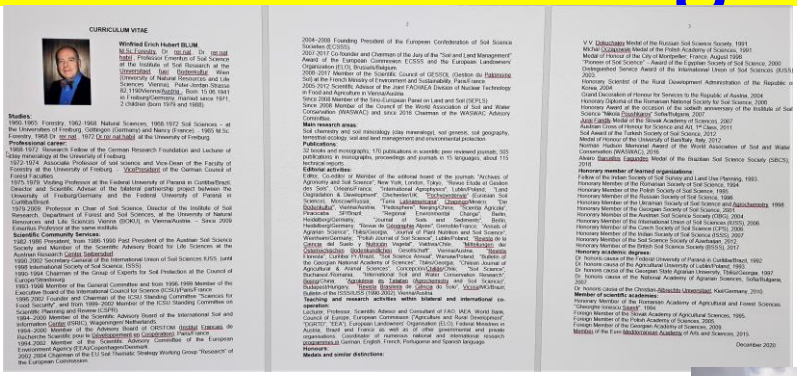
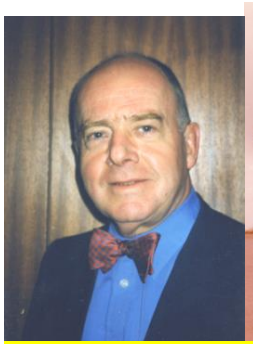
Herzlicher Glückwunsch zum 80.Geburtstag



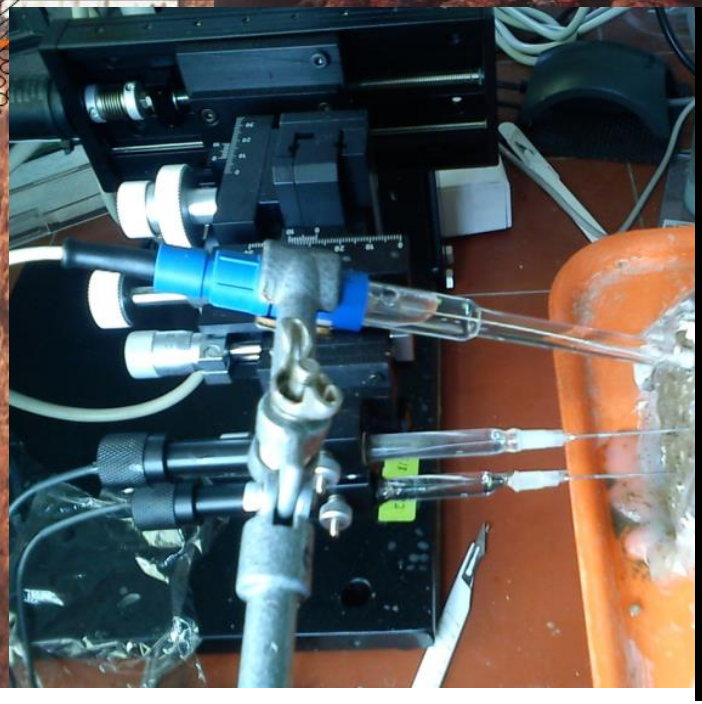


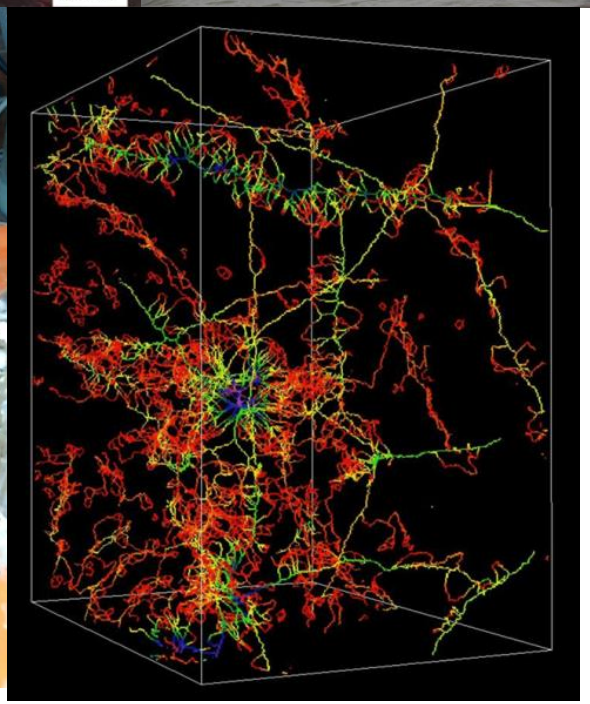
Dr.honoris causa, Agricultural and Food Science Faculty, Christian Albrechts University Kiel together with Prof.Schwertmann, Prof.Hartge and Prof.Schachtschabel

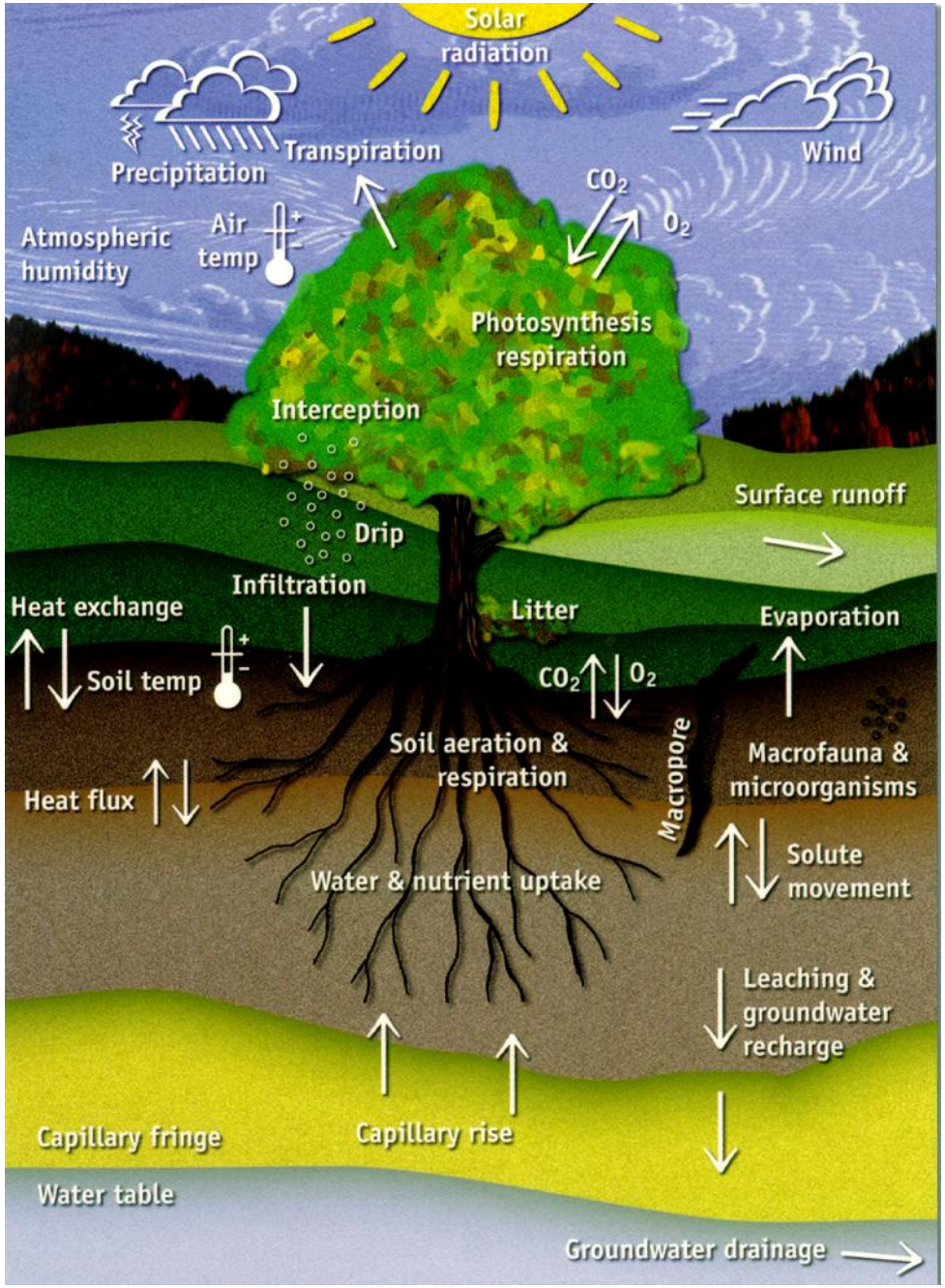
The most exciting and challenging aspect of soil science is the complexity of soils, which is like a scientific puzzle and requires a broad basis in sciences.

