RED
2005

REDD
2007

REDD+
2009

AFOLU
2011?

Agriculture, Forest and Other Land Uses – **AFOLU**

- Forest Land
- **Cropland**
- **Grassland**
- **Wetlands**
- Settlements
- Other Land

+

- **Livestock**
- **Managed soils**
- Harvested wood products (HWP)

RED
2005

REDD
2007

REDD+
2009

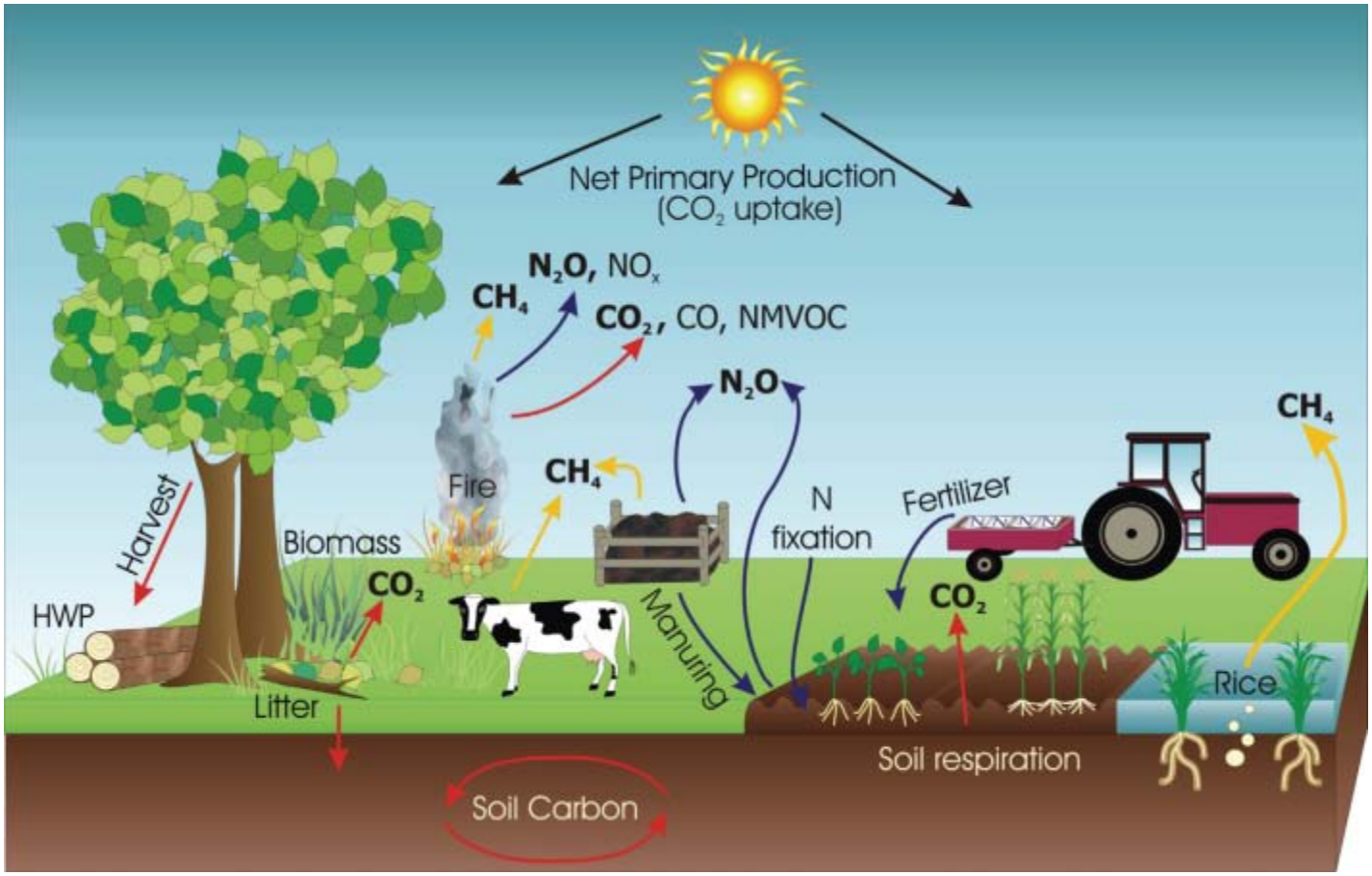
AFOLU
2011?

PES
- Landscape approach

- SLM

Main GHG emission sources/removals and processes in managed ecosystems

1. Mitigation Potential



Source IPCC, 2006 Guidelines

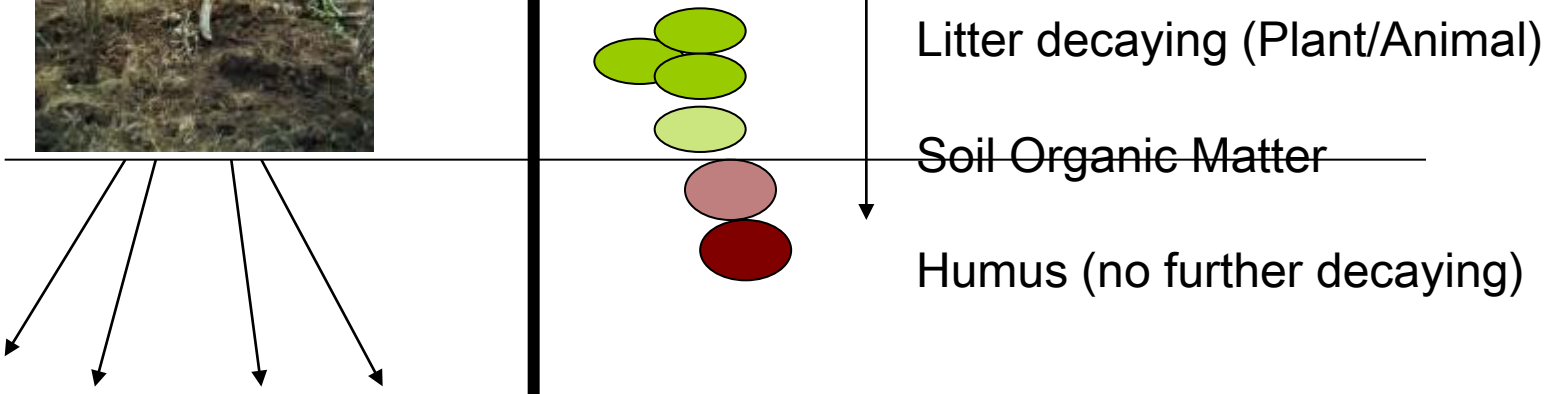
Carbon in 5 pools:

Above/below ground biomass, litter, dead wood, soil

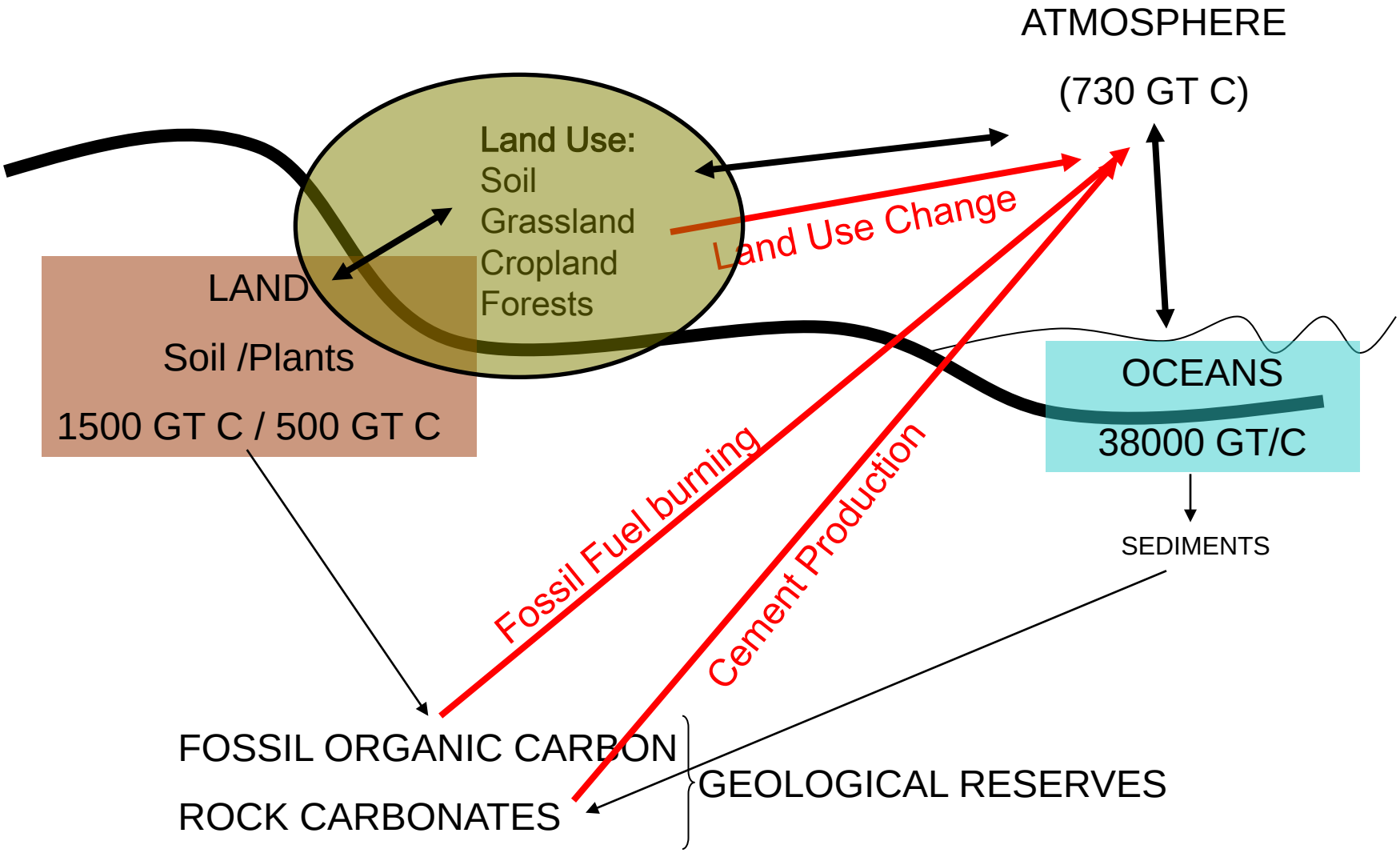
Other gases: Fertilizers, manure, transportation

1. Through growing plants establishing organic root material in the soil

2. Through processes of decay in or above ground leading to organic C in the soil



The natural carbon cycle (GT C) for the 1990‘s



Adapted from:
Smith, P. 2007. in: Land Use and Soil Resources. 2008. p 10. Springer Science & Business Media B.V.
ISBN-978-1-4020-6777-8

Mitigation options in agriculture

Emission reduction

- **Livestock/manure management**
- **Sustainable agricultural soils**
  - management of agricultural soils: soil erosion control, reduction of fires and mineral fertilizer utilisation

Carbon sequestration (increased sink)

- combined systems
- perennial crops (agroforestry systems)

Mitigation options in agriculture

Emission reduction

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Carbon sequestration (increased sink)

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Sustainable Land Management (SLM)

(decreased source and increased sink)

- **Restoration of C sequestration potential by maintaining vegetative soil cover & building of soil organic matter : 0.05 – 1.0 t C/ha/year [1] / 0.3. – 0.8 t C/ha/year [2]**

