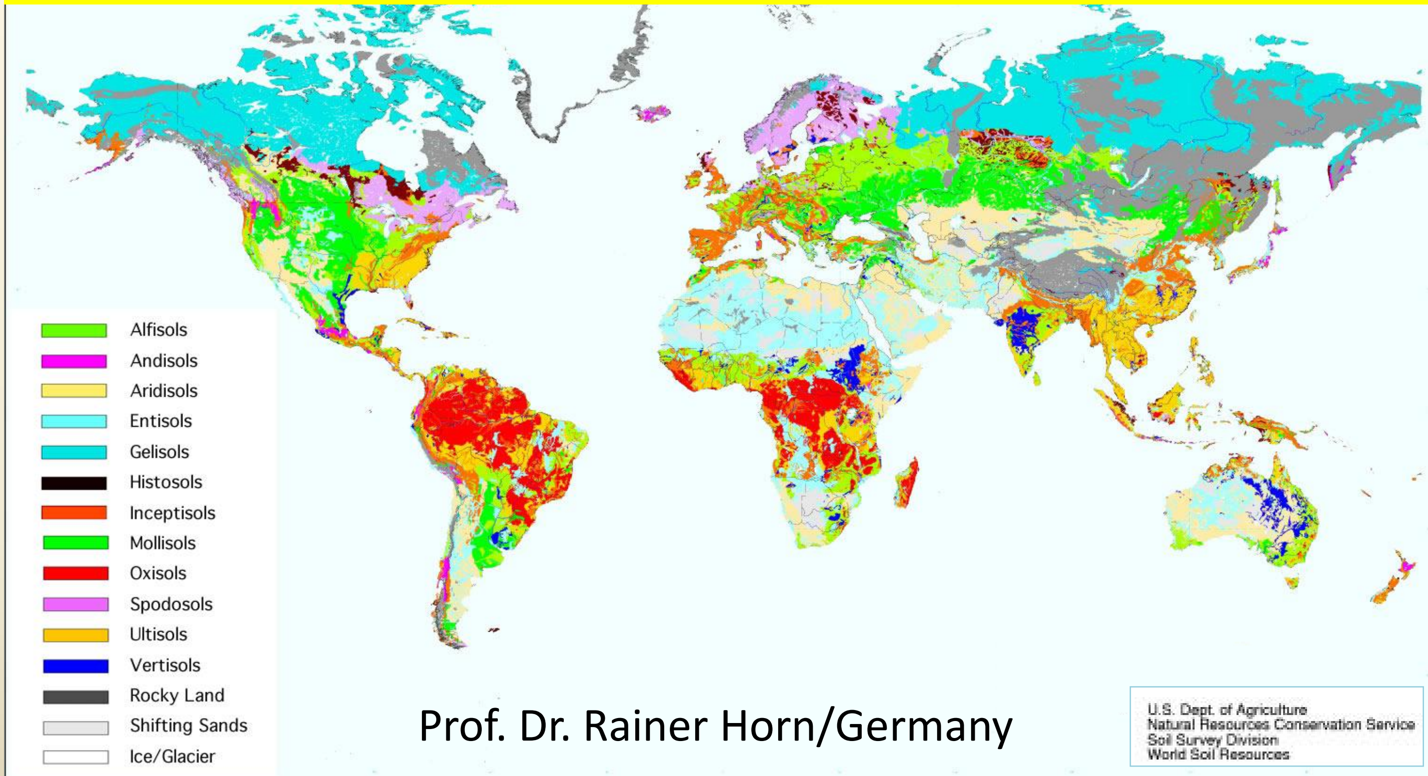
IUSS - Soil science research approaches and future needs



