

How can terrestrial systems (land sector) help deliver the Paris Agreement targets?



Photo: Stephanie Roe

Stephanie Roe
Community Climate Intervention Strategies | June 2020



Why land sector?



Why land sector?

Climate impacts

25% of
GHGs

30% of C
Sink

Evaporation
& albedo

Why land sector?

Climate impacts

Human dimension

25% of
GHGs

Provides
our food

Livelihoods
of +70% ppl

30% of C
Sink

Habitat and
biodiversity

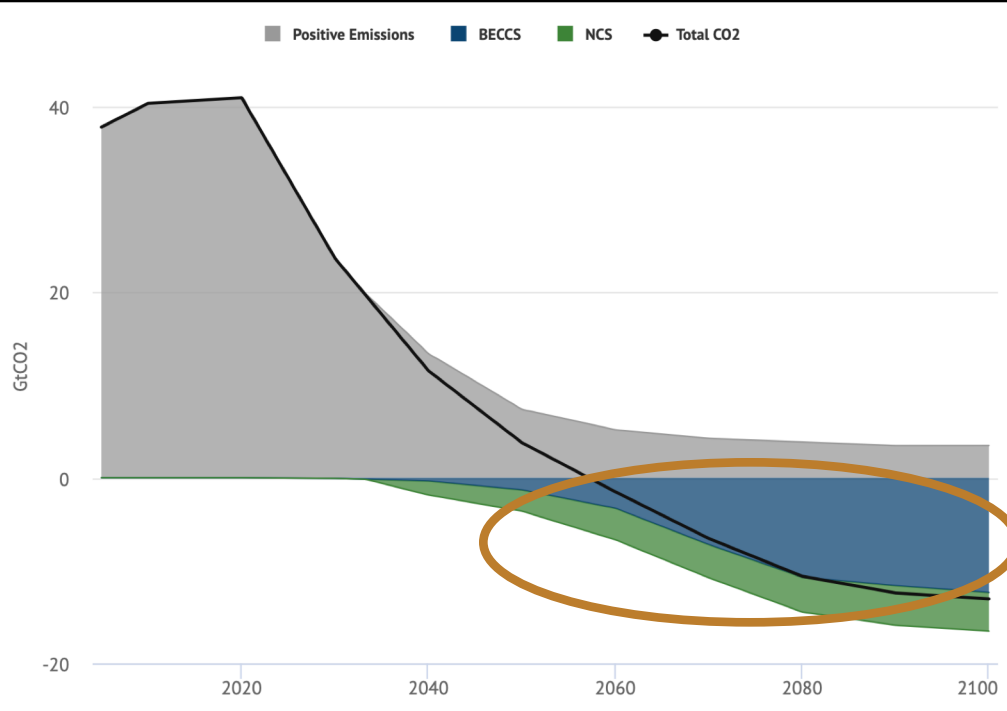
Water
quantity &
quality

Evaporation
& albedo

Bioenergy,
minerals,
fiber

Cultural &
recreational

Illustrative 1.5°C Pathway



Rogelj et al via Carbon Brief (2018)

Research questions from land-use community (NGO practitioners, policy makers, philanthropies):

In the 1.5°C and 2°C pathways, what can the land sector feasibly contribute?

What could be prioritized, when and where?

How can we account for trade-offs and also help deliver SDGs?



I. Top-down

Inter-model comparison



II. Bottom-up

Lit review of land sector potentials

Roadmap to 2050

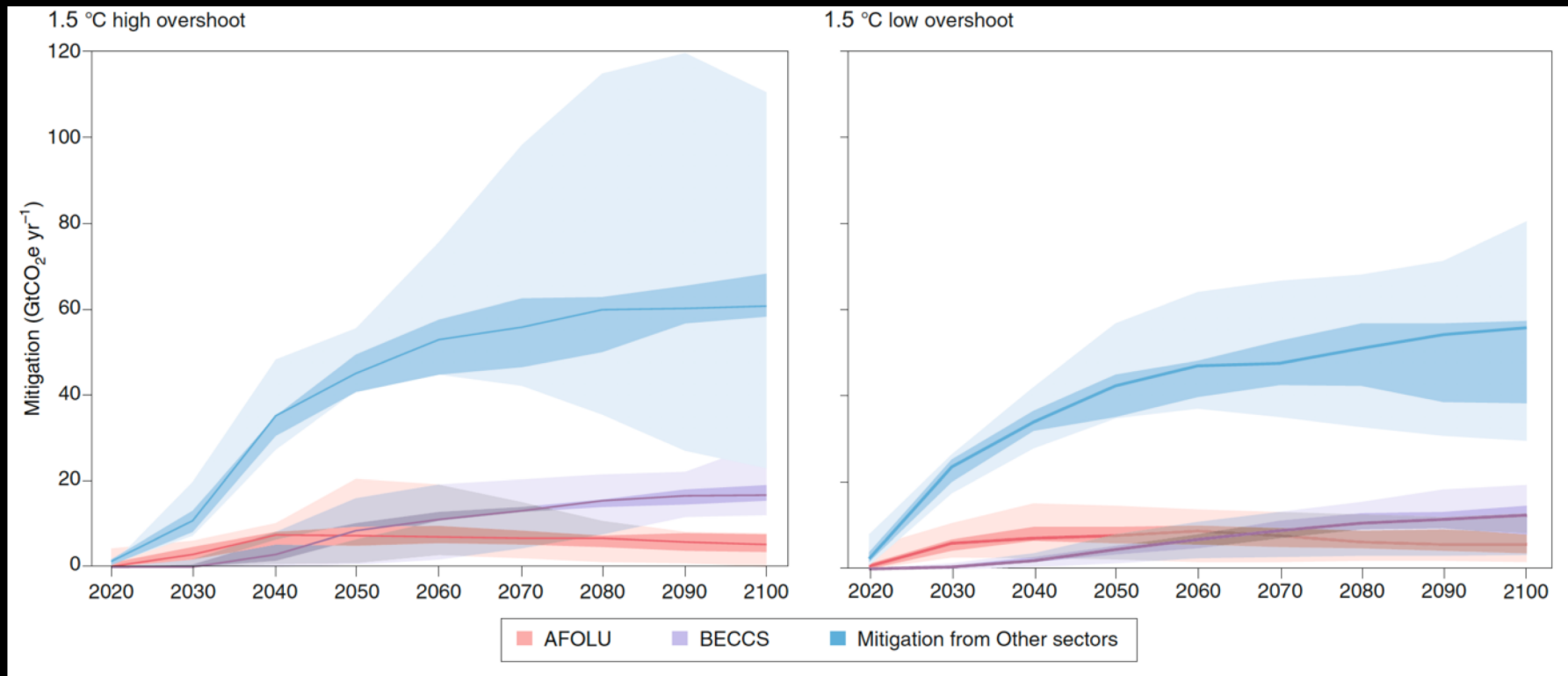
Reconcile top-down and bottom-up, feasibility & tradeoff assessment

