

# Strategic tools for sustainable hydropower development

## Alpine River Restoration Workshop

4<sup>th</sup> of September 2014

Zvolen, Slovak Republic



**University of Natural Resources  
and Life Sciences, Vienna**  
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# Hydropower – important source of renewable energy





# Impacts of hydropower



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## Altered flow regime and interruption of river continuity



## Alteration of sediment transport



## Ecological impacts

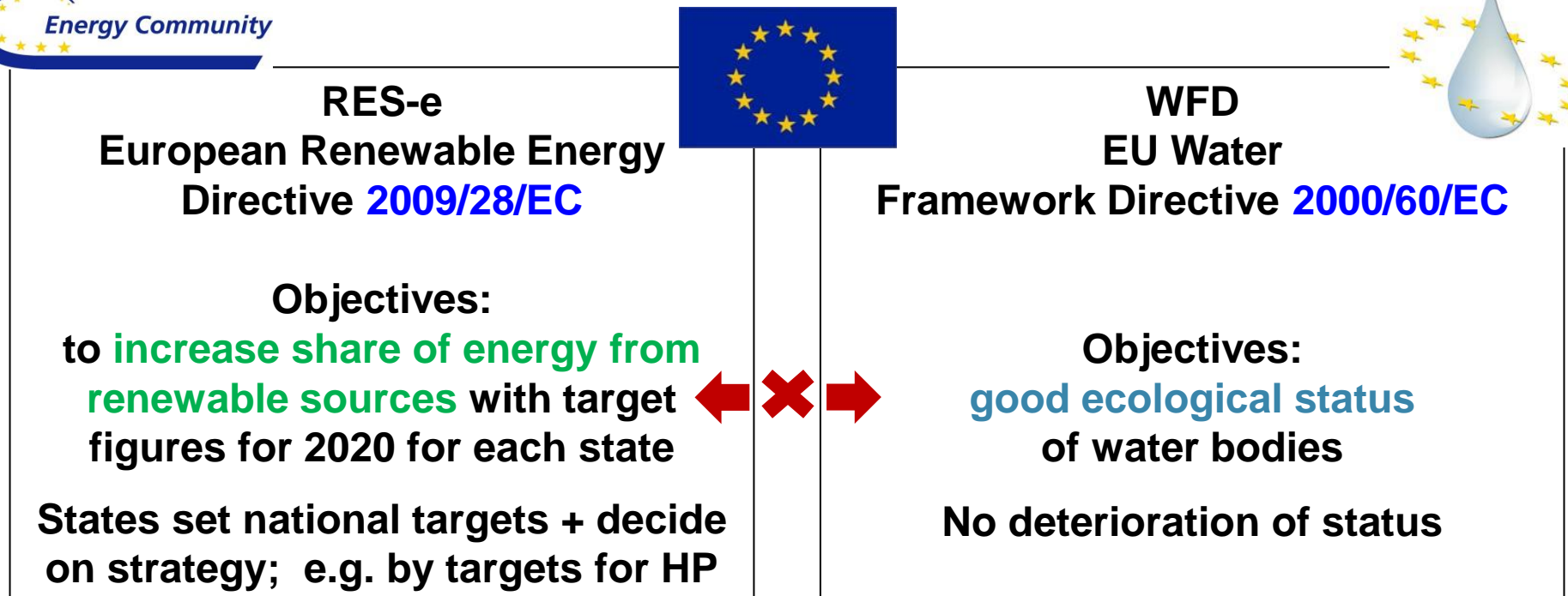
# Legislative framework



## Ambitious EU legislation for **energy** + **water**



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**Conflict of interest**

# Addressing the conflict of interest



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## How to balance?



