International Symposium on River Sedimentation
September 19 – 22, 2016 in Stuttgart, Germany

Universität Stuttgart

K. Holubová, M. Čomaj, K. Mravcová
Water Research Institute, Bratislava, Slovakia

Reconnection of the original Danube floodplain channels and wetlands as a vital step to restore river morphology and ecology

Restoration concept is basd on reintroducing of longitudinal contiuity, lateral connectivity and associated fluvial dynamics in the selected localities of the Danube river basin

Aims:

- improvement of the present habitat diversity
- enhancement of integrated effect of hydromorphological and ecological restoration of floodplain channels and wetlands with positive effect on flood protection

Results were obtained within the projects financially supported by EU funds:

Project HUSK/1001/ 2.1.2/0060: *Danube floodplain rehabilitation to improve flood protection and enhance the ecological values of the river in section between Sap-Szob,* ***DuReFlood,*** *SK-HU Interreg*

Project LIFE 12 NAT/SK/001137: *Restoration of nesting and feeding habitats of Sand Martin, Kingfisher and European Bee-eater in the Danube - Morava Region,* ***BeeSandFish;***

Project LIFE08 NAT/SK/000239: *Conservation of root vole and restoration of its habitats along the Čiliž brook and selected wetlands,* ***Microtus***

Where we are ?

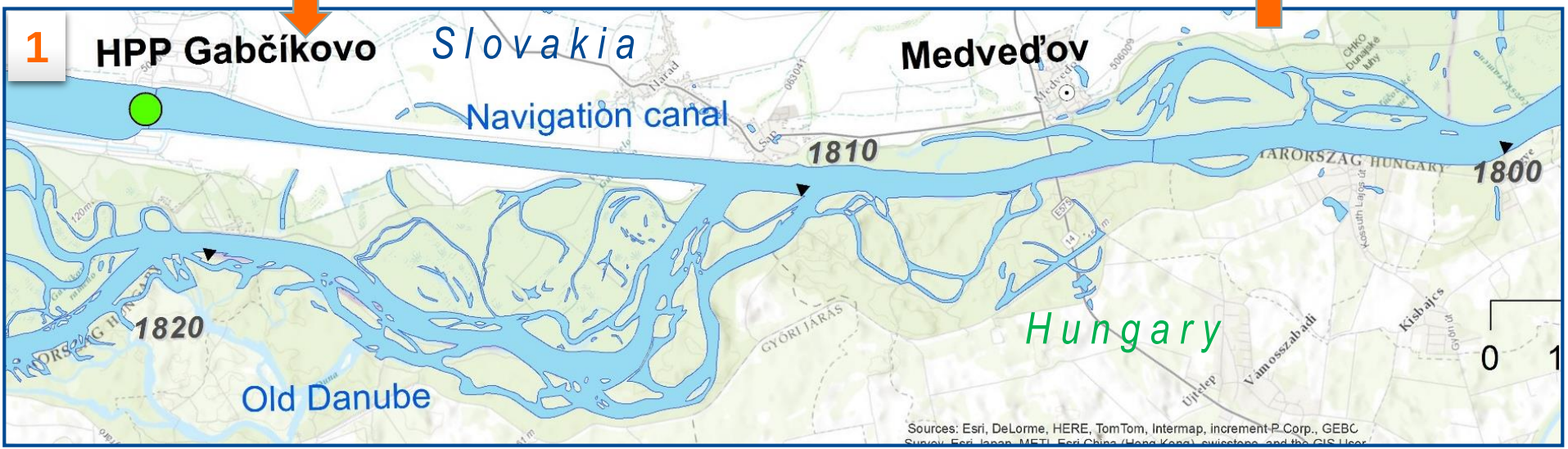
1) Medveďov – Kľúčovec side arm system

- From anastomosing section into transitional meandering
- Characteristic discharges in the Danube -Medvedov

Q (m^3s^{-1}) Medvedov station, km 1806,40 (SHMU)

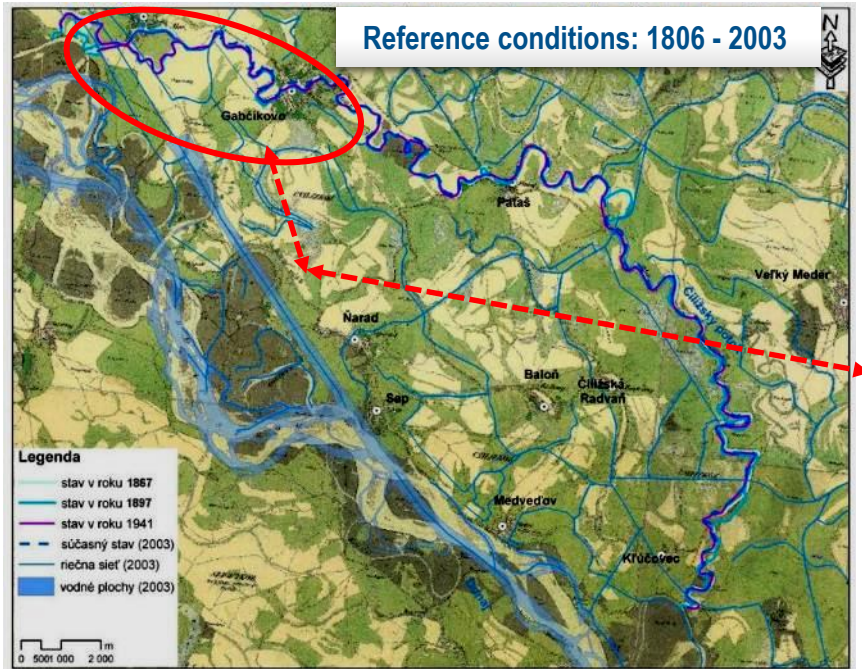
Q_{Nmin}*	Q_a	Q_b	Q_1	Q_5	Q_{50}	Q_{100}
1 040	1 998	4 000	5 100	7 150	9 650	10 400

