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EDUCATIONAL NETWORK ON SOIL AND PLANT ECOLOGY AND MANAGEMENT

Summer School Soil & Water 2015

Daily reports

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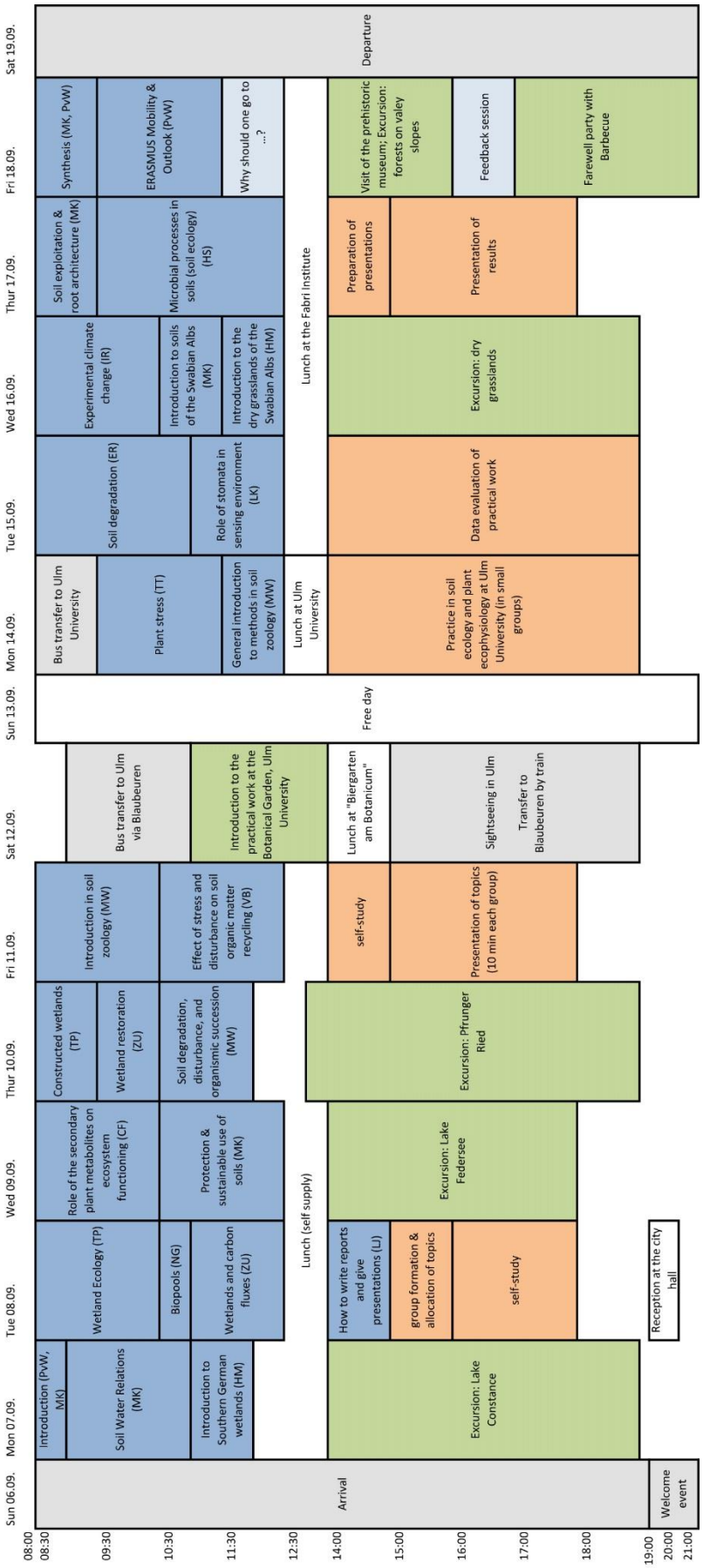
Work programme



Day 1 (07.09.2015)

Malte Aurich, Benjamin Honner, Emma Valadas

Lecturer: Dr. Philipp von Wrangell, Dr. Lena John, Prof. Marian Kazda, Prof. Hermann Muhle

Students from four different European universities, namely the Aix-Marseille université in France, Eesti Maaülikool in Estonia, University of South Bohemia in Czech Republic and Ulm University in Germany meet for the Summer School "Soil & Water". This year the Summer school takes place in Germany. For the first week we stay in the Thermalbad Center in Bad Buchau. In the second week we leave for the Fabri Institute in Blaubeuren.After a short introduction by Dr. von Wrangell and Dr. John to the Summer School in general, we started with a lecture. Prof. Kazda began to speak about soil and water relations.

There are three different components of soil: solid, liquid and gaseous phases and four textures: gravel (not important to characterize the soil), sand (well for gas exchange, but no water holding capacity), silt (good for wine, but vulnerable for erosion) and clay (well for keeping water and for ion exchange). No one of these textures alone is perfect for plant growth, the best is a mixture of all textures, called loam.

We learned about the importance of water potential for the comprehension of soil and water relations. It depends on the quantity of water in the soil which can absorbed by the roots.

It is a strategy of plants which live in dry areas to develop deep roots which can reach ground water of saturated soil layers in the ground. They also close the stomata to keep water and to stop transpiration.

Prof. Muhle talked about the history of the southern German wetlands:
The region was created by several glaciations in the ice age. After the ice melted some ice blocks stayed and caused large hollows, now called dead ice hollows. In this hollows lakes could form and with time organic materials filled up the lakes. With regional paludification especially by the growth of the peat-mosses (Sphagnum spec.) large areas were covered by bogs. These were used in the past to produce peat for burning in the local villages.
Therefore peat extraction has destroyed large part of the German bogs. Other parts were destroyed due to creation of meadows by humans for agricultural use.
Wetlands are very important for climate change because they are a good carbon sink. For this reason there are ecological organizations which try to create a market product named 'Moorfutures' . With the help of these funds they try to restore the bogs by rising the ground water level.In the Pfrunger Ried area Nature Conservation- is supporting this restoration.The rise of groundwater level in the surrounding wetlands can cause problems with local farmers. Therefore they propose to use alternative types of farming animals like Phoniac horses or "Heckrinder" (*Bos taurus*) which are better adapted to live in the swamps. However biodiversity of this reed-plant-communities will decrease. Similar wetlands will be shown on a field-trip through "Oberschwaben"ending at Lake Constance. The "Eriskirchener Ried" famous for Siberian iris (*Iris sibirica*)-wetlands was shown in summer aspects.

