# Restoration of Panonian Wetlands

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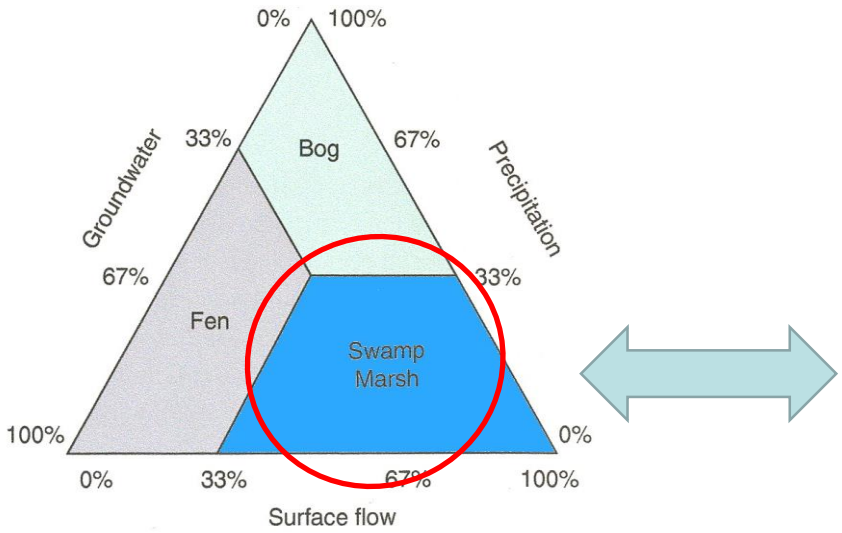
- Water in the wetlands - wetlands along the river
- Human impacts on water regime
- Principles for wetlands restoration
- Localities & investigation methods
- Field survey – specific and longterm (monitoring)
- Restoration of selected wetlands and Čiliž brook

# Water in wetlands ....

**Wetlands are created in temporarily of permanently wet or flooded land therefore water regime is the key factor for wetlands existence. The main water sources: surface water, groundwater and precipitation**

**Types of wetlands depending on water sources (Brinson,1993)**




**Hydrological conditions creates an unique environment at the border of terrestrial and aquatic ecosystems**

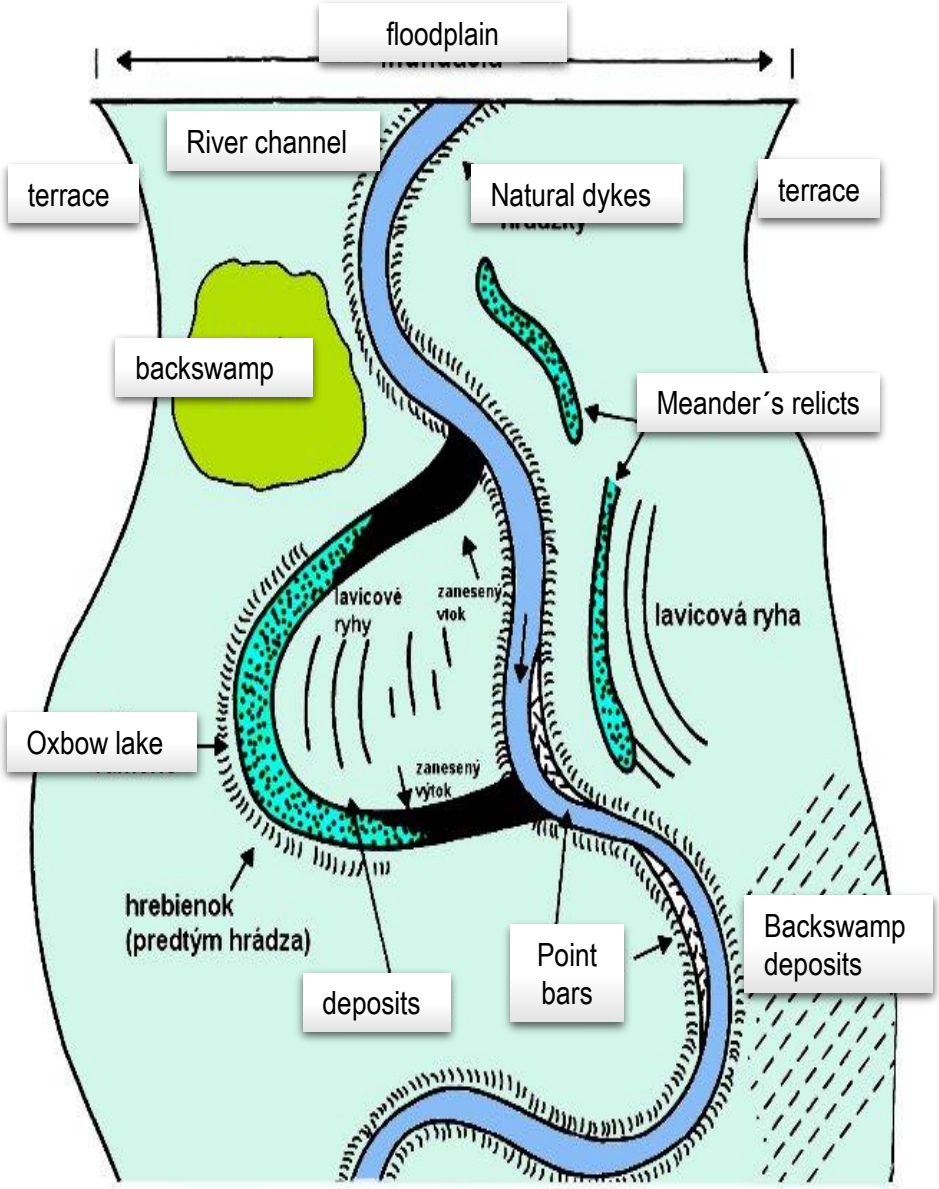
**Wetland hydrological status depends on:**

- **Water balance – inflow / outflow**
- **Type of surface**
- **Soil and geological conditions**
- **Conditions affecting the surface and groundwater**

# Wetlands along the river – floodplain wetlands

The wetlands in floodplains are the result of three principal processes:

**Flooding → Erosion → Deposition**



# Human impacts on water regime

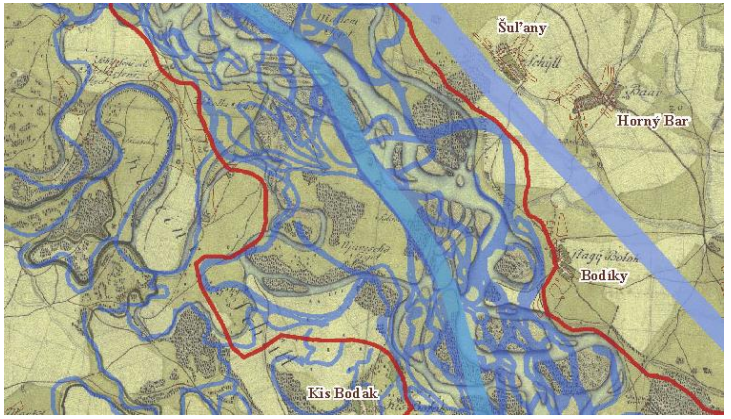
Water regime in wetlands has been modified due to water-management measures:

- **River regulation/training** – river channel is disconnected from floodplain – significant loss of hydrological connectivity (straightening, bank protection, etc)
- **Barriers (structures)** in the river channel– interruption of longitudinal continuity (dams, weirs, barrages, hydropower plants, etc.) , flow regulation (dams)
- **Flood protection measures** – construction of flood dykes – floodplain narrowing, wetlands isolation

Significant change of the natural physical processes (flow dynamics, erosion, deposition) within the river system - channel/floodplain.

Main impacts of dams on the hydrological regime of wetlands:

- **Stable water levels:** mostly stagnant water – no or limited water level fluctuation, permanent flooding
- **Changes in flooding periods**: months delay, shift from spring to growing season
- **Higher flooding elevation:** water concentrates in smaller floodplain
- **Floods reduction:** water retention in reservoir (flooded area is reduced, duration is shorter)



# Principles for wetlands restoration (water regime)

Effective wetland restoration should be based on knowledge about hydrological and morphological conditions :

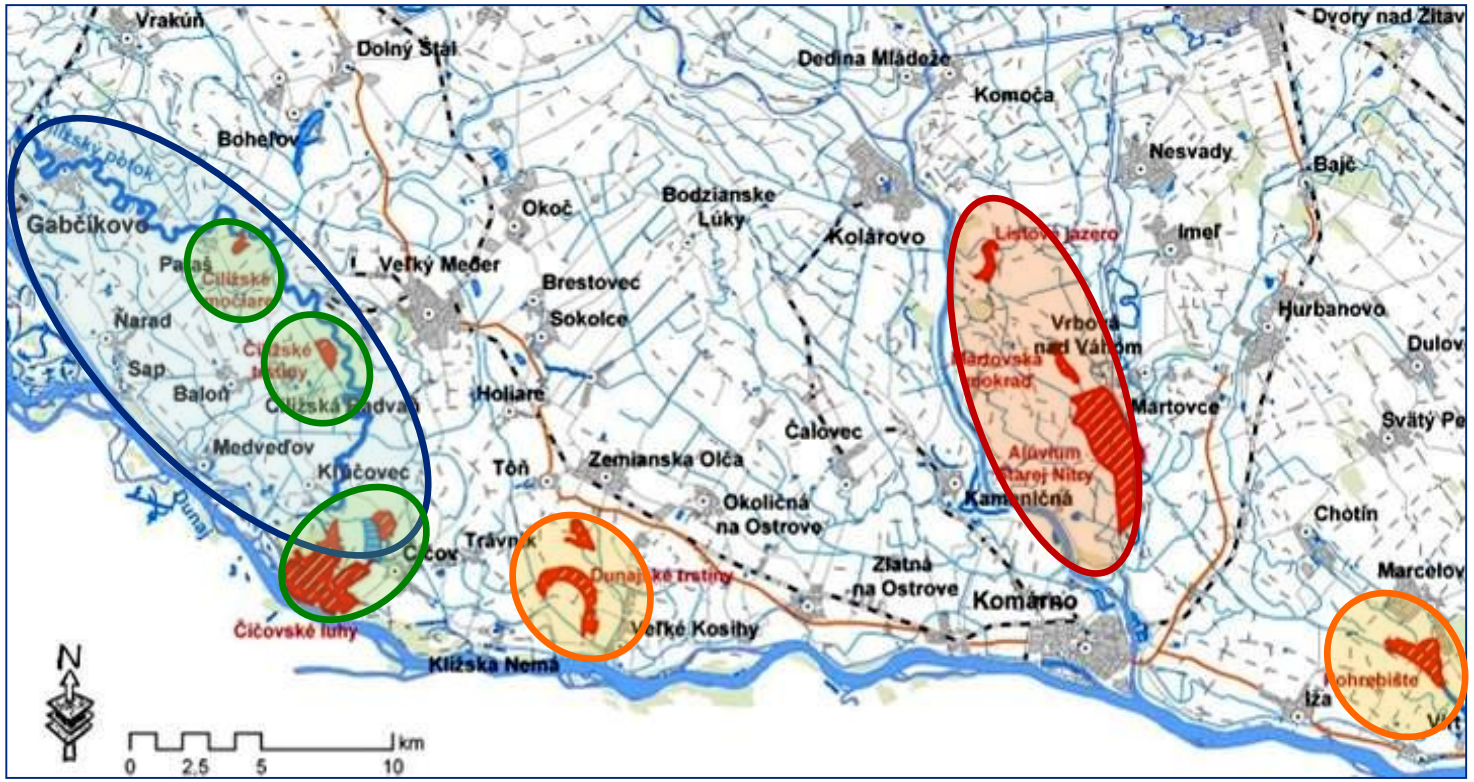
- **Natural situation - before significant modification:** understanding of wetland functioning under natural conditions –*basic framework for restoration*
- **Current situation – after modification,** the key physical processes important for wetland have been changed - wetland functioning under the changed conditions

