Land Carbon and Climate

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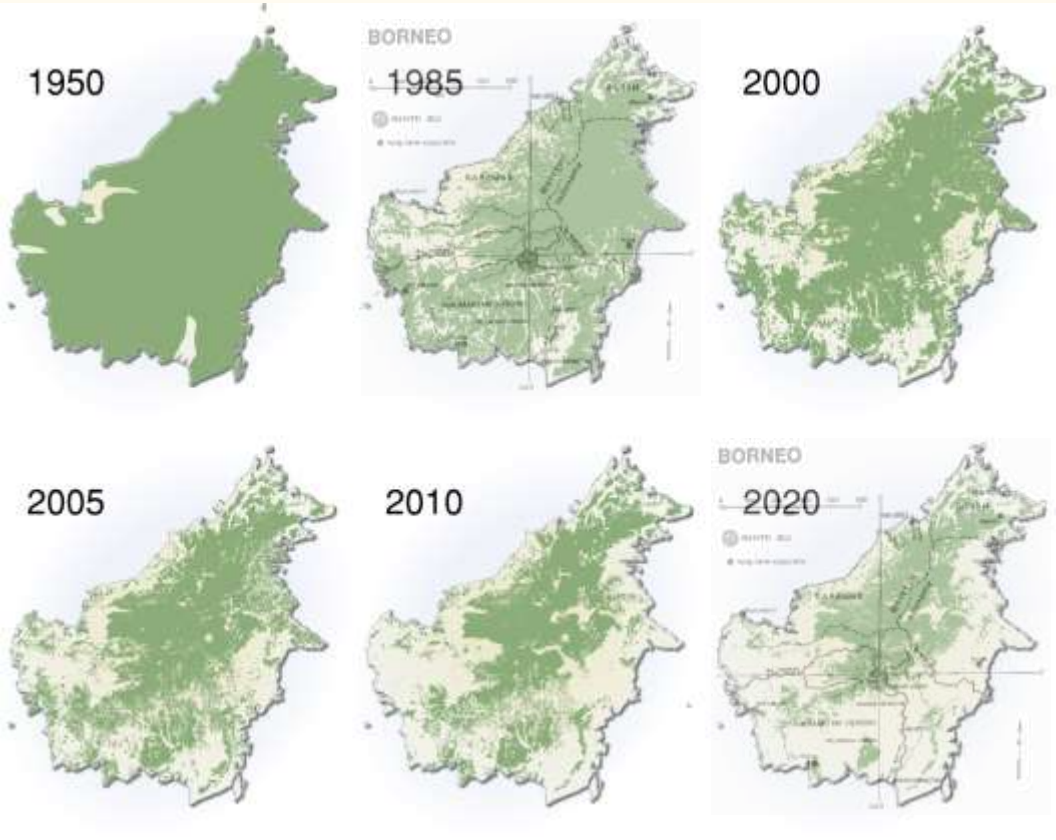
Borneo, Indonesia

Borneo: historical and projected area of forest cover

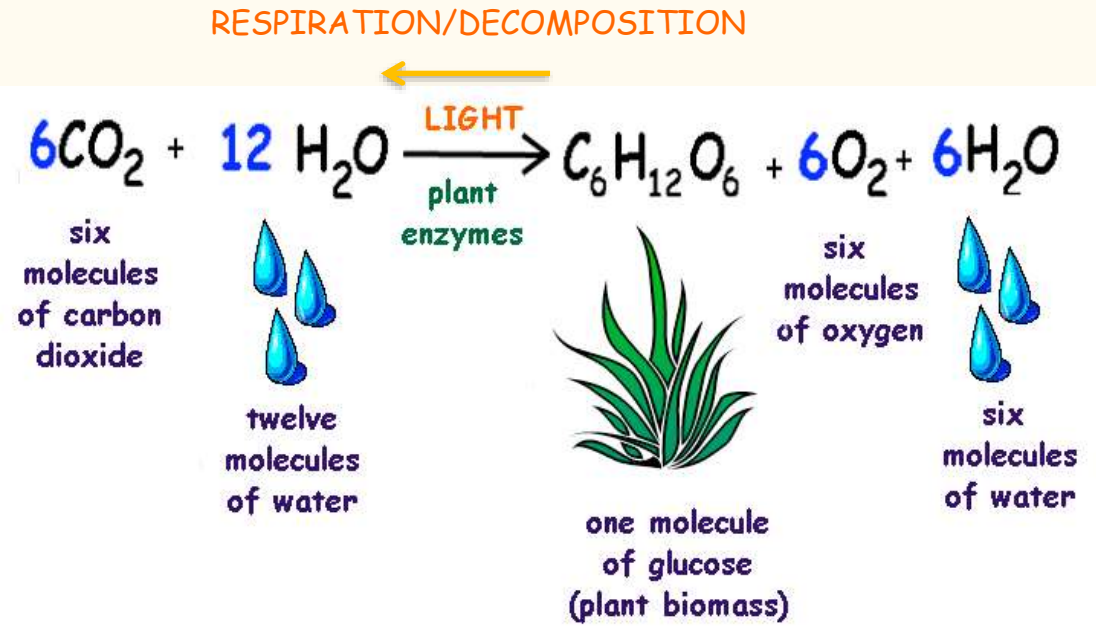


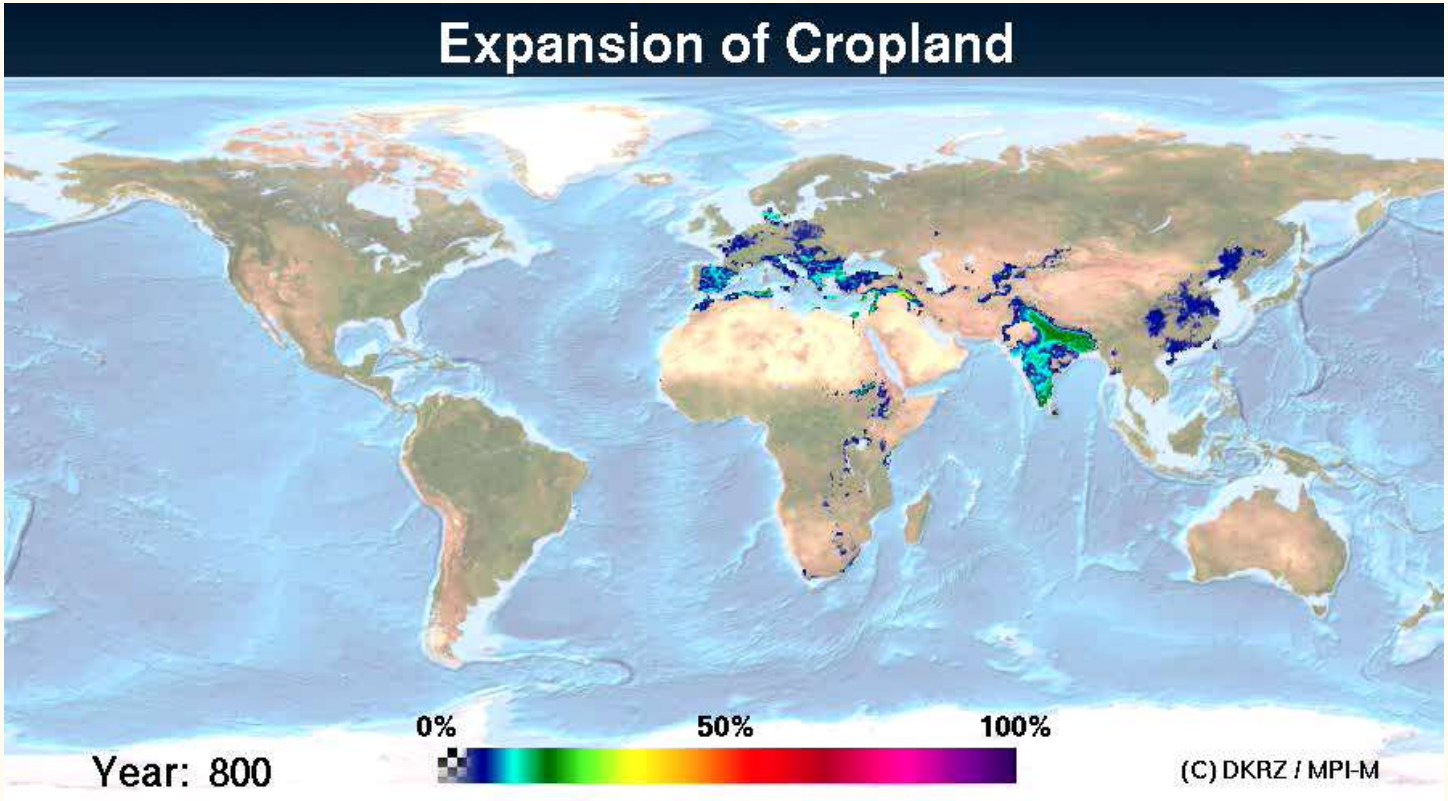
Map: Univ. of California, Riverside;
Photo: J. House)

