SEVENTH FRAMEWORK PROGRAMME

THEME 6: Environment (including Climate Change)

# Adaptive strategies to Mitigate the Impacts of Climate Change on European Freshwater Ecosystems

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# Deliverable 6.2: DEVELOPMENT OF IMPACT MATRIX AT CATCHMENT SCALE

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| RE | Restricted to a group specified by the consortium (including the Commission Services) |

***Abstract***

*In section 1 of this Deliverable we present for each catchment a simple two-dimension impact matrix which records the major impacts and their intensity. Our list of impacts is restricted to the effects caused to the hydromorphology, physical and chemical properties of water bodies by each major anthropogenic pressure. The intensity of impacts is defined as severe if the identified impact alone can cause the water body's status to be classified as poor or bad, moderate if the water body's status is classified as moderate and minor if the water body's status is classified as good or high correspondingly. In section 2 we present all impact matrices filled by each partner for all six case study catchments and for each one of the major anthropogenic activities identified in each catchment. Section 3 summarizes our findings by constructing short and simple tables that identify major drivers and impacts specific for each catchment. In section 3 we compare the results obtained by the impact matrices for each case study and conclude that the most severe impacts are met within the class of hydromorphological characteristics and of physical-chemical. Also we observe that the catchments of Morsa and Orlik have the highest number of "severe" impacts followed by Louros and Thames, while the catchments of Dee and Pyhajarvi/Ylaneenjoki have the highest number of "minor" impacts.*

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## 1. Introduction

An environmental impact is the effect of a water related activity (use or consumption) on the status of water. According to the WFD, the overall status of waters is classified on a 5 category scale (high-good-moderate-poor-bad). However, in the context of the present working paper, our intension is not to carry out a complete environmental impact assessment but, rather to identify the current major impacts of the most significant anthropogenic pressures which contribute to the overall classification of water bodies. For this reason we constructed for each catchment a simple two-dimension impact matrix which records the major impacts and their intensity. Theoretically speaking, the list of possible impacts is endless, however, a good starting point is to isolate the major set of impacts allowing a researcher to define and classify the status of a water body. Annex V of the WFD contains four set of indicators, namely biological, hydromorphological and physic-chemical which are used to define and identify the status of a body. Certain member states have proceeded to the definition of very specific allowable levels, or their range, for such indicators. Due to the fact that biological indicators are rarely recorded and their laboratory or field identification is rather difficult, our list of impacts is restricted to the effects caused to the hydromorphology, physical and chemical properties of water bodies by each major anthropogenic pressure. Such information is usually recorded in management plans or in publicly available scientific work. Moreover, the severity of such impacts is indicative of what may happen to the biological environment.

Taking into account that the impact matrix is repeated for each major pressure having at least one significant (sever or moderate) impact, we have kept the list of impacts short, not by excluding impacts, but by aggregating, where possible, impacts having the same nature. For example, instead of citing all possible heavy metals we include just one impact for metals and their compounds. The intensity of impacts is defined as severe if the identified impact alone can cause the water body's status to be classified as poor or bad, moderate if the water body's status is classified as moderate and minor if the water body's status is classified as good or high correspondingly. In the catchments reports (Deliverable 6.1) the WP6 research teams have already identified the significant anthropogenic pressures to which the surface water bodies in each catchment are liable to be subject to. At the same reports the scientific teams have

identified the major impacts and have located the sources these impacts. This identification utilized existing monitoring studies or management plans which record the intensity of major impacts for each important anthropogenic activity. In certain member states (e.g. Greece) water bodies have not been assigned a final status and management plans do not exist. In this case information was largely based and retrieved from existing scientific knowledge and the opinion of experts. This information was used to fill in the impacts matrices for each activity and catchment presented in the next section (Balana *et al.*, 2010a; 2010b; Políčková *et al.*, 2010; Skarbøvik and Bechmann, 2010; Skuras, 2010; Varjopuro, *et al.*, 2010). A "comments" column in each matrix explains the cause of a moderate or a severe impact.

Section 2 of this report presents all the matrices filled by each partner for all six case study catchments. Section 3 summarizes our findings by constructing short and simple tables that identify major drivers and impacts specific for each catchment.

## 2. Impact Matrices

The following sections 2.1 to 2.6 present the impacts matrices for the six case study catchments.

2.1 The Dee Catchment, Scotland

*2.1.1 Agricultural land use – Increasing human population*

| **IMPACTS** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| A. Hydro-morphological impacts | | | | |
| | | | | |
| Quantity of water flow | | X | | Increased water to meet the demands of an increasing population– decrease in quantity of water flow |
| Connection to groundwaters | | | X | Intensive use of fertilizers – modest groundwater pollution in some areas |
| Continuity of river | | | X | Problem from modification caused by engineering works -obstruction to fish passage and loss of natural habitats |
| Width of river | | | X | Sheet piling decreasing river width and destroying bank-side habitats |
| Depth of river | | | X | Drainage - reduced depths particularly in lakes because of sedimentation<br>Erosion from agricultural activities and urban runoff. |
| Structure of river bed | | X | | Flood defence and fishery improvements structures and erosion – river bed damage |
| Velocity of flow | | | X | Wetlands drainage for other agricultural uses– increasing spate flows |
| Morphology of riparian zone | | X | | Limited extent now being replaced with conifers. The remaining areas are under threat from grazing and invasive non-native plants. |
| B. Physical impacts | | | | |
| | | | | |
| Temperature | | X | X | Lower quantity of water in summer - increase in water temperature |
| Conductivity - Salinity | | | X | Induced salinity – excessive abstraction for agricultural and domestic/industrial particularly from groundwaters |

