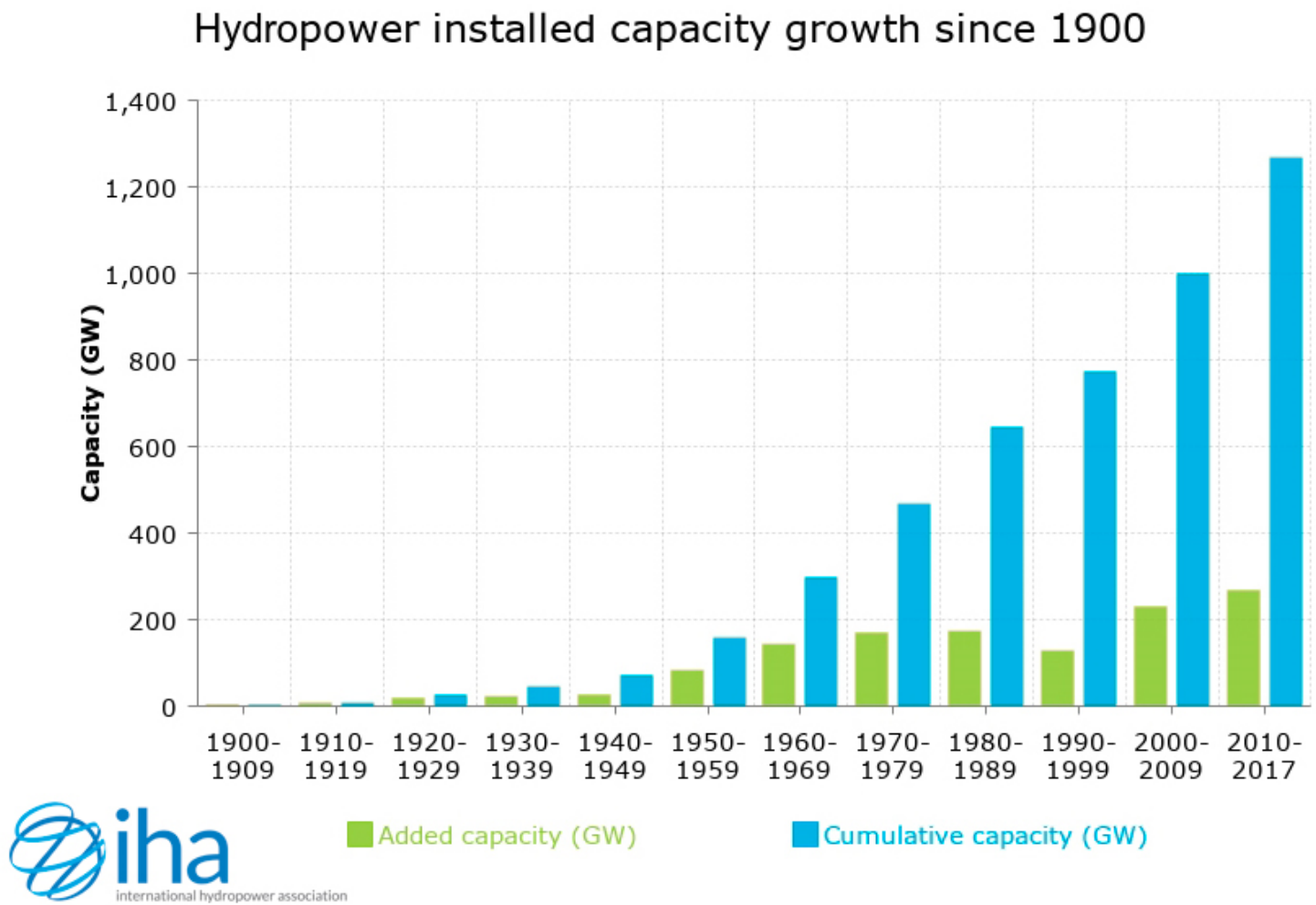
Hydropower and EU policy on water management, biodiversity, and climate adaptation

Wouter van de Bund, European Commission Joint Research Centre

Sustainability in Hydropower, Trondheim, 13-15 June 2023

European Commission


Hydropower installed capacity growth since 1900
Capacity (GW)
1,400
1,200
1,000
800
600
400
200
0
1900-1909
1910-1919
1920-1929
1930-1939
1940-1949
1950-1959
1960-1969
1970-1979
1980-1989
1990-1999
2000-2009
2010-2017
Added capacity (GW)
Cumulative capacity (GW)
iha
international hydropower association

enel
Green Power

Pascal Radue
President and CEO of GE's Hydro Solutions for GE Renewable Energy

CEENERGY NEWS

INTERVIEW

Hydropower: the only renewable solution for energy storage

"If we want to reach our global decarbonisation goals, we will have to almost double the installed capacities for hydropower by 2050. Given the need for grid flexibility to accommodate more renewable energy and the diversification of energy players, hydropower is projected to remain the largest renewable electricity source through 2023."

small hydro

Putting Hydropower Back on the Energy Transition Agenda

Wednesday, 14 December 2022

The 'forgotten giant' of renewables, hydropower, will play a critical role in the energy transition, explain Eddie Rich, CEO of the International Hydropower Association and Pascal Radue, CEO of General Electric Hydro Solutions.

Hydropower, an often overlooked energy source, has a long history of generating green electricity and providing grid services to support energy systems worldwide. It also has a crucial role to play in the climate challenges that lie ahead.

In fact, doubled hydropower output worldwide by 2050 will be vital to keeping global temperature increases under 1.5°C, according to the most recent International Energy Agency (IEA) projections.

Currently, hydropower is responsible for 60 percent of all clean electricity worldwide. With huge potential remaining for further development, hydropower is the only low-carbon technology that can provide flexible energy storage at scale to support the growth of wind and solar needed deliver net zero by 2050.

The Journal

THE MORNING LEAD

'Death by a thousand cuts': Hydropower killing, injuring and trapping fish by the tonne

Noteworthy investigates barriers along the River Shannon as deaths recorded at ESB stations and salmon hatcheries.

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Open letter: Counting on new hydropower in Europe is irresponsible.

Posted on 06 February 2023

130+ NGOs write to EU negotiators asking them to protect Europe's rivers from new hydropower deployment in the revised Renewable Energy directive.

Ahead of the next political trilogue on the revision of the Renewable Energy Directive, more than 130 NGOs are sending an open letter to co-legislators from the European Parliament, European Commission and Council Presidency, asking them to exclude hydropower from go-to areas as well as to include sustainability criteria recognizing that hydropower has direct impacts on freshwater ecosystems which must be mitigated.

Hydropower plant

© WWF Austria

A global-scale framework for hydropower development incorporating strict environmental constraints

Xu, R., Zeng, Z., Pan, M. et al. A global-scale framework for hydropower development incorporating strict environmental constraints. Nat Water 1, 113–122 (2023). https://doi.org/10.1038/s44221-022-00004-1