Identification of **deficits and its causes in water regime** – possibility to set up effective restoration within given constrains:

- **Non-structural measures:** natural changes of water regime, improvement of lateral hydrological connectivity, oxbow lake reconnection, etc. - *for slightly modified areas*
- **Structural measures:** construction of small structures that can improve water regime; combination of structural & non-structural measures – *for heavily modified rivers*

# Localities for improvement of water regime

- **Čiliž brook & adjacent wetlands** - the section Gabčíkovo – Čičov
- **Wetlands areas** - between rivers Stará Nitra and Vah & along the Danube




*Methods:*

- **Field survey**–identification of water *deficits and understanding of water regime functioning* area along the river and wetlands
- **Designation of restoration measures** for improvement of water regime in areas important for *Microtus oeconomus mehelyi,* using results *field survey* (hydrology, morphology, biology) and tools of *numerical and physical modeling*

# Field survey – specific and long term monitoring

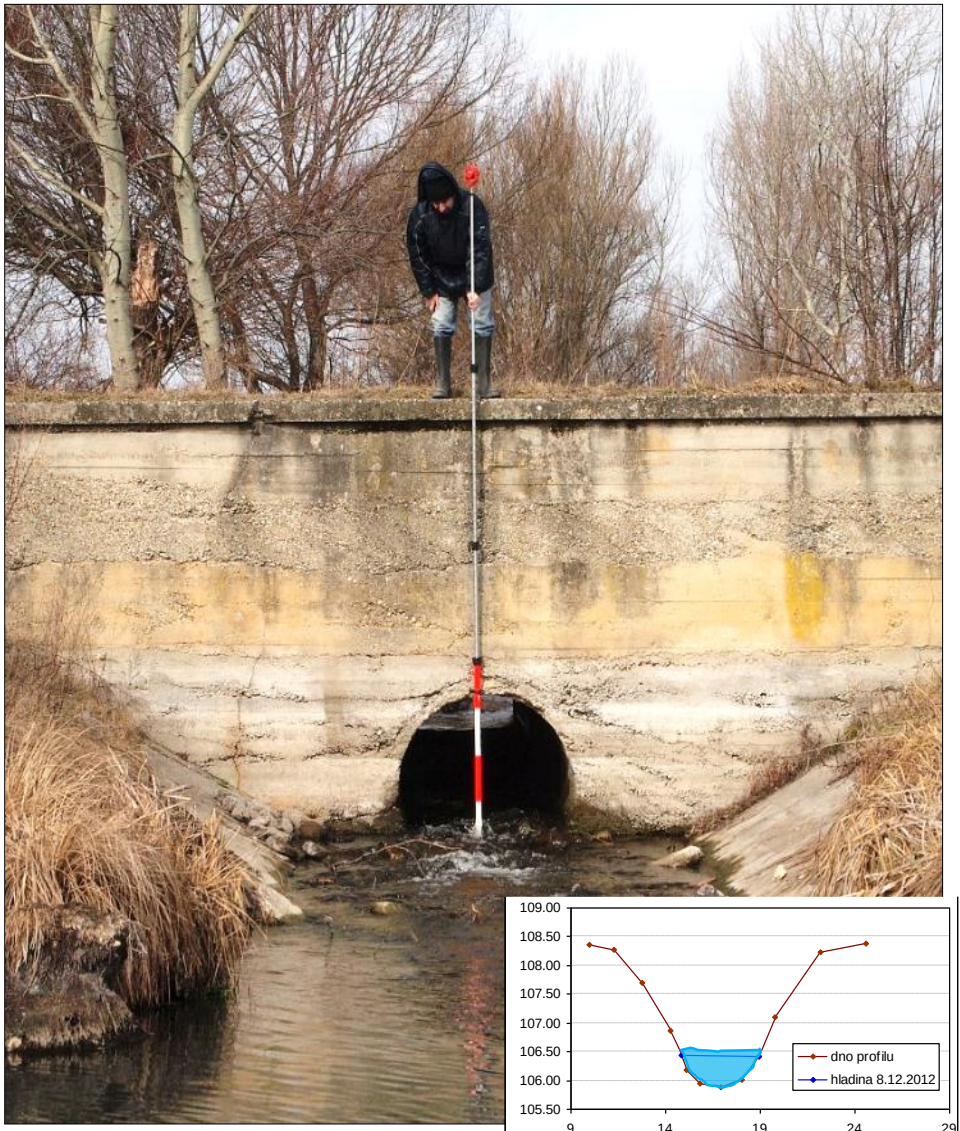
Identification of ***water deficits*** and understanding of ***water regime functioning*** – Ciliz brook, wetlands

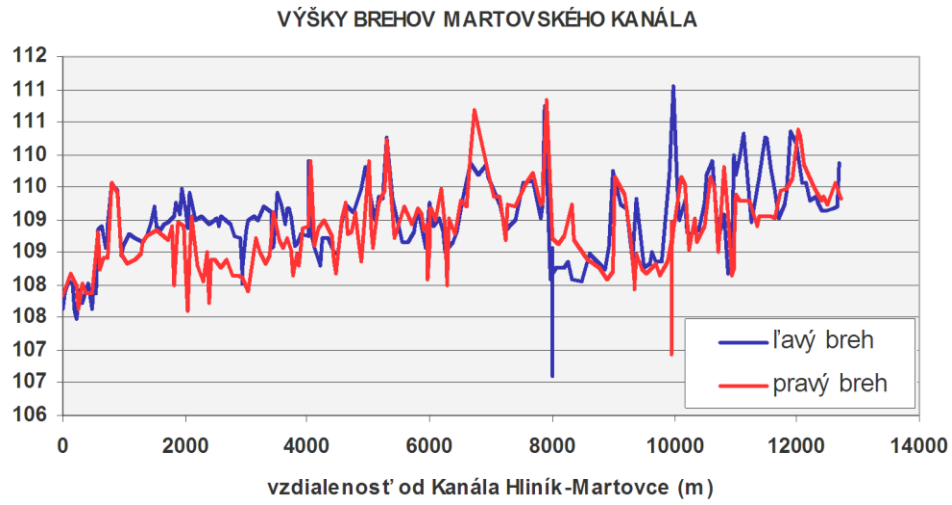
**Specific survey:**

- **Topography** - morphological characteristics: cross sections, bed sediments, etc.
- **Flow characteristics:** discharge, velocity, water level slope,
- **Structures:** - specific survey focused on: culverts, bridges, sluices, pipes... (Ciliz brook & canals)

# Specific Field Survey – Topography & morphology

**Detailed topography:** cross sections, bottom slope, terrain along the brook & canals, welands



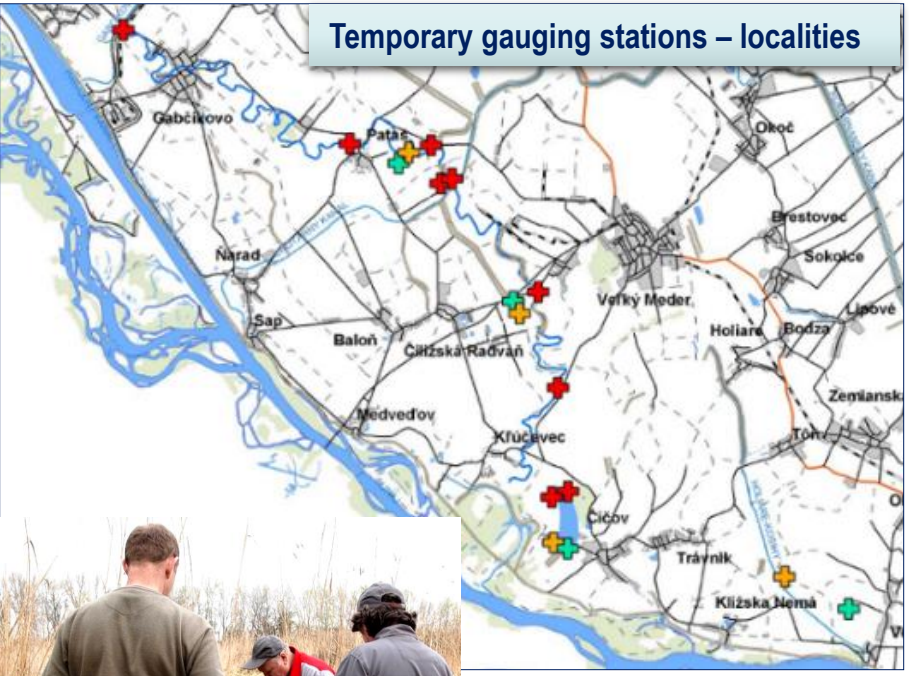
# Specific Field Survey – Structures

**Small structures: weirs, culverts, pipes, bridges -built on the system of irrigation/ drainage canals**
**Purpose: some of them are no longer used for original purposes some are damaged or broken**