[1] *UNCCD. 2009 Benefits of Sustainable Land Management. WOCAT. Centre for Environment and Development . 2009*

[2] *Smith, P. 2007. in: Land Use and Soil Resources. 2008. Springer Science & Business Media B.V. ISBN-978-1-4020-6777-8*

Sustainable land management (SLM)

reduced tillage	Avoidance of **N_2O** generation by avoiding soil compaction
set aside land and land use change	Increase soil organic matter, reduce soil disturbance, avoidance of compaction … **but:** possibly increase bacterial activity (nitrification/de-nitrification) activity > generation of additional **N_2O**
Livestock grazing intensity	Decrease C loss through improved pasture management **but:** continued **CH_4** generation
Degraded land restoration	Increase C storage, decrease C losses, reduce soil disturbance **but:** increased bacterial activity > **N_2O** generation
Increased agric. productivity	Increased C storage … **but:** increased bacterial activity > **N_2O** generation **…** **and:** increased **CH_4** from livestock production
Increased legu-mes / catch crop	Increased C storage **but:** increased bacterial activity > **N_2O** generation from additional N fixation in the soil

Mitigation options in agriculture

Emission reduction

- **Livestock/manure management**
- **Sustainable agricultural soils**
  - management of agricultural soils: soil erosion control, reduction of fires and mineral fertilizer utilisation

Carbon sequestration

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- perennial crops (agroforestry systems)

Sustainable Land management (SLM)

Carbon substitution

- Bio-fuels
- Substitution through agricultural by-products

Mitigation potential through soils

- Soils hold more than twice the carbon as compared to vegetation
- Agriculture has reduced soil organic contents in soils worldwide
- Restoration could offset 5 - 15% of global CO_2 emissions (Lal R., 2004 in: Science)

Cumulated historic global loss of C in bad managed ecosystems:

Annual CO_2 emission: 6.3 +/- GT C

Photos: H.P. Liniger

Soil C sequestration potential:

Potential annual offset through soil C sequestration: 0.9 +/- GT C
(5% – 15% of total current annual emission)

(Lal. 2004. in: Science)

Adaptation to Climate Change through soils

- Improved soil structure
- Higher infiltration rates > Higher water retention

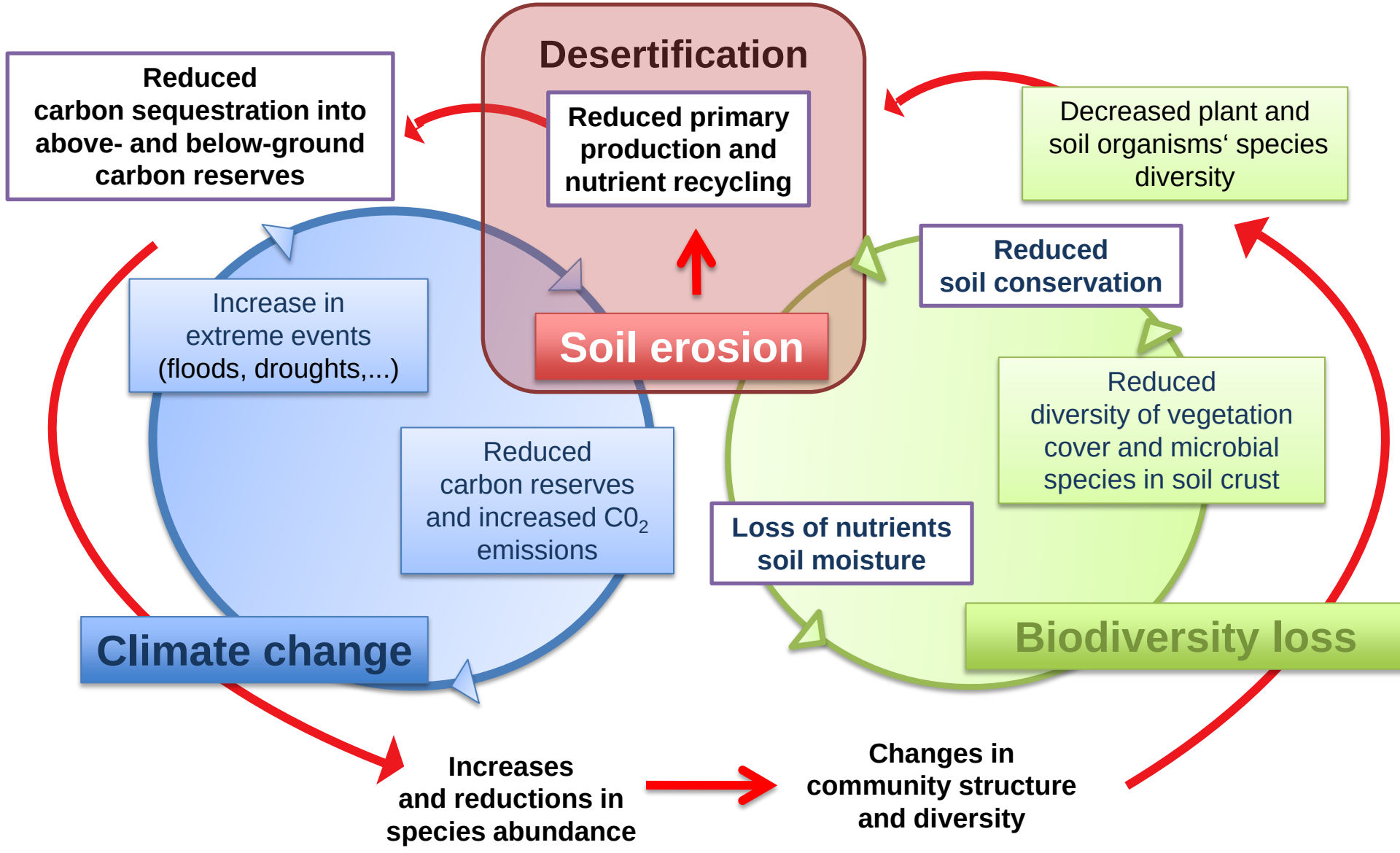
- Increased resistance against extreme events
- Improved production

C-Sequestration by Soils

Managament Aspect	C storage potential	Remark	Source
Trop. grassland	70 tons / ha	Comparable to forest soils Grassland usually higher in C-content than cropland Key factor is an extensive functional root system in grasslands to help increase SOM	Scurlock & Hall. 1998
Forests	> 45 tons / ha > 2 tons / ha / y increase	A major C sink also into soil *Prosopis juliflora increased SOM from 10 tons to 45 tons in an 8-year period (Garg.1998)* *Prosopis and Acacia ssp.* reported to increase soil C by 2 tons / ha (Geesing, Felker and Bingham, 2000)	

Management regime	Impact on soil related GHG	Remark
Unsustainable land management	• **C** loss to atmosphere • **N_2O** generation from fertilisation and unsustainable soil management	
Conversion forest / grassland to cropland	• Large losses of **SOC** • Reduction in **C** sequestration potential as C seq. in croplands only during cropping season • Increased anaerobic soil environment (compaction) leads to increased de-nitrification / generation of **N_2O** • Indirect de-nitrification through leaching of N fertilizer • Increased **CH_4** generation in case of rice cultivation	• Halt land conversion by increasing productivity of existing agric. areas (irrigation?, fertilisation?) • Ensure soil cover and reduce disturbances in upper soil layer (tillage intensity?) • Avoidance of degradation • Better targeting of fertiliser application
Conversion forests to grassland	Less or no loss of SOC **….but:** • Total amount of **C** stored in ecosystem reduced due to loss of plant carbon from forest • Increase in N input from fertilisation > generation of **N_2O** • Possible increase of **CH4** emission from ruminants	• Maintain tight grass cover • Ensure maximum rooting
Cultivation / drainage / liming of organic soils (peat lands)	• Large losses of SOC through oxidation (loss of seq. potential) • Mineralisation of organic nitrogen; subsequent de-nitrification and generation of **N_2O** • Less emissions from **CH_4**	• Halt land conversion of peat land by increasing productivity of existing agric. areas • But: peat-and wetlands remain to be **CH_4** sources
Fertilisation	Generation of **N_2O** from N applied to soils from: • livestock manure • legumes cultivated • chemical fertiliser	• Fertiliser management / improved targeting of fertiliser application

Feedback Loops - Desertification, Climate Change and Biodiversity



(Millenium Ecosystem Assessment, modified)

Klimawandel
indirekter Einfluss auf Bodendegradierung

- verringerte Produktivität Übernutzung,

verstärkter Druck auf natürliche Ressourcen

- Veränderung regionaler Anbaumuster Abgleiche / Anpassungen zwischen Ackerbau und Weidewirtschaft
- Verlagerung von Anbauzonen - Beispiel Baumwollanbau

erhöhter Druck auf natürliche Ressourcen (Entwaldung, Überweidung)

- Erhöhung der:
  - Niederschlagsvariabilität
  - Frequenz Trockenjahre

geringere Regenerationsfähigkeit der Vegetation

geringere
- Bodenbedeckung
- Wasserinfiltration

Erosion, Bodendegradierung

Wechselwirkungen zwischen Klimawandel und Desertifikation

Auswirkungen Klimawandel

- Ansteigen von ariden Bedingungen und daraus resultierender geringerer Vegetationsdichte:
  - Temperaturanstiege in Folge verringerter Evapotranspiration
  - weniger organische Bodensubstanz
  - geringere Wasserinfiltration - erhöhte Abflussraten -verstärkte Erosion .....
- Verstärkter Druck der Bevölkerung auf natürliche Ressourcen und steigende Bodendegeneration

Auswirkungen Desertifikation

- Bodendegradation trägt zur Veränderung des Weltklimas bei
- Einfluss auf globale atmosphärische Energie-bilanzen über gleichzeitige Veränderung der:
  - Albedo
  - Bodenfeuchtigkeit
  - Winderosion
  - CO_2 Emissionen und geringere CO_2 Bindungen
  - Wasserbilanz ....