Prof. Dr. Rainer Horn/Germany

2015 International Year of Soils

International Decade of Soils 2015-2024

බිම tal půdy Udongo mulla ᏓᏍᏓᏅ augsnes ithir dirvožemio

sol beheko 土壤 भूमि พื้นดิน terra pôda

Boden ভূমি মাটি grond ადგილზე maaperän

maa talaj inhlabathi suelo

አፈር dhulka ah

botten

ਜ਼ਮੀਨ έδαφος

приземен

tokës solului

ƙásáa

ground mặt bằng

ile Zem

ùir

почва mark

днище toprak

मैदान خاک

soil つち suolo bodem tla الـ تربة zemlja терен

मिट्टी مٹی yokutshuna

solo धरती

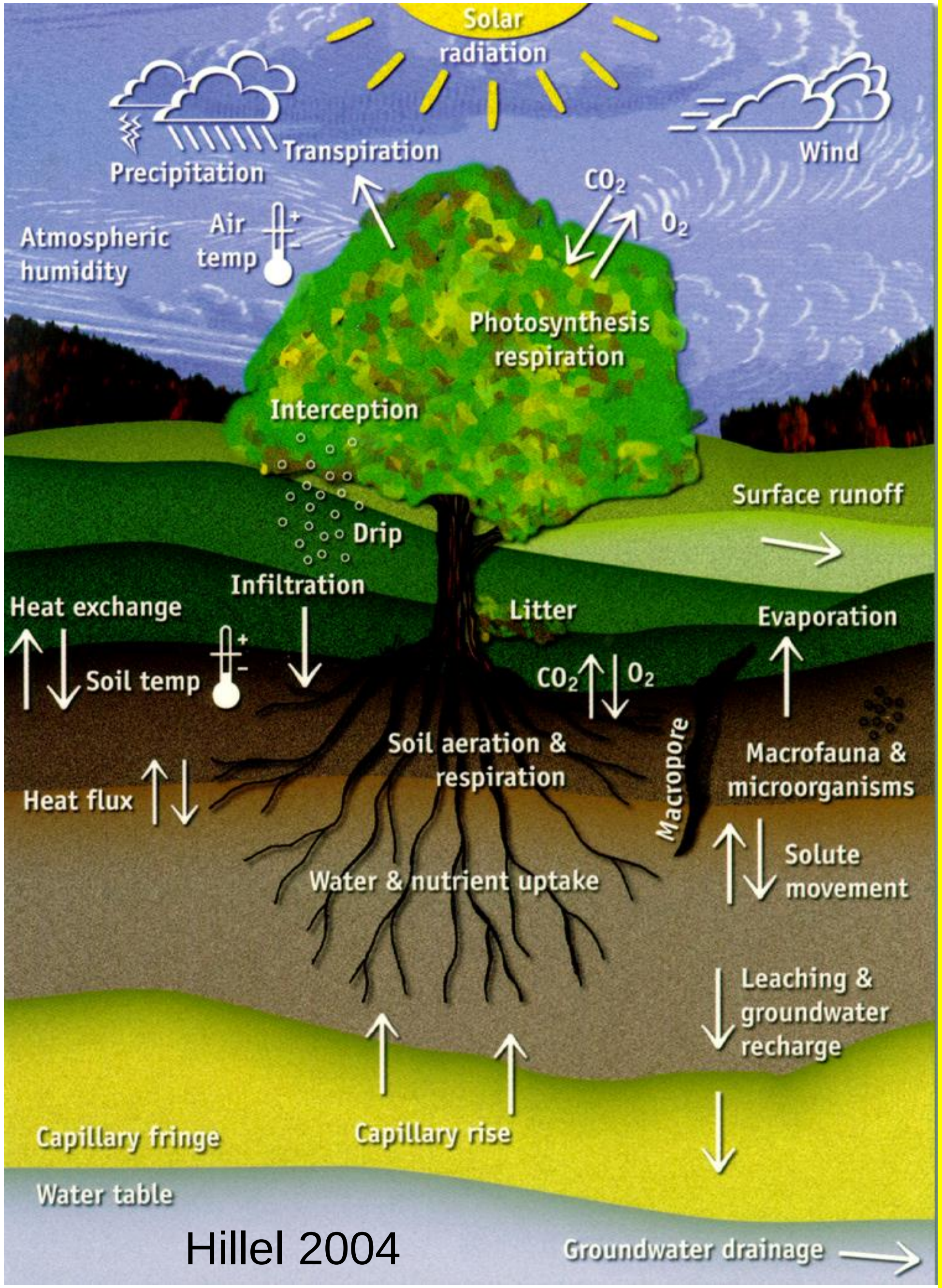
зямля tanah jord 토양 土 gleba அரிசி மண்வெட்டி

Some general statements about soils

Soils serve a variety of functions:-

- **Biomass production** – agriculture, fibre, (only 11 % arable soils are without limitations), and wood based resources
- **Environmental interactions** – regulating the flow and filtering of substances from water, emitting and removing atmospheric gases
- A key component in the **Carbon Cycle and global change** but they are endangered by an intense degradation
- **Source and sink** for bioenergy and biowaste – soil and environment degradation due to deformation and following erosion
- Support of habitat and **biodiversity**
- Protection of **cultural heritage** and archaeology
- Providing **raw materials**

