Agriculture:
victim, culprit and potentials for adaptation and mitigation

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Key components

1. Climate Change
2. Effects of Climate Change on Agriculture
3. Adaptation and Mitigation in Agriculture
4. Actions to combat climate change

Results IPCC Report 2014

- *In many regions, changing precipitation or melting snow/ice are altering hydrological systems,* ***affecting water resources*** *in terms of quantity and quality.*
- *…* ***negative impacts of climate change on crop yields*** *have been more common than positive impacts.*
- *Impacts from climate-related extremes … reveal significant* ***vulnerability and exposure of ecosystems and many human systems****…*
- ***Adaptation*** *is being facilitated in some areas through mainstreaming climate adaptation action into subnational development planning, early warning systems, integrated water resources management, and agroforestry.*

Climate change and agriculture

- Agricultural production suffers from anthropogenic climate change impacts
- Agriculture and land-use change produce important quantities of GHG emissions
- There are potentials to fix (sequester) GHGs in soils and vegetation (sinks)
- Developing countries are specifically at risk:
  - ✓ Potential occurrence of climate hazards that may cause health, economic or environmental impacts (hazard);
  - ✓ Presence of people, infrastructure, ecosystems in places that could be adversely affected (exposure);
  - ✓ Propensity to be adversely affected (vulnerability), due to dependence on climate reliant natural resources (climate sensitivity), limited access to adaptation technologies, sometimes weak institutions (adaptive capacity);

Agriculture suffers from climate change

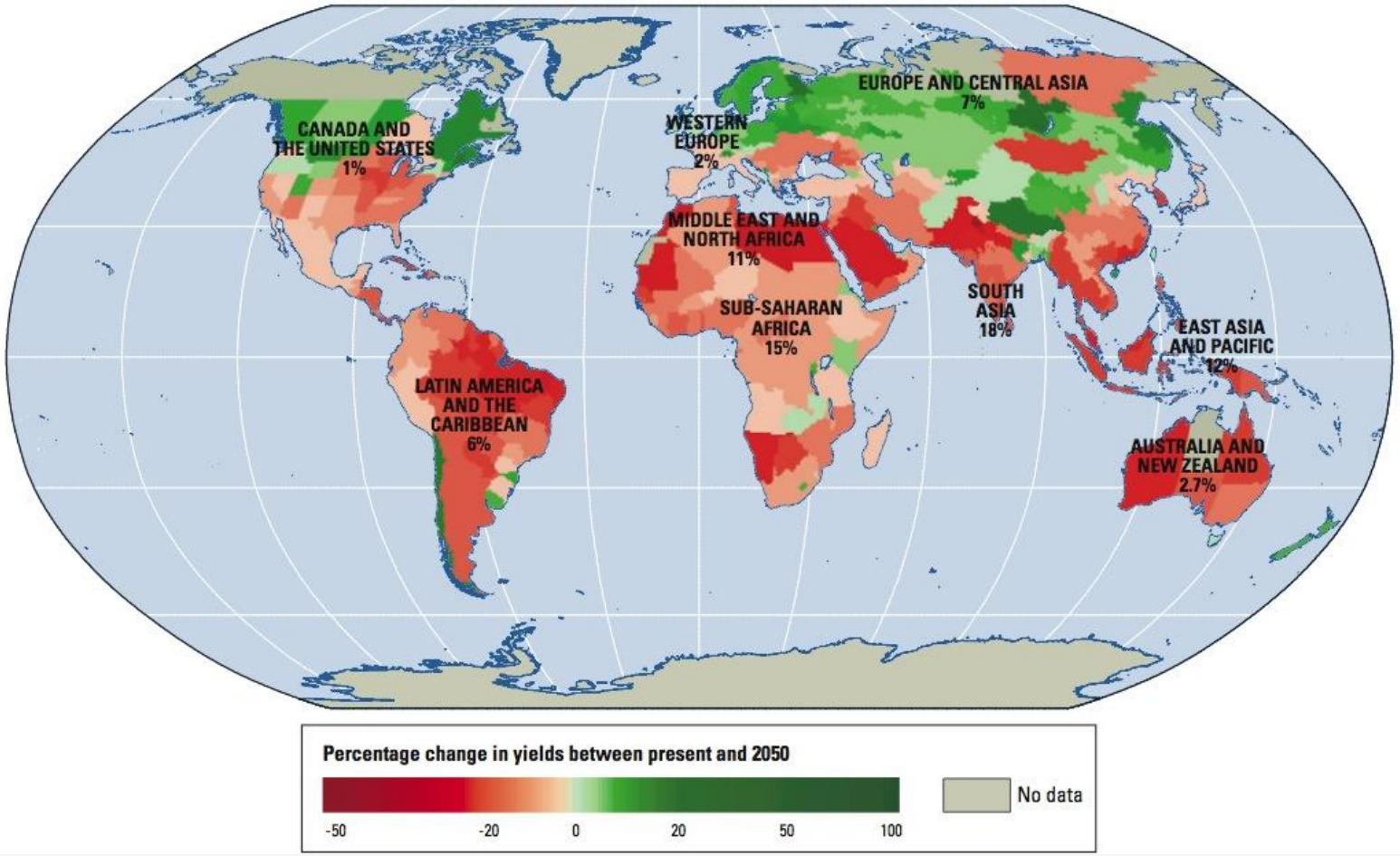
Climate change is associated with:

- Increasing temperature, increasingly varying rainfall
- Extreme weather events (floods, droughts, cyclones), sea-level rise
- Unsecure cropping conditions, crop failures
- Shift of agro-ecological zones and displacement of optimal growing regions
- Changes in pest exposition, invasive species and genetic losses
- Overall yield losses but with considerable regional differences i.e. increases in temperate regions, losses in tropical regions

