

AQUACROSS Project

Danube case study – storylines

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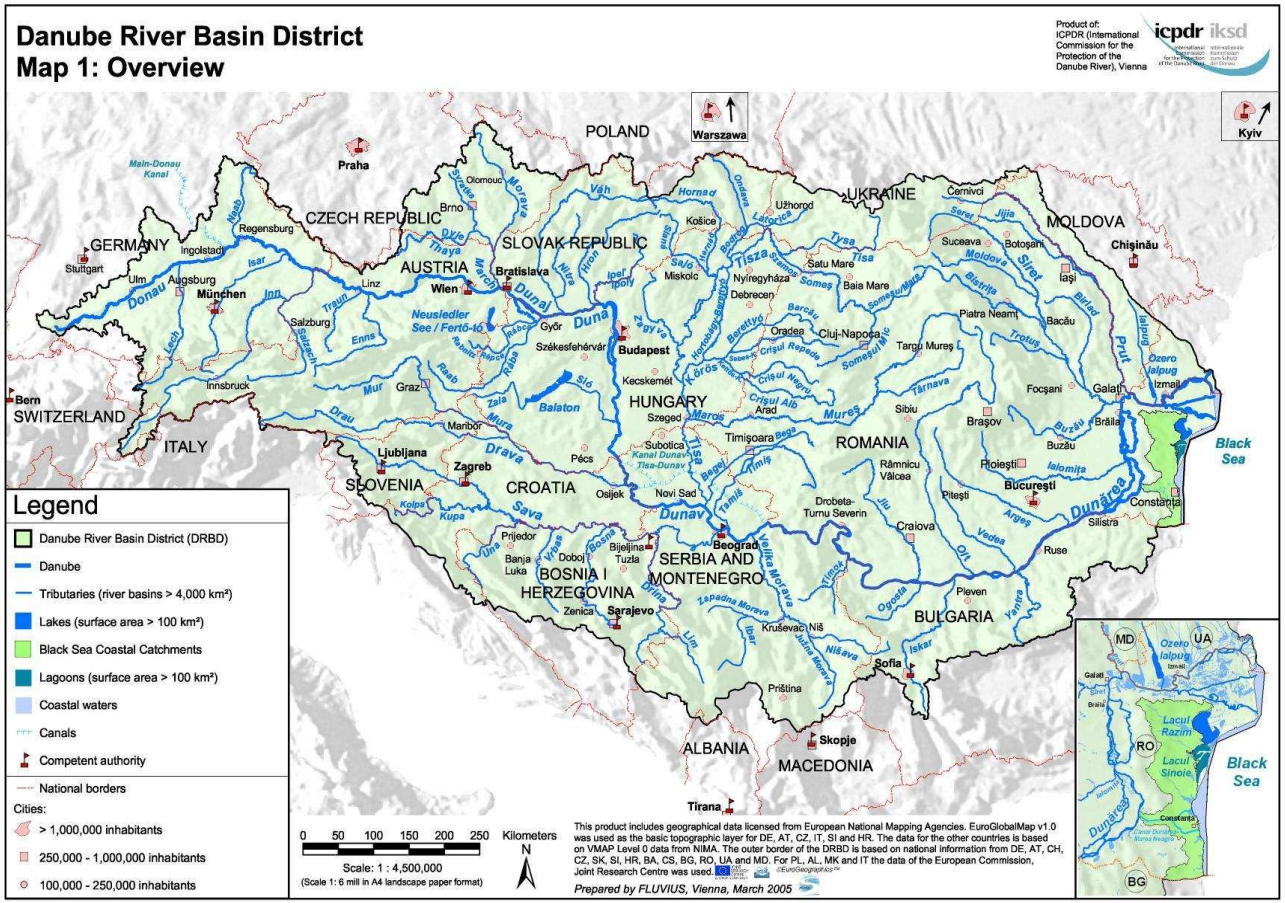
The AQUACROSS project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 642317.

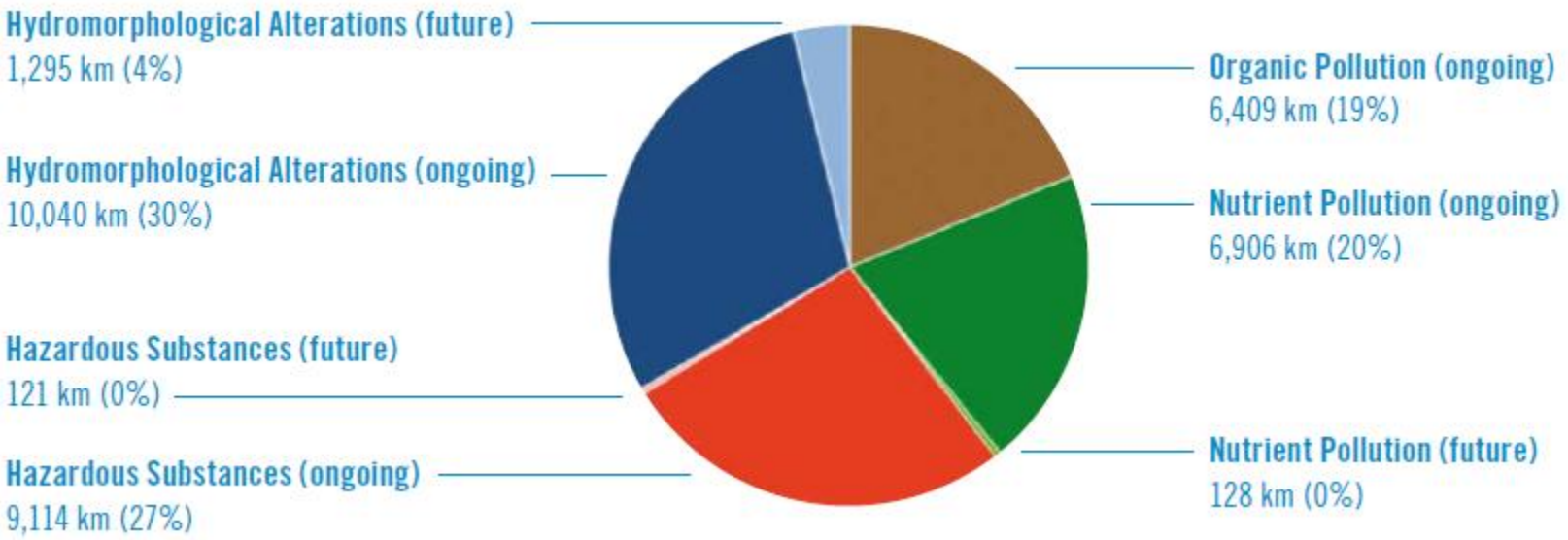
Introduction: Danube catchment



- Most international river basin in the world
- More than 80 million people from 19 countries
- Danube connects with 27 large and over 300 small tributaries

