Using LCA to inform GHG mitigation decisions

23/11/22

Carbon and LCA workshop, LUKE Finland

https://www.luke.fi/en/news/expert-workshop-carbon-stock-calculations-in-the-life-cycle-assessments-for-biobased-products-framework-modelling-and-applications

Michael MacLeod

Rural Economy, Environment and Society Group

SRUC #1 for Research Power in Agriculture, Food and Veterinary Sciences – REF2021

Leading the way in Agriculture and Rural Research, Education and Consulting

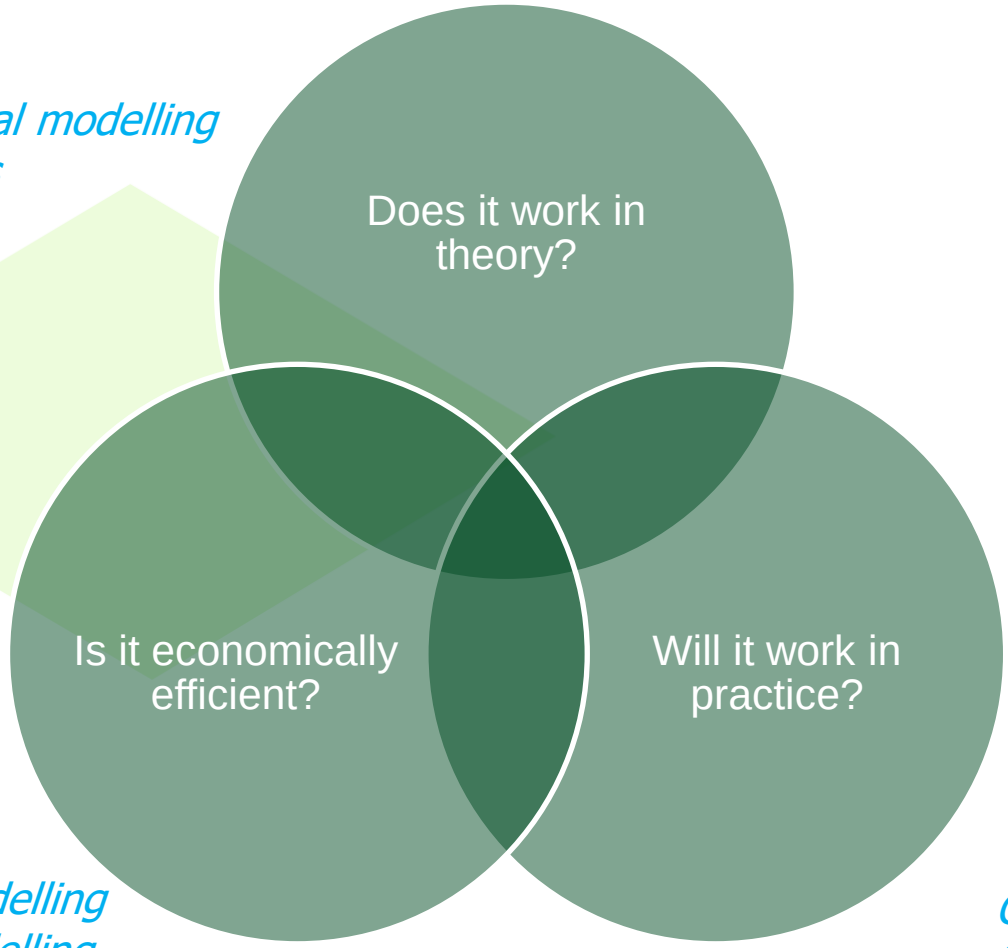
Overview

- Background to myself and REES
- Examples of our work relating to GHG mitigation and life-cycle analysis

Three key questions we ask when appraising a mitigation measure

Experiments and data collection

Agri-environmental modelling
Life-cycle analysis



Macroeconomic modelling
Microeconomic modelling
Cost-benefit analysis
Cost-effectiveness analysis

Choice experiments
Social surveys
Q methodology

What's our goal?