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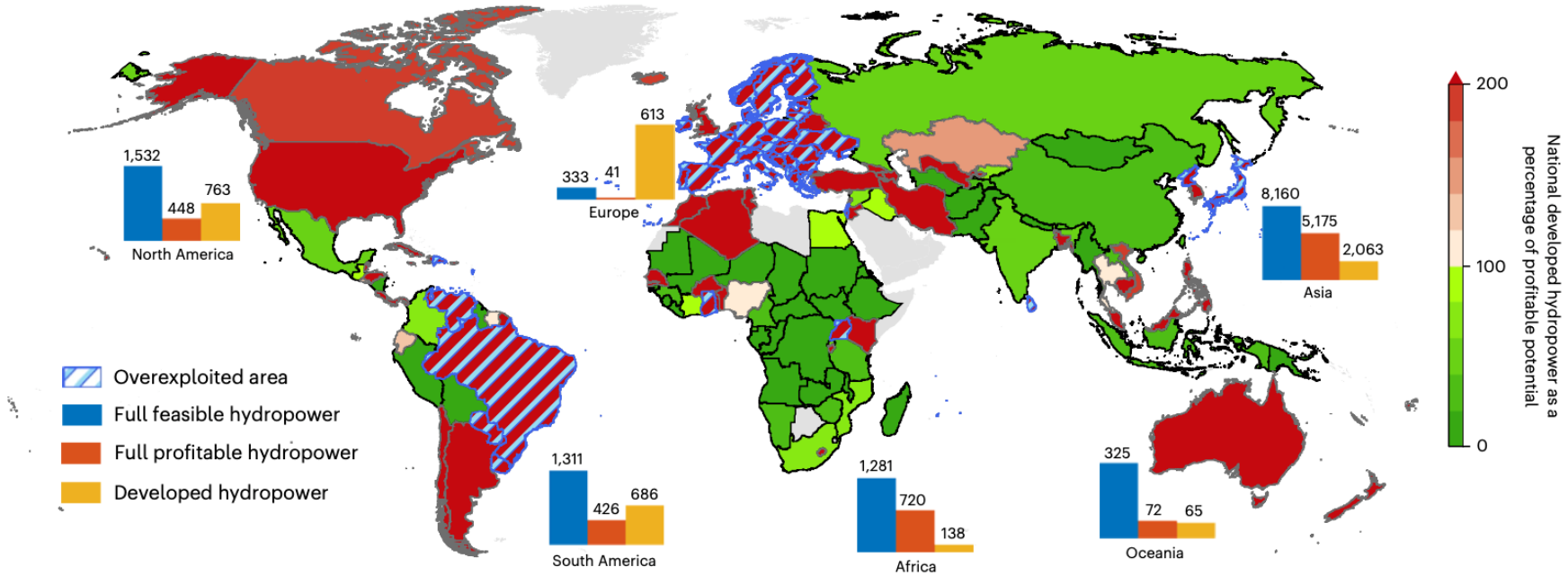
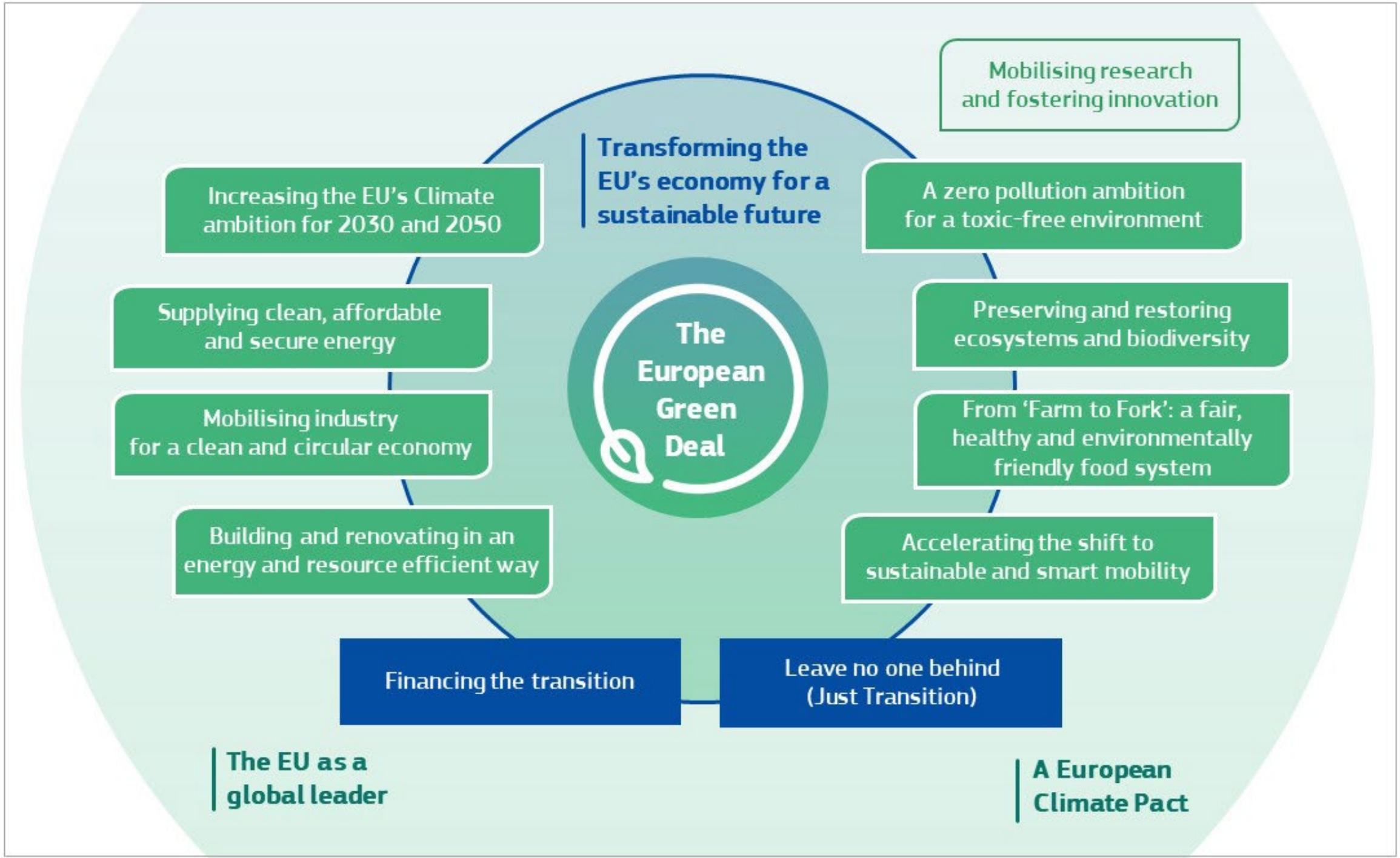


Fig. 3 | Extent of hydropower development for each country and continent. National developed hydropower as a percentage of full profitable potential. The green areas represent countries in which hydropower development can be continued, the red areas represent countries whose developed hydropower exceeds the full profitable potential and the red hatched areas indicate countries whose developed hydropower exceeds the full feasible potential. The bar charts represent the full feasible, full profitable and developed hydropower (in TWh yr^{-1}) of each continent.

Hydropower is at the heart of the water-energy nexus

- Energy policy
- Climate change adaptation policy
- Water resources management policy
- Biodiversity and nature conservation policy

- → need to achieve synergies and compromise solutions.
- EU policy framework recognises this reality but is also rather complicated and difficult to implement


Mobilising research and fostering innovation
Transforming the EU's economy for a sustainable future
Increasing the EU's Climate ambition for 2030 and 2050
A zero pollution ambition for a toxic-free environment
Supplying clean, affordable and secure energy
Preserving and restoring ecosystems and biodiversity
The European Green Deal
Mobilising industry for a clean and circular economy
From 'Farm to Fork': a fair, healthy and environmentally friendly food system
Building and renovating in an energy and resource efficient way
Accelerating the shift to sustainable and smart mobility
Financing the transition
Leave no one behind (Just Transition)
The EU as a global leader
A European Climate Pact

Outline

- Water Framework Directive and hydropower
  - Ecological Potential
  - Exemptions
- Biodiversity policy and hydropower
  - Free-flowing Rivers
- EU Taxonomy and hydropower
- Conclusions

EU Water Framework Directive

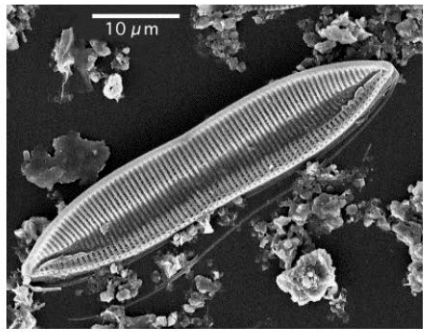
European Commission

The EU Water Framework Directive

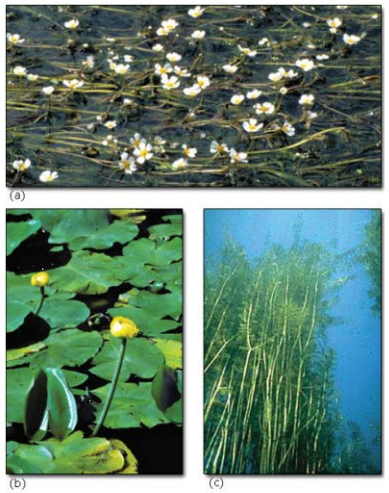
- Protecting all surface and groundwater, including transitional and coastal waters
- Covering all pressures and impacts
- Objectives: good ecological status (or good ecological potential) by 2015 (2027); non-deterioration
- Water management at river basin level → RBMPs

