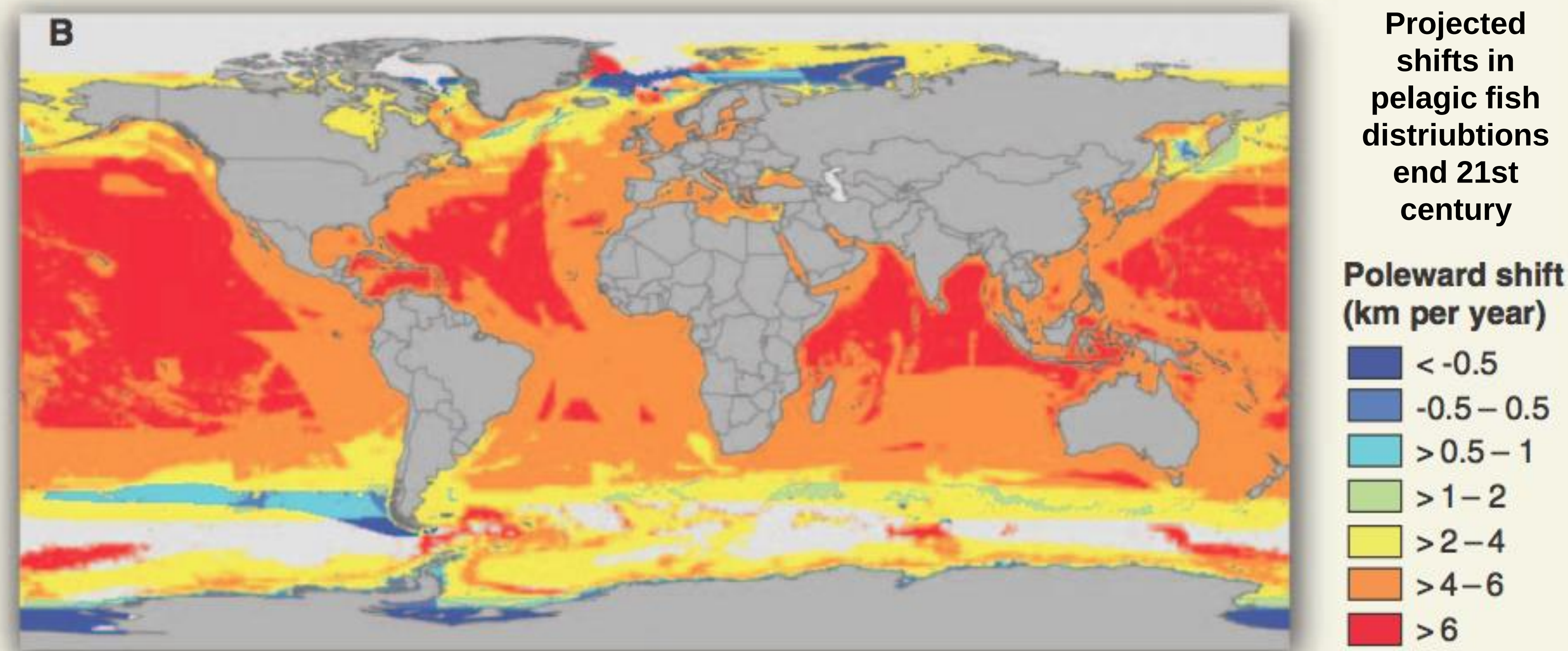


Biodiversity and ecosystem function at larger scales
Using Dynamic Vegetation Models



Linking scenarios and models of biodiversity, ecosystem services and human well being

PROJECTED SHIFTS IN THE DISTRIBUTION OF SPECIES, SPECIES GROUPS AND BIOMES



Source: Pereira, Leadley et al. 2010 Science. Based on Cheung et al. 2009. IPCC SRES A1B scenario.

