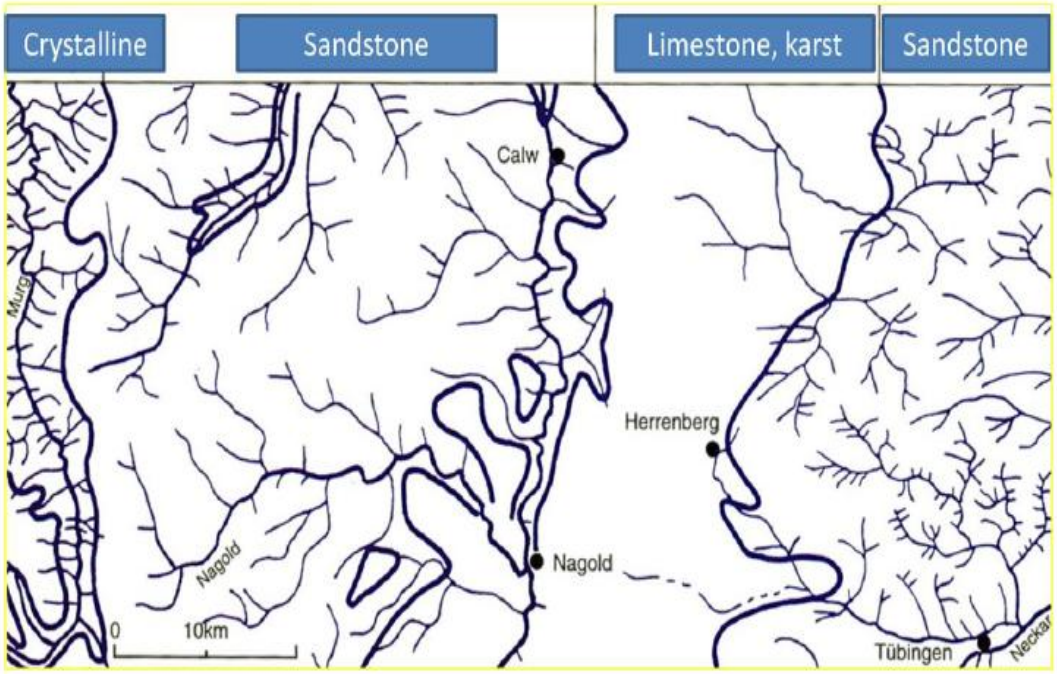
# WATENV – Water, Soil and Vegetation

# Lecture 3

### 3.1.2. Distribution and density of stream systems in Central Europe




Diverse **stream channel networks** in Baden-Württemberg, Germany. Controlled by the regional geology (porosity of the underlying rocks respectively sediments)

| Bedrock | Stream density (km/km²) |
|---|---|
| Limestone, karst | 0-1.1 |
| Sandstone, marlstone, moraines | 0.7-2.6 |
| Crystalline bedrock | > 2.0 |

Dependence of the **stream channel density** on the geological setting in the Federal State of Baden-Württemberg, Germany

### 3.1.3. Stream structure stability

- **Macro-structures** (general direction of flow, channel systems, drainage divide) were created by tectonic, glacial or erosive processes and are relatively stable
- **Meso-structures** (flow path within a valley, formation of oxbow lakes) and **micro-structures** (shore structures, scours, potholes, shallow banks) are subjected to medium and short-term changes like periodic or episodic occurring flood events.
- In Central Europe, meso- und micro- structures are often artificially created by water engineering
- The Rhine was straightened by the engineer Johann Gottfried **Tulla** between 1817 and 1876.

- Due to the straightening of the watercourse, the Rhine was shortened by more than 100 km. The river's original width of about 4000 m in the 18th century was reduced to about 250 m.

### 3.1.4. Anthropogenic intervention in stream systems

- In Germany, stream channels have a total amount of more than 600.000 km.
- The development and straightening of the streams and the resulting shortening and the decreasing water quality lead to a loss of most natural streams and the adjacent flood plains.
- Excluding the high montane and alpine regions, only about 10% of the streams are in a near-natural condition

### 3.2. Limnic systems

- **Sinkhole lakes:** sinkholes caused by the solution of salt structures in the underground and the subsequent collapse of overlying structures. The sinkholes are filled with both ground- and rainwater
- **Steppe lakes**, e.g. the shallow, low saline Neusiedler See with changing water surface, with an average of 320 km2 water surface area, surrounded by reed belts
- **Crater lakes** water-filled craters of volcanic origins. Crater lakes in the Eifel (Germany) were formed when magma got in contact with groundwater. The water vapor produced by the heat needs more volume than the initially fluid water and thus pushes away the surrounding rock with great force. Craters are formed which fill with water.
- The Meerfelder Maar in the Eifel is a more than 30,000 year old crater **lake**. The up to 53 m deep and 3,3 km2 big Laacher See, is Europe's sole **caldera lake**