- Optimal use of resources in support of economic growth, efficiency and equity.
- In theory, properly functioning markets allocate resources better than scientists (or politicians…) so what's our role?
- Helping to address market failure, e.g.
  - Imperfect information, e.g. consumers often unaware of what is involved in providing a good or service.
  - Externalities, e.g. cost of GHG emissions not usually included in prices, leads to overconsumption of synthetic fertiliser, higher carbon foods etc.

Climate change: the mother of all externalities

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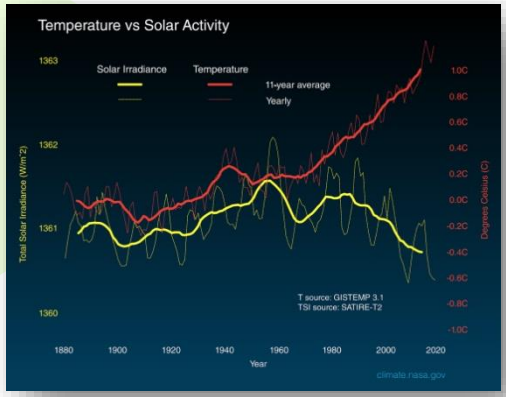
Physical flows to atmosphere

GHG in

GHG out

Mid-point impacts

e.g. increased T, changed rainfall



End point impacts

e.g. decreased feed, increased cattle mortality, decreased cow fertility, human malnutrition

https://www.theguardian.com/business/2021/sep/13/britain-last-coal-power-stations-to-be-paid-huge-sums-to-keep-lights-on-record-energy-prices
https://www.eaststaffsbc.gov.uk/es-news/seeing-wood-and-trees-esbc-launches-new-tree-planting-guidance
https://climate.nasa.gov/climate_resources/189/graphic-temperature-vs-solar-activity/
https://www.theguardian.com/global-development/2022/jan/30/we-pray-for-rain-ethiopia-faces-catastrophic-hunger-as-cattle-perish-in-severe-drought

IPCC Assessment Report 6 (2022)