Overview

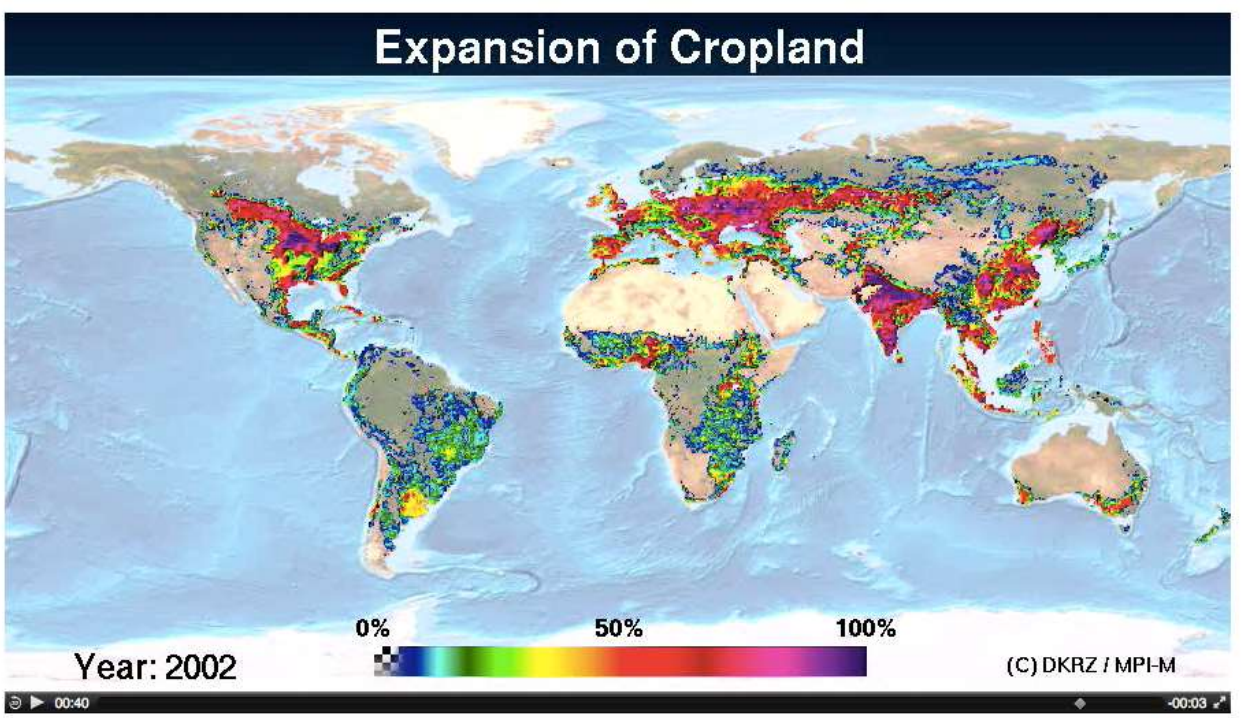
- Land-carbon-climate
- How humans affect land and climate change…and how climate change affects land
- The Paris Agreement
- What can we do? Land-based mitigation options

Photosynthesis primer



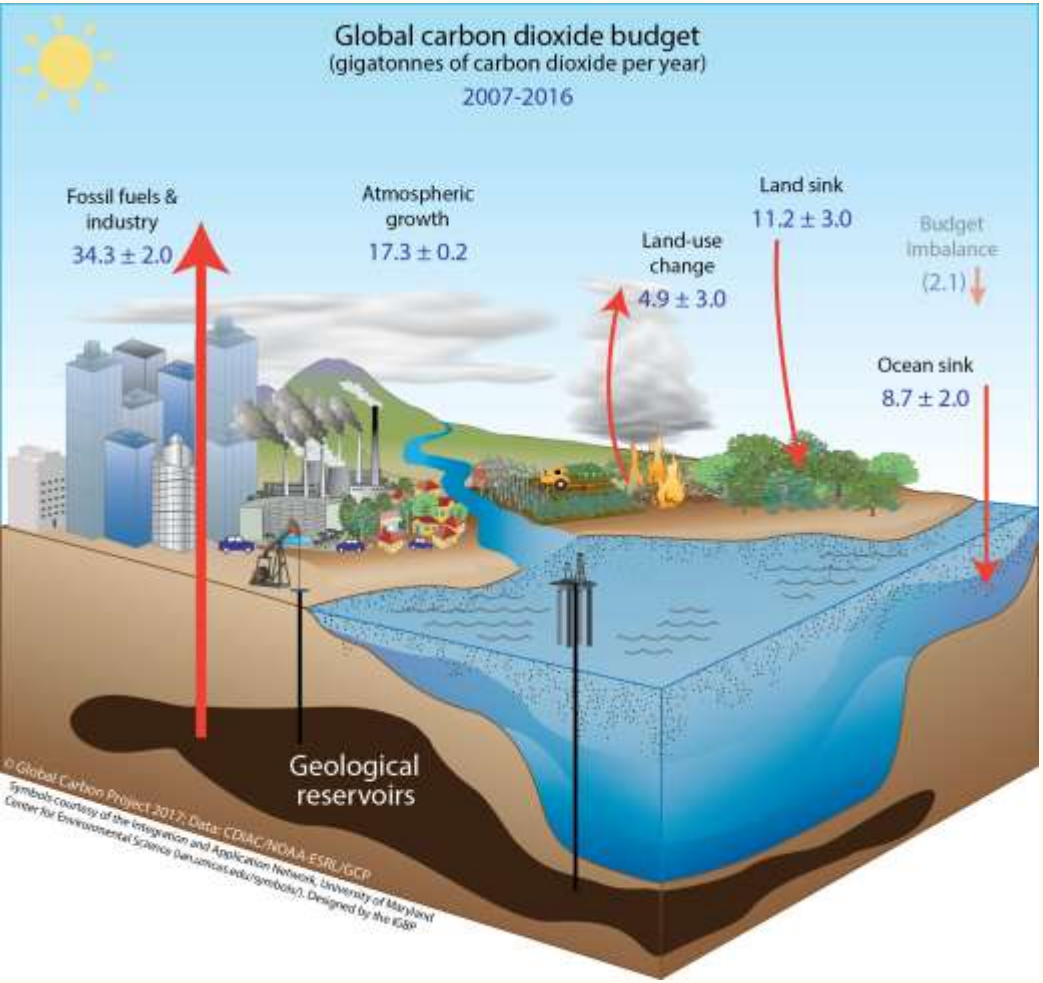


Cropland extent as fraction of grid cell from AD 800 to 2100.
More land was converted to cropland in the 30 years after 1950 than in the 150 years between 1700 and 1850.
http://www.mpimet.mpg.de/en/staff/julia-pongratz/datasets.html
(Visualized by DKRZ, data by Pongratz et al, Glob.Biog.Cyc., 2008, future scenario IPCC SRES A1b)



- 38% of Earth's terrestrial surface under agriculture, 12% under cropland (FAO, 2013)

Anthropogenic perturbation of the global carbon cycle



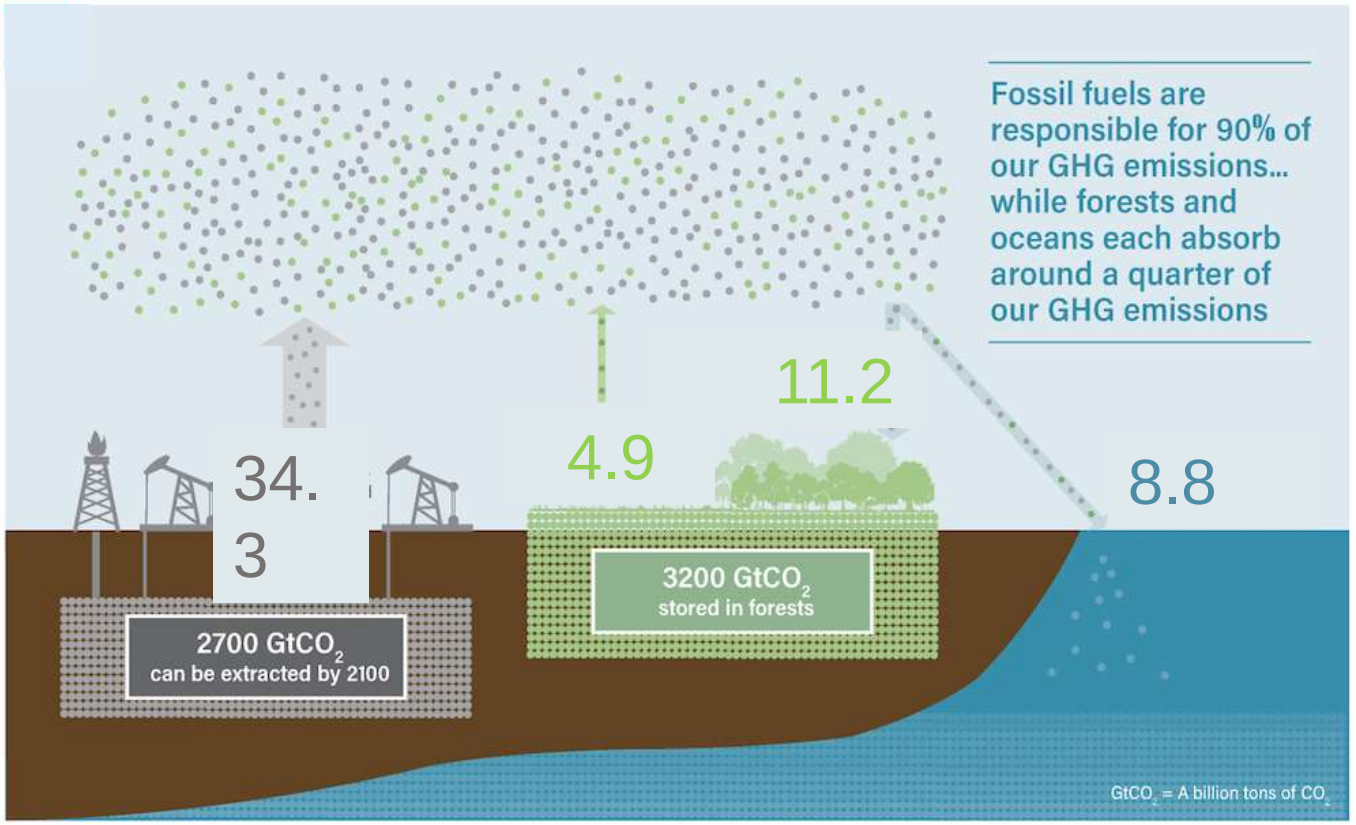
Average annual emissions and removals globally for the decade 2007–2016 ($GtCO_2$/yr):

Net land emissions due to human activity 12% total emissions (deforestation, afforestation)

Net land sink due to environmental change 30% total emissions

The budget imbalance is the difference between the estimated emissions and sinks.
Source: CDIAC; NOAA-ESRL; Le Quéré et al 2017; Global Carbon Budget 2017

What do we need to do?



