Daily Report - Monday September 2nd, 2013

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Introduction to soil-water relations (Kadza)

In the morning we had an introducing lecture about soil water relations.
First of all we heard something about the three soil phases:
There is a solid, a liquid and a gaseous phase.
The solid phase contains inorganic material, for example skeleton and fine soil (sand, silt, clay), as well as organic material like humus, plant roots, soil organisms, soil microorganisms and fungi.
The liquid phase consists of water with ions and DOC (Dissolved organic carbon).
The gaseous phase contains N_2, O_2, CO_2 and H_2O vapor in changing proportions.
Between the different phases, there are some interactions like exchange of ions and DOC.

In soil there is not the same concentration of the different gases like in the air: there is less O_2 because microorganisms breathe O_2 and produce CO_2.
If soil is saturated, there is a lack of oxygen and a higher amount of carbon dioxide what can lead to anaerobe conditions.

The soil water can be measured with the pressure head which is also called water potential Ψ what can be measured with a device called Tensiometer.

Here are some important states of soil moisture (in cm water column):

0 = saturated conditions
-340 = field capacity
<-15000 = wilting point (Water is unavailable to plants)

The water holding capacity of soils and also the plant available water depends also on the pore-size of the different structures.
Soil is a mixture of different particles:

Gravel: > 2 mm
Sand: 2 – 0,063 mm
Silt: 0,063 – 0,002 mm
Clay: > 0,002 mm

Clay plays an important role in soil structure, water retention and cation exchange. About 30% of clay water cannot be extracted by plants.

Water supply to plant roots

Plant roots percolate many layers of soil and play a huge role in the soil-water-plant interactions. The main functions of plant roots are:

-water uptake

-nutrient uptake

-anchoring the plant in soil

-interaction with biotic and abiotic soil environment

There are a lot of interactions between the roots, the soil-water solution and the solid phase of soil, what is summarized in the following:

Root	**Soil solution**	**Solid soil phases**
← Ion uptake	← ion exchange →	
→ H^+/OH- release	→ pH acid/base reactions →	
↔ respiration	← redox reactions →	
→ ligand	ligand exchange	
→ enzyme →		
↔		

The last topic of this lecture was the root turn over, the root distribution and architecture and finally the natural distribution of resources like light and CO_2. There are a lot of complex mechanisms and correlations between the root distribution, availability of resources and architecture of roots.

Functions of root turnover:

- renewing the fine roots
- carbon and nutrient cycling
- most important for absorption characteristics of the rooting system
- balance between fine rooting system and mortality
- fine roots construction costs 25-33% of total C invested under ground to the roots.

Natural distribution of resources:

- distribution of light and CO_2 concentration in the above ground space according to predictable gradient

- heterogeneously distributed resources
- vertical distribution: vertical gradients in soil, organic matter and infiltration of precipitation

architecture: clusters of available nutrient accompanied by preferential uptake of the seepage water
root clustering: a rule in natural soils for optimised exploitation of aggregated resources

<u>Taking samples for practical work (afternoon)</u>

After lunch break we went out on the campus to collect samples for the practical work in the following days and take a closer look on the typical flora of these locations.
At first we collected samples of uncompacted and compacted mineral soil, then we went to other place where we found organic soil and at last we took samples of sandy soil near the river Emajõgi.
On our way to this river we walked through grasslands (*Cirsium oleraceum*), which were used for recreational activities (Frisbee etc.).

On the riverbanks of the slow-flowing Emajõgi we saw old trees of willow species:
Salix alba
Salix pentandra
Salix viminalis
Salix phylicifolia

Whereas on the sandy beach we found species as:
Glyceria maxima
Butomus umbellatus
Iris pseudacorus
Thypha latifolia
Sium erectum

The high nutrient level in the water could be recognized with the presence of:
Potamogeton perfoiliatus
Phragmites australis
Nuphar lutea

Student presentations (afternoon)

1) General information about Estonia

In the first presentation we got general facts about Estonia and an overview about the typical Estonian landscape and geography, fauna, flora and climate.
Estonia is a small country in the North-East of Europe and counts about 1.4 million inhabitants. It is a very flat country with a typical hemiboreal flora. You can find about 64 mammal species including the moose. There are also about 329 bird species, especially the barn swallow, what is national bird of Estonia.

2) Vegetation zones and their sections in north western Europe

The second student presentation was a summary of a paper of Teuvo Ahti, Leena Hämet-Ahti & Jaako Jalas which was published in Acta Botanica Fennica 5 in 1968.
According to this paper, north-western Europe can be divided in three different vegetation zones:

Temperate Zone: deciduous forest consisting of e.g. beech, ash, oak, hornbeam and basswood
Hemiboreal Zone: Spruce, pine, beech, hornbeam, mountain oak, British oak, hazel etc.
Boreal Zone: Coniferous wood and frost resistant deciduous wood like meadow, birch, alder etc.
Furthermore we heard some facts about the climate, the distribution of coniferous and deciduous forests and the distribution of the forest landscape types in Estonia.

3) Rhizosphere geometry and heterogeneity arising from root-mediated physical and chemical processes

This review article, which was published in 2005 by Philippe Hinsinger *et al.* in the New Phytologist, deals with the processes which influence the rhizosphere and the soil microorganisms. It also deals with processes which are responsible for spatial and temporal heterogeneity of the soil. The article says that the rhizosphere is different from bulk soil due to biochemical, chemical and physical processes, what is a consequence of e.g. nutrient and water uptake, root growth, deposition and respiration. These processes are quite complex and are influenced by plants and microorganisms and also by the soil constituents.

4) Effects of rooting volume and nutrient availability as an alternative explanation for root self/ non-self discrimination

The next presentation was also based on an article, which was written by Linde, Hess and Hans de Kroon. It was published in the Journal of Ecology in 2007.

The article deals with three hypotheses, questioning the root mass, plant growth and root biomass production according to its dependency of the available rooting volume or to the total amount of available nutrients.