https://www.ipcc.ch/report/ar6/wg3/

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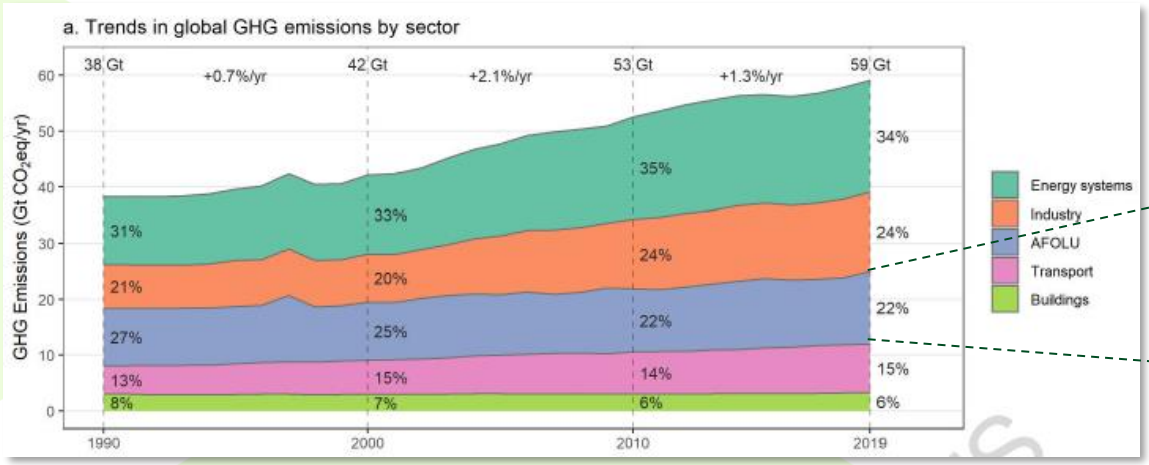
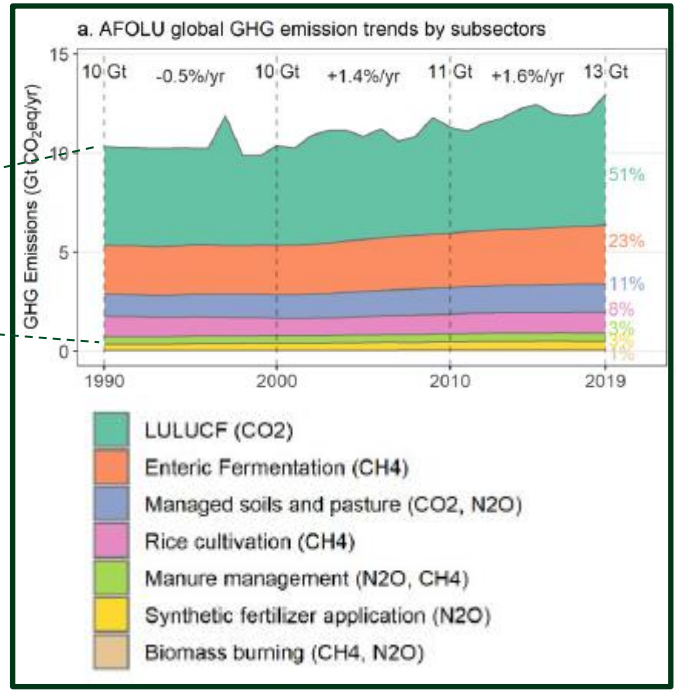
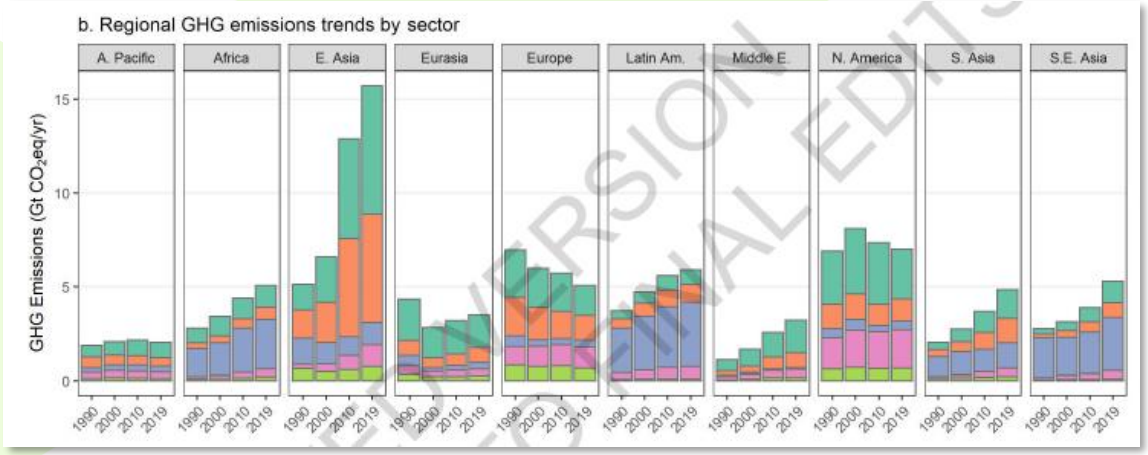




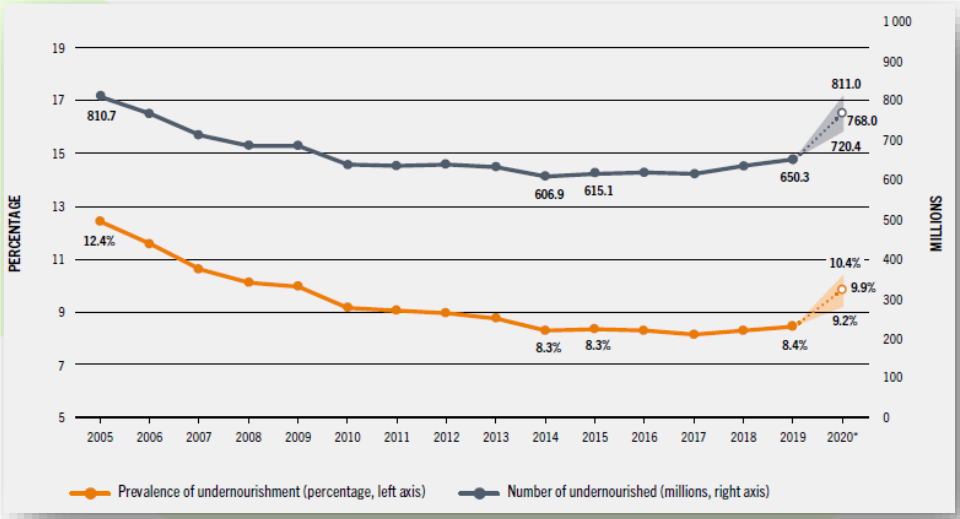


Note these are production-based emissions – some of the emissions will be exported