→ Major implications for food and livelihood security

Impact of climate change on agriculture

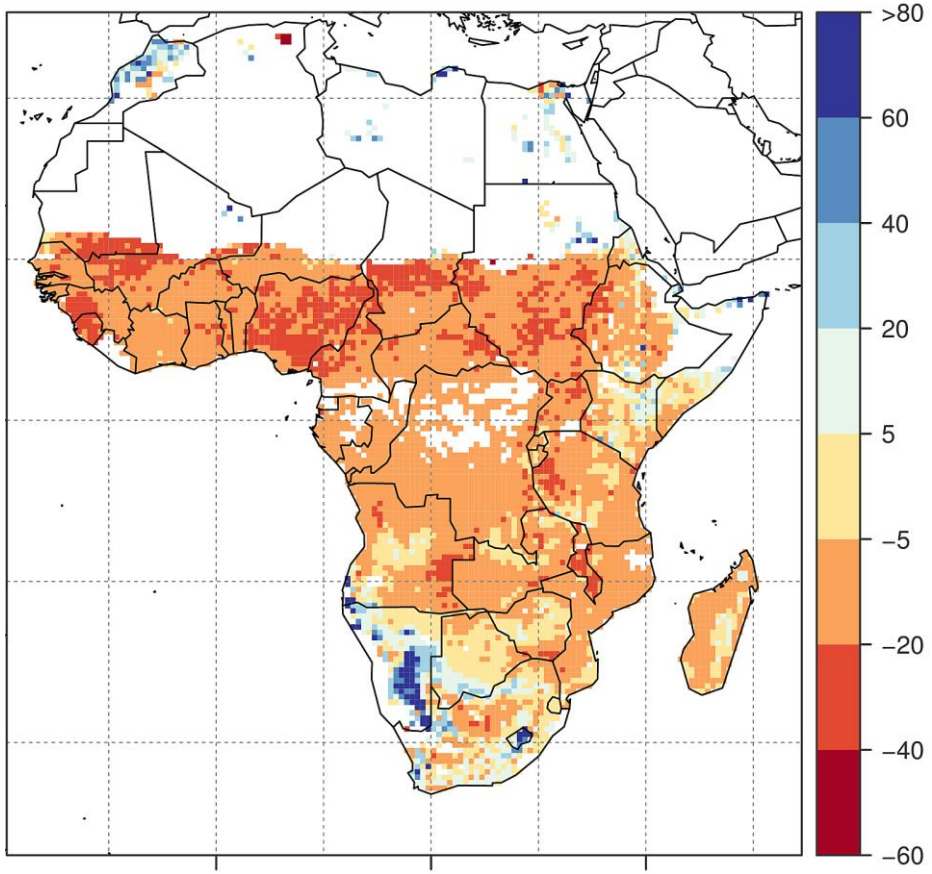
Map 1 Climate change will depress agricultural yields in most countries in 2050, given current agricultural practices and crop varieties



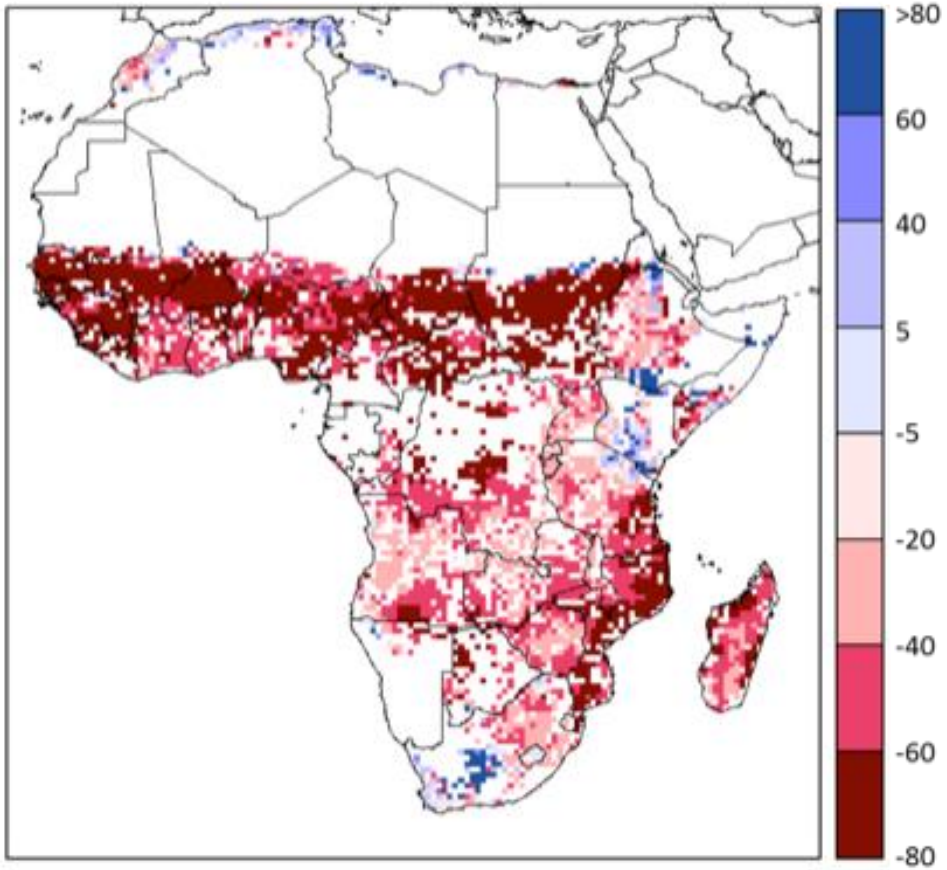
Source: http://www.fao.org/fileadmin/templates/cpesap/C-RESAP_Info_package/Links/Module_1/reduction_yields_wb.pdf

