Climate Change Policy and Governance

…with a focus on land sector

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iPROMO

2/10/2019

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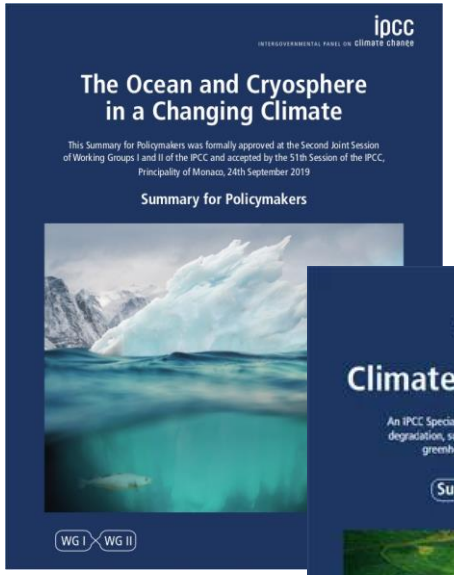
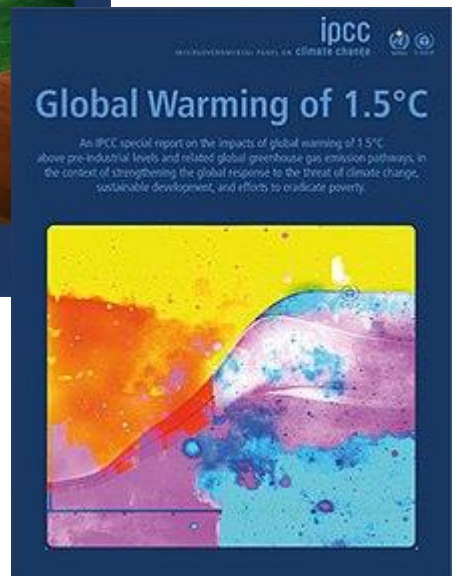
sui Cambiamenti Climatici

SCIENTIFIC EVIDENCE OF SEVERE IMPACTS ON MOUNTAIN AREAS

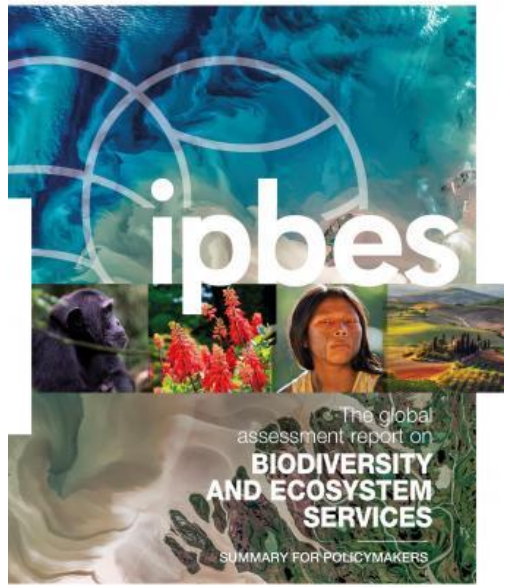


IPCC 2019

IPCC 2018



IPCC 2018

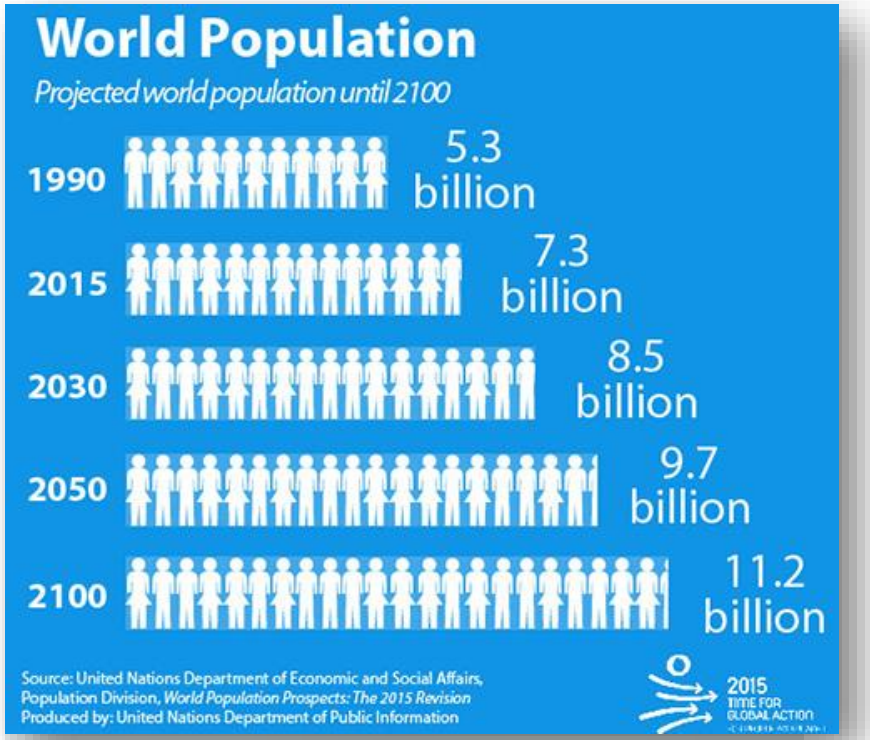


IPBES 2019

CONTEXT

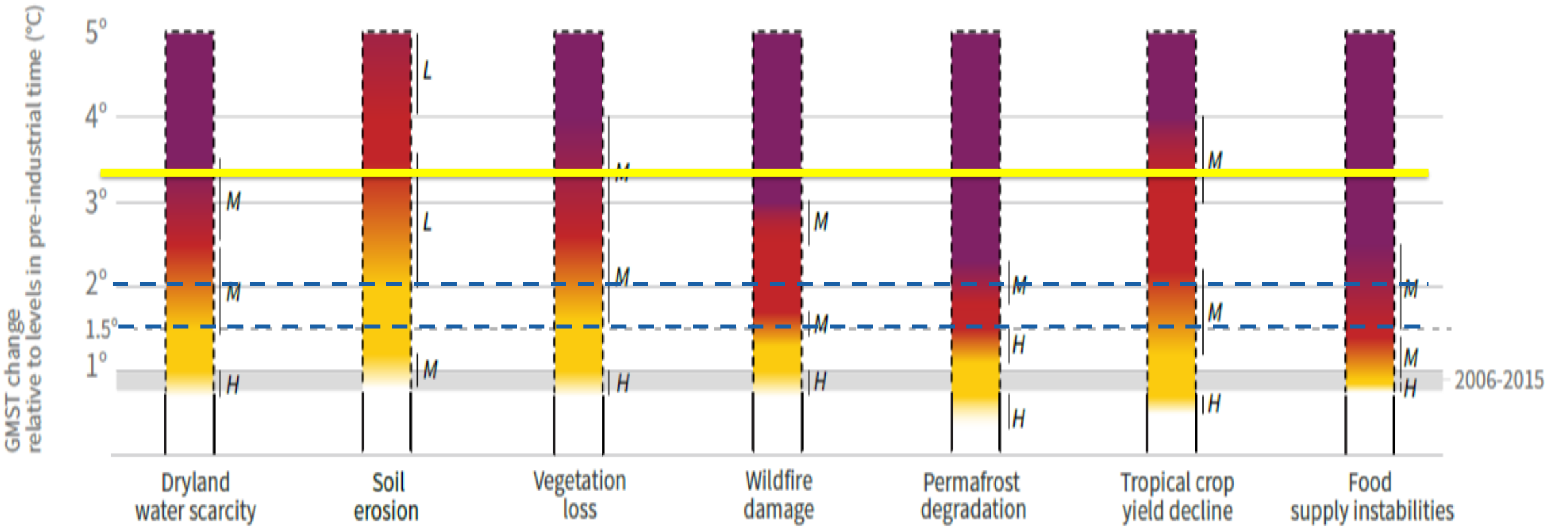
- **Unprecedented overexploitation of natural resources in human history**

- **70% of the global ice-free land surface is affected by human use**.
- **Croplands cover 12–14%**
- **Since 1961:**
  - Per capita **consumption of vegetable oils and meat x2**
  - Use of **inorganic nitrogen fertiliser x9**,
  - **Water for irrigation x2**
  - Human use, at varying intensities, **affects about 60–85% of forests** and **70–90% of other natural ecosystems** (e.g., savannahs, natural grasslands)
  - Land use caused global **biodiversity to decrease by around 11–14%**



Source: IPCC SRCCL 2019

Risks to humans and ecosystems from changes in land-based processes



Purple very high probability of severe impacts/risks persiistence of climate hazards limited ability to adapt

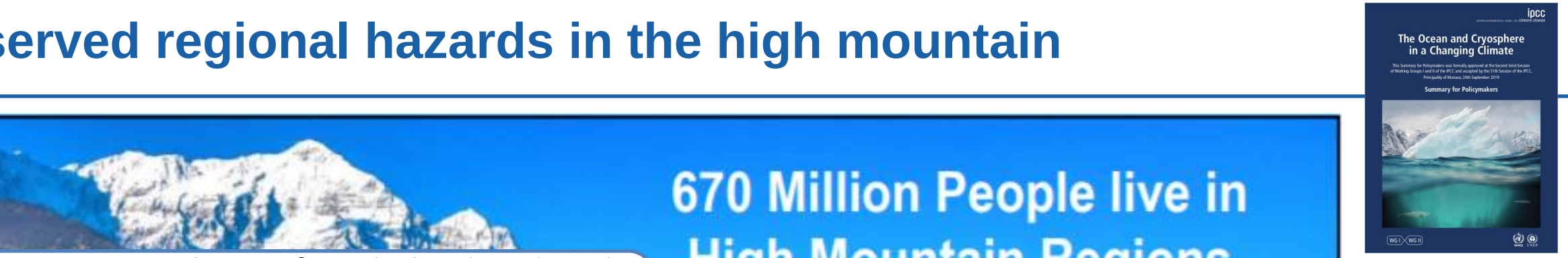
Red: significant and widespread impacts/risks

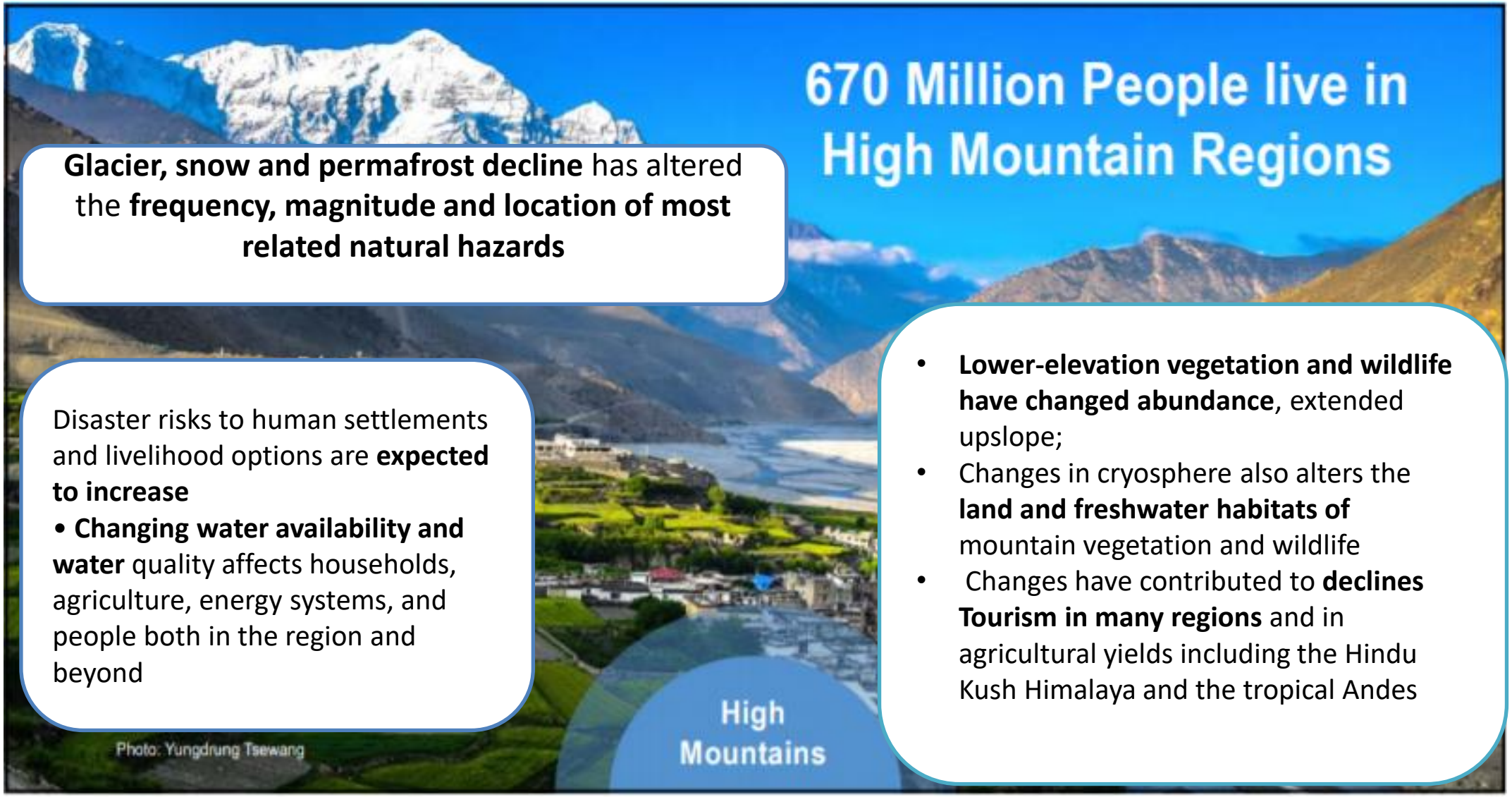
Yellow: Impacts&/risks are detectable and attributable to cc

White: impacts/risks are undetectable

Source: IPCC SRCCL 2019

Observed regional hazards in the high mountain





Glacier, snow and permafrost decline has altered the **frequency, magnitude and location of most related natural hazards**

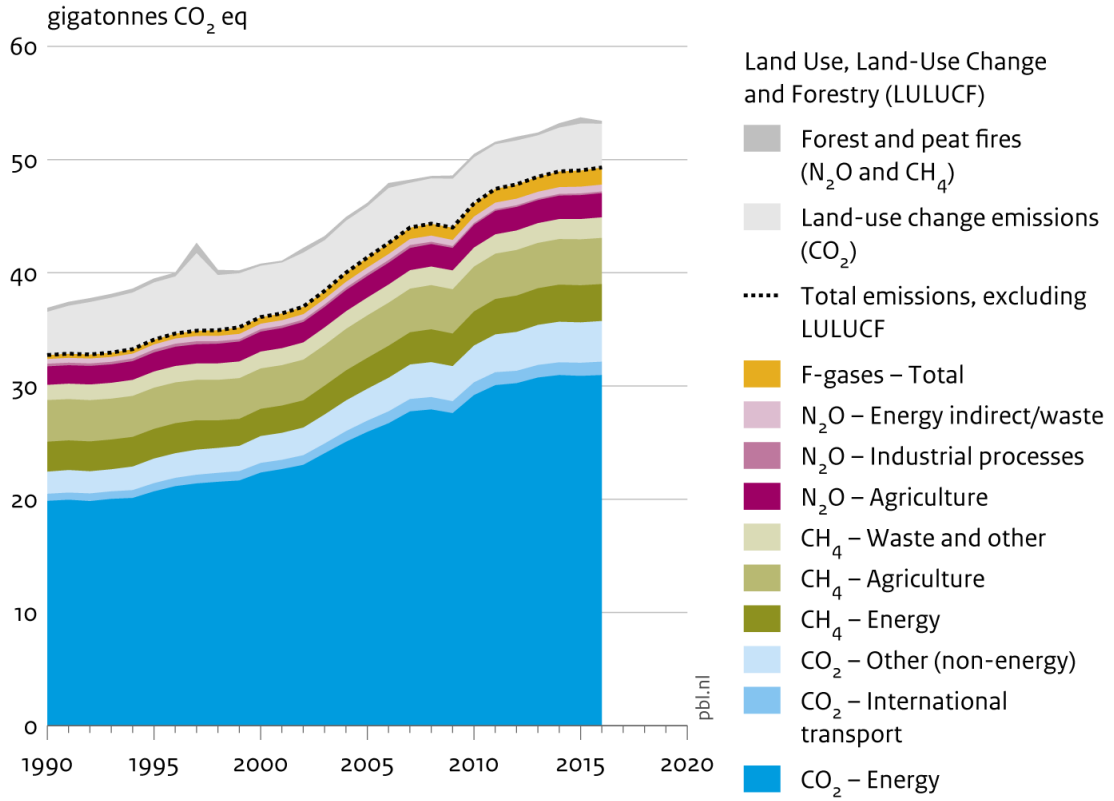
Disaster risks to human settlements and livelihood options are **expected to increase**

• **Changing water availability and water** quality affects households, agriculture, energy systems, and people both in the region and beyond

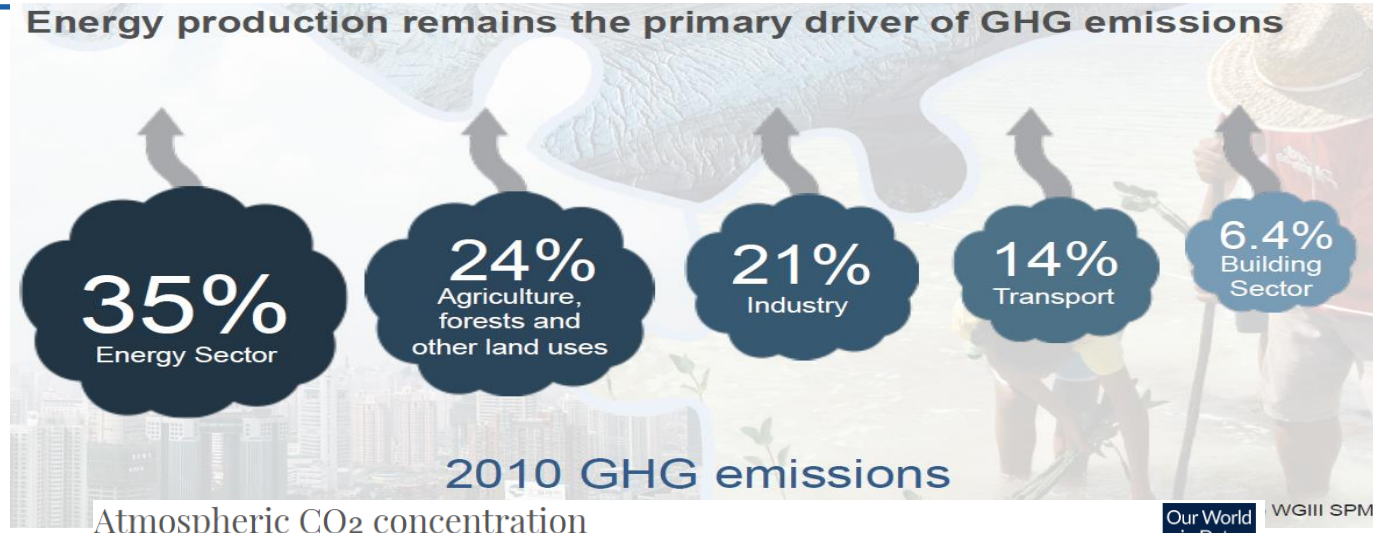
- **Lower-elevation vegetation and wildlife have changed abundance**, extended upslope;
- Changes in cryosphere also alters the **land and freshwater habitats of** mountain vegetation and wildlife
- Changes have contributed to **declines Tourism in many regions** and in agricultural yields including the Hindu Kush Himalaya and the tropical Andes

