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How do biodiversity & poverty relate?

Ben ten Brink, PBL
AHTEG Dehra Dun, 12-12-2011

Man homogenizes biodiversity

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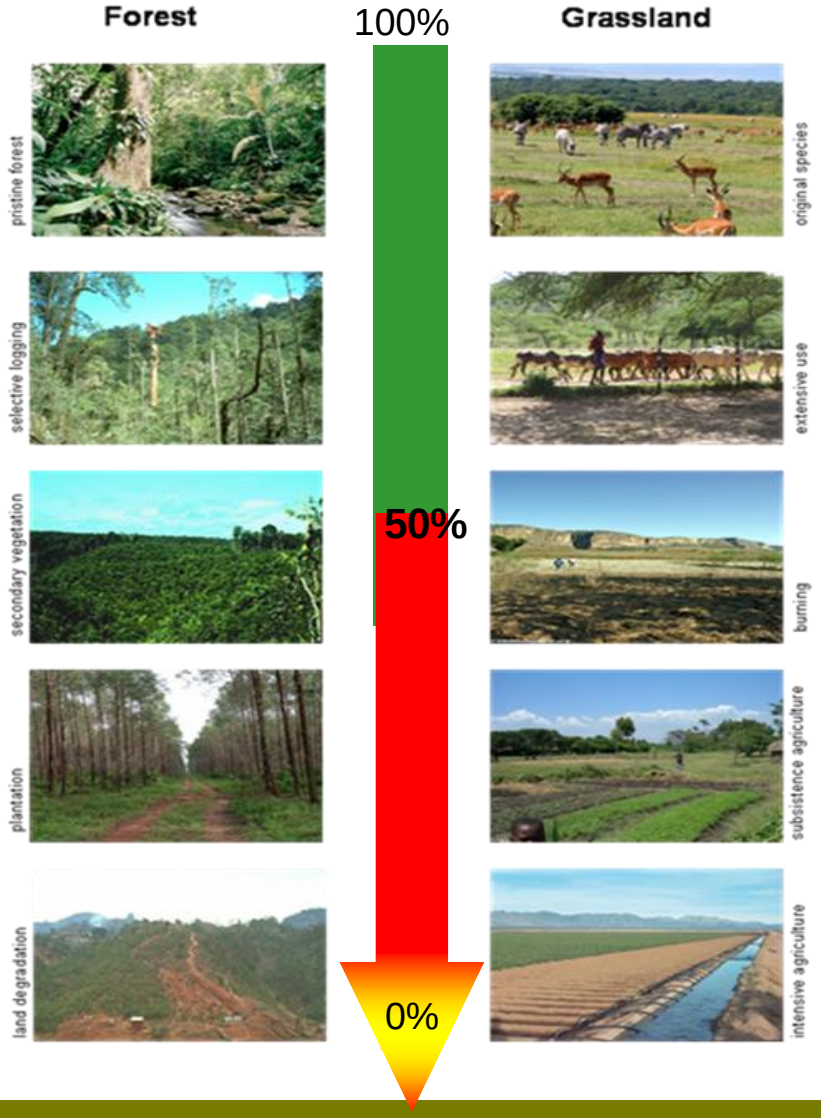
Pristine

Lightly used

Secondary

Plantation

Degraded



Pristine

Grazing

Burning

Extensive agri

Intensive agri

Mean species abundance (MSA)

Non-functional species replaced by functional species

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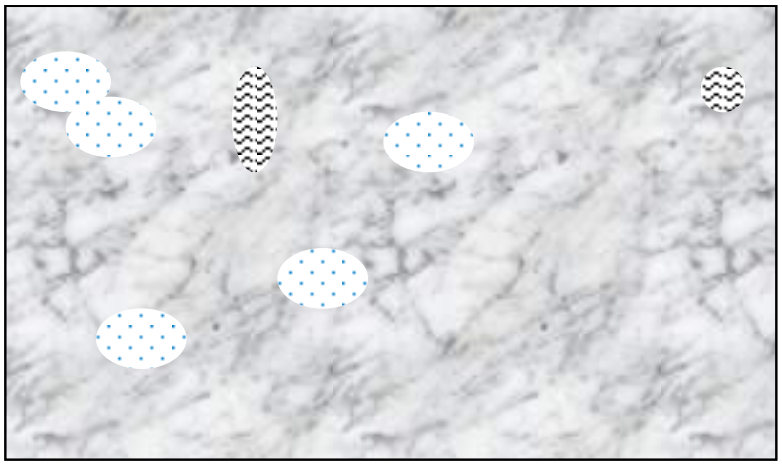
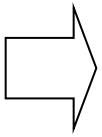
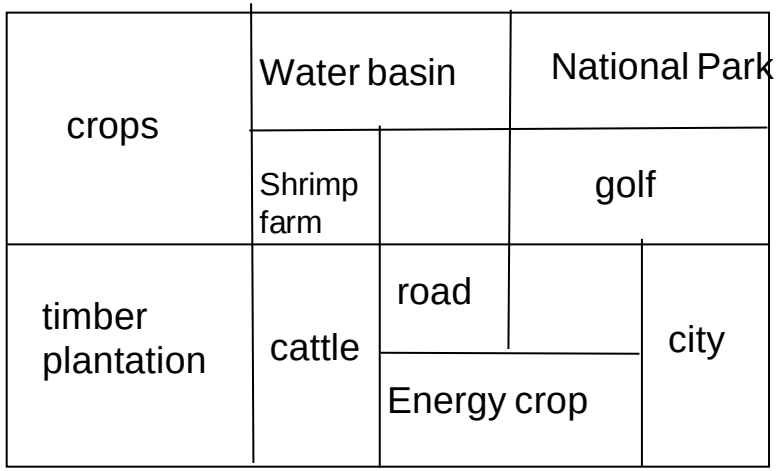
Yield increase from 40 -> 400 -> 4000 kg food\ha







Services lost for goods

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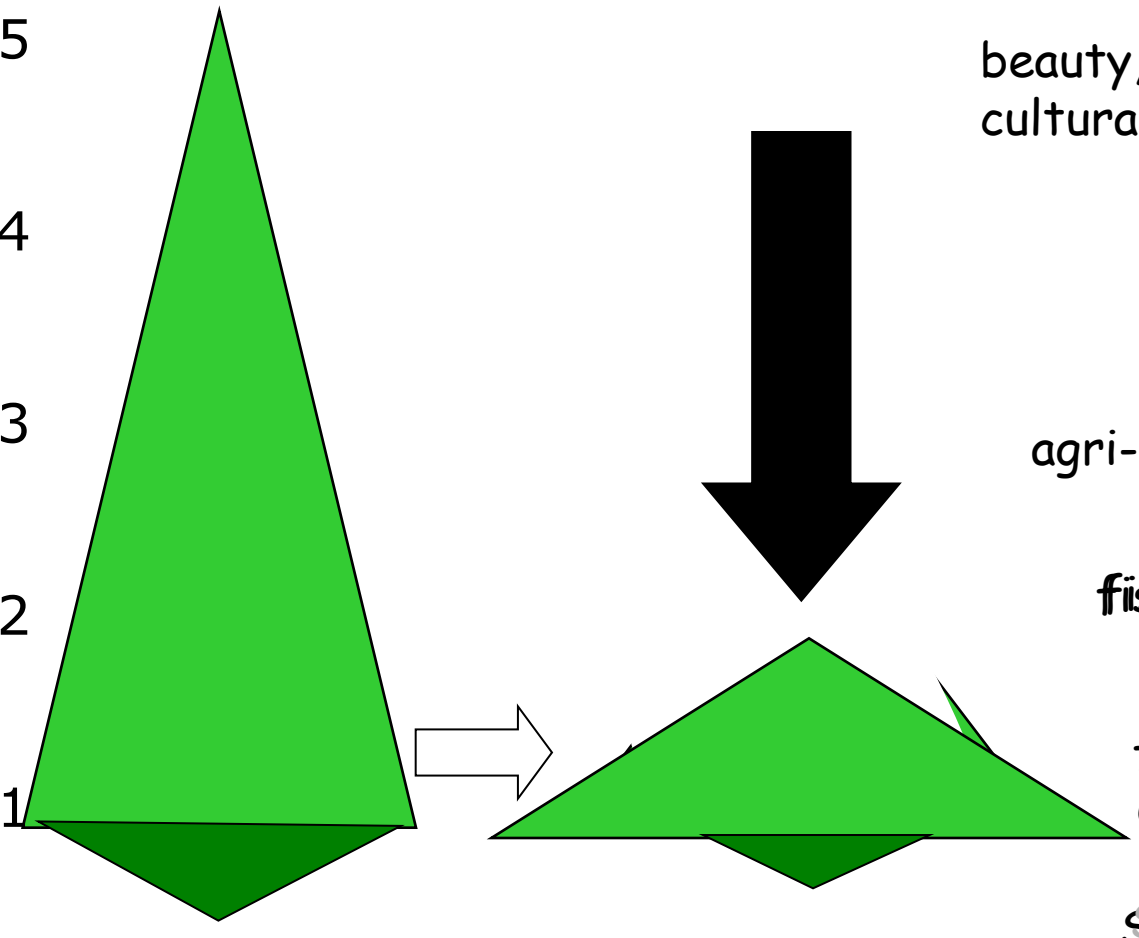

beauty, recreational, educational
cultural identity

agri- disease regulation

fish, meat, pollination

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

Soil fertility, C-org, water retention
& purification, nutrient recycling

Services lost for goods

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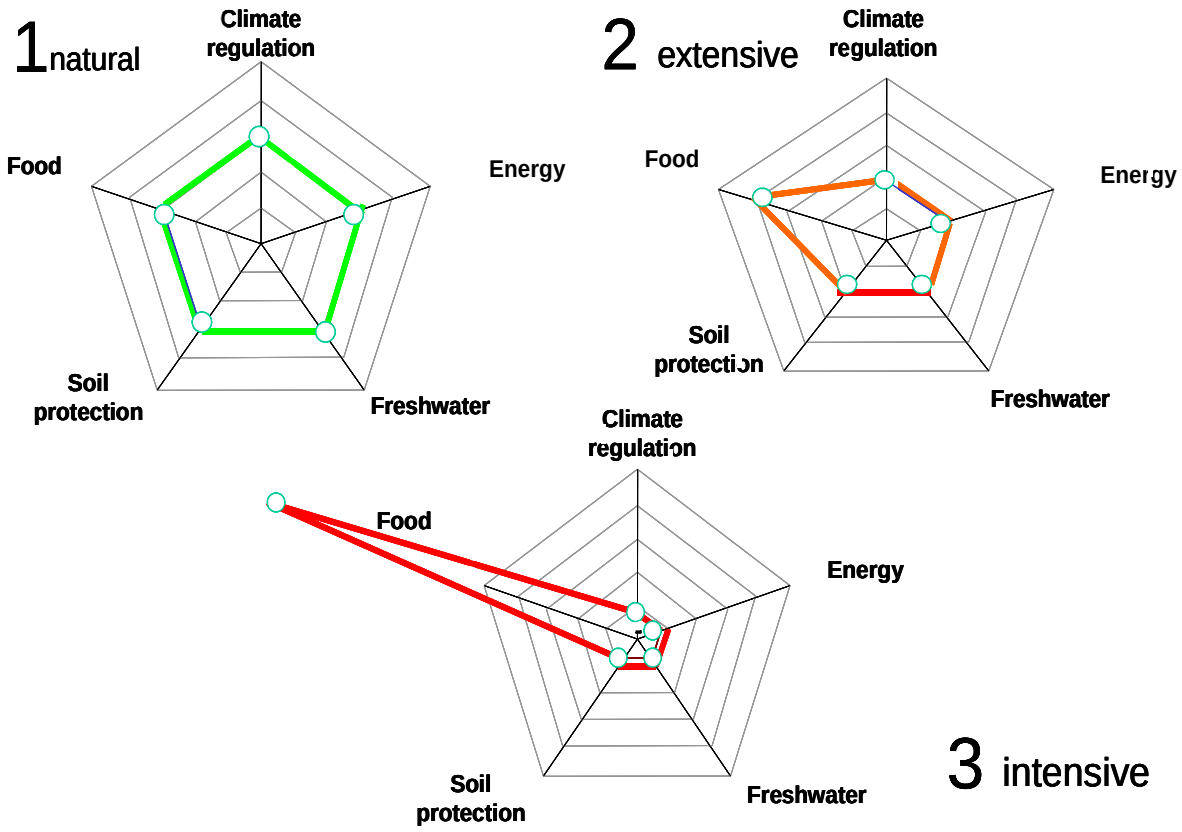

Human demands double by 2050

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Demands 2000-> 2050:

- 1.5 x global population
- 3 x income per person

- 2.0 x food demand
- 1.6 x fish demand
- 1.4 x wood demand
- 2.5 x energy use

Sources: OECD, IEA, FAO,

Cork et al,

Man homogenizes biodiversity

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Lightly used

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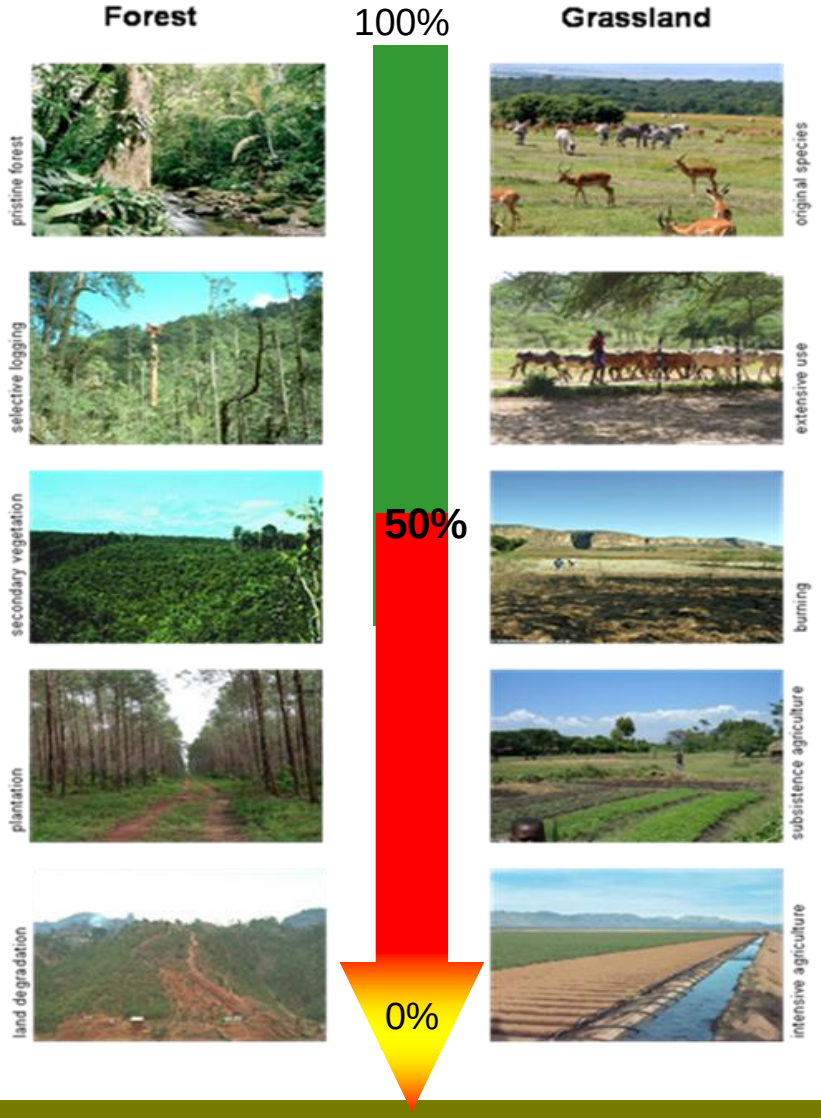
Degraded



Pristine

Grazing

Burning

Extensive agri

Intensive agri

Biodiversity 2010: 70%

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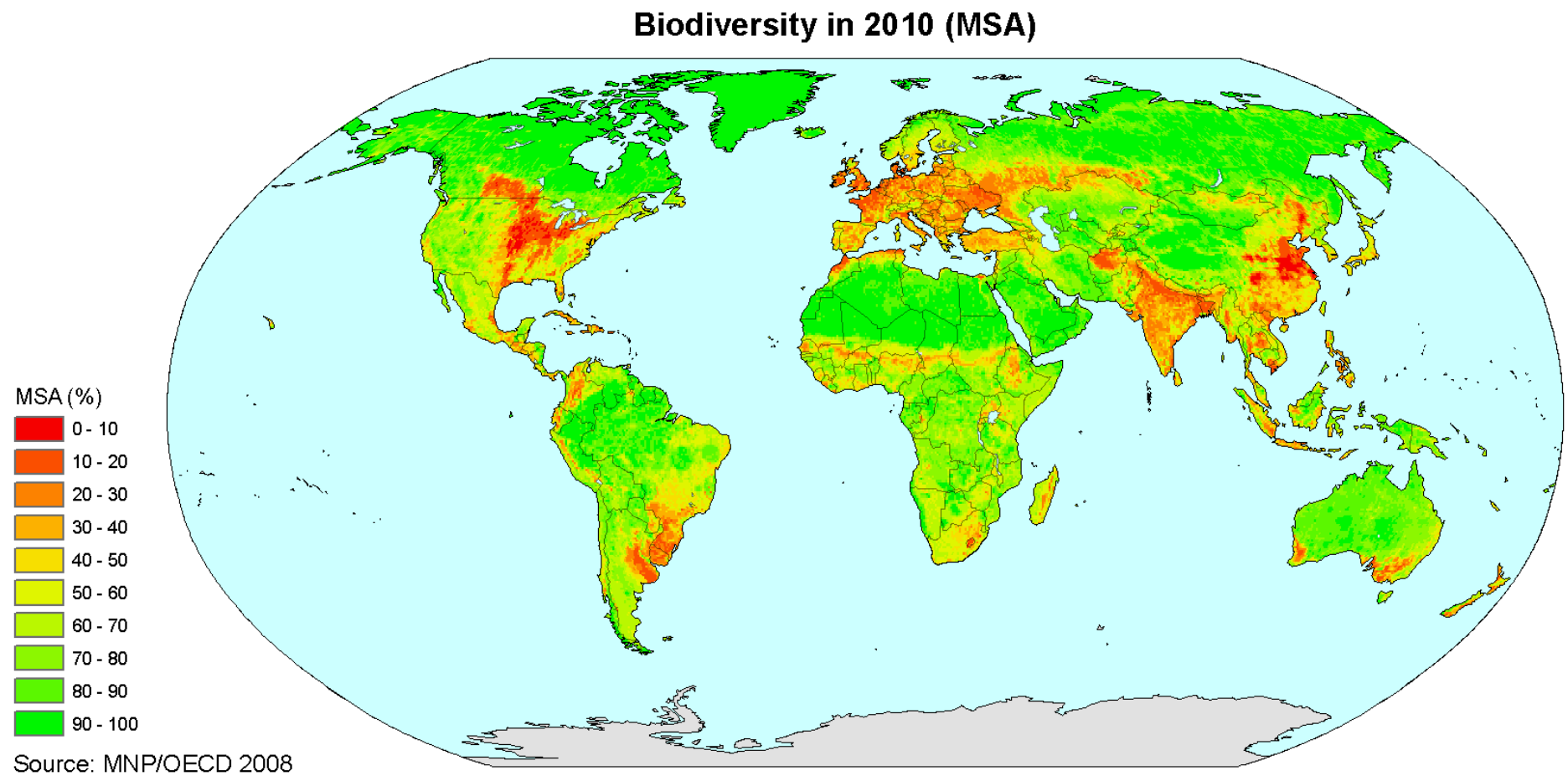
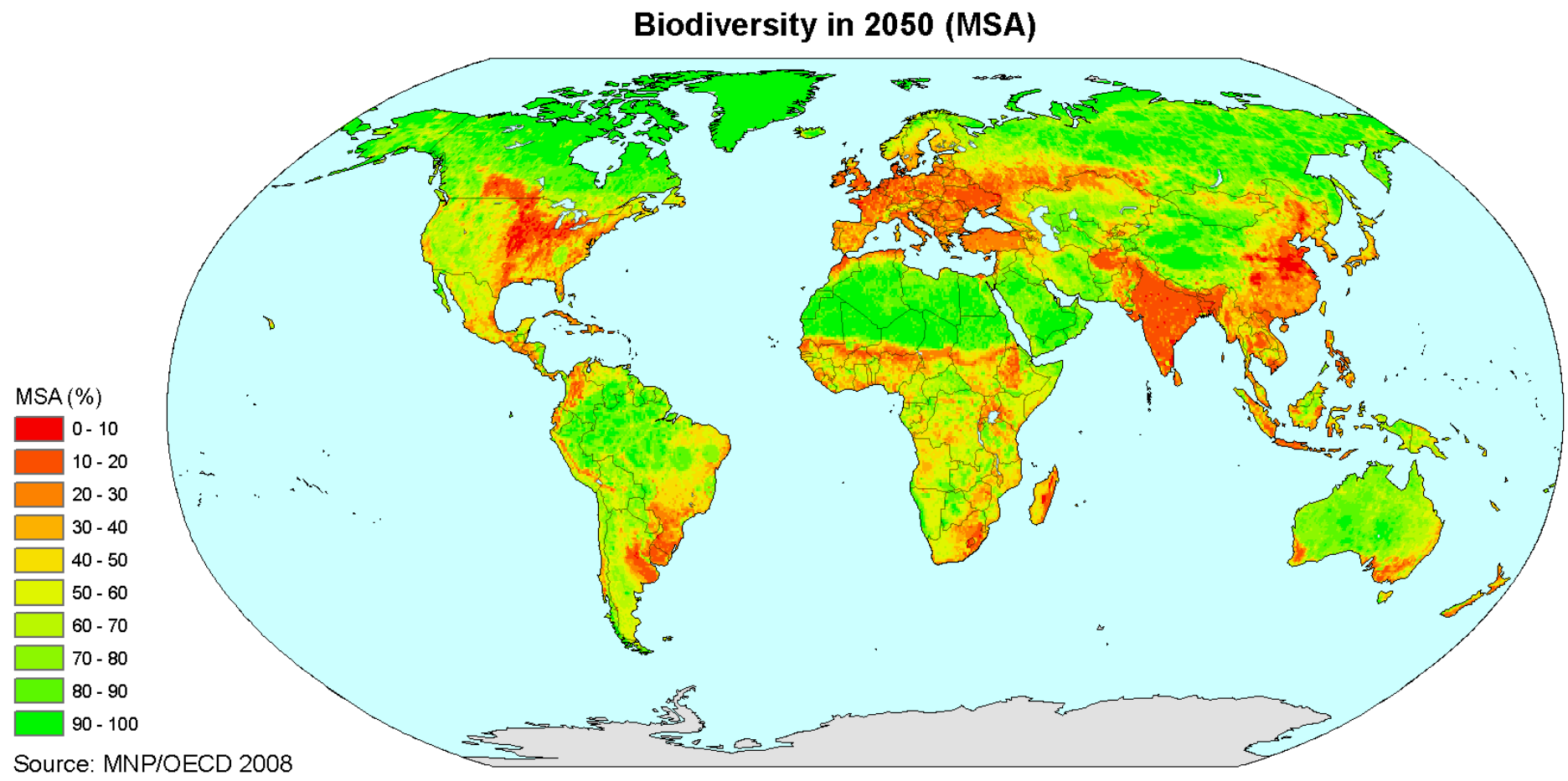


Biodiversity 2050: 60%

PBL Netherlands Environmental Assessment Agency



How do biodiversity and poverty relate?

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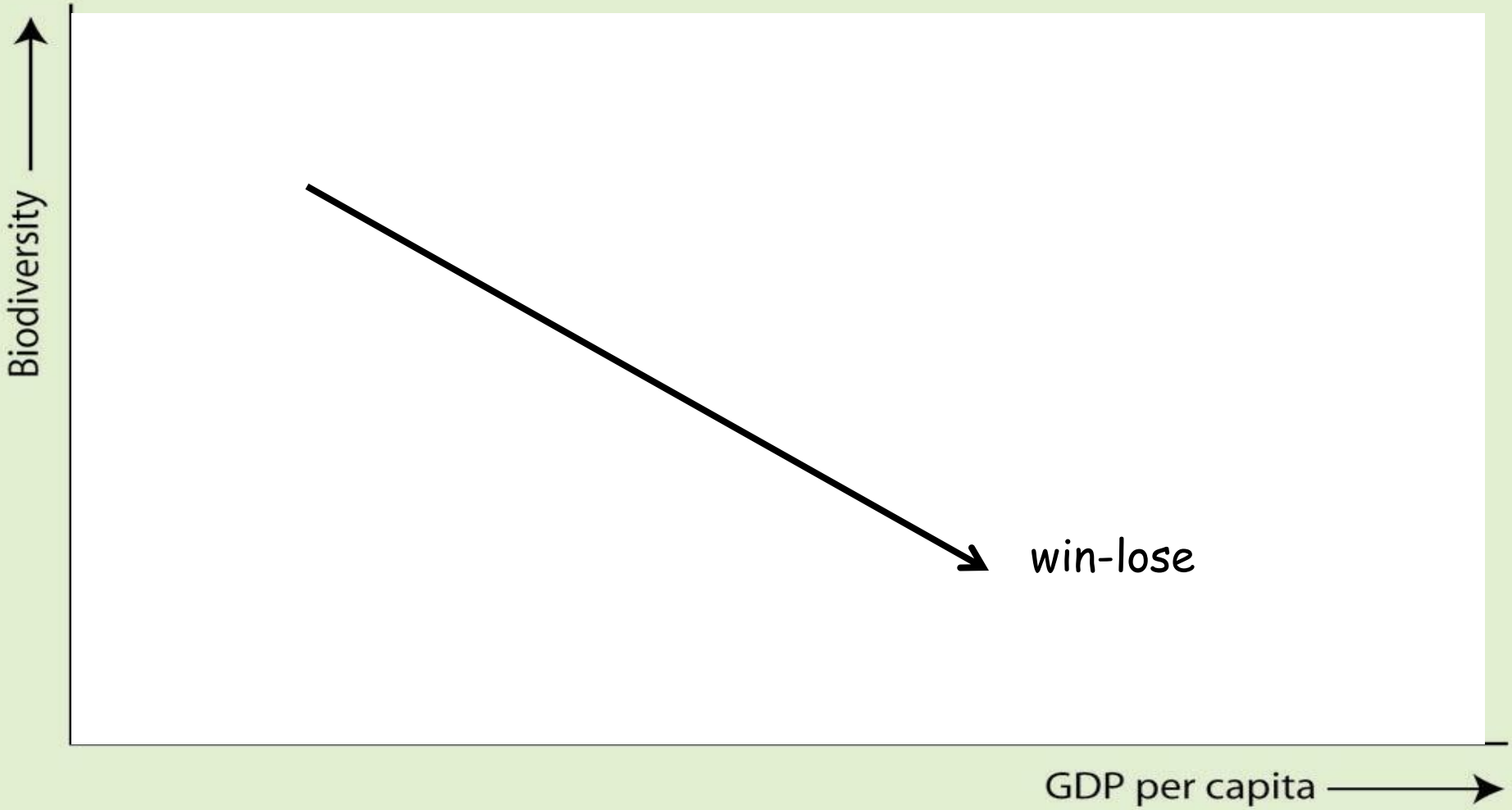
According to the literature



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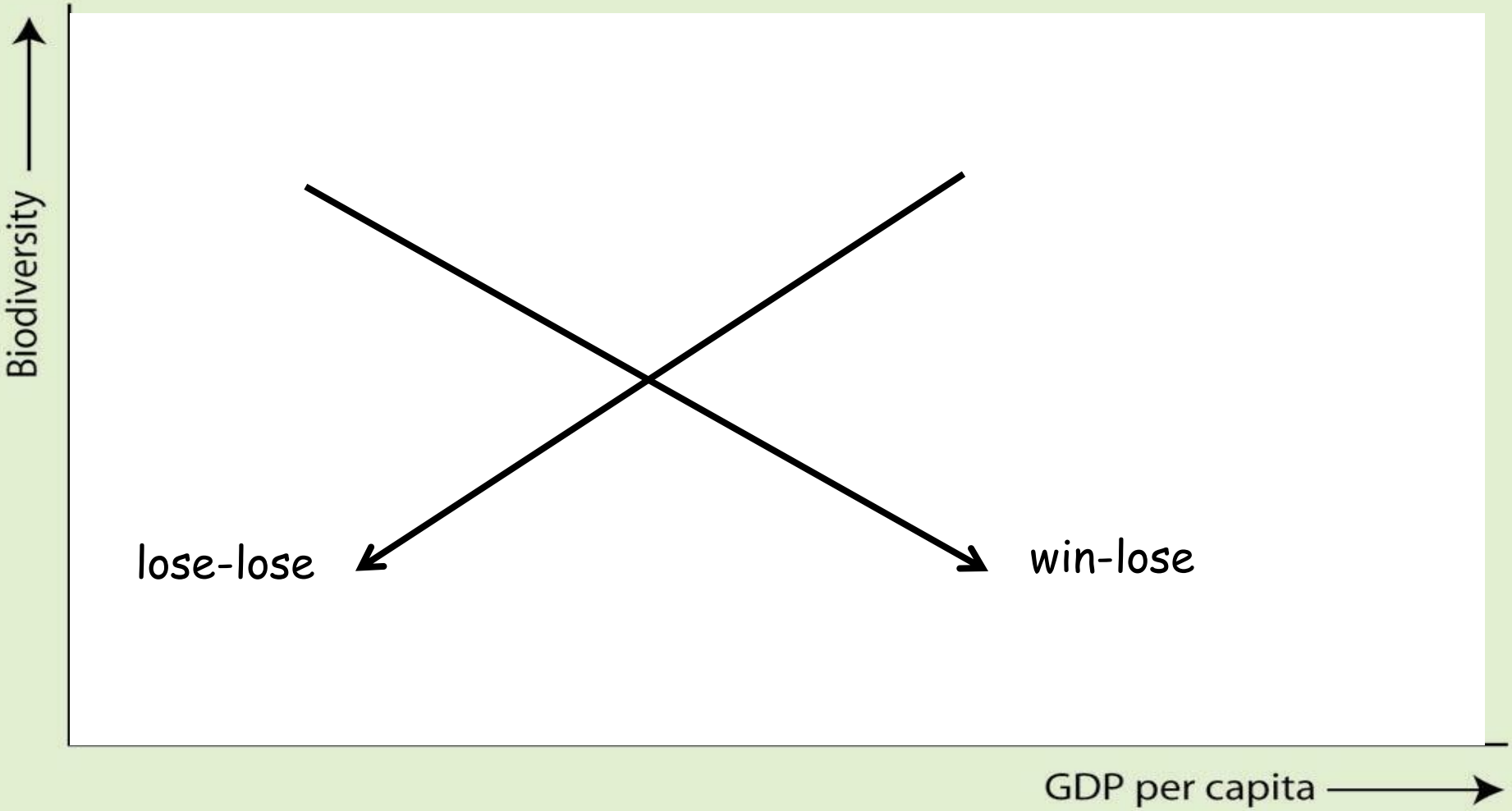