Soils are reactors



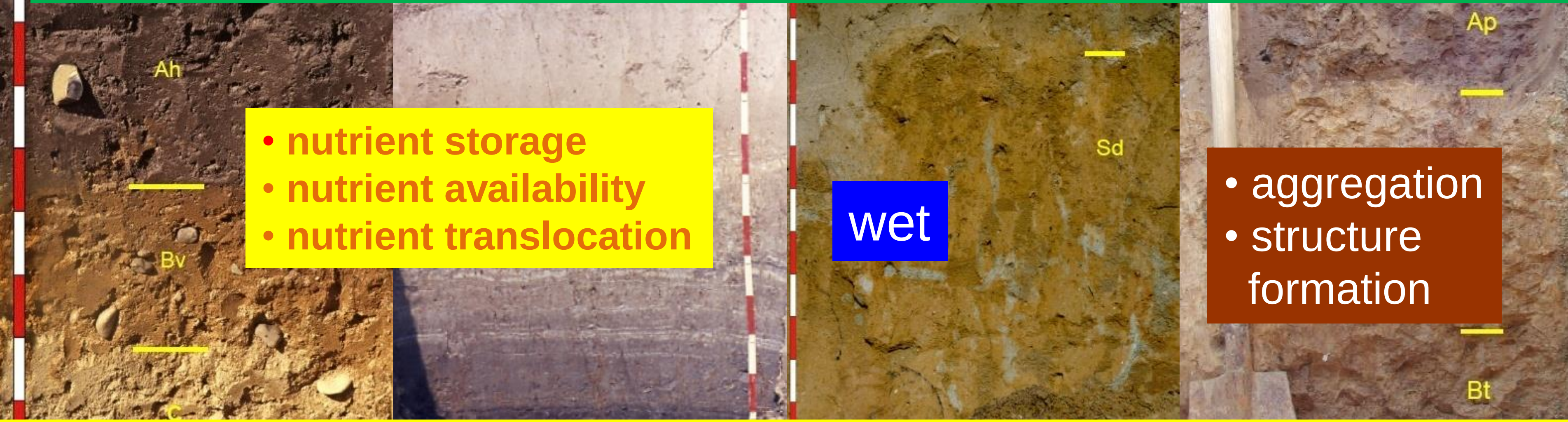
Hillel 2004

Soils are essential for food production

- 9 Billion people 2050
- >1 Billion people are starving already today
- +70 % food /2050
- 2,6 Bill. people live directly from agriculture, but 52% on degraded land
- + 300 km²/ day are irreversibly lost worldwide
- Vienna city is gone within 1,5 days!

- Sustainable development goals (SDG´s) for soils must be reached in time in order to perhaps maintain soil functions and adjust the management based on soil resilience demands.
- **Soil regeneration requires decades to centuries**

Soils are heterogenous (examples from Europe)



Soils have defined but only limited properties and functions. They are sensitive and can be irreversibly degraded if land use is not adjusted to soil properties.

Land Area (million km^2) in Land Quality Classes with Estimated Population (millions) in Each Class

Examples for soil types	Land Quality Class	Area: Million km^2	Area: %	Population: Millions	Population: %
Mollisols, Alfisols , Ultisols	I	3.06	2.38	424	5.9
	II	6.40	4.98	993	13.8
	III	5.85	4.55	331	4.6
Entisols, Inceptisols Vertisols	IV	5.08	3.95	820	11.4
	V	21.23	16.51	2073	28.8
	VI	17.13	13.32	850	11.8
Oxisols, Spodosol, Glacier, rocky land	VII	11.58	9.01	797	11.1
	VIII	21.46	16.69	128	1.8
	IX	36.78	28.61	784	10.9