1. Steady increase in ent CH4 and N2O from soils.
2. LULUCF (mainly deforestation and peatland degradation) erratic.
3. Driven by what is produced and how i.e. demand and supply-side drivers.
4. Demand a function of population and per capita consumption.

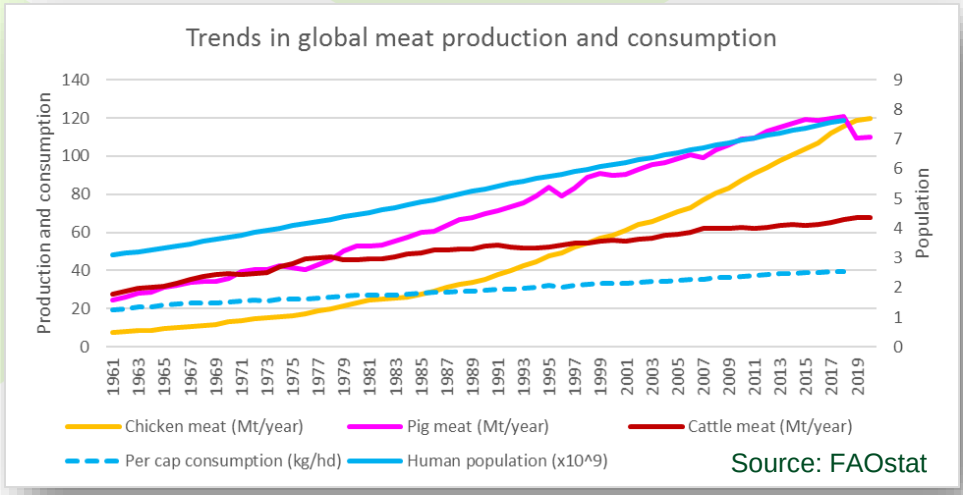
Trends in food security and meat production

Global prevalence of undernourishment, PoU (FAO 2021)



Source: https://www.fao.org/documents/card/en/c/cb4474en/

- Great progress was made 1990 – 2010 (PoU = 23% in 1990)
- Progress has stalled since 2010 (conflict, climate variability, economic downturns and COVID)



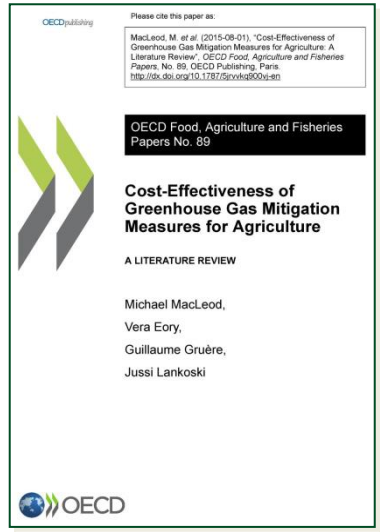
- Population and per capita meat consumption have doubled since ‘60s
- Demand likely to increase to 2050
- Reducing demand is theoretically a good way to reduce GHG, but difficult in practice

How can we reduce (or “mitigate”) GHG emissions?