10

WFD goal: “Good Ecological Status” – assessed using biological indicators

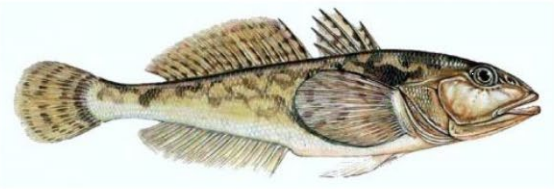


BENTHIC FLORA



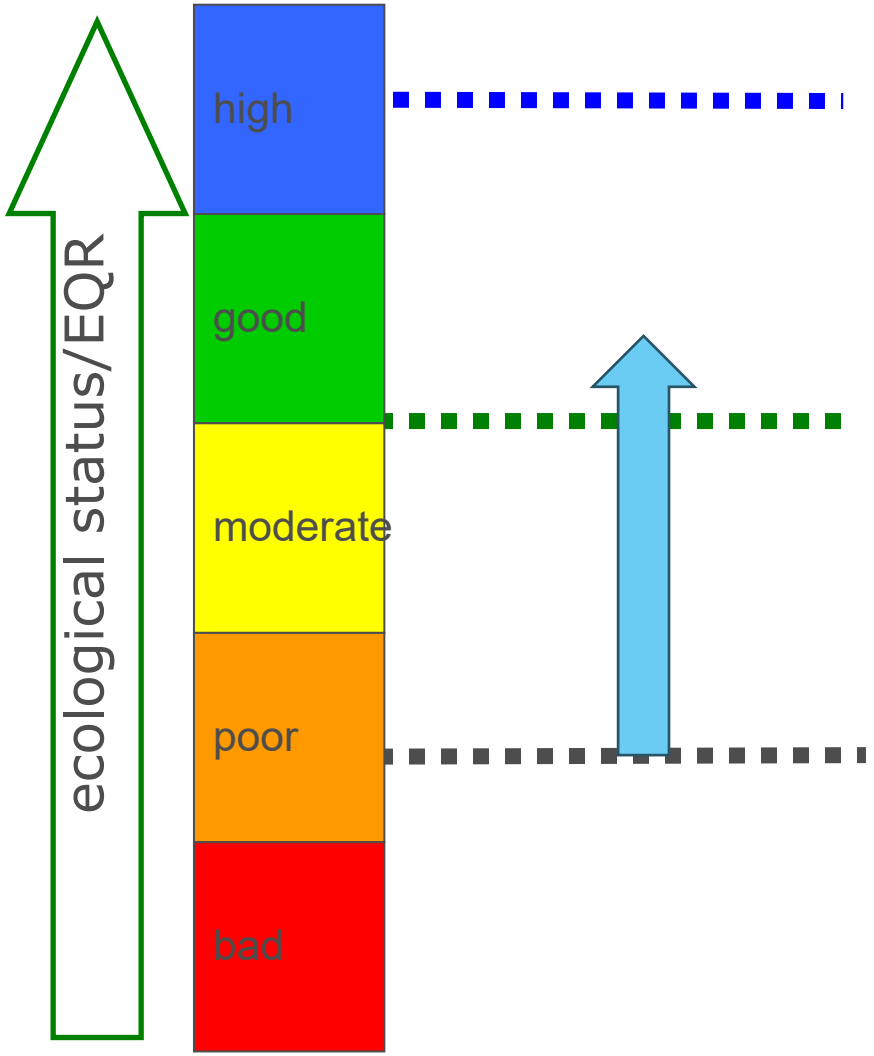
MACROPHYTES

BENTHIC FAUNA



FISH

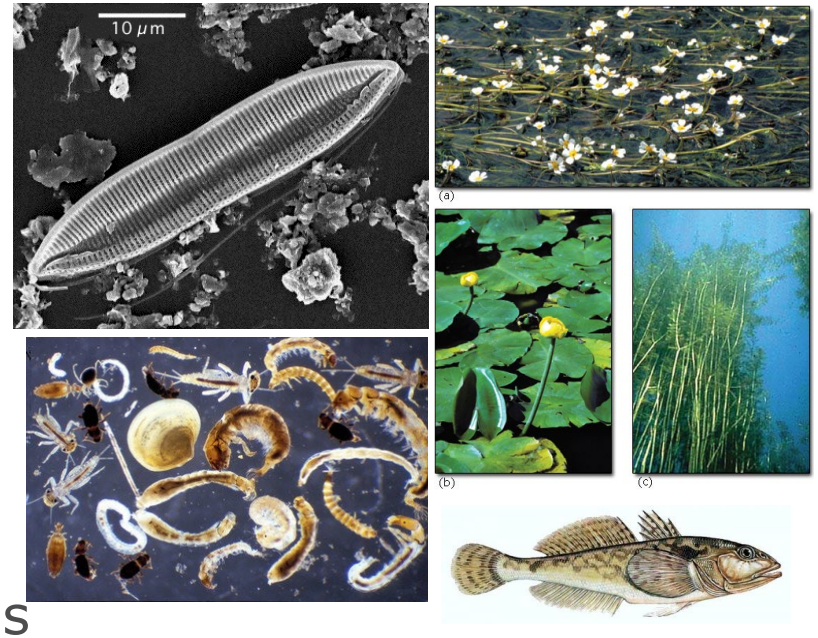
General WFD objectives: good ecological status; non-deterioration



Reference conditions

Good/Moderate boundary

Present ecological status



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WFD recognises that good status is not always compatible with sustainable human activities

- Physical alterations necessary for different uses, e.g.:
  - Agriculture: land drainage, irrigation
  - Energy production
  - Flood protection
  - Drinking water provision

- Objective is good ecological potential (maximizing ecological conditions given the constraints of the use)
  - “Heavily Modified Water Bodies”

WFD - Conditions for designation of Heavily Modified Water Bodies

- Sustainable human development activities causing changes in hydromorphological character as as result of physical alterations
- Not possible to reach good status without significant adverse effects on the use
- Beneficial objectives can not be reached by other means which are a better environmental option
    - For reasons of disproportionate costs
    - For reasons of technical feasibility

Best environmental option for energy provision

- Consider impacts of different renewable energy options
- Planning of hydropower minimizing the impacts

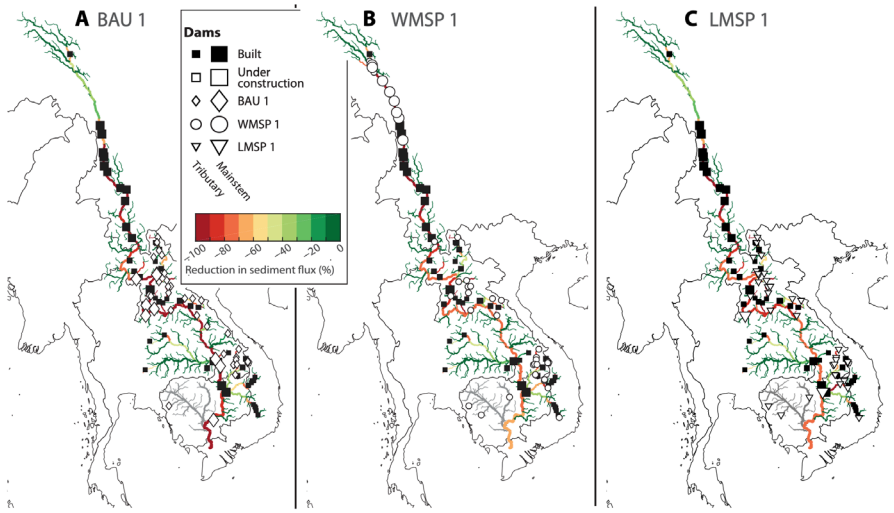
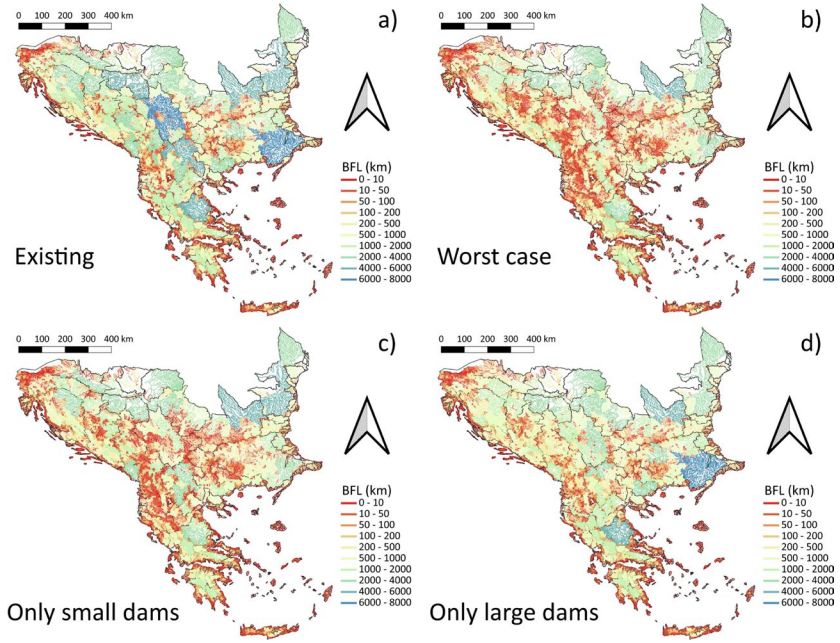