| | | | | |
|---|---|---|---|---|
| pH | | | X | |
| Oxygen balance | | X | | Poorly treated effluent from private septic tanks |
| Acid neutralizing capacity | | | X | Emission from transport activities at Aberdeen harbour |
| Nitrogen status | | | X | Small part of the catchment falls into Nitrate Vulnerable Zones (NZV) |
| Phosphorus status | | X | | Arising from use of inorganic fertilizers and from urban run-off |
| BOD | | X | | Misconnected public sewerage and drainage<br>Poorly treated effluent from septic tanks |
| COD | | | X | |
| C. Chemical impacts (synthetic and non-synthetic) | | | | |
| | | | X | Mainly from use of agrochemicals in farms, Sheep dip and Pesticides.<br>Urban runoff |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

*2.1.2 Recreation and tourism*

| **IMPACTS** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| A. Hydro-morphological impacts | | | | |
| | | | | |
| Quantity of water flow | | | X | |
| Connection to groundwaters | | | X | |
| Continuity of river | | | X | |

| | | | | |
|---|---|---|---|---|
| Width of river | | | X | River paths leading to bankside erosion |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | | X | Modest erosion at some key access points |
| B. Physical impacts | | | | |
| | | | | |
| Temperature | | | | |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | Emission from navigation vehicles/equipment |
| Nitrogen status | | | X | |
| Phosphorus status | | | X | |
| BOD | | X | | Human waste due to inadequate public toilets |
| COD | | | X | |
| | | | | |
| C. Chemical impacts (synthetic and non-synthetic) | | | | |
| | | | X | Mainly from litter |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

*2.1.3 Climate change*

| **IMPACTS** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| A. Hydro-morphological impacts | | | | |

| | | | | |
|---|---|---|---|---|
| Quantity of water flow | | X | | Drought -quantity of flows during summer are getting smaller. Possibly increased intensity of summer and winter storm flows |
| Connection to ground waters | | | X | Excessive abstraction as a result of low water flow from rivers |
| Continuity of river | | | X | |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | | X | |
| B. Physical impacts | | | | |
| Temperature | | | X | Lower quantity of water volume in summer and higher temperature |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | |
| Phosphorus status | | | X | |
| BOD | | | X | |
| COD | | | X | |
| C. Chemical impacts (synthetic and non-synthetic) | | | | |
| | | | X | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |

| | | | | |
|---|---|---|---|---|
| Materials in suspension | | | X | |

2.2 Thames catchment, England

*2.2.1 High population – High demand for water*

| **IMPACTS** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| A. Hydro-morphological impacts | | | | |
| | | | | |
| Quantity of water flow | | X | | Excessive abstraction – leading to reduced water flow |
| Connection to groundwaters | | X | | Groundwater provides around 40% of abstracted water. Rivers and streams also depend on groundwater for replenishment during drier months<br>Increasing water demand due to excessive abstraction is a threat |
| Continuity of river | | | X | Upper streams are drying out seasonally in hotter summers |
| Width of river | | | X | Almost 30% of the rivers and estuaries in the catchment have been physically modified for reason that include control structures, drainage, aggregate extraction, flood risk management etc - reduced width of the rivers |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | X | | High abstraction resulting in reduced flow velocity |
| Morphology of riparian zone | | X | | Lower water tables due to drainage or water abstraction – the habitat changing to drier woodland types |
| B. Physical impacts | | | | |
| | | | | |
| Temperature | | | | Mostly from discharges of treated sewage effluent.<br>Of the total length of the water bodies in the catchment 13%<br>is reported by EA to be at risk or probably at risk from |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | |

| | | | | |
|---|---|---|---|---|
| Phosphorus status | | | X | this factor whilst 12 % is reported at risk or probably at risk of failing BOD standard. |
| Biochemica Oxygen Demand (BOD) | | | X | |
| COD | | | X | |
| C. Chemical impacts (synthetic and non-synthetic) | | | | |
| | | | X | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

*2.2.2 Extensive transport networks and aquaculture*

| **IMPACTS** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| A. Hydro-morphological impacts | | | | |
| | | | | |
| Quantity of water flow | | | X | |
| Connection to groundwaters | | X | | Shortage of water from rivers may necessitate the use of groundwater for fish farms |
| Continuity of river | | X | | Modification by way of control structures and dredging for navigation – reduced river ‘s width |
| Width of river | | X | | |
| Depth of river | | | X | |
| Structure of river bed | | X | | |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | | X | |
| B. Physical impacts | | | | |
| | | | | |

| | | | | |
|---|---|---|---|---|
| Temperature | | | | Emission from transport |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | |
| Phosphorus status | | | X | |
| Biochemica Oxygen Demand (BOD) | | | X | |
| COD | | | X | |
| C. Chemical impacts (synthetic and non-synthetic) | | | | |
| Organohalogen compounds | | | X | Mainly from transport Recreation (boating, fishing etc) |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