- What do we mean by mitigation – reduction in total emissions or in emissions intensity?
- Supply-side (~production)
  - Improving efficiency of production
  - Substitution (of high emission intensity inputs, e.g. fossil fuels, steel, concrete)
  - Carbon sequestration
  - Exploiting synergies (e.g. agro-ecology, increased circularity)
- Demand-side management (~consumption)
  - Change what people consume (by changing consumer behaviour or public procurement)
  - Keep food intake constant, but change what people purchase – e.g. reduce food waste

Supply-side mitigation measures

Category (italic) and sub-category	Category (italic) and sub-category
Cropland management	*Livestock management*
Agronomy	Nutrient use efficiency and feeding
Nutrient management	Specific agents and dietary additives
Structural and management changes	Animal health
Tillage and residue management	Structural and management changes
Water and soil management	Animal breeding, genetics and herd structure
Rice management	*Housing and manure*
Orchards	Housing total
Grazing land management	Improved manure storage and handling
Grazing intensity and timing	Anaerobic digestion and CH4 capture
Increased productivity	*Land use change*
Fire management	*Energy efficiency*
Water and soil management	
Management of organic soils	
Restoration of degraded lands	



https://www.oecd-ilibrary.org/agriculture-and-food/cost-effectiveness-of-greenhouse-gas-mitigation-measures-for-agriculture_5jrvvkq900vj-en

- Review in 2015 identified 182 mitigation measures, arranged into 8 categories and 30 sub-categories.

Identifying suitable mitigation measures

Does it work in theory?

- What effect does the measure have on emissions and production?
- How does its effect vary (e.g. between countries, soil types, farm types)?
- What is the certainty of the effect?
- What might the unintended consequences be?

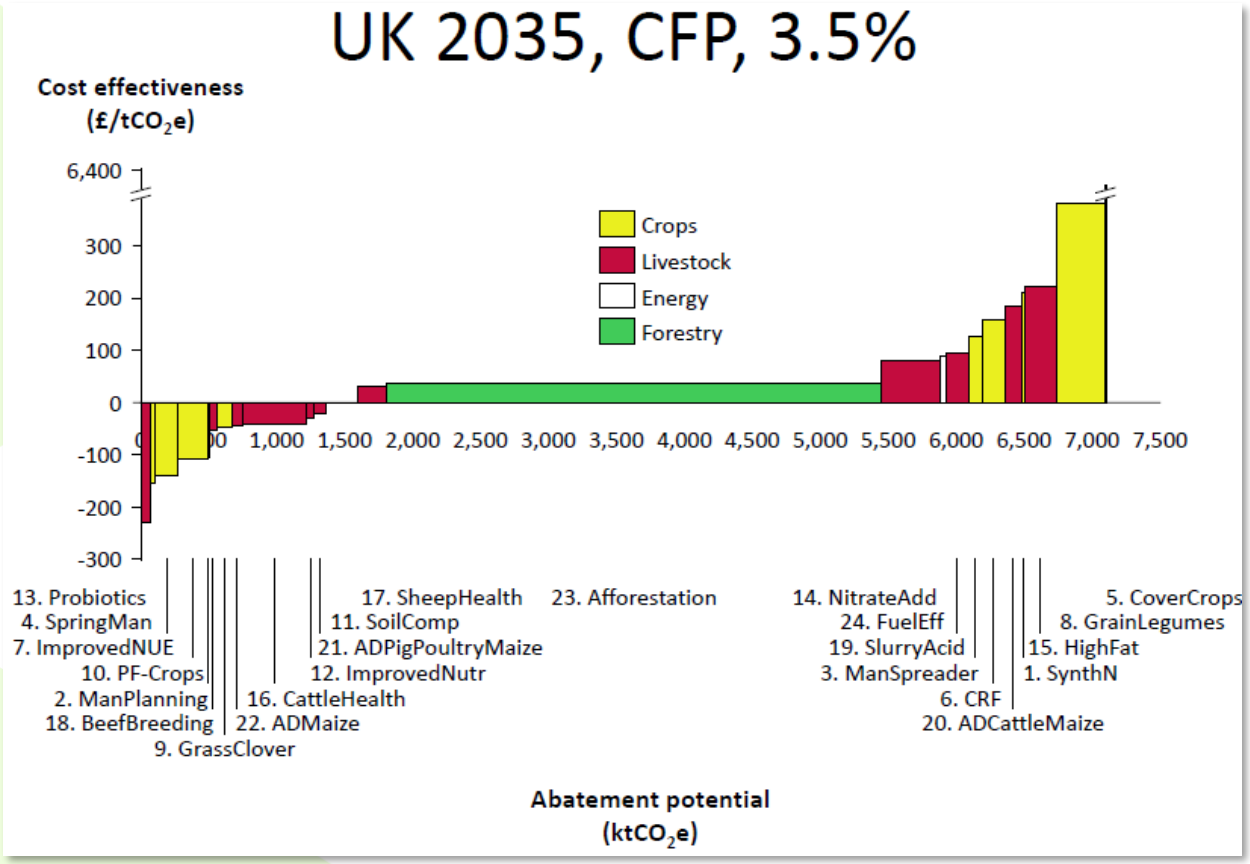
How much could it reduce emissions by in practice?