Threats to biodiversity

- Four significant water management issues in the Danube basin (DRBMP, 2015)

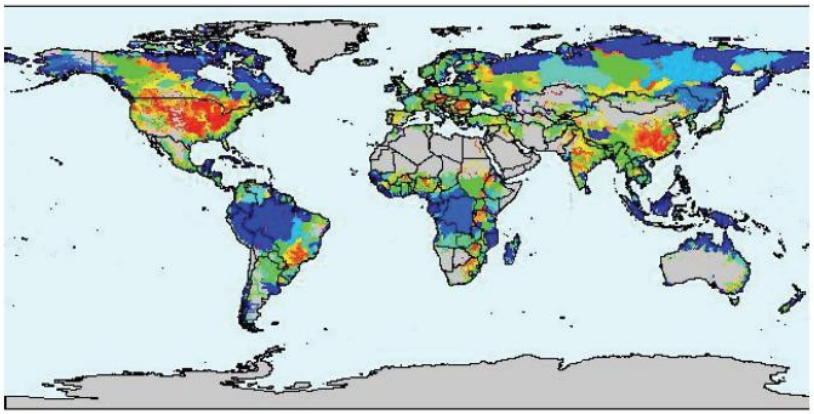


- Emerging issues: Infrastructure projects (navigation, hydropower and flood protection measures); agricultural activity

Threats to biodiversity – hydro-morphological alteration

- Identified as important **threat on biodiversity** on global scale (e.g. Vörösmarty et al. 2010)

Example: river fragmentation



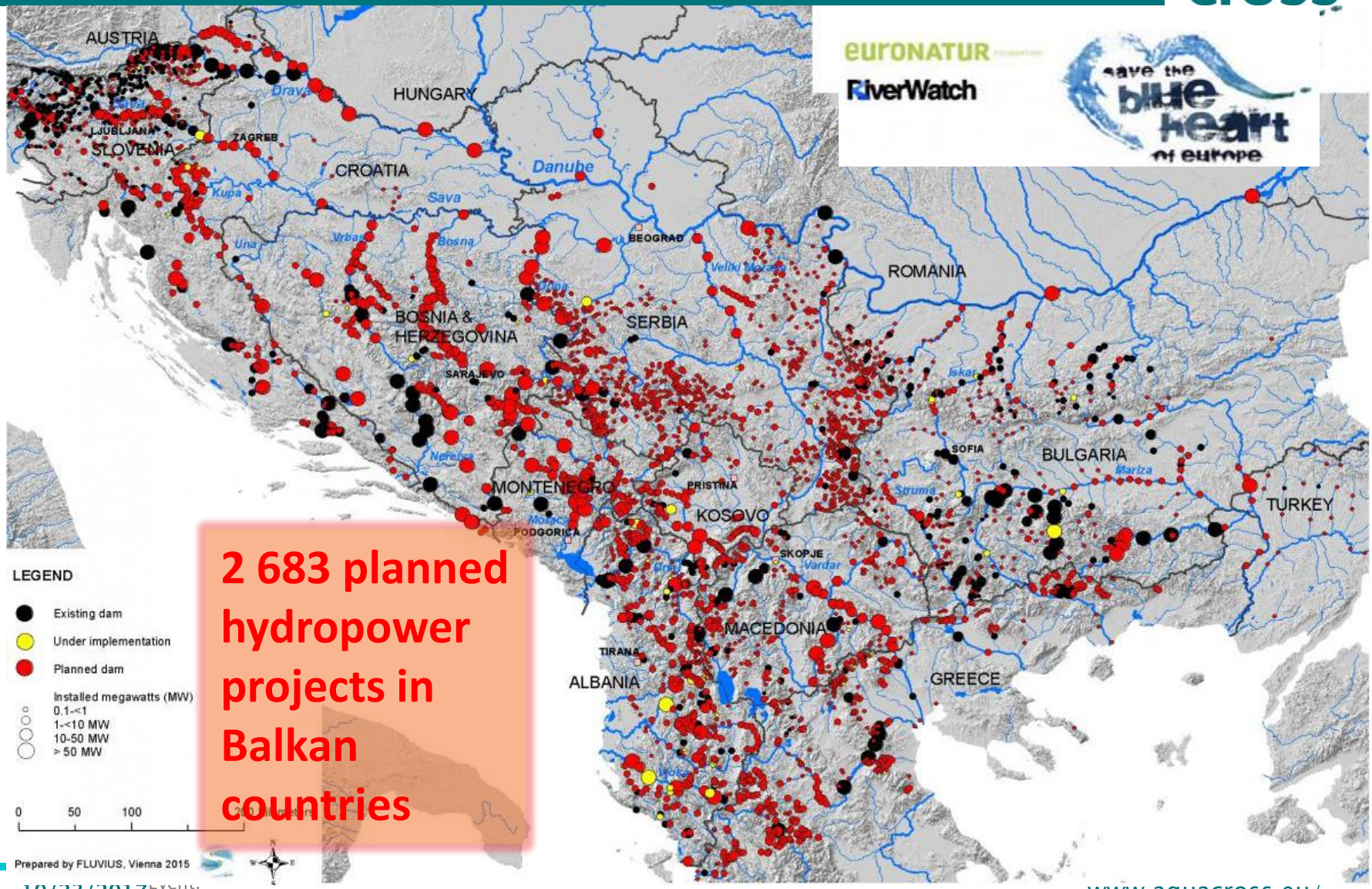
- Effects of **morphological changes** and degradations in combination with **hydrological alterations** from the basin headwaters to the Danube Delta is not sufficiently understood (Habersack et al. 2016)

- Focus of case study work on hydro-morphological alteration, including **longitudinal (topic 1: hydropower)** and **lateral** connectivity **(topic 2: floodplains)**

Towards EBM– multiple goals to balance

- Hydro-morphological degradation of rivers may **prevent reaching the EU's environmental targets**, as aimed at by the EU WFD, Habitat or Bird Directives (Danube River Basin District Management Plan 2015)
- **Sectoral EU policies** on hydropower, navigation, flood protection and agriculture exert various hydro-morphological pressures on rivers, and thus strongly interfer with EU WFD, Habitats or Bird Directives
- A **more co-ordinated implementation of sectoral policies** could maximize potential synergies and foster implementation efficiency (**EBM 3: uses multidisciplinary knowledge, EBM 4: considers synergies and trade-offs EBM 5: supports policy coordination**).
- For example, **in already significantly altered river corridors** the improvement of navigation may have a **synergistic effect** on nature protection goals (if ecological restoration is supported within the project), while in intact river sections always will degrade the system.