Top-down assessment

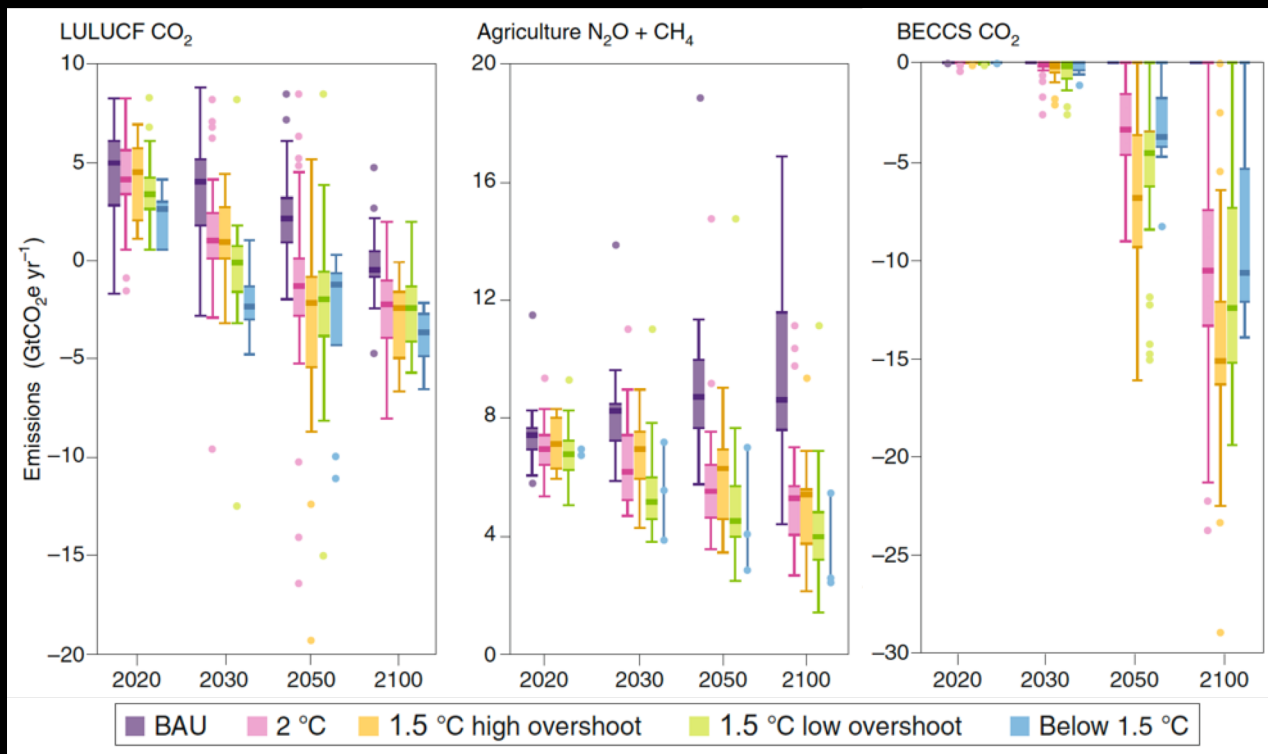
Integrated assessment model comparison (activities across multiple sectors)