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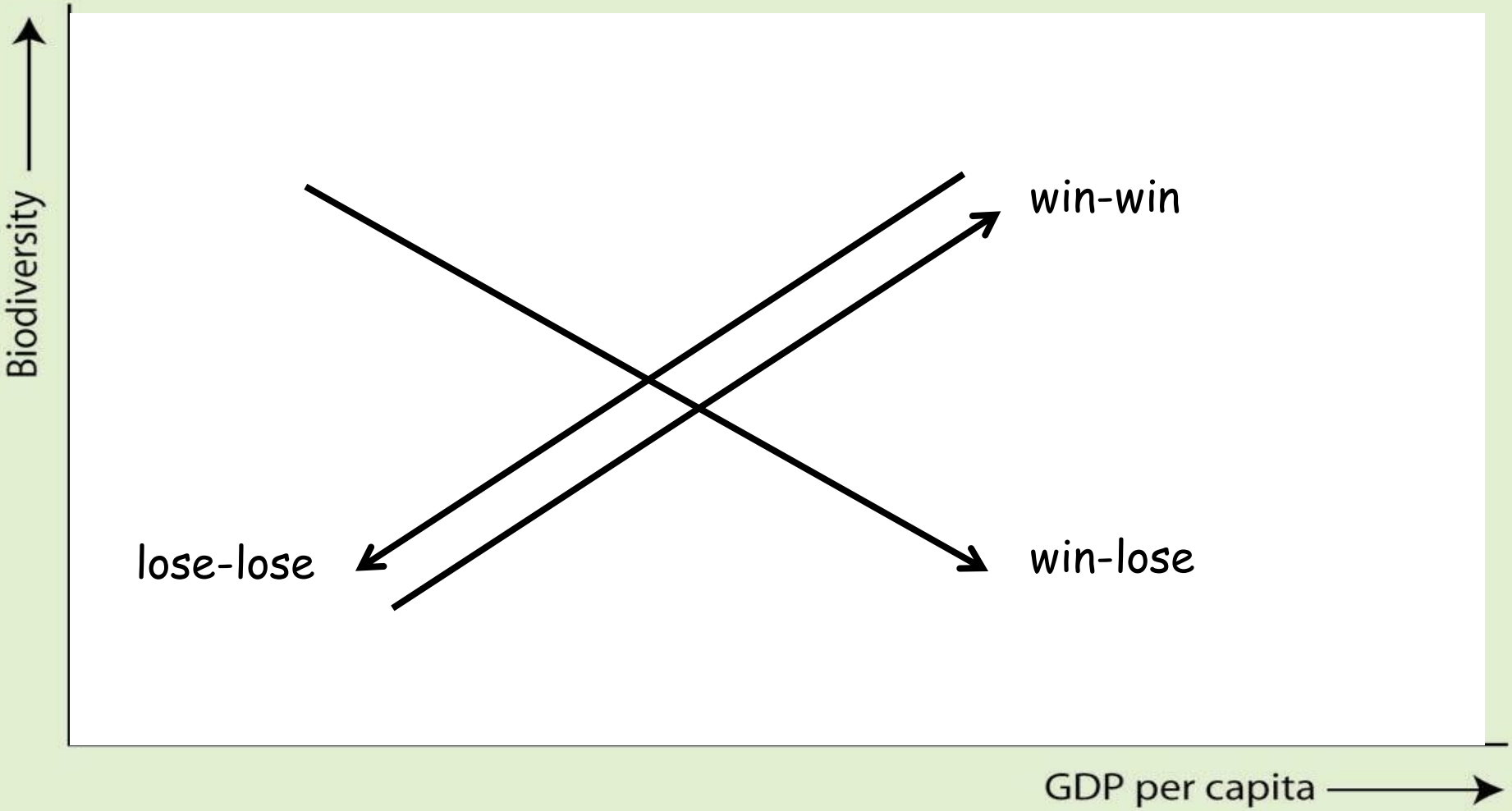

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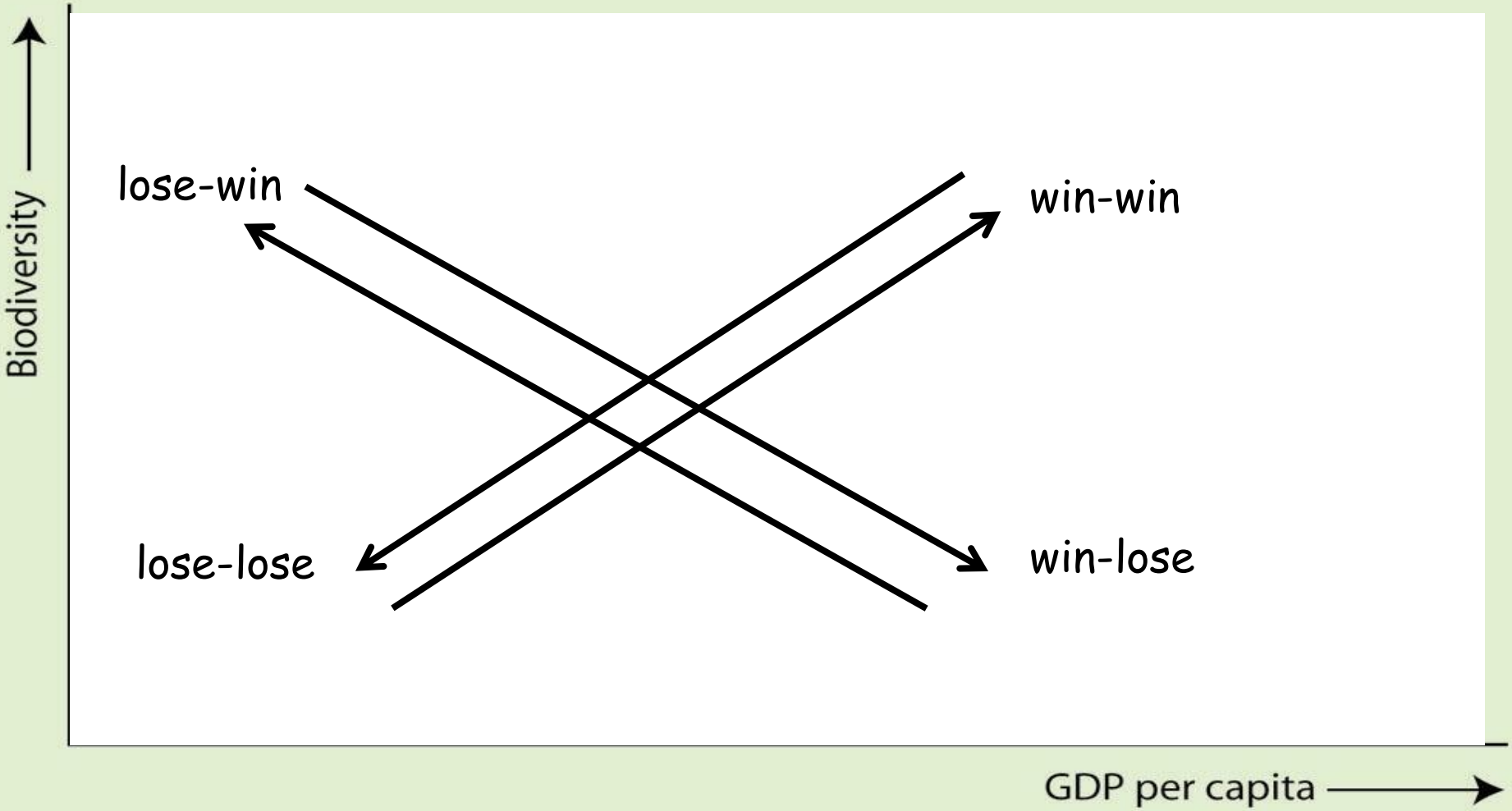

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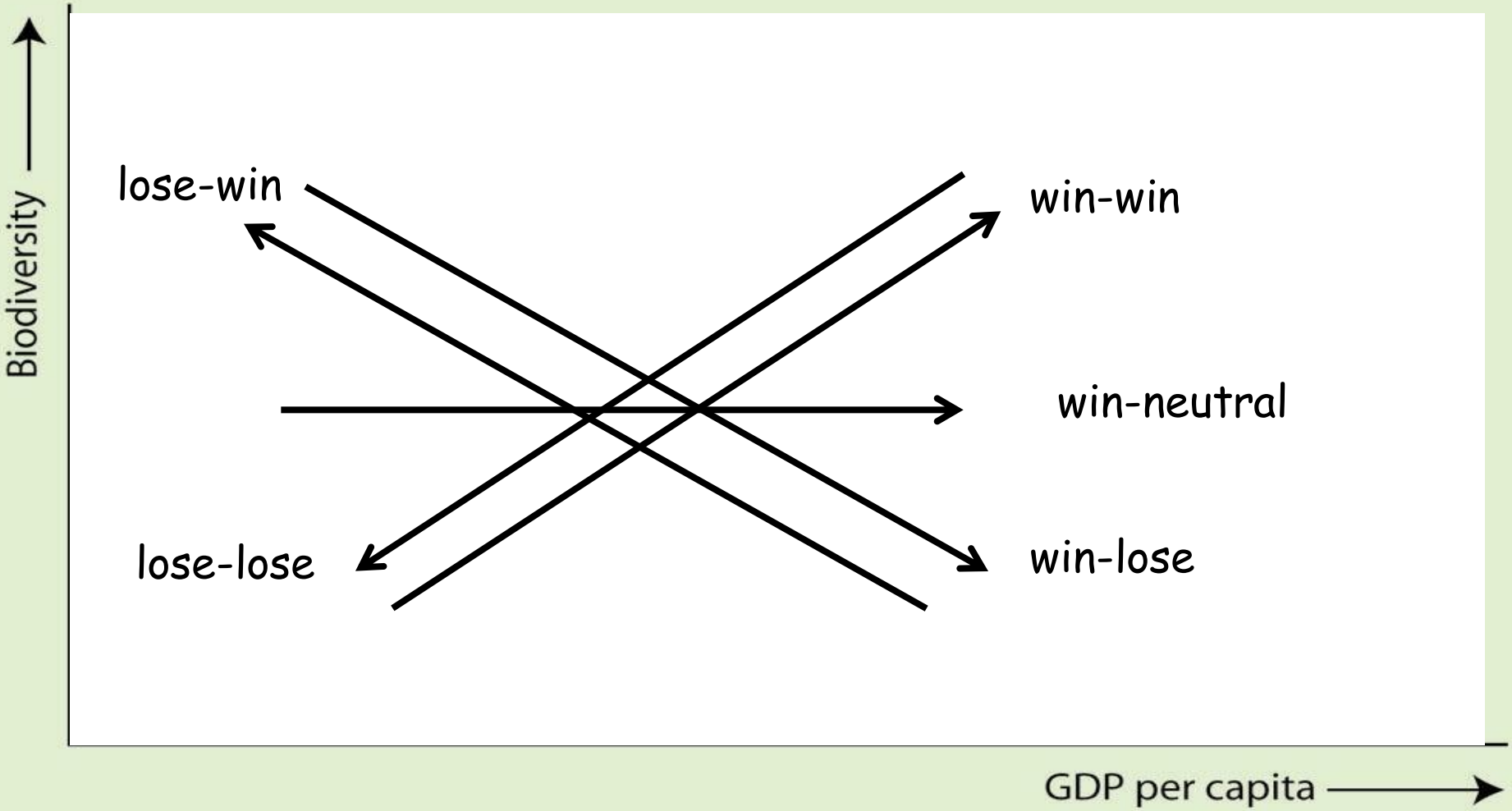

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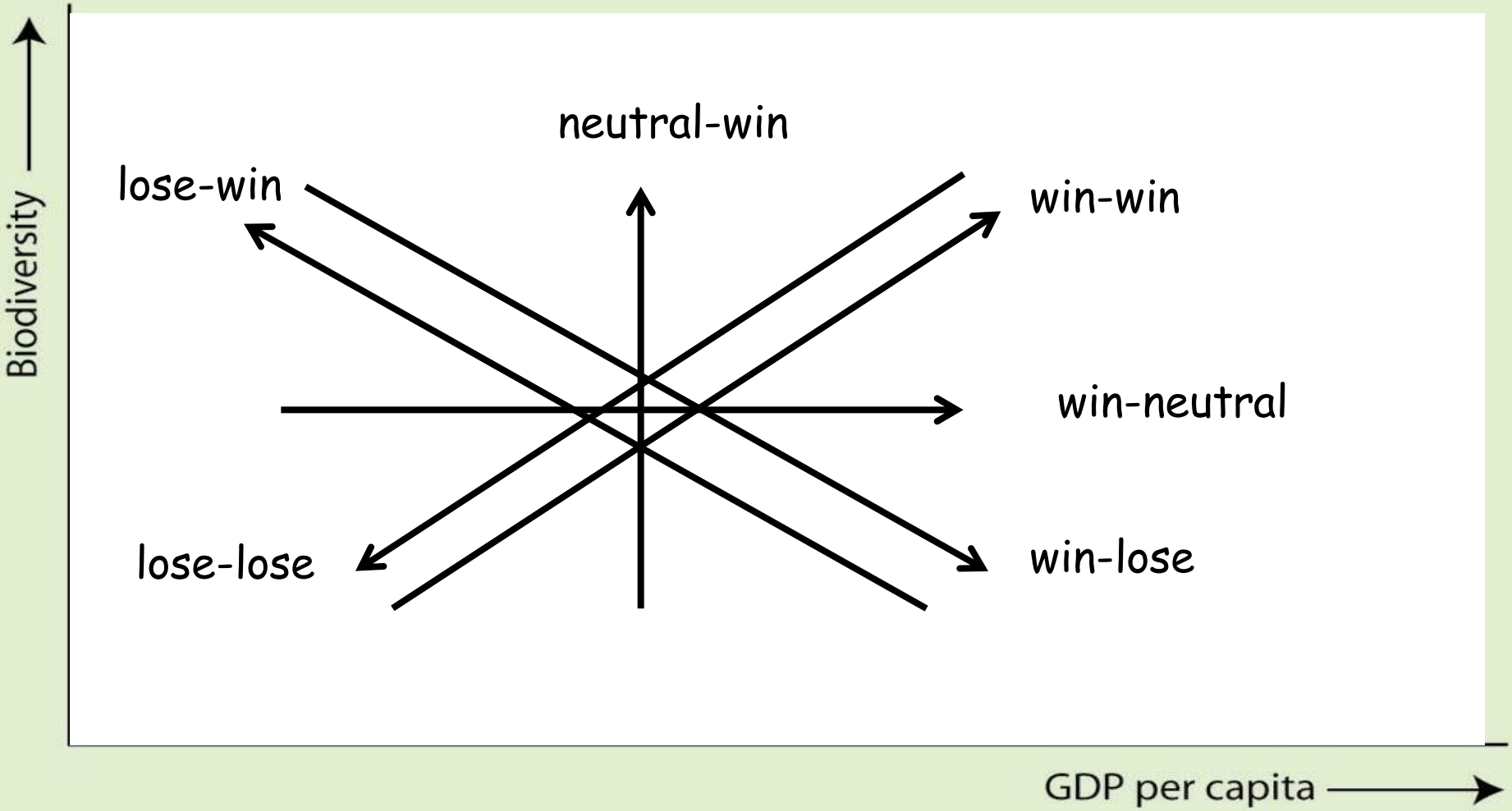

How do biodiversity and poverty relate?

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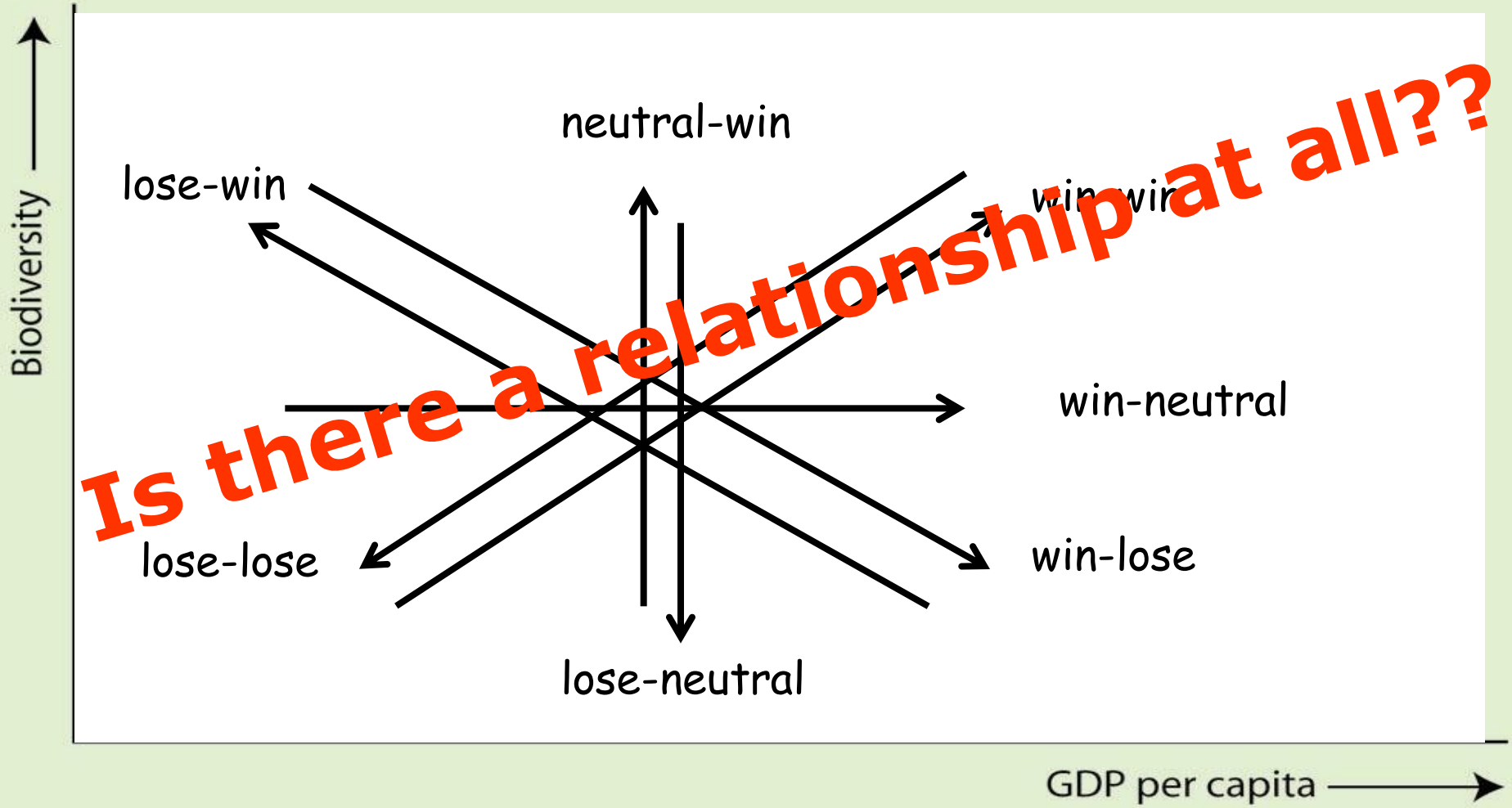

3 development pathways

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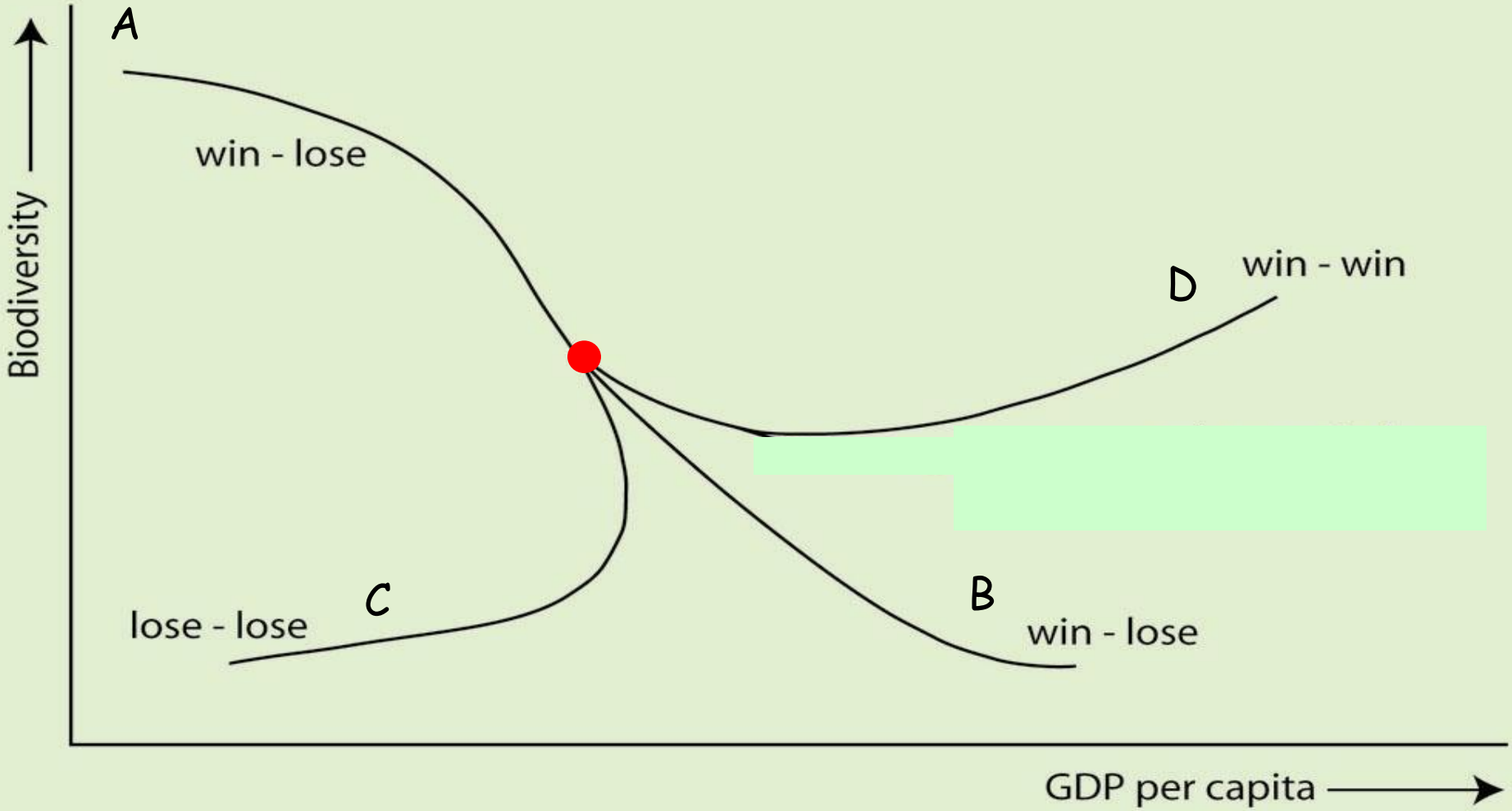
Pieces of one puzzle



Non-linear relationship biodiv lose -> production win

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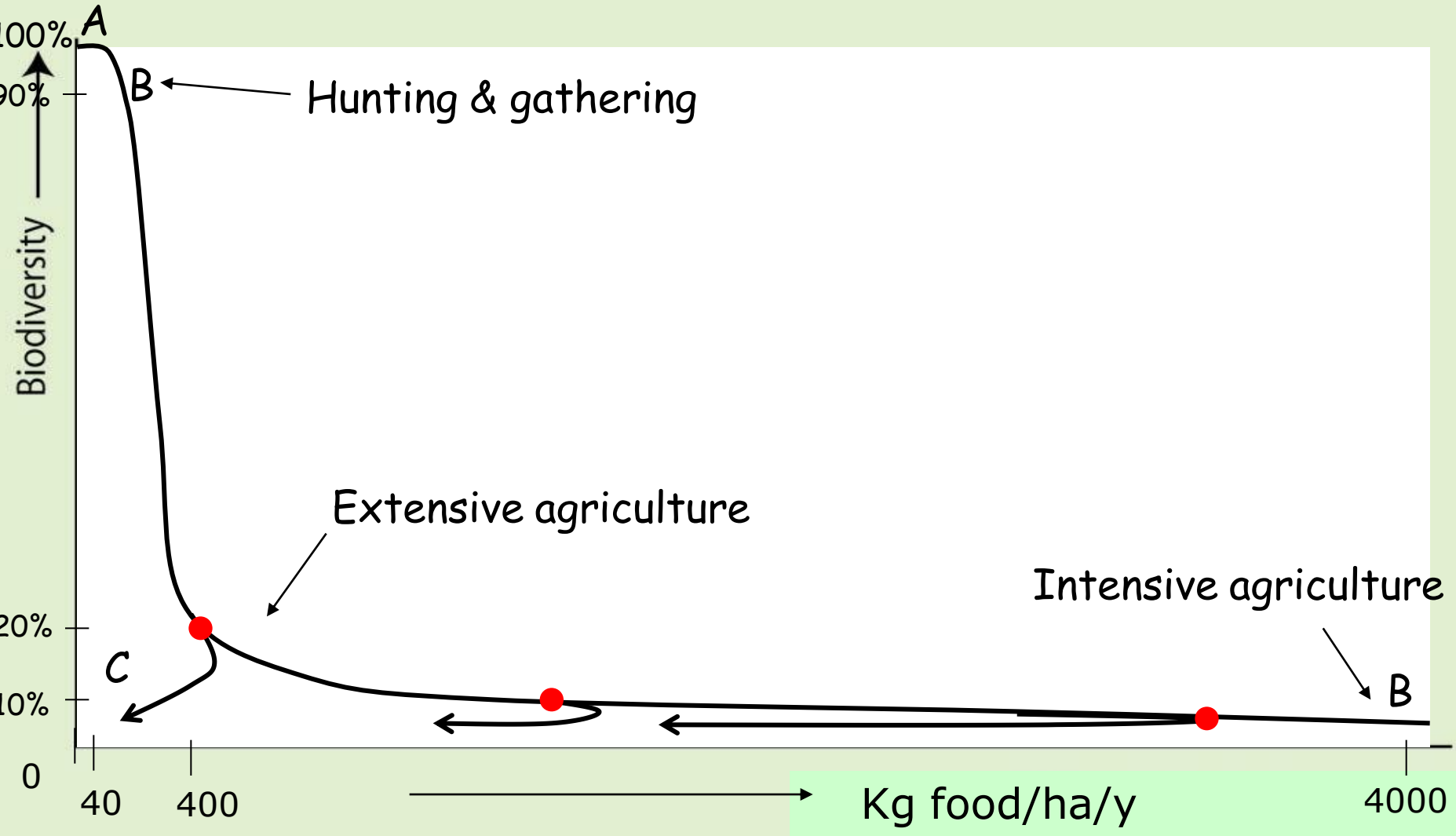
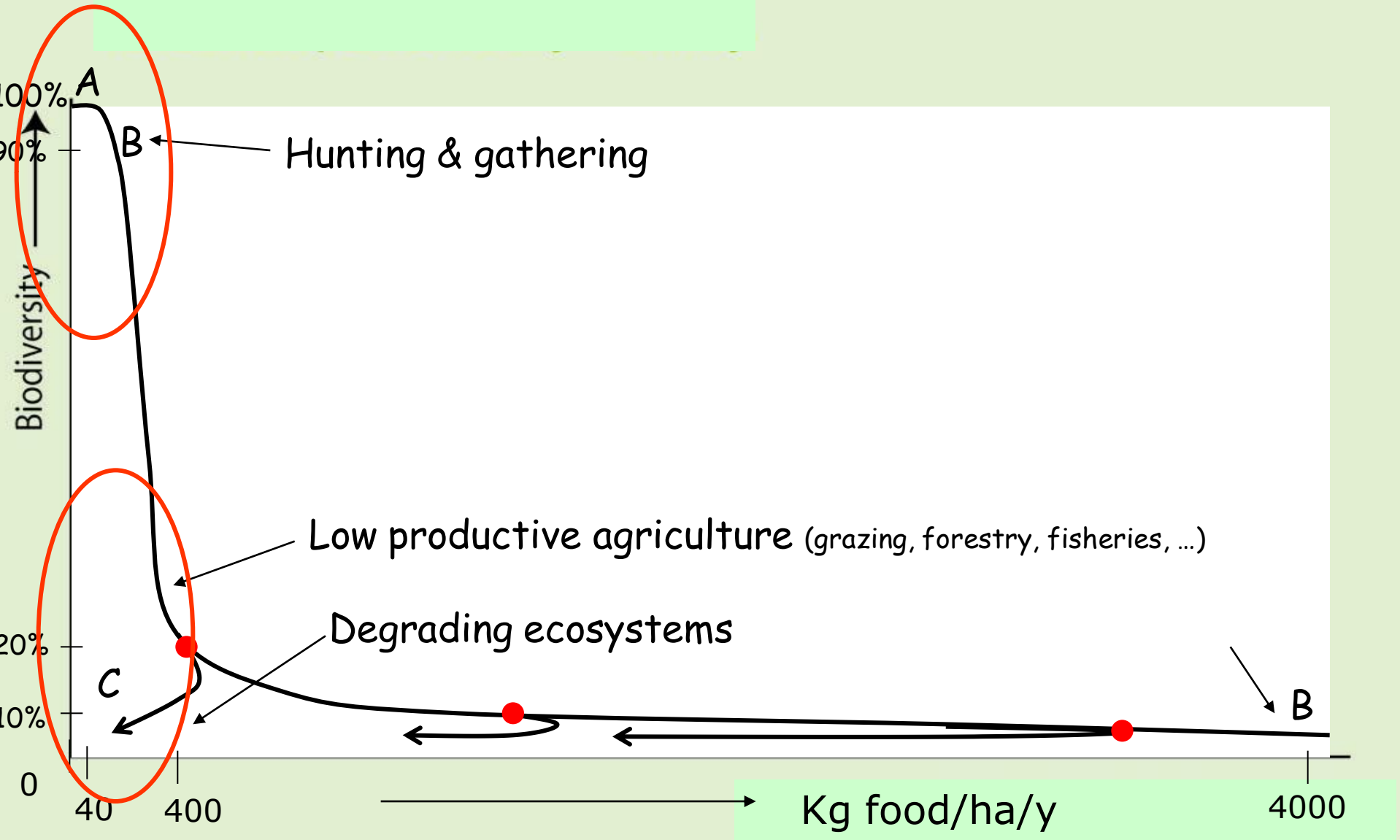


Poverty conc in 3 production stages

PBL Netherlands Environmental Assessment Agency



Systems vulnerable for degradation & poverty

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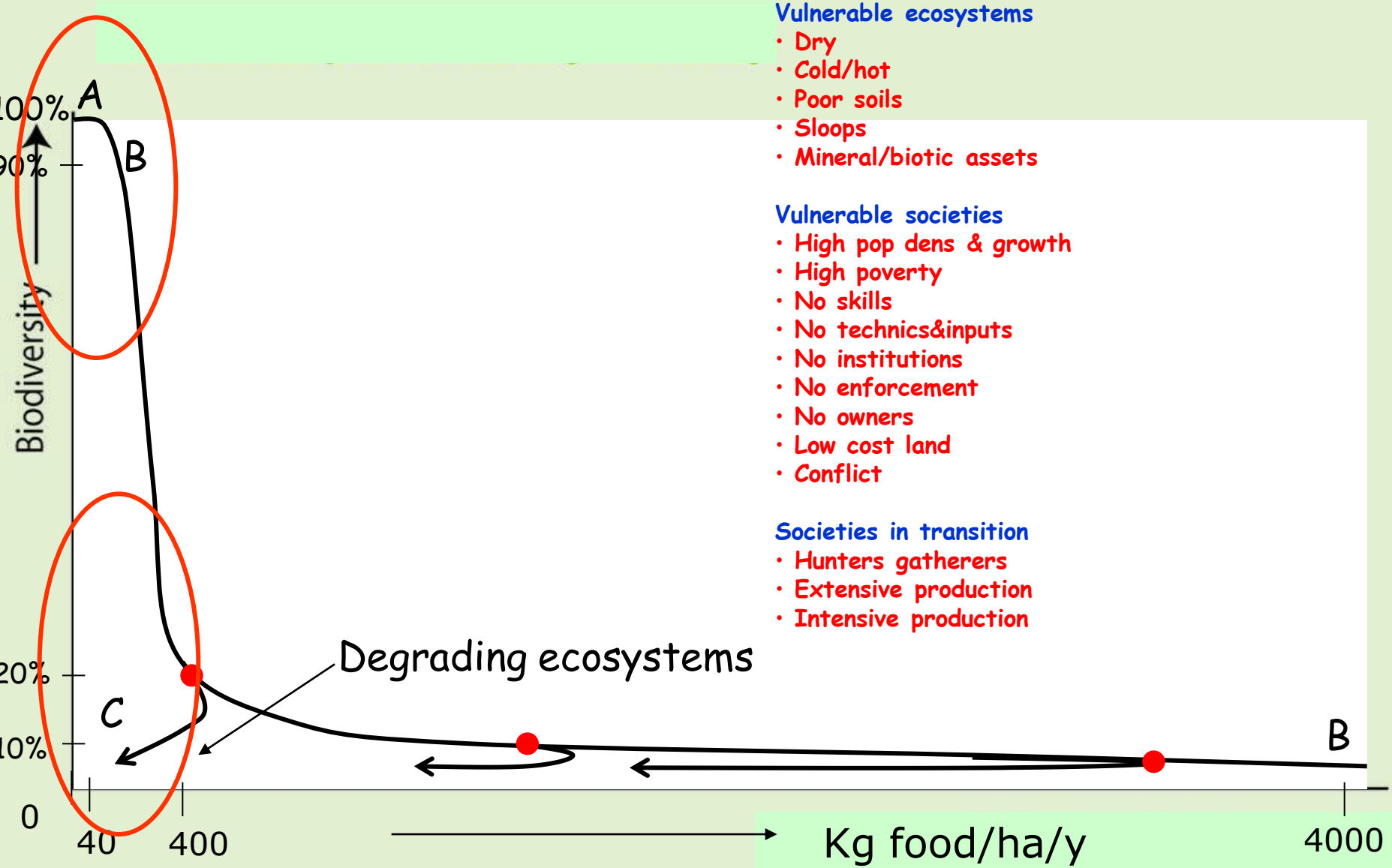

Vulnerable ecosystems
- Dry
- Cold/hot
- Poor soils
- Sloops
- Mineral/biotic assets

Vulnerable societies
- High pop dens & growth
- High poverty
- No skills
- No technics&inputs
- No institutions
- No enforcement
- No owners
- Low cost land
- Conflict

Societies in transition
- Hunters gatherers
- Extensive production
- Intensive production

Key dilemma: ex or intensification? integration or segregation?

