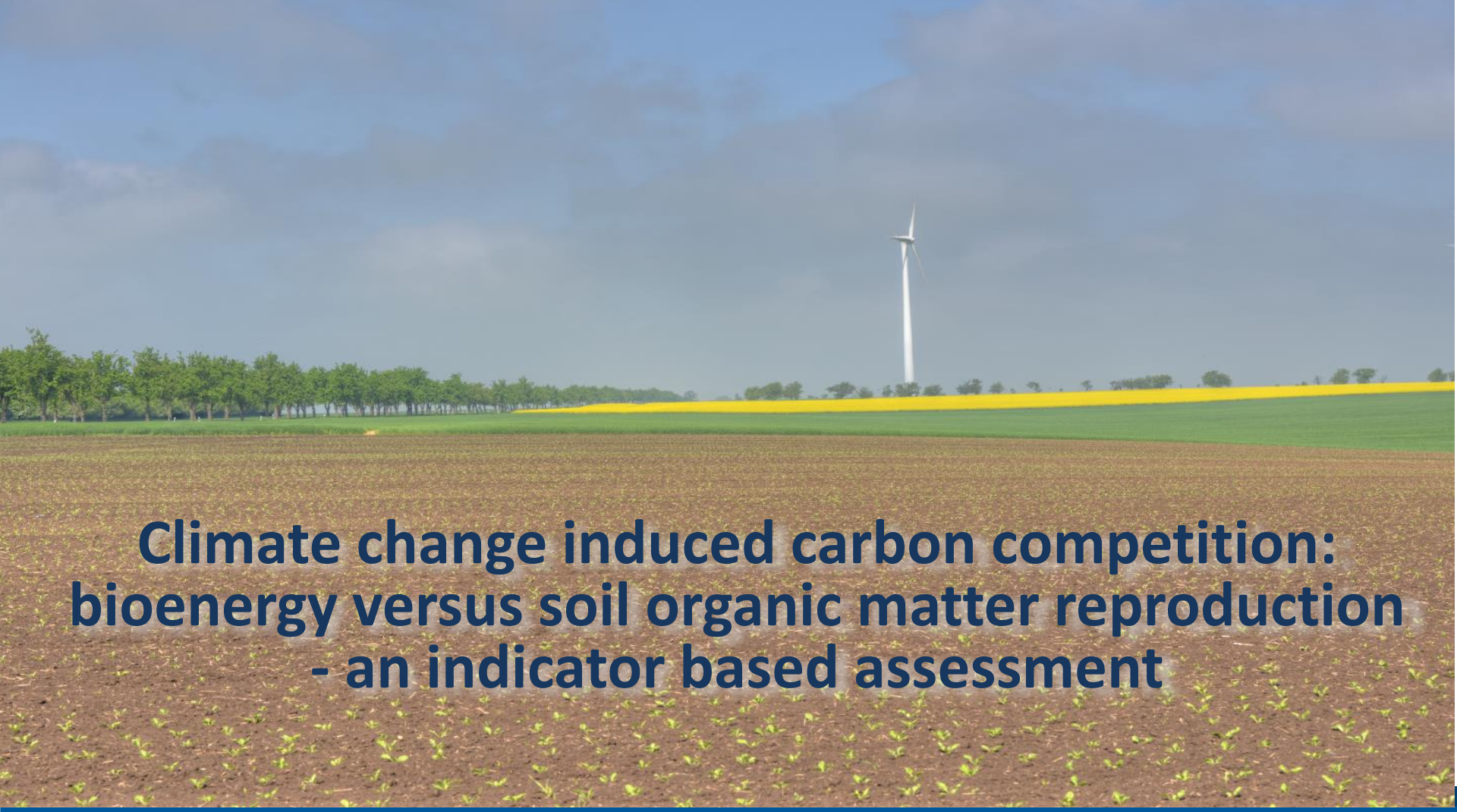

Climate change induced carbon competition: bioenergy versus soil organic matter reproduction - an indicator based assessment

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Problem

Climate change driven by fossil fuel burning

➔mitigation: renewable energies

Climate change will alter the soil carbon cycling

➔soil organic matter (SOM): globally important pool

Production of bioenergy has an impact on both:

Replacement of fossil energy

Changing the soil carbon cycle

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Objective

On a regional scale:

- ➔ Estimation of SOM turnover conditions driven by global warming
- ➔ Assessment of bioenergy impact on SOM (carbon re-production cycle)
- ➔ Provide an combined assessment scheme to identify “hot spots” of carbon competition

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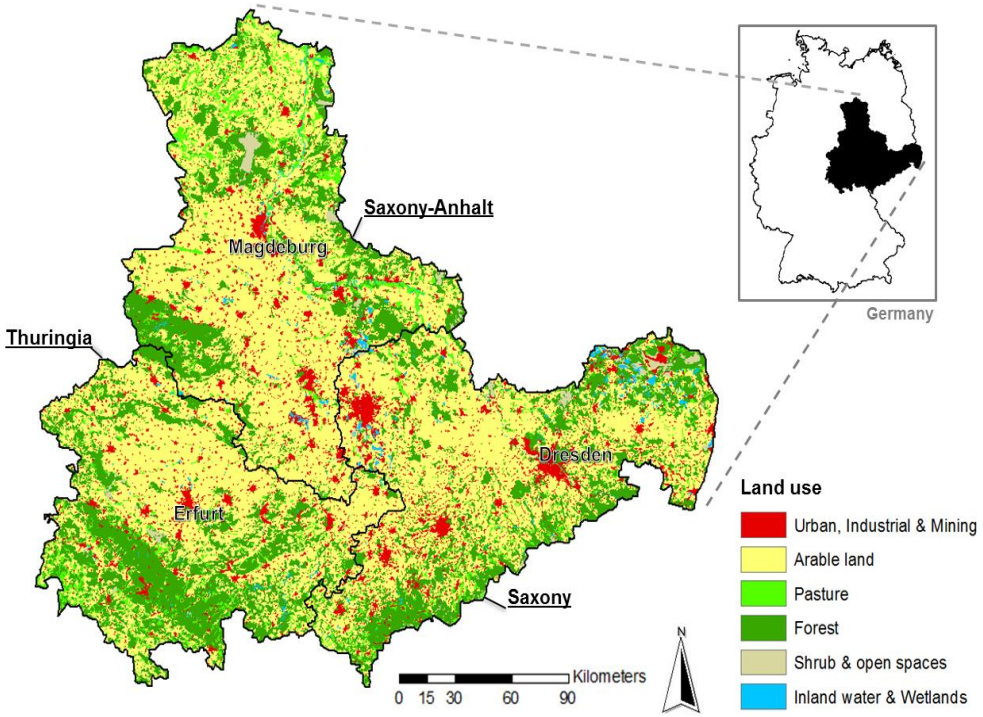
Study region: Central Germany



