miljøfakta 4

Publisher: ENVIRA as

ENVIRA facts

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 environ mental 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.

Institutions in ENVIRA:

Bioforsk

NIBR

NIKU

NILU

NINA

NIVA

CICERO

Contact information:

ENVIRA as

c/o NINA

NO-7485 Trondheim

NORWAY

Phone: +47 73 80 14 00

Fax: + 47 73 80 14 01

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 enviroment 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 scienty 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 requiremets

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.

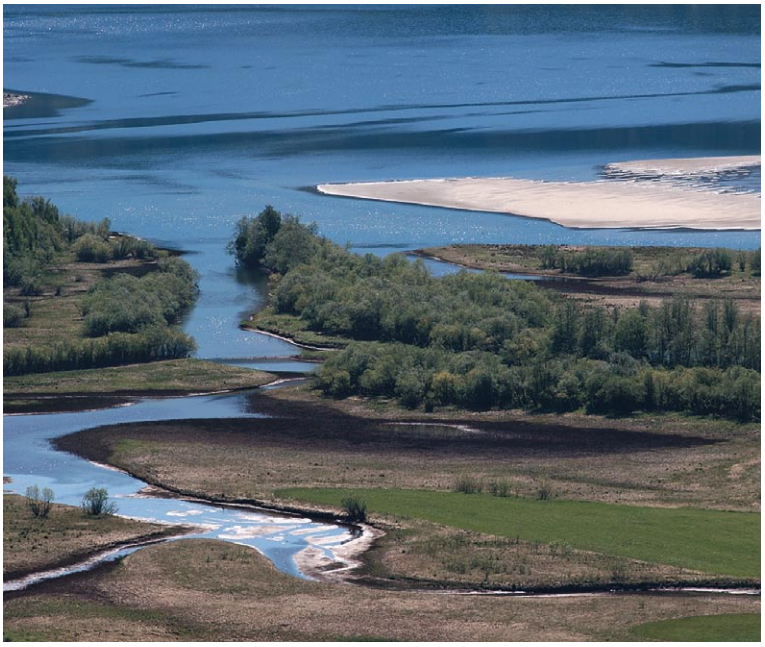
Hydrology on the river plains

Local topographical conditions on the river plain are important for the rejuvenation of the groundwater in spring. Surface water collects in dips in the terrain and the rejuvenation of groundwater in the spring 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.

River plains: habitat deterioration and loss

The deterioration and loss of river plains are more encompassing and rapid than previously believed. The loss has been especially extensive in the last 20 years, when flood prevention and cultivation has been the most damaging encroachment.

The Planning and Building Act and the municipal planning processes that have been established in accordance with this act do not protect the river plains in a sufficient degree to safeguard the diversity of pond types and species. The reason is that the encroachments are mainly considered as separate cases and are not seen in connection with earlier projects and the remaining undisturbed areas. Area conservation in accordance with the Nature Conservation Act is a more efficient tool for protecting larger, continuous river plains.



River plains are ecosystems covering relatively small areas of Norway. They are easily cultivated or otherwise utilised. Undisturbed river plains are therefore rare and are habitats for numerous rare and endangered species. Photo: Børre K. Dervo.

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 verticillatum) *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: B. Faafeng.*

Geographic dispersion

A geographic dispersion of the ponds is significant in order to cover the diversity of crustacean species, while there are fewer differences between ponds when considering aquatic plants and beetles. Important areas for the biological diversity are also located outside the current conservation zone.

Pond surface area

A general trend is that the number of species in the aquatic vegetation increases with increased lake surface area. This is because large lakes contain more habitats and there is more variation in the environmental factors, which make room for species with differing preferences. By Ringebu we found a similar increase of diversity of species with increasing pond size, but only for locations with an area of more than 1000 m^2.

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.