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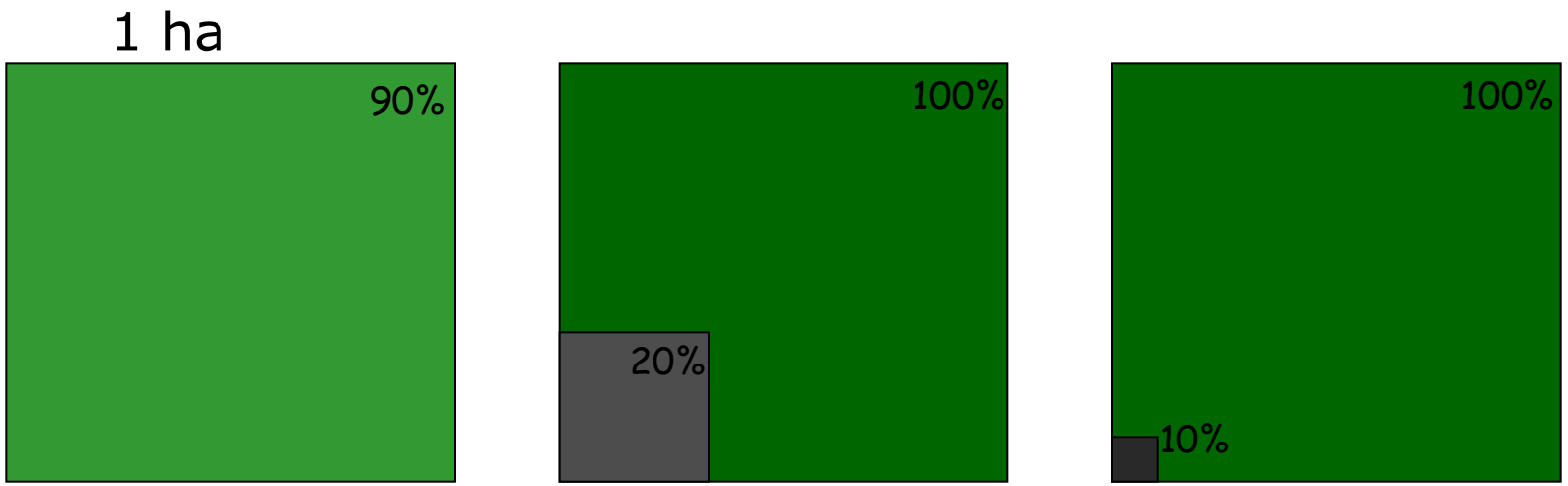
Area required to produce 40 kg food, and remaining biodiversity



dilemma

Biodiv loss inside production area,
But gain outside production area

Observations

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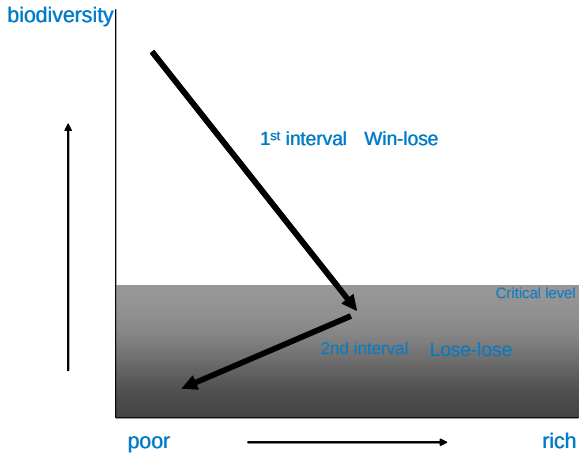
1. Biodiversity loss unavoidable for eradicating poverty
2. If converted, do it the most productive way (eco-efficiently)
3. Avoid degradation, safeguard capability to produce biomass (soil orgC)



Mainstream requires a clear direction!

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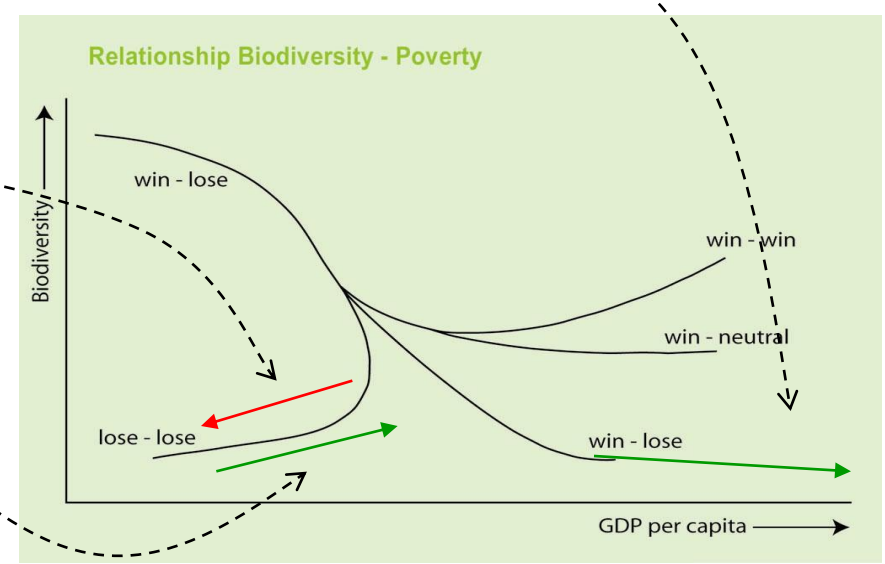
Do's and dont's:

1. Increase productivity (agri, grazing,forestry, aquacult..)
2. Decrease input per output (water, P, N, energy, ..)
3. Avoid degradation (5-10 mln km2)
4. Restore degraded ecosystems (10-20 mln km2)
5. Change diet (less meat)
6. Protect remaining natural area



Current agri area: 40 mln km2 (20 mln km2 reserve)


state in 1988
A signal of hop

state in 2008 (Ousseni Kindo, innovater)

Thank you

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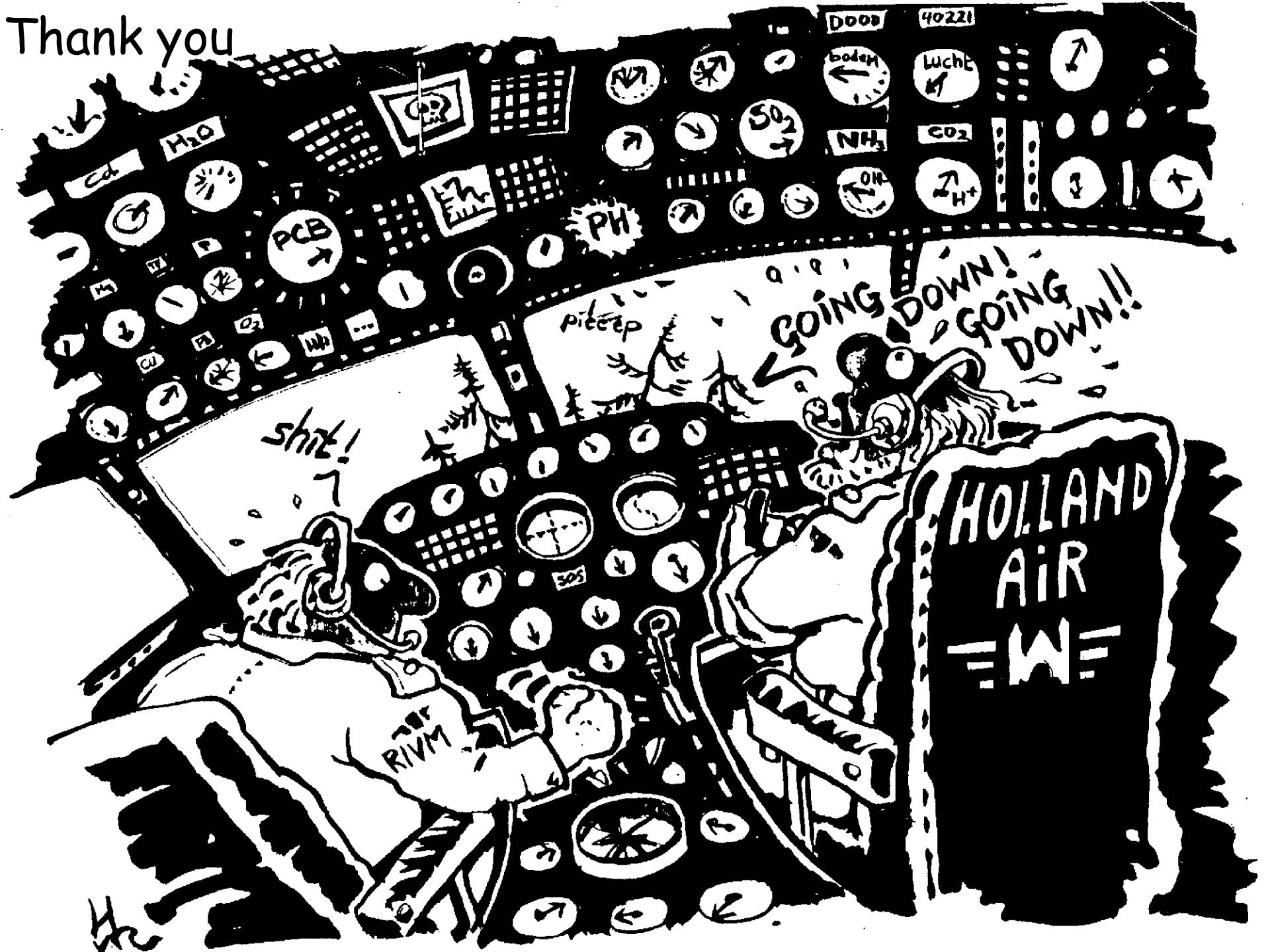
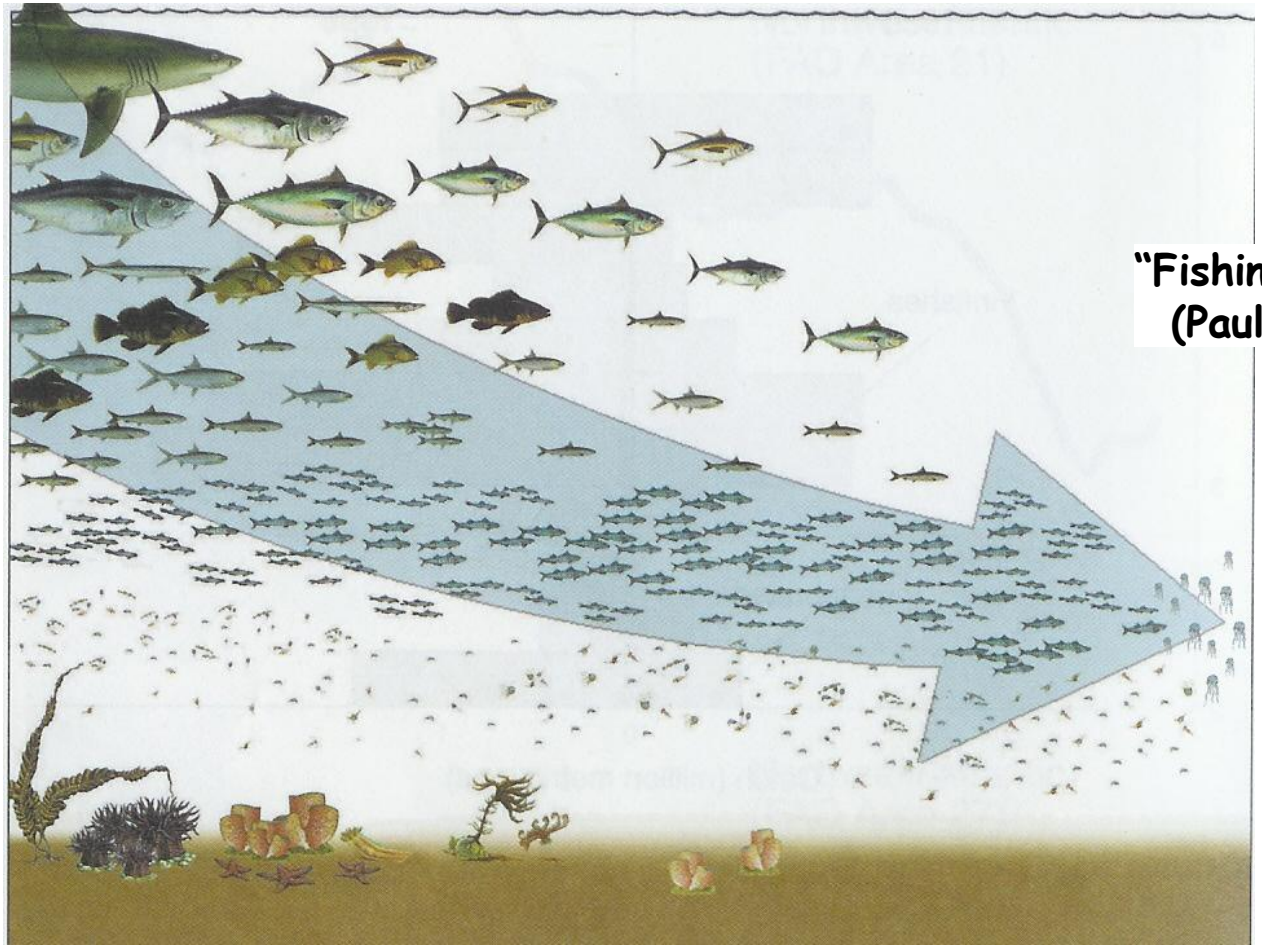
Thank you


DOOD
40221
bodem
lucht
H_2O
SO_2
NH_3
CO_2
OH
H^+
PCB
PH
pieeep
GOING DOWN! GOING DOWN!!
shit!
RIVM
HOLLAND AIR

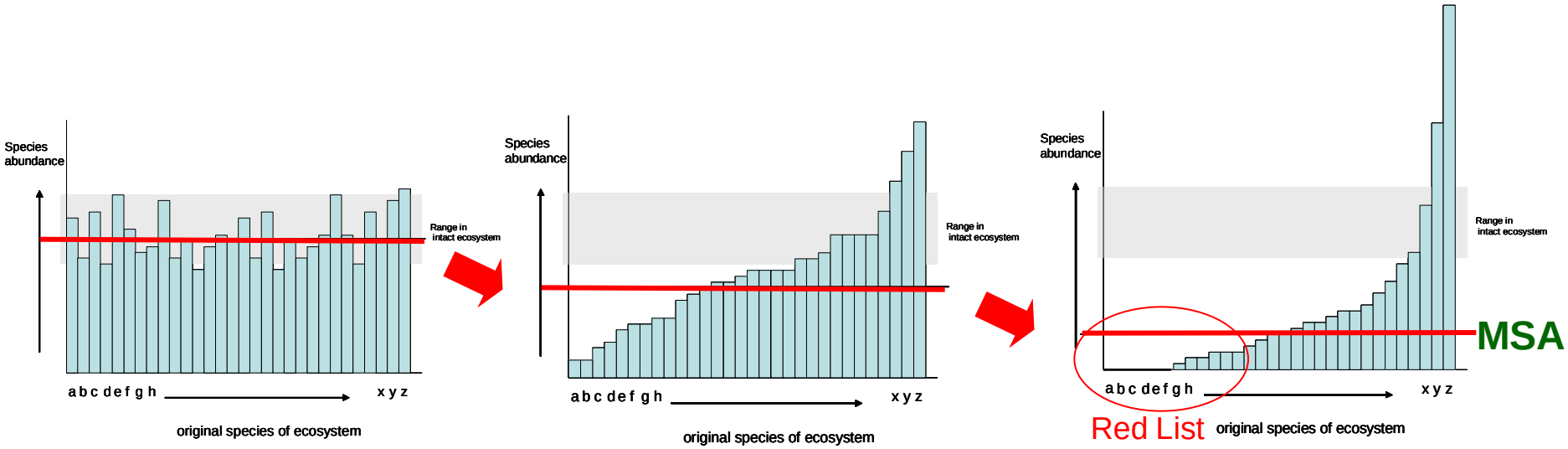
How do we measure biodiversity loss? → homogenisation



"Fishing down the foodweb (Pauly, 2001)"

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

Indicators: ecosystem extent & species abundance



Mean Species Abundance (MSA)

Lose – lose: degrading systems

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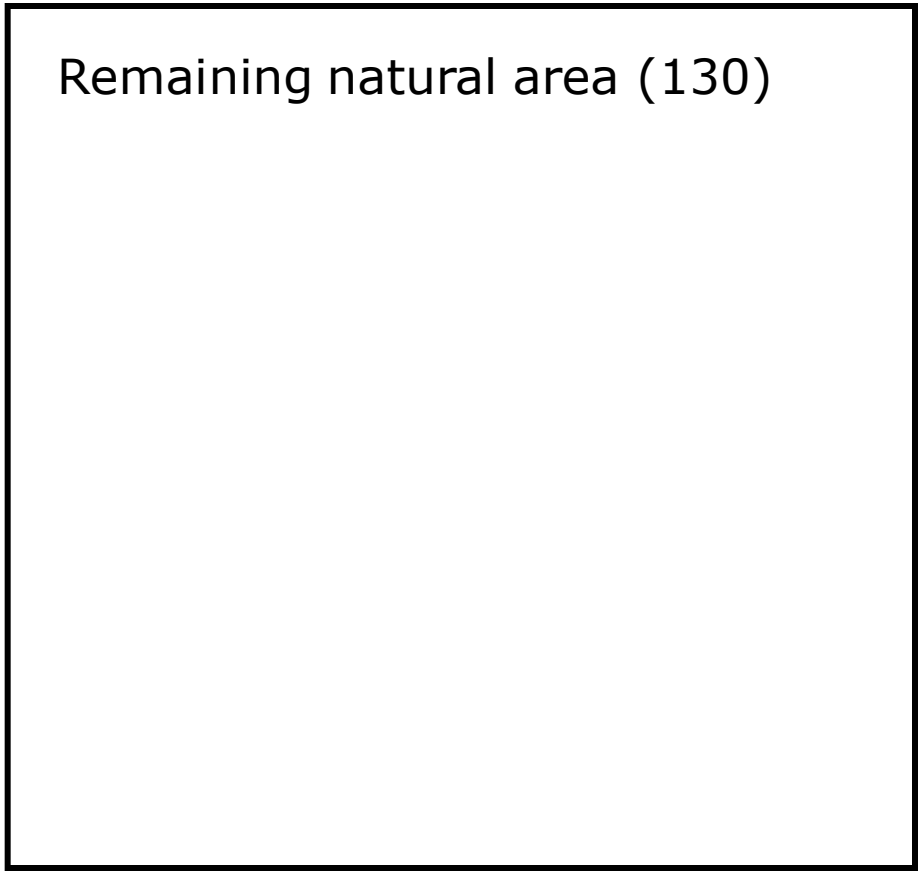

130 mln km2
Global terrestrial surface

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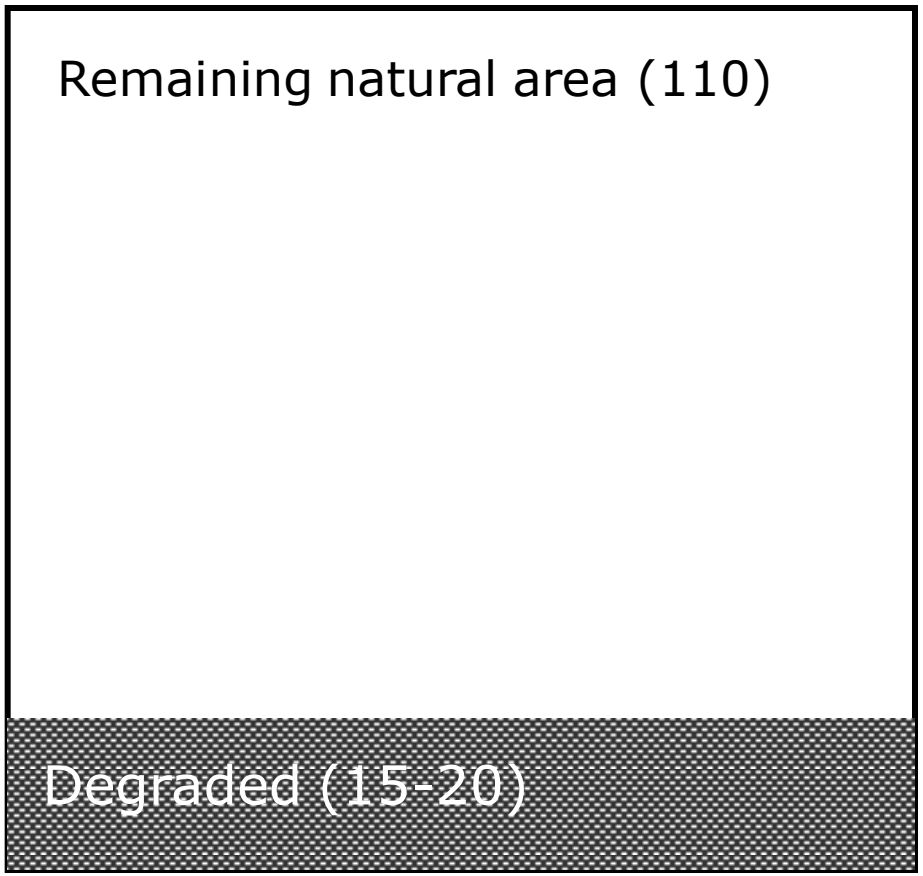
Degradation a serious threat



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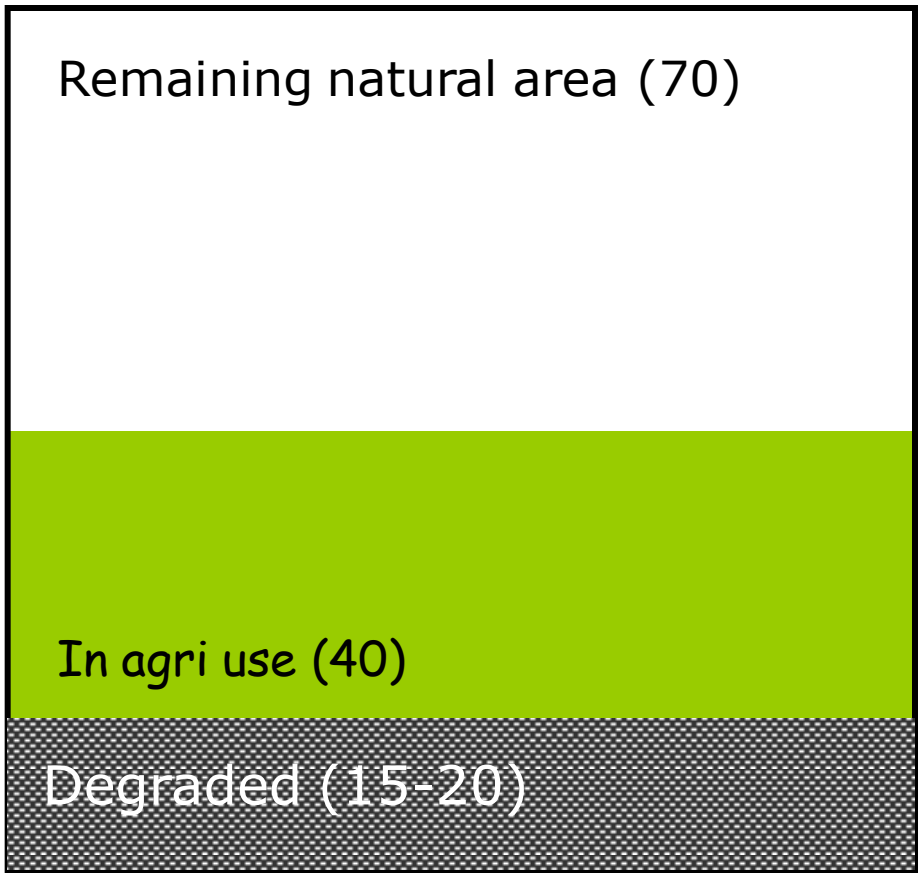

130 mln km2
Global terrestrial surface

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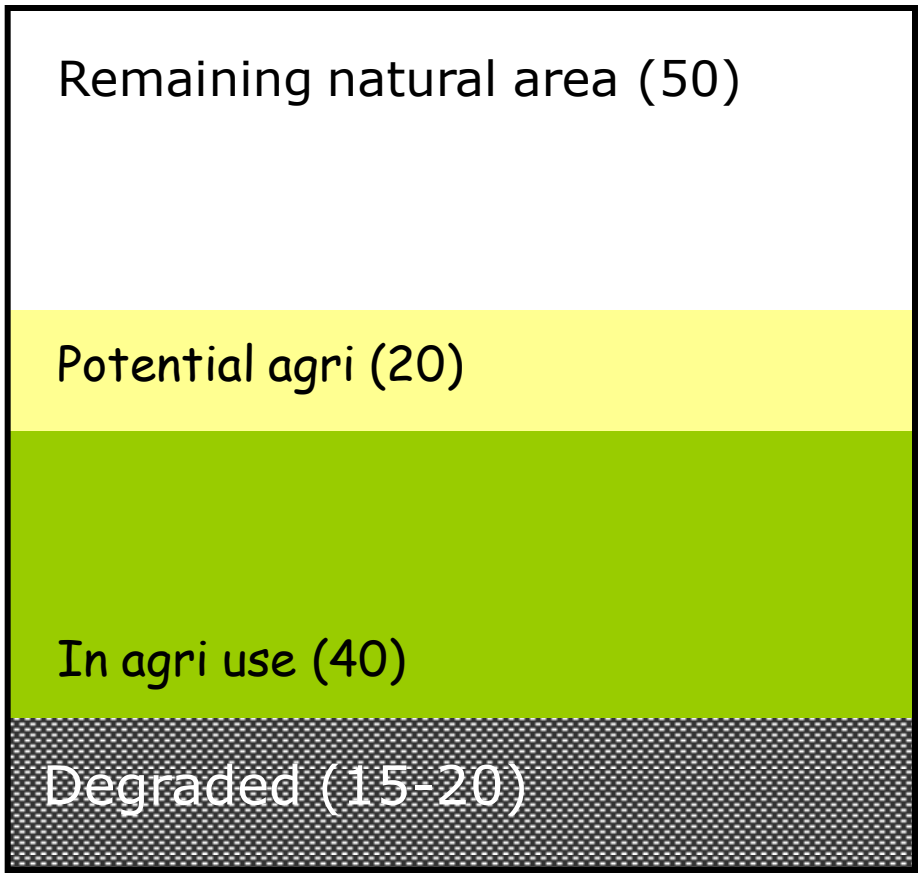
Degradation a serious threat



130 mln km2
Global terrestrial surface

Degradation a serious threat

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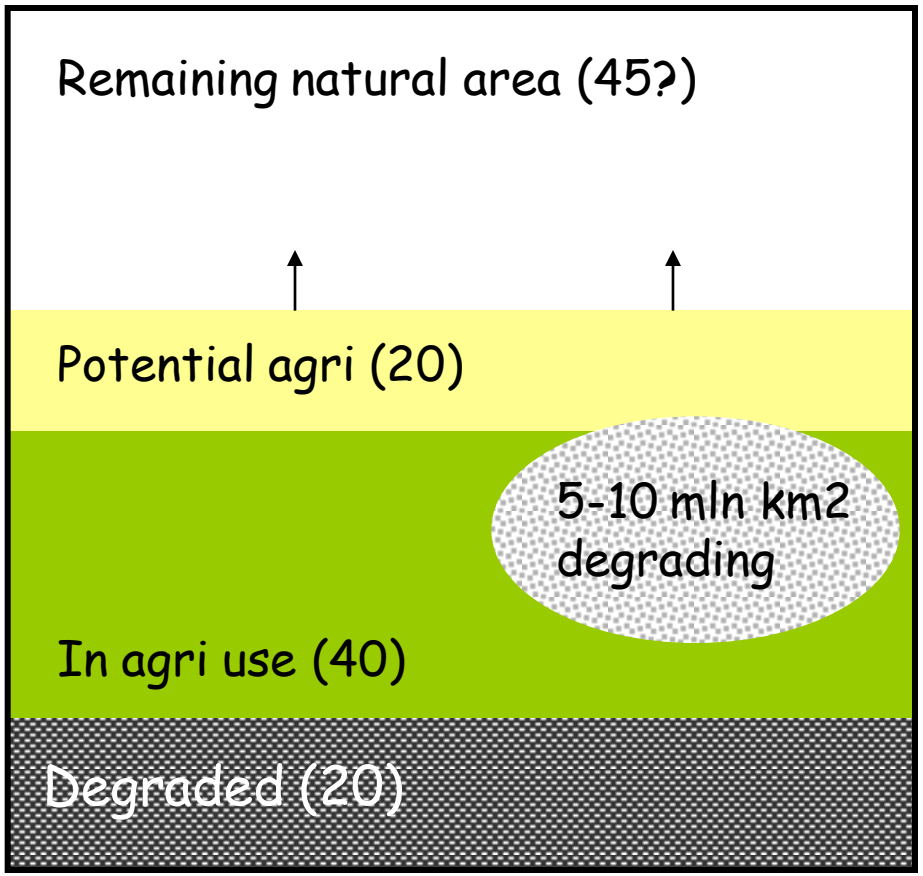