Data base:

Climate (821 cells):
Future (2001 – 2100):
IPCC scenarios A1B, A2 and B1
Past (1961-2000) : C20 data
Regionalized using REMO & WETTREG

Soil:
German soil map BUEK1000
(scale 1:1,000,000; Hartwich et al., 1998)

- problem:
  - Identification of sub regions with potential biomass competition between bioenergy and SOM
- scaling approach:
  - Identification of Bioenergy Producing Units (BPU)
- required:

  Indicator to assess bioenergy impact on carbon re-production cycle

  Indicator to assess SOM turnover driven by global warming

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Assessment of biogas production

Knowledge base about biogas plants:

Location

Data from Das et al. (2012)

Carbon catchment area

Subplots from Voronoi interpolationts

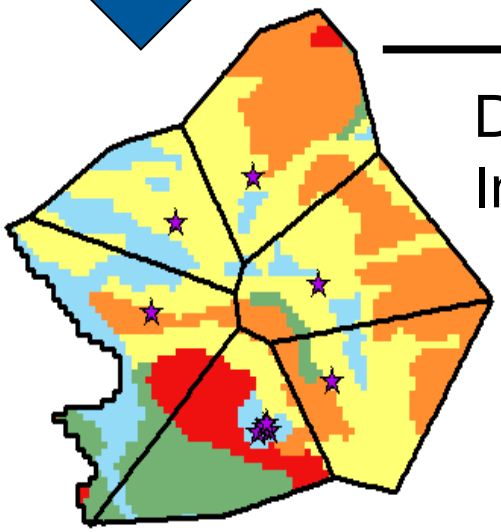
available agricultural area ➔ AA

CORINE data *(CLC2006; Keil et al., 2010)*

Carbon consumption

Installed capacity ➔ IC

Data from Das et al. (2012)



Definition of BPU‘s

Indicator for carbon consumption ➔ CAP=IC/AA

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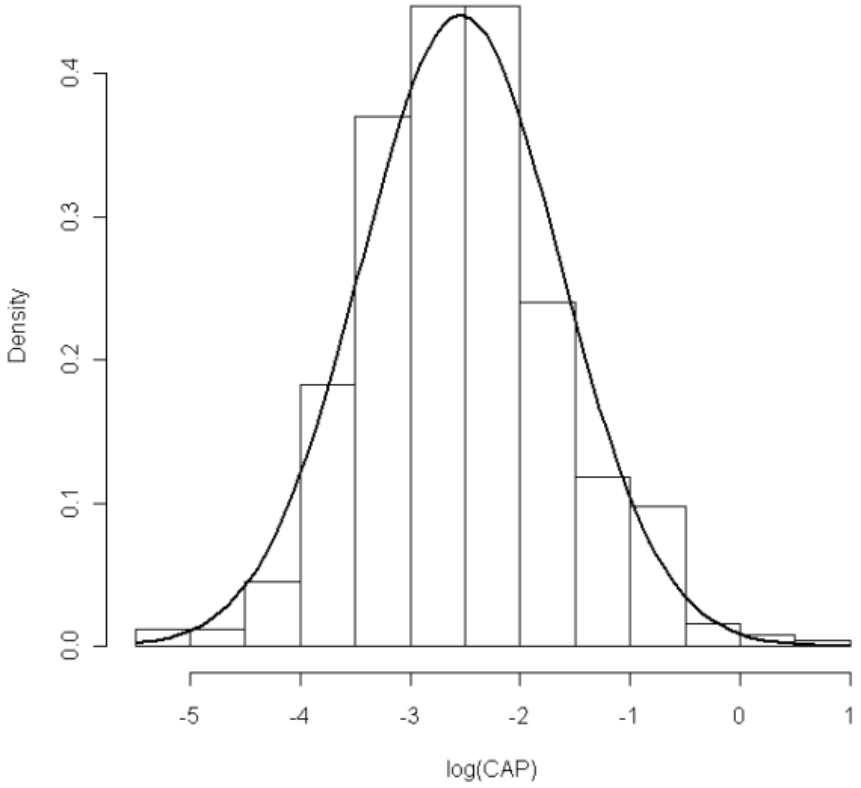
Classification approach

Capacity Index

➔ CAP=IC/AA

1st and 3rd quartile
of a lognorm dist.

low: CAP<=0.042
Medium: 0.042< CAP<=0.131
high: CAP>0.131



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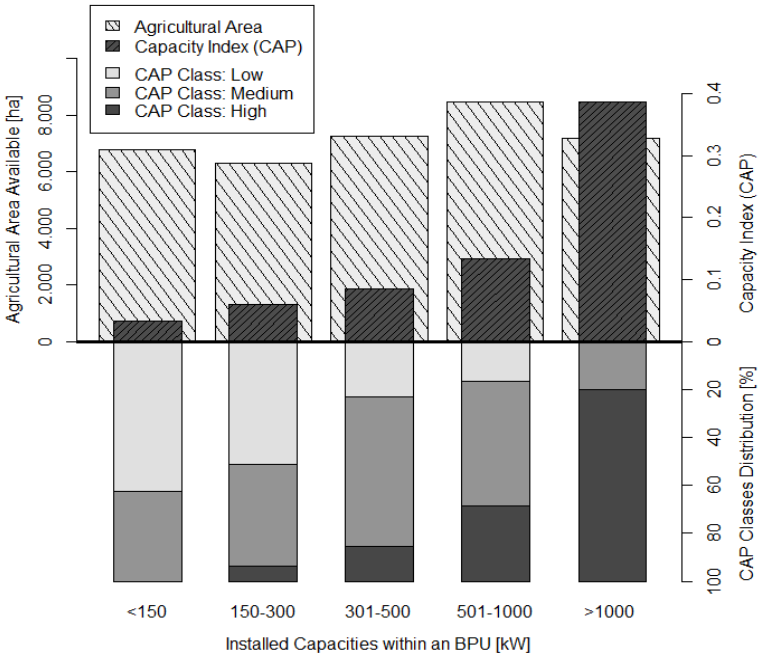
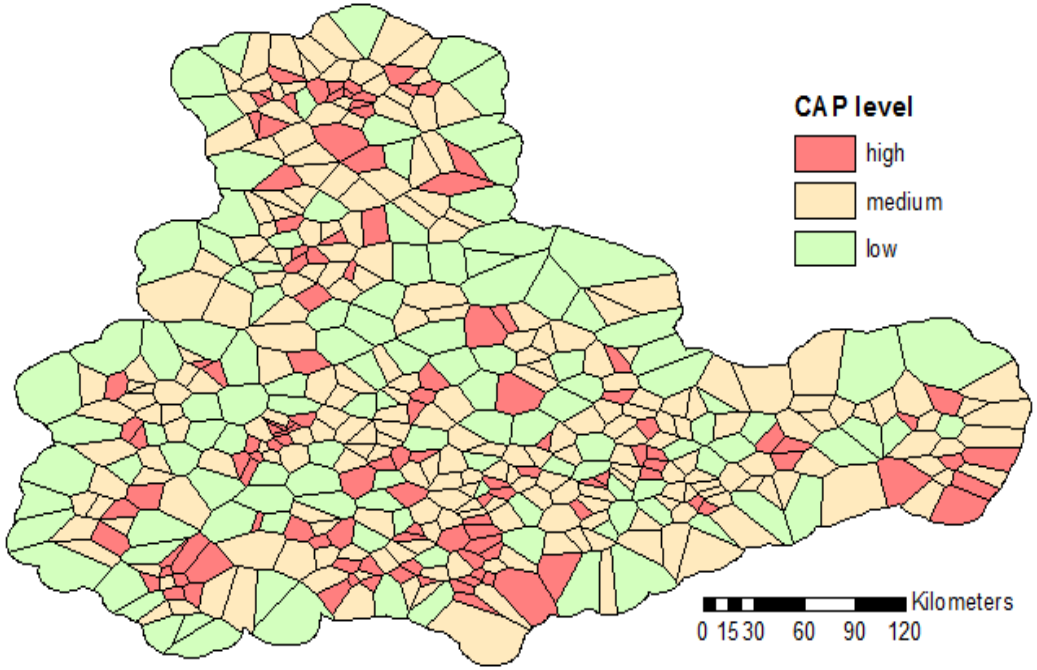
Results: CAP