0.3 Gt CO_2 equiv/ year = 4% of total annual $C0_2$ emissions worldwide

Reducing Emissions from Deforestation and forest Degradation
– REDD -

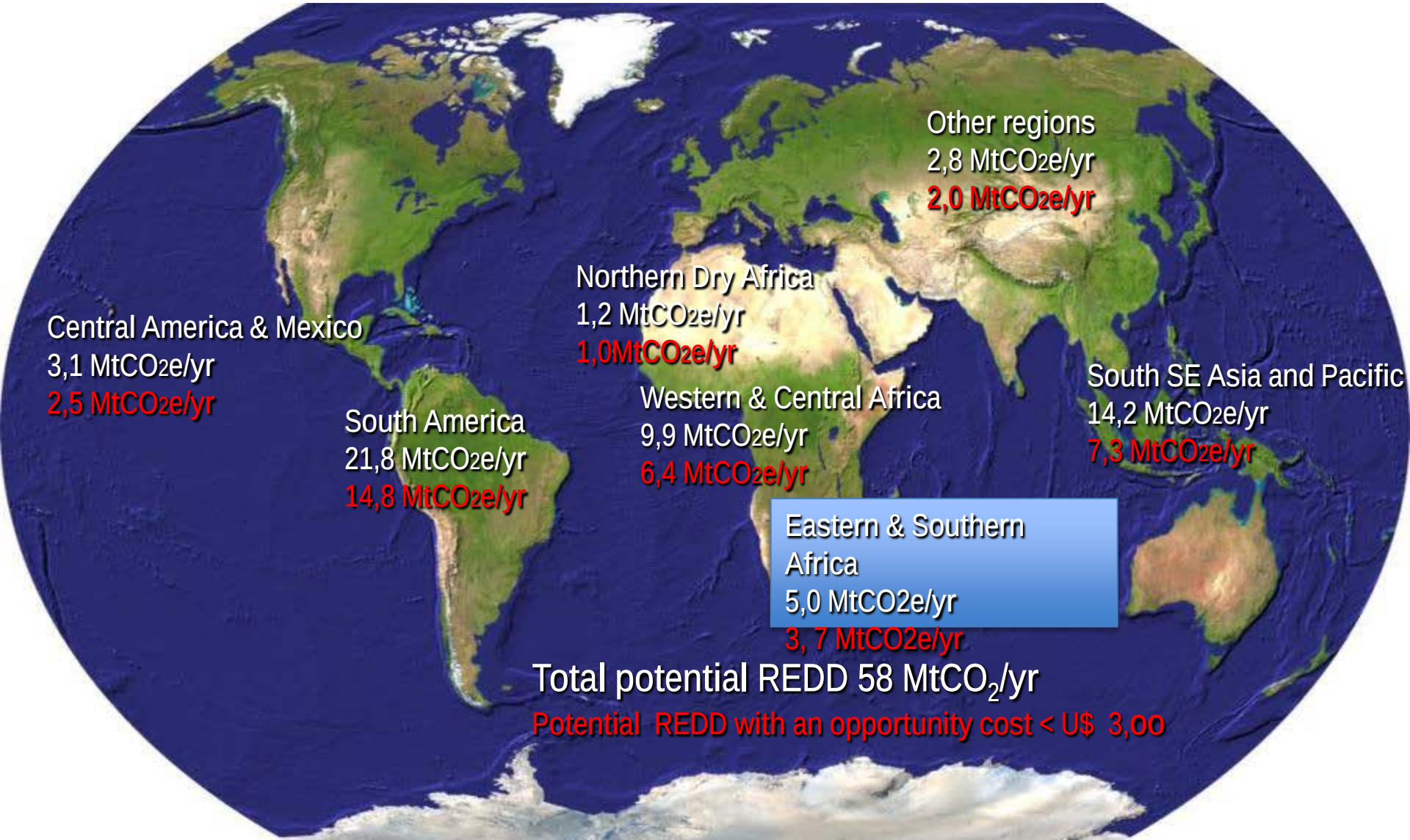
Direct drivers

- *Commercial agriculture*
  - Commercial crops
  - Cattle ranching

- *Subsistance farming*
  - Small-scale agriculture/shifting cultivation
  - Fuelwood and NTFP gathering

- *Wood extraction*
  - Commercial (legal & illegal)
  - Fuelwood/charcoal (traded)

Reducing Emissions from Deforestation and forest Degradation – REDD -



Kasigau Corridor REDD project

avoid the emission of over 3.5 Million metric tonnes of CO_2e (20 year project period /175000 t/year)

emitted due to slash and burn deforestation across the Carbon Pools of above and below ground Biomass, and Soil Carbon.

combination of Dryland Forest protection (Biodiversity aspects)
and
community sustainable development activities

Forest aspects: REDD + is ... a policy rocket with broad support: Now what??

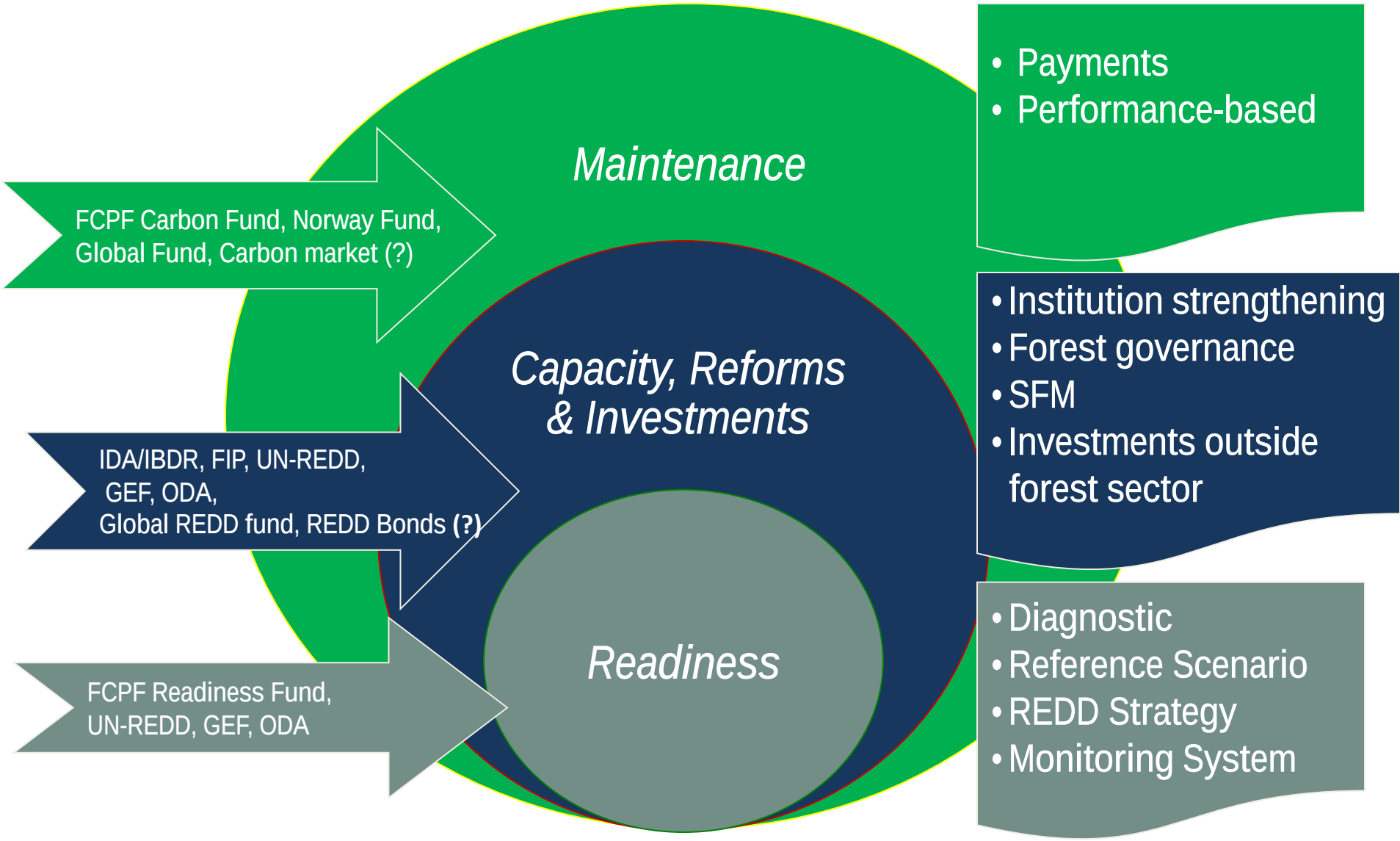
The Good News:

- REDD+ is likely to happen;
- Serious discussion of up-scaling and funding;
- We are slowly inventing how to do REDD+, at project and national scales

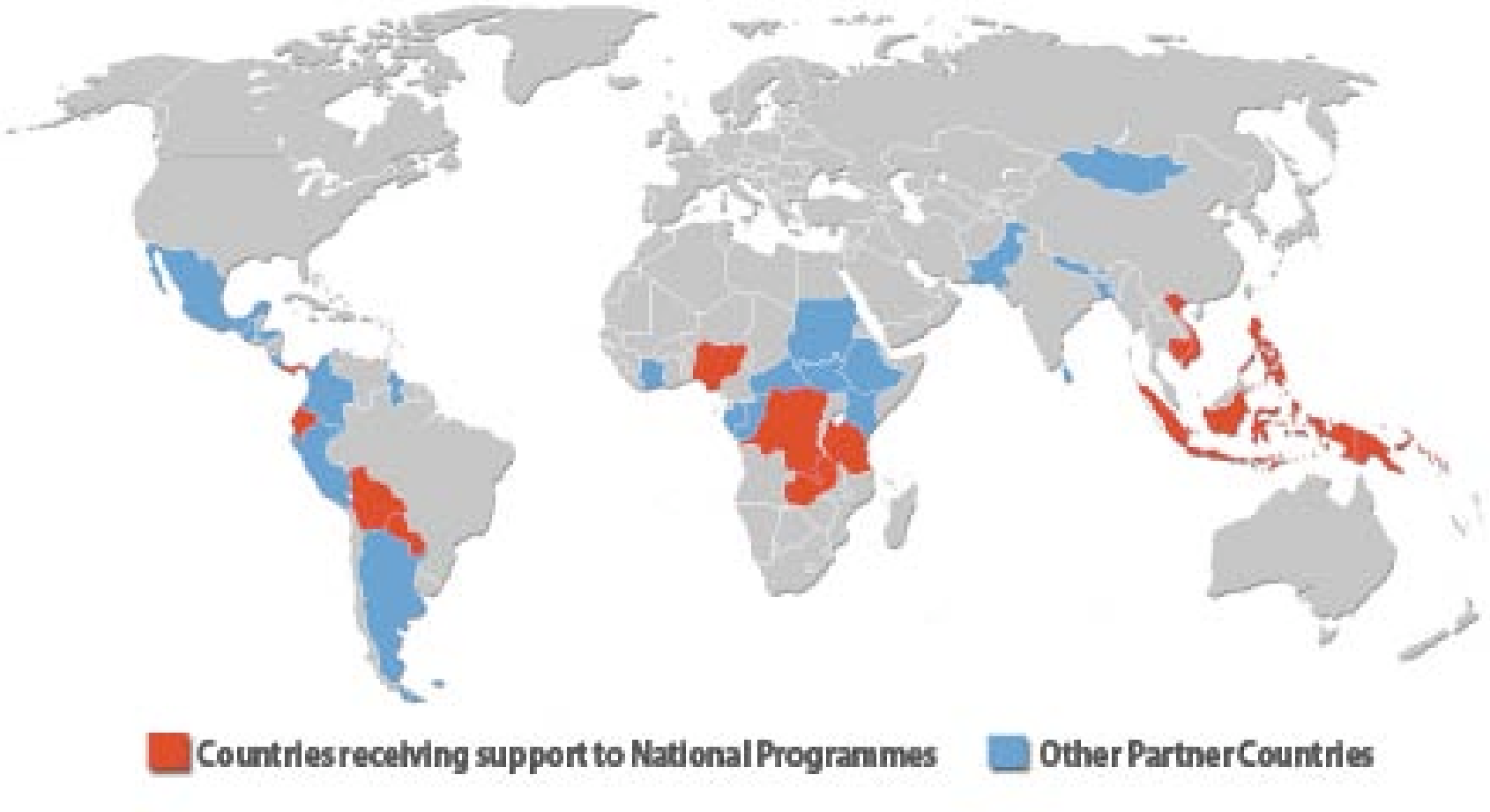
The Other News:

- But we need to harvest lessons faster, apply them at larger scales.
- We need to share experience & rapidly develop a vision of what national REDD+ looks like.

