Can albedo change offset the climate benefit of carbon sequestrating practices?

Albedo & Climate Change Mitigation

3 - 4 DECEMBER 2020

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cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

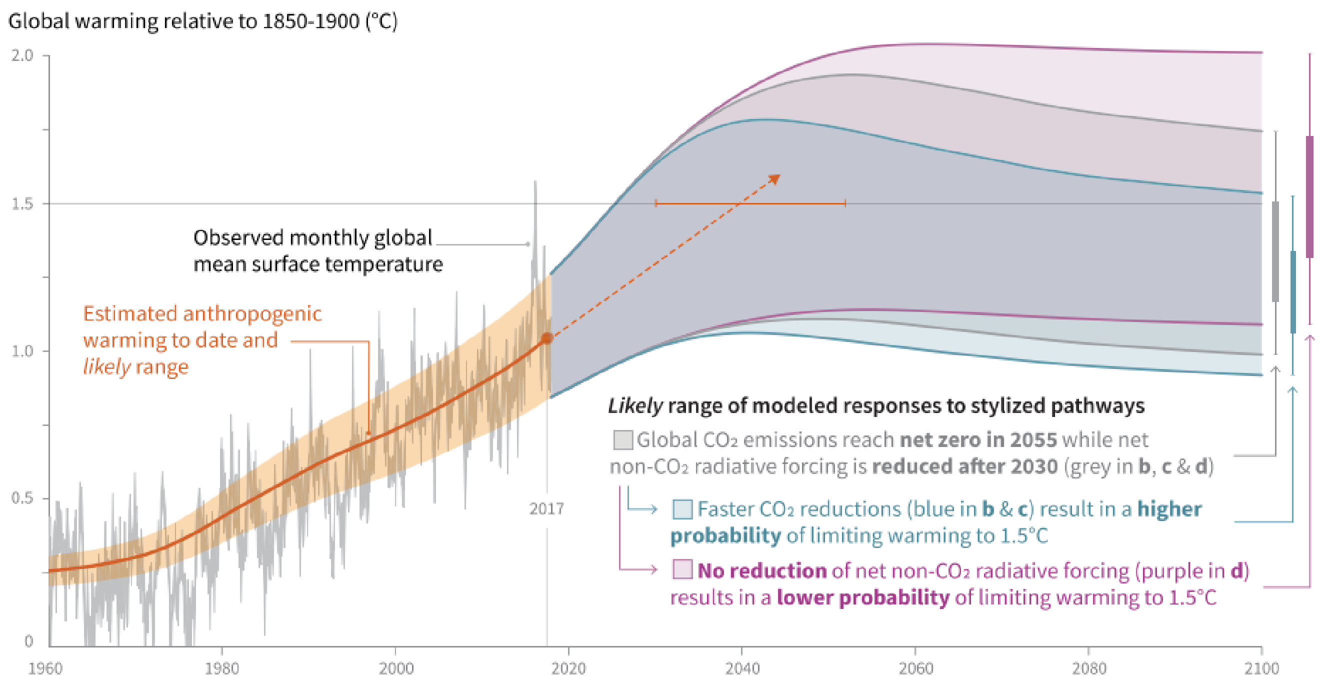
GLOBAL RESEARCH ALLIANCE ON AGRICULTURAL GREENHOUSE GASES

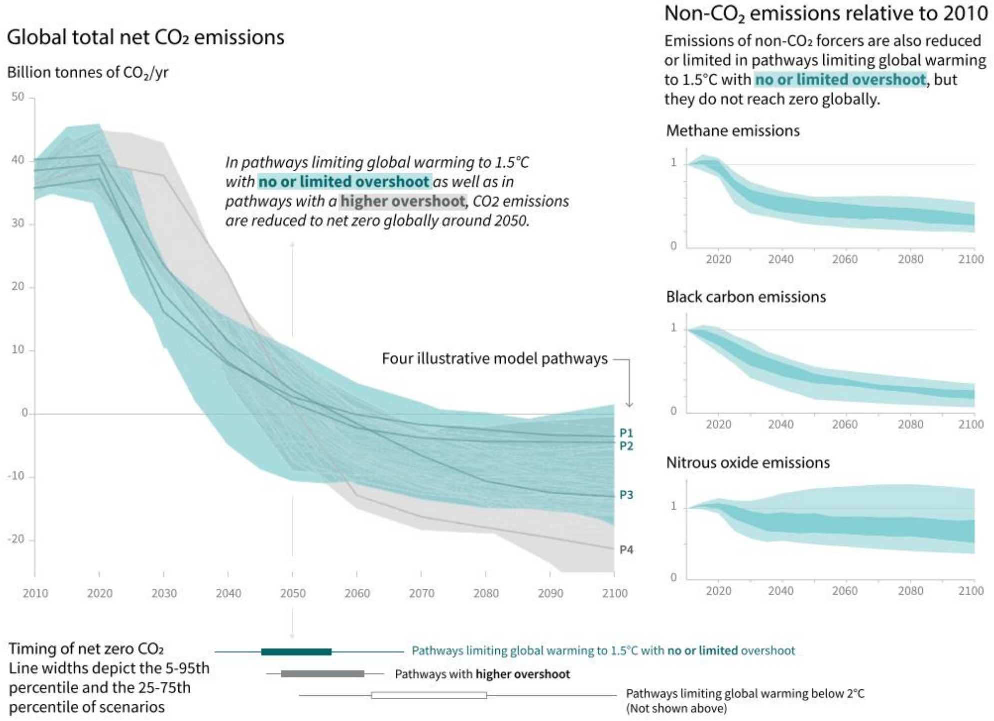
4 PER 1000 SOILS FOR FOOD SECURITY AND CLIMATE

Cland

Why organizing this workshop?