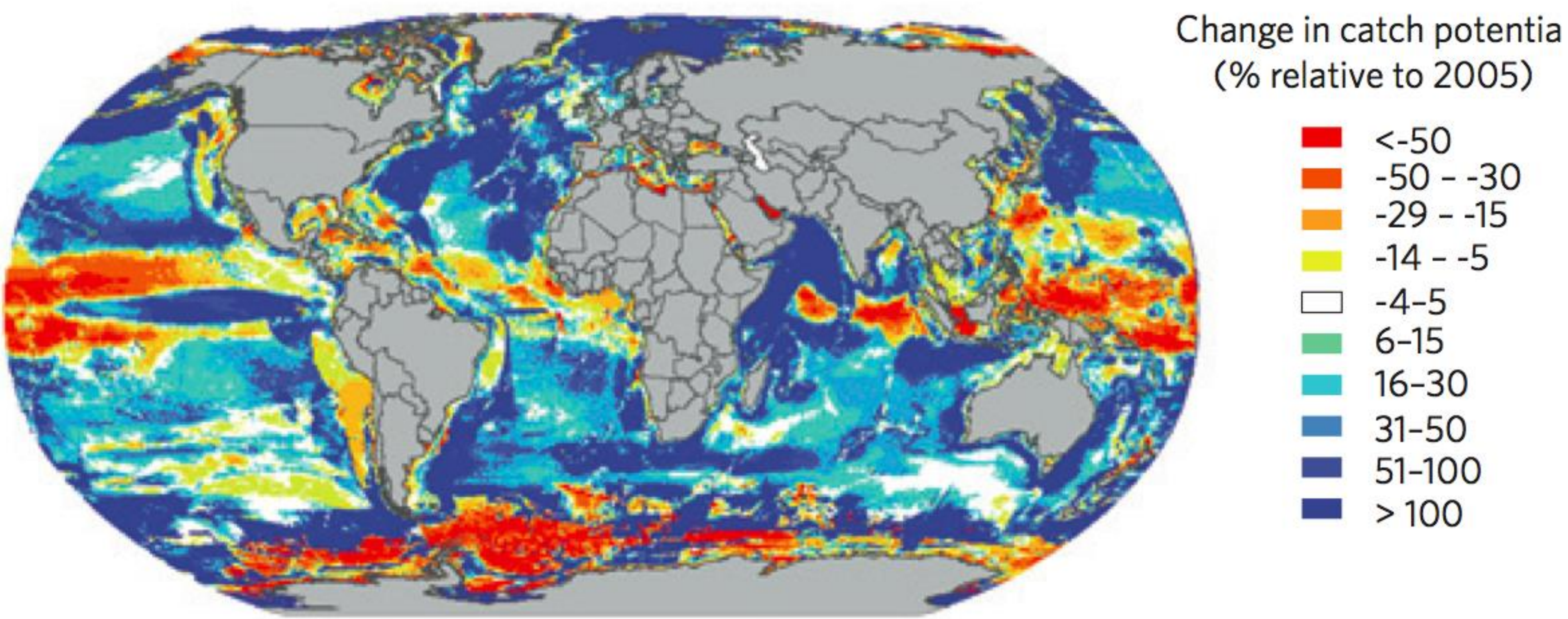
nature climate change

REVIEW ARTICLE

PUBLISHED ONLINE: 20 NOVEMBER 2011 | DOI: 10.1038/NCLIMATE1301

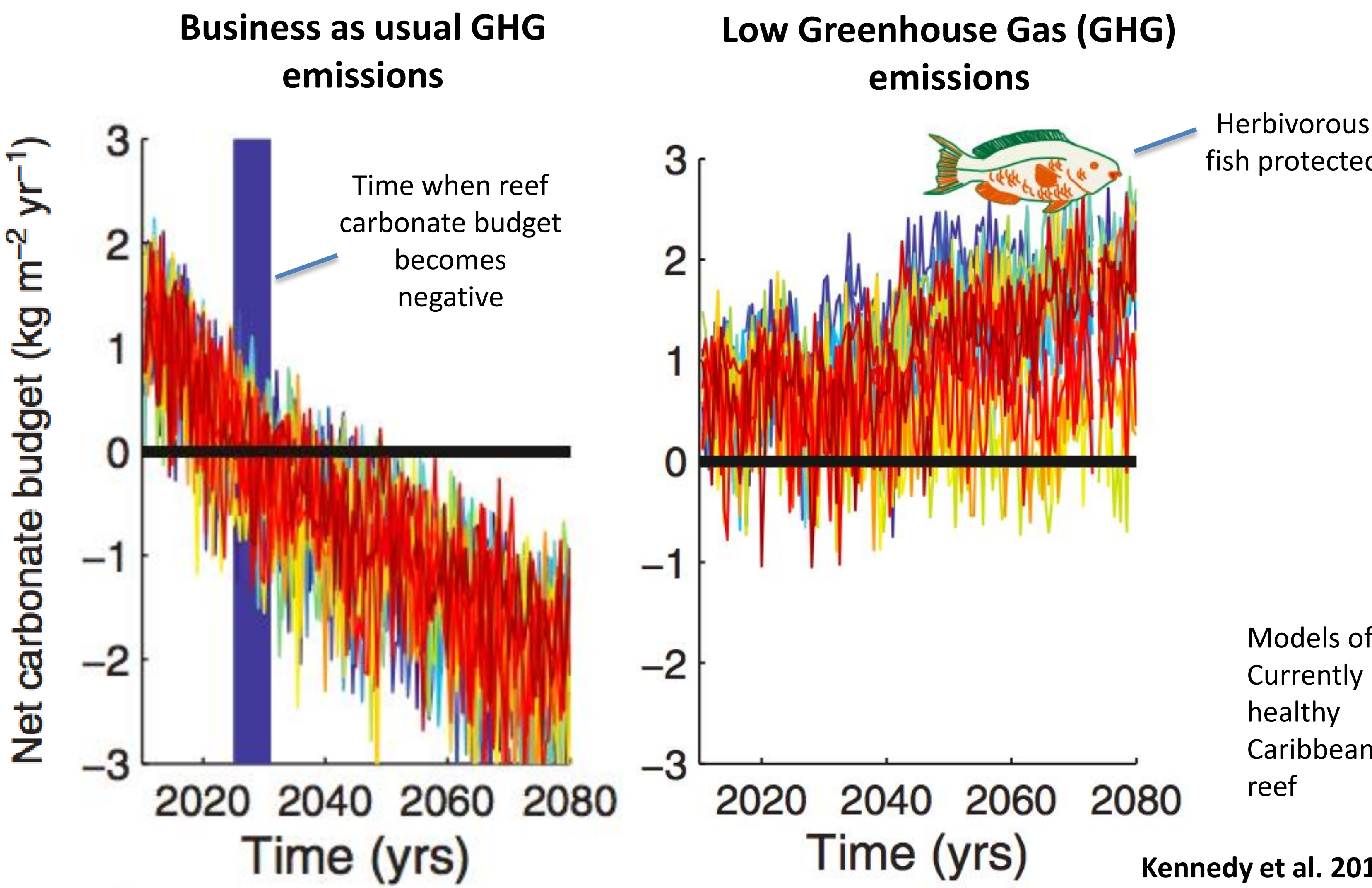
Climate change impacts on the biophysics and economics of world fisheries

U. Rashid Sumaila[1]*, William W. L. Cheung[2], Vicky W. Y. Lam[1], Daniel Pauly[2] and Samuel Herrick[3]



Target 10 - Actions to prevent tropical coral reef degradation

Global action (climate mitigation) and Local action (protection of herbivorous fish) are need



Kennedy et al. 2013

‘Backcasting’ as an innovative way to explore alternative pathways for reaching agreed upon objectives

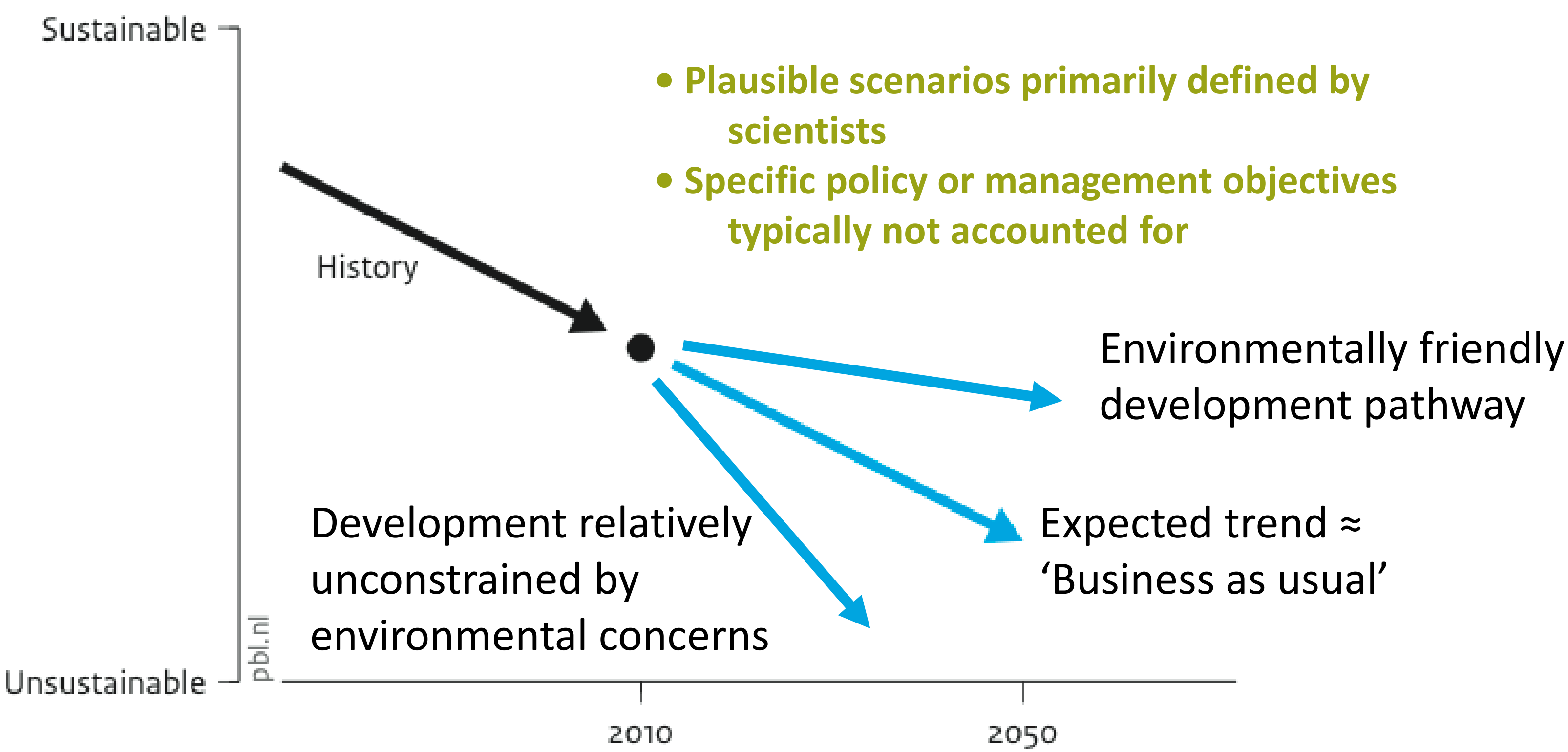
PBL Netherlands Environmental Assessment Agency

Roads from Rio+20

Pathways to achieve global sustainability goals by 2050

The ‘Storyline’ approach to developing plausible socio-economic scenarios

- Plausible scenarios primarily defined by scientists
- Specific policy or management objectives typically not accounted for



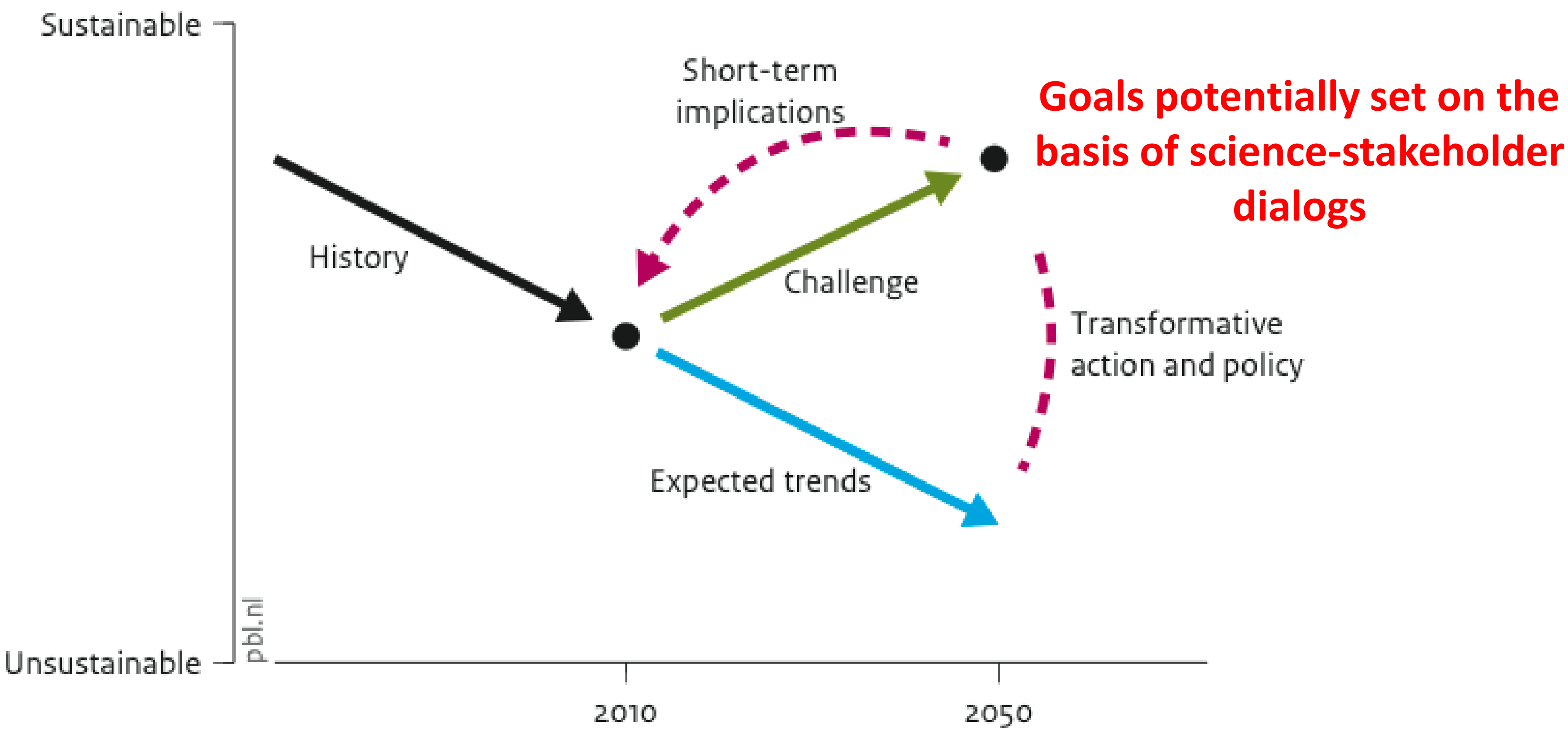
‘Backcasting’ as an innovative way to explore alternative pathways for reaching agreed upon objectives