Fig. 5. Impacts of different hydropower futures on network sediment flux. Results are shown for the BAU 1 (**A**), WMSP 1 (**B**), and LMSP 1 (**C**) portfolios (Fig. 3). Square markers in (A) to (C) mark dam sites that are built or under construction. Diamond (A), circle (B), or triangle (C) markers mark dam sites included in BAU 1, WMSP 1, and LMSP 1, respectively. The color of the river networks shows the relative reduction in sediment flux compared to pristine conditions without dams.

Schmitt et al., Sci. Adv. 2019;5:eaaw2175 23 October 2019



Carolli et al., Science of the Total Environment 871 (2023) 161940

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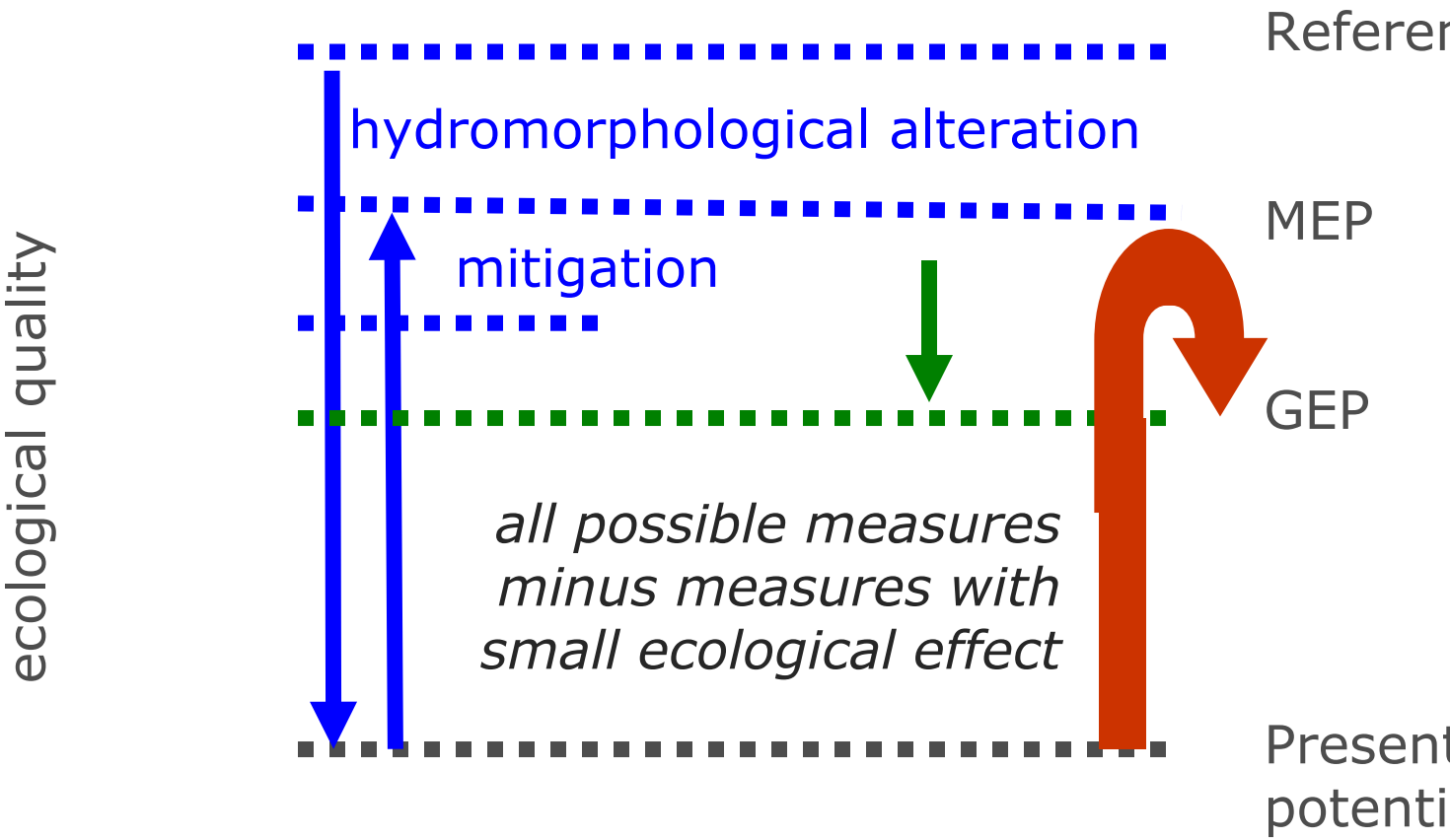
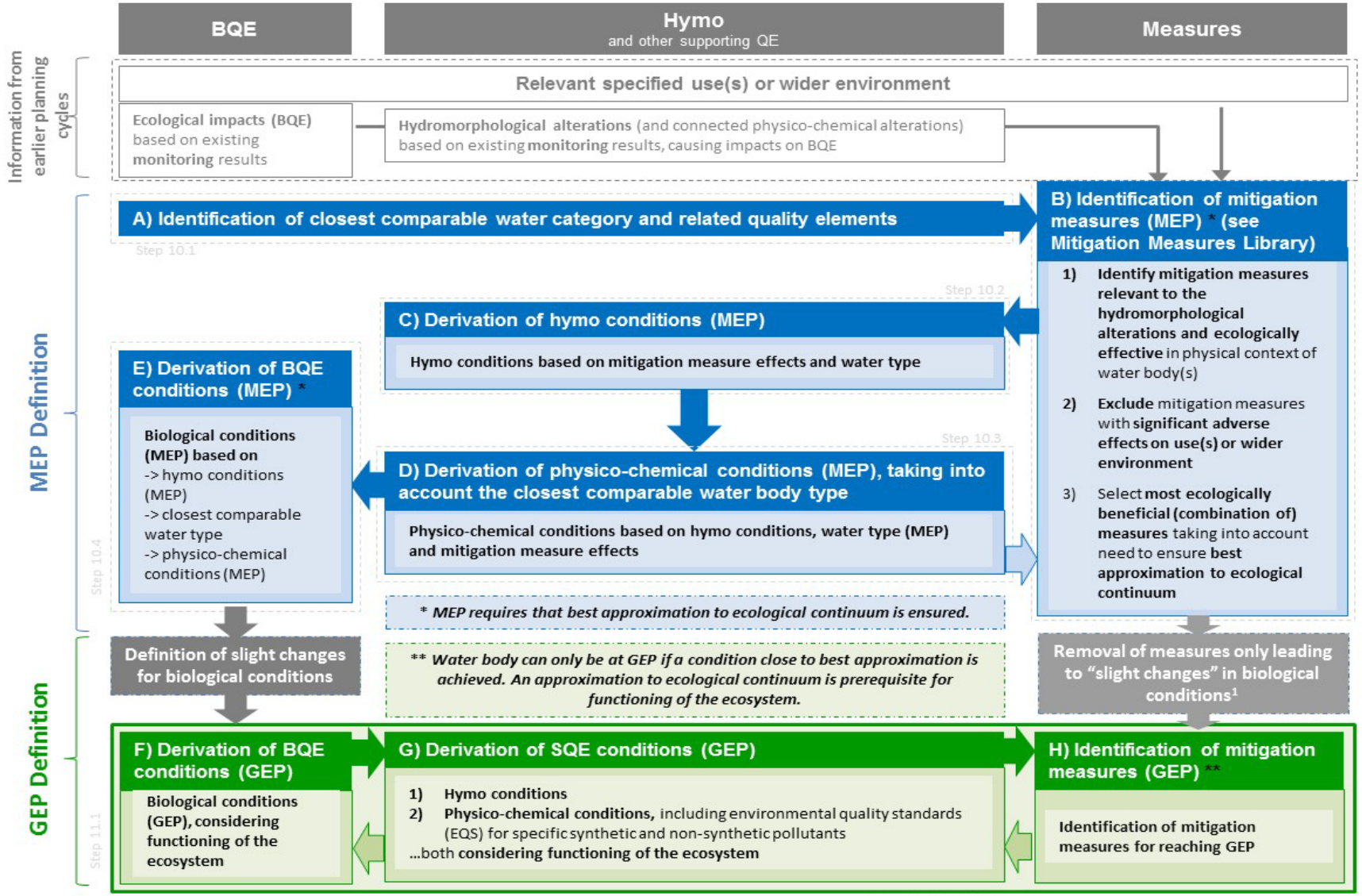
Objective for heavily modified waters: good ecological potential