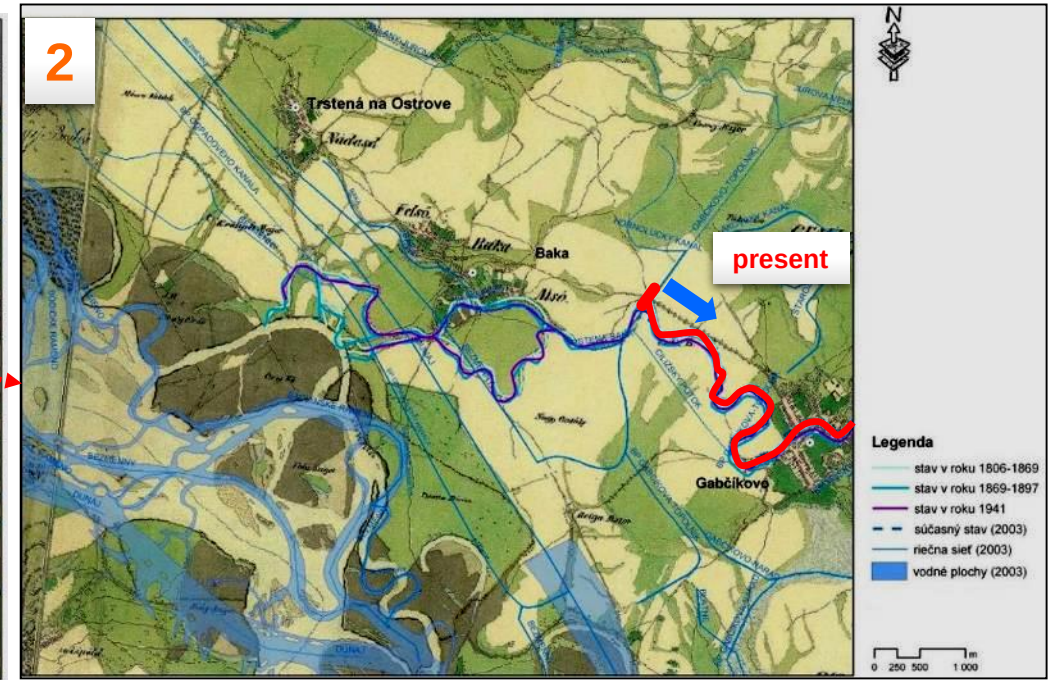
*minimal discharge for navigation



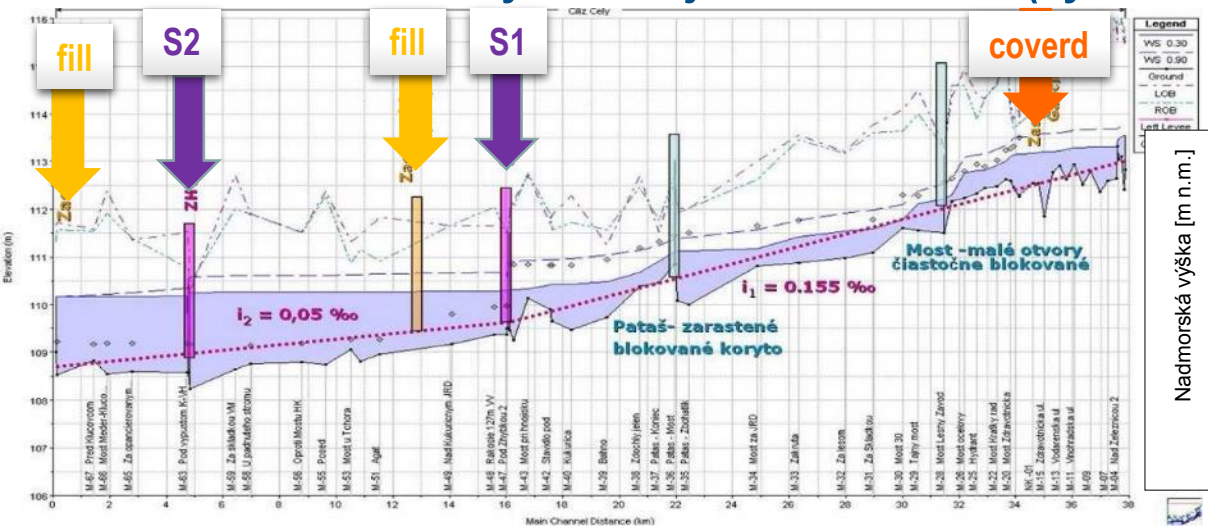
2) Čiliž brook (former Danube side arm) and adjacent wetlands

Objectives: Complex design of restoration measures that enable to improve water regime in the Čiliž brook and selected wetland areas important for *Microtus oeconomus mehelyi,* using results of detail field survey, hydromorphological & hydrobiological monitoring and tools of numerical and physical modeling.

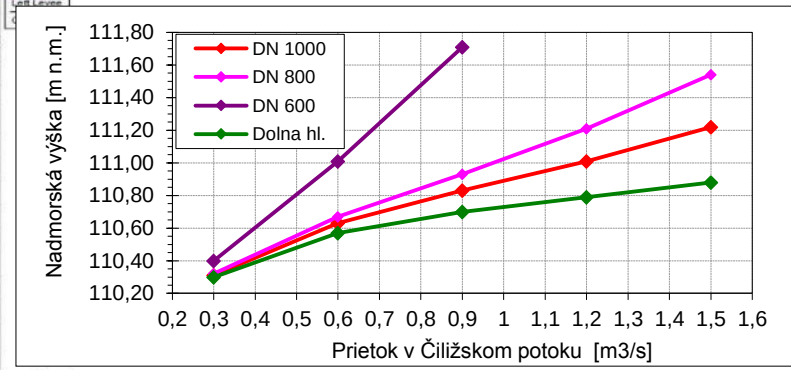




Problems: several barriers on the Čiliž brook – interruption of longitudinal continuity an and lateral connectivity with adjacent wetlands (system of irrigation/drainage canals)



