

CHALLENGE 1

Land-based climate mitigation

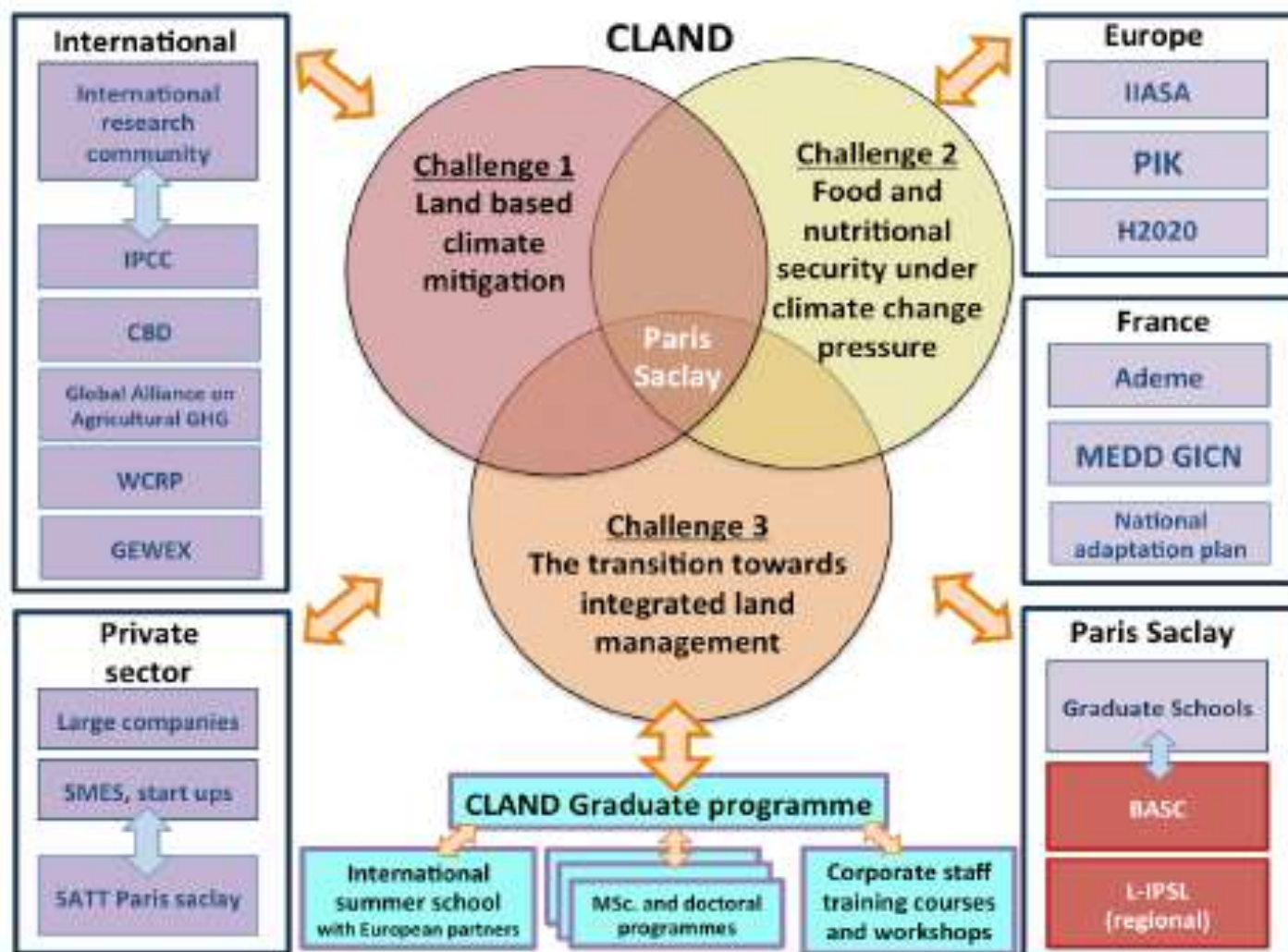
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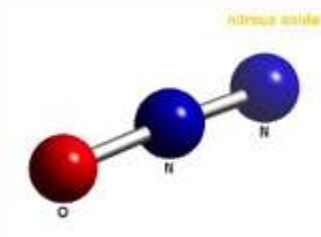
1: UMR EcoSys; 2: LSCE; 3: INRA; 4: UMR Economie Publique

DISCLAIMER





What are these land-based mitigation measures ?