After the break we left with the bus to Lake Constance. The first area was a wetland meadow dominated by several sedges (*Carex spec*.) and the Purple Moor Grass (*Molinia coerulea*).

Calamagrostis stricta, the rare Purple Small-reed was also present. In the late summer aspect species like *Colchicum autumnalis*, *Lotus corniculatus*, *Mentha aquatica*, *Lycopus europeus*, *Juncus articulates*, *Succisa pratensis* were still in flower whereas *Iris sibirica* was fruiting already.

We saw that the some parts of the wetland meadow were cut to stabilize biodiversity. In former times farmers cut sedges for instance and used them as bedding in livestock. This historical form of claim is called gathering of litter or litter utilization. Also we saw some invasive species of plants, for example *Impatients glandulifera* (from Southern Asia) and *Coniza canadensis* (from Canada).

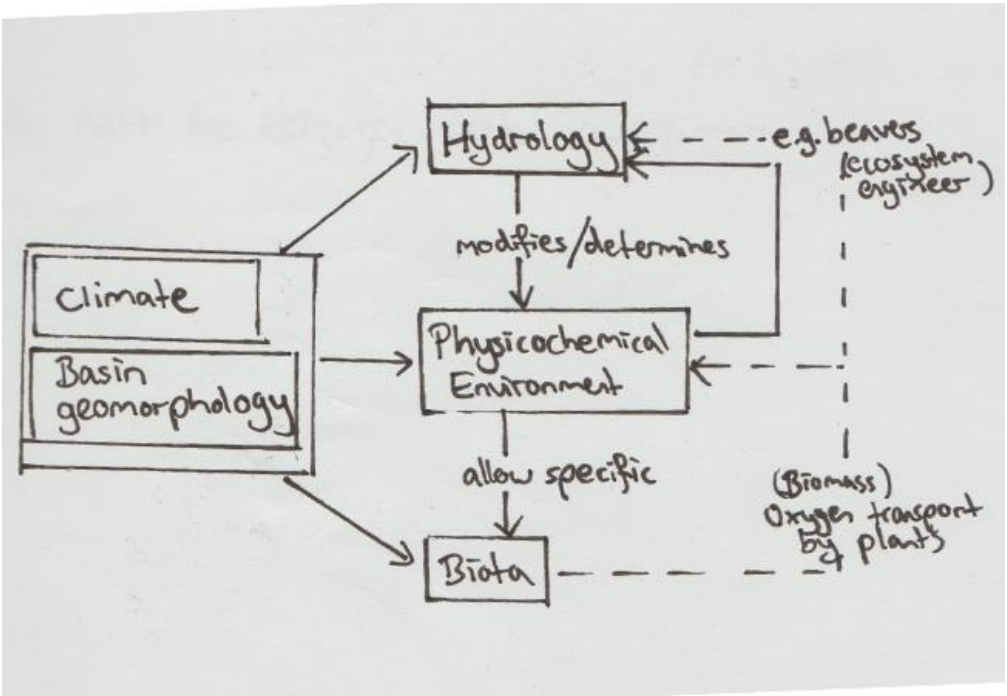
On the lake side we found an interesting shift of ecosystems, depending on the time that each of these systems spends submerged in the Lake Constance in time. Coming from the meadows in the inland we first saw a wood built up by widows and higher rising places oak trees. This area is only very seldom flooded. In the border region between land and water we saw fifty meters spanning area covered with reed. These plants are watered quite more often so trees can no longer grow except for some widows. The last ecosystem was the shallow coastal water of Lake Constance itself which is covered constantly with water. So only truly aquatic plants can exist here.

Particular species which can be observed at the lake are cormorants (*Phalacrocorax carbo*; they come to hundreds and cause problems for fish hunting), hobbies (*Falco subbuteo*) and Apollo butterflies

Daily report: 8th of September 2015

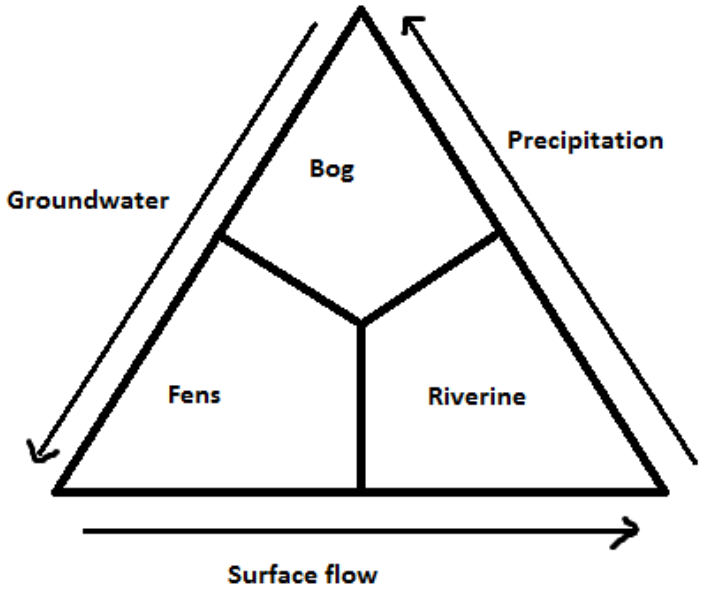
Lecture 1: Wetland Ecology by Dr. Tomáš Picek

- Examples and definition:
  - *do not have to be flooded the entire year
  - *shallow, seasonally/permanently flooded/waterlogged area
  - *supports specific vegetation
  - *6 m = officially set depth-limit for water bodies to be included in the term 'wetland' (Ramsar Convention)
  - *Examples: peat bogs, river deltas, constructed wetlands, salt marshes...
- Why important?
  - *habitat for specific animals & plants (reproduction site)
  - *carbon-sinks >> effect on global/local climate
  - *all fossil fuels (coal, oil, gas, peat) have origin in wetlands
  - *water cycle: water storage, prevention of floods, water purification, N-/P-fixation
  - *for humans (agriculture, fishing, peat, recreation building material, drinking water...)
- History:
  - *first peatlands: 300-360 million years ago (carboniferous period)
  - *at that time: tropical wet forest >> accumulation of peat, later transformed to coal
  - *tropical raised mire (recent in Indonesia) >> peat accumulation over clay >> covered by sediments >> high pressure/temperature >> coal, oil, gas
- Functioning & special features:



*periodically to permanently flooded
*source, sink or transformer for organic material
*high primary production (can even be higher than rainforests)

- Hydrology: *water input ≥ water loss (due to evapotranspiration)
  *Turnover or residence time: $t = \frac{V}{Q}$ [day] (V = average volume of water stored in wetland [m³], Q = total inflow rate [m³/day])
  *water balance equation



- Soils: *1) organic soils (contain > 12% of total C in the upper 1 m layer) >> peat
  *peat layers: Reed/Carex peat >> Sphagnum peats >> Eriophorum Sphagnum peat
  *2) mineral soils (reduced state of the minerals >> oxidation with sinking water level)
  *sandy, loamy or clay
  *gley: soil profile = water saturated for sufficient period of time
- Physicochemical conditions: *Redox potential E^0 = tendency of substance undergoing oxidation to give up electrons and gaining of electrons by the substance undergoing reduction
  *Nernst equation
  *model for processes from flooding on (decrease of organic substance (electron donor) >> O_2 reduction >> Nitrate reduction >> Sulfate reduction >> methanogenesis)
- Vegetation: *1) Oxygen transport (important for root transpiration)
  >> Aerenchyme (e.g. Juncaceae)
  >>Venturi-effect (influx of air via underpressure - through tall, dead,

broken culms)
>>Pressurization-effect (active transport)
>>Redox potential follows light over course of the day
*2) Carnivorous plants
>> *Drosera sp.* (gain N + P by catching insects >> organic matter)
*3) Sphagnum mosses
>> high water storing ability (hyaline cells)
>> cation exchange ability, low nutrient demands
>> organic metabolites prevent decay, no herbivory

- Terminology: 6 basic types
  *Swamp (trees rooted in hydric soil, not in peat)
  *Marsh (mostly herbaceous plants, rooted in hydric soil, mineral soil, no peat, usually emergent through water)
  *Bog (dominated by sphagnum moss, sedges, ericaceous shrubs, evergreen trees in peat)
  *Fen (fed by ground water, shallow peat, sedges + grasses)
  *Wet meadow (dominated by herbaceous plants rooted in occasionally flooded soils)
  *Shallow water (truly aquatic plants growing in/covered by at least 25 cm of water >> at the edges of lakes, river bays...)

<u>Special presentation: Biopools</u>

- origins in Austria/Switzerland
- = constructed wetland, sealed to underground, with biofilter
- >> water purification is done by mechanical and biological processes
- Input & output of nutrients is balanced >> bacteria & algae cannot grow so easily

<u>Lecture 2: Wetlands and the Carbon fluxes by Dr. Zuzana Urbanova</u>

- What is the use of Wetlands?
  - most productive ecosystem
  - living filter
  - element cycling
  - influence atmosphere and hydrosphere
  - food control

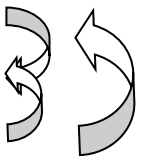
- Carbon in Wetlands
  - C basic element of life forms
  - organic and inorganic reservoirs of carbon
  - continuous interaction and exchange
  - photosynthesis fixing carbon
  - high storage potential in Wetland soils (450-700 nearly the same amount as in the atmosphere

- in the rainforest -> no storage of organic matter(no accumulation because of the high rate of decomposition)

- Carbon cycling in Wetlands
  - carbon income: Photosynthesis
  - Carbon loss: autotrophic & heterotrophic respiration, leaching
  - Carbon accumulation : When income exceeds carbon losses (oxidation very slow -> accumulation
  - NPP(Net primary production)= GPP -R_{plant} (gross primary production- Respiration)
  - NEE (Net ecosystem exchange)=GPP - Re (ecosystem respiration (plants, animals, microbes)
  - NEP(Net ecosystem productivity)= GPP- Re +/- water flow
  - C accumulates in wetlands because of slower decomposition (NPP >> Re)

- Decomposition rate is controlled by
  - hydrological regime
  - content of O_2
  - Temperature (Temp↓ ->slow)
  - quality and quantity of org. material and plant species
  - microbial activity
  - pH, nutrient content, water quality

- Variability of Carbon fluxes
  - GPP and Re are controlled by many factors
  - climate (radiation, temperature, precipitation)
  - Plant species composition (quality & quantity, root exudates)
  - Hydrology



- Wetland as a CH_4 source
  - wetlands are one of the largest natural source of CH_4
  - CH4 25 times stronger global potential than CO_2
  - Wetlands have dual impact on climate
  - Methane -> end product of anaerobic decomposition, under the most reduced condition -> when another e^--acceptor is depleted
  - CH_4 produced by methanogenic Achaea
  - Transport to the atmosphere via plants (aerenchym), diffusion, exudation
  - methane oxidation - aerobic, methanotrophic bacteria

- CH_4 Production/ Emission
  - Hydrology (aerobic /anaerobic condition)

    - trophic status (nutrients, pH, substrate availability)
    - Plant species composition (aerenchym, quality of org. matter , exudates
    - Temperature
    - (3% of NPP are pumped back as CH_4)

- Methane emissions
    - high seasonal and interseasonal ...

- Wetlands and climates
    - absorb the heat
    - global warming potential (GWP)...
    - CH_4- more effective thermal absorption
    - What will be the impact of climate change to wetlands?
    - Sea level rise-> coastal wetlands
    - higher temperatures : photosynt. ↑ respiration ↑ biomass production ↑, decomposition ↑, methane ↑ => changed composition

<u>Introduction: How to write reports and give presentations by Dr. Lena John</u>

Presentations – general comments:

- avoid too much text
- keep animations at the minimum
- simple background

Presentation of topics:

- Duration 10 min. per topic
- summary of publications
- discussed problems and methods
- what did I find interesting

Presentation of Results:

- introduction
- methods
- tables/results, tables and diagrams with legends
- discussion

Daily report:

- summary of given information

In the afternoon the following topics of the mini projects were allocated to seven student groups:

1. Soil mesofauna as Bioindicator (apl. Prof. Dr. Manfred Wanner)
2. Mesofauna und Allelopathy (Prof. Dr. Virginie Baldy, Prof. Dr. Catherine Fernandez)
3. Oxygen in wetland plants (Dr. Tomáš Picek, Anna Faußer)
4. Drought and plants (Pauline Bouche, Dr. Ilja Reiter, Liisa Kübarsepp)
5. Gas fluxes in Wetland soils (Andreas Lengerer, Dr. Zuzana Urbanová)
6. Plant nutrition and soil compaction (Prof. Dr. Endla Reintam, Dr. Martin Werth)
7. Plant adaptation to water supply (Daniel Schropp, Pia Burkhardt, Dr. Tiina Tosens)

In the evening: Reception at the City hall

Daily report of Wed 09.09.2015

1st lecture: **Role of secondary plant metabolites on ecosystem functioning (Prof. Fernandez)**

- Essential for survival but do not cover all necessary processes of the plant
- Unique, divers, adaptive, very low molecular weight,
- 3 types of secondary metabolites: Phenolic compounds, Terpenoids , Alkaloids
  → Phenolic compounds: Phenyl-Ring as a part of the chemical structure; Can be made out of many carbon-atoms
  → Terpenoids: Basic compound is Isopren (5 carbon-atoms), lipophilic
  → Alkaloids: Do not have a real basis; Nitrogen is mostly used as a basic Aaom
- biosynthesis of secondary metabolites: Mostly in Cytosol, Plastid, Mitochondria
  → Synthesis takes part in different parts of the cell and when finished, it gets trapped in the part, where it is needed (water soluble: Vacuole/ lipophilic: e.g. in trichomes)
- Function: UV protection, defence, attraction
- Allelopathy:
  "Any direct or indirect effect by one plant, including micro-organisms on another through the production of chemical compounds that escapes into the environment; it includes stimulatory and inhibitory biochemical interactions"
  Allelochemicals:
  "Secretion of plants of chemical substances which interacts with environment and possesses allelopathic activities"
- Interactions are between:
  → plant - plant
  → plant - microorganism
  → microorganism – microorganism
- Allelopathy could be considered as apart of competition.
- This process participate to the dynamic of the vegetation the ecosystem functioning and can prevent for example ecosystems from invasive species.
- Microorganisms is an important component in allelopathy processes.
- Impact on Allelopathy due to climate change will appear, because stress might Increase production of Allelochemicals
  Allelopathy may be employed in agriculture for managing weeds, insect pests and diseases in field crops or used in ecosystem restoration.

2nd lecture: **Protection and sustainable use of soils (Prof. Kazda)**

- Important Interaction between: Social acceptance, ecology, economy
- sustainable development: responsibility for future generation → soil should cover the needs of future generations as well
- soils are "non-renewable", changing in time and space and with limited quantity, but we are dealing with soil as an unlimited resource

→ Problem is the increasing demand for soil (for food, animal feed demand, fuel, fibre, construction, fun)
→ Implication for biodiversity

- Ways are needed to satisfy the increasing biomass demand
- Soil quality cannot be measured by one indicator and is not static
- Main soil degradations: erosion, decline in organic matter, contamination, sealing, compaction, declining biodiversity, salinization, floods, landslides…

Afternoon: **Excursion to Lake Federsee**

- Federsee Fen: product of the last Ice age, used to be quite large, but due to anthropogenic actions (drainage) it shrinked → people hoped to gain land for agriculture, but it failed (growing plants on the fen where not usable for feeding cattle)
- part of UNESCO world heritage since 2011
- NABU is doing the monitoring and management of the fen
- About 15000 visitors per year
- Has a high biodiversity today (orchids, birds…)
- Drainage is still a problem today, because there is still peat disappearing every year (5,2 mm/a) → CO_2 emissions
- Rewetting and restoration of the fen by locking the ditches
- Archaeological monuments

→ Species found on the walk through the Fen on the wooden footbridge (examples)

- *Phragmites communis*
- different species of *Carex*
- *Lythrum salicaria*
- *Salix aurita*
- *Solanum dulcamara*
- *Nymphaea lutea*

- *Podiceps cristatus*
- *Anas Penelope*
- *Fulica atra*

By Katharina Lutz, Ulysse Faure, Manon Peuker

Summer School Soil & Water 2015

Daily report – 10th September 2015

Lucie Pavlíková, Michaela Pocová, Karolína Kalinová

We had three lectures in the morning, they were presented by T. Picek (Constructed wetlands – CW), Z. Urbanová (Wetland restoration) and M. Wanner (Soil degradation, disturbance, and organismic succession).

The lecture was structured according to this outline:

1. What are CW?
2. What are types of CW?
3. Functioning of CW.
4. Building of CW.
5. Vegetation, advantages, disadvantages, examples of CW.

We learned pros and cons of CW as an alternative to common waste-water treatment plants. CW can be advantageous in low maintenance costs (but higher price at the beginning) and working without need of electricity. It is also a natural biotope, which cools the landscape. Enduring of floods is an important benefit, too. Large area need and quite low efficiency for N_2 and P removal belong to disadvantages.

The lecture about wetland restoration enriched us with very useful information:

1. Reasons for wetland protection.
2. Wetland management.
3. Ramsar convention.
4. Examples of restoration.
5. Drainage wetlands in comparison to restoration wetlands.

The lecture revealed the importance of wetland ecosystem services, which led to the Ramsar Convention on Wetlands. The Convention provides regulations for the protection of wetlands and says how to deal with them. The wetland restoration topic is relevant because of large melioration of the landscape in countries of the former Soviet Union in the past.

The third lecture was about:

1. Disturbance and succession.
2. Succession and community assembly.
3. Metapopulation theory.
4. Nature conservation topics – military training areas
5. Post-mining landscapes.

The use of fire and army heavy machinery in nature conservation (especially in former military training areas) is a very interesting type of management. Although it seems to be controversial among public. The maintenance of large treeless areas is very expensive, but controlled fire or army-vehicle fans event can make it cheaper and create new diverse habitats, opportunities to various organisms.

Excursion

In the afternoon we visited the Naturschutzzentrum Wilhelmsdorf with an exposition of the „Pfrunger Ried“ Moor. The modern exposition shows history and present of moors, fauna and flora and also peat extraction and its consequences.
Then we went to the „Pfrunger Ried“ Moor. Here we learned about light and opaque chambers, which are used for measuring of carbon dioxide and methane fluxes and calculation of carbon balance of the whole ecosystem.
The lady from the Naturschutzzentrum told us the advantages and disadvantages of extensive cattle breeding on wet meadows. We also spoke about the cooperation with local farmers.