Water level upstream of siphon 1



Methods: **hydrodynamic model** of Čiliž brook and main canals – development, calibration & verification of 1D numerical model for complicated system of Čiliž brook and network of irrigation/drainage canals

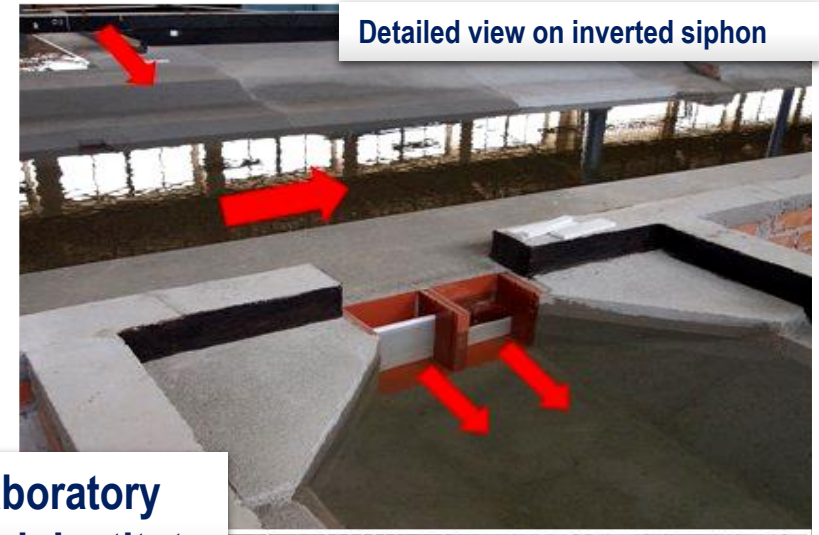
Čiliž flow – channel interruptions

- 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

Physical model – crossing of the Čiliž brook and Chotarny canal

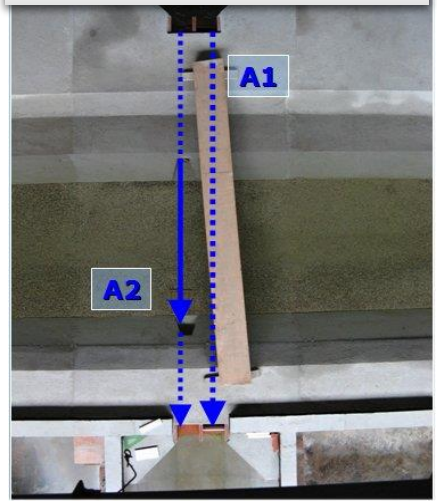
Crossing of the Chotarny canal and Čiliž brook

Detailed view on inverted siphon



Hydraulic laboratory
Water Research Institute

ALTERNATIVES



Alternative 1 - inverted siphon - outflow

Alternative 2–out/inflow through Chotarny

Hydraulic measurements

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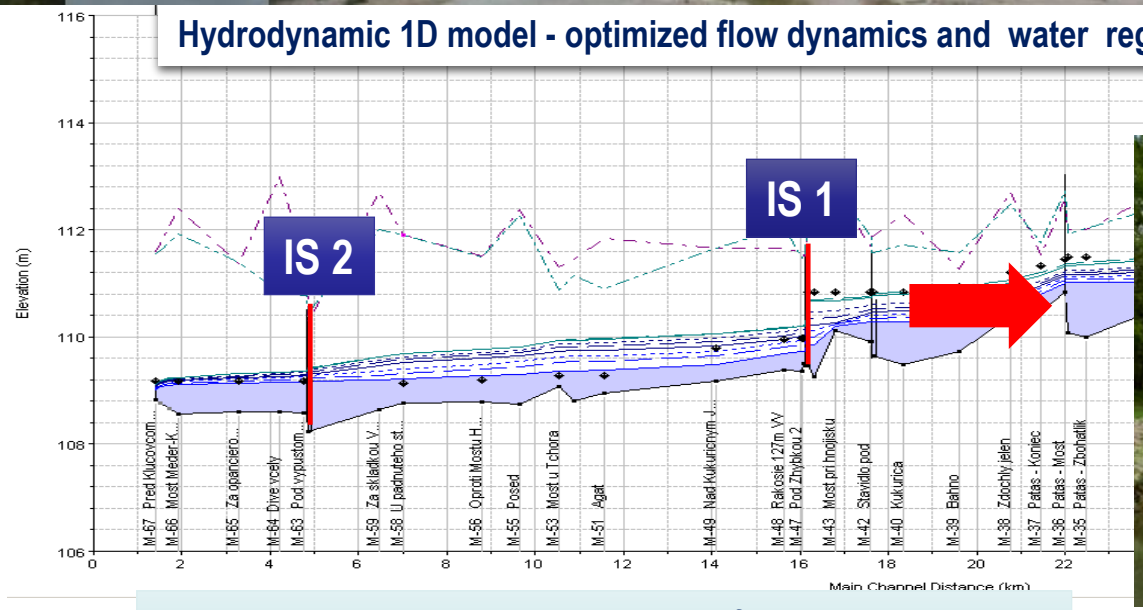
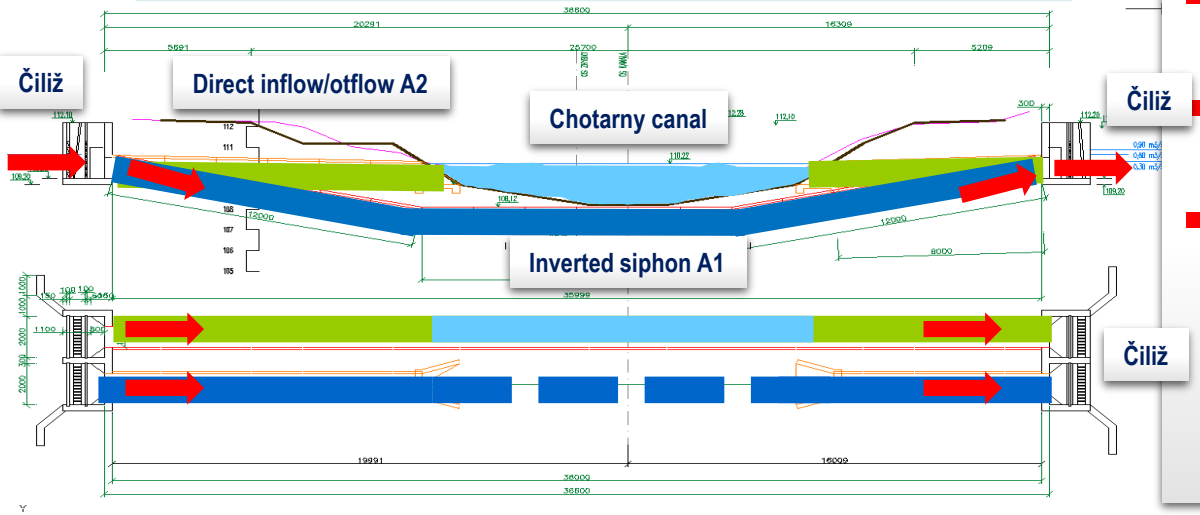
Hydrodynamic 1D model - optimized flow dynamics and water regime in Čiliž- including all restoration measures



