Press Briefing, COP23, Bonn, November 6, 217

Soil organic carbon sequestration and food security

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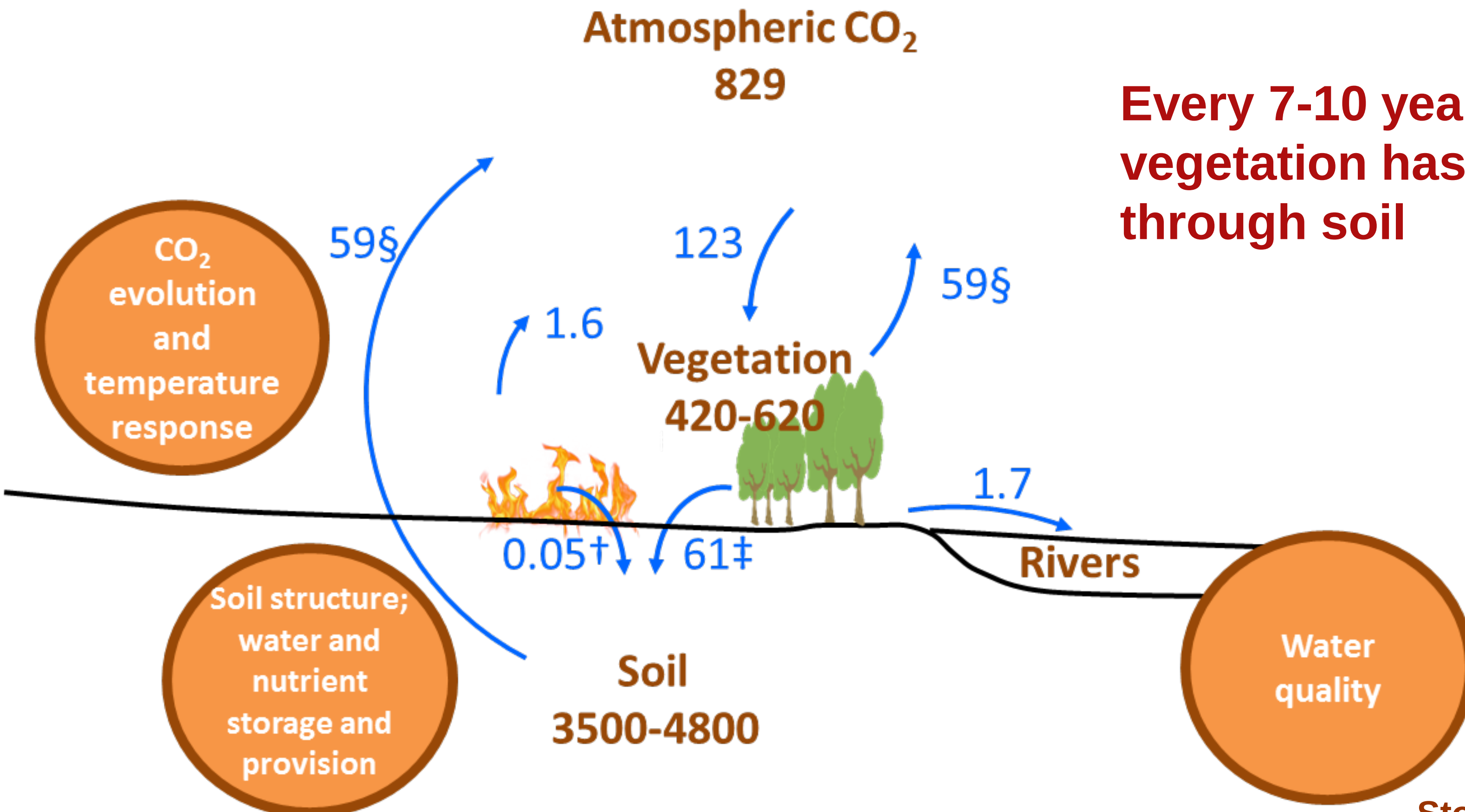
Cornell Booth, G.14.03, Bonn Zone
Side event: Nov 8, Room 9, Bonn Zone

DAVID R. ATKINSON CENTER
for a Sustainable Future

Soil Carbon for Climate-Smart Practice



Every 7-10 years, all vegetation has cycled through soil

Stocks in Pg
Flows in Tg yr^{-1}

Lehmann and Kleber, 2015, *Nature* 528, 60-68

Carbon – Paris Accord and 4‰

Carbon stocks and fluxes

Total soil (0–1 m) organic C stock[*] (Gt)	1,500 ± 230
Proposed 4‰ of total soil (0–1 m) organic C stock (Gt)	6.0 ± 0.92
Annual fossil-carbon emissions (flux to atmosphere)[†] ($Gt\ y^{-1}$)	9.8
Annual land use change C emissions (flux to atmosphere)[†] ($Gt\ y^{-1}$)	0.9
Annual net land C sink (2005–2014)[*,†] ($Gt\ y^{-1}$)	-3.2
Annual net ocean C sink (2005–2014)[*,†] ($Gt\ y^{-1}$)	-2.7
Rate of increase of atmosphere C (2005–2014)[‡] ($Gt\ y^{-1}$)	4.7

