Restoration of water ecosystems

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River Ecology

- *We must , in fact, not divorce the stream from its valley in our thoughts at any time. If we do, we lose touch with reality.*

Noel B. Hynes, 1975

- Increasing public and political awareness has initiated **measures to restore nature´s lost values**, starting with a effort to **clean the water** and followed by restoration work to **reinstate habitats in streams**.
- We started by re-instating some lost in-stream structures, such as **meanders and riffles**, in order to make streams a better place for flora and fauna
- **Streams are much more than waterways**
- **Not the stream but the its whole catchment is the fundamental unit** in stream functioning and stream-related management

Stream – riparian zone -catchment

The water that becomes visible in the stream channel has perfused the entire catchment

Décamps (1984): the importantce of placing streams in a landscape context

Streams are corridors in the landscape connecting the mosaic of habitats

Importance of riparian zones

Streams in 4 dimensions

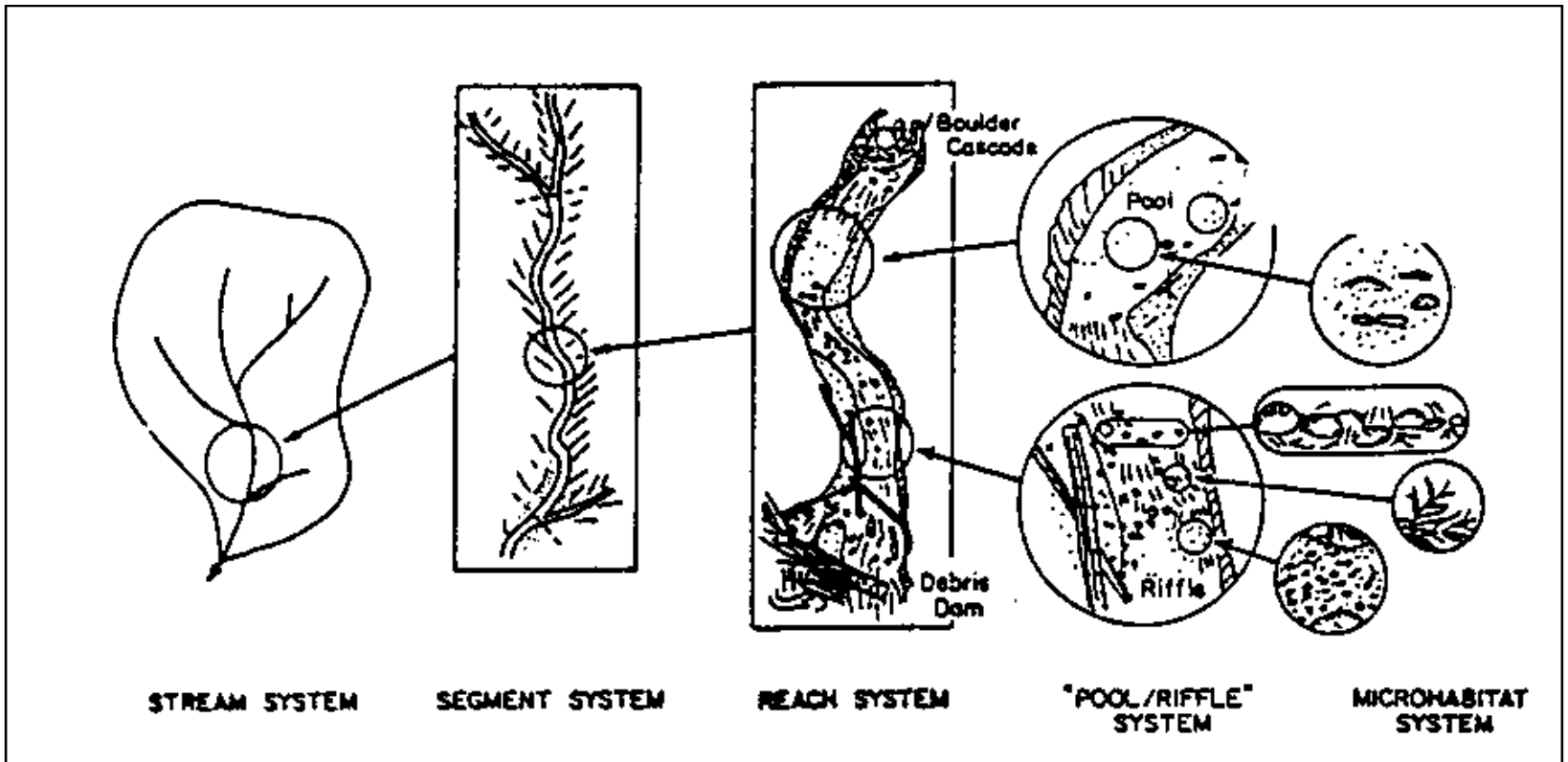
***Interactions** between streams and their floodplains are described in **4 dimensions** (e.g. Giller and Malmquist, 1998)*