- The 2015 Paris Agreement of the UNFCCC aims to hold the rise in global average temperatures by 2100 to "**well below 2 °C** above pre-industrial levels and to **pursue efforts to limit the temperature increase to 1.5 °C** above pre-industrial levels".





IPCC 2018, *SR1.5*

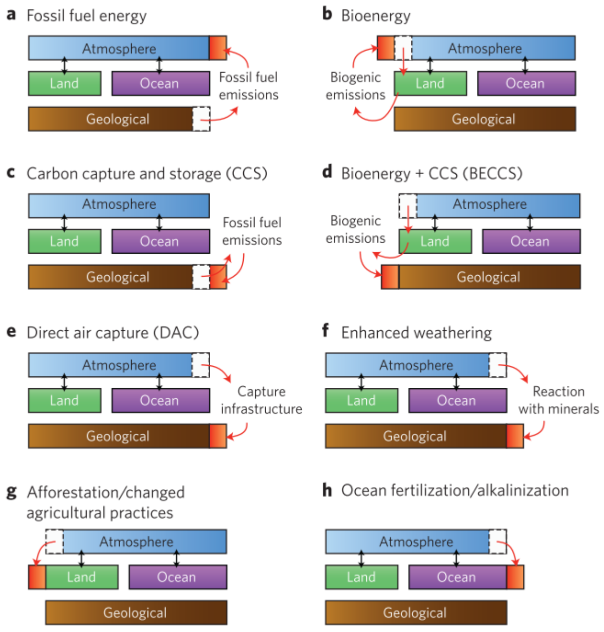
- Remaining carbon budget of 420-570 $GtCO_2$ for a 66% probability of limiting warming to 1.5°C. This remaining budget is being depleted by current emissions of 42 ± 3 $GtCO_2$ per year (IPCC 2018, *SR1.5*).

Why organizing this workshop?

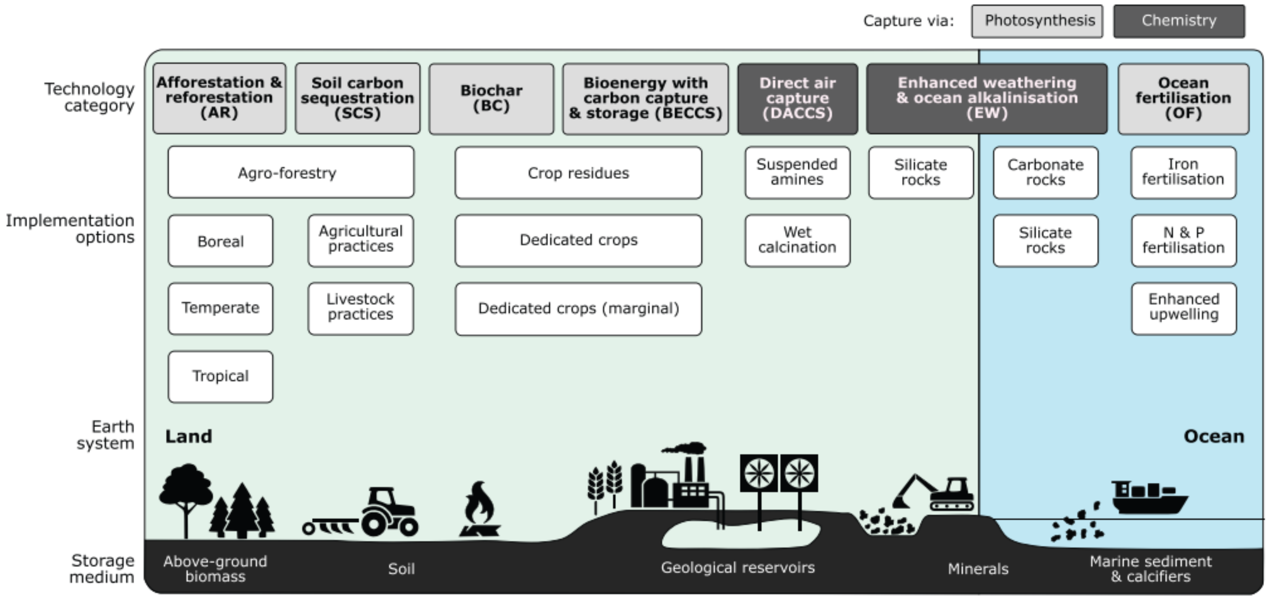
- Integrated assessment pathways limiting global warming to 1.5°C would require **rapid and far-reaching transitions** in energy, land, urban and infrastructure (including transport and buildings), and industrial systems (IPCC 2018, *SR1.5*). **Decarbonizing the economy**.

