Land-based mitigation measures and potentials

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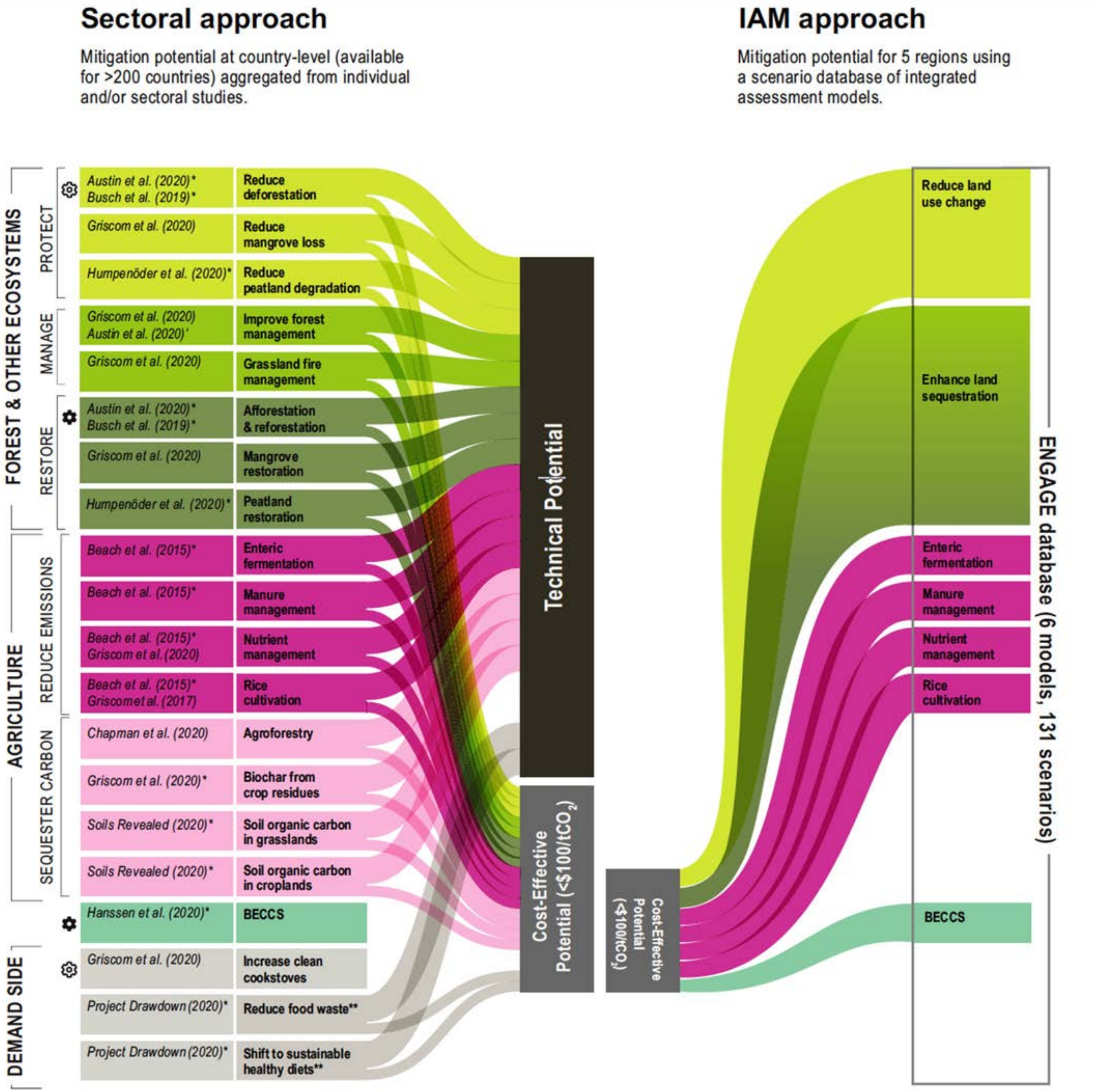

Roe et al 2021, GCB

Two common ways to estimate mitigation potential:

Sectoral approaches:

- Use bottom-up studies, sectoral models w/ various methods including EO, NGHGI
- Higher resolution estimates (country and sub-national levels)
- Large suite of land-based activities (>20)
- Difficult to account for inter- and cross-sector impacts (incl. land competition)

Integrated assessment models (IAMs):

- Links all the sectors in the economy, accounts for inter- and cross- sector interactions and trade-offs
- Coarse resolution (10-20 regions)
- Limited set of land-based activities (7; no wetlands, soil carbon, agroforestry)

Assessing the land sector potential (2020-2050) in IPCC AR6 WGIII

Mitigation option	Estimate type	<USD20 tCO_2-eq^{-1}	<USD50 tCO_2-eq^{-1}	<USD100 tCO_2-eq^{-1}	Technical
TOTAL AFOLU (Agriculture, forests and other ecosystems, diverted agricultural production from demand-side)	Sectoral	3.8 (2.7–4.9)	4.3 (2.3–6.7)	13.6 (6.7–23.4)	28.4 (8.8–65.1)
TOTAL AFOLU (Agriculture, forests and other ecosystems, BECCS)	IAM	3.4 (0–14.6)	5.3 (0.6–19.4)	7.9 (4.1–17.3)	ND

IPCC AR6 WGIII, Ch 7

- Estimates reflect the literature until 2021, do not estimate desirability or feasibility
- Cost-effective potential (<\$100/tCO_2) = 8 – 14 (11 avg) $GtCO_2$eq yr^{-1}
- 24-42% of technical potential is cost effective
- Difference of 5.7 $GtCO_2$eq yr^{-1} between IAMs and sectoral estimates

	Mitigation option	Estimate type	<USD20 tCO_2-eq^{-1}	<USD50 tCO_2-eq^{-1}	<USD100 tCO_2-eq^{-1}	Technical
Agriculture	**Agriculture total**	Sectoral	0.9 (0.5–1.4)	1.6 (1–2.4)	4.1 (1.7–6.7)	11.2 (1.6–28.5)
		IAM	0.9 (0–3.1)	1.3 (0–3.2)	1.8 (0.7–3.3)	ND
	Agriculture – Carbon sequestration (Soil carbon management in croplands and grasslands, agroforestry, and biochar)	Sectoral	0.5 (0.4–0.6)	1.2 (0.9–1.6)	3.4 (1.4–5.5)	9.5 (1.1–25.3)
		IAM	ND	ND	ND	ND
	Agriculture – Reduce CH_4 and N_2O emissions (Improve enteric fermentation, manure management, nutrient management, and rice cultivation)	Sectoral	0.4 (0.1–0.8)	0.4 (0.1–0.8)	0.6 (0.3–1.3)	1.7 (0.5–3.2)
		IAM	0.9 (0–3.1)	1.3 (0–3.2)	1.8 (0.7–3.3)	ND
Forests and other ecosystems	**Forests and other ecosystems total**	Sectoral	2.9 (2.2–3.5)	3.1 (1.4–5.1)	7.3 (3.9–13.1)	13 (5–29.5)
		IAM	2.4 (0–10.5)	3.3 (0–9.9)	4.2 (0–12.1)	ND
	Forests and other ecosystems – Protect (Reduce deforestation, loss and degradation of peatlands, coastal wetlands, and grasslands)	Sectoral	2.3 (1.7–2.9)	2.4 (1.2–3.6)	4.0 (2.5–7.4)	6.2 (2.8–14.4)
		IAM	ND	ND	ND	ND
	Forests and other ecosystems – Restore (Afforestation, reforestation, peatland restoration, coastal wetland restoration)	Sectoral	0.15	0.7 (0.2–1.5)	2.1 (0.8–3.8)	5 (1.1–12.3)
		IAM (A/R)	0.6 (0.2–6.5)	0.6 (0.01–8.3)	0.7 (0.07–6.8)	ND
	Forests and other ecosystems – Manage (Improve forest management, fire management)	Sectoral	0.4 (0.3–0.4)	ND	1.2 (0.6–1.9)	1.8 (1.1–2.8)
		IAM	ND	ND	ND	ND
Demand-side	**Demand-side measures** (Shift to sustainable healthy diets, reduce food waste, and enhanced and improved use of wood products) ** For all three only the direct avoided emissions; land-use effects are in measures above*	Sectoral	ND	ND	*2.2 (1.1–3.6)**	*4.2 (2.2–7.1)**
		IAM	ND	ND	ND	ND
Bioenergy/ BECCS	**BECCS** (Only the CDR component, for example, the geological storage. Substitution effects are accounted in other sectoral chapters e.g: Energy (ch 6), Transport (ch 10))	Sectoral	ND	ND	1.6 (0.5–3.5)	5.9 (0.5–11.3)
		IAM	0.08 (0–0.7)	0.5 (0–6)	1.8 (0.2–9.9)	ND

