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Oulujoki-case study – first phase/second milestone
(Multiple use and related environmental problems of northern river basin)

Introduction

The Oulujoki catchment is located in boreal zone in the Fennoscandian eco-region in Northern Finland. It is one of the largest river basins in Finland totalling 22841 km² with the annual mean flow of 259 m³s⁻¹. The river system in the upper reaches is characterized by chains of short river stretches and lakes. The total number of lakes over the size of 50 ha is 398, the largest one being the Lake Oulujärvi, with surface area of 928 km². The basin is relatively sparsely populated, total amount of population is 226 000, which makes 11.5 inh. km⁻². The population is concentrated to the western parts of the basin, mostly where the river discharges to the Baltic Sea. The catchment area is dominated by forests. The forestry operations, such as clear-cutting, drainage and tillage, may have significant impacts especially on the ecological status of the small upstream lakes and rivers. Locally, also peat production may deteriorate water quality and ecology.

The flow and water level of the Oulujoki river system has been regulated since 1940s mostly for hydropower production. Most of the river channels are dredged and series of rapids have been transformed to stable water systems under hydropower peaking. Presently, altogether 18 hydropower plants produce more than 2500 GWh, having power more than 550 MW. In order to facilitate the power production more than 1400 km² of the lake water levels are regulated.

Despite of these human induced effects there are large pristine areas situated at the upper part of the river basin including large Natura areas.

The aim of study

The aim of this study is divided into four main aims covering main problems of river basin.

1. Sub-study peat production

Land use in river catchments results in increased transport of nutrients and suspended solids (SS) to river channels. Eutrophication caused by nutrient pollution and siltation of the river bed due to SS loading are the most significant environmental problems in most Finnish rivers today. In the sub-study a visual GIS-based planning system for situating land use derived loading sources to river catchments is created. Peat production is used as an example of these sources. The planning system developed uses simple mathematical run-off and loading models to evaluate the effects of loading on water quality. In the sub-study the system is used to find best possible sites for peat production, to assess integrated impact of separate peat production plans at the same river catchment and also to consider loading from peat production areas in proportion with the total loading in the catchment. Sub-study is focused on River Muhosjoki basin, but includes also simulations in other parts of the River Oulujoki.

In order to increase the general motivation to use the planning system developed, the sub-study includes also demonstrations on the effects of loading and water pollution control methods, and on the environmental impacts of SS and nutrient loading in the riverine environment.

In the sub-study the role of Regional Plans for Land Use in planning peat production is also analysed and developed. Also the process in peat production permit application at the present is analysed, points of contact sought with the regional planning process, and recommendations presented for the cost-effective environmental impact estimation process in regional planning of land use. The planning processes are developed in cooperation of all the parties concerned, workshops and meetings being important methods of the work.

2. Sub-study forestry

Effective forestry is increasing silting and nutrient loading especially at the uppermost part of catchment; many small rivers and springs are suffering of siltation and increased amounts of suspended solids. Forestry is the major land use activity in Finland and almost 85 % of all land areas are used for forestry at upper part of Oulujoki catchment. Forestry authorities and wood processing industry are very well aware of environmental issues, but especially environmental changes in lakes are very slow and difficult to detect. Local inhabitants and recreational users have often noticed harmful effects caused by forestry.

Sub-study forestry focuses on evaluation of harmful effects of forestry on small lakes situated at Kainuu region. Both impacted and reference lakes are selected for focus areas and effects of forestry are described by using both land use models with historical data and field research to determine present ecological status of water courses. Also paleolimnological methods are applied to estimate change caused by drainage of forest areas. Sub-study will estimate the ecological status by general methods applied in WFD and uses load estimation tools developed in peat production sub-study to evaluate the effects of different forestry alternatives. Sub-study forestry will also evaluate the possibilities how land use planning measures could improve the status of these small lakes and gives recommendations how to apply these measures on regional planning. The planning processes are developed in cooperation of all the parties concerned, workshops and meetings being important methods of the work. Case study will focus on six different lake areas at the upper part of different catchments.

3. Sub-study hydropower

Hydropower is largely affecting on status of water courses. According to WFD these hydrologically and morphologically altered water bodies can be designated as heavily modified, which do have lower environmental goals called a good ecological potential. Definition of this ecological potential is relatively unclear, because mitigation measures to improve ecological status cannot cause significant harm for main use of water body. General trend of WFD is to limit modifications caused by hydropower. On the other hand commitments related to Directive of renewable energy sources demand to increase hydropower production by 10 – 20 % at national level.

Substudy hydropower will focus on determination of good ecological potential of rivers and lakes initially designated as heavily modified. Definitions of ecological potential are determined in more detail by applying the available methods and especially focusing on determination of different mitigation measures and their effects on use of water bodies. Case study will focus on modified downstream stretch of River Oulujoki and one initially designated lake.