IAMC 1.5°C and SSP Database

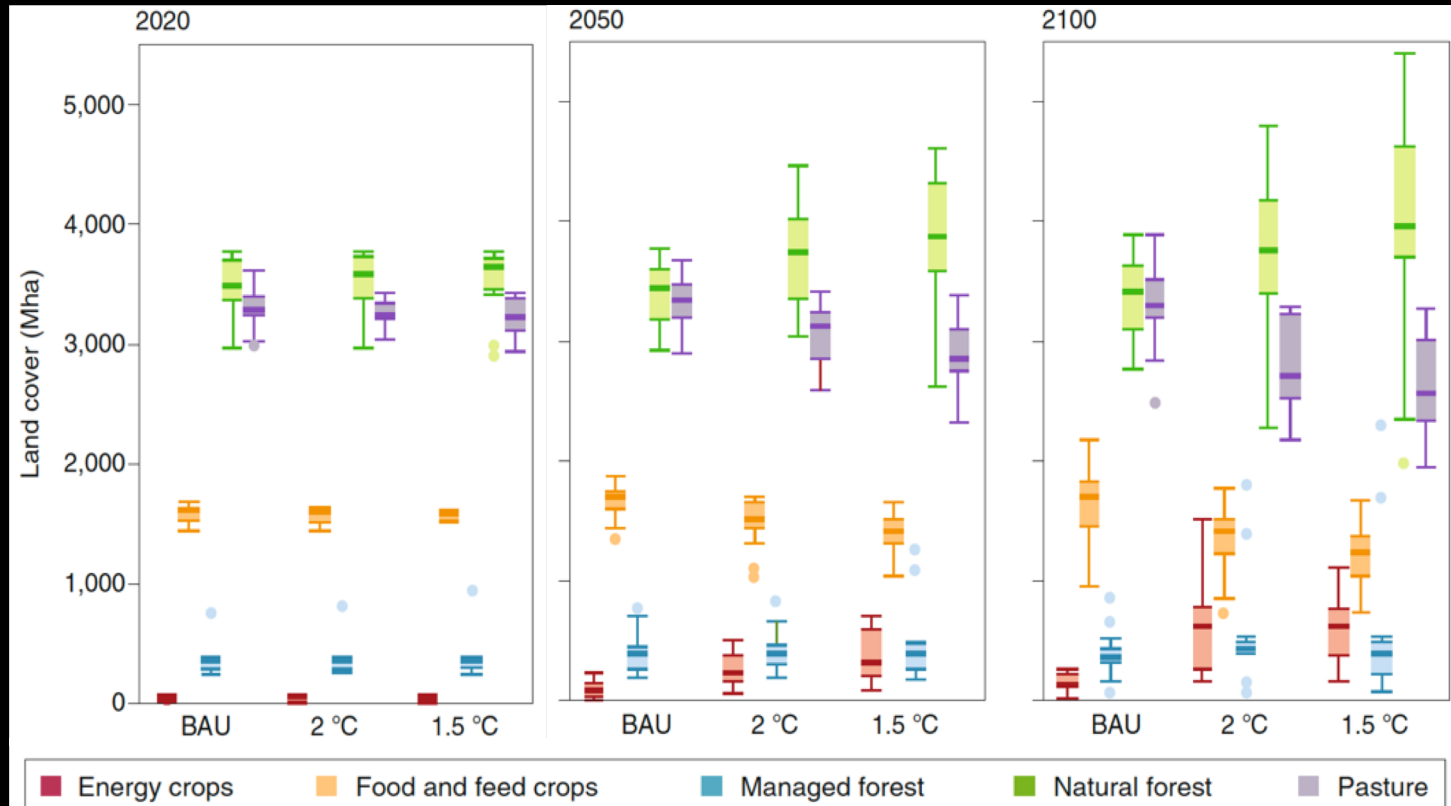
In 1.5°C pathways, 4-40% (median 25%) of total mitigation comes from land



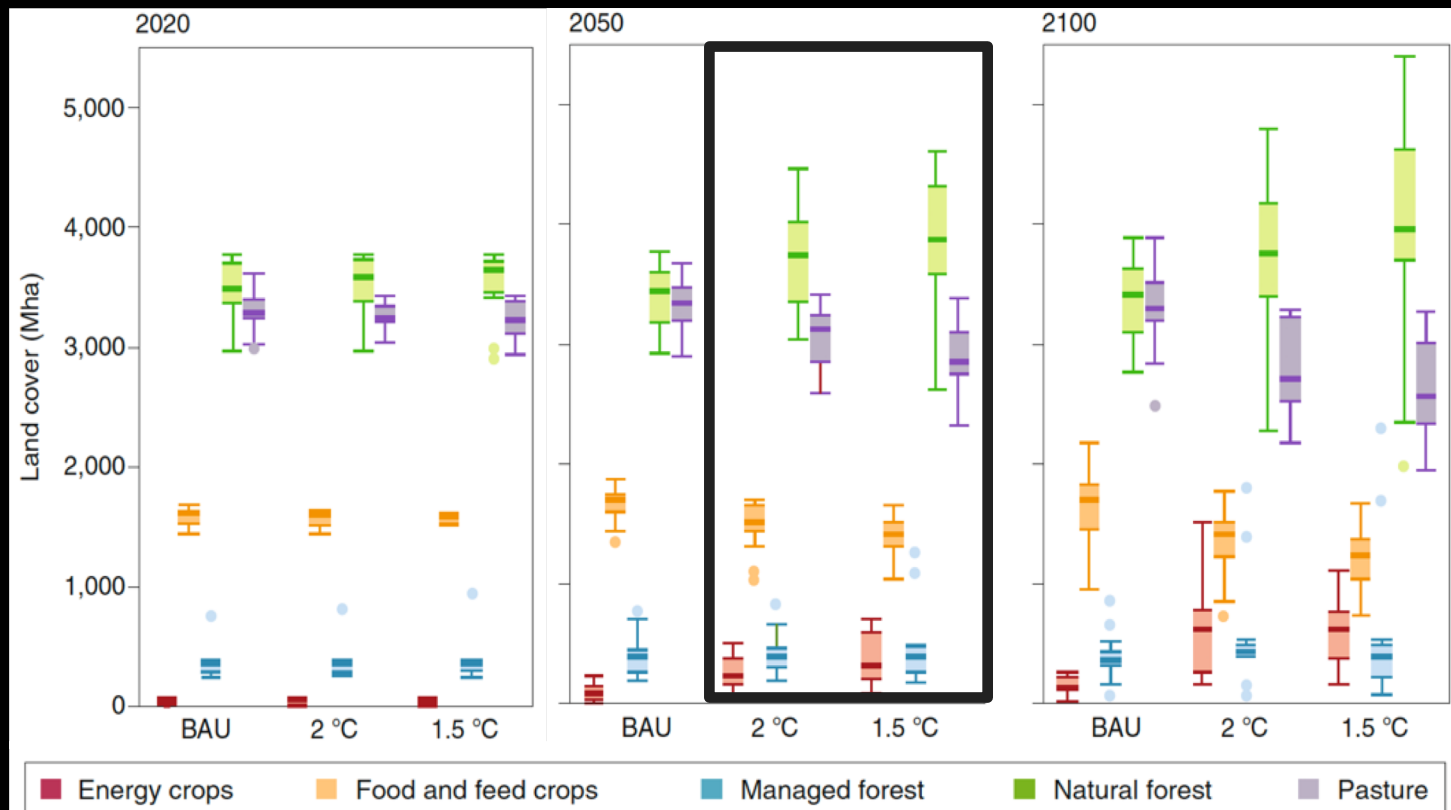
BAU no mitigation in agriculture and BECCS, 1.5°C and 2°C = large cut from LUC & Agriculture by 2030, and BECCS deployment by 2050