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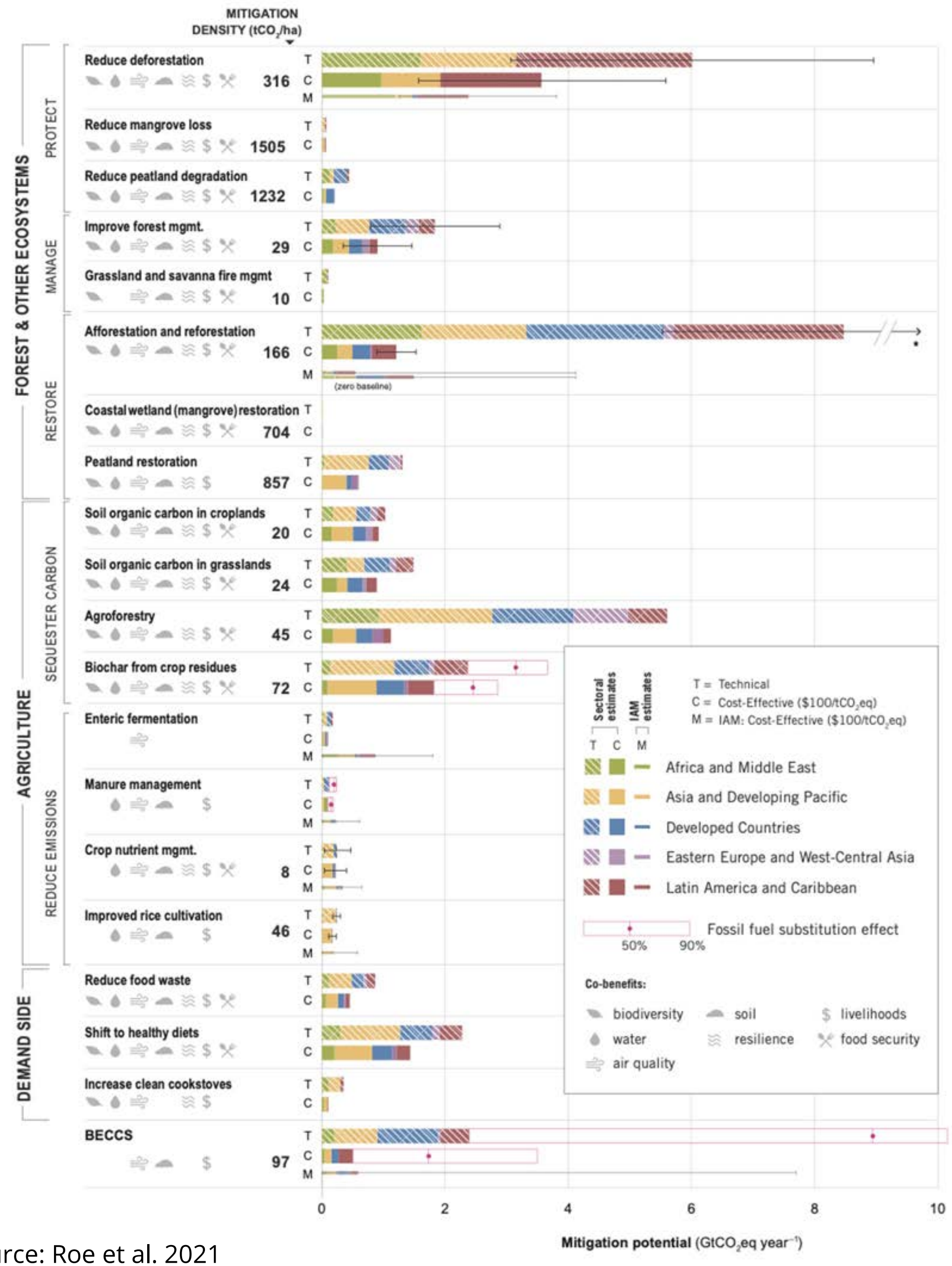