- **All pathways that limit global warming to 1.5°C project the use of carbon dioxide removal (CDR)** on the order of 100–1000 $GtCO_2$ over the 21st century. CDR would be used to compensate for residual emissions and, in most cases, achieve net negative emissions to return global warming to 1.5°C following a peak (IPCC 2018, SR1.5).

Negative Emissions Technologies (NETs)



Smith et al., 2016
Nature Climate Change

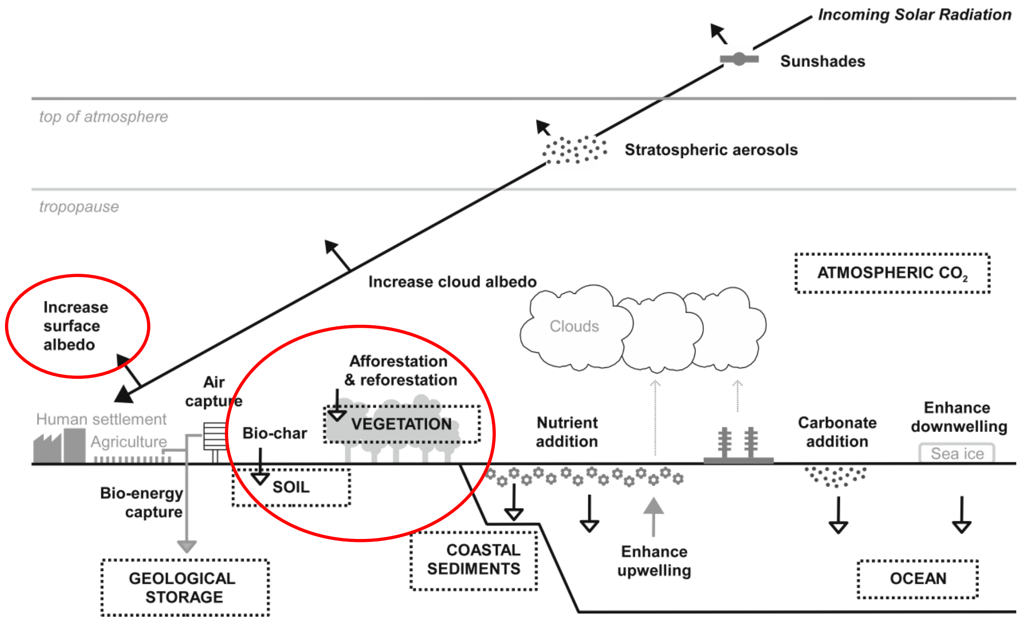


Minx et al., 2018 *ERL*

Why organizing this workshop?

- Climate **geoengineering**: solar radiation management (SRM) or carbon dioxide removal (CDR)

- **SRM measures are not included integrated assessment pathways** (IPCC 2018, *SR1.5*). Large uncertainties and knowledge gaps, substantial risks and institutional and social constraints to deployment related to governance, ethics, and impacts on sustainable development



Vaughan and Lenton 2011, *Climatic Change*

- CDR addresses the cause rather than simply the consequence of GHG emissions. Also helps directly mitigate ocean acidification and its potential marine ecological impacts (Ridgwell et al., 2012 *Phil. Trans. R. Soc. A*)

- CDR and SRM are not mutually exclusive of each other, potential for synergies, but also trade-offs. Especially for **land-based NETs**, **natural climate solutions** and **surface albedo management** (Singarayer and Davies-Barnard 2012 *Phil. Trans. R. Soc. A*)

Why organizing this workshop?

- **Regional land radiative management** and **cropland albedo management** can be an effective measure for **temperature mitigation**, especially for hot extremes (Davin et al., 2014 *PNAS*; Wilhem et al., 2015 *J Geophys Res Atmos*; Seneviratne et al., 2018 *Nature Geoscience*; Seneviratne et al., 2018 *Phil Trans R Soc A*).

