Danube Regional Project

3.1 Support for Institutional Development of NGOs and Community Involvement: Developing the DEF Network

Wetlands and Nutrient Reduction

Training materials

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Introduction

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The training manual was developed in the framework of the UNDP/GEF Danube Regional Project "Strengthening the Implementation capacities for Nutrient Reduction and Transboundary Cooperation in the Danube River Basin", under the Project component 3.1: Support for institutional development of NGOs and community involvement.

This training manual was compiled as an output of the "International Training on wetland restoration and nutrient reduction" organized by Danube Environmental Forum in November 2002, in Vinicne, Slovakia. The training manual will serve as the basis for organizing "National trainings on wetland restoration and nutrient reduction" which will be organized by DEF National Focal Points in the spring of 2003 (DEF National trainings).

Following the Quality Guidelines for Training and Consultation Workshops, prepared by Holger Nauheimer in 2002, the logistics of the DEF National Trainings was specified as follows:

Main training objective:
To improve the knowledge and skills of NGOs in wetland restoration and nutrient reduction in the Danube River Basin.. Furthermore, to help NGOs fulfil requirements set by the Regional Environmental Centre (REC) for the National and Regional Small Grant Programme under the UNDP/GEF Danube Regional Project.

Short term objectives (to be measured at the end of the workshop):

- After completion of the DEF National training, participants will have gained knowledge and skills in order to implement practical measures leading to restoration of wetlands and the reduction of nutrients in natural ecosystems.

- At the end of the DEF National training all participants will understand, the process, criteria and deadlines of the REC Small Grants Program.

Medium term objectives (to be measured some time after the workshop):

- Trained NGO representatives will develop and implement effective measures directly or indirectly leading to wetland restoration or/and nutrient reduction.

- Trained NGO representatives will prepare high quality project proposals, following the instructions and criteria of the REC Small Grants Program and applying knowledge gained during DEF National Training.

These are overall DEF objectives for the organization of national trainings. DEF National trainings will be organized by DEF National Focal Points in 11 countries of the Danube River Basin. The indicators for the identified objectives will be specified by each DEF National Focal Point before the training, based on national priorities identified by the DEF National training preparation team.

Target group for the training:
Non-governmental organizations in the country focused on the protection of natural ecosystems and pollution reduction.

Methodology:
Training workshop focused on enhancing human resources through active capacity building. Trainings are guided by trainers, who have substantial knowledge, skills and/or methodology compared to participants and possess certain training skills. The goal of the training workshop is to develop human resources in wetland restoration and nutrient reduction.

Participation will include active discussion, input and exchange of information/experiences among participants.

Training size greatly differs among countries. The estimated number of participants will be between 15 and 50.

Training duration also differs among countries. The estimated number of training days will be 2-3.

The agenda will be provided to the participants together with the invitation. The agenda will follow the structure of DEF International training (theoretical knowledge, case studies, and examples of effective measures) but national priorities should be reflected in the presented topics. The training agenda will include 2-4 hours of presentations and discussion about the REC Small Grants Program. It is highly recommended that practical exercises and/or excursions are included into the training agenda.

Each participant will be provided with a national training manual, which will follow the structure of this document. National training manuals will be developed by the national training preparation team and will include topics presented at the DEF National training in the country. The content of the national training manual does not have to be the same as this document,(ie: it should not copy all chapters), but it should reflect identified national priorities.

Representative of the training preparation team will fill the Templates 1, 2, 3b before and Template 8 after the training takes place (Annex I).

Evaluation of training will be done by each participant. An evaluation sheet to be translated and handed out to the participants at the end of the training is provided in the Template 7b. The evaluation sheets will be collected by each DEF National Focal Point and the English summary of training evaluation will be attached to the final training report. The training report will be provided to DEF Secretariat latest 2 weeks after the national training takes place.

1 What is a Wetland

Jan Šeffer

1.1 Wetland Definitions and Classifications

Ramsar Convention Article 1

For the purpose of this Convention **wetlands are** areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh brackish or salt, including areas of marine water the depth of which at low tide does not exceed six metres.

Wetlands - areas that are inundated or saturated by surface or ground water at frequency and duration sufficient to support, and that under normal circumstances support a prevalence of vegetation typically adapted for life in saturated soil conditions (Lewis 1990)[1].

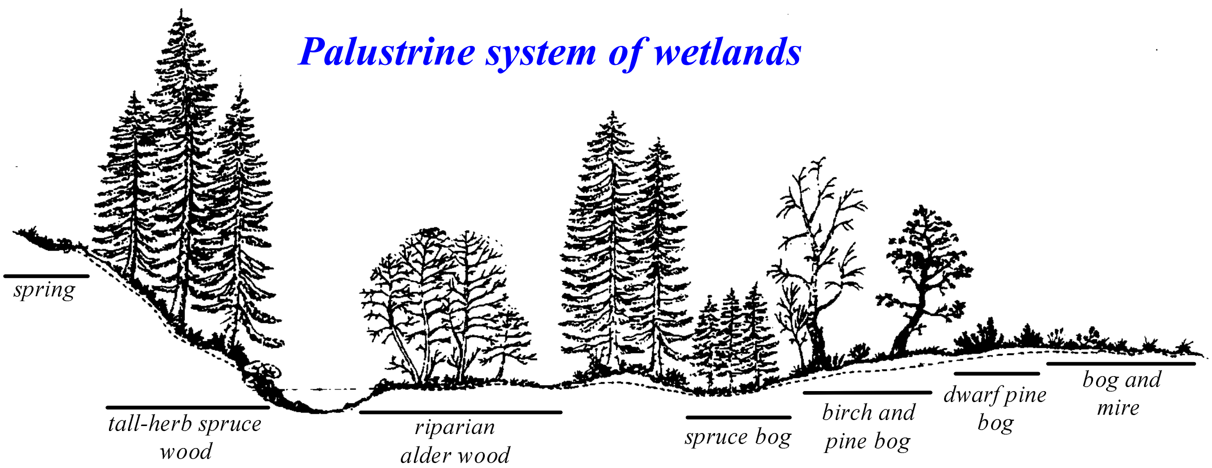
Three main conditions for existence of wetland are included in this definition:

1. the substrate is flooded or saturated with water during vegetation season
2. presence of wetland plants - hydrophytes and hygrophytes
3. presence of hydric soils with anaerobic conditions

Functional definition of wetlands is defined as:
"heterogeneous but distinctive ecosystems in which special ecological, biogeochemical and hydrological functions arise from the dominance and particular sources, chemistry and periodicity of inundation or saturation by water. They occur in a wide range of landscapes and may support permanent shallow (<2m) or temporary standing water. They have soils, substrates and biota adapted to flooding and/or water-logging and associated conditions of restricted aeration'.[2]

Inland wetlands are of a palustrine, riverine or lacustrine system type. This division is made according to how the wetland is supplied with water. In the cases of riverine and lacustrine systems, the wetlands are influenced by the water level of rivers and lakes. In the palustrine system of wetlands, water is supplied by groundwater, rain, snow and during periods of floods.

Palustrine system - is not bounded by deepwater habitats. Vegetation covers more than 50% of the area and it has to contain the previously mentioned three characteristics.

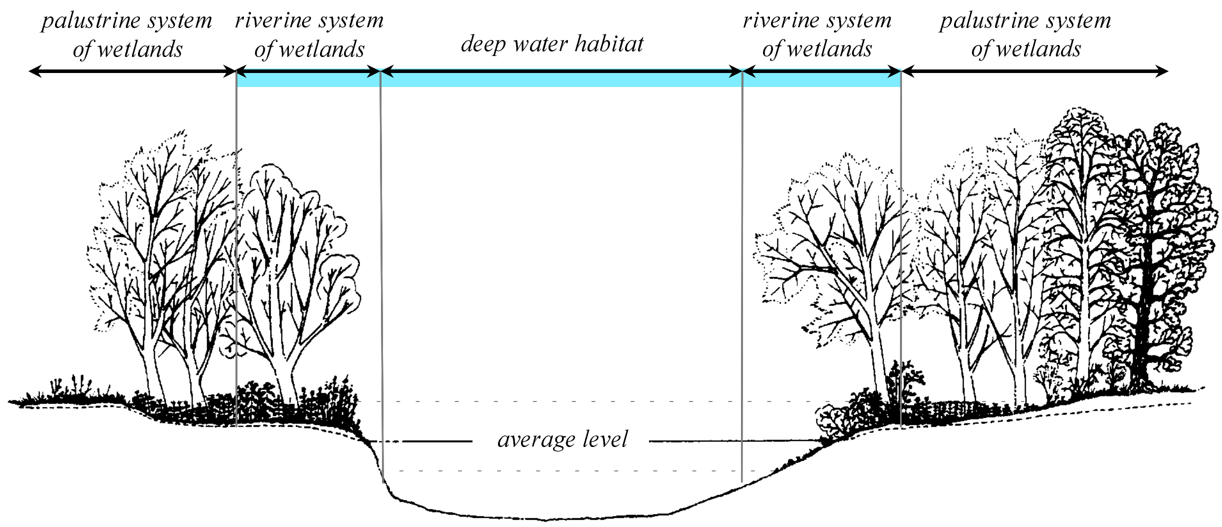


[1] KUSLER, J. A. et KENTULA, M. E. (eds.), 1990: Wetland Creation and Restoration. The Status of the Science. Washington, D.C., Covelo, California.

[2] Definition provided by Evaluwet. Evaluwet - European Valuation and Assessment tooLs supporting Wetland Ecosystem legislaTion - is a research project supported by the European Commission under the Fifth Framework Programme and contributing to the implementation of the Key Action "Sustainable Management and Quality of Water" within the Energy, Environment and Sustainable Development Contract n°: EVK1-CT-2000-00070

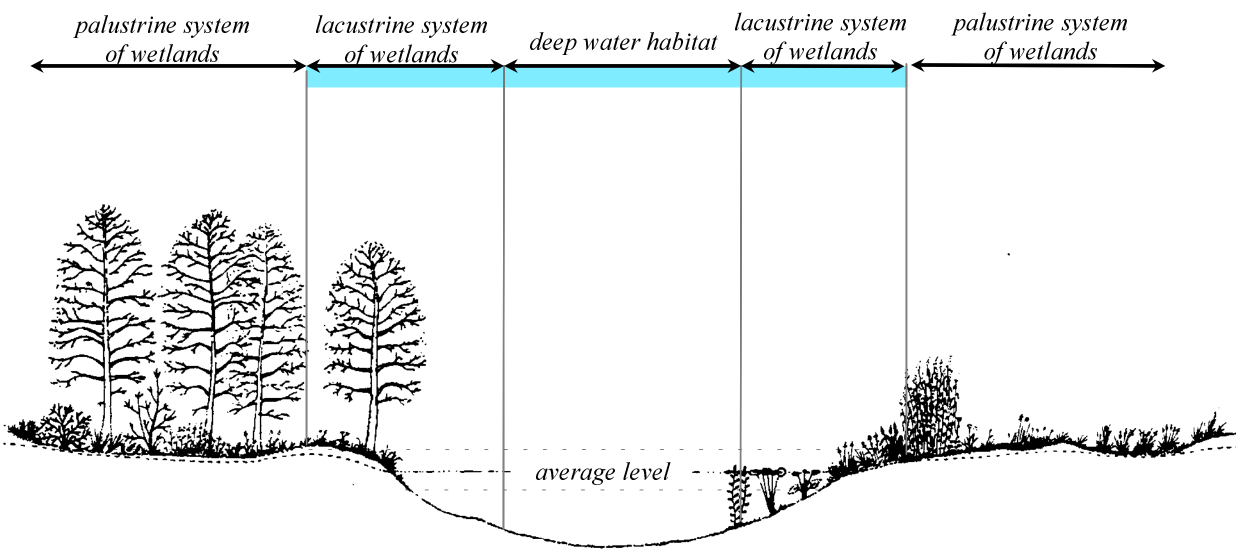
Riverine system - is situated by channels with moving water, and also near deepwater habitats. In some parts the average depth of the channel is at least 2 meters. Wetlands of smaller channels, which do not fulfill this condition belong to the palustrine system. Vegetation covers less than 50% of the area.

Riverine system of waters and wetlands



Lacustrine system - has to have the same conditions as the riverine system. The difference is in the state of water which is stagnant in this case.

Lacustrine system of waters and wetlands



It is necessary to distinguish

(Deep)Water system - permanently flooded lands lying below the deepwater boundary of wetlands. Water habitats include environments where surface water is permanent and often deep, so that water rather than air, is the principal medium within which the dominant organisms live. The substrate is considered nonsoil because the water is too deep to support emergent vegetation (Cowardin et al. 1979)[3]. The boundary lies at depth of 2 m below low water because it represents the maximum depth to which emergent plants normally grow.

Further classification is according to vegetation (Tab 1). **Formations** are divided according to the dominant live form of dominant plant species (tree, shrub, grasses, herbs and moss). **Vegetation types** are according to dominant plant species (spruce - spruce bog, alder - fen alder wood).

Most common are palustrine vegetation types, so we are concentrating on their characteristics. Vegetation types of riverine and lacustrine systems connected with specific palustrine vegetation types are added in the scheme on the inside cover page.

Besides this classification, other types of classification systems also exist. The most well known system of classification is that as described by the Ramsar Convention. Unfortunately, this classification is reflecting not very consistent definition of wetlands and its practical use is very limited eg. for inventory purpose.

This classification system also considers wetlands, which contain deepwater habitats. If there are some ponds, reservoirs and canals created by man we did not classify them as a specific category, but we included them in the review if they follow the definition.

Tab 1. Classification of inland wetlands[4] in Danube River Basin with links to Ramsar Classification (Annex).

System	Formation	Vegetation type	Ramsar Classification
Palustrine	***wood***	riparian alder wood	M,P,Xf
		fen alder wood	Xf
		spruce bog	Xp
		birch and pine bog	Xp
		tall-herb spruce wood	Xf
		willow-poplar wood	P,Xf
		oak-elm-ash wood	P,Xf
	shrub	willow shrub	M,W
		dwarf pine bog	W
	grass-herb	tall-sedge	Tp,Ts
		wet meadow and pasture	Sp,Ss,Ts,Va,4,9
		tal-herb floodplain	
		reed swamp	Tp,Ts
		aquatic vegetation	9
	moss	bog	U
		fen	U
		spring	Y
	ephemeral	bare bottom growth	Ts

[3] COWARDIN, L. M., CARTER, V., GOLET, F. C. et LaROE, E. T., 1979: Classification of Wetlands and Deepwater Habitats of the United States. Washington , D.C.

