MAPPING WATER TABLE DEPTH ON AGRICULTURAL ORGANIC SOILS AND CONSEQUENCES FOR THE CO_2-EMISSION

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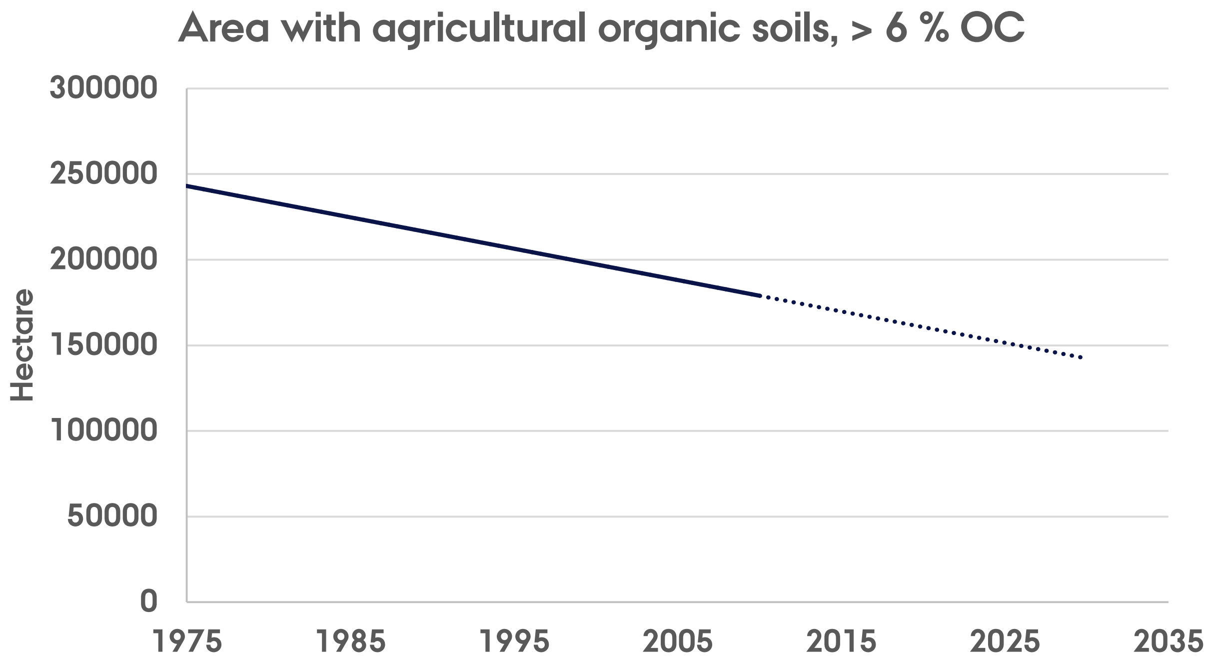
TIME TO CHANGE !

1. Concerns
2. Data availability
3. WTD mapping
4. Soil mapping
5. Emission
6. Further work

AGRICULTURAL ORGANIC SOIL AREA



Currently are the organic soils responsible for 10 % of the total Danish emission

Question:

Are we loosing organic soils or are we reclassifying the soil?

CONCERNS

Emission tax will very likely be implemented on organic soils in Denmark - probably from 2026

The tax shall, as a rule follow, the methodology in the national inventory

- I am not concerned about the emission factor from deep histosols horizons
- I am concerned about emissions from soils with
  - shallow peat layers
  - with high water tables depth (WTD)

CHALLENGES

- Organic soils are created when soils are waterlogged
  - Degradation is taking place when the water is removed/drainage
  - Turn over of organic matter is often seen as first-order decay
  - A soils equilibrium OC content depends on the annual input versus the annual degradation
    - Based on input, the equilibrium state will be around 1-1.5 % OC or 100-150 ton C/ha in the drained zone (0-100 cm)
    - All soils having > 1-2 % OC have been water logged in previous time and will evidently loose OC when drained
  - In organic soils – fixed emission factors are used- due to large OC stock and variable emission estimates
  - Emission estimates are premature as they are related to soil OC % content, typical in the upper 20-30 cm soil layer and not degradation available OC