**Increase of renewable energy**



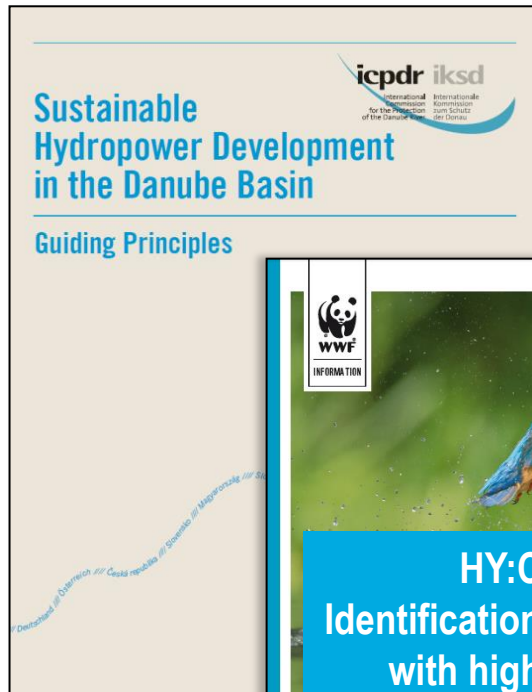
**Environmental objectives**

## Need for inter-sectoral cooperation !

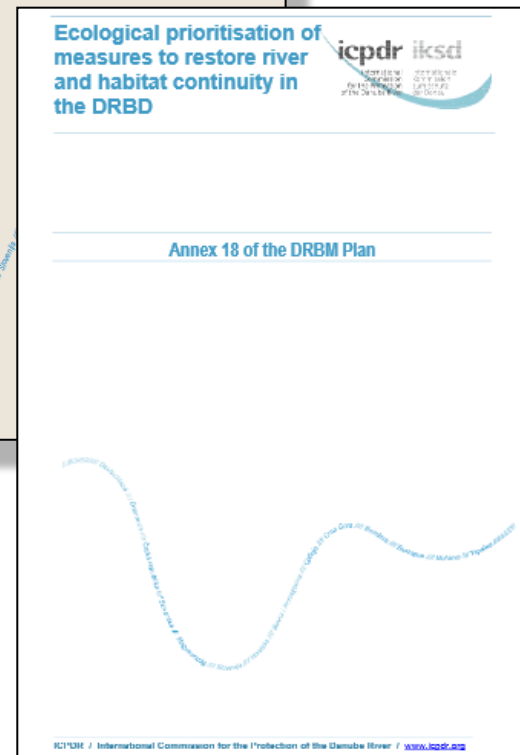
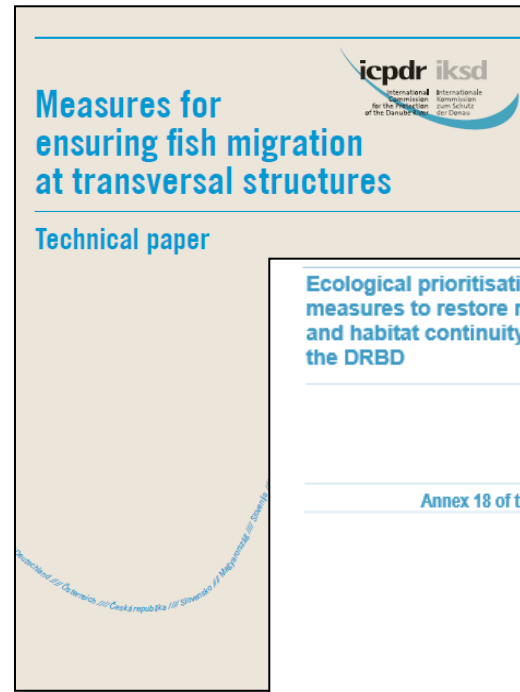
# 4 examples addressing the conflict of interest



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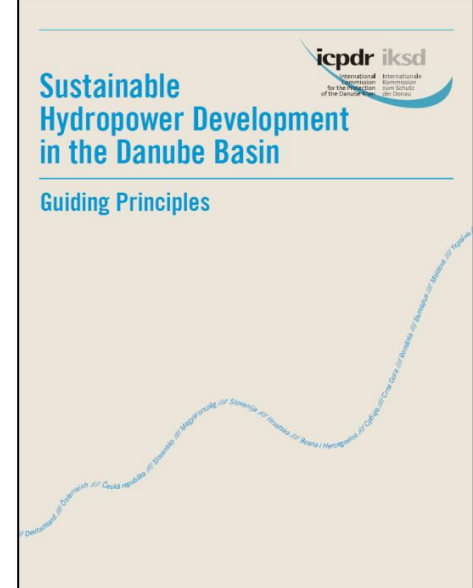