[4] based on Seffer et al.1996. Wetlands for life. Daphne, Bratislava, 32p.

Riverine	***tree***	with alders	L, M,Xf
		w. willows and poplars	L, M,Xf
	shrub	w. willows	L, M,W
	grass-herb	w. sedges	L, M
		w. grasses and herbs	L, M,4
		w. aquatic plants	L, M
	ephemeral	bare bottom growth	L
Lacustrine	***tree***	with alders	O,Xf
		w. willows and poplars	O,Xf,1,2,6,7
	shrub	w. willows	O,W,1,2,6,7
		w. dwarf pines	O,W
	grass-herb	w. sedges	O
		w. grasses and herbs	O,Q,R,Sp,Ss,1,2,6,7
		w. aquatic plants	O,1,2,6,7
	ephemeral	bare bottom growth	O,Q,R,Ts,1,2

Annex

Ramsar Classification System for Inland and Human Made Wetlands

The codes are based upon the Ramsar Classification System for Wetland Type as approved by Recommendation 4.7 and amended by Resolution VI.5 of the Conference of the Contracting Parties. The categories listed herein are intended to provide only a very broad framework to aid rapid identification of the main wetland habitats represented at each site.

Inland Wetlands

L -- ***Permanent inland deltas***.

M -- ***Permanent rivers/streams/creeks***; includes waterfalls.

N -- ***Seasonal/intermittent/irregular rivers/streams/creeks***.

O -- ***Permanent freshwater lakes*** (over 8 ha); includes large oxbow lakes.

P -- ***Seasonal/intermittent freshwater lakes*** (over 8 ha); includes floodplain lakes.

Q -- ***Permanent saline/brackish/alkaline lakes***.

R -- ***Seasonal/intermittent saline/brackish/alkaline lakes and flats***.

Sp -- ***Permanent saline/brackish/alkaline marshes/pools***.

Ss -- ***Seasonal/intermittent saline/brackish/alkaline marshes/pools***.

Tp -- ***Permanent freshwater marshes/pools***; ponds (below 8 ha), marshes and swamps on inorganic soils; with emergent vegetation water-logged for at least most of the growing season.

Ts -- ***Seasonal/intermittent freshwater marshes/pools*** on inorganic soils; includes sloughs, potholes, seasonally flooded meadows, sedge marshes.

U -- ***Non-forested peatlands***; includes shrub or open bogs, swamps, fens.

Va -- ***Alpine wetlands***; includes alpine meadows, temporary waters from snowmelt.

Vt -- ***Tundra wetlands***; includes tundra pools, temporary waters from snowmelt.

W -- ***Shrub-dominated wetlands***; shrub swamps, shrub-dominated freshwater marshes, shrub carr, alder thicket on inorganic soils.

Xf -- ***Freshwater, tree-dominated wetlands***; includes freshwater swamp forests, seasonally flooded forests, wooded swamps on inorganic soils.

Xp -- ***Forested peatlands***; peatswamp forests.

Y -- ***Freshwater springs; oases***.

Zg -- ***Geothermal wetlands***

Zk(b) – ***Karst and other subterranean hydrological systems***, inland

Note : "***floodplain***" is a broad term used to refer to one or more wetland types, which may include examples from the R, Ss, Ts, W, Xf, Xp, or other wetland types. Some examples of floodplain wetlands are seasonally inundated grassland (including natural wet meadows), shrublands, woodlands and forests. Floodplain wetlands are not listed as a specific wetland type herein.

Human-made wetlands

1 -- ***Aquaculture*** (e.g., fish/shrimp) ***ponds***

2 -- ***Ponds***; includes farm ponds, stock ponds, small tanks; (generally below 8 ha).

3 -- ***Irrigated land***; includes irrigation channels and rice fields.

4 -- ***Seasonally flooded agricultural land*** (including intensively managed or grazed wet meadow or pasture).

5 -- ***Salt exploitation sites***; salt pans, salines, etc.

6 -- ***Water storage areas***; reservoirs/barrages/dams/impoundments (generally over 8 ha).

7 -- ***Excavations***; gravel/brick/clay pits; borrow pits, mining pools.

8 -- ***Wastewater treatment areas***; sewage farms, settling ponds, oxidation basins, etc.

9 -- ***Canals and drainage channels, ditches***.

Zk(c) **–** ***Karst and other subterranean hydrological systems***, human-made

1.2 Wetland Functions

Jan Seffer

Wetlands are very important for biodiversity conservation. The species richness of organisms is caused by many different habitats, created in dependence of ground water level and the duration of floods. Several centimetres is often the distinction between life and death for many plant and animal species.

None of the species live in isolation, but are connected by many relationships with other species of this ecosystem. The result is a complicated network of symbiotic relationships. If one important species is eliminated from the network, this may result in dramatic effects to the entire system. We are unable to predict what will happen to an ecosystem due to interference and changes created by man.

Wetlands are a very important component in the cycling of nitrogen. Taken up into the nutrient the dissolved nitrogen in the water passes through a wetland, much of it is captured and transformed by microbes. Plants take up nitrogen as they grow and release nitrogen as they decompose. Because nitrogen may be the most limiting nutrient for plant growth in flooded soils, excess nitrogen can contribute to eutrophication or rapid plant growth. Nitrogen can be omitted from a wetland with the water outflow. Because of the anaerobic conditions of wetland soils, much of the nitrogen becomes a gas and escapes to the atmosphere.

Nitrates and other chemicals from fertilizers decompose in wetlands and are retained from entering the ground water. An increase of discharged nutrients especially nitrogen and phosphorus negatively impacts water quality by directly raising the level of nitrates in the groundwater and indirectly by the process of eutrophication in surface waters. Nitrates are also a serious health concern when found in high concentration in drinking water.

Growing vegetation removes nutrients from the water, and if the vegetation is removed the net result is a reduction of nutrients. The regularly mowed meadows in the Morava River Floodplains are a unique ecosystem not only for their high biodiversity value, but also because they act like huge nutrient sinks. After rough estimations we have predicted that 290 tons of nitrogen and 30 tons of phosphorus are removed by hay annually, but the potential for this area is 480 tons and 50 tons respectively.

Wetlands also slow flood waters allowing sediments, nutrients, pesticides, heavy metals and other toxic metals to be trapped and absorbed into the soil.

Wetlands are globally considered to be the most productive ecosystems. Wetland vegetation is a very effective use of the suns energy. Plants use light through the process of photosynthesis for the replication of cells and building of biomass. A result of this process is the release of oxygen by the plant. This biomass then serves as food for numerous species of aquatic and terrestrial animals and plants.

Review of the most significant wetland functions

Biodiversity conservation

- *habitat for an enormous diversity of micro-organisms, plants and animals*

Environmental functions

- *water quality control*
- *removal of nutrients from water*
- *purification of water from chemical and organic waste*
- *removal of sediments*
- *biomass and oxygen production*
- *water retention in the soil*

Socio-economic functions

- *flood control*
- *erosion control*
- *water supply*
- *wood, hay and reed production*
- *cattle and sheep grazing areas*
- *fishing and hunting*
- *recreation*
- *education and research*

Under natural conditions wetlands protect the land against floods. They catch surges of flooding water, and slow down running water. Captured water is then slowly released. In this way wetlands help with flood control, because the flood peaks on the tributaries do not reach the main stream at the same time. This function is very important, mainly in places of high population densities. By regulations, straitening of rivers and decreasing of flooded areas by the construction of dikes, the river is loosing its dynamic characteristics. We can compare this state with the situation when we put on coat, which is too small for us. After the first awkward movement, the coat will tear somewhere.

Wetlands are transitional areas between terrestrial and aquatic habitats, which protect the land against erosion. Wetland vegetation can reduce bank erosion in different ways: root systems which stabilise the bank, reduce the effect of flooding waters and slow down a stream by friction. Mainly trees act as stabilisers for river banks.

Wetlands are very important for people as a water resource. They serve as water reservoirs that are filled up when there is enough water and gradually let out when there is lack of water. Consequently, they serve in the high production of wood, hay and reeds. All of which have been used from historical times for traditional uses. Wetlands are also used as pastures, and for fishing and hunting. Above all, lowland wetlands are very popular for visitors because of a high diversity of different habitats and species.

2. Integrated Watershed Management

Jaromír Šíbl

2.1 Current Issues in Water Management

Water is one of our most precious natural resources. In moist, temperate regions, water is the fundamental mechanism in chemical flux and cycling. In arid regions, access to water lies at the heart of much conflict. Every living organism on this planet requires water in some form. Water, therefore, regulates population growth, influences world health and living conditions, and determines biodiversity.

For thousands of years people have tried to control the flow and quality of water. There are documented water disputes of 4,500 years ago in the Mesopotamian cities of Lagash and Umma. Engineering works related to military and urban development, drainage works, irrigation projects, and water diversions can all be documented over thousands of years. Even today the presence or absence of the water is critical in determining the uses to which the land can be put.

Yet despite this long experience in water use and water management, humans have failed to manage water well. Through the nineteenth century and much of the twentieth century, economic development in many countries was rapid, and often at the expense of sound water management. Frequently, optimism about the applications of technology – whether dam building, wastewater treatment, or irrigation measures – vastly exceeded concerns or even interest in their environmental shortcomings. Pollution was viewed as the inevitable consequence of development, the price that must be paid if economic progress was to be achieved.

In March 1977, UN sponsored a conference on water at Mar del Plata, Argentina. This conference is viewed as a landmark event in water management. The conference resulted in an „action plan“, including recommendations targeted at meeting the goal of safe drinking water and sanitation for all human settlements by 1990. The conference recommendations for water management policy can be summarised as follows:

1. Each country should formulate and keep under review a general statement of policy relating to the use, management, and conservation of water as a framework for planning and implementation. National development plans and policies should specify the main objectives of water-use policy, which in turn should be translated into guidelines, strategies, and programs.
2. Institutional arrangements adopted by each country should ensure that the development and management of water resources take place within the context of national planning, and that there be real coordination among all bodies responsible for the investigation, development, and management of water resources.
3. Each country should examine and keep under review existing legislative and administrative structures concerning water management and, where appropriate, should enact comprehensive legislation for a coordinated approach to water planning. It may be desirable that provisions concerning water resources management, conservation, and protection against pollution be combined in a unitary legal instrument. Legislation should define the rules of public ownership of water and of large water engineering works, as well as the provisions governing land ownership problems and any litigation that may result from them. This legislation should be flexible enough to accommodate future changes in priorities and perspectives.
4. Countries should make necessary efforts to adopt measures for obtaining effective participation in the planning and decision-making process involving users and public

authorities. This participation can constructively influence choices between alternative plans and policies. If necessary, legislation should provide for such participation as an integral part of the planning, programming, implementation, and evaluation process.

This „action plan“ emphasizes a strong, centralized, and national commitment to water management. Yet even 25 years later, the problems it was intended to solve remain significant. The significance of Mar del Plata lies in fact that it recognized, formally and globally, that existing water management policy was failing to reach its goals. The disappointing progress in the years since the conference has encouraged many authors re-examine the Mar del Plata action plan and the reasons for continued inaction. The main reasons why the responsible governmental institutions have not succeeded to reach the careful, strategic water management, can be summarised as follows:

1. The dominance of unregulated water uses
2. Inadequate and ineffective water resources management
3. A high degree of inefficiency in many water-related public utilities
4. A failure to retain trained staff of all types
5. Overcentralization and bureaucratization of decision-making authority
6. Inappropriate and inadequate water legislation

In the wide debate leading up to the Rio meeting, a number of authors analyzed the forces affecting water management. There is remarkable consensus among these authors who - come from countries around the world - about the current issues confronted by water managers (Viessmann 1990; Goodman and Edwards 1992; Nickum and Easter 1990):

Water Availability, Requirements, and Use

- Protection of aquatic and wetland habitat
- Management of extreme events (droughts, floods, etc.). Excessive extractions from surface and ground waters
- Global climate change
- Safe drinking water supply·
- Waterborne commerce

Water Quality

- Coastal and ocean water quality
- Lake and reservoir protection and restoration
- Water quality protection, including effective enforcement of legislation· Management of point- and nonpoint-source pollution
- Impacts on land/water/air relationships
- Health risks

Water Management and Institutions

- Coordination and consistency
- Capturing a regional perspective
- The respective roles of federal and state/provincial agencies· The respective roles of projects and programs
- The economic development philosophy that should guide planning· Financing and cost sharing
- Information and education

- Appropriate levels of regulation and deregulation
- Water rights and permits
- Infrastructure
- Population growth
- Water resources planning, including

- Consideration of the watershed as an integrated system
- Planning as a foundation for, not a reaction to, decision making
- Establishment of dynamic planning processes incorporating periodic review and redirection
- Sustainability of projects beyond construction and early operation
- A more interactive interface between planners and the public
- Identification of sources of conflict as an integral part of planning
- Fairness, equity, and reciprocity between affected parties

There is a marked trend from the early 1980s to the present time in several aspects of water management. Lee (1992) suggests that these trends may derive from shifts in economic forces, from aggressive economic growth in the early period to more fragmented, less successful growth in recent years. Certainly, a global economic recession through the early to mid-1990s has made governments more cost conscious and businesses more willing to evaluate the impacts of their actions in advance of implementation. The 1980s saw significant growth in public concerns about the environment, and these have not abated even in the face of economic downturns. The trends that can be observed include:

l. A move from end-of pipe (reactive) pollution control measures toward pollution prevention.
2. Increasing concern about chronic effects and "invisible" threats for instance, to human health as compared with acute effects and visible problems.
3. Increasing awareness that point-source controls are generally well in hand, and that urban and agricultural nonpoint sources of pollution are now major contributors to surface and groundwater impairment.
4. A shift from local action (e.g., abatement of a single point source) to global management strategies (e.g., the Rio Convention on Biodiversity). This trend is also reflected in the growing consensus about the value of watershed management, as compared with management by political boundaries such as those of municipalities.
5. Growing mistrust of, or perhaps understanding of the limits of, technology, and increased reliance on education and extension activities to change consumer behavior.
6. Increasing consensus that the user or exploiter of resources should pay for any damage done by that use: the "user pay" or "polluter pay" principle.