We can only put 750 $GtCO_2$ into the atmosphere to limit warming to 1.5 degrees – around 15 years or current emissions

Emissions $GtCO_2$ per year = a billion tonnes of carbon dioxide per year

Data Access and Additional Resources

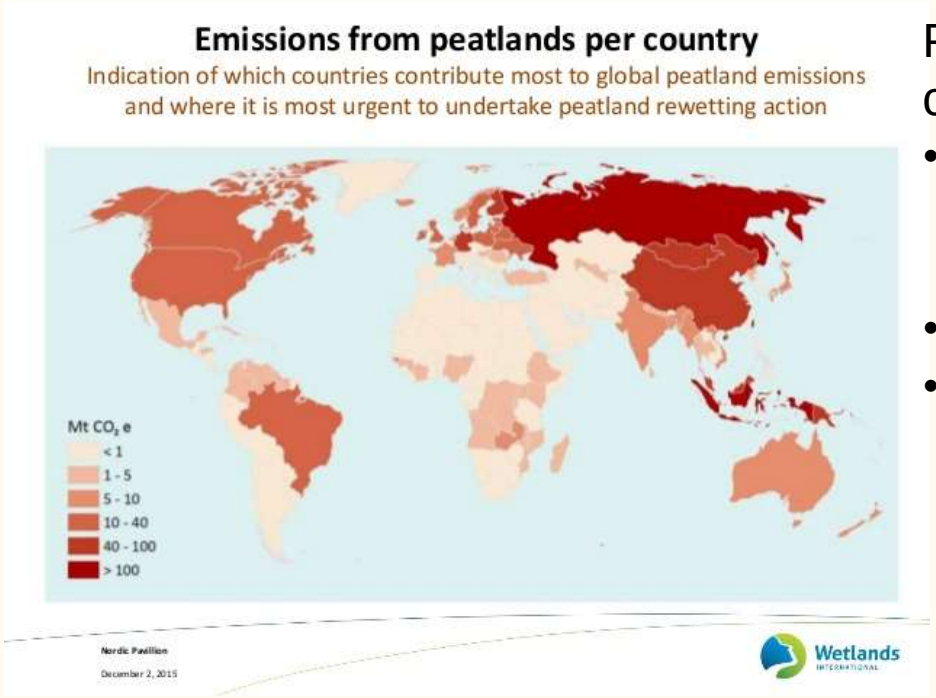
GCP Website

More information, data sources and data files:
http://www.globalcarbonproject.org/carbonbudget Contact: c.lequere@uea.ac.uk

Global Carbon Atlas

More information, data sources and data files:
www.globalcarbonatlas.org
(co-funded in part by BNP Paribas Foundation)
Contact: philippe.ciais@lsce.ipsl.fr

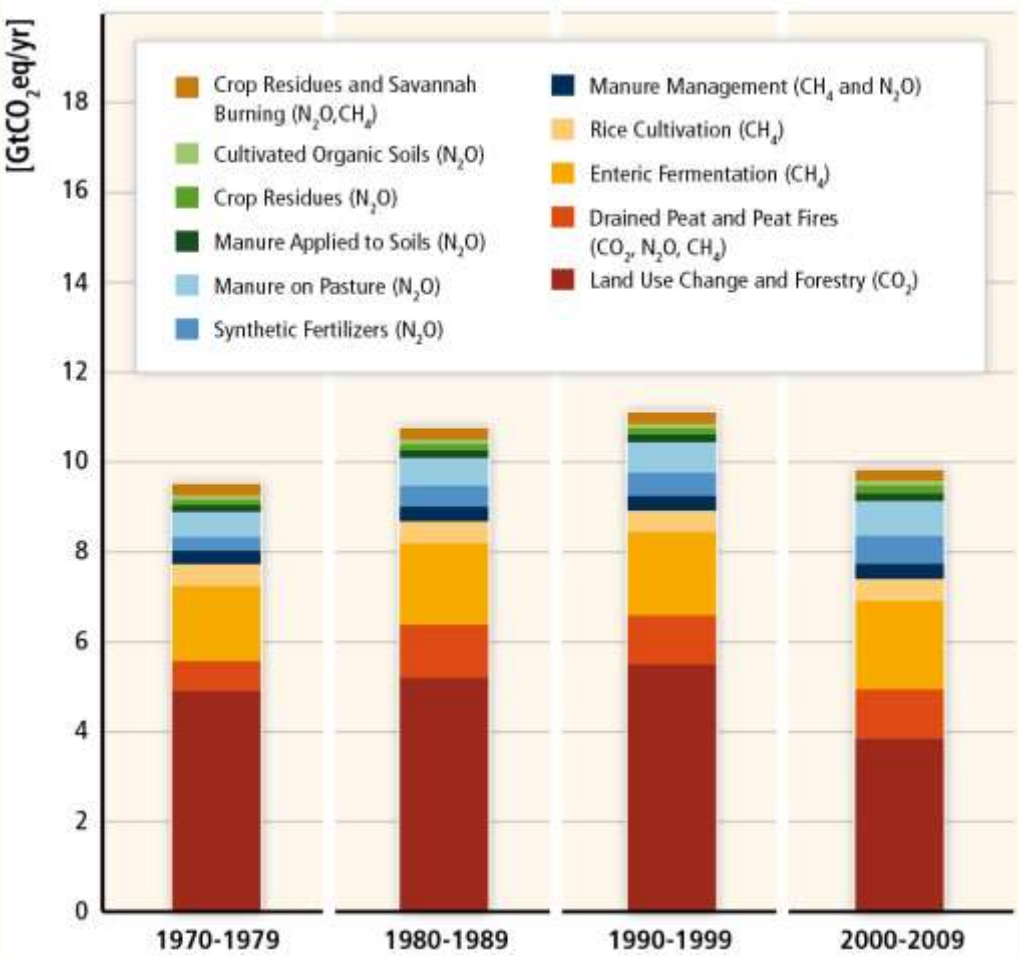
Carbon emissions from peatlands (draining and fires)



Peatlands/wetlands are a natural sink for carbon, on long time-scales.

- Waterlogged- anoxic-slow decomposition, net CO2 uptake, slow CH_4 release,
- Drained – aerobic- rapid CO_2 release
- Fire – rapid release of carbon

Emissions from Agriculture Forestry and Other Land Use (AFOLU)



- The land sector accounts for 24% of total anthropogenic GHG emissions
- Agricultural emissions are increasing, but *net* land use change (deforestation + afforestation) CO_2 emissions have fallen recently

IPCC (2014) WGIII, Chapter 11, Agriculture, Forestry and Other Land Use.
Tubiello et al., *Gl. Ch. Biol*, 2015

What can we do? The Paris Agreement

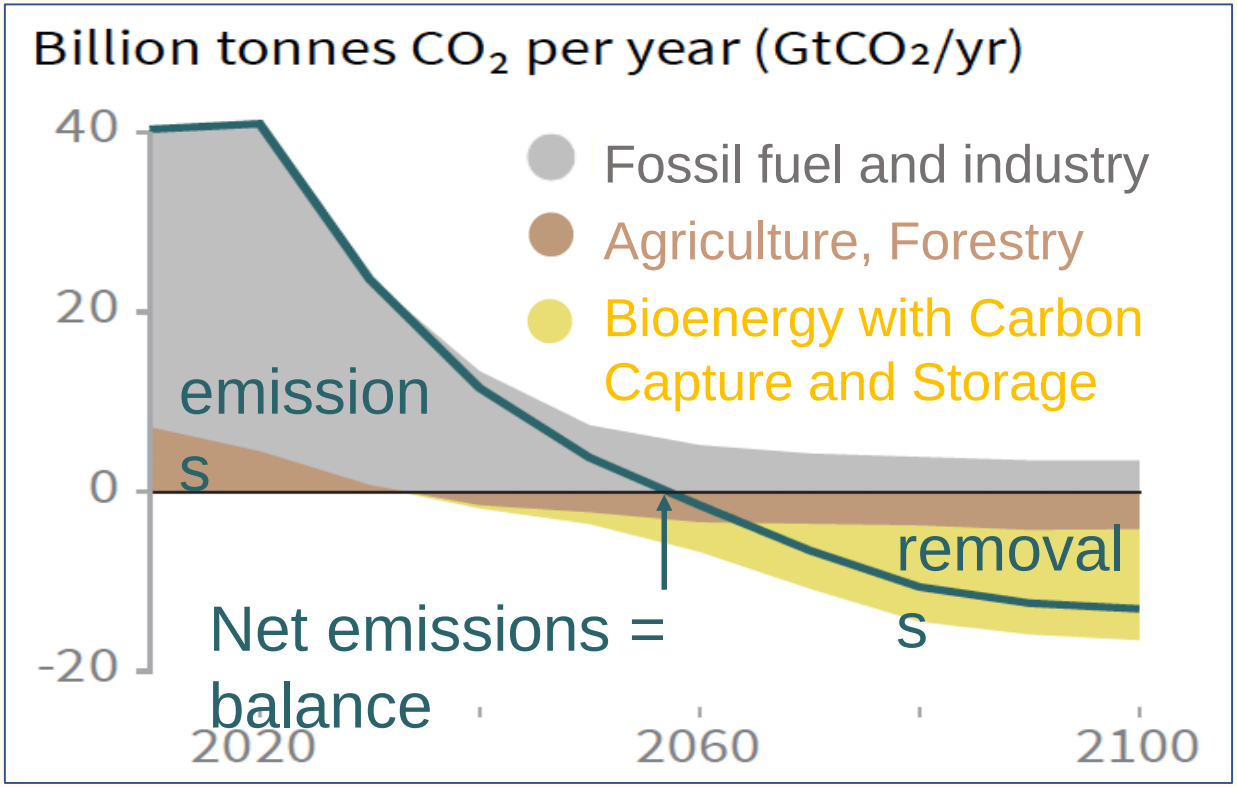
- 196 countries signed up to Paris Agreement
- Country pledges “Nationally Determined Contributions”