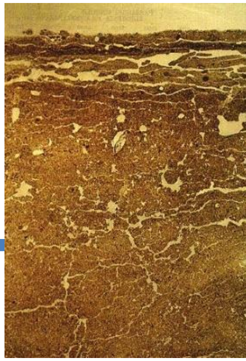
11,9% — 24.3 %

33,8% — 52%

54,3% — 23.8%

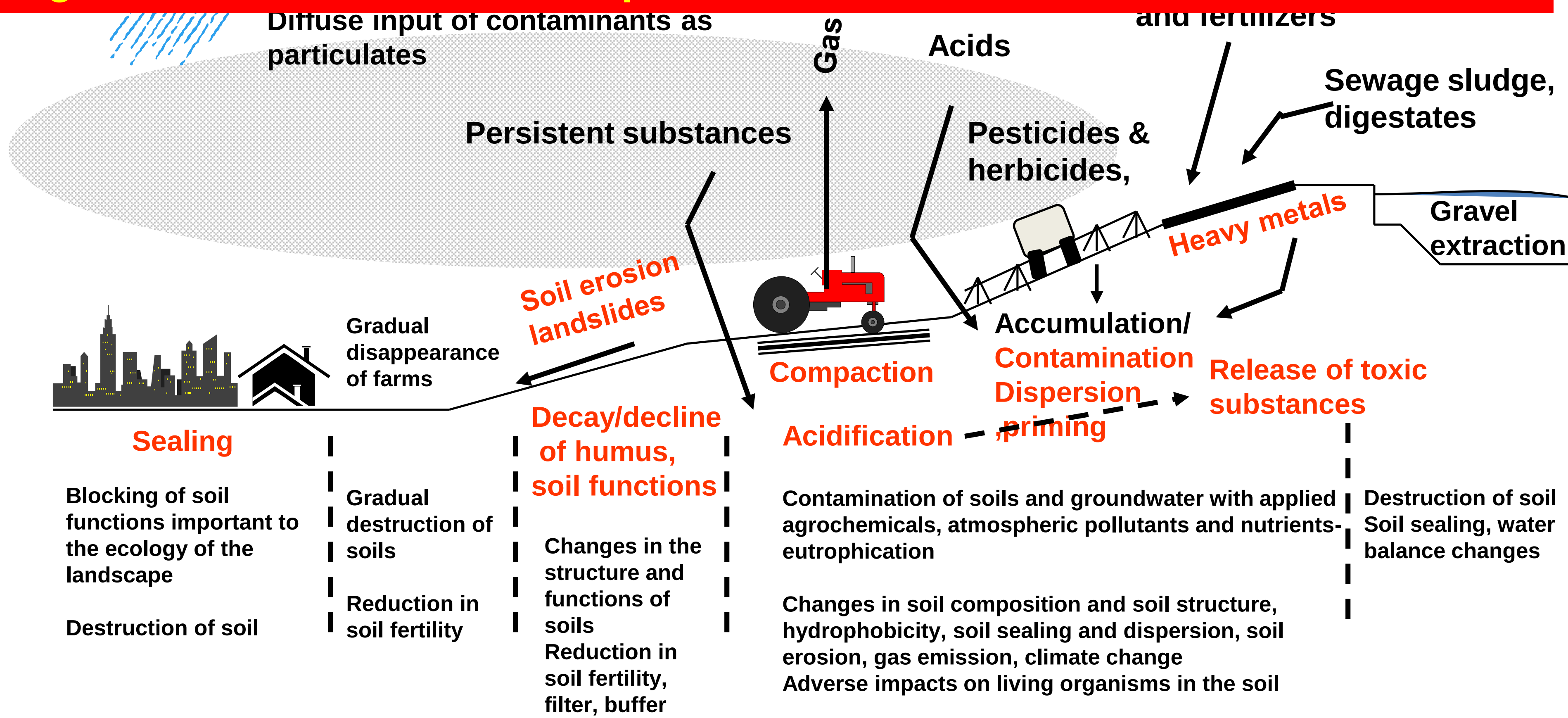
Source: Blum and Eswaran, 2004, modified

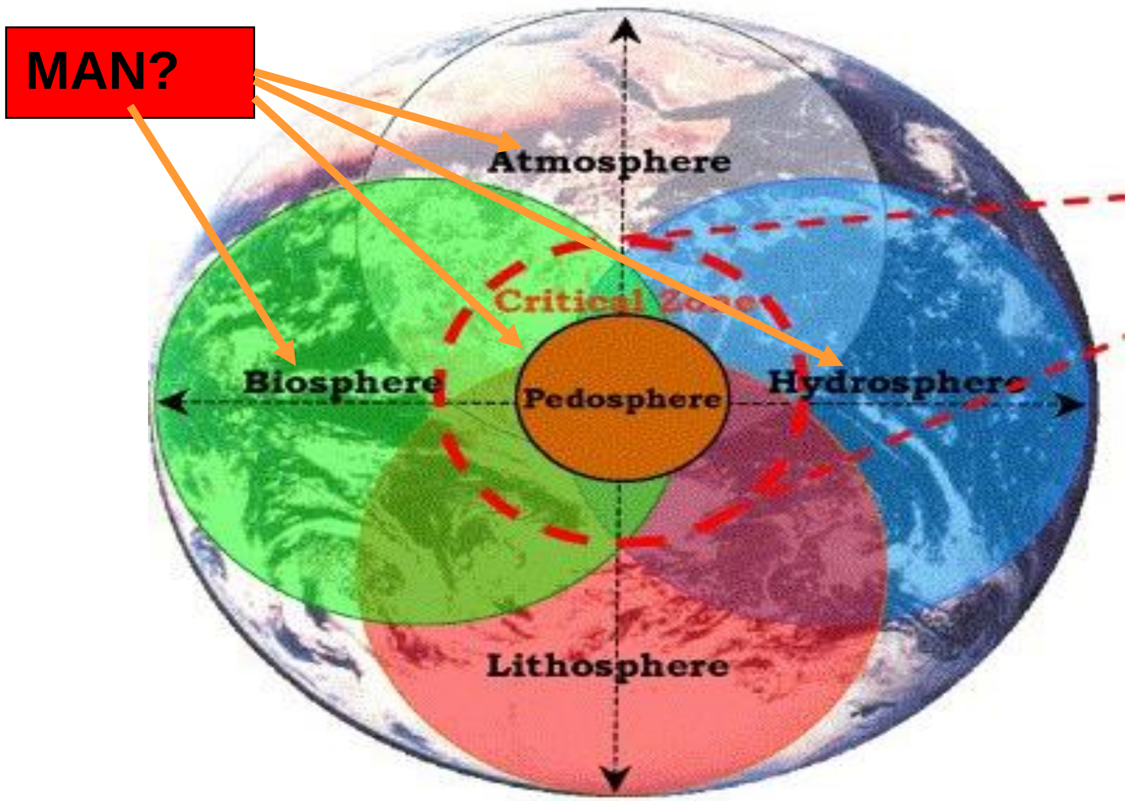




Although we know negative and often irreversible impacts of continuous human activities on soil properties and functions…..