### 3.2. Limnic systems

- The up to 346 m deep Lago di Garda
- The Schmale Luzin is a **late-pleistocene gully lake** in the Federal State of Brandenburg, Germany. The lake is mostly lacking reed belts due to its steep shores, thus the forest reaches the shorelines.
- The Feldsee on the foot of the 1493 m high Feldberg in the Hochschwarzwald is a typical **cirque lake**.
- **End moraine reservoir lake** at the Viola mountain pass, Bernina Alps. The **moraine wall**, on the right picture margin, was exposed by glacial retreat around 1920
- The up to 252 m deep Lake Constance, as seen from Kloster Birnau

### 3.3. Aging limnic systems

- **Aging lake:** within a certain amount of time, a lake disappears due to silting up

- The speed of such **silting-up processes** is depending on many factors such as tectonics, drainage area and regional climate.
- **Geogenic silting-ups** by deposition of clastic sediments are common in young orogenic tectonic uplift regions (e.g. Alps)
- **Biogenic silting-ups** are mainly dependent on the local nutrient influx and the regional climate conditions
- **Silting-up processes** depend on the size of the water body: Large lakes are silting up slowly due to the depth; the silting-up of shallow lakes depend on the particular surface area and the mean water depth. Small bodies of water usually show fast silting-up processes
- Most of the Neusiedler Lake (320 km2 with reed belts (142 km2 open water surface), 1 m mean depth (1,8 m maximal water depth)) is expected to fall victim to **drying up** until 2050.

**4. Springs and analogous water discharges**

- Springs are defined as „locally confined groundwater source leading to an at least temporary runoff“ (DIN 4049).
- Springs are the visible interfaces between underground and surface parts of the water cycle.
- Above confining layers, clearly distinguishable springs often occur in lines as so-called **spring horizons**.
- However, not all discharges feeding a surface water are locally confined groundwater discharges and thus do not fit into the definition mentioned above.
- Exceptions are extensively discharged groundwater and ***Qualmwasser***.
- In alpine areas, **melting water** of ice and snow is a major contribution to the annual runoff levels.
- Central Europe‘s humid climate leads to water surplusses in limnic systems as well as swamps and moors.
- Surplus water is not seeping but discharging at the surface.

**4.1 Kryal**

- Meltwater discharges and the adjacent glacier streams of the nival to high alpine levels form the **kryal**.
- This habitat is classified as **cold-stenothermal** due to temperatures permanently close to the freezing point.
- Due to the low nutrient supply and strongly changing and partially extreme water runoff, it is uninhabitable for macrophytes.
- Meltwater discharges of alpine glaciers are the “springs“ of many alpine streams.

### 4.2. Krenal

- The groundwater discharges called “springs“ form the **krenal**, a habitat mostly independent from the adjacent part of the stream.
- This areas show a broad variety of forms, water qualities and water levels depending on the hydrogeological features of the catchment area.
- The krenal includes a broad variety of cool-temperate, high humidity localities with extremely diverse habitats and accordingly distinguished living conditions and plant communities, the **krenon**.

### 4.3 Locality features of the krenal

- Large catchment areas with high water storage capacities, like pore groundwater aquifers, feed perennial springs with a relatively consistent outflow.
- Small catchment areas or catchment areas with low water storage capacities form e.g. karst springs.
- The mean temperature of groundwater-fed springs is quite constant, mostly cold-stenothermal, close to the mean annual air temperature of the catchment area.
- Exceptions are **thermal springs** or karst water systems, which include streams that partially flow beneath the surface.

### 4.4. Spring types

- Springs can be assigned to three morphologically different main types: **helo-, limno- and rheokrens**, depending on hydrogeological and vegetational criteria.

- Next to these main types, a great number of abbreviated forms with all imaginable transition forms occur.
- **Rheokrens** (fall and streaming spring): spatially strictly confined, strongly flowing groundwater discharges in form of waterfalls or spring mouths that immediately form a stream.
- Rheokrenes mostly occur in mountainous areas, where a significant relief energy is present.
- Wet rocks at springs carry different moss communities depending on the rock types
- **Limnokrens** (pond or bed spring): a groundwater discharge on the ground of a closed depression in solid or unconsolidated rocks leads to a water body with the features of limnic systems.
- The spring stream begins clearly definable with the overflow.
- This spring category includes diffuse and punctual groundwater discharges on the ground of already existing streams or limnic systems, referred to as **ground springs**
- Limnokrens can have constantly moved, uninhabitable grounds
- Trees falling into them are preserved for decades.
- Such spring habitats can be surrounded by peat moss.

- *Caricetum rostratae* reed grows in the background, evidence for the low nutrient levels.
- **Helokrens** (seeping or swamp spring): seeping springs are mostly large, diffuse groundwater discharges occuring at slopes or depressions, above confining layers or in carst areas.
- They form spring swamps rich in backwater and organic material, hardly definable from the surroundings.
- *(Picture)* Helokrens with *Cratoneuro-Arabidetum jaquinii*, an alpine plant community at calcareous spring swamps