Well below 2 ºC

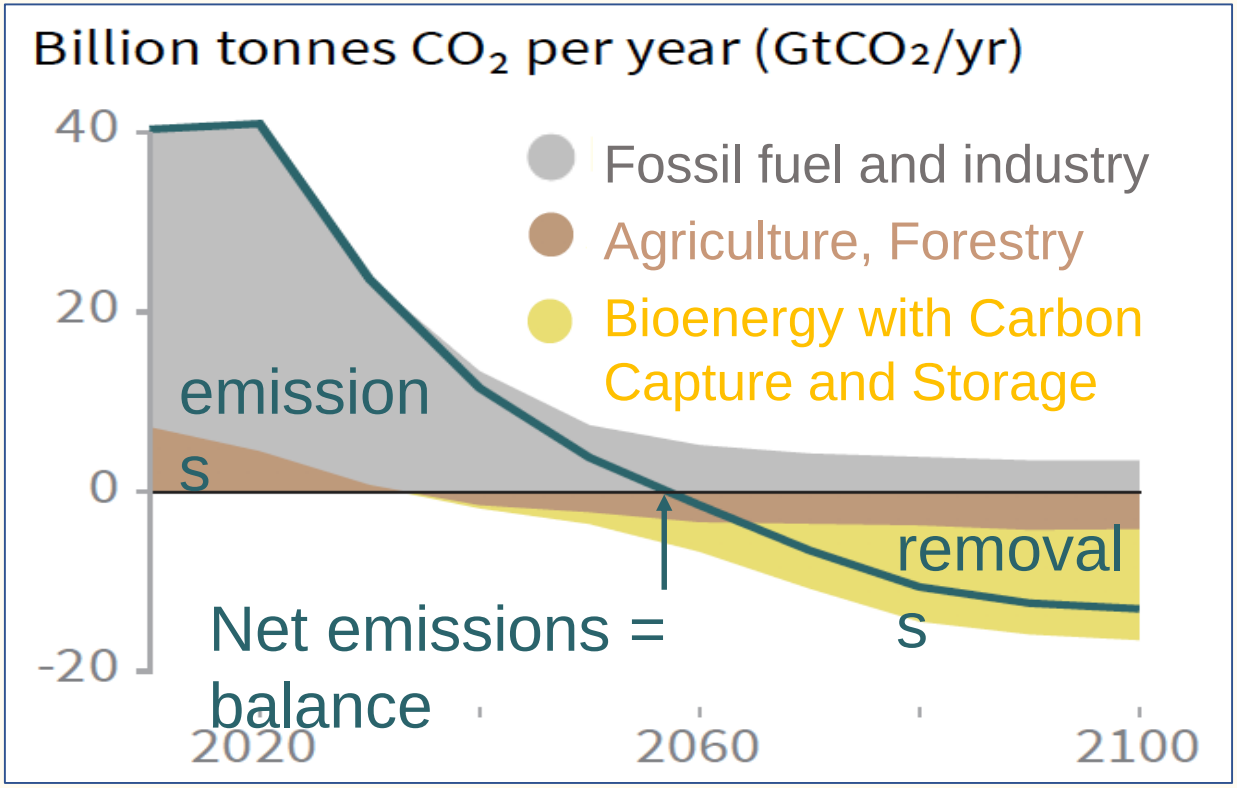
Pursue efforts 1.5 ºC

Balance of emissions & removals

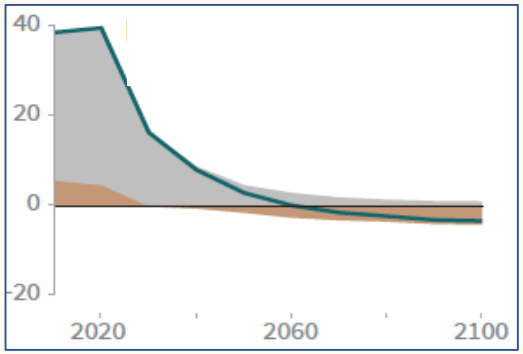
How do we get to 1.5 degrees?

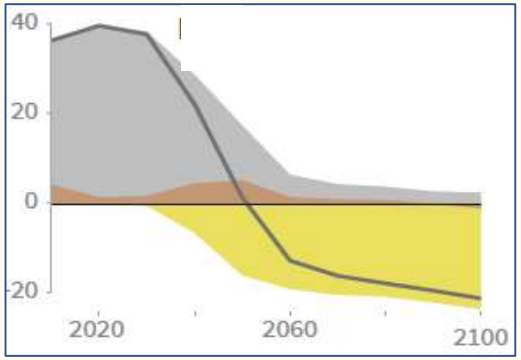


How do we get to 1.5 degrees?



There are multiple different pathways that can limit warming to 1.5 ºC





What can we do with energy and industrial emissions?

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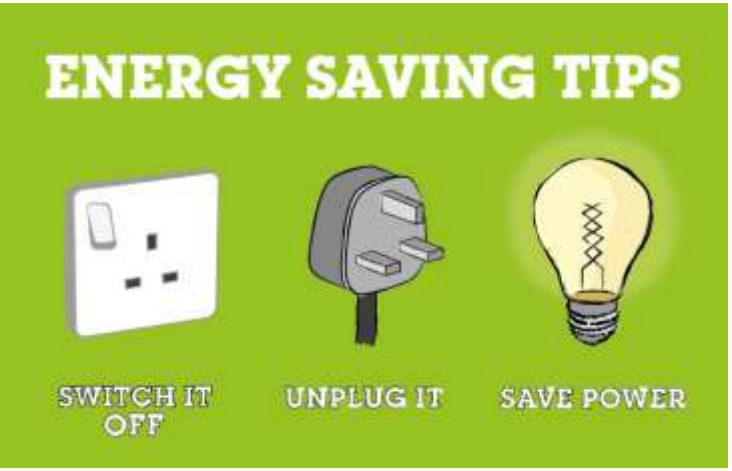
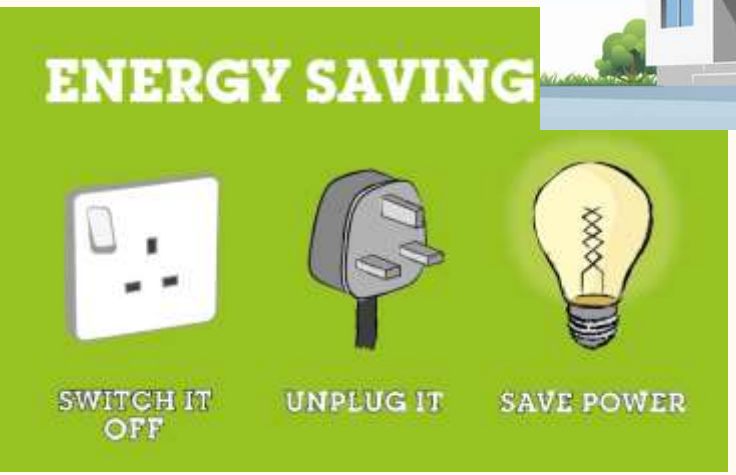
Reduce



- Save money
- Energy security

What can we do with energy and industrial emissions?

Reduce

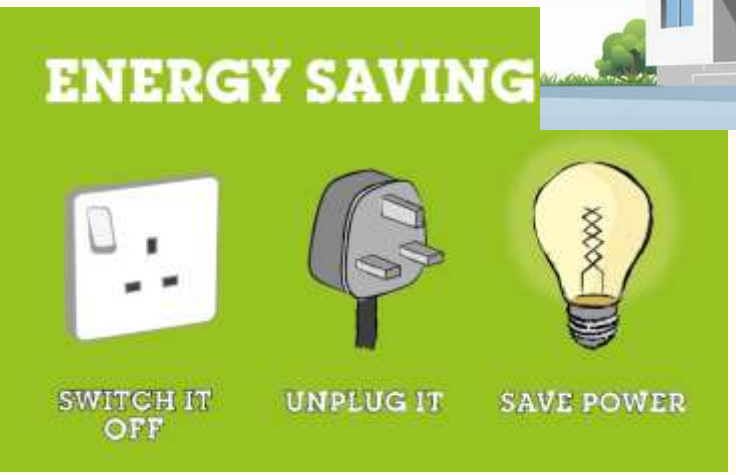


Replace

- Save money
- Energy security
- Health

What can we do with energy and industrial emissions?