- **Longitudinal** (from source to the mouth)
- **Lateral** (shapes the landscape due to erosive forces, e.g. formation of point bars, water lateral movement)
- **Vertical** (channel´s width and depth, deposits within the floodplain)
- **Temporal -** they are ever changing

„You can never step in the same river twice“

Stream habitat

- There is an ecological consensus that a **great diversity in habitats** is a prerequisite for a **high biological diversity** and **species abundance** *(Thienemann, 1918, 1950, Hynes, 1970)*
- A key determinant of the quality of stream habitats is the **character of the channel and riparian belt.** The habitats change in response to the fluvial processes.



River restoration

- 1. What is river restoration?
- 2. Why is river restoration important?
- 3. Methods of river restoration
- 4. River restoration and water retention?
- 4. River restoration in the Czech Republic

What is river restoration?

River restoration is the process of managing rivers to reinstate natural processes to restore biodiversity, providing benefits to both people and wildlife.

Definition of river restoration

Stream restoration (Riley, 1998): it is the modification of a stream´s width, depth, or meander to help restore balance between the sediment load the stream must move and the flow velocities needed to move that load through the system.

Ecological restoration (Society for Ecological Restoration, 2000)

Ecological restoration is the **process** of intentionally altering a site **to establish a defined indigenous historical ecosystem**. The goal of this process is to emulate the structure, function, diversity and dynamic of the specified ecosystem.

Stream restoration is not the creation of a „native garden“ with water running through it.

Strictly speaking we rehabilitate a habitat to acceptability rather than restore to some former state.

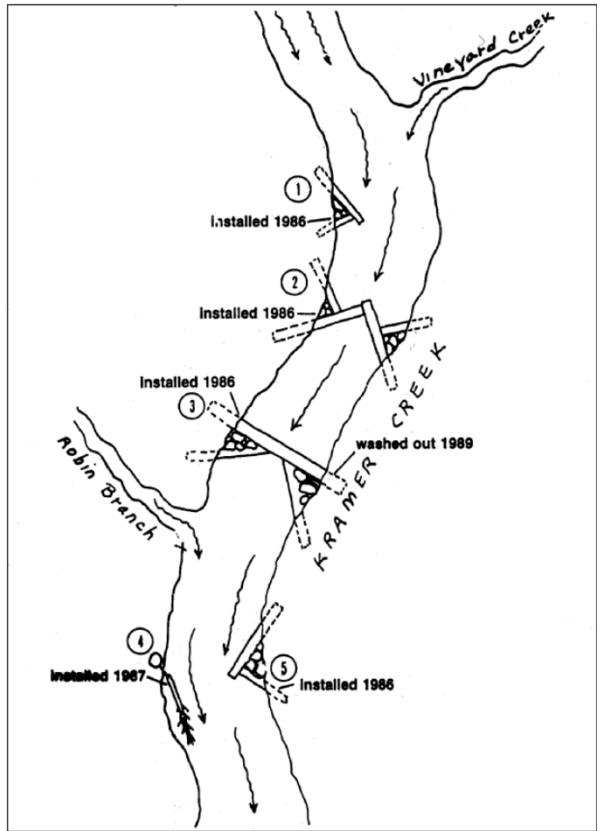
Methods of restoration

2 methods:

1) **Human made near natural conditions** of the river/lake ecosystem
2) **Renaturation** – natural process

Basic principles in restoration :

- protection of natural or near natural water ecosystems
- „freeing“ of the water body and natural renaturation
- antropogenic restoration, creation of near natural conditions



Restoration of water ecosystems

- Besides traditional technical approaches, ecohydrological solutions close to nature are being applied
- Attention is particularly being paid to the reduction of extreme flows
- The strategy of providing the necessary space to rivers is generally supported. There should not be any further growth in urbanized areas in flood plains (Nienhuis, Leuven; 2001)
- It is necessary to change the approach of people to hydrological extremes because there have always been floods/droughts and always will be ….

