WATENV – Water, Soil and Vegetation

Lecture 4

4.5. Vegetation at springs

- The great diversity of spring habitats makes a vegetational study difficult.
- First, all natural locality factors have to be analyzed in order to classify spring habitats.
- A first criterion is the elevation of the spring
- There are distinct differences between montane areas and lowlands
- It is often necessary to further distinguish the springs, as springs in the lowest lowlands can be different from those surrounded by low hills.
- In **carbonate springs**, the pH value is buffered.
- A very high calcite content leads to the formation of sinters.
- Such **sinters** can be of biogenic or abiogenic origin.
- They are mostly formed due to a reduction of the CO_2 partial pressure resulting from the discharge of the water, assimilative CO_2 extraction or a reduction of the solubility of CO_2 with increasing water temperatures
- Calcium carbonate is precipitated as **travertine**. Such localities are usually poor in species and are being inhabited by calcobiontic specialists.
- Next to the carbonate content, springs can be defined by other chemical properties.
- Salt concentrations in **brine springs** are so high that only extremely halobiontic species can be found that usually live in brackish waters or in marine environments.
- Important plant communities of rheo-, helo- and limnokrenes, sorted by elevation, light conditions water hardness and pH; M = moss-rich communities; A = algae communities; light factor (L): O = open country; W = forest; elevation (H): pl = planar, mo = mountane, hm = high montane, alp = alpine:

	H	L	Hard/ basic water	Soft, acid water
Rheokrene	pl/mo	W	---	---
		O	- *Cochleario pyrenaicae-Cratoneuretum commutati* (auch halbschattig) **M**	- *Hildenbrandietum rivularis* **A**
	hm/alp	O	---	- *Scapanietum undulatae* **M** - *Scapanietum uliginosae* **M**
Helokrene	pl/mon	W	---	- *Chrysosplenietum oppositifolii* - *Brachythecium rivulare*-Bestände **M** - *Caricetum remotae* - *Equisetum telmateija*-Bestände - *Cardaminetum flexuosae* - *Caricetum fuscae polytrichetosum*
		O	- *Cratoneuretum filicino-commutati* **M** - *Eucladietum verticillati* (trocken) **M** - *Catascopietum nigritii* (quellig) **M** - *Nasturtietum officinalis* **> Caricetalia davallianae**	- *Philonotido fontanae-Monietum rivularis* **M** - *Stellario alsines-Montietum rivularis* - *Cardamine amara*-Basalgesellschaft - *Ranunculetum hederacei* (atlantisch) **> Caricetalia nigrae**
	hm/alp	O	- *Cratoneuretum filicino-commutati* **M** - *Cratoneuro-Arabidetum bellidifoliae* **M** **> Caricetalia davallianae**	- *Bryo schleicheri-Montietum rivularis* (kalt) **M** - *Cardamine amara*-Basalgesellschaft - *Cratoneuro-Philonotidetum seriatae* **M** - *Mniobryetum albicantis* **M** - *Philonotido-Saxifragetum stellaris* **M** **> Caricetalia nigrae**
Limnokrene	pl/mon	W / O	- *Nasturtietum officinalis* - *Groenlandietum densae* - *Hippuris vulgaris* mod. fluv. -Ges. - *Ranunculo trichophylli-Sietum submersi* - div. Characeen-Bestände **A** - *Ranunculetum hederacei* + Marginal communities of the helokrenes	- *Fontinalis antipyretica*-Best. **M** - *Potamogeton natans*-Ges. - *Nitella* sp.-Bestände **A** + Marginal communities of the helokrenes

- In siliceous, shadeless to half-shaded rheokrenes of the planar to montane level, vascular plants are absent.
- Crust-like cryptogams are present, like the red algae *Hildenbrandia rivularis* with its noticably red thallus on and beneath rocks in cool, fast-flowing and CO2-rich waters.
- Red crust of *Hildenbrandia rivularis* and black to dark green coating of the water lichen *Verrucaria* sp. on sandstone rocks in a fast-flowing low mountain range stream.
- *Ranunculo trichophylli-Sietum submersi* or *Groenlandietum densae* almost always dominate deep, permanently water-bearing limnokrenes