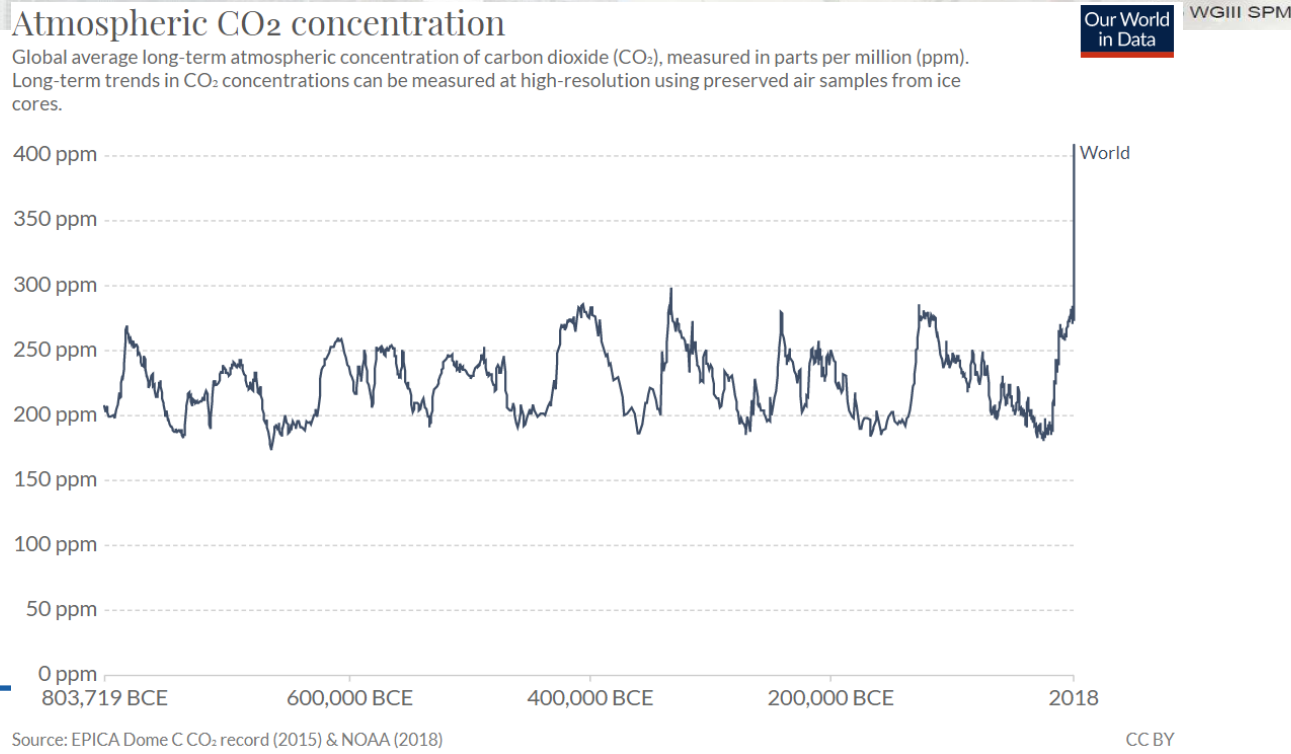
Sources of GHG concentrations in the atmosphere

Global greenhouse gas emissions, per type of gas and source, including LULUCF

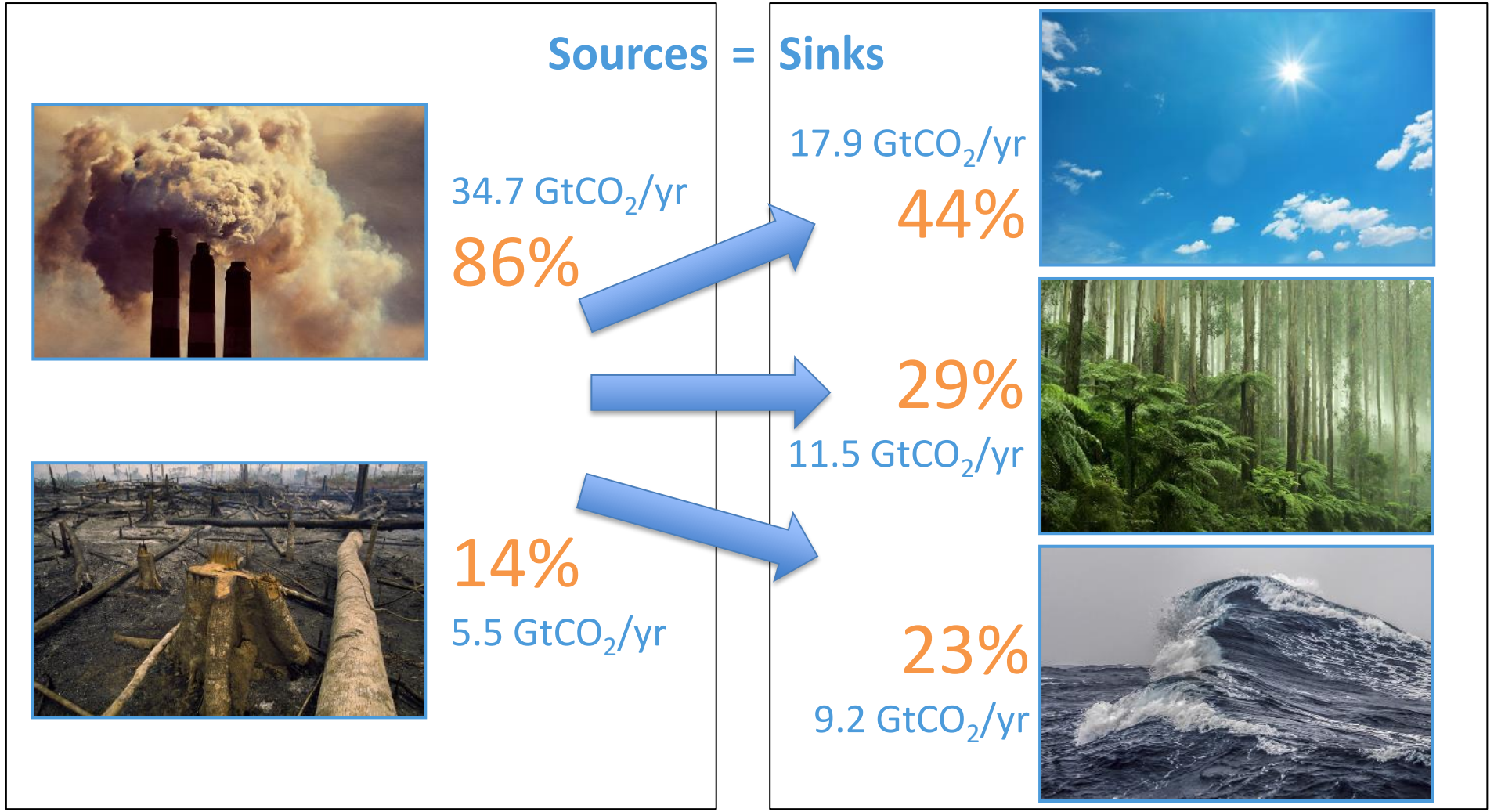


Source: EDGAR v4.3.2 (EC-JRC/PBL 2017); Houghton and Nassikas (2017); GFED 4.1s (2017)





Fate of anthropogenic CO_2 emissions (2009–2018)

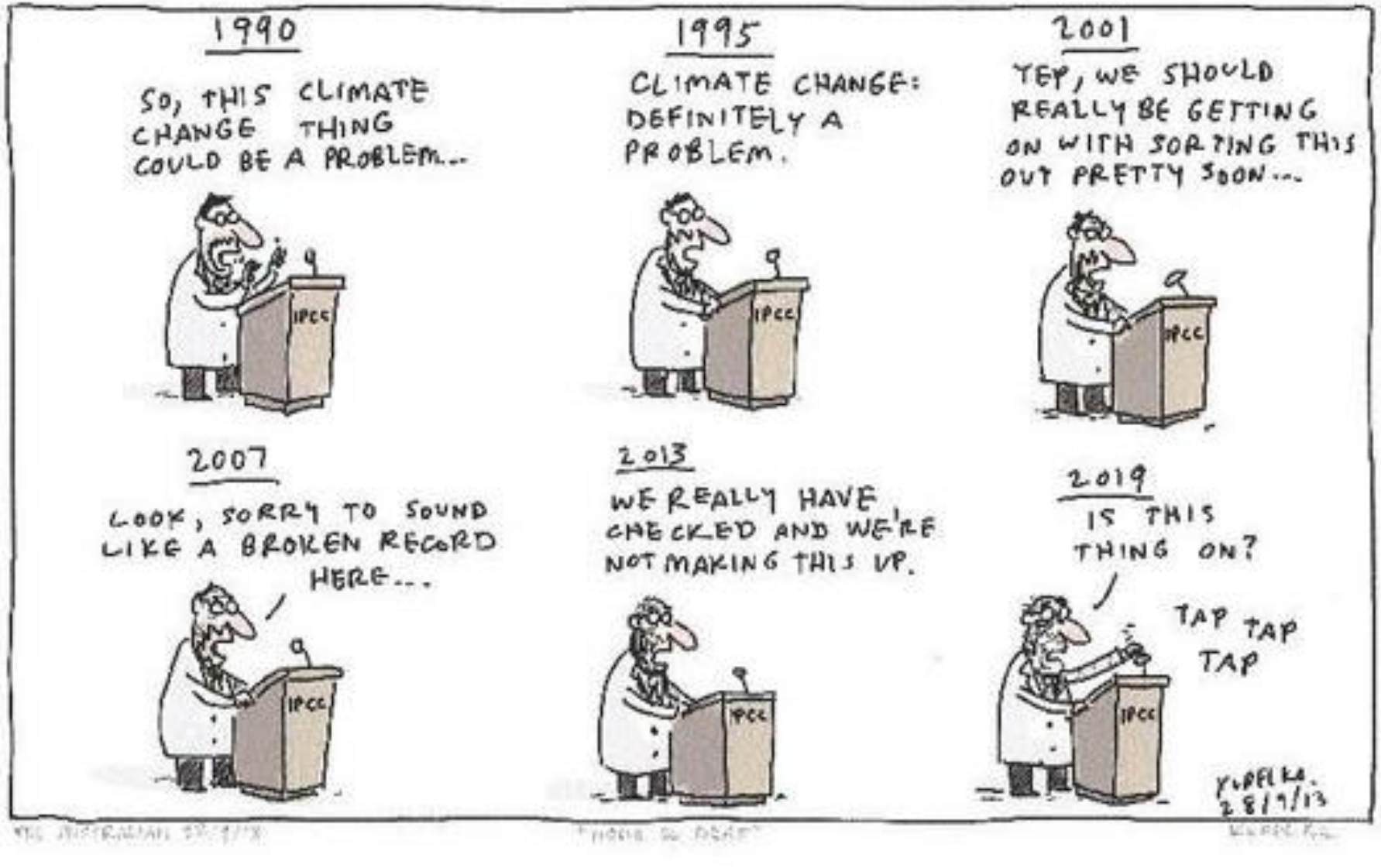


Budget Imbalance:
(the difference between estimated sources & sinks)

4%
1.6 $GtCO_2$/yr

Source: CDIAC; NOAA-ESRL; Houghton and Nassikas 2017; Hansis et al 2015; Friedlingstein et al 2019; Global Carbon Budget 2019

From science to action



MILESTONE	YEAR	IMPORTANCE
First World Climate Conference	1979	Lays the foundation for some international climate programmes including the Intergovernmental Panel on Climate Change (IPCC)
IPCC's First assessment report	1990	Provides the first estimates of confidence about the extent of global climate change and the human influences behind it
UN Framework Convention on Climate Change (UNFCCC) signed	1992	A major international climate change treaty representing worldwide agreement that action is needed against climate change
UNFCCC enters into force	1994	Countries signing the UNFCCC are now bound by its rules.
First Conference of the Parties (COP) of the UNFCCC	1995	The first of the (generally annual) international negotiations on climate change stipulated by the UNFCCC, leading to the Kyoto Protocol
Kyoto Protocol signed	1997	Thirty-seven developed nations and economies in transition commit to reducing their emissions by at least five per cent below 1990 levels from 2008-2012
Kyoto Protocol enters into force	2005	Countries with greenhouse gas reduction targets are now committed to them
IPCC's Fifth assessment report	2013-2014	Follows reports in 1995, 2001 and 2007. Makes strong statements about the high likelihood of human influence on the global climate and the consequent impacts
Twenty-first UNFCCC COP in Paris	2015	The meeting is aiming for an agreement to succeed the Kyoto Protocol

UNFCCC

KYOTO PROTOCOL 16 FEBRUARY 2005

DOHA 2012 UN CLIMATE CHANGE CONFERENCE COP18|CMP8

United Nations Climate Change Conference COP18/CMP8 Doha, Qatar

PARIS2015 UN CLIMATE CHANGE CONFERENCE COP21·CMP11

International context: Kyoto Protocol 2 - 2013-20

- Lentght **2013-2020** (8 years)
- Not signing: Canada, Russia, NZ, Japan and USA
- Target review in 2014 (reach 25-40% reduction)
- Entry into force: **ratification of 144 Parties on 194 (44 to date excluding EU)**

KYOTO PROTOCOL 16 FEBRUARY 2005

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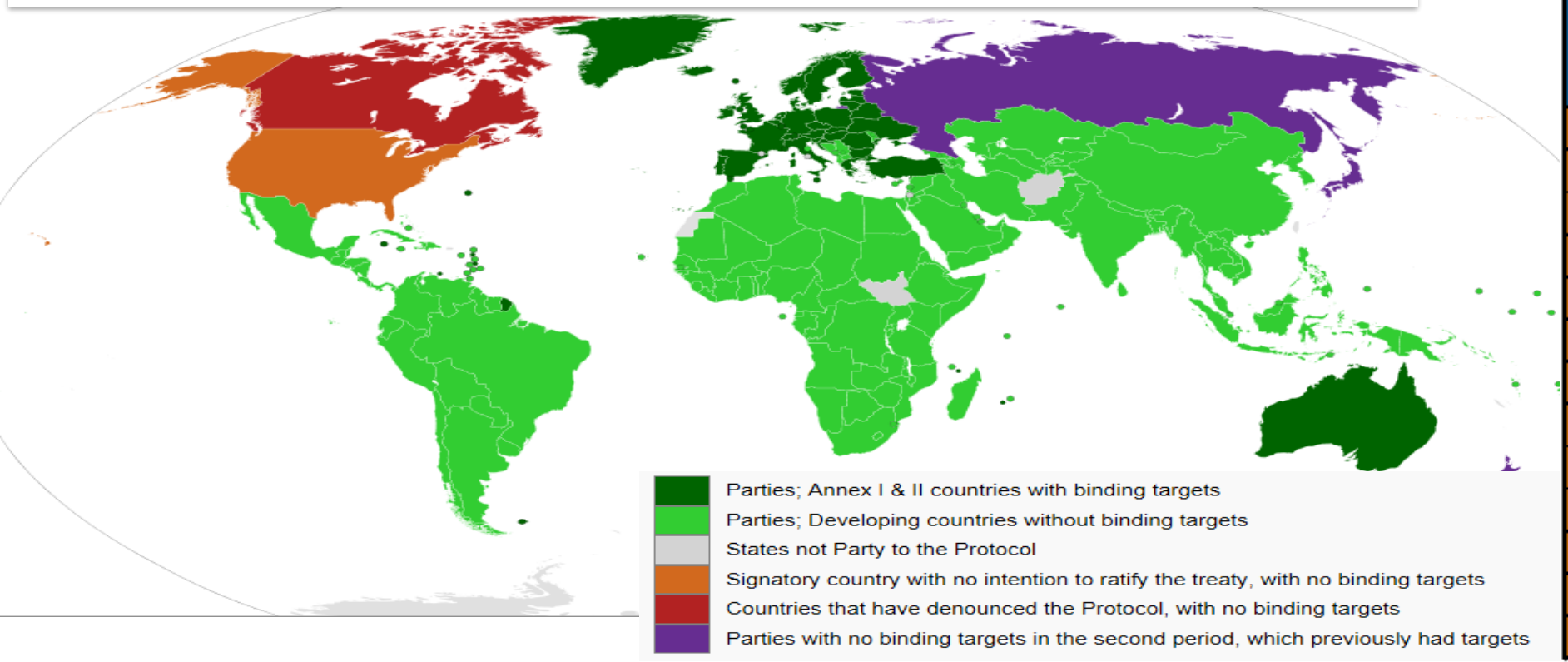
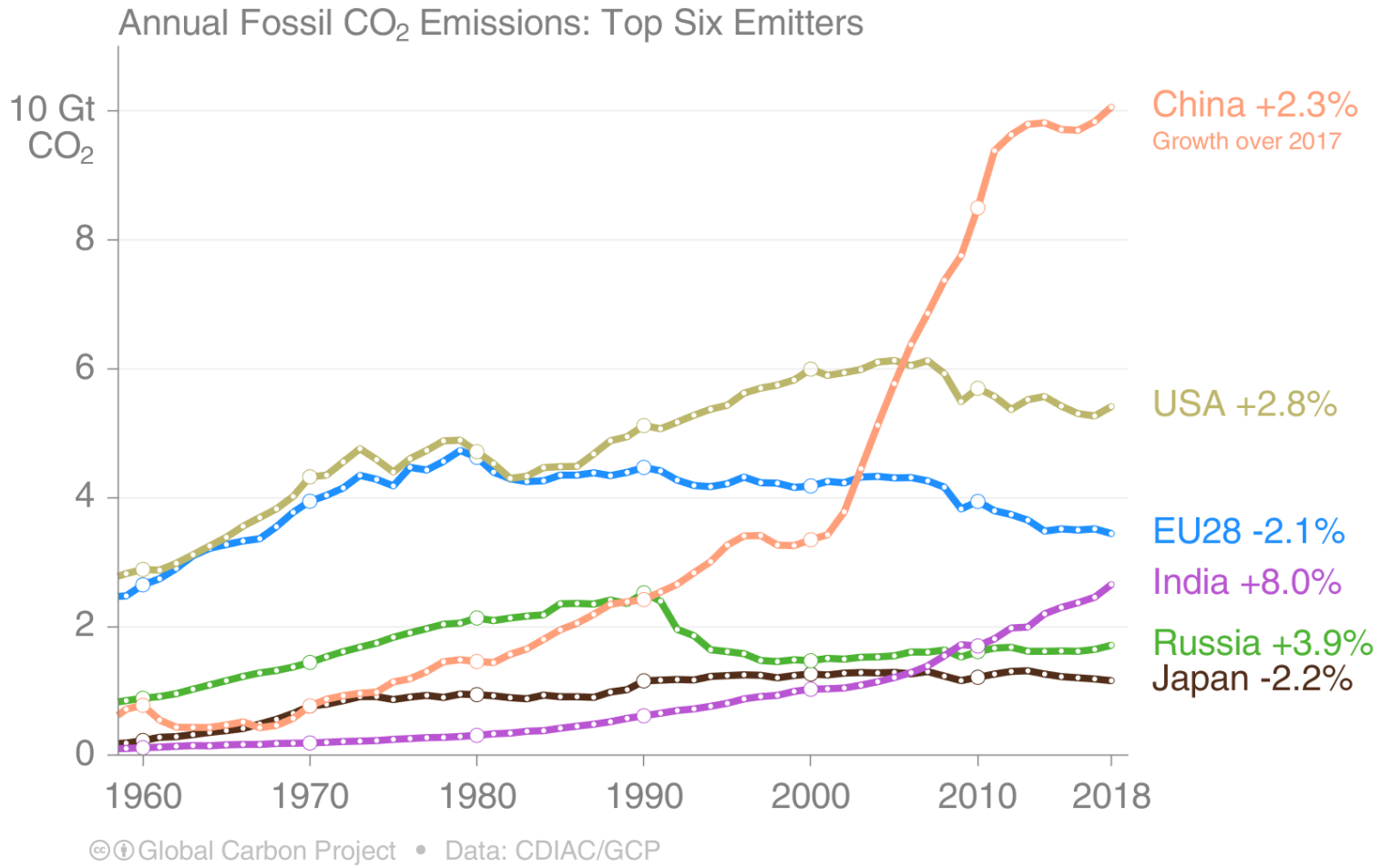