These principles are inherent in an effective integrated water management strategy.

2.2 Characteristics of Effective Watershed Management

Generally speaking, water management can be considered effective when it:

l. Allows an adequate supply of water that is sustainable over many years
2. Maintains water quality at levels that meet government standards and other societal water quality objectives
3. Allows sustainable economic development over the short and long term

We may, in fact, have reached a point perhaps signaled by recent environmental disasters like Love Canal and the Cuyahoga River and by water supply crises in many communities at which it is clear that future water use must be sustainable or development in some regions will

halt. Sustainability implies closer cooperation between water users than has typically been experienced in the past. It also implies consideration of the needs of the community, not just the individual a difficult proposition for many water users.
Goodman and Edwards (1992) state that the in this context word *plan* can mean any one of the following:

- A single-purpose, single-unit plan to serve a specific need, such as a demand for water or abatement of a water-related problem
- A multipurpose and multiproject plan
- A regional plan for water resources development, preservation, or enhancement, staged over a period of time with one or more planning horizons
- A national plan for water resources development, preservation, or enhancement

Planning may proceed in many ways. Bishop (1970) notes that clear goals may be set or a process may simply proceed without goals. One agency may lead and control the process, perhaps even forbidding participation by other groups or agencies. Or the process may be clearly a multiparty and multiperspective one, with community consensus established at every step. Some planning processes consist of a rigid schedule of meetings, formally chaired and run; others employ a flexible workshop or "kitchen table" approach in which discussion is open and unstructured. There are advantages and disadvantages to each method, but the point that must be stressed is that the choice of a planning process is often highly context-dependent; that is, its success will depend very much on the characteristics of the planning area, the water management issues in the area, and the interests and needs of the community of water users. It is increasingly clear, however, that unilateral planning processes that seek to exclude the public will fail if not in the planning stage, then in implementation. The rapid rise of public interest in, and knowledge about, environmental issues through .the 1980s has created a climate in which public participation is expected and, indeed, required in almost every planning situation.

Schramm (1980) offers the following general guidelines for successful river basin planning:

l. The institutional framework for the project must allow consideration of a wide range of alternatives to solve observed problems, including those that may be outside the specific responsibilities of the planning bodies.
2. The planning agencies must have the expertise needed for multiple-objective planning and evaluation procedures, especially in economic, social, and environmental areas.
3. The institutional framework must facilitate adaptation of the plan to meet changing national, regional, and local priorities.
4. The institutional framework must seek representation of all parties affected by the specific development plans and management.
5. The institutional framework must reward initiative and innovation among the members of the technical team and within cooperating agencies.
6. The technical team must be sufficiently free from day-to-day responsibilities so that they can concentrate on long-range planning and anticipation of future problems.
7. The institutions must.have the capacity for learning and improving over time, including sufficient contmuity over time and the ability to evaluate past programs.
8. There must be sufficient authority within the institutional framework to enforce conformity of execution with construction and operating plans.
9. The institutional framework must be capable of guaranteeing an acceptable minimum level of professional performance by the technical team.
10. The plan implementation stage must include provisions for the timely and qualitatively and quantitatively sufficient supply of needed services by other agencies, as well as

provisions to assure continued functioning i.e., operation, repair, and maintenance of the facilities and services provided.

Schramm emphasizes the need for coordination and cooperation at local, regional, and national levels, noting that:

“Planning and plan implementation do not proceed in a rarified vacuum derived from lofty, immutable principles that are a law unto themselves. Planning is done for people and people have different and often competing wants, desires, and hopes; political institutions should be designed to meet those wants. One of the best ways to condemn planning efforts to oblivion or failure is to turn the task over to a self-contained, isolated team of experts who fail to communicate with one another, the people their plans are to serve, and those with political, decision making authority. Within this dynamic, competing world of human wants and values there is no ultimate reality or single-dimensioned optimum that can be determined by scientific methods alone.”

2.3 Why “Integrated” Management?

The idea of trans-media environmental management management using the "ecosystem" concept is a relatively new one. In large part, it was born of experience showing that single-medium or single-source management was not successful in meeting short- or long-term goals. Until the mid-1970s, for instance, almost all pollution control effort was directed at controlling point sources like sewage treatment plants and industrial discharges. The International Joint Commission's Pollution from Land Use Activities Reference Group (PLUARG) (PLUARG 1983) examined the reasons that phosphorus-reduction efforts in the Great Lakes Basin had stalled. Its research showed that remediation of the lakes would require integrated management plans for both point and nonpoint sources throughout the entire Great Lakes Basin. In some areas, point-source controls would be most cost-effective; in others, the focus would have to be on nonpointsource controls. Without the overview provided by an integrated strategy, costly management efforts would continue to fail.

Sometimes water management efforts have been unsuccessful because they have focused on a single medium (water) rather than on other environmental components such as sediment, air, or biological tissue. Mercury poisoning at Minamata, Japan, and the Wabigoon-English River system, northwestern Ontario, Canada, are excellent examples. In each case, an industrial facility had discharged large volumes of wastewater containing inorganic mercury into receiving waters. In each case the inorganic mercury (which is relatively nontoxic to humans and other organisms) was converted in the water column and sediments to methyl mercury, which is highly bioaccumulative and persistent in body tissues. The methyl mercury was readily taken up by invertebrates in the waters, which in turn were eaten by larger species such as fish, and these larger animals were consumed by humans. The humans, at the top of this particular food chain, received concentrated doses of methyl mercury, which accumulated in their own body tissues, causing a wide range of nervous system impacts. Subsequent abatement efforts aimed at eliminating mercury-using technologies in the Wabigoon facility (a pulp and paper mill) were successful. Nevertheless, more than 20 years after the technology change, mercury continues to be released into the water from river and reservoir sediments and, possibly, from residual deposits within the mill. Consideration only of effluent quality from the mill might suggest that the problem was "solved" 20 years ago; in fact, methyl mercury continues to cycle through the Wabigoon-English River system as a result of trans-media environmental phenomena.

Very often, water management strategies have failed because they neglected to incorporate the full range of values and perspectives present among water users or agencies with an interest in water management. Wilkes (1975) noted that the provision of adequate water supplies in the Rhine River watershed is hampered because different agencies are responsible for water supply and for water quality, and the two are not always effectively coordinated. Wilkes also observed that watershed management requires the involvement of regional, state, national, and international agencies a measure that was unnecessary at the level of local water management and pollution control. The transition from local to watershed management can be difficult, because interested agencies may not have the necessary authority to take on new management roles, may encounter varying political influences, or may simply not work very well together in managing water resources. In multilingual countries or watersheds, or in less developed countries where external agencies like the World Bank may be involved in planning initiatives, cooperation across agencies and disciplines may be more difficult still.

"Integrated" watershed management, although a strategy that is increasingly advocated in the literature, is therefore still a relatively new concept. McDonald and Kay (1988) observe that there have been "few real attempts to provide integrated management information and even fewer evaluative studies of the policy and management of integration within the water resources field." More and more agencies are now esta.blishing administrative frameworks that permit and even encourage management of water on a watershed basis. Less frequently are water management activities integrated with other resource management activities affecting or affected by water. Heathcote (1993) notes that these may include, at minimum, the intensity and nature of agricultural activities, forestry, and commercial fisheries. Although integration at the watershed level is increasingly possible, integration at larger scales is, in the words of McDonald and Kay (1988), "conspicuously absent," although there are clear advantages to integrated water management at the international scale (especially in international river basins) and even at the global scale.

In the mid-1980s, the Canadian federal government established a formal inquiry on federal water policy, in response to a growing awareness that Canadian water resources were potentially at risk of overuse and underprotection. The inquiry called for "visionary policies" for the management of water resources in Canada (Pearse et al. 1985).

The inquiry drew attention to rising water consumption rates in Canada, conflicting water uses in many areas, and deteriorating water quality, especially in the heavily populated Canada-U.S. border region. Throughout their reports, the inquiry panel stressed the need for caution and prevention, rather than careless use and reaction. Among their recommendations were several relating to the administrative structures of water management and the need for what they termed "comprehensive management." In particular, they called for (Pearse et al. 1985):

- A watershed plan sufficiently comprehensive to take into account all uses of the water system and other activities that affect water flow and quality .
- Information about the watershed's full hydrological regime
- An analytical system, or model, capable of revealing the full range of impacts that would be produced by particular uses and developments in the watershed
- Specified management objectives for the watershed, with criteria for assessing management alternatives in an objective and unbiased way
- Participation of all relevant regulatory agencies
- Provisions for public participation in determining objectives and in management decisions

These recommendations are particularly notable because they come from a seasoned group of experts in a country that has long considered itself to have infinite water resources. In the decade following the release of the inquiry's report, many of the panel's admonitions about excessive water use and deteriorating water quality have been proven correct, and the need for integrated watershed management is now seen as urgent. In less-water-rich countries, including the United States and many European countries, population density and a limited resource base make integrated watershed management essential for sustainable water use. As global consensus about the need for integrated management grows, it may now be social and economic forces, rather than technical considerations, that determine the success of an integrated watershed planning effort.

2.4 Recommended Planning and Management Approach

From the social and political perspective, the water management planning is a process of achieving social change. In that sense, it is a consensus-building process, not a unidimensional scientific exercise. Most of all, the watershed management plan must reflect the current societal consensus about the value of water as a resource, about responsibilities and social attitudes, and about the community´s vision of an ideal watershed state. Integrated watershed management is, therefore, a journey, not a destination.

The development and implementation of workable solutions is not a process that has a single correct outcome. Rather, it is an ongoing process of dialogue with the community, learning about needs, teaching about options, and building consensus about an ideal watershed condition and the best way to get there. The central feature of this process is choice: humans use and affect water resources and have many choices available as to how and when that use occurs. Integrated watershed planning means developing a social consensus about best choices.

The general recommendations for the sound watershed management planning can be summarised as follows (Heathcote, 1998):

1. Develop an understanding of watershed components and processsses, and of water uses, water users, and their needs
2. Identify and rank problems to be solved, or beneficial uses to be restored
3. Set clear and specific goals
4. Develop a set of planning constraints and decision criteria, including any weights that may be assigned to criteria
5. Identify an appropriate method of comparing management alternatives
6. Develop a list of management options
7. Eliminate options that are not feasible because of time, cost, space or other constraints
8. Test the effectiveness of remaining feasible options
9. Determine the economic impacts and legal implications of the various feasible management options and their environmental impacts
10. Develop several good management strategies, each encompassing one or more options, for the consideration of decision makers
11. Develop clear and comprehensive implementation procedures for the plan that is preferred by decision makers

Planners ussualy find it helpful to divide the planning process into these discrete steps. In reality, however, the planning process is dynamic and continuous. Several tasks or steps may be under way simultaneously. Planning direction may change dramatically if new information comes to light, if political forces change dramatically, or if community consensus is redirected for other reasons. Above all, integrated watershed planning and management must be responsive and adaptive to changing conditions.

Heathcote (1998) presents some principal elements of a successful integrated watershed management. In summary, these are:

1. Adequate expertise for multiple-objective planning and evaluation procedures, especially in economic, social and environmental areas

2. Adequate resources of time and money for planning and implementation
3. Consideration of a wide range of alternatives to solve observed problems
4. A flexible, adaptable plan, reviewed and amended at regular intervals
5. Representation of all parties affected by the plan and its implementation
6. Sufficient authority to enforce conformity of execution with construction and operating plans

Sustainable management of water resources requires water users to make conscious choices that may sometimes reduce personal benefits in favour of community or intergenerational benefits. There is growing consensus among different stakeholders that those choices cannot be made solely on the basis of scientific evidence. Indeed, the science is not very clear, or may be contradictory, on key questions affecting water management. In addition to scientific evidence, sustainable watershed management requires community understanding and support, which in turn will generate political will and, thus, economic and human resources to make changes. Although those resources are now scarcer than they have been for many decades, public awareness of and concern about water resources issues are now higher than ever before. Integrated watershed management will therefore depend on the formation of partnerships between governments and the public, across disciplines and international borders, and among water users with different interests and values. This is a huge challenge, but one for which the payoff will be sustainable management of water resources for our own and future generations.

3 Wetland Managemenent and Restoration

Compiled by Jaromír Šíbl

3.1 Water Management

The conservation interest of wetlands and the ability to manage them effectively are influenced by the physical and chemical characteristics of the water and soil. Two aspects of water management are of particular importance: water regime and water quality. The first section looks at the problems of water availability on sites and how to control and manipulate water levels. The second examines the effects of water quality and measures that can be taken to improve it when problems occur. Table 1 outlines the factors, which should be considered before undertaking any water management.

Ideally, hydrological management should meet the water requirements of target species and communities. Where species' requirements are not fully known, it may be possible to mimic the hydrological regimes of other, similar sites which support high-quality wet grassland, or to reinstate historical regimes which supported it in the past. It cannot be stressed enough, however, that where reinstatement is required, wholesale and rapid change of hydrological and grazing regimes is not advisable.

Considerations for water management

Water-table and water level requirements (ie regime)
- different community / species needs

Water supply
- quantity available
- availability at key periods
- surety of supply (balance with needs of other users)

Water quality
~ soil type and sediments
~ salinity
~ plant nutrients (eutrophication)
~ chemical pollutants

Water management
~ distribution network infrastructure
~ condition of existing infrastructure
~ need for new structures (drainage channels, bunds, grips, etc)
~ maintenance needs (sluices, pumps, drainage channels, grips, drains)

Legal considerations
~ access to external supplies
~ modification of drainage infrastructure
~ modifications to existing hydrological regime

3.2 Water Regime

Water regime describes the combination of water-table depth, the length of time that depth is maintained and at what time of year. The water regime of a wetland may be influenced by environmental factors and by management.

These include:
environmental factors such as:
- catchment area
- rainfall
- evapotranspiration surface flows
- soil type
- topography
- groundwater flows.

management factors such as:
- other water demands in catchment
- drainage infrastructure on site.

The extent to which regimes should and can be managed varies between sites as a result of seasonal and geographical variation, existing drainage infrastructure on the site and adjacent land use (e.g. spray-irrigated agricultural land). Activities outside a site's boundaries may also affect proposed management and should be evaluated. This section examines factors influencing water supply and distribution on wetlands in turn. Methods for water control are then examined.