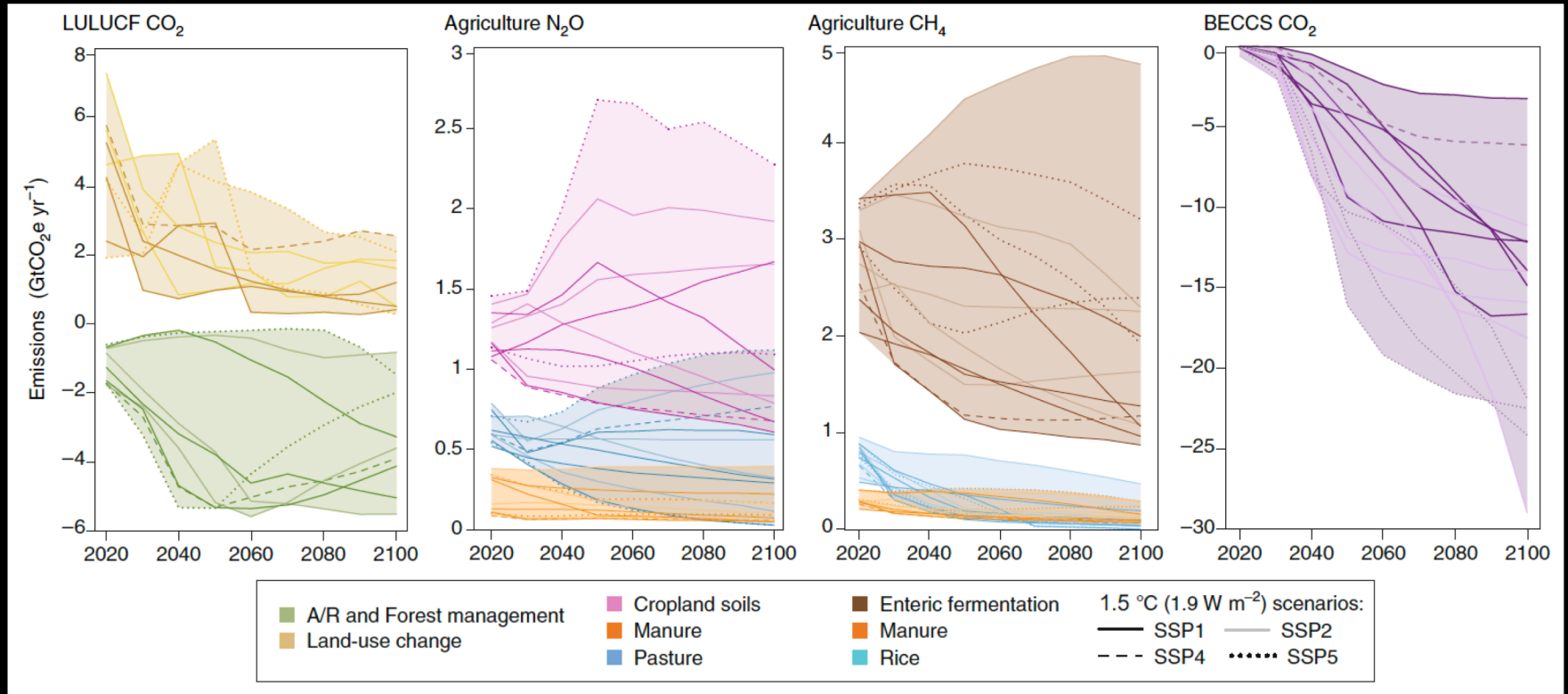
1.5°C and 2°C pathways produce large changes in land cover



Pasture and crop lands decrease, energy crops increase, natural forests increase



Large variation in emissions trajectories; limited portfolio of land-based measures in models



Some takeaways (top-down assessment)

1. Limitation: IAMS optimize for cost, however, do not measure economic costs and impacts due to climate change
2. IAMs can explore inter-sectoral effects, and some have ability to explore social and env trade-offs. But inter-model comparison relies on the lowest common denominator. Varying complexity and the use of different definitions makes it difficult to answer questions on benefits and consequences.
3. To be more relevant to policy makers and practitioners, would it be worthwhile in some instances, to reduce the number of models and scenarios that are compared to be able to answer trade-off questions?
4. How can model assessments and comparisons better incorporate socioeconomic and environmental 'safeguards' to avoid undesirable scenarios?