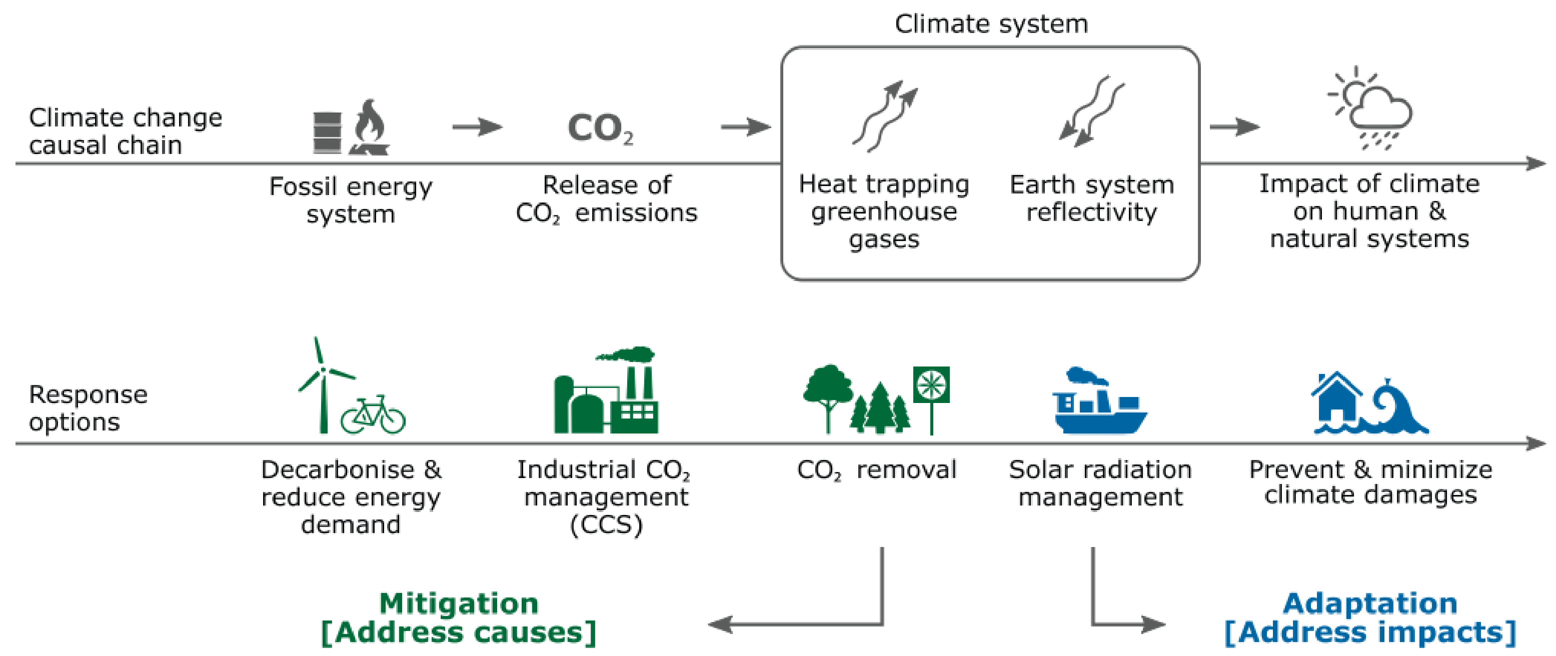


Figure 1. Human response options to the climate problem. Horizontal arrows in the top row show the causal chain of the climate change problem. Vertical arrows and bottom row define locus and modes of intervention for climate policy. Graph further developed from Keith (2000).

Minx et al., 2018 *ERL*

Why organizing this workshop?

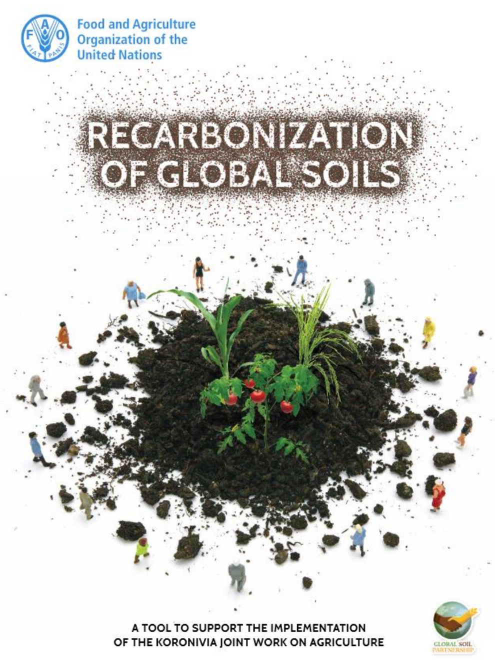
- Agriculture, Forestry and Other Land Use (AFOLU) responsible for 23% of total anthropogenic greenhouse gas emissions (2007-2016) (IPCC 2019, *SRCCL*).

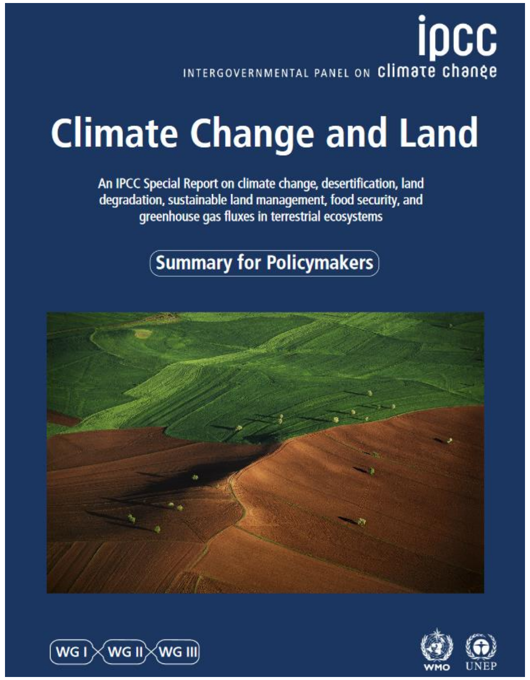
- Since the pre-industrial period, the land surface air temperature has risen nearly twice as much as the global average temperature (IPCC 2019, *SRCCL*).

- Many land-related responses that contribute to climate change adaptation and mitigation can also combat desertification and land degradation and enhance food security

- 4 per Thousand Initiative, Koronivia Joint Work on Agriculture, FAO RECSOIL…

➔ Critical role of land use and land management for climate change mitigation





Why organizing this workshop?