130 mln km2
Global terrestrial surface

Baseline 2030

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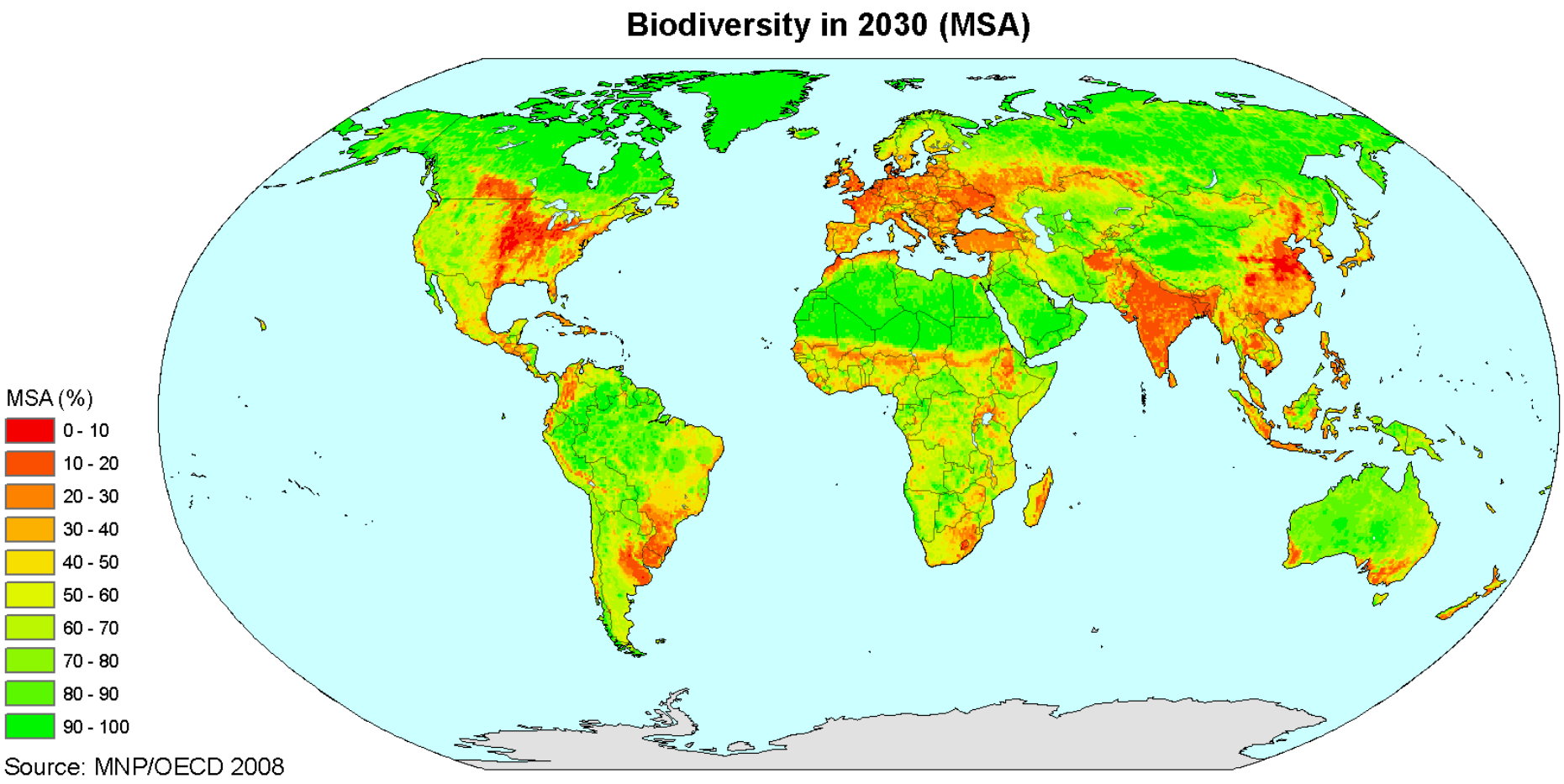

Lose – lose: degrading systems

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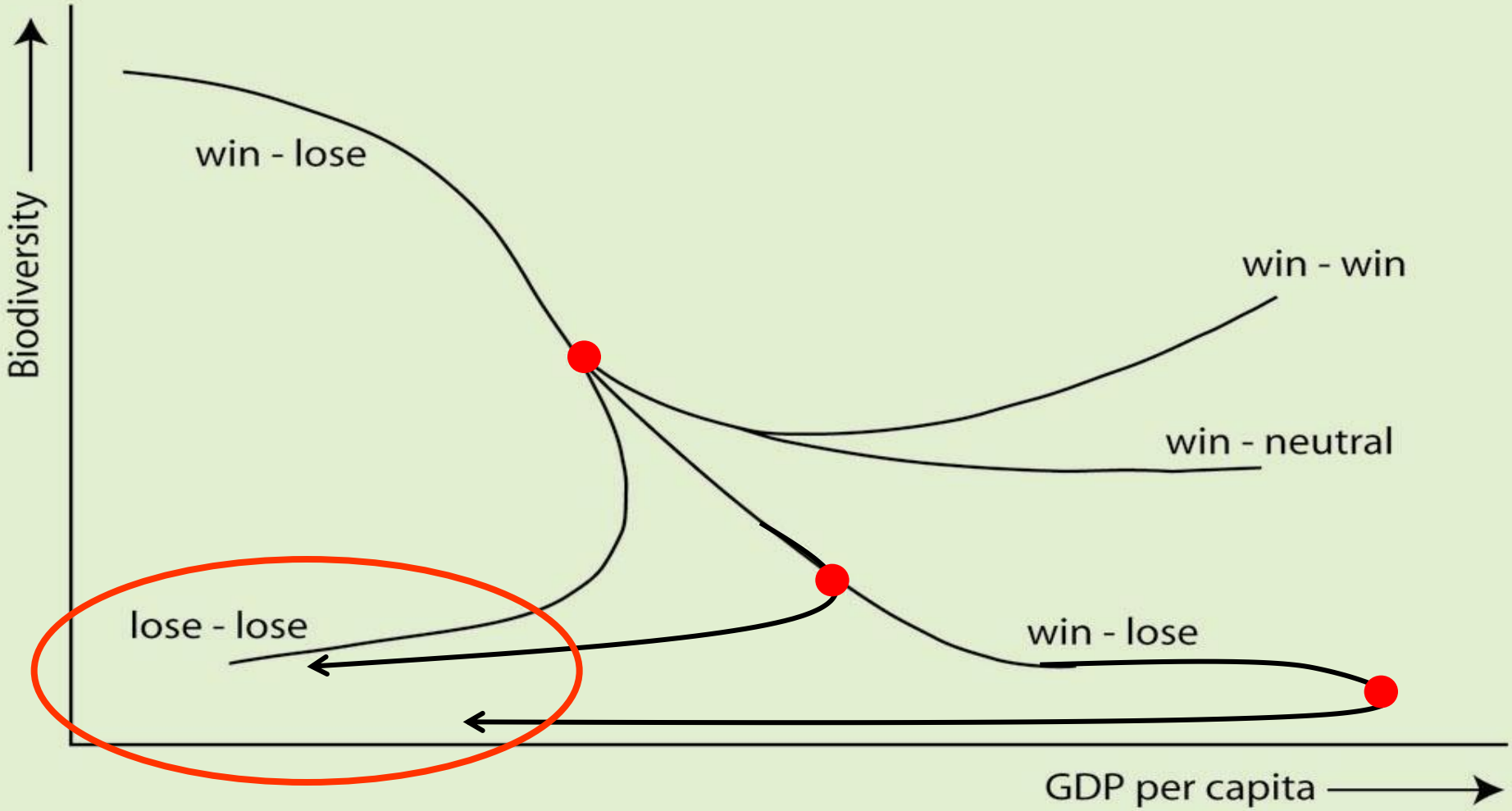

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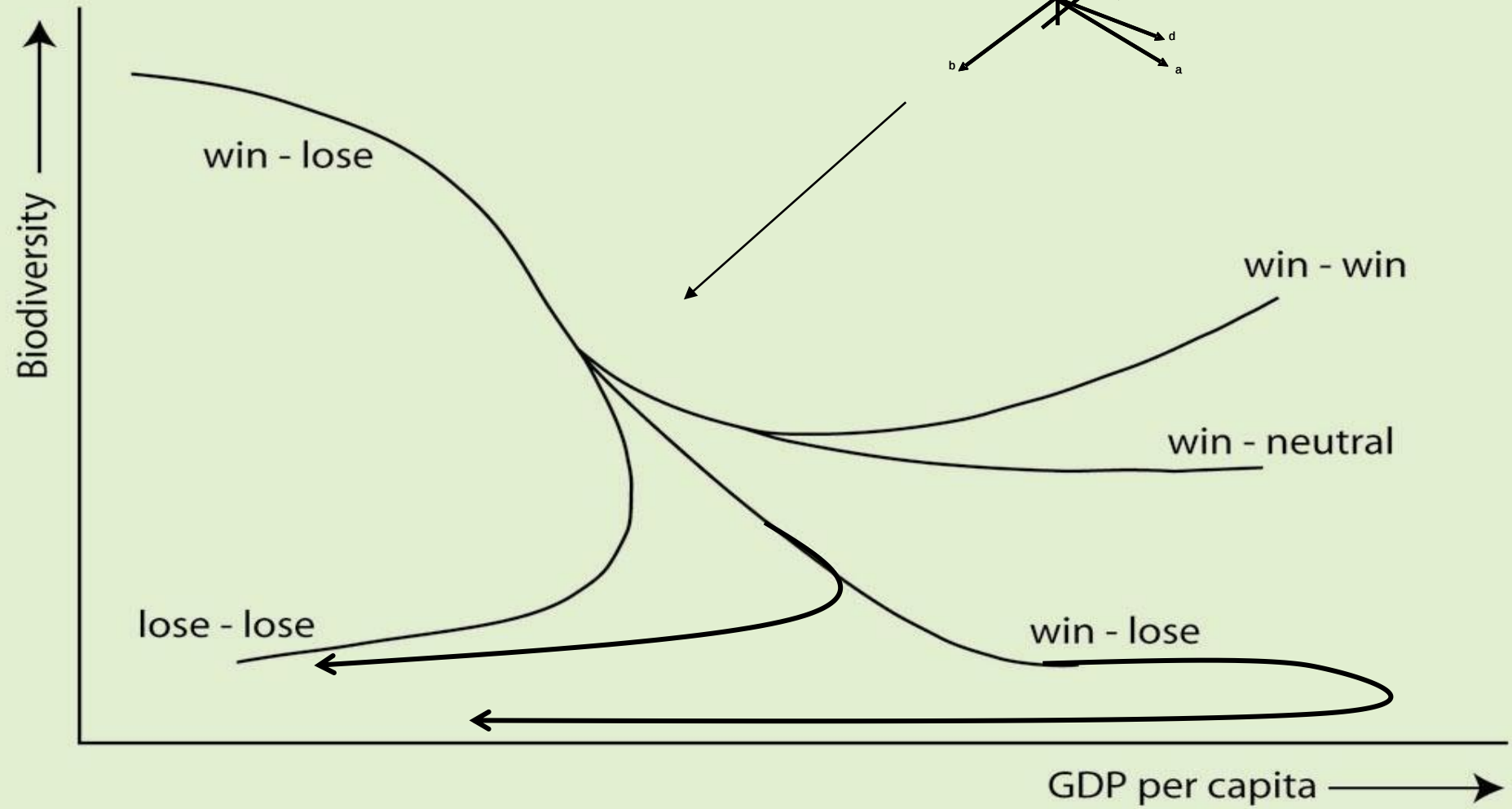

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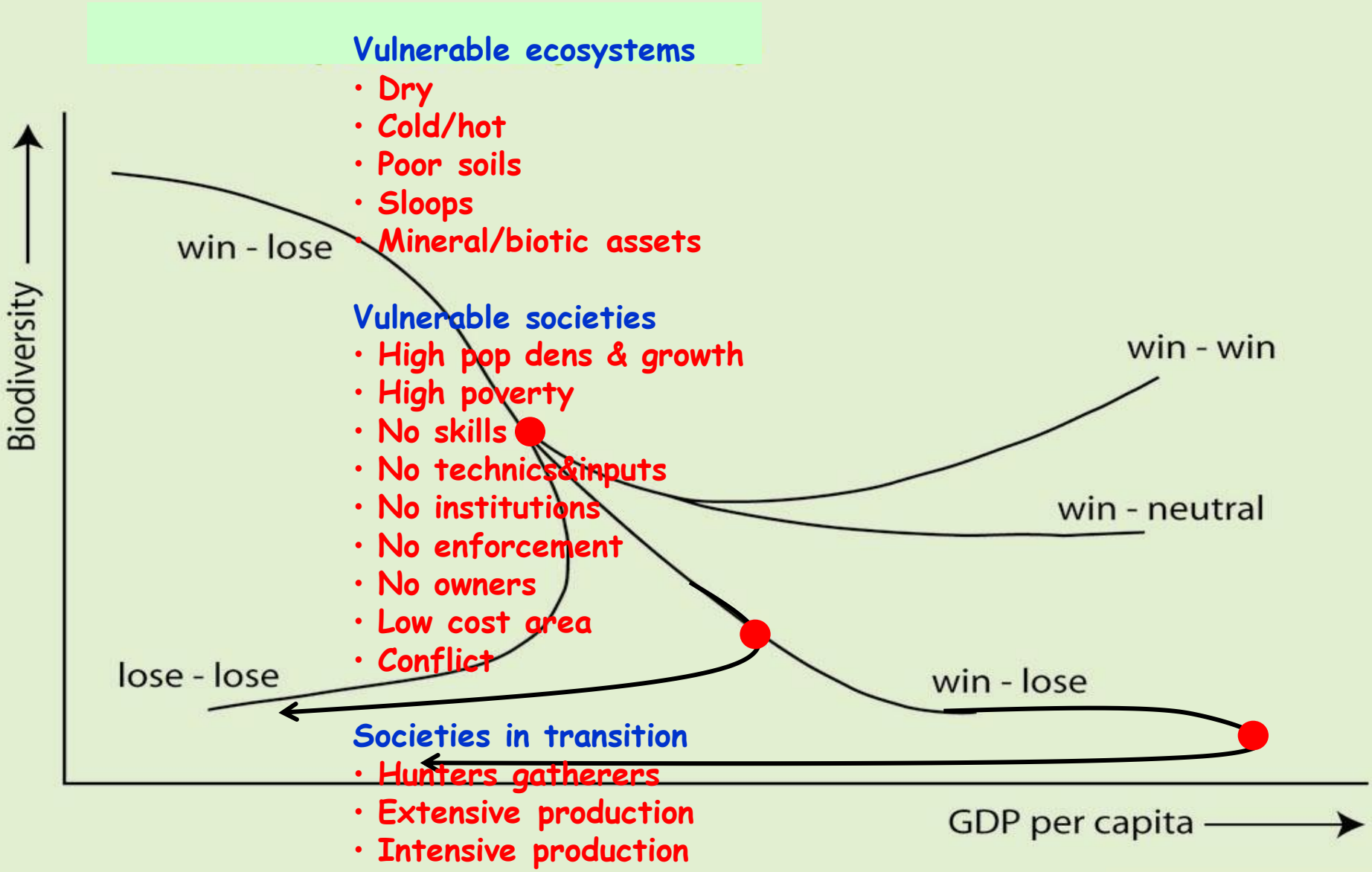

Turn into a win – win?

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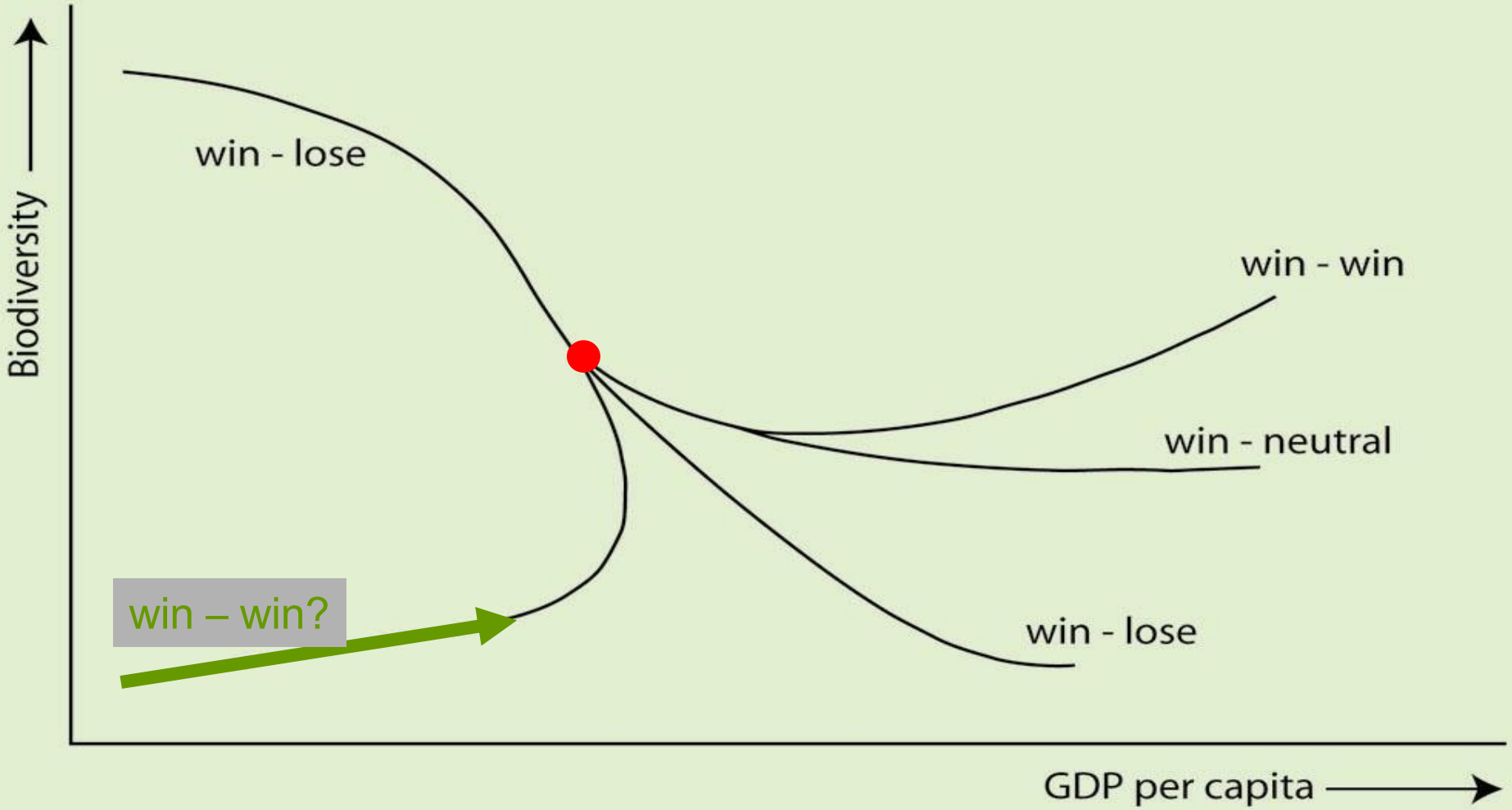
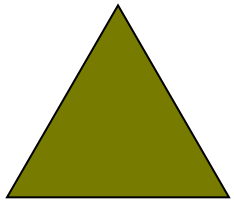


Degradation 10-20 mln km2

Mainstreaming sectors Δ



Historical human induced decline topsoil org C

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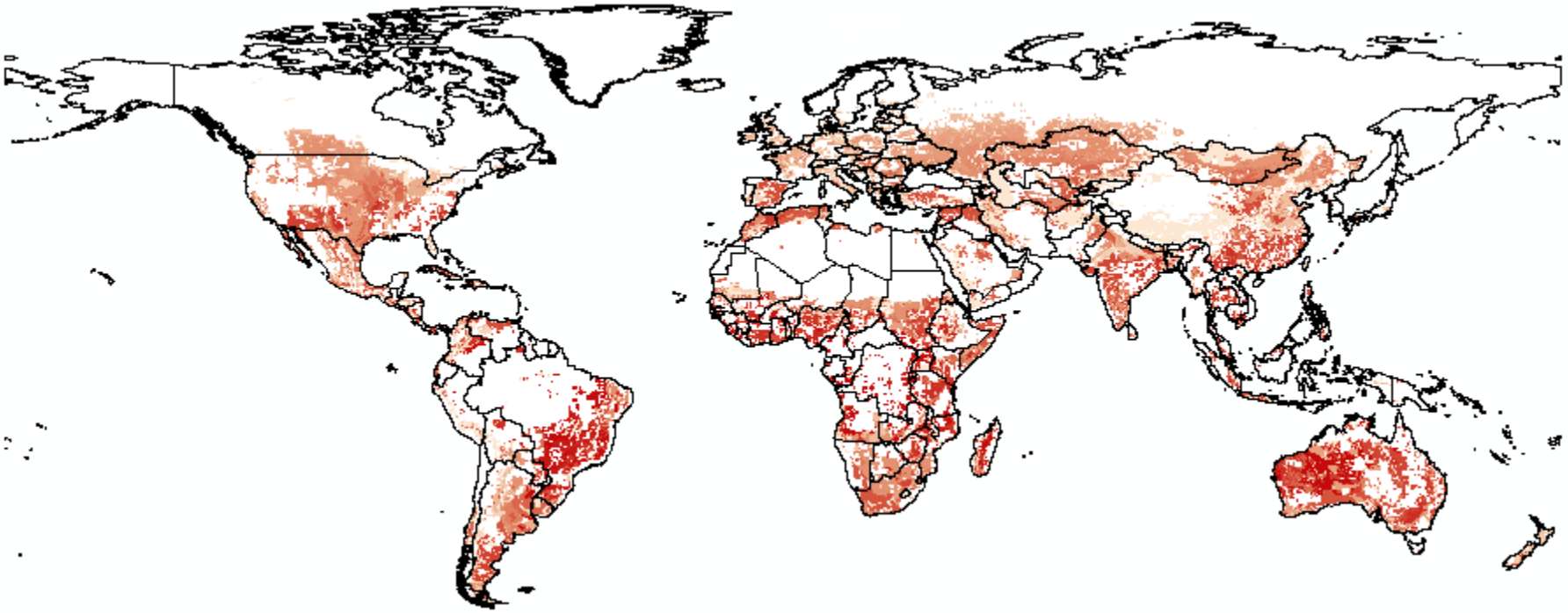

Preliminary results

WUR, Jetse Stoorvogel, in prog

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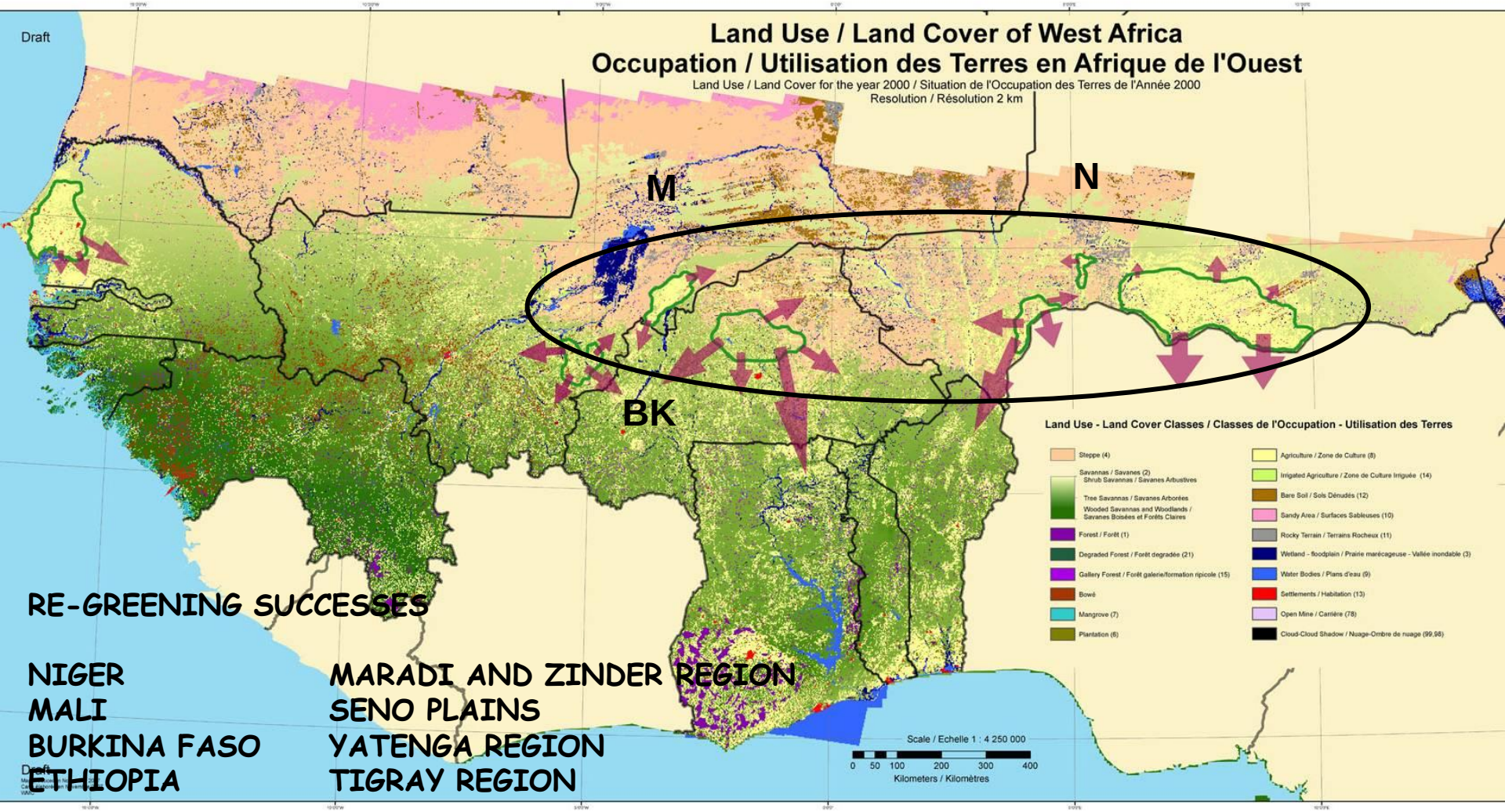
African re-greening initiatives (slides Chris Reij)



Until the 70ies massive degrading ecosystems

What they do?

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1. Revive underground forest & seeds
2. Plant trees
3. Create water & wind barriers
4. No free goat and sheep grazing!
5. Safeguard & manage trees

What they do?

Faidherbia albida, a fertilizer tree

Re-greening

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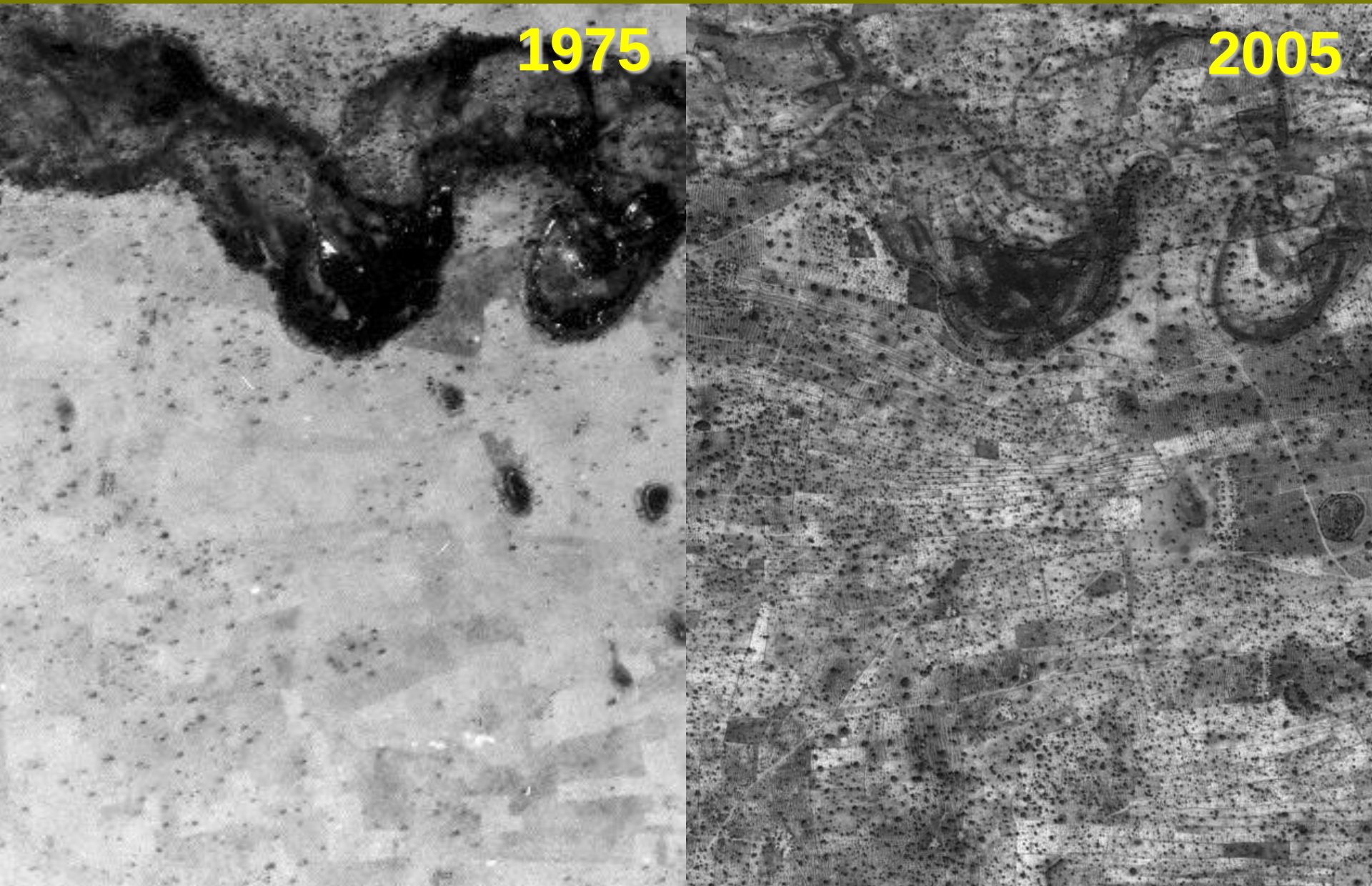
Vegetation in Galma in 1975 and 2005

Re-greening

PBL Netherlands Environmental Assessment Agency

Vegetation in Zinder



Re-greening

Half million ha of farmer-managed re-greening on Mali's Seno Plains


state in 2007 (barren in 1985)


state in 2008 (barren in 1985)

How does it work?