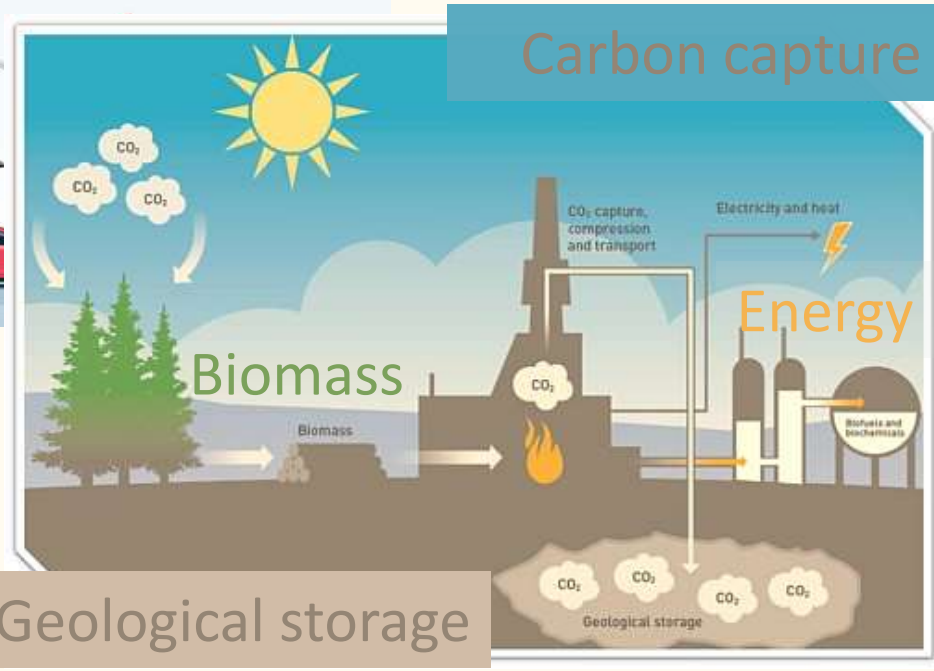
Reduce



Replace

Remove

Carbon capture



Geological storage

What else can we do on the land?

What else can we do on the land?

Protect

What else can we do on the land?

Protect

Enhance

What else can we do on the land?

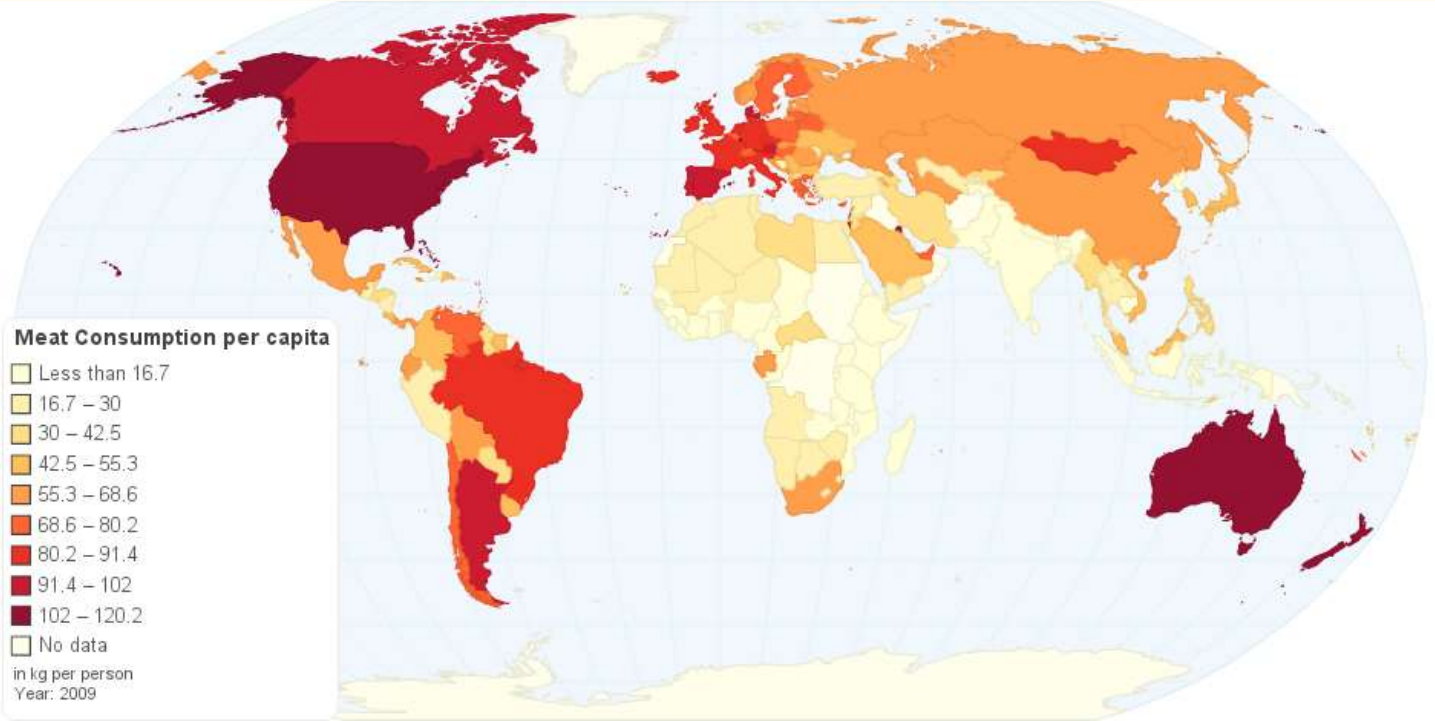
Protect

Enhance

Tree planting 'can reduce flooding'

Reduce

Meat consumption per capita



10kg feed for 1 kg beef

Big differences in the GHG intensity of different

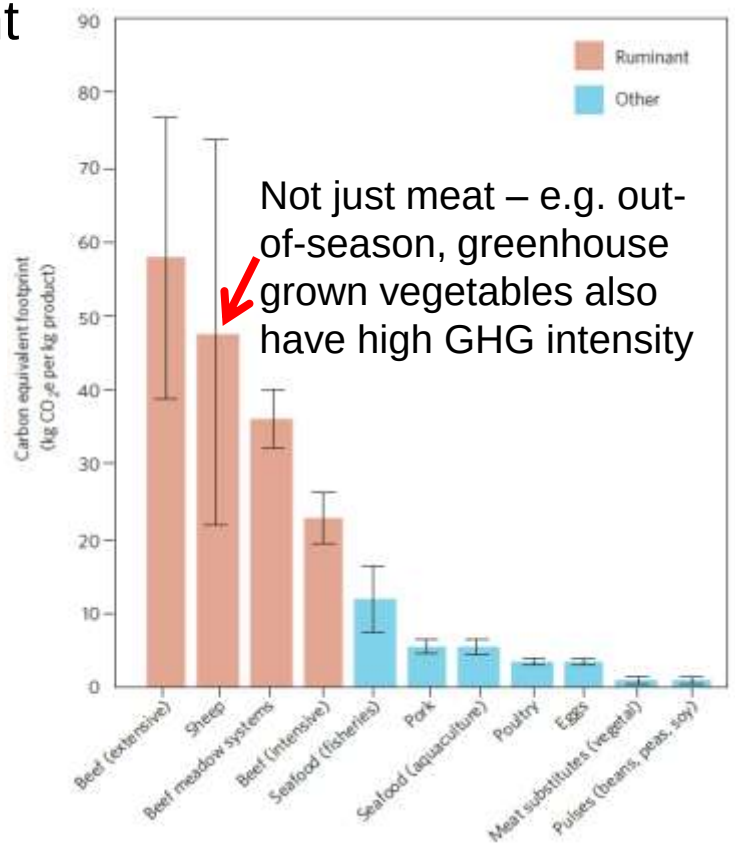
opinion & comment

COMMENTARY:

Ruminants, climate change and climate policy

William J. Ripple, Pete Smith, Helmut Haberl, Stephen A. Montzka, Clive McAlpine and Douglas H. Boucher