Soils are sensitive reactors- what are possible options to maintain their resilience for a sustainable soil or land use?

Prof. Dr. R. Horn Soil Science Kiel/ Germany







Hillel 2004

Soils are reactors with various tasks:

- **Food for 9 Billion people 2050, but >1 Billion people are starving already today**
- **+ 300 km²/ day are irreversibly lost worldwide**
- **Filter and buffer, groundwater recharge,**
- **Substrate for construction**
- **….**
- **But soils are non renewable**
- **They have a limited rigidity**
- **Thus, non adjusted soil management leads to declined functionality**
- **Sustainable landuse is demanded as site specific requirement to maintain soil resilience**

Soils are heterogenous

- nutrient storage
- nutrient availability
- nutrient fluxes

- aggregation
- aggregate strength

Pore rigidity, max. wetting and drying effects, aggregation ,accessibility of surfaces, tortuosity, global change effects …….

Redox reactions

wet

O2 deficiency

dry

wet

O2 deficiency

Braunerde

Kalkmarsch

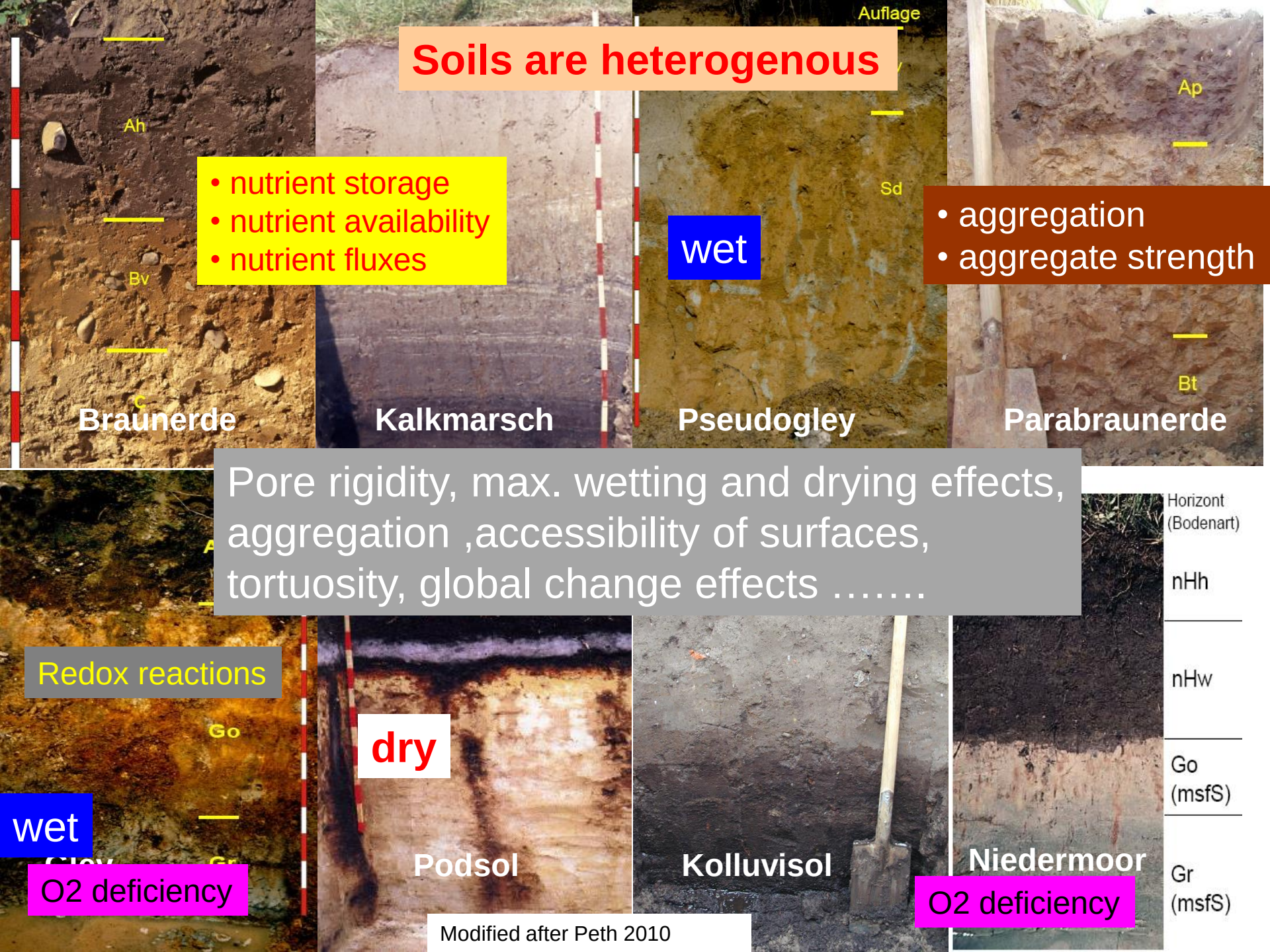
Pseudogley

Parabraunerde

Podsol

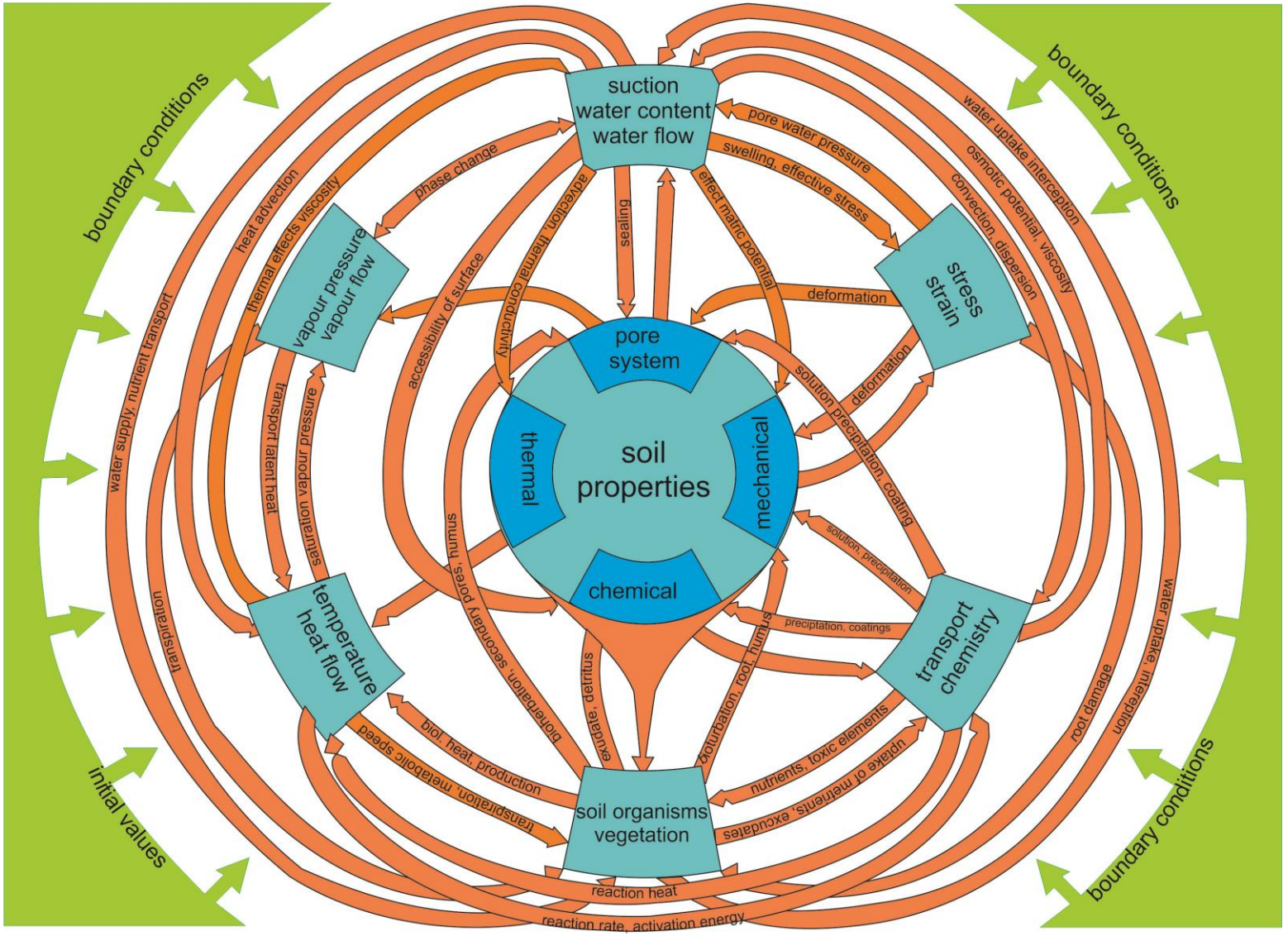
Kolluvisol

Niedermoor



Modified after Peth 2010

Soils are dynamic systems with uncounted interactions



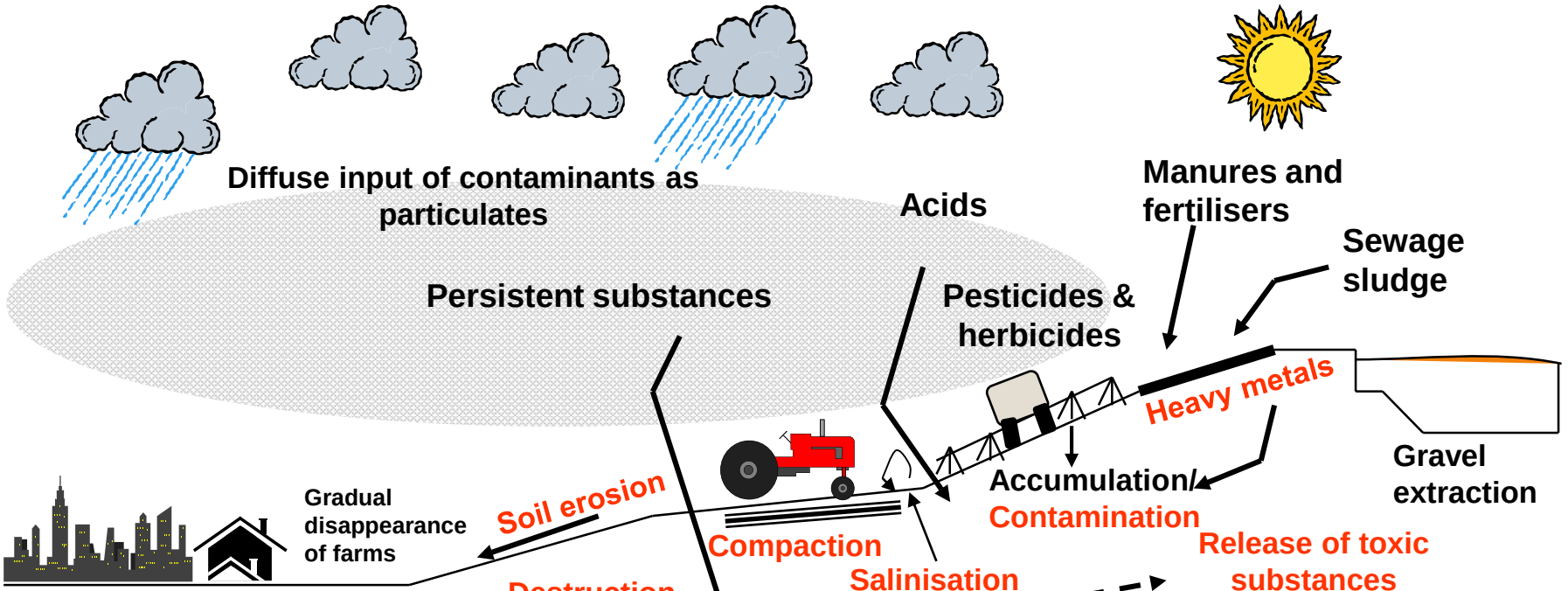
Gräsle 1999

Soil resilience refers to the ability of a soil to resist or recover the healthy state in response to destabilizing influences – furthermore the question about time and climate change interactions must be considered!