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1. Trees fertilize 150 N/ha/y
2. Higher Soil org C
3. Less wind exposure
4. Less sun exposure
5. Lower temperatures (- 6 C)
6. Higher soil turbation & aeration (termites)
7. Higher soil moisture
8. Higher groundwater tables
9. Higher water retention

1. Higher food production (>100 -800 kg/ha/y)
2. Higher food & water security (no deficits)
3. Higher (fuel)wood production (2.5 hr -> 0.5 hr)
4. Higher societal organisation & cohesion

-> Restarting the ecosystem

Impacts in Niger

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- 5 million ha re-greened in 20 years (size Netherlands)_
- Only labour for protection, no investment costs
- 200 million new trees
- Arrange exclusive users rights
- Additionally
  - 2.5 million people fed

Who did it? Individual innovators: mouth to mouth

Scaling up

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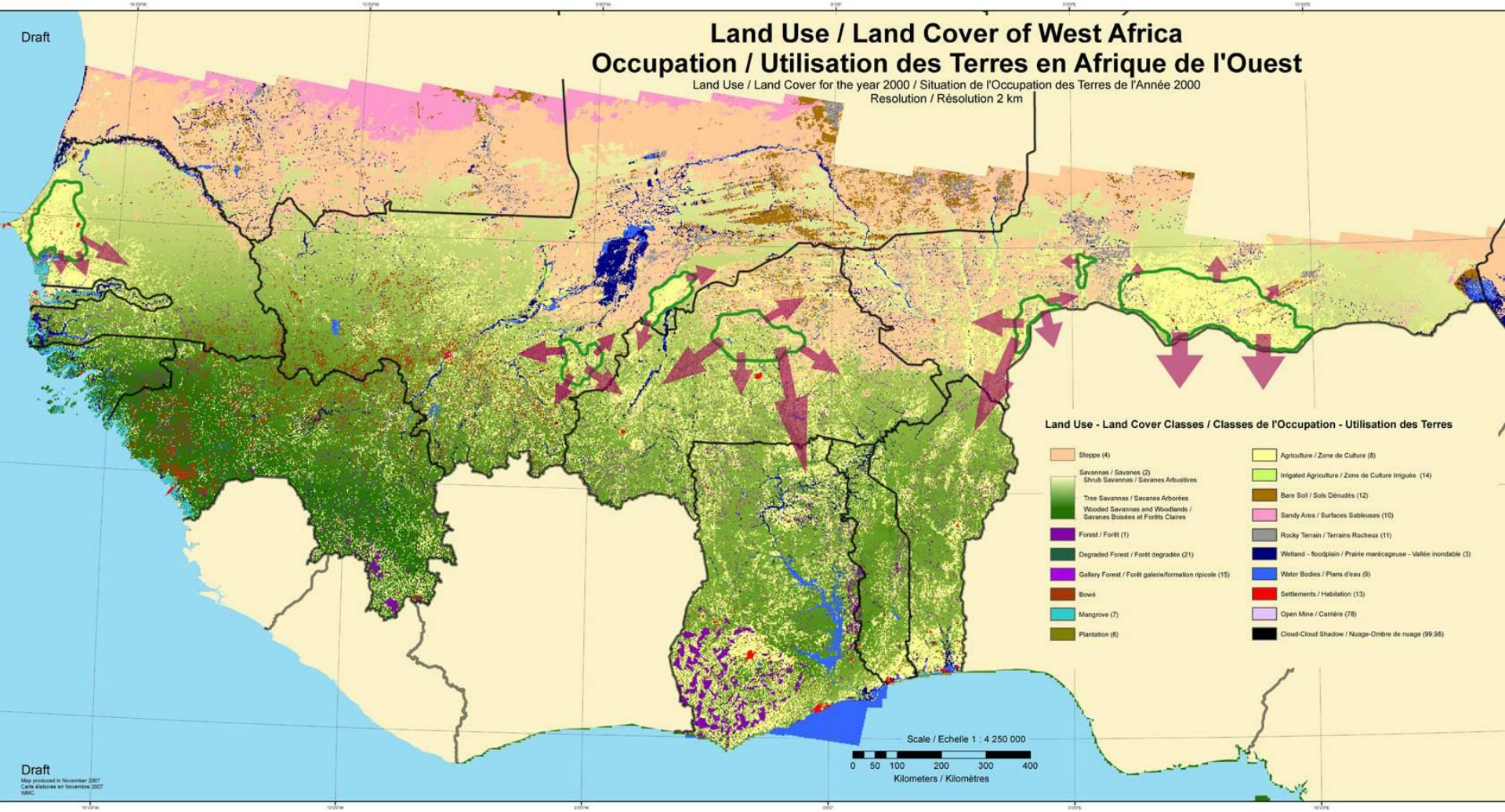
African re-greening initiatives




Thank you

3. How did they do it?

1990

Planting pits
Stone contoure bunds

Zaïg

Demi lunes

2004

and in the future

Test to hypothesis

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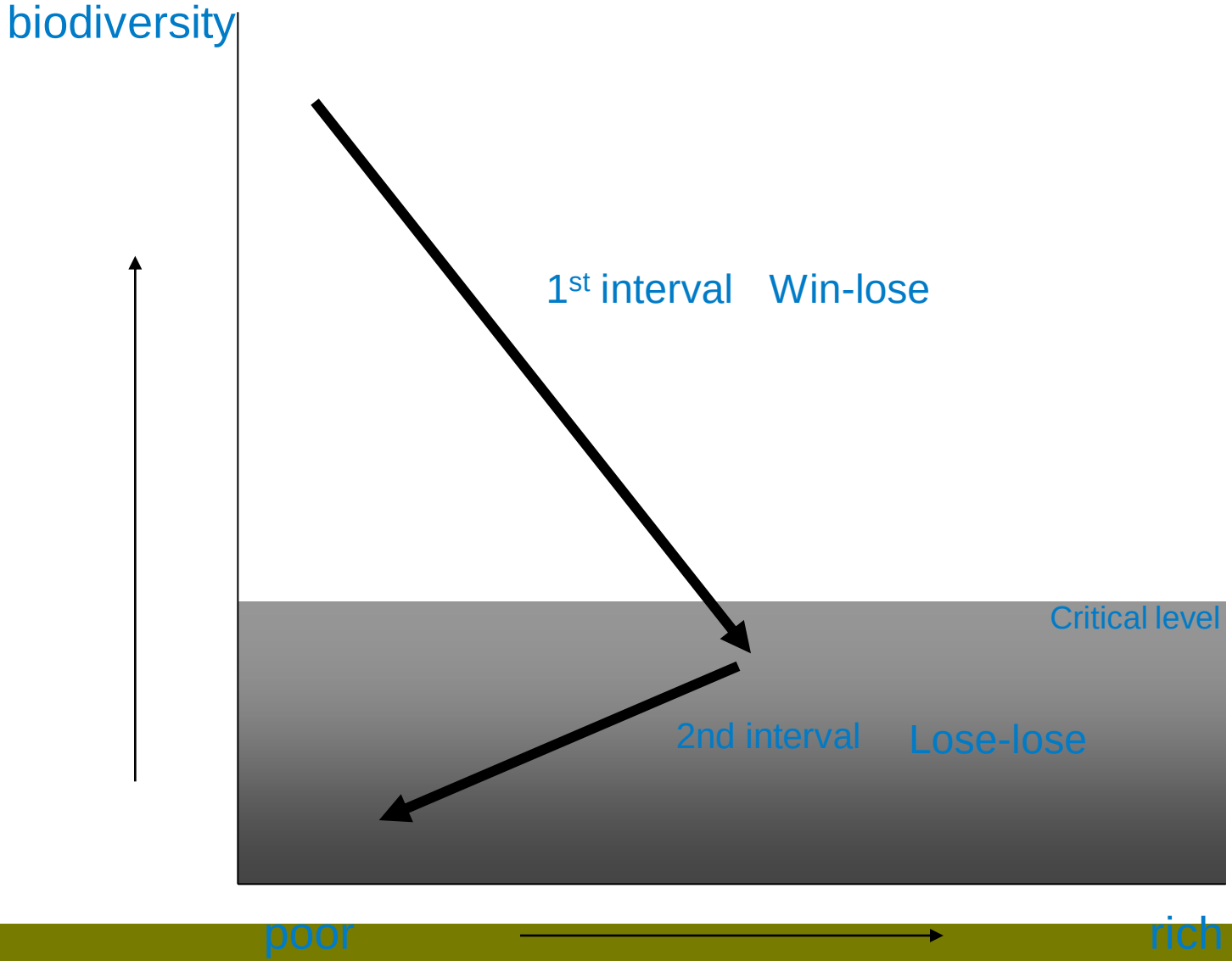
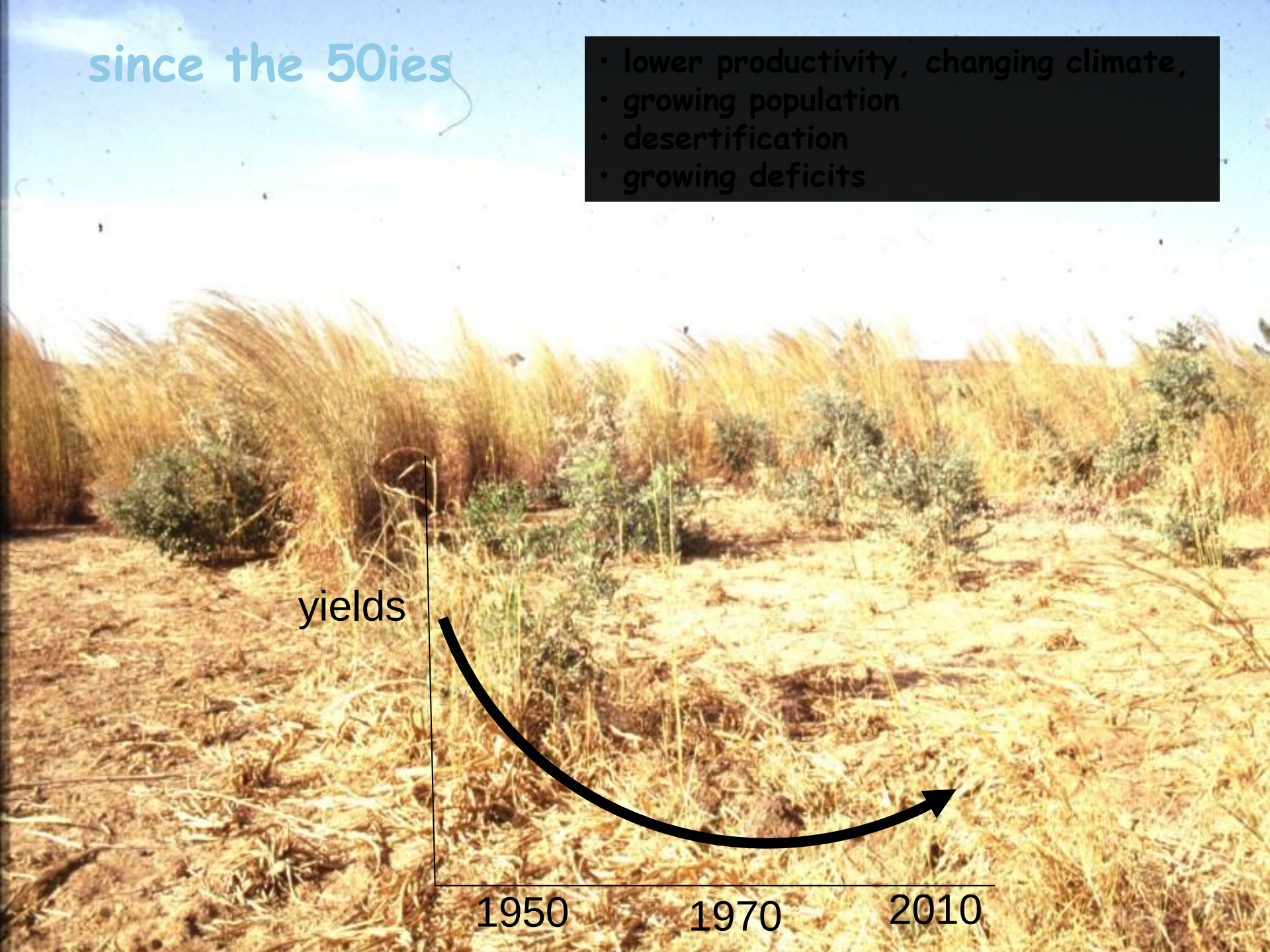


Vegetation reduces surface temperatures

Vegetation reduces wind speed and protects crops against sand

since the 50ies

- lower productivity, changing climate,
- growing population
- desertification
- growing deficits



5. Impacts: Improved soil fertility & crop yields

6. Who did it?

Catalysed with external help, farmer-to –farmer extension & spontaneous adoption

7. Scaling up: Challenge

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Mobilize millions of people to invest in trees

1. forest use rights
2. favorable agri policies
3. build a movement
4. expand in:
   - Senegal
   - Ethiopia
   - Nigeria
   - Ghana
   - Kenya

5. Multiple win:
   - Food-, water-, fuel-security, poverty,
   - climate, biodiversity, desertification

7. Scaling up: re-greening partners

Assessment Agency

1. RESEAU MARP AND PARTNERS (BURKINA FASO)
2. SAHELECO AND PARTNERS (MALI)
3. CRESA UNIVERSITY OF NIAMEY
4. HoAREC, UNIVERSITY OF ADDIS ABEBA
5. WORLD AGROFORESTRY CENTRE
6. WORLD VISION AUSTRALIA
7. WORLD WIDE WEB FOUNDATION
   NETWORK INSTITUTE VUA
8. IFAD
9. BOTH ENDS & TURING FOUNDATION
10. FINHUMF
11. ……..

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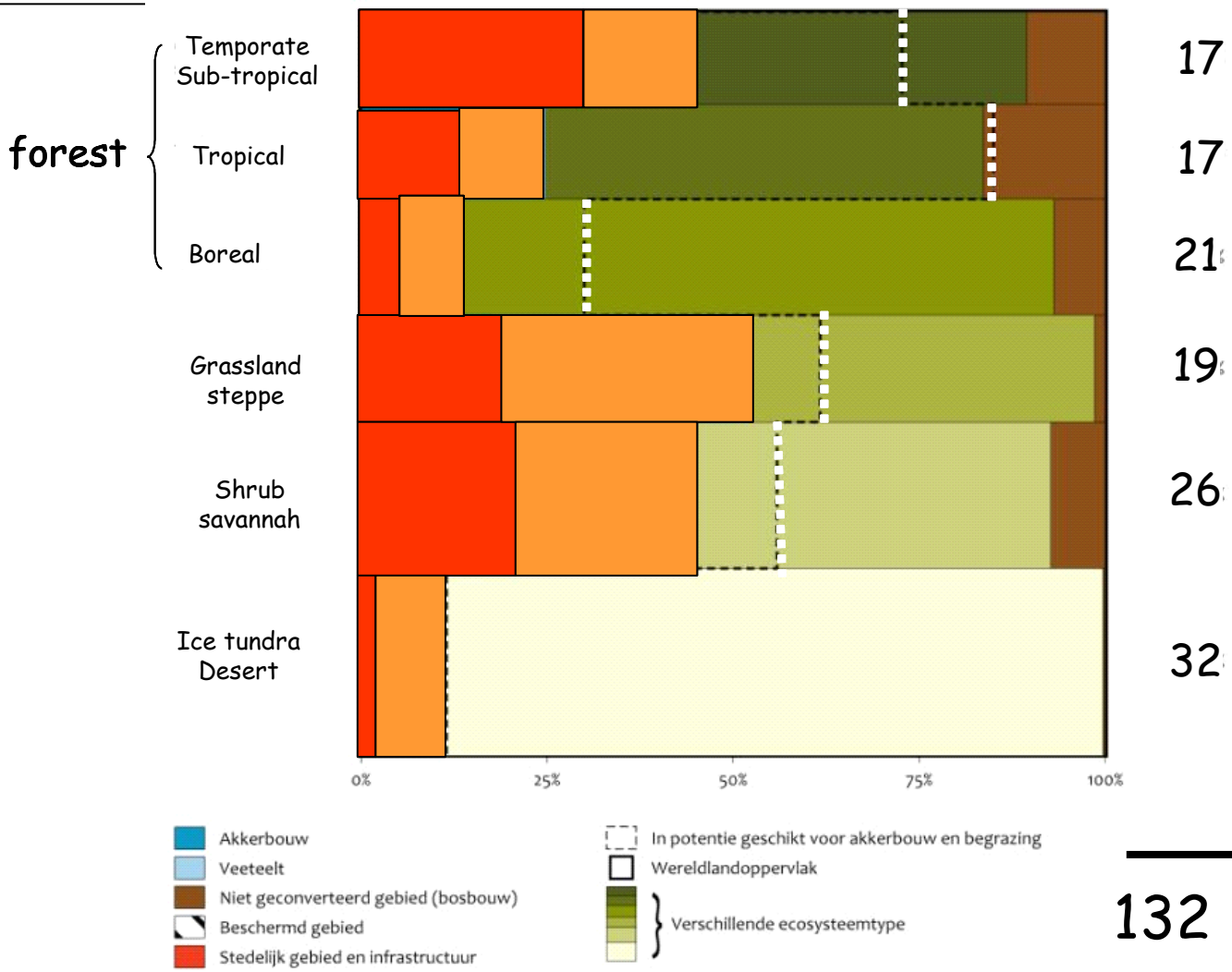
2050 Land use per ecosystem type

Million km²



baseline

agri + 6

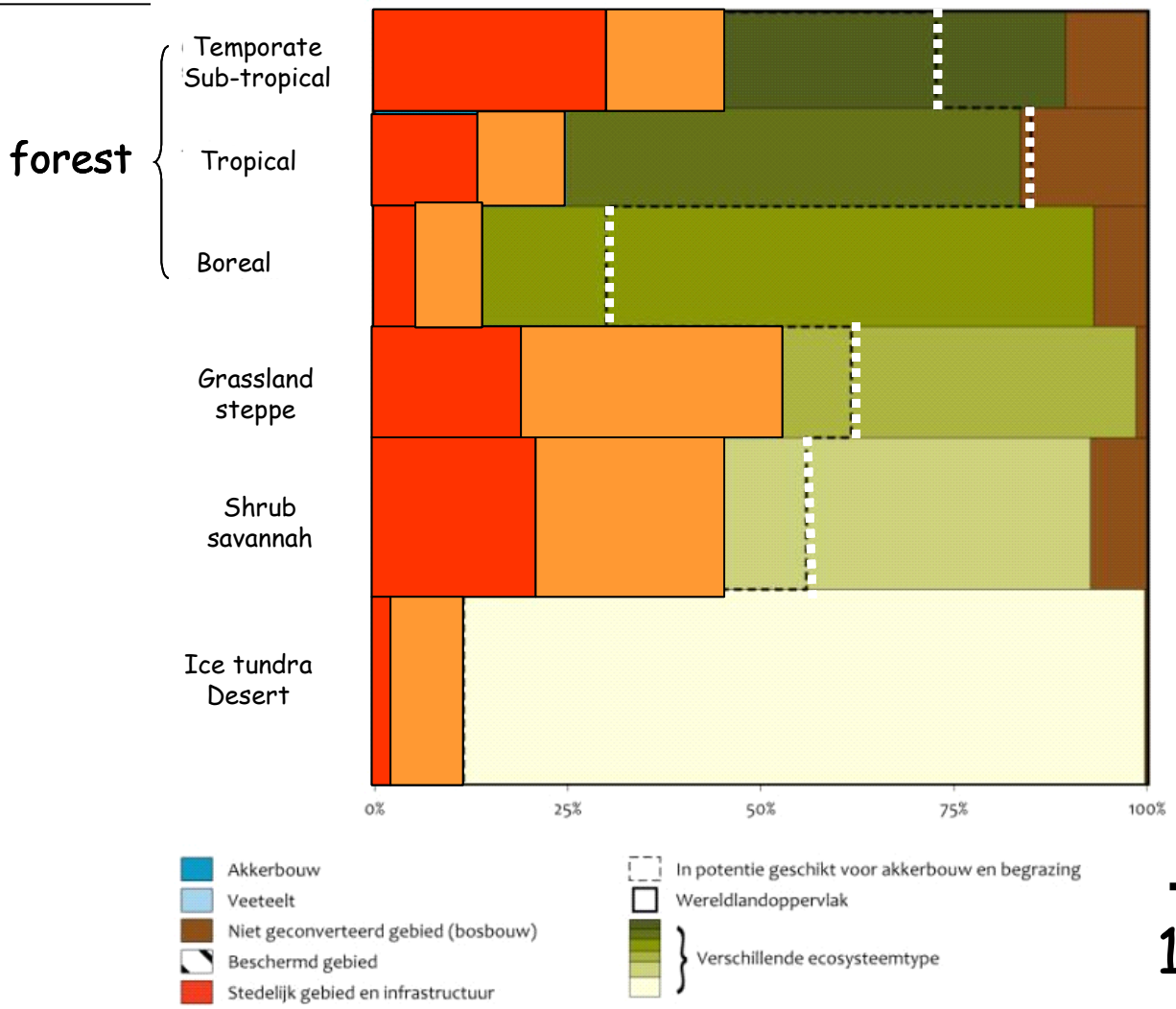
——— +

132 km²

5 mln km²

2050 Land use per ecosystem type

Million km²



Agri +12

forestry +5

biofuels +5

C-plantation +1

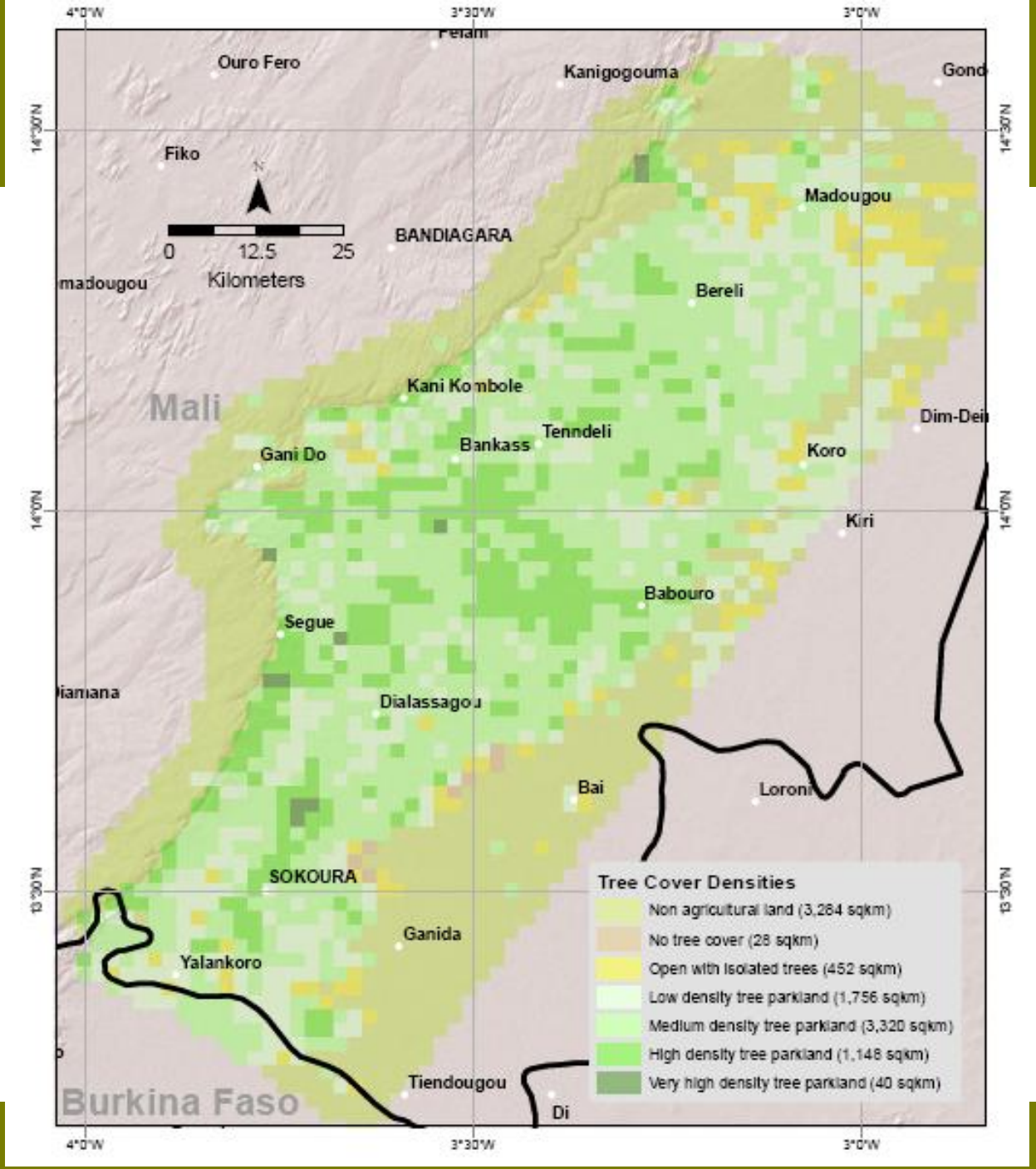
degrading +5

\+

132 km²

5 mln km²

Degraded 10-20?


4°0'W
3°30'W
3°0'W
14°30'N
14°0'N
13°30'N
Ouro Fero
Kanigogouma
Fiko
Madougou
BANDIAGARA
0
12.5
25
Kilometers
madougou
Bereli
Kani Kombole
Mali
Dim-Dei
Tenndeli
Bankass
Gani Do
Koro
Kiri
Babouro
Segue
Dialassagou
Bai
Loroni
SOKOURA
Ganida
Yalankoro
Tiendougou
Burkina Faso
Di
Tree Cover Densities
Non agricultural land (3,264 sqkm)
No tree cover (28 sqkm)
Open with isolated trees (452 sqkm)
Low density tree parkland (1,756 sqkm)
Medium density tree parkland (3,320 sqkm)
High density tree parkland (1,148 sqkm)
Very high density tree parkland (40 sqkm)

DRIVER: AGROFORESTRY IS A LOW-COST WAY TO INTENSIFY AGRICULTURE AND PRODUCE MULTIPLE IMPACTS

This is how it looks like on the ground

A brief history of man

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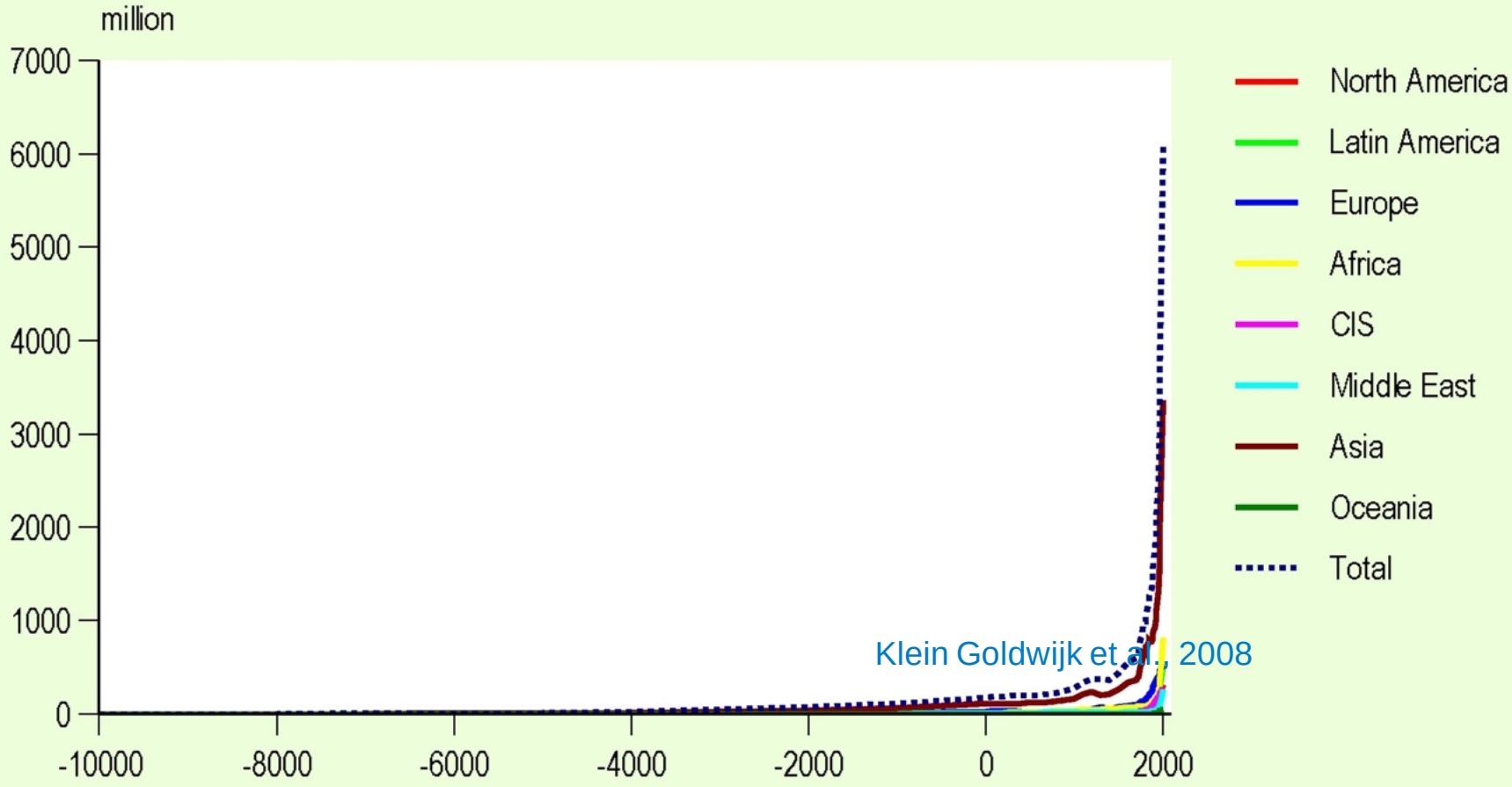
Historical population estimates over the Holocene (10,000 B.C - 2,000 A.D.)