- Reconstruction
- Removal
- New struceres

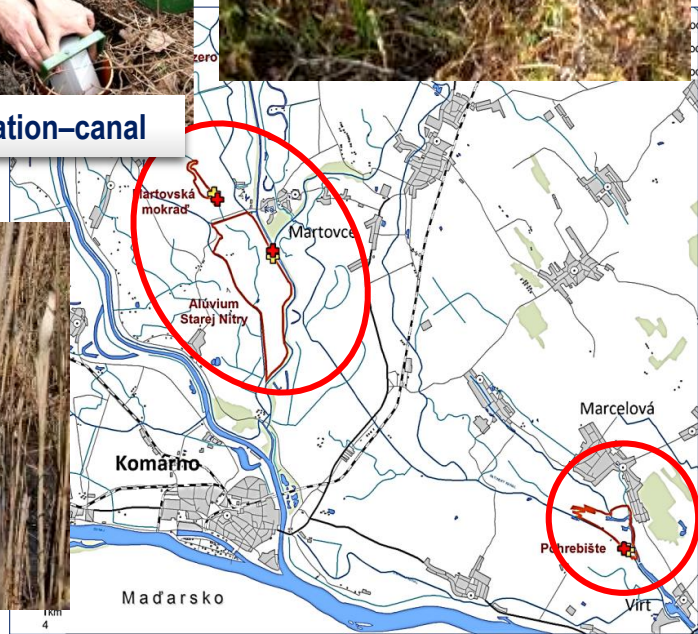
# Field Survey – Longterm Monitoring

**Collection of hydrological and morphological data important for analyses of surface and ground water interaction; numerical & physical modeling**







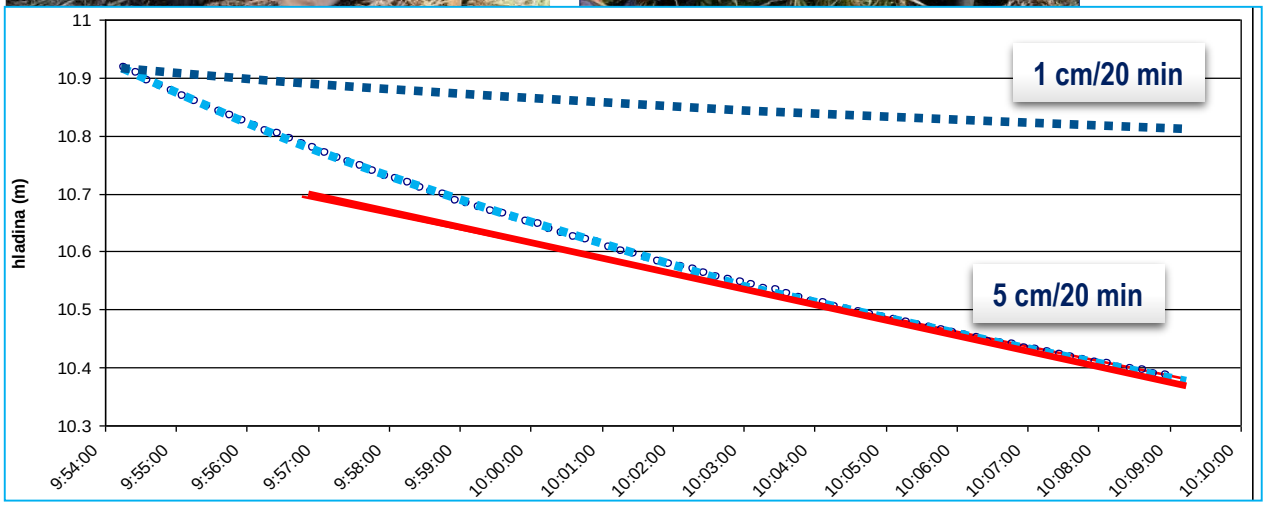
# Field Survey – Longterm Monitoring

**Soil layers impermeability – infilaration tests** – indicate interaction of surface and ground water levels

**Clogging** of the wtlands bottom – low interation between surface water and ground water

Infiltration tests in wetlands

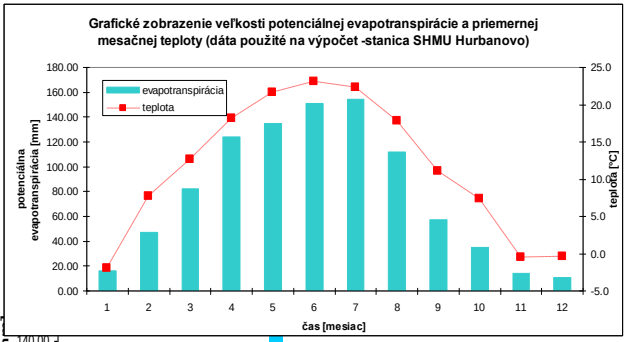
Infiltration probe

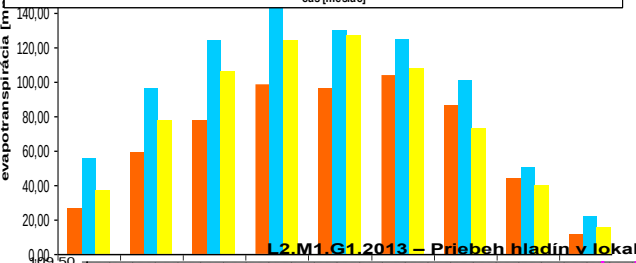



Clay-impermeable layer

# Field Survey – Longterm Monitoring

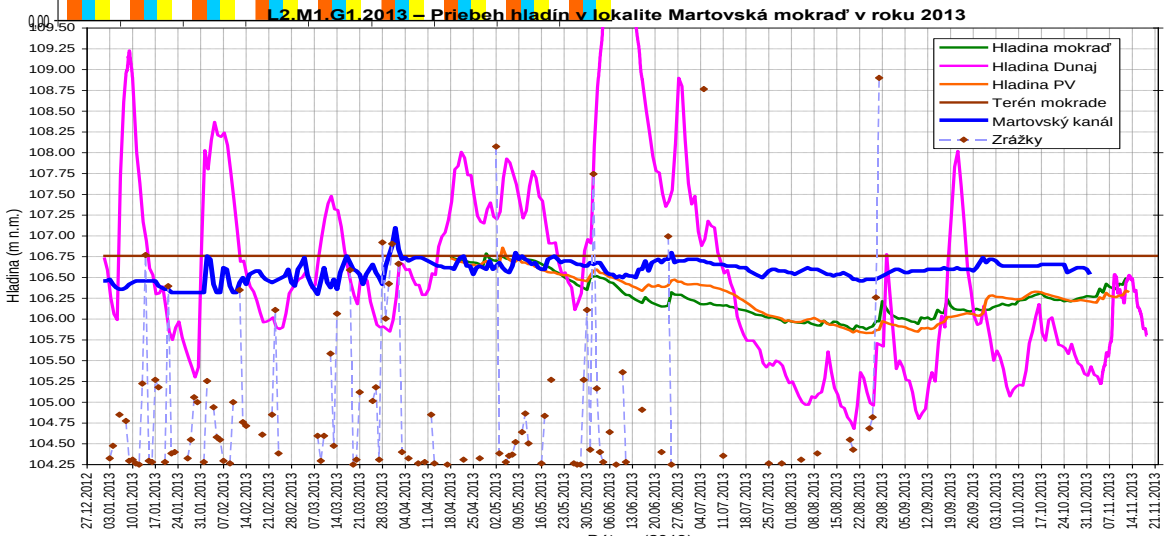
**Climatological & meteorological data are needed to estimate water loses (evapotranspiration)**
**temporary meteorological stations in wetlands (precipitation, temperature, wind, soil moisture...)**




## Field survey -main reusulas:

- Limited interaction surface & ground water
- Higher effect of soil clogging
- Water regime depends on precipitation
- Effect of seasonality

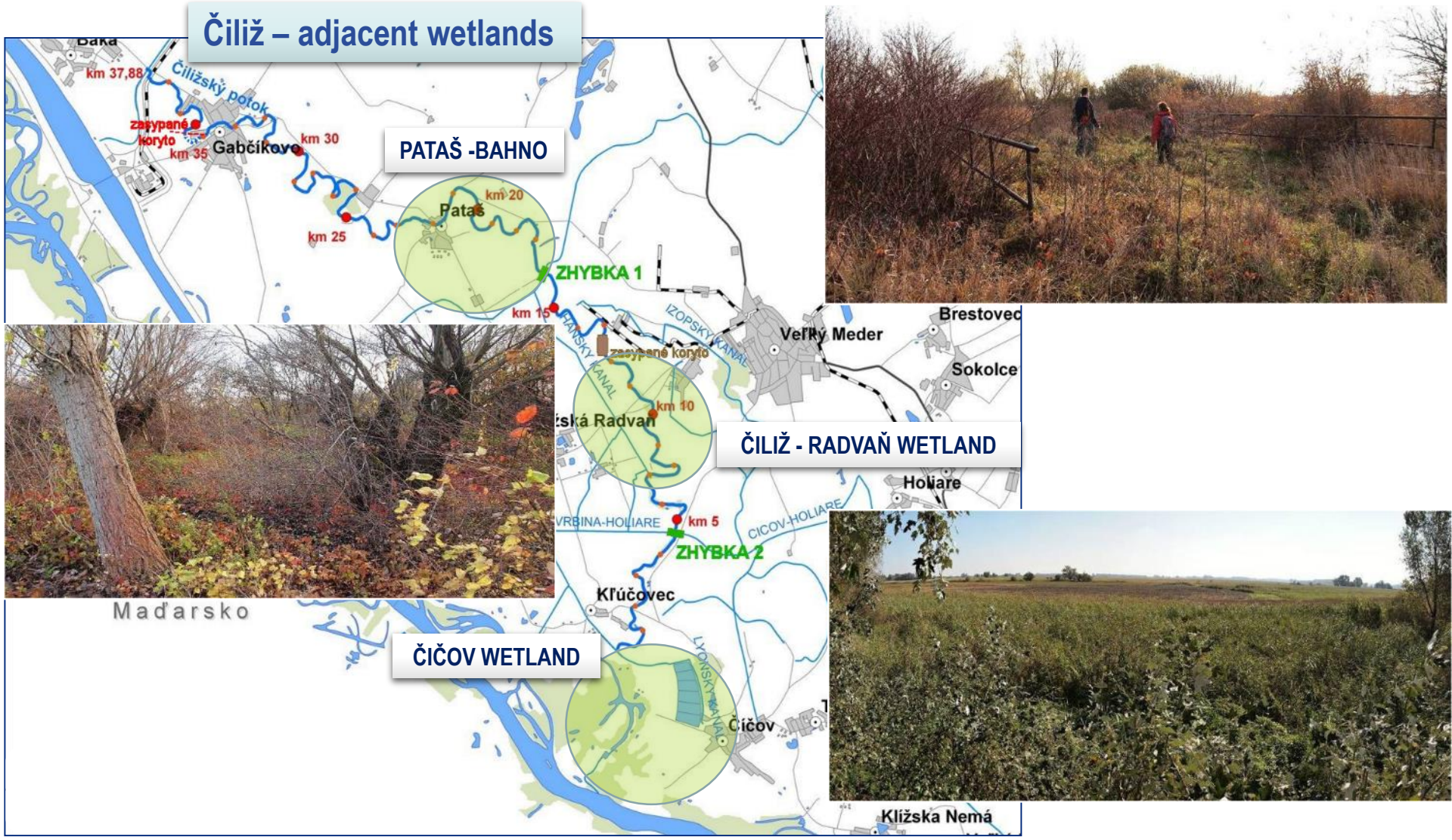



# Restoration of water regime in the Čiliž brook and reparian zone

## Čiliž brook– whole lenght - 38 km – 3 different sections

**SECTION 1:** 22 km flowing water, **SECTION 2:** 11 km stagnant water/ no water ZH1- ZH2,
**SECTION 3:** 5 km - stagnant water/ no water ZH2 – confluence with Lyon canal


