Hydropower impacts on river status components

Media support to represent the cause-effect relationships between status and pressure/impact and cross link

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Summary

SHORT DESCRIPTION
This document intends to describe the media support developed to represent cause-effect relationships between status and pressure/impact and cross link. **Interactive tables have been built to underline and specify which are the main pressure elements on ecosystem components due to HP facilities, showing for every HP facility the corresponding impact on each ecosystem status component and assigning to each one an impact value.**

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Introduction

This document intends to describe the media support developed to represent cause-effect relationships between status and pressure/impact and cross link on river status components.

Interactive tables have been built to underline and specify which are the main pressure elements on ecosystem components due to HP facilities, showing for every HP facility the corresponding impact on each ecosystem status component and assigning to each one an impact value.

The tables resume hundred of scientific papers analyzed during the project implementation representing the more advanced and significant scientific articles in this domain.

All those papers are very focused on particular biological communities or / and specific impacts but they often do not give an overall view allowing the identification of more reactive river components and the definition of impacts size.

For the reasons above mentioned, we tried to compact in a media support a lot of spare information useful to support the better environmental indicators choice and Multi Criteria Analysis feeding.

Media support to represent the cause – effect relationships between status and pressure/ impact and cross link

The media support to represent the cause – effect relationships between status and pressure/ impact and cross link consists of a Excel folder containing five tables, two Pivot tables and two interactive graphs listed below and described into the following paragraphs:

1. HP impacts on river components
2. Impacts indicators names
3. Impact code
4. Work sheet for Pivot table
5. HP schemes *versus* status components
6. Status components *versus* HP schemes
7. HP schemes *versus* status components graph
8. Status components *versus* HP schemes graph
9. List of status components indices

1. HP impacts on river components

HP IMPACTS AND RELATED EFFECTS	STATUS COMPONENTS AND IMPACT TARGET	BENTHIC MACROINVERTEBRATES AND HYPOREIC FAUNA					FISH FAUNA				MACROPHYTES			PHYTOBENTHOS			RIPARIAN VEGETATION		
		Benthic community structure	Benthic community composition	Total number of taxa [Taxa richness]	EPT composition	Total number of EPT [Taxa richness]	Fish size	Fish age structures	Fish species richness	Fish species quality	Macrophyte community composition	Macrophyte species coverage	Macrophyte species quality	Phytobenthos community composition	Phytobenthos species richness	Phytobenthos species quality	Riparian vegetation community composition	Riparian vegetation species richness	Riparian vegetation species quality
RESERVOIRS AND DAMS	Loss of river continuity	1	1	1	1	1	3	3	3	3	2	2	2	1	1	1	1	1	1
	Reduced downstream current speed	2	2	0	0	0	2	2	2	2	2	2	2	1	1	1	1	1	1
	Increased upstream water depth	2	2	0	0	0	3	3	3	3	2	2	2	1	1	1	2	2	2
	Reduced downstream discharge	2	2	0	2	2	3	3	3	3	2	2	2	1	1	1	2	2	2
	Reduced downstream wetted area	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	2	2
	Reduced sediment and bed-load downstream transport	2	2	0	0	0	0	0	2	2	2	2	2	1	1	1	2	2	2
	High loads of suspended sediment for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	2	2
	Sudden increase of water turbidity for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	2	2
	Sudden increase of discharge and current speed for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	2	2
	Increased upstream sedimentation and colmation of the interstitial	1	1	1	1	1	3	3	3	3	2	2	2	1	1	1	2	2	2
	Mitigation of natural floods and discharge fluctuations	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	2	2	2
	Fragmentation of habitats	2	2	2	2	2	3	3	3	3	2	2	2	0	0	0	2	2	2
	Turbine mortality and injuries	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
HYDROPEACKING	Artificial hydrological regime with surge and sunk periods	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1
	Sudden high currents with high sediment loads	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1
	Reduced stable wetted area	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	1	1	1
RIVER ENGINEERING STRUCTURES	Loss of soil and bank dynamics	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1	2	2	2
	Artificial or stabilized riverbeds, channels, pipings	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	2	2	2
WATER DIVERSION/RUN OFF	Reduced downstream discharge	2	2	0	2	2	3	3	3	3	2	2	2	1	1	1	1	1	1
	Reduced downstream water depth	2	2	0	0	0	3	3	3	3	2	2	2	1	1	1	0	0	0
	Reduced downstream current speed	2	2	0	0	0	2	2	2	2	2	2	2	1	1	1	1	1	1
	Reduced downstream wetted area	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0	1	1	1
	Mitigation of natural floods and discharge fluctuations	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1
	High loads of suspended sediment for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1
	Sudden increase of water turbidity for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1
	Sudden increase of discharge and current speed for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1
	Increased upstream sedimentation and colmation of the interstitial	1	1	1	1	1	2	2	2	2	2	2	2	0	0	0	0	0	0
	Turbine mortality and injuries	0	0	0	0	0	2	2	2	2	0	0	0	0	0	0	0	0	0

HP IMPACTS AND RELATED EFFECTS	STATUS COMPONENTS AND IMPACT TARGET	HYDROLOGICAL REGIME					RIVER BED STRUCTURE AND SUBSTRATE		PHYSICO-CHEMICAL PARAMETERS										OTHER COMPONENTS		
		Bankfull width variability	Flow velocity variability	Mean depth variability	Maximum depth variability	Flooding dynamics	River bed dynamics, structure & grain size distribution	River bed permeability & colmatation	Biological oxygen demand	Chemical oxygen demand	Concentration of disolved oxygen	Nitrate	Total nitrogen	Total phosphorus	Conductivity	Temperature	Salinity	pH	Riparian arthropod	Landscape diversity and spatial distribution of habitat types	Sinking downstream groundwater level
RESERVOIRS AND DAMS	Loss of river continuity	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	?	3	2
	Reduced downstream current speed	3	3	3	3	3	2	0	0	0	1	0	0	0	0	1	0	0	?	2	0
	Increased upstream water depth	3	3	3	3	3	3	3	2	0	2	0	0	0	2	2	2	2	?	3	2
	Reduced downstream discharge	2	2	2	3	3	2	0	2	0	2	2	2	2	2	2	0	0	?	3	2
	Reduced downstream wetted area	3	2	2	2	3	2	0	2	0	2	0	0	0	0	2	0	0	?	3	3
	Reduced sediment and bed-load downstream transport	3	0	1	1	2	3	0	0	0	0	1	1	0	1	0	1	1	?	1	2
	High loads of suspended sediment for sediment flushing	0	0	1	1	2	3	2	2	2	2	1	1	1	3	2	3	2	?	1	0
	Sudden increase of water turbidity for sediment flushing	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	?	1	0
	Sudden increase of discharge and current speed for sediment flushing	0	0	0	0	0	2	0	1	0	1	0	0	0	0	1	0	0	?	1	0
	Increased upstream sedimentation and colmation of the interstitial	3	3	3	3	3	3	3	2	0	3	0	0	0	0	0	2	1	?	2	2
	Mitigation of natural floods and discharge fluctuations	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	Fragmentation of habitats	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	Turbine mortality and injuries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0
HYDROPEACKING	Artificial hydrological regime with surge and sunk periods	3	3	3	3	3	2	1	0	0	0	0	0	0	0	2	1	0	?	2	2
	Sudden high currents with high sediment loads	3	3	3	3	3	2	1	2	2	2	1	1	1	3	3	3	2	?	2	2
	Reduced stable wetted area	3	3	3	3	3	2	1	1	0	1	0	0	0	0	1	0	0	?	3	2
RIVER ENGINEERING STRUCTURES	Loss of soil and bank dynamics	3	1	1	1	3	1	1	0	0	0	0	0	0	0	0	0	0	?	3	1
	Artificial or stabilized riverbeds, channels, pipings	3	3	3	3	3	1	1	0	0	0	0	0	0	0	0	0	0	?	3	1
WATER DIVERSION/RUN OFF	Reduced downstream discharge	1	1	1	2	2	1	0	0	0	0	0	0	0	0	0	0	0	?	2	1
	Reduced downstream water depth	2	2	2	2	2	2	2	1	0	1	0	0	0	1	1	1	1	?	2	1
	Reduced downstream current speed	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	?	2	0
	Reduced downstream wetted area	2	1	1	1	2	1	0	1	0	1	0	0	0	0	1	0	0	?	2	1
	Mitigation of natural floods and discharge fluctuations	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	High loads of suspended sediment for sediment flushing	0	0	0	0	1	2	1	1	1	1	0	0	0	2	1	2	1	?	1	0
	Sudden increase of water turbidity for sediment flushing	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	?	1	0
	Sudden increase of discharge and current speed for sediment flushing	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	?	1	0
	Increased upstream sedimentation and colmation of the interstitial	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	0	?	1	2
	Turbine mortality and injuries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0