Klein Goldwijk et al., 2008

Results previous project: literature

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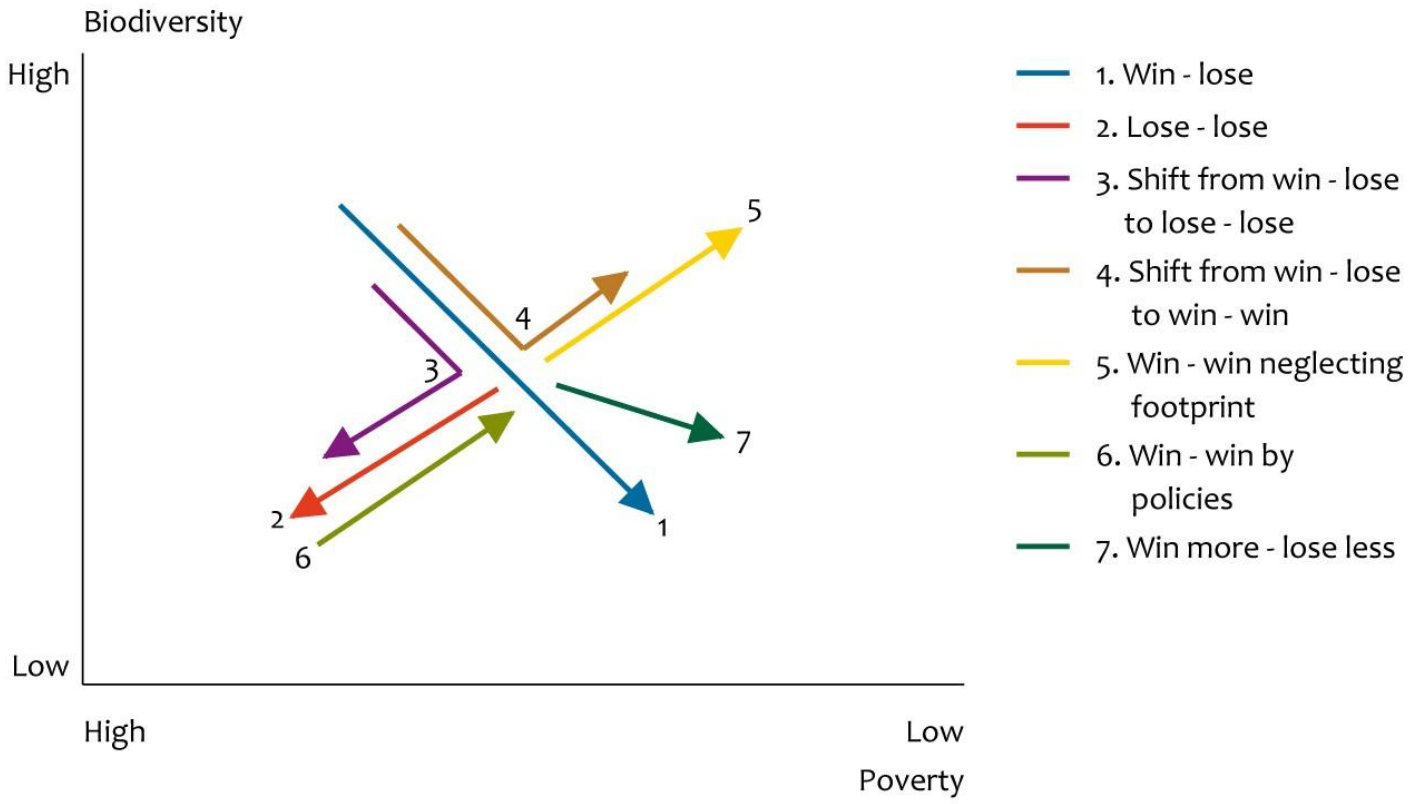
Findings of biodiversity - poverty connection from literature



Results previous project case studies

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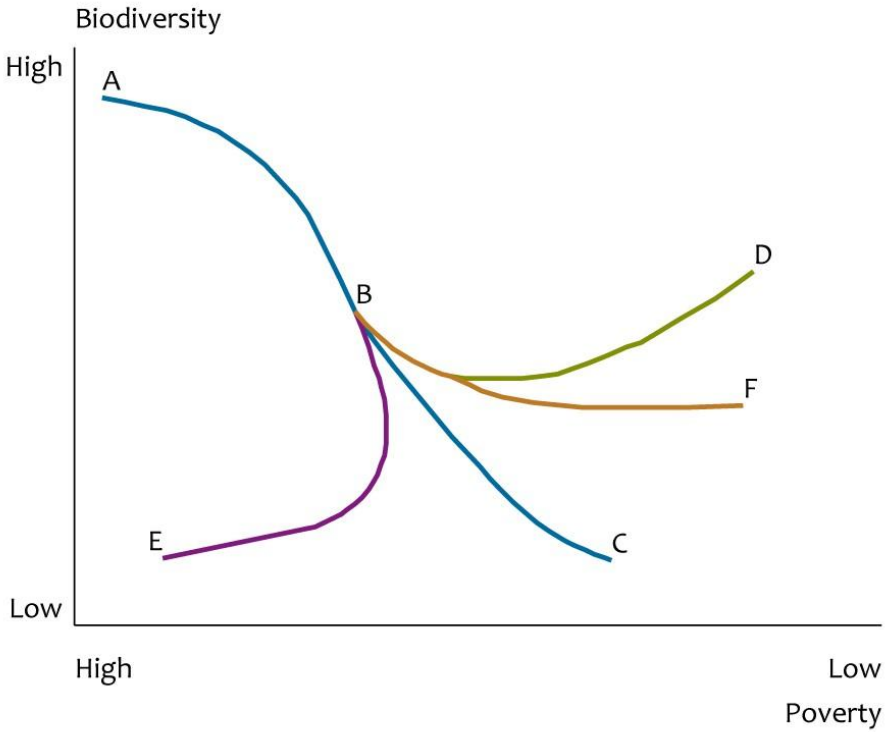
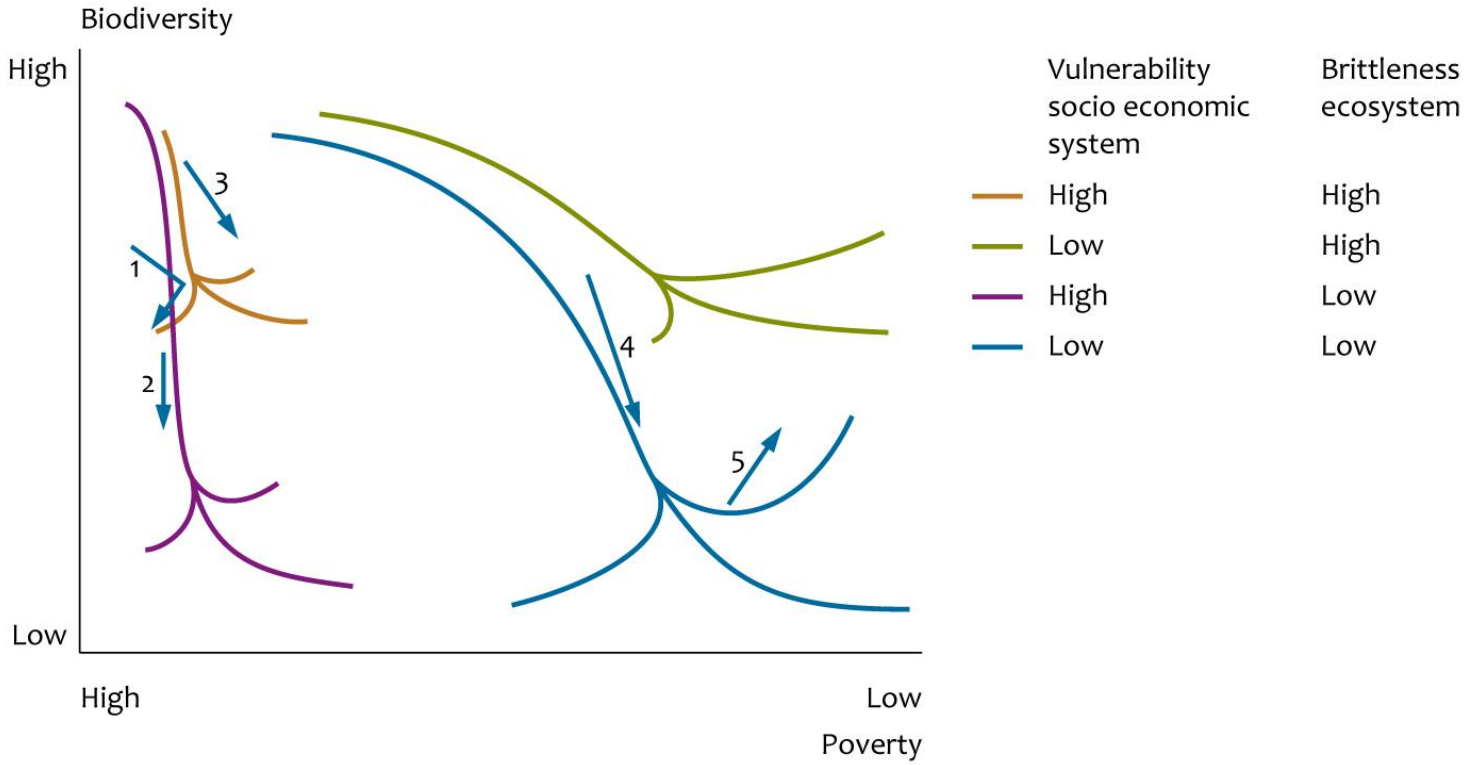
Hypothetical courses of biodiversity and poverty



Determinants:

- Brittleness ecosystem
- Fertility
- Ecosystem extent
- Population dens & growth
- Skills
- Migration
- Income re-distribution
- Access to capital
- Access to land
- Market integration
- Productivity land & labour
- Policies (expansion, intensification)
- Land tenure, law enforcement
- Infrastructure distance
- Champions

Various hypothetical biodiversity - poverty pathways



Results previous project: Review recommendations

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1. Further improve insights -> quantitative model
2. Relevant spatial & temporal scales
3. Add services next to goods (optimisation)
4. More policy-theory (options)
5. Resilience and collapse, vulnerability/probability
6. Take urban poverty into account
7. Limit determinants & standardize indicators and evaluation framework

Method:

- Do not set up own cases → too time and means consuming
- Cooperate in 6 on-going cases or finalised cases for 3 archetypes

Local and global dependence

lack of feedback -> unsustainable use (now even in poor regions)

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Rich people
- independent nbh

cities

small settlements

A poverty - consumption - bio-loss pump?

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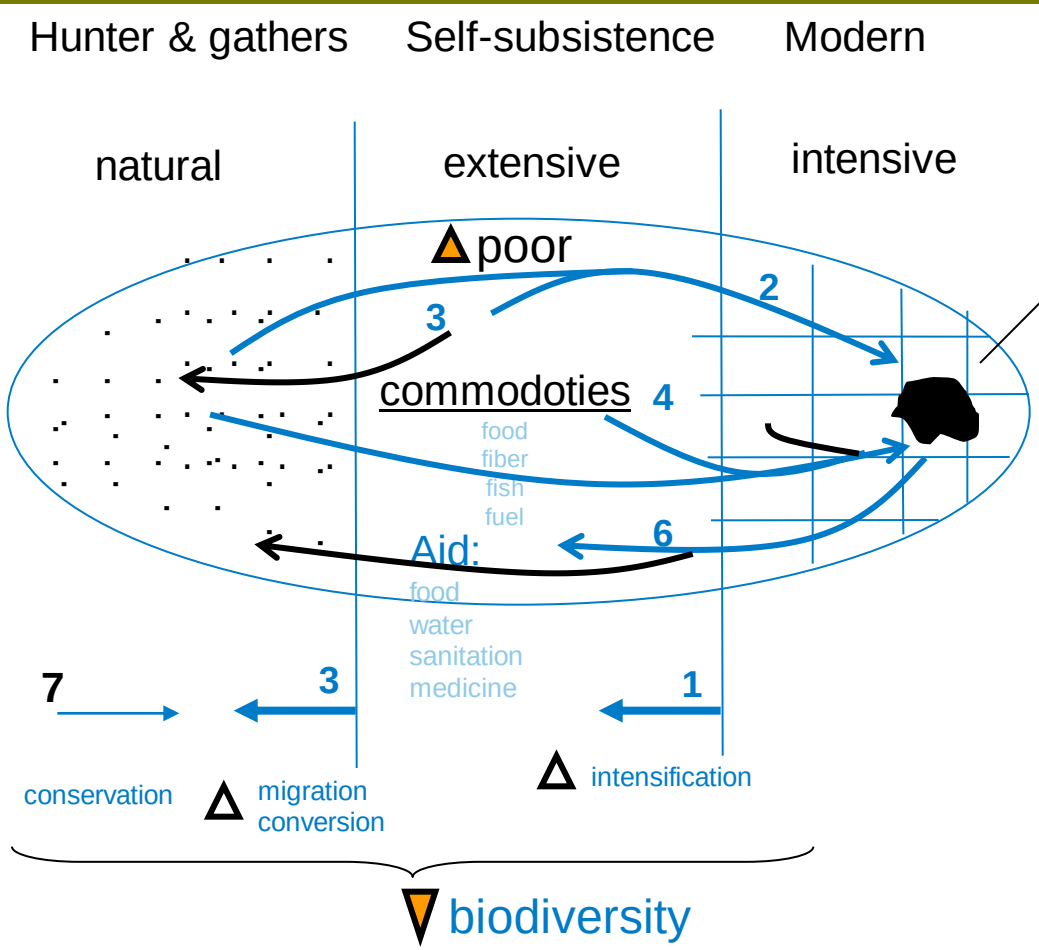

2 major mechanisms:

1. Poverty driven
2. Capital driven

and 2 major boosters:

1. Conflict
2. Bad governance

cities

Is there a way out?

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Solve rural poverty

1. Promote migration to the cities
2. Increase and guarantee farmer's income
3. Pay for environmental services (goods vs services)
4. Establish social security acts and income redistribution
5. Increase cost of raising child
6. Intensify, intensify, intensify
7. Technology transfer, education

Solve western consumers and growth paradigm

1. Limit consumption growth or
2. Limit economic growth -> biodiversity utilisation space?
3. Change consumption pattern or 'redefine succesfullness'

Stop unsustainable use

1. PES
2. Nationalise?
3. Forbid or punish depletion
4. Set a minimum natural capital level

Trapped in a vicious circle?

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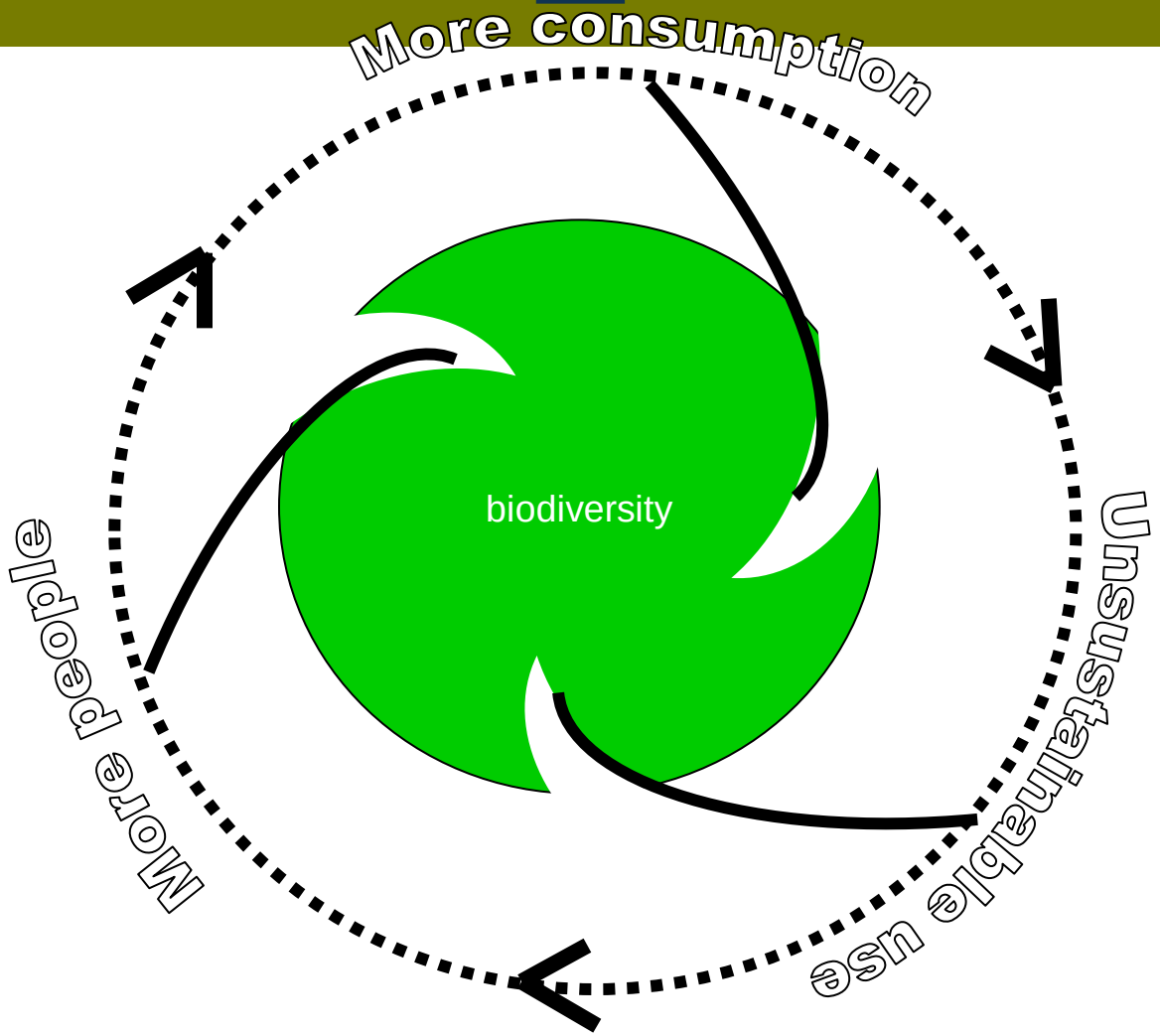

2. Can we halt biodiversity loss?

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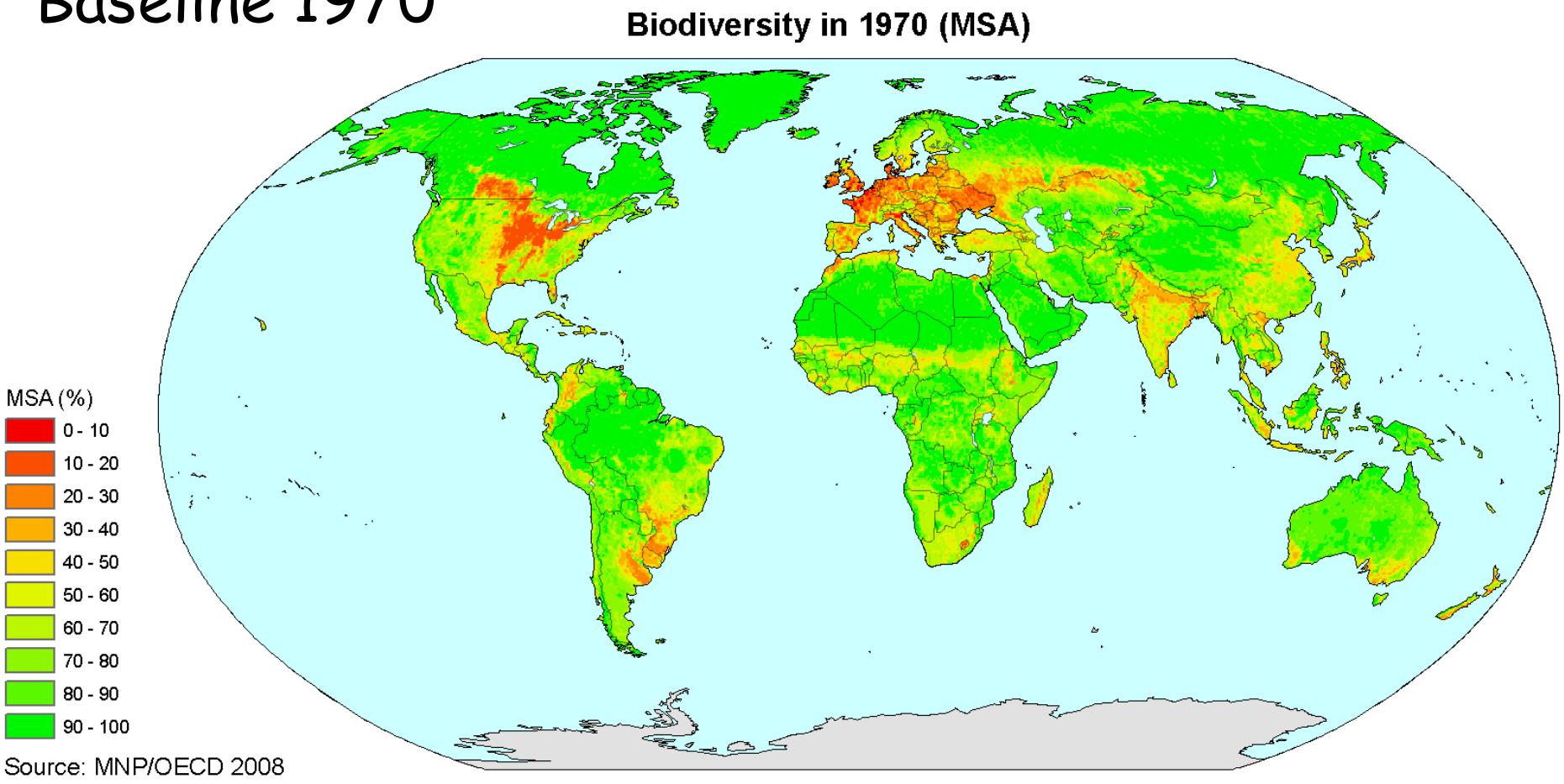
Baseline 1970



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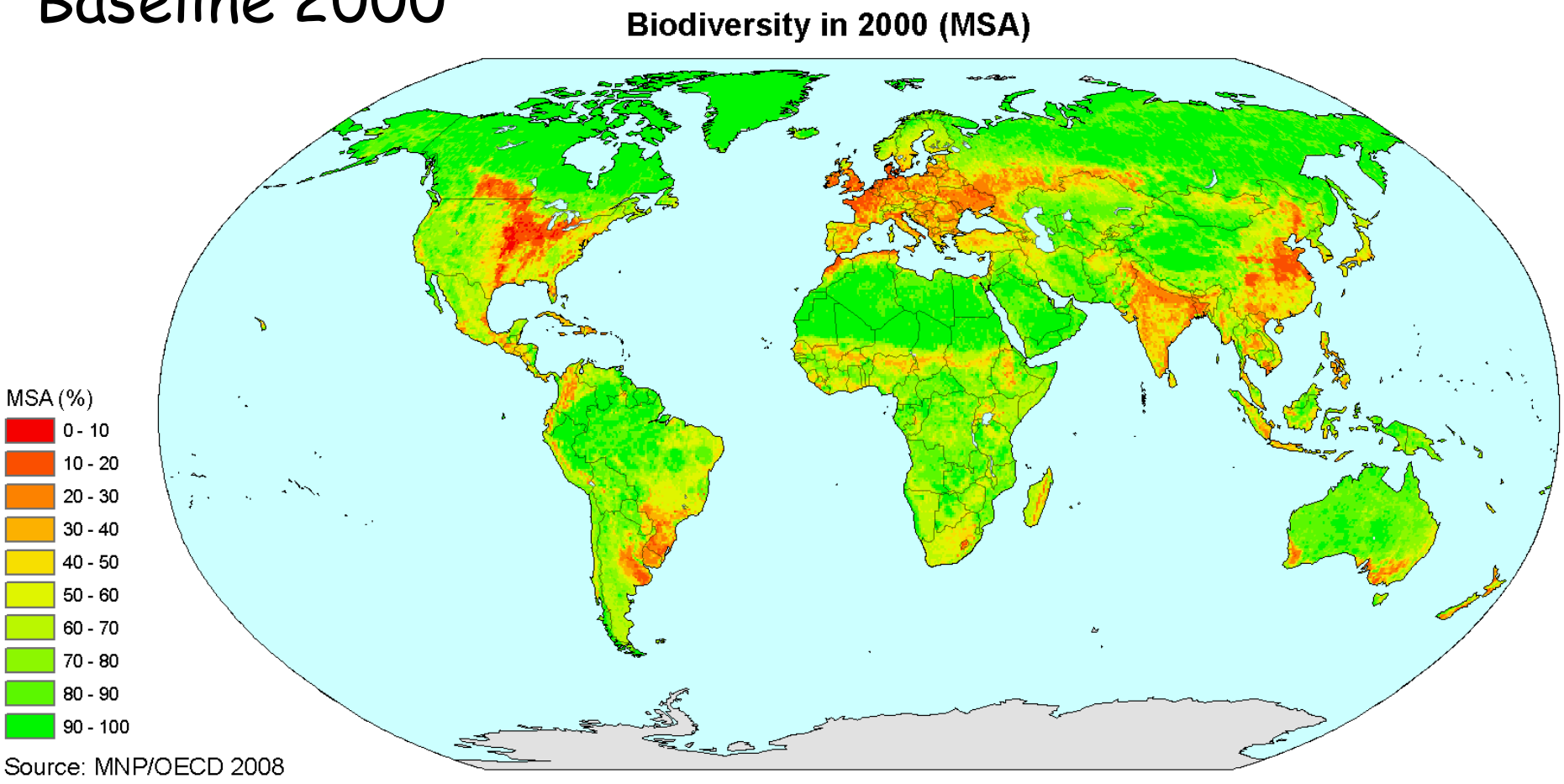
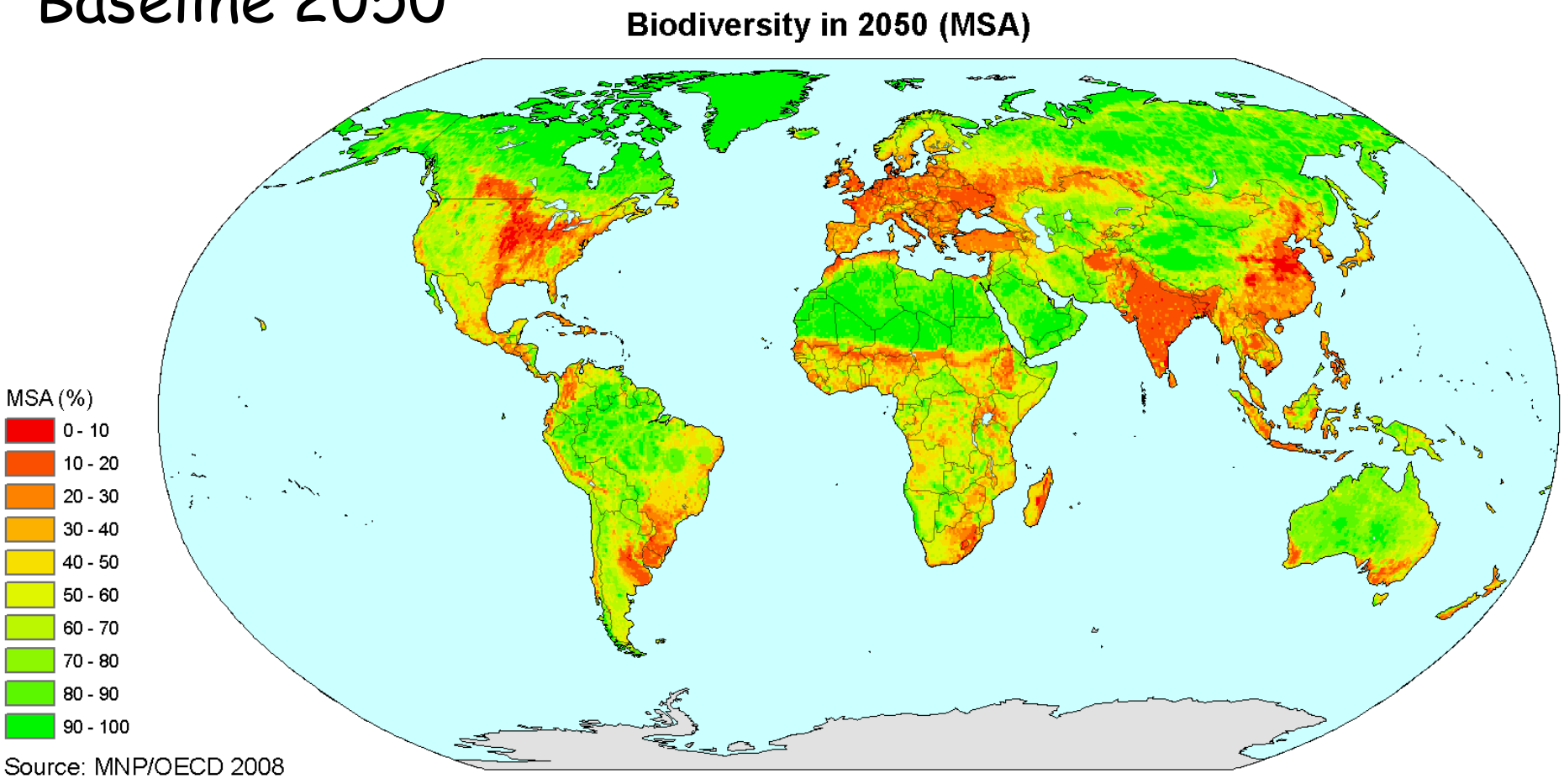
Baseline 2000



2. Can we halt biodiversity loss?

PBL Netherlands Environmental Assessment Agency

Baseline 2050



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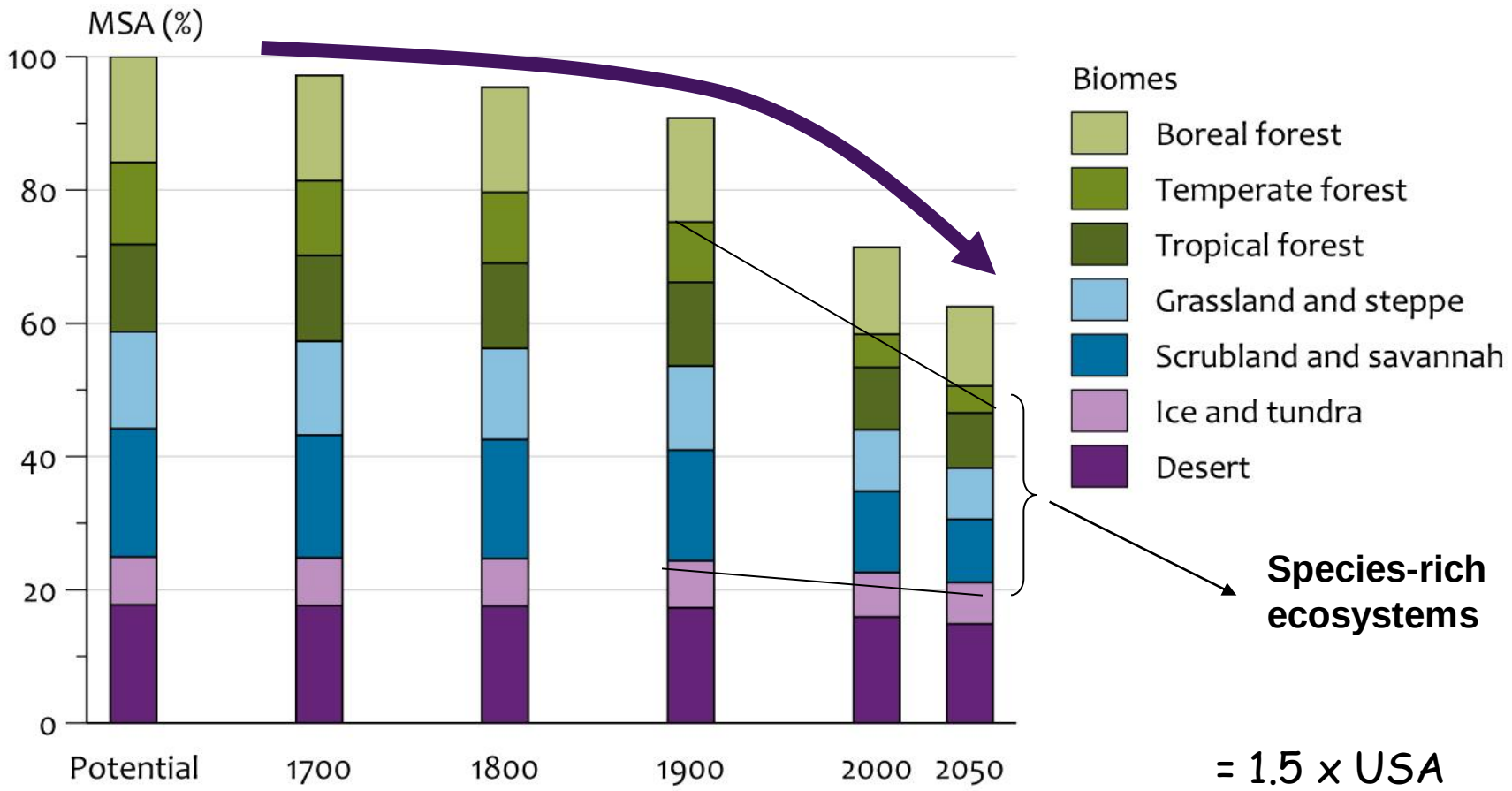
Baseline: 10% loss MSA 2000 - 2050

Global MSA in baseline scenario



= 1.5 x USA

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7 options

1. Increase agri-productivity (closing yield gap + 40%)
2. Reducing food loss (farm to fork -33%)
3. Change diet (healthy meat diet, no meat)
4. Mitigate climate change to + 2°C (with 25% & without biofuels)
5. Improve forest management (wood plantations 40% + RIL)
6. Reduce deforestation (no loss C-rich forest)
7. Expand protected areas (20%-50% per biome))

compared to BAU scenario

+ Option combination (ambitious but feasible)