Potential global contribution of response options to mitigation, adaptation, combating desertification and land degradation, and enhancing food security

	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	●●

Key for criteria used to define magnitude of impact of each integrated response option

		Mitigation *Gt CO₂-eq yr⁻¹*	Adaptation *Million people*	Desertification *Million km²*	Land Degradation *Million km²*	Food Security *Million people*
Positive	Large	More than 3	Positive for more than 25	Positive for more than 3	Positive for more than 3	Positive for more than 100
	Moderate	0.3 to 3	1 to 25	0.5 to 3	0.5 to 3	1 to 100
	Small	Less than 0.3	Less than 1	Less than 0.5	Less than 0.5	Less than 1
	Negligible	No effect	No effect	No effect	No effect	No effect
Negative	Small	Less than -0.3	Less than 1	Less than 0.5	Less than 0.5	Less than 1
	Moderate	-0.3 to -3	1 to 25	0.5 to 3	0.5 to 3	1 to 100
	Large	More than -3	Negative for more than 25	Negative for more than 3	Negative for more than 3	Negative for more than 100

←→ **Variable:** Can be positive or negative — no data na not applicable

Confidence level

Indicates confidence in the estimate of magnitude category.

- *H High confidence*
- *M Medium confidence*
- *L Low confidence*

Cost range

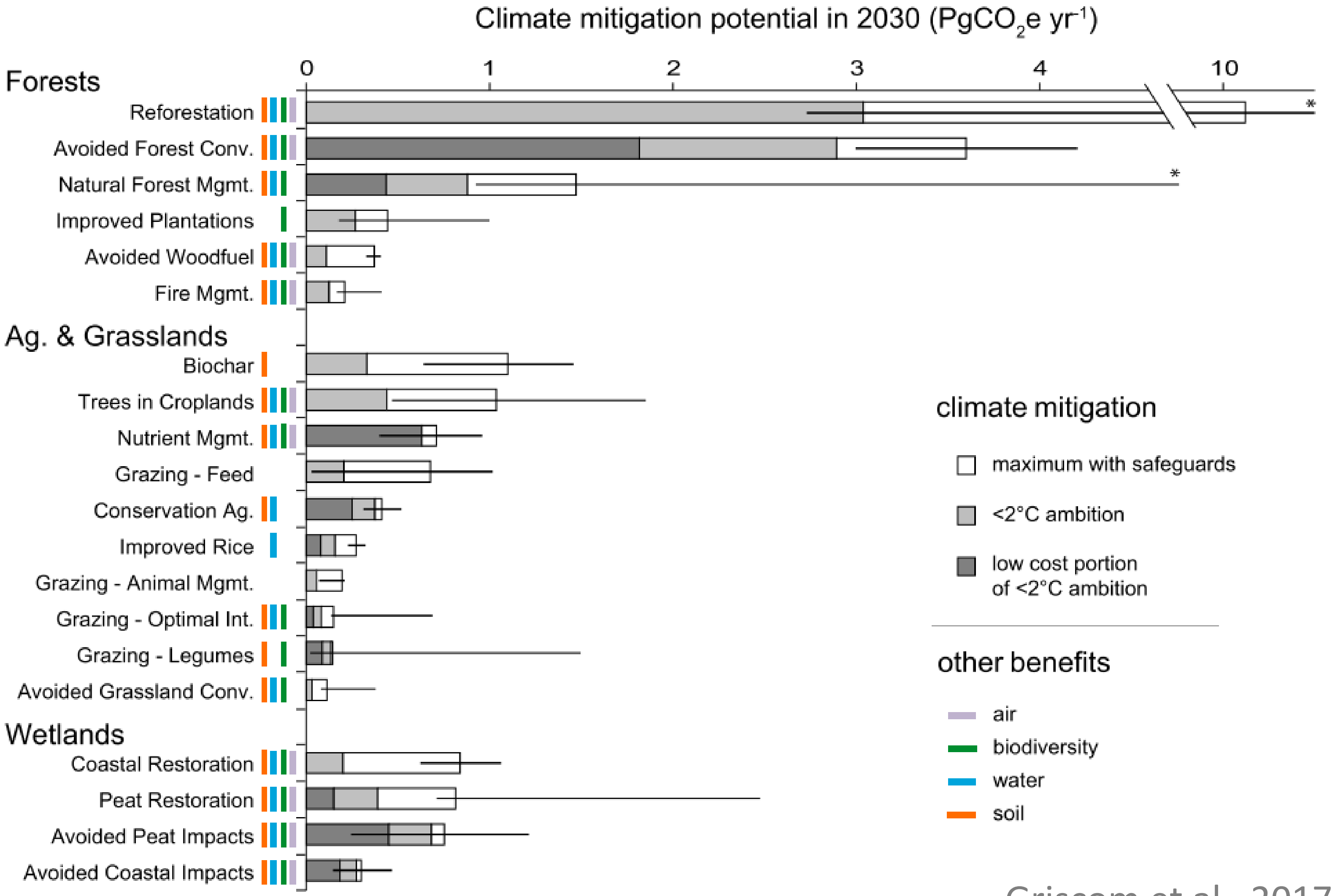
See technical caption for cost ranges in US$ tCO_2e^{-1} or US$ ha^{-1}.

- ●●● High cost
- ●● Medium cost
- ● Low cost
- — no data

IPCC 2019, *SRCCL*

Why organizing this workshop?