*2.2.3 Agriculture*

| **IMPACTS** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| A. Hydro-morphological impacts | | | | |
| | | | | |
| Quantity of water flow | | X | | Excessive abstraction to meet demand for agriculture |
| Connection to groundwaters | | X | | Increasing demand due to shortage of surface water. This can lead to habitats loss and tributaries becoming dry |
| Continuity of river | | | X | Drainage for agricultural use and flood risk management to protect agricultural lands |
| Width of river | | | X | |

| | | | | |
|---|---|---|---|---|
| Depth of river | | X | | Soil erosion is widespread in the catchment particularly from tillage resulting in sedimentation of rivers and wetlands. This sedimentation is changing the structure of the river bed which is vital for trout and salmon population |
| Structure of river bed | | X | | |
| Velocity of flow | | X | | High abstraction resulting in lower flow velocity. Land reclamation from wetland is causing increase in velocity of flow. |
| Morphology of riparian zone | | X | | Conversion into agricultural land,<br>lowering of water-tables through drainage or water abstraction resulting in change to drier habitat types<br>Threat from grazing |
| B. Physical impacts | | | | |
| | | | | |
| Temperature | | | | In the designated Nitrate Vulnerable Zones (NVZ) nitrate pollution is very extensive |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | |
| Phosphorus status | | | X | |
| Biochemica Oxygen Demand (BOD) | | | X | |
| COD | | | X | |
| C. Chemical impacts (synthetic and non-synthetic) | | | | |
| | | | | Mainly from the use of agrochemical and pesticides |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |

| | | | | |
|---|---|---|---|---|
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

*2.2.4. Industries*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| A. Hydro-morphological impacts | | | | |
| | | | | |
| Quantity of water flow | | | X | |
| Connection to groundwater | | | x | |
| Continuity of river | | | X | |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | X | | Major changes caused by wet gravel working |
| B. Physical impacts | | | | |
| | | | | |
| Temperature | | | | Discharge from factories |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | |
| Phosphorus status | | | X | |
| Biochemica Oxygen Demand (BOD) | | | X | |
| COD | | | X | |
| C. Chemical impacts (synthetic and non-synthetic) | | | | |
| | | | X | Mainly from industrial chemical waste discharge |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |

| | | | | |
|---|---|---|---|---|
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

*2.2.5 Climate change*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| A. Hydro-morphological impacts | | | | |
| | | | | |
| Quantity of water flow | | X | | Droughts – reduced water flow and habitats loss<br>Possible increase in storm events leading to flash floods |
| Connection to groundwaters | | X | | Droughts – lower water table and loss of dependent habitats and tributaries<br>Excessive summer abstraction - pollution |
| Continuity of river | | | X | Loss of surface flow in tributaries |
| Width of river | | | X | |
| Depth of river | | | X | Reduced water flow due to droughts – reduced rivers depths<br>Flash Floods/erosions - damage to river bed |
| Structure of river bed | | X | | |
| Velocity of flow | | | X | Reduced water flow due to droughts – reduced velocity of flow<br>Increased velocity in extreme rainfall events |
| Morphology of riparian zone | | X | | Loss of habitat due to drier condition as a result of droughts |
| B. Physical impacts | | | | |
| | | | | |
| Temperature | | | | Reduced water flow – increase in temperature<br>Induced salinity – excessive abstraction from groundwater<br>Pollution from increase flash floods |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | |
| Phosphorus status | | | X | |
| Biochemica Oxygen Demand (BOD) | | | X | |

| | | | | |
|---|---|---|---|---|
| COD | | | X | |
| C. Chemical impacts (synthetic and non-synthetic) | | | | |
| | | | X | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

2.3 Louros catchment, Greece

*2.3.1 Agriculture*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | X | | Significant abstraction |
| Connection to groundwaters | | X | | Due to widespread karstic structures |
| Continuity of river | | X | | The river's continuity has changed due to extensive irrigation and drainage channels and ditches |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | X | | Flood risk zone is usually cultivated |
| Velocity of flow | | X | | Irrigation and drainage have reduced velocity |

| | | | | |
|---|---|---|---|---|
| Morphology of riparian zone | | X | | In certain parts considerable change due to deposits |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | | X | |
| Conductivity - Salinity | | X | | High salinity due to low water flow and intrusion from saline water and due to drainage water that comes from deep drilling |
| pH | | X | | Due to salinity |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | X | | Due to excess use of fertilizers |
| Nitrogen status | | X | | Due to excess use of fertilizers |
| Phosphorus status | | X | | Due to excess use of fertilizers |
| BOD | | X | | Poorly treated effluents |
| COD | | | X | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | X | | Due to excess use of fertilizers |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | Traceable due to excess use of plant protection materials |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | X | | Traceable due to excess and improper use of plant protection substances |
| Materials in suspension | | | X | |

*2.3.2 Livestock*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | | X | |
| Connection to groundwaters | | | X | |
| Continuity of river | | | X | |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | | X | |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | | X | |
| Conductivity - Salinity | | X | | Poorly treated manure and sludge |
| pH | | X | | Poorly treated manure and sludge |
| Oxygen balance | | X | | Poorly treated manure and sludge |
| Acid neutralizing capacity | | X | | Poorly treated manure and sludge |
| Nitrogen status | | X | | Poorly treated manure and sludge |
| Phosphorus status | | | X | |
| BOD | | X | | Poorly treated effluents or leakages |
| COD | | X | | Poorly treated effluents or leakages |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |

| | | | | |
|---|---|---|---|---|
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | X | | |
| Materials in suspension | | | X | |