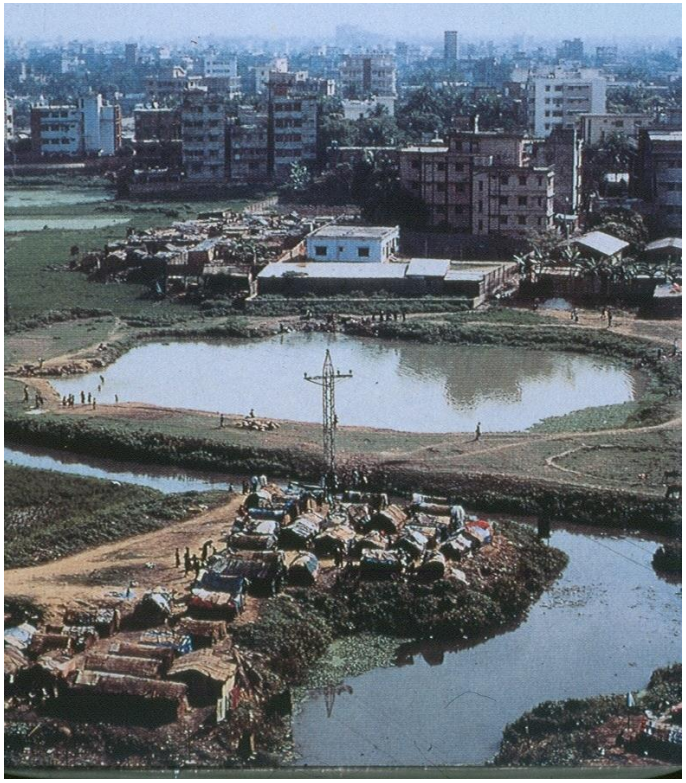
Blum 1994

Processes counteracting soil resilience

The impact of human activities on soil



The worst case: resilience is not existing because soils and material volume are lost!



Blum 2016

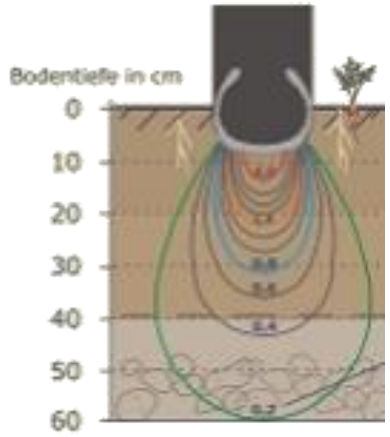
Water erosion:

Kellersee bei Eutin: Maisacker am Hang, ca 100mm NS im Herbst 2017, konv. Bearbeitung,
Abtrag: 511 m^3; bei 1,5 g/cm^3 ->767 Tonnen
Max. Abtragshöhe: 4,4 m,
Länge: 41,5 m, Breite: 9,8 m
Erodierte Fläche: 275m^2

Soil deformation and consequences for the definition of resilience

What are the least physical, chemical or physicochemical properties and values?

Physical Soil Degradation Threat



Stress propagation in the subsoil

Changes of physical soil functions

Cons es for properties

• structure deterioration

Which are the factors to define resilience and limits?

- **Infiltration**
- aeration
- water storage
- ponding

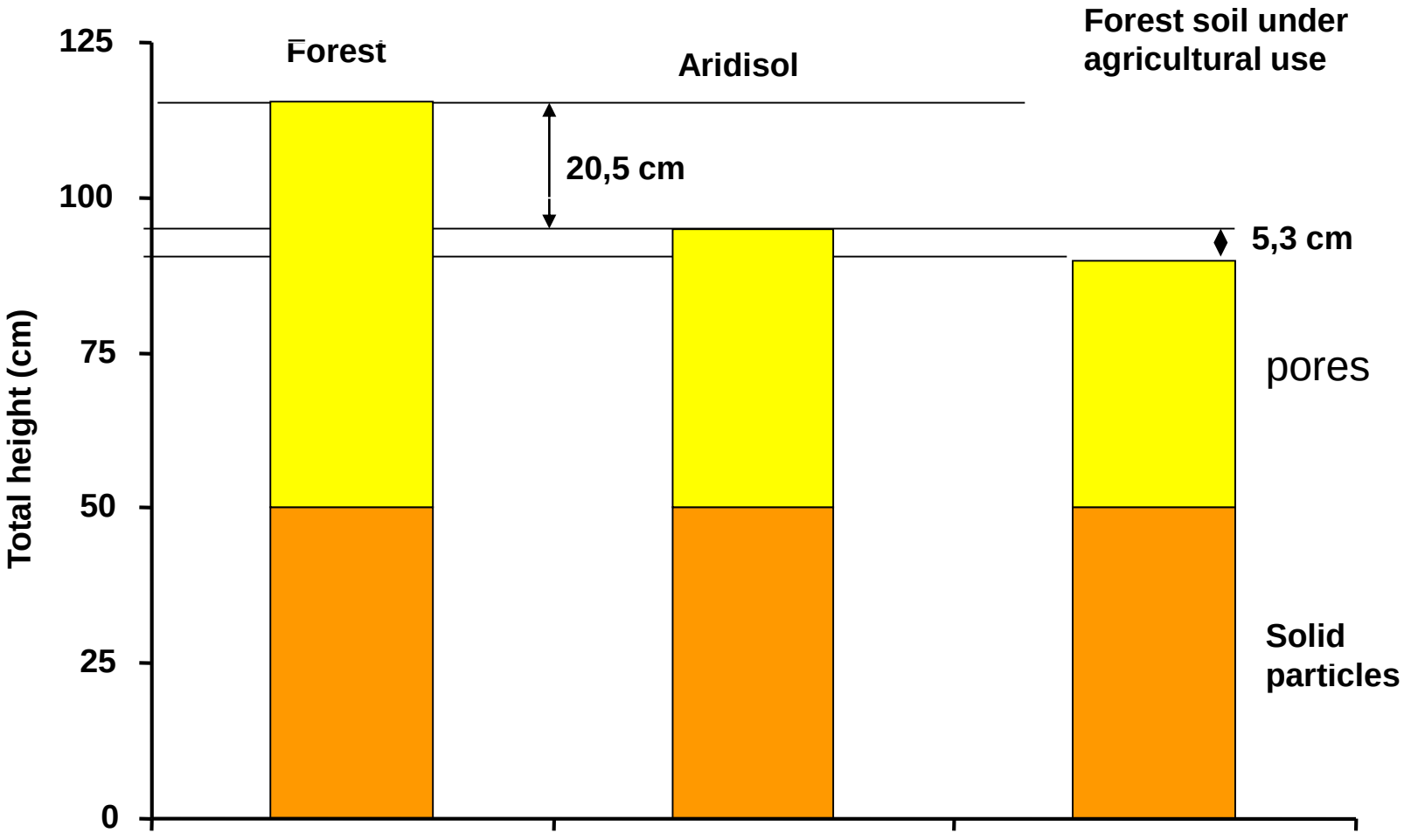
- root growth
- Water- , gas- and
- Nutrient uptake
- microbial activity

- **erosion/ landsliding**
- **nutrient loss**
- **water/ air pollution**

•Yield uncertainty

Loss of air and water filled pores – what is the reference basis for the resilience analysis?