NEW SET-UP FOR ORGANIC AGRICULTURAL SOILS

Water Table Map for low laying soils

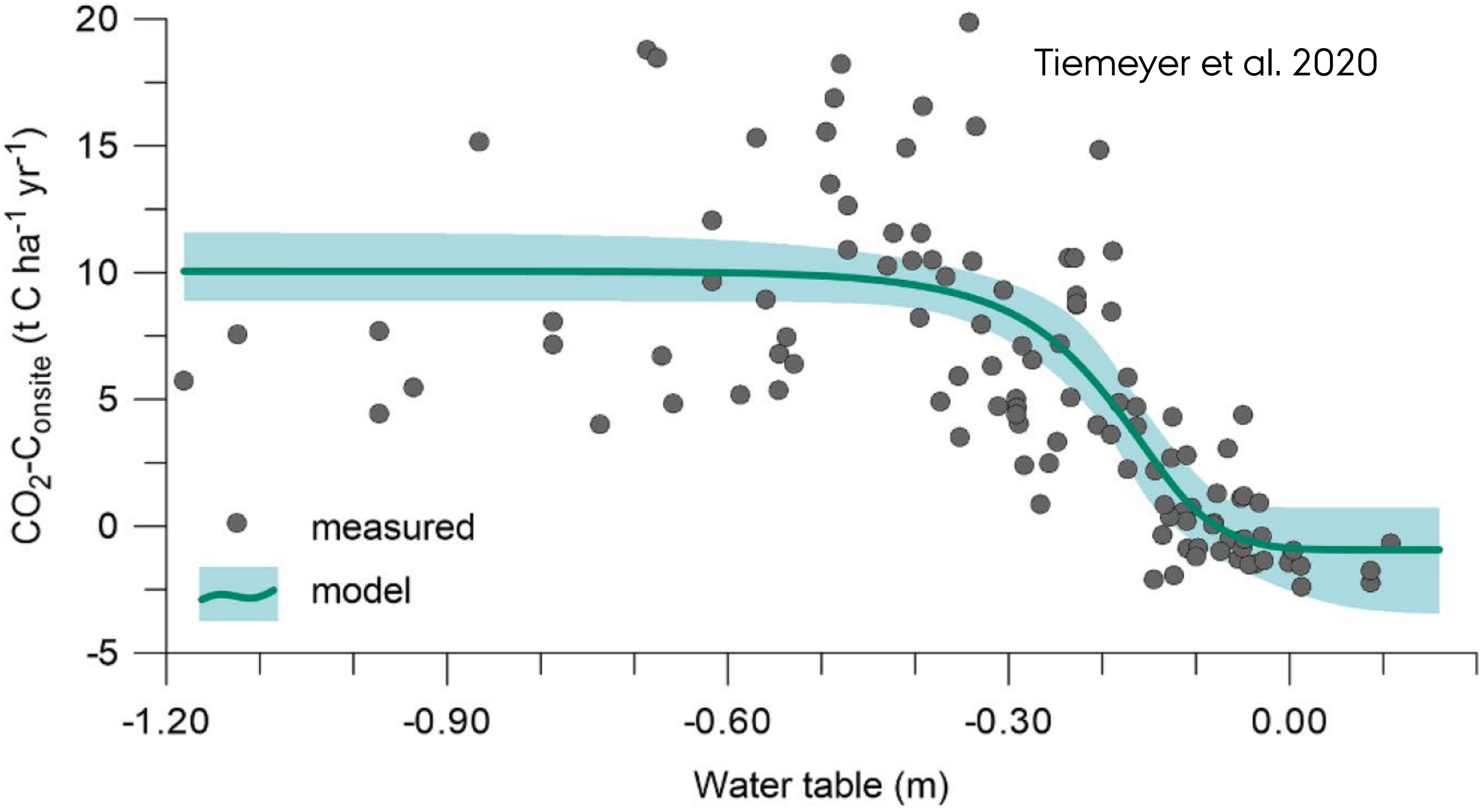
Updated for the organic soils

Reevaluation of the current emission factors

- 11.5 t C ha-1 y-1 for cropped land > 12 % OC
- 8.4 t C ha-1 y-1 for permanet grassland land > 12 % OC

- For soils with 6-12 % OC half of the above values
  - Simple assumption without any science behind

NEW SET-UP FOR ORGANIC AGRICULTURAL SOILS



WTD MAPPING

You find all parameters used here:

Koch et al. 2023, https://bg.copernicus.org/preprints/bg-2023-23/

10 x 10 m2 raster map made by ML

DATA AVAILABILITY

Field parcel history 2010 from LPIS – to establish farming practice

- Farming practice from 2016-2020 were classified into six wetness classes
  - Autumn cereals, spring cereals, grass in rotation, grass outside rotation with high N allowance, grass outside rotation with low/no N allowance and wetlands