Summer School 2015 - Authors: Britta Löw, Felix Biefel, Michael Kurka

Daily report 11.09.15

Introduction in soil zoology:

- soil: abiotic and biotic components
- soil is structured
- soil is important:
    - habitat and basis for organisms, regulates water and nutrient cycle
    - archive for natural and cultural history
    - source of raw materials and mineral resources
- soil contains a lot of microorganisms
- animals have a wormlike structure

What lives in a m^2 of soil (30 cm depth, central europe)?

- bacteria, fungi, algae, actinobacteria
- protozoa: flagellates, amoebae, ciliates
- rotifers, nematoda, springtails

- soil animals are mainly restricted to the upper layers containing organic matter

Why soil animals?

- Positive impact on soil structure
- responsible for soil fertility
- useful bioindicators
- understanding of political debates
- increased decomposition of organic matter
- ecosystem services
- ants, termites, earthworms -> most important ecosystem engineers
- ecosystem engineers can change their environment actively

Conclusion:

- soil is an important resource
- soil organisms are useful bioindicators
- soil organisms are necessary for soil functioning

Effect of stress and disturbance on soil organic matter recycling

- Leaf litter decomposition is controlled by two types of factors: leaf litter chemistry and environmental conditions -> Control decompostion rate
- Methods:

- Berlese funnel -> mesofauna extraction, identification and counting of organisms belonging to mesofauna
- Ergosterol: fungal biomass indicator, extraction, purification and quantification by HPLC

• Impact of plant secundary metabolites; biotic interactions, biogeochemical cycles

Presentation of topics:

Each group presented the different scientific papers they received and the topic of their following practical work.

Group 1-Soil fauna as a bioindicator

• Soil fauna is closely related to/depends on soil quality
• Soil fauna is widespread, abundant, diverse, has short reproduction cycles
• Soil fauna responds strongly to external damage/ degradation

Group 2- Mesofauna and Allelopathy in Mediterranean ecosystem

• Allelopathy is a biological process of plants, which produce biochemicals that influence the growth, survival and reproduction of other organisms.
• Those biochemicals can be either positive or negative for other organisms.
• The biochemicals with a negative influence are part of the plants' strategy against herbivory
• No significant differences in allelochemicals results between phenological stages and concentrations
• Mesofauna abundance is affected by severe drought

Group 3-Oxygen in wetland plants

• Oxygen is important for all plants, but wetland plants need special adaptions to transport oxygen due to the lack of oxygen in their environment.
• Gases move by diffusion or by through-flows
• Radial oxygen loss (ROL) is the flux of oxygen from the aerenchyma

Group 4- Drought and plants

• different water potential between soil and root as well as between leaves and atmosphere
• what happens without water supply: water absorption is more difficult, embolism, microorganisms and fungi get destroyed, breakdown of photosynthesis
• stomata closure and osmotic adjustment as short term adaptations; deeper root, reduction of biomass, enhancement of hydraulic conductivity and low cavitation risk as long term adaptations
• stomata closure gets regulated by phytohormone ABA

Group 5- Gas fluxes

• Different methods for gas flux measurements
• Gas fluxes are sensitive to temperature, variable
• The management of the wetland impacts the CO_2 fluxes

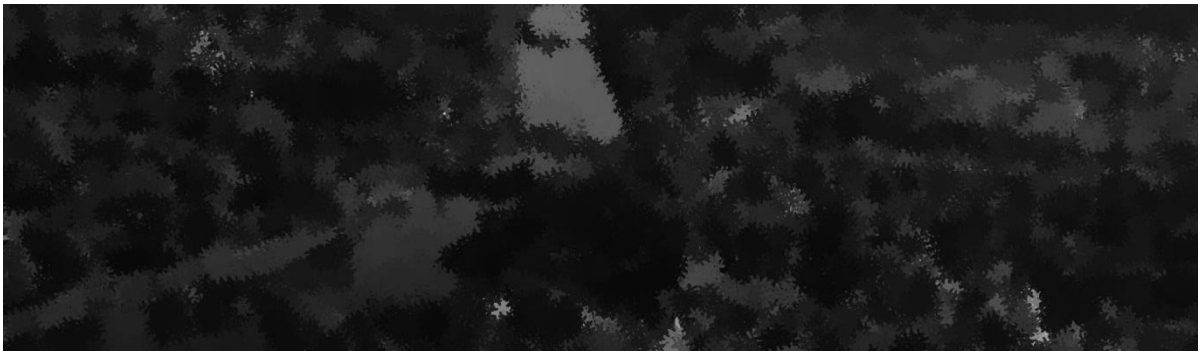
Group 6-Plant nutrition and soil compaction

• Manure essential for nutrient uptake

Group 7- Plant adaptation to water supply

• conservation: connecting fragmented populations
• plant reaction: isohydry or anisohydry
• Life forms might have a better ability to adapt to the extreme conditions than scientists had thought
• Trees grow relatively slow but can die quickly

DAILY REPORT: Saturday 12th of September 2015



This Saturday we left Bad Buchau to the University of Ulm. The day started with a tour into the Green houses of the Botanical Garden of the University. Marian Kazda gave us informations about typical tropical plants and the fragile ecosystem accompanying them.

We learned more about the use of green houses which were, by the time they were invented, a great invention. They allowed to preserve and to grow exotic plant species, such as oranges, vanilla, cacao and spices.

Then we walked through the Botanical garden where we've seen :

Medicinal plants and herbs
Different types of forest
Green class room for school education
Seasonal garden
Wetland structure and plant adaptation
Historical three-field agriculture and crops rotation
Artificial stream
We had lunch at the Beer garden at the Botanical

Garden. During the afternoon most of us decided to explore Ulm and to visit some touristic places:

- The Ulmer munster (with 162m height it is the highest church tower in the world)
- The Fishermans quarter and the old part of the city
- Dinner at a local swabian restaurant

Finally we took the train to Blaubeuren to end the day at the Heinrich Fabri Institute.

Daily report 14/09/15

1) Plant stress, Tiina Tosens

The aim of this course

- Concept of stress plants
- Mechanisms to response of stress
- Multiple plants reaction depending on their environment

Introduction of metabolism of plants

What are the most important factors they needed a plant for the photosynthesis?