Climate Change Impacts

Maize



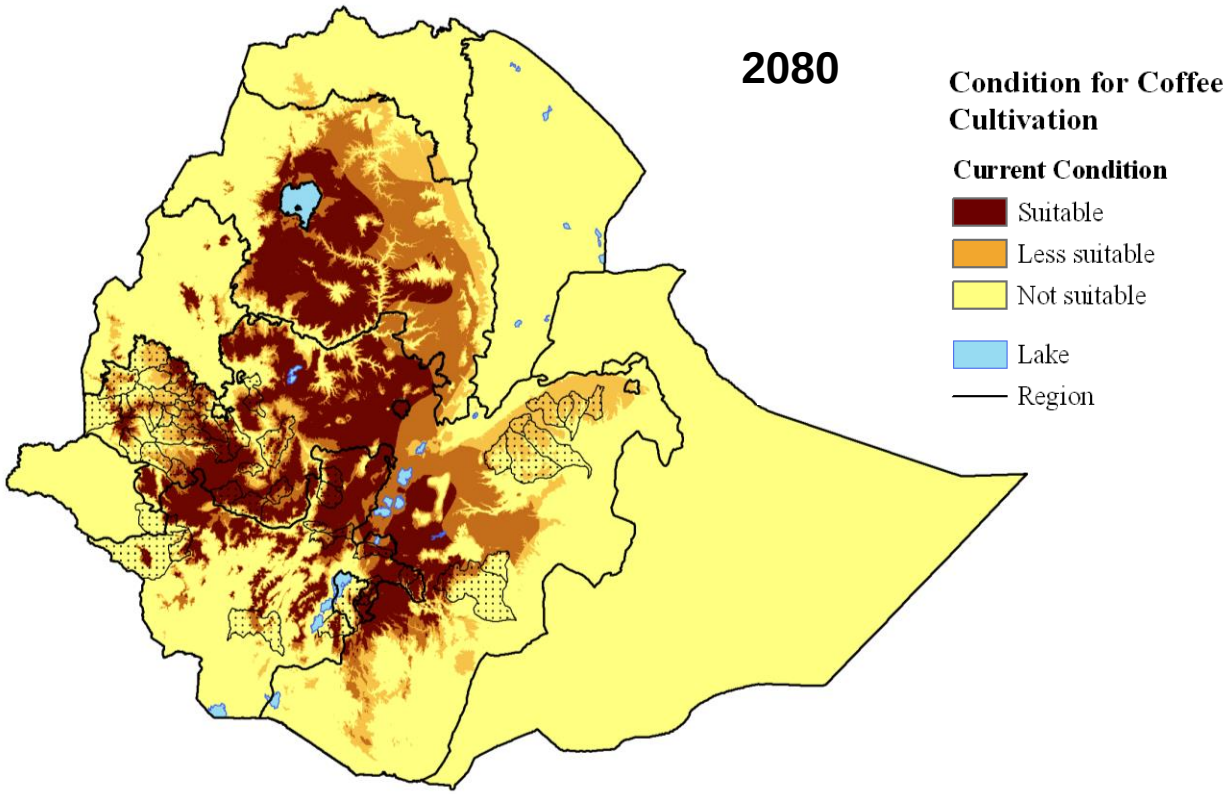
Beans



Change in production 2050 vs. 1971-2000 under RCP 8.5

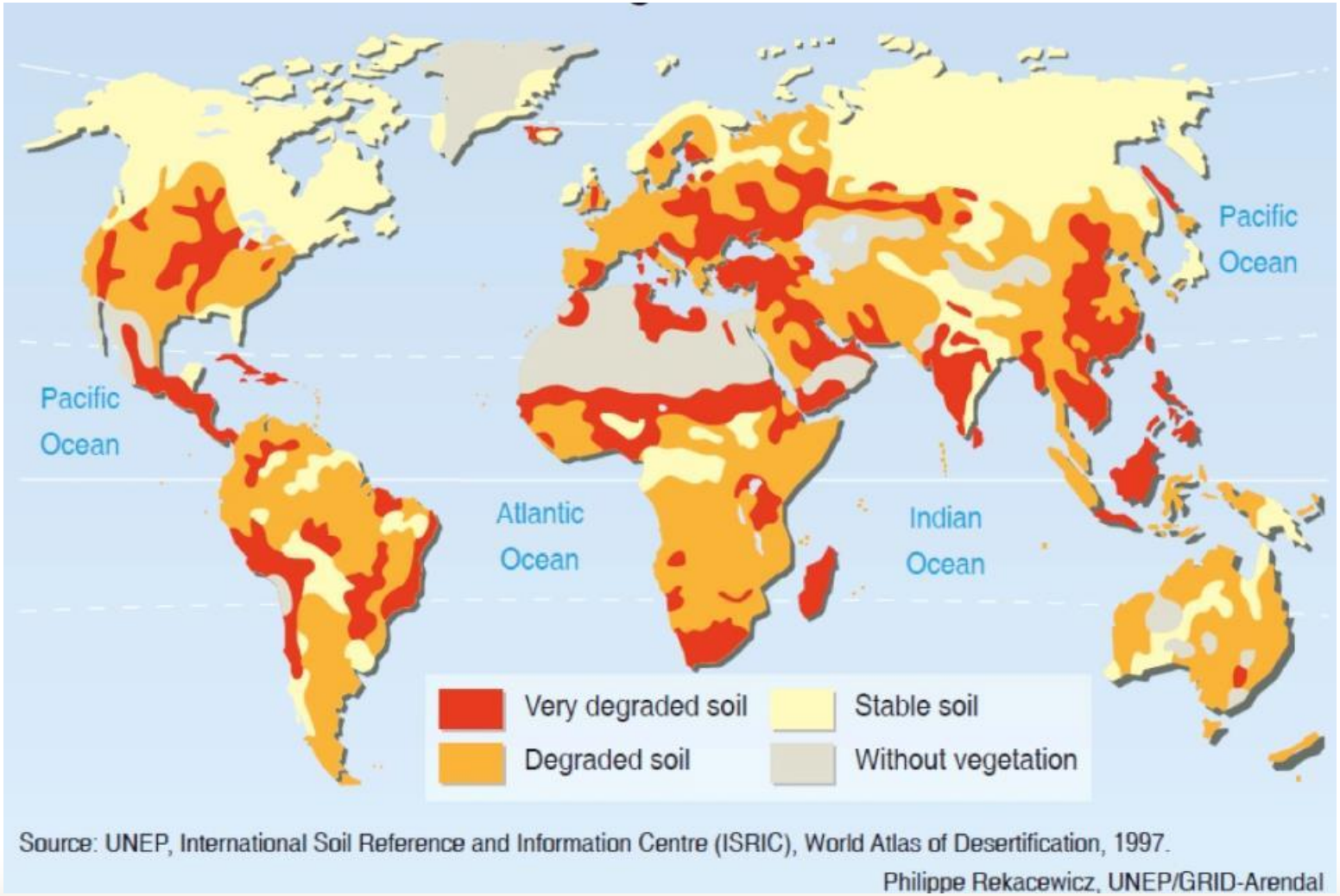
Ramirez & Thornton 2015

Example: Coffee cultivation in Ethiopia