Fertilizer N management, developing legumes.



Cover crops, conservation agriculture, agroforestry, reduced tillage, pasture management, organic waste application



Afforestation and reforestation

Tree growth takes up CO_2 from the atmosphere.



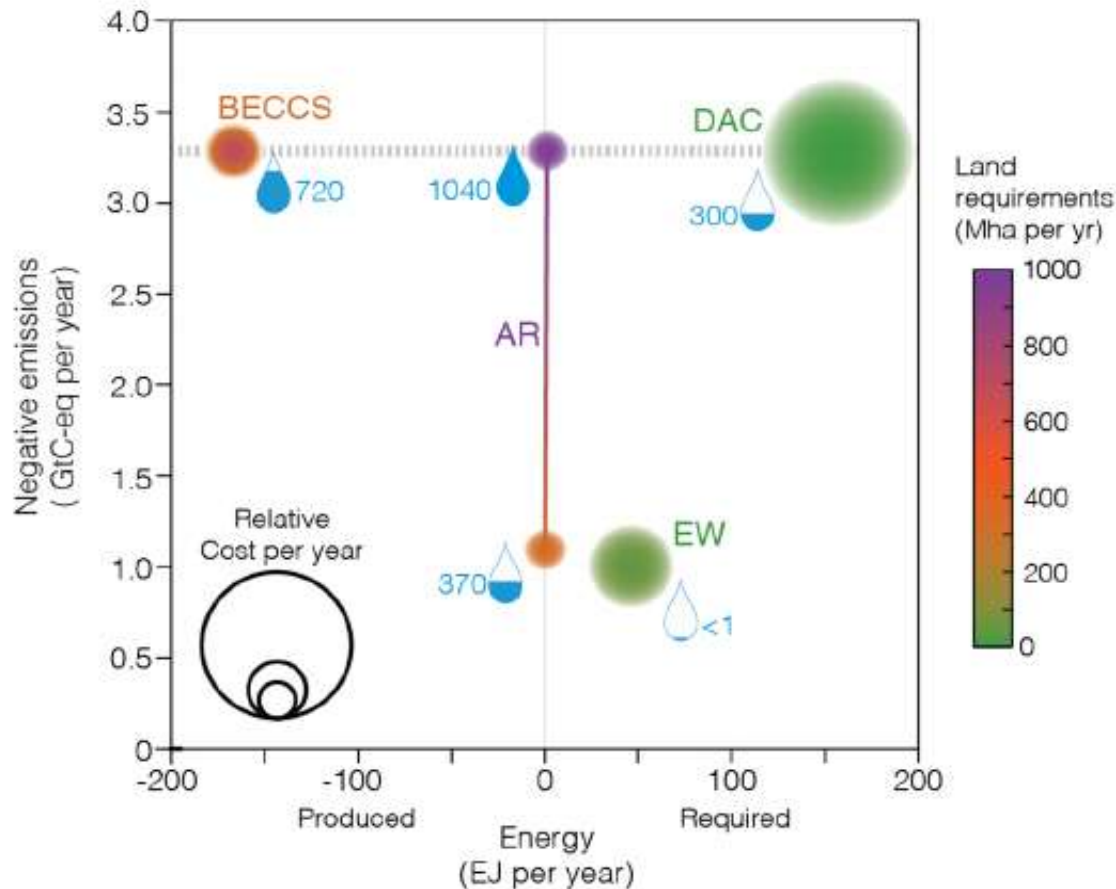
Biochar

Partly burnt biomass is added to soils absorbing additional CO_2 .