PBL Netherlands Environmental Assessment Agency

Roads from Rio+20

Pathways to achieve global sustainability goals by 2050

Backcasting analysis, working back from a sustainable end point to determine actions for today

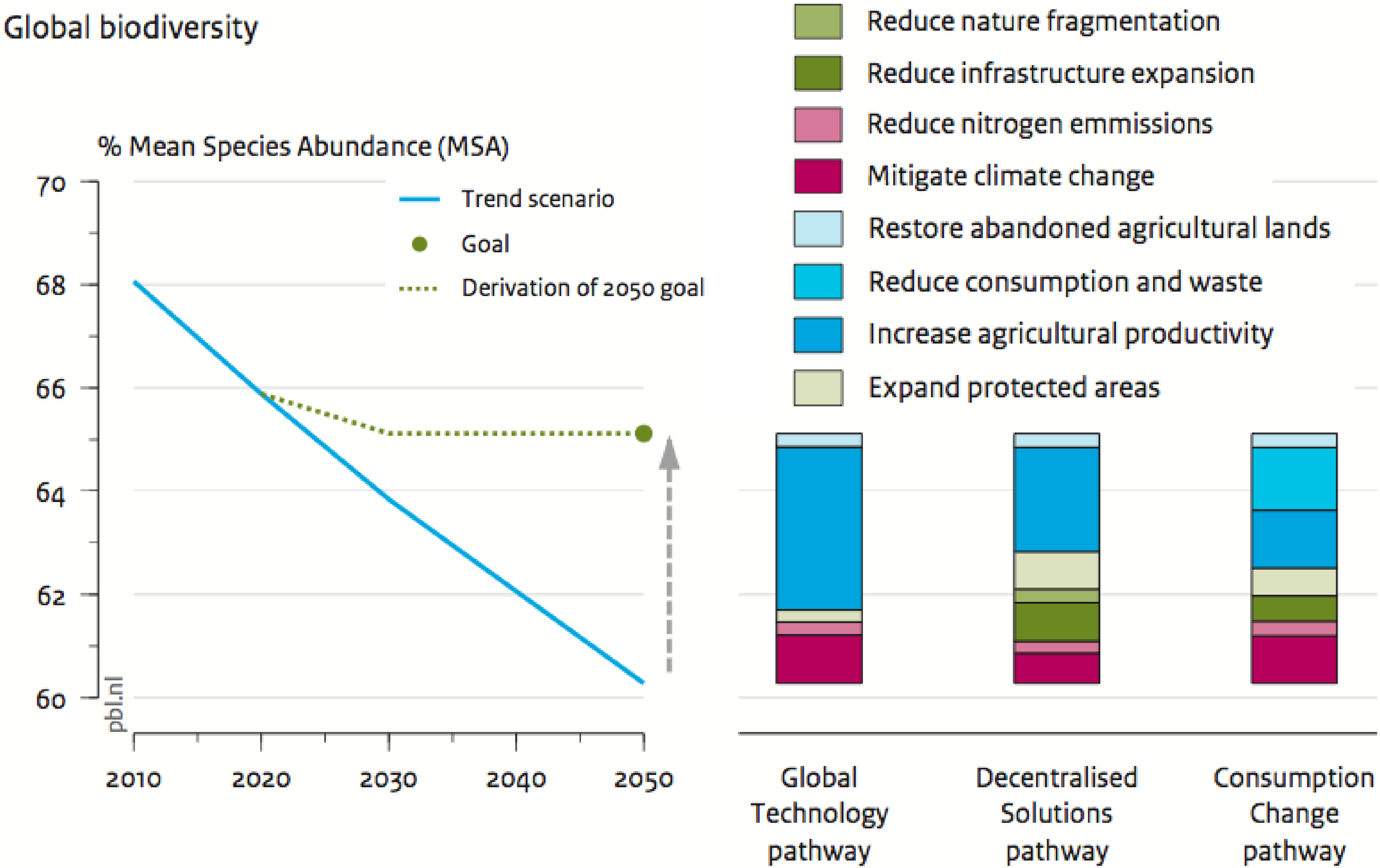


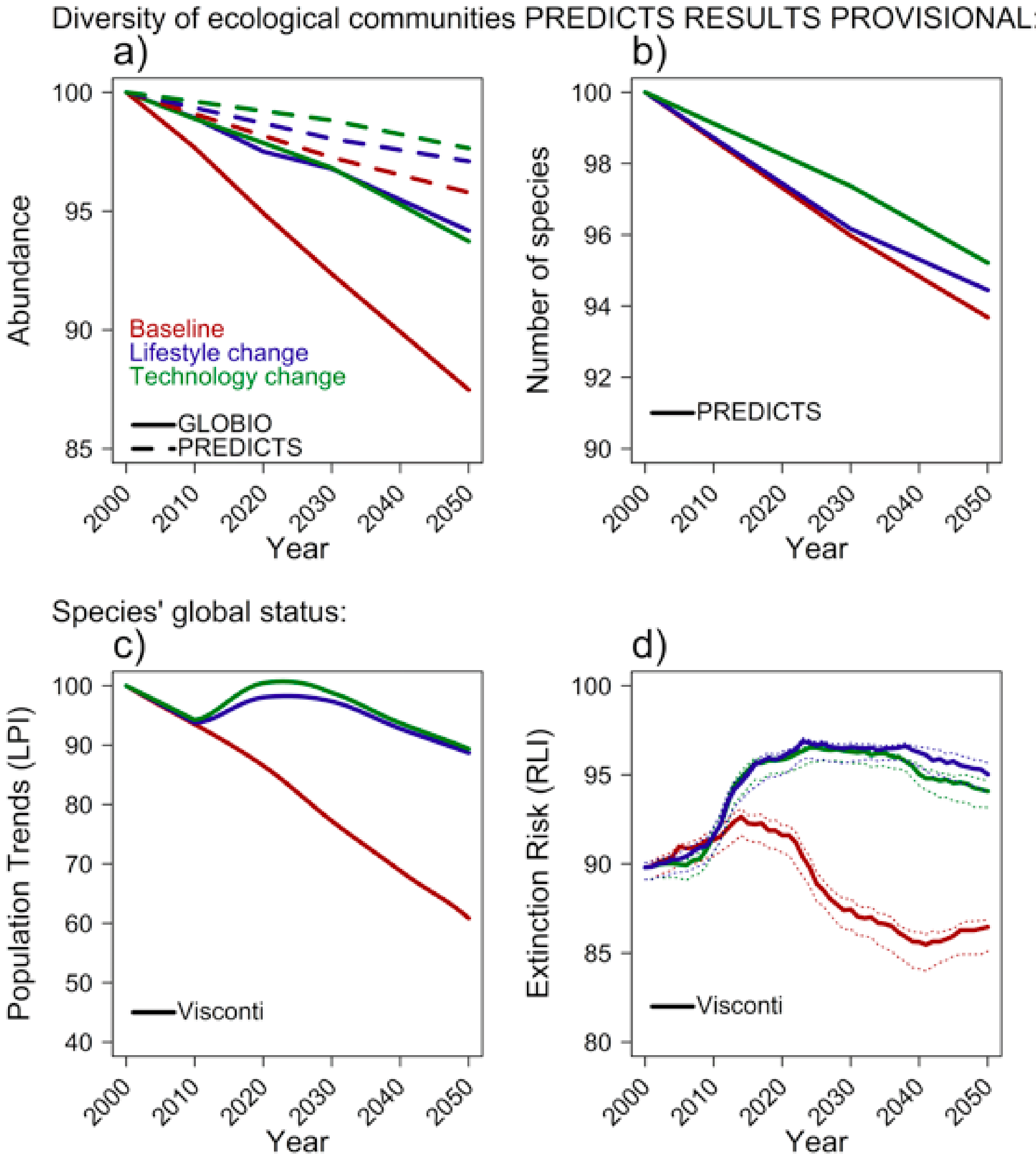
PBL Netherlands Environmental Assessment Agency

Roads from Rio+20

Pathways to achieve global sustainability goals by 2050

Global biodiversity and options to prevent biodiversity loss





Comparing multiple indicies of impacts of global change on species conservation status using the Rio+20 socio-economic scenarios

Draft for the CBD Global Biodiversity Outlook

Overview of scenarios and models of biodiversity and ecosystem services

- Scenarios and models of biodiversity and ecosystem services are a rapidly expanding field of research.