Source: Ruegsegger 2008

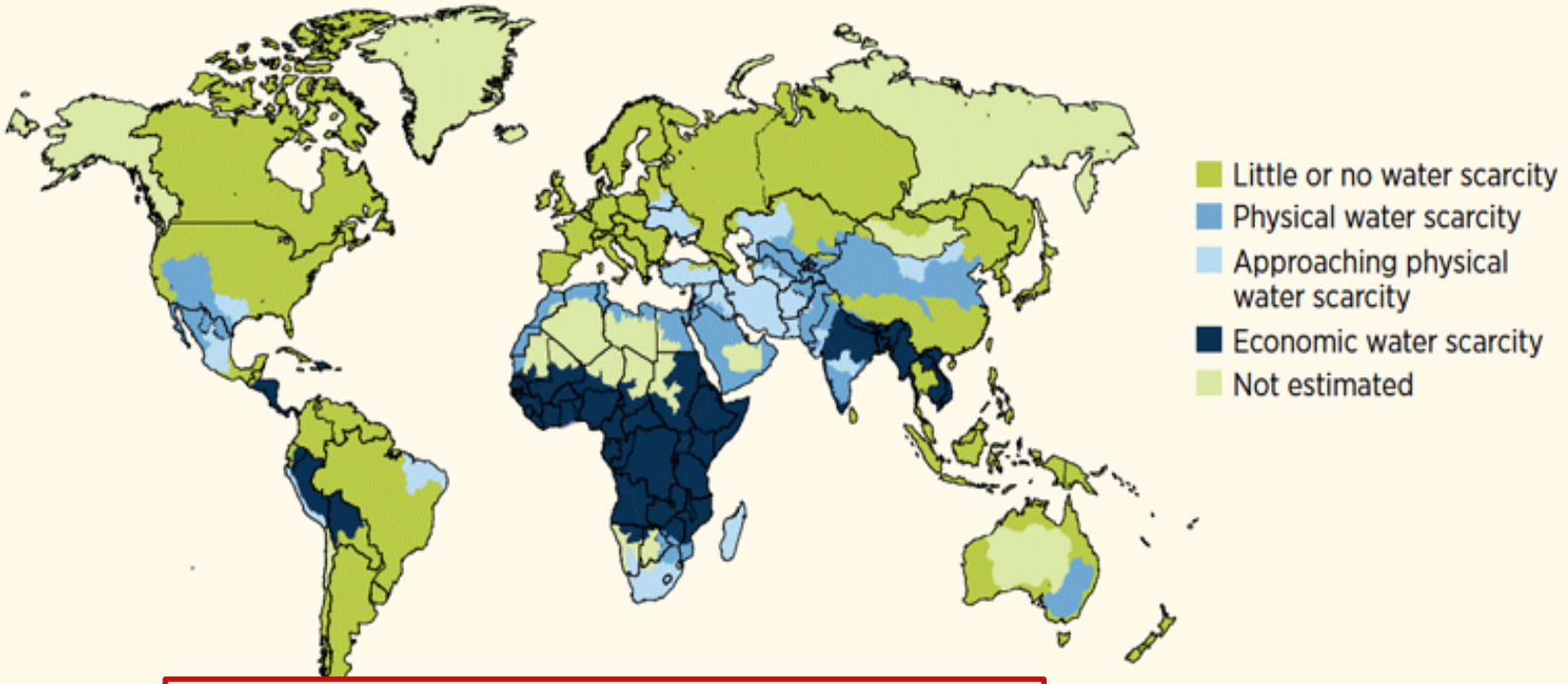
Alarming rates of land degradation



Source: UNEP, International Soil Reference and Information Centre (ISRIC), World Atlas of Desertification, 1997.