- Monotonous stocks of *Hippuris vulgaris mod. fluviatile*, *Potamogeton natans*, *Fontinalis antipyretica* or diverse characeae
- Shallow springs are characterized by submerse and emerse elements of stream reeds, like *Mentha aquatica*, *Apium nodiflorum* or *Nasturtium officinale*

5. Streams

5.1. Differences between rivers and creeks

- Creeks can be defined as streams with a relatively low water depth and a small cross-section. This results in strong interactions respectively border effects between water body, stream bed, shore and adjacent shore vegetation
- **Water and shore vegetation** are mostly in direct contact
- At natural streams, shoreline trees cover the stream with a canopy, reducing the **availability of light** for hydrophytes
- In contrast to that, the bigger **cross-section of rivers** leads to a lesser importance of shorelines
- Shore vegetation can only shadow marginal parts of the stream, which thus receives a lot more light than creeks
- The central, deep parts of rivers are often devoid of macrophytes due to currents and endogenic lack of light
- **Mountain river** with near-natural structure of shore vegetation (*Salicetum triandro-viminalis)*. Softwood alluvial forest, Saale

5.2. Outlining and typing of streams

- Each kind of typing respectively classification serves to sum up diverse water bodies in classes with comparable objects
- This is done by defining the respective similarities or specific uniquenesses within type classes and differences between type classes
- From case to case, identical water bodies can be classified differently if specific hydrological, hydrochemical, morphological, lithological, limnological or hydrobotanical features are intended to be emphasized – alone or in combination
- An **outlining** in ecological zones, both for the water body‘s cross-section and longitudinal section, at first follows primary, abiotic environmental factors and secondarily the respective biocoenoses
- Thus it can be executed independently from the landscape
- On the other hand, a **typing** of streams should always incorporate the landscape
- Thus it should include the natural space and regional potentials
- Locality-specific primary or secondary vegetation units respectively biocoenosises along the water body must be regarded
- In the following five subchapters, examples of stream outline features will be given:

5.3. Outline feature 1: Stream geomorphology

- At first glance, **valley forms** seem to have only minor influences on hydrophytes
- Width and shape of the valley bottom can have relatively far-reaching influences on potential growth places of macrophytes, though
- Slope, course of streams, valley morphology and alluvial floodplain development influence width and depth of the stream bed, the creation of current-poor zones, the shore development respectively stream course development and the possibility of bursting of a river‘s banks during flood events
- They control the kind of shore vegetation as well as its scope and distance from streams. Thus they influence the degree of shadowing, availability of light and temperature household of the water body
- Moreover, they control the maximal stream velocity during flood events via the size of the retention space

