CarMa

Carbon Management
IFP School Chair

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IDées

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Carbon Management and negative CO_2 emissions technologies towards a low carbon future

DÉPLOIEMENT DES BECCS ET OBJECTIFS DE DÉVELOPPEMENT DURABLE : QUEL AVENIR EN COMMUN ?

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TotalEnergies

FONDATION TUCK

AgroParisTech

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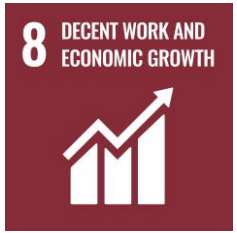
INRAE

- Land-based challenges
  - Climate change adaptation and mitigation
  - Land degradation and desertification
  - Food insecurity
  - Biodiversity loss
  - Ground water depletion and water pollution
- Need of integrated responses – Land management
  - Supply
  - Demand

SCOPE

Land Use & SDGs

Land-based Challenges



LAND USE & SDGS - INTEGRATED RESPONSES

- Agricultural non-CO_2 GHG abatement
- Soil organic carbon sequestration
- BECCS
- Increase in arable crop yields
- Increase in feed & herbage conversion efficiency by livestock
- Healthier diets
- Food wastes
- Forestry and other Land Use (FOLU) mitigation

LAND USE & SDGS - INTEGRATED RESPONSES

- Reduced direct N_2O and CH_4 emissions of agriculture
- Increased agricultural SOC stock (annual relative change)
- Carbon dioxide removal from non-food use of agricultural biomass
- Increased crop and fodder yields
- Reduced feed and forage consumption by livestock for same production
- Reduced animal food consumption
- Food waste reduction and reduced supply and emissions

CONCEPTUAL FRAMEWORK – LAND-BASED CHALLENGES

Land-based challenges
Climate change mitigation
Climate change adaptation
Food security
Land degradation / desertification
Biodiversity
Groundwater stress
Water quality

Drivers by 2050
Population
Land Use Change (LUC)
Land-based mitigation
Climate change impacts
Land degradation impacts
Undernourishment
Overnourishment
Diets westernization

Sustainable Development Goals (SDGs)
SDG 2 Zero Hunger - Food security
SDG 3 Good Health & Well Being
SDG 6 Clean Water and Sanitation
SDG 7 Affordable and Clean Energy
SDG 8 Decent work & Economic Growth
SDG 12 Responsible Consumption & Production
SDG 13 Climate Action
SDG 15 Life on Land

Response options
Agriculture
Forests
Soils
Other ecosystems
Carbon dioxide removal
Food demand

Responses w/o tradeoffs by 2050
Crop yields
Livestock feed conversion
Agricultural GHG abatement
Soil carbon sequestration
Bioenergy and BECCS
Forestry and other land use
Avoided deforestation
Dietary changes
Food wastes and losses

SDG based targets for land by 2050
Food availability & access (SDG2)
Healthy diets (SDG3)
Nitrogen use (SDG 6 & SDG8)
Bioenergy (SDG7 & SDG 13)
Food waste (SDG 12)
Land mitigation (SDG 13)
LUC and biodiversity (SDG 15)
Land degradation neutrality (SDG15)
[Water use] SDG6

Viable space for land by 2050:
Coordinated responses w/o tradeoffs,
matching land-based targets for 8 SDGs

AgRIPE Model

Agricultural Representative Identities and Pathways of Emissions

- Type: Mass Balance Model
  - C & N
- Spatial scale: Global
- Temporal scale: 2010 – 2050
- Input
  - Population
  - Land-use
  - Land-based production
  - Diets
  - GHG emissions