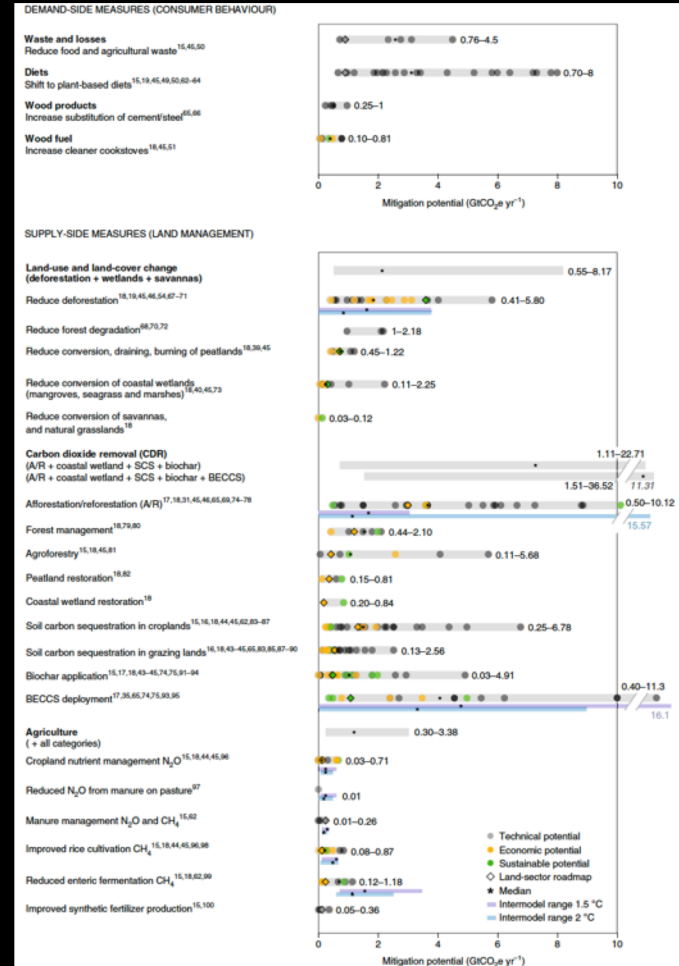
Bottom-up assessment

Literature review of single activity separately or within single sector

Much larger portfolio of land-based activities in the literature

24 mitigation activities:

- Land use change
- Agriculture
- Consumer behavior
- CDR



CDR activities have highest potential and largest range

Carbon dioxide removal (CDR)

(A/R + coastal wetland + SCS + biochar)

(A/R + coastal wetland + SCS + biochar + BECCS)