- Water
- Radiation (400 – 710 nm)
- CO_2
- O_2
- Temperature

Definition of stress

It is a biotic or abiotic factor that decrease the ratio of physiological process below the maximum rate that the plant could otherwise sustain (Figure 1).

There are 2 types of stress:

- Biotic (diseases, herbivory, competition)
- Abiotic (temperature, water, radiation, chemicals influences, mechanical influences…)

We observe different types of response to stress (Figure 2).

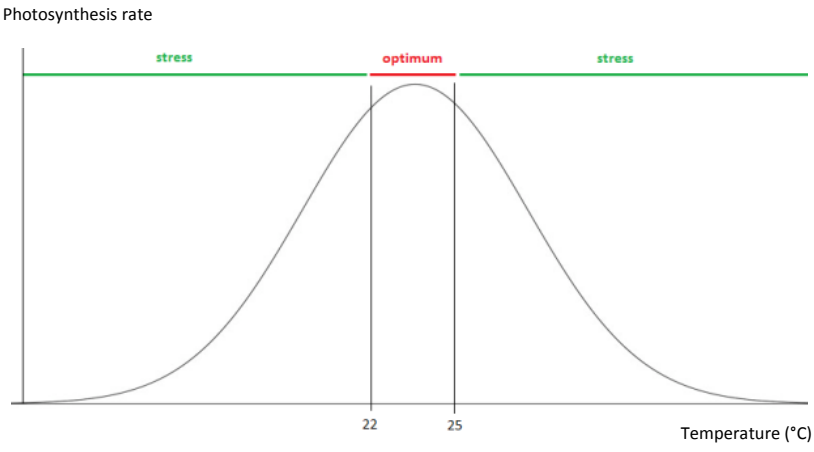
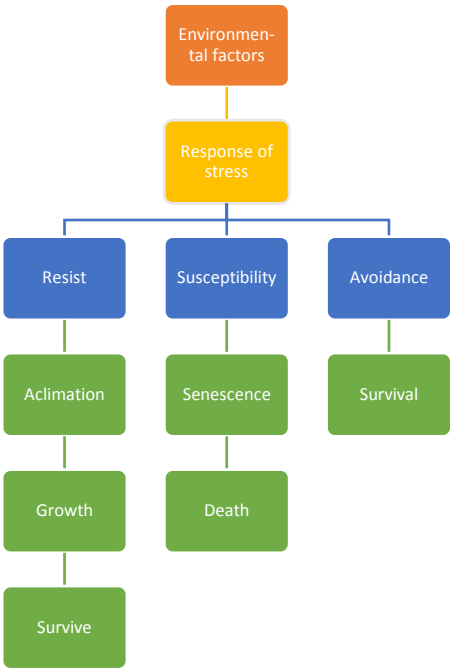


Figure 1: Optimum temperature (°C) for photosynthesis



The biotic and abiotic factors keep on changing on the spatial-temporal scale (biomes and evolutionary time; Figure 3).

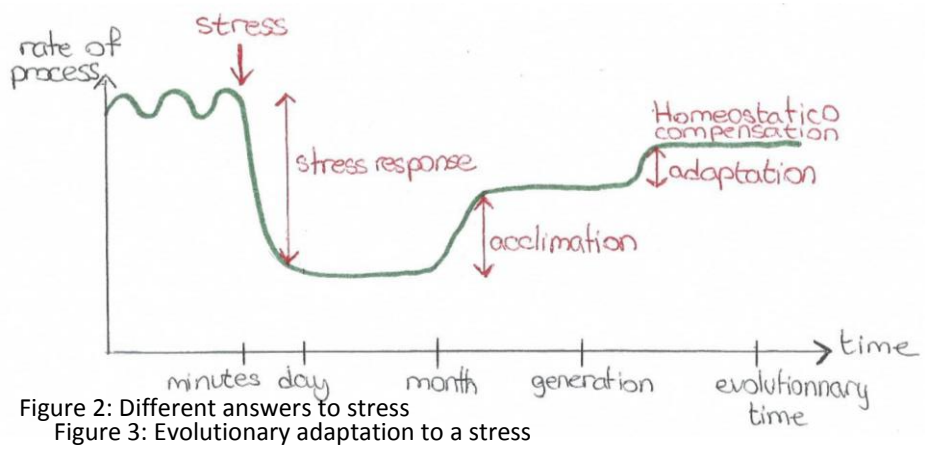


Figure 2: Different answers to stress
Figure 3: Evolutionary adaptation to a stress

Conclusion

To maintain the species through time, plants must constantly adapt but adaptations have a cost and the plant should strike a balance between the cost of adaptation and the benefit it will derive.

2) Methods in soil zoology, Manfred Wanner

The problem with studying animals in soil is that we need a lot of different methods for sampling them. You can find two different types of sampling, in the field and in the laboratory, depending on the species, biological cycle, the location of the sampling, the cost and the duration of the method.

3) Practical work

During the afternoon each group went with their supervisors to do their practical work.

Practical works and supervisors:

1. Soil zoology – field sampling, with Manfred Wanner.
2. Soil zoology – Mesofauna of the Mediterranean, with Virginie Baldy and Catherine Fernandez.
3. Oxygen in wetland plants, with Anna Faußer, Tomas Picek.
4. Drought and plants, with Ilja Reiter, Pauline Bouche.
5. Gas fluxes in wetland soils, with Andreas Lengerer, Zuzana Urbanová.
6. Plant nutrition and soil compaction, with Martin Werth, Endla Reintam, Marian Kazda.
7. Adaptation of plants to water, with Daniel Schropp, Tiina Tosens, Pia Burkhard.