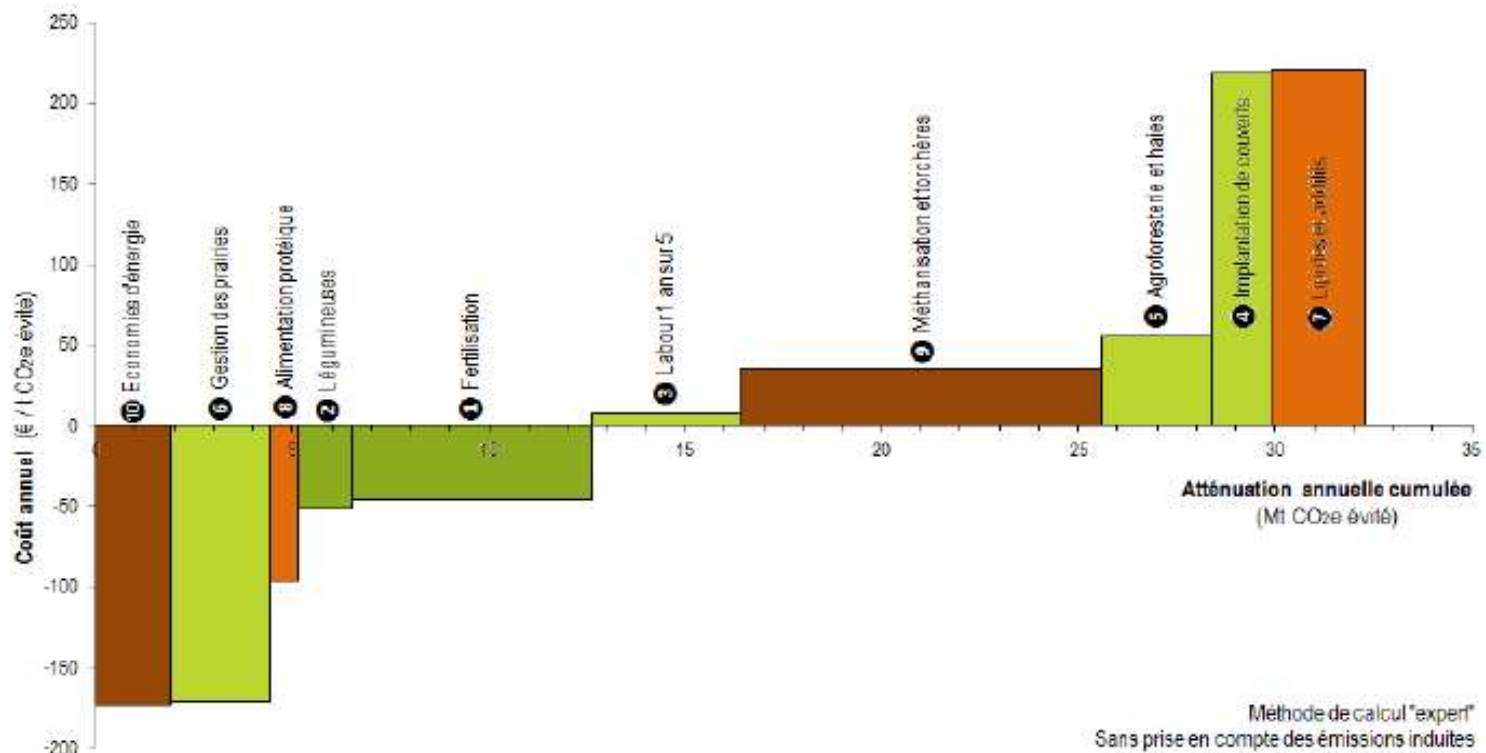
Bioenergy with carbon capture and storage (BECCS)

Plants turn CO_2 into biomass that fuel power plants. CO_2 is captured and stored underground.



Potential of negative GHG emission technologies mapped according to resource use. BECCS: bioenergy with carbon capture and storage; DAC: direct air capture of CO₂; EW: enhanced weathering; AR: afforestation/reforestation (Smith et al., Nature Climate Change, 2015).

Potential output: Marginal Cost Abatement Curve



Marginal costs of key measures to reduce GHG emissions from agriculture in France, and overall abatement potentials (Pellerin, Bamière et al., 2013).



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The grand challenge

This project seeks to design and assess land-based management strategies that:

- enhance carbon sequestration in biomass and soils, and/or reduce their CH₄ and N₂O emissions,
- are economically attractive, and incur minimal adverse impacts (on water, biodiversity, soil & air quality) or positive co-benefits (eg, on biodiversity),
- may contribute significantly to national and international mitigation plans.