Country	Commitment KP-CP2 pledged by countries (2013-2020) compared to base year
Australia	-0.5%
Belarus[2]	-12%
Croatia[3]	-20%
EU-27[4]	-20%
Iceland[3]	-20%
Kazakhstan[2]	-5%
Liechtenstein	-16%
Monaco	-22%
Norway	-16%
Switzerland	-15.8%
Ukraine	-24%
TOTAL	**-18%**
TOTAL excl. EIT[5]	**-18%**

Top emitters: Fossil CO_2 Emissions

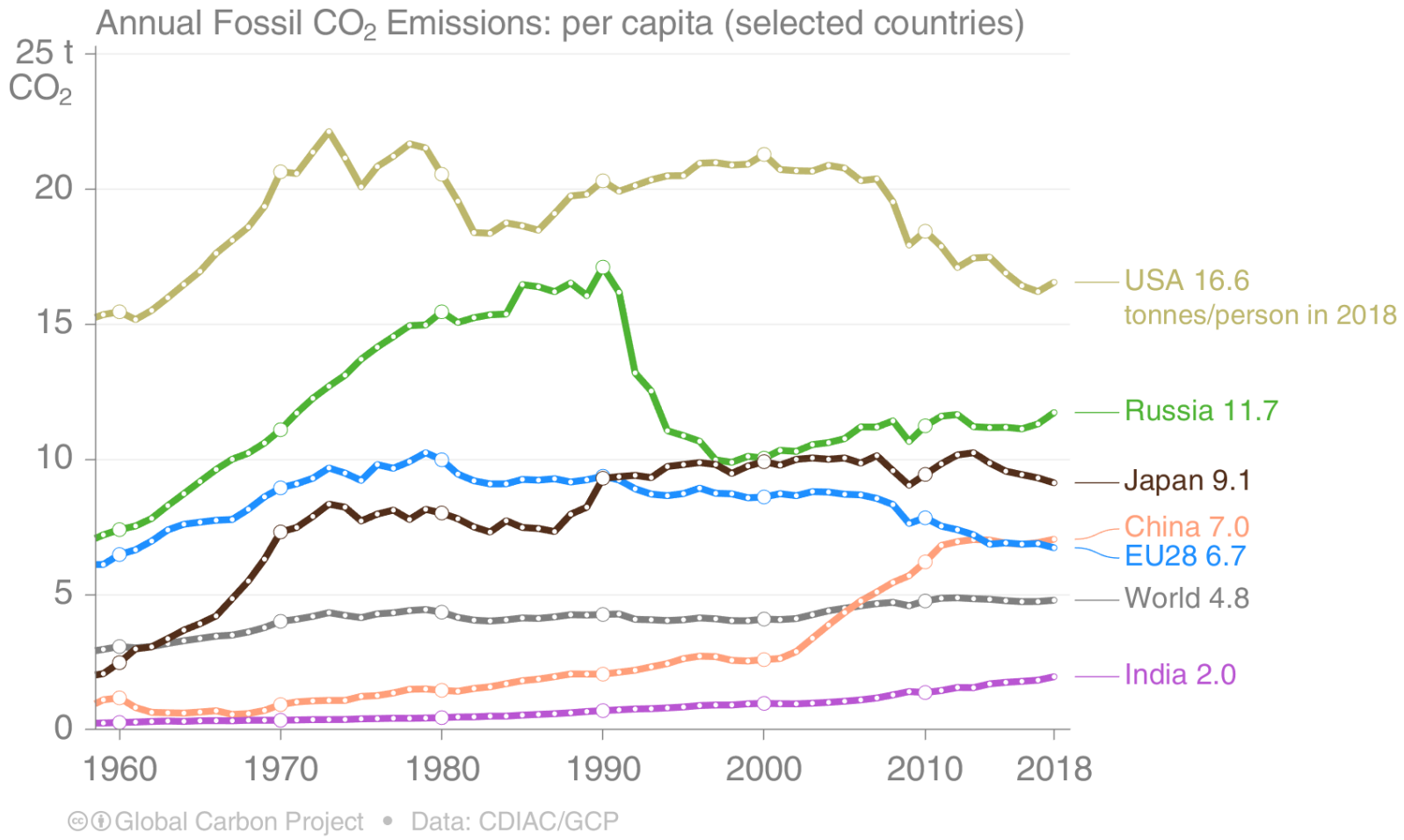
The top six emitters in 2018 covered 67% of global emissions
China 28%, United States 15%, EU28 9%, India 7%, Russia 5%, and Japan 3%



Bunker fuels, used for international transport, are 3.4% of global emissions.
Source: CDIAC; Peters et al 2019; Friedlingstein et al 2019; Global Carbon Budget 2019

Top emitters: Fossil CO_2 Emissions per capita

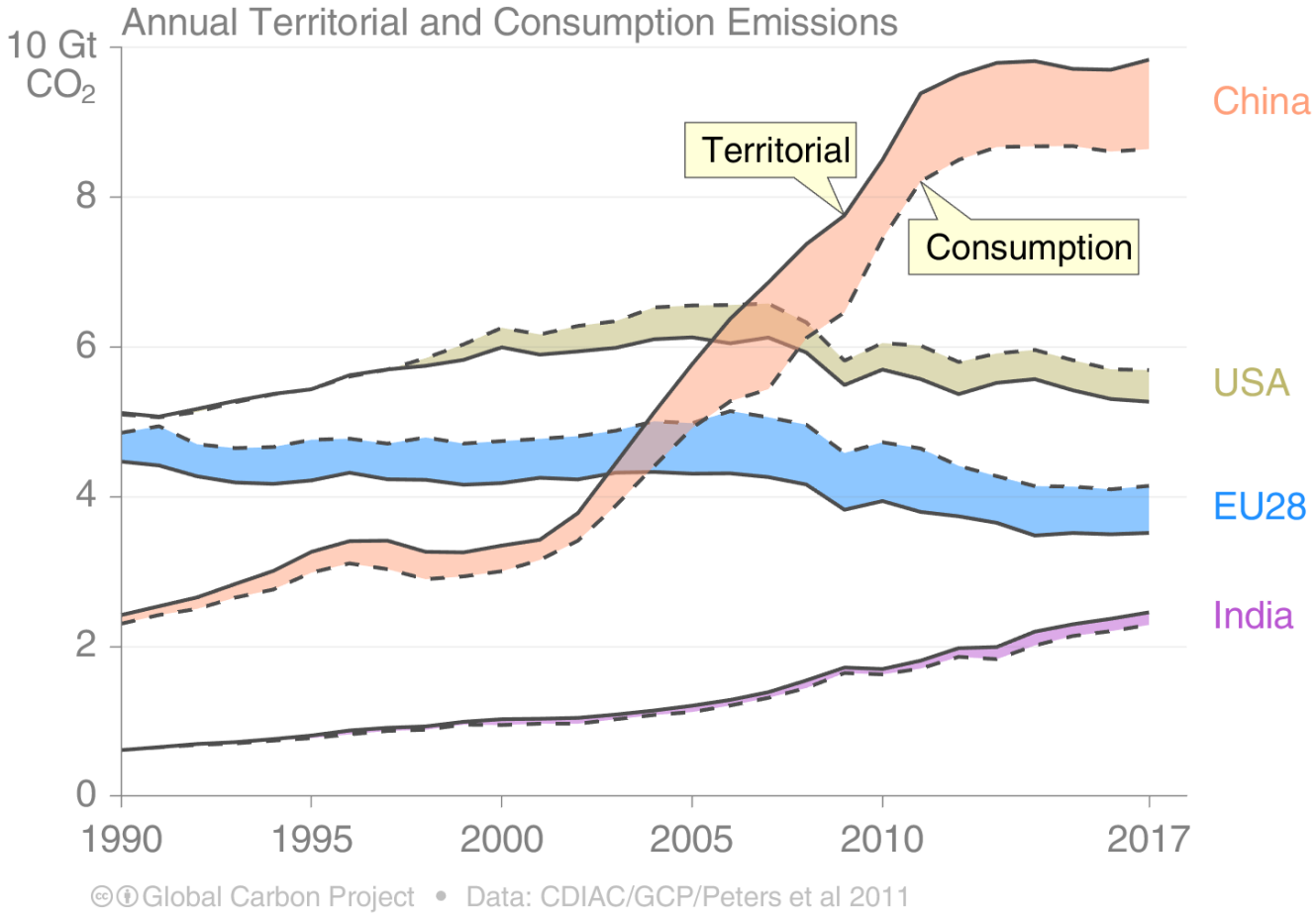
Countries have a broad range of per capita emissions reflecting their national circumstances



Source: CDIAC; Friedlingstein et al 2019; Global Carbon Budget 2019

Consumption-based emissions (carbon footprint)

Allocating fossil CO_2 emissions to consumption provides an alternative perspective.
USA and EU28 are net importers of embodied emissions, China and India are net exporters.



Consumption-based emissions are calculated by adjusting the standard production-based emissions to account for international trade

Source: Peters et al 2011; Friedlingstein et al 2019; Global Carbon Project 2019

Whose fault is it?

UNFCCC principle: "Common but differentiated responsibilities and respective capabilities, in the light of different national circumstances"

The **G20** countries are responsible for around 80% of global GHG emissions and 85% of the world GDP

PARIS AGREEMENT

To this date, 189 Parties have ratified of 197 Parties to the Convention

The Paris Agreement entered into force on 4 November 2016

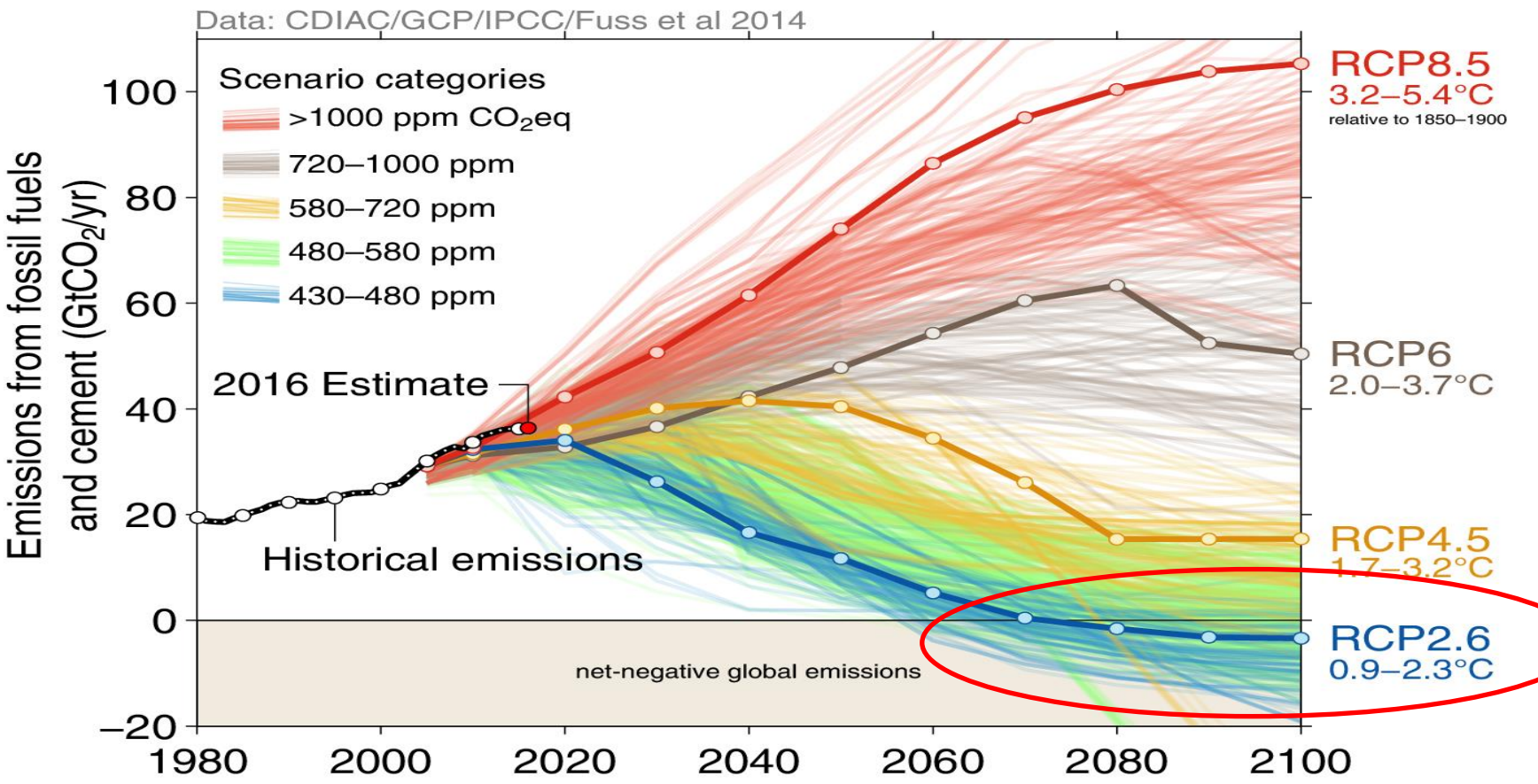
Effective on the 4th of November

PARIS AGREEMENT

Mitigation – long term objective: hold the increase in T below 2°C [1.5°C]

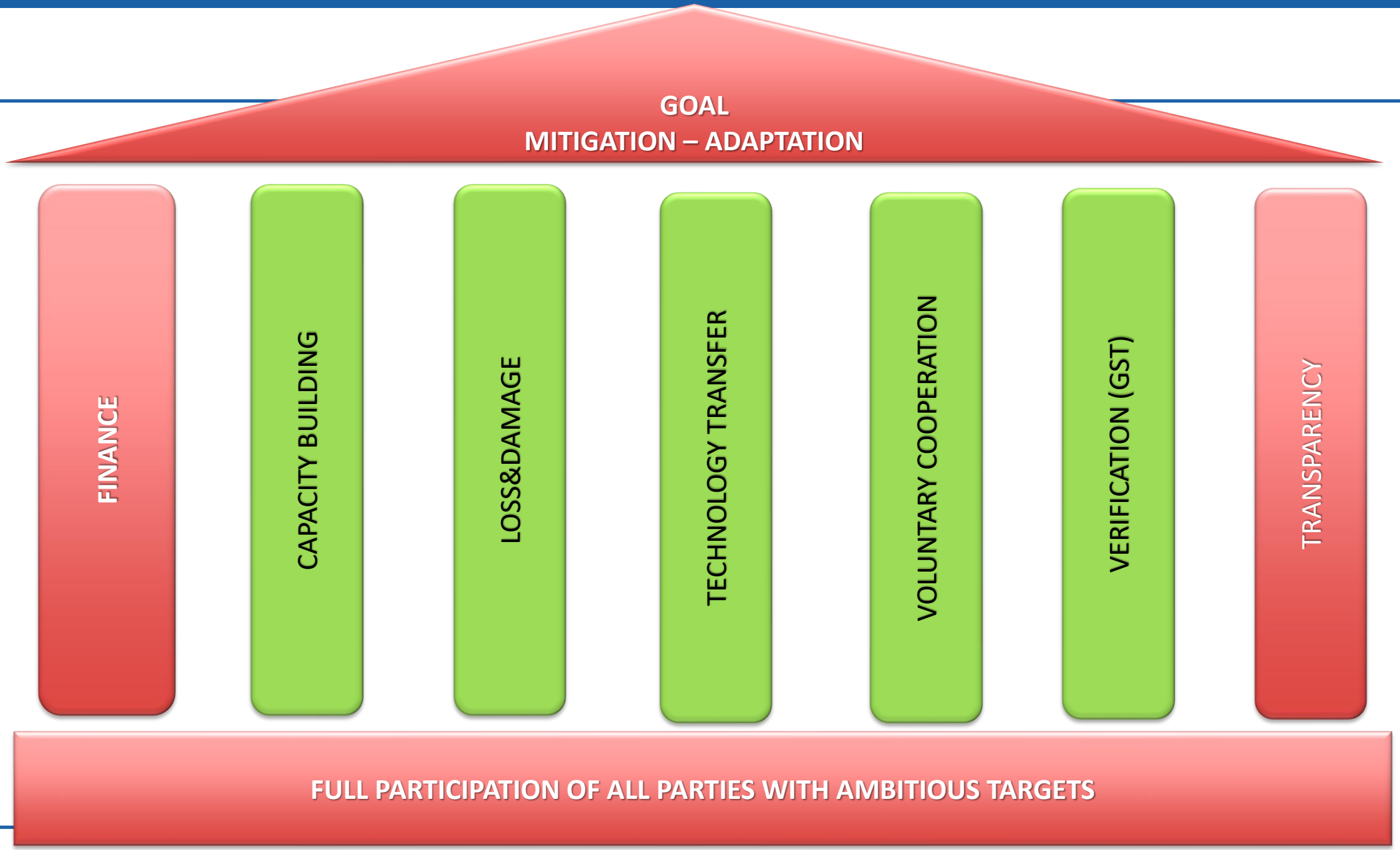
Adaptation – Increase the adapting capacity to climate change