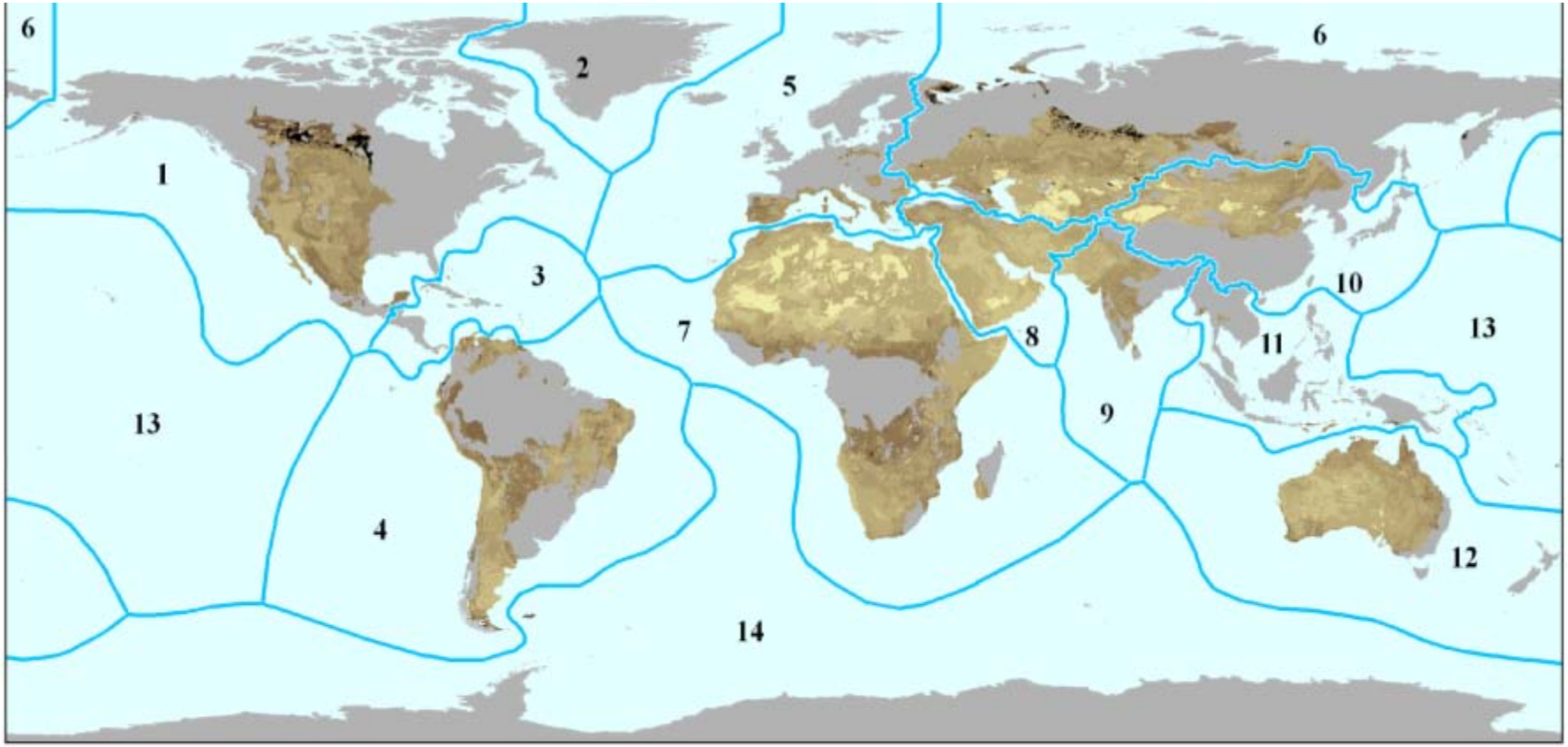
The Three Phases of REDD+



UN-REDD Programme



Carbon in dry lands



Carbon (tonnes/hectare)

0 - 10 | 10 - 20 | 20 - 50 | 50 - 100 | 100 - 150 | 150 - 200 | 200 - 300 | 300 - 400 | 400 - 500 | > 500

Non dryland areas

1 North America	8 Middle East
2 Greenland	9 South Asia
3 Central America & Caribbean	10 East Asia
4 South America	11 South East Asia
5 Europe	12 Australia & New Zealand
6 North Eurasia	13 Pacific
7 Africa	14 Antarctic & peripheral islands

Data sources:

Ruesch, A. S. & H. K. Gibbs. Global biomass carbon stock map based on IPCC Tier-1 Methodology. Oak Ridge National Laboratory's Carbon Dioxide Information Analysis Center (in review).

IGBP-DIS 2000. Global Soil Data Products CD-ROM. Global Soil Data Task, International Geosphere-Biosphere Programme, Data and Information System. Potsdam, Germany. Sourced from Oak Ridge National Laboratory Distributed Active Archive Center, Oak Ridge, Tennessee, U.S.A. http://www.daac.ornl.gov.

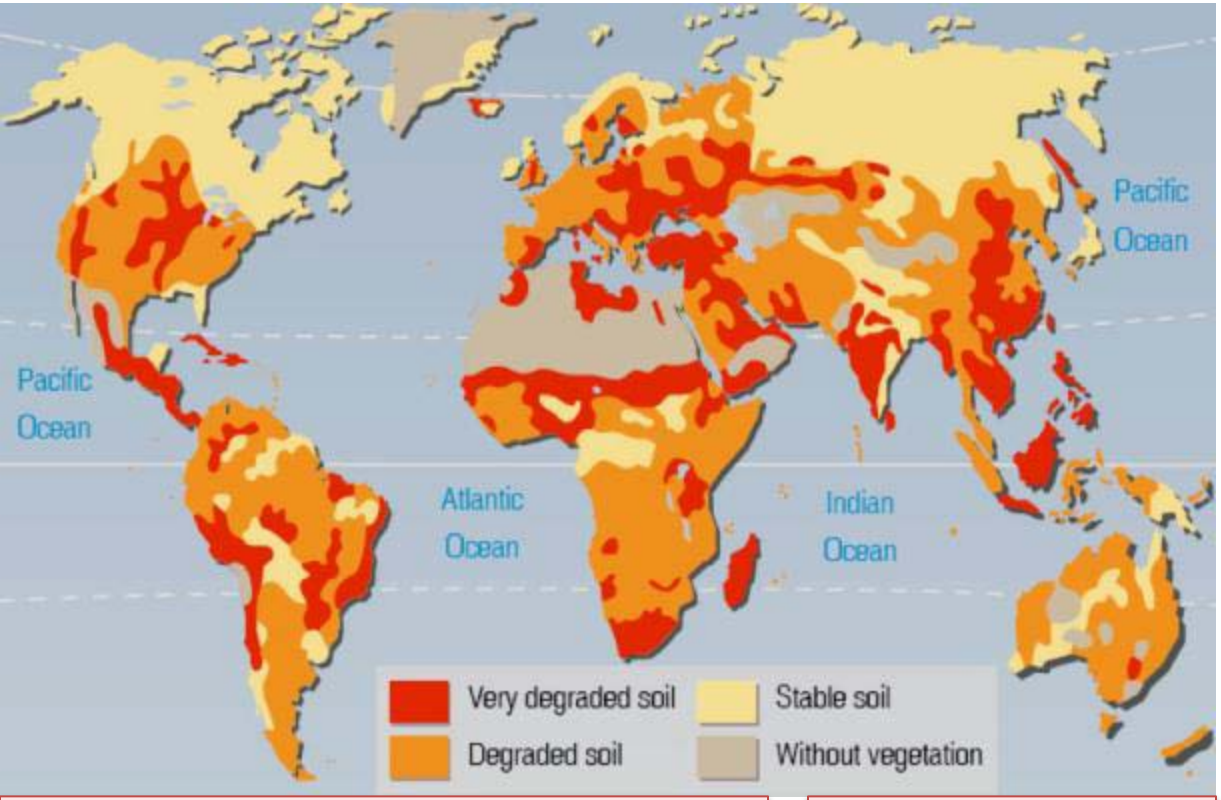
UNEP-WCMC, 2007. A spatial analysis approach to the global delineation of dryland areas of relevance to the CBD Programme of Work on Dry and Subhumid lands. http://www.unep-wcmc.org/habitats/drylands/dryland_report_final_HR.pdf

Carbon stocks in dry lands

	Total carbon stock per region (Gt)	Carbon stock in dry lands (Gt)	Share of regional carbon stock held in dry lands (%)
North America	388	121	31
Greenland	5	0	0
Cent.-America & Carib.	16	1	7
South America	341	115	34
Europe	100	18	18
Africa	**356**	**211**	**59**
Middle East	44	41	94
South Asia	**54**	**26**	**49**
East Asia	124	41	33
South East Asia	132	3	2
Australia/NZ	85	68	80
Pacific	3	0	0
Total (Average)	**2053**	**743**	**(36)**

weltweite Bodendegradation

110 Länder mehr oder weniger stark von Desertifikation betroffenen !



- Während der letzten 50 Jahre haben sich 9 Mio km^2 arider Flächen auf der Welt in Wüsten verwandelt (1/3 der Fläche in Afrika)
- > 1/3 der globalen Landoberfläche (42 Mio km^2) von Desertifikation bedroht

- **Afrika** (Trockengebiete)**:**
  - 61 % der Regenfeldbauflächen u. 74 % der Weideflächen degradiert.

- **Lateinamerika:**
  - 74% der Fläche betroffen

Asien:
- 35 % der Bewässerungsfläche
- 56 % der Regenfeldbaufläche
- 76 % des Weidelandes

(UNEP, International Soil Reference and Information Centre (ISRIC), World Atlas of Desertification)

Carbon storage in dry lands

- Plant biomass per unit area of dry lands is low (60 t per ha) compared to many terrestrial ecosystems (100-180 t per ha)