- **Research Line 1.1. Review and design of land-based mitigation deployment scenarios**
- **Research line 1.2. Multi-criteria assessment of selected land-based mitigation measures**
- **Research Line 1.3. Critical appraisal of NDCs and their mitigation potential; Possible NDCs improvements.**

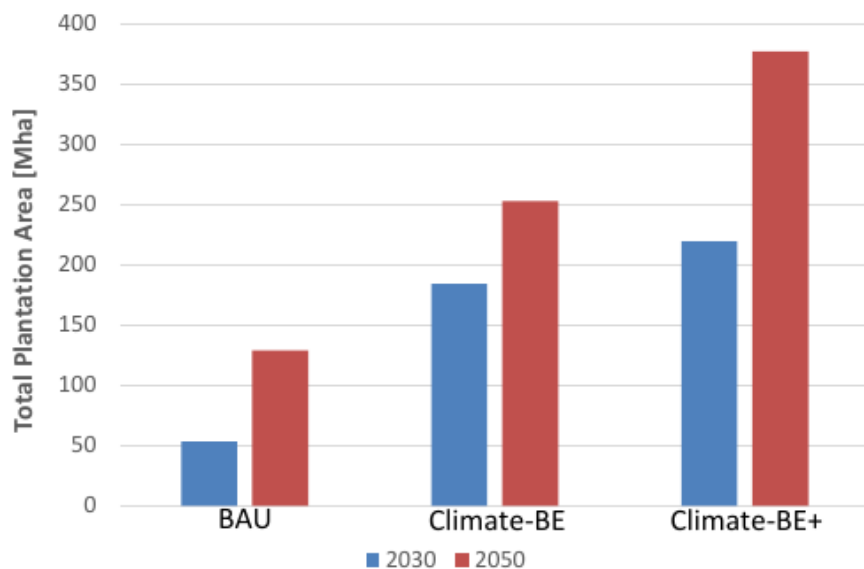
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This research line will:

- review the role of land-based mitigation measures in future climate scenarios (type, scale, timing, costs), set in global models or national road maps,
- focus on Bioenergy with Carbon Capture and Sequestration as a large-scale negative emission technology,
- explore the potential of land mitigation measures in France using economic models for various mitigation targets or sets of measures.

The role of land-based measures in mitigation scenarios

- Examined by dissecting outputs from Integrated Assessment Models, such as GLOBIOM (IIASA), for IPCC SSPs,
- Looking at other scenarios (IPBES, OECD, Afterres in France),
- Worldwide but also for China and France.



Areas cropped to short rotation coppice in scenarios aiming at meeting Sustainable Development Goals related to energy decarbonization, simulated by Globiom (Obersteiner et al., Sci. Adv., 2016)

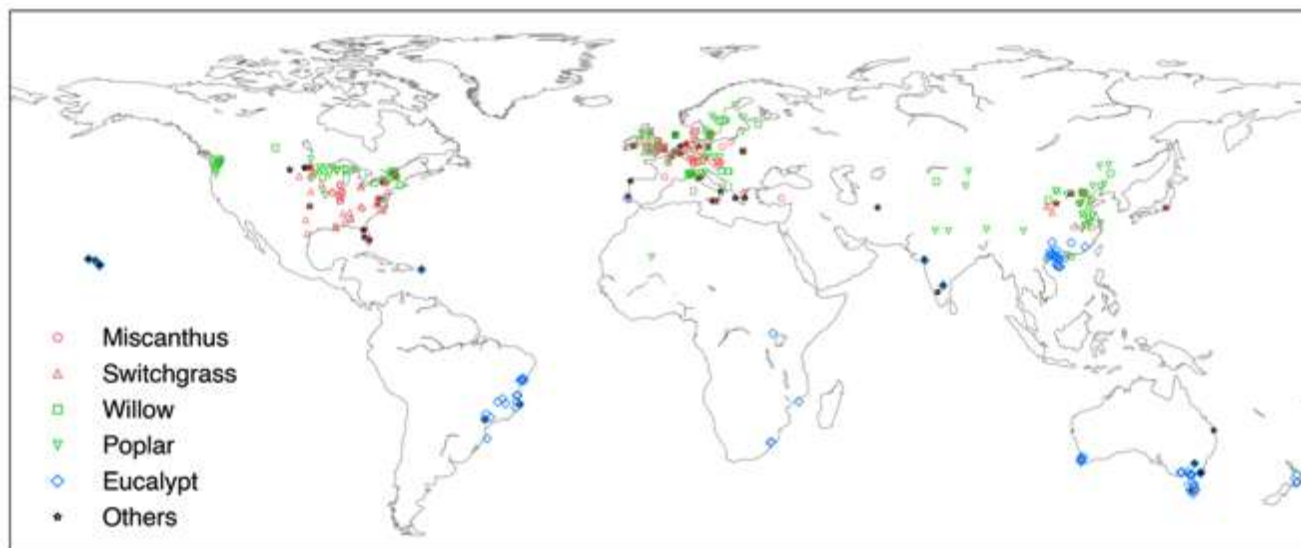
Rationale:

- BE(CCS) heavily relied on in mitigation scenarios,
- But with large uncertainties on the actual GHG balance (depending on where the crops are established),
- Indirect effects have been little investigated,
- Lignocellulosic crops have not been fully tested in ecosystem models,
- Strong expertise within CLAND on this issue



Methodology & outcomes:

- Calibration of gridded vegetation model (ORCHIDEE) on a new set of yield data (Li et al, in prep – see below)



Methodology & outcomes:

- Calibration of gridded vegetation model (ORCHIDEE) on a new set of yield data (Li et al),
- Implementation of biomass development scenarios (from WP1.1.1) in ORCHIDEE,
- Assessment of effects on soil C stocks and GHG emissions of biofuels + benefits over fossil fuels,
- Inclusion of Carbon capture and sequestration constraints (geological maps of reservoirs),
- Comparison of abatement potentials with Integrated Assessment Models.

Objectives :

- To assess the mitigation potential and cost of the French agricultural sector, incl. soil C sequestration,
- To analyse the cost-effective allocation of LMMs,
- To analyse the impacts of policy measures on the implementation of these LMM.

Methodology :

- model allocating LMM so as to minimize the total cost of mitigation for a given abatement target
- micro-economic farm-based models
- choice experiment
- Economic analysis of barriers and levers to the adoption (risk, transaction costs, liquidity constraints → feedback)

Outcomes :

- MACCs, maps, design of cost-effective policies

- LSCE
- CIRED
- Economie Publique
- EcoSys
- IIASA

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What are the impacts of developing land-based mitigation? And the efficiency?

Two possible lines of work:

- delving deeper into particular measures,
- looking into a broader range of impacts (on water, biodiversity, soil & air quality).

Proposed action: organization of an international workshop to review current literature (on impacts and also assessment methodology/indicators), to produce a review paper (end of 2018?).