5.4. Outline feature 2: stream cross-sections

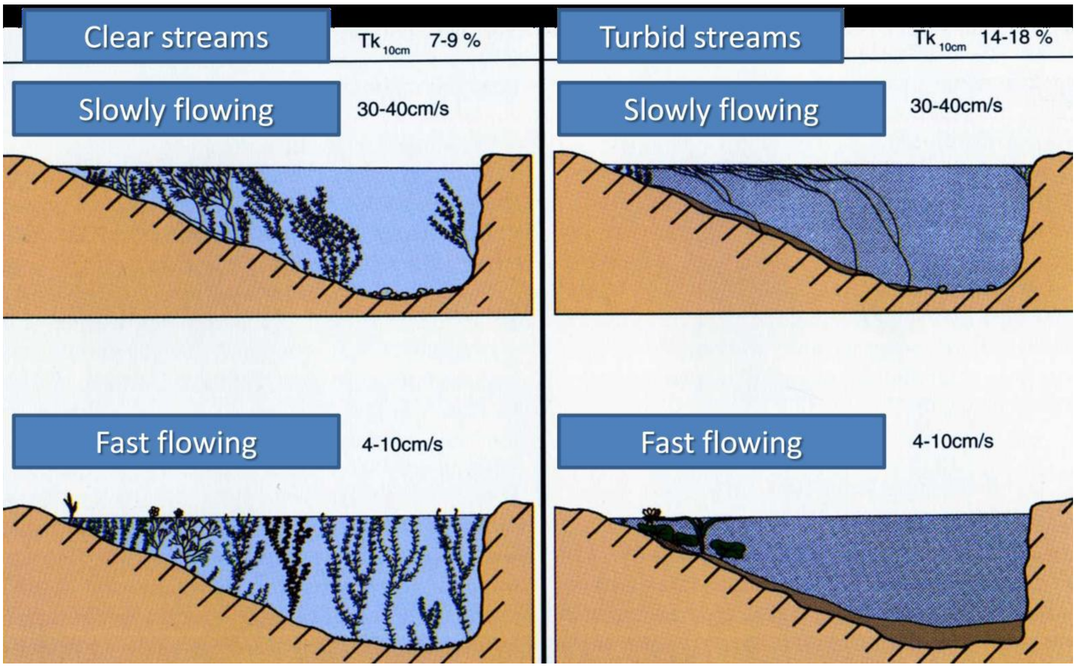
- An outline of the stream cross-section in potential growth areas respectively after geomorphological structure elements at and in streams can mainly be reduced to a differentation into an **aquatic**, **amphibic** and **terrestrial zone**, which are assigned after certain river high stands
- Most limnic systems are „simple three-dimensional“, mostly vertically layered water bodies
- Streams and river-lake systems show only a minor vertical profile. A much more prominent feature is a linear extension, and, caused by slope, a direction of flow

5.5. Outline feature 3: Abiotic and biotic factors

- The shape of a stream depends on the regional respectively local environment, like the hardness of the bedrock, the relief energy or the discharge rate
- A central factor is the stream velocity, which has numerous effects on other parameters
- As **erosion**, **transport** and **accumulation** are depending on currents and water level, currents have a major influence on all structures of the stream bed as well as the shores and thus of the shape of the stream cross-section
- Outlines regarding biotic factors have long been produced for fishery respectively zoo-limnologicigal concerns with an emphasis on specific temperature and oxygen amplitudes, while physico-chemical features important for vegetation and vegetational aspects in general played only a minor role
- The general systematics of creeks and rivers can be derived from the mentioned, mostly physiographic-hydro(geo)chemical features

5.6. Outline feature 4: Water turbidity

- The water-specific turbidity in combination with light availability, the color of the water and the width of the water strongly influences the vegetation density and the dominant growth forms
- Periodical, long-lasting turbidity phases can cause the devastation of whole streams
- Thus, turbidity, with its influence on the light availability, can be used as outlining feature
- There are clearly visible differences in the degree of turbidity respectively the color of the water at the Mosel estuary into the Rhine



Scheme of vegetation distribution and density, and the dominant growth forms in non-shadowed streams, depending on the degree of turbidity and currents

5.7. Outline feature 5: Altitude

- As our concepts for longitudinal zonation are based upon distinct altitude or slope gradients, the finer but clearly recognizable differences within streams, e.g. in relief-poor zones of lowlands, can not be differed from each other
- A classification or typing of streams in lowlands and at its peripheries in hilly or mountainous regions of **collin and montane zones** has thus not yet been conducted
- In the beginnings, typing was based on the typical fish species
- Including the macrozoobenthos and important abiotic factors like O2 concentration or temperature amplitude, the concept of longitudinal outlining into coenological stream regios was developed, with the following main parts:
- **Crenon** (spring region)
- **Rhithron** (salmonide region = headwaters = mountain creek region)

- **Potamon** (cyprinide region = middle reaches and tailwaters = depression rivers and creeks
- This outline is based upon the observation that next to changes in abiotic factors in the longitudinal course, significant changes of the food supply occur
- As the whole specter of species characteristically changes at the same time, a further differentation into coenological river and creek regions based upon index organisms (thus on biocoenoses) can be made
- The communities of the different stream sections differ by specific dependences and adaptions