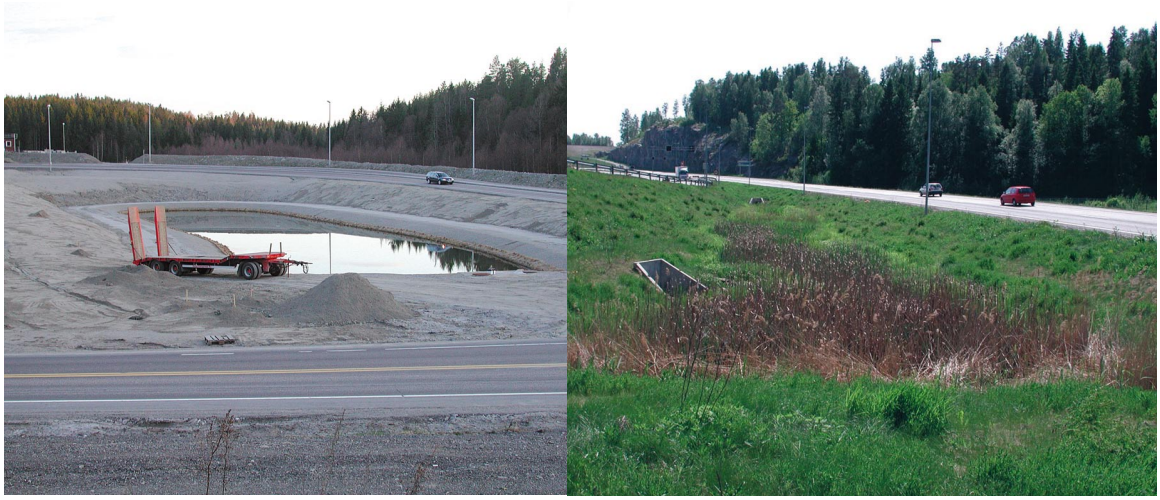
Water velocity

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 dikes, 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.

Cleaning road runoff



Investigations focused on two stormwater ponds along the new E6 main road in Akershus county - one deep pond without vegetation and one shallow pond with macrophyte vegetation. Photo: Roger Roseth.

The runoff from roads can be a significant source for pollution of both surface and groundwater in many areas. One measure to reduce this pollution is the building of stormwater ponds that contribute to cleaning the water before it reaches streams or groundwater.

Heavily polluted runoff

The runoff which reached the stormwater ponds in our experiment comprised 10 to 40% of the precipitation that fell on the relevant stretch of road, the rest was probably lost through evaporation or infiltration. The runoff from the road to the stormwater ponds was at times very heavily polluted with the typical, traffic-related metals; copper, sink and nickel, as well as the nutrients phosphorus and nitrogen.

Sludge

Sludge collected in the stormwater ponds was found to have such a high content of heavy oil components that this determines how the sludge subsequently should be handled.

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.

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.

Deposits

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.

Particles are retained

Sedimentation ponds efficiently retain soil particles. Retention rates of 35 to 76% have been measured, depending on the conditions in the catchments and the size of the sedimentation ponds. In two sedimentation ponds in the clay soil area in southeastern Norway, four to six times more clay was retained than indicated by the theoretical estimates based on the results of texture analyses of the sediment material.

Utilizing Isotopes

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.

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.

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.

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.

The fact sheet is based on:

Sandlund, O.T., S. Hovik, J.R. Selvik, L. Øygarden & B. Jonsson (red.) 2006. Nedbørfeltorientert forvaltning av store vassdrag. – NINA Temahefte 35. 80 s. (in Norwegian).

ISSN: 0804-421X
ISBN-10: 82-426-1751-1
ISBN-13: 978-82-426-1751-4

Also published in the report series:
Norsk institutt for vannforskning (NIVA)
NIVA-rapport 5282-2006
ISBN: 82-577-5010-7

Bioforsk Jord og miljø:
Bioforsk Rapport Vol 1 126 2006
ISBN-10: 82-17-00113-8
ISBN-13: 978-82-17-00113-3

Ordering publications:

The publication is available as pdf-file:
http://www.nina.no/archive/nina/PppBasePdf/temahefte/2006/35.pdf

Hand copies may be ordered from:
Phone: + 47 73 80 14 00 or
e-mail: firmapost@nina.no.
Price per copy, NOK 160.-

Participating institutes:

Norwegian Institute for Urban and Regional Research (NIBR)
P.O.Box 44 Blindern
NO-0313 Oslo, NORWAY
Phone +47 22 95 88 00
E-mail: nibr@nibr.no

Norwegian Institute for Nature Research (NINA)
NO-7485 Trondheim, NORWAY
Phone: + 47 73 80 14 00
E-mail: firmapost@nina.no

Norwegian Institute for Water Research (NIVA)
Gaustadalléen 21
NO-0349 Oslo, NORWAY
Phone: +47 22 18 51 00
E-mail: niva@niva.no

Bioforsk Soil and Environment
Fredrik A. Dahls vei 20
NO-1432 Ås, NORWAY
Phone: +47 40 60 41 00
E-mail: post@bioforsk.no

Production of miljøfakta 4:

Text: Hans G. Jürgens
English translation: Ragnhild S. Lervik
Editor: Odd Terje Sandlund
Graphic design: Kari Sivertsen
Trondheim 2007

Miljøfakta 4 can be found here:
http://www.nina.no
Go to the link: Dette er NINA and Miljøalliansen.

ISSN: 1890-2782 (printed version)
ISSN: 1890-2839 (digital version)

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.

Good spawning areas for pike are no longer a rarity after the damming of Løpsjøen. Photo: Jon Museth.

Detrimental 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 physically 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. Low regulation height and small water level variations through the year secure stable conditions and reduce the negative impacts of regulation.

Important environmental goal

Maintaining migration systems in fish will probably be an important environmental goal for heavily modifed 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 modelling 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.

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.

Detailed knowledge

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.