About ENVIRA:
ENVIRA represents a strategic collaboration between the environment research institutes in Norway. ENVIRA has the following main tasks:

• Research politics
• Disciplinary collaboration
• Promoting the environmental institutes

The disciplinary collaboration in ENVIRA is largely effected through strategic programmes where two or more institutes participate, and are funded by the Ministry of the Environment or The Research Council of Norway.

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River basin oriented management of large rivers

Collaboration between four ENVIRA institutes

Norway is a country rich in water. Lakes and ponds, rivers and streams are characteristic features of the landscape. Wherever you travel, your view will include streams, lakes or coastal waters. Thus, sustainable management of our water resources means sustainable management of a central aspect of Norwegian landscapes.

The Strategic Institute Programme “River basin oriented management of large rivers” is a step towards a more comprehensive river basin management. The combined competencies of the collaborating institutes Bioforsk, NIBR, NINA and NIVA covers a wide aspect of river basin research. This programme is a result of the improved collaboration among the institutes, facilitated through the ENVIRA consortium.

One of the main challenges in the programme has been to improve our understanding of relationships between the biological processes in large, complex river basins, and the impacts on these systems from various use and exploitation. Photo: Odd Terje Sandlund

Activities in the river basin affect the watercourses

It has long been known that watercourses are affected by activities in the river basin. The environment in the water is affected differently by cultivation along the course of the river than where the forest is left in standing.

Altered hydrology
Ditches through bogs and drainage of cultivated areas lead to altered hydrology and transport of particles and nutrients to the watercourse. Urbanisation and industrialisation introduces nutrients and pollutants. Encroachments like dikes and hydropower development lead to local and regional effects on the life in the river.

Limited knowledge
Our knowledge of the various causes and mutual quantitative relations is frequently limited or fragmentary. Holistic watercourse research, where various disciplines from natural and social science collaborate and include complete river basins as a research area, has barely been covered in Norway. This is caused partly by the fact that the various disciplines are located in different institutions with no tradition for collaboration, and partly that research such as this requires large resources.

Cultivation, roads, industry etc. has lead to loss and deterioration of the river plains. Photo: Børre K. Dervo

More cross-disciplinary research required

The common strategic institute programme 2002-2006 was instigated because of the need for more cross-disciplinary research on natural processes and dynamics in watercourses, and how human activities affect these.

Considerable changes
At the same time the EU Water Framework Directive was being adopted.

This will require considerable changes in watercourse management and introduce new demands for knowledge and research skills. The programme was therefore directed according to these needs.

Broader disciplinary environment
The participating institutes in the ENVIRA consortium wish to develop their collaboration. The goal is to offer a broader and more holistic disciplinary environment in order to serve the management institutions and strengthen the institutions’ positions in relation to The Research Council of Norway and other sources of funding. The collaboration may create synergies on many levels. In some cases researchers with different specialities combine in common projects, or a common main theme is illuminated from different angles and with different points of departure.
The EU Water Framework Directive has three requirements

The EU Water Framework Directive sets up three specific requirements for the management of watercourses:

- The management entity should be the river basin, not an area defined by a municipal or county border.
- The main goal for the management of watercourses is to ensure that the waters keep or regain a high ecological status (defined relative to a natural or “undisturbed” status).
- Rivers or lakes that are heavily modified because of important social interests (in Norway this normally entails hydropower developments) should be managed so as to ensure the best possible ecological potential in their modified state.

Hydrology on the river plains

Local topographical conditions on the river plains are important for the rejuvenation of the groundwater in spring. Surface water collects in dips in the terrain and the rejuvenation of groundwater is largely caused by this surface water seeping into the ground. Such points will therefore be crucial if one attempts to introduce measures to prevent pollution of the groundwater.

Dikes may reduce the number of species

The number of species in the water vegetation in ponds, backwaters and flood channels on the river plain by Ringebu is significantly higher than the number of species one may expect to find in a lake with the same surface area. This is because the different ponds represent different habitats. A development of the river plain which leads to a reduction in flooding and longer periods of drought results in a reduction in the number of species.

Geographic location is important

We have analysed how the current conservation area covers the biological diversity of the river plain by Ringebu. The analysis shows that the ponds’ geographic location affects which organisms they contain, and that different groups of organisms have different dispersion on the river plain.

The diversity of species in the river plain ponds along Lågen in Ringebu municipality has been studied. Whorl-leaf watermilfoil (Myriophyllum verticilatum) is on the Norwegian red list of threatened species and has only been recorded at a few locations in eastern and southwestern Norway. In the Ringebu area it was recorded in 16 ponds and is consequently one of the most common species in this area. Photo: Børre K. Dervo.

Soil quality

Sedimentation and soil quality was examined at various points on the river plain at various distances from the river channel. Soil quality is affected more by location relative to the river than by the size of floods.

Water velocity

The coarseness of sediment carried by the water is determined by water velocity. When the water runs onto the river plain, it rapidly loses speed and the coarsest particles are soon deposited. Vegetation zones lead to an even more rapid reduction in the velocity of the water and increases the effect. Coarse and moderately fine sand carried by large floods is soon deposited when the water flows over land. Large scale floods deposits fine sand further away from the river bed than floods on a smaller scale.