Figure 1 – HP impacts on river components table

The purpose of this table (Figure 1) is to underline and specify which are the **main pressure elements** on ecosystem components due to HP facilities:

- identifying which elements produce effectively an **impact** on different fluvial ecosystem components;
- by assigning them a **value** for each component of fluvial ecosystem that represents the impact degree.

As shown in Figure 2, for the evaluation of the HP facilities impacts on river ecosystems **4 general HP schemes** have been considered:

1. Reservoirs and dams
2. Hydropeaking
3. River engineering structures
4. Water diversion/run off

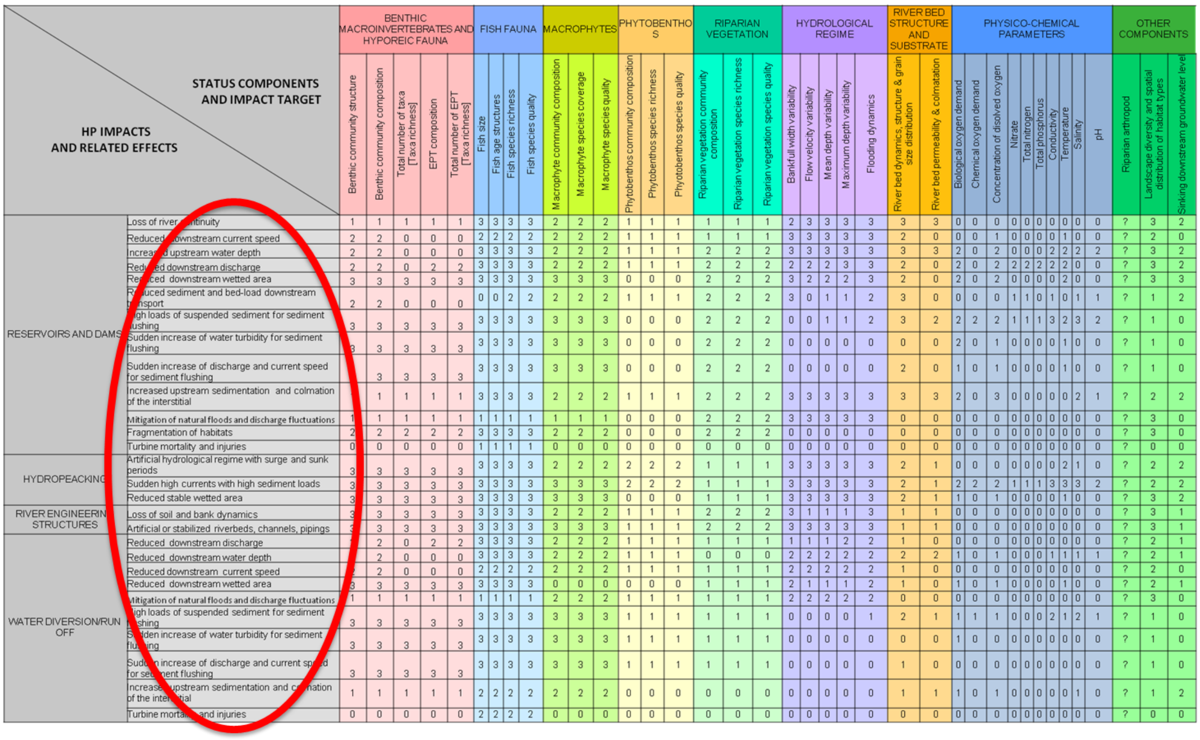
HP IMPACTS AND RELATED EFFECTS	STATUS COMPONENTS AND IMPACT TARGET	BENTHIC MACROINVERTEBRATES AND HYPOREIC FAUNA					FISH FAUNA				MACROPHYTES			PHYTOBENTHOS		
		Benthic community structure	Benthic community composition	Total number of taxa [Taxa richness]	EPT composition	Total number of EPT [Taxa richness]	Fish size	Fish age structures	Fish species richness	Fish species quality	Macrophyte community composition	Macrophyte species coverage	Macrophyte species quality	Phytobenthos community composition	Phytobenthos species richness	Phytobenthos species quality
RESERVOIRS AND DAMS	Loss of river continuity	1	1	1	1	1	3	3	3	3	2	2	2	1	1	1
	Reduced downstream current speed	2	2	0	0	0	2	2	2	2	2	2	2	1	1	1
	Increased upstream water depth	2	2	0	0	0	3	3	3	3	2	2	2	1	1	1
	Reduced downstream discharge	2	2	0	2	2	3	3	3	3	2	2	2	1	1	1
	Reduced downstream wetted area	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0
	Reduced sediment and bed-load downstream transport	2	2	0	0	0	0	0	2	2	2	2	2	1	1	1
	High loads of suspended sediment for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0
	Sudden increase of water turbidity for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0
	Sudden increase of discharge and current speed for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0
	Increased upstream sedimentation and colmation of the interstitial	1	1	1	1	1	3	3	3	3	2	2	2	1	1	1
	Mitigation of natural floods and discharge fluctuations	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0
	Fragmentation of habitats	2	2	2	2	2	3	3	3	3	2	2	2	0	0	0
	Turbine mortality and injuries	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0
HYDROPEACKING	Artificial hydrological regime with surge and sunk periods	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2
	Sudden high currents with high sediment loads	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2
	Reduced stable wetted area	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0
RIVER ENGINEERING STRUCTURES	Loss of soil and bank dynamics	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1
	Artificial or stabilized riverbeds, channels, pipings	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1
WATER DIVERSION/RUN OFF	Reduced downstream discharge	2	2	0	2	2	3	3	3	3	2	2	2	1	1	1
	Reduced downstream water depth	2	2	0	0	0	3	3	3	3	2	2	2	1	1	1
	Reduced downstream current speed	2	2	0	0	0	2	2	2	2	2	2	2	1	1	1
	Reduced downstream wetted area	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0
	Mitigation of natural floods and discharge fluctuations	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1
	High loads of suspended sediment for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1
	Sudden increase of water turbidity for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1
	Sudden increase of discharge and current speed for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1
	Increased upstream sedimentation and colmation of the interstitial	1	1	1	1	1	2	2	2	2	2	2	2	0	0	0
	Turbine mortality and injuries	0	0	0	0	0	2	2	2	2	0	0	0	0	0	0