Restoration and retention ability

- The question of the retention ability of the landscape was widely discussed in the Czech Republic after the floods in 1997 and 2002
- Flood plains represent natural, “**cheap”, effective and permanent retention areas“**
- The main aim of the restoration measures is not to reduce discharge only during floods. Their primary importance is the long-term increase in the retention ability of the landscape, i.e. during all types of water situations

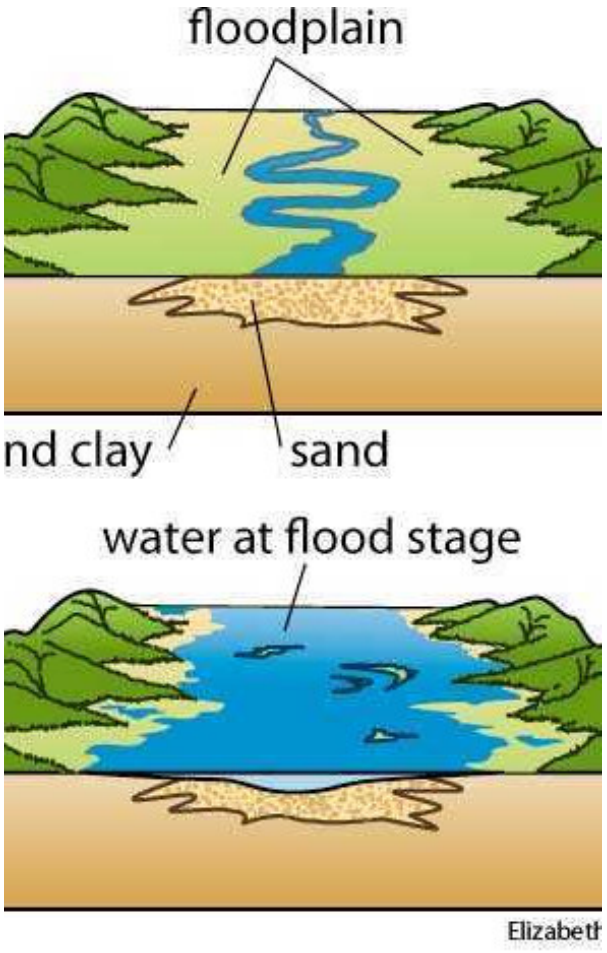
Human impact on landscape in Czech Republic

- In terms of water retention, the structure and character of the land use are also important
- The Czech Republic experienced fundamental changes in its landscape structure after World War II, particularly between the 1960s and 1980s
  - under the communist regime - **individual plots of land were put together into large tracts of land (50-200 ha)** without any connection to the character of relief
  - **the area of natural meadow decreased significantly in flood plain regions**
  - application of large-scale drainage of agricultural land and alterations to rivers

Land cover – south Moravia

Restoration & Flood Protection

Morava River by Uherské Hradiśtě, 1997



The relationship between river restoration and flood protection can be seen on **two levels**

- the potential effect of restoration measures on holding back and slowing down water discharge during floods
- floods can act as an effective restoration factor in nature

Aims of river restoration

- One aim - the **optimum water regime** in the landscape
  - The priority is to **restore the retention ability of the landscape**, which corresponds, with the aims of flood protection
  - Flood events in Europe in 1993, 1994, 1995, 1997, 2002, 2006, 2013 in Europe brought about a change in understanding of flood protection

Flood damage on main European Rivers

River	*Year*	*Totally Losses to Society (millions $}*	*Totally Insured Losses (millions $}*
Rhine	**1993**	**2000**	**800**
Po	**1994**	**9300**	**300**
Rhine	**1995**	**2000**	**780**
Oder	**1997**	**5275**	**785**
Elbe	**2002**	**18500**	**3000**

Flood protection measures

ACTIVE (TECHNICAL)

- Water reservoirs
- Dykes
- Poldres
- etc.