Sub-study hydropower will promote sustainable planning by increasing the awareness of large public related to modified water courses and enhancing the possibilities to improve ecological status without significant effect on use. Project co-partners are based largely on ongoing Oulujoki-pilot river basin project, where specialist group of hydropower producers, environmental authorities, nature protection associations, NGO:s and researchers were

created. A common meeting is organized and different options of developing the river is demonstrated.

4. Sub-study protected areas

Areas harbouring aquatic ecosystems or aquatic biota of high conservational value need to be addressed and promoted in water protection as well as in land use practices. According to the Water Framework Directive (WFD) article 6 and annex IV, member states have to establish register(s) of several different protected areas. Of these, the "relevant Natura 2000 sites", as defined in annex IV (v), are of specific interest due to their conservational value. Furthermore, such sites need to be addressed in the river basin management plan in accordance to the directives that concern them.

However, identification, classification and evaluation principles of the conservational values (in the Natura 2000 areas) that are considered "relevant" under the WFD are currently unclear and not yet well established. Moreover, the relationships between the WFD objectives and the objectives of Birds and Habitat Directives need to be explored and further defined in order to apply them into water and land use management practices.

Sub-study protected areas investigates the classification criteria and the objectives of the Birds Directive (79/409/EEC), the Habitats Directive (92/43/EEC) and the WFD and promotes water managers and spatial planners to take into account these in practical land use planning in a case study.

The problems encountered

Main environmental problems of River Oulujoki basin are relatively limited and focused on heavily modified rivers and lakes. Migratory fishes have largely lost their spawning grounds and continuity of rivers have interrupted by dams and weirs. Natural spring flood has been cut down causing deterioration of flood meadows and further limitations for spring spawning fishes. Winter drawdown of lake water levels has also largely changed communities of aquatic macrophytes and benthic invertebrates.

Eutrophication problems have been concentrated of downstream area of River Oulujoki and in some lakes surrounded by agricultural areas. Effects of forestry and peat production were found only at limited areas, but they were representing a typical situation of the northern regions with relatively high recreational value.

Natura site under investigation was found to be relatively well protected, but slight increase in eutrophication caused by fish farming and especially increasing land use for recreational purposes was found to be a threat for these pristine conditions

The impact matrix

The Oulujoki case study is divided to deal with four different problems related to implementation of WFD environmental goals and spatial planning. General description of different problems are described in the following preliminary pressure matrix:

	Impacts =>	Physico-chemical quality elements										Biological quality elements					Hydromorphological quality elements					
		Transparency	Temperature	Oxygen conditions	Conductivity	Salinity	Nitrogen	Phosphorous	Suspended solids	Dis. org. matter/Humic subst.	Acidification	Priority substances	Other pollutants	Phytoplankton	Planktonic blooms	Macrophytes	Benthic invertebrates	Fishes	Hydrological regime	Morphology	River continuity	Tidal regime
Diffuse sources	Scattered settlements sewage																					
	Agriculture diffuse																					
	Forestry																					
	Urban storm waters																					
	Atmospheric deposition																					
Point sources	Industrial wastewaters																					
	Municipal wastewaters																					
	Mining																					
	Contaminated lands																					
	Animal husbandry																					
	Solid waste management																					
	Aquaculture																					
	Peat production																					
	Peat production																					
Abstraction	Raw water supply																					
	Agriculture																					
	Industry																					
	Fish farming																					
	Hydropower																					
	Open cast coal mining																					
Morphological pressures	Dams (transversal)																					
	Weirs (transversal)																					
	Longitudinal embankments																					
	Straightening																					
	Dredging																					
	Shore protections																					
	Urbanisation																					
	Urbanisation																					
Hydrological pressures	Flow regulation (rivers)																					
	Hydropeaking																					
	Level regulation (lakes)																					
	Change in riverprofile																					
Other anthropogenic pressure	Recreation																					
	Fishing/angling																					
	Climate changes																					
	Land drainage (forestry)																					
	Overgrazing																					
	Introduced species																					
	Introduced diseases																					

- Not present
- No effect
- Low impact
- Moderate impact
- High impact

Conclusions

Oulujoki-case study proceeded during second reporting period by planned way. Forestry case study started intensive field work period at six different small lakes. Peat production case study focused their efforts on model development, demonstrations and additional environmental data. Hydropower case study worked with existing data and used main efforts with determination of environmental potential. Nature protection area case study developed criteria for determination of water dependent Natura 2000 values in an approach for selecting

the relevant Natura 2000 areas into the register of protected areas; practical investigation of Lake Lentua is proceeding.

Peat production and forestry case studies organised several stakeholders meeting, whilst main actions of hydro power and nature protection areas case studies are going to take place during third reporting period. Field work will be finalised before the end of summer season and comprehensive reports will be written.