On the relevance of discussing sediment-soil and soil-sediment transitions

by Susanne Heise, on behalf of the participants of the SedNet-Workshop 2016

Workshop: When sediment becomes soil and soil becomes sediment..

- Prenzliner Mühle, Germany
- May 10th – 13th, 2016
- 15 participants
- 11 countries
- Funded by SedNet

Objectives:
Exchange of information on transition processes
Identification of research gaps

First step: What is soil? what is sediment?

On the differentiation between soils and sediments

Soil or sediment?

On the differentiation between soils and sediments

Soil or sediment?

On the differentiation between soils and sediments

Where does sediment end …

On the differentiation between soils and sediments

Where does sediment end …

…and soil begin?

On the differentiation between soils and sediments

Definitions of soil refer to

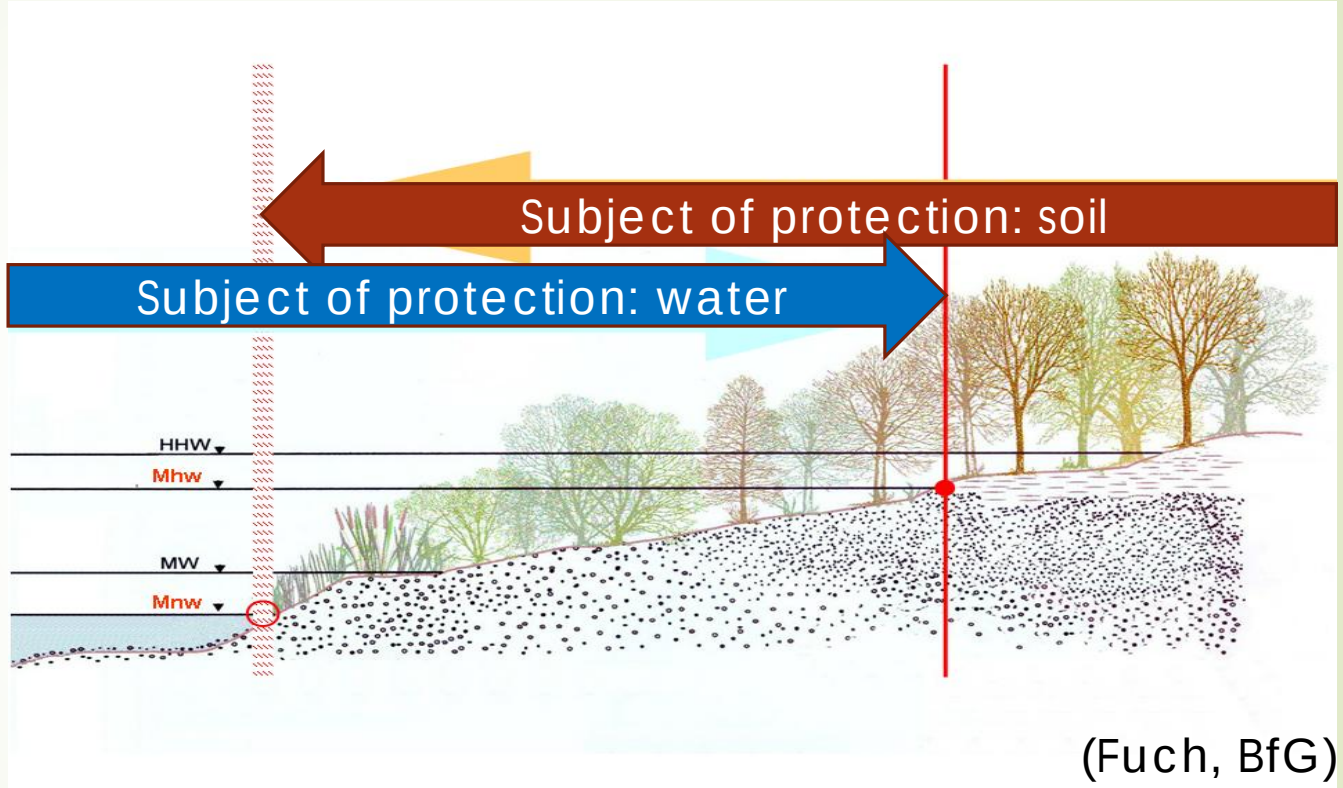
- food supporting service (see Hartemink 2016)
- supporting the growth of rooted plants (Soil Survey Staff 1999)
- layered material, having undergone transformation (Dema & Rabenhorst 1999)

Perception of sediment by the sediment community, e.g.:

"aquatic particulate material with differing physical and chemical properties that can be biologically influenced. It is made up of layers of increasing solid content with depth and includes suspended material, fluid layer, unconsolidated and consolidated material, so all matter that could potentially comprise the suspension-sedimentation cycle." (SedNet WG 5, 2002)

There are different perceptions of soil and sediment.