- There are several international networks focusing on these issues, for example DIVERSITAS, EU-COST Action Harmbio, SESYNC themes (US Socio-Environmental Synthesis Center), etc.

- There is a great need for international research projects especially in developing integrated scenarios and models at regional to global scales. This includes research in support of national, regional and global assessments.

Modeling and governing feed-backs between ecological and economic dynamics

Martin F. Quaas

Department of Economics
Christian-Albrechts-Universität zu Kiel

October 2013

Environmental and Resource Economics; Ecological Economics

Sustainability economics

1. Subject focus: relationships between humans and nature.
2. Orientation towards (uncertain) future.
3. Normative foundation of sustainability: justice in the relationships between
   - presently living humans (intragenerational justice)
   - future generations of humans (intergenerational justice)
   - non-human nature
4. Concern for efficiency: non-wastefulness

Baumgärtner and Quaas (2010). What is sustainability economics? *Ecological Economics* 69:445–450.

Environmental- and Resource Economics; Ecological Economics

General Approach

1. Descriptive model: Ecological and economic dynamics
2. Normative criteria to evaluate outcomes
3. Policy recommendations: Which institutions and instruments achieve the desired outcome?

Baumgärtner/Becker/Frank/Müller/Quaas (2008). Relating the Philosophy and Practice of Ecological Economics. The Role of Concepts, Models and Case Studies in Inter- and Transdisciplinary Sustainability Research. *Ecological Economics*, 67(3):384–393.

Questions and Issues

- Improve models: Take into account
  - uncertainties
  - feed-backs between ecological and economic dynamics
    (example: demand-side interactions in fisheries)
- How to meet multiple objectives?
  (example: stochastic viability analysis)
- Identifying trade-offs: Who gains, who loses?
  (example: workers in fishing industry)
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  (example: fishing quotas in terms of numbers vs. biomass)

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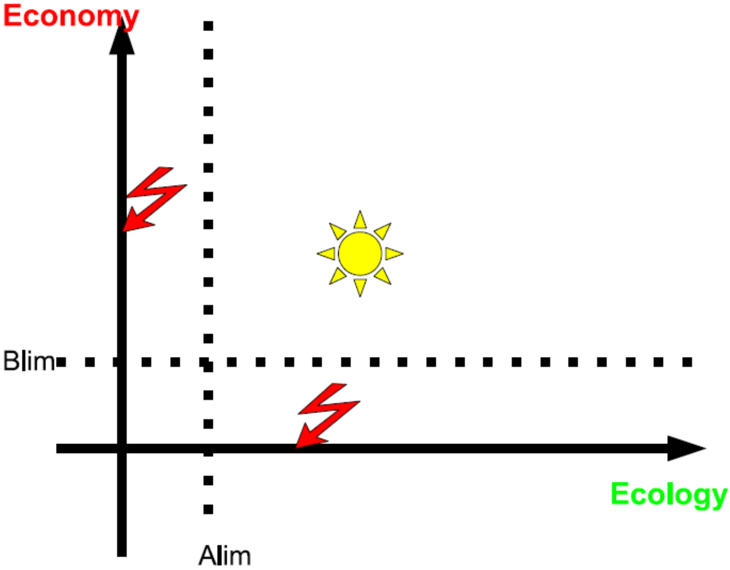
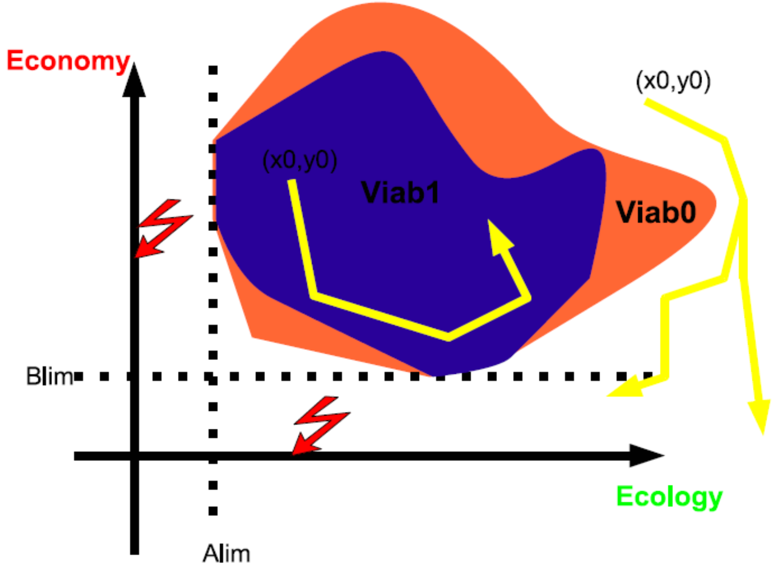
Viability

Viability



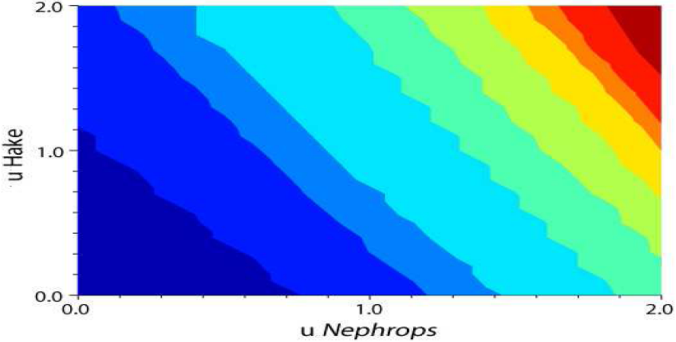
Doyen/Cissé/Gourguet/Mouysset/Hardy/Béné/Blanchard/Jiguet/Pereau/Thébaud (2013). Ecological-economic modelling for the sustainable management of biodiversity, Comput Manag Sci DOI 10.1007/s10287-013-0194-2

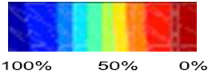
Viability analysis



Doyen/Cissé/Gourguet/Mouysset/Hardy/Béné/Blanchard/Jiguet/Pereau/Thébaud (2013). Ecological-economic modelling for the sustainable management of biodiversity, Comput Manag Sci DOI 10.1007/s10287-013-0194-2

Stochastic Viability: Multi-Species Fisheries

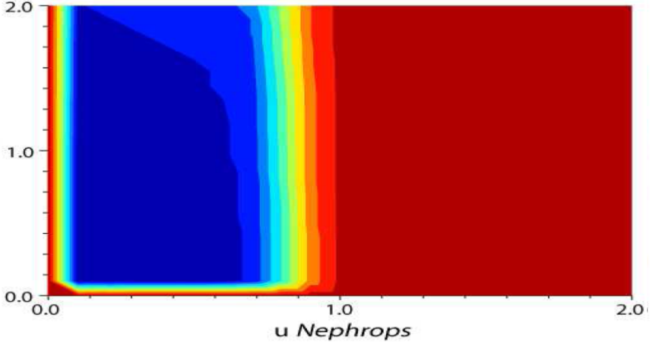


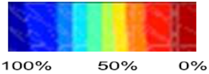


probability of ecological viability

Doyen/Thébaud/Béné/Martinet/Gourguet/Bertignac/Fifas (2012). A stochastic viability approach to ecosystem-based fisheries management, *Ecological Economics* 75:32–42.