Case study topic 1: Hydropower development



2 683 planned hydropower projects in Balkan countries

Case study topic 1: Hydropower development

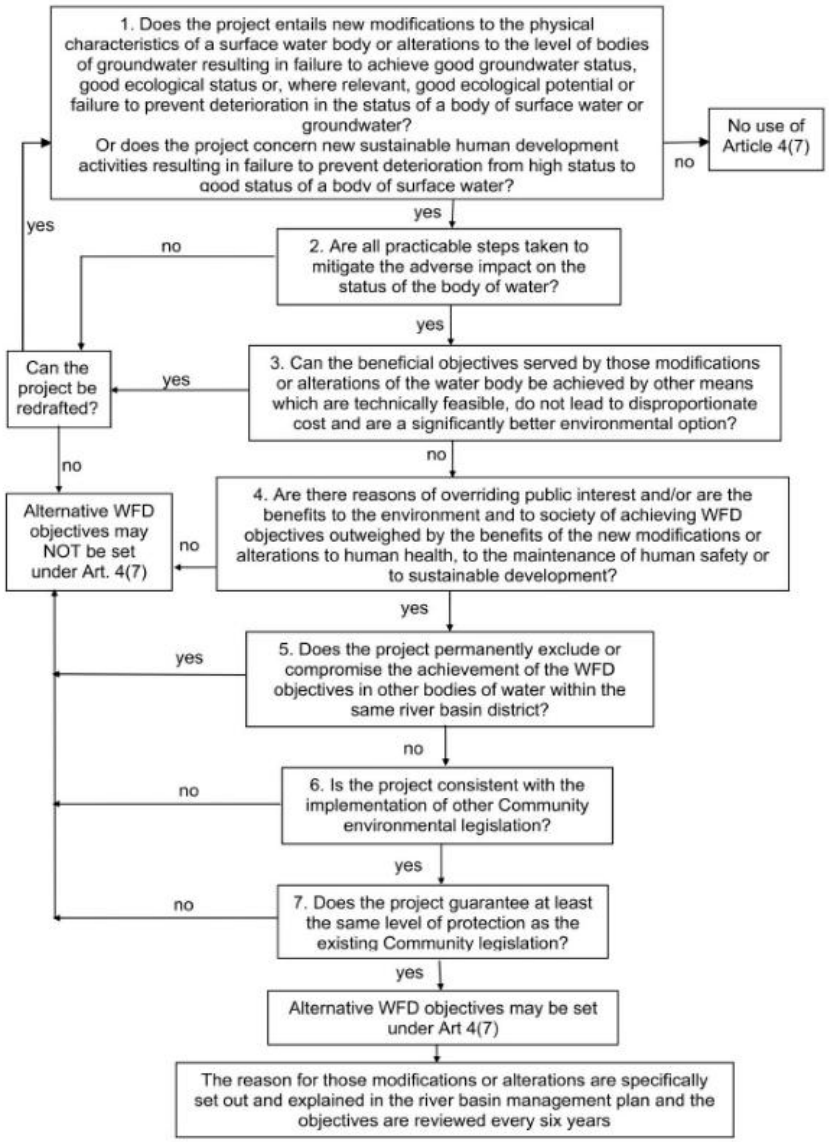
- The construction of **hydropower dams** represents one of the **most severe pressures** affecting the integrity of river ecosystems
- Hydropower development is driven by the political goal to develop renewable energies, especially by the implementation of the **EU Renewable Energy Directive (RESD)**
- **Additional drivers** are i) commercial interests of construction companies, ii) licensing fees paid to governmental agencies for permissions, and iii) currently very low bank rates of interest which generally favour investments
- Due to the high environmental risks, the construction of hydropower plants must be accompanied by **environmental impact assessment** (EIA) studies which must be elaborated acc. to the EU Directive on Environmental Impact Assessment.

Analyzing the effects of hydropower development on the goals of EU directives

- **The Renewable Energy Directive 2009/28/EC**
  - Driver for the **massive development of hydropower** generation in SE Europe

- **Water Framework Directive 2000/60/EC**
  - Prevention of further deterioration, protect and enhance the status of aquatic ecosystems
- **Natura 2000**
- **Convention of Biological Diversity**
  - The long-term survival of Europe's most valuable and threatened species and habitats
- **EU Biodiversity Strategy**
  - Halting biodiversity loss and restoring degraded biodiversity