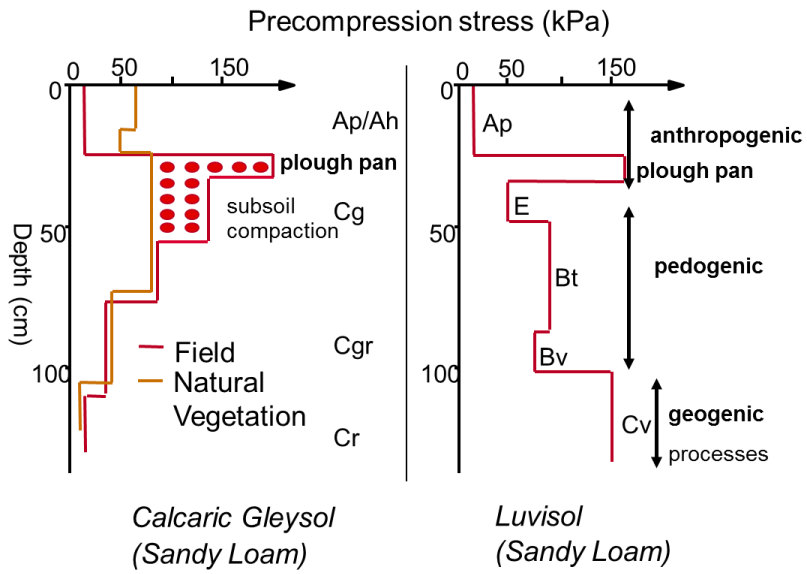
Insight in soils as 3 phase systems under various landuse



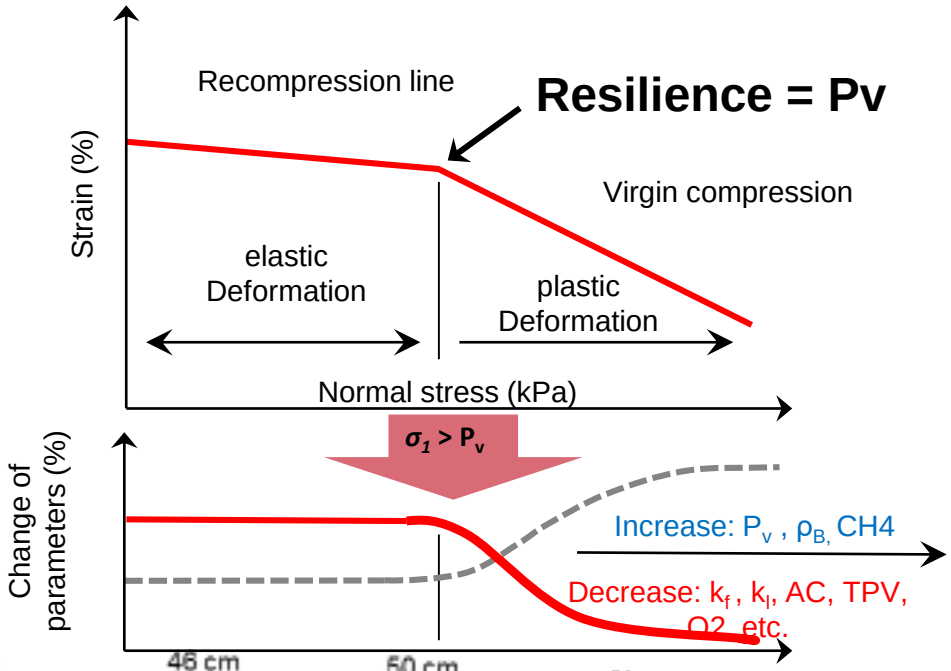
The loss of approx. 260 mm water storage or air filled and rootable pores are the actual site conditions

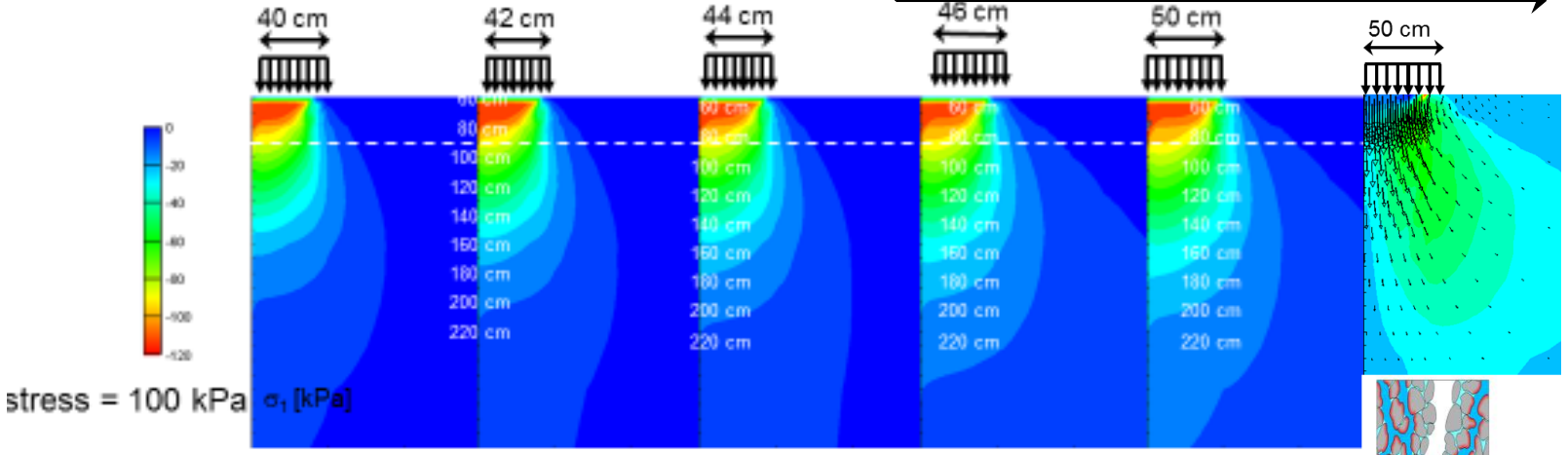
Soil resilience definition requires soil strength analysis understanding of coupled processes