Ecological Potential – key steps



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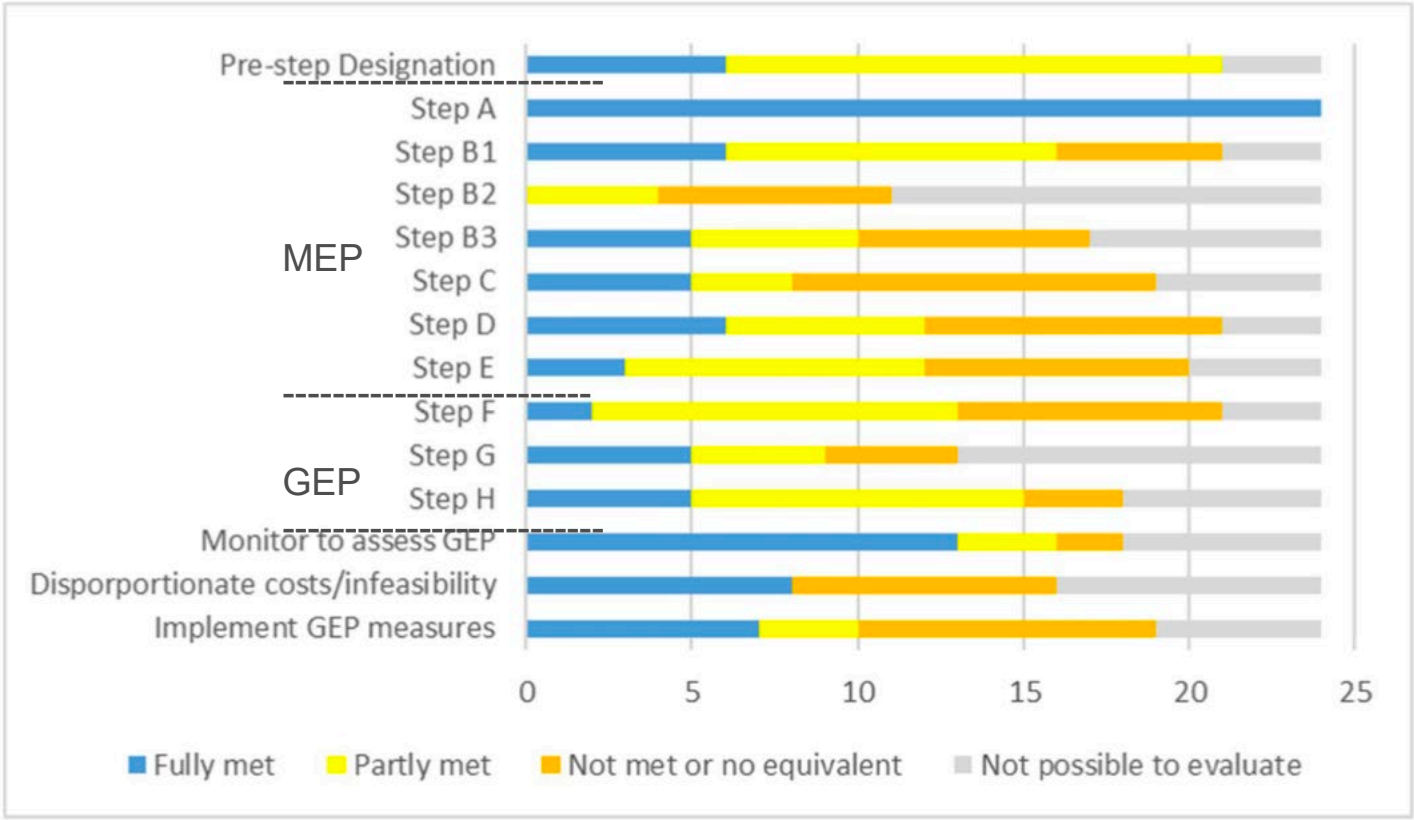
Ecological Potential – key steps

- Identification of mitigation measures excluding those that have a significant adverse impact on use
- Ensure ecological continuum
- Identify hydromorphological conditions and biological conditions at MEP and GEP
- Identify GEP measures

Intercomparison of ecological potential: challenging in practice!

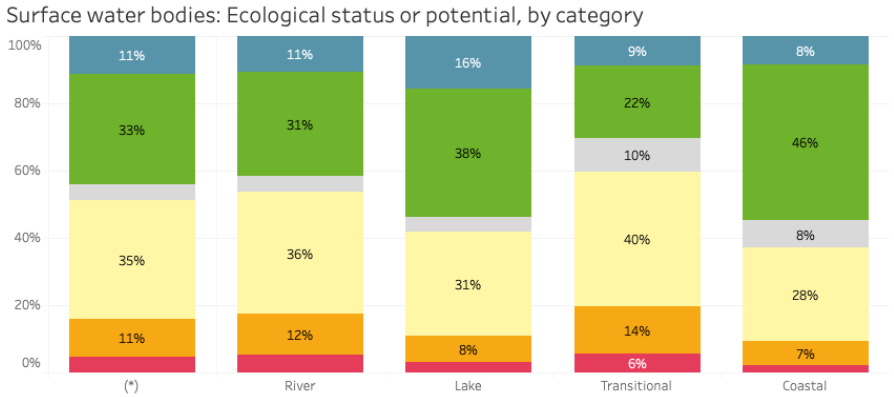
Figure 5 Numbers of countries which fully meet, partly meet or do not meet the criteria set for the intercomparison of methods for each step