PASSIVE (NONTECHNICAL)

- By-pass channels/ oxbow
- Natural riparian zone
- Natural flood plains
- etc.

Ecohydrological solutions for flood protection

Besides traditional technical approaches, **ecohydrological solutions close to nature** are being applied

- the strategy of providing the necessary **space to rivers**
- to **change the approach of people** to flood dangers because **there have always been floods and always will be …**

Alluvial plains represent natural, “cheap”, effective and permanent retention areas,

they can reduce culmination discharges in lower river sections and help slow down the course of flood waves

their primary importance is the long-term increase in the retention

Alluvial plain in CHKO Křivoklátsko

River Restoration methods in practice

Concentrate on the creation of ‘near-natural’ riverbeds and the renewal of riparian belts

results: reducing the discharge capacity of channels

- when calculating flood losses - smaller degree of damages
  - Because the water **overflows** the channel during floods.
  - The **energy** of the water flow **is distributed to the riverbed and the bank zone**
  - Modified riverbeds in urban areas are sized to take **only N-year return period floods**, usually 50 to 100-year return periods

Passive flood protection measures

- Traditional “hydrotechnical” solution: building **polders**
- From the ecological point of view, it is advisable to build multifunctional **half-dry polders** which hold a relatively small amount of water for the whole year and which are filled to their full capacity only during flood flow

Polder Žichlínek on Moravská Sázava

Alluvial plain of Moravská Sázava a Lukovský stream

- The bigest polder in Czech Republic and Central Europe

-Capacity: 5,9 mil. m^3 and area 166 ha

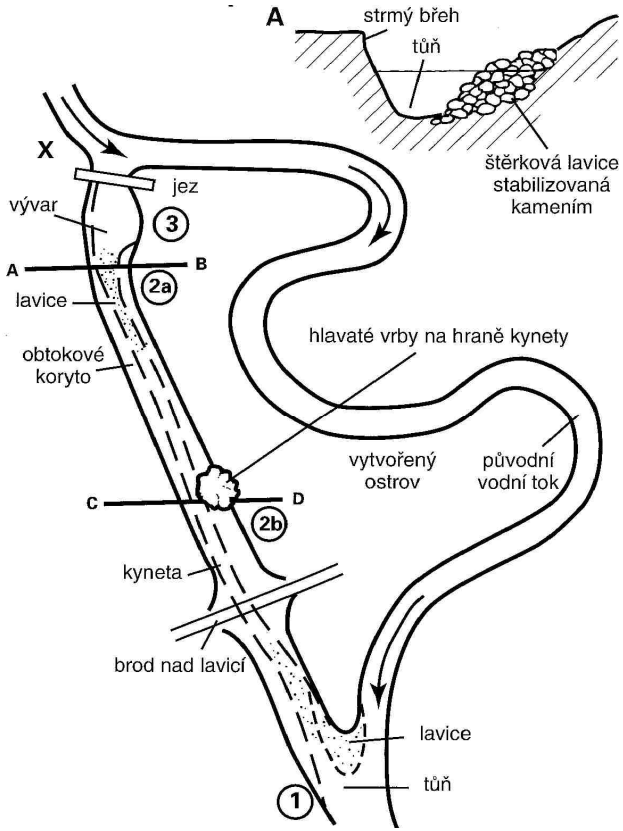
- Transformation of flood wawes by Q100 from 126 m^3/s to 59 m^3/s

Polder Žichlínek on Moravská Sázava

By-pass channels

- The creation of **by-pass flood channels** is another option for increasing the retention ability of the landscape
- During flood discharges by-pass channels can be used **to transfer a certain amount of water away from urbanized areas**
- Alternative to by-pass channels is the restoration of **old river arms (oxbow)**