# Wetlands localities along the Čiliž brook



# Restoration of the Čiliž brook – natural & current situation

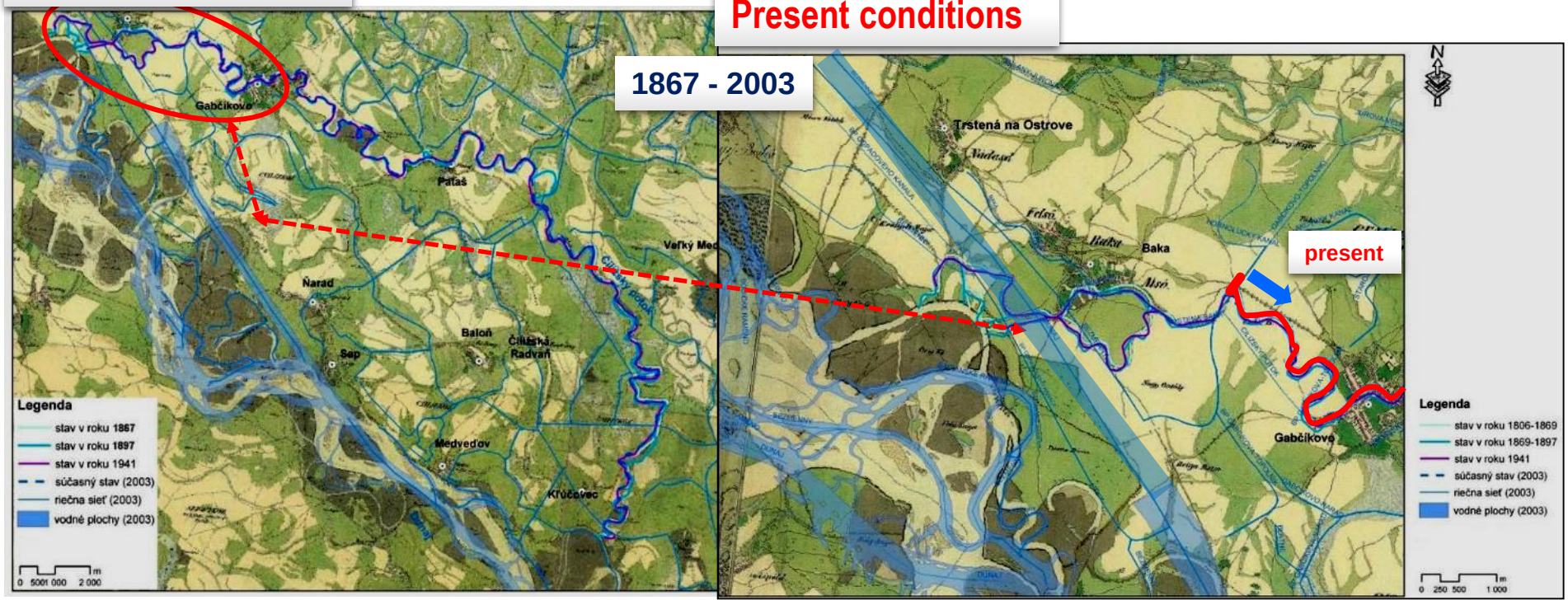
**Natural conditions:** Čiliž was the river branch reconnected with of the Danube inland delta (Baka arm) = slowly flowing, meandering channel with low energy

**Present conditions: significanty modified** by - flood protection measures (dykes – since 1853), system od drainege canals, construction of HPP Gabčíkovo

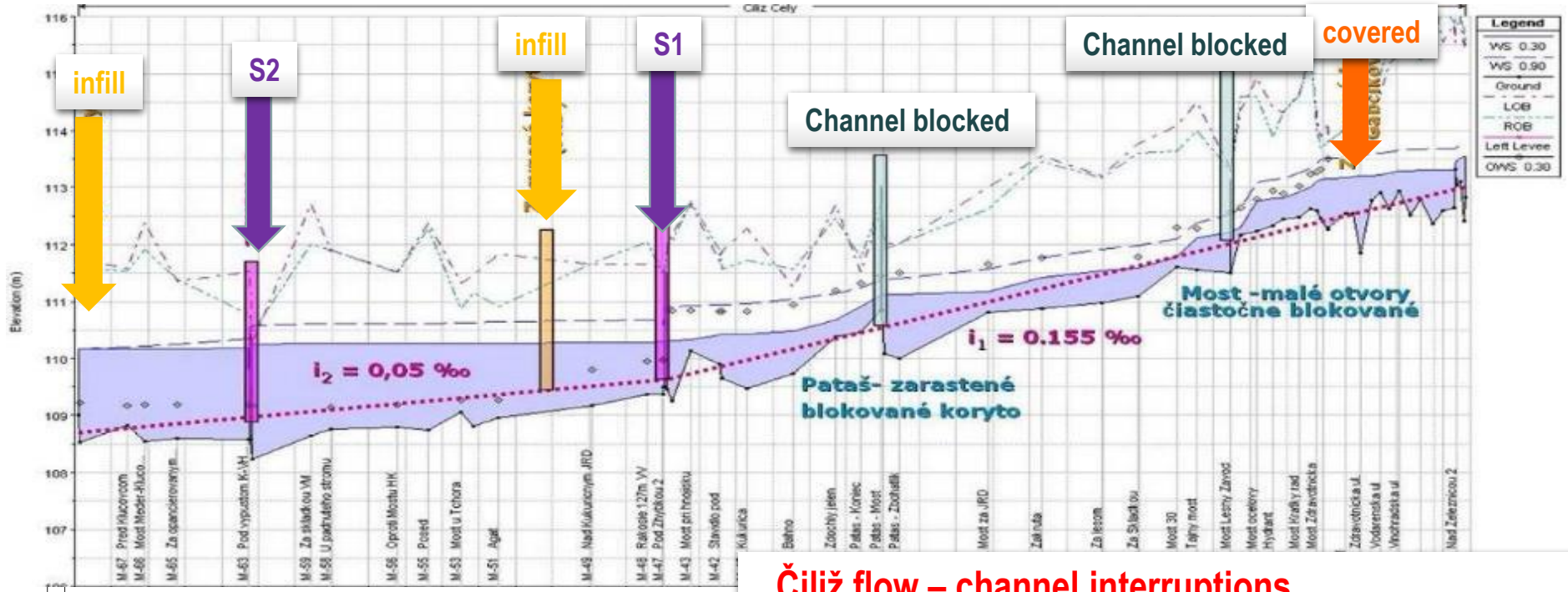
**Hydrology**: artificial flow regime - supplied from canal, drainage canals interrupted river channel
**Morphology**: channel is interrupted / blocked at many places