Measured summer WTD on 800 locations – large uncertainty as it is not piezometer measures

2000 defined water tables – streams and lakes

0.4 x 0.4 m2 Digital Elevation Model (DEM)

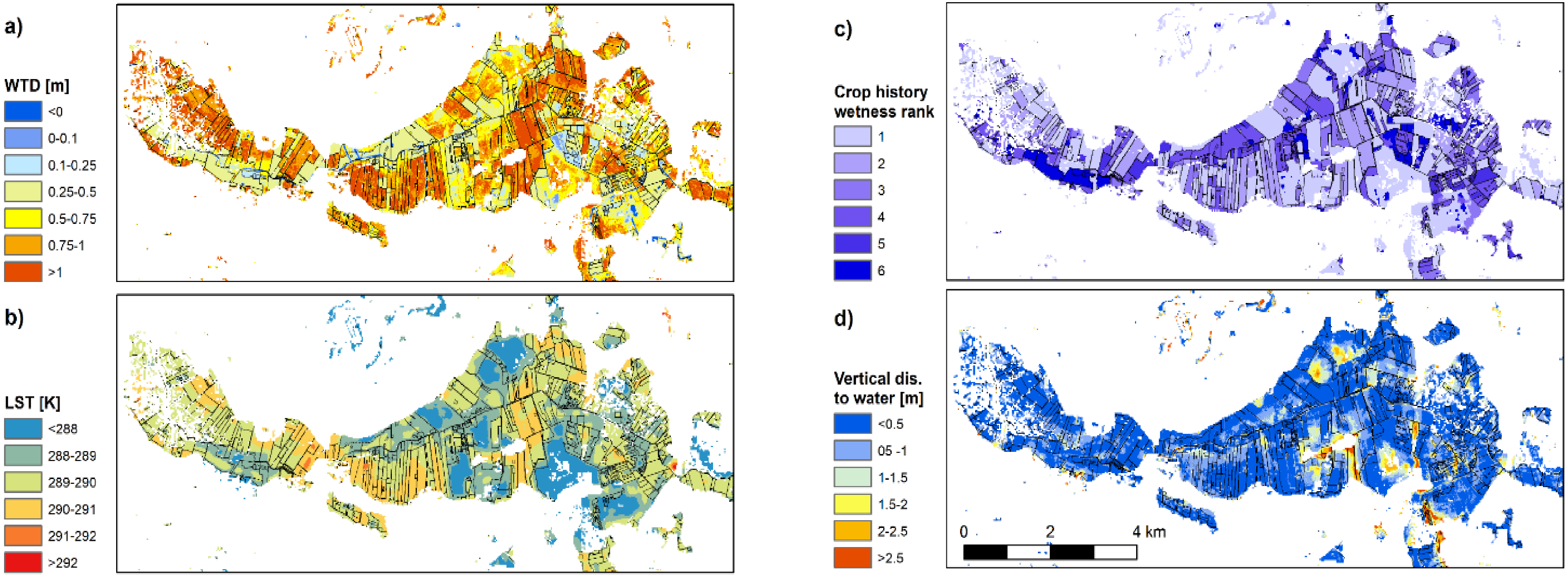
Vector map of low laying soils

WTD monitoring from dwells with < 5 meter WTD

Soil surface temperature – 2001-2020

etc

WTD MAPPING



a)
WTD [m]
<0
0-0.1
0.1-0.25
0.25-0.5
0.5-0.75
0.75-1
>1
b)
LST [K]
<288
288-289
289-290
290-291
291-292
>292
c)
Crop history wetness rank
1
2
3
4
5
6
d)
Vertical dis. to water [m]
<0.5
05 -1
1-1.5
1.5-2
2-2.5
>2.5
0
2
4 km