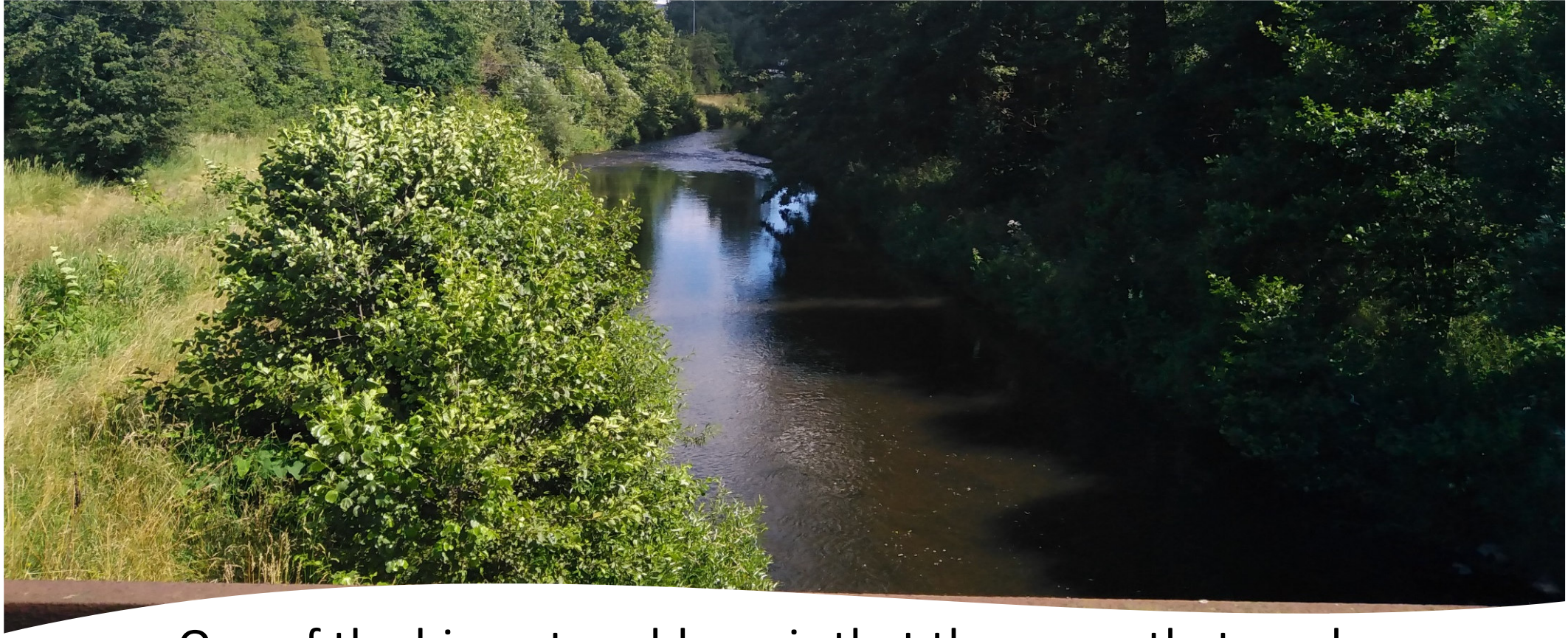
Upper Otava River



„Long-distance“ dykes

Dykes built **away from the river** ☺

- Draining and flooding canals and ditches are usually built for the purpose of controlled overflowing. The space between dykes can be used as extensively managed **meadows, floodplain forests and areas for sport and recreation**.
- Spontaneous overflow can be used only in non-urban areas with suitable vegetation

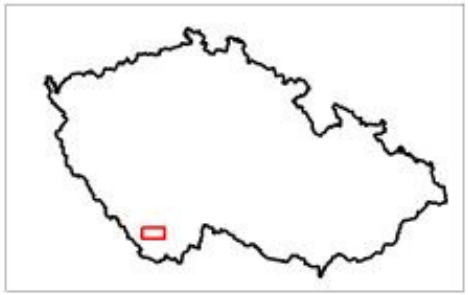


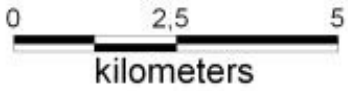
- One of the biggest problems is that the **space** that can be returned to rivers is limited. It is necessary to find a compromise between the technical and near-natural solutions
- Effective restoration measures can help to **reduce the extremity of hydrological events**
- Restoration approaches are different in urban and rural areas