HP IMPACTS AND RELATED EFFECTS	STATUS COMPONENTS AND IMPACT TARGET	RIPARIAN VEGETATION			HYDROLOGICAL REGIME					RIVER BED STRUCTURE AND SUBSTRATE		PHYSICO-CHEMICAL PARAMETERS										OTHER COMPONENTS		
		Riparian vegetation community composition	Riparian vegetation species richness	Riparian vegetation species quality	Bankfull width variability	Flow velocity variability	Mean depth variability	Maximum depth variability	Flooding dynamics	River bed dynamics, structure & grain size distribution	River bed permeability & colmatation	Biological oxygen demand	Chemical oxygen demand	Concentration of dissolved oxygen	Nitrate	Total nitrogen	Total phosphorus	Conductivity	Temperature	Salinity	pH	Riparian arthropod	Landscape diversity and spatial distribution of habitat types	Sinking downstream groundwater level
RESERVOIRS AND DAMS	Loss of river continuity	1	1	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	?	3	2
	Reduced downstream current speed	1	1	1	3	3	3	3	3	2	0	0	0	1	0	0	0	0	1	0	0	?	2	0
	Increased upstream water depth	2	2	2	3	3	3	3	3	3	3	2	0	2	0	0	0	2	2	2	2	?	3	2
	Reduced downstream discharge	2	2	2	2	2	2	3	3	2	0	2	0	2	2	2	2	2	2	0	0	?	3	2
	Reduced downstream wetted area	2	2	2	3	2	2	2	3	2	0	2	0	2	0	0	0	0	2	0	0	?	3	3
	Reduced sediment and bed-load downstream transport	2	2	2	3	0	1	1	2	3	0	0	0	0	1	1	0	1	0	1	1	?	1	2
	High loads of suspended sediment for sediment flushing	2	2	2	0	0	1	1	2	3	2	2	2	2	1	1	1	3	2	3	2	?	1	0
	Sudden increase of water turbidity for sediment flushing	2	2	2	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	?	1	0
	Sudden increase of discharge and current speed for sediment flushing	2	2	2	0	0	0	0	0	2	0	1	0	1	0	0	0	0	1	0	0	?	1	0
	Increased upstream sedimentation and colmation of the interstitial	2	2	2	3	3	3	3	3	3	3	2	0	3	0	0	0	0	0	2	1	?	2	2
	Mitigation of natural floods and discharge fluctuations	2	2	2	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	Fragmentation of habitats	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	Turbine mortality and injuries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0
HYDROPEACKING	Artificial hydrological regime with surge and sunk periods	1	1	1	3	3	3	3	3	2	1	0	0	0	0	0	0	0	2	1	0	?	2	2
	Sudden high currents with high sediment loads	1	1	1	3	3	3	3	3	2	1	2	2	2	1	1	1	3	3	3	2	?	2	2
	Reduced stable wetted area	1	1	1	3	3	3	3	3	2	1	1	0	1	0	0	0	0	1	0	0	?	3	2
RIVER ENGINEERING STRUCTURES	Loss of soil and bank dynamics	2	2	2	3	1	1	1	3	1	1	0	0	0	0	0	0	0	0	0	0	?	3	1
	Artificial or stabilized riverbeds, channels, pipings	2	2	2	3	3	3	3	3	1	1	0	0	0	0	0	0	0	0	0	0	?	3	1
WATER DIVERSION/RUN OFF	Reduced downstream discharge	1	1	1	1	1	1	2	2	1	0	0	0	0	0	0	0	0	0	0	0	?	2	1
	Reduced downstream water depth	0	0	0	2	2	2	2	2	2	2	1	0	1	0	0	0	1	1	1	1	?	2	1
	Reduced downstream current speed	1	1	1	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	?	2	0
	Reduced downstream wetted area	1	1	1	2	1	1	1	2	1	0	1	0	1	0	0	0	0	1	0	0	?	2	1
	Mitigation of natural floods and discharge fluctuations	1	1	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	High loads of suspended sediment for sediment flushing	1	1	1	0	0	0	0	1	2	1	1	1	1	0	0	0	2	1	2	1	?	1	0
	Sudden increase of water turbidity for sediment flushing	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	?	1	0
	Sudden increase of discharge and current speed for sediment flushing	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	?	1	0
	Increased upstream sedimentation and colmation of the interstitial	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	0	?	1	2
	Turbine mortality and injuries	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0

Figure 2 – General HP schemes occurence

To detail if, how and how much every general HP scheme produces an impact on each river ecosystem status component **19 HP effects** have been selected (Figure 3):

1. Loss of river continuity
2. Reduced downstream current speed
3. Increased upstream water depth
4. Reduced downstream discharge
5. Reduced downstream wetted area
6. Reduced sediment and bed-load downstream transport
7. High loads of suspended sediment for sediment flushing
8. Sudden increase of water turbidity for sediment flushing
9. Sudden increase of discharge and current speed for sediment flushing
10. Increased upstream sedimentation and colmation of the interstitial
11. Mitigation of natural floods and discharge fluctuations
12. Fragmentation of habitats
13. Turbine mortality and injuries
14. Artificial hydrological regime with surge and sunk periods
15. Sudden high currents with high sediment loads
16. Reduced stable wetted area
17. Loss of soil and bank dynamics
18. Artificial or stabilized riverbeds, channels, piping
19. Reduced downstream water depth