Finance - ensure funds in line with the pathway towards a low carbon and resilient development

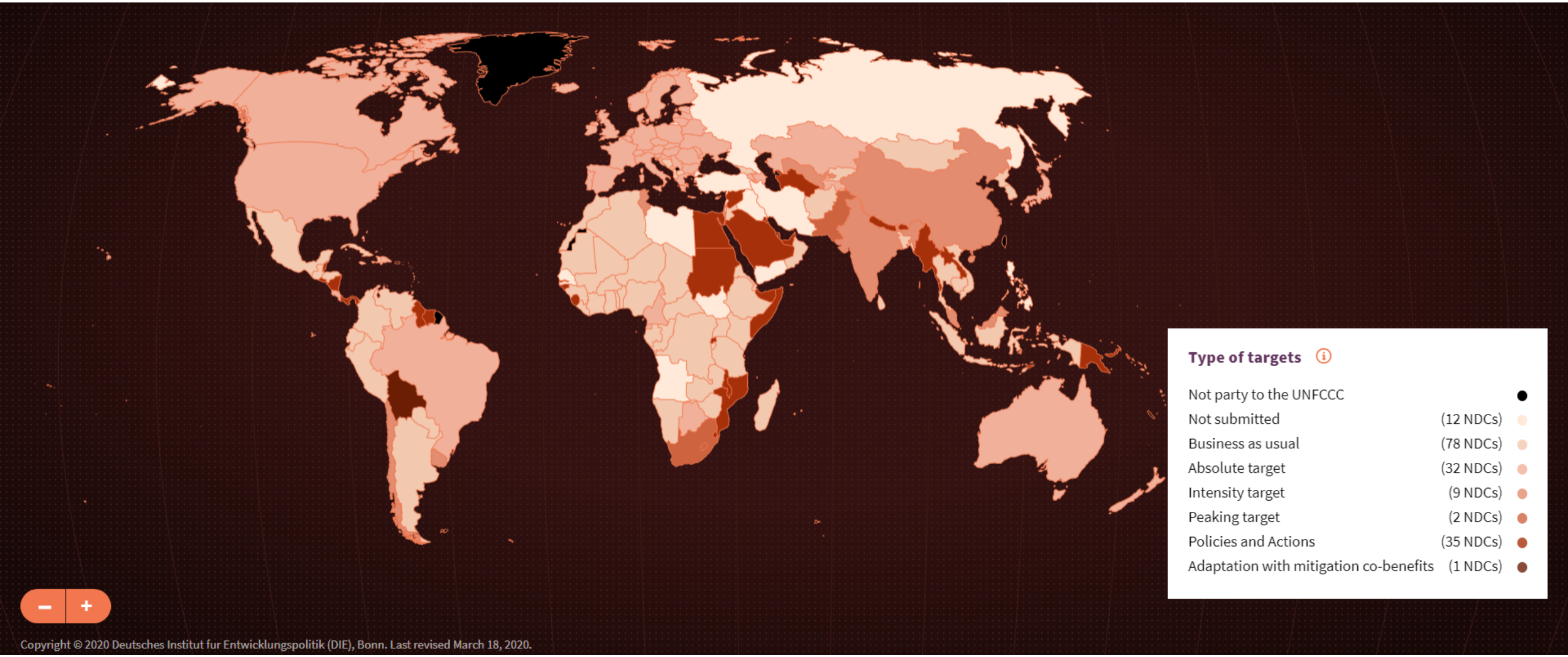


«BOTTOM UP» agreement based on National Determined Contribution (NDC) with a long term ambition

The stabilization of the temperature increase below 2° C is considered the level that allows the adaptation to climate change to human being at a reasonable level of social, economic and environmental costs.

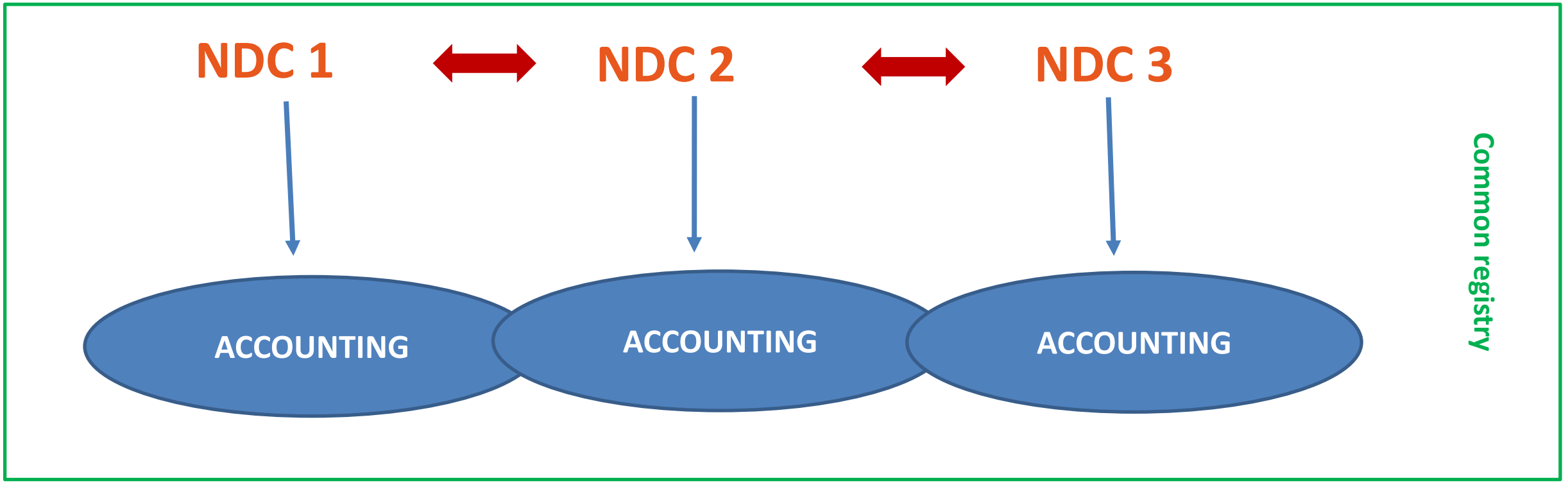

GOAL
MITIGATION – ADAPTATION
FINANCE
CAPACITY BUILDING
LOSS&DAMAGE
TECHNOLOGY TRANSFER
VOLUNTARY COOPERATION
VERIFICATION (GST)
TRANSPARENCY
FULL PARTICIPATION OF ALL PARTIES WITH AMBITIOUS TARGETS

Types of NDC



https://klimalog.die-gdi.de/ndc/#NDCExplorer/worldMap?INDC??climatechangemitigation???cat1

General accounting framework



Guidance for robust accounting - ensure avoidance of double counting

Enhanced Transparency Framework: Katowice Rulebook

The modalities, procedures and guidelines of the Paris' transparency framework are defined in the Katowice Rulebook

All Parties provide, on **a biennial basis and starting from 2024, in** their **Biennial Transparency Report (BTR)** (dec. 18/CMA.1):

- The **national inventory report of anthropogenic emissions and removals**, consisting of a national inventory document (including a description of the methods used) and common reporting tables (noting that developed countries the still have to provide flux estimates annually, i.e. at the same frequency and details as done in the past);
- The **information to track progress of targets as defined in the NDCs**;
- The **information on support provided to developing countries in terms of financial support, capacity building and technology transfer** (by the developed countries only), or information on **support needed and received** (by the developing countries only);
- The **adaptation actions** (if a country wishes).

Article 13 of the Paris Agreement: transparency of action and support

Reporting

All Parties *(shall)*

- National greenhouse gas (GHG) inventory report *(Article 13.7(a))*
- Progress made in implementing and achieving nationally determined contribution (NDC) *(Article 13.7(b))*

All Parties *(should, as appropriate)*

- Climate change impacts and adaptation *(Article 13.8)*

+

Developed country Parties *(shall)* and other Parties that provided support *(should)*

Financial, technology transfer and capacity-building support provided to developing country Parties under Article 9, 10 and 11 *(Article 13.9)*

Developing country Parties *(should)*

Financial, technology transfer and capacity-building support needed and received under Articles 9, 10 and 11 *(Article 13.10)*

Technical expert review

All Parties *(shall)*

- Undergo technical expert review of information submitted under Articles 13.7 *(Article 13.11)*

+

Developed country Parties *(shall)*

- Undergo technical expert review of information submitted under Articles 13.9 *(Article 13.11)*

Multilateral facilitative consideration

All Parties *(shall)*

- Multilateral facilitative consideration of progress with respect to efforts under Article 9, and its respective implementation and achievement of its NDCs *(Article 13.11)*

* The transparency framework shall provide flexibility in the implementation of the provisions of this Article to those developing country Parties that need it in the light of their capacities *(Article 13.2)*;

* The transparency framework shall recognize the special circumstances of the least developed countries and small island developing States *(Article 13.3)*.

IPCC2006
For all!

Source: UNFCCC

ADAPTATION GOAL

The Paris Agreement **aims to strengthen the global climate change response by increasing the ability of all to adapt to adverse impacts of climate change** and foster climate resilience.

Global goal on adaptation:

- to **enhance adaptive capacity and resilience**;
- to **reduce vulnerability**, with a view to contributing to sustainable development;
- **ensuring an adequate adaptation response** in the context of the goal of holding average global warming well below 2 degrees C and pursuing efforts to hold it below 1.5 degrees C.

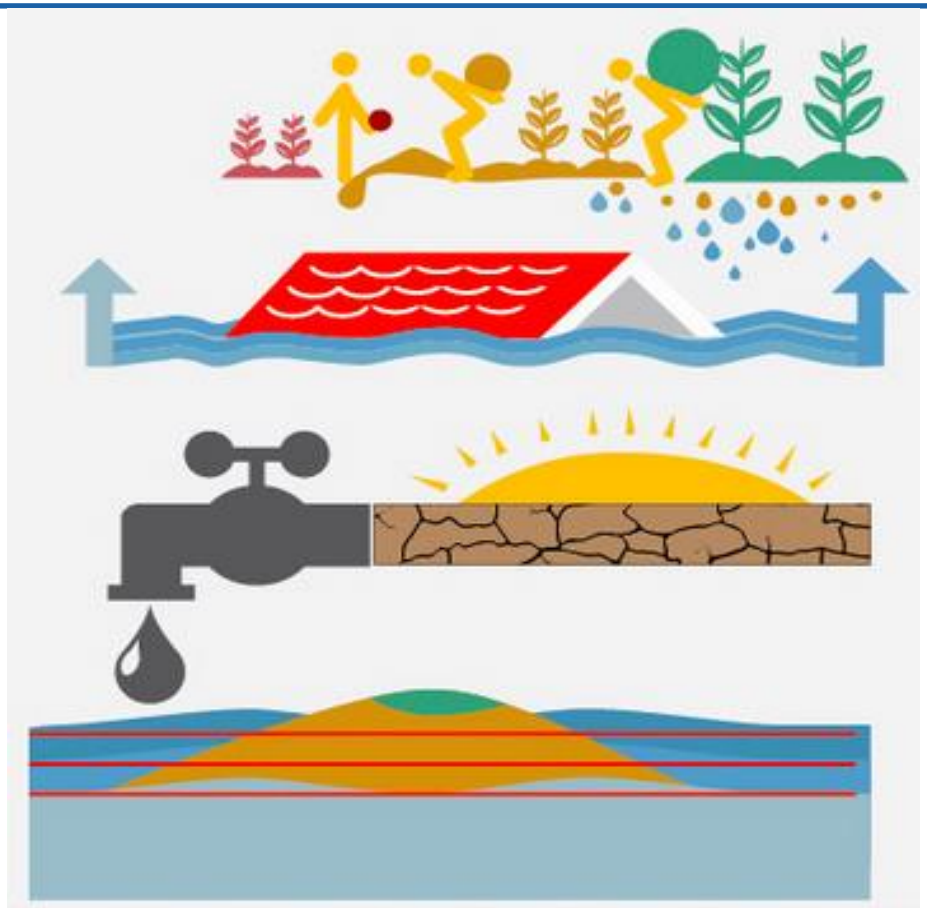


Image: Climate Reality @ WWF

ADAPTATION

Adaptation planning and implementation

- The Agreement requires all Parties, to **engage in adaptation planning and implementation** through e.g. **national adaptation plans, vulnerability assessments, monitoring and evaluation, and economic diversification**.
- All Parties should, communicate their priorities, plans, actions, and support needs through **adaptation communications**, which shall be recorded in a public registry.

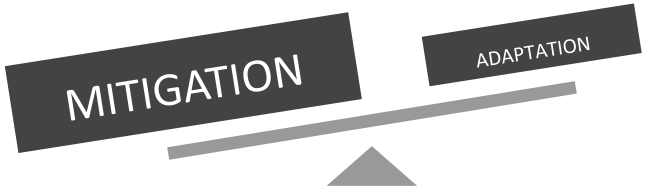
Transparency

- Parties should provide information related to climate change impacts and adaptation within the Ehanced Transparency Framework

Global stocktake

Article 14 of the Paris Agreement requires the CMA to periodically take stock of the implementation of the Paris Agreement in order to assess collective progress towards achieving the purpose of the Agreement and its long-term goals, including **Adaptation goal**

Ph credit: Steve Hamilton



Warsaw International Mechanism for Loss and Damages (WIM)

IPCC WGII AR5 primarily associates losses and damages with extreme weather events and economic impacts, and treats it primarily as a future risk

The Warsaw International Mechanism for Loss and Damage promotes the implementation of approaches to address loss and damage associated with climate change impacts (See decision 2/CP.19 for the details).

E stablished under UNFCCC (2014) and reaffirmed under the Paris Agreement (Article 8) process to avert, minimize and address loss and damage associated with climate change impacts, including extreme weather events and slow onset events.

Mechanism for developing countries that are particularly vulnerable to the adverse effects of climate change by:

- Enhancing knowledge and understanding of comprehensive risk management approaches to address loss and damage
- Strengthening dialogue, coordination, coherence and synergies among relevant stakeholders
- Enhancing action and support, including finance, technology and capacity-building

Executive Committee of the WIM

- The Executive Committee guides the implementation of the functions of the Mechanism through the workplan of the Committee.

The Executive Committee currently has four thematic expert groups on:

- slow onset events
- non-economic losses
- displacement related to the adverse impacts of climate change
- comprehensive risk management and transformational approaches

Finance (Art.9) - Tecnology (Art.10)
Capacity Building (Art.11)

- "ex-ante" – information on public finance for developing countries to be communicated every 2 years
- **New global financial target** –at least 100 billion $/yr starting from 2020
- **Green Climate Fund, Global Environmental Facility, Adaptation fund shall serve the Paris Agreement**
- A technology framework is established and capacity-building activities will be strengthened, as well as through education

Transparency (Art.13)

- Transparency guidelines include also financial and technical support and capacity buiding:
  - provided/mobilized- developed countries
  - needed/recieved – Developing countries

Global Stocktake

NDC

National Determined Contribution

Focus on Mitigation, Adaptation on voluntary basis

GST

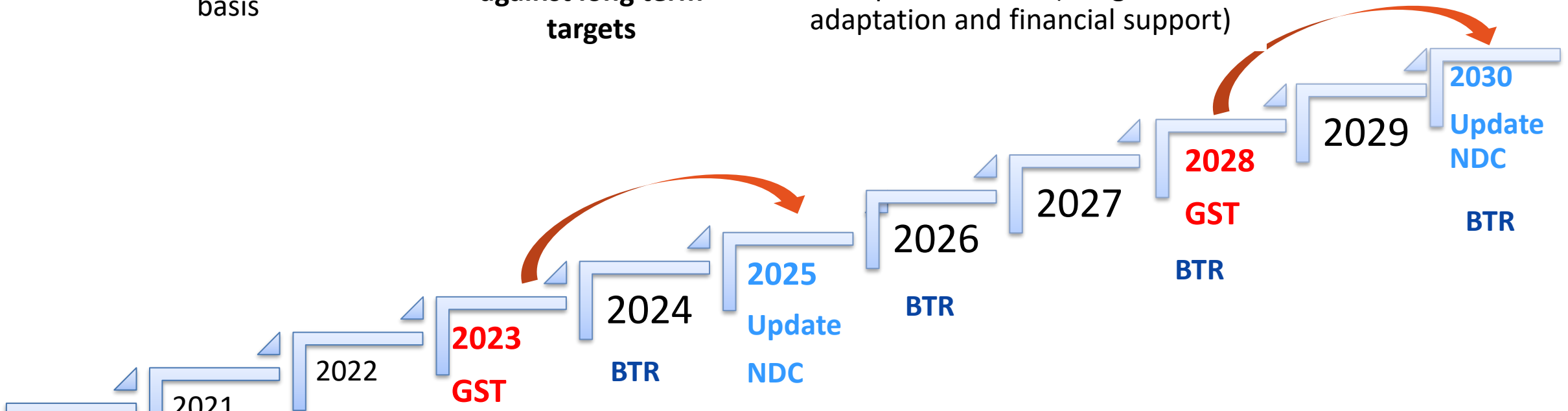
Global Stocktake

Every 5 years to assess the collective progress against long term targets

BTR

Biennal Transparency Report

GHG inventories
Track progress of NDC implementation (mitigation, adaptation and financial support)



- Communicate long-tem low GHG emission development strategy by 2020
- NDC up to 2025 or 2030 -> New NDC by 2020 then every 5 years

Market: Voluntary cooperation for NDC

Article 6.2 – COOPERATION APPROACHES refers to countries engaging on a voluntary basis in cooperative approaches to use “internationally transferred mitigation outcomes” to fulfil their NDCs