Daily report 15.09.2015

By Katharina Eckel, Sarah Fritsch and Yi-Ling Kao

Soil degradation – Endla Reintam

Soil degradation is when soil deteriorates because of human activity and loses its quality and productivity

- Important to talk about, because the amount of land for agriculture is limited
- Cumulative productivity loss over the past 50 years

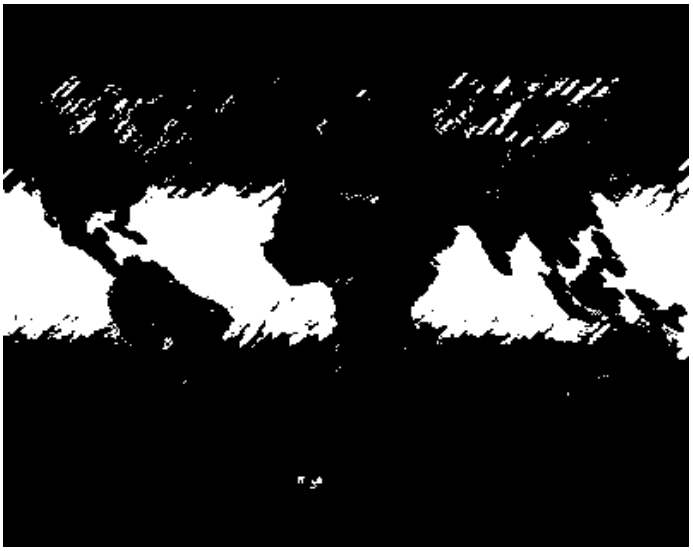


Fig.1: Distribution of the soil degradation over the world

Main threats:

- *Erosion* = group of processes by which material is removed from any part of the earth surface by water, wind, ice, snow or other
  - Causes: inappropriate agriculture, deforestation, forest fires, overgrazing,…
  - Stop: ploughing style-contour farming, strip farming, cover crops, no-tillage

- *Soil sealing* = covering of the soil surface with an impervious material or the changing of its nature so that the soil becomes impermeable
  - Stop: no

- *Soil contamination* = contamination of soil with heavy metals, mineral oil,..
  - Causes: Diffuse sources (atmospheric deposition, flowing water, application)
    Localized sources (industrial plants no longer in operation,..)

- *Soil salinization* = accumulation of salt on or near the surface of the soil, results in completely unproductive soils
  - Causes: incorrect irrigation, increase of water table, drought events

- *Decline of organic matter* = reduction of C_{org} content compared with earlier

- Causes: cultivation, deep ploughing, overgrazing, soil erosion, drainage
- Stop: use of manure/slurry, green manure, straw-NB, reduced tillage

- *Soil compaction* = occurs when soil particles are pressed together, reduce pore space between them
  - Causes: raindrop impact, tillage operations, wheel traffic, minimal crop rotation
  - Stop: reducing pressure on soil, use of trafficability map

➔ Best protection for the soils are the plants!

The role of stomata in sensing the environment – Liisa Kübarsepp

Stomata:

- Mostly on the lower surface of plant leaves
- Enables gas exchange between plants and atmosphere
- Maintain balance between water loss and CO_2 entrance
- Various shapes and sizes (kidney or dumbbell shape)
- Smaller ones have a faster conductance

Drought adaptations:

- CAM plants open stomata at night
- Sunken stomata adapted to low air humidity
- Drought adapted leaf morphology (hair, bended leaves etc.)

Measurement:

- Water content change in air entering and leaving the measuring equipment (e.g. infrared gas analyzer) is measured and from this stomatal conductance is calculated

Reactions of stomata to environmental changes:

	stomata	
Low soil water	close	Because of abscisic acid
Low air humidity	close	Helps to avoid wilting
Light	open	Blue light has stronger impact, than red light
Low CO_2 level	open	Helps gas exchange
Pollutants (O_3)	(open)	Causes oxidative stress, slower reaction of stoma conductance

In the afternoon there was the data evaluation of the practical work and every group worked together with his supervisor.

Report
September 16, 2015

Annika Jõemaa
Kaarel Kilki
Deborah Cabes

LECTURES

1. **Experimental Climate Change by Ilja Reiter**

Definitions of what is change, Global change, and Climate change?

Change is:

- Steady state
- A dynamic aquilibrium
- Pseudo-steady-state or quasi-steady-state
- Steady (hange), unsteady, transient

Exeprional warning is in the range of 0,3-6˚C.

Experimental methods applied for temperature studies: Electrical heat resistance ground cables; greenhouses, vented and unvented field chambers; overhead infrared lamps; passive night-time warming

Results of global warming experiments: Experimental warming in the range of 0,3-6,0˚C increases rates of soil respiration, net N mineralization and above ground plant productivity.

FACE vs Chamber studies:

- ✓ Same: CO_2 assimilation, growth and above ground productivity increase stomatal conductance, specific leaf area decrease.
- ✓ Different: In FACE trees are more responsive than herbaceaous species; Grain crop yields increased far less than in chamber studies.

Elevated CO_2 effects on the soil comparment: More C entering the soil; additional substrate is metabolised by soil microorganisms; huge variability in microbial biomass, N mineralization.

Examples of precipitation manipulationexperiments

Different type of precipitation manipulation experiments can be:

1. Precipitation is lower than world average and the same time temperature and CO_2 concentrations are the same as world average.
2. Precipitation is higer (temperature and CO_2 are same)
3. Precipitation is lower (temperature varies and CO_2 is the same)
4. Precipitation is higher (temperature varies and CO_2 is the same)
5. Precipitation is lower (temperature is the same and CO_2 varies)
6. Precipitation is higher (temperature is the same and CO_2 varies)

CO_2 and temperature are increasing, but no change in global precipitation.However, .dry regions will be dryer and wet regions will be wetter. I think these two different regions will be balancing each others so overall average of clobal precipitation will not change.

Multifactorial experimental studies

Climate change is multifunctional, i.e. CO_2, temperature, precipitation, humidity, ozone, radiation are expected to change at the same time. Responses to simple combinations of single fator differ greatly from single factor responses.

What are current and future challenges for experimental climate change studies?

The challenges are with measuring the results and making conditions good enough for the experiment.

2. **Soils of Swabian Alb by Marian Kazda**

Soil types of the Swabian Alb:

- ✓ **Rendzina-** Limestone+ Organic material (humus) pH~7
- ✓ **Regosol-** Limestone + impurities (glay)+ org (humus) pH ~7
- ✓ **Rendzina-**Cambisolbuilding of clay minerals + Humus pH< 6
- ✓ **Terra rossa–**clay(relictic), redish colour through limestone
- ✓ **Luvisol-** redistributes glay down in the profile
- ✓ **Gleyic luvisol-** high clay content leads to stagnant waterwhich causes a lack of oxygen for plants

3. **Introduction to the dry grasslands of the Swabian Albs by Hermann Muhle**

Hermann Muhle presented some plant communities grazed by sheep on the Swabian Alb. These grasslands are rich in terrestrial orchids. Especially in the valley of the Blau river harbor several de-alpine plants which are considered relictic can be found (continuous plant-distribution during ice-ages: e.g. *Draba azoides, Hieracium humile, Aster Amellus*, *Pulsatilla vulgaris, Serratula tinctoria, Saxifragia paniculata,* etc.). Furthermore he indroduced the Nature Conservation sites of the „Schloßberg“ close to Schelklingen. Although the grassland was heavily grazed at the end of the summer the typical „Mesobrometum“ species could be shown.