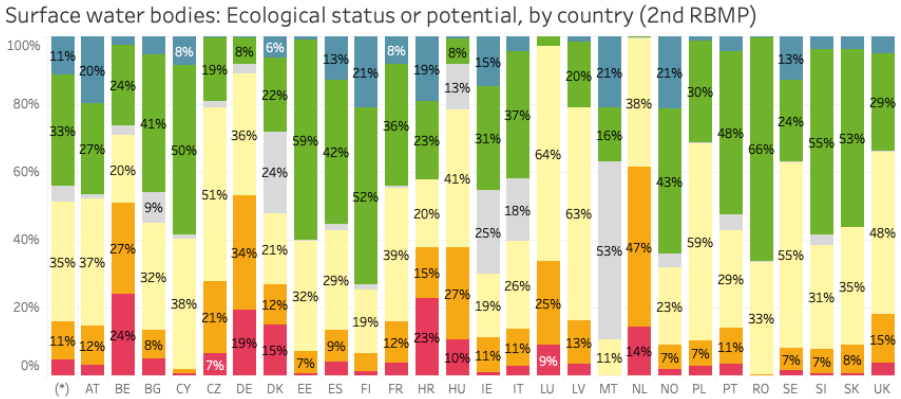


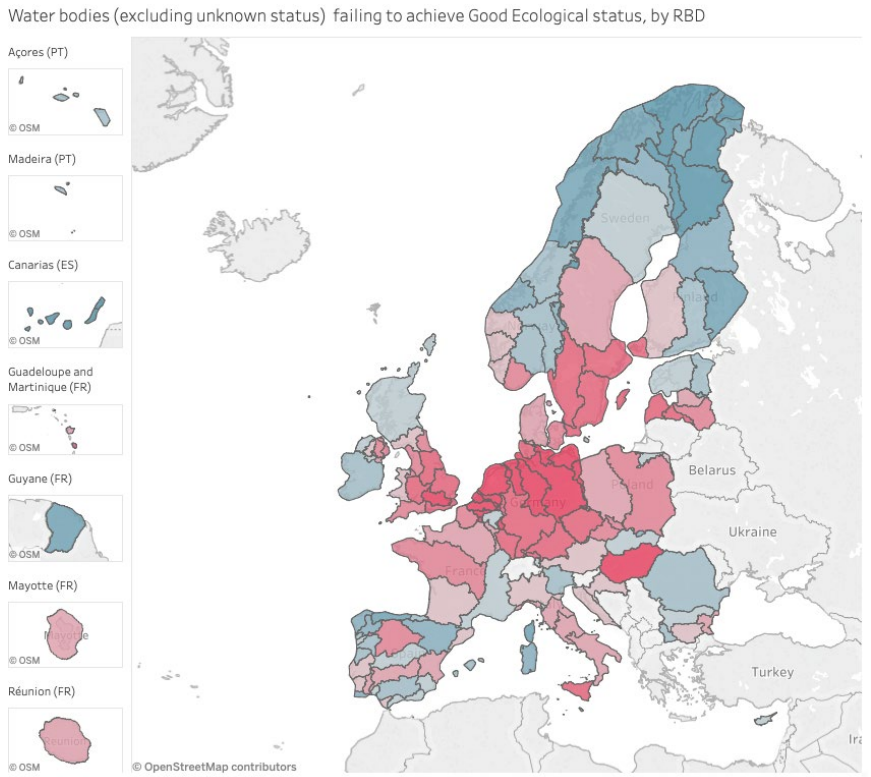
Implementation of Ecological Potential not always comparable – key issues

- Significant adverse impact on the use
- Not all impacts are considered (e.g. focus on salmon only)
- Not all feasible mitigation measures are considered
- Linking mitigation measures with hydromorphological and biological impact

Achievement of WFD objectives (2015 plans)







https://www.eea.europa.eu/data-and-maps/dashboards/wise-wfd

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WFD Exemptions

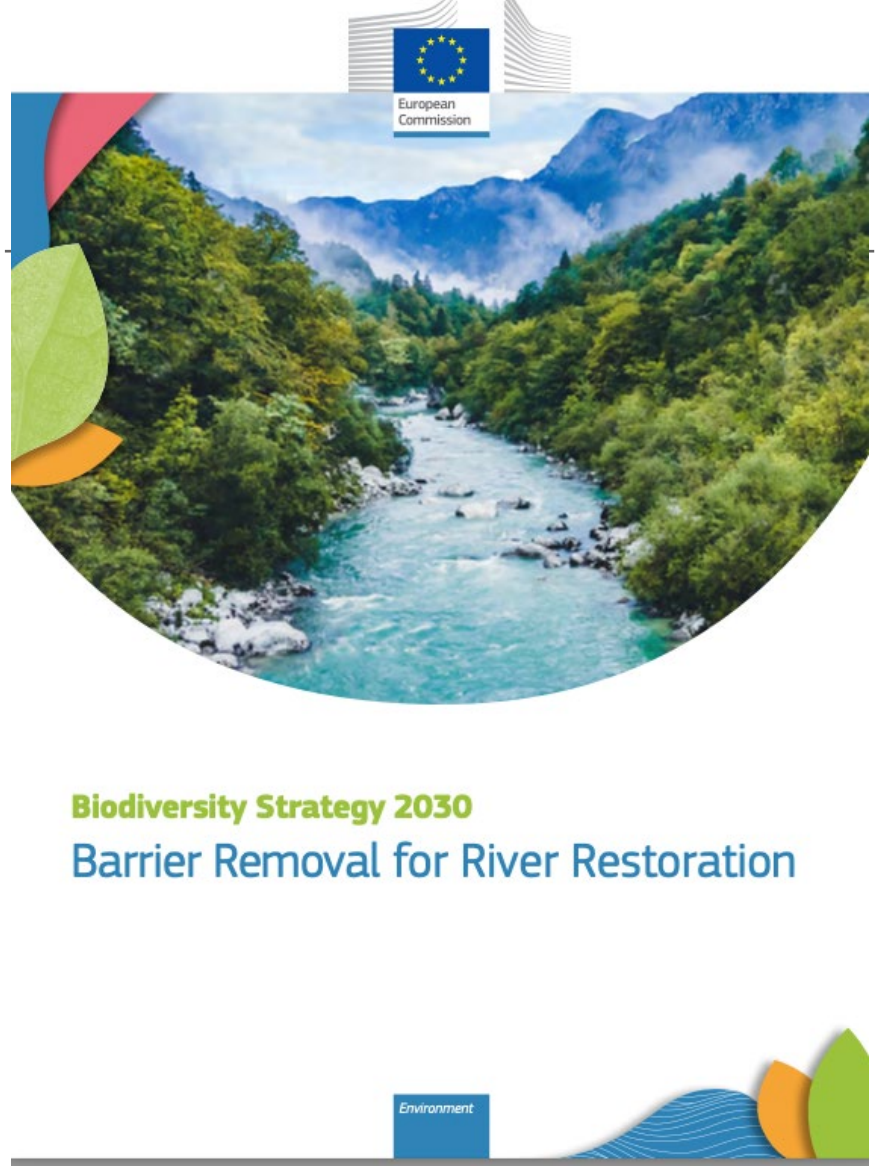
- Extension of the 2015 deadline until 2027 at the latest
- Less stringent objectives if achievement of objectives infeasible or disproportionally expensive
- Temporary deterioration e.g. due to extreme floods or droughts
- Failure of objectives due to new modifications of physical characteristics linked with sustainable use (e.g. construction of new hydropower facility, mitigating droughts and floods)
    - Overriding public interest, benefits outweigh the impact
    - Beneficial objective can not be reached by other means with less impact
    - Would normally result in designation of a new heavily modified water body

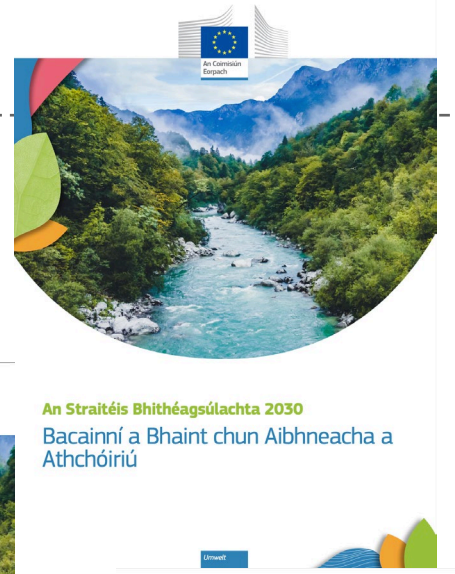
Biodiversity policy and the free-flowing river target

European Commission

BDS targets for freshwaters

- EU Biodiversity Strategy: full implementation of existing legislation → Water Framework Directive
  - Good status and good potential are linked to ecosystem health and therefore biodiversity
- Specific target addressing river continuity
  - Restoring 25,000 km of free-flowing rivers by removing barriers