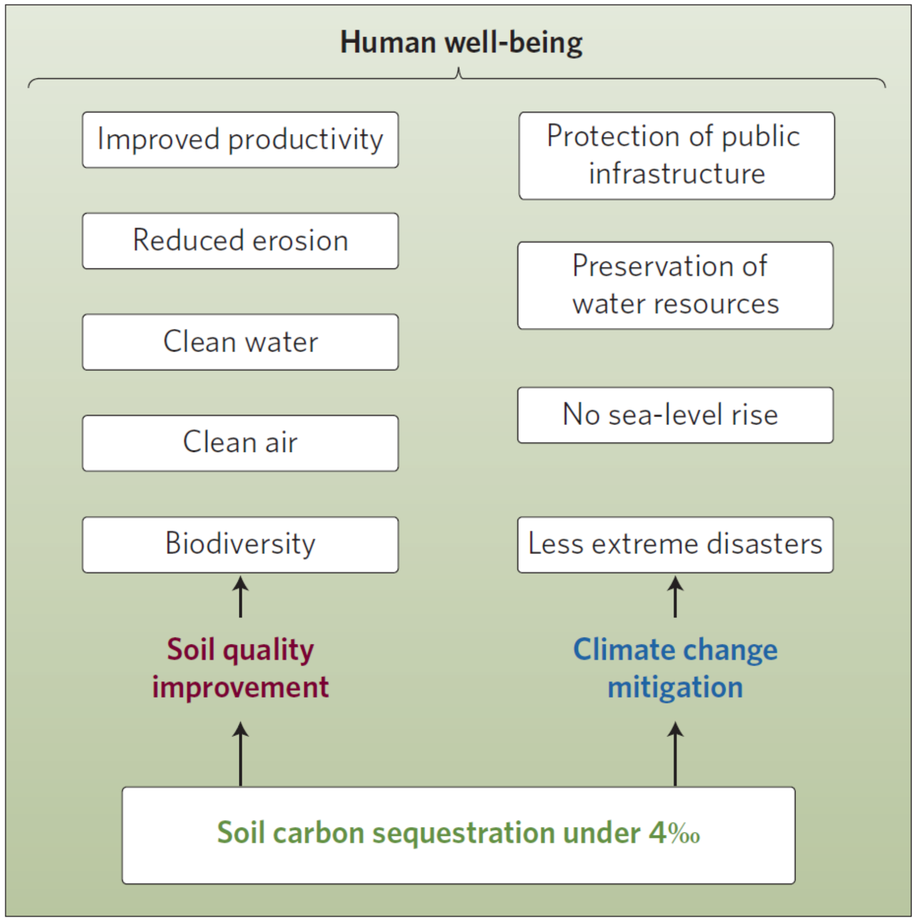
A negative sign indicates a flux from the atmosphere to the biosphere; ± values denote 1 s.d; units are given in brackets. *Does not include permafrost[14]; †GCP 2014, only includes CO_2 sources, does not include non-CO_2 sources of greenhouse gas emissions[15]; ‡http://go.nature.com/2nTK1oA and http://go.nature.com/2oVQyyC