*2.3.3 Municipal Wastes*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | X | | Increased demand from towns and large villages |
| Connection to groundwaters | | X | | Increased demand from towns and large villages |
| Continuity of river | | | X | |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | | X | In the future, demand for urban land will affect riparian zone in certain places |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | | X | |
| Conductivity - Salinity | | X | | Poorly treated municipal wastewater |
| pH | | X | | Poorly treated municipal wastewater |
| Oxygen balance | | X | | Poorly treated municipal wastewater |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | X | | Poorly treated municipal wastewater |
| Phosphorus status | | | X | |
| BOD | | X | | Poorly treated municipal wastewater |
| COD | | X | | Poorly treated municipal wastewater |
| | | | | |
| **C. Chemical impacts** | | | | |

| | | | | |
|---|---|---|---|---|
| **(synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | X | | Poorly treated municipal wastewater |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | X | | Chlorine |
| Materials in suspension | | | X | |

*2.3.4 Hydroelectric power plant (Energy)*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | X | | Although the river is cut in two parts due to the dam (upper and lower parts) the flow is not severely affected due to the springs that supply municipal water and are at the upper part of the river |
| Connection to groundwaters | | | X | |
| Continuity of river | | X | | |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | X | | |
| Morphology of riparian zone | | X | | To the lower velocity of water downstream the river |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | X | | Due to the cooling of |

| | | | | |
|---|---|---|---|---|
| | | | | turbines |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | X | | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | |
| Phosphorus status | | | X | |
| BOD | | | X | |
| COD | | | X | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

2.4 Orlik area, Vlatva catchment, Czech Republic

*2.4.1 Dam construction for hydropower, water supply, flood protection, etc.*

| **Impact** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | x | x | | severe flow reductions (>90%) occur downstream from several dams due to diversion of water via power stations (e.g., Lipno Res., cca 20-km reach at the Vltava River; Hradiště Dam, 5-km reach at the Černá Stream |
| Connection to groundwaters | | | x | |
| Continuity of river | x | | | |
| Width of river | x | | | |
| Depth of river | x | | | |
| Structure of river bed | x | | | |
| Velocity of flow | x | | | |
| Morphology of riparian zone | x | | | |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | x | | | |
| Conductivity - Salinity | | | x | |
| pH | | x | | |
| Oxygen balance | x | x | | locally important downstream from deep eutrophic dams (e.g., Orlík Reservoir) |
| Acid neutralizing capacity | | | x | |
| Nitrogen status | | | x | |
| Phosphorus status | | x | | |
| BOD | | x | | shallow eutrophic reservoir and weirs can increase BOD and COD status due to planktonic primary production |
| COD | | x | | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | x | |
| Organophosphorous compounds | | | x | |
| Organotin compounds | | | x | |

| | | | | |
|---|---|---|---|---|
| Carcinogenic and related substances | | | x | |
| Persistent hydrocarbons | | | x | |
| Persistent and bioaccumulable organic toxic substances | | | x | |
| Cyanides | | | x | |
| Metals and their compounds | | | x | |
| Arsenic and its compounds | | | | |
| Biocides and plant protection products | | | x | |
| Materials in suspension | | | x | |

*2.4.2 Agriculture*

| **Impact** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | | x | |
| Connection to groundwaters | | | x | |
| Continuity of river | | x | x | moderate to severe impacts at small streams (1st to 3rd order) when they are modified – typically by straightening, deepening and fortifying of channel, placing underground |
| Width of river | | x | x | |
| Depth of river | | x | x | |
| Structure of river bed | | x | x | |
| Velocity of flow | | x | x | |
| Morphology of riparian zone | | x | x | |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | | | |
| Conductivity - Salinity | | | | |
| pH | | | | |
| Oxygen balance | | | | |
| Acid neutralizing capacity | | | | |
| Nitrogen status | | x | | |
| Phosphorus status | | x | x | severe if erosion is allowed |
| BOD | | x | x | high impact when accidental or undue manipulation with manure or silage cause leaching in streams |
| COD | | x | x | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |

| | | | | |
|---|---|---|---|---|
| Organohalogen compounds | | | x | |
| Organophosphorous compounds | | | x | |
| Organotin compounds | | | x | |
| Carcinogenic and related substances | | | x | |
| Persistent hydrocarbons | | | x | |
| Persistent and bioaccumulable organic toxic substances | | | x | |
| Cyanides | | | x | |
| Metals and their compounds | | | x | |
| Arsenic and its compounds | | | x | |
| Biocides and plant protection products | | x | x | increased surface water concentrations have been detected at local scale |
| Materials in suspension | | | x | |

*2.4.3 Municipal use*

| **Impact** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | | x | |
| Connection to groundwaters | | | x | |
| Continuity of river | | | x | |
| Width of river | | x | x | flood control embankments or other measures |
| Depth of river | | x | x | |
| Structure of river bed | | x | x | |
| Velocity of flow | | x | x | |
| Morphology of riparian zone | | x | x | |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | x | x | increases due to discharges from heating stations |
| Conductivity - Salinity | | | x | |
| pH | | | x | |
| Oxygen balance | | | x | |
| Acid neutralizing capacity | | | | |
| Nitrogen status | | x | x | |
| Phosphorus status | x | | | |

| | | | | |
|---|---|---|---|---|
| BOD | | x | | locally important at small streams |
| COD | | x | | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | x | |
| Organophosphorous compounds | | | x | |
| Organotin compounds | | | x | |
| Carcinogenic and related substances | | | x | |
| Persistent hydrocarbons | | | x | |
| Persistent and bioaccumulable organic toxic substances | | | x | |
| Cyanides | | | x | |
| Metals and their compounds | | x | x | |
| Arsenic and its compounds | | | x | |
| Biocides and plant protection products | | | x | |
| Materials in suspension | | | x | |