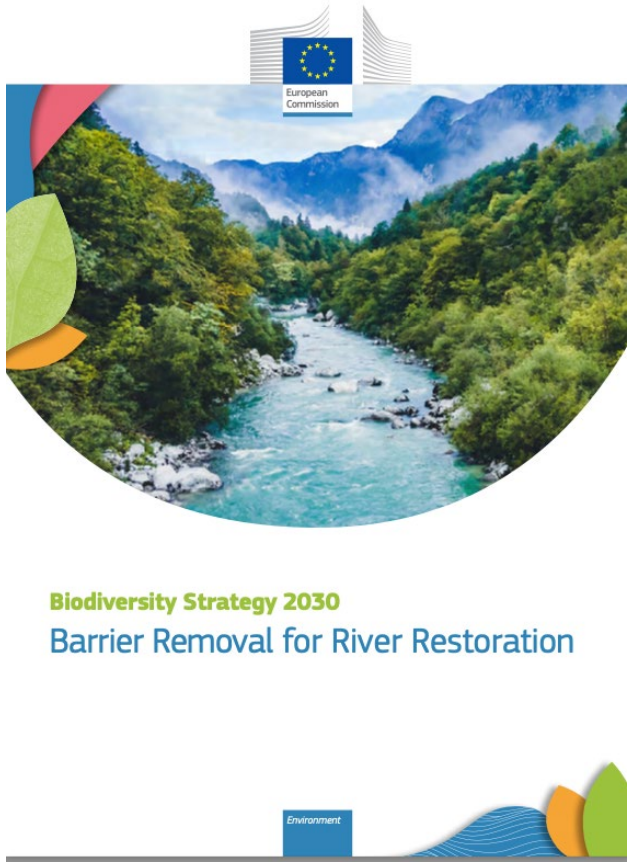




Published July 2023 in all EU languages

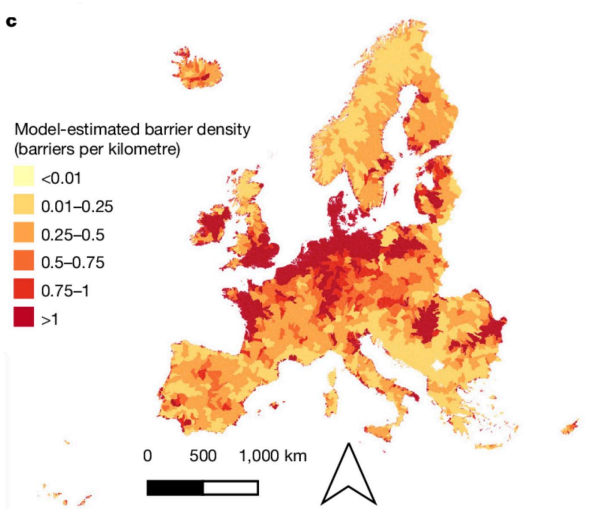
Some key messages

- WFD target of good status/potential requires action to restore rivers in all river basins
- BDS2030 target to restore 25,000 km of rivers to free-flowing status by removing obsolete infrastructure and restoring floodplains goes beyond good status target
- BDS2030 restoration targets are not about removing all hydropower dams as long as WFD provisions for GEP are met
- Two main sets of actions to be taken in parallel:
  - Actions for barrier removal and restoration need to start immediately based on available knowledge
  - Actions to improve science-based knowledge for further restoration actions (including to define river functional units to support the assessment of free-flowing river status

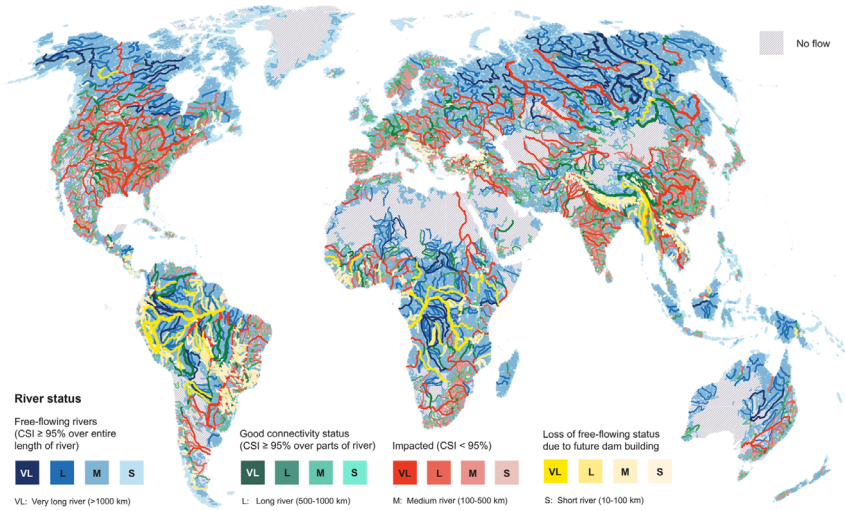


Quantifying FFR (method in development)

- Considering local and catchment scales
- Longitudinal and lateral barriers
- Building in existing approaches



Belletti et al., 2020, Nature



Grill et al., 2019, Nature

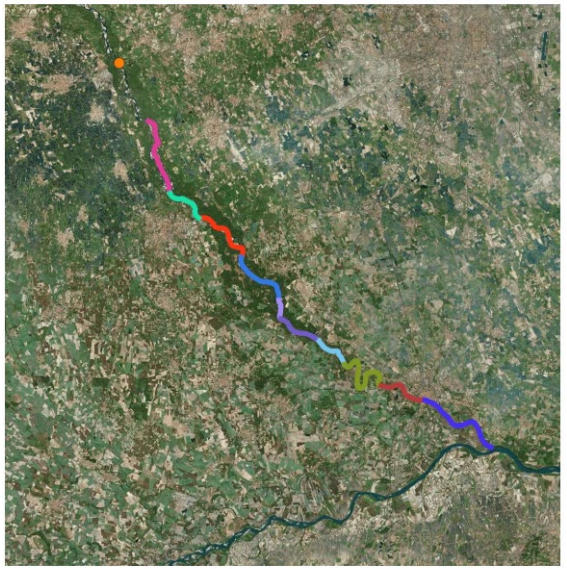
Criteria for FFR

Key steps

1. Segmentation - defining assessment unit
2. Criteria for connectivity within the section: longitudinal
3. Criteria for connectivity within the section: lateral
4. Large scale assessment

Segmentation

- Need homogeneous sections
- Using existing methods where possible
- In most cases shorter than the water bodies



Criteria for connectivity within the section: longitudinal

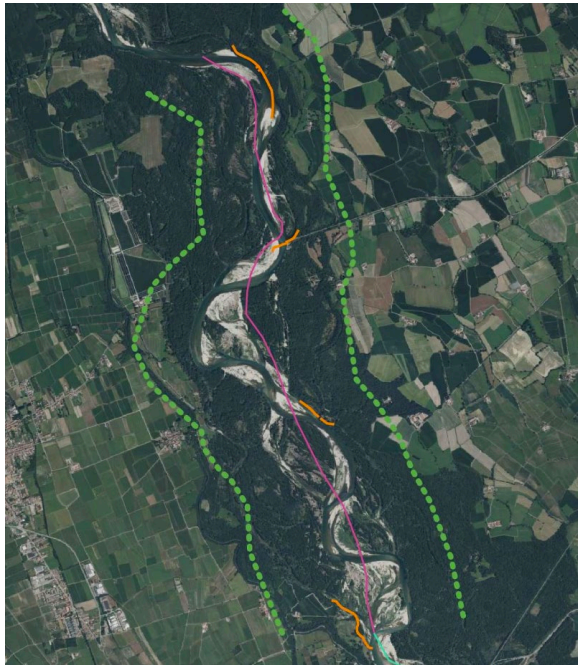
Key issues: fish migration and bedload transport

- Criteria for fish:
  - Presence/absence of barriers that have an impact on fish in the section (cf barrier typology)
  - Presence/absence of physical discontinuity due to hydrological alteration (e.g. low flow)
- Criteria for sediment:
  - presence/absence of any significant structure for sediment transport (cf barrier typology)

→ Not possible to have hydropower dams within a FFR segment

Criteria for connectivity within the section: lateral

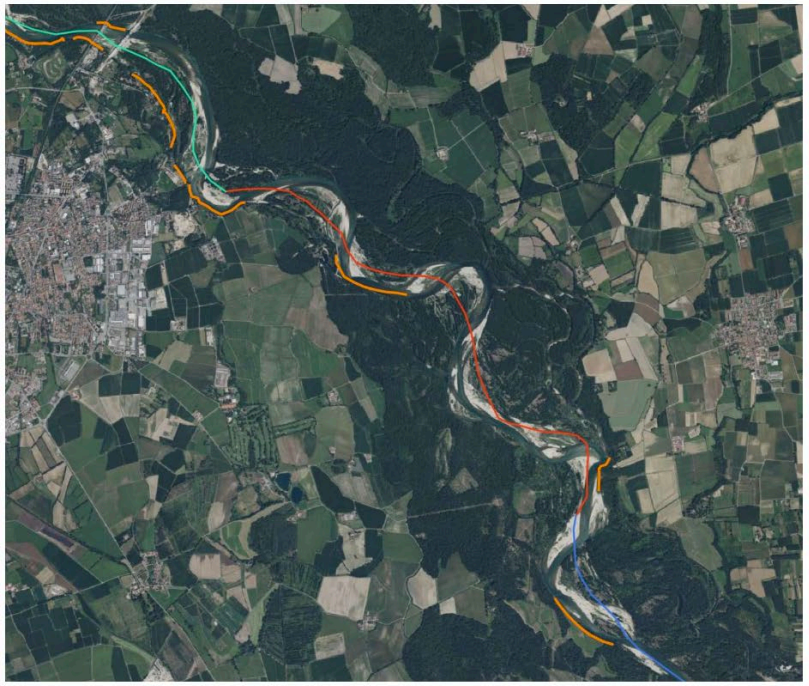
- Step 1: Define the corridor around the river bed where lateral connectivity will be assessed
- This represents the “erodible corridor”, which is the minimum lateral allowing free lateral movements and also flooding
- 1-2 times channel width (depending on river type, based on scientific literature)