Afforestation/reforestation (A/R)^{17,18,31,45,46,65,69,74-78}

Forest management^{18,79,80}

Agroforestry^{15,18,45,81}

Peatland restoration^{18,82}

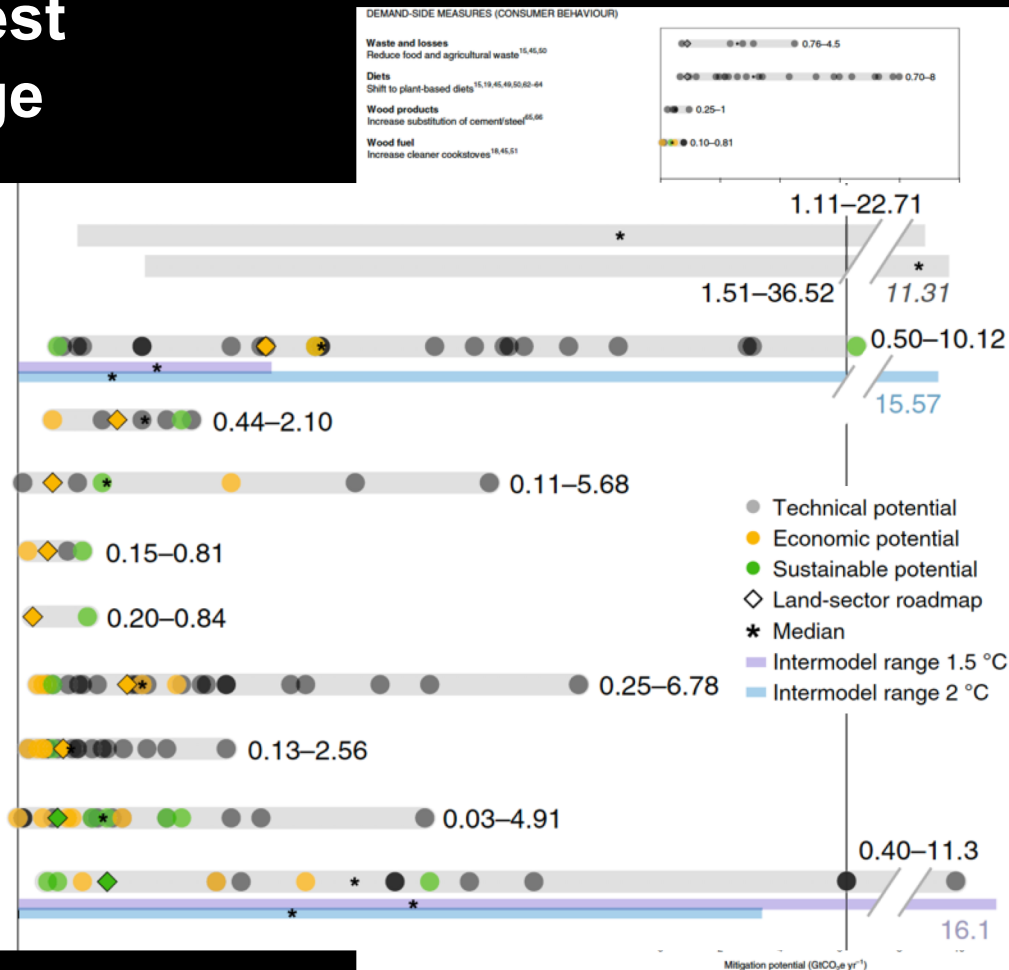
Coastal wetland restoration¹⁸

Soil carbon sequestration in croplands^{15,16,18,44,45,62,83-87}

Soil carbon sequestration in grazing lands^{16,18,43-45,65,83,85,87-90}

Biochar application^{15,17,18,43-45,74,75,91-94}

BECCS deployment^{17,35,65,74,75,93,95}



Restoring Forests Could Help Put a Brake on Global Warming, Study Finds

Timeline: How BECCS became climate change's 'saviour' technology

Tree planting 'has mind-blowing potential' to tackle climate crisis

Research shows a trillion trees could be planted to capture huge amount of carbon dioxide

GOV.UK

Government launches new scheme to boost tree-planting

Woodlands and forests will play an important role in the UK's efforts to hit ...
By planting more trees and creating new woodland, land managers ...

Nov 4, 2019



Ethiopia plants 350m trees in a day to help tackle climate crisis

National 'green legacy' initiative aims to reduce environmental degradation



"A Trillion Trees" is a great idea—that could become a dangerous climate distraction

Reforestation is critical for lots of reasons, but it's no substitute for cutting emissions.

Farming could be absorber of carbon by 2050, says report

Veganism and trees could help stop agriculture contributing to global heating, study says

Can regenerative agriculture reverse climate change? Big Food is banking on it.

Regenerative agriculture works to draw carbon out of the atmosphere and into the soil, but there's an ongoing debate on how much carbon can be stored there and for how long.

Soil Carbon: The Secret Weapon to Battle Climate Change?



Carbon farming is the hot (and overhyped) tool to fight climate change

Using farms to capture and store more carbon in soil is becoming trendy, but the science is still not settled on how much it can help to address climate change.



Some takeaways (bottom-up assessment)

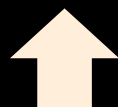
1. More spatially explicit studies are needed
2. Mitigation potentials do not yet incorporate biophysical climate impacts, nor impacts from climate change, more research needed
3. Types of management and implementation, by geography drive certain risks and benefits

Mitigation potential in 2050



Top down (IAMs)

Land-based activities (AFOLU and BECCS) =
0.9–36.6 (median **~14**) GtCO₂e yr⁻¹



Bottom-up (Literature)

Land-based activities (AFOLU and BECCS) =
2.4–48.1 (**~15**) GtCO₂e yr⁻¹

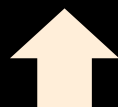
Mitigation potential in 2050



Top down (IAMs)

Land-based activities (AFOLU and BECCS) =
0.9–36.6 (median **~14**) GtCO₂e yr⁻¹

AFOLU = 0.9–20.5 (median **9.1**) GtCO₂e yr⁻¹
>>8 activities



Bottom-up (Literature)

Land-based activities (AFOLU and BECCS) =
2.4–48.1 (**~15**) GtCO₂e yr⁻¹

AFOLU = 2–36.8 (median **10.6**) GtCO₂e yr⁻¹
>>23 activities

Mitigation potential in 2050

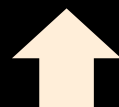


Top down (IAMs)

Land-based activities (AFOLU and BECCS) =
0.9–36.6 (median **~14**) GtCO₂e yr⁻¹

AFOLU = 0.9–20.5 (median **9.1**) GtCO₂e yr⁻¹
>>8 activities

BECCS = 0–16.1 (median **4.7**) GtCO₂e yr⁻¹



Bottom-up (Literature)

Land-based activities (AFOLU and BECCS) =
2.4–48.1 (**~15**) GtCO₂e yr⁻¹

AFOLU = 2–36.8 (median **10.6**) GtCO₂e yr⁻¹
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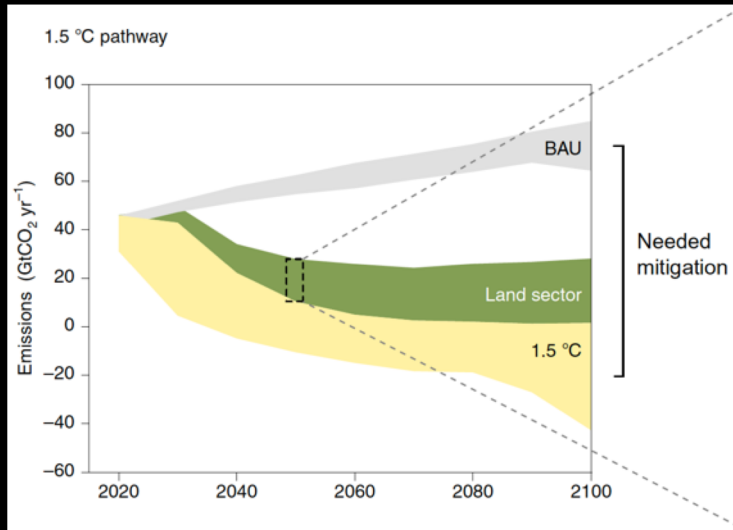
BECCS = 0.4–11.3 (median **4.0**) GtCO₂e yr⁻¹