Chabbi, Lehmann et al, 2017, *Nature Climate Change* 7, 307-309

Soil Carbon – Many Sustainability Outcomes

More

Food security,
habitat,
natural resources
and so on

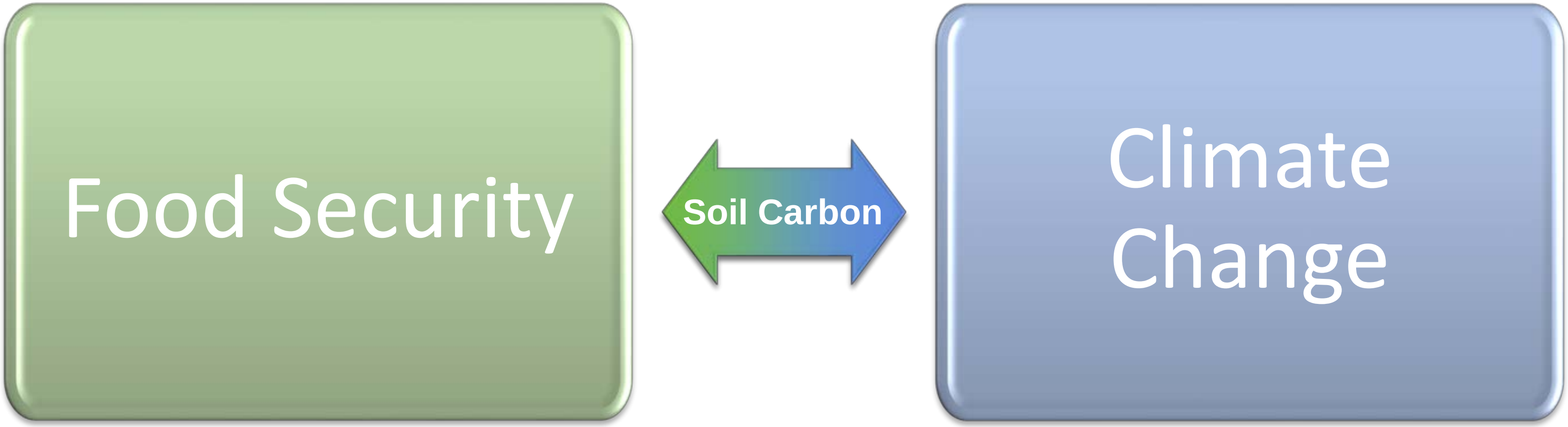


Less

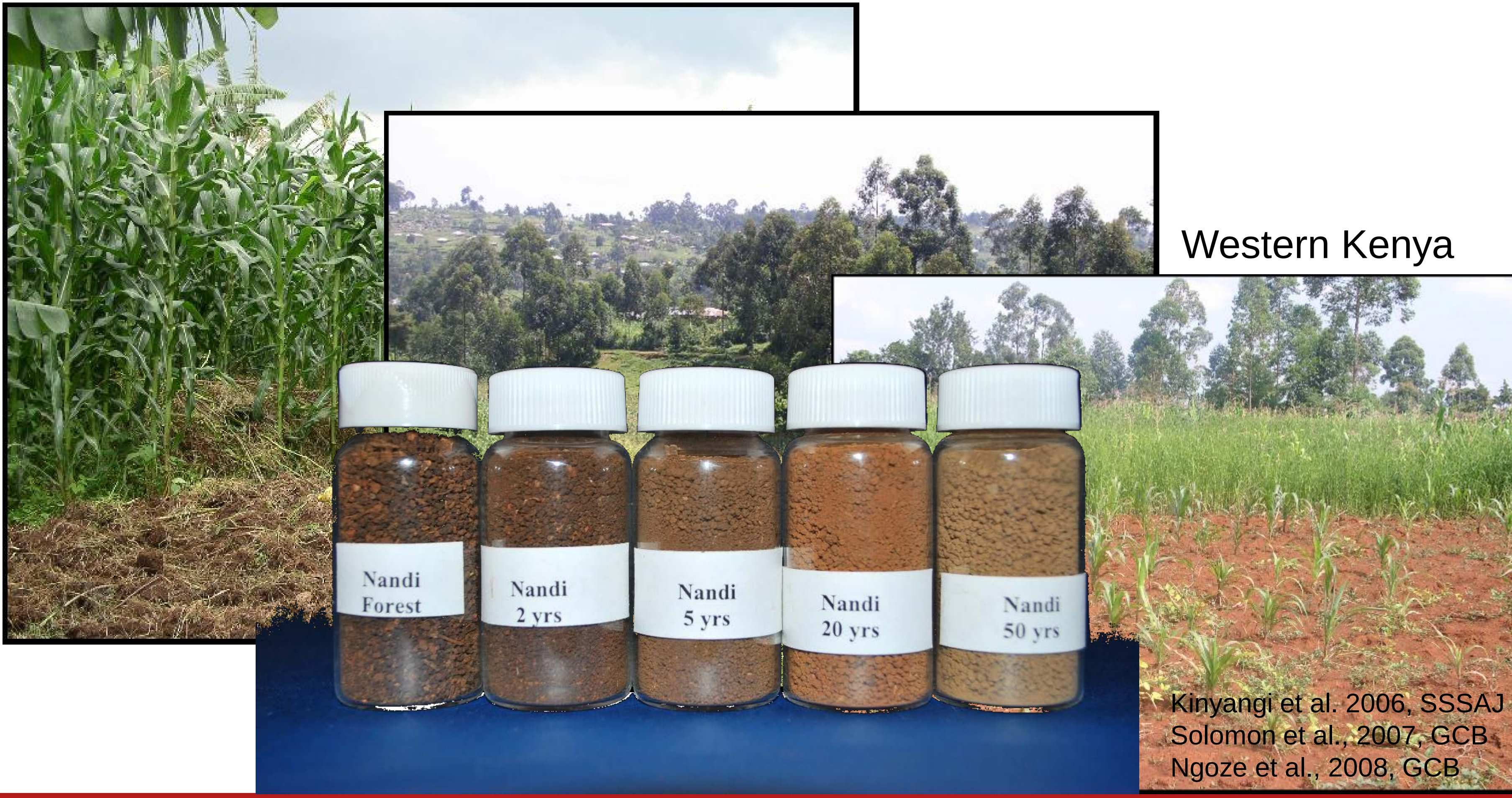
Migration,
political instability,
pollution hazards
and so on