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**

Restoration measures – Čiliž brook and adjacent wetlands

Inflow channel improvment

Channel dredging

Pataš-Bahno wetland restor.

Inverted siphon 1 construction

Sluice gate recon. Hany 1c

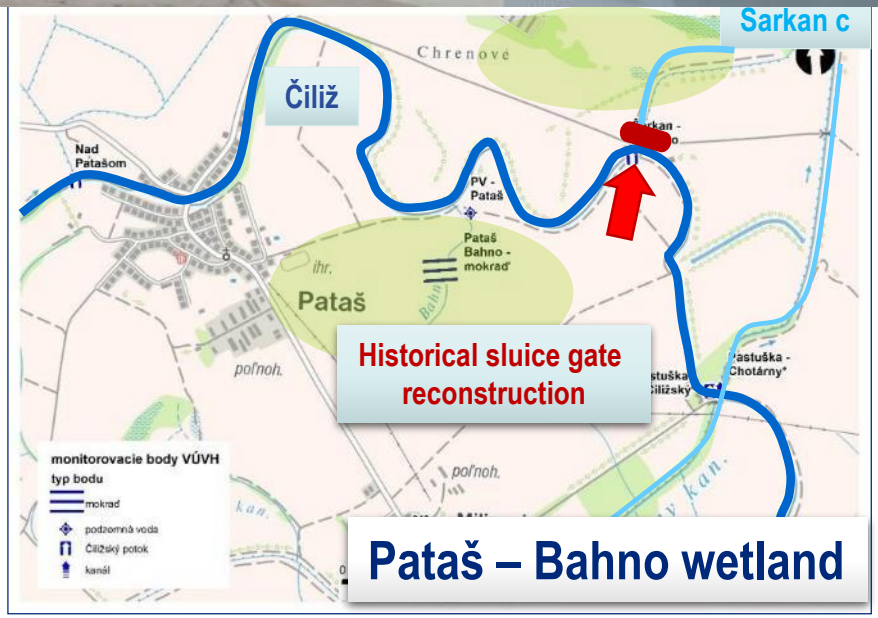
Sluice gate recon. Hany 2c

Sluice gate Červeny c

Inverted siphon 2 construction

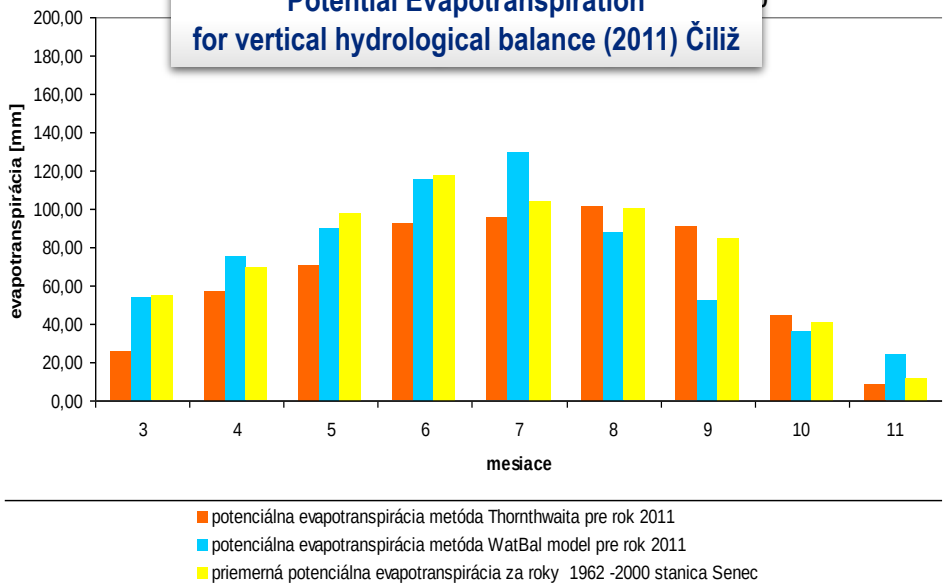
Sluice gate reconstr. on Hamsky canal

Boheľov
Gabčíkovo
Pataš
Čiližská Radvaň
Medveďov
Čičov
Dunaj
VRBINA-HOLIARE
MILINOVICE-VRBINA
HAMSKÝ KANÁL
0 1

