



The concept of ecological restoration of a sub-alpine river and its tributaries in Slovenia – Suggestions for regulation of riverbed and reconstruction of hydro-technical facilities

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The concept of an ecological restoration:

- Catchment approach
- Interest for flood risk reduction and good ecological and chemical status (quality of the aquatic environment) merged
- Water rights guaranteed or updated in accordance to ecosystem capacities
- Reconstruction of existing or building new objects should guarantee the above mentioned needs, but also provide development opportunities



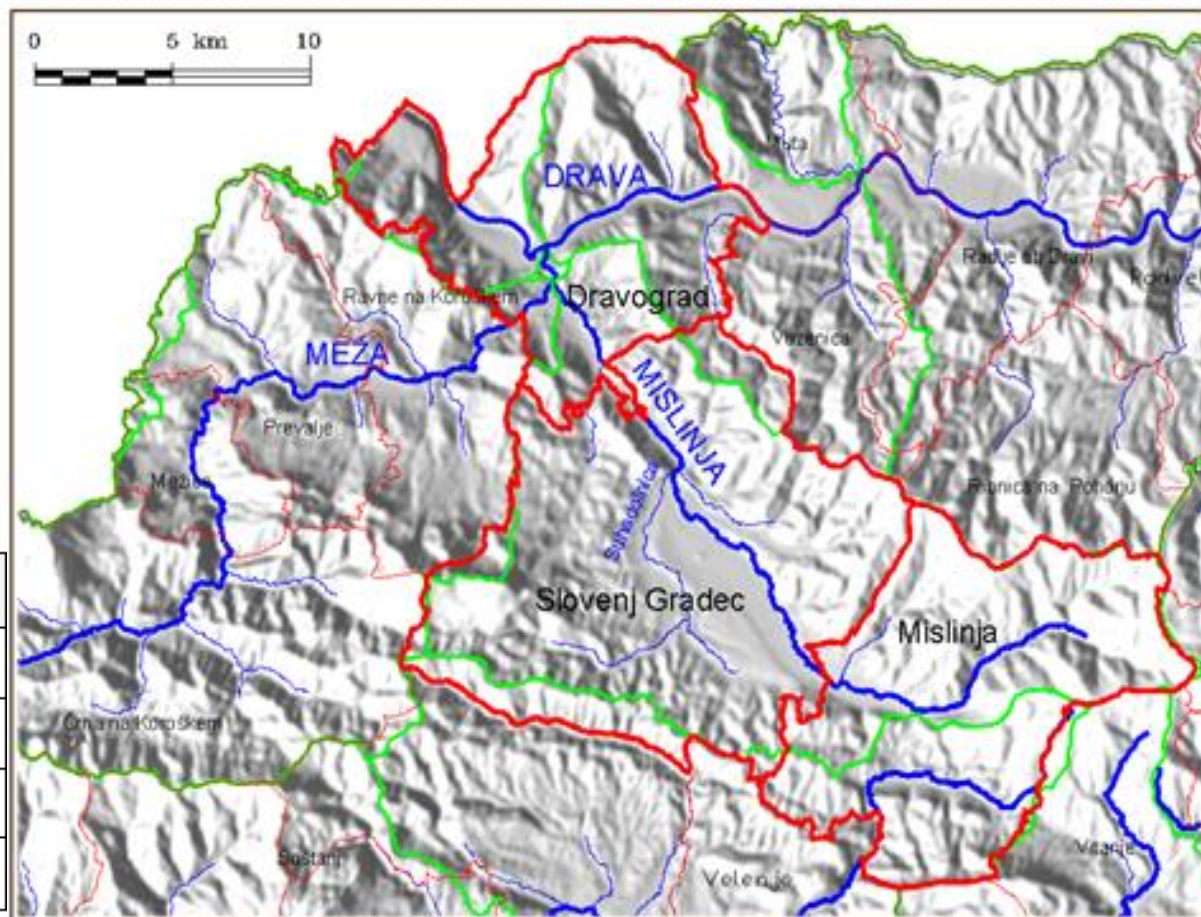
Comprehensive plans are needed on the river basin level to consider existing hydrodynamic conditions and the primary purpose of existing objects, facilities and arrangements. Operational goals are:

- Reducing flood risk by preventing rapid water drainage from river basins and hinterland areas (retaining water in the areas with minimum flood damage and threat)
- Maintaining river flow in relation to use of space (settlements and outside) and minimal ecological requirements
- Improving living conditions for aquatic flora and fauna

Study area:

Mislinja river basin

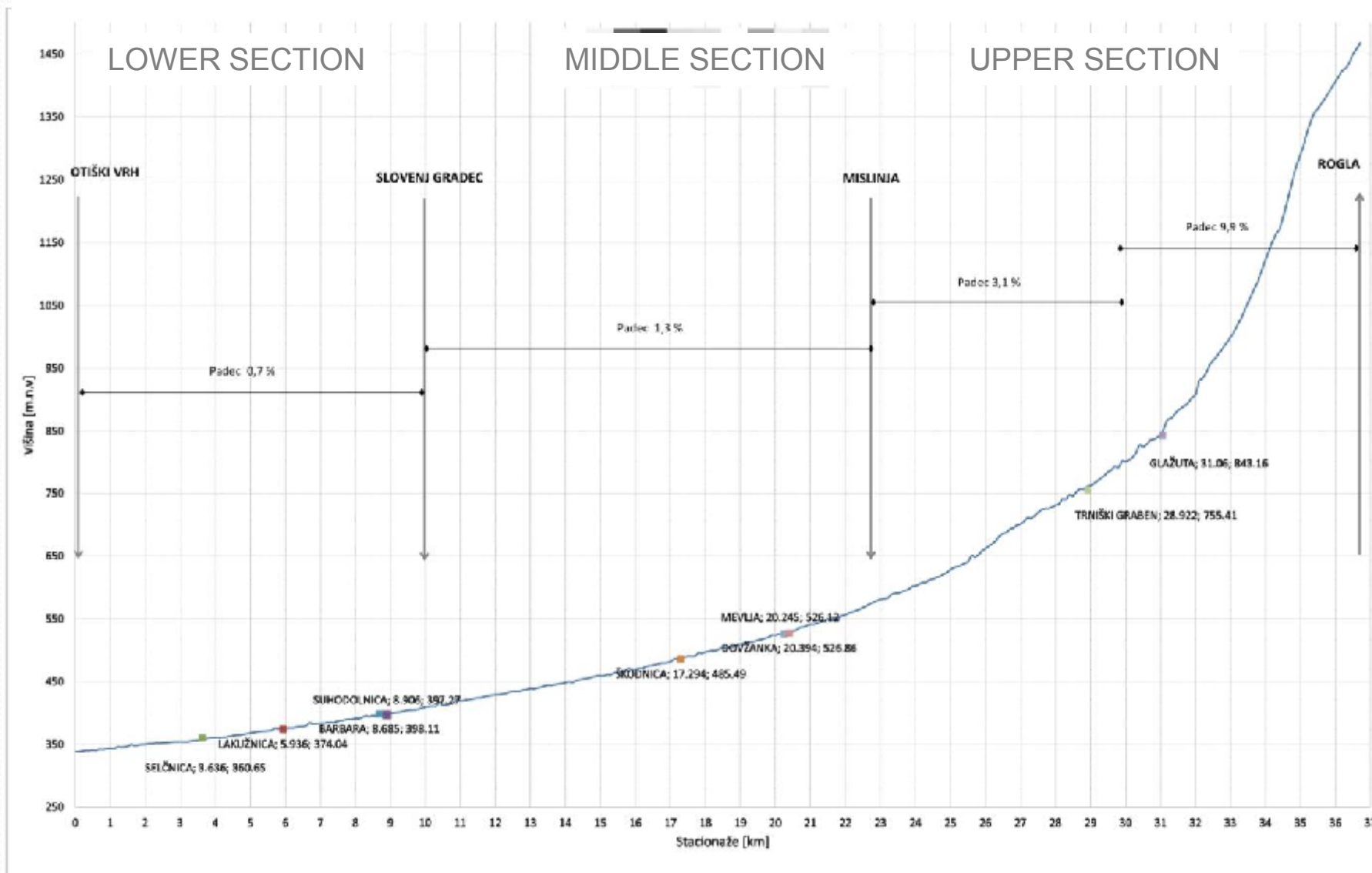
- Extending on the area of three municipalities (Mislinja, Slovenj Gradec and Dravograd)
- River length 36 km, average flow 2.35 m³/s, low flow 0.66 m³/s, max flow 230 m³/s (year 2012, v.s. Otiški vrh)



Municipality	Catchment area [km ² /municipality]	%	Population
Slovenj Gradec	149.5	62.7	16893 (97/km ²)
Mislinja	70.96	29.7	4686 (42/km ²)
Dravograd	13.11	75	9046 (35/km ²)
SUM:	238.6	100	30625 (78/km²)