So what?



(Fuch, BfG)

Example Germany: Overlapping jurisdictions in environmental impact analyses:

Soil: Federal Soil Protection Ordinance (BBodSchG 1998)

Water: Federal Water Act (WHG)

Potential conflicts if regulated by different authorities

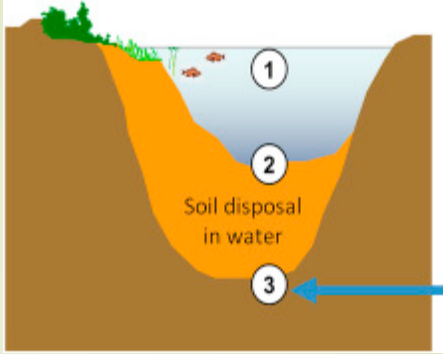
There are different perceptions of soil and sediment.

So what?

Risks of parallel research or of research gaps,
and of misunderstandings

Blum (2005) : „…it can be said that soils or sediments can only be defined for time intervals, during which they are either under hydrological or under terrestrial conditions”

“(terrestrial) soil to water”



(Vink et al. 2017)

- Storage of soils in lakes
- Erosion of river banks, land slides
- Inundations (permanently or periodically)

River bank erosion
Elbe backwater

Land slides
River Göta Älv

Flood plain restoration
(Kreetsand, Elbe)

Flooding
Elbe flood plain

Does (terrestrial) soil easily transform into sediment and vice versa?

- What impact do these transitions have on ecosystem functions of soils and sediments?
- Do we adequately address the risk from contaminants to soil and/or to sediment functions in transition zones?
- What implications does this have for management decisions?
- And – perhaps the most important question of all**: Is it "relevant"?**

“(terrestrial) soil to water”

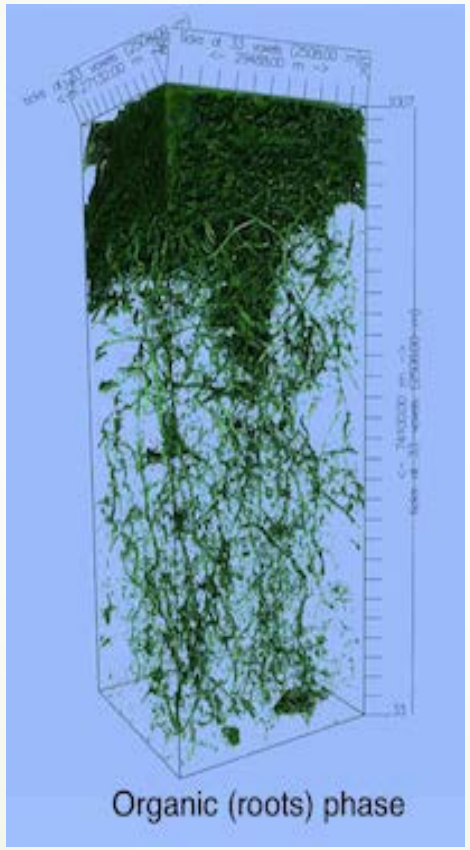
Example from England: Saltmarsh restauration (Kate Spencer)

- Deliberate removal of a coastal defence to allow inundation of a previously defended coastal area ‘Managed Realignment’
- Resulted in tidal inundation of low-lying, drained agricultural land.

3D sediment reconstruction: isolation of organic matter (by Kate Spencer)

Natural

Restored



Even after 3 decades:

Differences in

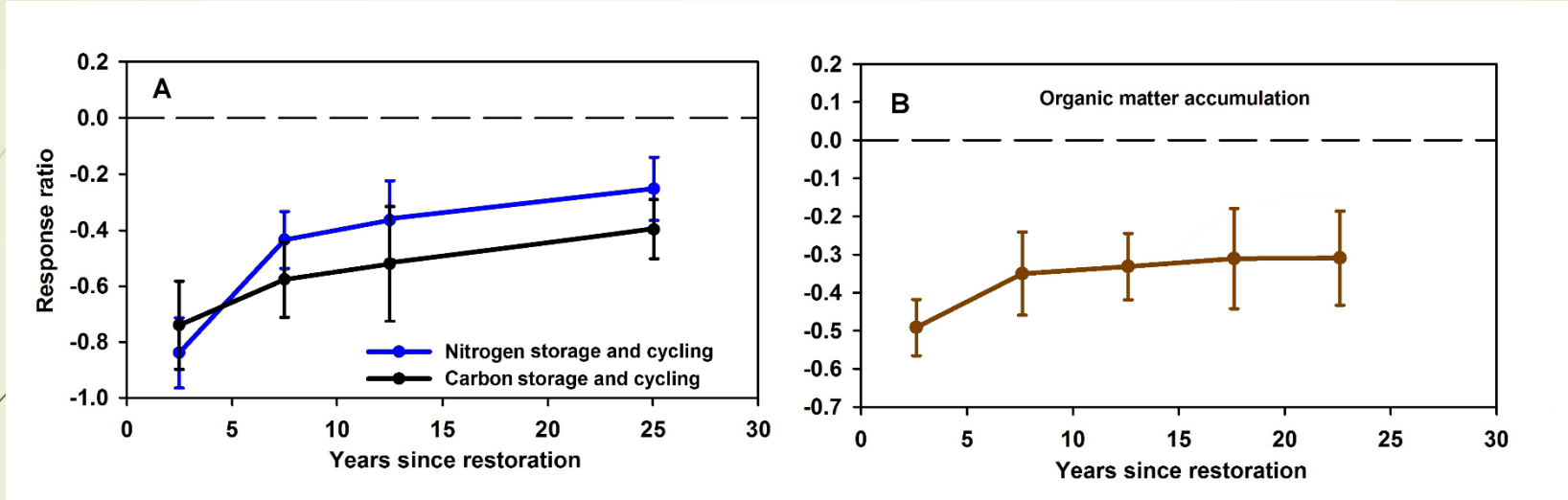
- density of plant roots in deeper layers

also in

- connectivity of pore volume
- hydraulic efficiency
- nutrient cycling

Recovery of restored wetlands

Review by Moreno-Mateos et al. 2012



Low recovery of C-storage

Low accumulation of soil organic matter

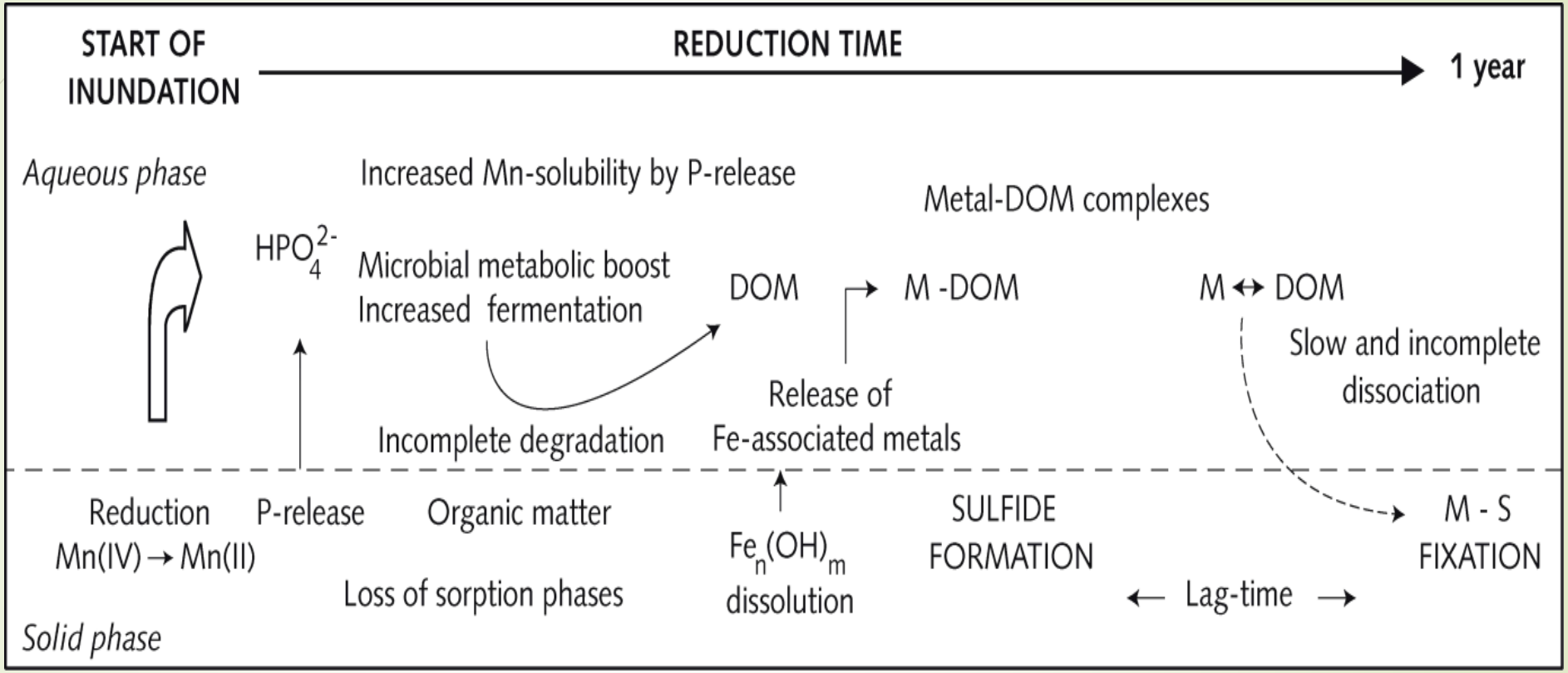
Only 74 % of wetlands recovered their **biogeochemical functioning** (50-100 yrs)