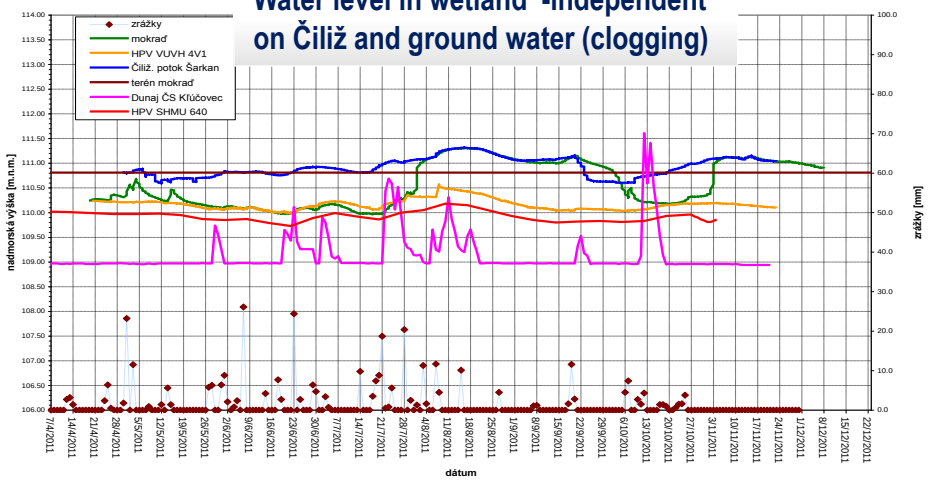


Pataš – Bahno wetland

Potential Evapotranspiration for vertical hydrological balance (2011) Čiliž



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



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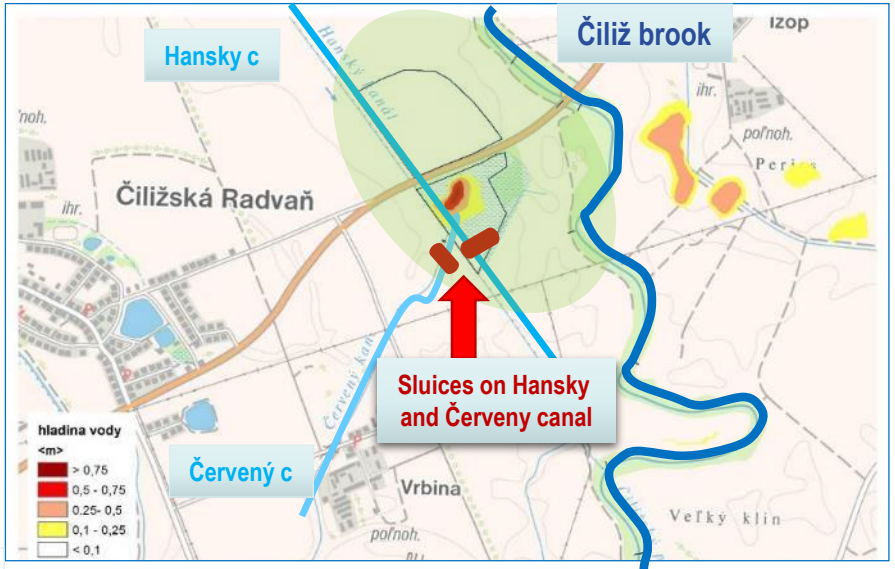
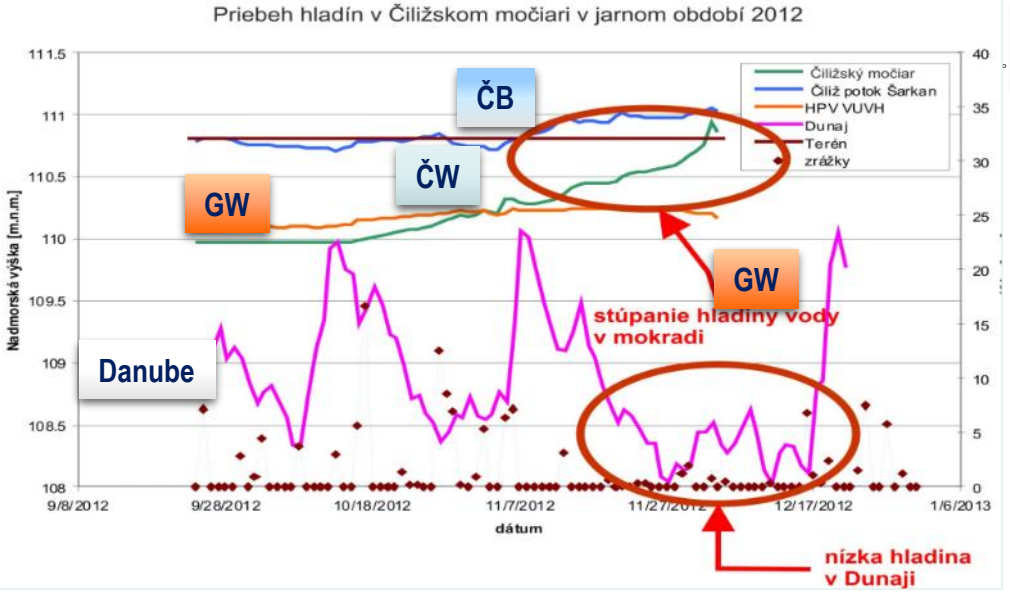




Čiližská Radvaň - wetland

Locality: Medveďov – Kľúčovec side arm system, Danube rkm 1800 - 1810

Reference state (end of 19th century)