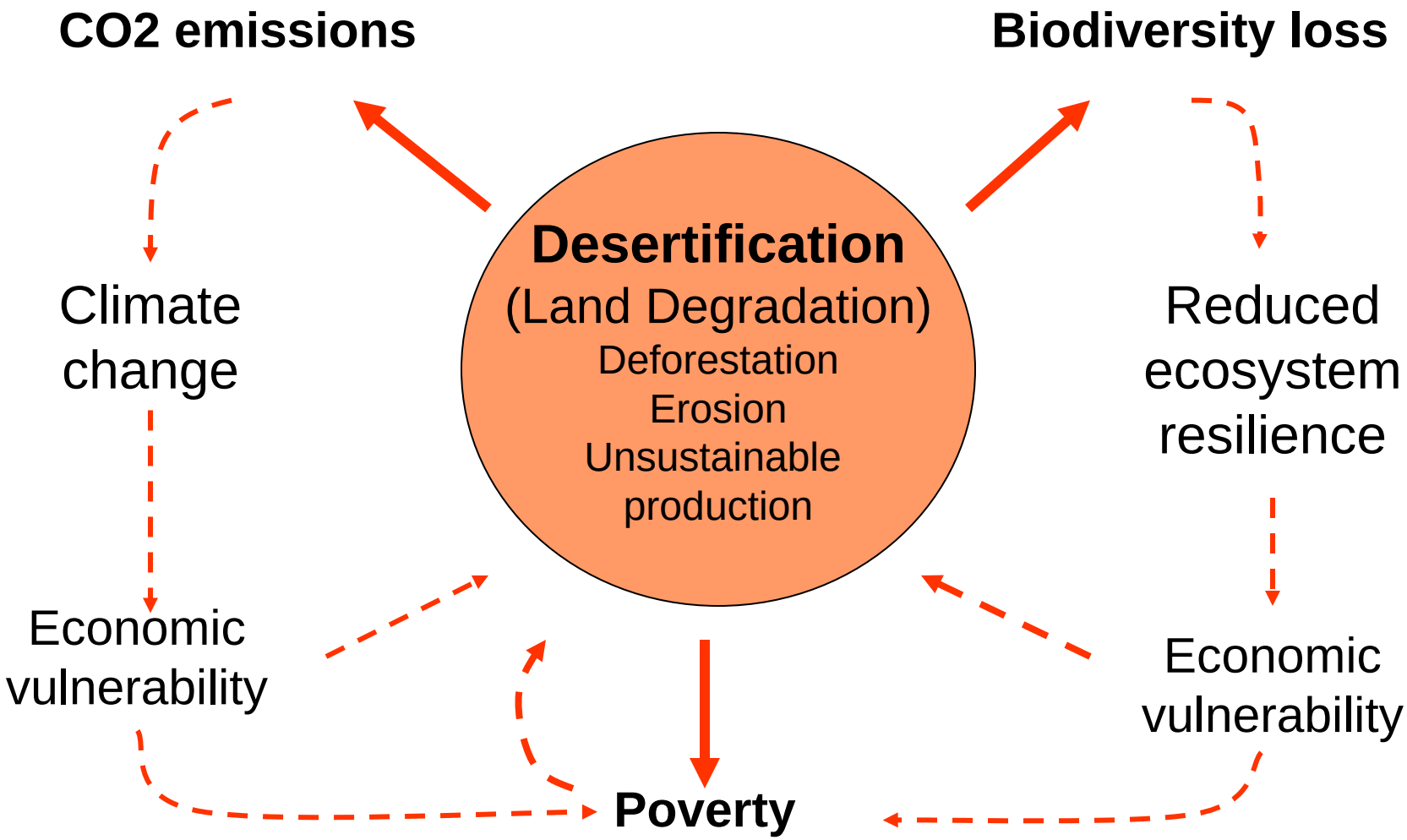
- Total carbon stock in dry lands is 36% of total carbon stock in terrestrial ecosystems

Large surface area

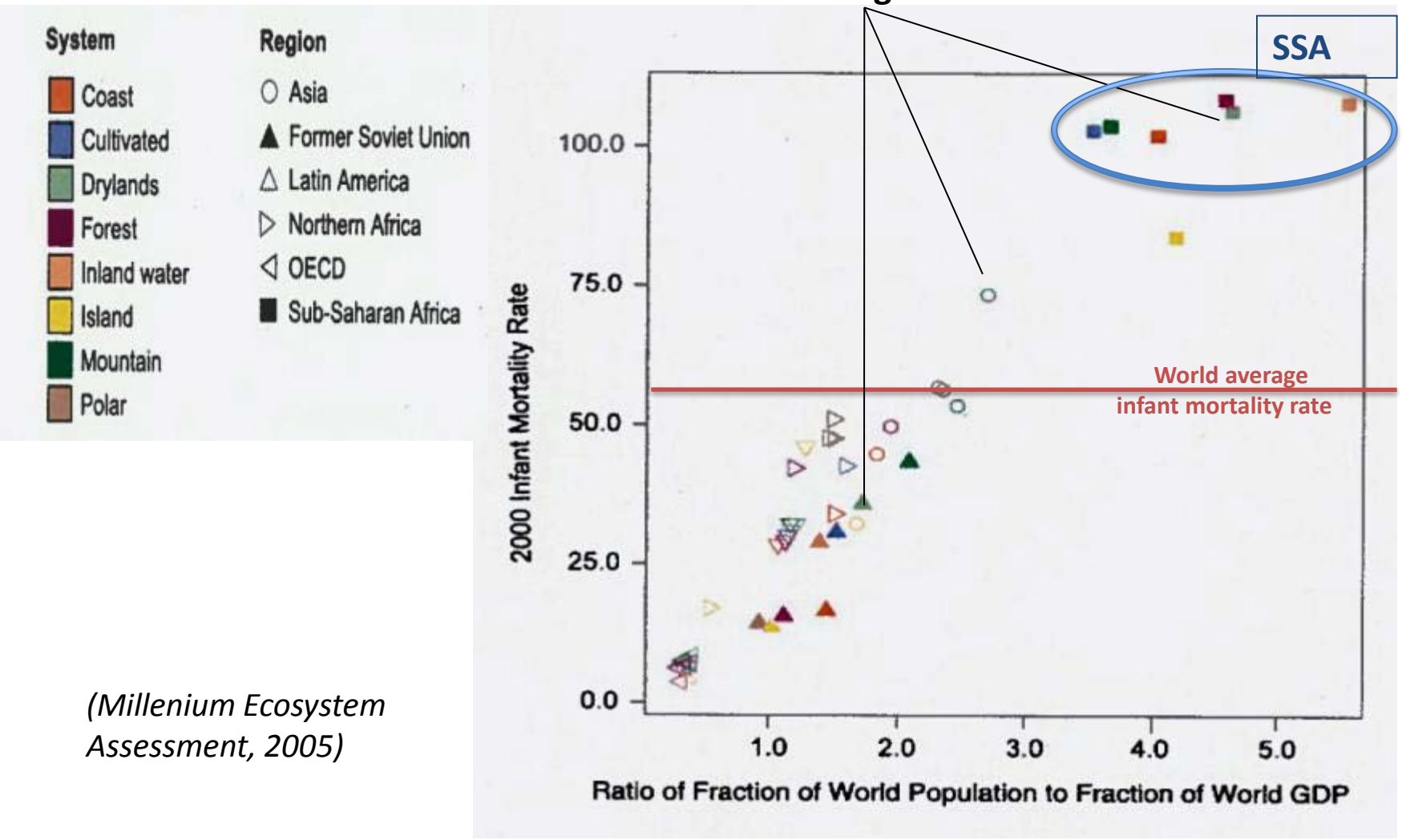
gives dry land carbon significance !

→ significant scope for sequestration

Critical themes and linkages



Armut: Hotspots im ländlichen Raum



(Millenium Ecosystem Assessment, 2005)

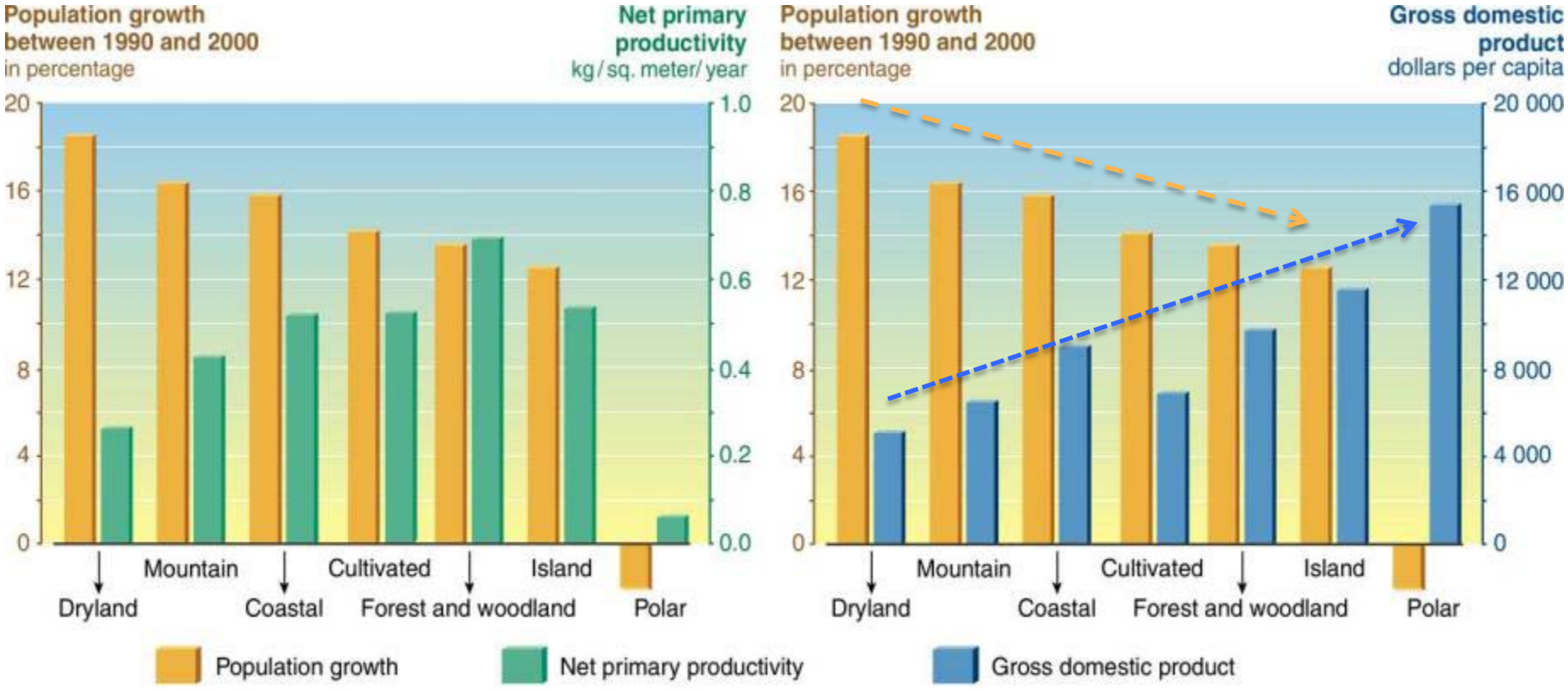
kritische Situation von Trockenlandsystemen

- Entwicklungsmöglichkeiten in Trockengebieten hängen besonders vom Zustand der Ökodienstleistungen ab
- nur 8% der weltweit erneuerbaren Wasserresourcen
- fernab gelegene Staatsgebiete
- grosse Mobilität von Weidehaltern (erschwerte Nutzung von staatlichen Dienstleistungen)