*2.4.4 Fish pond aquaculture*

| **Impact** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | x | | during periods of filling and emptying |
| Connection to groundwaters | | | x | |
| Continuity of river | x | | x | severe when no bypass channel in constructed |
| Width of river | | | x | |
| Depth of river | | | x | |
| Structure of river bed | | | x | |
| Velocity of flow | | | x | |
| Morphology of riparian zone | | | x | |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | x | | |
| Conductivity - Salinity | | | x | |

| | | | | |
|---|---|---|---|---|
| pH | | x | | |
| Oxygen balance | | x | | |
| Acid neutralizing capacity | | | x | |
| Nitrogen status | | x | x | loss of nitrate during summer month due to denitrification |
| Phosphorus status | x | | | at high fish production intensities |
| BOD | x | | | |
| COD | x | | | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | x | |
| Organophosphorous compounds | | | x | |
| Organotin compounds | | | x | |
| Carcinogenic and related substances | | | x | |
| Persistent hydrocarbons | | | x | |
| Persistent and bioaccumulable organic toxic substances | | | x | |
| Cyanides | | | x | |
| Metals and their compounds | | | x | |
| Arsenic and its compounds | | | x | |
| Biocides and plant protection products | | x | | |
| Materials in suspension | x | | | during fish hauling from emptied ponds |

*2.4.5 Forestry*

| **Impact** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | x | |
| Quantity of water flow | | | x | |
| Connection to groundwaters | | | x | |
| Continuity of river | | | x | |
| Width of river | | | x | |
| Depth of river | | | x | |
| Structure of river bed | | | x | |
| Velocity of flow | | | x | |
| Morphology of riparian zone | | | x | |
| | | | | |
| **B. Physical impacts** | | | | |

| | | | | |
|---|---|---|---|---|
| Temperature | | | x | |
| Conductivity - Salinity | | | x | |
| pH | | | x | |
| Oxygen balance | | | x | |
| Acid neutralizing capacity | | | x | |
| Nitrogen status | | | x | |
| Phosphorus status | | | x | |
| BOD | | | x | |
| COD | | | x | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | x | |
| Organophosphorous compounds | | | x | |
| Organotin compounds | | | x | |
| Carcinogenic and related substances | | | x | |
| Persistent hydrocarbons | | | x | |
| Persistent and bioaccumulable organic toxic substances | | | x | |
| Cyanides | | | x | |
| Metals and their compounds | | | x | |
| Arsenic and its compounds | | | x | |
| Biocides and plant protection products | | | x | |
| Materials in suspension | | (x) | x | erosion |

*2.4.6 Flood rains together with technical adjustments of flows*

| **Impact** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | x | | | |
| Connection to groundwaters | | | x | |
| Continuity of river | | x | | |
| Width of river | | x | | |
| Depth of river | | x | | |
| Structure of river bed | | x | | |
| Velocity of flow | x | | | |
| Morphology of riparian zone | | x | | |
| | | | | |

| | | | | |
|---|---|---|---|---|
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | | x | |
| Conductivity - Salinity | | | x | |
| pH | | | x | |
| Oxygen balance | | | x | |
| Acid neutralizing capacity | | | x | |
| Nitrogen status | | | x | |
| Phosphorus status | x | | x | severe impacts during floods with large-scale surface runoff from landscape |
| BOD | x | | x | |
| COD | x | | x | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | x | |
| Organohalogen compounds | | | x | |
| Organophosphorous compounds | | | x | |
| Organotin compounds | | | x | |
| Carcinogenic and related substances | | | x | |
| Persistent hydrocarbons | | | x | |
| Persistent and bioaccumulable organic toxic substances | | | x | |
| Cyanides | | | x | |
| Metals and their compounds | | | x | |
| Arsenic and its compounds | | | x | |
| Biocides and plant protection products | | | x | |
| Materials in suspension | x | | x | |

2.5 Morsa catchment, Norway

*2.5.1 Dam - Power supply*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | X | | In the downstream parts of the catchment |
| Connection to groundwaters | | | X | |
| Continuity of river | X | | | Dam obstructs flow, fish migration etc. |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | X | | | Dam operation causes velocity changes in lower reaches of Morsa River |
| Morphology of riparian zone | | | X | |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | X | | High temp in lower parts of Morsa River during summer |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | X | | No throughflow past the dam may cause anaerobic conditions upstream |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | |
| Phosphorus status | | | X | |
| BOD | | | X | |
| COD | | | X | |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |

| | | | | |
|---|---|---|---|---|
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | | X | |

*2.5.2 Agriculture*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | | X | |
| Connection to groundwaters | | | X | |
| Continuity of river | | | X | |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | X | | Some places lack of vegetation (buffer strips, trees) along rivers/lakes. |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | | X | |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | X | | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | X | | | |
| Phosphorus status | X | | | |
| BOD | | X | | Uncertain |
| COD | | X | | Uncertain |
| | | | | |
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | X | |
| Organophosphorous | | | X | |

| | | | | |
|---|---|---|---|---|
| compounds | | | | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | X | | Impact uncertain, but some residues can probably be found in waters. |
| Materials in suspension | X | | | |