We must define the relevance and consequences under various climatic, hydraulic conditions and for various landuse systems to avoid further degradation but maintain soil performance and resilience



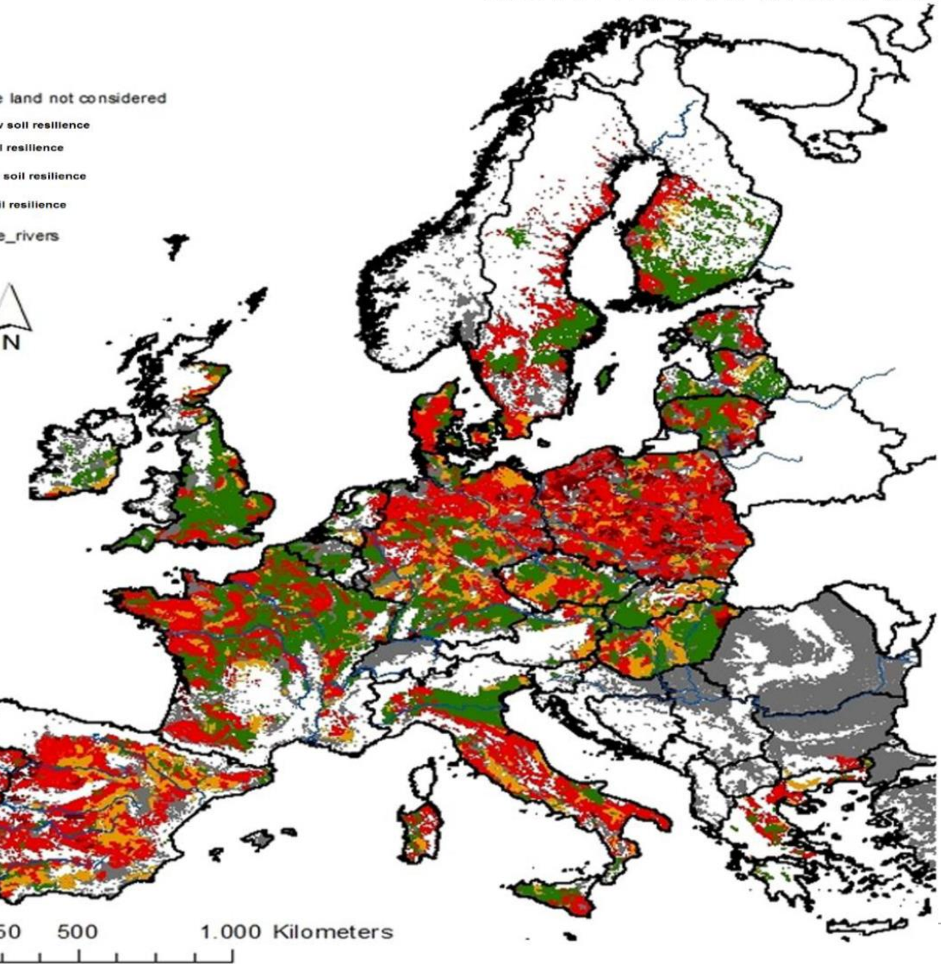


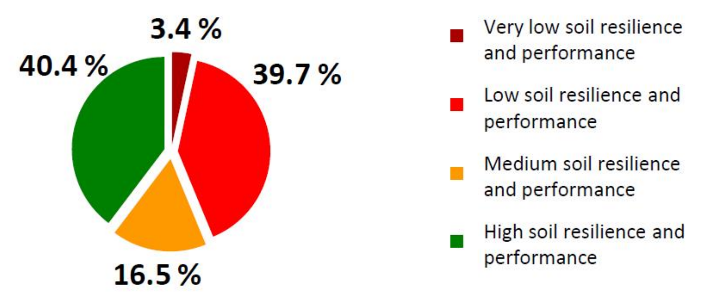
A few examples of soil sciences research approaches:

We have to quantify soil functions on **local and global scale** based on existing soil map information