SOIL MAPPING

Ortho photo 2020

SOIL MAPPING

Ortho photo 2020

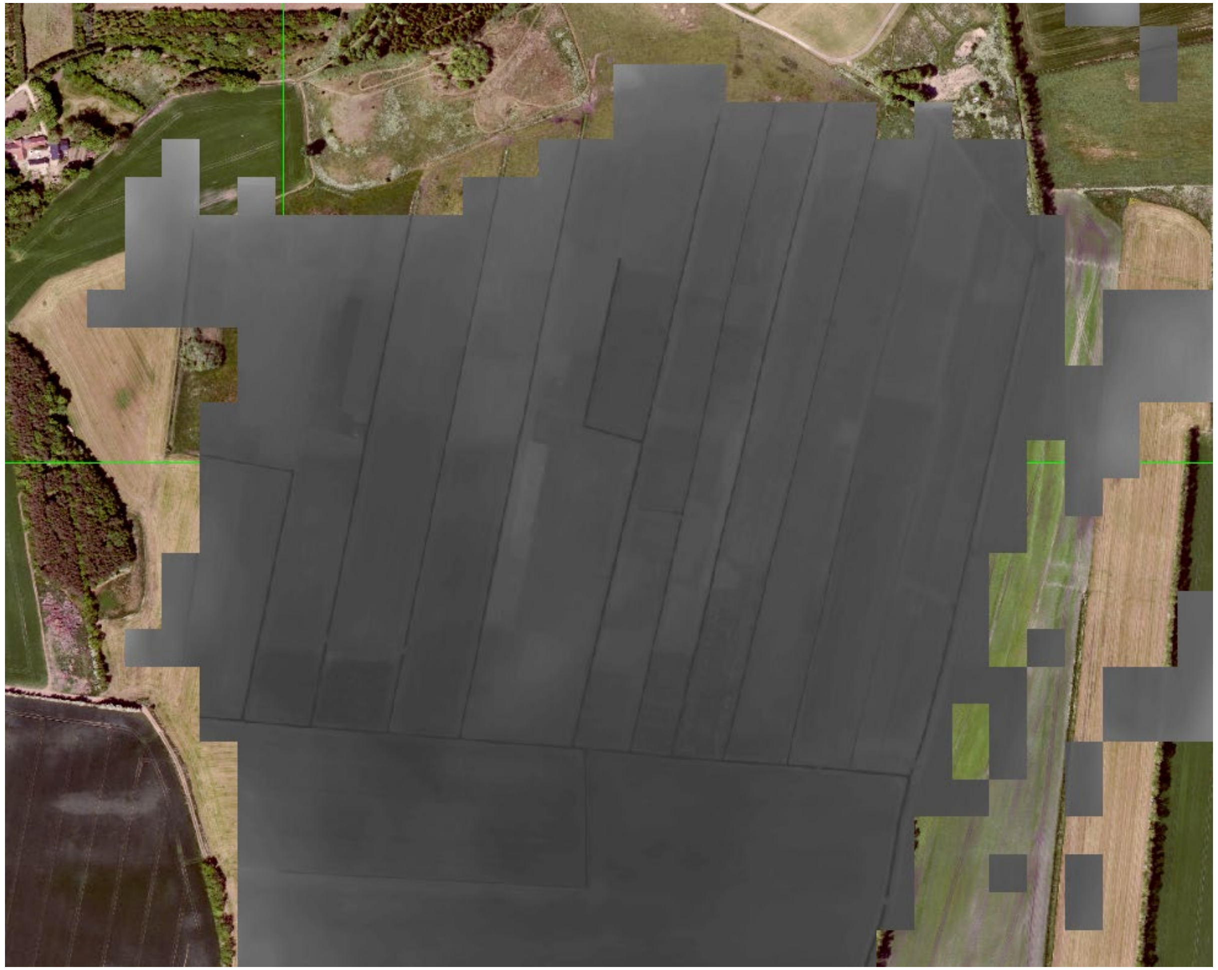
Organic soil map 2010

SOIL MAPPING

Ortho photo 2020

Organic soil map 2010

DEM, 40*40 cm



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SOIL MAPPING

Ortho photo 2020

Organic soil map 2010

DEM, 40*40 cm

WTD, 10*10 m

WTD

Typical crop	Summer WTD		
	Wetness rank	WTD, Avg., cm	WTD, Std., cm
Vinter cereals	1	85	36
Spring cereals	2	86	37
Good grass in rotation	3	62	24
Perm. Grass with high N	4	36	14
Perm. Grass with low N	5	29	15
Other, Wetlands	6	27	13

SOIL CARBON STOCKS

What do we know?

SOIL CARBON STOCKS

Avg. Bulk Density (g cm^{-3}) in four different depths characterized after the C content in the topsoil (0-30 cm)

% OC	0-32 cm	32-64 cm	64-96 cm	96-128 cm
3-6	1.10	0.83	0.63	0.67
6-12	0.74	0.57	0.40	0.42
>12	0.35	0.23	0.17	0.17

Source: Olesen et al., 2019, report to the Danish DAA

Do not citee or quote.