Chabbi, Lehmann et al, 2017, *Nature Climate Change* 7, 307-309

Soil Organic Carbon: Climate and Food



Loss of Soil Carbon – Loss of Food Security

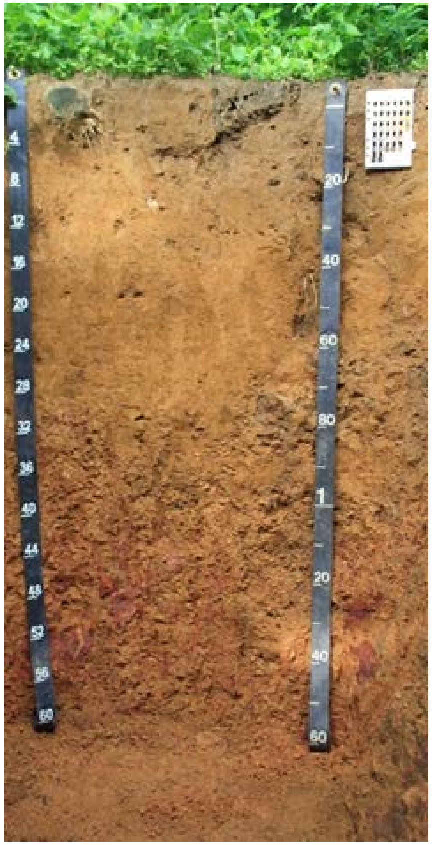


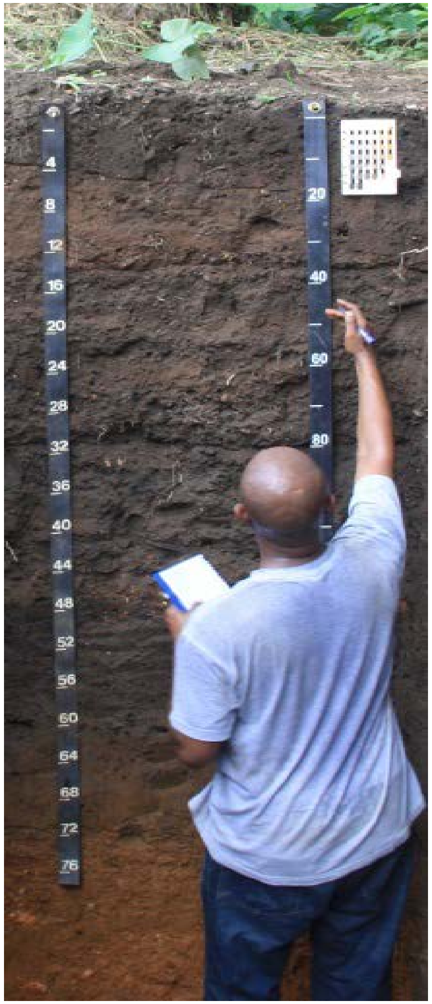
Western Kenya

Kinyangi et al. 2006, SSSAJ
Solomon et al., 2007, GCB
Ngoze et al., 2008, GCB

Traditional Soil Carbon – African Dark Earths

Liberia



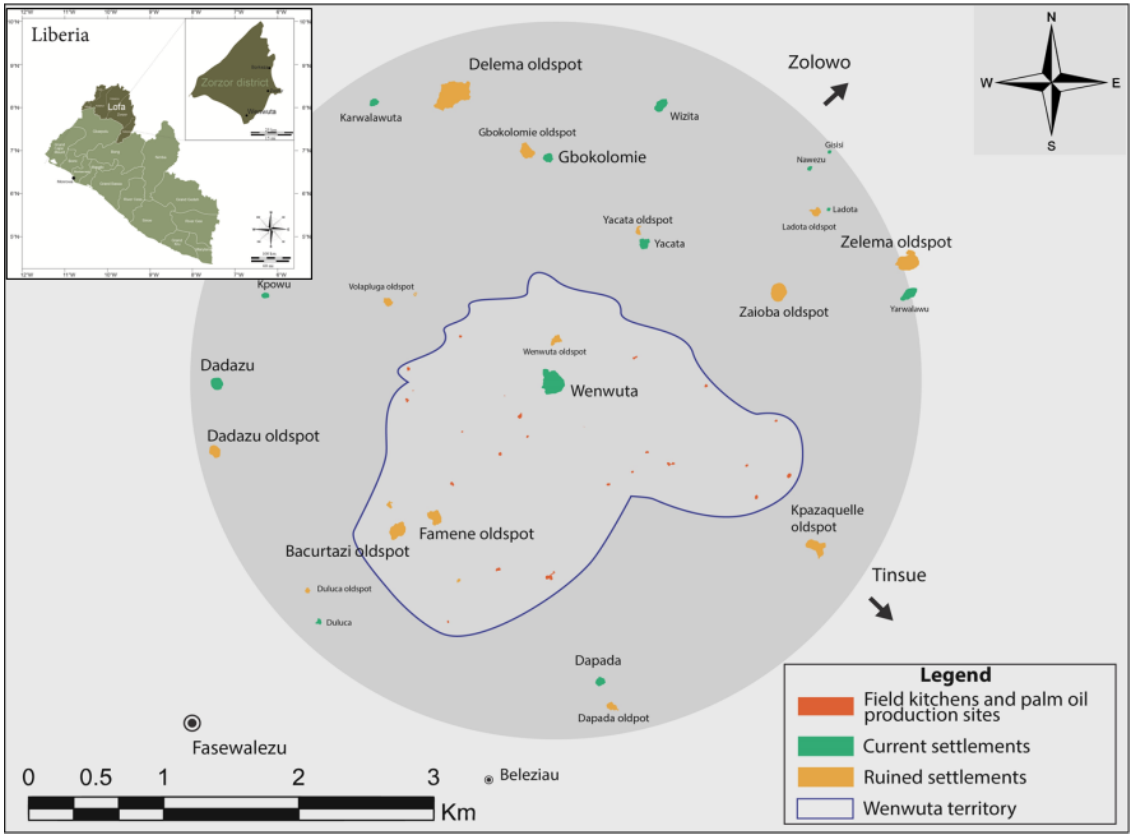


2-3 times more organic carbon
2-26 times greater biochar-type carbon
5-270 times more plant-available phosphorus

Solomon et al. 2016, Frontiers in Ecol and Env 14, 71–76

African Dark Earths and Food Security

1% of the agric. area
26% of food consumption
24% of household income



Solomon et al. 2016, Frontiers in Ecol and Env 14, 71–76

Soil Organic Carbon Improvement

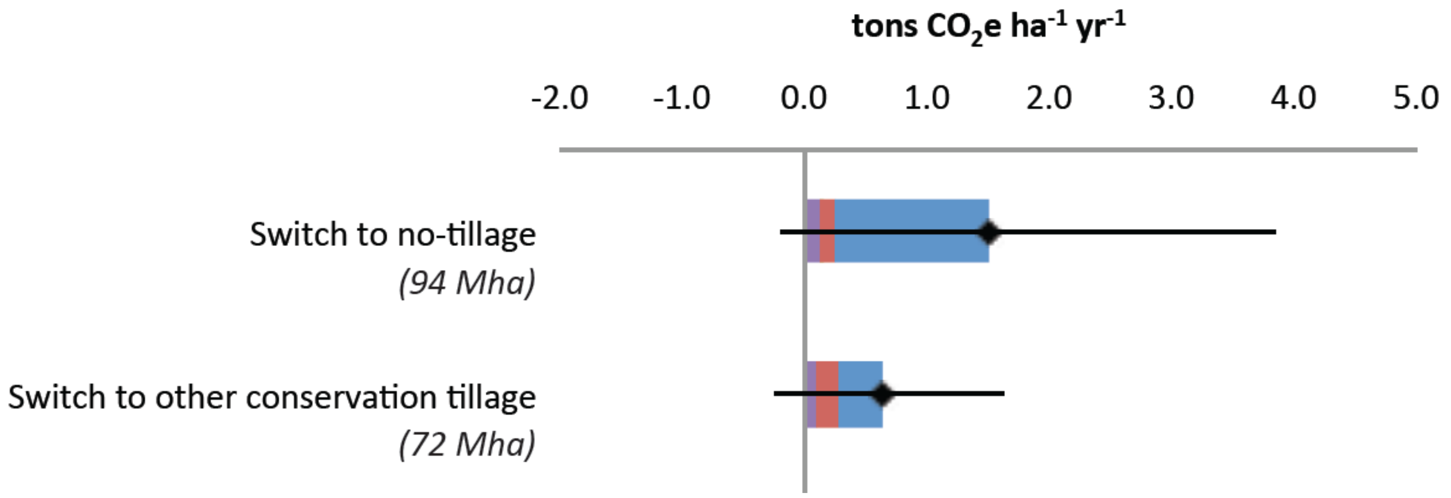
Scientific certainty judged by soil scientists

Activity	Target GHG	Estimates used in calculations[a]	Regional coverage of data[b]	Scientific certainty[c]
Positive mitigation potential – significant research				
Switch to no-till	Soil C	246	1, 2, 3, 4, 7, 8, 9	Medium
Switch to other conservation tillage	Soil C	65	1, 2, 4, 5, 6, 7, 9	Low
Eliminate summer fallow	Soil C	33	2, 5, 7 (+ Canada)	n/a
Use winter cover crops	Soil C	31	1, 3, 6, 8, 9	Low
Diversify annual crop rotations	Soil C	87	1, 2, 7, 8	Low
Incorporate perennials into crop rotations	Soil C	28	1, 2, 4 (+ Canada)	Medium