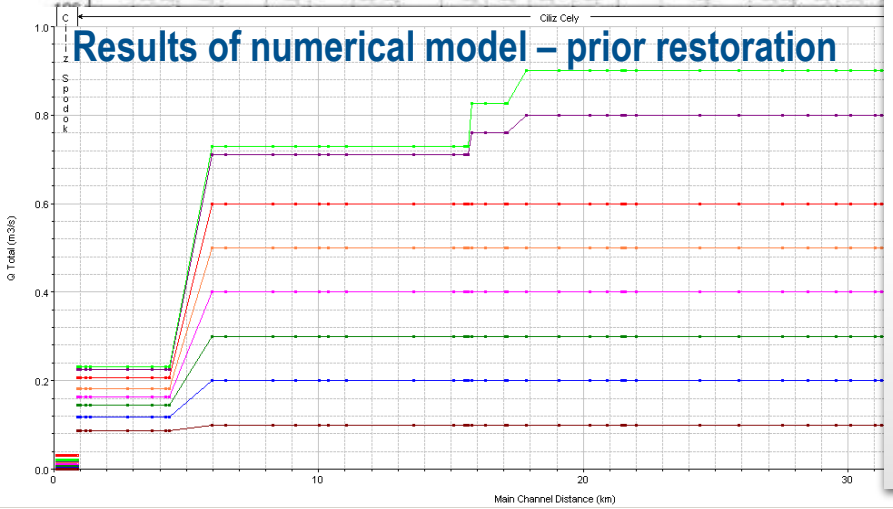
## Natural conditions

## Present conditions



# Restoration of the Čiliž brook



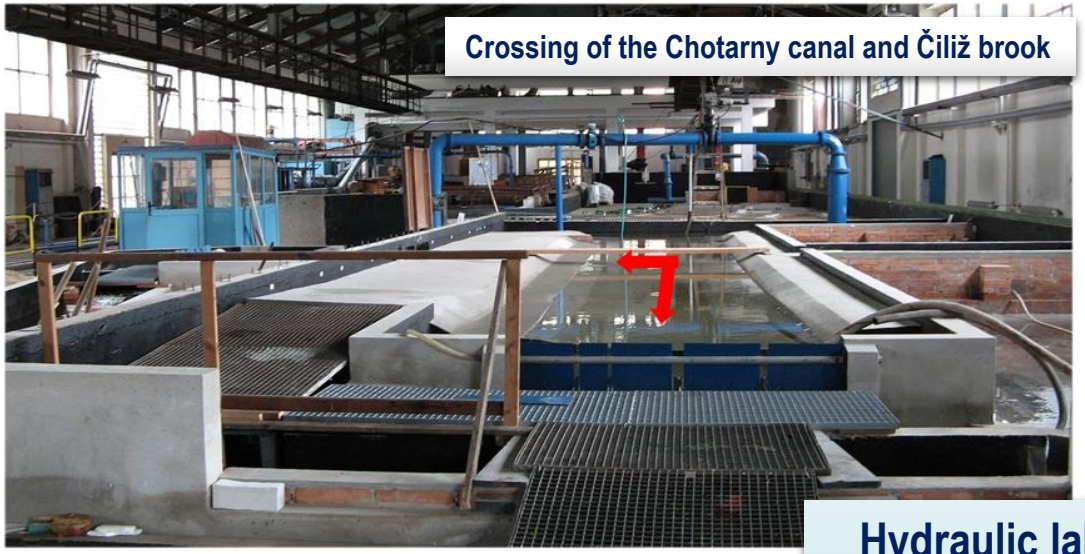




## Čiliž flow – channel interruptions

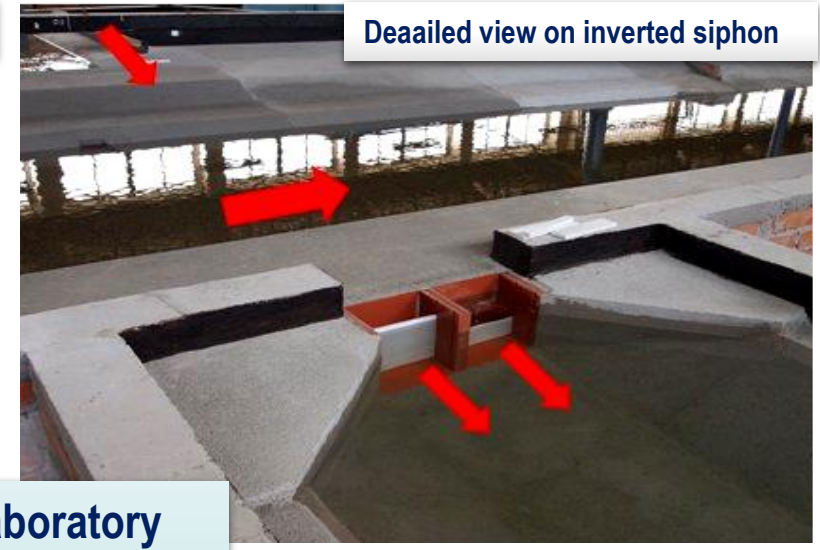
- Limited inflow – low capacity of pipe and sluice gate
- Gabčíkovo km 34,09–34,6 – stream in pipe (500m)
- Bridge km 31,3 - small profile – barrier
- Pataš km 21,5 – stream channel blocked by vegetation
- **Inverted siphon 1 km 16** – nonfunctional structure – barrier
- Channel blockage km 12,8 - filled by soil (400 m) – barrier
- **Inverted siphon 2 km 5** – nonfunctional structure – barrier
- Channel blockage km 0,5 - filled by soil (400 m) – barrier

# Restoration of the Čiliž brook

## Physical model for crossing of the Čiliž brook and Chotarny canal



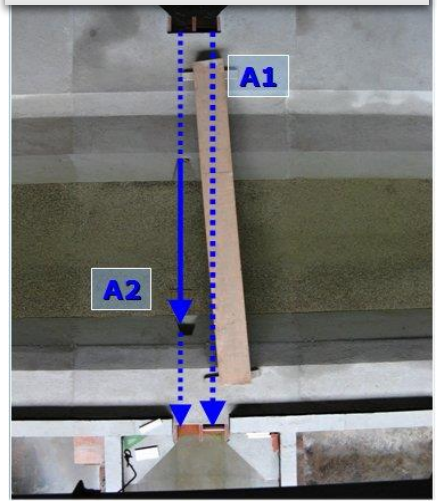
Crossing of the Chotarny canal and Čiliž brook



Deaailed view on inverted siphon

Hydraulic laboratory
Water Research Institute

### ALTERNATIVES



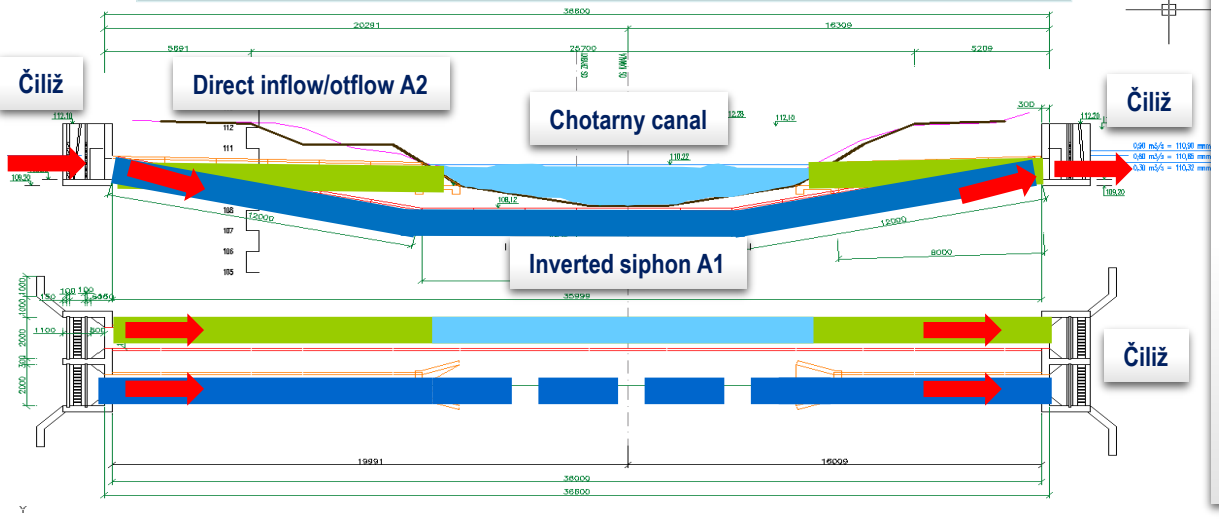

Alternative 1 - inverted siphon - outflow

Alternative 2–out/inflow through Chotarny

Hydraulic measurements

# Restoration of the Čiliž brook

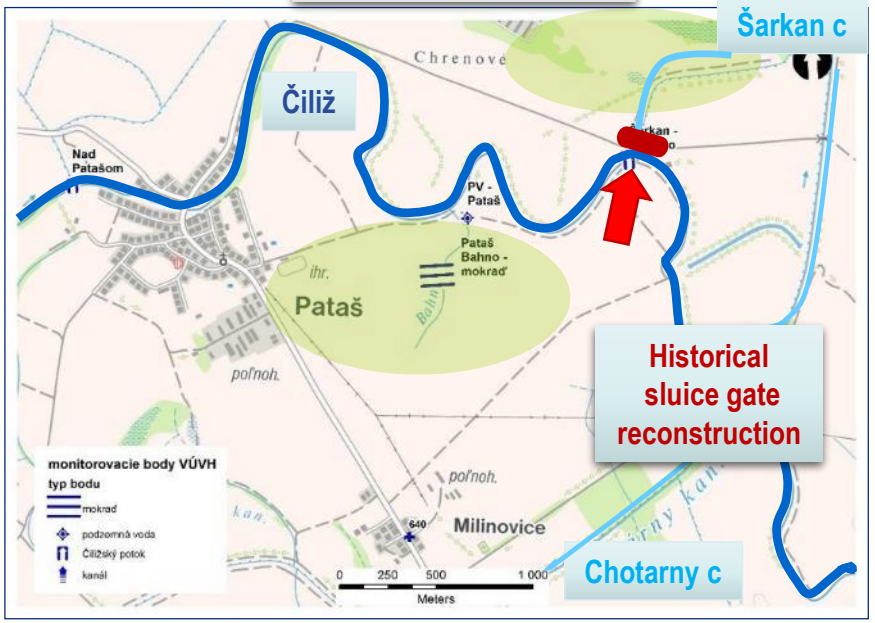

## Physical model - technical parameters for inverted siphon



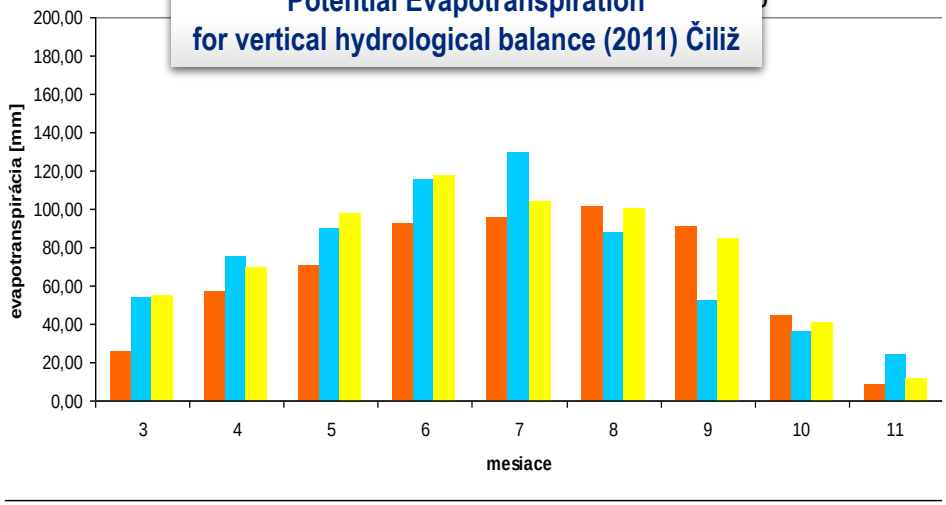

- **Water regime in Čiliž & adjacent wetlands for different Q**
- **Technical parameters for inverted siphons (in two localities)**
- **Proposal of all further measures on canals – construction/ reconstruction of sluices, channel dredging/cleaning barriers removal to keep optimal water levels in wetlands: Pataš-Bahno, Čiliž Radvaň, Čičov tŕstiny**