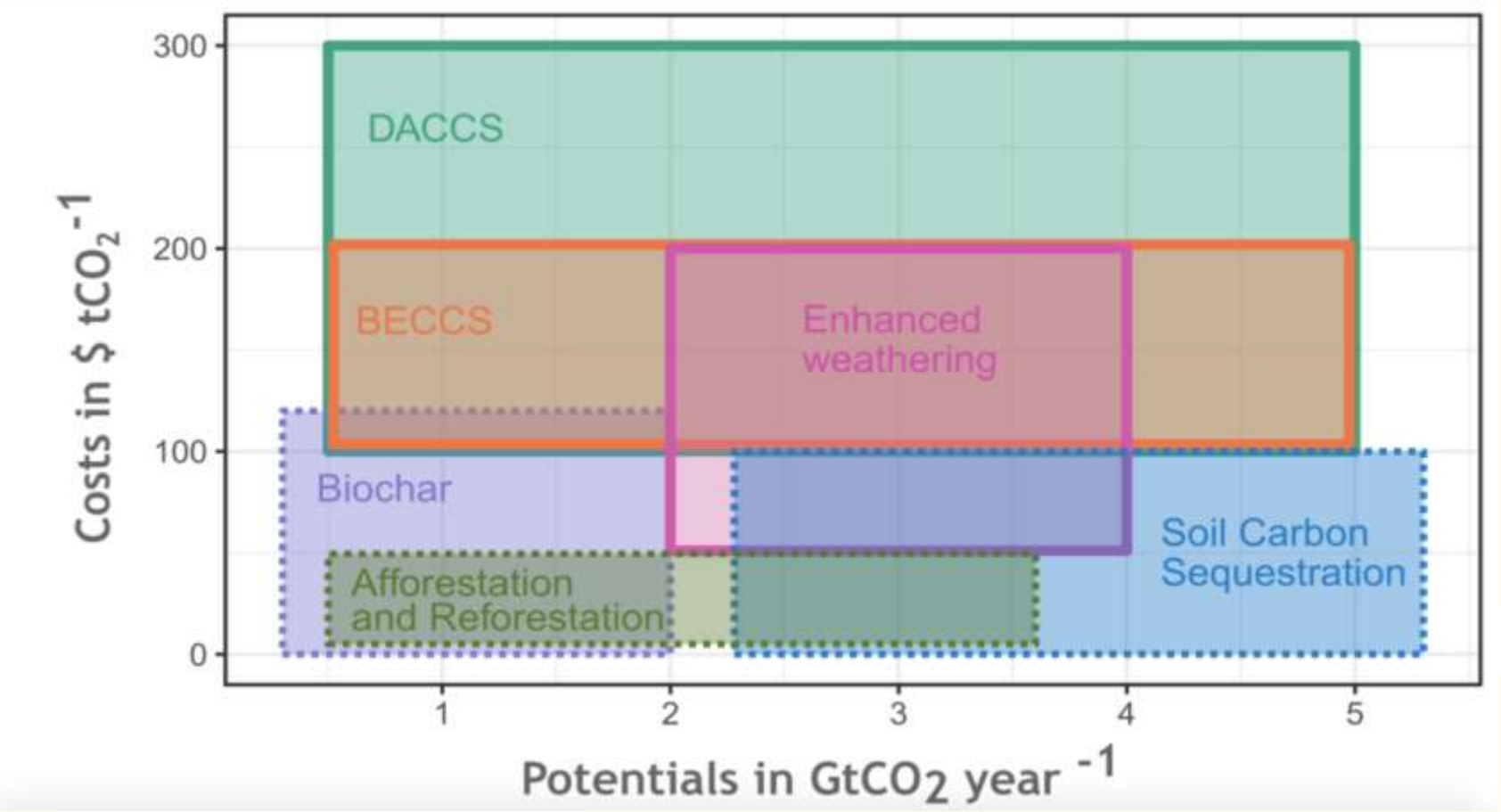
Greenhouse gas emissions from ruminant meat production are significant. Reductions in global ruminant numbers could make a substantial contribution to climate change mitigation goals and yield important social and environmental co-benefits.



Not just meat – e.g. out-of-season, greenhouse grown vegetables also have high GHG intensity

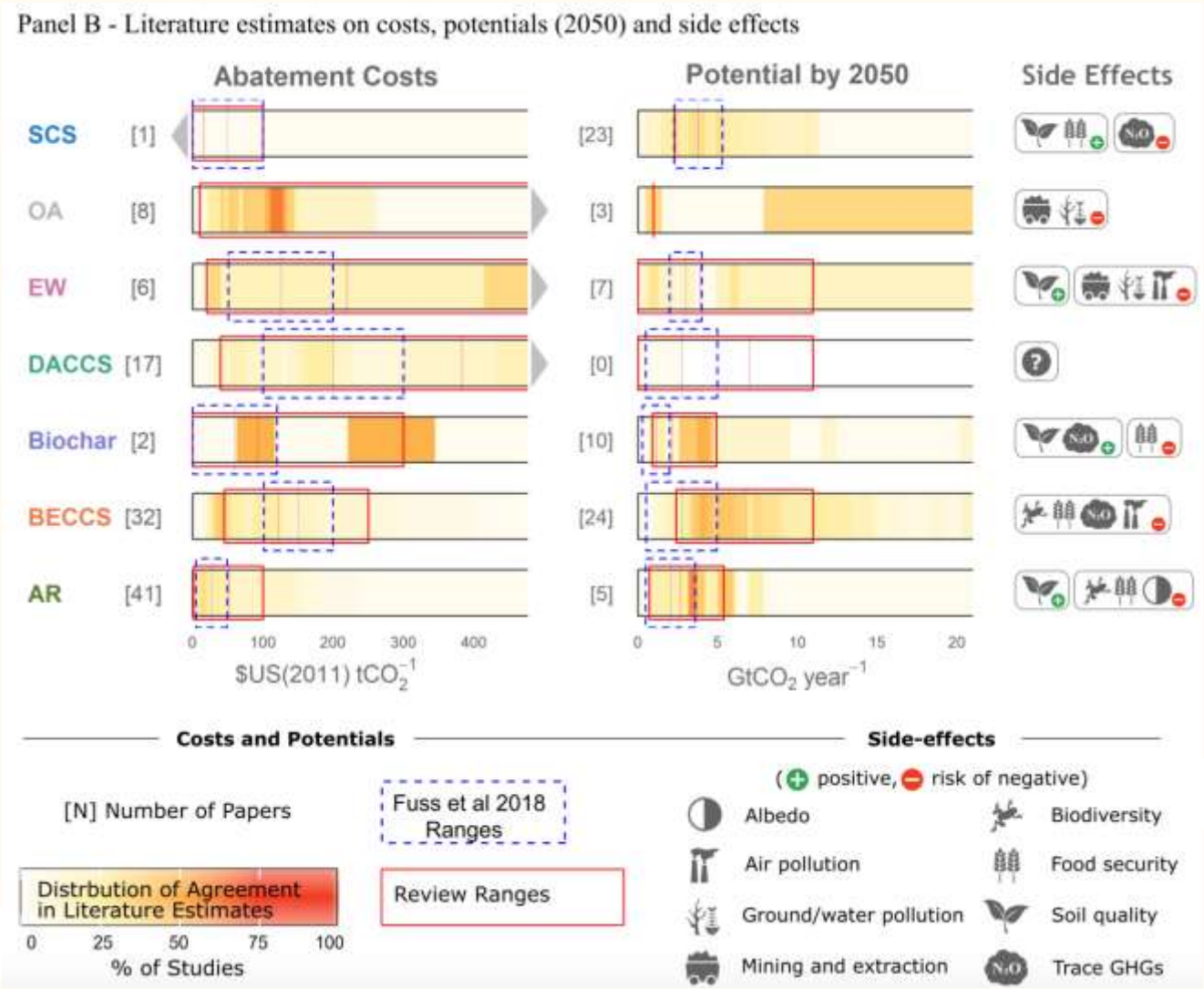
Ripple *et al.*(2014) Nature CC

Estimated carbon removal potentials Fuss et al., 2018

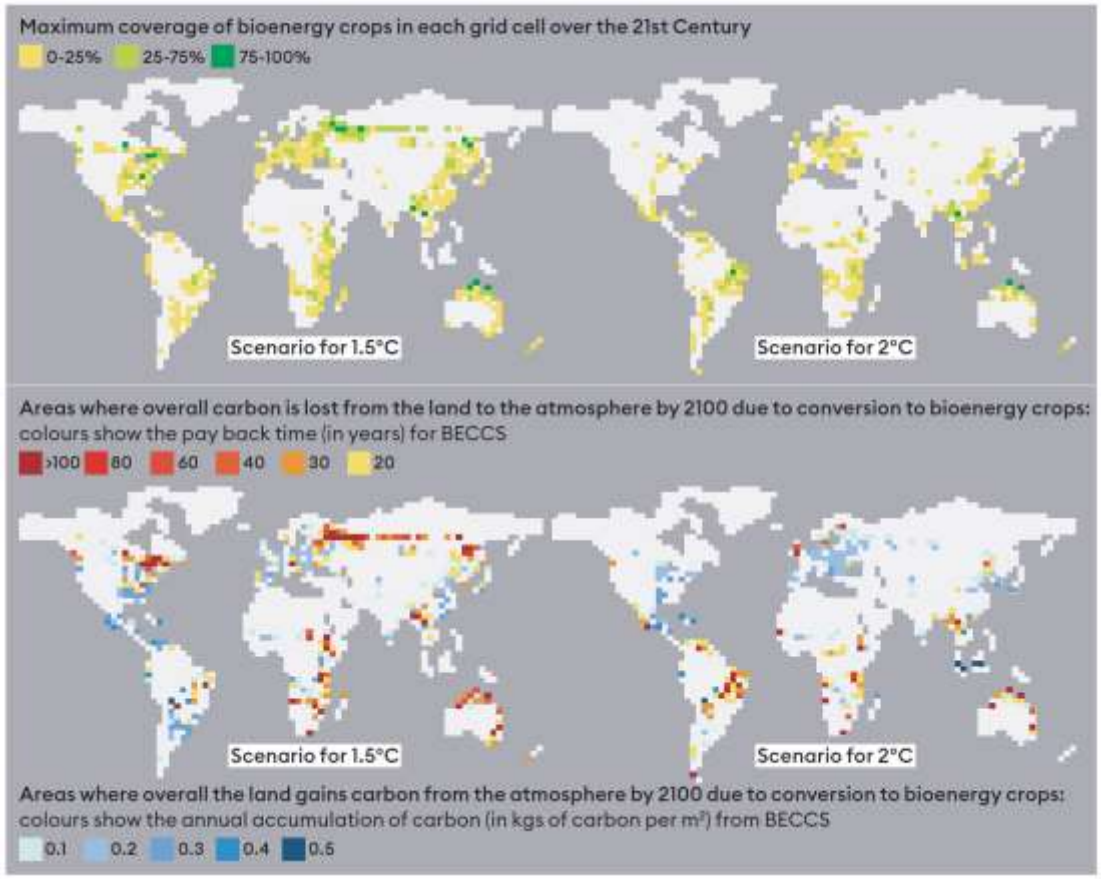


Land-based mitigation – benefits, trade-offs, limits

- Can you think of any?