Capacity Index ➔ CAP=IC/AA

(Carbon transformed to biogas)





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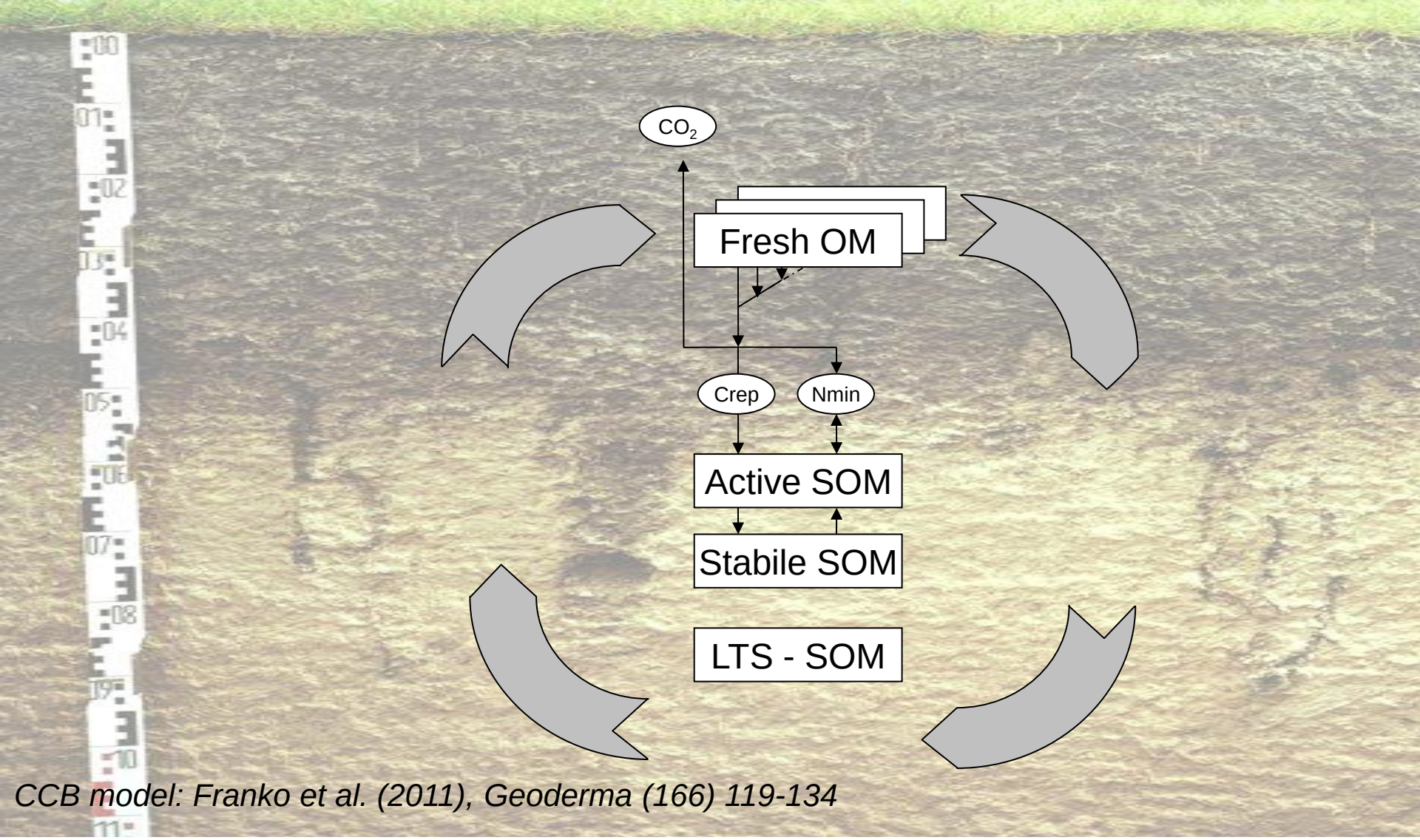

CCB model: Franko et al. (2011), Geoderma (166) 119-134

Conditions for SOM turnover (soil organic matter)