Multi-criteria evaluation of mitigation scenarios in case studies

- Using state-of-the-art methodology derived from previous task

Anderson-Teixera et al.,
GCB Bioenergy, 2009

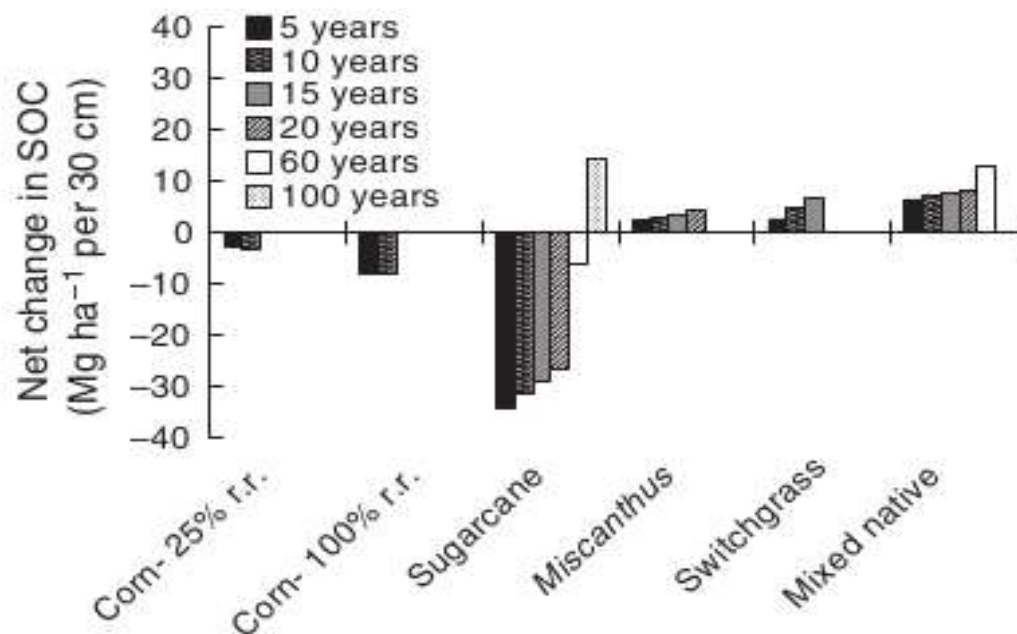
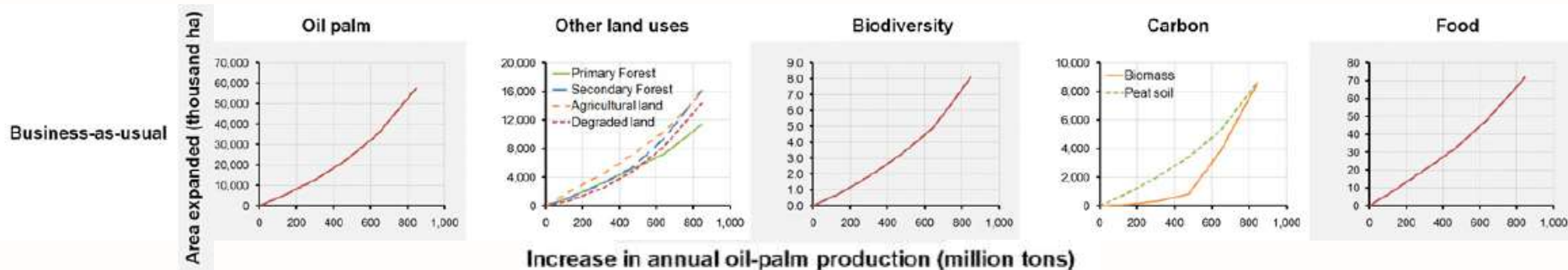


Fig. 3 Projected net changes in SOC_a (MgC ha^{-1}) in the top 30 cm of soil under biofuel crops of various ages. Estimates are based on the reduced ANOVA model for SOC_a (Table B2). Ages plotted are those represented in our data set (Table 1).

Multi-criteria evaluation of mitigation scenarios in case studies

- Using state-of-the-art methodology derived from previous task,
- Applied to the France and China cases,



Estimated effects of oil palm development in Malaysia on land-use, biodiversity, soil carbon content and food supply (Koh and Gazhoul, PNAS, 2010).

Multi-criteria evaluation of mitigation scenarios in case studies

- Using state-of-the-art methodology derived from previous task,
- Applied to the France and China cases,
- With some degree of focus/scope in terms of mitigation measures relevant to each case,
- In interaction with the scenario work in RL1.1 and the abatement cost curves.