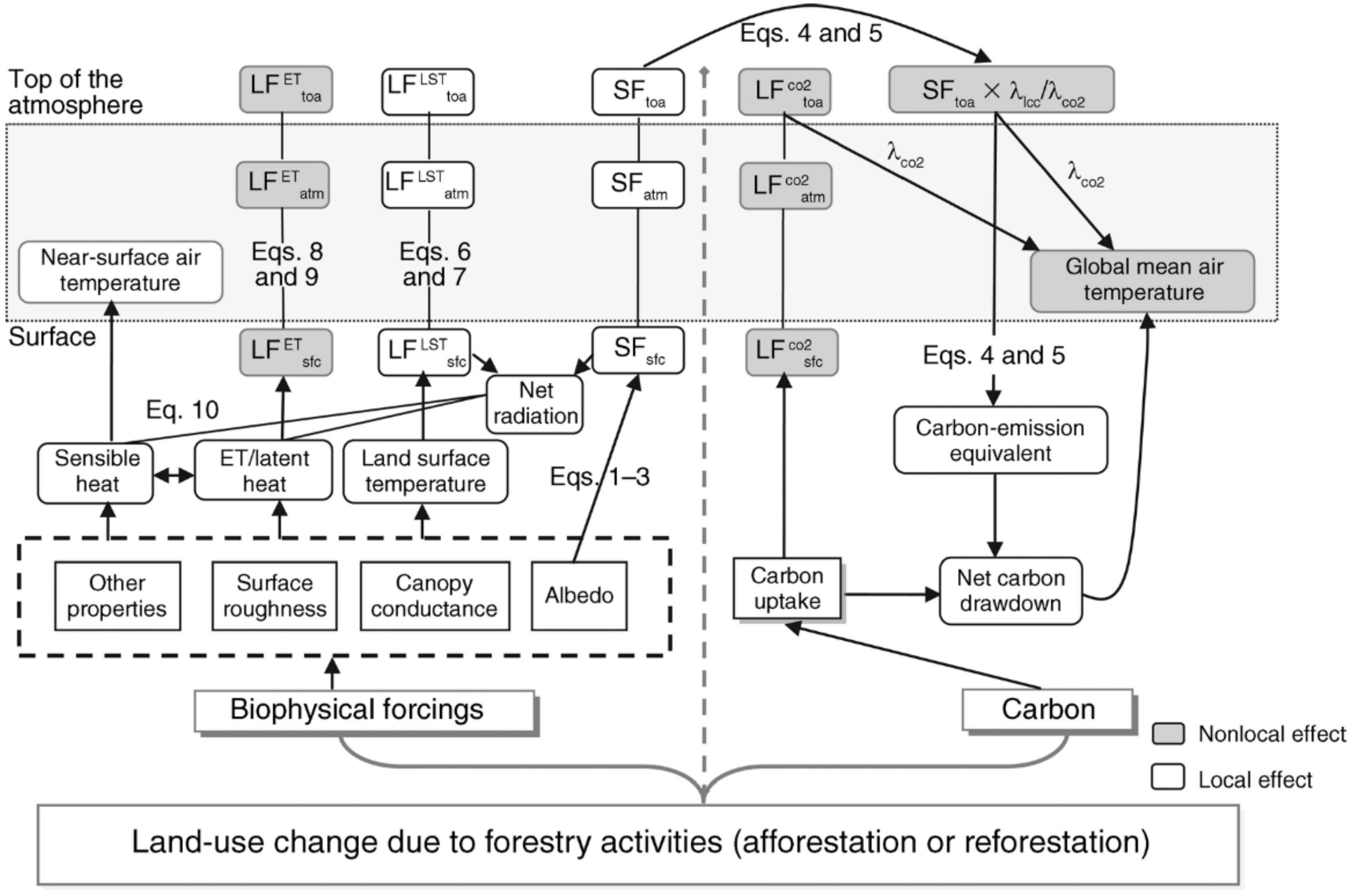
The maximum potential of NCS—when constrained by food security, fiber security, and biodiversity conservation—is 23.8 petagrams of CO_2 equivalent ($PgCO_2e$) y^{-1} (95% CI 20.3–37.4).



Griscom et al., 2017 *PNAS*

Why organizing this workshop?

➔ Can climate change mitigation only be achieved through biochemical effects of carbon sequestrating practices? What about biophysical effects? Are they important/relevant? Is surface albedo management only about climate change adaptation?



SF: Shortwave radiative forcing
LF: Longwave radiative forcing

ET: Evapotranspiration

Zhao and Jackson 2014, *Ecological Monographs*

- Highly complex – radiative budget & water cycle

Why organizing this workshop?

- **Increased climate benefit due to biophysical effects** for **reduced tillage** and **irrigation** (Lobell et al., 2006 *Geophysical Research Letters*), **cover crops** (Carrer et al., 2018 *Environmental Research Letters*).