Recovery of biological components (averages):

Vertebrates (~ 5 yrs) > macroinvertebrates (5-10 yrs) >> plants (>30 yrs)

Value of compensaton measures?

Geochemical changes – time related



(Vink et al. 2010)

Probably dominated by shift from aerobic to anaerobic conditions.
Partly competing and time dependent processes

Ageing processes
Bioavailability of contaminants

Availability of contaminants?

A

B

Sediment 0-10 cm

Sediment 10-20 cm

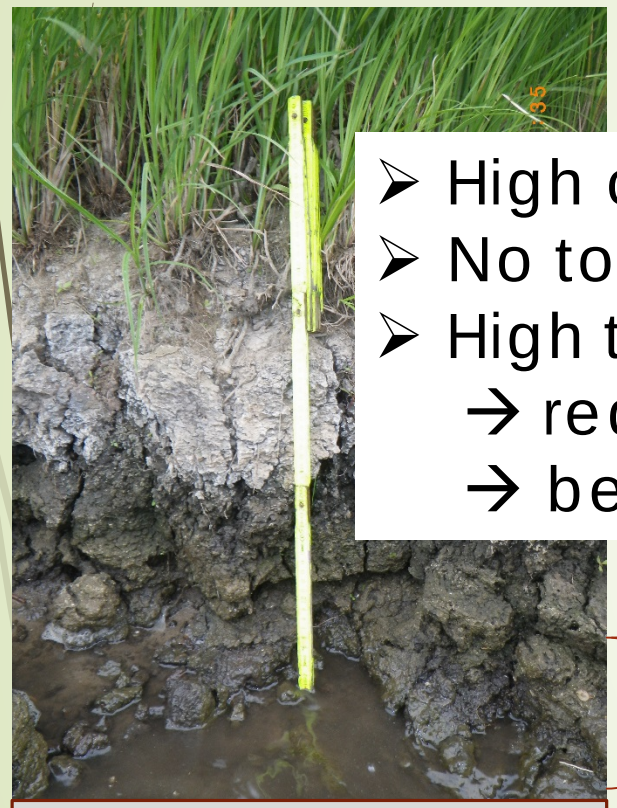
Availability of contaminants?

Sediment 0-10 cm

Sediment 10-20 cm

	As	Pb	Cu	$\sum PCB_7$	pp' DDD
	mg/kg			µg/kg	
	< 20 µm fraction			< 2 mm	
A	151	340	258	99,2	1600
B	211	435	402	158	1600
	226	427	388	126	2200
	140	327	259	16,60	280

Availability of contaminants?



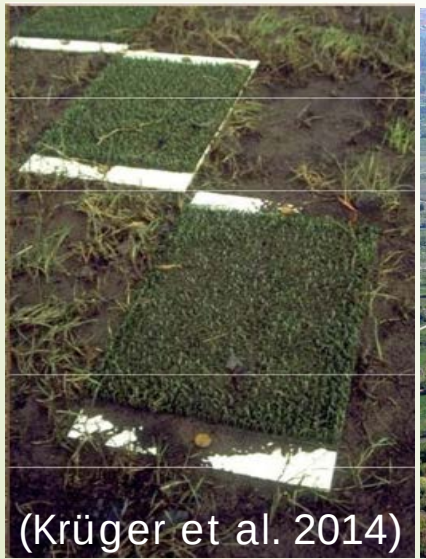
- High contamination with anorganic and organic contaminants
- No to moderate toxicity in elutriates
- High toxicity in direct sediment contact
  - → reduced bioavailability in overlying water
  - → benthic fauna could be affected.