Olander et al., 2011, *TAGG report*

Conservation/No-Tillage in the United States

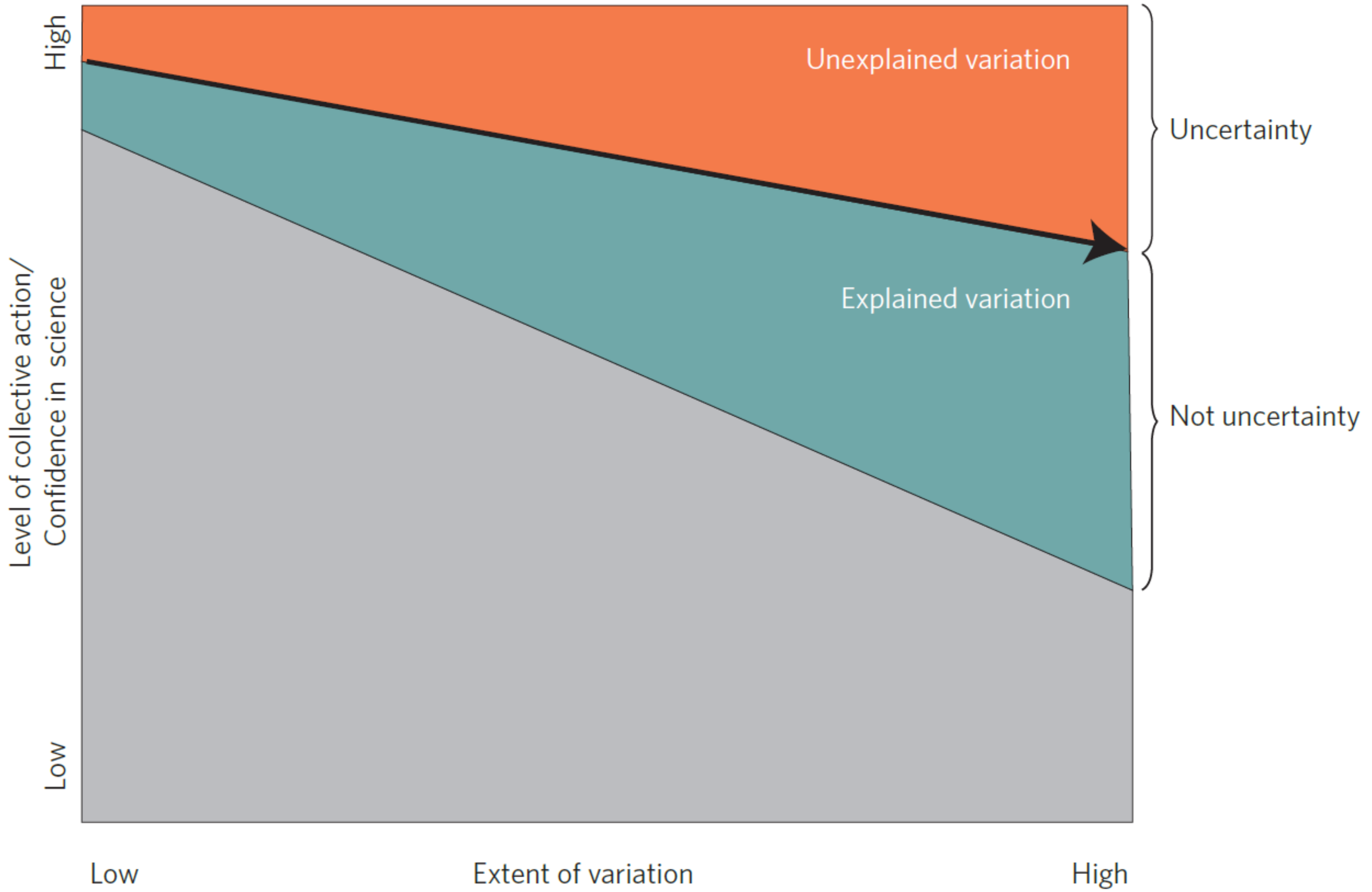
Variable responses – not uncertainty!
No “one-size-fits-all” Management!