Article 6.4 – CENTRALIZED MARKET MECHANISM is commonly understood to establish a mitigation mechanism under UNFCCC authority, with provisions that for many Parties could resemble those of the CDM/JI. The mechanism has a dual objective of **supporting mitigation action** as well as **sustainable development**; it is supervised by a UNFCCC body; it involves public as well as private entities

Guidance for robust accounting - ensure avoidance of double counting, rules, modalities and procedures are still to be defined

Market mechanism aims:

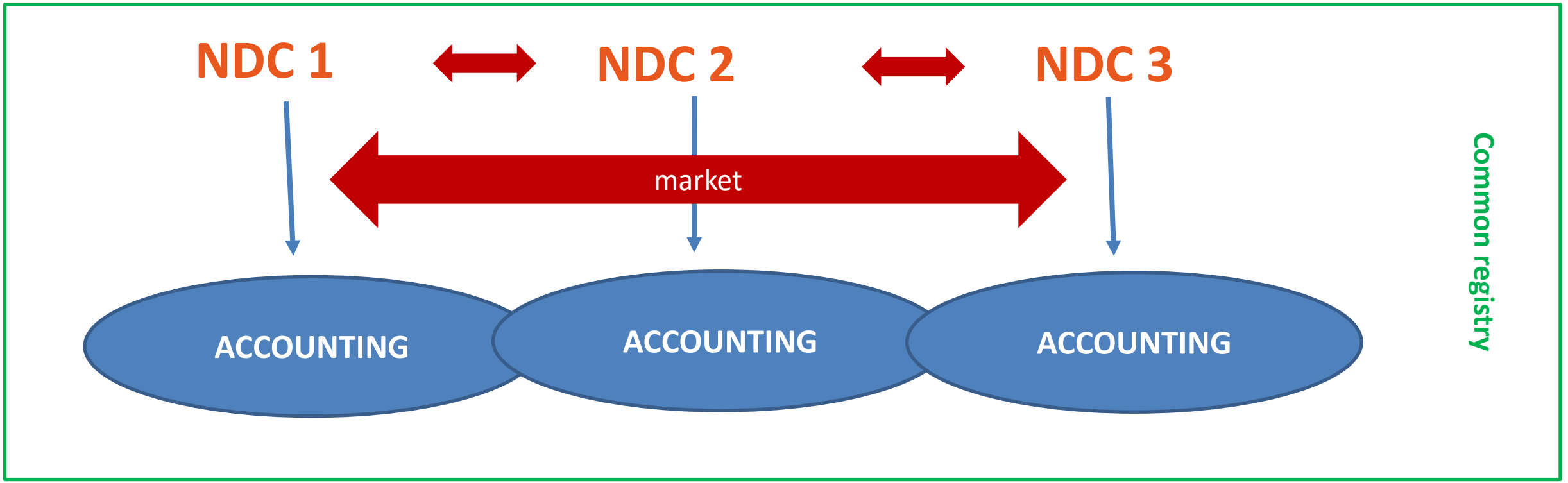
(a) To promote the **mitigation of GHG** emissions while fostering **sustainable development**;

(b) To **incentivize and facilitate participation** in the mitigation of GHG emissions **by public and private entities** authorized by a Party;

(c) To **contribute to the reduction of emission levels in the host Party**, which will benefit from mitigation activities resulting in emission reductions that can also be used by another Party to fulfil its NDC; and

(d) To deliver an overall mitigation in global emissions.

General accounting framework



Guidance for robust accounting - ensure avoidance of double counting

Open issues to be decided at COP26 (Glasgow, UK – November 2021)

UN CLIMATE CHANGE CONFERENCE UK 2021

IN PARTNERSHIP WITH ITALY

Transparency:

- Outline of the reporting
- Common reporting formats and tables

Art.6 (voluntary cooperation appraches/market mechanism)

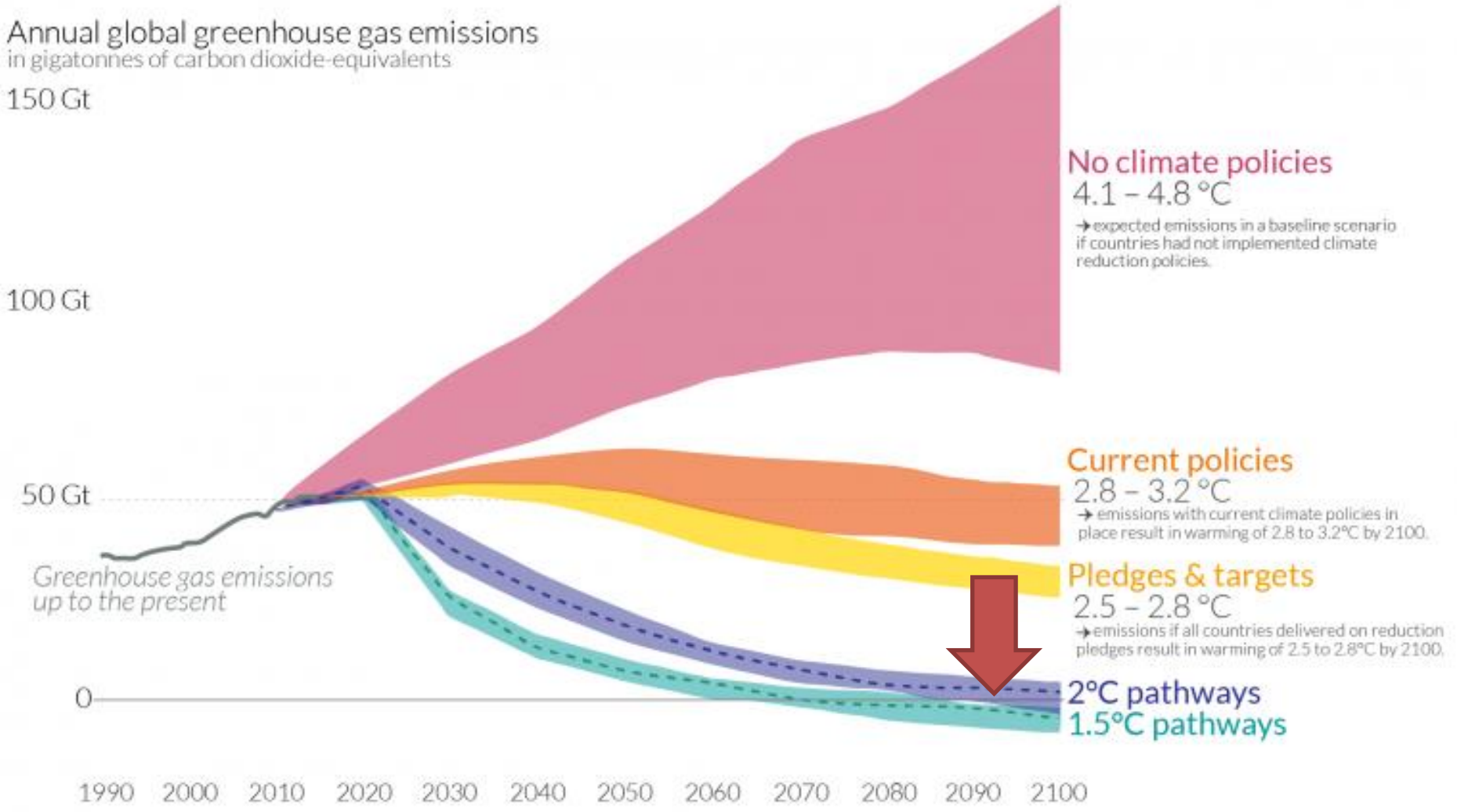
- correct quantification of units and avoid double accounting
- Involvement of the private sector
- How to avoid double counting and increase ambition
- Ouside or inside the NDC?
- CDM will continue in the future?
- Pre-2020 unit transition?
- Finance for adaptation

Are we on track?

Global greenhouse gas emissions and warming scenarios

Our World in Data

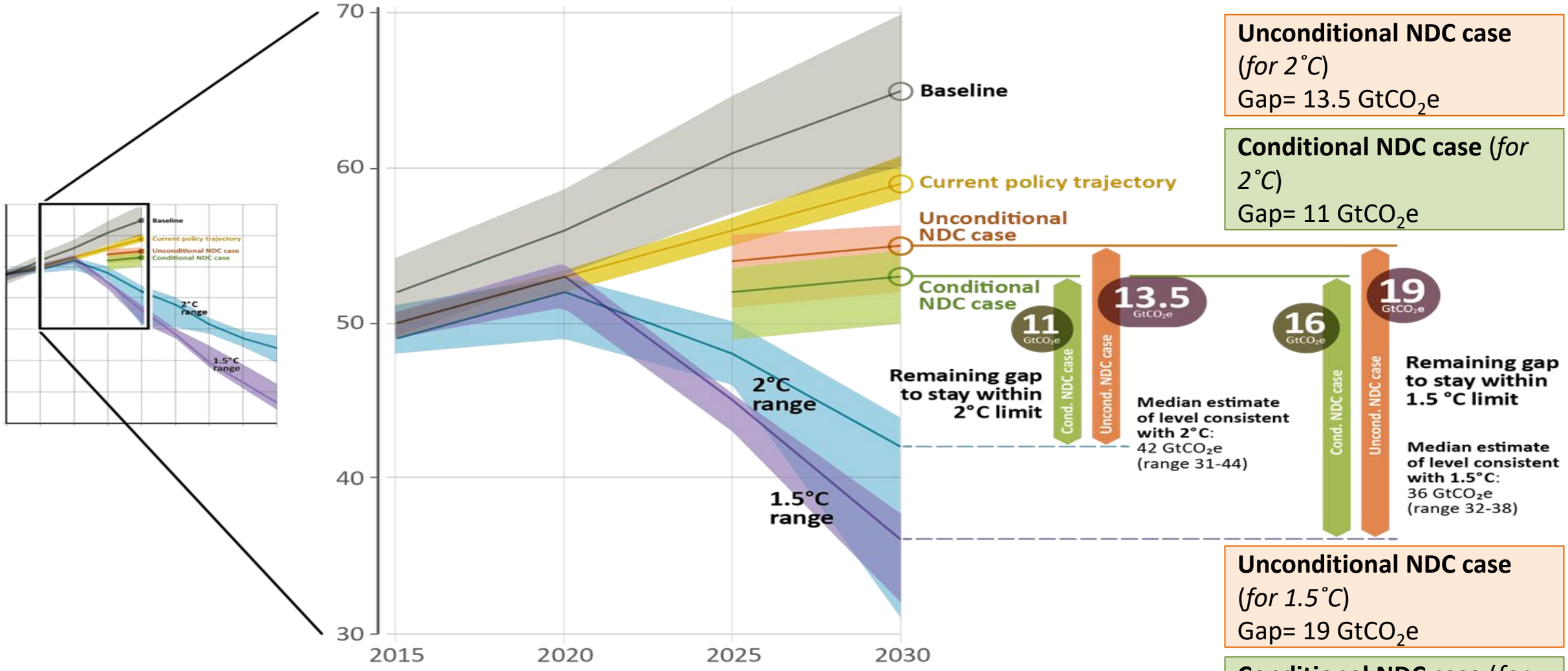
– Each pathway comes with uncertainty, marked by the shading from low to high emissions under each scenario.
– Warming refers to the expected global temperature rise by 2100, relative to pre-industrial temperatures.



Data source: Climate Action Tracker (based on national policies and pledges as of December 2019).
OurWorldinData.org – Research and data to make progress against the world's largest problems.

NDC contributions and the emissions gap

Annual global total greenhouse gas emissions ($GtCO_2e$)

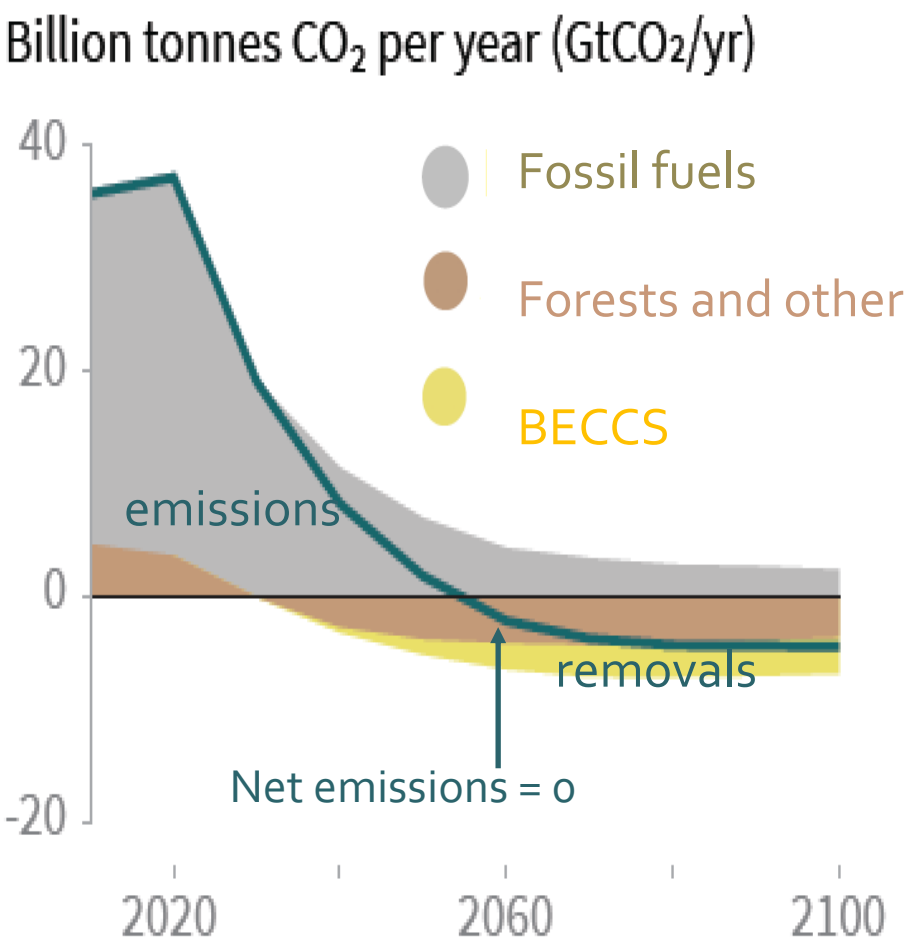


Unconditional NDC case (*for 2˚C*)
Gap= 13.5 $GtCO_2e$

Conditional NDC case (*for 2˚C*)
Gap= 11 $GtCO_2e$

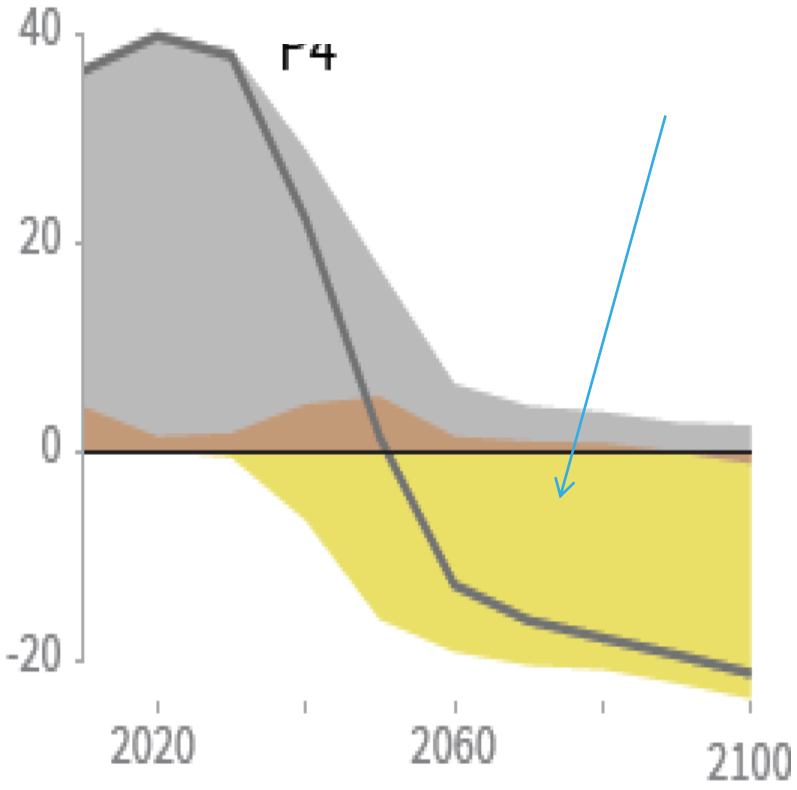
Unconditional NDC case (*for 1.5˚C*)
Gap= 19 $GtCO_2e$

Conditional NDC case (*for 1.5˚C*)
Gap= 16 $GtCO_2e$



(IPCC Special Report 1.5C)

Large scale application?



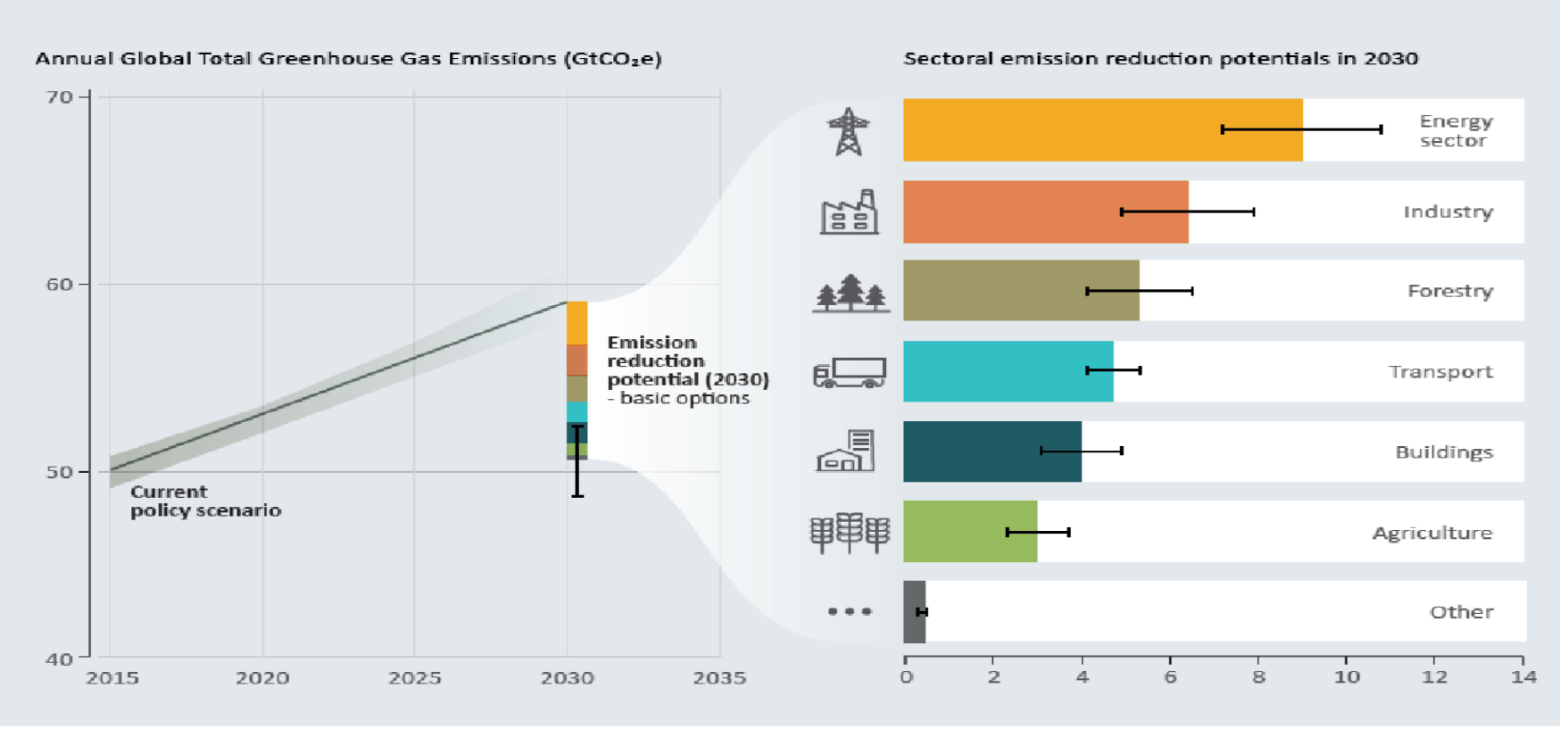
Annual emission reduction

1,5°C → -7,6% up to 2030
2°C → -2,6% up to 2030

(1,5°C 10 yr→-3%!)