Roadmap to 2050

Reconciling top-down and bottom-up, adding feasibility + tradeoffs

Roadmap for land-based climate mitigation in 2050

15 GtCO₂e yr⁻¹ =
30% total mitigation



Roe et al 2019, *Nat. Clim. Chang.*

Feasibility & Sustainability

Risks

Other benefits

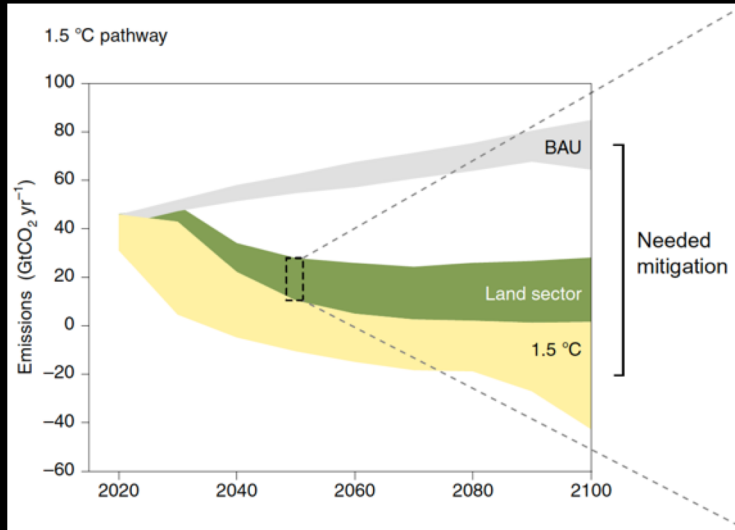
Biodiversity, Water, Soil, Air, Resilience, Food security, Livelihoods

International policies & commitments

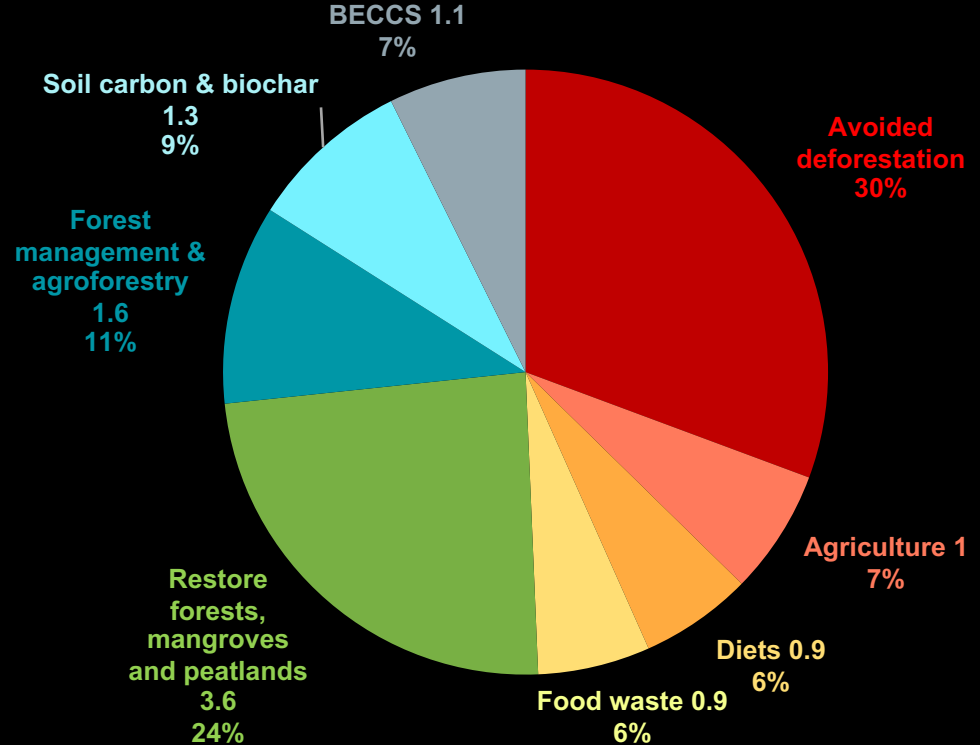
Sustainable Development Goals, Aichi Targets (UNCBD), New York Declaration on Forests