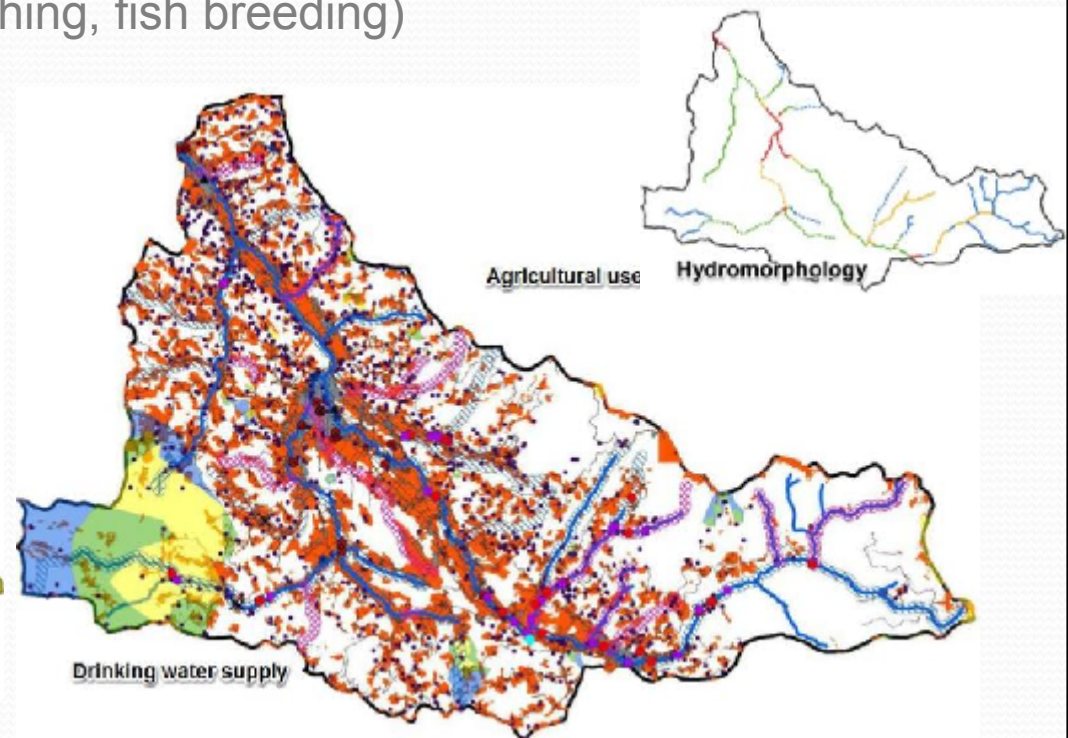
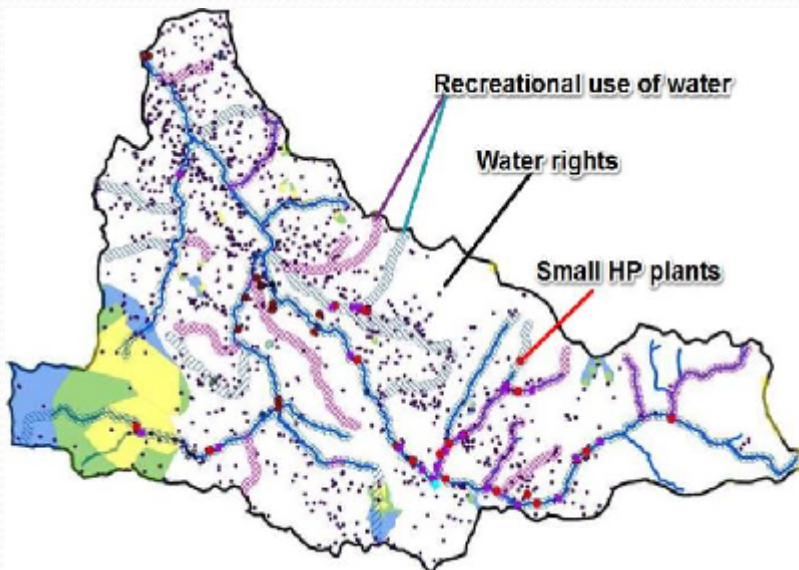
RIVER PROFILE: Torrential character (torrential flow, high sediment transport)



Main pressures:



- Point and diffuse water pollution (settlements, nutrient inputs due to agriculture, traffic, ...)
- Hydrological and morphological pressures due to water abstraction for the needs of small hydropower plants and hydrotechnical objects
- Hydrological pressures due to drinking water supply
- Hydrological and morphological pressures due to land reclamation and flood protection (urbanisation and agriculture) with river channel regulation objects (bank and bed stabilisation, straightening and deepening of channels)
- Recreational use of river (sport fishing, fish breeding)



Proposed solutions:

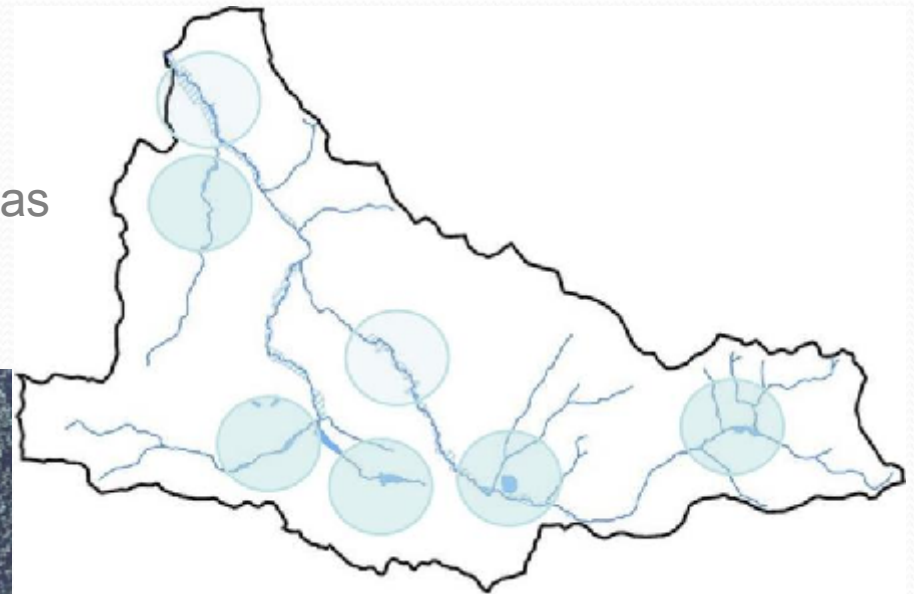


River restoration:

- more effective and environmentally acceptable flood risk management
- creating conditions for new development projects and programs related to water and riverain areas.