Water supply

Adequate water supply is essential to enable enhanced management and restoration of wetland habitats. Water supply for a site is influenced by climatic conditions (i.e. rainfall and evapotranspiration), which vary throughout the continent. Sites may be dependent on surface water (eg river flows) or groundwater supplies; however, in , many areas these have become increasingly limited, especially where rainfall is low or where there are other competing demands (eg abstraction for spray-irrigation or public water supply). Modification of rivers for flood control has altered natural flooding regimes and has in many areas resulted in a general lowering of watertables. Abstraction from rivers and groundwater for domestic, agricultural and industrial use has exacerbated water supply problems in many areas.

The extent to which supply can be managed will vary between sites, and the following factors should be considered:

- seasonal variations
- water source (inputs - eg river, groundwater and rainfall)
- access to supply (competing demands)
- losses from site (eg seepage and abstraction).

Natural seasonal variations of water supply should be taken into account when determining proposals for enhanced management and restoration. Evapotranspiration will typically be highest in June, July and August when water levels will naturally be at their lowest. Water availability for sites can be calculated and should be examined in conjunction with other water demands to see whether the site is capable of sustaining wetland where creation or restoration options are being considered.

In some areas agriculture is now a major user. Shortages are particularly common in the summer months, when evapotranspiration rates are high and supplies are limited. Shortages as a result of abstraction from main rivers could potentially be alleviated by providing onsite storage of winter water. Winter water is often available in excess, particularly on washlands or on areas which are natural sinks for water and could be retained to maintain water-tables in summer.

The easiest way to store this water may appear to be on the wetland itself during the spring, using bunds. It must be borne in mind, however, that this can have a negative impact on the species diversity of both the grassland flora and the invertebrate community where water is stored. Holding water at high levels on grassland during spring creates very stressful conditions for grass swards and extensive grass kills may result due to a lack of oxygen in the soil. Where wet grassland conservation is the objective, water should be stored in reservoirs or on areas of swamp vegetation or reedbed.

The many pressures on limited water supplies can make it difficult to meet conservation needs. Water Level Management Plans (WLMPs) are one way of attempting to ensure that environmental requirements are met. WLMPs can help to resolve potentially conflicting interests. There is, however, some concern as to how far WLMPs can deal with water supply problems owing to water abstraction. It is essential that action should be taken to integrate water abstraction issues into WLMPs where appropriate. Addressing shortages arising as a result of abstraction is a common problem.

Water distribution

Water distribution or movement at a site is influenced by:
- topography
- surface flows (eg in drainage channels)
- regional and local groundwater flows
- soil type.

Topography

Natural variations in topography can provide a variety of wetness regimes in an area. Topography affects plant community composition because of its influence on water-table levels. Localised depressions often provide wetter „islands" which typically contain inundation grassland but which may also support swamp or sedge-bed communities. Higher areas may support communities characteristic of drier soils. Small-scale variations in micro-topography or soil structure may produce very different water regimes in directly adjacent points, as in ridge and furrow grassland.

Surface flows

Controlled distribution of water and the regulation of water levels is much easier on sites with a well developed water distribution network. Paradoxically, this is more likely on sites which have been intensively managed in the past. Systems of water-filled drainage channels can be used to both drain or irrigate land, depending on the position of the soil water-table relative to drainage channel water levels.

In lowland areas, where the land is essentially flat, hydraulic gradients within the system are often almost zero. Where there is gravity-feed from surrounding higher ground, drainage channel water levels can be controlled simply by setting levels at the outlet, for example by using sluices. It is advantageous to create a terraced irrigation system where water flows from one hydrological unit to another. Where there is no natural supply from surrounding high ground or from groundwater recharge, it will be necessary to import water to meet evaporative demand, particularly in the summer. This may require the manipulation of inlet sluices, for example to let water onto the site from adjacent carrier channels, or even pumping .

Groundwater

Knowledge of groundwater levels and gradients (direction of flow is usually down a valley or towards a river) can be very valuable when creating new wetland. However, it can be very difficult to make accurate predictions and the advice of a hydrologist or hydrogeologist should be sought.

Soil types and their effect on in-field water levels

Soi1 type and structure influence the ability to manage water levels on a site. It is generally assumed that clay/silt soils depend on surface flooding to maintain wetness and wildlife interest, whereas water-table levels in peat soils can be influenced by the lateral (sideways) movement of water (eg to and from ditches). However, this is a generalisation and should be treated with extreme caution. Soil structure can be the overriding factor controlling water movement in soils. Soil type and structure influence the ability of the soil to hold water (and hence influence plant growth and soil penetrability) and also the degree of water movement through the soil.

Water flow or permeability (which can be measured in terms of hydraulic conductivity in metres per day) is affected by particle size and structure. The flow rate through a sandy soil (with large pore spaces) is greater than in an unstructured clay soil. A clay soil with a large block (cube-like) or columnar structure is less permeable than a clay soil with a small granular or crumb-like structure. Peat soils generally have higher hydraulic conductivity enabling faster lateral water movement. These properties have major implications for how a manager can control or manipulate water levels on a site.

On peat soils (which have high hydraulic conductivity) high drainage channel water levels can be used to keep field water levels high. Conversely low drainage channel levels result in drainage. It should be noted that there is little influence beyond 40/50 m from the drainage channel edge. The use of drainage channels for sub-surface irrigation (raising water levels) of field centres is considered later in this section.

Peat soils which have been maintained wet and uncompacted have a conductivity of about 0.7-2.0 m/day. However, desiccation or compaction by heavy machinery or overburdens of other soils can reduce this. Dry peat can actually repel water and, in the 17th century, was used to line and provide the essential seal for some of the fen drainage channels. Re-wetting dry peat is extremely difficult. The point at which drained peat repels water is not known, nor are these physical processes completely understood. An occasional summer drawdown or drought may not damage the ability of peat to absorb water again, whereas prolonged draw-down may have irreversible effects. It is advisable to seek specialist hydrological/soils advice for sites with desiccated peat soils. Actual losses of soil through mineralisation at the surface are also likely with desiccated peats.

In contrast to sites with peat soils, water levels in drainage channels on sites with poorly structured clay and alluvial soils, have little influence over soil water-tables in field centres. This is because of their low hydraulic conductivity. Surface inundation is therefore often the only method of maintaining soil wetness. These poorly structured clay soils also have a low drainable porosity (a measure of the volume of water which will drain from a saturated soil under gravity). It is measured as a percentage and ranges from 0.5-5.0% for clays and from 15-35% for peats (Smedema and Rycroft 1983). It can be used, when fields are saturated, to estimate the amount of water required to saturate the soil before flooding occurs. Clays absorb less water before they become saturated than do peats.

Compacted clay soils can also form hard surface pans which prevent movement of water to the lower soil profile. Such pans are common on clay soils, on sites which have been heavily winter-grazed. On such sites, it may be necessary to develop different approaches to soil management; which can be used to assist in re-wetting. Site managers often resort to winter flooding, using natural topographic variation to maintain wet hollows during the summer. It is worth noting that the deposition of dredged soil on drainage channel banks can elevate the areas adjacent to drainage channels and make them surprisingly dry.

Water level control

Water levels on a wet grassland site are controlled by the rate at which water enters and leaves. Although influenced by natural factors, levels can be managed using:
- bunds, dams or sluices
- winter water storage
- pumps
- surface irrigation
- sub-surface irrigation.

Bunds

Where water is available only during the winter, it may be possible to retain it by constructing levees or bunds (low earth banks keyed into the substrate). These permit water to be stored during the winter to counter summer deficits, create permanent lagoons and also protect areas from the effects of flooding (Armstrong et al 1995).

Bund construction follows the same general principles as dam construction but is less complicated and relatively cheap. At Berney Marshes (UK), low bunds with a top width of 75 cm were created at a rate of 25 m per day using a tractor mounted McConnel PA8 digger-arm. Using a Hymac increased the rate to 80 m per day, at a cost of about 1.50 pounds/m.

Bunds should be set well back from the edges of drainage channels to prevent slumping and reduce seepage. Mower friendly profiles are advisable as bunds are often invaded by rank vegetation such as thistles.

Dams

Dams can be constructed in drainage channels to retain water in, and isolate, hydrological units. Dividing areas of wetland into smaller hydrological units using dams enables independent control of water levels, for example allowing rotational flooding in winter. However, flows of water and consequently the movement of fauna around a site may be inhibited. Movement of water through and around such systems is therefore important to prevent stagnation, build up of nutrients and to allow species access to all parts of the system.

Dam construction is easier in areas with loamy or clay soils. Clay and silt dams can effectively be used across drainage channels up to about 5 m wide. Peat will only make satisfactory dams if well compacted and even then the effective width is less. In general, the basal width of a dam should be five times its height. The top of the dam should be level and at least 50 cm above the normal water level. Table 2 outlines the principles, which should be adopted when constructing dams.

Dam construction is likely to take up to half a day with a tractor-mounted hydraulic digger-arm and cost from 40 to 200 pounds per unit, depending on size. Diggers or Hymacs accomplish the task more efficiently and cost-effectively but are rarely available inhouse and have to be contracted. Additional costs will be incurred in areas grazed by livestock, as it will be necessary to fence the dam against trampling and subsequent erosion.

Principles to be adopted when building dams

- Construct during the late summer when water levels are lower and rainfall less likely.
- Use temporary dams to block drainage channels on both sides and pump dry before constructing the dam itself. Temporary coffer dams can be constructed from double rows of sandbags or wooden boards with a clay infill.
- Remove topsoil and scarify the sub-soil where the dam is to be built, to enhance keying and minimize seepage.
- Build the dam up slowly, eg in 15 cm layers and then compact. Allow extra material for settling: 10% for mechanical compaction and 20% for compaction by foot. Peat may settle up to twice as much as silt.
- Topsoil can be replaced above the normal water level and sown with a proprietary grass mix. This stabilizes the surface and discourages deeper rooting plants. Creeping bent and rough meadow-grass are ideal (ensure seeds are of known provenance).

Sluices

Sluices can perform the same function as dams, but are designed to permit controlled through-flow so that water levels in drainage channels can be regulated. There are four main types: flexi-pipe, dropboard, lif ting-gate and tilting-weir. Different types of sluices are described below:

- Flexi-pipe sluices consist of flexible ribbed plastic pipe about 25 cm in diameter (pipes greater than 35 cm in diameter are difficult to adjust). They are usually incorporated into an earth bund or dam. Choose darkcoloured pipe (eg black) as lengths of brightly coloured pipe can be visually intrusive in open landscapes.

- Dropboard sluices are relatively simple structures, comprising a series of boards which drop into a grooved spillway. To counteract seepage, two parallel sets of boards may be used. Water levels are adjusted by inserting or removing boards as appropriate. Construction details are given in Brooks (1981).

- Lifting-gate sluices are characteristic of old water meadow systems. Water level control is, however, difficult using this type of sluice.

- Tilting-weir or drawbridge sluices are very effective, but relatively uncommon. They are based on a hinged weir that can be adjusted to give very precise water level control. However, they are more expensive.

In areas where flooding of adjacent land must be prevented and sluices are not large enough to take predicted storm flows, a spillway must be incorporated into all sluice designs.

Design of timber dam and sluice

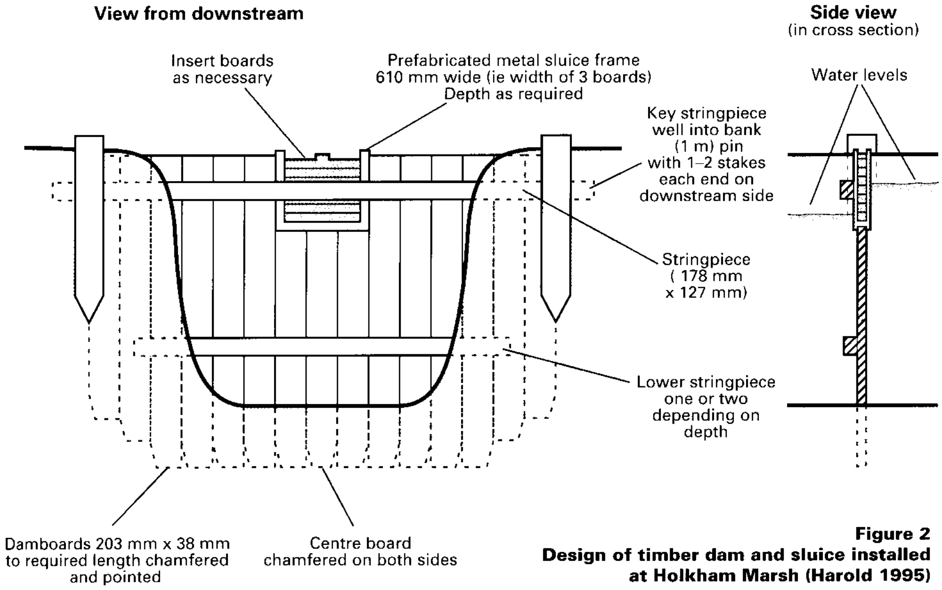


Figure 2
Design of timber dam and sluice installed at Holkham Marsh (Harold 1995)

Winter water storage

Where summer water supplies are unpredictable, construction of a water reservoir may be the only option. Water storage systems greatly facilitate water management during spring and summer. Care should be taken when siting the reservoir to ensure valuable habitats are not destroyed. Wherever possible steps should be taken to ensure a wildlife-friendly design (see Orford 1996 for details). The following options greatly enhance the value of reservoirs to aquatic plants and animals:

- Providing floating islands, planted with vegetation, which will be used by nesting birds and other wildlife.
- Creating a deep area in the reservoir bed provides water for fish and invertebrates even when the reservoir is low during the summer.

- Creating a shelf for marginal plants and maintaining a water flow to the shelf during summer draw-down is an expensive option but very worthwhile. Water can be provided to these areas by bleeding off some of the water during abstraction from the reservoir.

Pumps

Pumps are required to move water against prevailing hydraulic gradients. Pumping is often used where more water is required than can be supplied by inflowing streams, groundwater or precipitation, for example to move water from a low-level drainage channel to supply a raised water level area. Pumping may also be used to alleviate the effects of stagnation where flows have been arrested owing to construction of dams, bunds or sluices. Wherever possible wind-pumps should be considered.