AgRIPE Model

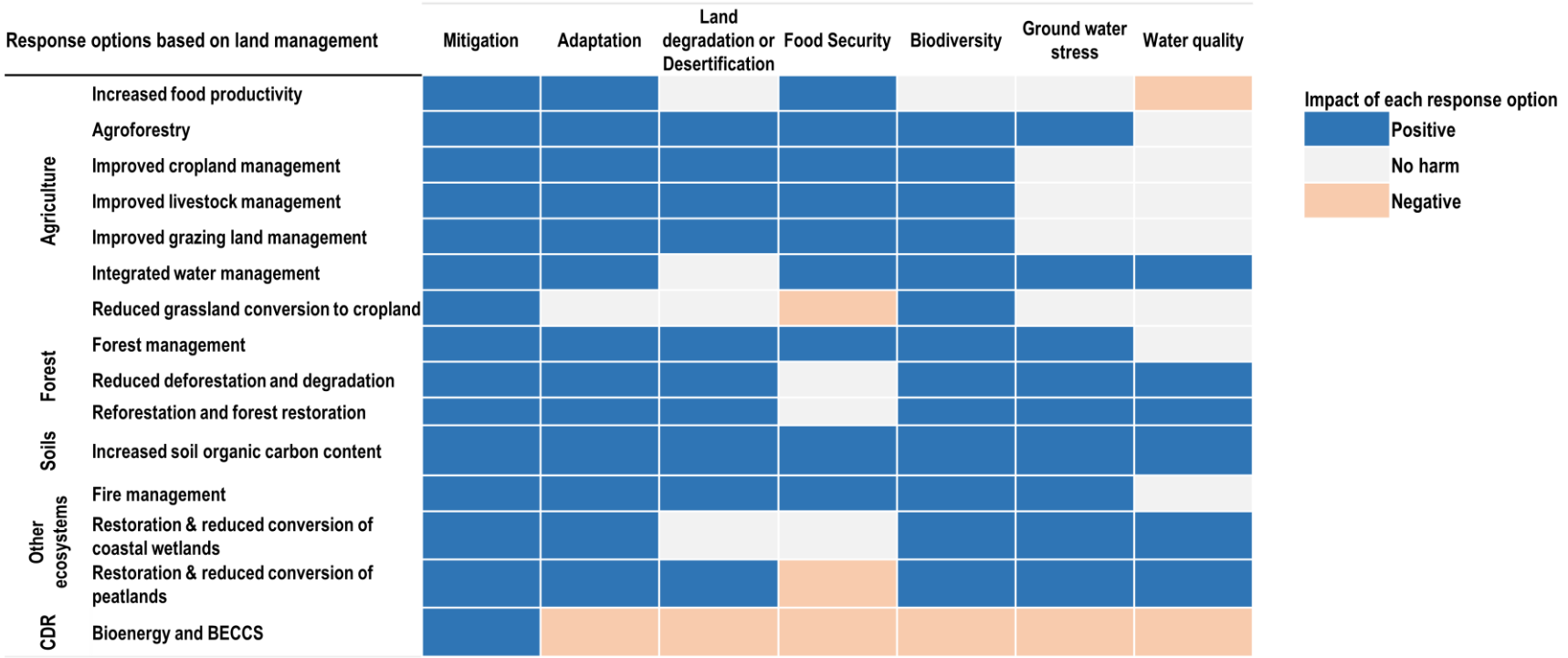
- Outputs
  - Arable land expansion
  - Food protein demand
  - Crop protein supply
  - Climate change
  - Land degradation
  - Livestock feed conversion efficiency
  - Agricultural GHG abatement
  - Soil Cabon sequestration
  - Food Waste
  - Healthy Diets
  - Bioenergy and BECCS
  - Forestry and other land uses
- Scenarios
  - Land Use Change (No, Low)
  - Global Warming (1.5 °C, 2.0 °C)