Case study topic 1: Hydropower development



In practice new dams are planned and constructed…

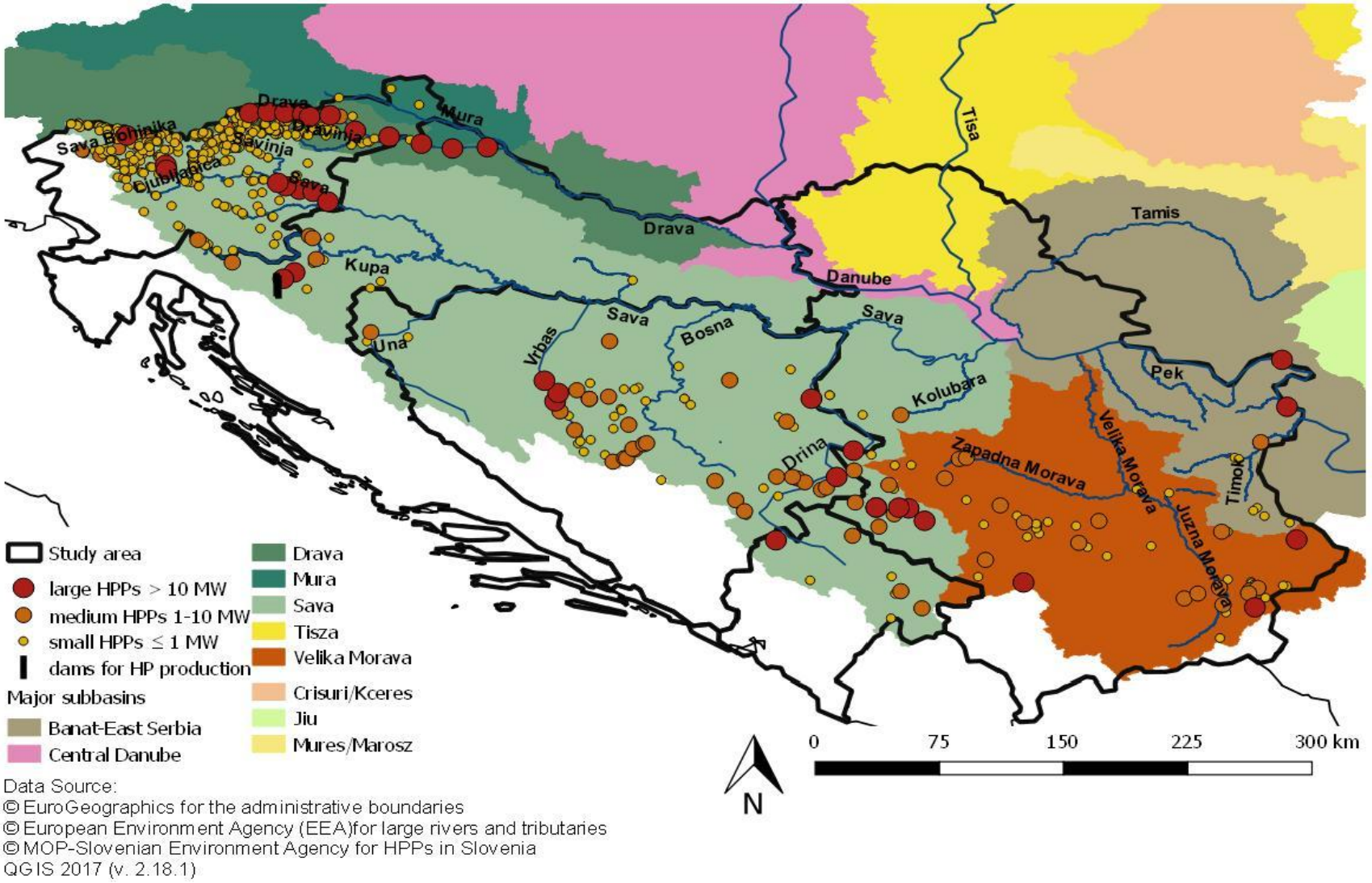
- in Natura 2000 areas and national parks
- without elaborating EIAs that meet the standards of the EU Directive on Environmental Assessment
- without strict checking of environmental effects
- without considering technical guidelines

Article 4(7) assessment of the WFD

Case study topic 1: Approach

- Analyzing the **effects of hydropower** development on the goals of WFD and Natura 2000 Directives
- **Overview on** existing **hydropower plants** as well as on planned ones
- **Review** the current state of knowledge on the ecological effects of these hydropower dams on biodiversity
- **Collection of** hydrological and biological (fish and inverte-brate) **monitoring data** in order to asses the ecological impacts of existing hydropower plants
- Assessment of the **application of the EU Directive on Environmental Impact Assessment,** and development of performance standards of EIAs of existing hydropower projects in south east Europa

Overview on existing hydropower plants



Data Source:
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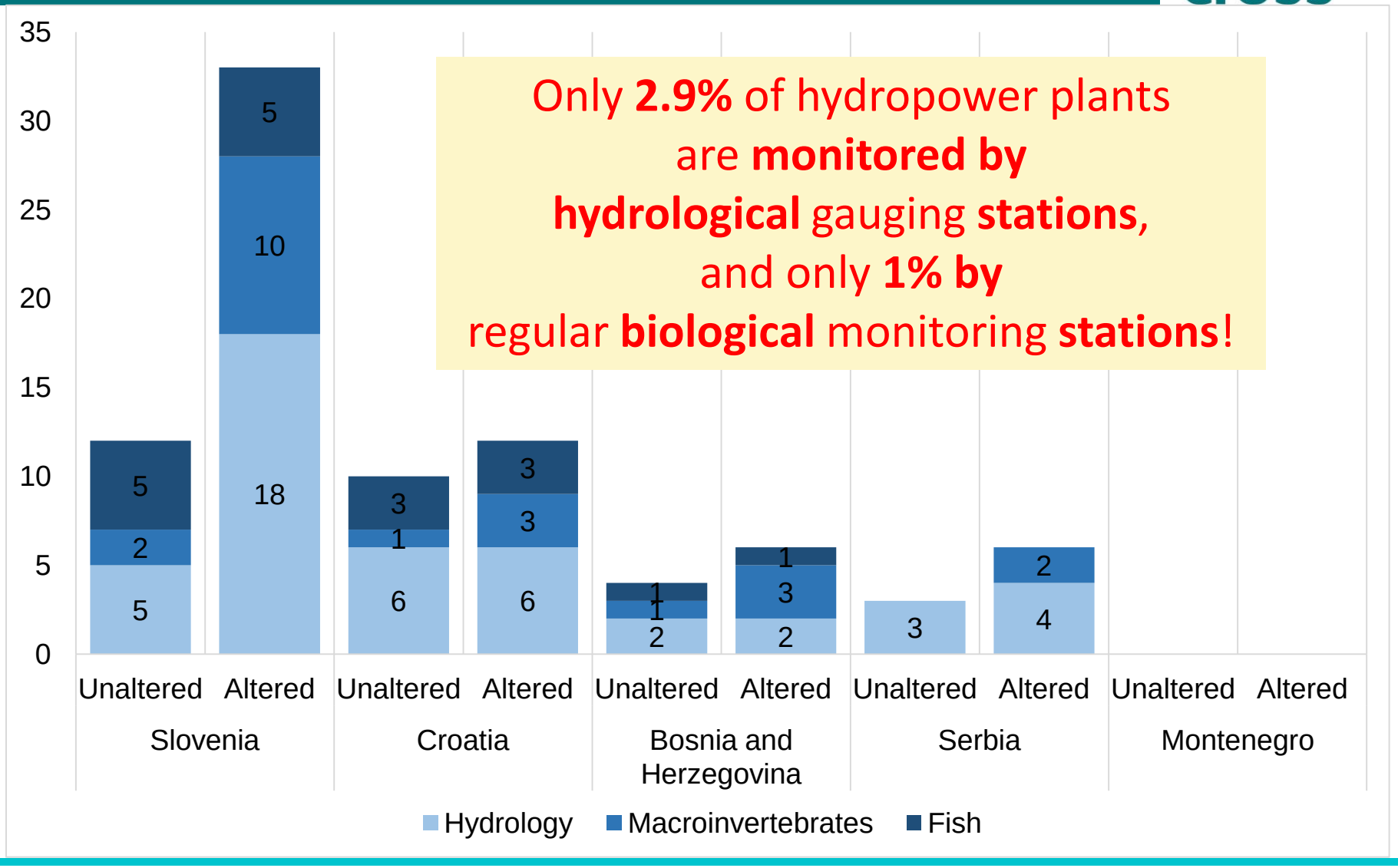
QGIS 2017 (v. 2.18.1)

Monitoring status of hydropower stations



Only **2.9%** of hydropower plants are **monitored by hydrological** gauging **stations**, and only **1% by** regular **biological** monitoring **stations**!