- What is the measures applicability, e.g. what % of land could it be implemented on?
- What are the barriers to uptake?
- How amenable is it to different policies approaches? (i.e. could incentives be provided and compliance monitored?)

Is it economically efficient?

- Are the total economic (i.e. monetary and non- monetary) benefits of the measure greater than the total economic costs?
- Is the measure cost-effective, i.e. does it achieve reduction at a lower financial cost than the social cost of carbon?

UK Marginal Abatement Cost Curve



Eory et al. (2015) Review and update the UK Agriculture Marginal Abatement Cost Curve to assess the greenhouse gas abatement potential for the 5th carbon budget period and to 2050 London: Climate Change Committee

- Forestry has a big AP, but CE is sensitive to the discount rate (and there is the question of displacement of emissions).
- Further mitigation may be possible via soil carbon sequestration (SCS) but faces challenges:
  - Non-permanence
  - Transaction costs
  - Additionality
- Henderson et al. (2022) review the policy challenges of SCS.

Review of SCS measures: Sykes, A.J., et al. (2019) Characterising the biophysical, economic and social impacts of soil carbon sequestration as a greenhouse gas removal technology Global Change Biology

Policies to encourage SCS: Henderson et al. (2022) Soil Carbon Sequestration by Agriculture: Policy Options. OECD FOOD, AGRICULTURE AND FISHERIES PAPER January 2022 n°174

Wetland restoration project – Wet Horizons

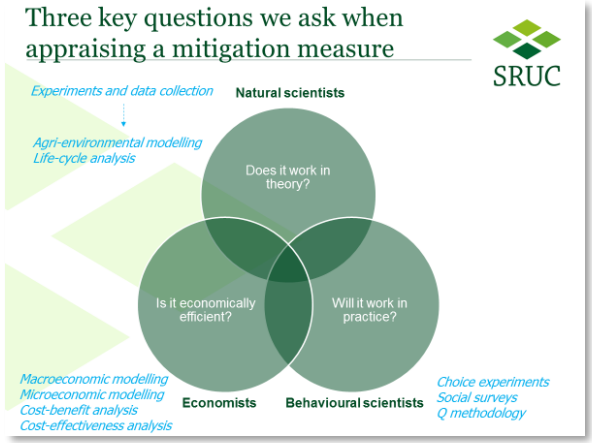
WET HORIZONS https://www.wethorizons.eu/

- Inform wetland restoration by modelling the effects of restoration measures and analysing the potential socioeconomic impacts.
- SRUC's role: developing MACCs for wetland restoration

https://www.nature.scot/landscapes-and-habitats/habitat-types/mountains-heaths-and-bogs/blanket-bog#:~:text=Blanket%20bog%20is%20one%20of,Western%20Isles

Livestock and C sequestration

- Could we free up land for C sequestration by making livestock production more efficient?
- We use various models to investigate the impacts of changing livestock systems (e.g. ~GLEAM, Agrecalc)
- Example - estimating the change in production and emissions from improving livestock health in the UK for Defra:
  - Collect evidence on the effects of disease
  - Modelling
  - Workshops to check assumptions and estimate uptake of treatments



Concluding remarks

- There are two competing demands: food products v environmental services.
- Finding a balance between these competing demands is a major challenge, and has stimulated much debate.
- However, the debate is often fuelled more by opinion than evidence.
- Our job is to provide objective, useful, transparent analysis.

Acknowledgements

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