Pump specifications must match site water requirements and conditions. The following considerations should be taken into account when considering a pumping operation and what type of pump to use:
- volume of water and rate of delivery required
- the height of head (vertical difference between input and output levels)
- distance between intake and discharge points
- proximity to electricity supply
- whether an abstraction licence is required

Surface irrigation (grips or foot drains)

Grips or foot drains are small spade-sized channels, connected to the main water system. Typically a grip is 30-60 cm wide and no more than 50 cm deep. On sites with old surface grips or foot drains flooding them in winter can be an effective way to keep soils locally wet (surface irrigation). Grips were often spaced just far enough apart for natural and efficient sub-surface feed between them. During the summer, grips should be kept wet until the need for the desired high water level has passed.

Water may have to be pumped into the main feeder drainage channel or from the drainage channel to the field to ensure supply. Often the grips can have their own wildlife interest, for example, they are often dominated by yellow iris. Management options for grips are similar to those for drainage channels

Sub-surface irrigation

Sub-surface irrigation (where the infrastructure exists) can be used to raise soil water-tables on sites where the distribution of water channels is too sparse to guarantee the delivery of water to field centres. It is not recommended that subsurface irrigation systems are installed to achieve this aim, as they act as an efficient and uncontrolled drainage system when drainage channel levels are low. Sub-surface irrigation can use natural water-soil transfers or water can be helped to reach the centres of fields by the use of sub-surface pipes, either plastic pipes or compression mole drains (sub-surface channels forced through the soil), dug from feeder channels or drainage channels maintained at a higher level. Installation of a new piped system or moiling should not be considered in areas of archaeological interest, as it can be damaging to remains below the surface.

The pipe systems transport water to the centre of a field using simple gravity feed from a feeder channel. However, there are several important principles and requirements that must be adhered to for success:

- Any smearing or compaction around the plastic pipe must be kept to a minimum to enable the water to move easily in and out.
- Avoid using plastic pipes in soils rich in free iron to avoid blockage with iron ochre. Mole channels could be satisfactory in these situations, being easy and cheap to renew if blockage occurs.
- Milled mole channels (ie where the soil is removed mechanically to create a subsurface channel) are much more satisfactory in peat soils than compression moles and can have a life of 3-20 years depending upon the type and density of the peat.
- Milled moles must be installed under saturated conditions with an adequate supply of water in the feeder drainage channel to lubricate the machine. This technique avoids the need to lower water-tables and drainage channel levels before installation as is required with pipe drains.

Subsoiling is another recognized agricultural technique frequently used in cultivated fields. Its potential value in improving soil structure on wet grassland sites is not clear. Anyone wishing to undertake such an operation should seek expert advice and ensure that there is no damage to archaeological interest on their site.

Advantages and disadvantages of foot drains

Advantages

- Good for creating linear pools in summer.
- Particularly useful on clay and silt where use of sub-surface pipes may be impractical, soil permeability is poor and movement of water through the soil is nonexistent.
- A rapid way of creating shallow floods, particularly when drainage channel levels are high, for wintering wildfowl.
- Excellent where the field profile is naturally concave and water can be run on merely by raising drainage channel levels.
- If blocked off at the drainage channel end in early spring, can be used to create valuable feeding areas for breeding lapwings and redshanks.

Disadvantages

- Impractical for transporting water in summer as it is rapidly lost into the soil and through evaporation.
- The channels create extra hazards for machinery, particularly during mowing operations.
- In many cases water must be pumped from the drainage channel into the grip.

3.3. Water Quality

Water quality is particularly important for drainage channel plants and invertebrates. The main water quality problems likely to be encountered relate to eutrophication, levels of salinity, the presence of toxic iron and sulphur compounds and the presence of agro-chemicals. Heavy sediment loads are also a problem for some species. To establish the nature of water quality problems at a site it may be possible to use information from the relevant government agency water quality monitoring programmes, or water-testing may be required. Chemical analyses, invertebrate or plant monitoring may also be used.

Eutrophication

Lowland water courses are frequently polluted by elevated levels of nitrate and phosphate. This may be a result of fertilizer leaching from farmland or from point sources of treated sewage effluent. For all natural trophic states the ratio between nitrogen and phosphorus lies in the range of 10-20 parts of nitrogen to 1 of phosphorus. Changes beyond these ratios may indicate a potential pollution problem. Algal blooms and the presence/absence of different indicator species can indicate pollution problems.

Many sites are affected by flood control works upstream, which alter the timing of flows and floods. Uncontrolled winter flooding nowadays can spread silt containing high levels of phosphate over a site and potentially reduce botanical and invertebrate interest. Historically this practice was carried out deliberately by farmers to enhance fertility and probably benefited some grassland plant communities (eg at Southlake on the Somerset Levels and Moors, UK).

Where there is concern about high river nutrient levels:

- abstraction of river water should not be undertaken during the first flood after a long dry period, as the water will contain high nutrient levels flushed from the catchment
- abstraction should be undertaken just after flood peaks, to avoid high sediment concentrations to which phosphates may be bound.

Salinity

Most plant and invertebrate species have a restricted range of tolerance to salinity. Salt is a very efficient herbicide for all freshwater plants and at salinities in excess of 200 mg/1 of sodium, freshwater communities may become stressed.

Clay and peat soils lose their structure on exposure to sea water. Clays lattices break down and the soil becomes fluid and deoxygenated. Sodium replaces calcium in the soil structure and plants and invertebrates, which are not adapted to saline conditions die. Even if such extreme conditions are absent, freshwater plants will die when their roots hit a saline water table. Maintaining conditions of salinity to which the flora and fauna are adapted is very important. For invertebrates, gradients of salinity can be vital in maintaining some species and communities of high conservation value.

Under stable salinities the tolerance of freshwater plant communities is higher. Fluctuating salinity can reduce tolerance by a factor of 4. Plants found at a stable salinity of 1,000 mg/1 sodium will become stressed if the salinity fluctuates between, for example 1,000 mg/1 and 250 mg/1 and if fluctuations persist, the community will tend to become confined to areas where the water has an average sodium concentration of 250 mg/1 or less (Remane and Schleiper 1971). This has major implications for the maintenance of aquatic communities dependent on brackish water.

Toxic effects of iron and sulphur

There can be problems with iron toxicity (ochre) in some peat soils. Under certain conditions peats form a toxic iron pan which plant roots cannot penetrate. Drainage channels dug in such peats can release a toxic tide of iron-rich water. Pools can be created in iron-rich peats if water levels are kept stable. However, if levels are allowed to fluctuate, ferric sulphates and sulphides can form on exposure to the air as levels fall. These are reduced to the ferrous state as levels rise again and combine with water to form sulphuric acid which, depending on its concentration can be very damaging to the ecosystem.

Solutions to water quality problems

Dealing with water quality problems may require drastic measures including:
- isolating areas of conservation value from a eutrophic water supply
- phosphate stripping.

Isolation of a site from a eutrophic water supply may involve major land-forming works, for example the construction of bunds, though in some circumstances, it may be possible to construct simple dams to isolate drainage channels from eutrophic rivers. However, measures should be taken in the first instance to address the cause of the problem where possible before considering such an option. Phosphate stripping has been carried out by the water companies to remove up to 90% of the phosphate contained in sewage effluent before it is released into rivers. It has been shown to provide benefits over 5-10-year periods, reducing algal levels and allowing some plant recovery. The lag-time before recovery takes place is very dependent on the nature of the sediments. It is a relatively expensive technique which should only be considered for large-scale treatment of phosphate-rich water. However, a small experimental system at Slimbridge in Gloucestershire (UK) has proved very effective. This uses crushed limestone to absorb phosphorus from nutrient-rich water (Hawke and José 1995). Potential solutions to water quality problems are listed in Table 4.

Possible solutions to some water quality problems where the source cannot be tackled

Sediment loading
- Construct sediment traps at inflow points to remove sediment

Phosphorus enrichment
- Strip phosphates using limestone, eg in specially constructed channels.

Nitrogen enrichment
- Consider use of reedbeds or other wetland plants to breakdown nitrate. Use watertable management to encourage denitrification.

Acidification
- Buffer using limestone.

Salinity
- Dilute with fresh water.
- Gypsum can sometimes be effective in reducing salinity in pools.

Iron ochre
- Seal drainage channel sides. A precautionary approach should be taken when digging new drainage channels or ponds, to avoid iron ochre deposits.

Buffer zones may be used to treat more diffuse sources of nutrients, including agricultural run-off (Large and Petts 1992). These are considered in detail in Haycock et al (1997), which should be consulted for further details.

3.4 Drainage channel management

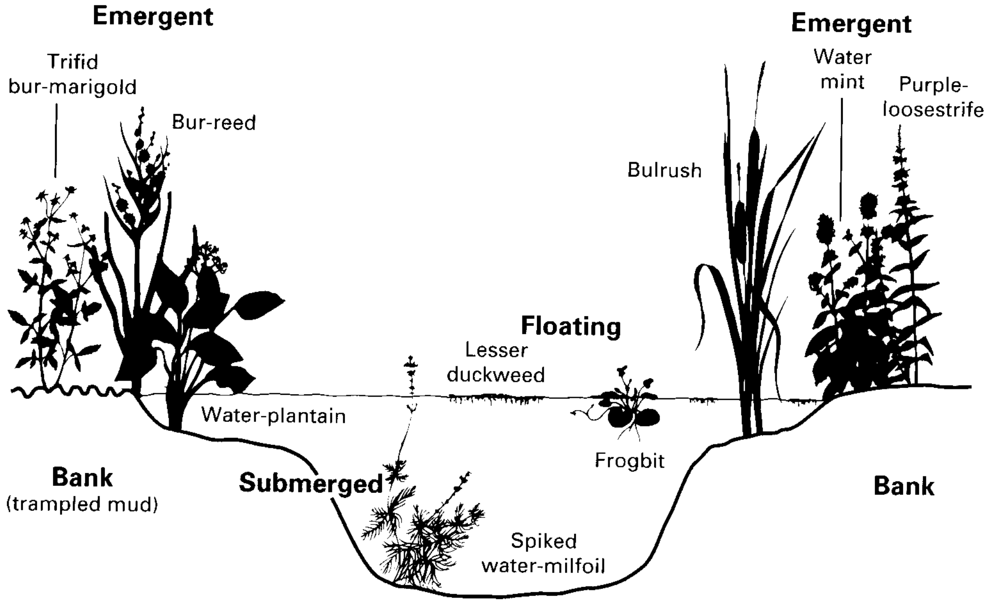
Assuming there is appropriate water quality and water level, the most diverse drainage channel floras and faunas are found on sites with:

- extensive networks of drainage channels
- a wide range of drainage channel types
- a range of seral stages, representing habitats from open water to drainage channels choked with well established emergent vegetation
- sympathetic drainage channel maintenance regimes.

Channel maintenance is critically important for both wildlife and drainage. It is clearly important to identify who has responsibility for the maintenance of drainage channels on any site, prior to commencing any work. Cleaning drainage channels (slubbing) prevents the choking of channels and involves the removal of plant material and accumulated silt. In the past this would have been done manually on a „little and often“ basis, using scythes, peat spades, or sharp chains dragged along the bottom of the drainage channel by two people. These techniques resulted in a great variety in the depth, width, profile and vegetation composition of drainage channels, providing suitable habitat for a diverse range of species. Nowadays, by employing a rotational program and a „little and often“ philosophy, mechanical management can maintain a similar variety of successional stages.

Before undertaking channel management, it is advisable to undertake a rapid survey, to identify stretches supporting rare plants, such as sharp-leaved pondweed, which may have special requirements. Similarly, some invertebrates like the variable damselfly may be restricted to short lengths of drainage channels.

Drainage channel profile illustrating the different growth forms and habitats of aquatic and bankside plants



Frequency of management

To maintain a diverse community of plants and associated invertebrates, a range of drainage channel management rotations should be adopted. Infrequent management, or its restriction to a limited part of the drainage channel system at any one time:
- allows a full range of successional stages to develop
- permits less mobile species to escape catastrophic effects
- may require specific intervention to control weeds.

Highest species diversity of floating, emergent and submerged aquatic plants is most often associated with freshwater drainage channels managed every three to five years (Thomas et al 1981, Wolsey et al 1984). Drainage channels on peat may have to be cleaned more frequently if they are subject to subsidence and are essential as wet fences. Brackish drainage channels require less maintenance and can be managed on a 10 year rotation.

Length of rotation depends on factors such as whether the drainage channels have an important water transport or livestock control function, or the type of grazing animal present. Possible options for drainage channel cleaning cycles are:
- light maintenance every year
- a two-year cycle, cutting half of the channel width each year
- less frequent routine maintenance with targeted control of emergents more often as necessary
- radical cleaning of 10-20% of the drainage channels every year

Distribution of management

In drainage channels where the prime function is one of drainage, sympathetic management is still possible. Options for dredging and cutting aquatic and marginal vegetation annually, to cater for the needs of wildlife and drainage are:

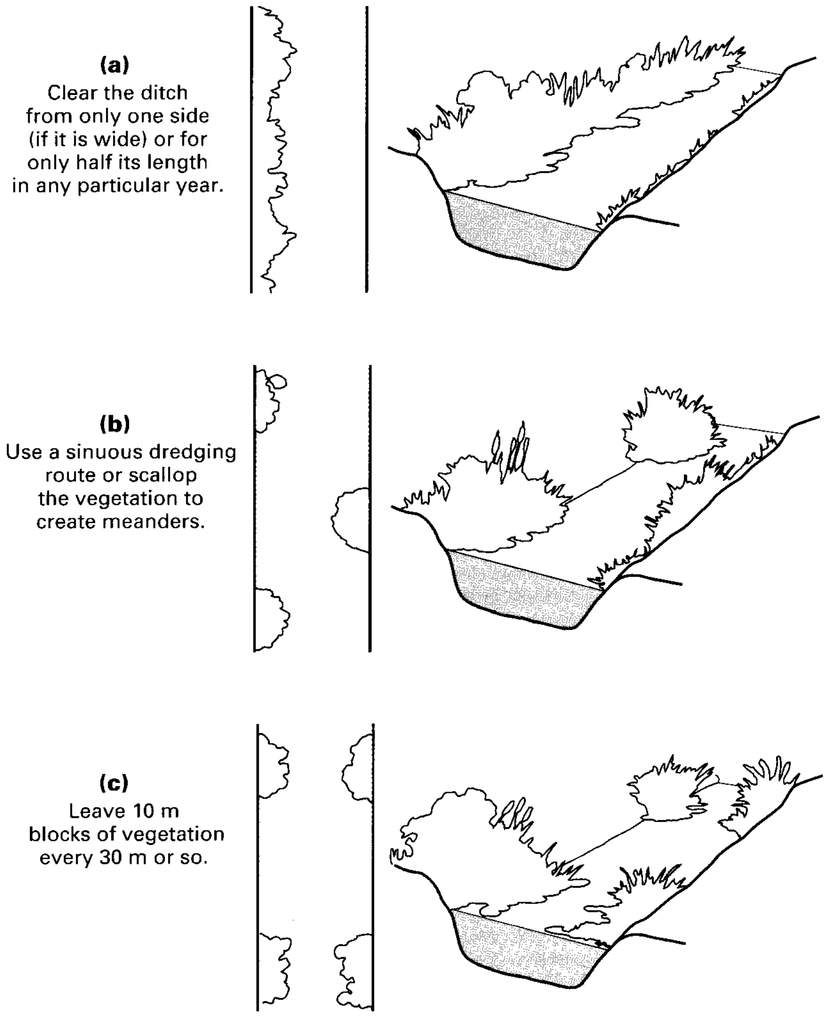
- leave a continuous strip of emergent and aquatic plants untouched on one margin
- leave a fringe of emergents on both sides of the channel

- dredge a sinuous route, leaving plants in patches on alternate sides (scalloping)
- dredge 30 m for full width of channel then leave 10 m dredged to half the width and so on. **Level-dependent drainage channels**, ie those where water flow is less than 20 m/hr and where drainage is of secondary importance, can be managed to include a range of vegetation stages from clear, open water with submerged, floating and emergent plants to developed reed swamp:
- Ideally 10-30% of the ditches in one marsh should be slubbed out annually in late summer and early autumn.
- Care should be taken to work from one side only or to clean only part of each ditch in any one year.
- Water levels should preferably be maintained at marsh height during spring and early summer with a water depth of 0.7-1 m.