AgRIPE Model - Drivers and response types

		2010		2050		
			SSP1 1 LOW	SSP2 2 MEDIUM	SSP3 3 HIGH	Source
Global population (millions)		6867.4	8459.4	9164.2	9949.1	FAO stats for 2010; SSP database
% Arable lands		10.6		2 LUC scenarios (NO, LOW) (see Table 4)		Scenario consistent with SSP database
% Agricultural lands		36.9	36.9	36.9	36.9	FAOstats for 2010; SSP database
A. Drivers	**Modelled impacts**	**2010 value**	**Relative change in 2050**			
			Minimum	**Maximum**		
Climate change	Decline of global crops and rangelands yields	-	-6.5%	0.0%		IPCC (2014)
Land degradation	Decline of global crops and rangelands yields	-	-10.0%	0.0%		ITPS (2016)
Non-food use of agricultural biomass	Increase in non-food use (bioenergy, biochemical, biomaterials)	25.3%	0.0%	+6%		Based on area adoption for BECCS in Mitigation scenario (see Extended Table 5)
Diets westernization	Increase in animal food fraction of protein intake	39.4%	0.0%	+15%		FAO, Food and Agriculture projections by 2050
Number of chronically undernourished (millions)	Change in global mean per capita calorie demand	1970 millions	-100%	+100%		FAO, Food and Agriculture projections by 2050
B. Response types	**Primary simulated responses**		**2050 relative changes**		**Productivity and Mitigation scenario range (see Extended data Table 5)**	**Other references**
			Minimum	**Maximum**		
Agricultural non-CO_2 GHG abatement	Reduced direct N_2O and CH_4 emissions of agriculture, increased legume crops, substitution of inorganic N by mineral N		-25%	0.0%	-11% to -5.7%	Wollenberg et al., 2015
Soil organic carbon (SOC) sequestration	Increased agricultural SOC stock (annual relative change)		0.0	+8% (0.2%/yr)	+0.076 to +0.15%/yr	Soussana et al. (2019)
BECCS	Carbon dioxide removal from non-food use of agricultural biomass		0.0	3.3 Gt CO_2 eq yr^{-1}	0 to 3.3 Gt CO_2eq yr^{-1}	IPCC (2019), Chapter 6, for 0.68 M km^2
Increase in arable crop yields	Increased crop and fodder yields		+18%	+88%	+62 to +78 %	Up to +25% compared to current baseline trend
Increase in feed & herbage conversion efficiency by livestock	Reduced feed and herbage consumption by livestock for same production		0.0%	+16%	N.A.	Up to +25% compared to current baseline trend
Healthier diets with less animal products and less red meat in animal products	Reduced animal food consumption targeting red meat, substitution by other crops (fruits and vegetables)		-25%	0.0%	N.A.	EAT Lancet Commission report (2019)
Food wastes	Food waste reduction and reduced supply and emissions		-50%	0.0%	N.A.	FAO, Food and Agriculture projections by 2050
Forestry and other Land Use (FOLU) mitigation			0.0	2.1 Gt CO_2 eq yr^{-1}	2.1 Gt CO_2 eq yr^{-1}	Fire management; Reforestation and forest restoration; Forest management; Peatland restoration and avoided degradation