		BENTHIC MACROINVERTEBRATES AND HYPOREIC FAUNA					FISH FAUNA				MACROPHYTES			PHYTOBENTHOS			RIPARIAN VEGETATION			HYDROLOGICAL REGIME					RIVER BED STRUCTURE AND SUBSTRATE		PHYSICO-CHEMICAL PARAMETERS										OTHER COMPONENTS		
HP IMPACTS AND RELATED EFFECTS	STATUS COMPONENTS AND IMPACT TARGET	Benthic community structure	Benthic community composition	Total number of taxa [Taxa richness]	EPT composition	Total number of EPT [Taxa richness]	Fish size	Fish age structures	Fish species richness	Fish species quality	Macrophyte community composition	Macrophyte species coverage	Macrophyte species quality	Phytobenthos community composition	Phytobenthos species richness	Phytobenthos species quality	Riparian vegetation community composition	Riparian vegetation species richness	Riparian vegetation species quality	Bankfull width variability	Flow velocity variability	Mean depth variability	Maximum depth variability	Flooding dynamics	River bed dynamics, structure & grain size distribution	River bed permeability & colmatation	Biological oxygen demand	Chemical oxygen demand	Concentration of disolved oxygen	Nitrate	Total nitrogen	Total phosphorus	Conductivity	Temperature	Salinity	pH	Riparian arthropod	Landscape diversity and spatial distribution of habitat types	Sinking downstream groundwater level
RESERVOIRS AND DAMS	Loss of river continuity	1	1	1	1	1	3	3	3	3	2	2	2	1	1	1	1	1	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	?	3	2
	Reduced downstream current speed	2	2	0	0	0	2	2	2	2	2	2	2	1	1	1	1	1	1	3	3	3	3	3	2	0	0	0	1	0	0	0	0	1	0	0	?	2	0
	Increased upstream water depth	2	2	0	0	0	3	3	3	3	2	2	2	1	1	1	2	2	2	3	3	3	3	3	3	3	2	0	2	0	0	0	2	2	2	2	?	3	2
	Reduced downstream discharge	2	2	0	2	2	3	3	3	3	2	2	2	1	1	1	2	2	2	2	2	2	3	3	2	0	2	0	2	2	2	2	2	2	0	0	?	3	2
	Reduced downstream wetted area	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	2	2	3	2	2	2	3	2	0	2	0	2	0	0	0	0	2	0	0	?	3	3
	Reduced sediment and bed-load downstream transport	2	2	0	0	0	0	0	2	2	2	2	2	1	1	1	2	2	2	3	0	1	1	2	3	0	0	0	0	1	1	0	1	0	1	1	?	1	2
	High loads of suspended sediment for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	2	2	0	0	1	1	2	3	2	2	2	2	1	1	1	3	2	3	2	?	1	0
	Sudden increase of water turbidity for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	2	2	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	?	1	0
	Sudden increase of discharge and current speed for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	2	2	2	0	0	0	0	0	2	0	1	0	1	0	0	0	0	1	0	0	?	1	0
	Increased upstream sedimentation and colmation of the interstitial	1	1	1	1	1	3	3	3	3	2	2	2	1	1	1	2	2	2	3	3	3	3	3	3	3	2	0	3	0	0	0	0	0	2	1	?	2	2
	Mitigation of natural floods and discharge fluctuations	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	2	2	2	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	Fragmentation of habitats	2	2	2	2	2	3	3	3	3	2	2	2	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	Turbine mortality and injuries	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0
HYDROPEACKING	Artificial hydrological regime with surge and sunk periods	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1	3	3	3	3	3	2	1	0	0	0	0	0	0	0	2	1	0	?	2	2
	Sudden high currents with high sediment loads	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1	3	3	3	3	3	2	1	2	2	2	1	1	1	3	3	3	2	?	2	2
	Reduced stable wetted area	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	1	1	1	3	3	3	3	3	2	1	1	0	1	0	0	0	0	1	0	0	?	3	2
RIVER ENGINEERING STRUCTURES	Loss of soil and bank dynamics	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1	2	2	2	3	1	1	1	3	1	1	0	0	0	0	0	0	0	0	0	0	?	3	1
	Artificial or stabilized riverbeds, channels, pipings	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	2	2	2	3	3	3	3	3	1	1	0	0	0	0	0	0	0	0	0	0	?	3	1
WATER DIVERSION/RUN OFF	Reduced downstream discharge	2	2	0	2	2	3	3	3	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2	1	0	0	0	0	0	0	0	0	0	0	0	?	2	1
	Reduced downstream water depth	2	2	0	0	0	3	3	3	3	2	2	2	1	1	1	0	0	0	2	2	2	2	2	2	2	1	0	1	0	0	0	1	1	1	1	?	2	1
	Reduced downstream current speed	2	2	0	0	0	2	2	2	2	2	2	2	1	1	1	1	1	1	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	?	2	0
	Reduced downstream wetted area	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0	1	1	1	2	1	1	1	2	1	0	1	0	1	0	0	0	0	1	0	0	?	2	1
	Mitigation of natural floods and discharge fluctuations	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	High loads of suspended sediment for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	0	0	0	0	1	2	1	1	1	1	0	0	0	2	1	2	1	?	1	0
	Sudden increase of water turbidity for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	?	1	0
	Sudden increase of discharge and current speed for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	?	1	0
	Increased upstream sedimentation and colmation of the interstitial	1	1	1	1	1	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	0	?	1	2
	Turbine mortality and injuries	0	0	0	0	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0

Figure 3 – HP effects on river ecosystems

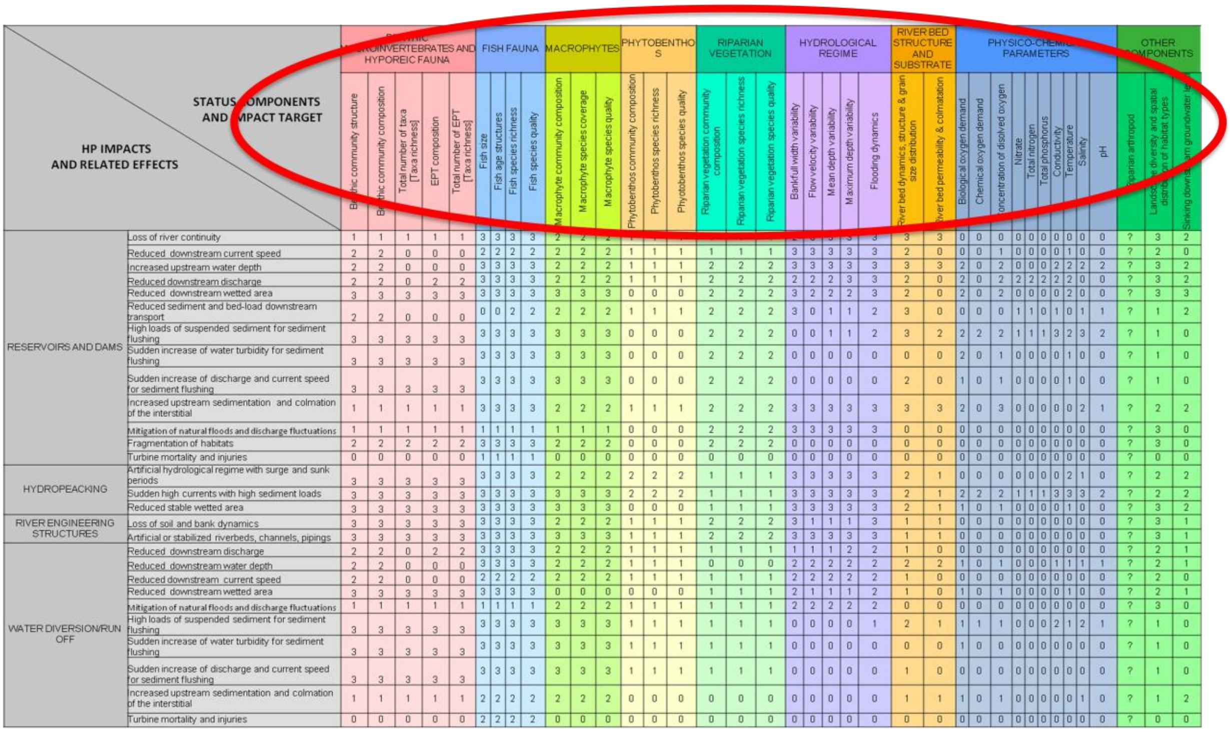


Figure 4 – River ecosystem components affected by HP

As showing in Figure 4, **9 river ecosystem components** potentially impacted in composition, richness and quality by HP, have been considered:

1. Benthic macroinvertebrates and hyporeic fauna

2. Fish fauna
3. Macrophytes
4. Phytobenthos
5. Riparian vegetation
6. Hydrological regime
7. River bed structure and substrate
8. Physico-chemical parameters
9. Other components

and each possible impact has been **coded** as shown below (Figure 5):