	As	Pb	Cu	$\sum PCB_7$	pp'	Algae	Microtox	SCT
A	151	340	258	99,2	1600			
B	211	435	402	158	1600			
Sediment 0-10 cm	226	427	388	126	2200	-24,76	42,23	76,59
Sediment 10-20 cm	140	327	259	16,60	280	-48,38	31,03	85,47

“Sediment to land”-transitions

- Deposition on flood plains
- Land disposal of dredged material
- Land reclamation

Sediment traps in the flood plain



Land disposal of DM in Hamburg

Reclaimed land in the NL

Little information on sediment to soil transitions

- land is “re”claimed for human use, not ecological value
- sediment disposal sites are engineered structures, seldom monitored (information welcome!)

Sediment to soil

Example from France (Bataillard, BRGM, France):

Sediment deposited in a pit on land!

Figure 1: soil profile developed on a 10 years old dredged sediment. Cracks are due to the deposit of the sediment in a pasty state.

- After 10 years, flora seems to blend into environment
- In the material below: no earthworms or other invertebrates

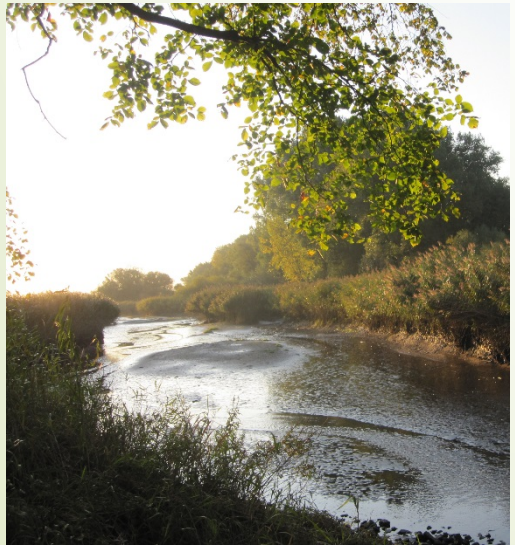
→ provision of ecosystem services?

Figures provided by courtesy of Philippe Bataillard

And we haven't even mentioned soil-sediment-soil-sediment .... Processes during frequent transitions

- Intertidal areas
- Water reservoirs

Freshwater mudflat
Heuckenlock (D)



Marine mudflat
Neufelder Watt (D)

Water reservoir for hydropower
Norway

Conclusion

Soil ≠ sediment

- It can take decades before restored wetlands can fulfill the same functions as “natural” wetlands

  → Compensation measures?

- Decision makers should address the time scale of transitions
- Sediments → soil: Transition processes ???
- Periodic transitions: Impact of rapidly changing factors?
- Development of innovative assessment techniques may be necessary that apply to both, soil and sediments.

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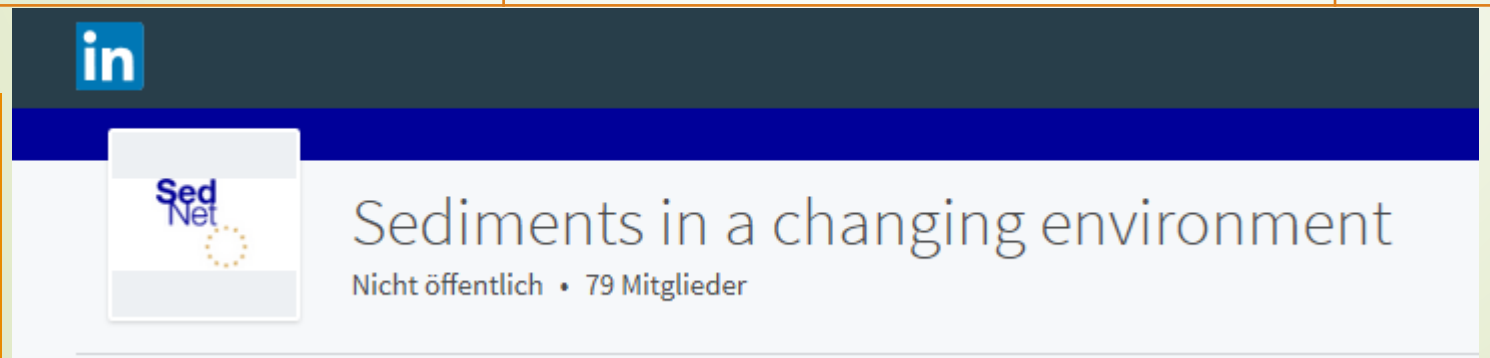

If you are interested to join the discussion group, please send me an email.

Thank you for your attention

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