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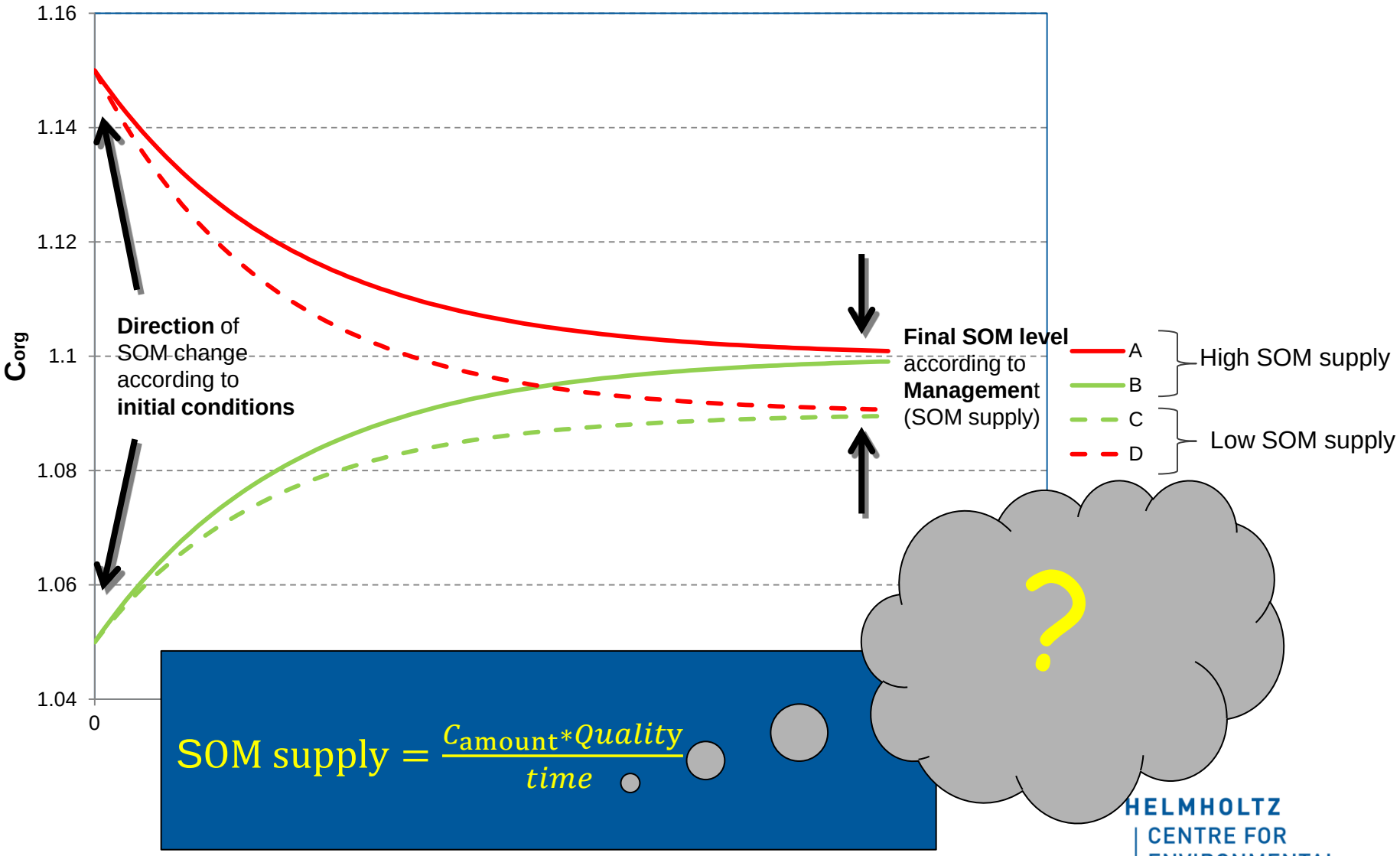
Assessment of soil management



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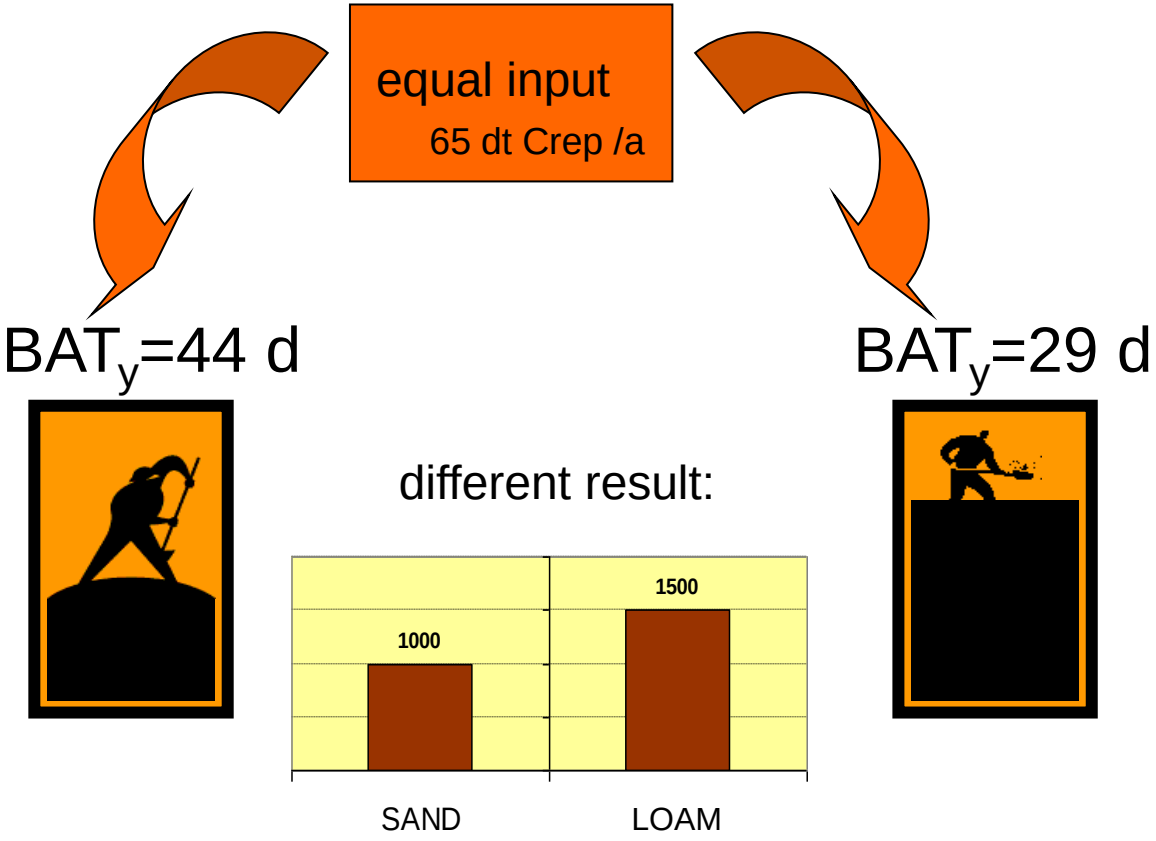
Biologic Active Time (BAT)

- BAT is an indicator for environment conditions of microbes
- BAT is a function of soil temperature, soil moisture and soil aeration
- annual BAT is calculated from air temp., rainfall and soil texture