- 0 = no impact
- 1 = small impact
- 2 = significant impact
- 3 = high impact

HP IMPACTS AND RELATED EFFECTS	STATUS COMPONENTS AND IMPACT TARGET	BENTHIC MACROINVERTEBRATES AND HYPOREIC FAUNA					FISH FAUNA				MACROPHYTES			PHYTOBENTHOS			RIPARIAN VEGETATION			HYDROLOGICAL REGIME					RIVER BED STRUCTURE AND SUBSTRATE		PHYSICO-CHEMICAL PARAMETERS										OTHER COMPONENTS		
		Benthic community structure	Benthic community composition	Total number of taxa [Taxa richness]	EPT composition	Total number of EPT [Taxa richness]	Fish size	Fish age structures	Fish species richness	Fish species quality	Macrophyte community composition	Macrophyte species coverage	Macrophyte species quality	Phytobenthos community composition	Phytobenthos species richness	Phytobenthos species quality	Riparian vegetation community composition	Riparian vegetation species richness	Riparian vegetation species quality	Bankfull width variability	Flow velocity variability	Mean depth variability	Maximum depth variability	Flooding dynamics	River bed dynamics, structure & grain size distribution	River bed permeability & colmatation	Biological oxygen demand	Chemical oxygen demand	Concentration of dissolved oxygen	Nitrate	Total nitrogen	Total phosphorus	Conductivity	Temperature	Salinity	pH	Riparian arthropod	Landscape diversity and spatial distribution of habitat types	Sinking downstream groundwater level
RESERVOIRS AND DAMS	Loss of river continuity	1	1	1	1	1	3	3	3	3	2	2	2	1	1	1	[illegible]	1	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	?	3	2
	Reduced downstream current speed	2	2	0	0	0	2	2	2	2	2	2	2	1	1	1	[illegible]	1	1	3	3	3	3	3	2	0	0	0	1	0	0	0	0	1	0	0	?	2	0
	Increased upstream water depth	2	2	0	0	0	3	3	3	3	2	2	2	1	1	1	[illegible]	2	2	3	3	3	3	3	3	3	2	0	2	0	0	0	2	2	2	2	?	3	2
	Reduced downstream discharge	2	2	0	2	2	3	3	3	3	2	2	2	1	1	1	[illegible]	2	2	2	2	2	3	3	2	0	2	0	2	2	2	2	2	2	0	0	?	3	2
	Reduced downstream wetted area	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	[illegible]	2	2	3	2	2	2	3	2	0	2	0	2	0	0	0	0	2	0	0	?	3	3
	Reduced sediment and bed-load downstream transport	2	2	0	0	0	0	0	2	2	2	2	2	1	1	1	[illegible]	2	2	3	0	1	1	2	3	0	0	0	0	1	1	0	1	0	1	1	?	1	2
	High loads of suspended sediment for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	[illegible]	2	2	0	0	1	1	2	3	2	2	2	2	1	1	1	3	2	3	2	?	1	0
	Sudden increase of water turbidity for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	[illegible]	2	2	0	0	0	0	0	0	0	2	0	1	0	0	0	0	1	0	0	?	1	0
	Sudden increase of discharge and current speed for sediment flushing	3	3	3	3	3	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	0	2	2	2	0	0	0	0	0	2	0	1	0	1	0	0	0	0	1	0	0	?	1	0
	Increased upstream sedimentation and colmation of the interstitial	1	1	1	1	1	3	3	3	3	2	2	2	1	1	1	2	2	2	3	3	3	3	3	3	3	2	0	3	0	0	0	0	0	2	1	?	2	2
	Mitigation of natural floods and discharge fluctuations	1	1	1	1	1	1	1	1	1	1	1	1	0	0	0	2	2	2	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	Fragmentation of habitats	2	2	2	2	2	3	3	3	3	2	2	2	0	0	0	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	Turbine mortality and injuries	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0
HYDROPEACKING	Artificial hydrological regime with surge and sunk periods	3	3	3	3	3	3	3	3	3	2	2	2	2	2	2	1	1	1	3	3	3	3	3	2	1	0	0	0	0	0	0	0	2	1	0	?	2	2
	Sudden high currents with high sediment loads	3	3	3	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1	3	3	3	3	3	2	1	2	2	2	1	1	1	3	3	3	2	?	2	2
	Reduced stable wetted area	3	3	3	3	3	3	3	3	3	3	3	3	0	0	0	1	1	1	3	3	3	3	3	2	1	1	0	1	0	0	0	0	1	0	0	?	3	2
RIVER ENGINEERING STRUCTURES	Loss of soil and bank dynamics	3	3	3	3	3	3	3	3	3	2	2	2	1	1	1	2	2	2	3	1	1	1	3	1	1	0	0	0	0	0	0	0	0	0	0	?	3	1
	Artificial or stabilized riverbeds, channels, pipings	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	2	2	2	3	3	3	3	3	1	1	0	0	0	0	0	0	0	0	0	0	?	3	1
WATER DIVERSION/RUN OFF	Reduced downstream discharge	2	2	0	2	2	3	3	3	3	2	2	2	1	1	1	1	1	1	1	1	1	2	2	1	0	0	0	0	0	0	0	0	0	0	0	?	2	1
	Reduced downstream water depth	2	2	0	0	0	3	3	3	3	2	2	2	1	1	1	0	0	0	2	2	2	2	2	2	2	1	0	1	0	0	0	1	1	1	1	?	2	1
	Reduced downstream current speed	2	2	0	0	0	2	2	2	2	2	2	2	1	1	1	1	1	1	2	2	2	2	2	1	0	0	0	0	0	0	0	0	0	0	0	?	2	0
	Reduced downstream wetted area	3	3	3	3	3	3	3	3	3	0	0	0	0	0	0	1	1	1	2	1	1	1	2	1	0	1	0	1	0	0	0	0	1	0	0	?	2	1
	Mitigation of natural floods and discharge fluctuations	1	1	1	1	1	1	1	1	1	2	2	2	1	1	1	1	1	1	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	?	3	0
	High loads of suspended sediment for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	0	0	0	0	1	2	1	1	1	1	0	0	0	2	1	2	1	?	1	0
	Sudden increase of water turbidity for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	?	1	0
	Sudden increase of discharge and current speed for sediment flushing	3	3	3	3	3	3	3	3	3	3	3	3	1	1	1	1	1	1	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	?	1	0
	Increased upstream sedimentation and colmation of the interstitial	1	1	1	1	1	2	2	2	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	0	0	0	0	0	1	0	?	1	2
	Turbine mortality and injuries	0	0	0	0	0	2	2	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	?	0	0

Figure 5 – Impact code

2. Impacts indicators names

As shown in Figure 6, following the short review & update of the effects of HP on biological communities this table contains a full/short description of:

- **4 general HP schemes** to consider for the evaluation of the HP facilities impact on river ecosystems;
- **19 HP effects** to considered to detailing if, how and how much every general HP scheme produces an impact on each river ecosystem status component.