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# Guiding Principles on Sustainable Hydropower Development



- Recommendations based on EU legislation & EU policies
- Strike for balance, represent state of the art in Europe

## Guiding Principles promote

1. Set of **general principles** (inclusiveness and transparency of process, call for holistic approaches, ...)
2. Technical upgrading of **existing hydropower** plants combined with ecological restoration
3. **Strategic planning** approach for **new hydropower** based on two level assessment (regional + site specific) in order to find appropriate sites in region with lowest impacts
4. **Mitigation** of negative ecological impacts

# Strategic planning approach for new hydropower development

## Two-level assessment



icpdr iksd

International Commission for the Protection of the Danube River  
Internationale Kommission zum Schutz der Donau

Recommended list for national/regional criteria

TABLE 1

National/Regional criteria	Description
<b>Energy Management</b>	
Hydro-electrical potential (theoretical or line Potential)	Product between quantity of flow and head
<b>Environment</b>	
Naturalness	Status of river stretches/water body in relation to conditions regarding hydrology, morphology and communities
Status of water body with regard to rarity and ecological value	Rarity of the river type, ecological status of the water body
Specific ecological structure and function of the river stretch also with regard to the whole catchment/ sub-basin and in relation to ecosystem services	e.g. Particular habitats for sensitive/valuable species in the riverine ecology (e.g. red list species)
Conservation areas and protected sites	e.g. Natura 2000 areas (Birds and Habitats), UNESCO Biosphere Reserves, National, Regional Parks
<b>Landscape</b>	
Naturalness	no significant anthropogenic impacts
Diversity	Intact terrestrial ecology with extensive use of land (e.g. small agriculture with low fertilizer use)
Landscape scenery	e.g. aesthetic values, high architectonic and cultural values
Recreation value	Use for soft tourism and recreation, such as fishing, canoeing, etc.
Cultural heritage	Historical buildings and villages or towns, traditional crafts, etc.
Spatial planning obligations	Legal regulation for different areas and uses

Recommended list for project-specific criteria

TABLE 2

Project-specific criteria	Description
<b>Energy Management</b>	
Hydropower plant size	Installed capacity
Hydropower plant type	e.g. run-of-river, diversion, storage, pumped storage
Security of supply	Production and supply of energy (Auto supply),
Quality of supply	Production characteristics – base load/ peak load (storage option, pumping storage)
Contribution to climate protection	lower CO <sub>2</sub> emissions of the energy mix
Technical efficiency	Grid connection, potential use, size of plants
<b>Environment and water management</b>	
Ecological impacts of the project	Longitudinal/lateral/vertical connectivity; impacts on habitats and biota taking into account already existing impacts
Flood control	Protection of sites at flood risk; alteration of flow regime
Irrigation	Positive or negative effects on water availability for irrigation
Sediment management	Reservoir siltation, bedload transport, sediment contamination, plant design
Surface and groundwater quantity	Infiltration and exfiltration, minimum ecological flow,
Surface and groundwater quality	Nutrients, persistent organic substances, hazardous substances, thermal effects
Drinking water supply	Positive or negative effects on quality and service security
Bank protection and restoration	Foster erosive banks
Fisheries	Ensuring natural reproduction and fish migration across dams and residual water stretches
Effects of climate change	Changes in flow regime and impacts on economic feasibility of projects
Effects on water bodies already restored	water bodies restored by public money should not be effected again
<b>Socio-economic criteria</b>	
Conformity with local spatial planning	Compliance with the local regulations
Necessity of further infrastructure for construction and operation	Access, energy grids, etc.
Regional economic effects	Taxes, income for the public; investments in local economy, induced employment
Recreation, tourism	Potential positive and negative effects on tourism
Other socio-political considerations	depending on the local situation



# Strategic planning for new hydropower

## National/Regional level assessment



icpdr iksd

International Commission  
for the Protection  
of the Danube River  
Internationale Kommission  
zum Schutz  
der Donau