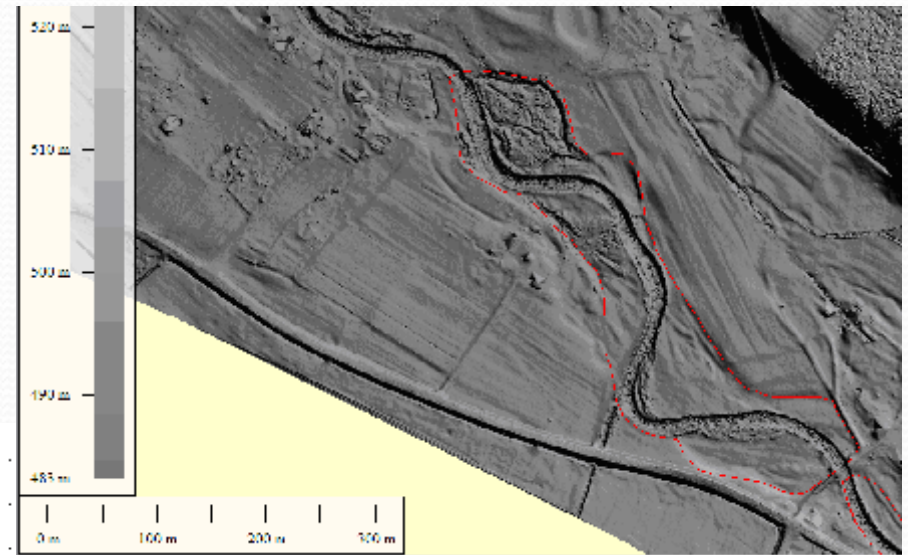
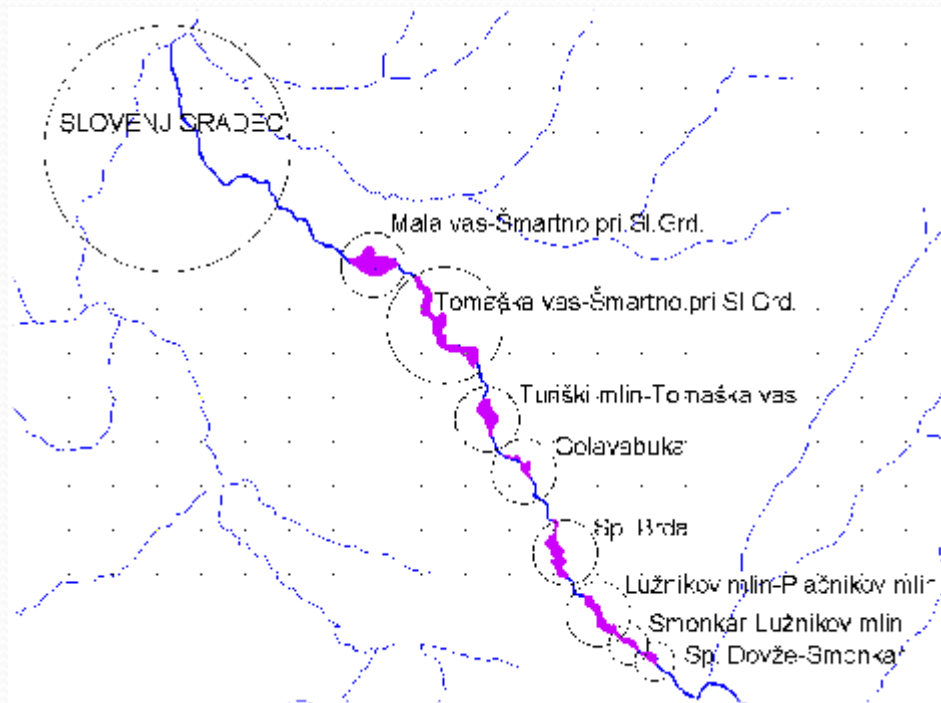
1) Water retention

- Dry or wet reservoirs
- River natural inundation and retention areas





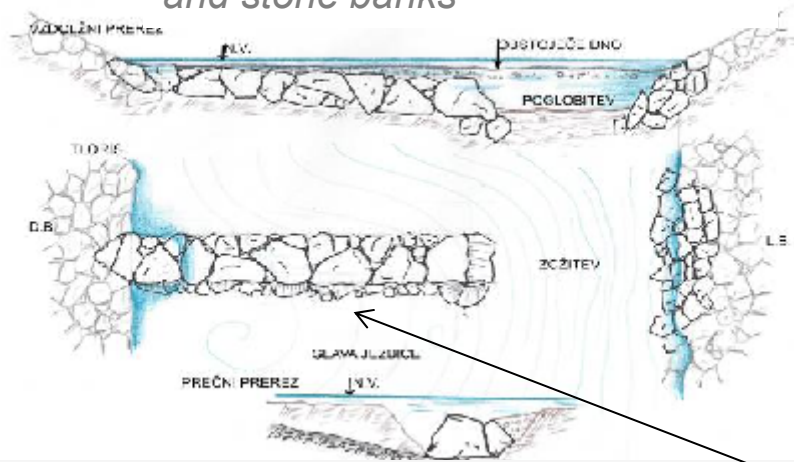
IMPORTANT TO DEFINE a) a targeted channel discharge capacities (high water) of the river and natural inundation/retention areas along the channel nad b) existing morhpodynamics and land use of riverain areas (existing flood areas, wetlands)