Bevölkerung von Trockengebieten

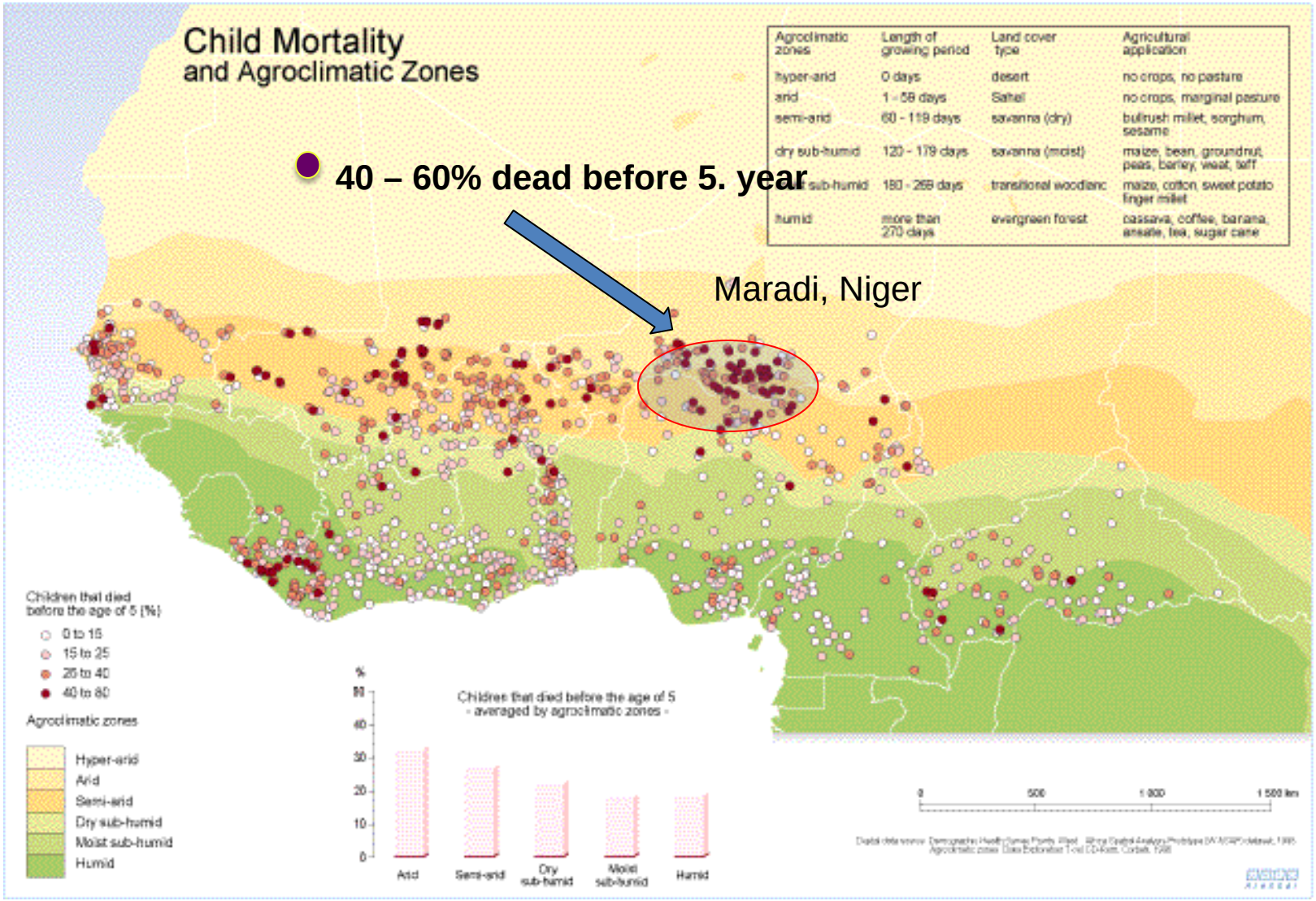
- geringster Lebensstandard
  (geringstes BSP/Person, höchste Kindersterblichkeitsraten…)
- Wasserverfügbarkeit/Person entspricht nur 2/3 des menschlichen Minimalbedarfs
- Höchste Bevölkerungswachstumsraten

Trockengebiete im Vergleich zu anderen Ökosystemen: Bevölkerungswachstum, Nettoprimärproduktivität und Bruttosozialprodukt



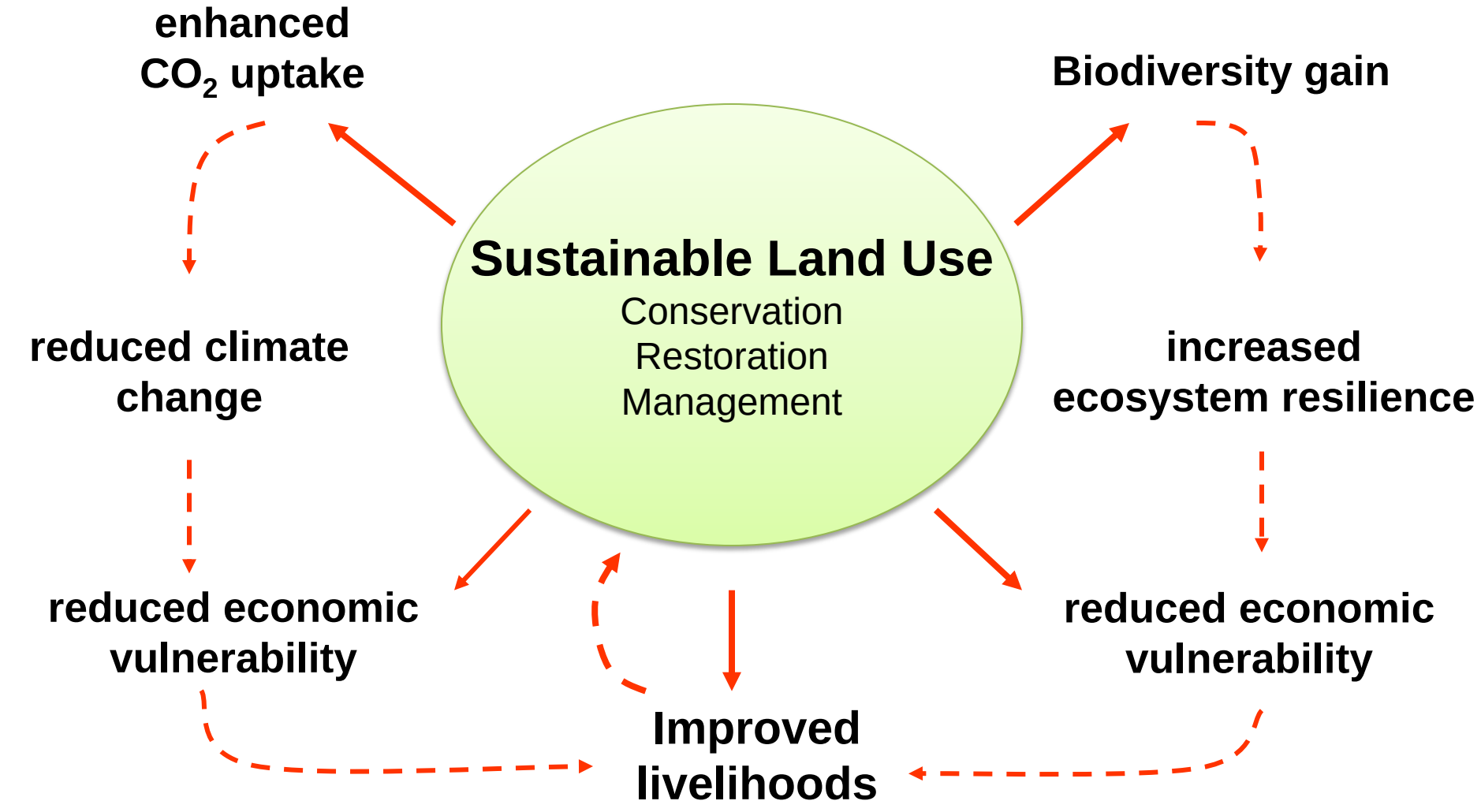
Sources: Millennium Ecosystem Assessment

Armut und agroklimatische Zonen



Bournay, Rekacewicz, UNEP/GRID-Arendal

Sustainable land use: creating synergies to combat climate change, desertification and biodiversity loss



Addressing degradation

- **Addressing degradation not only contributes to goals of UNCCD but also to climate mitigation**
  - By slowing degradation, associated emissions are reduced
  - Changes in land management practice can promote carbon sequestration

and poverty alleviation!

International policy framework

- UNFCCC treatment of land use and land use change does not include anything specific to dry lands

Signs of moves to a more comprehensive approach. Chair's negotiating text for LCA includes references to:

Agriculture,

Soil carbon,

Dry-lands

Land use

Assessing options for carbon management in dry lands

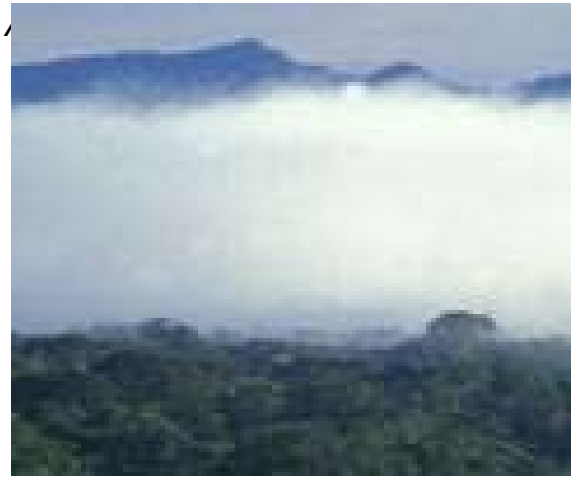
- UNFCCC treatment of carbon emissions from land use and land use change is partial

- UNCCD aims to tackle these issues

(UNEP-UNDP-UNCCD Technical Note for Discussions at CRIC 7, Istanbul, Nov 2008)

Conclusions

- Sustainable land management practices that address desertification in dry lands can have significant mitigation potential (decreasing emissions and increasing removals)
- There is potential to draw on Carbon finance.
- Particularly if combined with other sources in light of recognition of the multiple benefits of action
- Need for UNFCCC to develop an appropriate policy framework that includes dry lands

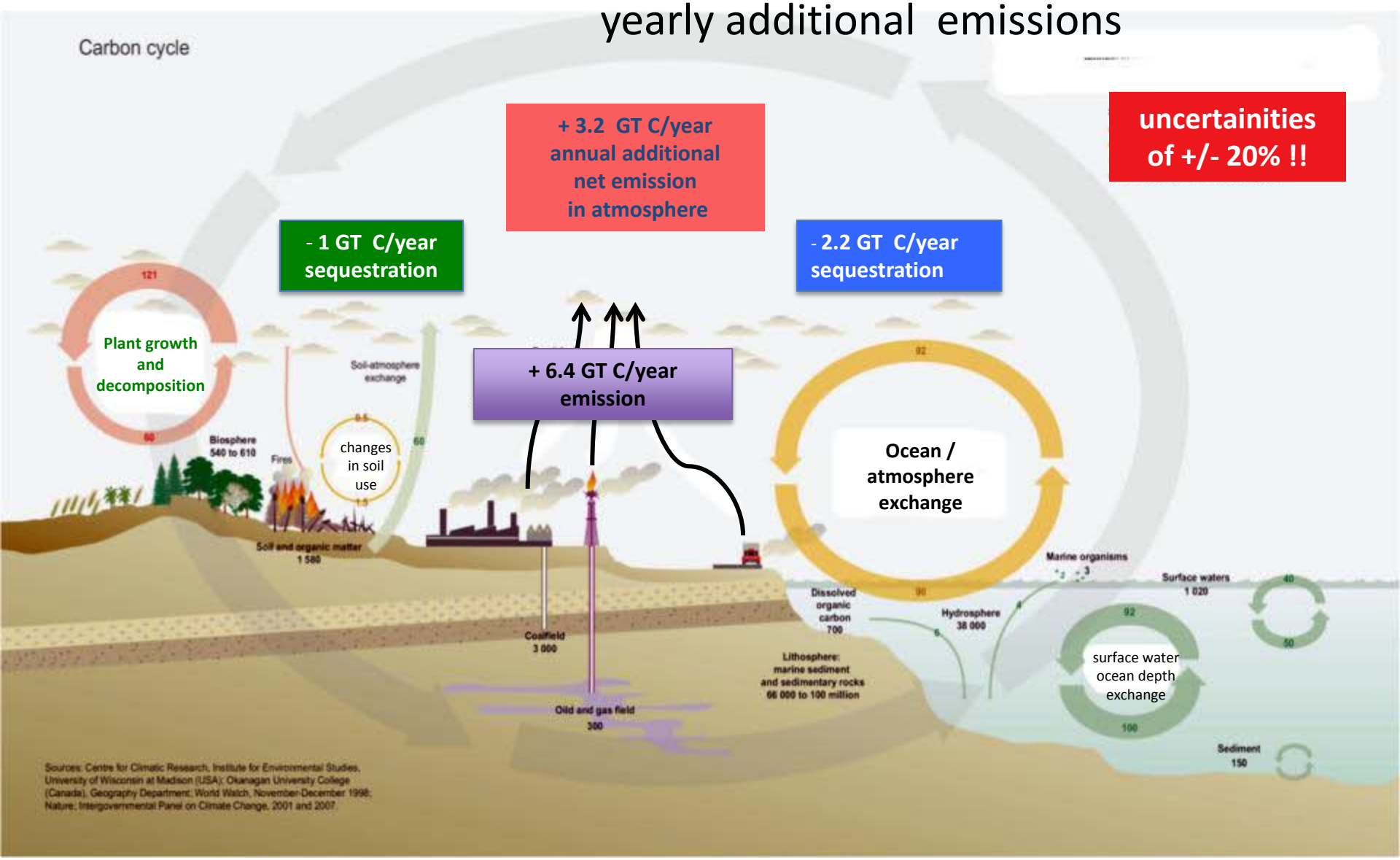


AFOLU,

An opportunity to move from forest to a landscape approach:

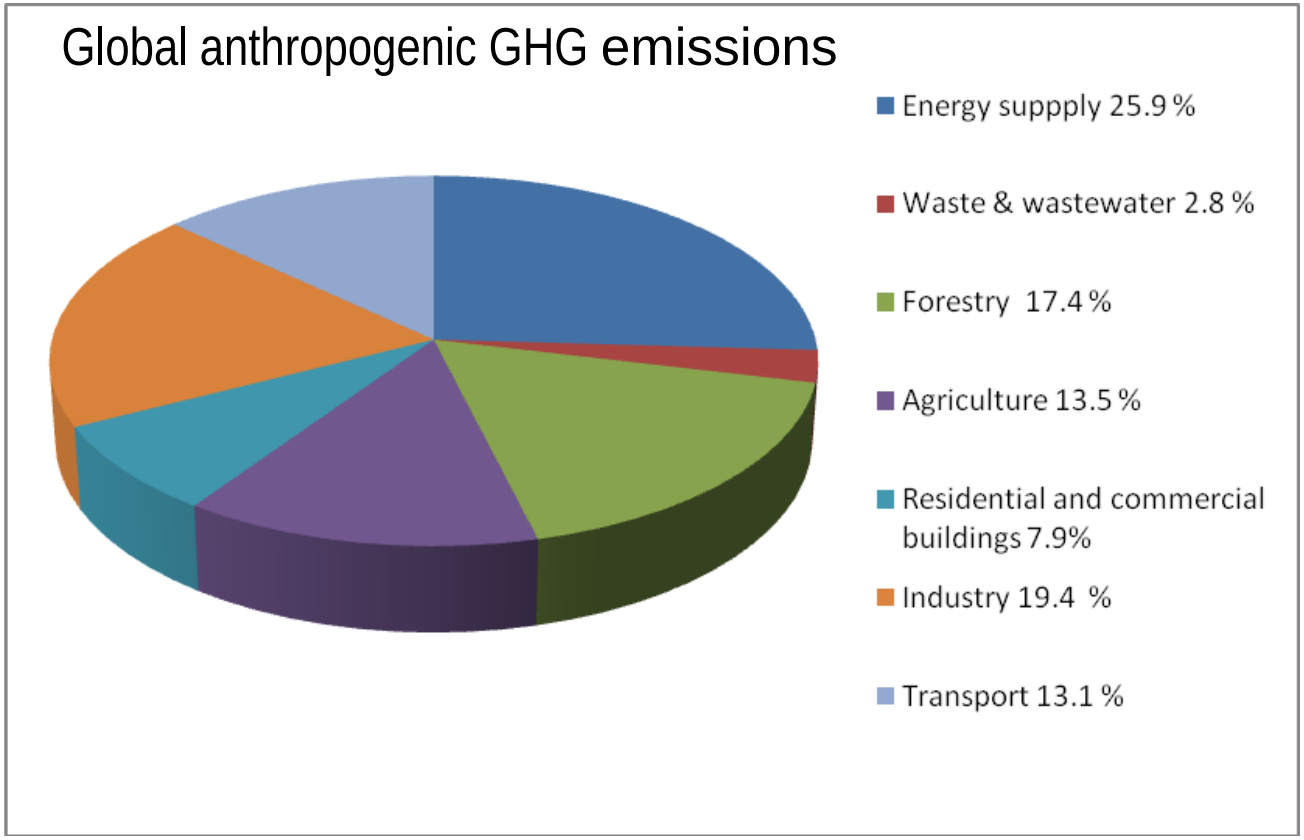
Natural Resource Management and Climate Change

Carbon cycles and yearly additional emissions



(http://maps.grida.no/go/graphic/the-carbon-cycle1 modified), IPCC 2007 data

AFOLU emissions – mitigation potential



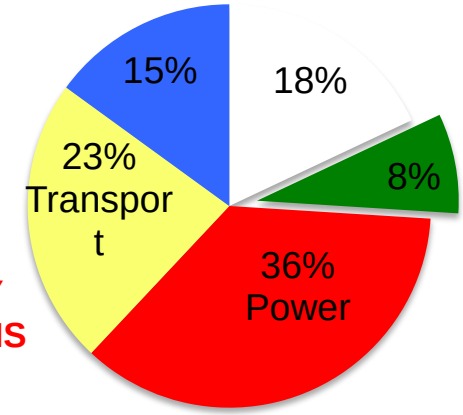
Source IPCC, Fourth Assessment Report, Summary for Policy Makers

→ **AFOLU: over 30% of the NET GHG emissions**

→ **Most of these emissions happen in developing countries**

Greenhous gas emissions by sector

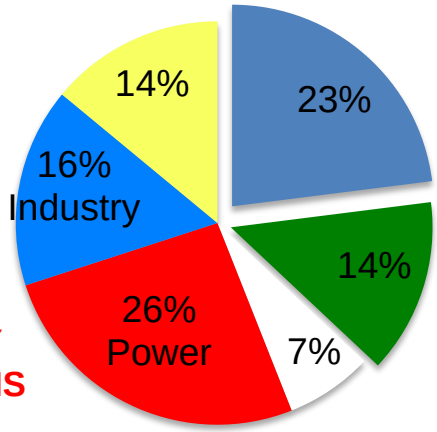
High Income Countries



ENERGY EMISSIONS 92 %

NON-ENERGY EMISSIONS 8 %

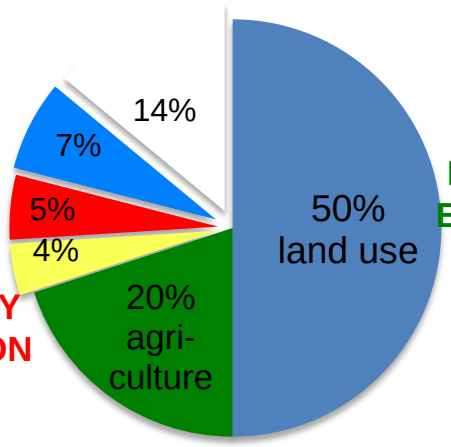
Middle Income Countries



ENERGY EMISSIONS 63 %

NON-ENERGY EMISSIONS 37 %

Low Income Countries



ENERGY EMISSIONS 30 %

NON-ENERGY EMISSIONS 70 %

(World Development Report 2010 modified)

Geschätztes Einsparungspotential an Emissionen und Kosten verschiedener Sektoren

Sektor	2050 Jährliche Emissions-einsparungen ($GtC0_2$)	Durchschnittliche jährliche Kosten 2025 – 2050 ($/t$CO_2$)
Fossiler Energiesektor	40	22 -33
Abfall, füchtige Emissionen, Industrieprozesse	4.1	3 - 5
Entwaldung	3.5 – 5.0	2 - 4
Bioenergie	2 – 3	25
Aufforstungen	1 - 2	5 - 15
Landnutzungspraktiken	1 - 2	20 - 27
Landwirtschaft (CH_4 , $N0_2$)	1	27

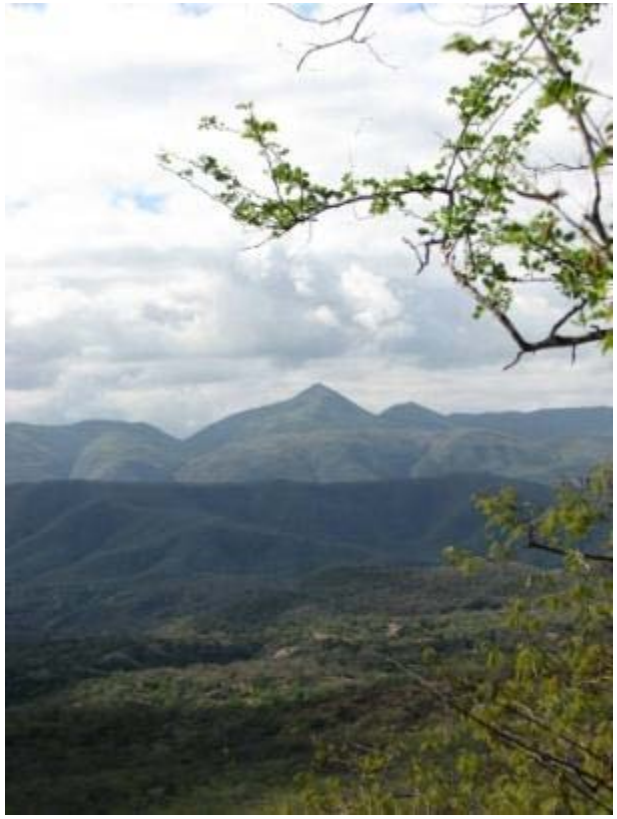
Stern review, 2007

AFOLU options for mitigation in developing countries

Source

Emission by:

- **Deforestation**
- **Degradation**
- **Devegetation**
- **Manure management**



Sink

Sequestration

- **Afforestation**
- **Reforestation**
- **Forest Restoration**
- **Sustainable Agriculture**

Substitution

- **Bioenergy**

(with wood products)

Implementing AFOLU through landscape approach

Agricultural land:

- Food security
- Production of Non-Food crops (e.g. biofuels)
- Emissions reductions (e.g. manure management)
- Environmental services ?