### Suitability

Step One

Is hydropower development possible  
according to existing national or regional  
legislation/agreements?\*

no

yes

Exclusion\*

Step Two

Energy management

Environment/  
landscape

FAVOURABLE for hydropower development	LESS- FAVOURABLE for hydropower development	NON- FAVOURABLE for hydropower development
Generally considered as possible	Possible under specific circumstances	Possible in exceptional cases**

Energy Management  
Hydro-electrical Potential

high				
medium				
low				
low				
medium				
high				

Environment and Landscape

# Austrian Water Catalogue (AWC)

- Published by the Austrian Ministry of Life (2012)
- Defines important assessment criteria
  - Energy
  - Ecology
  - Project specific/ water-management related criteria

AWC does not include an approach  
on how to combine the criteria to an overall assessment

**HY:CON** ➡ **Instrument for identifying projects with  
*high energy efficiency & least conservation concern*  
based on economic & ecological criteria**

## Österreichischer Wasserkatalog Wasser schützen – Wasser nutzen

Kriterien zur Beurteilung einer nachhaltigen Wasserkraftnutzung  
(BMLFUW-UW 4.1.2/0004-1/4/2012)



# Identification of Conservation needs based on ecological criteria

8 groups out of > 40 conservation criteria

- Ecological status
- Hydro-morphological status
- Key habitats (e.g. lake outflow, rare river types...)
- Key species (e.g. *Hucho hucho*, *Margaritifera margaritifera*)
- Floodplain forests
- Protected sites with strict restrictions (e.g. national park)
- Other protected sites (e.g. protected landscapes)
- Free flowing sections and migration corridor of medium-distant migrating fish species



## Exclusion criteria

Criterion with highest rating defined group rating



Group ratings were averaged to overall rating



Results divided into 4 equally distributed groups

(very high / high / medium / low)

## 6 different conservation scenarios



# Hydropower attractiveness based on energy economic criteria



➔ **Scoring 0-5**



Group	Criteria	HP type	Overall weight
Economic attractiveness	Specific investment costs	run-of-river, storage pumped-storage	33%
	€/kWh €/kW		
Security of supply	Annual production (GWh/a)	all	17%
Quality of supply	Production characteristic	run-of-river	33%
	Installed capacity (MW)	storage, pumped-storage	
	Storage duration (h)	storage, pumped-storage	
	Pump storage	storage, pumped-storage	
Climate protection	CO <sub>2</sub> avoidance (ktCO <sub>2eq.</sub> p.a.)	all	17%
	Renewables support	all	