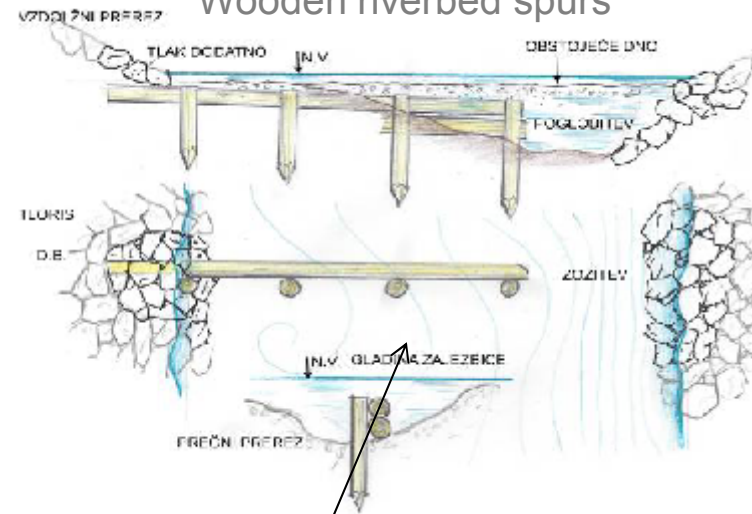
2) Restoration of morphodynamical characteristics of river to improve living conditions for fish and other aquatic life and to control flood risk



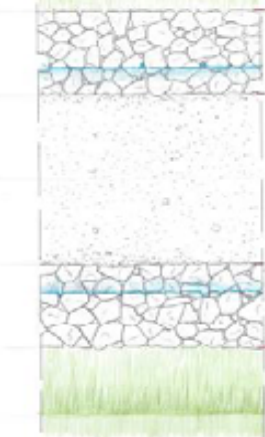
a) Stone riverbed spurs (*jezbice*) and stone banks