# Wetlands Restoration along Čiliž brook

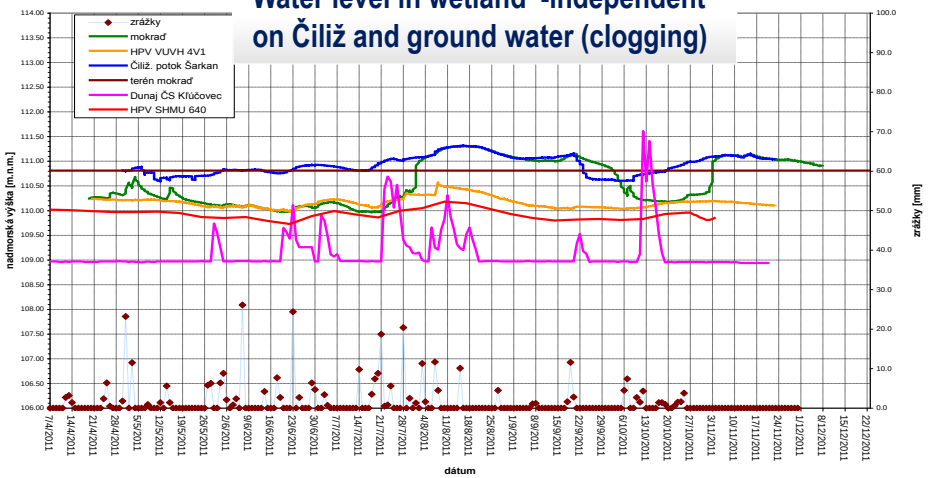
## Pataš – Bahno




## Potential Evapotranspiration for vertical hydrological balance (2011) Čiliž

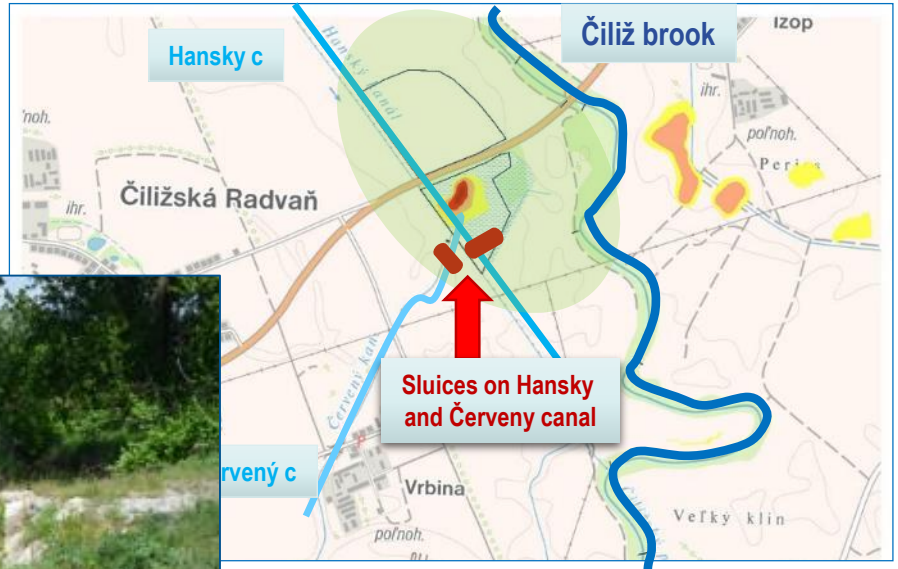


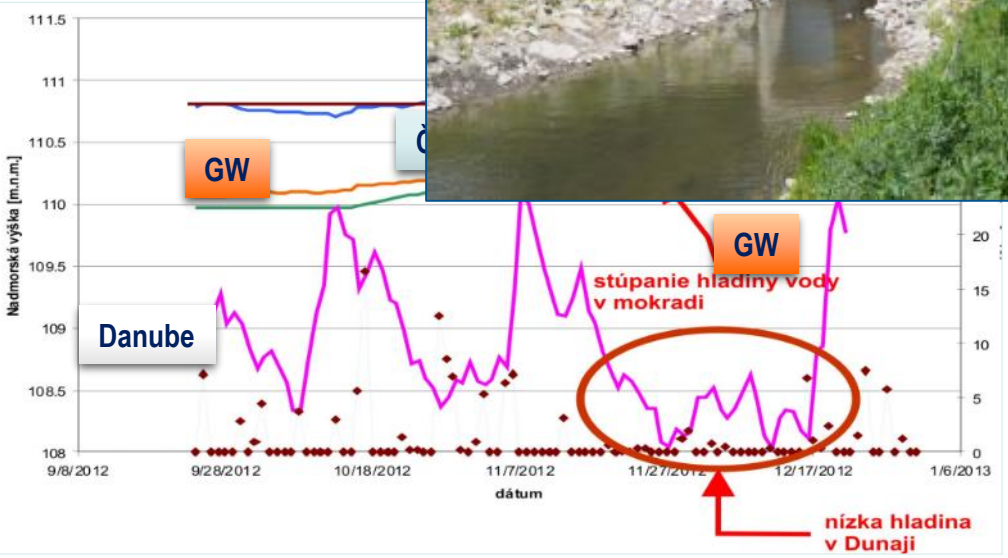

## Water level in wetland -independent on Čiliž and ground water (clogging)



# Wetlands Restoration along Čiliž brook

## Čiližská Radvaň - wetland




# Wetlands Restoration along Čiliž brook

## Čičov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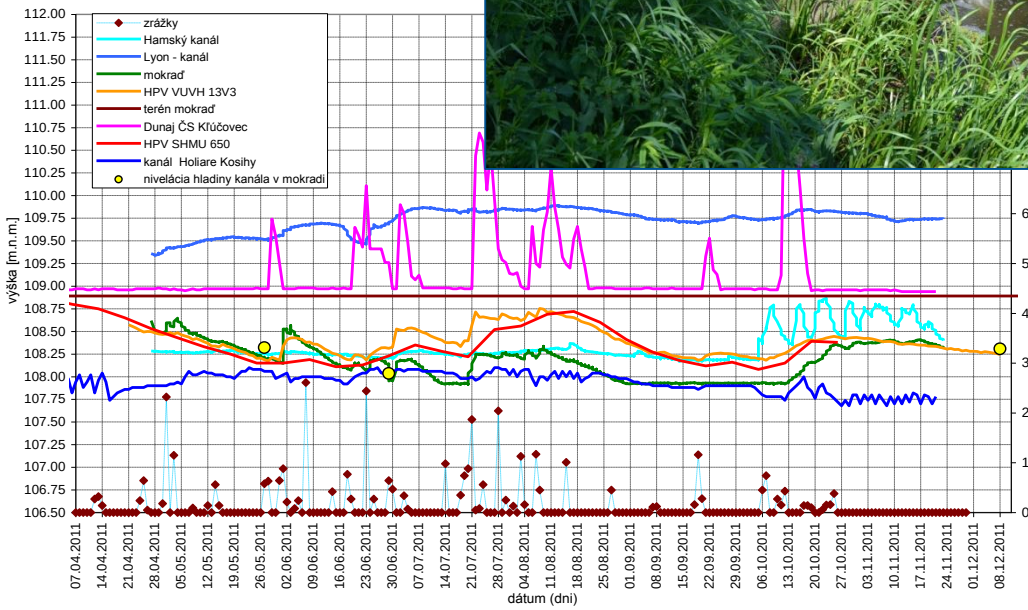



Sluice gate reconstruction on Hamsky canal to keep water in wetland

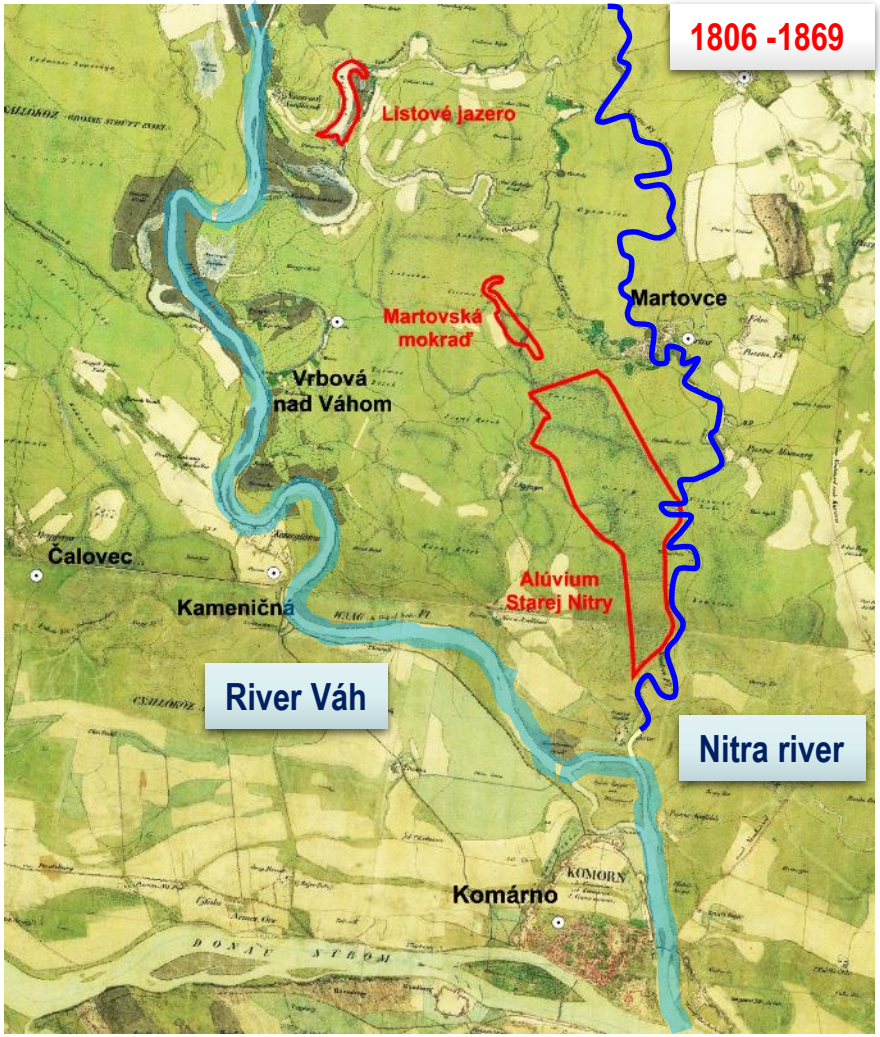
# Wetlands Restoration – localities between the river Vah and Old Nitra

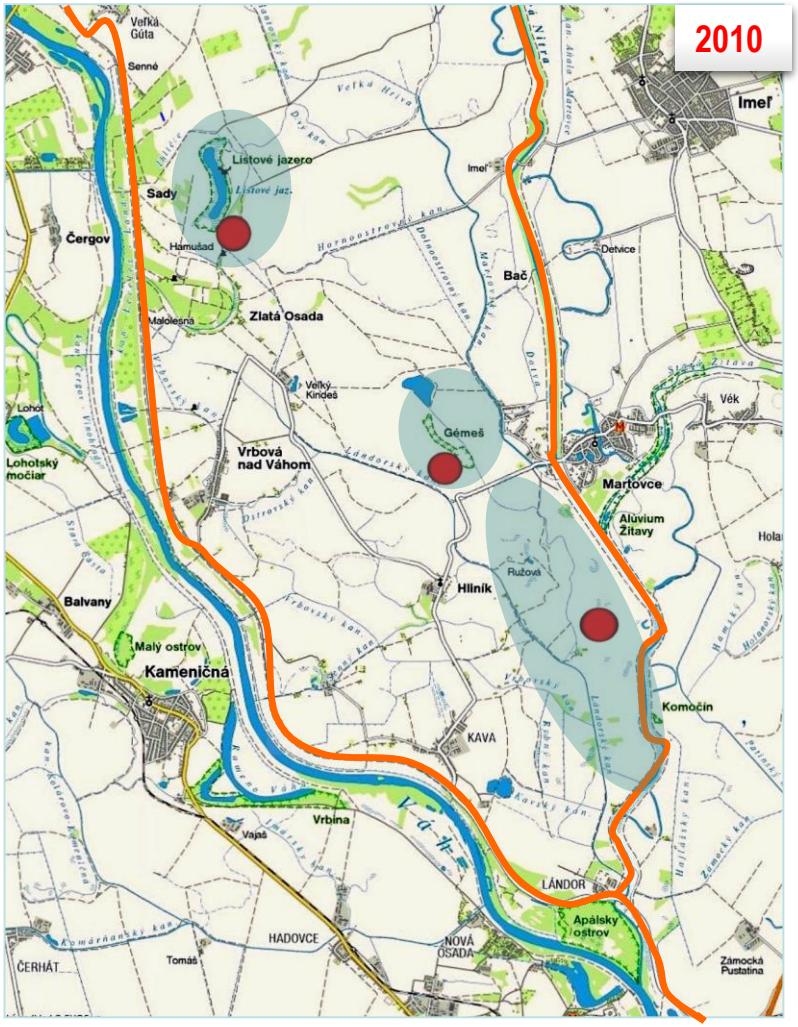
## Wetlands: Listové jazero, Martovská mokraď, Alúvium Starej Nitry