HP IMPACTS	HP IMPACTS DEFINITION	HP EFFECTS	HP EFFECTS DEFINITION
RESERVOIRS AND DAMS	A dam is a barrier that impounds water or underground streams. Dams generally serve the primary purpose of retaining water. [...] Hydropower and pumped-storage hydroelectricity are often used in conjunction with dams to generate electricity. A dam can also be used to collect water or for storage of water which can be evenly distributed between locations. [From *Wikipedia*, the free encyclopedia]	Loss of river continuity	*Dams and weirs interrupt the river continuum and affected the biology and ecology of several biota (interupted fish migration) in riverine systems.*
		Reduced downstream current speed	*The reduction of the flow velocity altered the hydromorphological conditions and the habitat quality.*
		Increased upstream water depth	*Impounded river stretches are primarily characterized by a decreased flow velocity and an increased water volume.*
		Reduced downstream discharge Reduced downstream wetted area	*Reduction of water depth and a decrease of the ground-water level and altered the physico-chemical conditions in the residual water stretch.*
		Reduced sediment and bed-load downstream transport	*Reduced sediment and bed-load downstream transport altered the habitat conditions, and the habitat suitability for the typical aquatic biota of the ecoregions and the river system.*
		High loads of suspended sediment for sediment flushing Sudden increase of water turbidity for sediment flushing Sudden increase of discharge and current speed for sediment flushing	*The flushing event increases the water discharge and the loads of sediment. This affects immediately the macroinvertebrates and fish fauna.*
		Increased upstream sedimentation and colmation of the interstitial	*Decreased flow velocity leads to increased sedimentation in the tailrace of weirs/dams and altered the habitat conditions for the aquatic biota. Lose of the region typical habitat characteristics and habitat diversity.*
		Mitigation of natural floods and discharge fluctuations	*The mitigation of the hydrological condition of riverine systems is caused by the renaturation of water courses.*
		Fragmentation of habitats	*Dams and weirs interrupt riverine system, and leads to habitat fragmentation.*
		Turbine mortality and injuries	*Sudden changes of hydrostatic pressure that can cause swim bladder rupture and bubble formation inside tissues. The power station devices (turbine) can cause mechanical damages or chop fish into pieces.*
HYDROPEACKING	*Surge waves and fast sinking of water levels is a typical effect of the power peaking management of reservoir hydropower plants. Phases of still-stand and water storage are followed by phases of water release for electricity production. Hydropeaking means in general high disturbances and a loss of habitat quality. Surge waves often approach very quick and aquatic species cannot adapt to this like to natural flood events by seeking shelter. Catastrophic drift of fish, eggs and macroinvertebrates is often the consequence. When water levels are sinking again some aquatic organisms are don´t able to reach the main flow channel or to find shelter in deeper soil layer and get captured in pools or strand on gravel banks. Dry falling of spawning grounds and nests are also major problems concerning fish populations.*	Artificial hydrological regime with surge and sunk periods	*Hydropeaking (surge and sunk periods) altered the physic-chemical condition (themperature, water chemistry, wettet area, ...) in riverine systems and affected the aquatic ecosystems.*
		Sudden high currents with high sediment loads	*Flushing events increases suddently the water discharge and the sendiment load. This affects immediately benthic macroinvertebrates and fish fauna.*
		Reduced stable wetted area	*The reduction of the stable wetted area in water courses is mainly the result of hydropeaking and water abstraction.*
RIVER ENGINEERING STRUCTURES	*For hydropower plants are range of installations and structures as roads, powerhouse, power lines, dams and riverbed fixations have to be built. The stretches in the reach of the facility are often heavily modified and do not offer adequate habitats for the typical flora and fauna. The banks and the soil are stabilized by loose rip-rap or sheeted with concrete walls or floorings, and the natural slope can be decreased and equalized. Head- and tailraces are straightened and built as channels to bring the water masses in a straight way to the powerhouse and back into the river.*	Loss of soil and bank dynamics	*The loss of hydromorphological dynamic is mostly the result of the reduced water discharge.*
		Artificial or stabilized riverbeds, channels, pipings	*Artificial constructions like dams and riverbed fixations affect riverine systems and their aquatic habitat.*
WATER DIVERSION/RUN OFF	• *The impacts are concentrated in the water stretches downstream of the withdrawal. The intensity of the pressure depends on how much water is abstracted and it is measured by the remaining instream flow and the length of the section until the point of return.* • *The hydrological regime in residual water stretches depends on the hydropower operation and mangement. Some hydropower operations use the whole discharge and a dotation for the diversion stretch is missing; then the rivers fall completely dry. Only bigger flood events bring in some dynamic. In areas of decreased flow velocities suspended sediments sink down, deposit into the interstitial and can clog the gravel substrate.* • *Residual flow stretches are further exposed to higher risks of deterioration of water quality by nutrients, pollutants and toxicants because of the decreased puffer capacity of their smaller water volume.* • *In reservoirs and in impounded stretches sand is deposited in special sedimentation chambers of the dam or the weir to protect the turbines. From time to time, depending on the size, the chambers must be emptied and the collected sediment gets flushed downstream.*	Reduced downstream discharge	
		Reduced downstream water depth Reduced downstream current speed Reduced downstream wetted area	*Reduction of water depth/discharge/currend speed altered the physico-chemical conditions in the residual water stretch.*
		Mitigation of natural floods and discharge fluctuations	*The mitigation of the hydrological condition of riverine systems is caused by the renaturation of water courses.*
		High loads of suspended sediment for sediment flushing Sudden increase of water turbidity for sediment flushing Sudden increase of discharge and current speed for sediment flushing	*The flushing event increases the water discharge and the loads of sediment. This affects immediately the macroinvertebrates and fish fauna.*
		Increased upstream sedimentation and colmation of the interstitial	*Decreased flow velocity leads to increased sedimentation in the tailrace of weirs/dams and altered the habitat conditions for the aquatic biota. Lose of the region typical habitat characteristics and habitat diversity.*
		Turbine mortality and injuries	*Sudden changes of hydrostatic pressure that can cause swim bladder rupture and bubble formation inside tissues (gas bubble disease).*

Source: SHARE - Criteria and indicators to identify vulnerable Alpine river ecosystems - *Innsbruck – Austria, 07th October 2011 - Workshop on HP & river biological indicators* - PPT presentation;
SHARE - Short review & update of the effects of HP on biological communities - *Innsbruck – Austria, 07th October 2011 - Workshop on HP & river biological indicators* - PPT presentation;
SHARE - Hydropower impacts on Alpine river ecosystems - 2nd Draft - WP5 - Action 5.3 - deliverable WP5-35.

Figure 6 – Impact indicators names

3. Impact code

This table (Figure 7) defines **4 different degree of impact** that every HP facility and its related effects *could* have on each river ecosystem status component and its associated impact value and a full/short description of each of them.

- 0 = no impact
- 1 = small impact
- 2 = significant impact
- 3 = high impact

IMPACT	DEFINITION	VALUE
No impact	Absence of impact on the considered river ecosystem component	0
Small impact	Presence of a slight impact on the considered river ecosystem component	1
Significant impact	Presence of an important impact on the considered river ecosystem component	2
High impact	Presence of an elevated impact on the considered river ecosystem component	3

Figure 7 – Definition of the impact code

4. Work sheet for Pivot table

The "4 Work sheet for Pivot table" contains the same data present in the "1HP impact on river components" sheet but rearranged to allow the Pivot tables feeding.