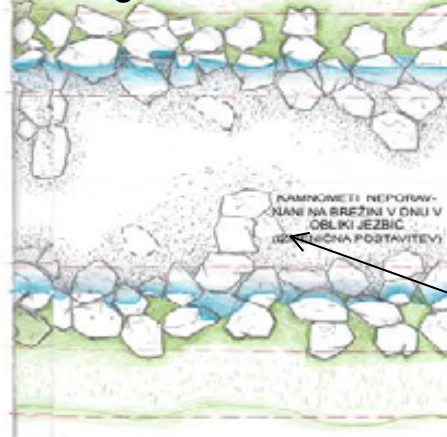
Wooden riverbed spurs



Current state



Ecological restoration



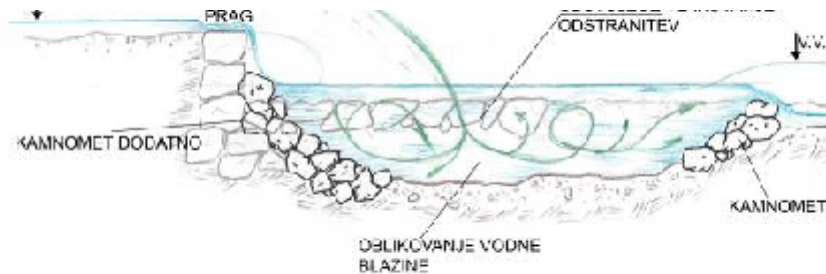
pool formation

Riverbed spurs (*jezbice*) and stones

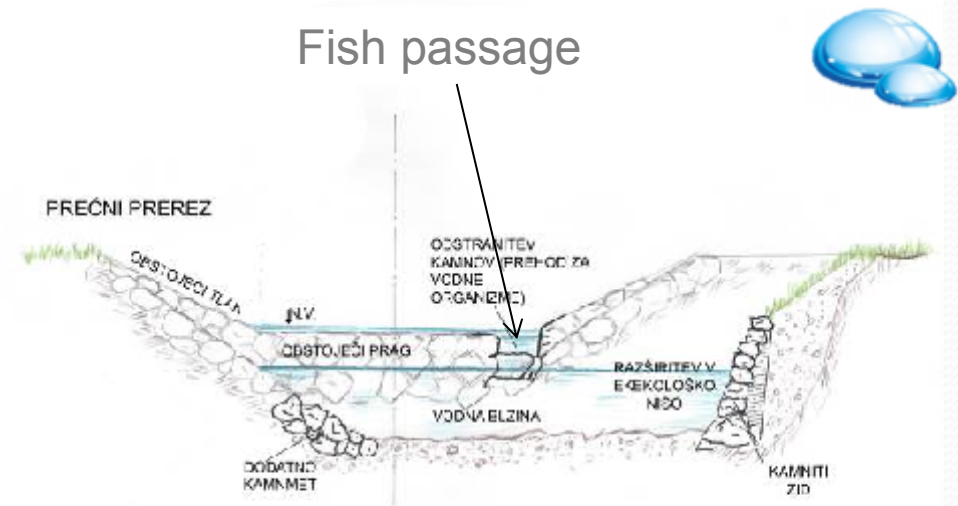
ODSEK S KAMNITIMI JEZBICAMI IN NEPORAVNANIM KAMNOMETOM NA SPODNJI STRANI BREŽIN

KAMNOMETI NEPORAVNANI NA BREŽINI V DNU V OBLIKU JEZBICE (JEZBICNA POSTAVITEV)

b) Restoration of low dams (weir):
 fish passages with water cushion,
 ecological niche and
 riverbed reinforcement to prevent
 failures



Fish passage



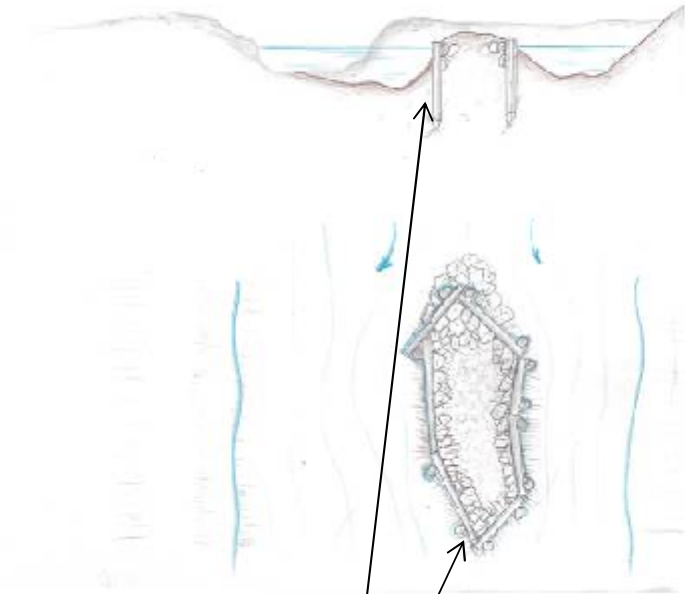
Water cushion formation
 and ecological niche



Permanent pool beneath
 stone weir (river Zilja)



c) Formation of islands and dunes



Wooden columns and beams



Artificial islands
protected with exposed
big stones
(River Zilja)

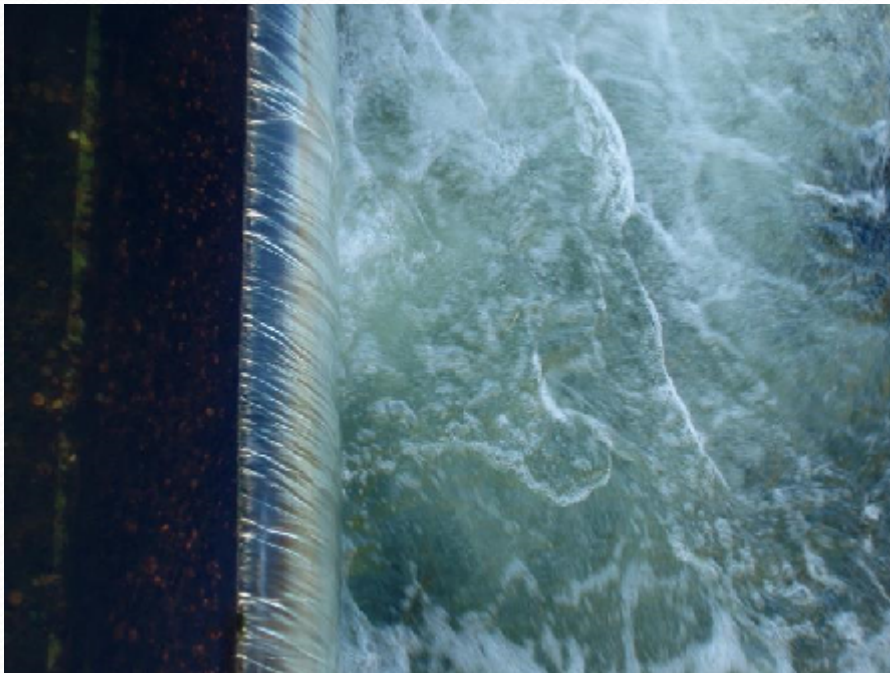
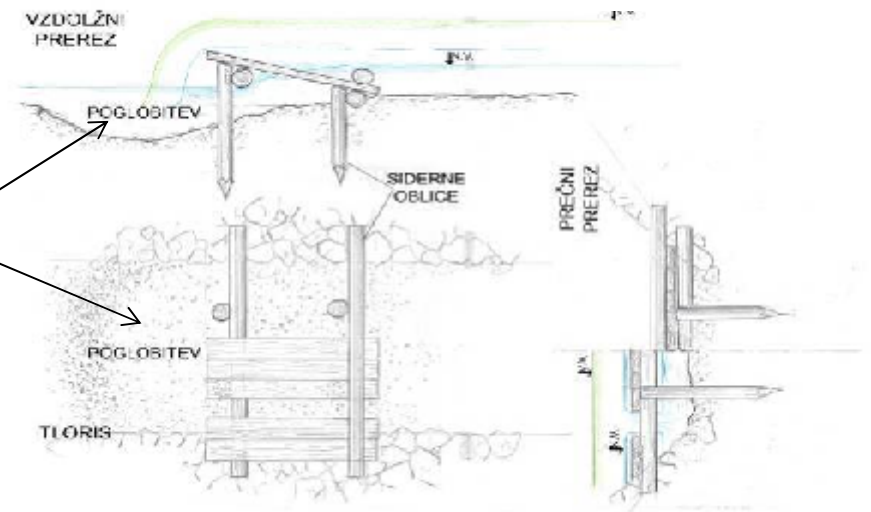