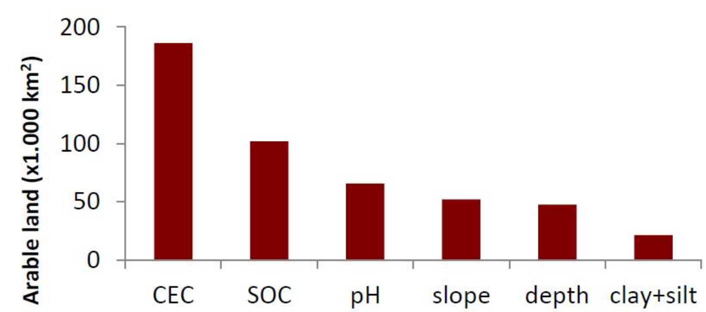
The potential of sustainable intensification of food production in Europe based on the natural resilience and performance of soils

CONTINENTAL SCALE- EU 25





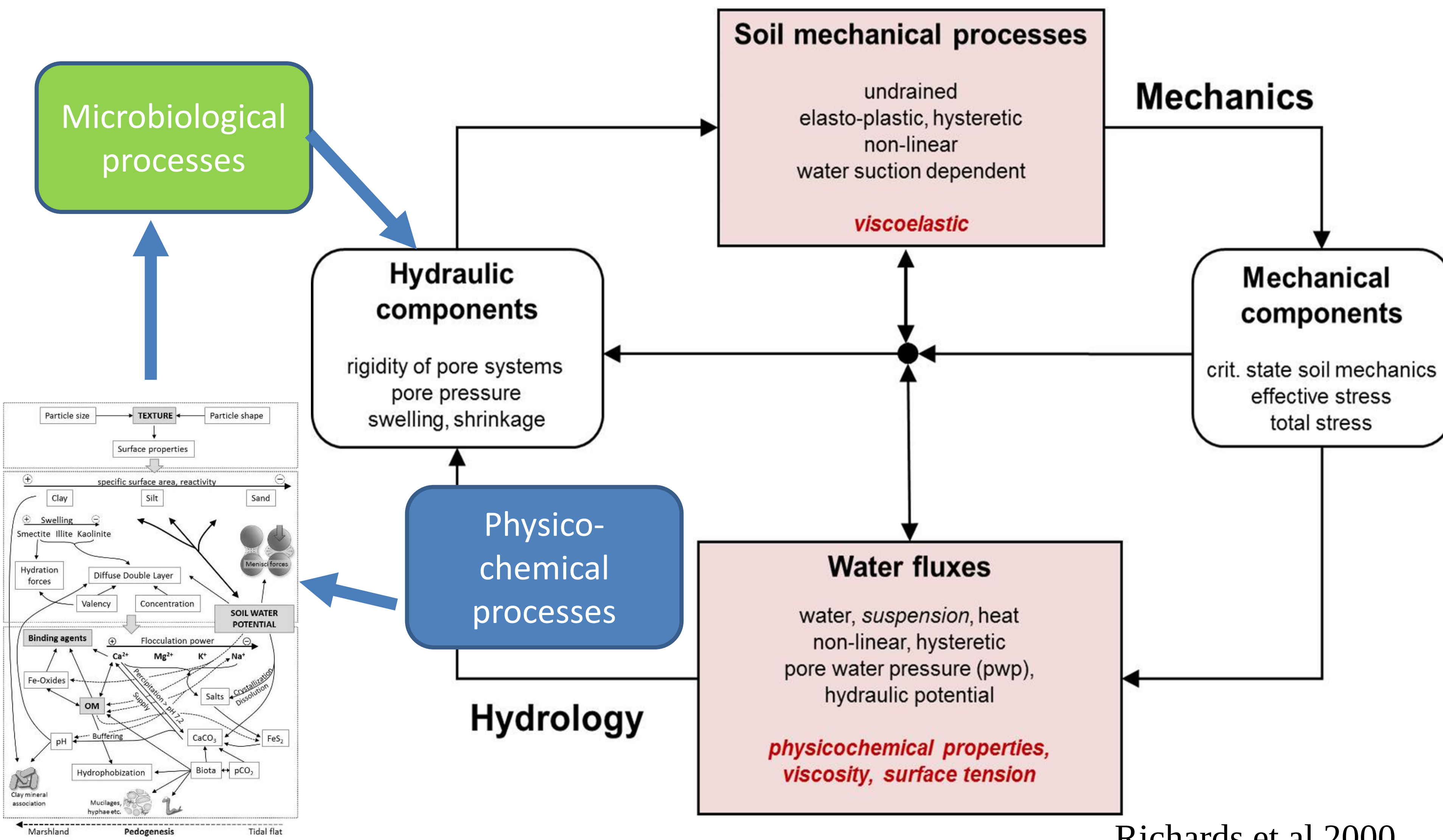
Limiting indicators on analyzed land:



Analysed arable land: 671,672 km2

Schiefer et al. 2018

Soil Processes are always coupled at all scales– the link between physical, chemical and biological processes

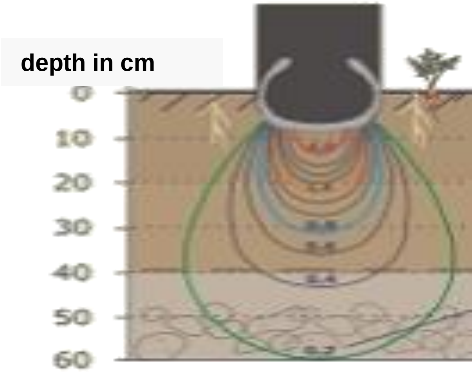


Richards et al 2000

We know and need to react: Development of the mechanical stress input in agriculture and forestry - anthropogenic effects

Increased area requires more powerful machinery

Enhanced stress intake and depth distribution



>50Mg

10,5Mg

3,5Mg

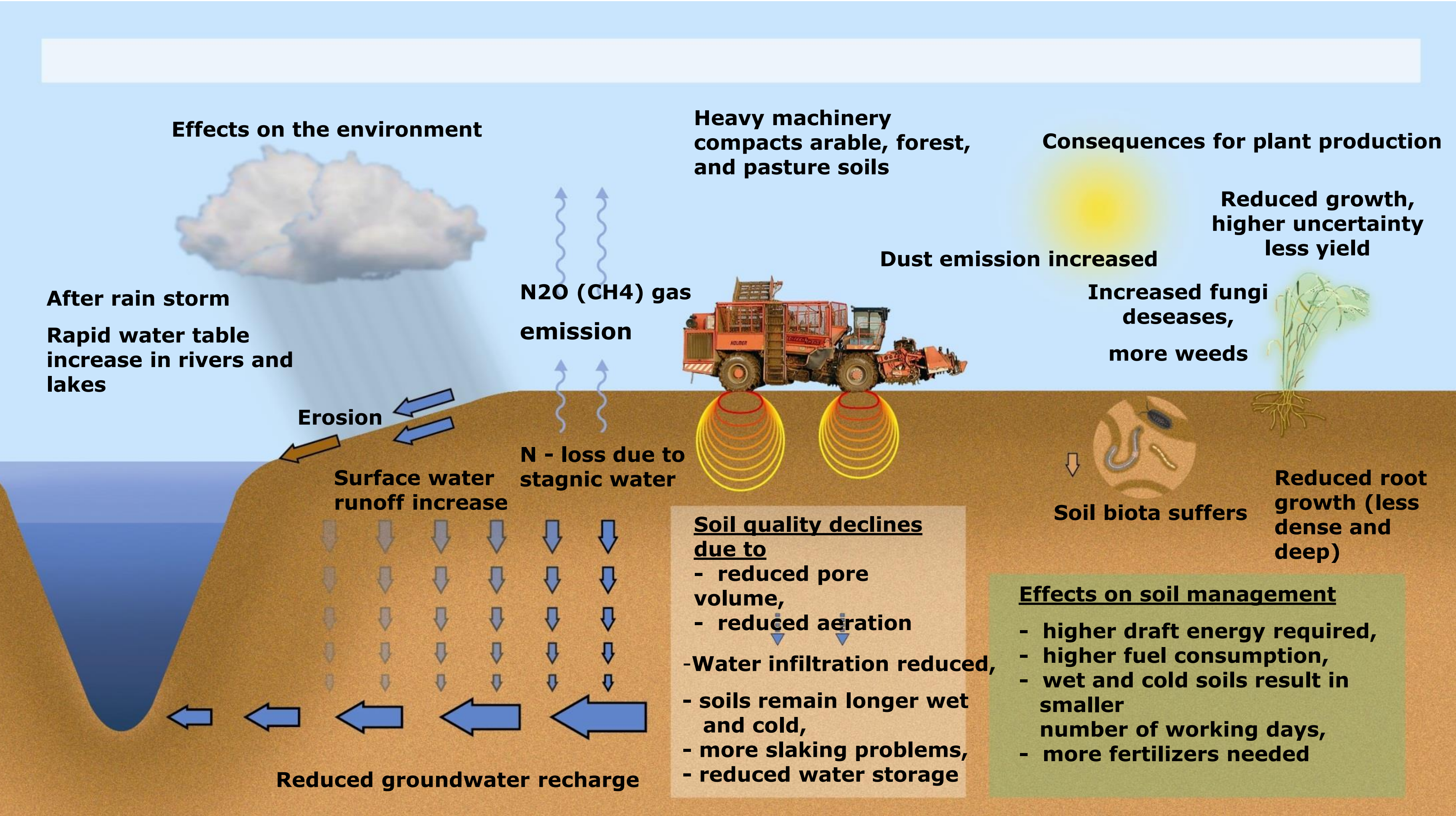
today future?