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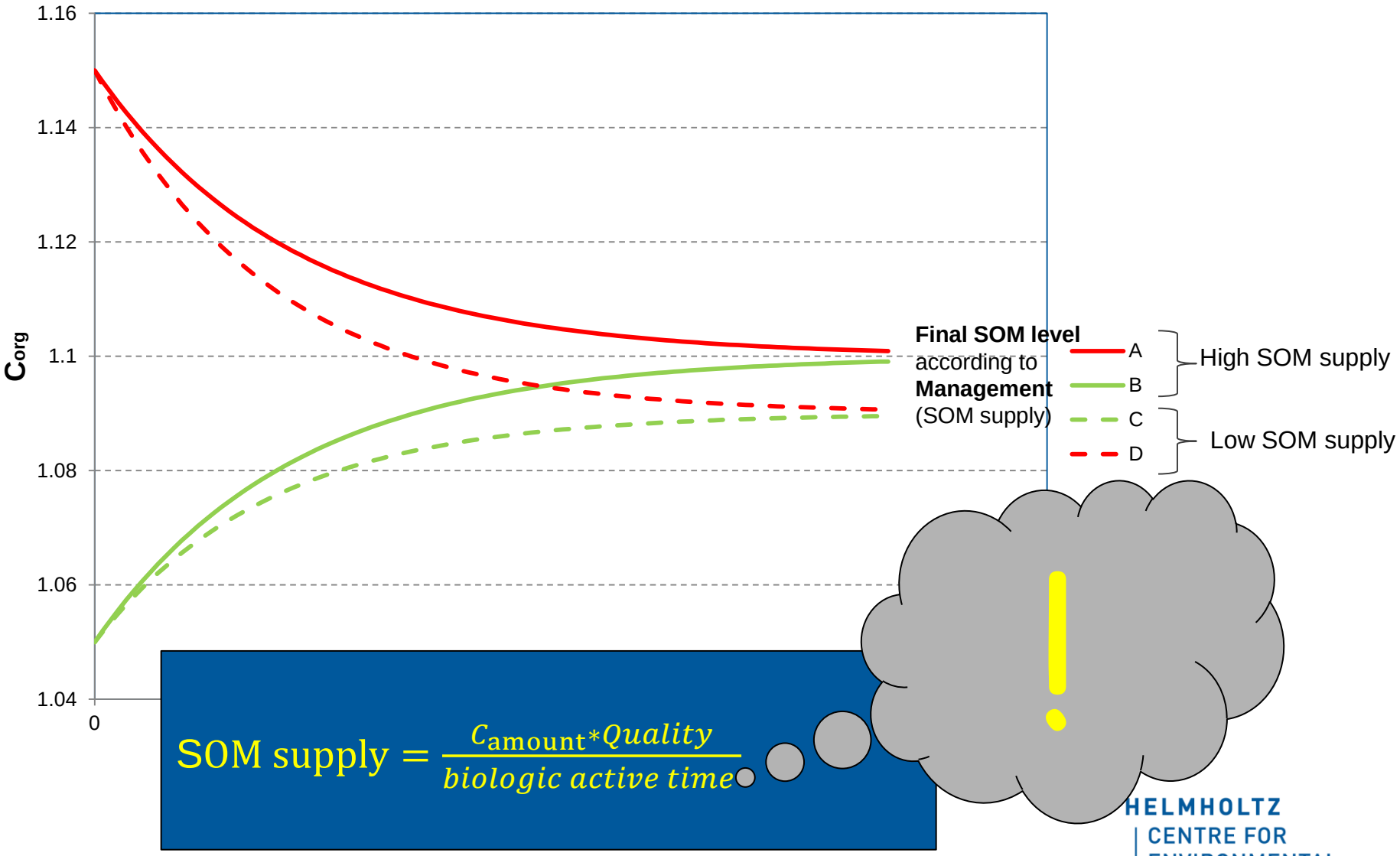
Assessment of soil management



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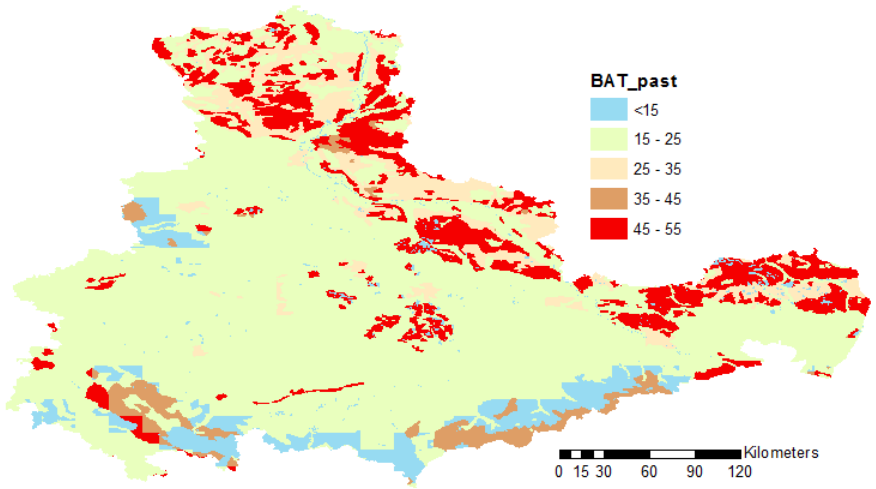
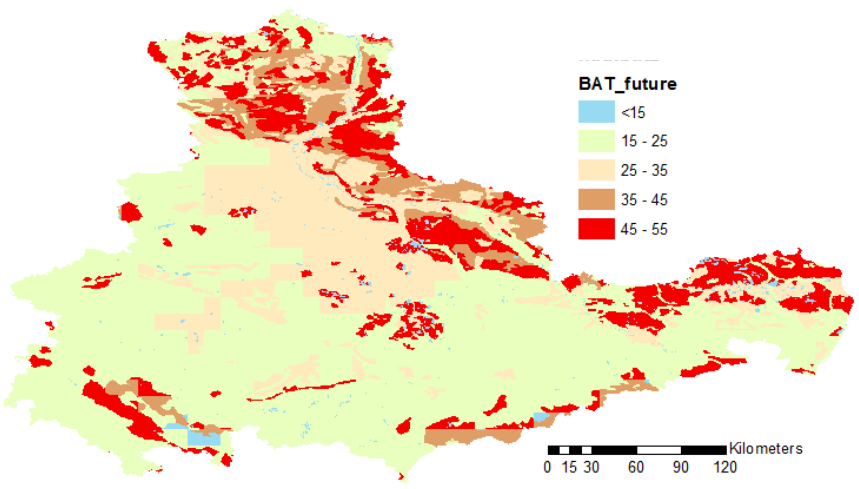
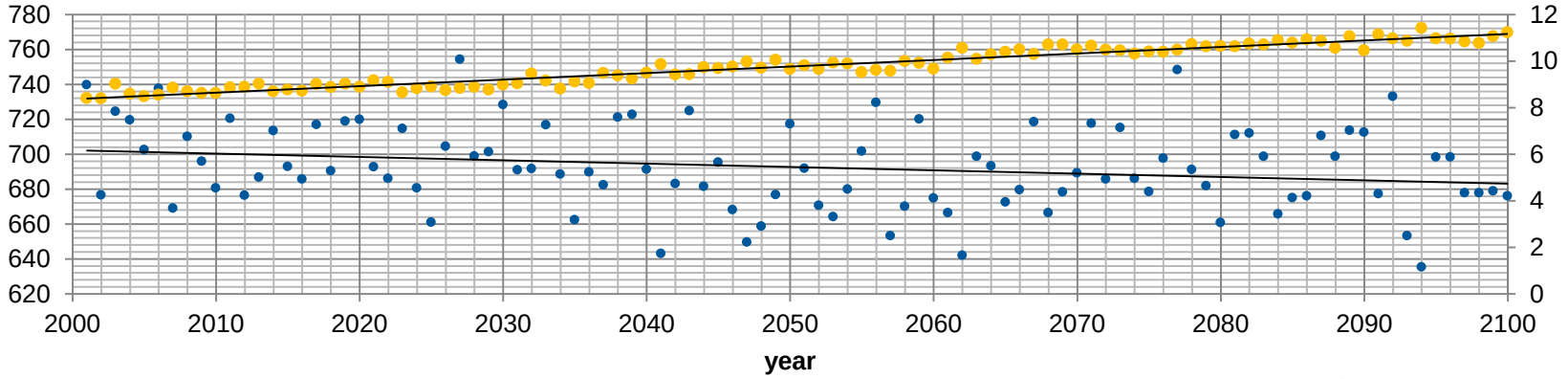
Climate change: BAT