Stochastic Viability: Multi-Species Fisheries





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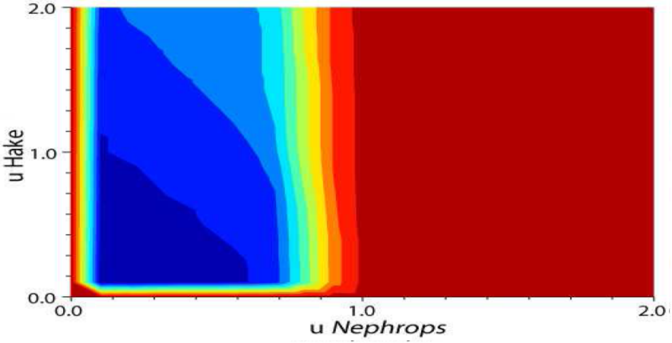
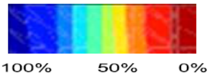
Stochastic Viability: Multi-Species Fisheries

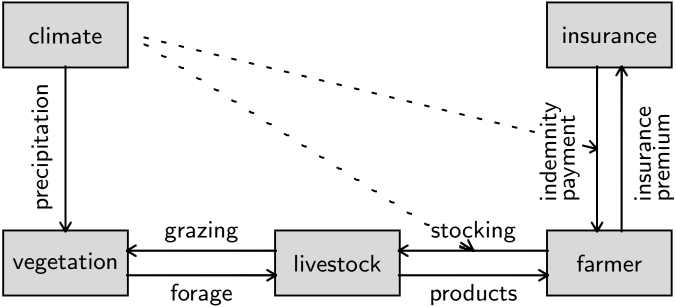




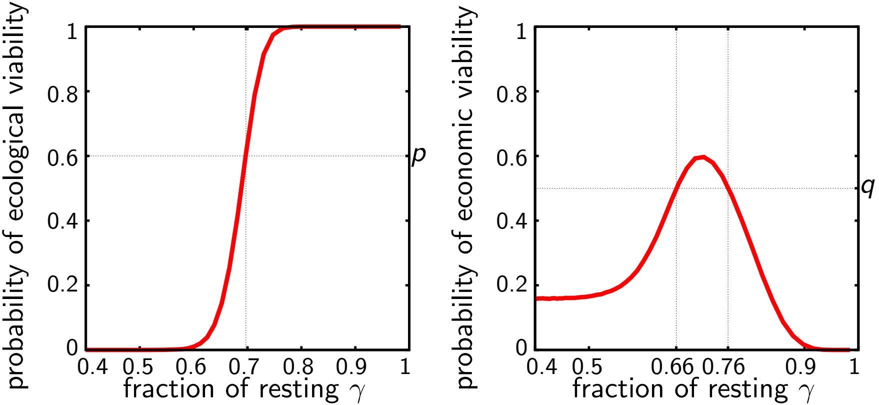
probability of ecological and economic co-viability


Source: Nguni Cattle Breeders Association of Namibia


Source: Wikipedia, 2010

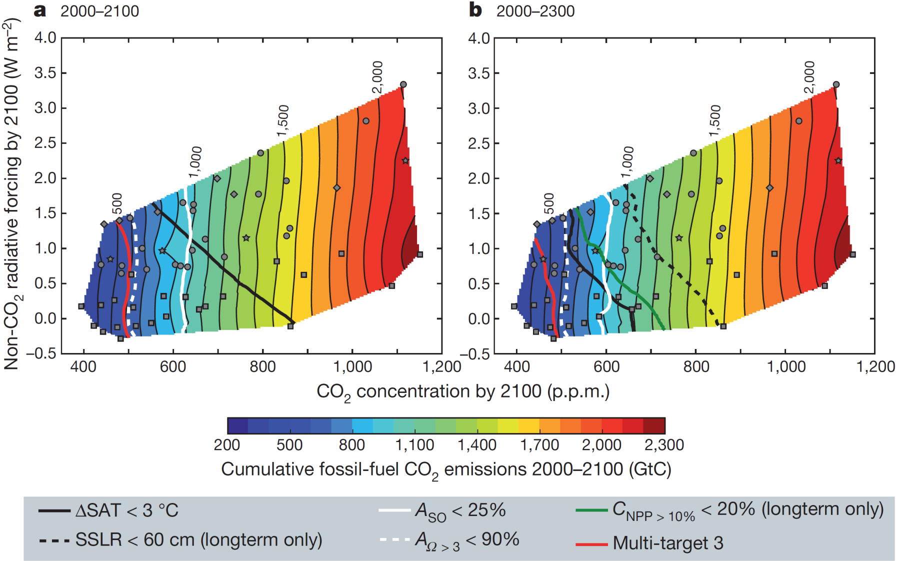

climate
insurance
precipitation
indemnity payment
insurance premium
grazing
stocking
vegetation
livestock
farmer
forage
products

Stochastic Viability: Rangelands



Baumgärtner/Quaas (2009). Ecological-economic Viability as a Criterion of Strong Sustainability under Uncertainty. *Ecological Economics*, 68:2008–2020.

Stochastic Viability: Global Climate



Contour lines: 66% Chance of complying with viability constraints.

Steinacher/Joos/Stocker (2013). Allowable carbon emissions lowered by multiple climate targets, *Nature* 499:197–201.

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Maximizing expected present value of utility

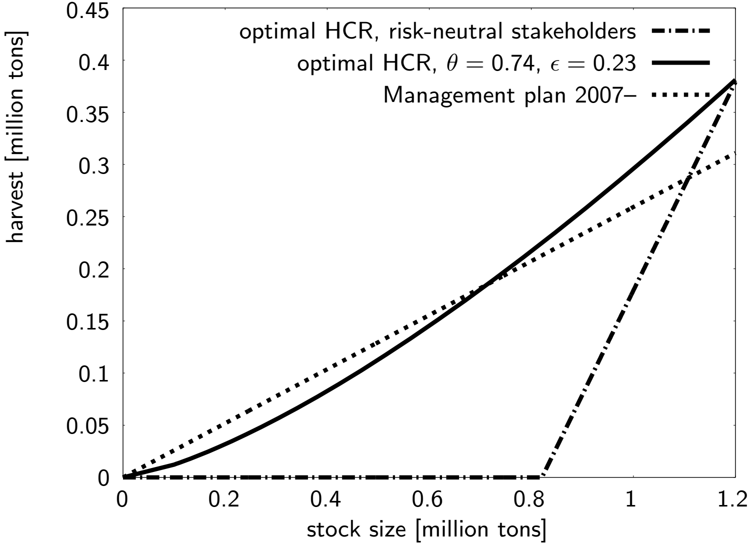
$$\max_{\{x_t\}} E \sum_{t=0}^{\infty} \delta^t \, U(\pi(s_t, x_t))$$

- s_t: stock size; x_t: harvest
- $\delta < 1$: discount factor
- method: stochastic dynamic programming
- solution: optimal feedback policy
  (in fisheries often termed harvest-control rule; HCR)

McGough/Plantinga/Costello (2009). Optimally Managing a Stochastic Renewable Resource under General Economic Conditions, *B.E. J Econ Analysis & Policy*, 9(1), 56.
van Dijk/Haijema/Hendrix/Groeneveld/van Ierland (2013). Fluctuating quota and management costs under multiannual adjustment of fish quota. *Ecol Modelling* 265:230–238.

Maximizing expected present value of utility

Example: Eastern Baltic cod fishery



Kapaun/Quaas (2013). Does the optimal size of a fish stock increase with environmental uncertainties? *Environmental and Resource Economics* 54(2):293–310.

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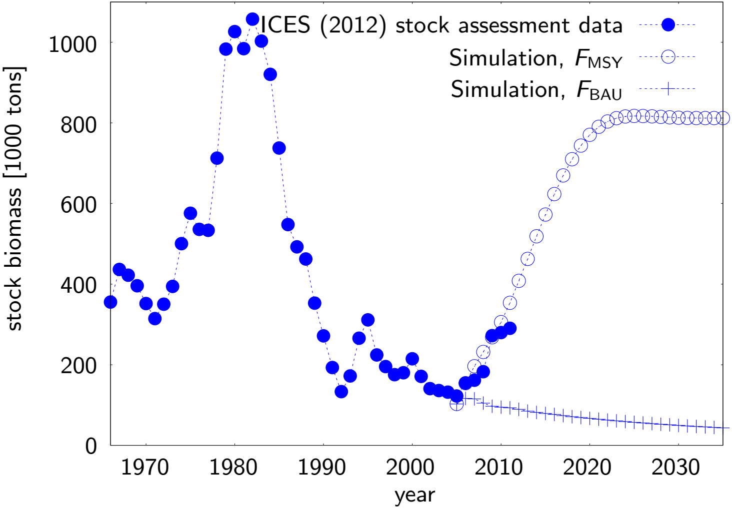
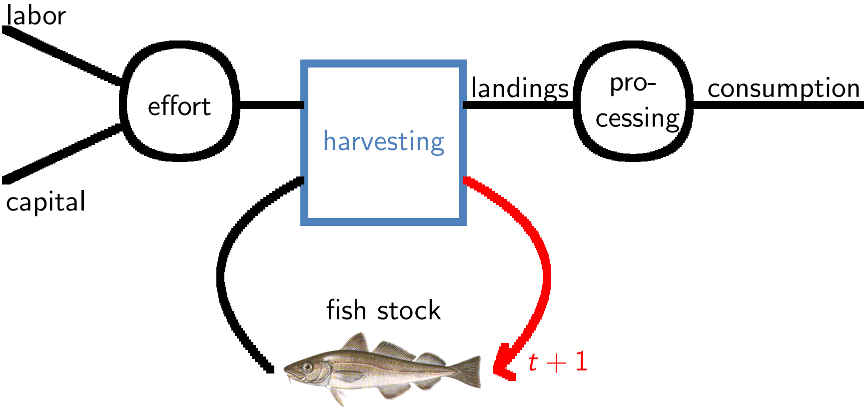
Eastern Baltic cod fishery

maximum sustainable yield (MSY) management vs. business as usual (BAU)

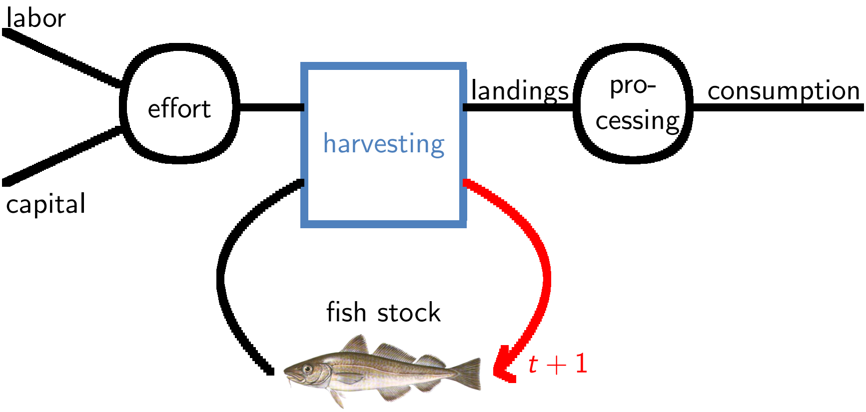


Quaas/Stoeven (submitted). Public and private management of renewable resources: Who gains, who loses?