Topic 1: Summary & outlook

- Analyse the **effects of hydropower** on the goals of WFD and Natura 2000 Directives
- **Overview** on existing and planned hydropower plants
- Summary the **current state of knowledge** on the ecological effects of these hydropower dams on biodiversity
- Assessment of the application of the **EU Directive on Environmental Impact Assessment** and development of performance standards of EIAs of existing hydropower projects in south east Europa (**EBM 5: support policy coordination**).
- **Modelling** cumulative effects, linkages and dependencies between dam-mediated alterations on hydrology and biodiversity (**EBM 1: considers the dynamic relationships within ecosystems**)

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Case study topic 2 – Floodplains

- **Biodiversity hotspots**
- broad variety of **ecosystem functions** by controlling the regional water cycle and the retention and transformation of nutrient
- Provide multiple **ecosystem services** (recreation, drinking water, flood protection,…)

Case study topic 2 Floodplains: Background

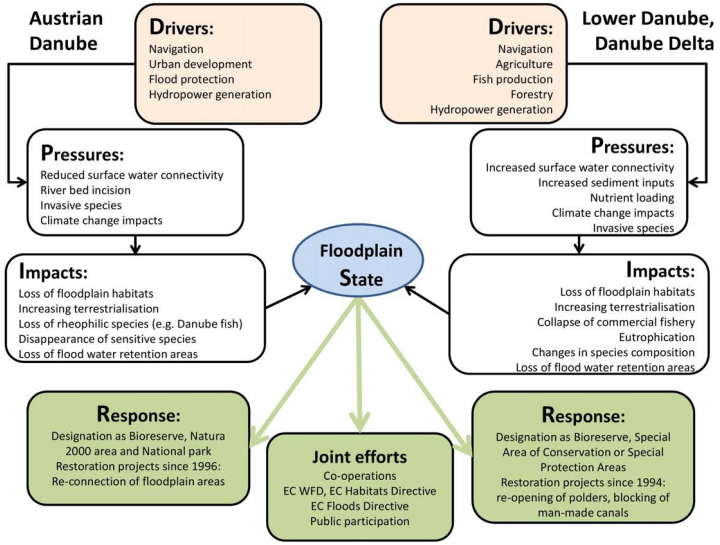
- **Multiple policy targets**: Consider multiple EU legislations that are relevant for large river-floodplain systems and their biodiversity
  - EU water (WFD) ~70% heavily modified – focus on main stem
  - EU nature legislation (HD and BD)– focus on floodplains (~ 120 sites)
  - EU TEN-T Regulation for navigation – claims good navigation status of waterways
  - EU floods directive – focus on floodplains for sustainable flood management
  - …

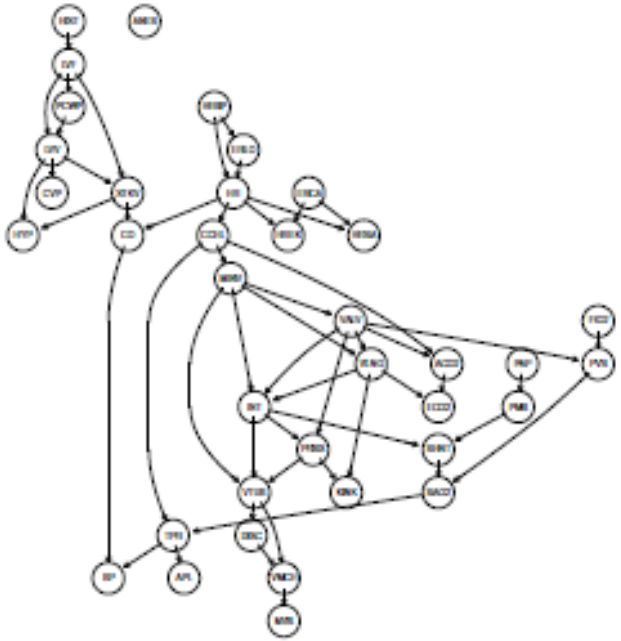
- **Potential conflicts** between different targets are important and widely recognised
- Specific **data are collected** for each policy target
- So far no detailed analysis on the synergies and trade-offs between biodiversity and other targets based on available data

Case study topic 2: Objectives

- Give a **statistical proof of multiple relationships** of human activities/services, pressures and biodiversity along the navigable stretch of the Danube River
- Final models can be used to **predict the impact on status** of biodiversity components of the HD and BD due to changes in drivers and pressures
- Basis for a **strategic and more integrated management** approach at large scales.
- A **policy analysis** will serve the identification of challenges in implementation of existing policies

Case study topic 2: approach derived from DPSIR-framework





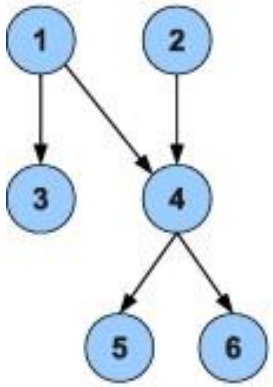
DPSIR-framework

D-P-S assessment (Bayesian Network)

- Framework to network
- Descriptive model to quantitative (data-based) model
- Quantify importance of drivers and pressures

selection of method - Bayesian Network

- Possibility to model hierarchical structure – D-P-S chain
- Good graphical representation
- Often used as basis for management and restoration
- High flexibility regarding input data – e.g. ordered factors
- Good model performance