SOIL CARBON STOCKS

Avg. C stock (ton C/ ha^{-1}) 0-30 cm

% OC	N	t C ha^{-1}
0-3	121	112
3-6	259	216
6-12	385	305
12-24	494	353
>24	777	415

Source: Olesen et al., 2019, report to the Danish DAA

SOIL CARBON STOCKS

An updated soil map changing from 2-D to 3-D with peat layer depth

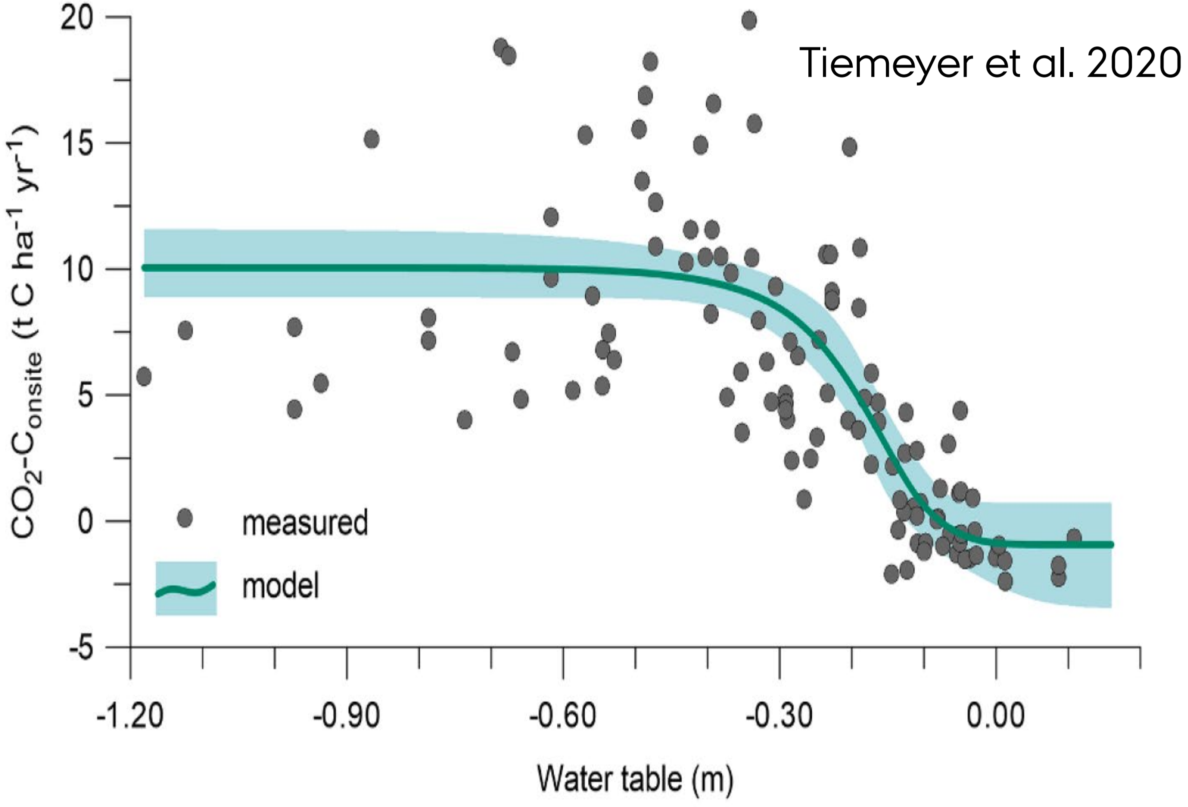
- Currently we do not know how far we can go into size/presision of different layers
- Will probably be in place by end of 2023

EMISSION FACTORS

A head ache

We cannot use % OC in the soil as main classification factor

We have to look for something better



CARBON LOSS

From these can loss be estimated to 1.5-2.5 % per year of the amount of OC above WTD

We are exploring if this is a way forward

Fluctuating water level is critical as degradation occur mainly in summer

FURTHER WORK

Advancing from 2-D to 3-D organic soil maps

- how do we deal with fluctuating mineral soil beds under the peat layer ?

- Inclusion of Bulk density in different layers
- Use a continuous dynamic model – ie a fixed degradation factor of 1.5-2.5 %/yr
- Use of categories – because the explanation variables are not well understood
- What precision do we need when dealing with carbon farming / avoided emissions on farm level / national level ?

Thanks to all colleagues in Denmark and elsewhere for invaluable discussions, their previous work, publications and their future work

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