Sustainable fishery management: Who gains, who loses?



Sustainable fishery management: Who gains, who loses?



fishermen
surplus FS

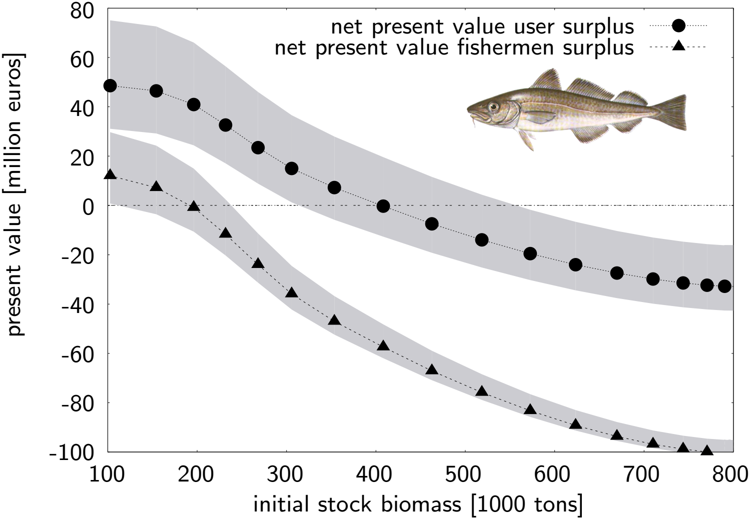
resource
rent RR

user
surplus US

Quaas/Stoeven (submitted). Public and private management of renewable resources: Who gains, who loses?

Sustainable fishery management: Who gains, who loses?

Comparing present value of benefits under maximum sustainable yield (MSY) management vs. business as usual (BAU)



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Interactions in multi-species fisheries

- ecological interactions: predator-prey, competition, symbiosis

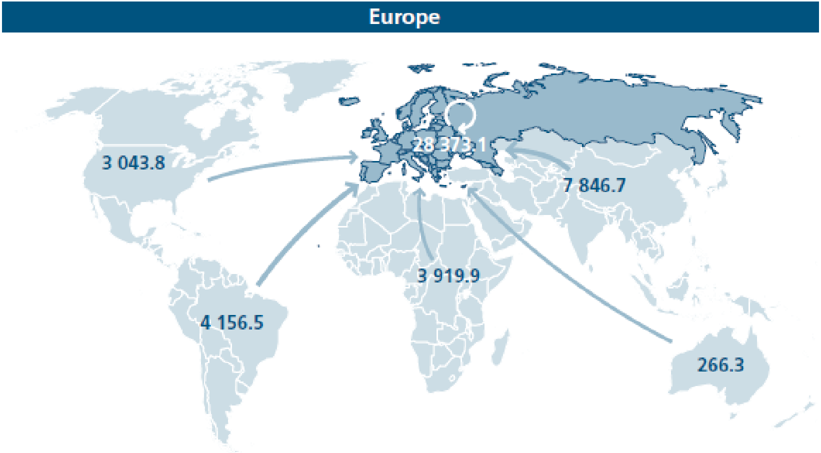
Interactions in multi-species fisheries

- ecological interactions: predator-prey, competition, symbiosis
- economic interactions: technical (bycatch),

Quaas/Requate (2013). Sushi or fish fingers? Seafood diversity, collapsing fish stocks, and multi-species fishery management, *Scandinavian Journal of Economics* 115(2):381–422.

Interactions in multi-species fisheries

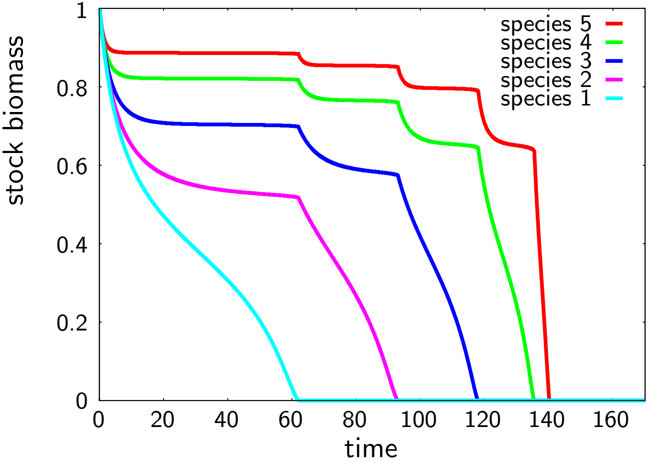
- ecological interactions: predator-prey, competition, symbiosis
- economic interactions: technical (bycatch), demand-side



trade in fishery products, million US $, FAO SOFIA 2012

Quaas/Requate (2013). Sushi or fish fingers? Seafood diversity, collapsing fish stocks, and multi-species fishery management, *Scandinavian Journal of Economics* 115(2):381–422.

Demand-side interactions between fisheries

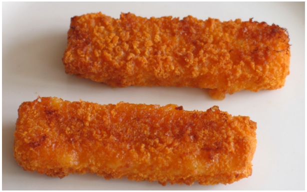


Quaas/Requate (2013). Sushi or fish fingers? Seafood diversity, collapsing fish stocks, and multi-species fishery management, *Scandinavian Journal of Economics* 115(2):381–422.

TWO ASPECTS OF OVERFISHING

consumer value seafood diversity: ‘love of variety’

$\succ$



- collapse of fish stocks is economic problem on top of inefficiently low stocks and yields

Quaas/Requate (2013). Sushi or fish fingers? Seafood diversity, collapsing fish stocks, and multi-species fishery management, *Scandinavian Journal of Economics* 115(2):381–422.

TWO ASPECTS OF OVERFISHING

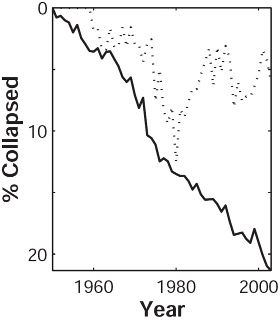
1. inefficiently low stocks and yields
   - extensively studied
   - fundamental principles well understood

e.g. Clark (1990)

2. collapse of stocks at world-wide scale
   - recognized more recently
   - has become focus of scientific interest and public concern in the last years

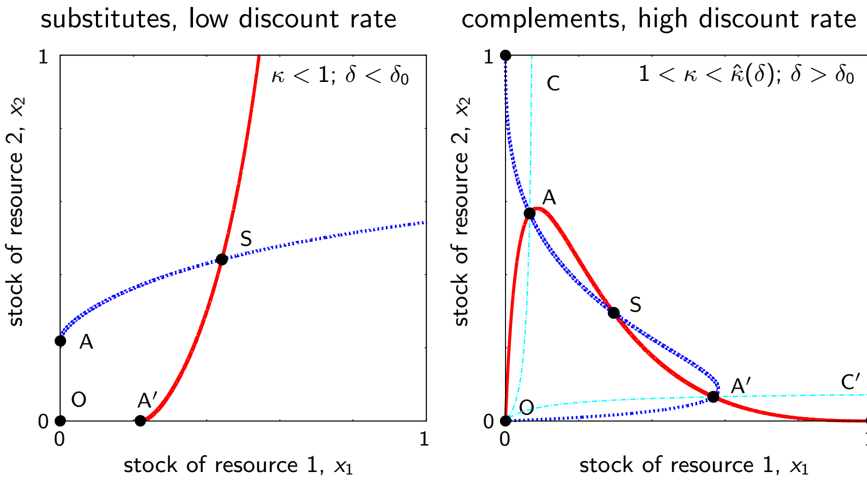
Costello et al. (Science, 2008)
Heal and Schlenker (Nature, 2008)

Worm et al. ((Science, 2006)



Costello et al. (2008)

Coupled ecological-economic system may have multiple equilibria even if the natural system has not



Quaas/van Soest/Baumgärtner (2013). Complementarity, impatience, and the resilience of natural-resource-dependent economies. *J Env Econ Management* 66(1):15–32.