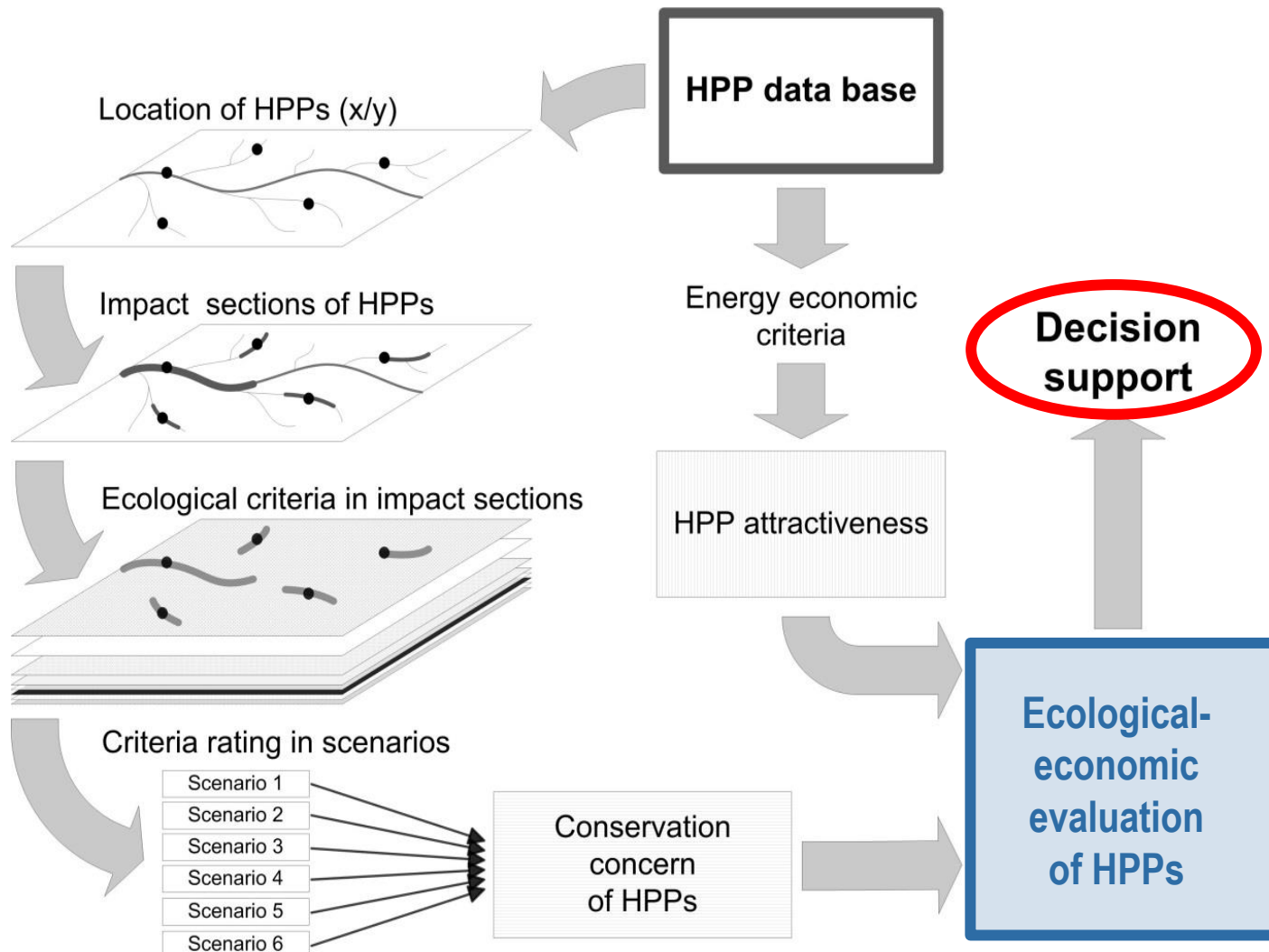


# The HY:CON approach

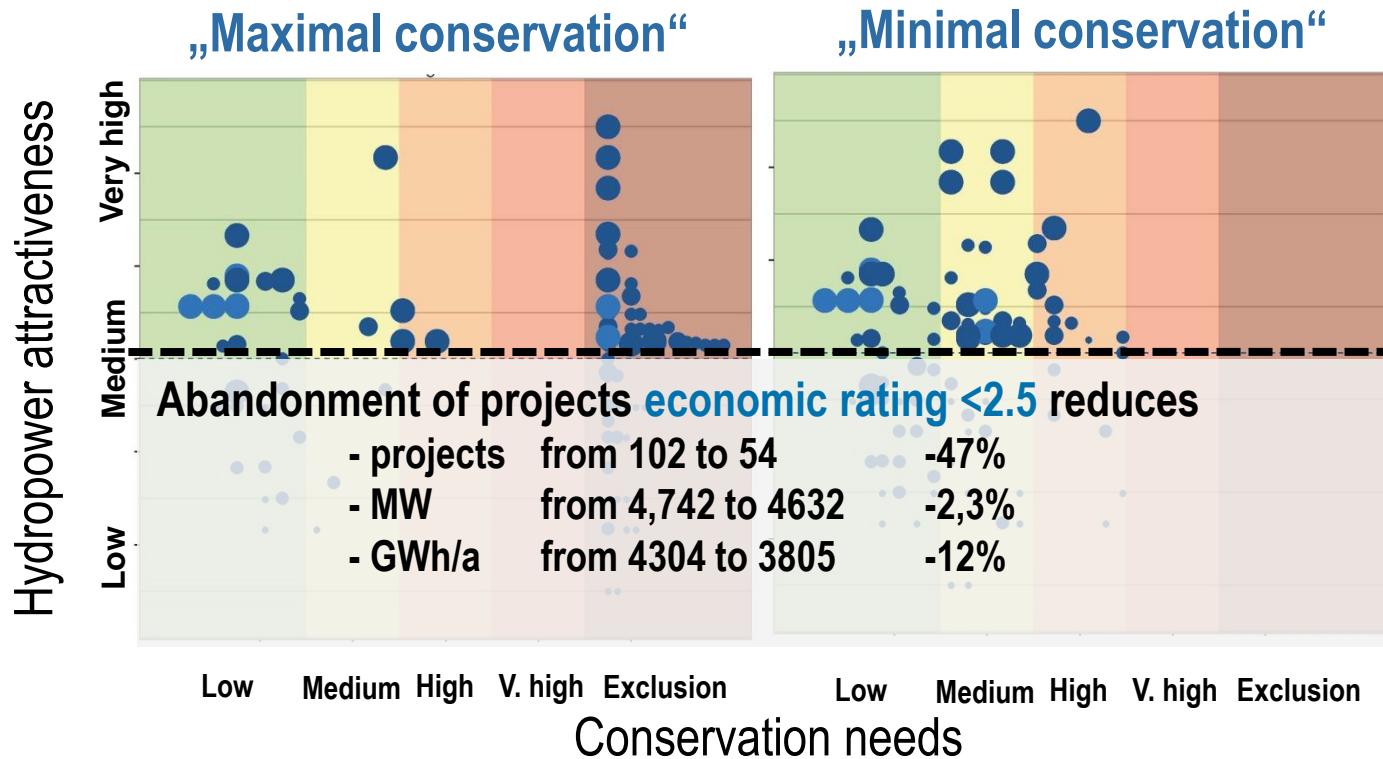
(national scale: rivers, catchment area >10 km<sup>2</sup>)



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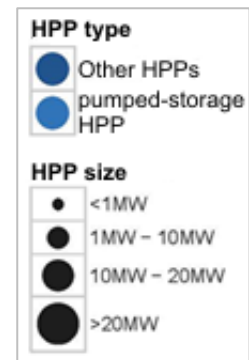
# HY:CON results – combined evaluation



n HPP	Low	Medium	High	V. high	Exclusion	Low	Medium	High	V. high	Exclusion
	29	5	3	0	65	44	39	19	0	0



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# Mitigation measures: Continuity restoration

Long-term goal: continuity restoration at all barriers

- construction of fish passes
- transformation of weirs to ramps
- removal of barrier



Nature-like fish ramp, River Melk



Nature-like fish pass, River Pielach

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International  
Cooperation  
Program  
for the Danube  
International  
Cooperation  
Program  
for the Danube

## Measures for ensuring fish migration at transversal structures

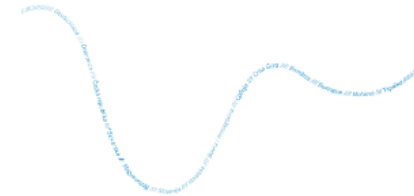
Technical paper

High number of barriers  $\leftrightarrow$  limited resources

Where to start to obtain the highest ecological benefit?