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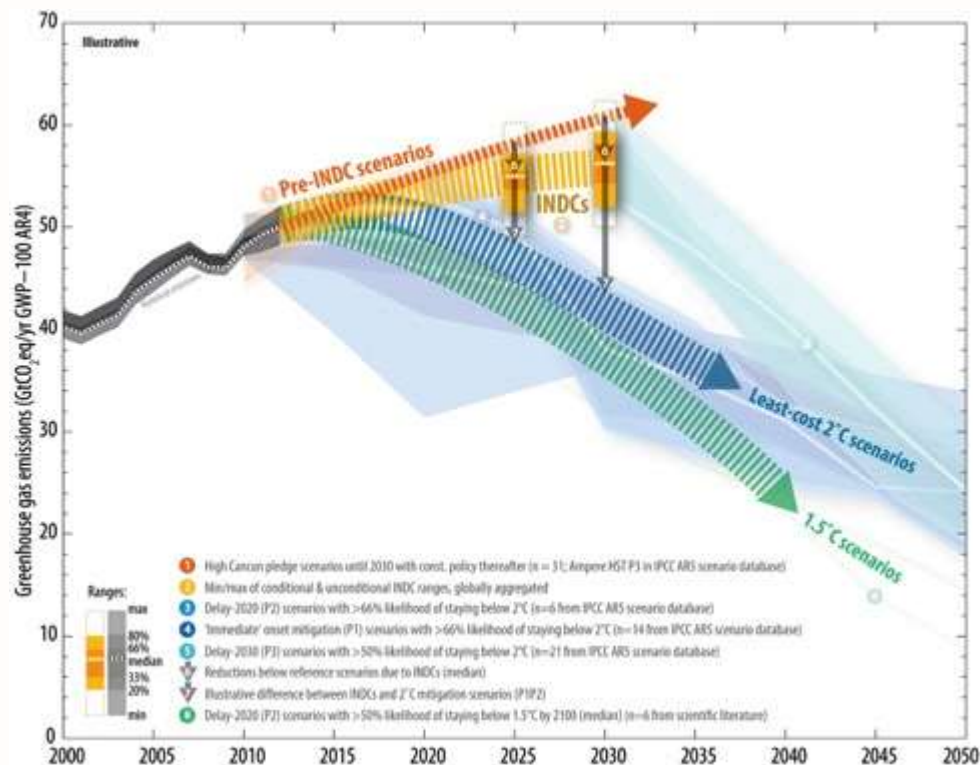
Partners (tentative)

- All interested CLAND partners for workshop
- Economie Publique
- EcoSys
- IIASA
- Chinese partners (Beijing University & Chinese Academy of Agricultural Sciences)

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Nationally Determined Contributions (NDCs) to Paris agreement:

- Land sector \approx 25% of world GHG emissions
 - Land sector \approx 25% of NDCs
 - 128 countries selected land-based NDCs (mitigation and adaptation)
- (IIASA, 2016)*



http://unfccc.int/focus/indc_portal/items

Review Land based mitigation measures in NDCs Overview

Review the measures currently proposed in the **NDCs in the land use sector**: relevance, scientific soundness (in particular evaluation methodology).

Potential to **mitigate climate change** (not only be based on GHG emissions but also biophysical effects).

Review Land based mitigation measures in NDCs Overview

This will be done based on a set of **harmonized, state-of-the-art methodological guidelines** which will be drafted to assess LUM-based measures, based on the consortium's expertise and the findings of previous WP.

A re-appraisal of selected NDCs will be proposed to emphasize the **key measures** or **uncertainties** of the **LUM sector** in various national contexts .

A focus will be placed on options involving **soil organic carbon sequestration**

To which extent should **CO₂ emissions** be reduced, assuming that all the effort will be put in increasing **SOC sequestration**?

Evaluate the amount of SOC sequestration needed to fully compensate the GHG emissions => **mechanistic modeling**

No clear consensus on how SOC dynamics should be modeled (Schmidt et al., 2011, Luo et al., 2016, Dignac et al., 2017).

Difficult to simply evaluate if this objective is reachable.

Uncertainties related to the different approaches to model SOC.

Different models will be used (SYMPHONY, MOMOS, ORCHIDEE, etc.) based on different approaches to evaluate the effective SOC sequestration.

Idealized simulations performed for a given location with a large set of models.

National or global evaluations performed with a subset of models able to run on a spatial grid.



Partners (tentative)

- LSCE
- CIRED
- Economie Publique
- IIASA
- EcoSys
- Agronomie
- SADAPT
- LATMOS
- GEOPS
- Hban

- Scales, scales, scales... (Ile de France vs China as a whole?)
- Case-studies (France, China... relevant?)
- Prioritization of mitigation options
- In RL1.2: exploring multi-criteria assessment vs some key mitigation measure ?
- ...

Questions ?