# Wetlands Restoration – localities between the river Vah and Old Nitra

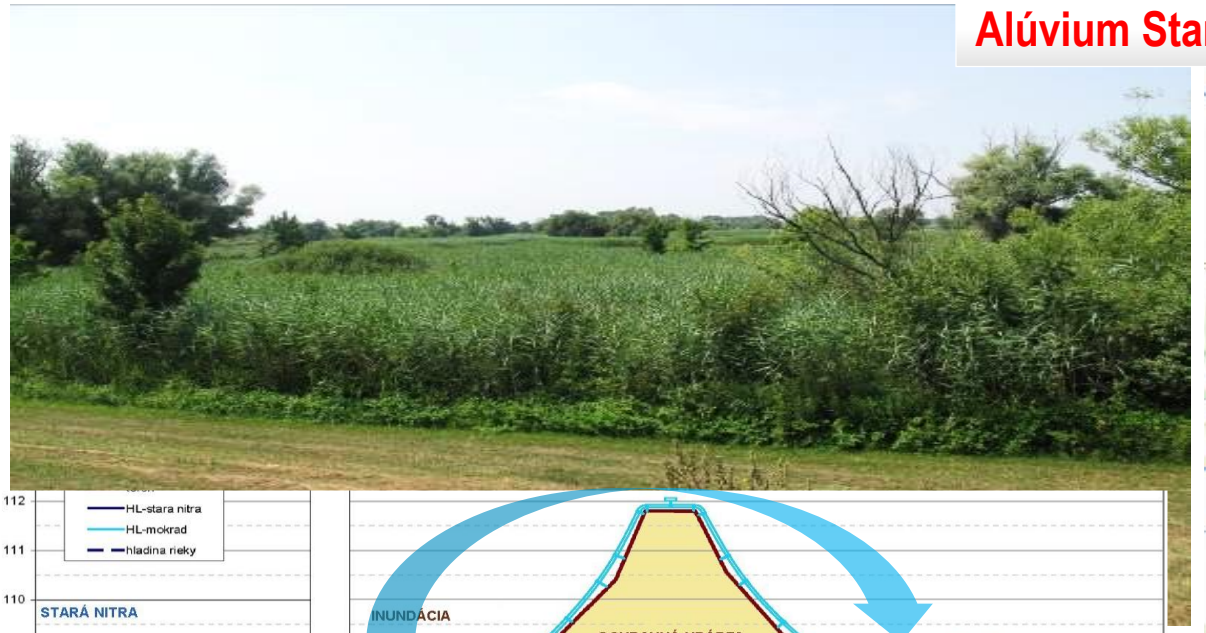
**Natural conditions & present situation: Listové jazero, Martovce, Old Nitra Alluvium**
**Main pressures: on hydrology (flood protection, irrigation/drainage canals ) & agriculture**