0,8Mg

about 1960

around 1900

Soil degradation due to increasing soil deformation



Consequences of climate change: topsoil drought, reduced accessibility of deeper soil, yield and carbon storage!

In short: we work also on anthropogenic influences like:

- physically: Sealing, land slides, erosion, compaction, desertification, improvement of water storage SWRT, waste deposit sealing systems, earth cable installation problems etc.

- chemically: (de-)salinization, pollution by organic and inorganic compounds, decline in organic matter, fertilizer application, liming etc.

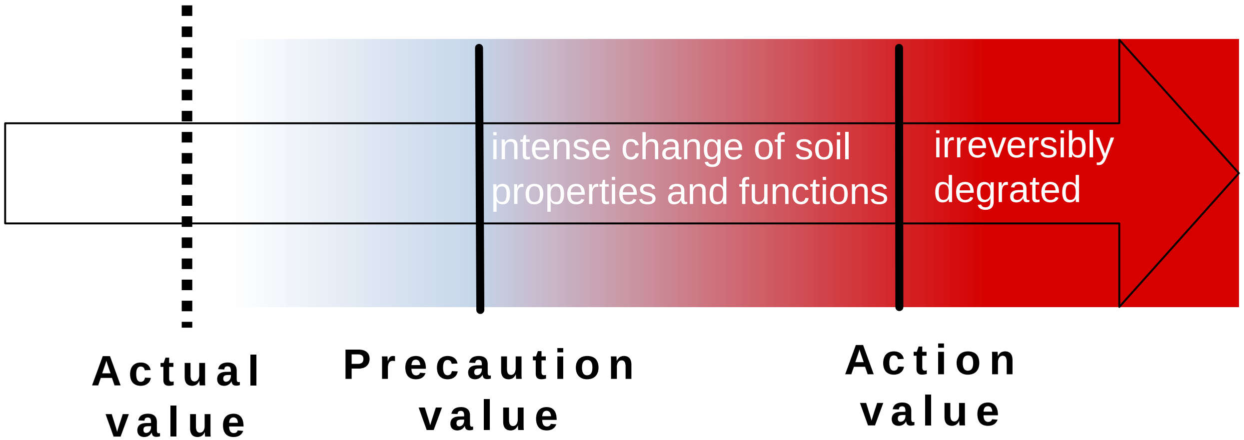
- biological: decline in biodiversity and biological activity.

Discussion of Soil Protection & Sustainable Land Management …….

….. always depends on our advanced knowledge, but also the link to the public, organisations and politicians

A few examples of urgently needed research topics: We must interest farmers, the public and politicians-

We know the relevant values for a sustainable landuse management -
we can apply our knowledge to maintain
<u>chemical, physical and biological soil properties</u>
an approach to formulate an European soil protection law



<u>Cadmium</u> (mg/kg dry matter)

- ***soil***
  (according to soil texture)

<u>Precaution value</u>:
clay: 1,5
loam/silt: 1
(at pH<6, precaution value like sand)
sand: 0,4

- exposure pathway
  soil - human

<u>Action value</u>:
- garden: 2
- Playground for children: 10
- housing area: 20
- park: 50
- industrial area: 60

Values for a sustainable landuse planning! We can prepare recommendations to formulate laws e.g. avoidance of soil deformation

Modified according to the German Soil Protection Law (1998)

In order to sustain soil properties and functions, a more site related land use and soil management strategy is needed!
We must intensify these approaches!!!

Actual value (Reference)	precaution value(PV)	Action value (AV)
Soil properties	**AC <8 Vol.%** **ks < 20 cm/d**	**AC <5 Vol.%, O2 availability** **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.

Celebration of the International Year of Soils, 2015

2015 International Year of Soils

Home | Description | Rules and Standards | Logistics | Participation and Registration | Contacts

International Field Course and Soil Judging Contest

We need to educate and to fascinate people for soils worldwide starting from the Kindergarten up to the professionals and public as partners to counteract or avoid further soil degradation

Conclusions

IUSS is able to promote:

1. Continuous development of new insights in processes in and reactions of soils under various land use, climatic and anthropogenic inputs.

   - Development of site specific management strategies including the structure rigidity as boundary condition.

2. We know, that **landuse and soil protection are not conflicting each other, if the boundary conditions are considered – soil degradation must and can be prevented because it can not be reameliorated worldwide quickly!**

3. **IUSS has the potential to deliver the essential information for a more sustainable future land management**

Many thanks for your attention

Quelle: KIEL.SAILING CITY Foto: Peters

Soil is the Central Dogma, Soil Governance requires an intense and continuous support in the 21st Century

Picture taken from Jae Yang