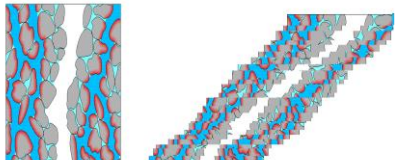
Internal soil strength

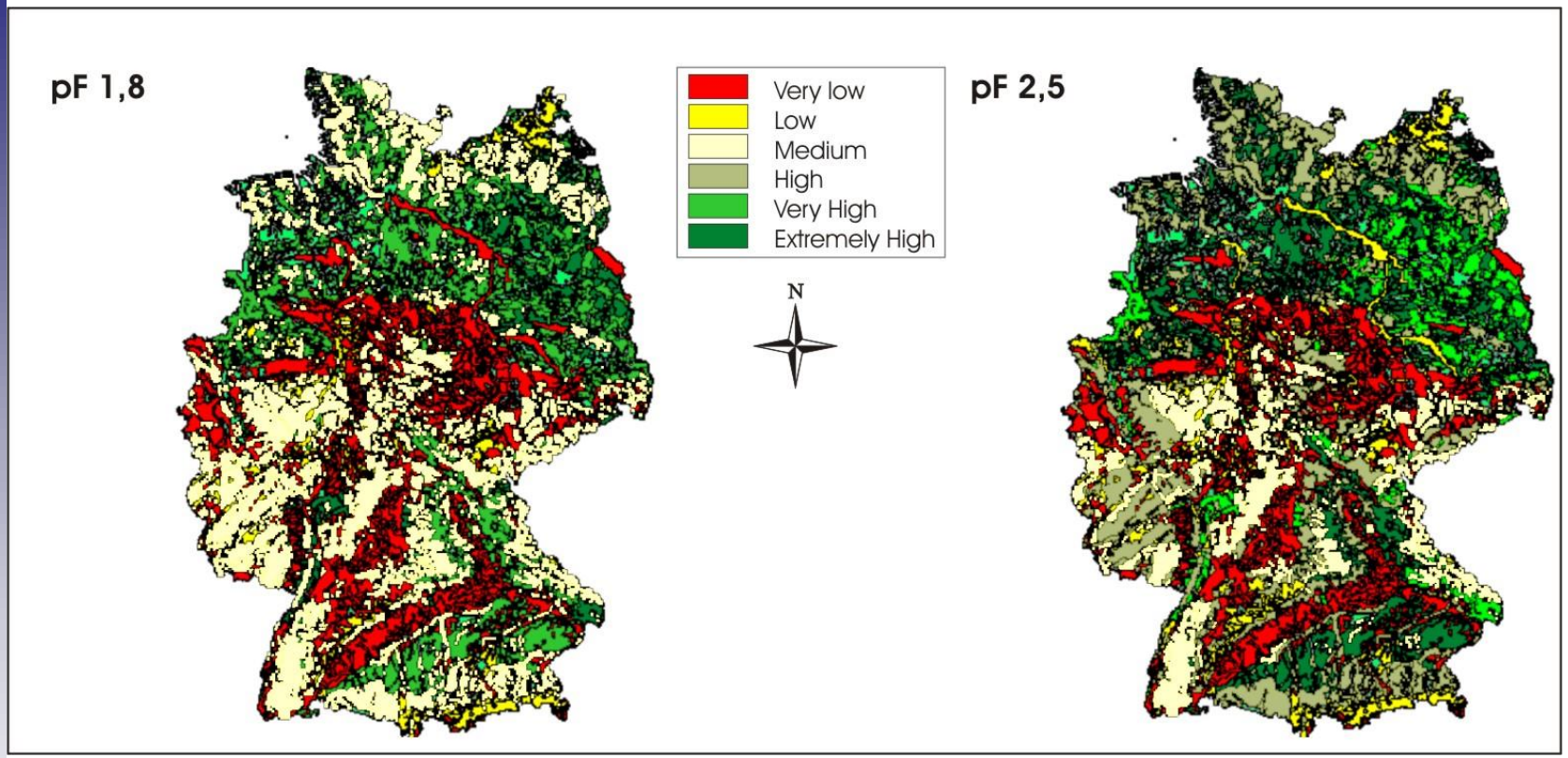


Consequences of stress strain







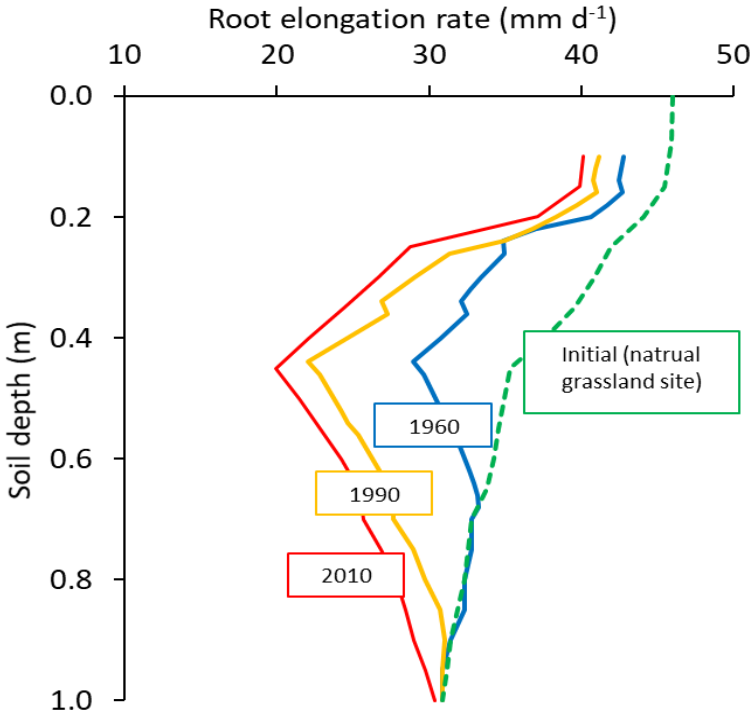


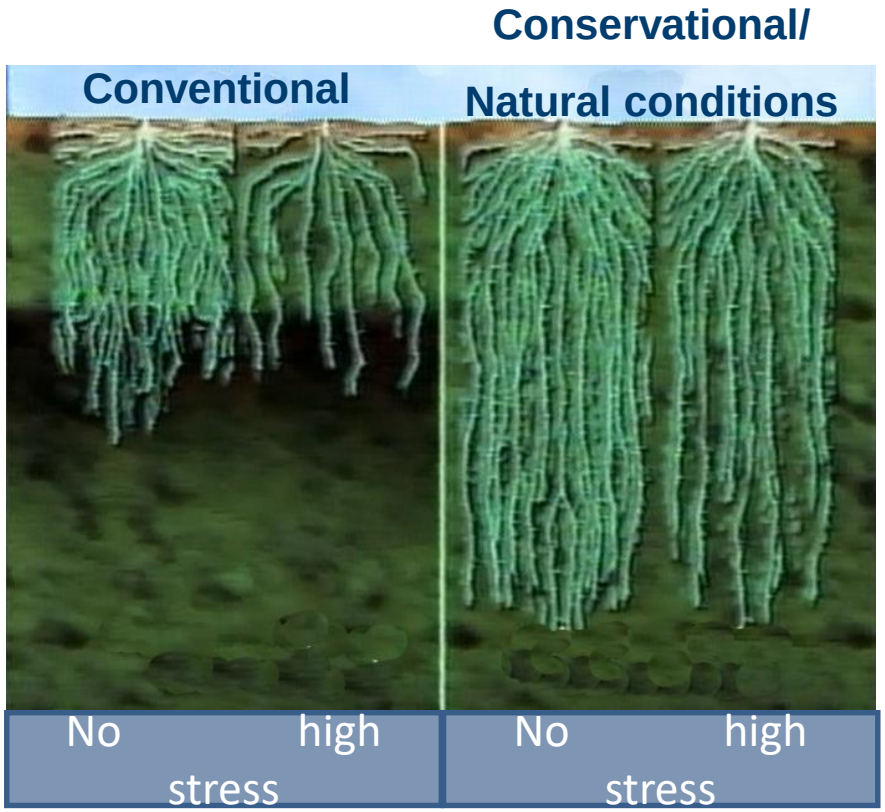
Calculated values of the precompression stress (kPa) at pF 1.8 and pF 2.5 for representative topsoils (0 - 30 cm) of Germany.

Classification of the precompression stress (kPa): very low < 30, low 30-60, medium 60-90, high 90-120, very high 120-150, extremely high > 150