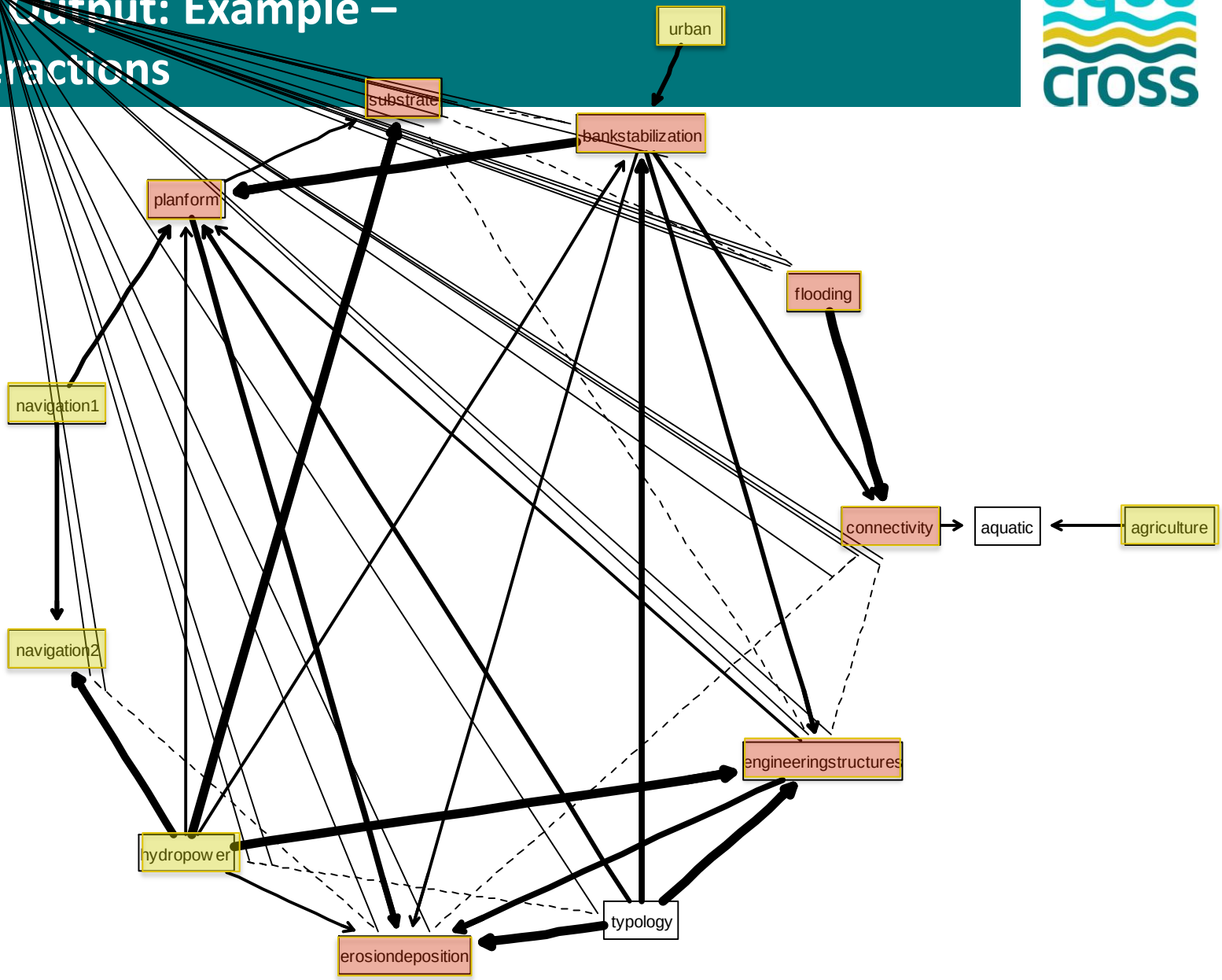


(a) Structure

X_1	1	1	1	2	2	2
X_2	1	2	3	1	2	3
$P(X_4=1 \mid X_1,X_2)$	θ_{411}	θ_{421}	θ_{431}	θ_{441}	θ_{451}	θ_{461}
$P(X_4=2 \mid X_1,X_2)$	θ_{412}	θ_{422}	θ_{432}	θ_{442}	θ_{452}	θ_{462}
$P(X_4=3 \mid X_1,X_2)$	θ_{413}	θ_{423}	θ_{433}	θ_{443}	θ_{453}	θ_{463}
$P(X_4=4 \mid X_1,X_2)$	θ_{414}	θ_{424}	θ_{434}	θ_{444}	θ_{454}	θ_{464}
$P(X_4=5 \mid X_1,X_2)$	θ_{415}	θ_{425}	θ_{435}	θ_{445}	θ_{455}	θ_{465}

(b) Conditional probability table

Topic 2: Output: Example – D-P interactions



Topic 2:Summary & outlook

- **Quantify the relationships of activities/services**, **pressures and status of biodiversity** components across the Danube (**EBM 4: Considers synergies and trade-offs between benefits and beneficiaries; EBM 3: uses multidisciplinary knowledge**)
- **Basis for management and restoration** of protected areas at a large scale (**EBM 2: supports transboundary coordination)**
- A **policy analysis** will serve the identification of challenges in implementation of existing policies and the identification of appropriate EBM responses (**EBM 5: support policy coordination**).

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Further topics Danube Delta and coastal systems

- Hydromorphological alterations (dredging – navigation) within Danube Delta
- Eutrophication (interaction with sediment dredging)
- Waste pollution – solid waste pollution in the Danube Delta.
  - Main drivers: economic development, tourism

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Topic 3-5:Summary & outlook

- **Analyse the effect of sediment dredging on channel network, sediment transport**
- **Analyse the effects of Danube transport of nutrients on Black Sea coast**
- **Build on several projects and activities on waste management and analyse relationships between waste distribution and habitats**
- Main stakeholder DDBR

Questions?

Suggestions?

Comments?

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Data within the hierachical structure