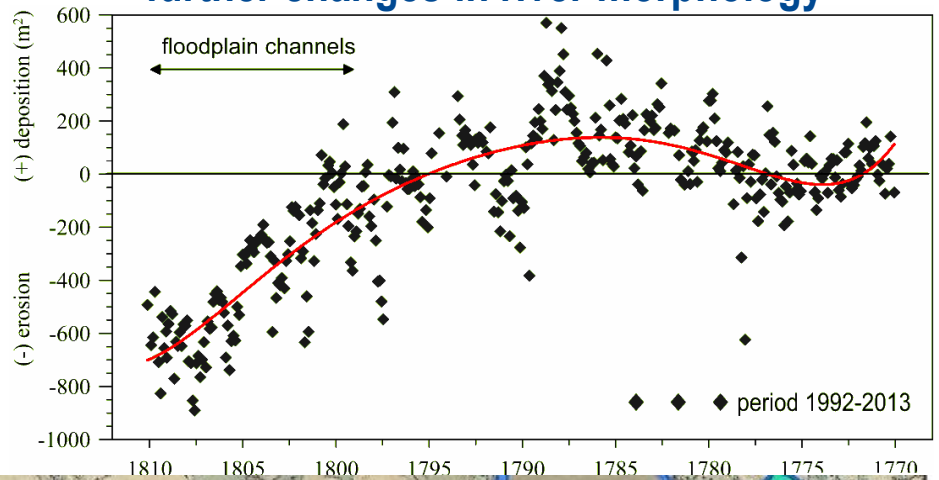
- very dynamic river system
- complex of mosaic channel habitats
- high diversity in riparian & wetland communities

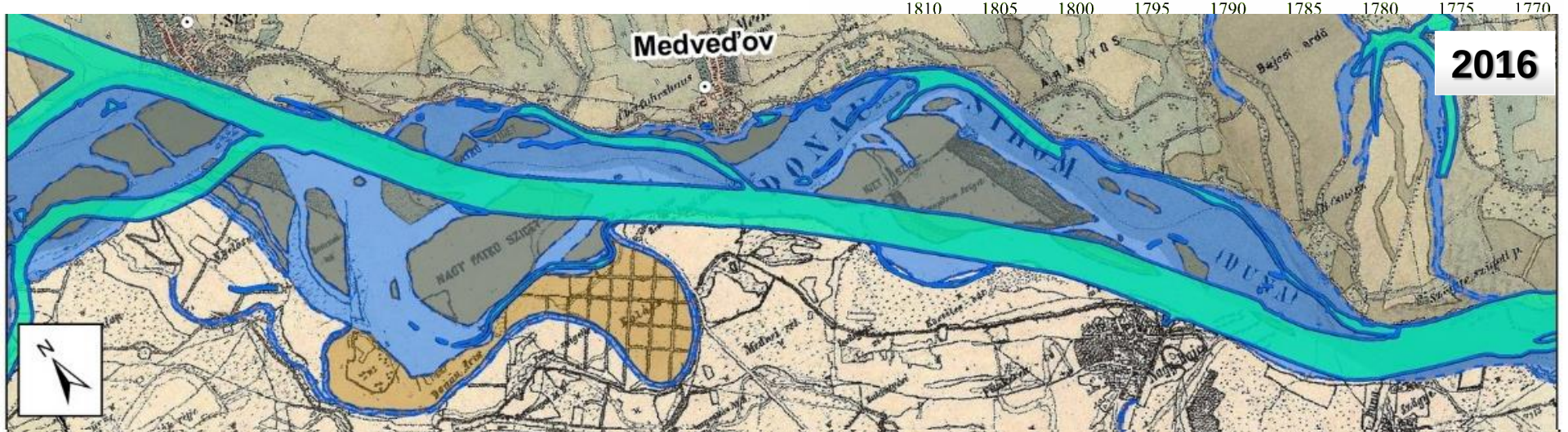
Regulation impacts (20th century):

- isolation of the river & floodplain processes
- changes in flow dynamics and sediment transport – aggradation/degradation areas

HPP – Gabcikovo impact (since 1992):

- further changes in river morphology



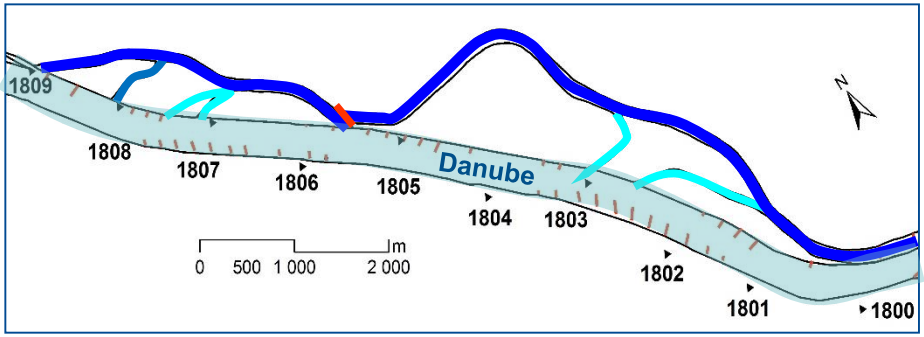


Locality: Medveďov – Kľúčovec side arm system, Danube rkm 1800 - 1810

Combination of restoration measures - scenarios

Floodplain

- **Development of the main floodplain channel – reconnected with the Danube (**both ends) including removal of central weir (dividing side arm system into 2 parts)
- **Reconnection of smaller side channels with the main river** (inflow at low flow), deposits removal,