Philippe Rekacewicz, UNEP/GRID-Arendal

Global physical and economic water scarcity

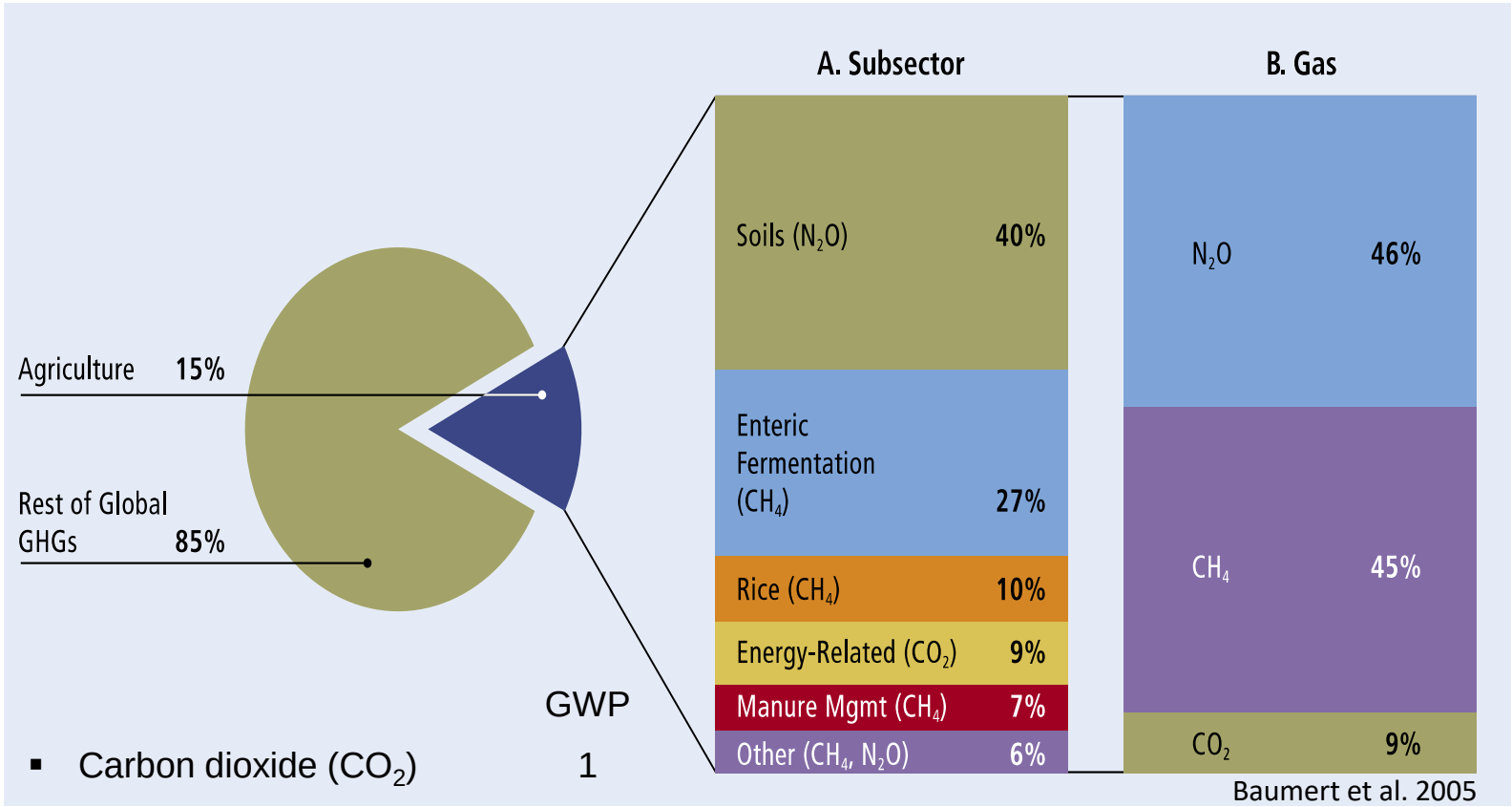


Already by 2025, 1.8 billion people will be living in countries or regions with absolute water scarcity, and two thirds of the world population could live under water stress conditions. **(UN Water, 2013)**

Source: World Water Development Report 4, World Water Assessment Programme (WWAP), March 2012

Maize sensitivity chart				
climatic stimuli	**Production phase**			
	germination	**growth/ flowering/ fruit setting**	**ripening**	**harvest**
temperature	low temperature can be harmful	High temperature decreases growth and grain yield		
rainfall	Well distributed rainfall (500 – 750 mm) required			Less water required
drought		affects grain filling		
flooding	damaging effect, but not well quantified			
salinization	good tolerance	poor tolerance		
tropical storms		hurricanes can damage crop through high wind / heavy rain		
CO_2 conc.	[little effect, as C_4 plant]			

GHG emissions in agriculture



	GWP
▪ Carbon dioxide (CO_2)	1
▪ Methane (CH_4)	21
▪ Nitrous Oxide (N_2O)	310

Ecosystems and their CO2 storage capacity

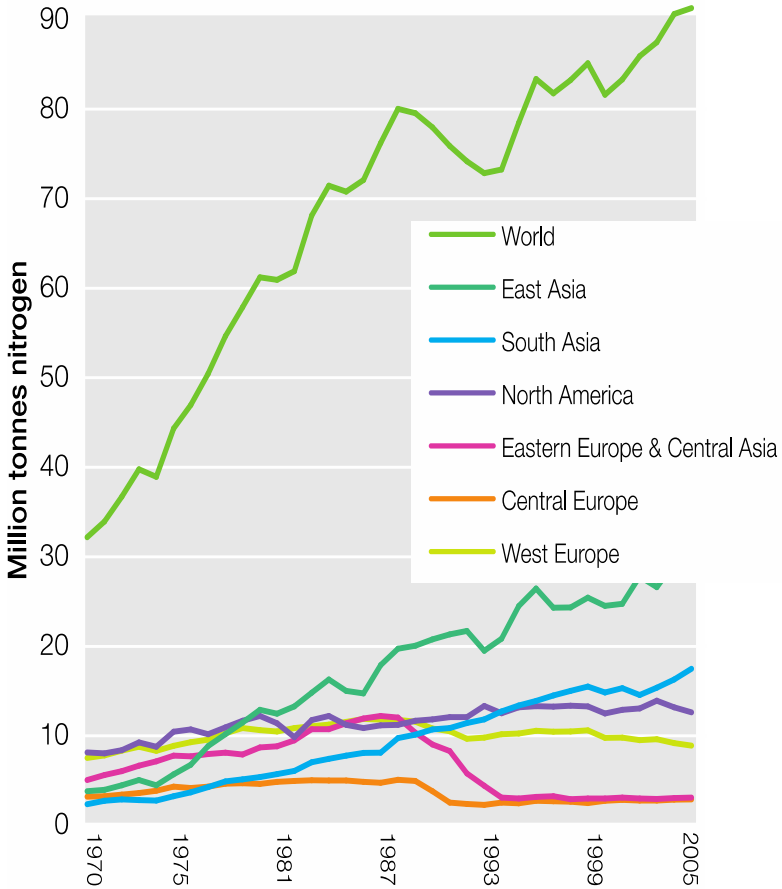
Biome	Area (M km²)	Carbon stock (Gt CO_2 eq.)	Carbon concentration (Gt CO_2-eq M km²)
Tropical forest	17,6	**1.566**	**89**
Temperate forest	10,4	582	56
Boreal forest	13,7	**2.046**	**149**
Tropical savannah	22,5	**1.208**	54
Temperate grassland	12,5	**1.113**	**89**
Desert / semi-desert	45,5	728	16
Tundra	9,5	465	49
Wetland	3,5	878	**251**
Cropland	16,0	479	30