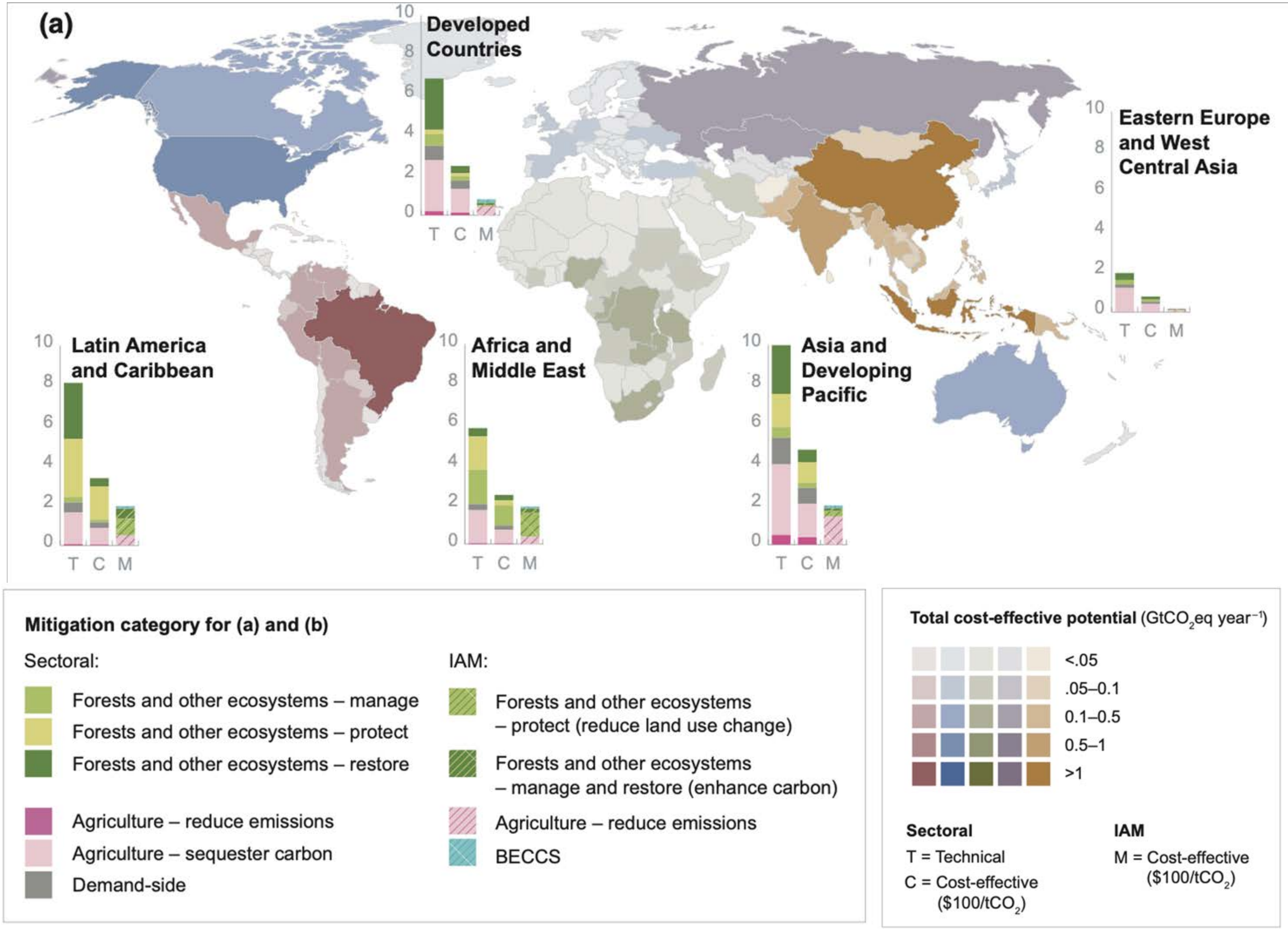
Source: Roe et al. 2021

Land-based options are relatively low cost, readily available, and can provide high co-benefits

Highest cost-effective (<$100/tCO2e) potential by activity:

- Reduce deforestation (3.6 Gt)
- Shift to sustainable & health diets (1.8 Gt)
- Biochar (1.8 Gt)
- Afforestation/reforestation (1.2 Gt)
- Agroforestry (1.1 Gt)
- Soil carbon croplands (0.92 Gt) & grasslands (0.9 Gt)
- Forest management (0.9 Gt)
- Reduce food waste (0.8 Gt)
- Peatland restoration (0.6 Gt)

- ~55% ecosystems, ~30% agriculture
- ~40% emission reductions/ ~60% CDR
- Protection and soil carbon is most cost-effective and provides many other core benefits
- Coastal wetland, peatland and forest protection have highest potential per unit area (density)



Land sector potential:
Asia (34%)
Latin America (25%)
Dev. Countries (18%)
Africa (18%)