*2.5.3 Municipalities and scattered dwellings (incl roads):*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | | X | |
| Connection to groundwaters | | | X | |
| Continuity of river | | | X | |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | X | | Some few sites there are mooring places for boats, constructions etc in the riparian zone. |
| | | | | |
| **B. Physical impacts** | | | | |
| | | | | |
| Temperature | | | X | |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | X | | Due to sewage |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | X | | | Sewage |
| Phosphorus status | X | | | Sewage |
| BOD | X | | | Sewage |
| COD | X | | | Sewage |
| | | | | |

| | | | | |
|---|---|---|---|---|
| **C. Chemical impacts (synthetic and non-synthetic)** | | | | |
| | | | | |
| Organohalogen compounds | | | X | |
| Organophosphorous compounds | | | X | |
| Organotin compounds | | | X | |
| Carcinogenic and related substances | | | X | |
| Persistent hydrocarbons | | | X | Except if accidents occur on roads (seldom, but has been observed). |
| Persistent and bioaccumulable organic toxic substances | | | X | |
| Cyanides | | | X | |
| Metals and their compounds | | | X | |
| Arsenic and its compounds | | | X | |
| Biocides and plant protection products | | | X | |
| Materials in suspension | | X | | Building of new roads or maintenence of existing. |

2.6 Lake Pyhajarvi/River Ylaneenjoki, Finland

*2.6.1 Agriculture*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | Erosion forces can be considerable. |
| Quantity of water flow | | | X | |
| Connection to groundwaters | | | | no impact |
| Continuity of river | | | | no impact |
| Width of river | | | X | |
| Depth of river | | X | | Erosion may have an impact |
| Structure of river bed | | X | | Small creeks in agriculture areas are slightly altered. |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | | X | |
| | | | | |
| | | | | |
| **B. Physical-chemical impacts** | | | | |
| | | | | |
| Temperature | | | | not relevant |
| Conductivity – Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | |
| Nitrogen concentration | | X | | |
| Phosphorus concentration | | X | | Can be considerable/severe on certain years |
| BOD | | | X | |
| COD | | | X | |
| Suspended solids | | X | | |
| | | | | |
| **C. Harmful substances (Priority substances) (synthetic and non-synthetic)** | | | | Not relevant for this area, minor leaching of pesticides possible |
| | | | | |
| Organohalogen compounds | | | | |
| Organophosphorous compounds | | | | |
| Organotin compounds | | | | |
| Carcinogenic and related substances | | | | |

| | | | | |
|---|---|---|---|---|
| Persistent hydrocarbons | | | | |
| Persistent and bioaccumulable organic toxic substances | | | | |
| Cyanides | | | | |
| Metals and their compounds | | | | |
| Arsenic and its compounds | | | | |
| Biocides and plant protection products | | | | |
| Materials in suspension | | | | |

*2.6.2 Forestry*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | | |
| | | | | |
| Quantity of water flow | | | X | |
| Connection to groundwaters | | | | |
| Continuity of river | | | | |
| Width of river | | | X | |
| Depth of river | | | X | |
| Structure of river bed | | | X | Supplementary forest drainage works may have an impact |
| Velocity of flow | | | X | |
| Morphology of riparian zone | | | X | " |
| | | | | |
| **B. Physical-chemical impacts** | | | | |
| | | | | |
| Temperature | | | | |
| Conductivity - Salinity | | | | |
| pH | | | | |
| Oxygen balance | | | | |
| Acid neutralizing capacity | | | | |
| Nitrogen concentration | | | X | At the moment. Possible future impacts of new forestry practices (biomass energy and supplementary drainage) |
| Phosphorus concentration | | | X | " |
| BOD | | | | |
| COD | | | X | " |
| Suspended solids | | | X | Supplementary drainage of forest lands |

| | | | | |
|---|---|---|---|---|
| **C. Harmful substances (Priority substances) (synthetic and non-synthetic)** | | | | No impacts |
| | | | | |
| Organohalogen compounds | | | | |
| Organophosphorous compounds | | | | |
| Organotin compounds | | | | |
| Carcinogenic and related substances | | | | |
| Persistent hydrocarbons | | | | |
| Persistent and bioaccumulable organic toxic substances | | | | |
| Cyanides | | | | |
| Metals and their compounds | | | | |
| Arsenic and its compounds | | | | |
| Biocides and plant protection products | | | | |
| Materials in suspension | | | | |

*2.6.3. Dispersed housing in the Finnish Catchment*

| **Impacts** | Intensity of Impact | | | Comments |
|---|---|---|---|---|
| | Severe | Moderate | Minor | |
| **A. Hydro-morphological impacts** | | | X | |
| | | | | |
| Quantity of water flow | | | X | |
| Connection to groundwaters | | | | no impact |
| Continuity of river | | | | " |
| Width of river | | | | " |
| Depth of river | | | | " |
| Structure of river bed | | | | " |
| Velocity of flow | | | | " |
| Morphology of riparian zone | | | X | |
| | | | | |
| **B. Physical-chemical impacts** | | | | |
| | | | | |
| Temperature | | | X | |
| Conductivity - Salinity | | | X | |
| pH | | | X | |
| Oxygen balance | | | X | |
| Acid neutralizing capacity | | | X | |
| Nitrogen status | | | X | May variate between |

| | | | | |
|---|---|---|---|---|
| | | | | minor and moderate |
| Phosphorus status | | | X | " |
| BOD | | | X | |
| COD | | | | |
| | | | | |
| **C. Harmful substances (Priority substances)(synthetic and non-synthetic)** | | | | No impacts |
| | | | | |
| Organohalogen compounds | | | | |
| Organophosphorous compounds | | | | |
| Organotin compounds | | | | |
| Carcinogenic and related substances | | | | |
| Persistent hydrocarbons | | | | |
| Persistent and bioaccumulable organic toxic substances | | | | |
| Cyanides | | | | |
| Metals and their compounds | | | | |
| Arsenic and its compounds | | | | |
| Biocides and plant protection products | | | | |
| Materials in suspension | | | | |