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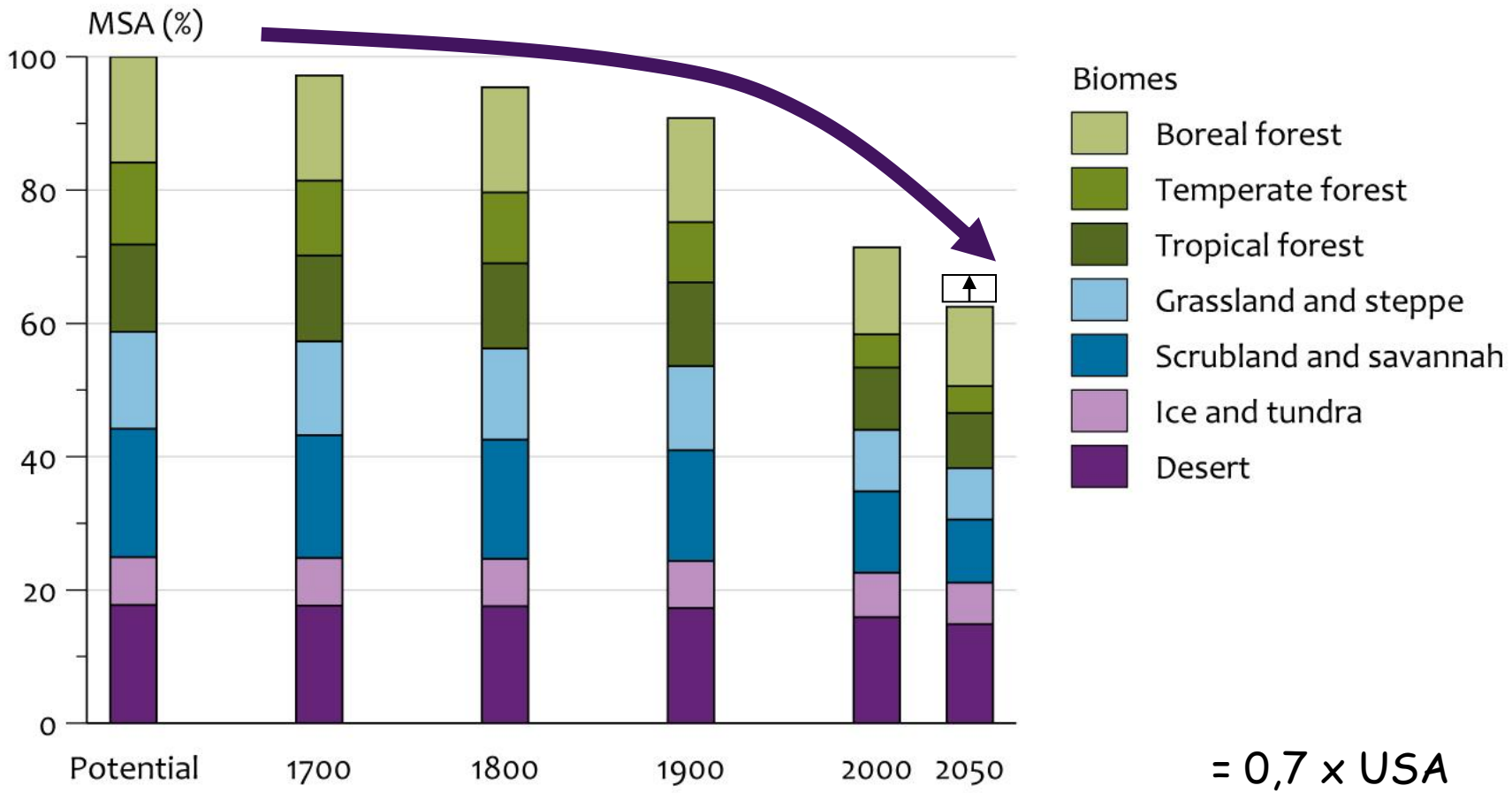
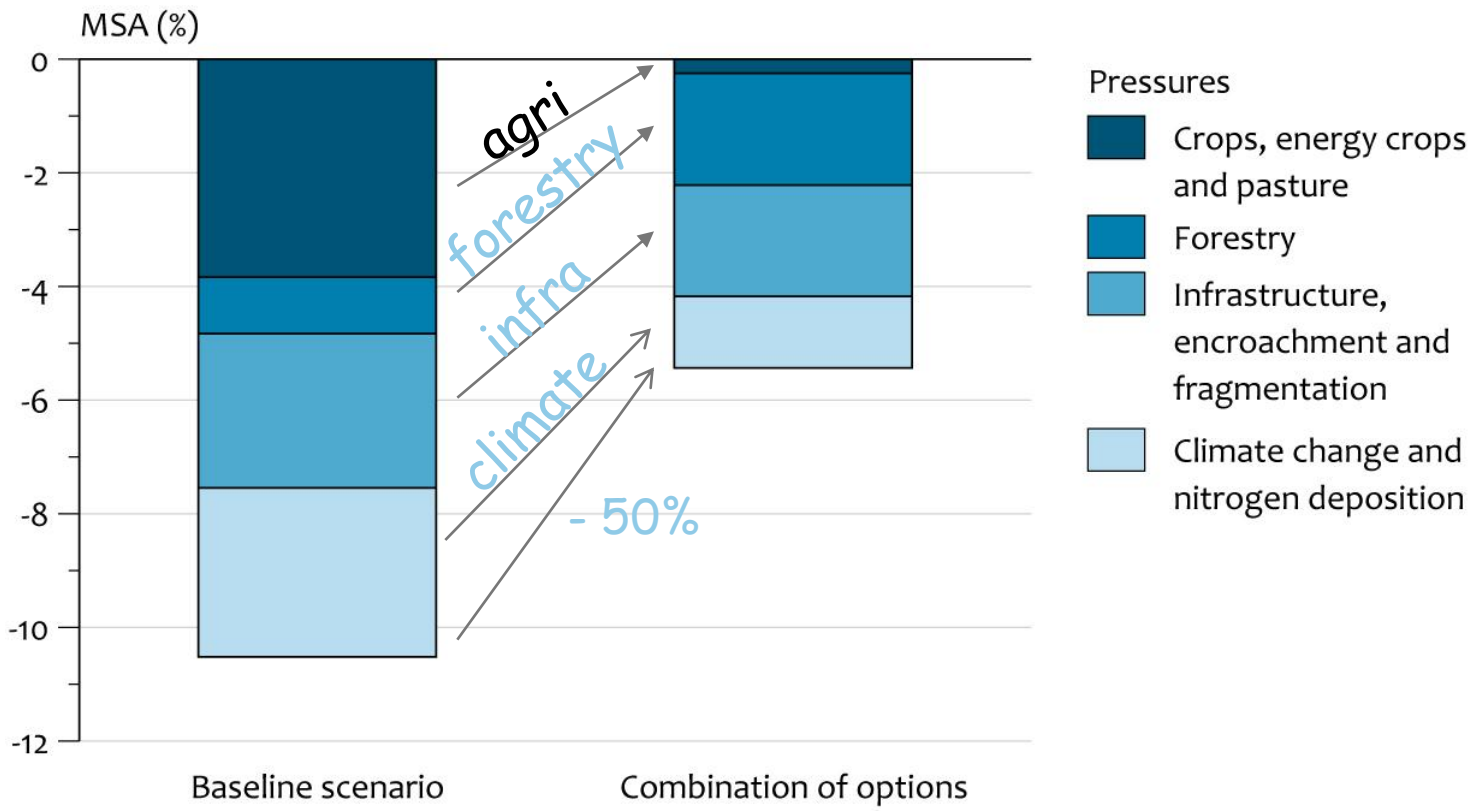
option: 5% loss MSA 2000 - 2050

Global MSA in baseline scenario

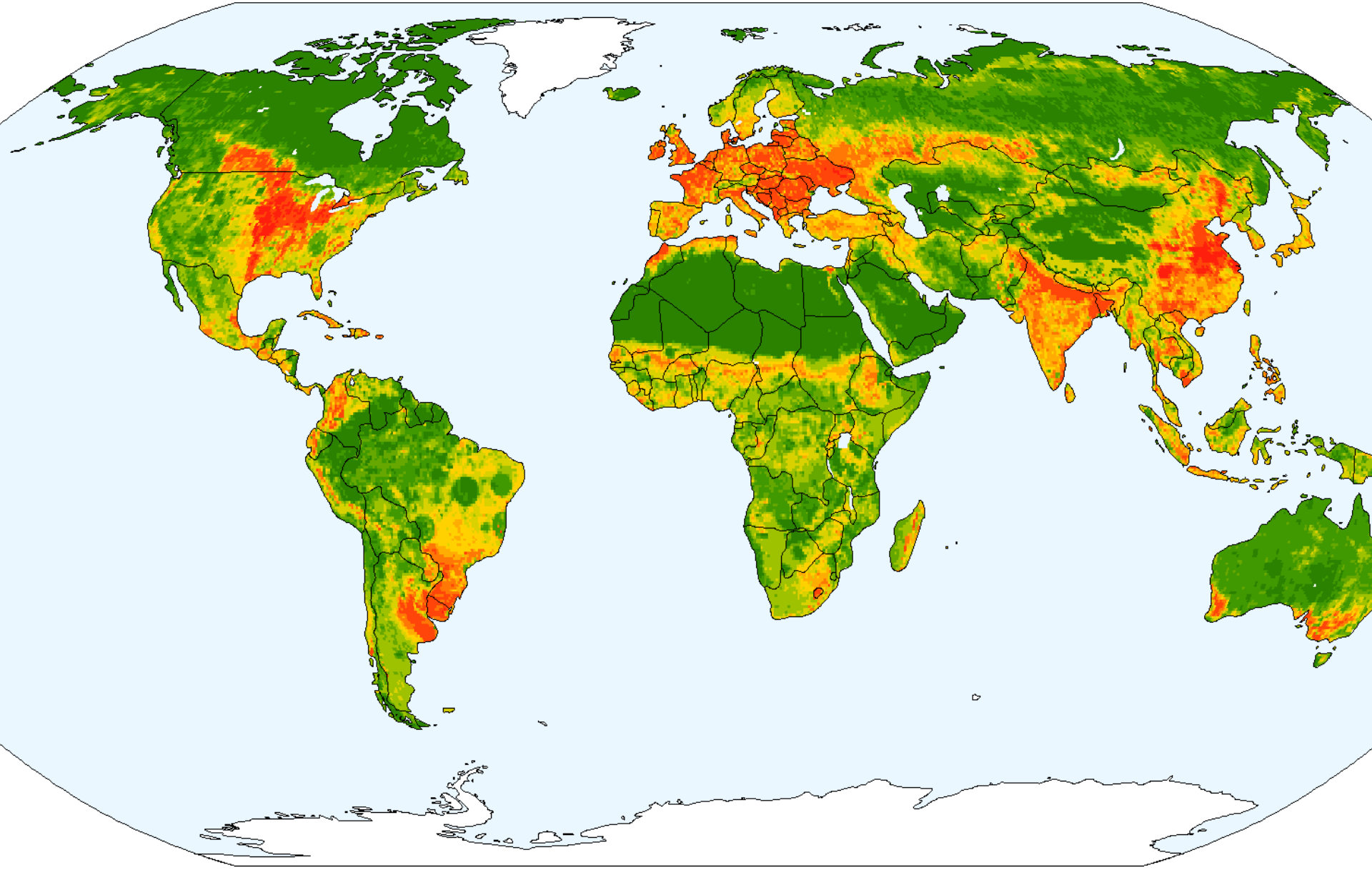


= 0,7 x USA

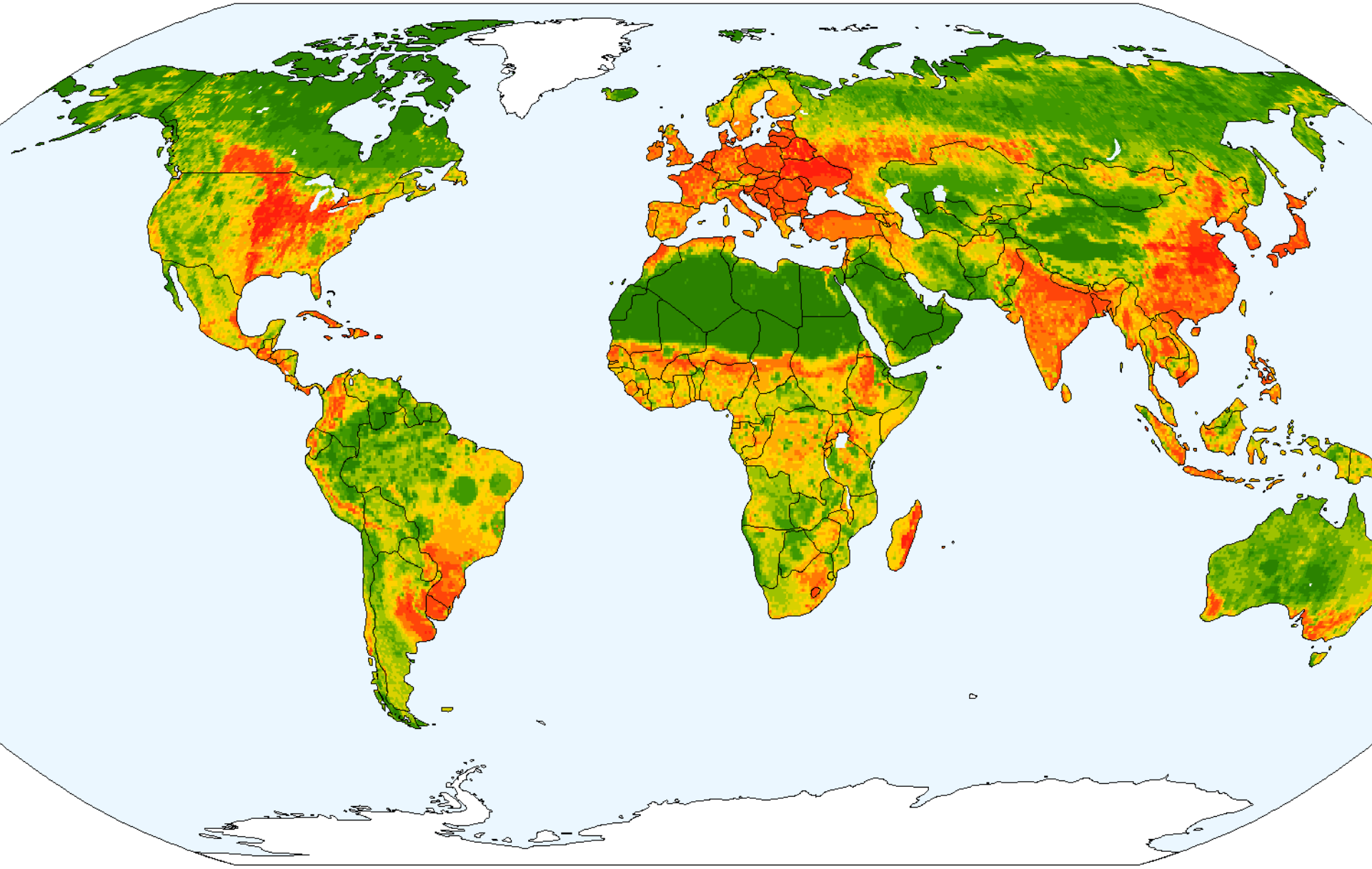
Pressures driving global biodiversity loss, 2000 – 2050



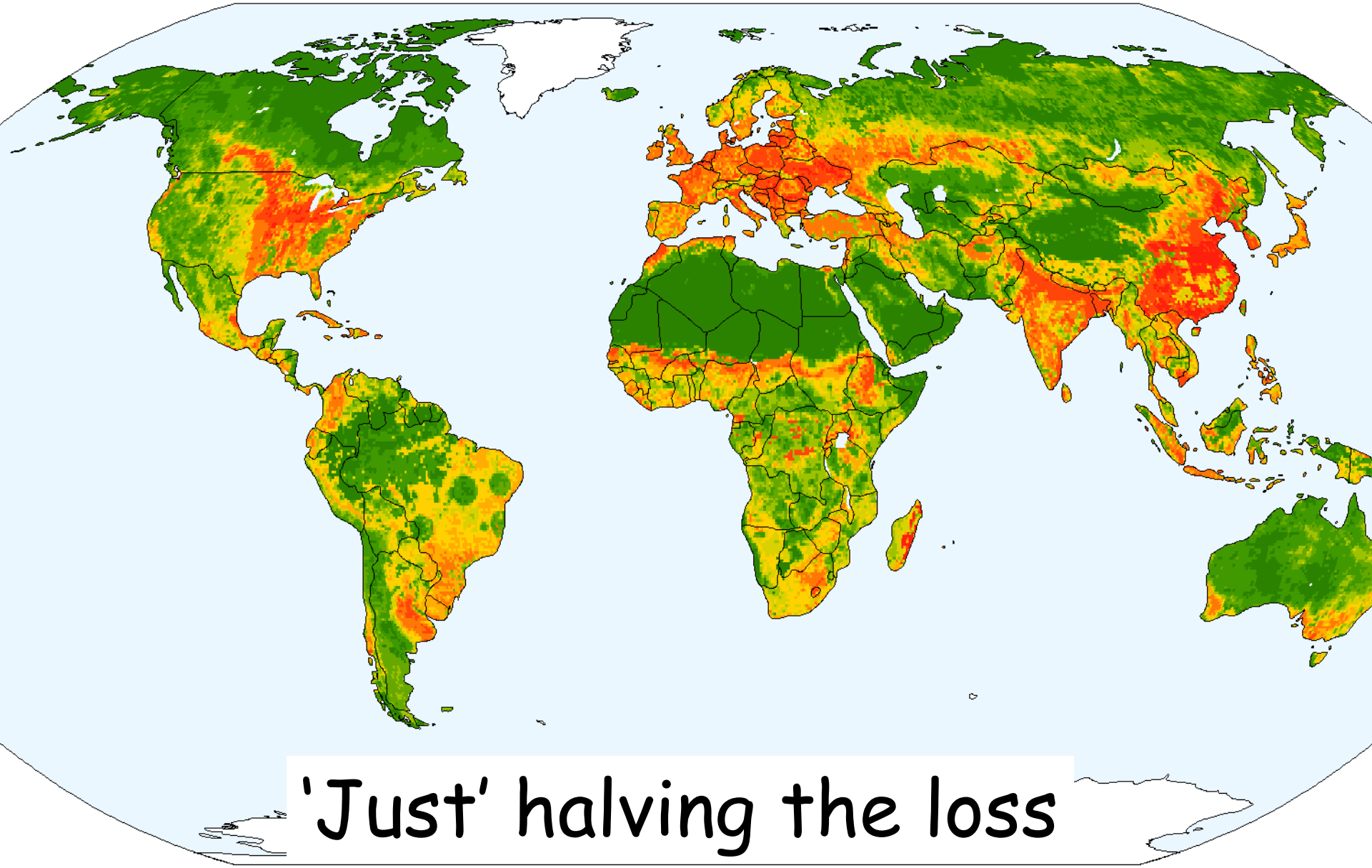
2010



2050 baseline



2050 option combination:



'Just' halving the loss

3. Restoration potential

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Key questions:

1. what could 15% restoration contribute?
2. 15% FROM WHAT ?

…… How much is degraded?

Not known..??!

How do biodiversity & Poverty relate?

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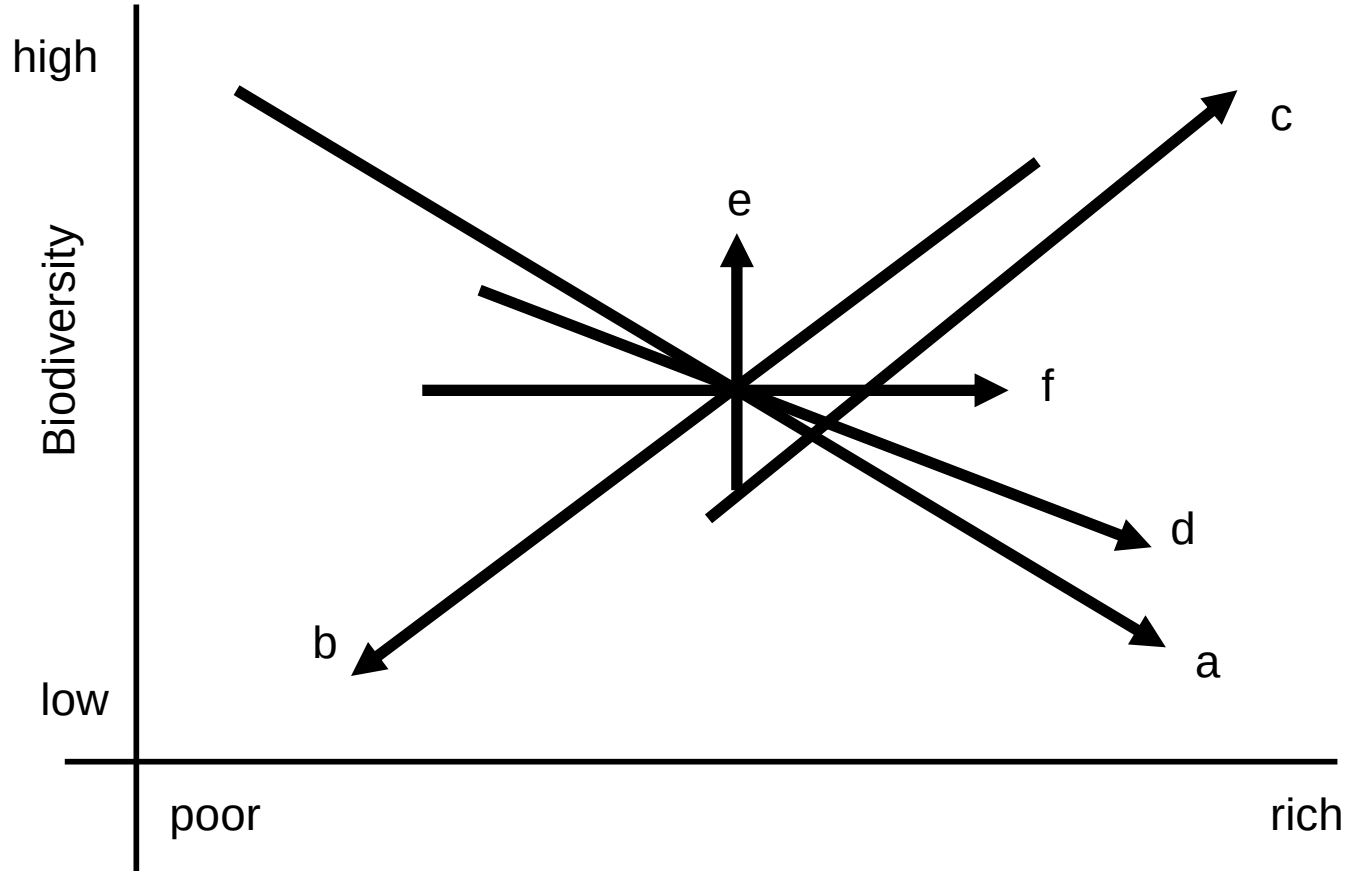

How do biodiversity and poverty relate?

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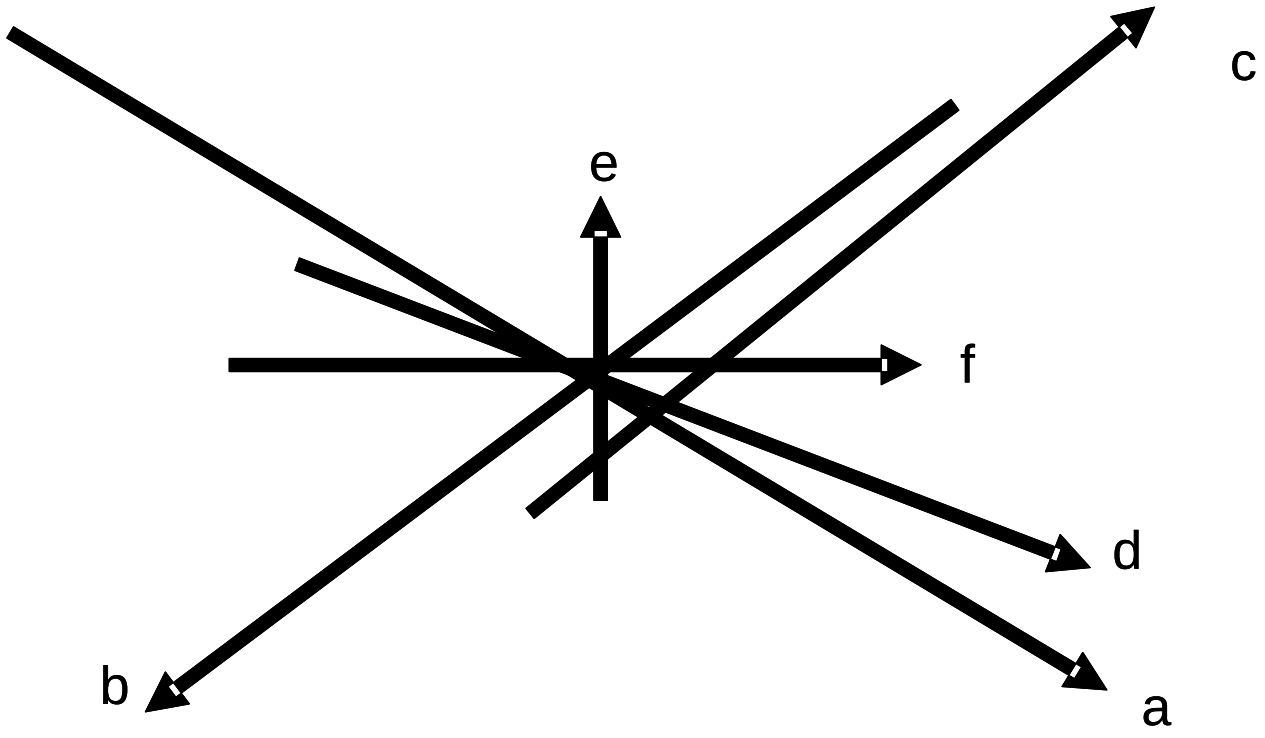
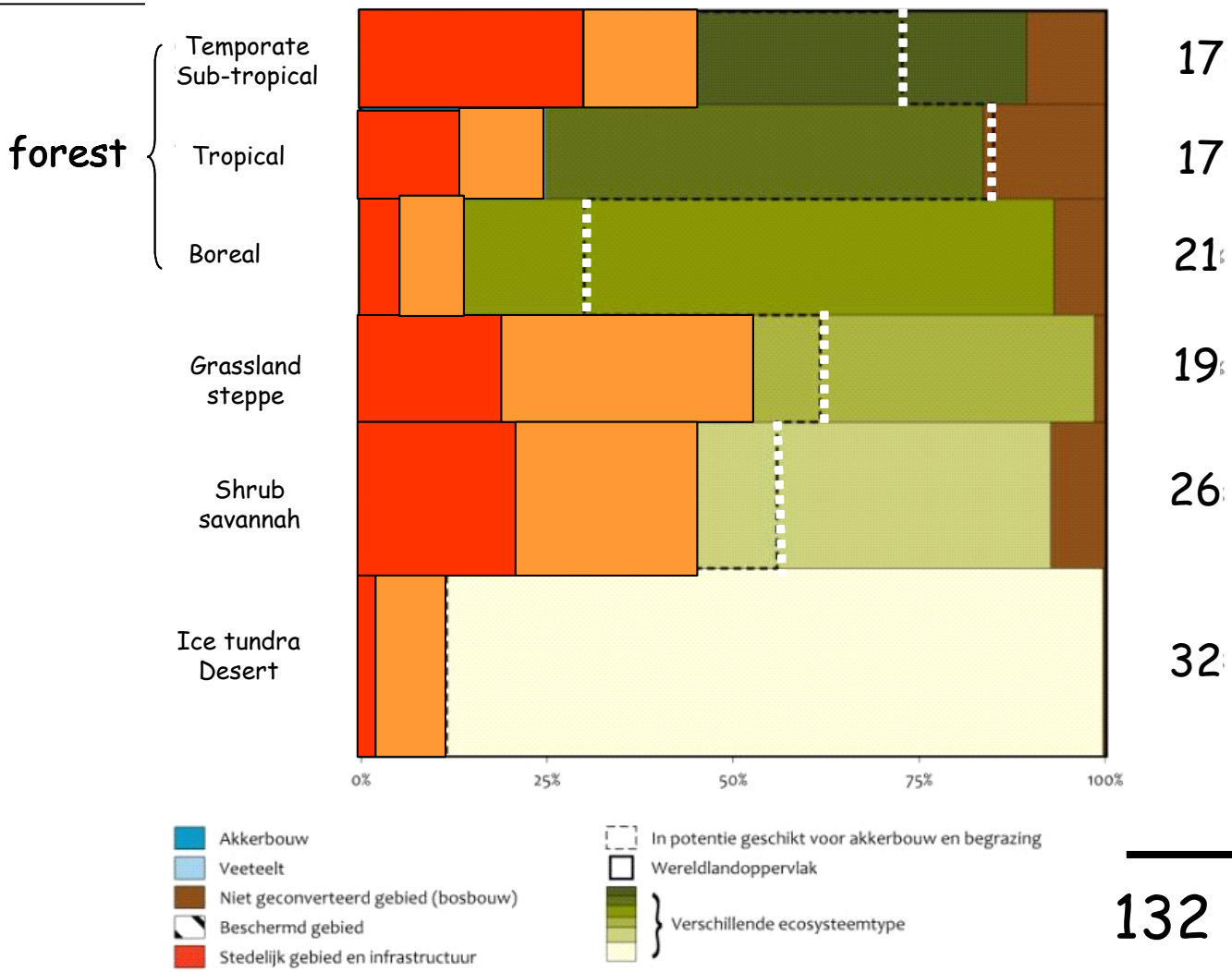


2050 Land use per ecosystem type

Million km²



baseline

agri + 6

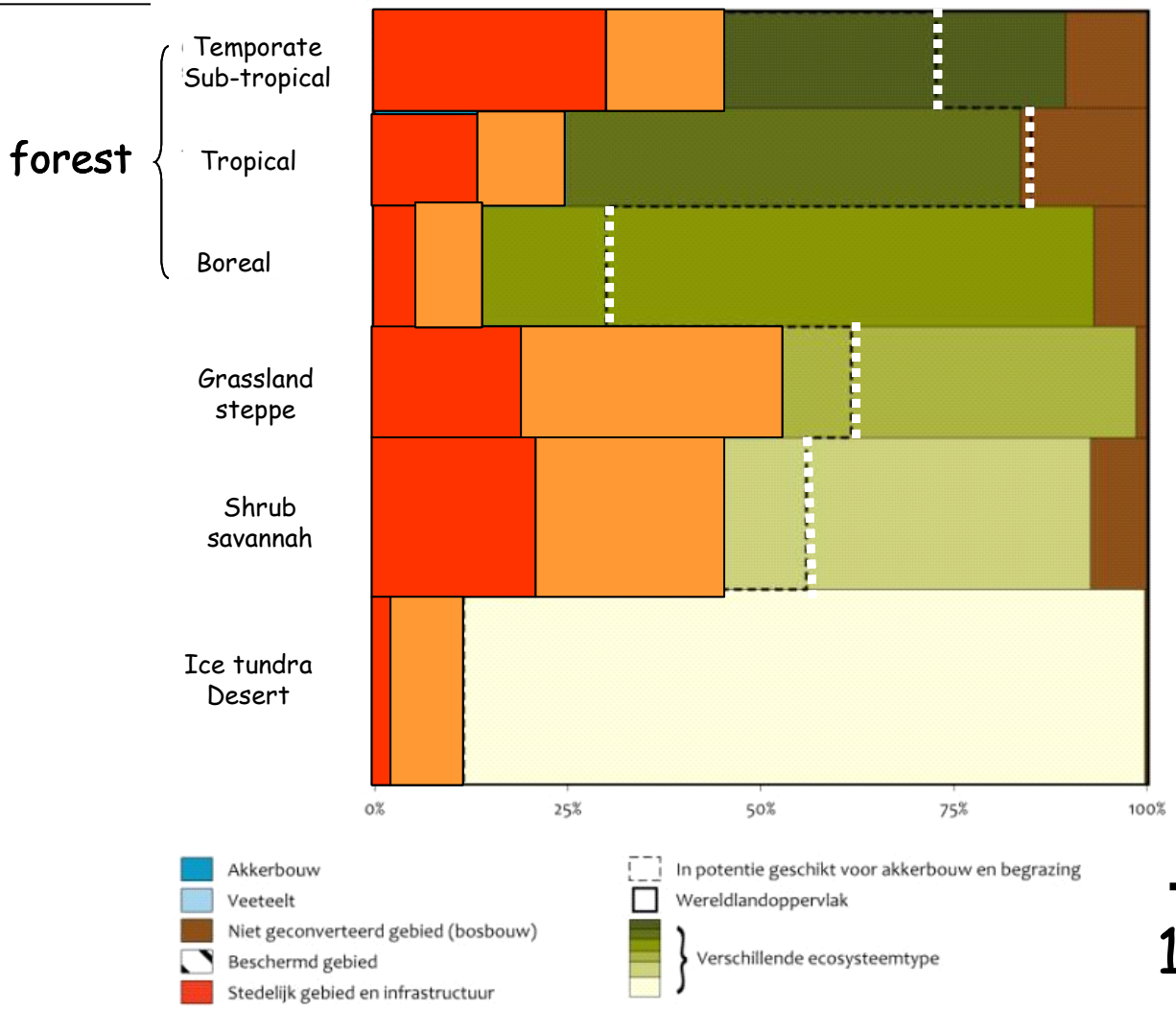
——— +

132 km²

5 mln km²

2050 Land use per ecosystem type

Million km²



Agri +12

forestry +5

biofuels +5

C-plantation +1

degrading +5

\+

132 km²

5 mln km²

Degraded 10-20?