Maintenance of **flow-dependent drainage channels**, ie those ditches where water flow exceeds 20 m / h, should be carried out to retain a variety of channel features and flow velocities:

- always try to leave at least 10% of the channel vegetation uncut
- create a sinuous, de-silted channel within wider drainage channels to mimic natural meanders, with a wider margin on the inside of bends for wetland plants to establish
- maintain any natural meanders in the channel
- where gravel beds and riffles have established try to leave alone as these are important habitats
- leave channel features that result in variety in flow velocity and substrate. For example, where banks have slumped this often constricts the channel without significantly reducing overall flood capacity (but increases the velocity of water, creating silt-free and valuable habitat)
- do not over-widen the channel as this will promote siltation, smothering valuable habitats and increasing maintenance frequencies
- maintain or create wet marginal shelves

Sympathetic options for drainage channel management



Timing

Drainage channels management should be undertaken in late summer or early autumn:

- after plants have seeded
- after the bird breeding season but before wintering birds arrive
- when water levels are low.

Tools and techniques for channel maintenance

Tractor-mounted diggers are the best tool to use, as they are relatively inefficient, leaving patches of vegetation undisturbed and creating an irregular profile (Doarks 1994). Cutting should always be carried out above the sediment layer. Spoil is usually disposed of on-site by incorporating into adjacent land. To avoid problems with the disposal of spoil:

- deposit spoil away from the bank and in areas of low wildlife interest. Avoid smothering important bankside and field habitats
- leave spoil on the bankside for several hours to allow invertebrates and amphibians to return to the water

- place spoil where eutrophic run-off from plant decomposition does not feed directly into a watercourse
- do not in-fill wet hollows with spoil as these may provide important habitat for waders and wildfowl
- ensure that livestock do not have access to spoil that may contain toxic aquatic/bankside plant matter (eg hemlock, iris and water-dropworts)

Where spoil is to be disposed of off-site, and used or sold for bund construction etc, the mineral planning or local planning authority should be consulted.

Drainage channel reprofiling

Profile and depth significantly influence the wildlife value of drainage channels. Some species are dependent on specific water depths. It is important to maintain a variety of depths in the channel, grading to a shallow, wet marginal fringe. Winter levels are not so critical, but some water must be maintained year round. Drainage channel reprofiling offers opportunities to enhance the interest of existing networks, and also removes accumulated sediment full of nutrients. If drainage channels become regularly choked with algae, consider removing the sediment layer on an annual basis, and try to identify the nutrient source and consult the relevant Government agency over its treatment.

For major reprofiling of drainage channels, work should be carried out on one side of the drainage channel only and in alternate 100 m stretches. Remaining sections should be reprofiled only when the originally worked sections have recovered (Figure 3).

As a general rule cutting into the substrate should be avoided where problems with ochre are suspected. When disturbed, some peat soils leach iron hydroxide which is toxic to plants and invertebrates. Overdeepening of drainage channels should also be avoided.

Drainage channel creation

It may be desirable to create new drainage (irrigation) channels to:

- improve water transport capacity
- provide additional aquatic habitat.

New drainage channels should be 70-100 cm deep and have a shallow profile (30-45°). It should be remembered that physical disturbance of soil when creating new drainage channels may release nutrients and cause eutrophication in the new drainage channel. New drainage channels should not therefore be connected up to pristine drainage channel networks until their nutrient status has stabilized. At Ludham Marshes (Norfolk, UK) this process took three years and involved the annual removal of invasive species such as reed. At new drainage channels riparian habitats can be created.

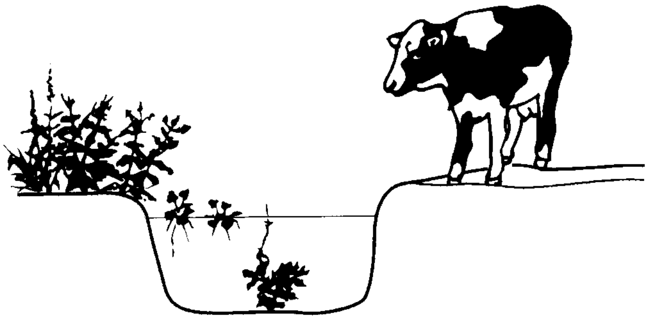
Options for drainage channel enhancement by reprofiling

Original ditch

Steep sides, depth 0.7–1 m

- Allows growth of submerged plants
- Maintains water flow

Greatest water flow, minimal conservation value

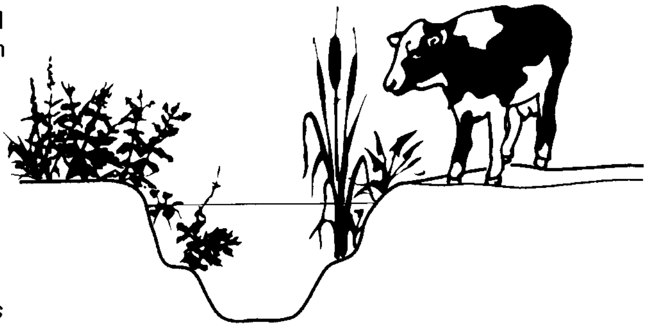


Option 1

Deepening of the channel bed to more than 1 m and creation of submerged berms

- Allows growth of emergents
- Deepened bed prevents spread of emergents across ditch

Good water flow, increased conservation value, requires no land-take



Option 2

One side steep and the other sloped to about 45°

- Allows growth of emergents
- Cattle can drink without falling in
- Wading birds can feed on shallow edge

Best conservation/farming compromise – minimal land-take

Option 3

Both sides sloped to about 45°

- Gently sloping banks allow greatest light penetration into ditch for plants
- Cattle can drink without falling in
- Wading birds can feed on shallow edge

Best for wildlife conservation – maximum land-take

Sequence of drainage channel reprofiling

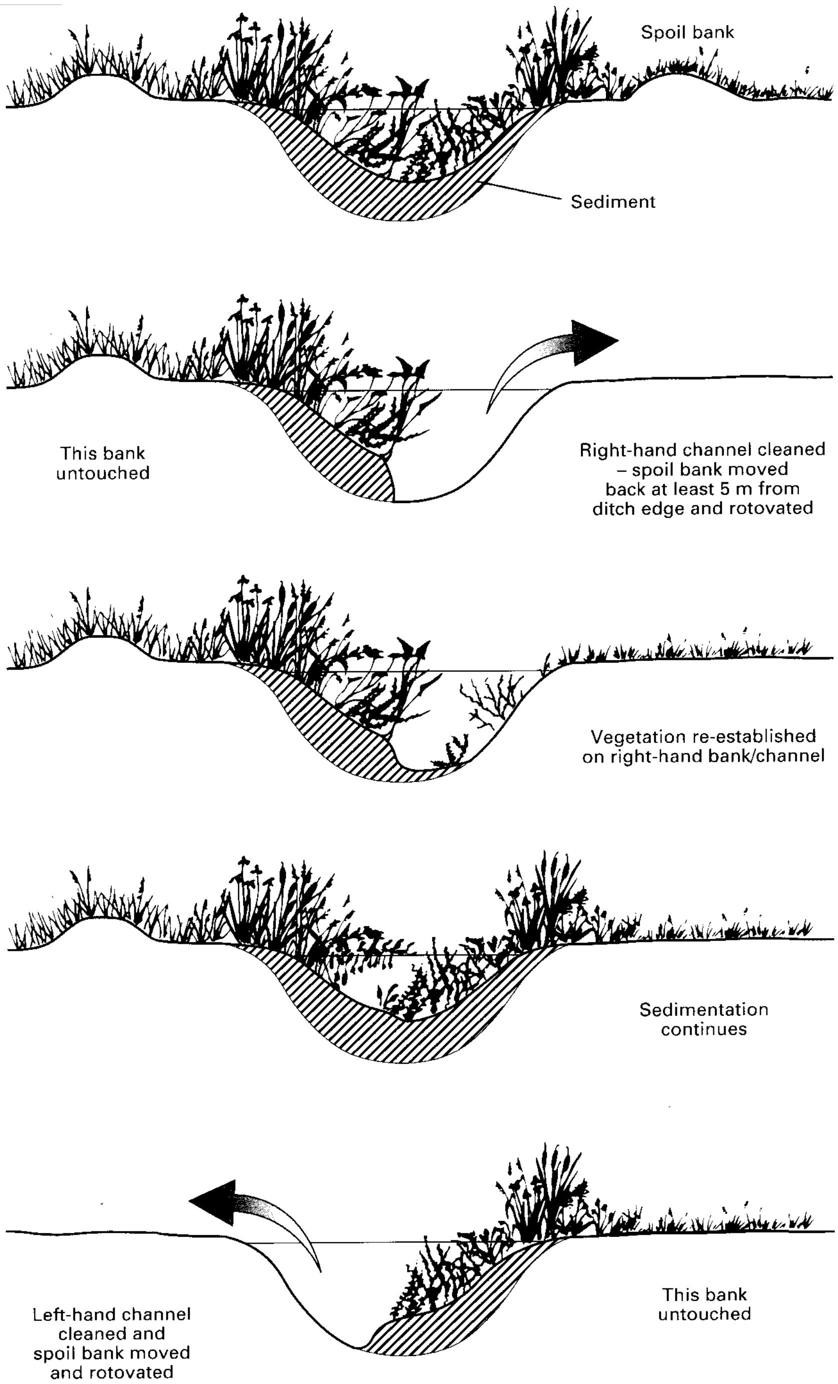


Figure 2 Sequence of drainage channel reprofiling

Bankside management

The design and management of drainage channel banks can contribute greatly to the overall wildlife value of the drainage channel habitat. A steep, deep bank, commonly found in the hydraulically efficient trapezoidal channel, is of relatively little value for wildlife. The most diverse drainage channel margins are invariably of a shallow gradient and lightly grazed by cattle. This creates a damp marginal habitat for numerous invertebrate and plant species.

An edge trampled by stock will cause slumping of the banksides, but there are many ecological advantages to such a trampled zone. Trampling creates a berm which provides a niche for shallow water and bare mud-adapted plants and animals. Many annual plants, some of which are nationally scarce, thrive in such habitats. Bare mud is also a critically important niche for many invertebrate species. The best option is to ensure a diversity of treatments, ranging from trampled, muddy edges to long bankside vegetation.

The most diverse banksides can contain relict fen communities of ancient wetlands and are important refuges. Where drainage channels with an important water-carrying function also support such communities or other scarce or rare species, it may be advisable to dig separate feeder drainage channels, rather than risk losing species through regular maintenance. However, cutting of botanically diverse banksides can sustain communities if the timing and frequency is adjusted to annual reproductive cycles of constituent species.

Recommendations:

- As a general rule, floristic, invertebrate and bird diversity can be maintained by cutting one side of the bank only, in alternate years (ie a two-year rotation). Cutting should take place as late as possible, preferably after the first frost or around October. If it is necessary to cut earlier, cutting in mid-August allows most plants to set seed and gives time for any second broods of birds, such as reed warblers, to fledge. Even so, cutting at this time will affect the survival of some late-flowering plants and some invertebrates.
- Cutting vegetation on longer than a 1-year rotation encourages coarser species and provides cover for nesting birds.
- It is best to remove cut material to prevent it falling into the drainage channel, as it may impede drainage and cause pollution when it rots.
- Where possible grazing of bankside vegetation is preferable to cutting as it introduces greater structural variety (from bare, poached muddy margins to long, rank vegetation) and is less destructive.

Pesticides also have an impact on aquatic flora and fauna (Beardall 1996). A recent report (NRA 1995) concluded that, although surprisingly little ecological fieldwork had actually been completed, significant effects were found at disturbingly low water column concentrations for some pesticides „concentrations likely to arise from normal usage“.

In UK, this has led the Environment Agency to recommend a minimum 6-m „no spray zone“ for all pesticides adjacent to all watercourses. The Pesticide Safety Directorate (PSD) have already restricted the use of over 150 pesticides from a 6-m buffer zone adjacent to all watercourses, and more will no doubt be restricted as the PSD reviews other products on the market.