predicted change: ca. +2.5 K ; -20 mm

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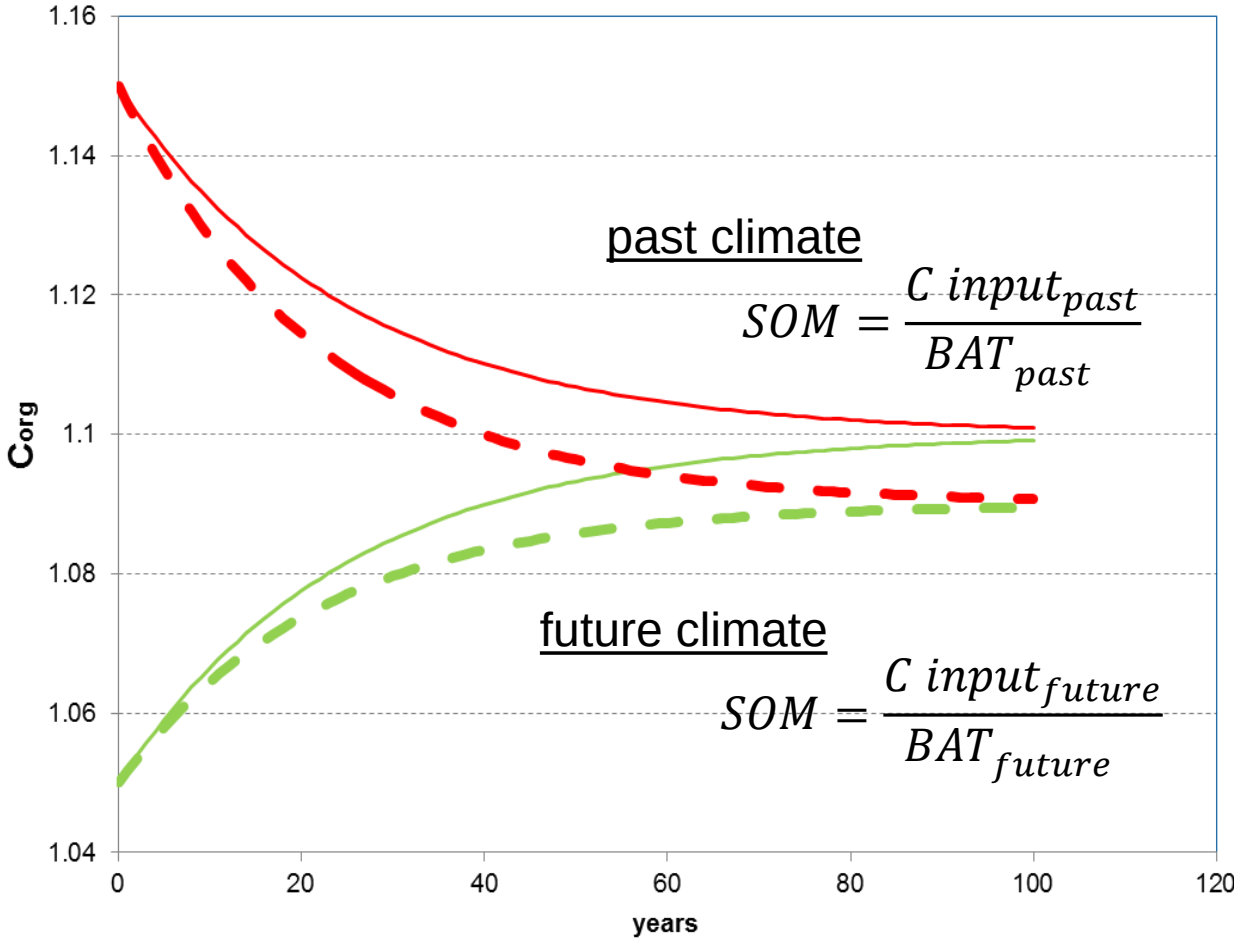
Sustainable SOM supply