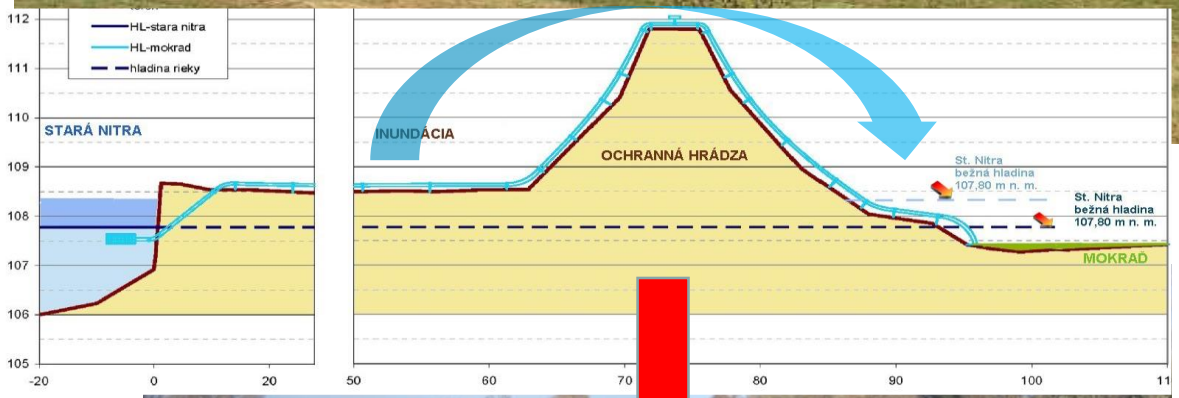


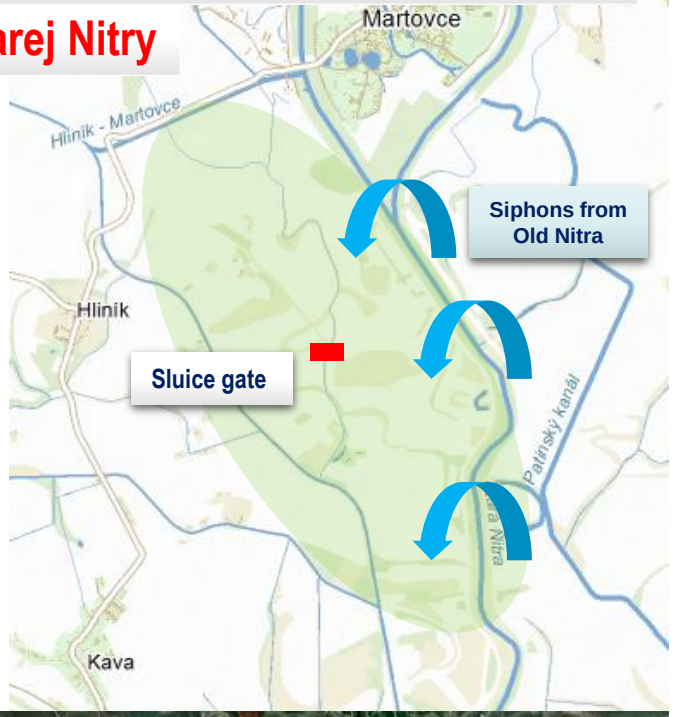



# Wetlands Restoration – localities between the river Vah and Old Nitra

## Alúvium Starej Nitry

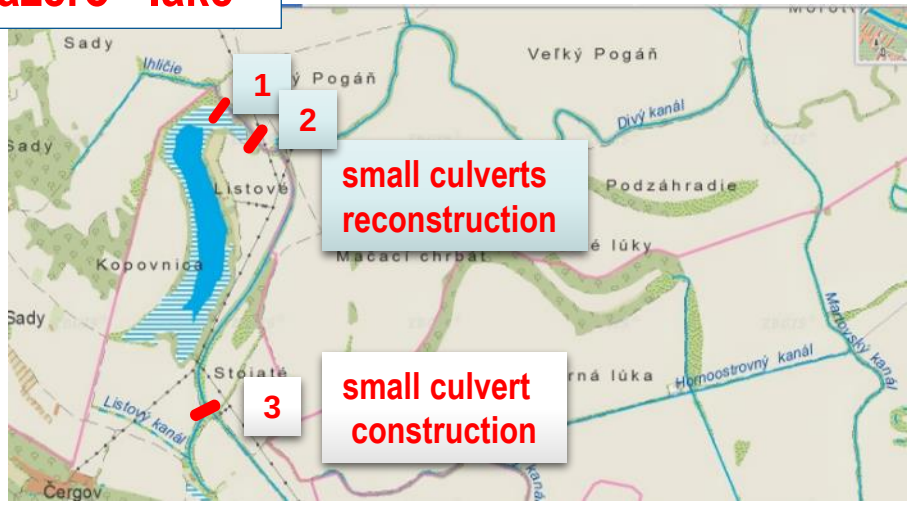


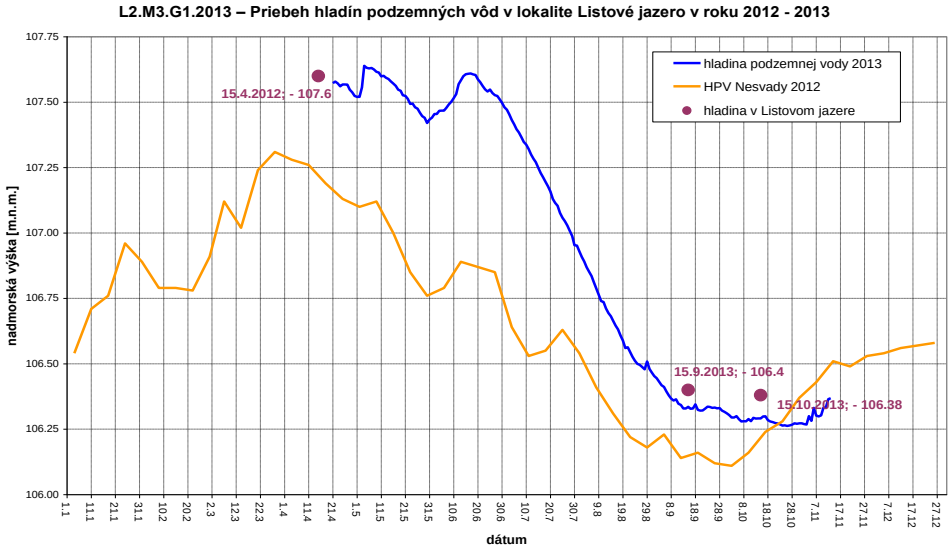


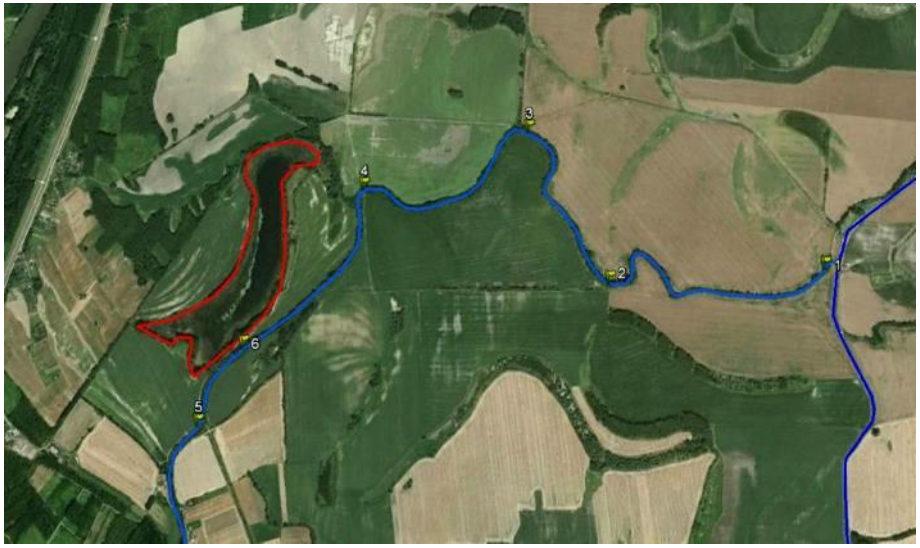




# Wetlands Restoration – localities between the river Vah and Old Nitra

## Listové jazero - lake

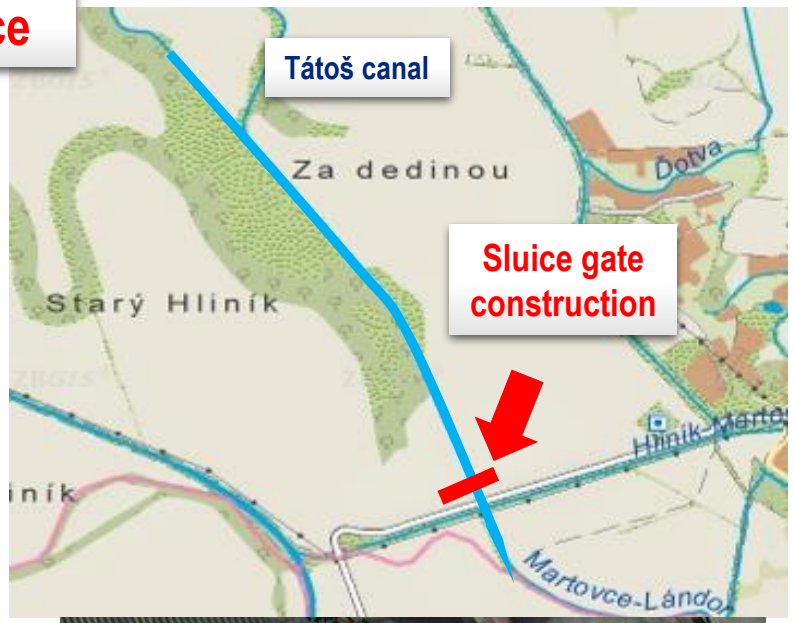


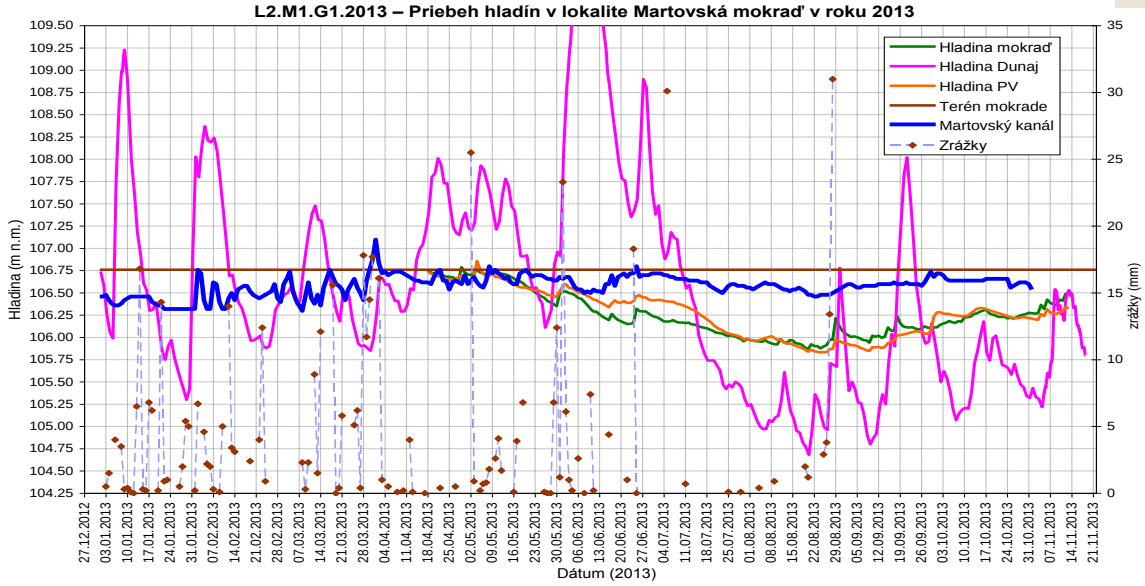



# Wetlands Restoration – localities between the river Vah and Old Nitra

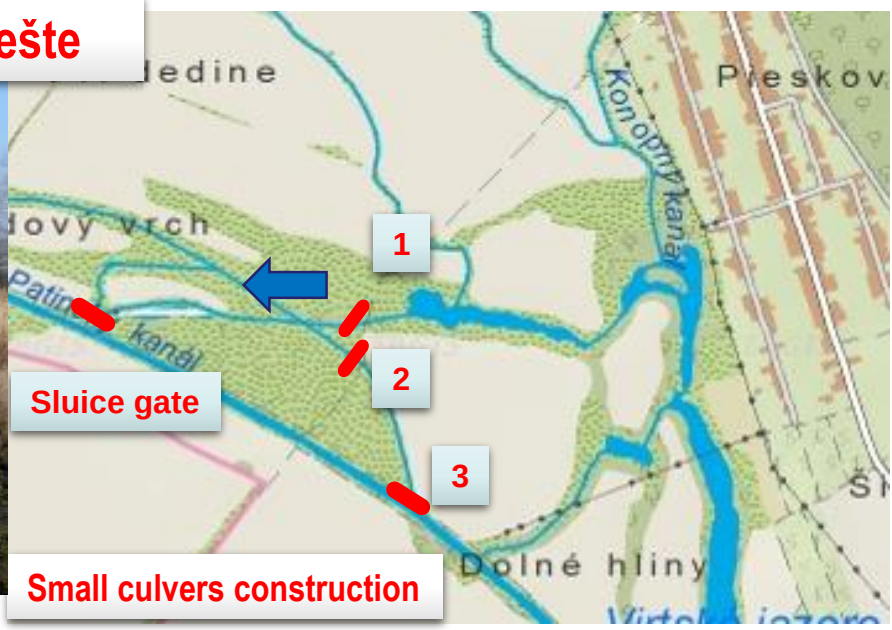
## Martovce

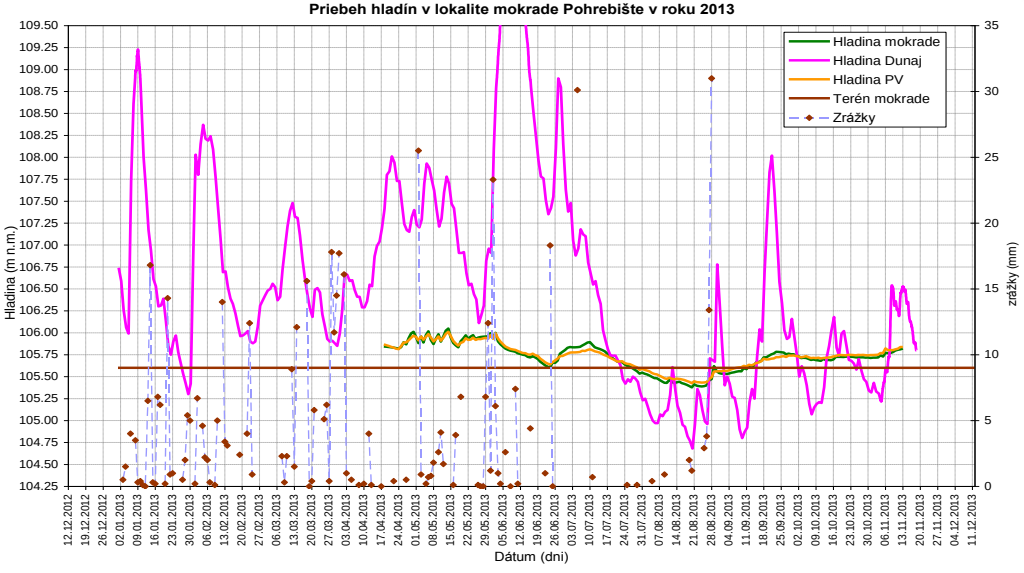



# Wetlands Restoration – localities close to the Danube

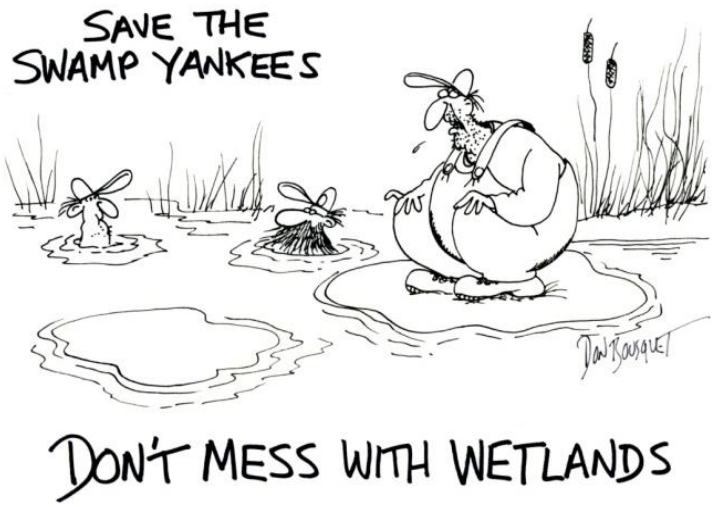
Pohrebiešte




# Summary

- Water regime in selected wetlands is highly modified by flood protection measures and system of irrigation/drainage canals
- Designated restoration measures are mostly structural – small weirs, culverts (reconstruction or new const. but also cleaning
- Proposed restoration measures has been implemented step by step – not all structures can be implemented within this project (costs)
- Proposed restoration measures allow to improve water regime in Ciliz brook and in wetlands – it is already proved by long term hydromonitoring;
- Restoration measures can support creation habitats appropriate for Microtus oeconomus mehelyi and also other aquatic species
- Structures allow water regulation – thus optimizing of water regime in wetland areas is partly possible
- water regime in each wetlands different (different human impacts) – individual approach




Thank you . . .