d) Construction of small lateral overflow structures (creation of pools and rapids, fish shelters, more oxygen..)



Roof type wooden weir

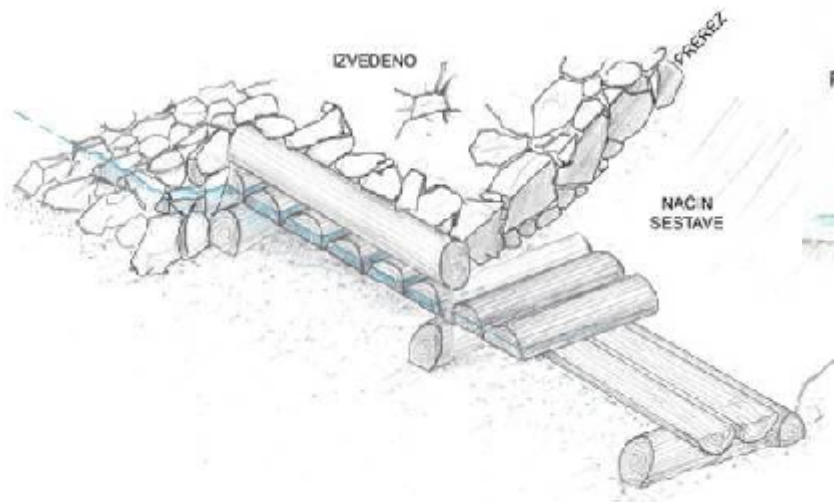
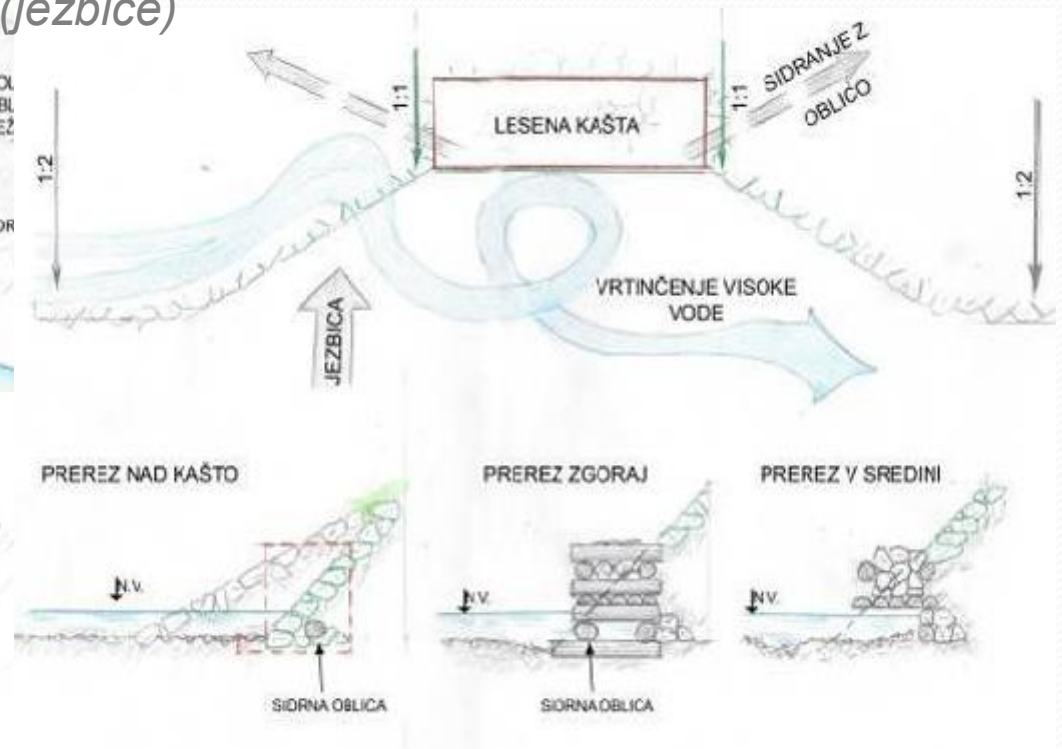
Bottom deepening



e) River bank wooden protection and fish shelters "kranjska stena"