Olander et al., 2011, *TAGG report*

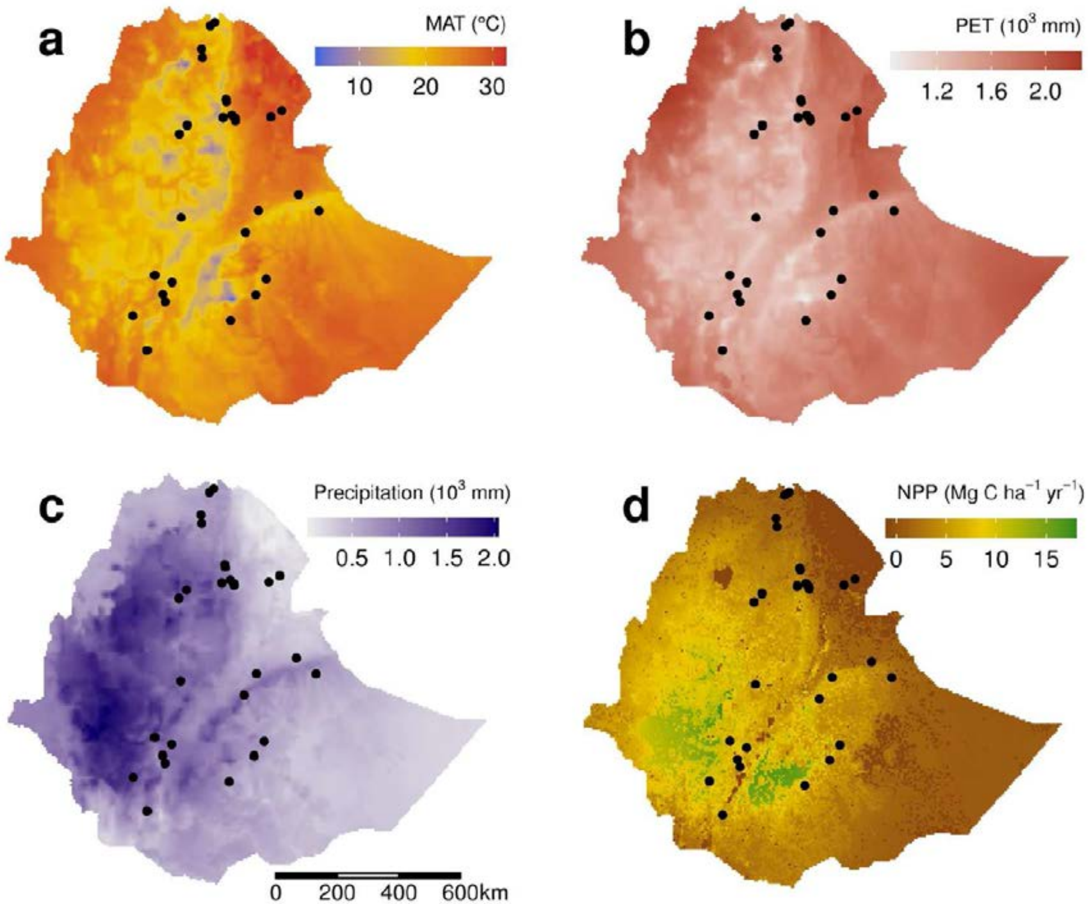
Variability ≠ Uncertainty

Lehmann et al., 2014, *Nature Climate Change* 4, 153



Lehmann et al., 2014, *Nature Climate Change* 4, 153

Soil Carbon Sequestration: Ethiopia



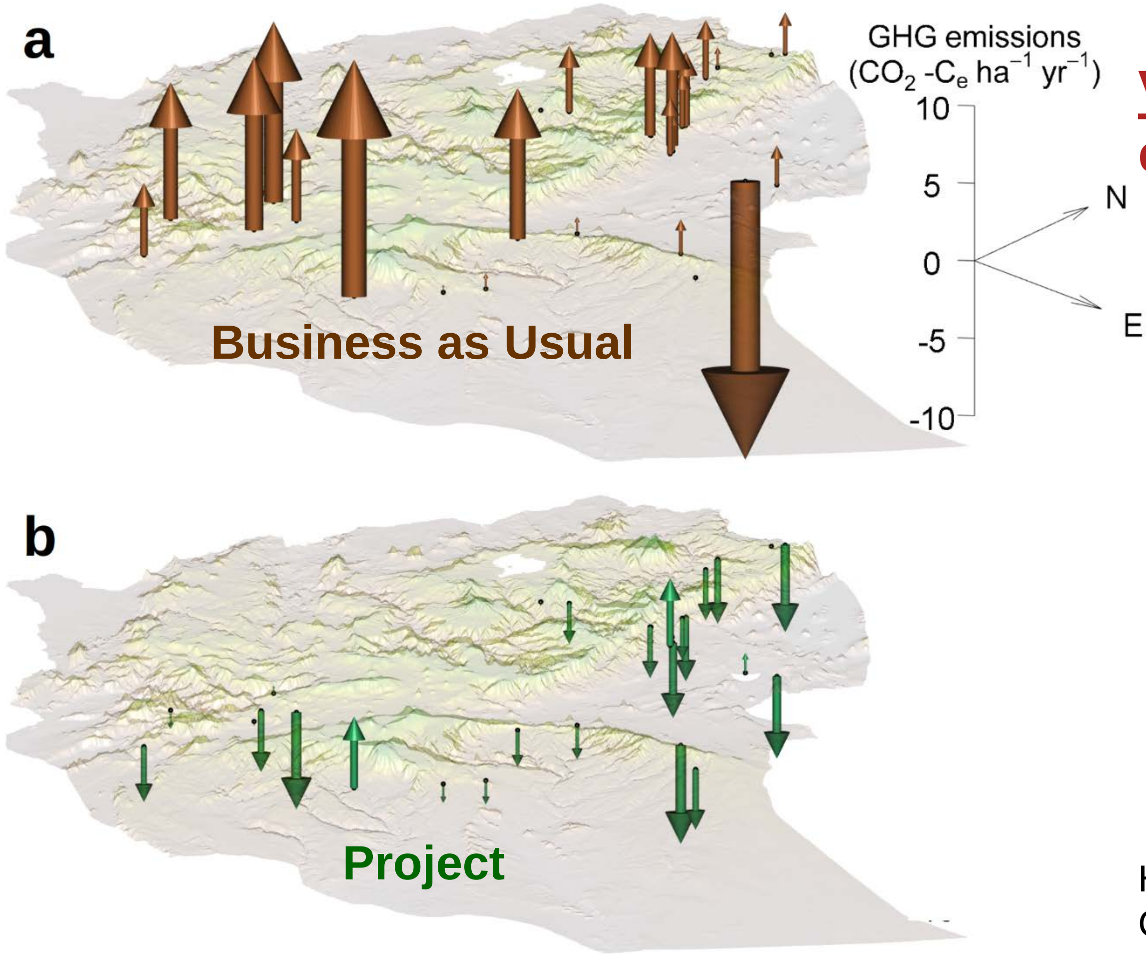
Lessons from Ethiopia's Social Safety Net Program:

Climate-Smart Initiative

PSNP
Productive Safety Net Programme

Woolf, Solomon & Lehmann, 2017, *Climate Policy Journal*, accepted

Soil Carbon Sequestration: Ethiopia



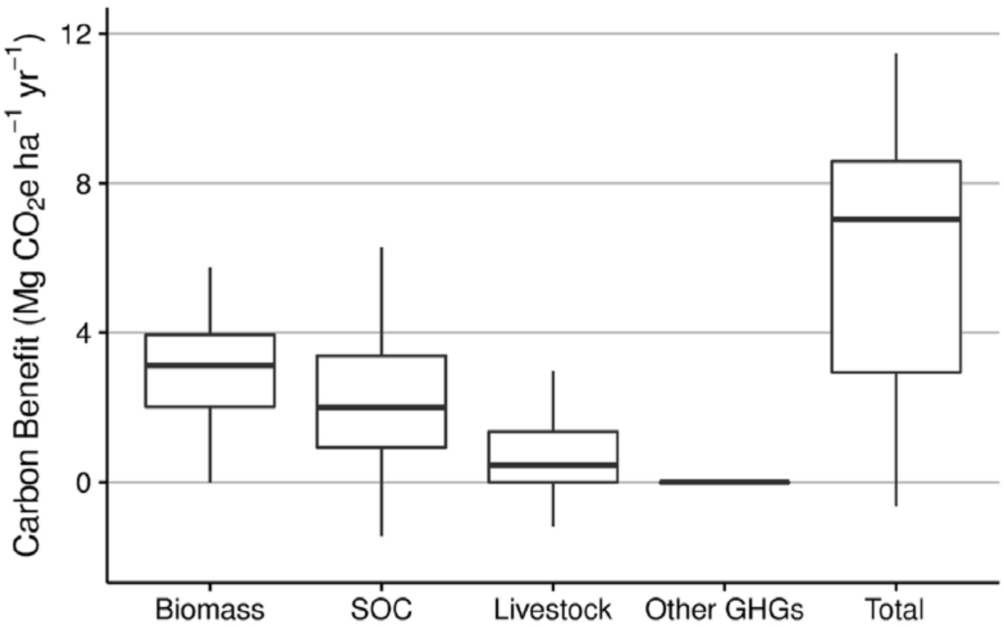
<u>Variable</u> greenhouse gas emissions