4. Excursion: dry grasslands

First we went to Schelklingen by train and started our 15 km walk back to Blaubeuren.

Places, we visited:

- Tower of the castle
- Different forests (Conifer, broadleaf)
- Jurassic rocks“Kissing pigs“ in the Blau Valley
- A passway from the 18’th century

Different topics:

- Zoology- snails (*Helix pomatia*), insects (beetles)
- Plants- slope plants, wetland plants, alpines plants (*Fraxinus, Bromus erectos,Thymus vulgaris, Allium montanum etc)*
- Forest- natural (Bannwald) or artificial
- Geology- lack of water, valleys
- Soils (*Leptosols*)

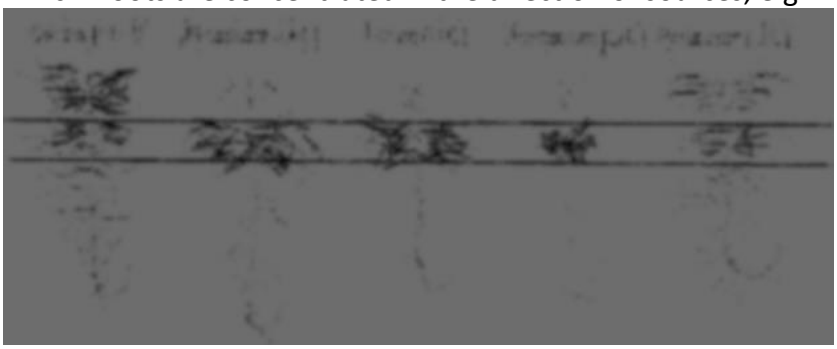
Daily report 17.9.2015

Summer School Soil & Water

Soil exploitation and root architecture, lecture by Prof. Dr. Marian Kazda (8:30 - 9:30)

Introduction to root functions

- water, nutrients, stability, biotic and abiotic interactions
    - roots are concentrated in the direction of sources, e.g.:



- roots can have herringbone/dichotomous-like structure

Microbial processes in soils, lecture by Prof. Ing. Hana Šantrůčková (9:30 - 12:30)

- Soil microorganisms as a part of soil organic matter (5 % of soil is organic matter – Soil organisms ~ 7 % → Soil is alive)
    - The highest abundance in upper soil layers (up to 90 % in upper soil layer)
    - Microbial physiology and growth (complicated metabolic pathways, aerobic x anaerobic metabolism, osmosis, homeostasis (ratio C/N, C/P, P/N), substrate (CO_2, organic matter), enzymes, ecological stoichiometry)
- Main factors affecting microbial processes (moisture and temperature)Effect of seasonality and soil heterogeneity (microbial activity occurs even under the snow)
- carbon, nitrogen and phosphorus cycle in the soil (90 % of carbon and nutrient transformations are carried out by microbes)
    - respiration and biosynthesis in C cycle, priming effect
    - main processes of N transformation in soil (mineralization, nitrification, denitrification N_2 fixation)
    - P transformations, availability and dependency on pH

Presentation of results by student's groups (15:00 - 18:00)

In the afternoon, the seven groups presented their results of the practical work:

1. Group No. 6 – Plant nutrition and soil compaction
2. Group No. 7 – Plant adaptation to water supply
3. Group No. 4 – Drought and plants
4. Group No. 2 – Allelopathy in Mediterranean plants
5. Group No. 1 – Soil zoology

6. Group No. 3 – Oxygen in wetland
7. Group No. 5 – Gas fluxes

SUMMER SCHOOL 2015 "SOIL & WATER"

DAILY PROTOCOL REPORT

Friday, 18.09.2015

Daily Report Participants: Nnamdi Okeke, Ann Inger Kari, Maria Mäeorg,

- **Synthesis (MK, PvW)**

Prof. Dr. Marian Kazda started the day by briefing the daily activity to the participants of the program. He went on further to ask, "Questions on what was learnt and what was interesting for us within the two weeks?" Also, he did a brief review on what we saw on the wetlands, e.g. peat. He asked, "What we do with wetlands?" and "What's the driving force for the use of land?"

Prof. Kazda asked the following questions:

- What are the processes in a peat?
- Why is the emission of methane from peatland not high just like in the biogas producing facility?
- Are plants important for the methane oxidation?

Later there was a short summary on the good and bad of the practical works and also on the excursions and the students participated with their suggestions and questions before Prof. Kazda's session timed out.

- **ERASMUS mobility and outlook (PvW)**

This session was coordinated by Dr. Philipp von Wrangell and he spoke about the ERASMUS program. He cited the advantages and disadvantages of a study abroad: experience, cultural integration, learning a new language as the pros and possible problems such as not following up with the academic program at the home university, difficulties in recognition of the courses/credits gained abroad by the home university.

Further, teachers from the participating universities presented their field of focus and research topics in their group and what they're working on. They explained the possibilities of joining them in either the research or university studies.

- **Why should one go to…?**

In this session, students from the participating universities of Aix Marseille University (France), Estonian University of Life Sciences (Estonia), University of South Bohemia (Czech Republic) and Ulm University (Germany) had their presentations on why one should visit their country and to come to their university.

Figure 1: Presentation by Czech students

This session ended with a presentation from a Taiwan student: Yi Ling Kao, who also told us why we should visit Taiwan, highlighting the strength of her country.

- **Visit of the prehistoric museum and Farewell party with barbecue**

Inside the museum, our guided tour by Iris Bohnaeker presented us artefacts on human settlements especially around the areas of the town Blaubeuren and explanations on what happened during the ice age. Important artefacts seen include: Venus of Hohler Fels, the oldest female statue made of mammoth ivory etc.

We ended the evening socializing with a barbecue on a hill, having a very nice evening, tasting local products around a bonfire. There also was a feedback session coordinated by Dr. Ilja Reiter collecting impressions by the students on selected topics such as lectures, excursions, internationality, organisation.