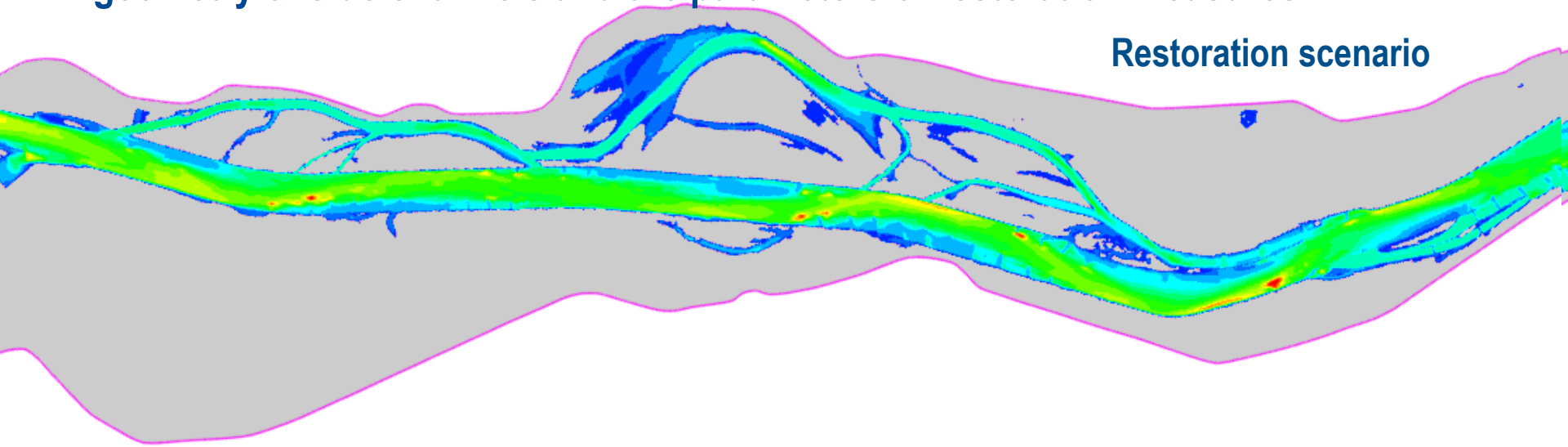


Main river channel

- **Modification of groyne fields** – lowering to the low flow water level (Q_{minN}+ 1.2 m or +0. 5 m)
- **Further smaller measures** (removal of deposits between groins, construction of the weirs at upstream parts of smaller side arms, barriers removal, deflective structure ...

Method

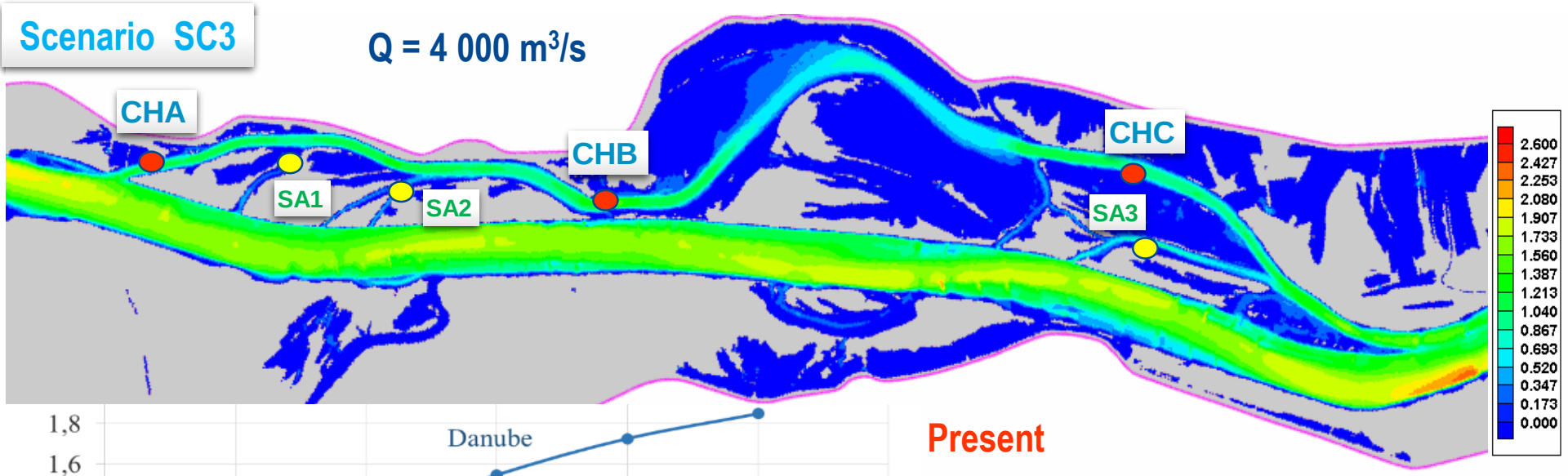
- Field measurements and observations, analyses is of DTM and monitoring results
- 2D hydrodynamic model CCHE2D was developed to optimize the flow conditions, geometry of side channels and the parameters of restoration measures

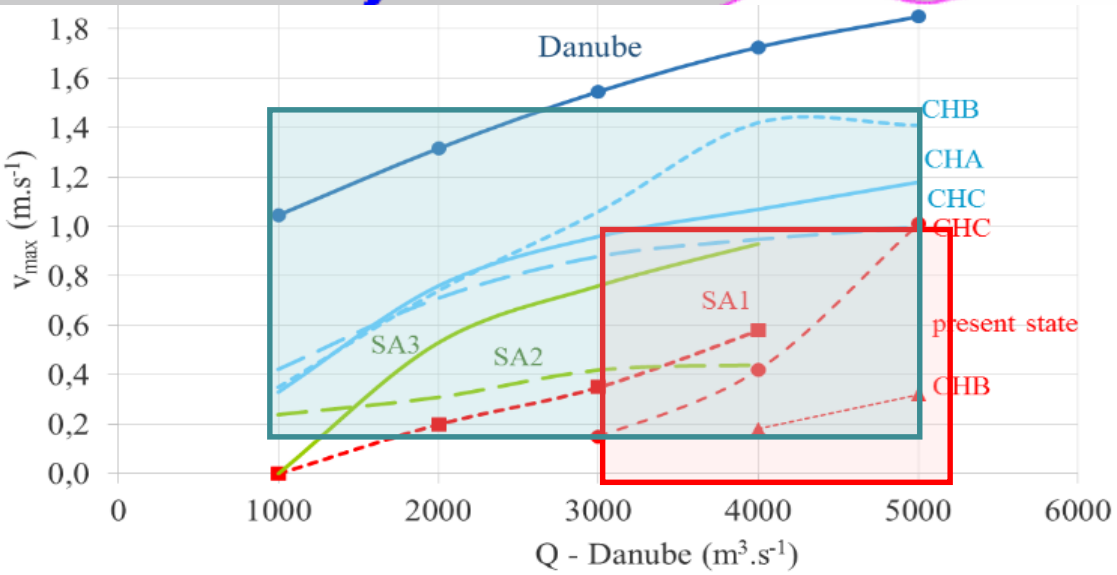


Main indicators for optimising the scenarios

- Discharge conditions, velocity pattern, shear stress distribution
- Frequency and duration of lateral connectivity
- Geometry of reconnected side channels particularly the length ratio and offtake angle