How can we define degradation „steps“ to classify soil resilience from minimum to moderate or maximum (=non disturbed) based on soil functionality values? Which physical parameters can be used?

1) Root growth with time and depth in soils: effects on availability and accessibility

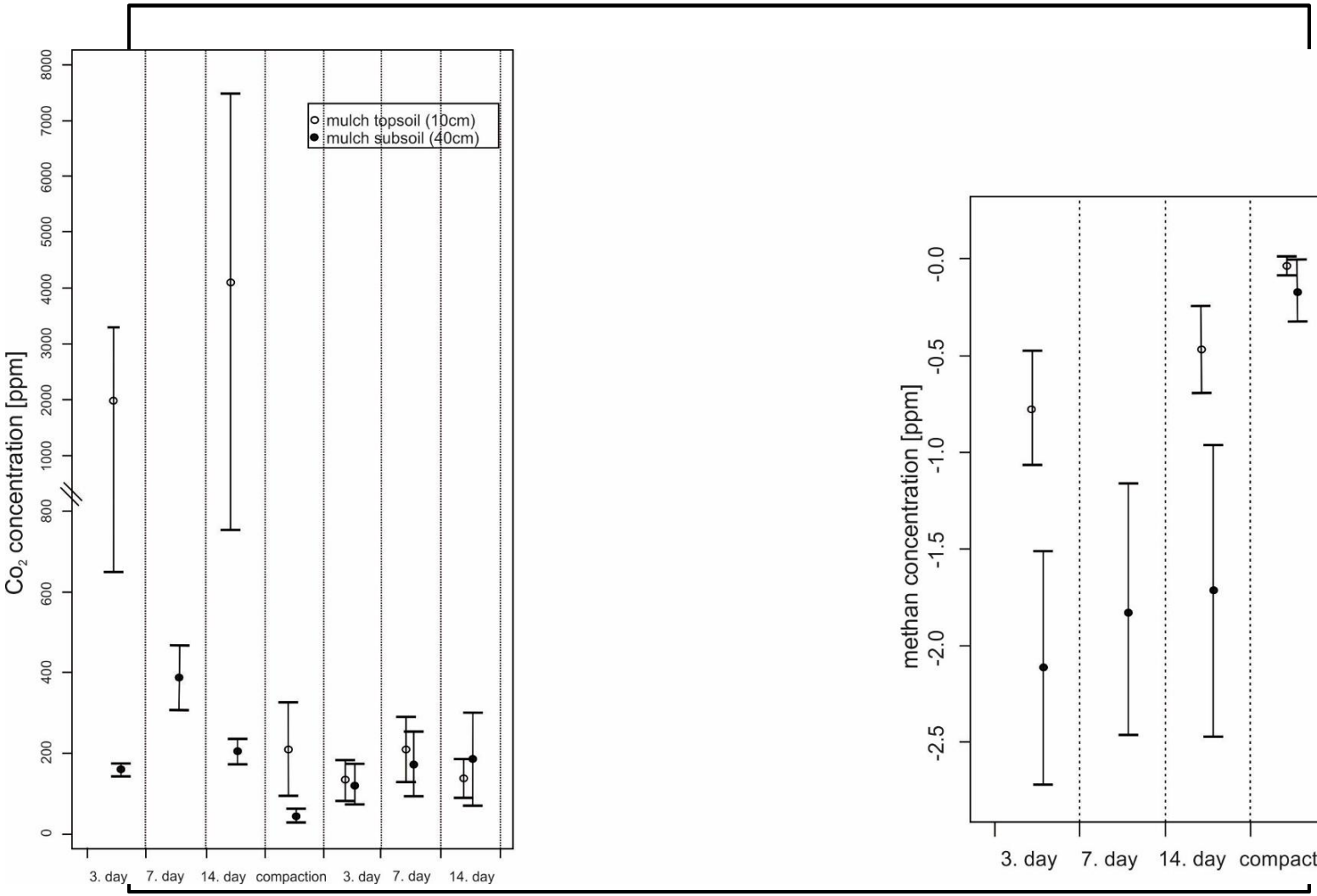




Rooting depth and growth rates decide about nutrient, water, and gas uptake efficiency and biodiversity impacts

Possible parameters to classify soil resilience with „biological“ properties: root length density, root surface density, root distribution