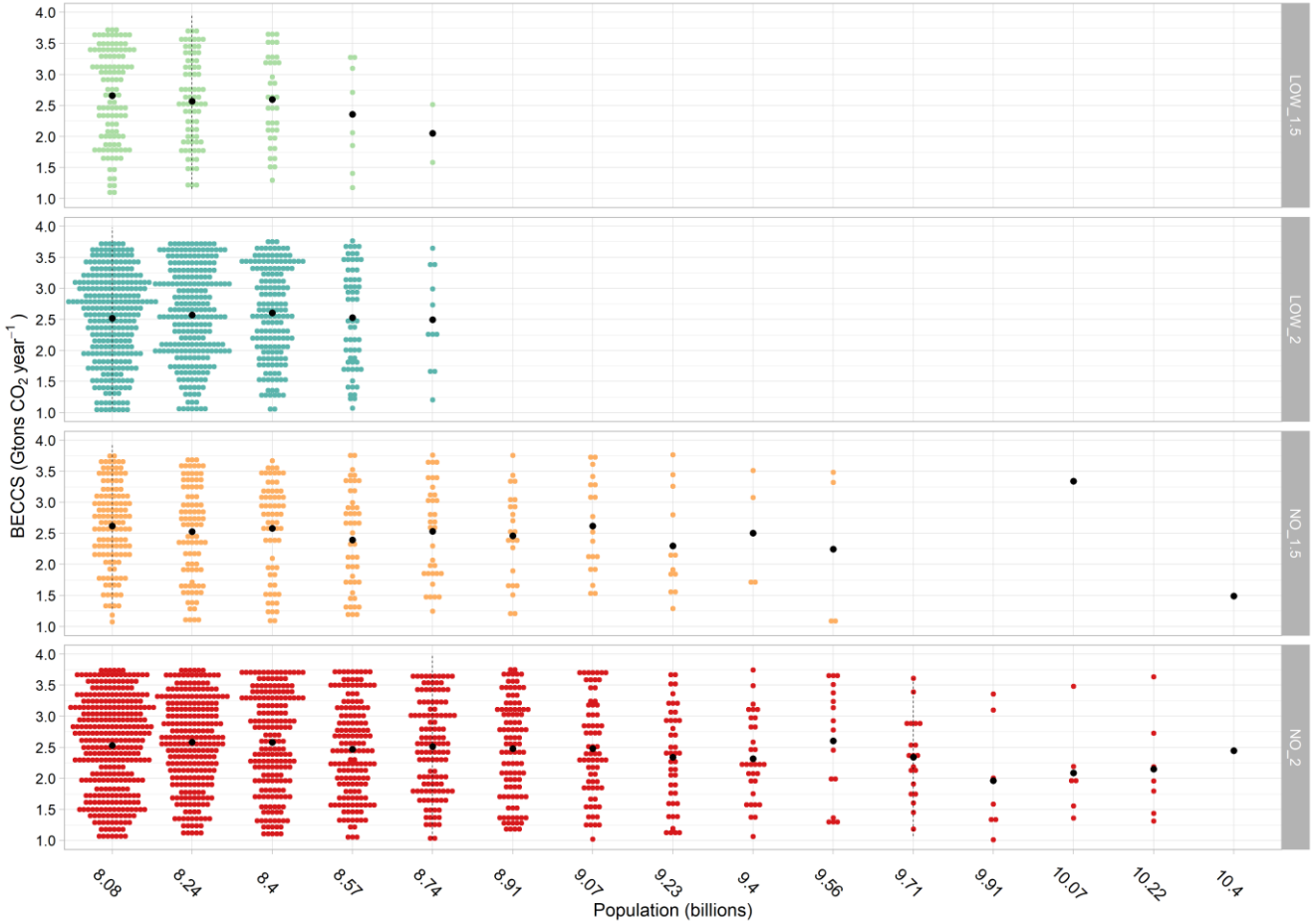
RESULTS

Co-benefits and trade-offs



Modified from IPCC SRCCL (SPM and Chapter 6) and Smith et al.

RESULTS


LOW_1.5
LOW_2
NO_1.5
NO_2
BECCS (Gtons CO_2 $year^{-1}$)
4.0
3.5
3.0
2.5
2.0
1.5
1.0
8.08
8.24
8.4
8.57
8.74
8.91
9.07
9.23
9.4
9.56
9.71
9.91
10.07
10.22
10.4
Population (billions)

- ✓ Solution space: there are land management and value chain side responses having no adverse side effects that could be adopted to meet 8 SDGs by 2050
- ✓ Viable space:
  - ✓ Stop cropland expansion
  - ✓ Stabilization global population below 10 billion
- ✓ Changes brought by integration of land use, bioenergy, agriculture, food and nutrition
- ✓ Through cross-sectorial structuring of policies and economic mechanisms

THANK YOU!

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