- Others reported total or partial **offset of climate benefit due to biophysical effects**, for **forests/afforestation** (Betts 2000 *Nature;* Luyssaert al., 2018 *Nature*), **biochar** (Bozzi et al., 2015 *Environmental Research Letters*)

- **A same practice can have opposite biophysical effects depending on soil type, latitude, etc**. Hirsch et al., (2018) *Global Change Biology* found that conservation agriculture (CA) generally contributes to local cooling (~1°C) of hot temperature extremes in mid-latitude regions, while over tropical locations CA contributes to local warming (~1°C): changes in the partitioning of evapotranspiration between soil evaporation and transpiration are critical for the sign of the temperature change

The workshop – keynote speakers

Ryan BRIGHT
(NIBIO)

Eric CESCHIA
(INRAe/CESBIO)

Philippe CIAIS
(LSCE)

Edouard DAVIN
(ETHZ)

Morgan FERLICOQ
(CESBIO)

Lorenzo GENESIO
(IBE-CNR)

Emanuele LUGATO
(JRC)

Sebastiaan LUYSSAERT
(VU Amsterdam)

Jean-Louis ROUJEAN
(CNRS)

Sonia SENEVIRATNE
(ETHZ)

Petra SIEBER
(SLU)

Aude VALADE
(CIRAD)

The workshop – program

- 5 keynotes each half day.

Can albedo change offset the climate benefit of carbon sequestrating practices?		
3 December 2020: *How to measure albedo change and related biophysical effects? How to compare biochemical and biophysical effects of carbon sequestrating practices? How to compute radiative forcing of land use and management? Methodological aspects*		
Schedule	**Title**	**Speaker**
13:30-13:40	Welcome and Introduction	Rémi CARDINAEL (CIRAD)
13:40-13:50	Presentation of the CLAND Convergence Institute	Philippe CIAIS (LSCE)
13:50-14:00	Presentation of the Global Research Alliance on Agricultural Greenhouse Gases	Hayden MONTGOMERY (GRA)
14:00-14:10	Presentation of the 4 per Thousand Initiative	Paul LUU (4P1000)
14:10-14:50	Biophysical land-use-climate interactions in low-emissions scenarios	Sonia SENEVIRATNE (ETHZ)
14:50-15:30	A review of CO2-equivalent metrics for surface albedo change in land management contexts	Ryan BRIGHT (NIBIO)
15:30-15:45	Break	
15:45-16:25	Prioritizing conservation and restoration based on the overall climatic value of forests	Edouard DAVIN (ETHZ)
16:25-17:05	Crops, albedo and climate impact from a life cycle perspective	Petra SIEBER (SLU)
17:05-17:45	Land surface albedo at high spatial resolution from a merging of Sentinel-2 and Landsat-8 data; analysis of times series at landscape scale and validation	Jean-Louis ROUJEAN (CNRS)

4 December 2020: *Land use and management, albedo, carbon sequestration and climate change mitigation*		
Schedule	**Title**	**Speaker**
8:30-8:40	Welcome and Introduction	Rémi CARDINAEL (CIRAD)
8:40-9:20	Shall we consider biogeochemical and biogeophysical effects to prioritize changes in cropland management in a perspective of climate change mitigation?	Eric CESCHIA (CESBIO), Morgan FERLICOQ (CESBIO)
9:20-10:00	A (pale) green revolution for the 'Green deal'	Emanuele LUGATO (JRC)
10:00-10:40	Biochar and albedo: facts and perspectives	Lorenzo GENESIO (CNR)
10:40-10:55	Break	
10:55-11:35	Global biophysical climate change induced by bioenergy crop plantation	Philippe CIAIS (LSCE)
11:35-12:15	Forest management cools the Earth! Did it? Will it?	Sebastiaan LUYSSAERT (Vrije Universiteit Amsterdam), Aude VALADE (CIRAD)
12:15-12:30	Workshop wrap-up	

- 30 minutes talk + 10 minutes questions. Questions can be sent in the chat. A Google Doc will be shared for un-answered questions.

Who is organizing?

- Previous workshop organized by CLAND:

A Workshop Series Organized by the CLAND Convergence Institute

DOI: 10.1111/gcb.15342

RESEARCH REVIEW

Global Change Biology WILEY

Can N_2O emissions offset the benefits from soil organic carbon storage?

Bertrand Guenet[1] | Benoit Gabrielle[2] | Claire Chenu[2] | Dominique Arrouays[3] | Jérôme Balesdent[4] | Martial Bernoux[5] | Elisa Bruni[1] | Jean-Pierre Caliman[6] | Rémi Cardinael[7,8,9] | Songchao Chen[3] | Philippe Ciais[1] | Dominique Desbois[10] | Julien Fouche[11] | Stefan Frank[12] | Catherine Henault[13] | Emanuele Lugato[14] | Victoria Naipal[1] | Thomas Nesme[15] | Michael Obersteiner[12] | Sylvain Pellerin[15] | David S. Powlson[16] | Daniel P. Rasse[17] | Frédéric Rees[2] | Jean-François Soussana[18] | Yang Su[2] | Hanqin Tian[19] | Hugo Valin[12] | Feng Zhou[20]

Short presentation of CIRAD

cirad AGRICULTURAL RESEARCH FOR DEVELOPMENT

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RÉPUBLIQUE FRANÇAISE

A French public research organization with an international vocation

- CIRAD is the French agricultural research and international cooperation organization working for the sustainable development of tropical and Mediterranean regions
- A staff of **1650** including **800** researchers
- 6 key thematic fields: Biodiversity, Integrated health approach, Agroecological transitions, Territories, Food systems, **Climate change**