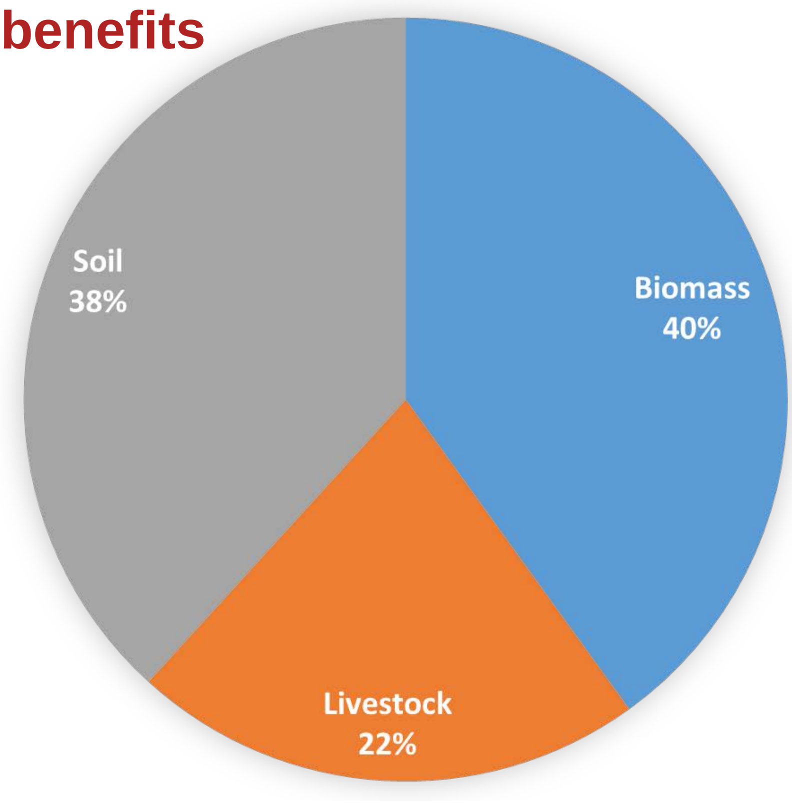
Hybrid tier 1–tier 2 approach
Carbon Benefits Project (CBP) model

Woolf, Solomon & Lehmann, 2017, *Climate Policy Journal*, accepted

Soil Carbon Sequestration: Ethiopia

Soil Carbon is one third of total carbon benefits





Hybrid tier 1–tier 2 approach
Carbon Benefits Project (CBP) model

Woolf, Solomon & Lehmann, 2017, *Climate Policy Journal*, accepted

Climate-Smart Initiative – PSNP Ethiopia

Extent of country-wide GHG reduction by current PSNP in Ethiopia

5.7	tonnes CO_2e ha^{-1} yr^{-1}
600,000 (est.)	ha
3.4 million	tonnes CO_2e yr^{-1}

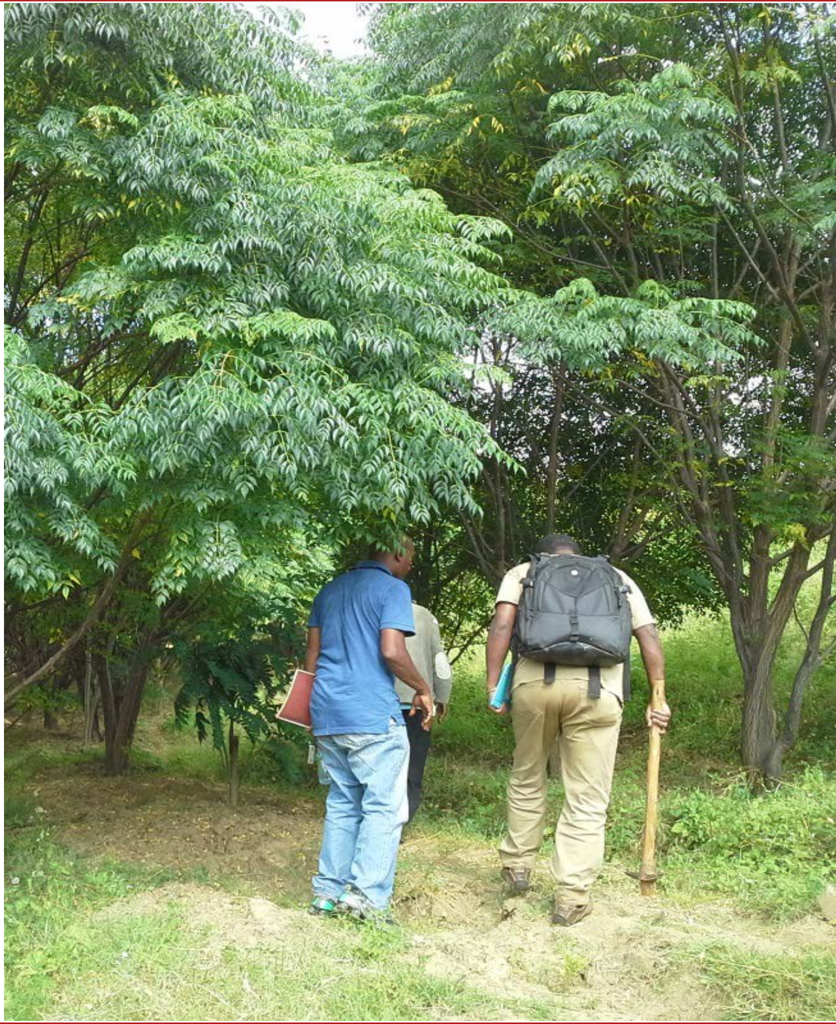
Costs of Assessment – Example

\$48 ha^{-1} yr^{-1}

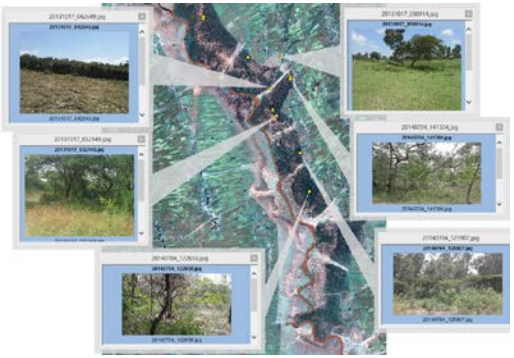
\$0.4 CO_2e^{-1} yr^{-1}

7366 ha, 18 months

(no soil analyses, Tier 1+2 hybrid, Carbon Benefits Project UNEP; less than doubling cost for direct measurements using rapid field techniques)