IPCC 2001

- Not only tropical forests but also cold temperate forests and grasslands store large quantities of carbon
- Wetlands have the highest carbon concentration in their soils
- Carbon storage capacities of agricultural soils are comparatively low

Emissions from soils

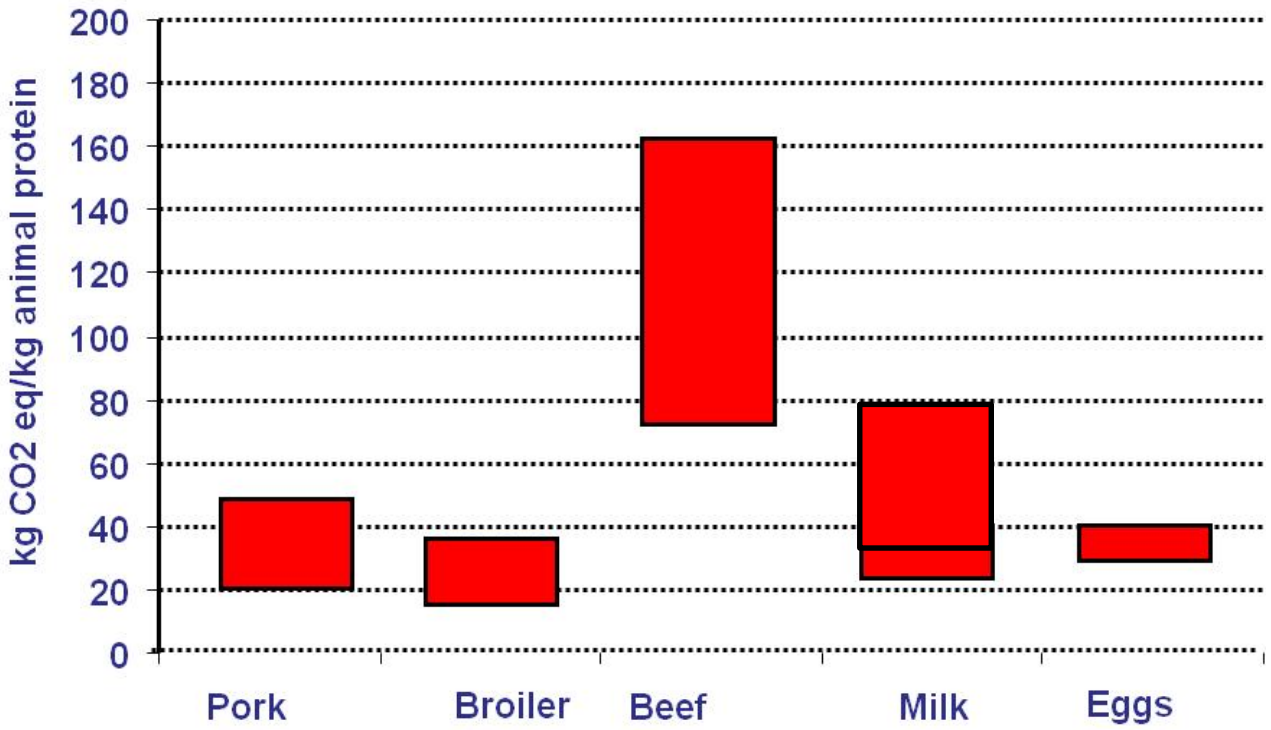
- **N_20: Consumption of synthetic nitrogen fertilizer (1970 – 2005)**
  - ✓ Global consumption of synthetic N-fertilizer has tripled (strong increase in Asia, stable or reduction in industrialized countries, stagnant in many African countries)
  - ✓ N_2O emissions through high application rates / wrong application;
  - ✓ Basic N application has positive effects on GHG-balance (productivity).
- **CO_2: Decomposition of soil organic matter (humus)**
  - ✓ Degradation of soils (intensive tillage, insufficient input of organic matter, erosion).
  - ✓ Land-use changes.