Panel B - Literature estimates on costs, potentials (2050) and side effects
Abatement Costs
Potential by 2050
Side Effects
SCS [1]
OA [8]
EW [6]
DACCS [17]
Biochar [2]
BECCS [32]
AR [41]
[23]
[3]
[7]
[0]
[10]
[24]
[5]
0 100 200 300 400
$US(2011) tCO2-1
0 5 10 15 20
GtCO2 year-1
Costs and Potentials
Side-effects
[N] Number of Papers
Fuss et al 2018 Ranges
Review Ranges
Distrbution of Agreement in Literature Estimates
0 25 50 75 100
% of Studies
(positive, risk of negative)
Albedo
Air pollution
Ground/water pollution
Mining and extraction
Biodiversity
Food security
Soil quality
Trace GHGs

What can we do on the land?



- *Grow more trees*
- *Soil carbon sinks*
- *Bioenergy:* Model simulations of a 1.5ºC future suggest bioenergy crops could be grown on up to 760 Mha of land = half of current day food cropland

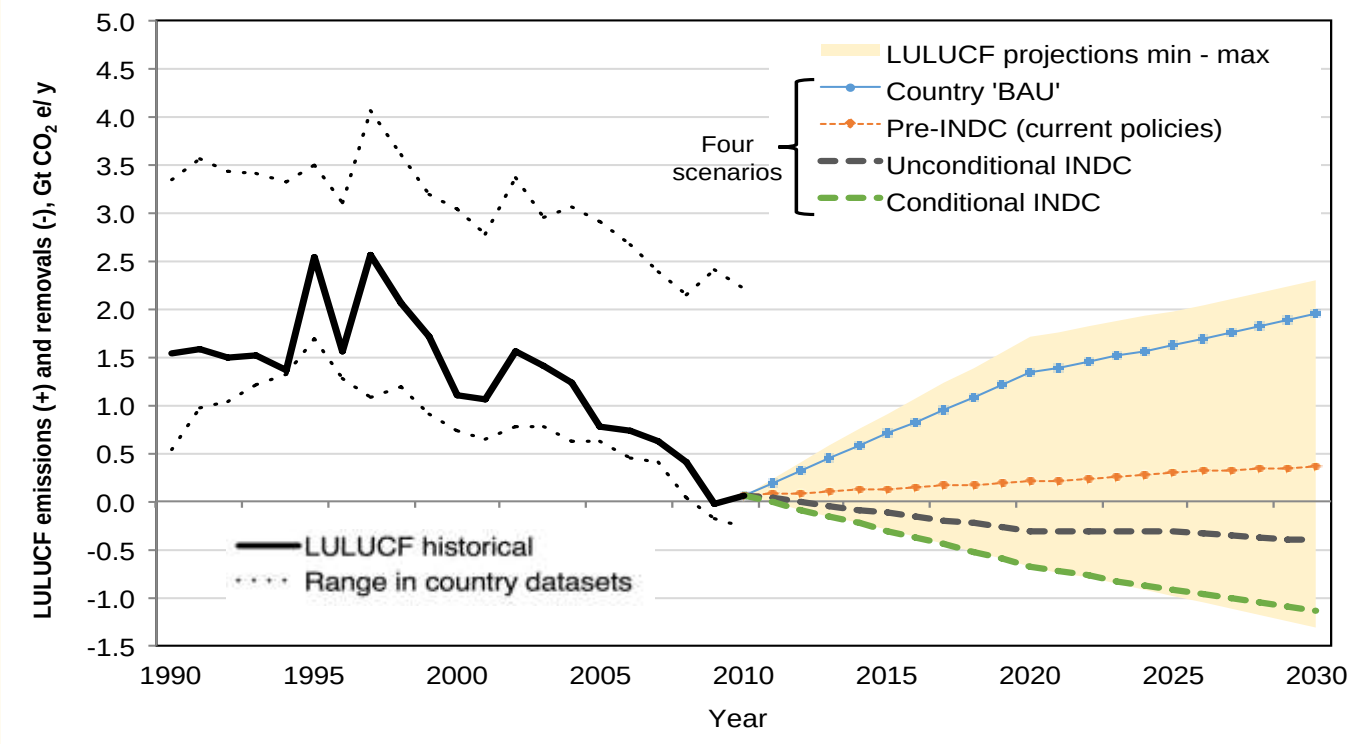
In areas where natural carbon storage on the land is high (tropical and boreal forests and peatlands), it is better to protect and restore natural ecosystems than implement Bioenergy with Carbon Capture and Storage (BECCS) (Harper et al., 2018)

Where are we at so far?

INDCs land sector examples

- **Brazil**: reduce emissions 36% to 39% compared to 2020 Business as Usual, reduce deforestation in the Amazon region by 80% between 2005 and 2020
- **Mexico**: intensity -25% by 2030, 0% deforestation, afforestation for wetland protection
- **China**: peaking 2030, increase forest stock volume by 4.5 billion m^3
- **Gabon**: -50% by 2025, most from land management
- **USA**: reduce net GHG emissions by 26–28% below 2005 in 2025, incl LULUCF
- **India**: lower the emissions intensity of GDP by 33% to 35% by 2030 below 2005 levels, Green India Mission: enhance carbon sequestration annually by about 100 $MtCO_2e$
- **Russia**: reduce emissions -20-25 % by 2030, forest management is one of the “most important elements of Russian policy to reduce GHG emissions”.

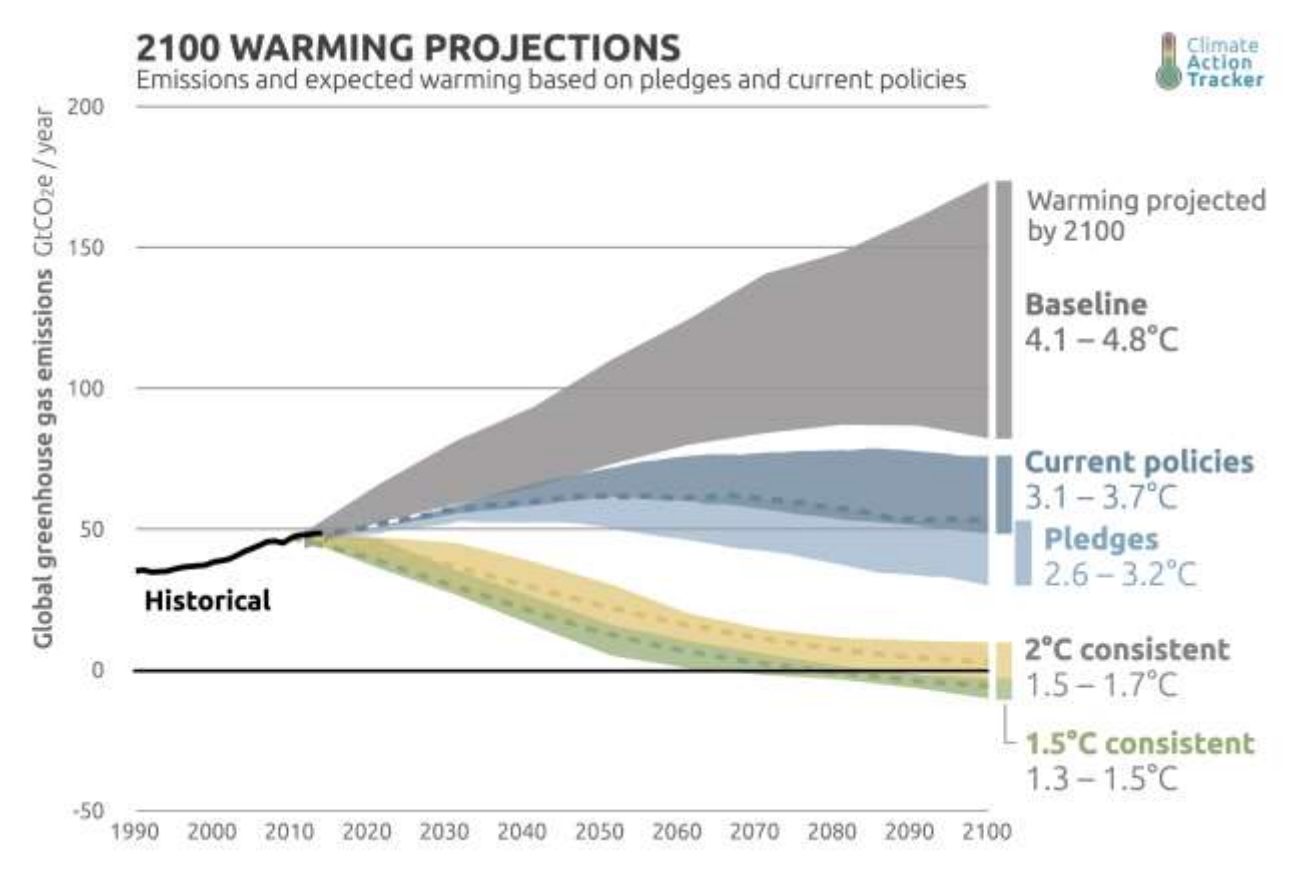
Contribution of land (LULUCF) sector to country's mitigation pledges (I)NDCs