4 Nutrient and Toxic Removal

4.1 Mechanisms and Processes Involved in Nutrient Removal and Storage in Riverine Wetlands

Mathias Zessner

Transport

Transport is the most important mechanism in respect of nutrient removal in riverine wetlands. Nutrient removal in wetland systems is limited by the amount of nutrients transported into the wetland. This amount always has to be considered in comparison to the nutrient load transported in the river itself, if the removal efficiency of wetland systems is studied. Nutrients in river systems are transported as dissolved compartments or as particulate compartments. For the nitrogen transport in river systems mostly the dissolved compartments prevail, phosphorus is mainly transported in particulate forms. Monitoring concepts have to focus on the transport of nutrients into and out of a wetland. In respect of the transport of nutrients to riverine wetlands it has to be distinguished between three pathways: (i) transport during low flow and average flow conditions, (ii) transport during high flow and flood conditions and (iii) transport by groundwater or infiltration water (bankfiltration). Nutrients is transported out of the wetland system by the same pathways as they are transported into it. In addition to water related nutrient fluxes for nitrogen depositon and biotic N-fixation have to be considered as inputs into the wetland systems.

Transport at low flow and average flow conditions

Generally concentrations of the sum of dissolved fractions of nutrients transported in river systems, predominate the particulate forms at low and average flow conditions. Concentrations of the dissolved fractions of nutrients usually not change very much in dependency of the discharge (e.g. figure 1). Main parts of nutrients transported at low or average flow are in dissolved forms and the main parts of a yearly discharge of dissolved nutrients in a river are transported at low or average flow conditions. Transport into a wetland system during low and average flow happens only through channels that are connected with the main river most of the time. The potential retention is limited by the water volume flowing through these channels (e.g. para potamons). Other important factors are flow velocities and the residence time in these channels.

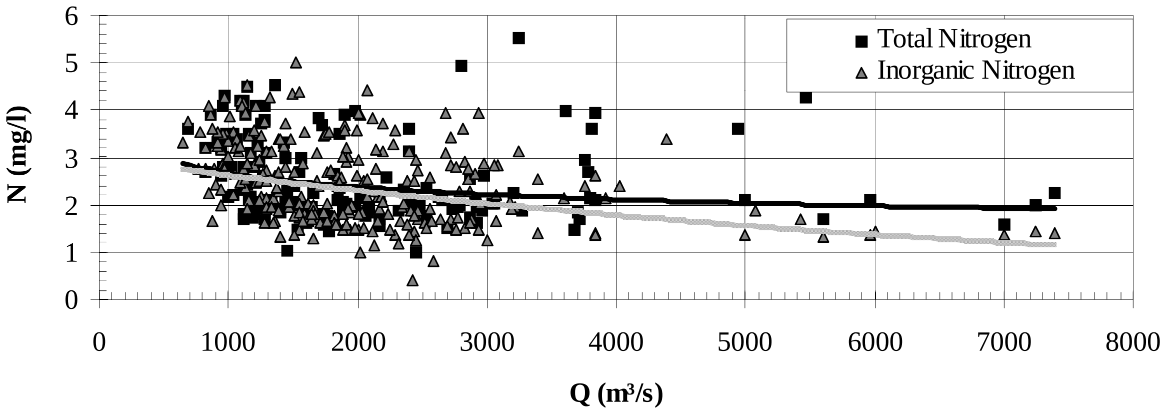


Figure 1: Relation between discharge of the Danube at Vienna and nitrogen concentrations (1978-1997) (Zessner, 1999)

Transport at flood conditions

Transport of suspended solids (SS) and thus transport of nutrients in particulate forms in river systems is highly dependent on the flow regime of the river. Concentrations of suspended solids usually rise at high flow and flood conditions with increasing flow (figure 2). Therefore, the SS-load transported rises superproportional with increasing discharge. The transport of suspended solids happens mainly at high flow and flood conditions. At flood conditions loads in the size of the yearly averages can be transported in the river within few days. In respect to the nutrient transport into the wetlands all flooded areas are endowed. This might be only temporarily connected channels as well as terrestrial ecosystems. In respect to the transport of suspended solids (and nutrients bound to suspended solids) into wetlands mainly flood conditions are of interest.

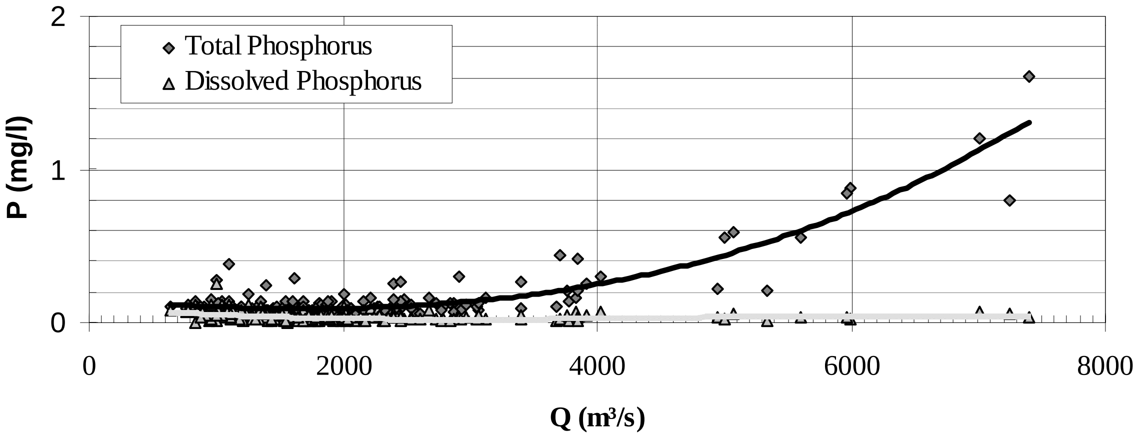


Figure 2: Relation between discharge of the Danube at Vienna and phosphorus concentrations (1991-1997) (Zessner, 1999)

Transport by groundwater or infiltrating water

In additions to the input by surface water nutrients may be transported into wetlands by groundwater (from the catchment) or by infiltrating water (from the river system). Mainly nitrate is transported this way over longer distances. Ammonia and Phosphate are absorbed, precipitated or metabolized in the underground under aerobic conditions. Transport of Ammonia and Phosphate might be of higher importance under anaerobic conditions.

Depostition, N-fixation

Depostition is the nutrient input via the Atmosphere. Average values for Austria are about 20 kg N/ha.a, which is more than an average removal by harvest from a forest ecosystem. N-fixation is done by bacteria living in symbioses with leguminous and for instance arles. Amounts depend on the presence of these plants. Free living bacteria are able to fixate up to 30 kg N/ha.a. As a general tendency N-fixation will by higher in cases of nitrogen deficiency.

Storage

Storage can be considered as temporary or long lasting retention in the wetland system. Main mechanisms and processes that lead to storage are: sedimentation, precipitation, adsorbtion and filtration to sediments, algae and plant uptake as well as heterotrophic growth. Most of the nutrients stored in wetlands will be stored only temporarily.

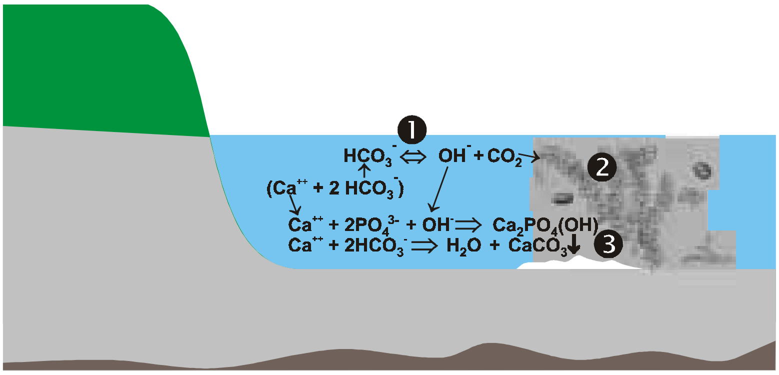
Sedimentation

The transport of suspended solids depends on the flow velocity. In zones with reduced flow velocity sedimentation takes place. This may happen in the channels (e.g. para potamons) of riverine wetlands as well as in flooded areas. Only particle bound nutrients are affected. These nutrients may be matter of further transformation (mineralisation, remobilisation/solution, resuspension, etc.)

Precipitation

Phosphate may be precipitated mainly as Strengit ($FePO_4$), Variscit ($AlPO_4$), Struvit ($MgNH_4PO_4$) or Apatit ($CA_{10}(PO_4)_6(OH)_2$). In waters that are rich with lime the Apatit precipitation induced by macrophytes may have an important role in respect to the phosphorus cycle.

Algae (macrophyte) growth leads to CO_2 consumption and pH increase. This leads to disturbance of the calciumcarbonate – calciumbicarbonate equvilibrium. The precipitation of calcite is introduced, but Calcium may be precipitated as Apatit (e.g. Dihydroxyapatit $Ca_{10}(PO_4)_6(OH)_2$) as well if ortho-phosphate is available. The growth of 1 g of algae biomass may induce a precipitation of up to 2,3 g of phosphorus by this way. This significantly exceeds the phosphorus uptake by algae (Kreuzinger, 2000).



1 Dissociation of hydrogen carbonate

2 CO_2 consumption and pH increase
assimilation by macrophytes / green algae as driving force for dissociation, and biomass production with incorporation of C and P

3 Chemical precipitation of lime and calcium phosphates

Apatit precipitation (Kreuzinger, 2000)

Iron or aluminium precipitation happens in case of infiltration into soils, underground and groundwater. Together with ferric or aluminium ions phosphate may be precipitated. Prerequisite are aerobic conditions and the availability of ferric or aluminium ions, which is mostly the case in sediment/soil/subsurface conditions. In general this process will be of importance only in case with infiltration into sediments and underground (groundwater).

Adsorption and filtration

Mainly polyphosphates, organic phosphorus compounds and ammonia can be adsorbed at the matrix of sediments (e.g. clay particles, extra cellular polymeric substances (EPS)). This is mainly important in respect to infiltration into groundwater. Suspended substances and particulate organic matter (POM) containing nutrients may be retained by filtration in case of infiltration from wetland channels into the groundwater.

Algae uptake and sedimentation

For algae growth of 1 g biomass (DS) an average from about 8 mg P and 60 mg N are needed und thus taken from the dissolved fraction. The P-content in macrophytes might be much smaller (e.g. 2,3 mg P/g DS; Humpesch et al., 1998). The amount of nutrients taken in by algea is stored in the algae biomass and after dying off transported to the sediments by sedimentation. In addition to nutrient availability important factors controlling this process are temperature and light. Thus the intensity of biomass production highly depends on seasonal changes. In addition it is influenced by the suspended solid concentrations, which might limit the availability of light for algae growth. Nitrogen will be released with degradation of the biomass, while phosphorus might be precipitated and stored in the sediments under aerobic conditions or be released as well under anaerobic conditions.

Plant uptake and sedimentation/huminification

If transported to the terrestrial ecosystem of wetlands (deposits from floods, transport by groundwater, direct uptake form surface waters) nutrients might be taken in from terrestrial plants as well. The nutrient uptake from plants in forest ecosystems is somewhere around 100 to 150 kg N/ha.a and 3 – 10 kg P/ha.a. Fertilised agricultural systems have uptake rates between 130 and 200 N/ha.a and about 15 – 20 P kg/ha.a. Plant residuals (e.g. leaves) are matter of degradations, huminification, mineralization and release and will be (temporarily) stored in soils to some extent. In addition the input into the water courses by falling leaves can be considerable. Again seasonal changes are of high importance. In contradiction to algae terrestrial plants form more stable particulate organic matter (POM) for storage. In addition growth of trees in wetland my have influence on the storage of nutrients in wetlands by forming debris dams.

Heterotrophic degradatation and growth

Heterotrophic microorganisms degrading organic substances need nutrients for the growth. Of main importance is the biofilm at the bottom sediments of channels. Makrozoobenthos grazing this biofilm can transport the nutrients deeper into the sediments. In addition macrozoobenthos degrades the coarse particulate organic matter (C-POM) to fine particulate matter (F-POM). In case of infiltration F-POM will be transported more deeply into sediments and interstitial.

Removal

In contradiction to “storage” “removal” is the final elimination of nutrients out of a river by wetland system in a way that no future release from the wetland system to the river will happen. In this sense only denitrification and harvest can be considered as “removal” out of the river and wetland system. In addition storage (retention) of nutrients over long periods (e.g. decades) may be considered as removal as well, depending on the regarded time horizon.

Denitrification

Denitrification in general is the reduction of nitrate. Several processes are known. The most important denitrification process in case of nitrogen removal from wetlands is the denitrification by heterotrophic microorganisms. In case of absence of dissolved oxygen nitrate is reduced to gaseous N_2. Depending on conditions of denitrification N_2O may be produced as well. For the denitrification of 1 g NO_3-N about 1 g TOC is consumed by the bacteria. The availability of organic carbon and temperature are important factors in respect to the intensity of this transformation.

The carbon source in a wetland for denitrification may be organic substances transported into the system from the river. More important is algae (plant) production in the wetland. 60 mg of nitrogen are taken in for the production of 1 g algae biomass. This algae growth leads to an input of about 330 mg TOC into the water. Degraded under anaerobic conditions this may lead to a denitrification of up to 330 mg NO_3-N, which is significantly more than the nitrogen consumed for algae growth. In addition of TOC availability scarcity of oxygen is controlling this process. Even if soluble oxygen is measured in the water phase denitrification might take place at places where the transport of oxygen is restricted. Mainly bottom sediments are decisive in this respect. Even if there is enough oxygen on the surface of the sediment, the transport into deeper zones of the sediment is restricted in contradiction to the transport of nitrate and conditions for denitrification might be advantageous.

In addition to the heterotrophic denitrification autotrophic denitrification may be of importance in sediment and subsurface zones in the case of presence of pyrite. Again the absence of dissolved oxygen is a prerequisite for this process. For each g of removed NO3-N about 0.7 g Pyrit are needed.

Harvest

Harvest is the removal of plants or their products out of a wetland system. This might be the case if there is any use for agriculture or forestry. For instance the removal of nutrients with the harvest from grassland can by quantified with 30 – 50 kg N/ha.a and 7 – 9 kg P/ha.a for each cut. From a forest an average value of about 5 kg N/ha.a and 0,5 kg P/ha.a can be removed if the wood is harvested.

Longtime storage

Sediments (from suspended solids, plant/algae residuals, precipitates) and adsorbed nutrients can be stored in wetland systems over longer times. If this is a continuous process of stock building within the time horizon considered, this kind of storage can be seen as removal. In this case either the sediments retained in the wetland (silting) or the nutrient concentrations in sediments increase. Silting may lead to the loss of wetlands.