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GROWTH OVERFISHING: EXAMPLE OF BALTIC COD

Baltic Sea, early 1980s

GROWTH OVERFISHING: EXAMPLE OF BALTIC COD

Baltic Sea 2007

Fishing Quotas in Terms of Numbers vs. Biomass

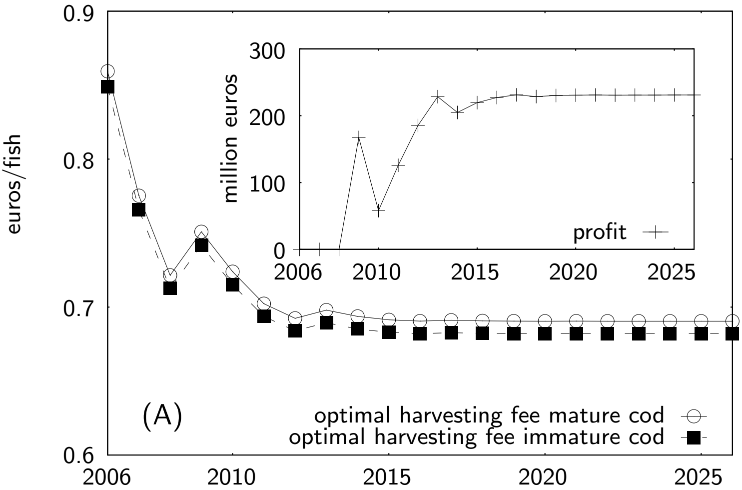
Proposal for new design of regulation

- Total allowable catch (TAC) in number of individual fish
- System of tradable quotas (TQ) in numbers of individual fish and appropriate exchange rates

Conventional biomass management	New individual-based management
TAC in tons of biomass	TAC in number of individual fish
TQs in tons of biomass save fishing cost but have no positive effect on stock	TQs in numbers save fishing cost and set incentives that prevent growth overfishing
Gear restrictions are necessary to prevent growth overfishing	Fisherman decides on fishing gear

Quaas/Requate/Ruckes/Skonhoft/Vestergaard/Voss (2013). Incentives for Optimal Management of Age-Structured Fish Populations. *Res Energy Econ* 35(2):113–134.
Diekert (2012). Growth Overfishing: The Race to Fish Extends to the Dimension of Size, Environ Resource Econ DOI 10.1007/s10640-012-9542-

Fishing Quotas in Terms of Numbers vs. Biomass



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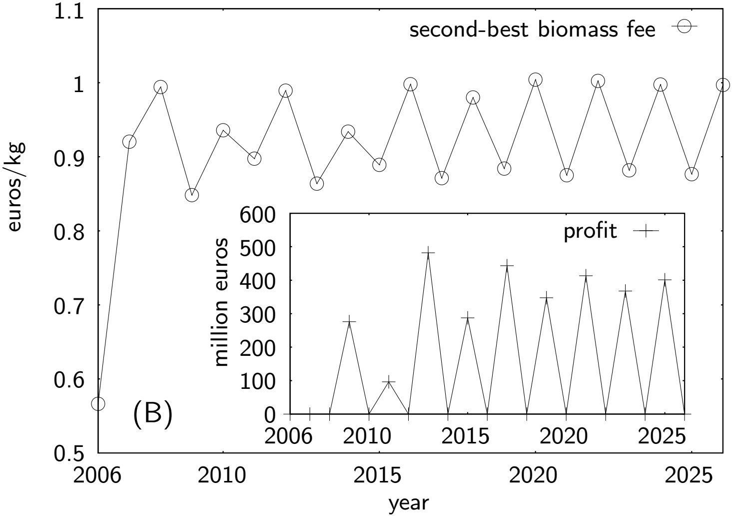

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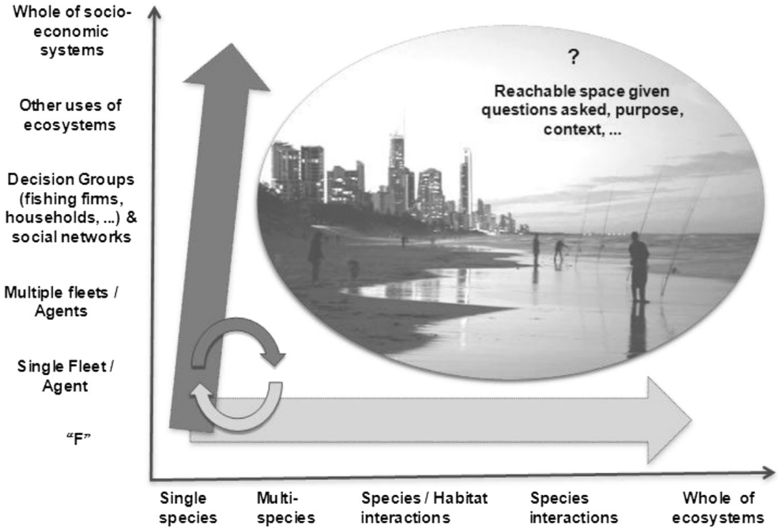
Ecological-economic models: Scale and Scope



Thébaud/Doyen/Innes/Lample/Macher/Mahévas/Mullon/Planque/Quaas/Smith/Vermard (2014). Building ecological-economic models and scenarios of marine resource systems: Workshop report. *Marine Policy* 43:382–386.

- World's **major and emerging funders** of global environmental change research, and international science councils
- Acting as Council of Principals for **IGFA**, a larger group of funding agencies

Belmont Forum Membership

- **Australia/CSIRO**
- **Austria/BMWF**
- **Brazil/FAPESP**
- **Canada/NSERC**
- **China/NSFC**
- **European Commission/DG R&I**
- **France/CNRS&ANR**
- **Germany/DFG&BMBF**
- **India/MoES**
- **Japan/MEXT&JST**
- **Norway/RCN**
- **South Africa/NRF**
- **United Kingdom/NERC**
- **United States/NSF**
- ***International Council for Science (ICSU)***
- ***International Social Sciences Council (ISSC)***

BELMONT FORUM

- Initiated in 2009, by NSF (US) and NERC (UK)
- **Belmont Challenge**:

to accelerate delivery of the environmental research needed to remove critical barriers to sustainability by aligning and mobilizing international resources

- Convergence with other processes of collective thinking within the Global Environmental Change community

⇒ **S&T Alliance for Global Sustainability** with **Future Earth** as first major action

⇒ The BF's **International Opportunity Fund**

The International Opportunity Fund

- A yearly call with 2/3 thematic **Collaborative Research Actions** (CRAs)
- Main goals:
  - **Address the Belmont Challenge priorities** - Deliver knowledge needed for action
  - **Support Future Earth** by promoting innovative types of research
  - **Lever IGFA/Belmont Forum member's existing investments** through international added value
  - **Bring together new partnerships** of natural, geo scientists, humanities and social scientists, and stakeholders
- A flexible tool
  - ***A la carte*** for a given CRA
  - Suitable for **various kinds of incentives**: networking, clustering, integration, capacity building…
  - **Open to any funder** (BF, IGFA or not) - Possibility of **joint call** with other international initiatives
  - **Everything is common** (scoping, call, selection, scientific follow-up) **but the money** (each partner funds its own eligible community)

BELMONT FORUM

IOF 2012

- CRAs on **Freshwater Security** and **Coastal Vulnerability**, joint with **G8HORCs**, aligned with FP7 and NSERC
- **130 pre-proposals,** involving more than **1000 partners** from ~ **50 countries** (high number of partners from non-BF member countries, coming on board with their own funding)
- **53 full proposals**
- **13 funded projects; 2-3-year;** ~ **1-2 M€** projects

IOF 2013

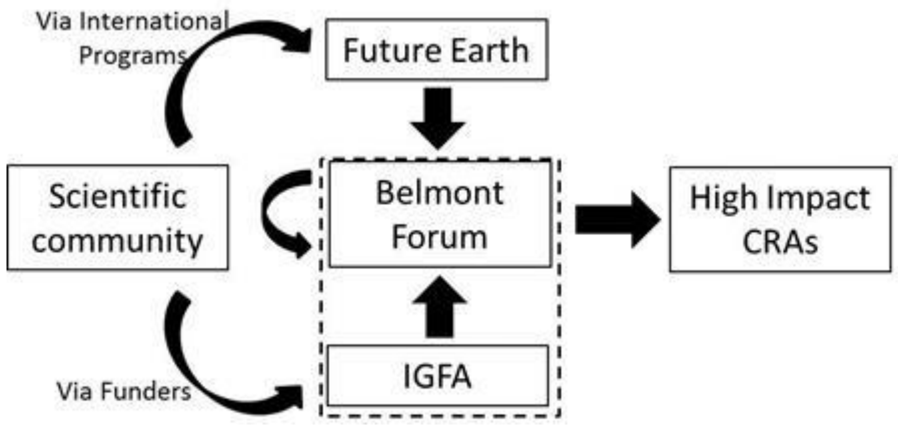
- **E-infrastructure and Data Management -** Foresight
- **Food Security and Land Use Change - Joint Belmont Forum - FACCE JPI call (~ 10 M€) – 2 types of project (community building and research projects)**