Three scientific departments

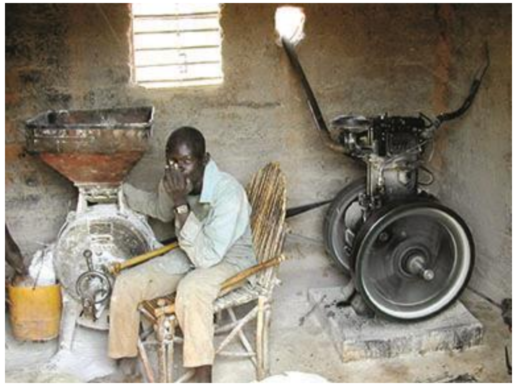
UNDERSTANDING
biological systems, from molecule to ecosystem

>

ANALYSING
the practices and performance of farming systems, from plot to farm

>

SUPPORTING
players in rural areas, from a local to a global level



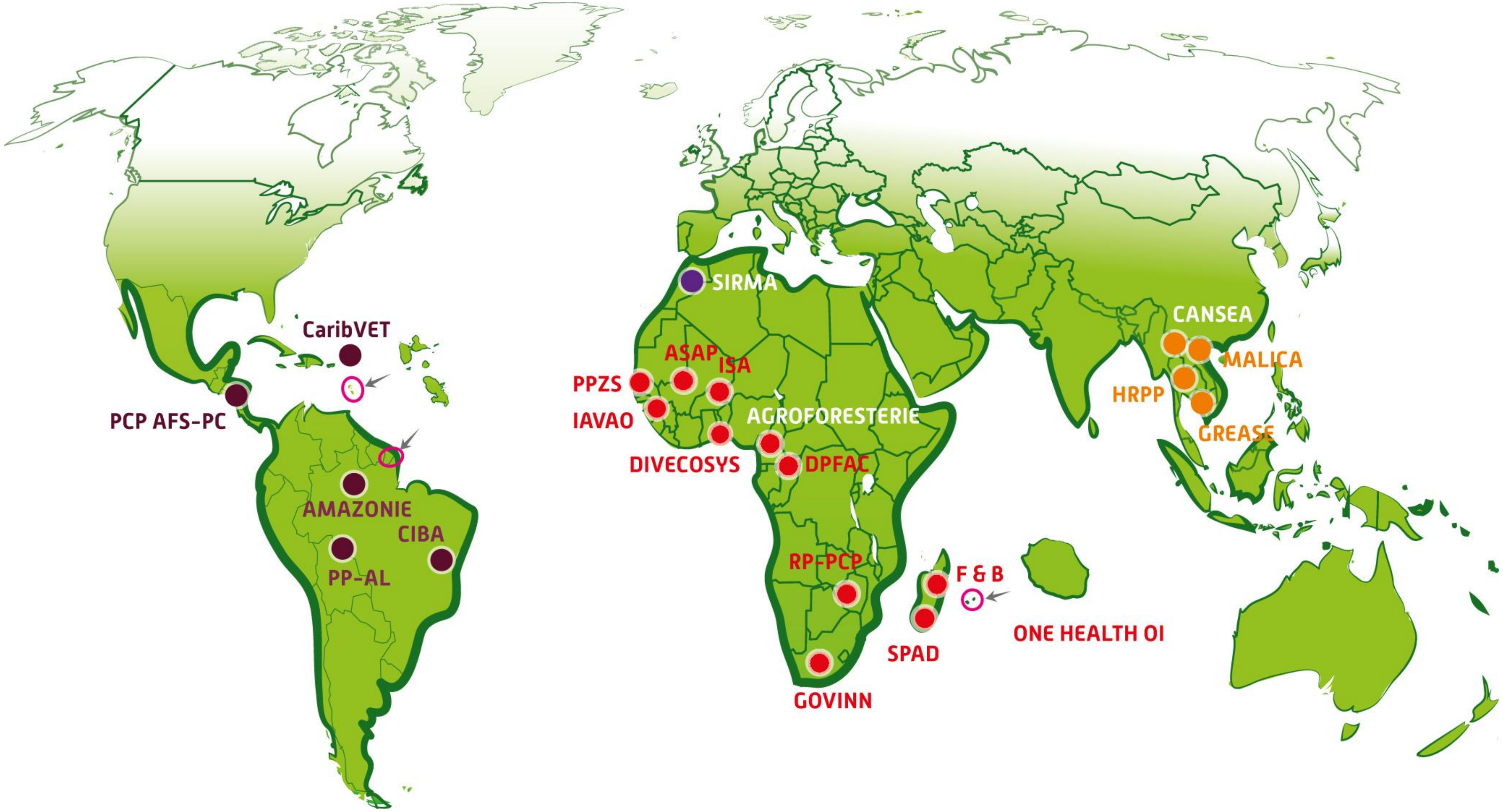
Biological Systems Department (BIOS)
11 research units

Tropical Production and Processing Systems Department (PERSYST)
12 research units

Environment and Societies Department (ES)
10 research units

22 platforms in partnership for research and training

350 researchers assigned abroad and in the French overseas regions



The workshop – now!

http://albedocc.lsce.ipsl.fr/

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Albedo
& Climate Change Mitigation

3 - 4 DECEMBER 2020

Enjoy the worskhop!