**Prioritisation approach!**

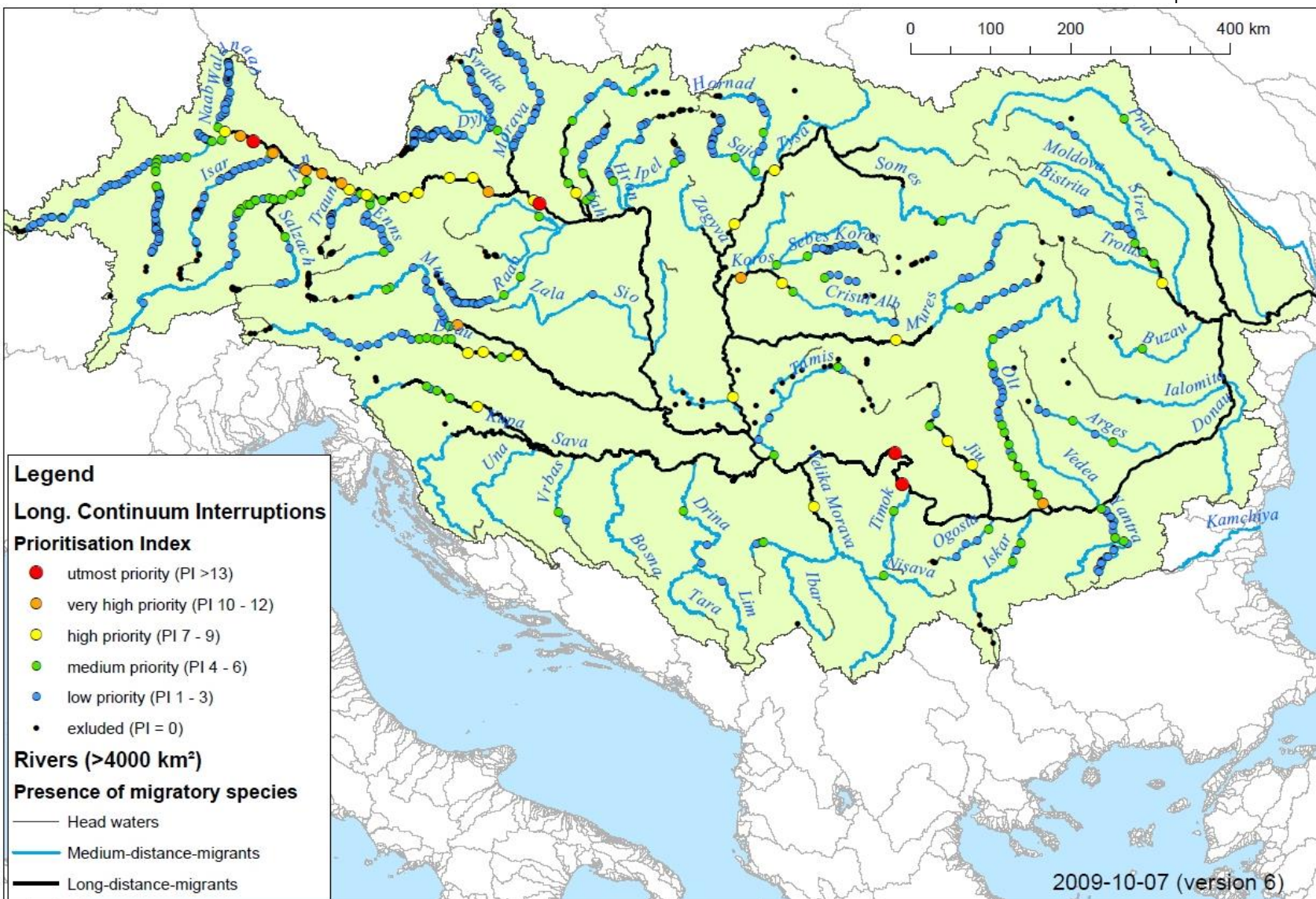
# Mitigation measures: Prioritisation index



<b>Migratory habitat</b>	higher priority to barriers in habitat of long-distant migrants
<b>Location of barrier</b>	higher priority to barrier in or close to the Danube
<b>Reconnected habitat length</b>	higher priority to barrier reconnecting long habitat stretches
<b>Protected site (Natura2000)</b>	higher priority to barrier in/ close to Natura2000 sites



# Mitigation measures: Prioritisation index



# Conclusions



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- **A high number of projects is in conflict with conservation needs**
- **Many small projects** are implemented which **contribute only a little to the RES-e Directive** but **jeopardize the aims of the WFD**
- **Well processed data and transparent results** are required for decision making
- **Further HP development plans** have to base on a **large scale assessment**, integrating **conservation needs & energy economics**
- If HPPs are realized, **ecological mitigation measures, e.g. fish passes, need to be considered**
- **Investments need to be assigned strategically to allow most efficient restoration process**



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