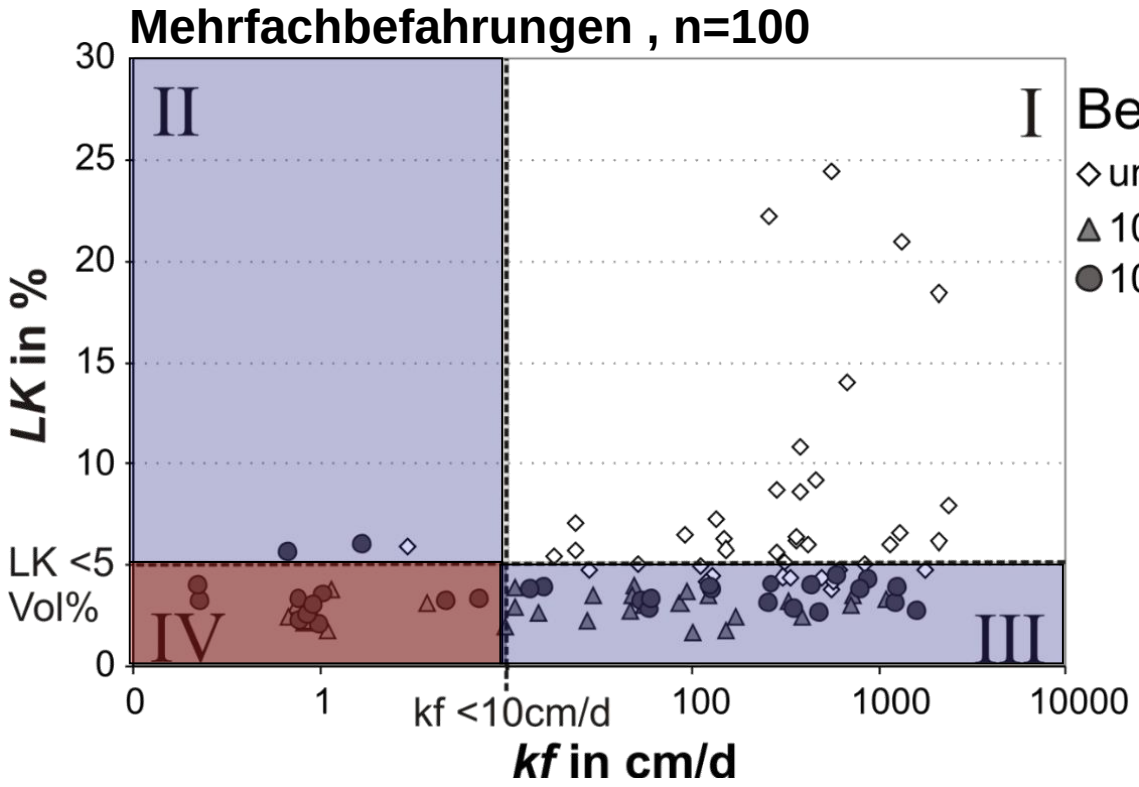
2) Effect of soil deformation on changes in redox potential and gas composition

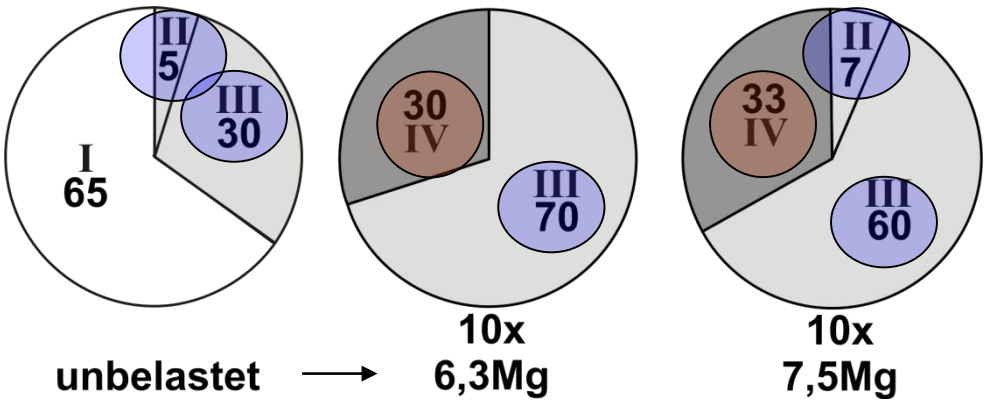


•Possible parameters to define the physico chemically based resilience declines: Redox Resistance: >5; < 3 days 300mV (Stepniewska 2007), air permeability kL>10^{-6} , < 10^{-7} cm², or Oxygen diffusion rate ODR >70, <30

"Resilience limits" based on soil hydraulic conductivity and air capacity

A more complete example





% decline portions of Resilience classes

I = optimal: kf>10 cm/d

LK>5 Vol%

II= minor: kf>10cm/d LK<5Vol%

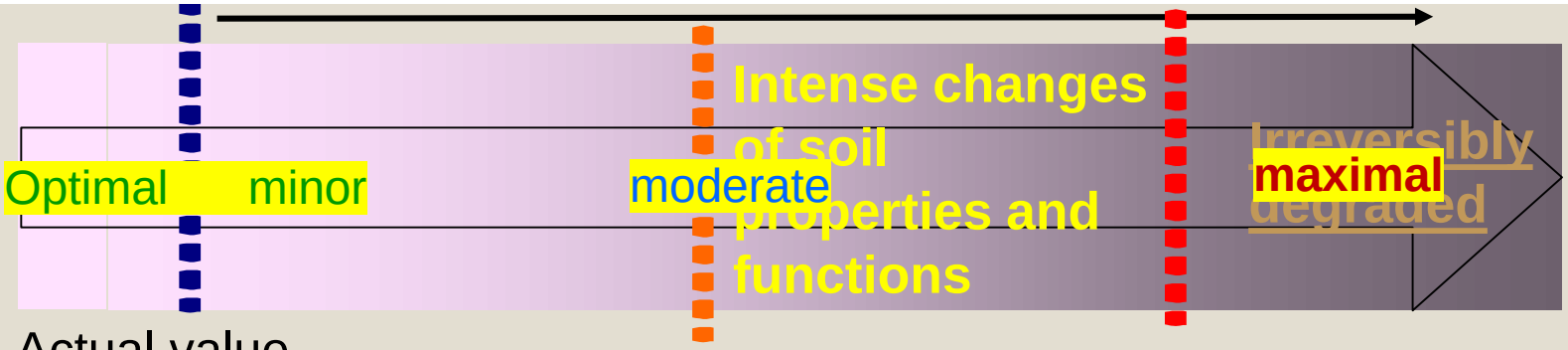
III= moderate: kf<10cm/d

LK>5 Vol%

IV maximum = kf<10cm/d LK<5Vol%

Values for resilience classification – we can apply our knowledge over scales also for regulations and formulation of soil resilience impact loss classes

Modified according to the German Soil Protection Law (1998)



Actual value (**Reference = resilience**) Soil properties	precaution value(PV)	Action value (AV)
	AC > 5 Vol.%	**AC <5 Vol.%, O2 availability**
	ks > 10 cm/d	**ks < 10 cm/d**
No problems e.g. Cambisol, Inceptisol, Spodosol (sandy material)	Labile soils : Loamy Alfisols E, (Bt), Cv ,	Sensitive soils: e.g. Kolluvisol, stagnic Luvisols, Gleysol , derived from glacial till or loam, Vertisols,

Actual values depend on: parent material texture, structure, bulk density, Corg. etc.

Conclusions

Soil management based decisions require the knowledge of physical, chemical, and biological properties, soil rigidity limits, and the vulnerability etc.

Soil resilience can be classified based on physical, chemical and also on physicochemical soil functions.

However: Classification depends on the requirements on soil functions with respect to land management

Further research and discussions about limits and land management options are needed to develop site specifically required all relevant impacts including resilience class recommendations .

General take home message: Preserve at least the actual rigidity and the related soil properties and functions to avoid further irreversible soil degradation, because soil amelioration is a process for centuries.

Discussion of Soil Protection & Resilient Land Management

….. always depends on our advanced knowledge