2014 CRA proposals under **scoping process**

- **Arctic** : Data Observing System and Sustainability Science
- **Biodiversity and Ecosystem Services:** Improving our capacity to predict global changes in biodiversity and ecosystem services
- **Climate Services** : Seasonal to Decadal Predictability of Regional Climate (incl. monsoons and polar areas)

CRA lifecycle

Schematic for emergence of new BF IOF/CRA



Timeline

Annual IGFA-BF meeting in December2013:

- ***2014 CRAs:*** **Decision on launching calls**
- *2015 CRAs*: Decision on launching scoping processes

Call opening for selected 2014 CRAs : February 2014

Scoping Workshops for 2015 CRAs: April/May 2014

Thank you for your attention …

and for

your contribution to this

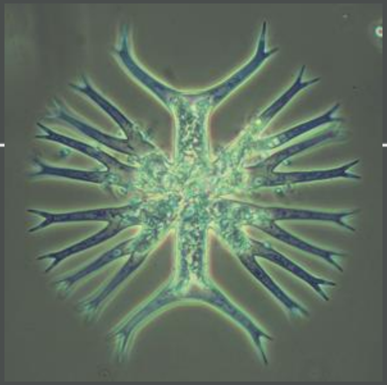
scoping workshop !

DIVERSITAS
an international programme
of biodiversity science

Scoping Workshop on Biodiversity and Ecosystem Services

Anne-Hélène Prieur-Richard

Belmont Forum, 21-22 Oct 2013



DIVERSITAS

Goals

DIVERSITAS
an international programme of biodiversity science

- Develop models & scenarios to predict future interactions between socio-economic dynamics, global environmental change, biodiversity and ecosystem services
- Support of decision making processes

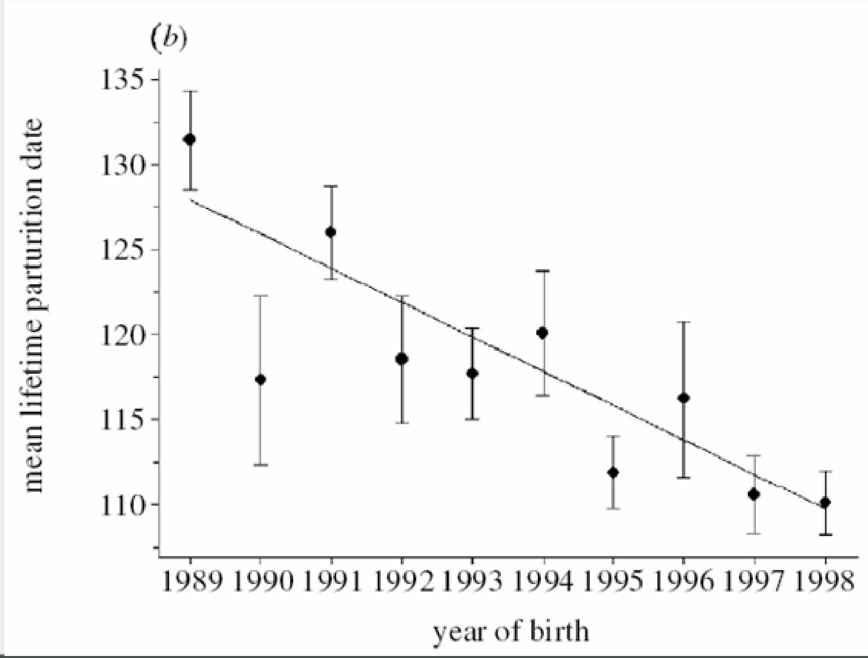
bioDISCOVERY
a core project of DIVERSITAS

bioGENESIS
a core project of DIVERSITAS

futurearth

Eco-Evolutionary framework for biodiversity change

- Predict species range shifts in response to GEC by integrating
  - Species capacity to adapt (migration, plasticity)
  - Species interactions (e.g. mutualism, predation) & their evolution



Yukon squirrel

Bradshaw & Holzapfel, 2007, PNAS

TRY

DIVERSITAS
an international programme of biodiversity science

- To compile information about ecological traits of plant species at world scale

Biodiversity
Species richness

Earth system science
Few fixed model parameters

Plant traits

Functional diversity

- Redefinition of plant functional types
- Functional trait analysis
- Development a new generation of vegetation models

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Coupling socio-economical & ecological models

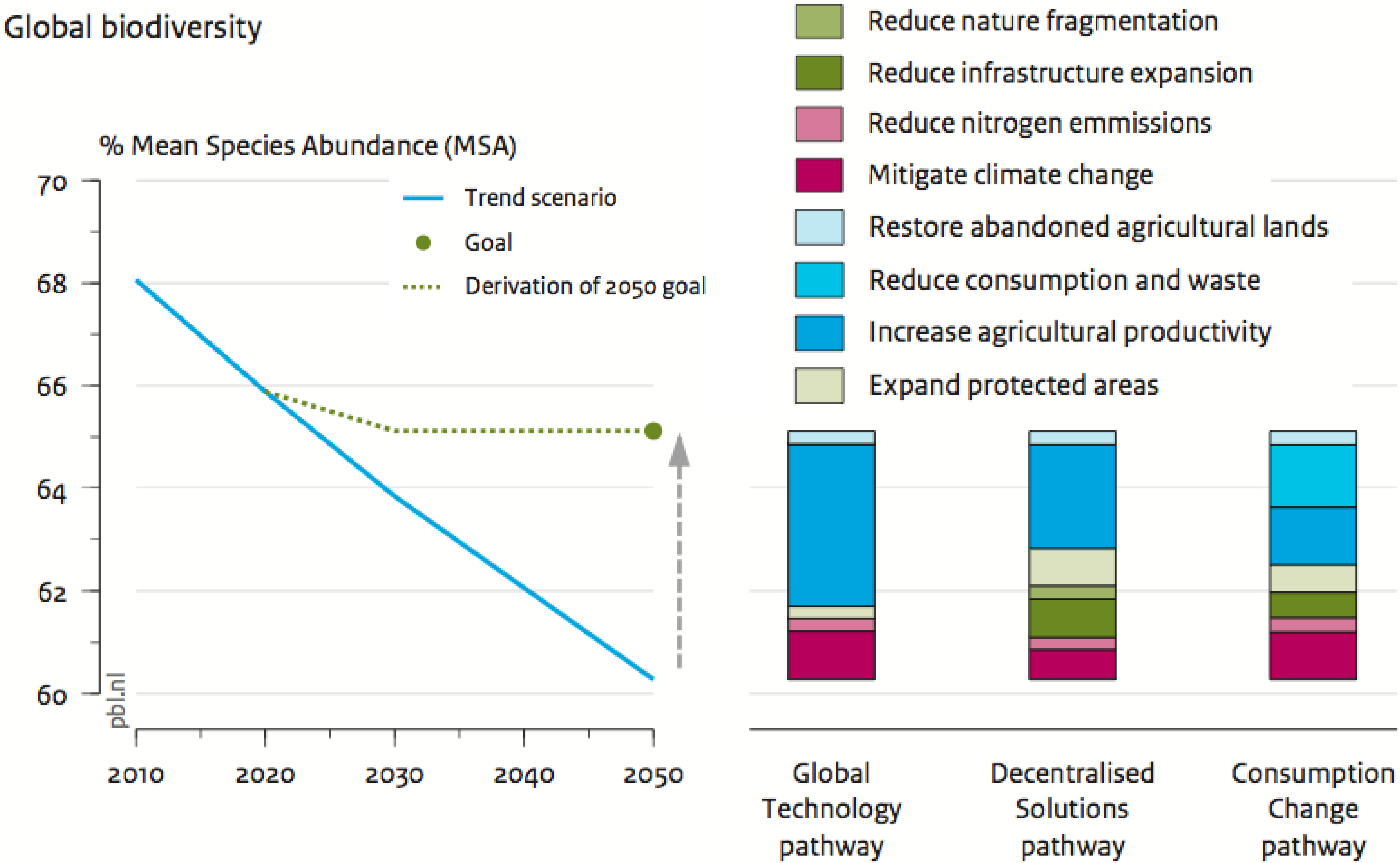
- Mandate from the Convention on Biological Diversity to develop the modelling and scenario chapter of the Global Biodiversity Outlook 4
- Technical report on status, trends and futures of biodiversity
- New ways to explore alternative pathways for reaching agreed upon objectives (towards global sustainability)

PBL Netherlands Environmental Assessment Agency

Roads from Rio+20

Pathways to achieve global sustainability goals by 2050

Global biodiversity and options to prevent biodiversity loss



Key knowledge gaps

1) Inclusion of adaptative capacity
2) Better representativeness of biodiversity: inclusion of more functional diversity
3) Coupling socio-economical and ecological models
4) Better understanding and evaluating uncertainty: inter-model & inter-dataset comparison (Harmbio)

Thank you !

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