5. HP schemes versus status components

MEAN IMPACT VALUE		STATUS COMPONENTS / IMPACT TARGET				
HP SCHEMES IMPACTS	HP IMPACTS	BENTHIC MACROINVERTEBRATES	FISH FAUNA	MACROPHYTES	PHYTOBENTHOS	RIPARIAN VEGETATION
RESERVOIRS AND DAMS	Fragmentation of habitats	2,00	3,00	2,00	0,00	2,00
	High loads of suspended sediment for sediment flushing	3,00	3,00	3,00	0,00	2,00
	Increased upstream sedimentation and colmation of the interstitial	1,00	3,00	2,00	1,00	2,00
	Increased upstream water depth	0,80	3,00	2,00	1,00	2,00
	Loss of river continuity	1,00	3,00	2,00	1,00	1,00
	Mitigation of natural floods and discharge fluctuations	1,00	1,00	1,00	0,00	2,00
	Reduced downstream current speed	0,80	2,00	2,00	1,00	1,00
	Reduced downstream wetted area	3,00	3,00	3,00	0,00	2,00
	Reduced downstream discharge	1,60	3,00	2,00	1,00	2,00
	Reduced sediment and bed-load downstream transport	0,80	1,00	2,00	1,00	2,00
	Sudden increase of discharge and current speed for sediment flushing	3,00	3,00	3,00	0,00	2,00
	Sudden increase of water turbidity for sediment flushing	3,00	3,00	3,00	0,00	2,00
	Turbine mortality and injuries	0,00	1,00	0,00	0,00	0,00
RESERVOIRS AND DAMS Subtotal		1,62	2,46	2,08	0,46	1,69
HYDROPEACKING	Artificial hydrological regime with surge and sunk periods	3,00	3,00	2,00	2,00	1,00
	Reduced stable wetted area	3,00	3,00	3,00	0,00	1,00
	Sudden high currents with high sediment loads	3,00	3,00	3,00	2,00	1,00
HYDROPEACKING Subtotal		3,00	3,00	2,67	1,33	1,00
RIVER ENGINEERING STRUCTURES	Artificial or stabilized riverbeds, channels, pipings	3,00	3,00	3,00	1,00	2,00
	Loss of soil and bank dynamics	3,00	3,00	2,00	1,00	2,00
RIVER ENGINEERING STRUCTURES Subtotal		3,00	3,00	2,50	1,00	2,00
WATER DIVERSION/RUN OFF	High loads of suspended sediment for sediment flushing	3,00	3,00	3,00	1,00	1,00
	Increased upstream sedimentation and colmation of the interstitial	1,00	2,00	2,00	0,00	0,00
	Mitigation of natural floods and discharge fluctuations	1,00	1,00	2,00	1,00	1,00
	Reduced downstream discharge	1,60	3,00	2,00	1,00	1,00
	Reduced downstream water depth	0,80	3,00	2,00	1,00	0,00
	Reduced downstream wetted area	3,00	3,00	0,00	0,00	1,00
	Reduced downstream current speed	0,80	2,00	2,00	1,00	1,00
	Sudden increase of discharge and current speed for sediment flushing	3,00	3,00	3,00	1,00	1,00
	Sudden increase of water turbidity for sediment flushing	3,00	3,00	3,00	1,00	1,00
	Turbine mortality and injuries	0,00	2,00	0,00	0,00	0,00
WATER DIVERSION/RUN OFF Subtotal		1,72	2,50	1,90	0,70	0,70
Total		1,90	2,57	2,11	0,68	1,29

Figure 8 – HP schemes versus status components table

This is the **Pivot table** (Figure 8) connecting effects of HP schemes impacts the river ecosystem status components. This table can be used to detect if and how much specific HP facilities *could* produce an impact on the river ecosystem status components.

The first column "**HP schemes impacts**" allows to **flag the specific HP schemes impacts** to consider choosing among the 4 identified as explained in the "1 HP impacts on river components" paragraph.

The second column "**HP impacts**" allows to **flag for each HP schemes impacts the related HP effects** identified as explained in the "1 HP impacts on river components" paragraph.

The following column "**status components**" allows to **flag and screen river ecosystem status components** to be considered in each specific case (i.e. benthic macroinvertebrates, fish fauna, macrophytes, hydrological regime and riparian vegetation could be considered but **not** phytobenthos because less reactive or / and due to lack of data related to this community).

The "**impact target**" column allows to **flag and screen for each flagged river ecosystem status components the target elements** to consider in each specific case (i.e. for fish fauna: fish size, fish age structures and fish species richness but **not** fish species quality because of genetic data lack).

The **Values Field** shows the impact value assigned to each impact target element reflecting the effect of each HP impact as the Subtotal rules and columns show the mean value for each components/elements group.

After flagging components and elements to consider in the specific case in the "7HP *versus* status components graph" sheet, it is possible to drawn an **interactive graph** showing for each HP scheme which are the **status components more affected by each HP facilities**.

6. Status components *versus* HP schemes

MEAN IMPACT VALUE		HP SCHEMES IMPACTS	HP IMPACTS			
		RIVER ENGINEERING STRUCTURES	RESERVOIRS AND DAMS	HYDROPEACKING	WATER DIVERSION/RUN OFF	Total
STATUS COMPONENTS	IMPACT TARGET					
BENTHIC MACROINVERTEBRATES AND HYPOREIC FAUNA	Benthic community composition	3,00	1,92	3,00	2,00	2,14
	Benthic community structure	3,00	1,92	3,00	2,00	2,14
	EPT composition	3,00	1,46	3,00	1,60	1,79
	Total number of EPT [Taxa richness]	3,00	1,46	3,00	1,60	1,79
	Total number of taxa [Taxa richness]	3,00	1,31	3,00	1,40	1,64
BENTHIC MACROINVERTEBRATES AND HYPOREIC FAUNA Subtotal		3,00	1,62	3,00	1,72	1,90
FISH FAUNA	Fish age structures	3,00	2,38	3,00	2,50	2,54
	Fish size	3,00	2,38	3,00	2,50	2,54
	Fish species quality	3,00	2,54	3,00	2,50	2,61
	Fish species richness	3,00	2,54	3,00	2,50	2,61
FISH FAUNA Subtotal		3,00	2,46	3,00	2,50	2,57
RIPARIAN VEGETATION	Riparian vegetation community composition	2,00	1,69	1,00	0,70	1,29
	Riparian vegetation species quality	2,00	1,69	1,00	0,70	1,29
	Riparian vegetation species richness	2,00	1,69	1,00	0,70	1,29
RIPARIAN VEGETATION Subtotal		2,00	1,69	1,00	0,70	1,29
HYDROLOGICAL REGIME	Bankfull width variability	3,00	1,69	3,00	0,90	1,64
	Flooding dynamics	3,00	1,92	3,00	1,10	1,82
	Flow velocity variability	2,00	1,46	3,00	0,80	1,43
	Maximum depth variability	2,00	1,69	3,00	0,90	1,57
	Mean depth variability	2,00	1,62	3,00	0,80	1,50
HYDROLOGICAL REGIME Subtotal		2,40	1,68	3,00	0,90	1,59
RIVER BED STRUCTURE AND SUBSTRATE	River bed dynamics, structure & grain size distribution	1,00	1,77	2,00	0,90	1,43
	River bed permeability & colmatation	1,00	0,85	1,00	0,40	0,71
RIVER BED STRUCTURE AND SUBSTRATE Subtotal		1,00	1,31	1,50	0,65	1,07
PHYSICO-CHEMICAL PARAMETERS	Biological oxygen demand	0,00	1,00	1,00	0,50	0,75
	Chemical oxygen demand	0,00	0,15	0,67	0,10	0,18
	Concentration of disolved oxygen	0,00	1,08	1,00	0,40	0,75
	Conductivity	0,00	0,62	1,00	0,30	0,50
	Nitrate	0,00	0,31	0,33	0,00	0,18
	pH	0,00	0,46	0,67	0,20	0,36
	Salinity	0,00	0,62	1,33	0,40	0,57
	Temperature	0,00	0,85	2,00	0,30	0,71
	Total nitrogen	0,00	0,31	0,33	0,00	0,18
	Total phosphorus	0,00	0,23	0,33	0,00	0,14
PHYSICO-CHEMICAL PARAMETERS Subtotal		0,00	0,56	0,87	0,22	0,43
Total		1,62	1,37	1,95	0,99	1,31

Figure 9 – Status components *versus* HP schemes

This is the **Pivot table** (Figure 9) connecting river ecosystem status components with effects of HP schemes impacts.