Systematically constructed objects form woodlogs and stone on the river bank; opposite lies riverbed spurs (*jezbice*)

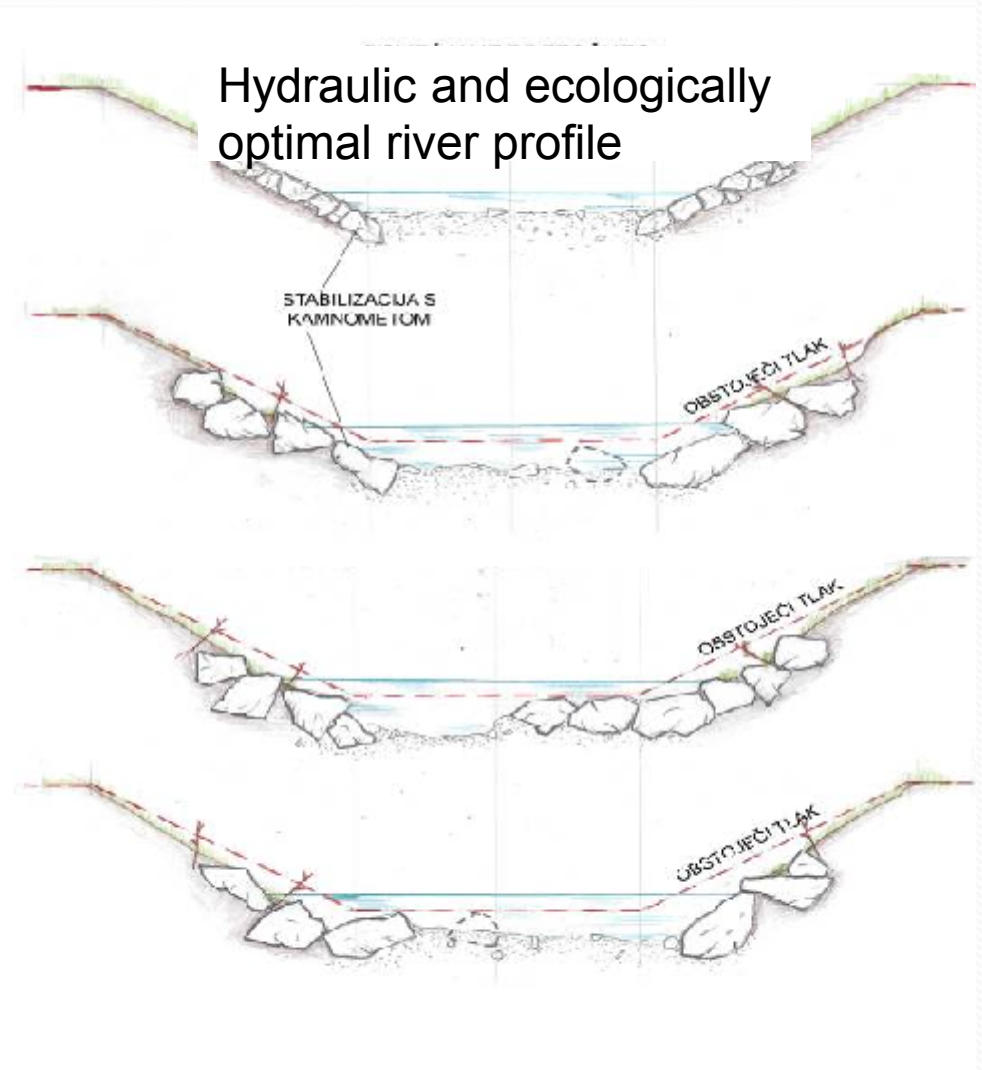


(creation of fish shelters, high dynamic of river flow)

f) Restoration of straightened and evenly shaped channel sections into hydraulically and ecologically optimal river profile to guarantee „approved“ discharge capacities (flood risk control management) and to encourage higher morpho-dynamics (pools and rapids)



Irregularly exposed stones and stone banks (Zilja river)





Costs estimation for proposed solutions on the section of the river between Dravograd and Mislinja:

- River channel length 22.5 km (approximately 18 km in rural areas and 5 km in urban)
- Appr. 700,000.00 €
- Appr. 35 objects (one / 300 m) and restoration of 1 km evenly shaped section

OBJECTS	€
Insertion of bank stabilization stones (1 km river length)	199,600
Wooden riverbed spurs "jezbice" (2 river reach, 15 objects)	70,200
Stone and spurs "jezbice" and irregularly exposed large stones (5 locations)	106,640
Fish river bank shelters "kranjska stena" with stone spurs (4 locations)	108,000
Wooden weir (8 locations)	65,600
Wooden weir-roof type (4 locations)	34,800
Dam structure with water cushion (2 locations)	103,620
ESTIMATED COSTS	688,460



Thank you!