Sectoral emission reduction potentials in 2030

- The emissions reduction potential in six key sectors, at cost <US$100/tCO$_2$e, is sufficient to close the emissions gap in 2030 - if implemented immediately and at scale
- Such action would provide benefits for other important environmental, social and economic goals



ROLE OF LAND SECTOR IN CLIMATE POLICY

ANNUAL AFOLU BALANCE (2007-2016)

Emissions

Removals

5.8 ± 2.6 GtCO2 yr-1

Net LULUCF

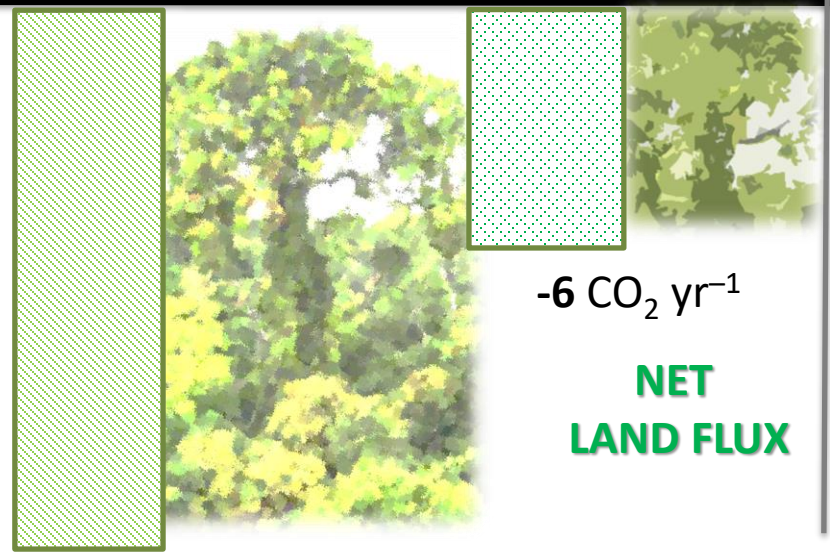
Deforestation, AR, other land use activities

6.2 ± 1.4 GtCO2 yr-1

AGRICULTURE

non-CO2 emissions due to fertilization, enteric fermentation, manure management, rice fields

Natural response



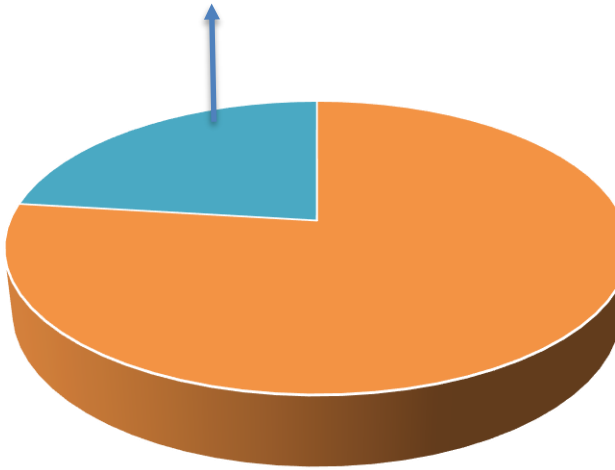
-6 CO_2 yr^{-1}

NET LAND FLUX

-11.2 +/- 2.6 Gt CO_2 yr^{-1}

The natural response of land to human-induced environmental changes

AFOLU 23%
OF GLOBAL EMISSSIONS

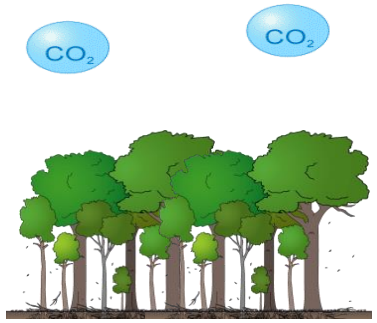


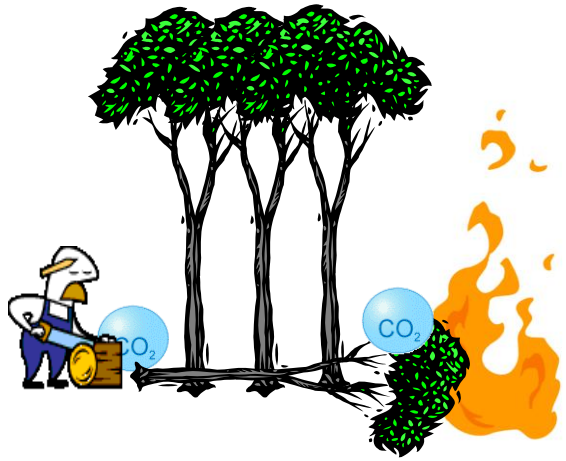
Data: IPCC SRCCL 2019

MITIGATION POLICIES IN FOREST SECTOR

1. **Enhancement of C sink** (new forests, increased C stocks in existing forests)
2. **Reduction of C sources** (reduce deforestation and forest degradation)
3. **C substitution** (wood replacing fossil fuels or other products)

Forests offer synergies between mitigation (at low cost), adaptation, biodiversity ... **forests are a key element in climate policy debate**



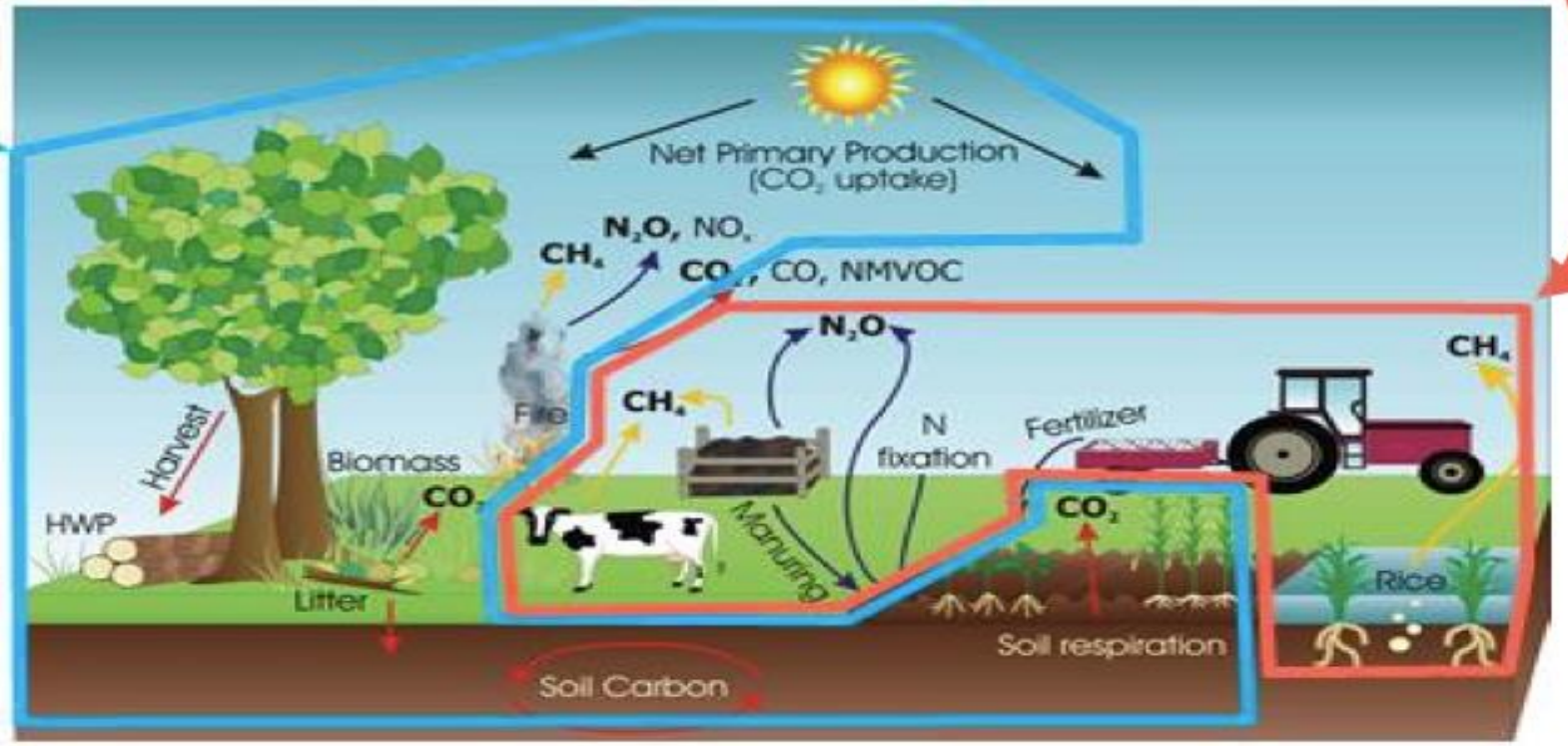


LAND SECTOR IS PART OF THE PROBLEM BUT ALSO PART OF THE SOLUTION

AFOLU SECTOR

Land Use, Land Use Change and Forestry (**LULUCF**): CO_2

AGRICULTURE *non-CO₂* (CH_4, N_2O)



Partly human induced (strongly linked to global natural carbon cycle)

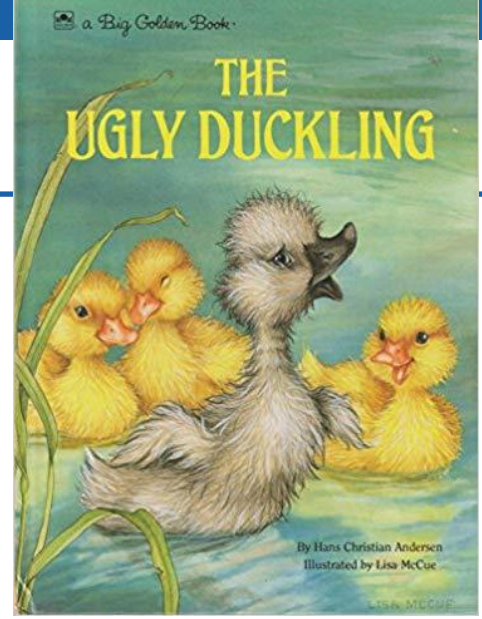
Uncertainties?
Additionality?
Permanence?
Leakage?

Mainly human-induced

=> More readily quantifiable

Emissions will remain high and increasing following the increasing demand of food, biofuel, fibers linked with the population increase

Specific issues in the land sector

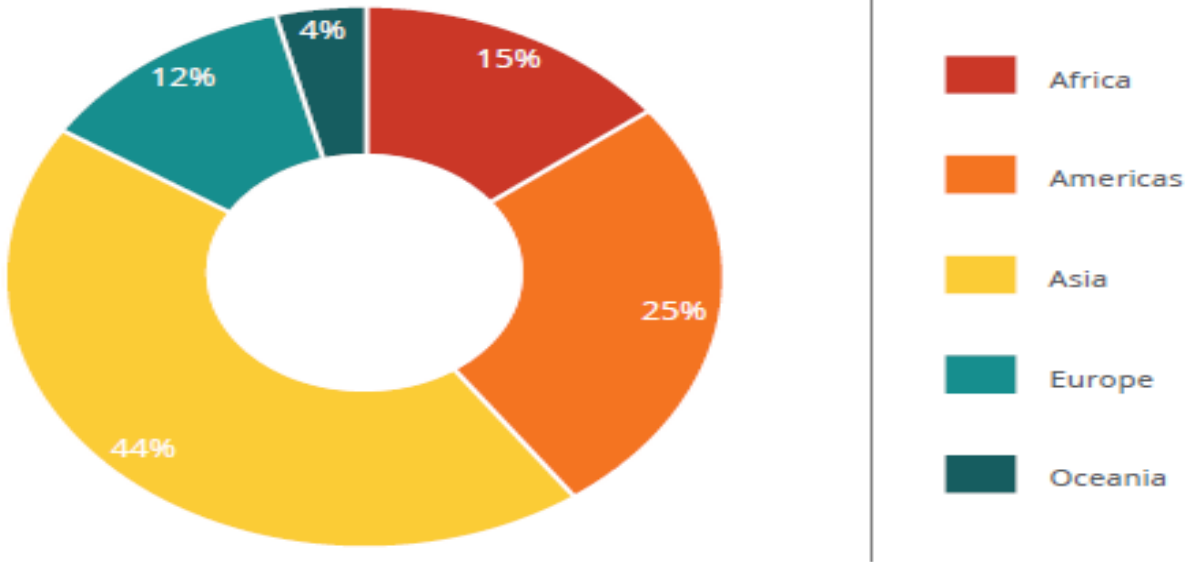


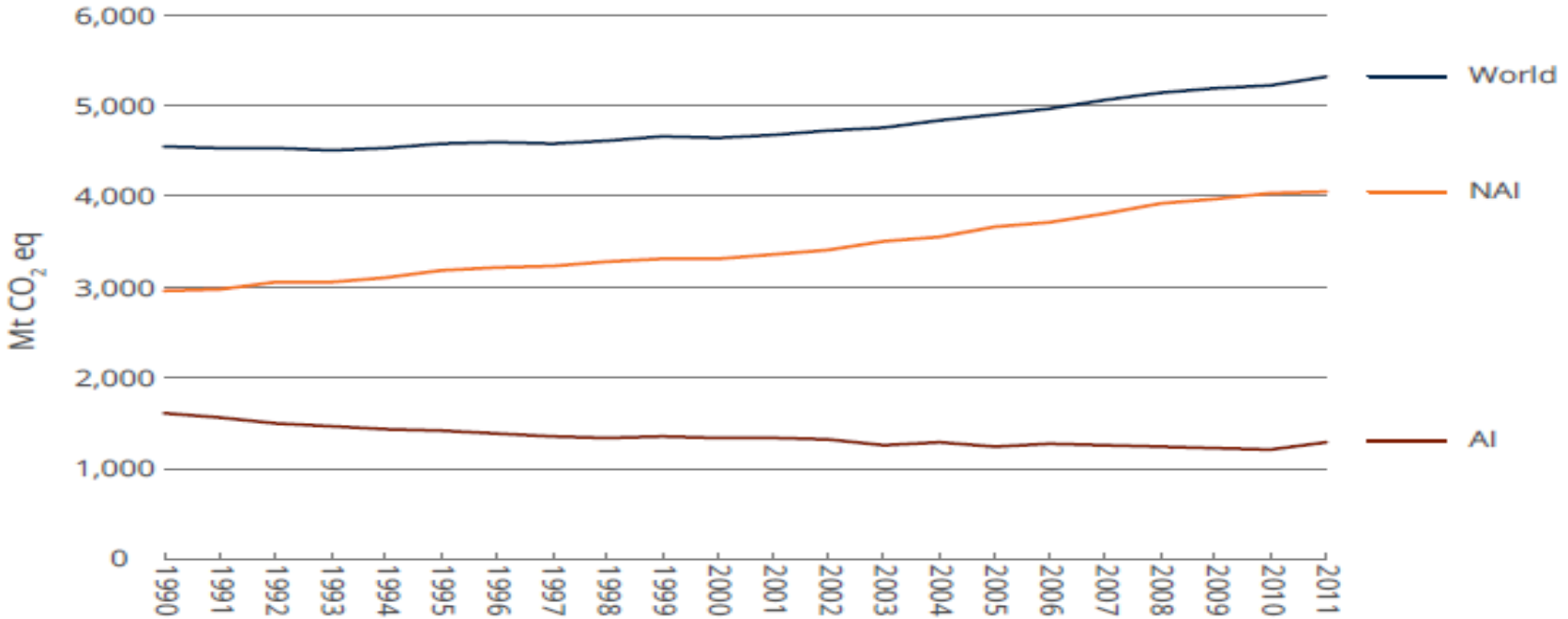
- **Natural component**
- **Non-permanence**
- **Long time scales**
- **Saturation**
- **Uncertainity** (e.g. UE uncertainties for land sector ~30% other sectors <5%)

Terrestrial ecosystems provide food, fuel, and shelter; preserve biodiversity; and supply other services and environmental benefits. **The sector offers opportunities for synergies between mitigation, sustainable development, biodiversity and adaptation, but also potential conflicts.**

Emissions in Agriculture

Increases in emissions of agriculture (from 4.6 to 5.0 Gt CO2 eq yr-1 in 1990s and 2000s; 5.3 Gt CO2 eq yr-1 in 2011)





GHG intensity of products (i.e., GHG emissions per unit commodity produced) decreased during 1990-2010, but that if no further mitigation measures and technical efficiency improvements are implemented, future emissions may further increase by up to 30% by 2050.