3. Restoration potential

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Key questions:

1. what could 15% restoration contribute?

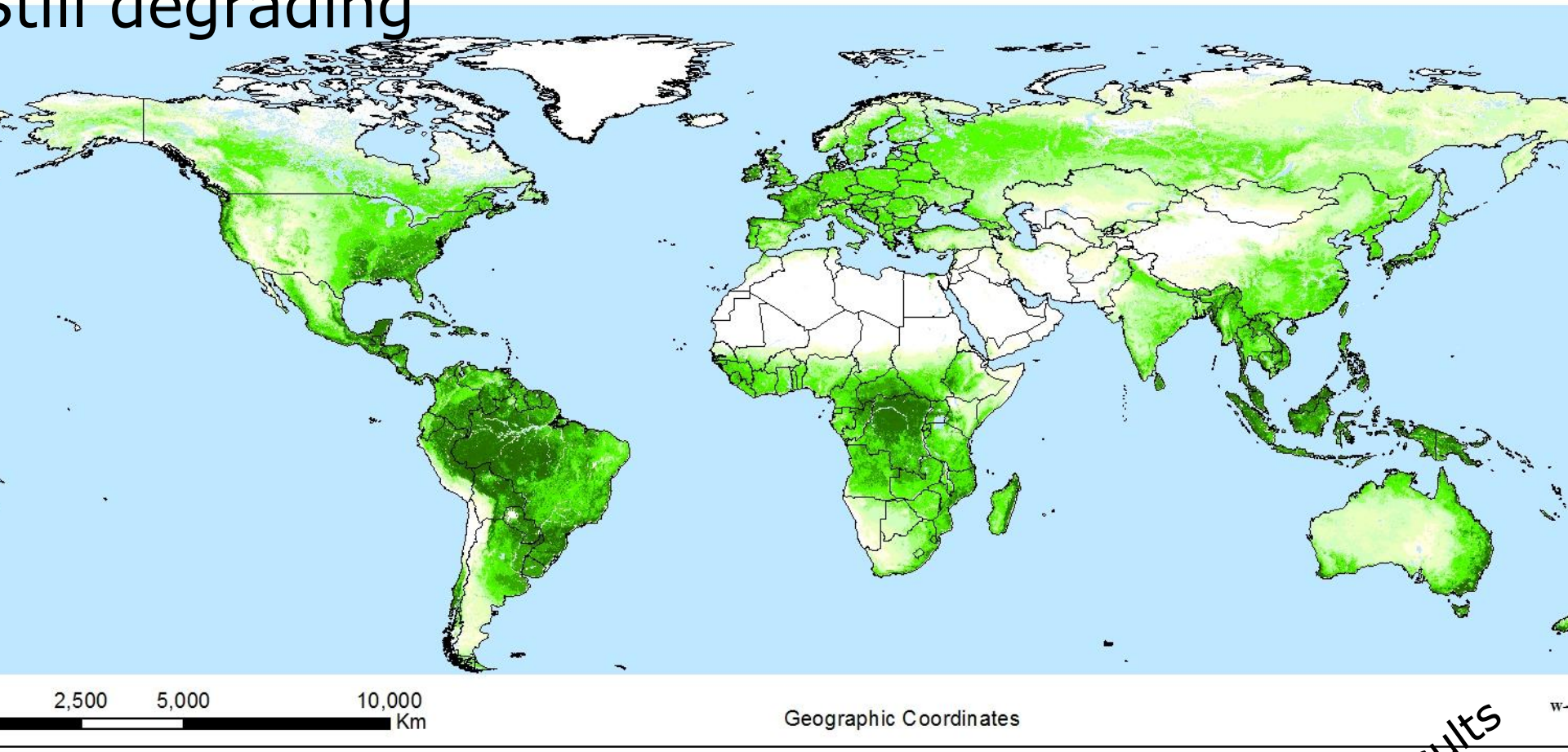
-> Global potential maps: (a quick look)

1. Biodiversity
2. NPP
3. Org C store (climate)
4. Water retention, floods & droughts
5. Temperature fluctuation
6. Food & fiber productivity

Soil related

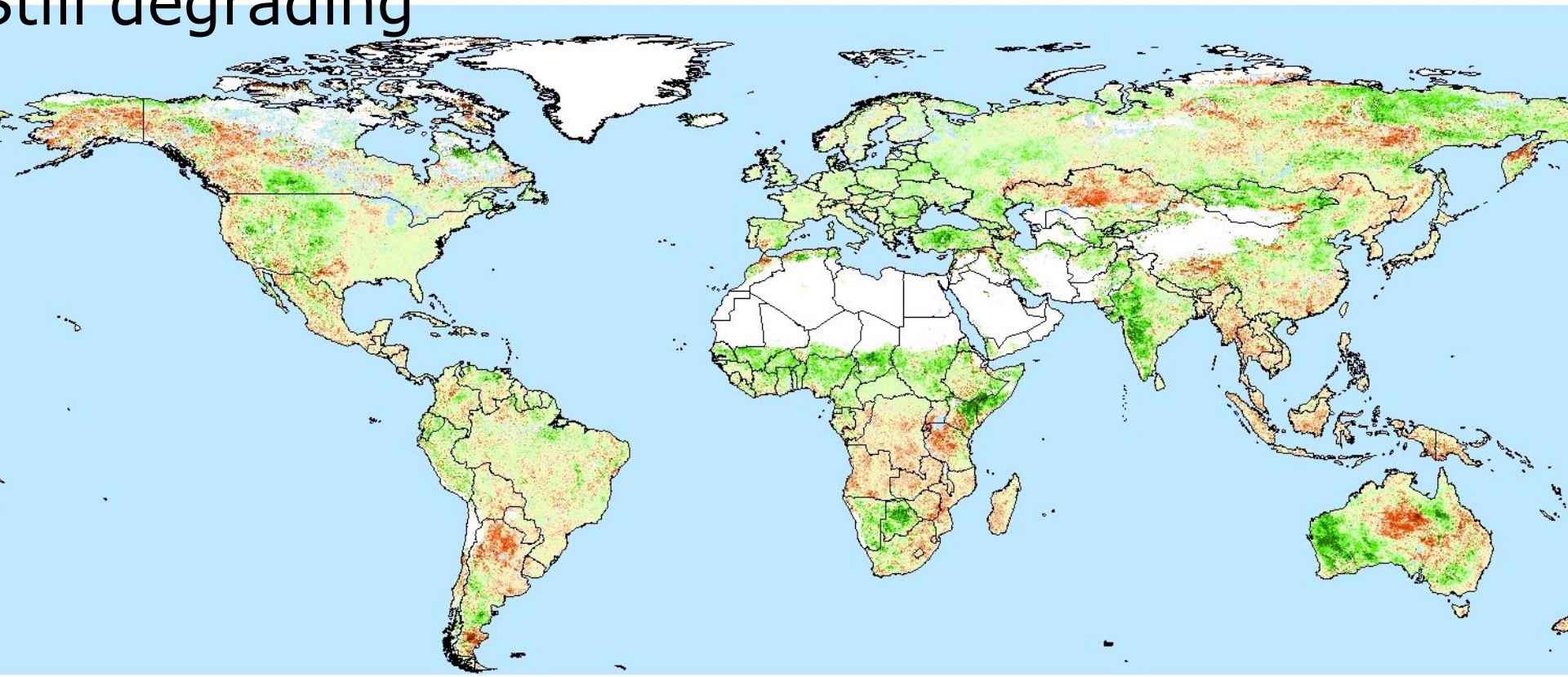
Global Greenness Pattern by Annual Sum NDVI (1981-2006

Still degrading



Global Changes in Greenness by Annual Sum NDVI (1981-2006

Still degrading



Greenness Changes by Annual Sum NDVI (1981-2006)
(%/year)

No Vegetation

Water

< -1.2	-1 - -0.8	-0.6 - -0.4	-0.2 - 0	0.2 - 0.4	0.6 - 0.8	1 - 1.2
-1.2 - -1	-0.8 - -0.6	-0.4 - -0.2	0 - 0.2	0.4 - 0.6	0.8 - 1	> 1.2

Preliminary results

Change in river discharge % (current/potential veg)

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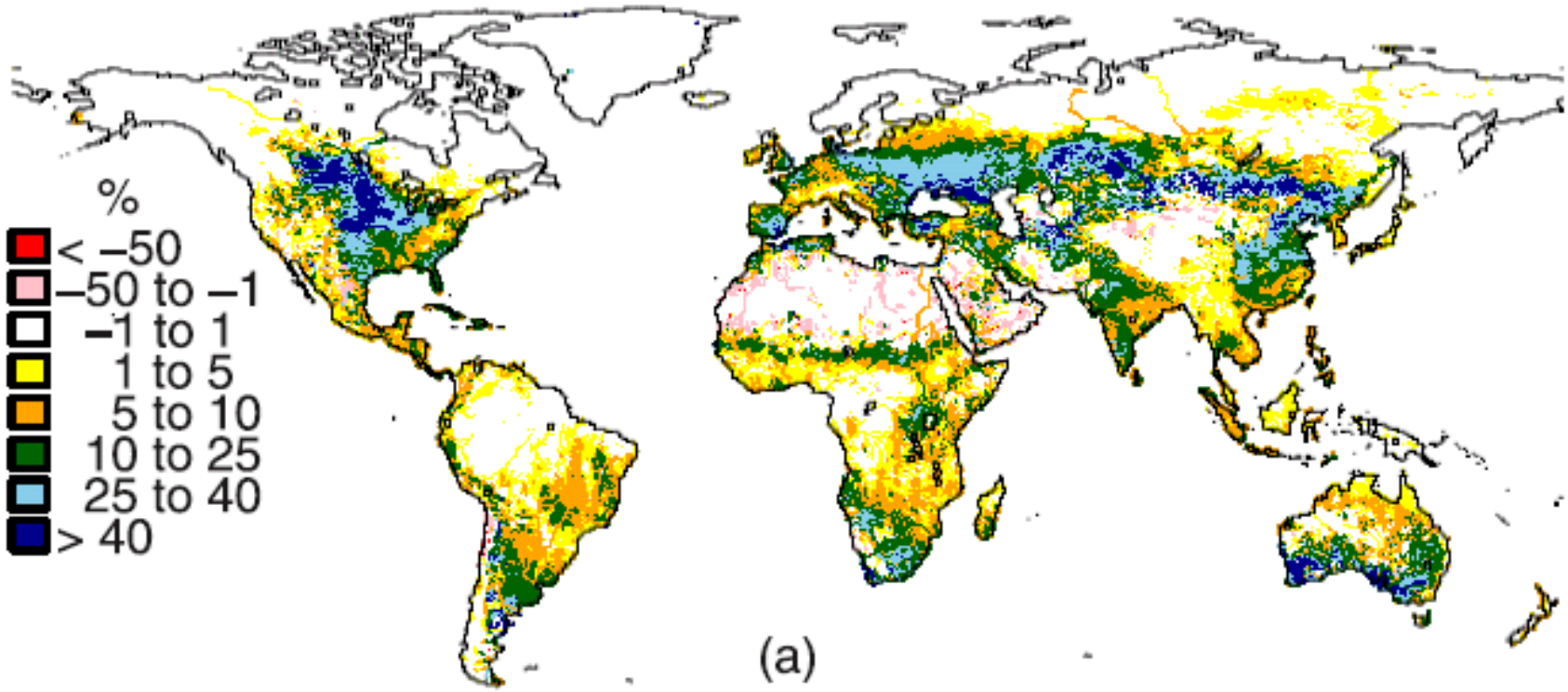

LPJ model, Rost et al 2008

Discharge to rivers: difference (in %) for current land use situation (excl. irrigation) compared to potential natural vegetation. Global average = +5%.
Simulations by LPJmL model (Rost et al., 2008, Wat.Res.Res.)

Absolute change in living Carbon
With & without agriculture

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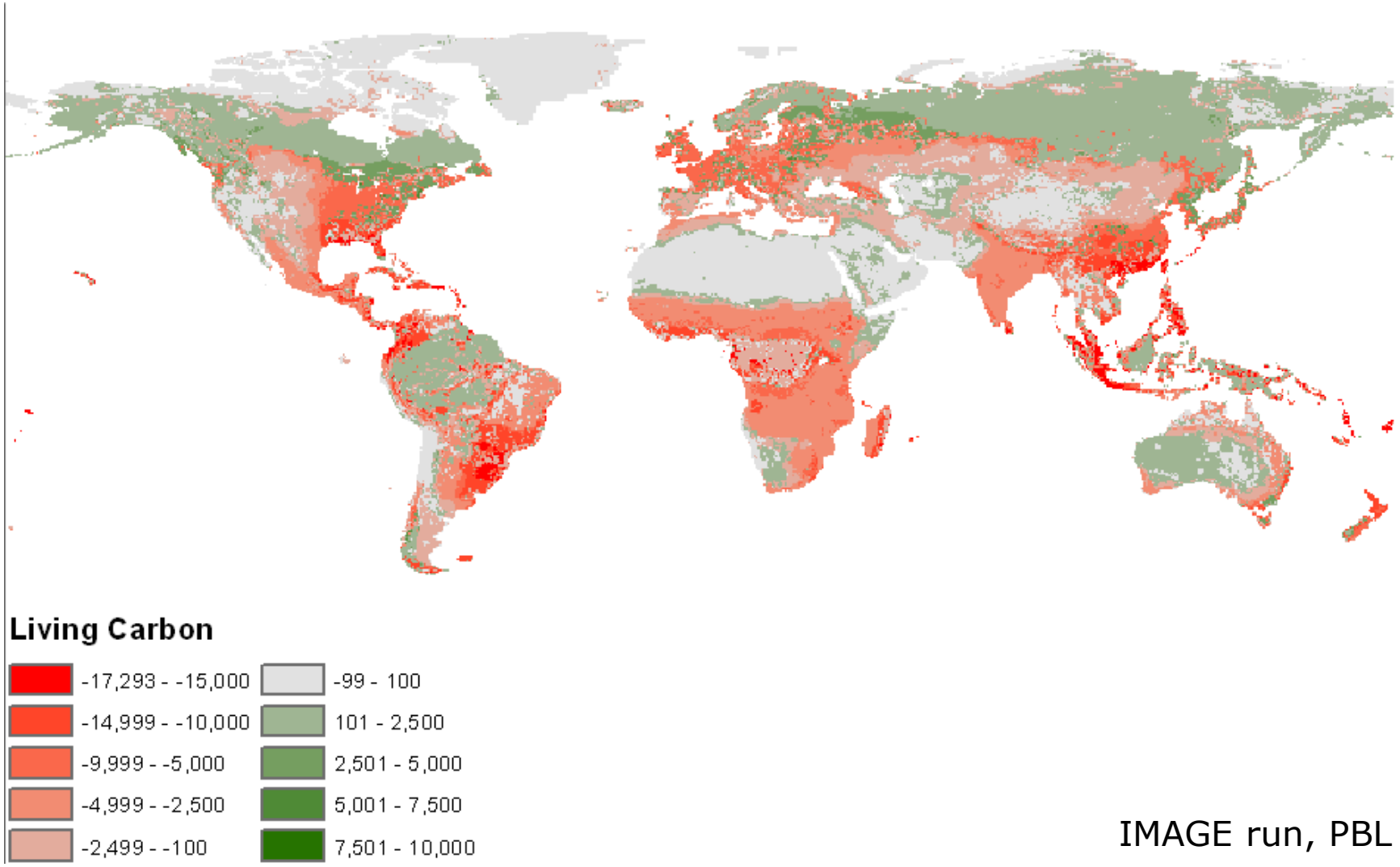

IMAGE run, PBL

Flood risk 2010

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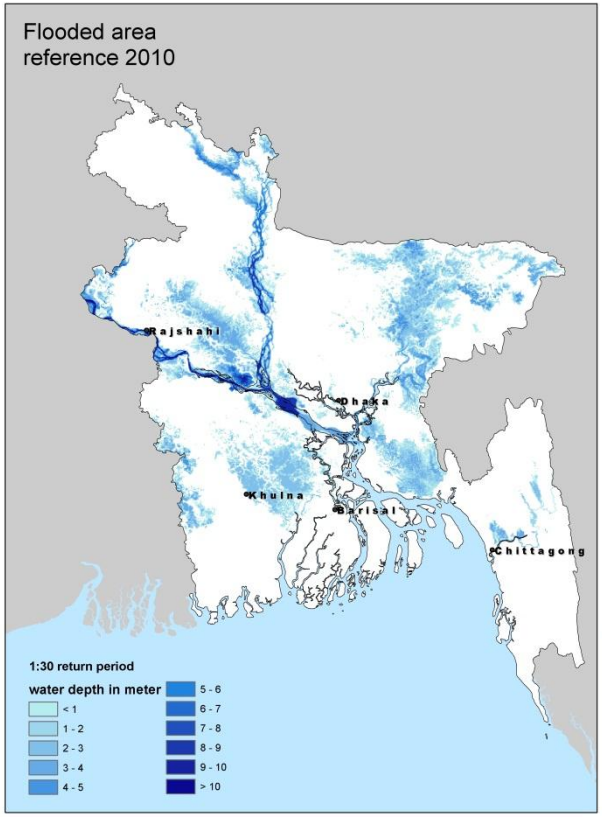

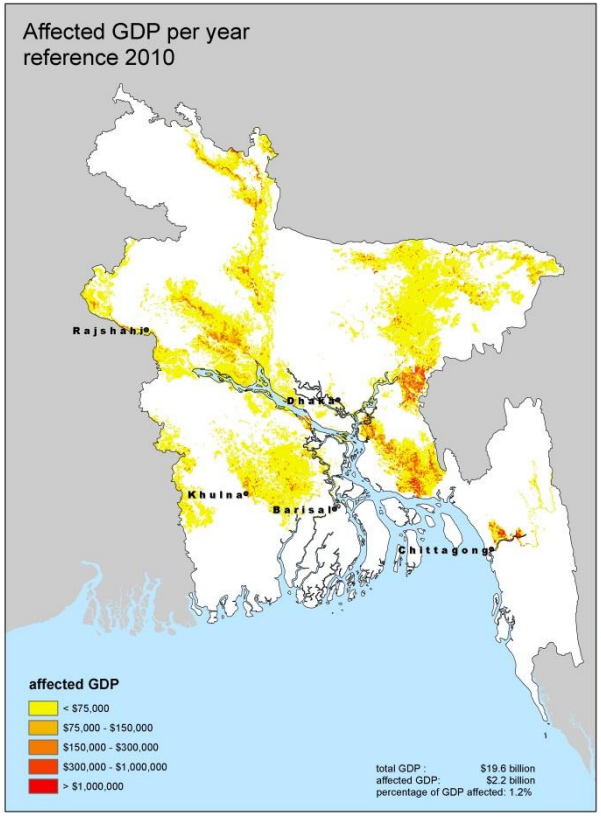

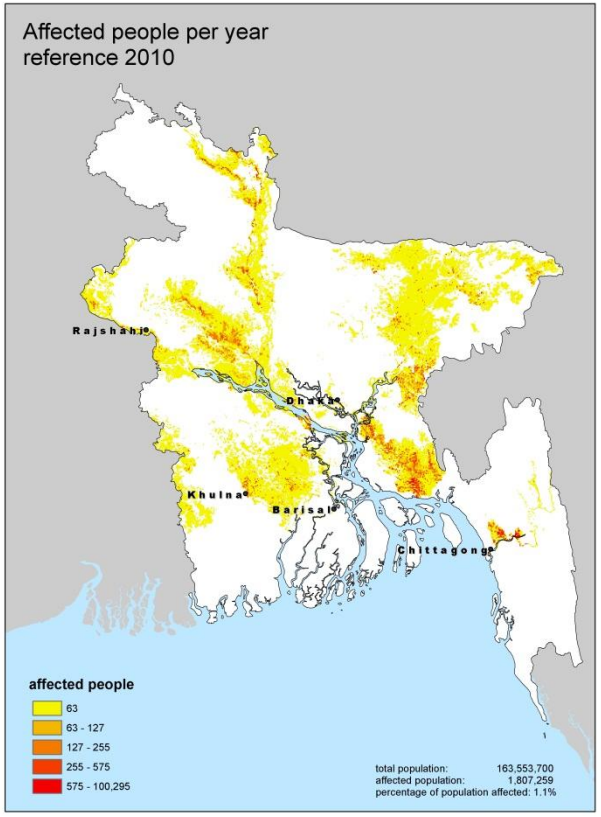

Once in 30-year flood | **Affected GDP per year** | **Affected people per year**

Flood risk 2050

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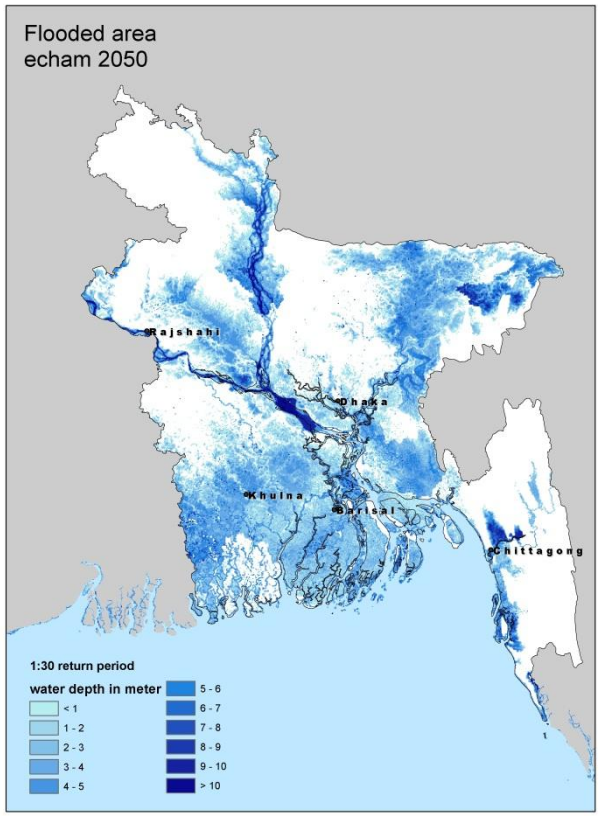

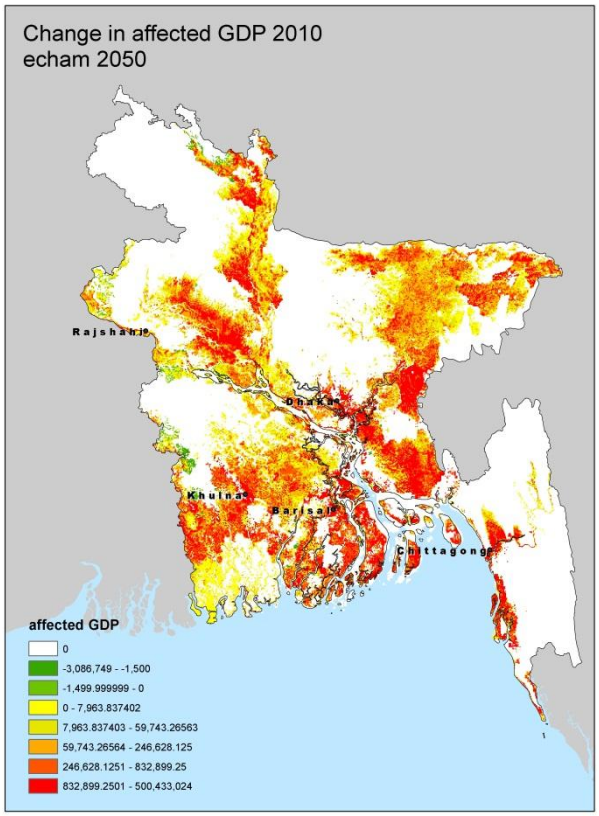

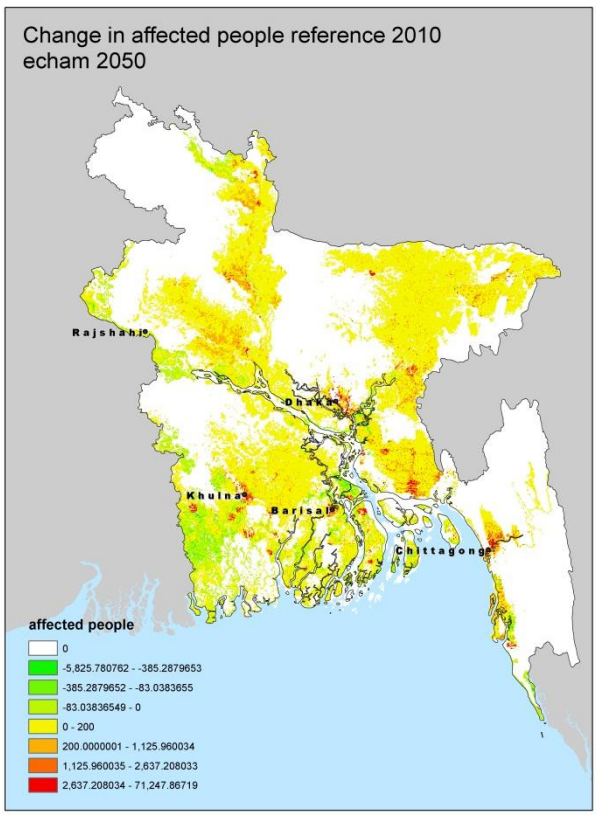

Once in 30-year flood **Affected GDP per year** **Affected people per year**

Results: change in ECHAM 2050 scenario

Absolute change in NPP

with & without agriculture

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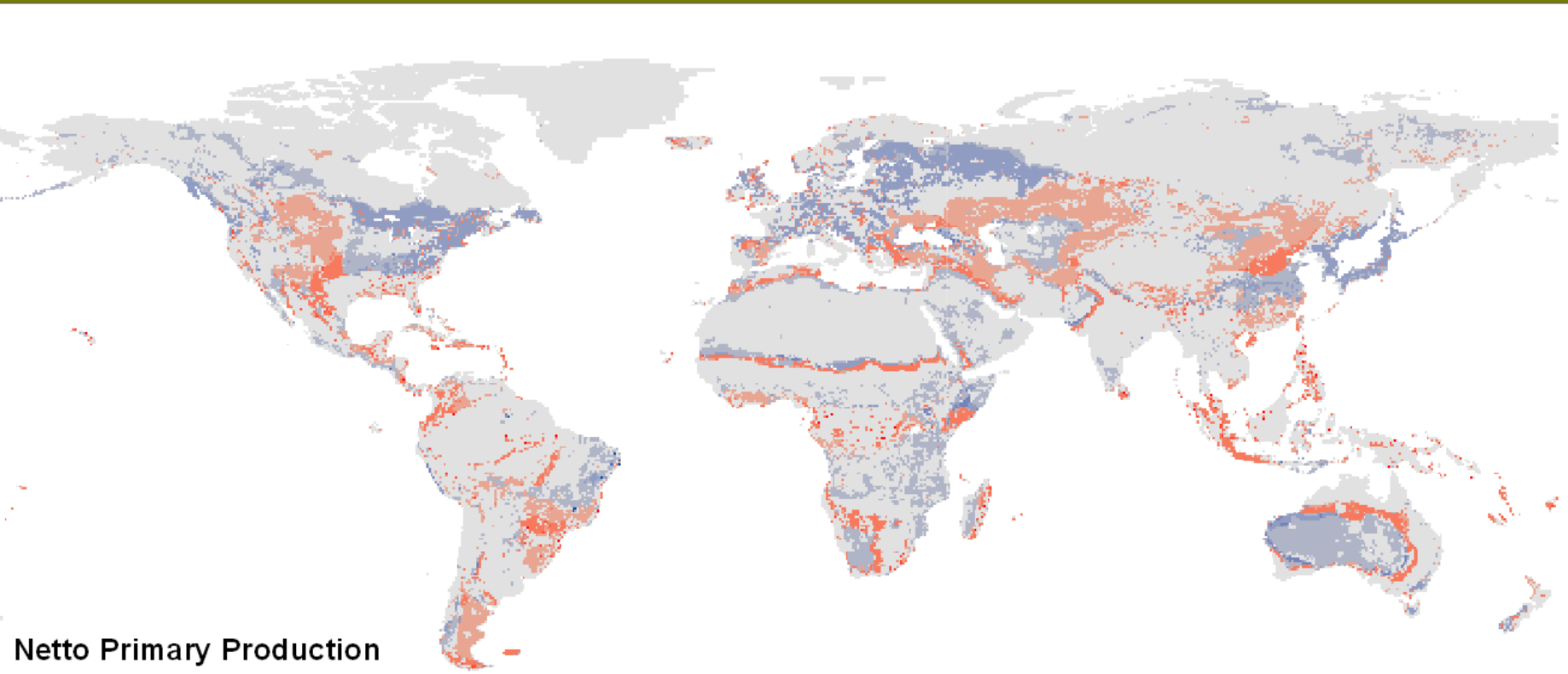

IMAGE run, PBL

Key question: ecosystem degradation & restoration important?

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~40 million km2 productive land in use (global total 132 million km2)

~20 million km2 productive land in reserve (forest & savannah)

Additional claims at productive land by 2050:

~2-10 million km2 expansion of agriculture
~5-10 million km2 expansion of forestry & fuel crops
~3- 6 million km2 protected area
~2- 4 million km2 degraded (?) +
~12-30 million km2 = potential demand

~15-20 million km2 already degraded in the past (?)
~9-12 million km2 restored and productive by 2050 (?)

Development & biodiversity inversely related