5.7.1. Glacier creeks

- The predominantly turbid, milk-like colored runoffs of glaciers can only be found in the nival and alpine level
- They proceed mostly stretched in the trough valleys of glaciers at middle to strong slopes
- The stream bed is mostly broad and flat with strongly fluctuating water levels, sometimes highly turbulent runoff, perennial strong turbidity and low water temperature
- These localities, which are not inhabited by macrophytes, are extremely hostile to life
- Exceptions are singular occurences of *Fontinalis antipyretica* or colonies of cyano-bacteria
- **Meltwater runoff** of alpine glaciers are the “springs“ of numerous alpine streams

5.7.2. Montane streams

- This stream type can only be found in the montane areas of Central Europe (e.g. Vosges Mountains, Black Forest, Harz Mountains, Erz Mountains, Sudeten Mountains, Bohemian Forest)
- Depending on the relief, slopes of 20 up to over 70 ‰ are common, which flatten in the foothills
- The slope can be significantly reduced in plateaus or in intramontane basins
- In contrast to the milky colored glacier runoffs, the other streams of alpine or montane regions have mostly clear to weakly turbid water
- It can have a strong turbidity for short periods of time after snowmelt and heavy rainfall events, it is then called nival runoff type
- Red crust of *Hildenbrandia rivularis* and black-dark green coating of the water lichen *Verrucaria* sp. on sandstone debris in a fast-flowing creek in the Central German Uplands

5.7.3. Creeks and rivers in low mountain ranges

- This stream type can be found in low mountain ranges, in montane and submontane environments
- The streams have on average a lower slope than apline streams
- Their origins are mostly in **rheocrenes** and **limnocrenes**, which are often followed by a fast flowing stream in due to the high relief energy of the Central German Uplands
- **River in the Central German Uplands** with flat, gravelly shores and a typical dense riparian forest of the *Alnetum incanae* type mixing with the *Aceri-Fraxinetum*, the ash-maple valley forest with the total disappereance of the Wutach.

5.7.4. Streams of hill lands

- This stream type occurs at the transition zones between low mountain ranges and the lowlands, and on the gently sloped plateaus in the Central German Uplands (e.g. northern Rhoen, Eifel, Ardennes, Weser Hills) as well as in intramontane basins (e.g. Thuringian Basin)
- Several creeks of more stronger reliefed Pleistocene landcape of the northern lowlands as well as the Alpine foothills also belong to this category
- A river in the Central German Uplands in the summer. Caved-in shores are overgrown by *Phalaridetum arundinaceae.* In the middle of the stream, gravel is deposited.
- Calc-tuff creek with cascade-like falls over biogenic carbonate from chironomide tuff

5.7.5. Lowland streams with gentle slopes

- Except the Upper Rhine Valley and other big plateaus within the Central German Uplands, extensive, typical flatland and lowland streams only occur in northern Central Europe
- The Central European lowland with its lowland bays reaches from the Central German Uplands to the North Sea and the Baltic Sea
- Its specter of stream types is very diverse, ranging from trench-like creeks up to the big streams with their wide alluvial floodplains
- Trench-like lowland creek with a mosaic of communities of creek reeds *Typhoides arundinacea* and *Nuphar lutea*
- **Stream valley** of the Elbe at Dömitz with wide flood areas and relics of the formerly closed softwood and hardwood meadows
- Stream bed of a fast-flowing sand creek with typical ripple marks, the place of growth of a *Callitricho-Myriophylletum alterniflori*.
- Biotope complex of oxbow lake-"**Flutrasen"**, reeds and softwood alluvial forest at the Danube at Hainburg
- **Oxbow lake** of the Ems with *Nuphar lutea* typical for silent waters. Surrounded by relics of the softwood alluvial forest *Salicetum triandro-viminalis*