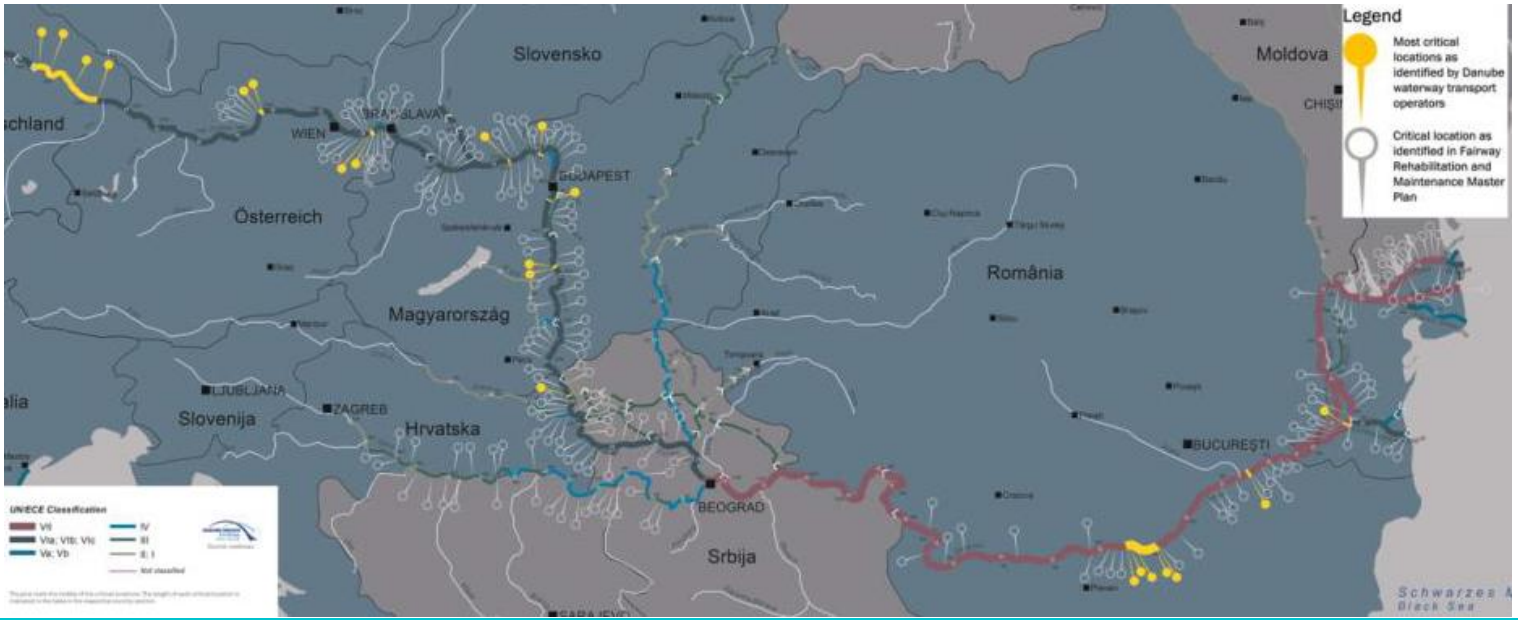
Austrian Danube

Drivers:
Navigation
Urban development
Flood protection
Hydropower generation

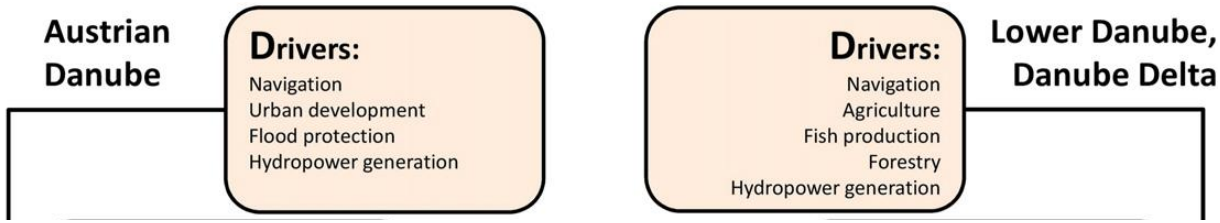
Drivers:
Navigation
Agriculture
Fish production
Forestry
Hydropower generation

Lower Danube, Danube Delta

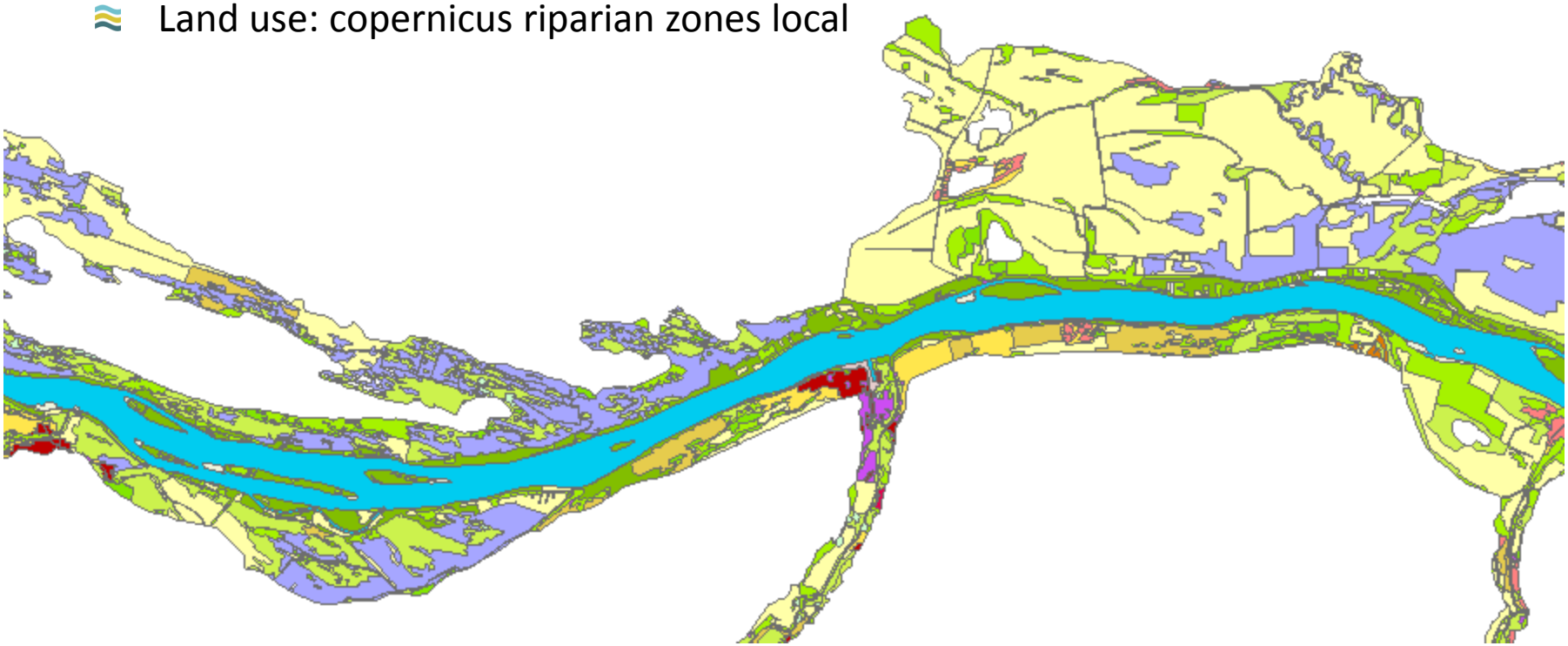
- Navigation: critical locations, navigation class
- Hydropower: position, production and impacted channel lenght



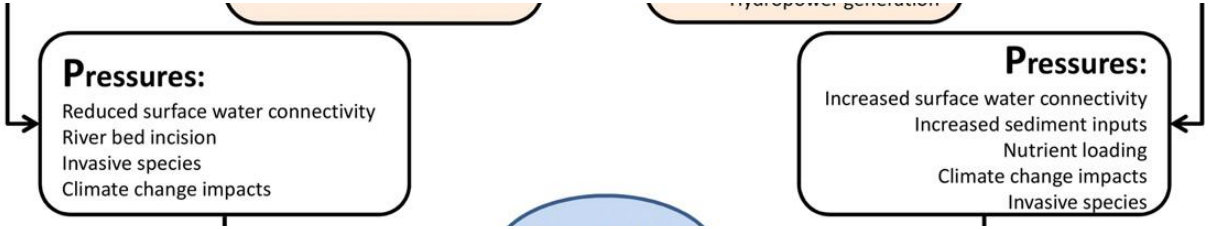
Case study topic 2: Data within the hierachical structure