Eastern Europe (5%)

Important measures across countries:

- Asia & Developed:
  - SCS (soil, agroforestry, biochar)
  - Restoration
  - Healthy diets and food waste
  - Livestock mgmt.
- LAC, Africa, SEAsia:
  - Protection
  - Restoration
  - Mgmt
  - SCS

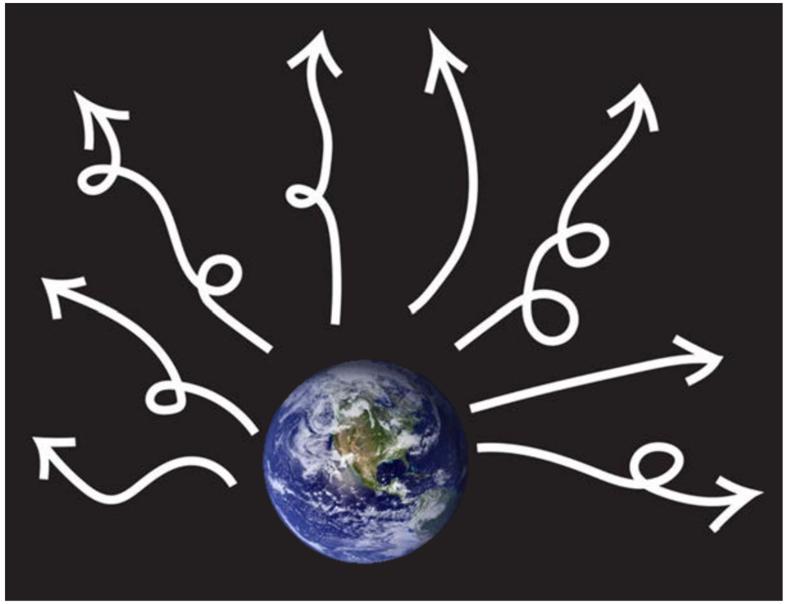
Roe et al. 2021 GCB

Gaps & limitations of land-based mitigation potential estimates

Large ranges due to a wide variety of methods

Majority of estimates don't include/consider:

- **Biophysical effects** (albedo, evapotranspiration, etc)
- **Future impacts of climate change** (enhanced disturbances, permanence, CO2 fertilization, etc)
- **Desirability** (delivering on multiple outcomes: biodiversity, socioeconomic, sustainable dev)
- **Feasibility** beyond cost (carbon price)



Plenty of room for refining & improving estimates

Thank You

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