## 3. Comparative analysis

### 3.1 Impact analysis

Tables 1 to 3 below show the highest impact recorded by any of the activities considered in the previous section for each catchment. For example, if the quantity of water flow for a catchment is influenced by the activity "agriculture" moderately and by the activity "hydroelectric power supply" severely, the impact is recorded as "sever". It is evident that:

- The most severe impacts are met within the class of hydromorphological characteristics and of physical-chemical.
- The catchments of Morsa and Orlik have the highest number of "severe" impacts followed by Louros and Thames, while the catchments of Dee and Pyhajarvi/Ylaneenjoki have the highest number of "minor" impacts
- It is also important to note that there are not "severe" impacts caused by harmful substances with the exception of substances in suspension in the Morsa and Orlik catchments

Table 1. Major Hydromorphological impacts

| **Impacts** | **Intensity of Impact** | | |
|---|---|---|---|
| | **Severe** | **Moderate** | **Minor** |
| | | | |
| **Quantity of water flow** | | Dee | |
| | | Thames | |
| | | Louros | |
| | | Morsa | |
| | Orlik | | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Connection to groundwaters** | | | Dee |
| | | Thames | |
| | | Louros | |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Continuity of river** | | | Dee |
| | | Thames | |
| | | Louros | |
| | Morsa | | |
| | Orlik | | |
| | | | Pyhajarvi/Ylaneenjoki |

| | | | |
|---|---|---|---|
| **Width of river** | | | Dee |
| | | Thames | |
| | | | Louros |
| | | | Morsa |
| | Orlik | | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Depth of river** | | | Dee |
| | | Thames | |
| | | | Louros |
| | | | Morsa |
| | Orlik | | |
| | | Pyhajarvi/Ylaneenjoki | |
| **Structure of river bed** | | Dee | |
| | | Thames | |
| | | Louros | |
| | | | Morsa |
| | Orlik | | |
| | | Pyhajarvi/Ylaneenjoki | |
| **Velocity of flow** | | | Dee |
| | | Thames | |
| | | Louros | |
| | Morsa | | |
| | Orlik | | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Morphology of riparian zone** | | Dee | |
| | | Thames | |
| | | Louros | |
| | | Morsa | |
| | Orlik | | |
| | | | Pyhajarvi/Ylaneenjoki |

Table 2. Major Physical-chemical impacts

| **Impacts** | **Intensity of Impact** | | |
|---|---|---|---|
| | **Severe** | **Moderate** | **Minor** |
| | | | |
| **Temperature** | | Dee | |
| | | | Thames |
| | | Louros | |
| | | Morsa | |
| | | Orlik | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Conductivity - Salinity** | | | Dee |
| | | | Thames |
| | | Louros | |
| | | | Morsa |

| | | | |
|---|---|---|---|
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **pH** | | | Dee |
| | | | Thames |
| | | Louros | |
| | | | Morsa |
| | | Orlik | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Oxygen balance** | | Dee | |
| | | | Thames |
| | | Louros | |
| | | Morsa | |
| | | Orlik | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Acid neutralizing capacity** | | | Dee |
| | | | Thames |
| | | Louros | |
| | | | Morsa |
| | | Orlik | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Nitrogen status** | | | Dee |
| | | | Thames |
| | | Louros | |
| | Morsa | | |
| | | Orlik | |
| | | Pyhajarvi/Ylaneenjoki | |
| **Phosphorus status** | | Dee | |
| | | | Thames |
| | | Louros | |
| | Morsa | | |
| | Orlik | | |
| | | Pyhajarvi/Ylaneenjoki | |
| **BOD** | | Dee | |
| | | | Thames |
| | | Louros | |
| | Morsa | | |
| | Orlik | | |
| | | | Pyhajarvi/Ylaneenjoki |
| **COD** | | | Dee |
| | | | Thames |
| | | Louros | |
| | Morsa | | |
| | Orlik | | |
| | | | Pyhajarvi/Ylaneenjoki |

Table 3. Major Harmful (priority) substances (synthetic and non-synthetic)

| Impacts | Intensity of Impact | | |
|---|---|---|---|
| | Severe | Moderate | Minor |
| | | | |
| **Organohalogen compounds** | | | Dee |
| | | | Thames |
| | | | Louros |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Organophosphorous compounds** | | | Dee |
| | | | Thames |
| | | Louros | |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Organotin compounds** | | | Dee |
| | | | Thames |
| | | | Louros |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Carcinogenic and related substances** | | | Dee |
| | | | Thames |
| | | | Louros |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Persistent hydrocarbons** | | | Dee |
| | | | Thames |
| | | | Louros |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Persistent and bioaccumulable organic toxic substances** | | | Dee |
| | | | Thames |
| | | | Louros |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Cyanides** | | | Dee |
| | | | Thames |

| | | | |
|---|---|---|---|
| | | | Louros |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Metals and their compounds** | | | Dee |
| | | | Thames |
| | | | Louros |
| | | | Morsa |
| | | Orlik | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Arsenic and its compounds** | | | Dee |
| | | | Thames |
| | | | Louros |
| | | | Morsa |
| | | | Orlik |
| | | | Pyhajarvi/Ylaneenjoki |
| **Biocides and plant protection products** | | | Dee |
| | | | Thames |
| | | Louros | |
| | | Morsa | |
| | | Orlik | |
| | | | Pyhajarvi/Ylaneenjoki |
| **Materials in suspension** | | | Dee |
| | | | Thames |
| | | | Louros |
| | Morsa | | |
| | Orlik | | |
| | | | Pyhajarvi/Ylaneenjoki |