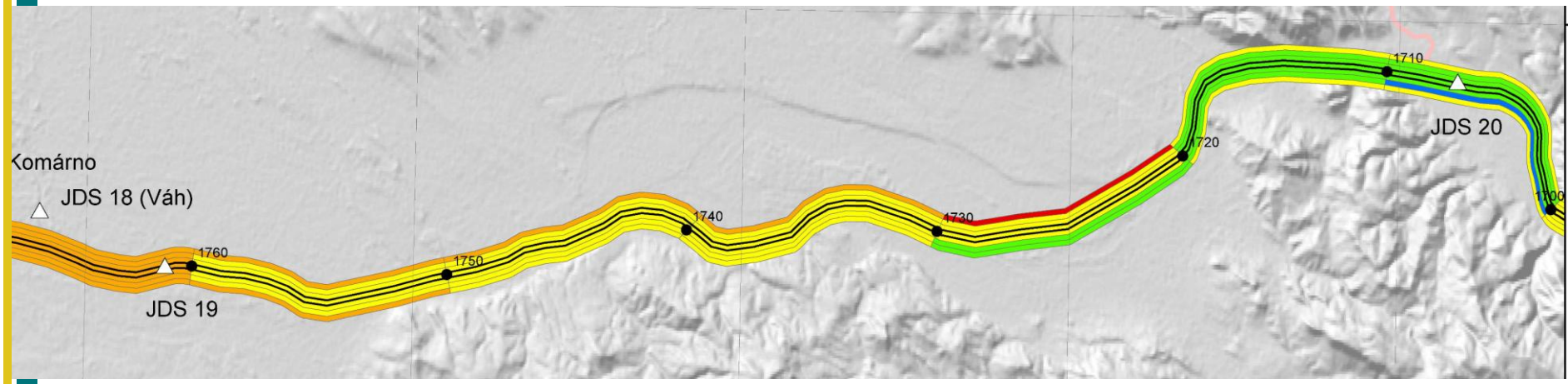
- Land use: copernicus riparian zones local



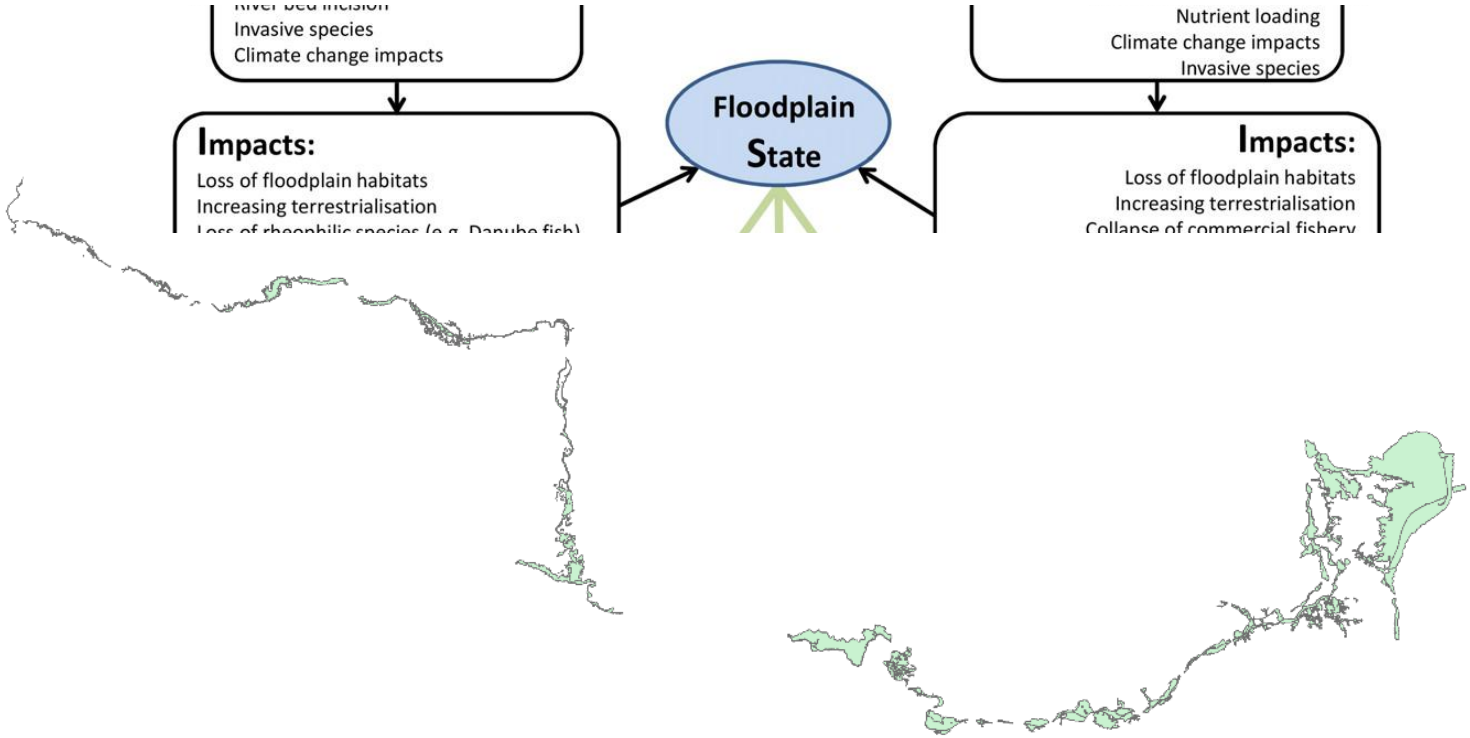
Case study topic 2: Data within the hierachical structure



- WFD/JDS: quantifies hydromorphological pressure, 10 km stretches– quantification of impact of artificial structures, levees, hydropower plants, land use … on the hydrology and morphology of floodplain, banks and channel



Data within the hierachical structure



Ecosystem state: Heterogeneity of data is especially challenging for large river-floodplain systems

- Data from protected areas available (~ 130 Natura 2000 sites along the Danube)
- systematically summarizes heterogenous monitoring data based on local expert judgement (conservation status of aquatic species - fish, amphibia,..)