This table can be used to **detect which are the river ecosystem status components affected by HP and how much they are affected by specific HP facilities**.

The first column "**status components**" allows to flag and screen river ecosystem status components to consider in each specific case (i.e. benthic macroinvertebrates, fish fauna, macrophytes, hydrological regime and riparian vegetation could be considered but **not** phytobenthos because less reactive or / and due to lack of data related to this community).

The second column "**impact target**" allows to flag and screen for each flagged river ecosystem status components the target elements to consider in each specific case (i.e. for fish fauna: fish size, fish age structures and fish species richness but **not** fish species quality because of genetic data lack).

The following column "**HP schemes impacts**" allows to flag the specific HP schemes impacts to consider choosing among the 4 identified as explained in the “1 HP impacts on river components” paragraph.

The following column "**HP impacts**" allows to flag for each flagged HP schemes impacts the related HP effects identified as explained in the “1 HP impacts on river components” paragraph.

The **Values Field** shows the impact value assigned to each impact target element reflecting the effect of each HP impact as the Subtotal rules and columns show the mean value for each components/elements group.

After flagging components and elements to consider in the specific case, in the "8 Status components *versus* HP schemes graph" sheet, it is possible to drawn an **interactive graph** showing, for each river ecosystem status component the **HP schemes and HP impacts producing more significant effects on impact targets**.

7. HP schemes *versus* status components graph

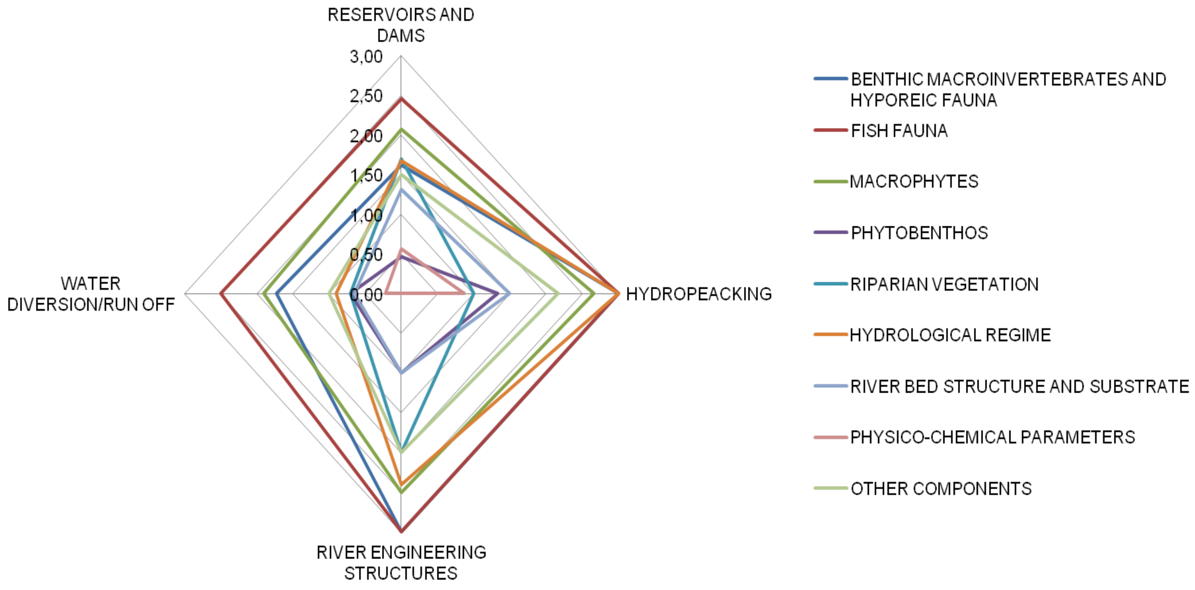


Figure 10 – HP schemes *versus* status components graph

After flagging components and elements to consider in the specific case in the Pivot table called "HP *versus* status components ", in the "HP schemes *versus* status components graph" sheet, it is possible to draw an **interactive graph** showing for each HP scheme which are the **status components more affected by each HP facilities** (Figure 10).

8. Status components *versus* HP schemes graph

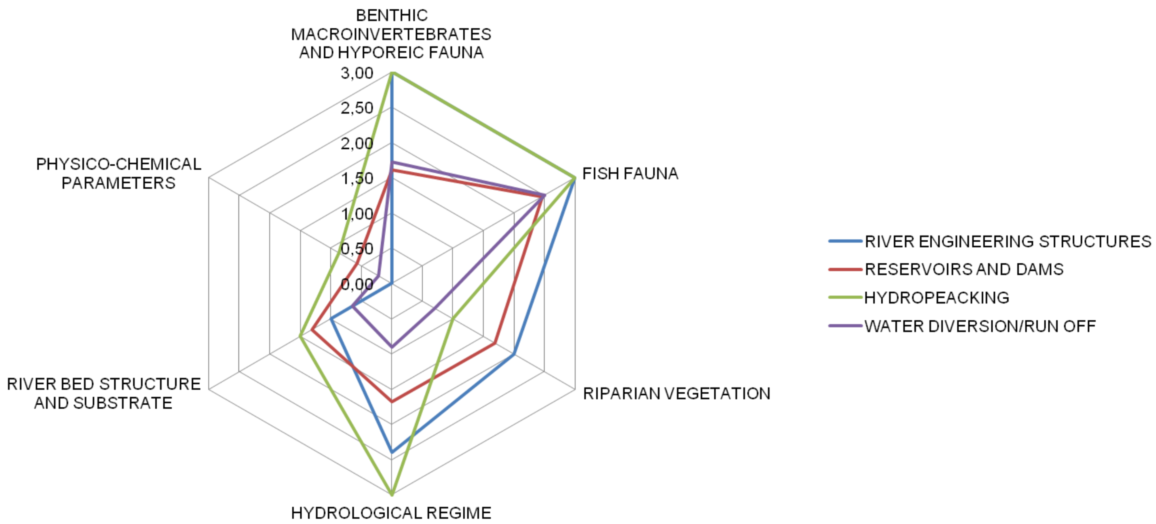


Figure 11 – Status components *versus* HP schemes graph

After flagging components and elements to consider in the specific case in the Pivot table called "Status components *versus* HP schemes ", in the "Status components *versus* HP schemes graph" sheet it is possible to draw an **interactive graph** showing, for each river ecosystem status component, which are the **HP schemes and HP impacts who produce more effects on the impact targets**(Figure 11).

9. List of status components indices

This table shows a list of the main Indices available for each river ecosystem component evaluation for Austria, France, Germany, Italy and Slovenia.