Flow dynamics for the present & restoration scenario SC3





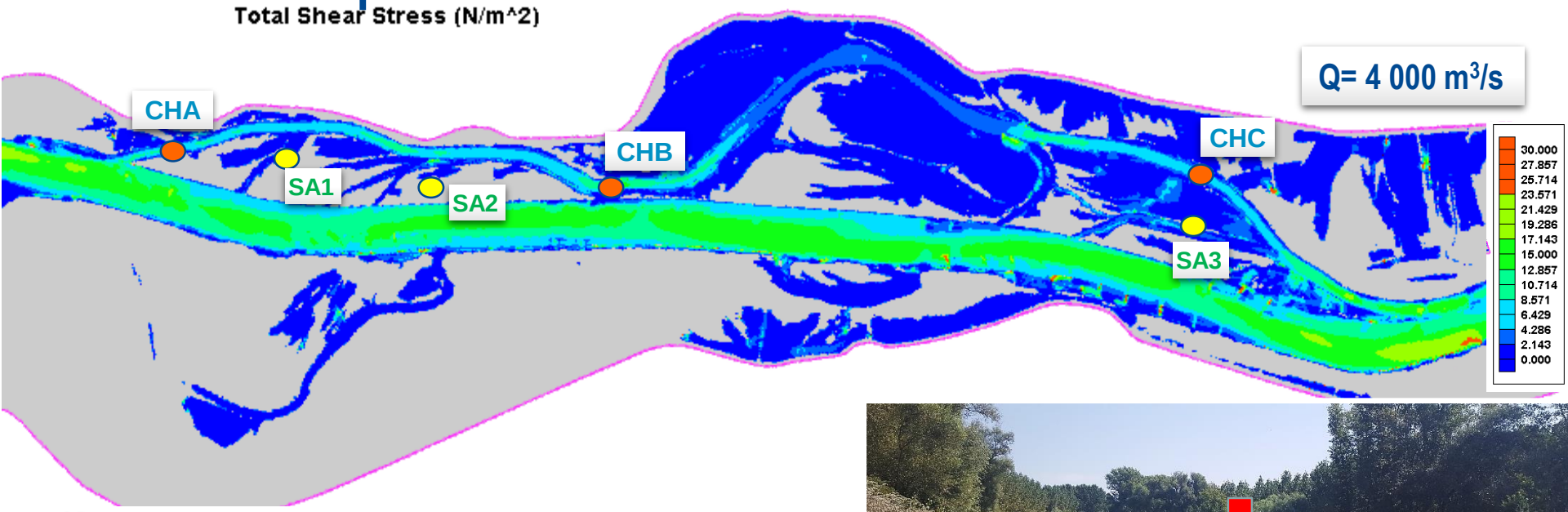
Present

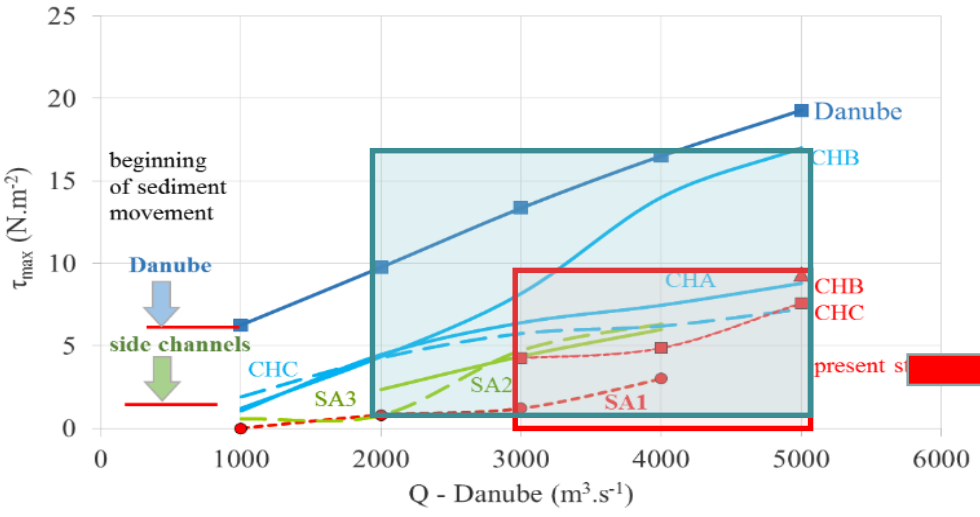
- low flow velocity for up to $Q_{bankfull}$
- mostly stagnant water except of opened (filling & emptying of the side arms)

Scenario SC3

- flow velocity in the main floodplain channel – close to the Danube
- higher flow velocity in smaller channels
- keeping areas with low flow velocity

Shear stress & potential sedimentation for SC3





Results shows ...

- Reconnection of the former floodplain channels and adjacent wetlands supports reintroducing of the river and floodplain processes providing better flow & sedimentary conditions to promote complex and dynamic habitats in the Danube floodplain
- Restoration of longitudinal continuity and lateral connectivity associated with incresed flow dynamics is more important for maximising the river system's potential for biodiversity than simple increased of water surface area
- Improvement of hydromorphology can result in restoration of more natural conditions on heavily modified areas of the Danube river floodplain providing significant ecological improvement and multiple benefits for the river system
- Higher sustainability of the restored hydrological connectivity and higher stabilization effect of the river bed in the Danube river channel can only be achieved by integration of more complex measures in the river channel (e.g. removal of bank protection, etc.).


Thank you ...