3.2 Major drivers and impacts

The tables 4 to 10 below summarize the impacts per major activity/driver for all six catchments considered in this report. Agriculture (including livestock production) is, by far, the most harmful activity in all regions. Dams and hydroelectric power supply generation is also harmful and occurs in three out of the six case study catchments considered in this report. Water for municipal use and the discharge of wastes also constitute harmful activities. In two regions climate change is considered as a driver for changes with significant negative impacts on the catchments' environment.

Table 4. Agriculture (incl. Livestock) as a major driver of impacts

| Catchment | Impacts |
|---|---|
| | |
| Dee | Diffuse pollution, sedimentation, pesticide residues and organic pollution cause eutrophication, aquatic ecology and fish population under threat |
| Thames | Diffuse pollution, sediments, pesticides and organic pollution cause eutrophication, threaten aquatic ecology and threaten fish population |
| Louros | High levels of surface and groundwater abstraction. Nitrification from excess use of fertilizers, contamination from excess and improper use of plant protection substances. Change of hydrographic network due to dense drainage ditches and irrigation channels. Nitrogen loadings and suspended solids due to improper operation of waste water treatment plants or discharge directly to the river without undergoing prior treatment from livestock units. Certain biocides including antimicrobial substances from sterilizing or treating livestock are present |
| Morsa | Phosphorus and nitrogen pollution, suspended sediments, erosion. Eutrophication problems in downstream lakes. Harmful algae growth (Microcystis). Swimming occasionally banned. |
| Orlik | Nitrate pollution, erosion, denaturalisation of small streams |
| Pyhajarvi/Ylaneenjoki | Nitrogen, phosphorous and suspended solids loading - contributing to eutrophication and harmful algae blooms in the lake. |

Table 5. Municipal water use and residential demand for land and recreation

| Catchment | Impacts |
|---|---|
| | |
| Dee | Areas of scattered development dependent on private water supplies and septic tanks; pressures below sewage works with limited capacity to take out all pollutants; Eutrophication; Biodiversity may be compromised from modifications to water courses such as hydro-schemes |
| Thames | Growing demand for water (esp. domestic water demand); significant discharges from sewage works. Risk of public water, supply shortfall (i.e., water supply becomes more vulnerable) threats the sustainability and quality of water supply.<br>Diffuse pollution; point source pollution; chemicals Phosphorus pollution, eutrophication. |
| Louros | High abstraction and discharge levels. Certain communities lack waste water treatment plants and discharge wastes (illegally) directly in the river. |
| Morsa | Phosphorus and nitrogen pollution due to untreated sewage. Presence of coliform bacteria. Eutrophication in downstream lakes. Harmful algae growth (Microcystis). Swimming occasionally banned. |
| Orlik | Phosphorus pollution, eutrophication, channel modifications for flood control measures. |
| Pyhajarvi/Ylaneenjoki | Nitrogen and phosphorous loading, water hygienic risks. |

Table 6. Dams and hydroelectric power generation

| Catchment | Impacts |
|---|---|
| | |
| Louros | Discontinuity of flow causes changes in morphology and certain physical characteristics (e.g. temperature) of the river downstream the dam. |
| Morsa | Discontinuity of flow. May also enhance eutrophication problems in lake due to periods of stagnant waters during summer (studies to this effect have been performed, to be finalised in April 2011). |
| Orlik | Discontinuity of flow, locally also flow quantity and oxygen depletion problem |

Table 7. Forestry

| Catchment | Impacts |
|---|---|
| | |
| Orlik | Erosion (low, point) |
| Pyhajarvi/Ylaneenjoki | Potentially a source of growing importance for nutrient and organic matter loading in the near future. |

Table 8. Public construction works including flood works and transport networks

| Catchment | Impacts |
|---|---|
| | |
| Thames | Physical modification (changes to the structure of water bodies such as for flood defence purposes)<br>Wetland and floodplain destruction, substitution by artificial lakes Discontinuity of flow; affecting the natural functioning of wetland ecosystems, and fish population, and habitats; flooding |
| Morsa | Roads. Some accidental petrol/oil spills may occur. New roads or maintenance of roads may increase erosion. Impact assumed to be relatively small as compared to other drivers; |
| Orlik | Erosion, floods, diffuse runoff |

Table 9. Climate change

| Catchment | Impacts |
|---|---|
| | |
| Dee | Floodplain pressures and conflicts between ecological flood management and productive land use demands. Risk of flooding; Winter flow is anticipated to increase but summer flow may decline, meaning that water quality is more compromised at the time of greatest demand; Biodiversity may be compromised by new flow regimes arising from climate change |
| Thames | Drought; changes in the pattern and intensity of rain fall. Low summer flows and high winter flows threaten the aquatic ecology. |

Table 10. Fish pond aquaculture

| Catchment | Impacts |
|---|---|
| | |
| Thames | Discontinuity of flow; affecting the natural functioning of wetland ecosystems, and fish population, and habitats; flooding |
| Orlik | Phosphorus pollution, eutrophication |

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