Fonte FAO 2014

AGRICULTURE

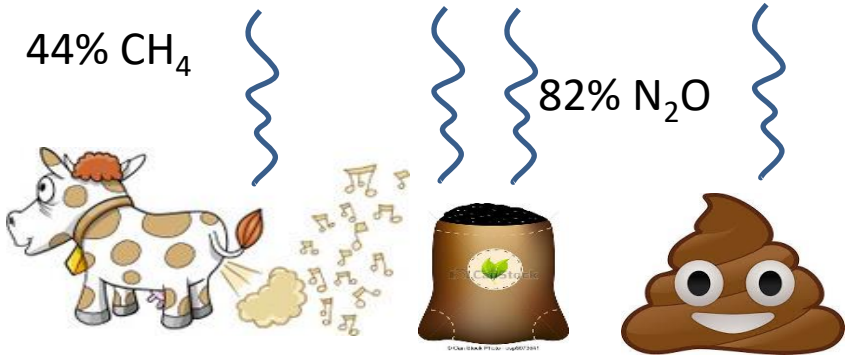
1 Kg

14-20 Kg

GHG emissions

44% CH_4

82% N_2O



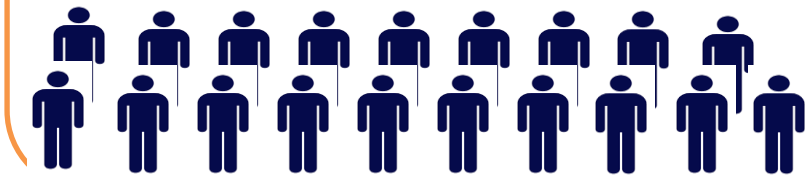
Enteric fermentation

Fertilizers

Manure management

1 ha rice production

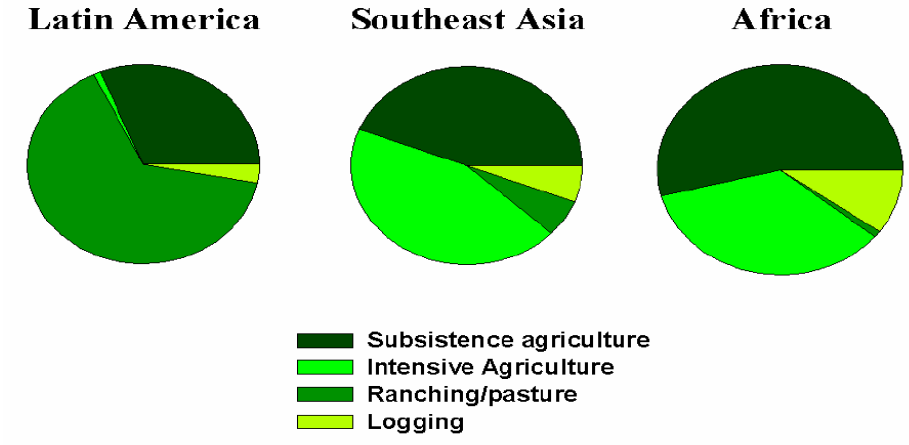
1 ha Cow grazing



In US and Europe, half of cereal production is for animal consumption

Annual rate of forest expansion and deforestation, 1990–2020

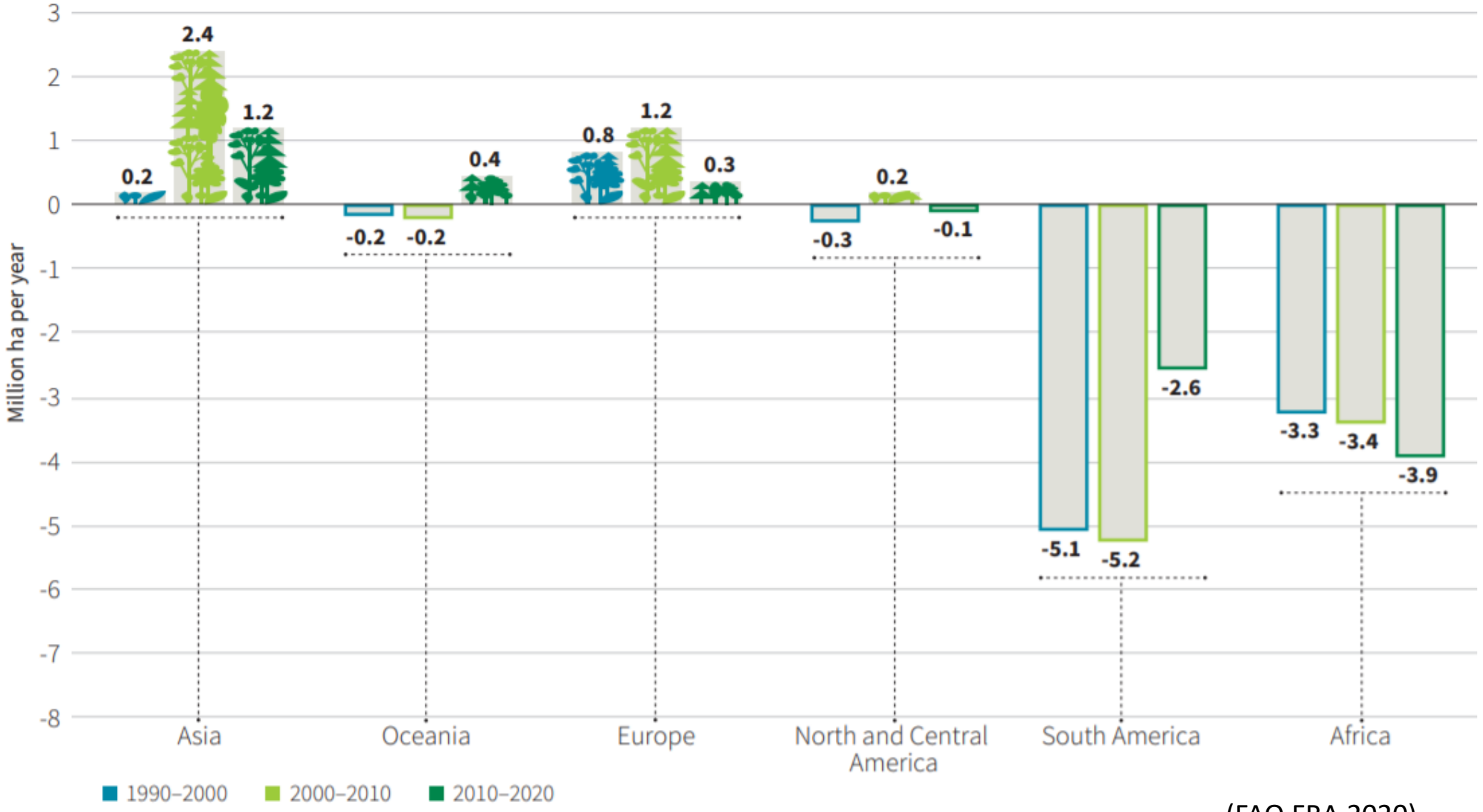
¾ of tropical deforestation is linked to cash crops



- **An estimated 420 million ha of forest has been lost worldwide through deforestation since 1990**
- The rate of forest loss has declined substantially.
- In 2015–2020, the annual rate of deforestation was estimated at 10 million ha, down from 12 million ha in 2010–2015.

(FAO FRA 2020)

Annual forest area net change, by decade and region, 1990–2020



(FAO FRA 2020)

FOREST DEGRADATION EMISSIONS

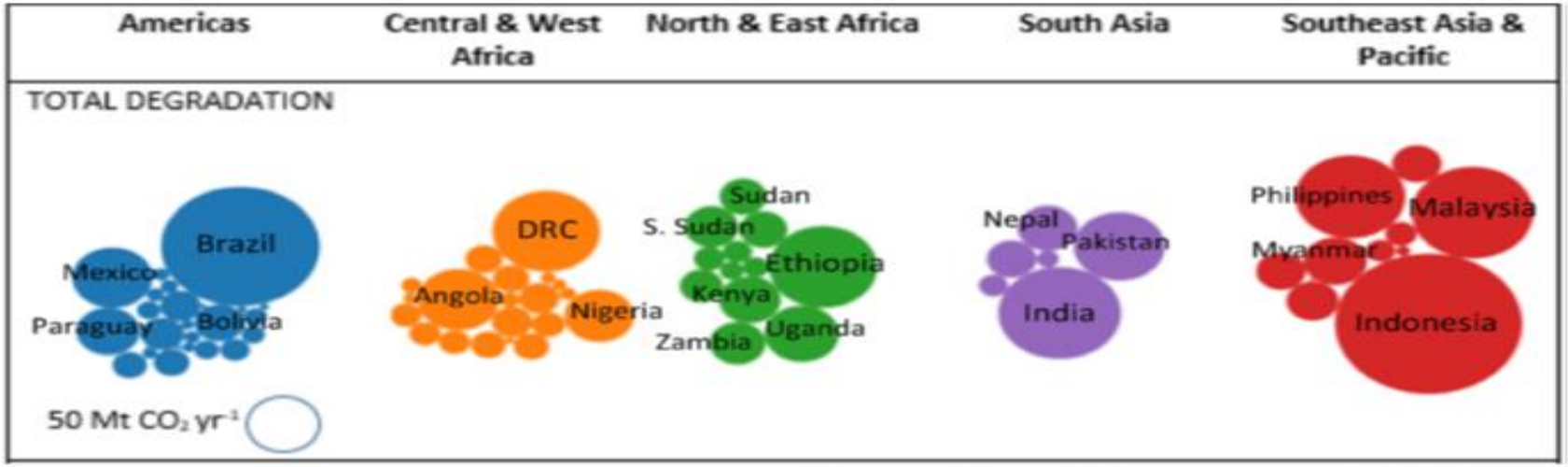
53% timber harvest

30% woodfuel harvest

17% forest fires

Forest degradation emissions = 2.2 Gt CO_2 $year^{-1}$

25% of the summed emissions from deforestation and forest degradation (8.28 Gt CO_2 $year^{-1}$)



Pearson et al. Carbon Balance Manage (2017) 12:3

REDD+ scope (Dec. 1/CP.16 par. 70)

RED

*Reducing emissions from **deforestation***

D

*Reducing emissions from forest **degradation***

+

***Conservation of forest** carbon stocks;*

Sustainable management of forests;

***Enhancement of forest** carbon stocks;*

Afforestation/reforestation Activities

SCALE: National (sub-national ad interim)

IS REDD+ JUST ABOUT FOREST?

REDD+ framework

Framework of 13 decisions developed in 7 years

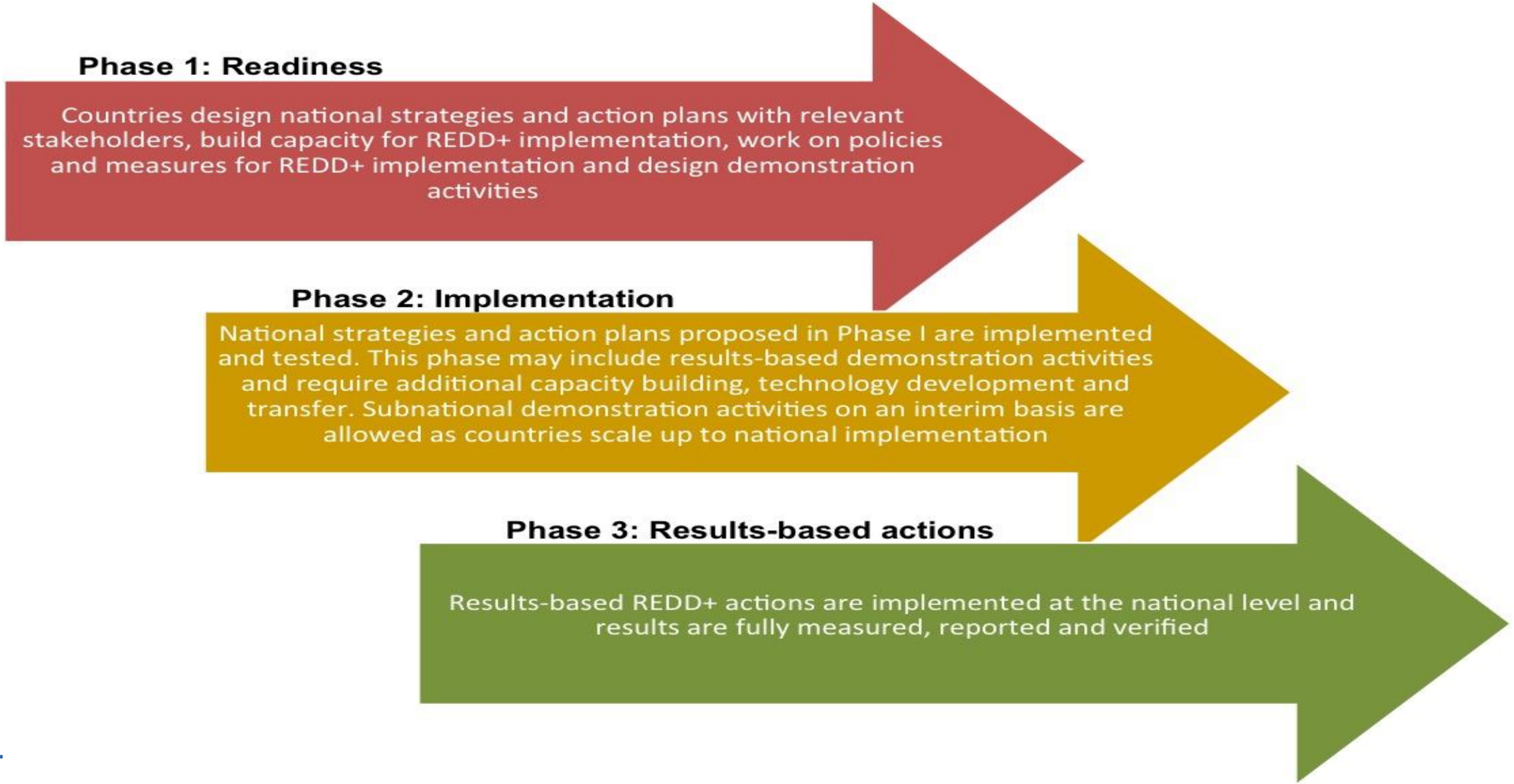
Covers all the aspects of the framework:

Step-wise approach -> from readiness to result based payment

Criteria for access (National strategy; FRL/FREL; Monitoring system; SIS)

- **Forest reference level/Emissions level** + Tech. Assessment process
- **Safeguard information system**
- **MRV**
- **Financing ->** role of GCF; private and public sectors, coordination of support
- **Information hub ->** publish information on the results of REDD+ activities, and corresponding results-based payments (Lima REDD+ Information Hub)

Three phases of REDD+



LAND SECTOR IN THE PA: Article 5

Land use is the only sector that has a dedicated Article in the Paris Agreement

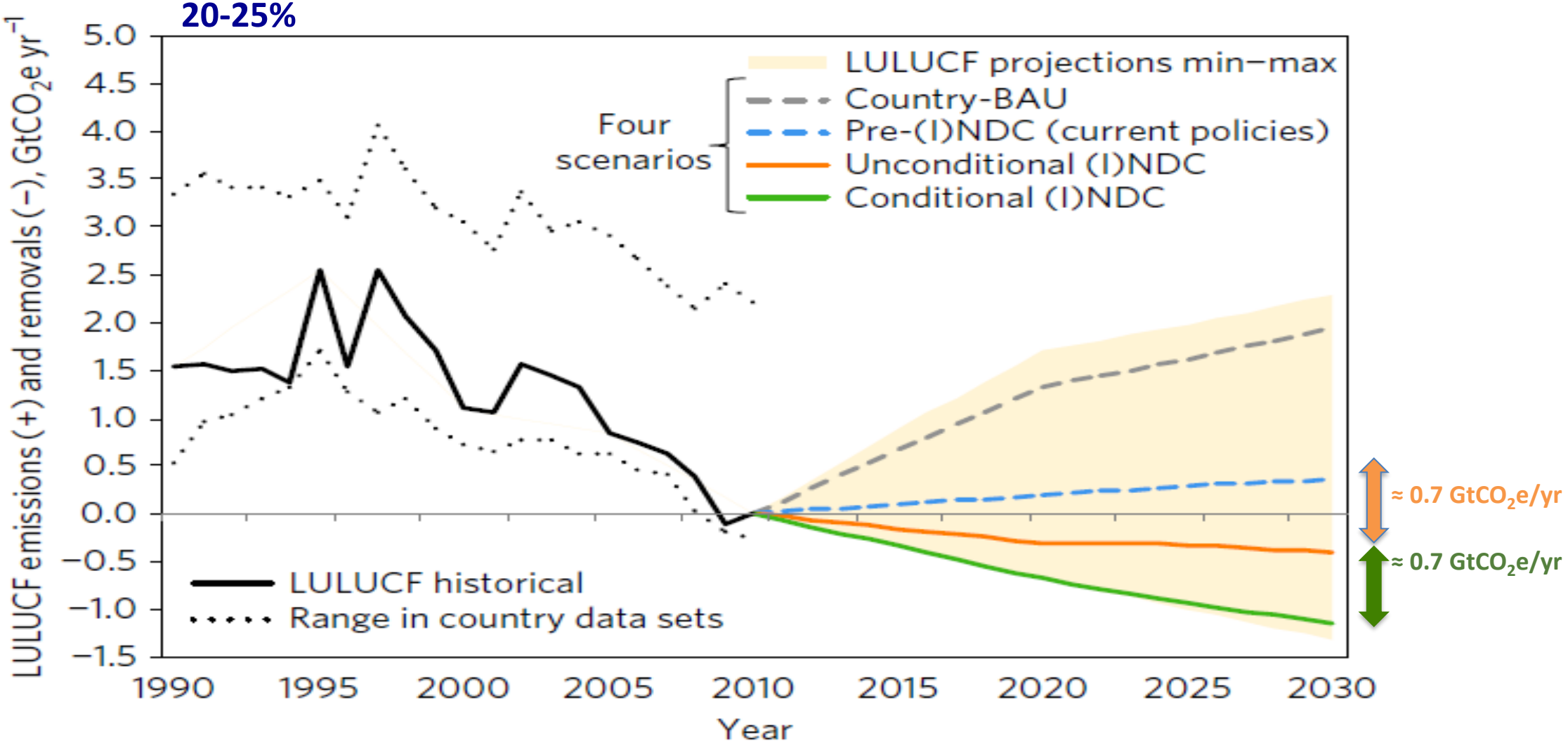
Parties should take actions to conserve, enhance, sinks and reservoirs of GHG

Parties are *encouraged* to take action to implement and support, including through results-based payments, **the existing framework under UNFCCC for REDD+**

Dec. 1/CP21-> Recognizes the **importance of adequate and predictable financial resources**, including for results-based payments, for the implementation of REDD+

What is the contribution of land in NDC?