Criteria for connectivity within the section: lateral

- Step 2: identify and map lateral barriers located in the corridor and compute their cumulative length

- Step 3: Compare the cumulative length of lateral barriers to flooding to a (type-specific) threshold



Average bankfull width: 381 m

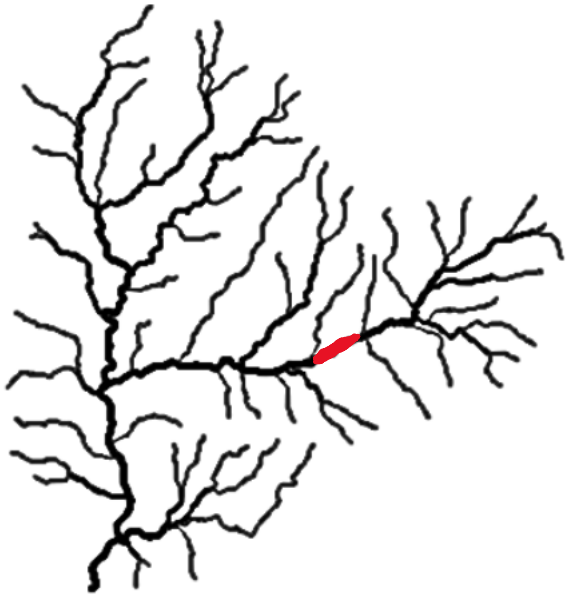
Total length of segment (L): 6266 m

River type: multiple channel (wandering)

Evaluation corridor: 381 m from the bankfull (both sides)

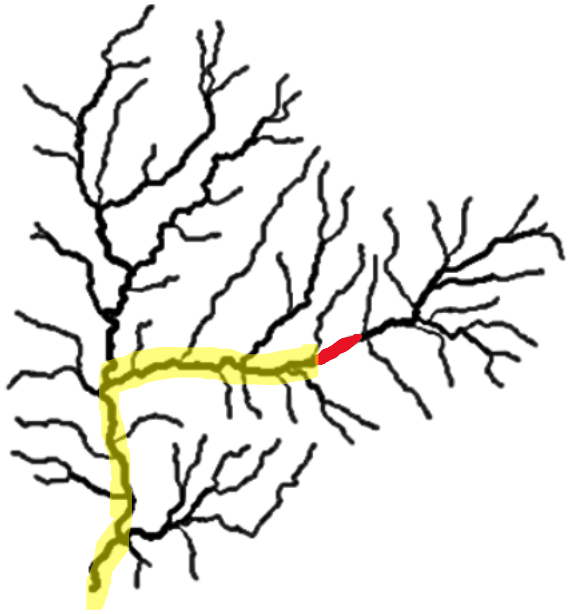
Total length of bank protection: 1569 m = 25% L

Large scale assessment



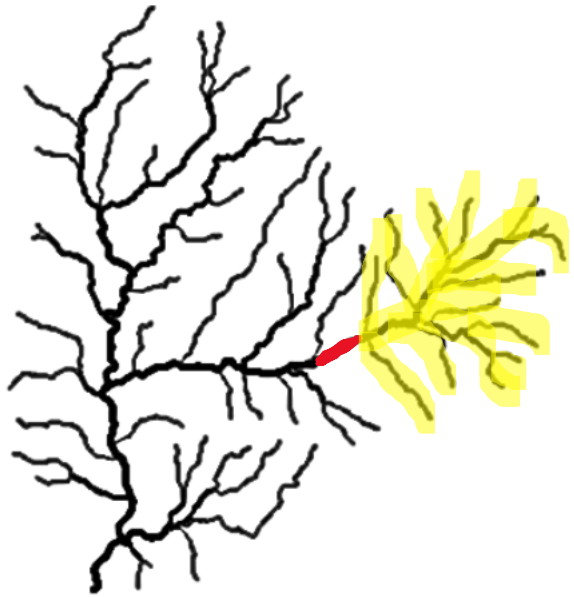
- FFR is not only about locally restoring local connectivity
- Need to take into account what happens upstream (for sediment transport) and downstream (for fish migration)
- Hydropower infrastructure may be imporant

Large scale assessment – downstream (fish migration barriers)



- Evaluation of barriers migration for target fish species downstream of the (potentially) FFR section
  - No barriers for target fish species: OK
  - Barriers allowing migration of target fish species for the FFR section: OK
  - Target fish species blocked by downstream barriers: Not OK
- Hydropower infrastructure downstream may prevent river segments to be designated FFR
- Fish migration mitigation measures are important

Large scale assessment – upstream (sediment connectivity)



- Evaluation of barriers for sediments upstream the (potentially) FFR section
- Approach considered:
  - Map upstream barriers for sediments
  - Calculate % of the upstream catchment where sediments are blocked
  - Agree on threshold:
    - % blocked < threshold OK
    - % blocked > threshold not OK

FFR Target and hydropower

- Focus on removal of obsolete infrastructure (mainly weirs but may also be dams)
- No requirement to remove HP infrastructure
- Hydropower relevant in large scale assessment
  - Mitigation for fish migration downstream a FFR stretch
  - Hydropeaking, eflows, sediment balance upstream a FFR stretch
- For hydropower, FFR criteria do not go beyond what is already required in the WFD

EU Taxonomy

European Commission

The EU Taxonomy is a key tool to reorient private capital towards the green transition

The Taxonomy is a classification system of science-based criteria for economic activities to substantially contribute to environmental objectives

Three basic conditions

1. **Substantially Contribute** to one environmental objective
2. **Do No Significant Harm** to any other objective

Technical Screening Criteria

3. **Minimum safeguards** Social/HR

38

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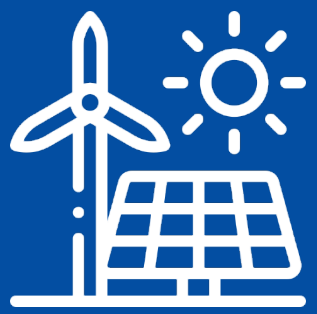
The EU Taxonomy is built around six environmental objectives

Climate objectives



Climate Change Mitigation

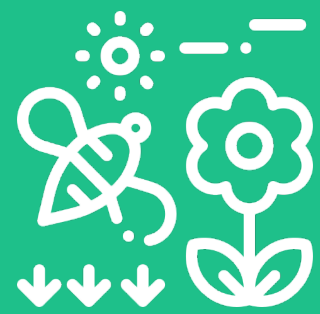
Climate Change Adaptation

Other environmental objectives

Transition to a circular economy

Pollution prevention and control

Sustainable use and protection of water and marine resources



Protection and restoration of biodiversity & ecosystems

39

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EU Taxonomy and hydropower

"Do Not Do Significant Harm" criteria directly linked with WFD requirements:

- Activity complies with WFD provisions, especially Art. 4
- Operation and refurbishment of existing HP plants complying with WFD
- Construction of new HP plants in accordance with WFD Art. 4(7)
- All technically feasible and ecologically relevant mitigation measures are implemented
- No increase of fragmentation of water bodies in the same river basin district

Key messages

Key messages

EU has a consistent and comprehensive framework for sustainable hydropower

If fully implemented, this ensures a level playing field for the hydropower sector

Concept of ’ecological potential’ is key, Taxonomy follows similar logic

GEP: need to link mitigation measures with hydromorphological and biological impact

WFD was established in 2000, but implementation still leaves much to be desired

Biodiversity Strategy Free-flowing Rivers target: importance for HP mainly linked to the catchment scale criteria


Thank you for your attention…