Land sector contributes a quarter of pledge mitigation by 2030

Grassi, House *et al* *Nature Climate Change*, (2017)

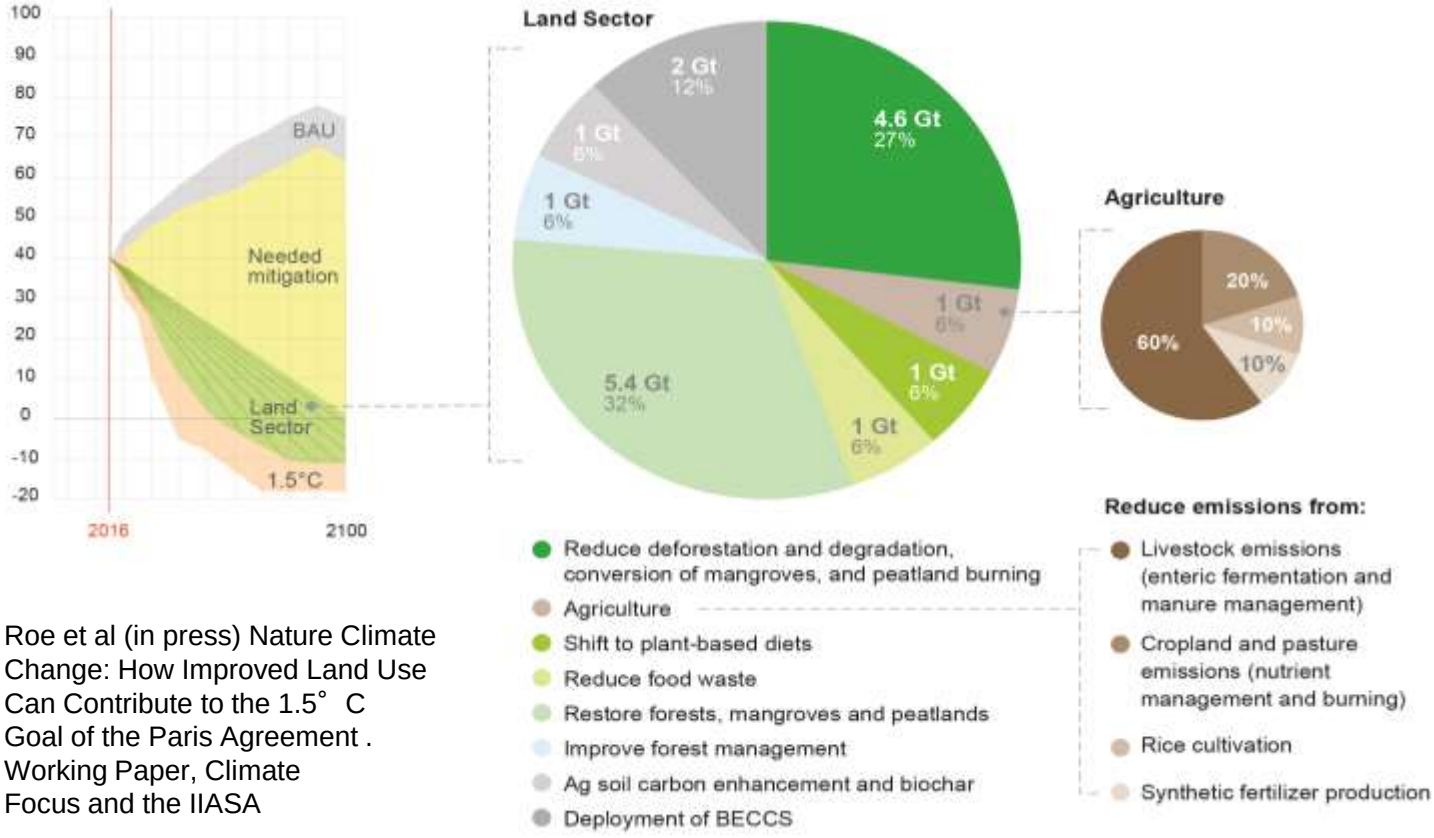
Where have we got to so far?



Climate pledges so far will limit global warming …. but not enough.

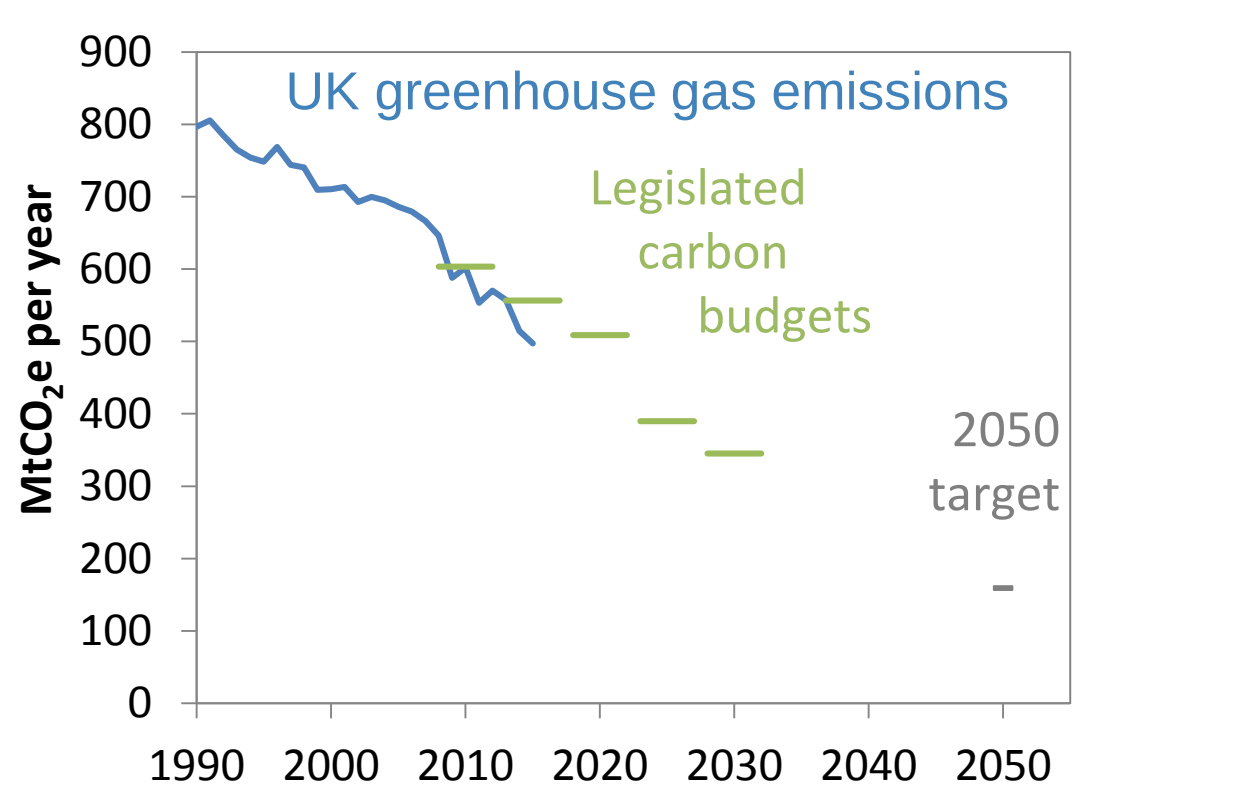
Climate Action Tracker – check out web site!

Contribution of the land sector to filling the emissions gap – around a third of total mitigation in 2030 to 2050



Roe et al (in press) Nature Climate Change: How Improved Land Use Can Contribute to the 1.5˚C Goal of the Paris Agreement . Working Paper, Climate Focus and the IIASA

What is the UK government doing …. and not doing?



Climate Change Act 2008

80% reduction in UK greenhouse gas emissions for 2050 compared to levels in 1990

Committee on Climate Change

What about Bristol?

Target: Reduce carbon dioxide emissions 80% by 2050 compared to 2005

So Far: reduced energy use by almost 20% and carbon dioxide emissions by almost 18% between 2005 and 2013

Well Below
2 °C

https://www.bristol.gov.uk

Linking international policy

- UNFCCC
- Montreal Protocol
- Convention on Biological Diversity
- Sustainable Development Goals
- Sendai Framework on Risk Reduction

Summary

- Human land use is responsible for a quarter of total greenhouse gas emissions
- Land is also an important sink for carbon dioxide
- Protecting forests and peatlands is key
- Planting forests, diet change etc. all help
- Reducing fossil fuel emissions is critical as the land cannot do it all.

Glossary and units

IPCC – Intergovernmental Panel on Climate Change

UNFCCC – United Nations Framework Convention on Climate Change

LULUCF – land use and use change and forestry

AFOLU – agriculture, forestry and other land use (= LULUCF + Agriculture)

CO_2 – carbon dioxide, 1 kg carbon (C) = 3.664 kg carbon dioxide (CO2)

CO_2eq – carbon dioxide equivalent (weighting greenhouse gases in relation to CO_2)

N_2O – nitrous oxide

CH_4 – methane

Gt or Pg – Giga tons or petagrams = a billion tonnes