Relative to the emissions from all sectors, the estimated contribution from LULUCF at global level is a 20-25%



Grassi et al. Nature Climate Change (2017)

LAND USE SECTOR

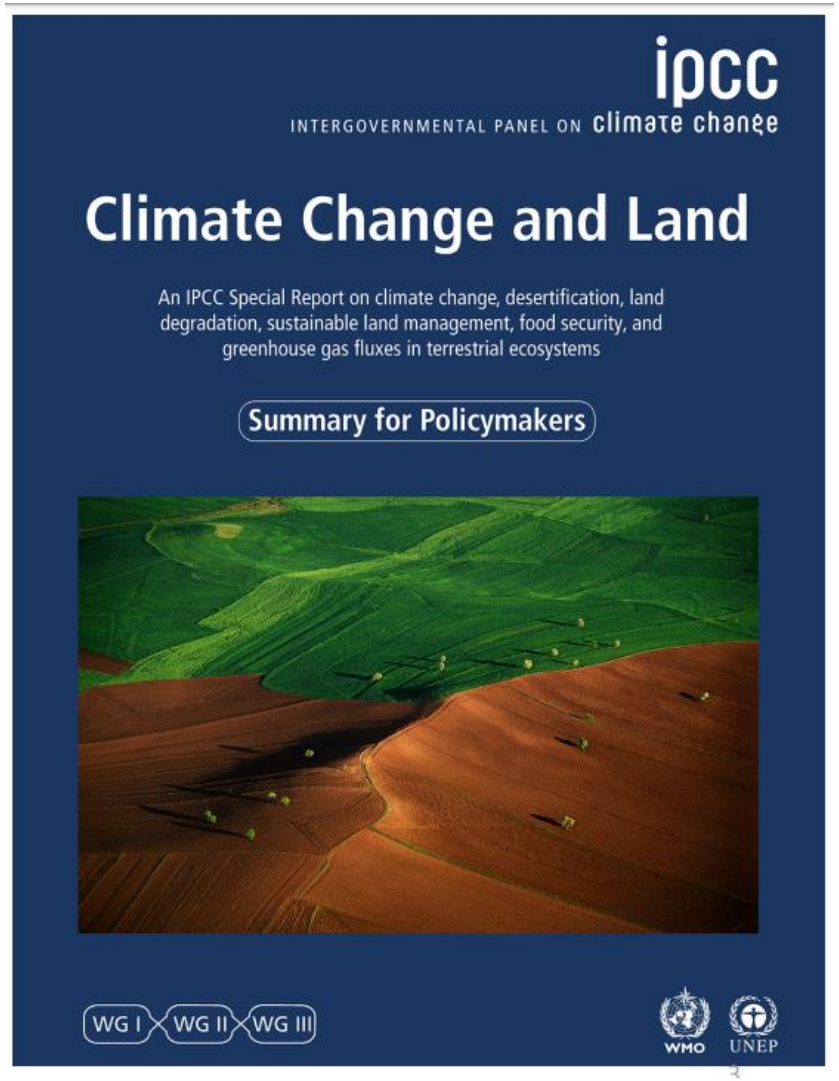
	1990	2000	2010	2030				Comment
				Country-BAU	Pre-INDC	Unconditional INDC	Conditional INDC	
	LULUCF emissions (+) and removals (-), Gt CO2e/y							
Developed countries	-1.02	-1.44	-1.77	-1.51	-1.51	-1.71	-1.71	The most important country in explaining the difference between Country-BAU and Unconditional INDC is USA (see refs 17)
Developing countries	2.56	2.54	1.78	3.45	1.87	1.30	0.56	The most important countries in explaining the difference between Country-BAU and Unconditional INDC are Brazil (≈1.4 GtCO2e/y), Indonesia (≈0.5 GtCO2e/y), Gabon (≈0.1 GtCO2e/y) and Mexico (≈0.05 GtCO2e/y). See "Country examples" for more details.
TOTAL	**1.54**	**1.10**	**0.00**	**1.94**	**0.36**	**-0.41**	**-1.14**	

Grassi et al. Nature Climate Change (2017)

IPCC special report on Land

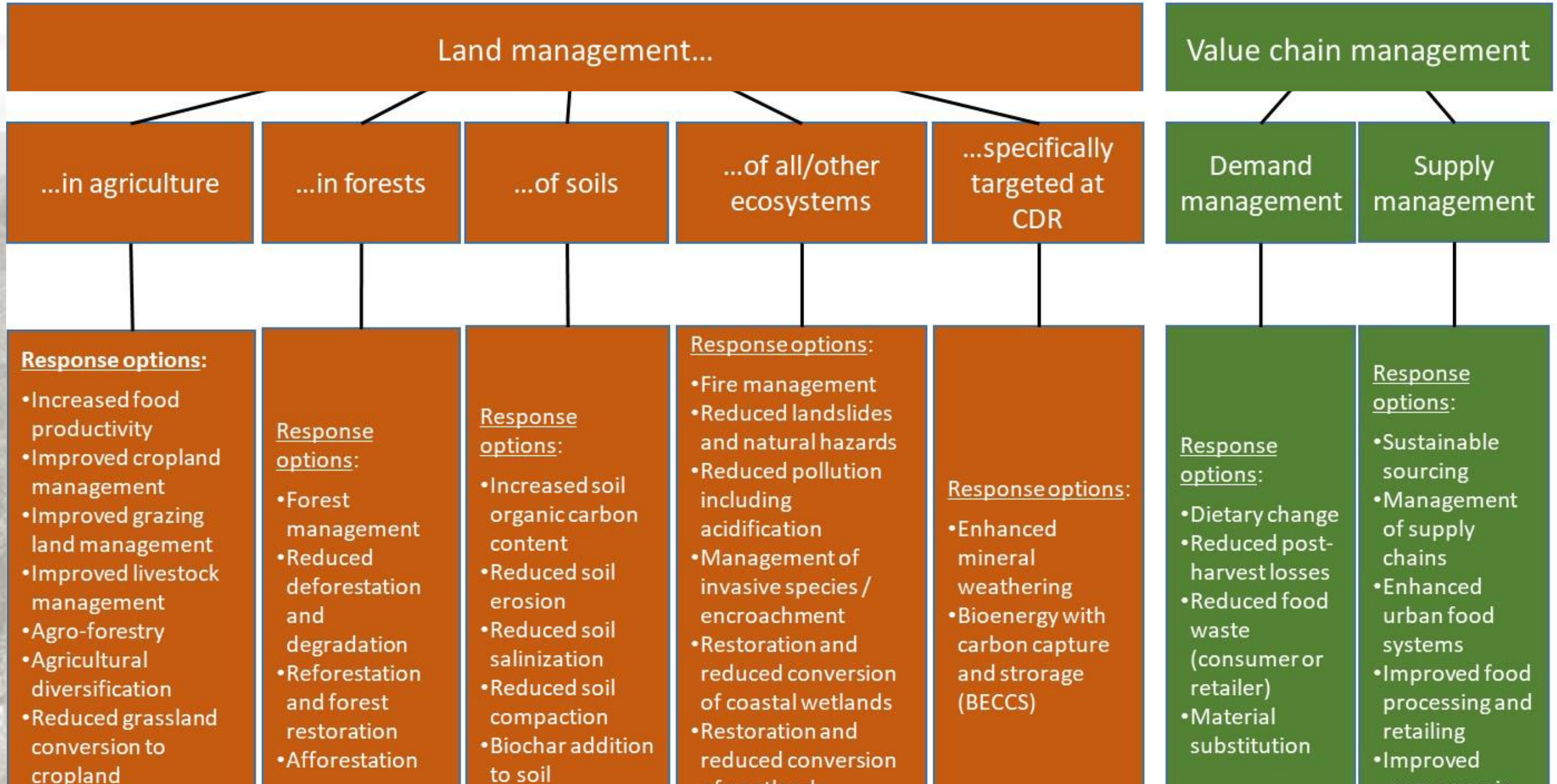
107 Authors → 40% of CLAs are Female → 52 Countries

53% Authors from Developing Countries → 7,000 Scientific Publications Assessed → 28,275 Review Comments

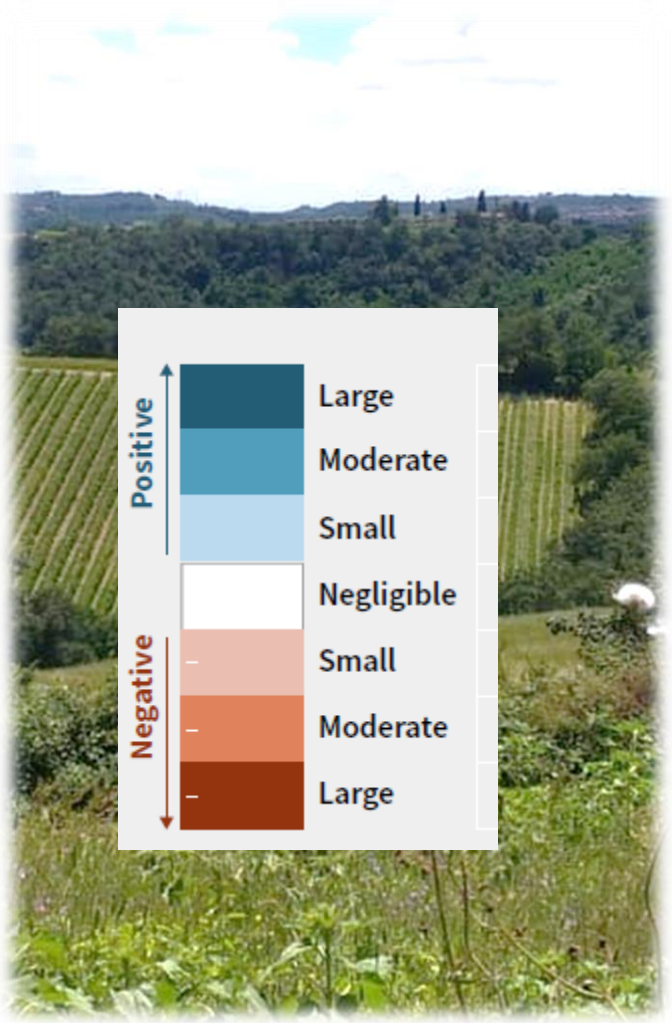


40 options identified

Response options



Assessment



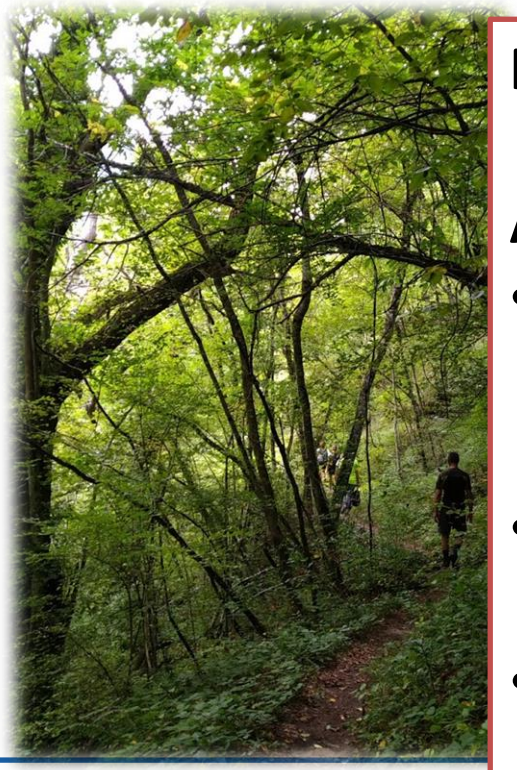
Response options based on land management		Mitigation	Adaptation	Desertification	Land Degradation	Food Security	Cost
Agriculture	Increased food productivity	L	M	L	M	H	—
	Agro-forestry	M	M	M	M	L	●
	Improved cropland management	M	L	L	L	L	●●
	Improved livestock management	M	L	L	L	L	●●●
	Agricultural diversification	L	L	L	M	L	●
	Improved grazing land management	M	L	L	L	L	—
	Integrated water management	L	L	L	L	L	●●
	Reduced grassland conversion to cropland	L	—	L	L	– L	●
Forests	Forest management	M	L	L	L	L	●●
	Reduced deforestation and forest degradation	H	L	L	L	L	●●
Soils	Increased soil organic carbon content	H	L	M	M	L	●●
	Reduced soil erosion	↔ L	L	M	M	L	●●
	Reduced soil salinization	—	L	L	L	L	●●
	Reduced soil compaction	—	L	—	L	L	●
Other ecosystems	Fire management	M	M	M	M	L	●
	Reduced landslides and natural hazards	L	L	L	L	L	—
	Reduced pollution including acidification	↔ M	M	L	L	L	—
	Restoration & reduced conversion of coastal wetlands	M	L	M	M	↔ L	—
	Restoration & reduced conversion of peatlands	M	—	na	M	– L	●
Response options based on value chain management							
Demand	Reduced post-harvest losses	H	M	L	L	H	—
	Dietary change	H	—	L	H	H	—
	Reduced food waste (consumer or retailer)	H	—	L	M	M	—
Supply	Sustainable sourcing	—	L	—	L	L	—
	Improved food processing and retailing	L	L	—	—	L	—
	Improved energy use in food systems	L	L	—	—	L	—
Response options based on risk management							
Risk	Livelihood diversification	—	L	—	L	L	—
	Management of urban sprawl	—	L	L	M	L	—
	Risk sharing instruments	↔ L	L	—	↔ L	L	●●

FOREST MANAGEMENT

Context

Responsible of the 12% of global emissions (deforestation, forest degradation)
Natural sink of 30% of human emissions

	Response options	Mitigation	Adaptation	Desertification	Land degradation	Food security	Costs	Potential $GtCO_2\,yr^{-1}$
Forests	Forest management	M	L	L	L	L	●●	0.4-2.1
	Reduced deforestation and forest degradation	H	L	L	L	L	●●	**0.4-5.8**



Reforestation and land restoration (MAX **1.5-10.1** $GtCO_2\,yr^{-1}$)

Afforestation (MAX **0.5-8.9** $GtCO_2\,yr^{-1}$)

- Afforestation helps to address **land degradation and desertification** (water retention capacity, quality by reducing runoff, trapping sediments and nutrients
- **Food security** could be hampered since an increase in global forest area can increase Food prices through land competition
- Side-effects occur when afforestation is based on non-native species,

AGRICULTURE MANAGEMENT

Context

11% of global emissions: CH_4 (enteric fermentation); N_2O (fertilizer)
CO_2 emissions from soil disturbances

Response options based on land management		Mitigation	Adaptation	Desertification	Land Degradation	Food Security	Cost	Potential $GtCO_2\,yr^{-1}$
Agriculture	Increased food productivity	L	M	L	M	H	—	>13
	Agro-forestry	M	M	M	M	L	●	0.1 - 5.7
	Improved cropland management	M	L	L	L	L	●●	1.4 - 2.3
	Improved livestock management	M	L	L	L	L	●●●	
	Agricultural diversification	L	L	L	M	L	●	
	Improved grazing land management	M	L	L	L	L	—	
	Integrated water management	L	L	L	L	L	●●	
	Reduced grassland conversion to cropland	L	—	L	L	– L	●	

Improved cropland management (1.4-2.3 GtCO2e year)

a) *management of the crop* (crop rotation, use of cover crops, perennial cropping systems)
b) *nutrient management*: including optimized fertiliser application rate, fertiliser type
c) *reduced tillage intensity and residue retention*
d) *improved water management*
e) *improved rice management*: including water management such as mid-season drainage
f) *biochar application*.

Other ecosystems

	Response option	Mitigation	Adaptation	Desertification	Land degradation	Food security	Costs
Other ecosystems	Fire management	M	M	M	M	L	●
	Reduced landslides and natural hazards	L	L	L	L	L	—
	Reduced pollution including acidification	⟷ M	M	L	L	L	—
	Restoration & reduced conversion of coastal wetlands	M	L	M	M	⟷ L	—
	Restoration & reduced conversion of peatlands	M	—	na	M	- L	●

Fire management

0.48-8.1 $GtCO_2$ yr^{-1}

Restoration and reduced conversion of coastal wetland

0.3-3.1 $GtCO_2$ yr^{-1}

Restoration and reduced conversion of peatland

0.6-2 $GtCO_2$ yr^{-1}

Soil

Context

Soils contains twice carbon than the atmosphere
Soil erosion can be 20 (no tillage) to 100 times higher than the soil formation rate

		Mitigation	Adaptation	Desertification	Land degradation	Food security	Costs	Potential $GtCO_2\,yr^{-1}$
Soils	Increased soil organic carbon content	H	L	M	M	L	●●	0.4-8.6
	Reduced soil erosion	↔ L	L	M	M	L	●●	
	Reduced soil salinization	—	L	L	L	L	●●	
	Reduced soil compaction	—	L	—	L	L	●	

Biochar (MAX: 6.6 GtCO2 yr^{-1})

Biochar is an organic compound used as soil amendment

Biochar could provide moderate benefits for food security by improving yields by 25% in the tropics, but with more limited impacts in temperate regions, or through improved water holding capacity and nutrient use efficiency.

Large scale production can compete with food production

FOOD SYSTEM

Context

37% OF GLOBAL EMISSIONS (8-10% FOOD WASTE)
+40% increase of food waste since'60 – TODAY: 30% wasted or loss

Demand side

Losses

Production

Post harvest

Processing

Distribution

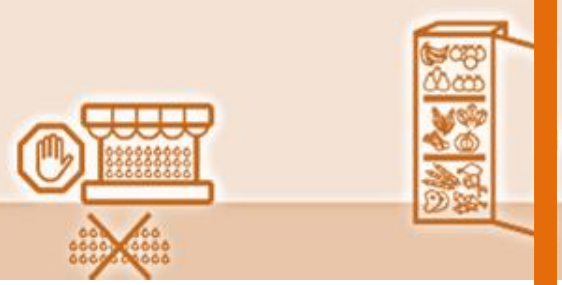
Reduction of post harvest losses **4.5 $GtCO_2$ a^{-1}**
Free **2 Mkm^2** from agriculture

Supply side

Waste

Retailers

Consumers



Reduction: 0.8 to 4.5 $GtCO_2$ yr^{-1}
Free: 0,8-2,4 Mkm^2

Consum.

0.7 to 8 $GtCO_2$ yr^{-1}
0,8-2,4 Mkm^2

Conclusions

- **Land management has high mitigation potential**
- When **sustainable**, proper **land management has the potential to provide multiple co-benefits**
- **Rapid reductions in anthropogenic GHG emissions across all sectors** reduce negative impacts of climate change on land ecosystems and food systems (medium confidence).
- **Delaying climate mitigation and adaptation responses** across sectors would lead to **increasingly negative impacts on land** and reduce the prospect of sustainable development

Thanks

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