Roadmap for land-based climate mitigation in 2050

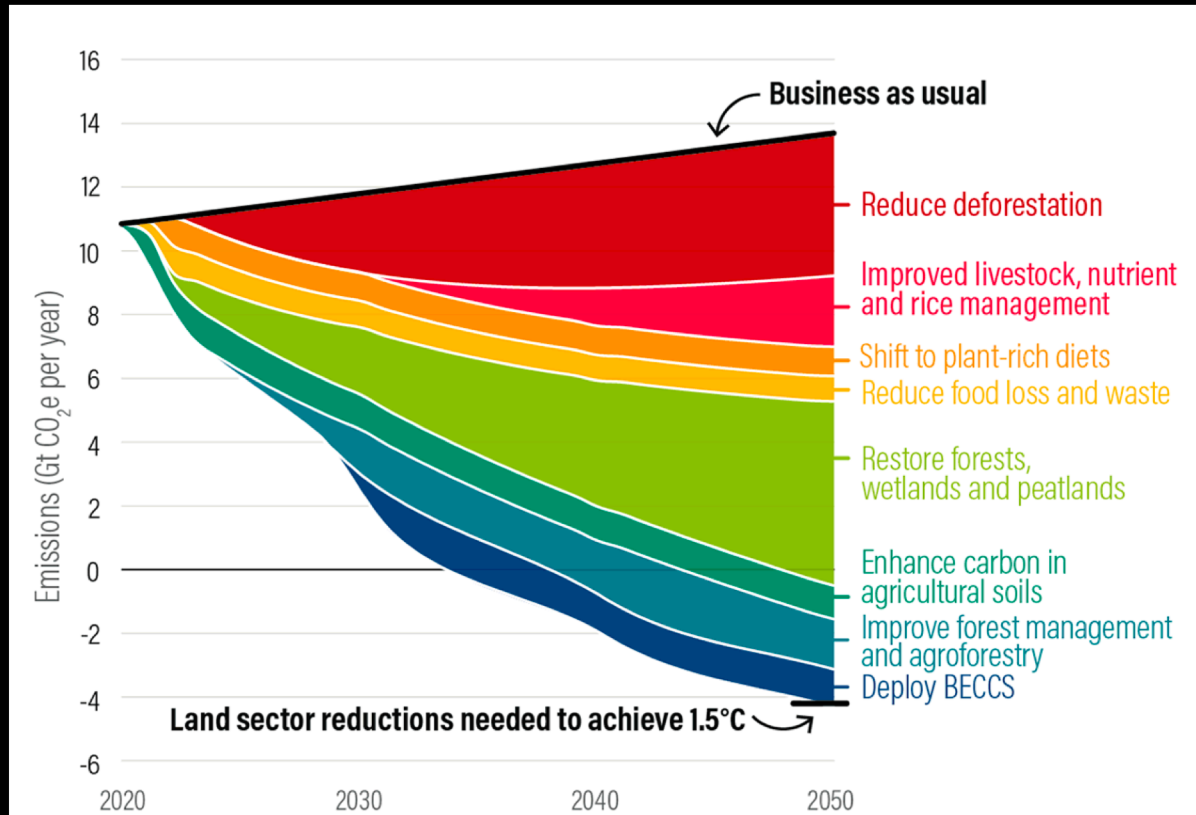
15 GtCO₂e yr⁻¹ =
30% total mitigation



Roe et al 2019, Nat. Clim. Chang.



Roadmap for land sector in 2050



Roe et al 2019, Nat. Clim. Chang.

Roadmap mitigation

30 %

15 GtCO₂e/yr

Total mitigation

14.8%

7.4 GtCO₂e/yr

Gross emissions
reductions

15.2%

7.6 GtCO₂e/yr

Carbon removals

Roadmap mitigation

Natural carbon sink

Le Quere et al 2018, Global Carbon Project

30 %

15 GtCO₂e/yr

Total mitigation

+

29 %

11.6 GtCO₂/yr

Land

14.8%

7.4 GtCO₂e/yr

Gross emissions reductions

22%

8.9 GtCO₂/yr

Ocean

15.2%

7.6 GtCO₂e/yr

Carbon removals

44%

17.3 GtCO₂/yr

Atmosphere

Roadmap mitigation

Natural carbon sink

Le Quere et al 2018, Global Carbon Project

30 %

15 GtCO₂e/yr

Total mitigation

+

29 %

11.6 GtCO₂/yr

Land

14.8%

7.4 GtCO₂e/yr

Gross emissions reductions

22%

8.9 GtCO₂/yr

Ocean

15.2%

7.6 GtCO₂e/yr

Carbon removals

44%

17.3 GtCO₂/yr

Atmosphere

***Mitigation #s do not reflect future climate change, but new research is coming**

Example of new research on A/R mitigation potentials in different climate futures



Link:

https://seminar.cgd.ucar.edu/archive/2020/CGD_20200512_peter_lawrence.mp4

Human Land Management: Historical changes to the climate and carbon cycle, and where do we go from here?

Peter Lawrence

**Terrestrial Science Section
Climate and Global Dynamics Laboratory**
lawrence@ucar.edu



(Dave Lawrence, Danica Lombardozzi, Keith Oleson, Jackie Shuman, Rosie Fisher, George Hurtt, Louise Parsons Chini and many others)




Mitigation potentials in SRCCL and AR6 WGIII Land Chapter

ipcc
INTERGOVERNMENTAL PANEL ON climate change

Climate Change and Land

An IPCC Special Report on climate change, desertification, land degradation, sustainable land management, food security, and greenhouse gas fluxes in terrestrial ecosystems

Summary for Policymakers



WG I WG II WG III

WMO UNEP

First Order Draft Chapter 7 IPCC AR6 WG III

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In AR6:

New model outputs, some added mitigation activities, similar comparability

Updated bottom-up assessment

Countries have requested a deeper assessment on regional applicability: potentials, feasibility, risks and benefits

Conclusions

1. Better land management could feasibly and sustainably contribute ~30% of mitigation to deliver on the 1.5 °C goal of the Paris Agreement [70% still needs to come from energy transformation!]
2. 30% mitigation potential is on top of the ~30% of carbon emissions that land already sequesters naturally
3. Equates to ~50% emissions reductions per decade (85% total decrease by 2050), and about a ten-fold increase in carbon removals
4. Carbon removals would be a ~60% increase to existing carbon sink
5. These numbers do not consider the impacts from future climate, but should
6. Not all mitigation measures, and types of implementation are the same >> should be optimized to deliver on other goals e.g. SDGs
7. It would be helpful if models can help provide more nuance on #5 and #6



Thank You

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stephanieroe@virginia.edu



[@stephanieroe](https://twitter.com/stephanieroe)

Annex

The top ten countries with the highest mitigation potential represent 55% of current land sector emissions