carbon demand will increase

$$CDI = \frac{C_{future}}{C_{past}} = \frac{BAT_{past}}{BAT_{future}}$$

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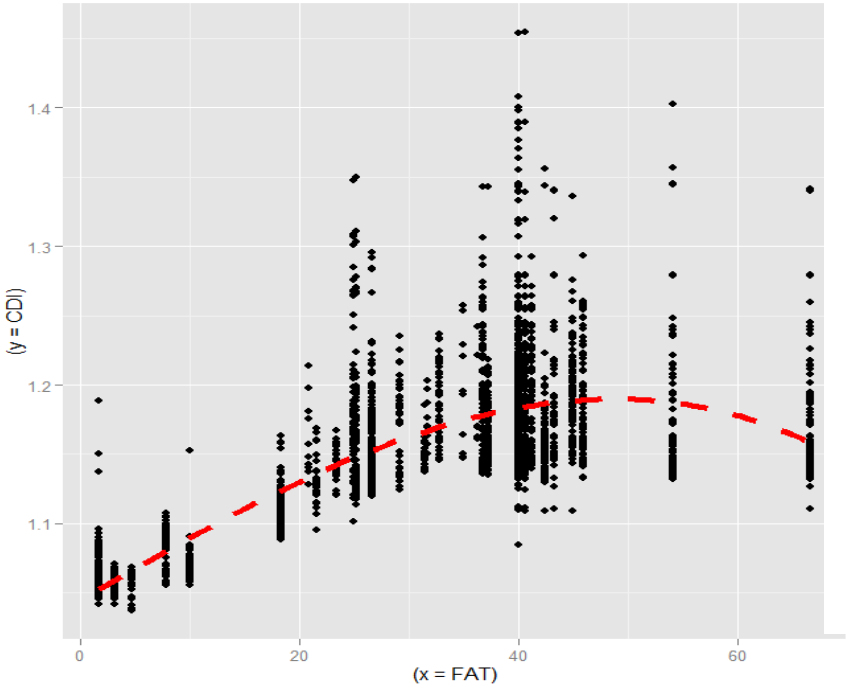
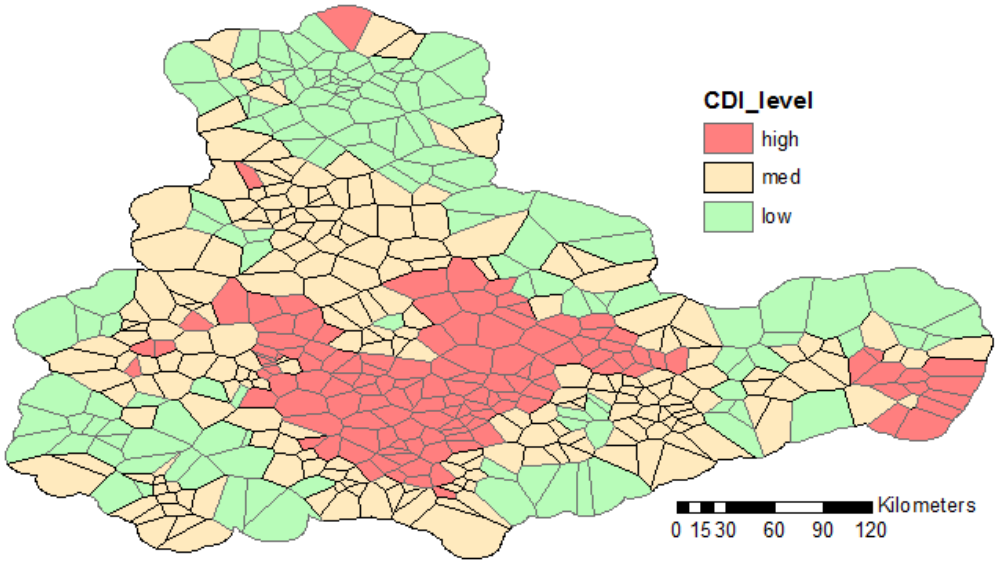
Results: carbon demand index

CDI: carbon demand for soil

Increase of SOM supply to sustain SOM level



soil texture



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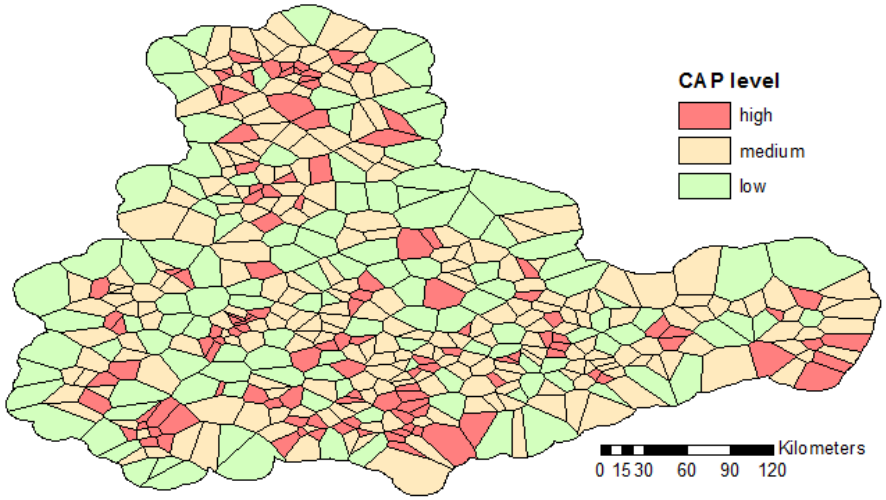
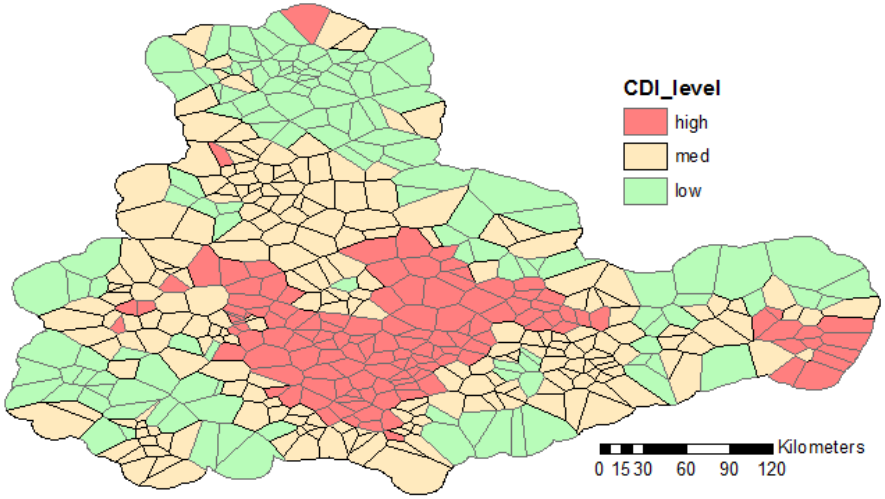
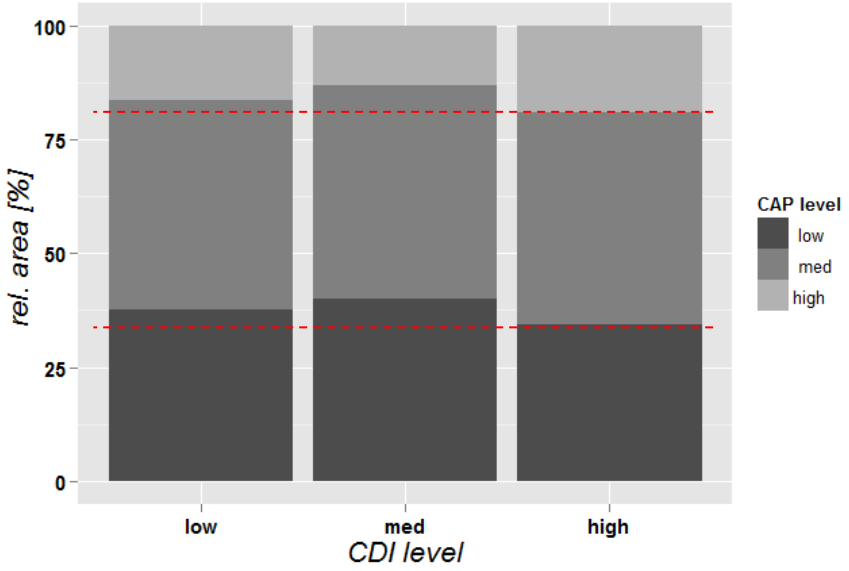
Combined Assessment