Quelle: Bellarby et al. 2008, IFA Statistik

Livestock produces GHGs from different sources

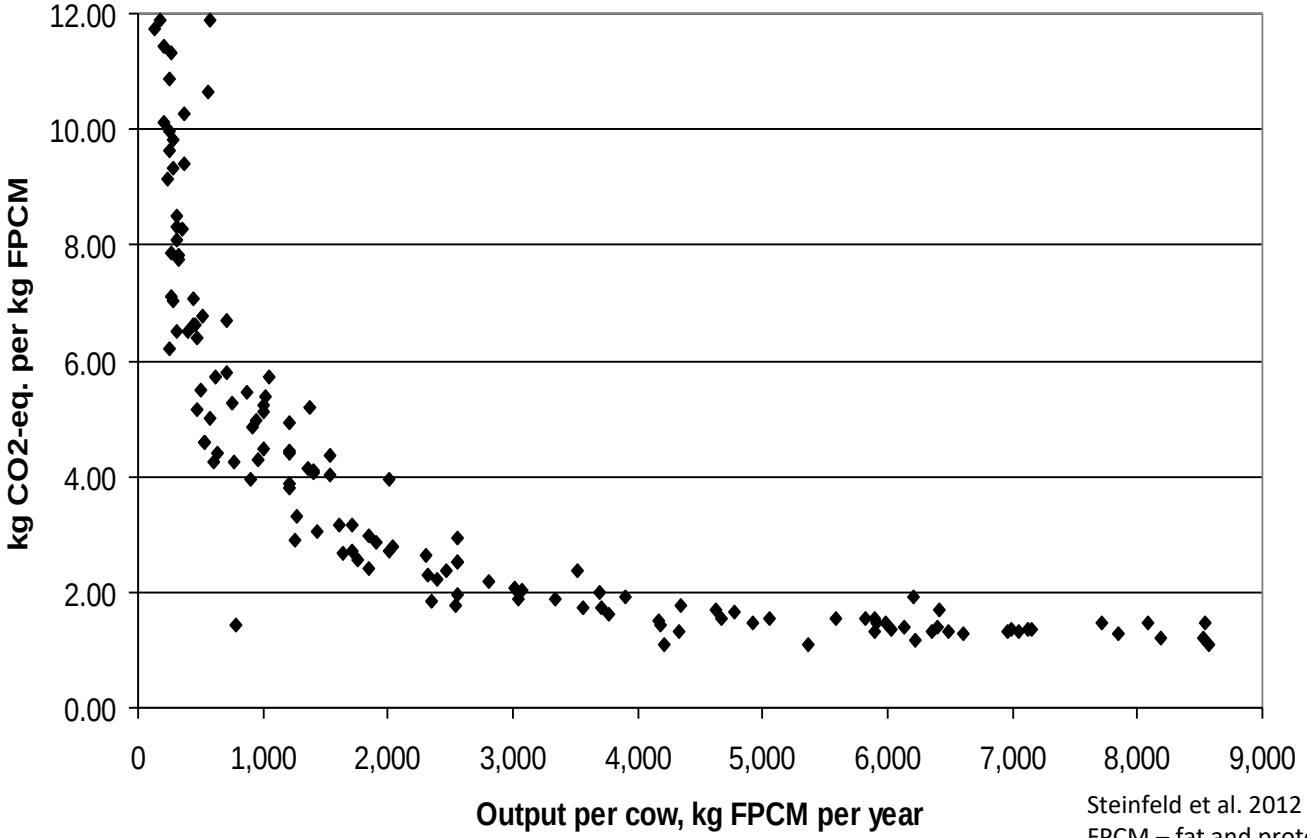
- Direct CH4 emissions through ruminants (cattle 75 Mt CH4, sheep/goats 9 Mt);
- Increasing meat consumption causes extension of fodder and grazing areas often by transforming forests and wetlands;
- 73% of the world‘s grazing areas are degraded



Global emission intensities by commodity

Methane emissions per kg milk as related to milk production per cow

- Extensive cattle rearing with low productivity (especially milk) produces high GHG emissions per unit milk;
- On the other side extensive livestock systems are the only use option for semi-dry areas and livelihood of many (agro-)pastoralists



Steinfeld et al. 2012
FPCM – fat and protein corrected milk

Potentials

What are incentives for adaptation and mitigation of climate change?

"The Economics of Climate Change" by Sir Nicolas Stern (London School of Economics)

700 page report (2006) to the British Government

Main conclusion:

"Benefits of strong, early action on climate change far outweigh the costs of not acting"

The Challenge:

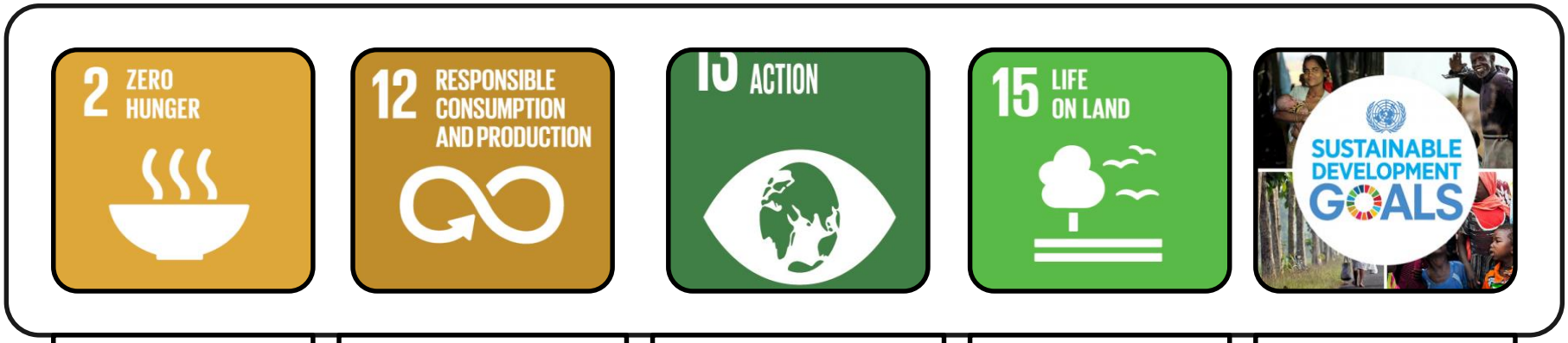
"by 2050, we need to…

1. *Double world food production on ~ the same amount of land*

2. *Make farms, fields and landscapes more resistant to extreme weather, while…*

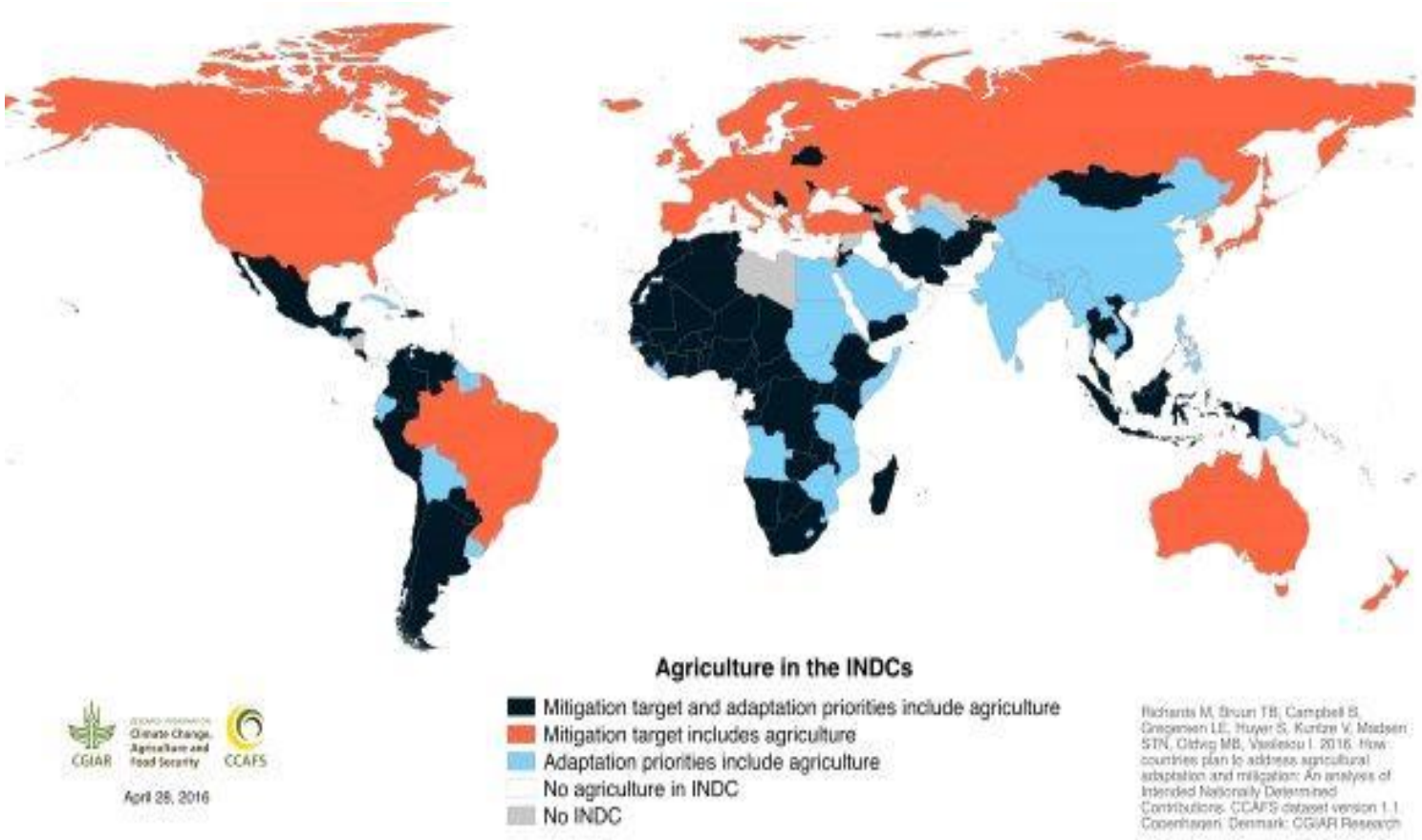
3. *… massively reducing GHG emissions."*

Agenda 2030 and Paris Agreement



SDG 2: Zero Hunger	SDG 12: Responsible Consumption & Production	SDG 13: Climate Action	SDG 15: Life on Land	Integrated Approach including all SDGs

The global framework: Agriculture & (I)NDCs



Source: CGIAR/CCAFS 2016

Mitigation options in agriculture and land use

- Sequestration of atmospheric CO2 in soils and vegetation (tree planting, humus build up)
- Reduction of direct emissions through improved management:
  - ✓ Reduced emissions from fertilizer application, soil degradation, livestock keeping and rice cultivation, biomass burning
  - ✓ Planned land use change
  - ✓ Reduce post harvest losses and food wastage,
- Indirect measures to reduce emissions
  - ✓ Reduce population growth
  - ✓ Use climate-sensitive diets i.e. reduced meat consumption

Using Synergies between Adaptation and Mitigation in Agriculture to Combat Climate Change

Adaptation in Agriculture - a multidimensional and multi-level process to increase resilience and improve livelihood of farmers

Farm-level

- Improved crop management (crop varieties, diversification)
- Improved nutrient, soil and water management (organic and mineral fertilizer, improved water use efficiency, reduced tillage, mulching, soil and water conservation, etc.)
- Livestock management (e.g. breeds and herd composition, improved feeding, animal health)
- Reducing post-harvest losses

Adaptation in Agriculture – a multidimensional and multi-level process

Community level

- Soil and water conservation on communal land
- Agro-biodiversity and biodiversity management
- Land-use regulation
- Supporting farmers‘ organisation
- Gender equity and women‘s rights
- Livelihood diversification (off-farm income)
- Improved processing and marketing

Adaptation in Agriculture – a multidimensional and multi-level process

Public level

- Improved weather forecasts
- Landscape planning
- Biodiversity management
- Crop insurance systems
- Supportive policy, legal and regulation instruments
- Financial instruments (e.g. NAIPs, credit schemes, NEPAD Climate Change Fund, GCF)

Thank you for your attention !!!!