Forests:

- Environmental services
- Trees as renewable material/energy source

Water:

- Water security
- Renewable energy

Interdependence at landscape level

in carbon mitigation terms:

source and/or sink

In adaptation:

key natural assets

of ecosystems for reducing vulnerability

Ecosystems play a central role in climate change

Intact and functioning
ecosystems can increase resilience of people
and ecosystems fix and maintain carbon

Mitigation and adaptation options in the AFOLU sector need to be fully understood and used in the context of promoting sustainable development

use AFOLU mitigation options for promoting sustainable development

Mitigation options in AFOLU

- **REDD, forest restoration, A/R CDM, forest management**
- **Wood products**
- **Cropland and livestock management**
- **Biofuels**
- **Agricultural by-products**

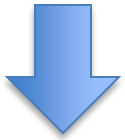
SLM

MDG: 1, 3, 7 and 8

use AFOLU mitigation options for promoting sustainable development (continued)

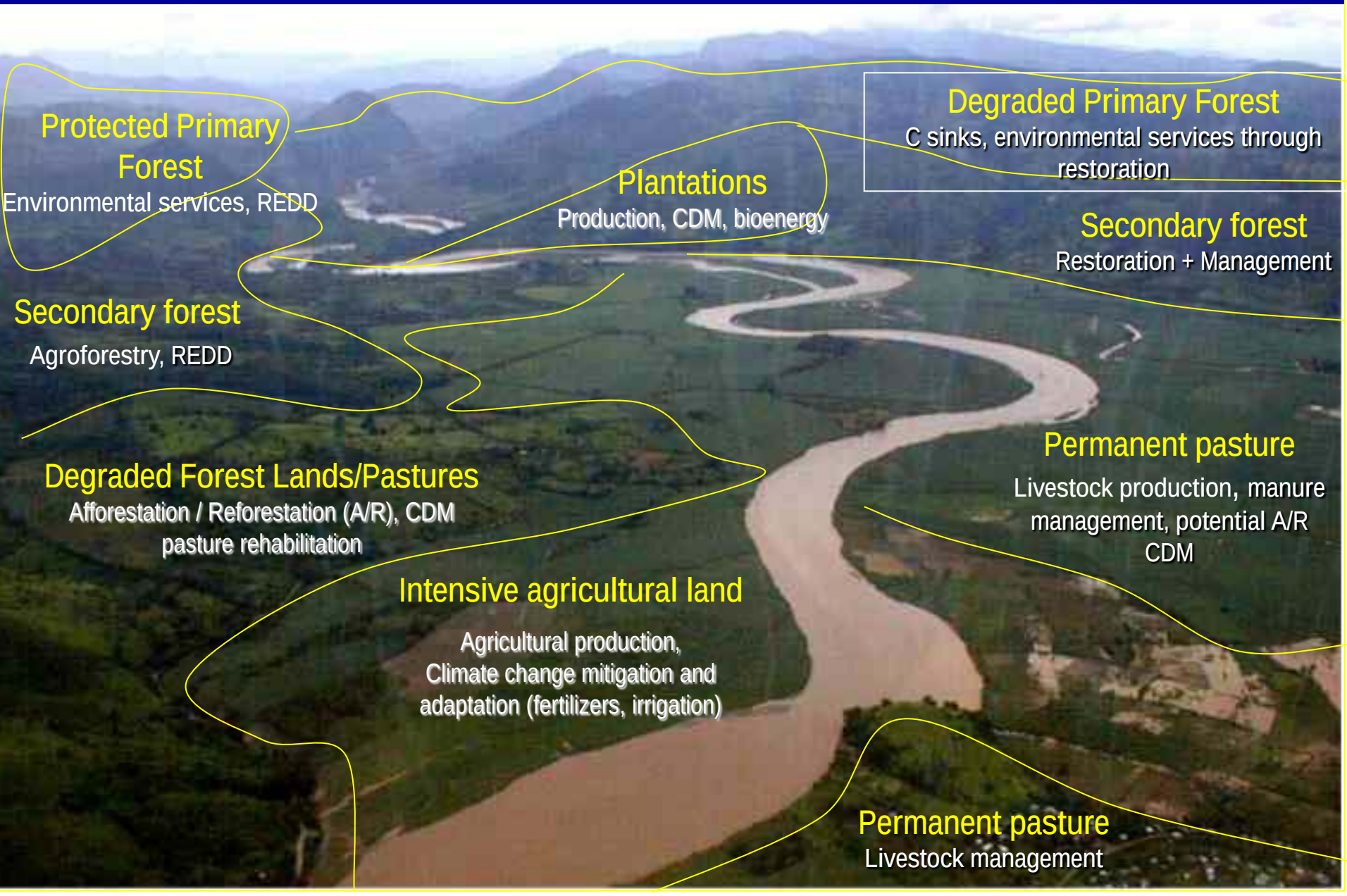
Open questions:

- land tenure and ownership of carbon credits
- incentives: design, C allocation, distribution
- integral approach to sustainable landscape management
- methods for C accounting



Landscape governance is at the center of any effort to use AFOLU mitigation options

Landscape paradigm…



Aboveground biomass

Below ground biomass

Dead woody material

Litter

Carbonic organic soil

- How much carbon is stocked in the organic soil in all landscapes?
- Which are the proceeses that affect emissions and sinks in soil?
- Link to activities in the development cooperation ?

Disputed issues for design same as for other PES (REDD)

- Additionality
- Leakage
- Scale
- Baselines
- Permanence
- Equity and side benefits

Conclusions

- The **AFOLU sector is the major GHG emittor** in most developing countries → great mitigation potential
- AFOLU mitigation and adaptation activities are closely related to the MDG
- **AFOLU methods for GHG quantification are (artificially) complicated**
  - How to account for carbon pools and non-anthropogenic emissions in agriculture ?
- There is reduced experience in quantifying adaptation and NRM
- **There is experience/knowledge/know-how of developing cooperation in on-going coping strategies**

What happened in Copenhagen?

- **Agriculture**
  - **Before Copenhagen, in 2009:**
    - First UNFCCC session dedicated to agriculture
    - First technical brief produced by UNFCCC on potential
  - **In Copenhagen:**
    - Increasing overall interest, though no text yet
    - Agriculture Day 1

Negotiation process

1997 → Kyoto protocol

2001 → Marrakesch Accords (for developed countries all LULUCF activities, for developing countries only A/R in CDM)

2003 → Modalities and procedures for A/R CDM

2004 → Modalities and procedures for small-scale A/R CD:

2005 → Kyoto protocol ratified

2005 → RED (only deforestation)

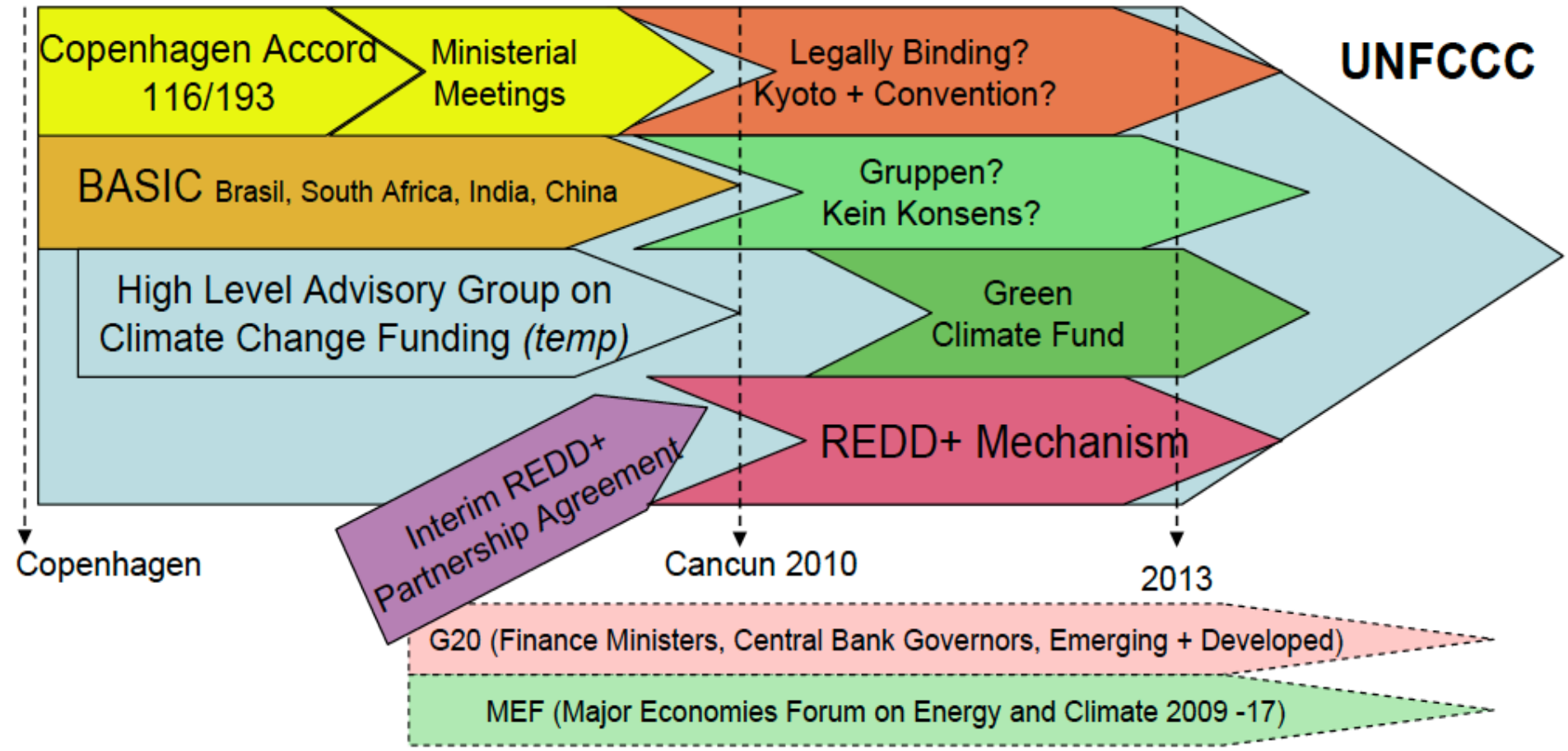
→ Negotiation in the Convention

2007 → REDD (including degradation)

2009 → REDD +: including forest management and conservation, restoration and also agriculture

→ Negotiation in AWG-LCA of the Convention

AFOLU is a term from IPCC:
- Not in the negotiations
- Currently almost all AFOLU alterna-tives are under consideration


Copenhagen Accord
116/193
Ministerial
Meetings
Legally Binding?
Kyoto + Convention?
UNFCCC
BASIC Brasil, South Africa, India, China
Gruppen?
Kein Konsens?
High Level Advisory Group on
Climate Change Funding (temp)
Green
Climate Fund
REDD+ Mechanism
Interim REDD+
Partnership Agreement
Copenhagen
Cancun 2010
2013
G20 (Finance Ministers, Central Bank Governors, Emerging + Developed)
MEF (Major Economies Forum on Energy and Climate 2009 -17)

AFOLU options for mitigation in developing countries

- Eligible in the CDM for the first commitment period (2008 – 2012)
  - Afforestation and Reforestation
  - Biofuels
- Under discussion for a post 2012 regime (3 parallel negotiation processes: AWG-KP, AWG-LCA & SBSTA)
  - Reducing Emissions from Deforestation & Forest Degradataion – REDD
  - REDD plus (now potentially inluding agriculture)
  - Carbon sequestration: A/R, Restoration
  - Forest conservation and management
- **Other mitigation options (status not clear):**

  Soil restoration

  Livestock management

  Cropland management

Agriculture ????

(how far can the process go?)

in Durban wird wahrscheinlich nur beschlossen, die Landwirtschaft im FCCC-Kontext durch eine Arbeitsgruppe unter SBSTA diskutieren zu lassen

L e t u s c o n t i n u e d r e a m i n g !

Main Acronyms…

- A/R = Afforestation/Reforestation
- CDM = Clean Development Mechanism
- CoP = Conference of the Parties
- LCA = Long-Term Cooperative Action
- LULUCF = Land Use, Land-Use Change and Forestry
- REDD = Reducing emissions from deforestation and forest degradation in developing countries
- REDD+ = REDD, forest carbon stock conservation, sustainable management of forests and enhancement of forest carbon stocks
- SBSTA = Subsidiary Bodies on Scientific & Technological Advice
- UNFCCC = UN Framework Convention on Climate Change