“Management Learning”

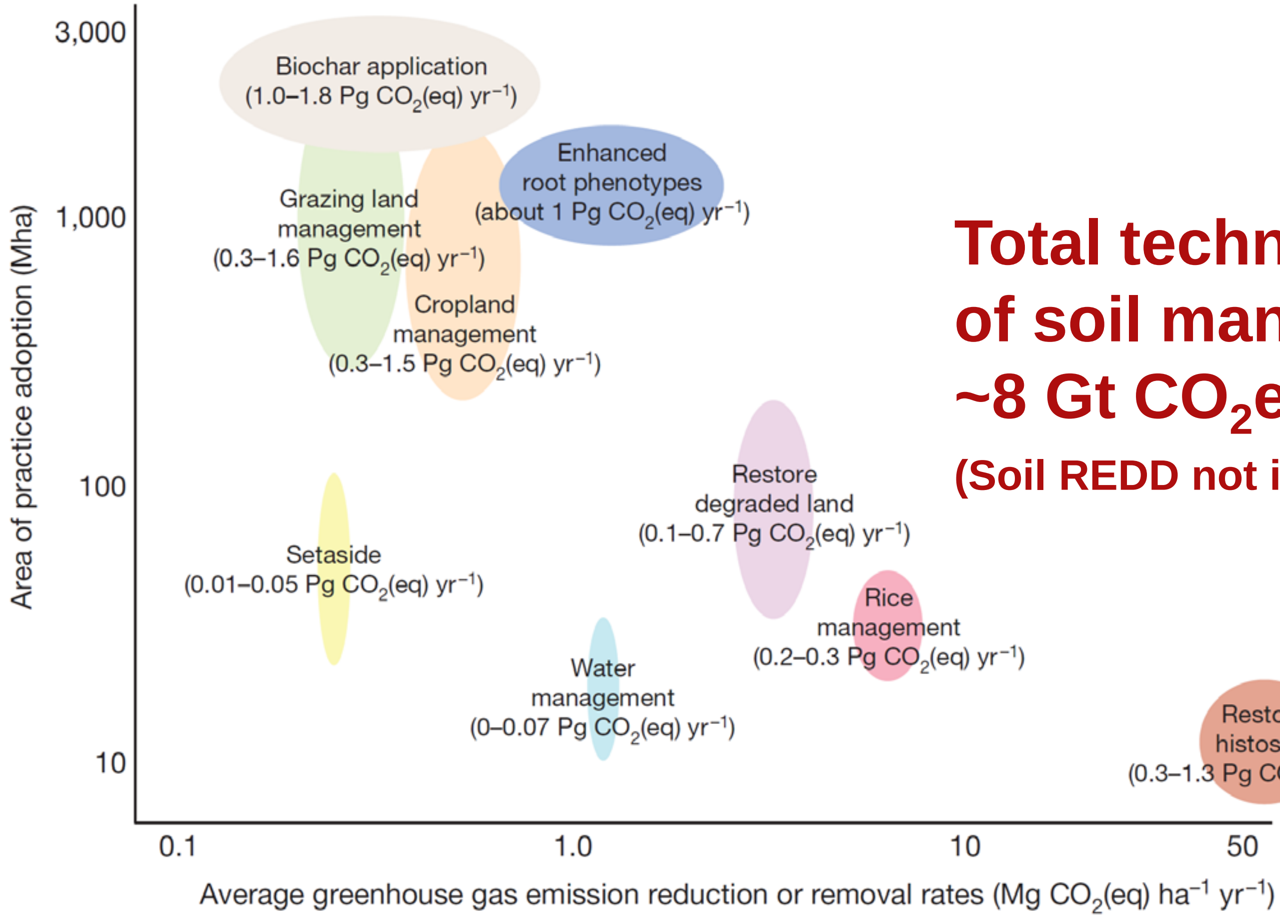


Management → Data → Learning

“Management Learning”

1. Remote sensing (practice and landscape)
2. Local soil, vegetation and practice data (inexpensive sensors – no excuse!!!)
   → Quality control
3. Central computational platforms
4. Global use of practice-based modeling

Soil Management to Mitigate Climate Change



Total technical potential of soil management: ~8 Gt CO_2e per year

(Soil REDD not included)

Paustian et al, 2016, *Nature* 532, 49-57

Take Home

1. Food security interventions contribute to climate-change mitigation with large soil carbon benefits
2. … on a scale comparable to the largest AFOLU projects *intended* for climate mitigation
3. "Management Learning" provides local guidance through global data platforms and practice-based modeling

Abstract

Reducing uncertainties in soil organic carbon predictions through "management learning"

More organic carbon resides in global soils than exists carbon in the atmosphere and the entire biosphere together. Therefore, small changes in soil organic carbon translate into meaningful changes in atmospheric carbon dioxide. This is the basis for the 4p1000 proposal: to increase existing soil organic carbon stocks by 0.4% each year and thereby match the remaining anthropogenic emissions. The proposal has generated excitement from various sectors, but also faces significant challenges. Scientists welcome the approach but also point out the huge task and the inadequate data to make informed decisions. This presentation will highlight some of the key misconceptions in the scientific and policy discussion and introduce an approach of iterative improvement of site-specific management. Such a "management learning" concept will rely on best management practices for a given soilscape and improve practices through organized data and continuously improved modeling. Critical is to recognize the difference between uncertainty in predicting the outcome of a management intervention and the variability of soil responses due to predictable differences in climate and soil type. The vast majority of uncertainty does not lie in our inability to predict the outcome but in data management issues. Local data must be fed into models that will improve its performance for guiding management decisions locally and globally. This requires distributed data entry and its quality control, development of inexpensive sensors that are easy to use, and computational platforms that are fit for big data. Investments in sensor technology and operations can be financially justified through improved soil services as related to food, energy and water. The up-front investment in the science and infrastructure must be borne by the public sector, and will generate a vibrant industry around food-energy-water that contributes a vital pathway to global carbon dioxide removal.