carbon demand for biogas



carbon demand for soil org. matter





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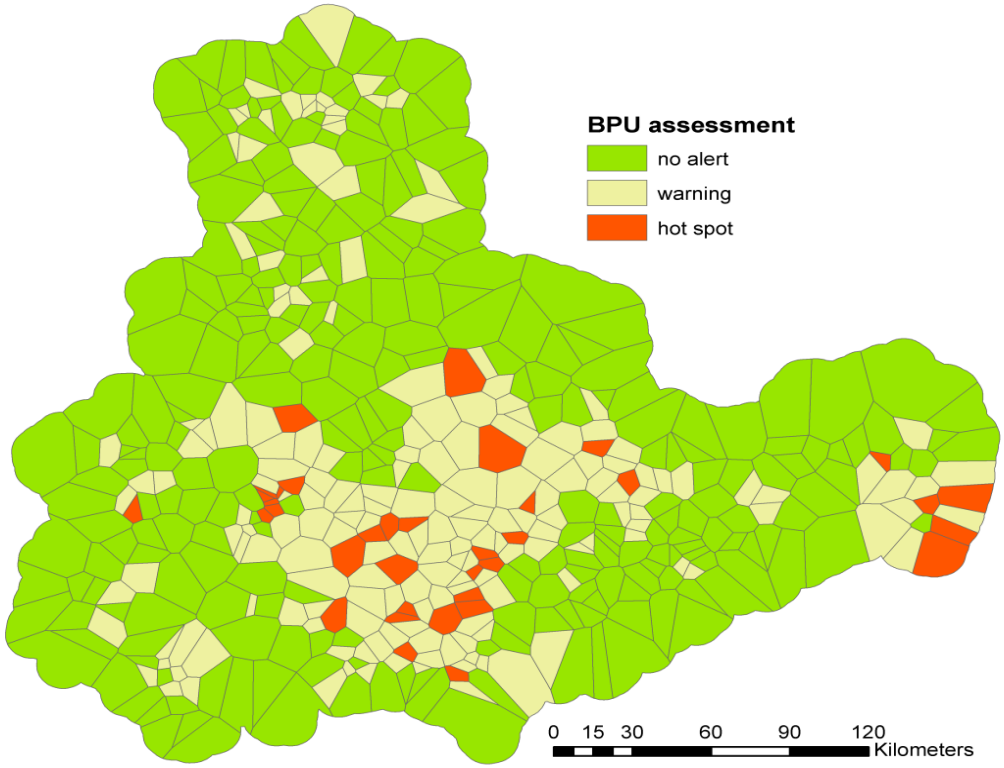
Results: BPU assessment

CAP	CDI	BPU
Low	Low	No alert
	Medium	No alert
	High	Warning
Medium	Low	No alert
	Medium	No alert
	High	Warning
High	Low	Warning
	Medium	Warning
	High	Hot spot



➔ hot spots:
adaptation strategies may be developed on *local scale*

paper accepted in JPNSS

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Conclusions / Summary

Methodology:

Definition of BPU as spatial system

CDI and CAP: indicators for large scale assessment of potential carbon competition

Advantages: low data requirements and transferable

Results for Central Germany:

general increasing carbon demand to sustain SOM

„hot spot“ areas ≈ 5% ; „warning“ level ≈ 30%
➔ further CAP increase should take into account CDI values

Search for adaptation strategies requires more detailed database

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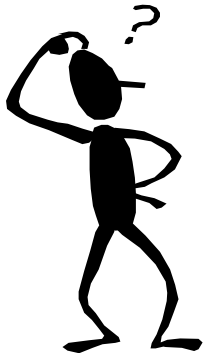
Thank you for attention !

….. any questions



Acknowledgements

This study was partly supported by the Helmholtz Association of German Research Centres within the project funding "Biomass and Bioenergy Systems" and Helmholtz Impulse and Networking Fund of Helmholtz Interdisciplinary Graduate School for Environmental Research (HIGRADE).

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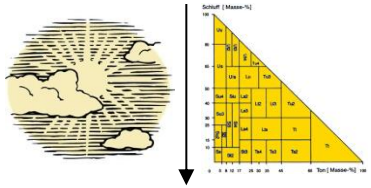
Basic principle of CCB Candy Carbon Balance

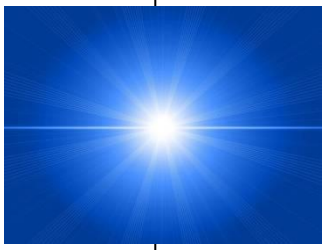
SOM dynamics in dependence of

site conditions

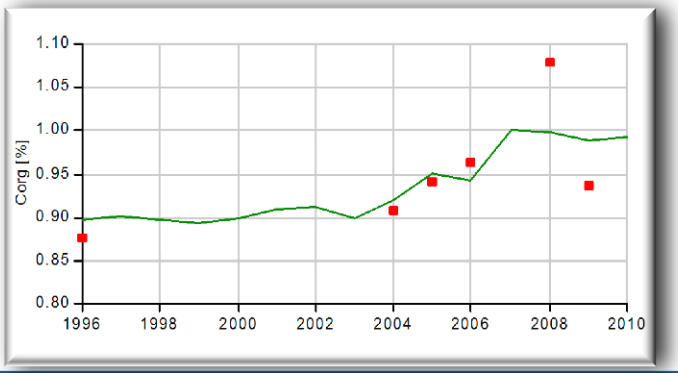


turnover conditions
BAT

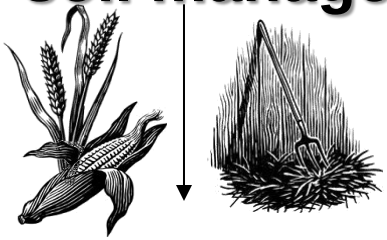
Initial conditions



C_{org}-Dynamics
in annual time steps



soil management



reproduction flux
C_{rep}

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