Case study

Restoration of the Borová Stream

1996





2000

Changes of the landscape in Borová catchment

1947

1996

2001

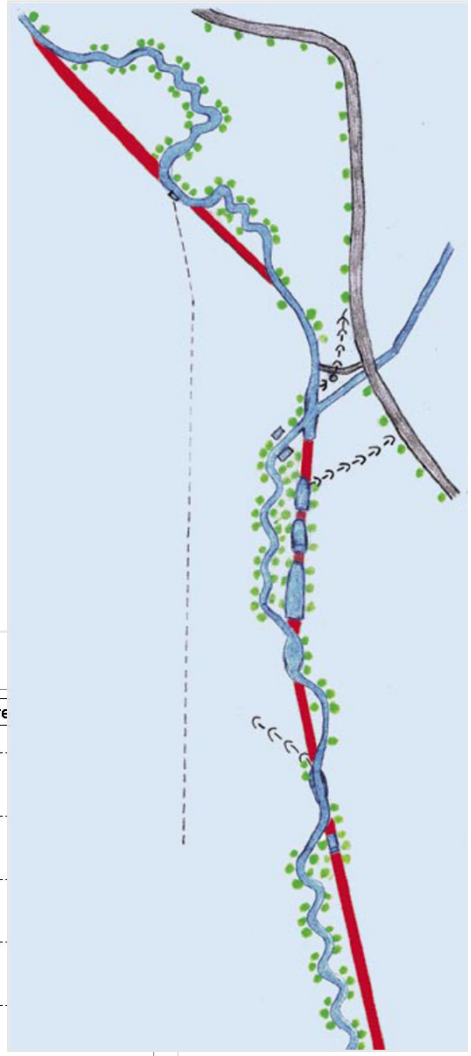
Restoration of the Borová Stream

State in 2001

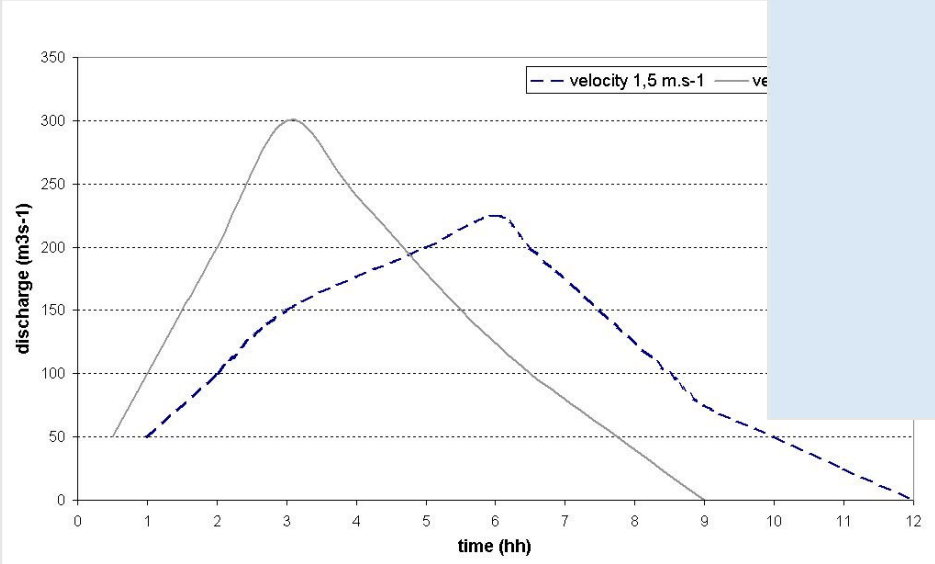
- The Borová brook was restored in two stages in 1997 – 1998 and in 2000 and subsequently affected by floods.
- The main aim of the restoration was to change the riverbed character - a new shallow flow profile was created to allow overflow onto surrounding meadows.
- The old streambed (channel) was partly filled in, grassed over and partly utilized to create a number of small pools.

Borová catchment - flood in 2001

- The water basin was subsequently hit by a 100-year flood in August 2001
- Only small flood losses were recorded because water overflowed into the flooding area, with an average width of 20m, which reduced both the speed of flow and the erosion ability of the water



The culmination discharge was reduced by almost 20%, which limited potential flood losses (Matoušek 2002)



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