No more small scale floods

Because of current dikes the small scale floods depositing silt and mud are more or less gone. Large scale floods tend to cause breaks in the dike, so that the traces of a large scale flood will probably be more obvious today than they were at the end of the 18th century.
Isotopes that occur naturally in water may be useful tools in the study of different processes in the river basin which have a bearing on the management of the watercourses. New information

A combined analysis of different hydrogen and oxygen isotopes may provide new information on stream paths in small catchments. This provides a significant background for an assessment of pollution risk and planning measures to be taken. Combined analysis of hydrogen and oxygen isotopes may be an important aid in tracking diffuse sources contributing to the nitrate content in agricultural streams.

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Denitrification

We provide examples of the use of stable nitrogen isotopes as an aid for quantifying the significance of denitrification in artificially constructed sedimentation ponds.

Retention of nutrients in constructed wetlands

The amount of nutrients retained in the constructed wetlands proved to be significantly dependent on hydraulic stress.

Nitrogen and phosphorus

Retention of nitrogen is reduced to a larger degree than the retention of phosphorus with an increased hydraulic stress. Planted wetland filters showed the best retention of both nitrogen and phosphorus.

Retention of nutrients and pesticides by different filters or substrates relative to the hydraulic stress has been investigated at an advanced test site in Lier. Photo: Bent Braskerud.

Fauna and water quality

The records of crustaceans in the entrance and exit areas of the constructed wetlands show that the fauna clearly reflects the differences in water quality. The number of species of water fleas (Cladocera), a group which reacts negatively to agricultural pollution, was throughout the period higher in the exit than the entrance area of the constructed wetlands.

Erosion material in the runoff water

In all fields there is erosion with transport of particles in the water runoff. Some of the erosion material follows the water flow into the watercourses and is sedimented where the current velocity is reduced sufficiently to let the particles deposit.

Particles are retained

Sedimentation ponds and constructed wetlands are therefore built in streams running through agricultural areas to reduce current velocity, to enable the largest possible proportion of the erosion material in the water flow to deposit.

Salt

The distribution of road salts leads to the formation of salt stratification in the stormwater ponds through the winter, with heavy, salty water at the bottom and lighter, fresher water near the top. This salt stratification affects duration of stay, current and cleaning degree in the pond.

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Reservoirs in the watercourses have lead to significant ecological changes

The establishment of reservoirs in Norwegian watercourses has lead to significant local and regional ecological changes. Detrital for fish migration

The most important negative effect of such reservoirs is probably in relation to fish migration. A dam represents a physical migration obstacle, even if a fish ladder has been built. This has been shown in several studies of fish ladders in various watercourses. Studies in Løpsjøen in Søndre Rena, Åmot municipality, has shown that the fish community in the reservoir above the dam probably represents another significant migration obstacle, in that the predatory stress increases due to an increase in species such as pike and perch which feed on fish. Genetic studies of brown trout show that the fragmentation of the stock caused by the dam, has probably changed the genetic structure of this species in Søndre Rena.

Productive lake

However, the studies in Løpsjøen also show that the watercourse has gained a new landscape element in the form of a shallow and productive lake. This has given this section of the watercourse a greater diversity, both physical and biologically. New areas under water have lead to an increase in biological production and new habitats for both plants and animals. A water vegetation of taller plants has developed which includes several species that are otherwise rarely seen in this part of the country. Løpsjøen has become a regionally important core area for the diversity of water plants. A productive, species rich zoobenthos community also provides a base for a large production of fish and a diverse birdlife, and Løpsjøen has developed into a regionally important bird location.

River plain modelled

Through map-based methods we have investigated more closely two different approaches tied to scaling of information. We have modelled river plains in the total Glomma river basin and assessed them in relation to intervention status. The emerging information has been compared with the results of the detailed studies of the river plains by Ringebu. Important environmental goal

Maintaining migration systems in fish will probably be an important environmental goal for heavily modified water bodies in connection with the implementation of the EU Water Framework Directive. Improving the fish ladders will be an important action in order to secure upstream migration. We have, through this project, shown that one must also focus on downstream migration of both young fish and adults of e.g. grayling and brown trout. Especially young fish are vulnerable to predatory fish in their downstream migration through reservoirs, something that leads to significant selection against migrational behaviour in the stock.

Spatial scaling of data – a crosscutting activity

The sub-project “Spatial scaling of data” has been a crosscutting activity in the strategic institute programme, and a series of scientific approaches have been covered.

Methods

The various methods may be grouped under two main headlines: River Basin Based Modelling and Representative Selection. River basin based modeling means combining fields of study in relatively homogenous entities, so that the parameters used in the model may be assumed to vary insignificantly within each of these entities.

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Together these two studies provide indications that the detailed knowledge collected at Ringebu may be generalised for the whole Glomma river basin. Correspondingly we may also see indications of whether a general modelling of ecosystems can produce data which may be useful in assessing the situation in a smaller, selected area.

The whole Glomma river basin

We have also investigated the whole Glomma river basin and collected information for all identifiable subcatchments using the Regine database of the Norwegian Water Resources and Energy Directorate. Through statistical analysis we have researched how the various catchments group according to similarities and differences.