Release

Nutrients stored in wetlands are matter of release as well. Erosion is the sediment/soil output by surface runoff from the wetland surface. This happens at flood conditions as well as through heavy rainfall. Resuspention means release of bottom sediments of wetland channel, which increases with increased flow. Stored nutrients are transferred into dissolved forms by mineralization, solution and desorbtion. Transport out of the wetland might be via surface waters (channels or flood events) or groundwater.

4.2 Economic Valuation Of Nutrient Sink of Floodplain Meadows

Rastislav Rybanič, Ján Šeffer, Mirka Čierna

As humankind has continued to develop there has been an increasingly significant loss of biological diversity, mainly at an ecosystem and habitat level. This depletion has been caused by conversions in land use, where another more intensive (and from a human point of view more effective) way of use has replaced a previously more sustainable way of use.

Moreover, in some cases the destruction of biodiverzity and functioning ecosystems can severely damage ecosystem services that support society and its long-term survival. Consequently, action to remedy this damage may be more costly than the benefits of development. This is why it is very important to determine the role of conservation of biological diversity in economic development.

Until now, even though it has been generally appreciated that conservation and restoration of biodiverzity are investments in the future of society, it has often been suggested that such investment primarily serves aesthetic rather than economic or social values. Our dependence on functioning ecosystem services and resources form biodiverzity is not broadly recognized (Swanson & Barbier 1992). Therefore, the valuation of protected areas (and benefits from their conservation) provides an economic rationale, which complements the biodiverzity rationale for governments - and others - to invest in them (Bagri et al. 1998).

From this point of view it is important to know the economic value of both the sustainable and development alternatives. On a general level, several theoretical studies concerning the issue of monetary valuation of environ-mental goods and services have been done. As we know, the use of biodiverzity, natural habitats and protected areas to produce environmental goods and services is multifunctional. For example the Morava floodplain is used for hay production, pasture grazing, recreation and angling. Therefore, the majority of authors (Barbier 1992; Perrings 1995; Pearce & Moran 1994; Turner et al. 1994; Bateman 1996; Turner et al. 1996; Bagri et al. 1998) either use or recommend the concept of total economic value (TEV) as a theoretical base for valuation.

TEV is broadly accepted as, a general base for valuation of environmental assets. However, since it is very complicated and time-consuming, only a few studies considering more than one kind of total economic value (Bateman et al. in Andréasson-Gren & Groth 1995) have been done. On the other hand, according to Bagri et al. (1998), it is rarely necessary to undertake a valuation study that measures all of the values identified in the TEV.

Although the issue of valuation of the benefits of biodiverzity conservation seems to be the most intangible and problematic in the case of environmental valuation, there are some useful works that can be used as a framework for the valuation of the benefits of conservation of the Morava floodplain.

The approach used by Constanza et al. in their study (1997) is an important milestone in the issue of environmental valuation. These authors tried to estimate the economic value of the world’s ecosystem services on a global level. As one of its main outcomes, this paper showed a major dependence of the global economy on functioning ecosystems and their ecosystem services. Although this article raised quite a big polemic debate (e.g. Daly 1998; El Serafy 1998 etc.), the paper gave a new point of view to the valuation of ecosystem services and pushed the discussion forward.

There are quite a lot of studies dealing with the economic valuation of wetlands and the benefits of their functions in ecosystems and landscape (Gren et al. 1994; Barbier 1994; Andréasson-Gren & Groth 1995; Frederiksen 1996; MacDonald et al. 1998). Other authors (Vymazal, 1995; Kowalik & Obarska-Pempkowiak 1996 and Craft & Richardson 1996) have underlined the organic nutrients sink (nutrient abatement) as one of the most important and most valuable ecological functions of wetlands.

In the following studies, the authors value the sink for nitrogen as a significant ecosystem service and thus the biggest part of the TEV of a particular locality. Andréasson-Gren & Groth (1995) worked on a study on the economic valuation of the Danube floodplain. For the estimation of the total value of the Danube floodplain, they used the values from different selected services produced by the chosen floodplain habitats. The floodplain services were divided into the following classes: input of production goods (wood, grass/hay for cattle and fish); ecotechnology (nitrogen and phosphorus abatement) and finally consumption (recreation including hunting and angling). The nitrogen sink was considered the most valuable service of the Danube floodplain’s TEV.

Gren (1995) investigated the effectiveness of investment for nitrogen abatement. She compared investing in wetlands (either restoration of natural or creation of artificial wetlands), wastewater treatment plants and pollution reduction measures in agriculture. Through analytical results and the empirical example of Gotland island in Sweden, she shows the marginal value of investment in wetlands, including current and future utility, exceeds that of other measures.

As identified above, knowledge of the values of biodiverzity and ecosystem services in protected areas are the essential assumptions for effective investments in conservation measures. Moreover, in our opinion, there is a big gap in research concerning the economic values of environmental goods in Slovakia and only few studies have been carried out on this issue (e.g. Kluvánková 1998).

The aim of this chapter is to demonstrate that sustainable[5] use of the Morava floodplain is more valuable for society than other alternative uses, i.e. using it as arable land or for gravel mining. Further, we want to show that investments in the restoration of degraded meadows in the Morava floodplain are profitable for society not only from an aesthetic and intrinsic, but also from an economic point of view.
Therefore, the main objectives of this chapter are to calculate the benefits of the nitrogen sink in the lower part of the Morava floodplain's species-rich meadows (indirect use value). Furthermore, we want to compare the profit of sustainable use of these species-rich meadows with profits from another alternative, to use it as arable land and make an Cost-Benefit Analysis of investment in the restoration of arable lands in the meadows of the Morava floodplain.

Methods

The valuation study is conducted on a complex of floodplain meadows in the Slovak part of the Morava floodplain. The assessed regularly cut meadows have an area of 1727 hectares of grasslands. As a general framework for obtaining a value of the benefits from the conservation and restoration of the Morava floodplain we used the concept of Total Economic Value (TEV) as it was described in many studies (Barbier 1992; Perrings 1995; Pearce & Moran 1994; Turner et al. 1994; Bateman 1996; Turner et al. 1996). The TEV concept is a well-established and useful framework for identifying the various values associated with environmental goods (Bagri et al. 1998).

[5] By sustainable use of these meadows, we mean that way of use, which does not deplete biodiversity of these habitats in long term view (i. e. hay production, pasturing, fishing, hunting and recreation that do not exceed the carrying capacity of this area).

The concept is based on the assumption that the economic value of environmental goods is composed of the following types of different values (Rule 1).

TEV = (DUV + IUV + OV) + (BV + EV) (Rule 1)

Where DUV is a direct use value; IUV is an indirect use value; OV is an option value; BV is a bequest value; and finally, EV is an existence value.

In accordance with the ecological conditions and requirements of biodiverzity protection, the best agricultural use of this area is hay production and pasture grazing. From the point of view of nature conservation, we can consider this way of management of the Morava floodplain meadows as sustainable. The sustainable use of these meadows is more efficient and valuable if Rule 2 is valid (Pearce & Moran 1994).

B(SUB) - C(SUB) - [B(DEV) - C(DEV)] > 0 (Rule 2)

where B(SUB) is a benefit of sustainable use of meadows; B(DEV) is a benefit of development of the land (e.g. to use it as arable land); C(SUB) is the cost of the sustainable use option; and finally, C(DEV) is the cost of the development option.As the base for measurement of the benefits of sustain-able use of the Slovak part of the Morava floodplain we used the following classes of floodplain ecosystem services:

- Direct use values: input in production of market goods - hay/grass for cattle.
- Indirect use values: „ecotechnology“ - nutrient abatement.

In this valuation study, we only considered direct and indirect use values because it is not necessary to undertake a valuation study that measures all of the values identified in the TEV (Bagri et al. 1998). A similar approach was used in the valuation study of the Danube floodplain (Andréasson-Gren & Groth 1995). Moreover, in our opinion the production of hay and nutrient abatement represents the biggest part of TEV of this area.

Hay production

The production of hay is a traditional form of agricultural management in this area. Farmers usually mow meadows once or twice a year depending on flood conditions. For a calculation of the benefits of the production of hay we used direct market prices. The prices of hay are actual prices on the market (1200 Sk/t of hay). Data used in the analysis were obtained from local farmers, co-operatives and agricultural firms. These data were collected in the form of questionnaires (Stanová et al. 1997)

Nitrogen abatement

To obtain the value of nitrogen abatement in the lower part of the Morava floodplain, we used the substitute market approach. The value of the nitrogen sink (equal to around 434 tons of nitrogen removed annually on an area of 1727 ha) can be expressed in monetary terms as the operational clean-up cost for the same amount of nitrogen in a conventional wastewater treatment plant with the biological elimination of nitrogen. The capacity of wastewater treatment plants (WWTP) is measured in equivalent citizens (EC). Every EC produces about 11 grams of nitrogen per day. The efficiency of the cleaning process of a WWTP with the biological elimination of nitrogen is 50 %. If we extrapolate this to a meadow complex, the area of meadows incorporates 50 % of 864 tons of nitrogen per year into its biomass. The capacity of the wastewater treatment plant, which represents the same clean-up potential, can be calculated as (Drtil & Hutnan 1999; Drtil personal communication):

$$C[EC] = \frac{2 \cdot Rm[tN/y]}{PEC[tN/y]}$$

where C[EC] represents the capacity of WWTP, Rm is the clean-up of nitrogen from meadows in the form of hay and PEC is the production of nitrogen by one equivalent citizen per one year (production per day is about 11 grams of nitrogen). The operational costs of a wastewater treatment plant (OCWWTP) consist of labour (CL), energy (CE), chemicals (CCh), transport (CTW) and waste disposal (CDW).

$$OCWWTP = CL + CE + CCh + CTW + CDW$$

We did not value the phosphorus abatement because the phosphorus is removed from both floodplain meadows and WWTP by the same processes as nitrogen. Therefore, it is not necessary to detail phosphorus abatement separately.

<u>Cost-Benefit Analysis of restoration of floodplain meadows</u>

Furthermore, we investigated whether the investments in wetland restoration and its sustainable use are more valuable than other alternative uses of land as arable land. We used the Benefit-Cost Analysis (BCA) approach. The theoretical model adopted in BCA is the so-called compensation principle. According to this, if the monetary value of benefits from the activity exceeds the monetary value of costs, then the winners can hypothetically compensate the losers and still have some gains left over (Munda 1996). In other words, the future profit for the whole of society has to be bigger than the cost associated with the conservation and/or restoration including all kinds of costs and benefits. The restoration of species-rich meadows will be done on the basis of DAPHNE's proposal for restoration and management of meadows in the Morava floodplain (· effer at al. 1995). The detailed description of methods and activities of meadow restoration is in Chapter 7.

The successful restoration of degraded or converted wetlands is a process, that will take some time. A restored wetland does not provide all services (e.g. good hay production and nitrogen sink) until the restoration process is completed. Therefore, we used a 10-year period for the Cost-Benefit Analysis of degraded meadows restoration (140 ha). This time should be sufficient for full development of wet meadow communities that will provide above-mentioned ecological services. In accordance with experiences after the first year of restoration (1999), the production of hay and nitrogen abatement was about 1/3 of expected productivity after upon completed restoration. Similarly, for the second year we expect about 2/3 of productivity of investigated services. We suggest that restored meadows will provide whole productivity of services in the third year of restoration.

The monetary expression of restoration costs are derived from the market cost of degraded and converted meadow restoration (140 ha). For restoration of meadows, we used agreed prices that reflect the level of market prices for such kinds of agricultural activities. The final price for restoration consists of the costs of cultivation, seed collection, mowing twice in the first year and additional seeding and mowing in the second year.

The data on agricultural production used in this BC analysis are from the agricultural firm Agra-M Malacky (Masarovic personal communication). This agricultural firm manage the biggest part of degraded and converted meadows in the Morava floodplain and the project of restoration is done at their agricultural land.

We did not discount the estimated values. Still, there is no consensus among environmental economist whether it is necessary to employ the discount rate in every case of environmental valuation of future benefits (e.g. Folmer et al. 1995; Coker & Richards 1996; Green 1996; Rees & Wackernagel 1999). In our opinion there is no need to discount the future benefits of restoration of the Morava floodplain meadows in the BCA in this study because these benefits may became more valuable in the future (mainly nitrogen abatement).

Results

In this section, we present the findings and results of the valuation analysis and BCA from the assessment of sustainable use of the meadows of Slovak part of the Morava floodplain. The results are presented in the tables and/or graphs with commentary. We evaluated two ecosystem services of floodplain meadows: hay production and nitrogen abatement. Further, we assessed the economic value of other land use alternatives to use these meadows as arable land for production of corn. Finally, we made a BCA of investment in the restoration of degraded meadows in the Morava floodplain.

<u>The Value of Hay Production</u>

The ecosystems of the Morava floodplain meadows are semi-natural ecosystems and they are fully dependent on human management. Therefore, the best form of management of this area is the production of hay. In this part, we assessed whether the hay production is also valuable for farmers. There is a long tradition of high quality hay production in the Morava floodplain. The hay is used for feeding livestock and in the past it was exported to Austria. Usually meadows are mowed twice a year depending on weather and flood conditions.

As we can see from Table 1, the production of hay is quite profitable. Despite they do not sell hay, they use it for their own needs. The average net benefit from hay can reach over 3.4 millions Sk (79 093 EUR) for the whole meadow area. However, there are some problems with the second mowing, which is not profitable for the average yield. In practice, farmers do not mow a second time when the yield is not very good. In accordance with the analysis, the second mowing is profitable only when the yield exceeds two tons per hectare. The quality and yield of the hay depends on weather, duration of floods and other ecological conditions.

Tab.1. Hay benefit potential for species-rich meadows in the Slovak part of the Morava floodplain (1727 ha of meadows).

	1st mowing	2nd mowing
Area of meadows in hectares	1727,0	1727,0
Average yield from 1 ha in tons	3,5	1,5
Average yield from whole area/t	6044,5	2590,5
Moving cost for 1 ha	2 000 Sk	2 000 Sk
Moving cost for whole area	-3 454 000 Sk	-3 454 000 Sk
Benefit from 1 t of hay	1 200 Sk	1 200 Sk
Potential benefit from hay	7 253 400 Sk	3 108 600 Sk
Net benefit	3 799 400 Sk	-345 400 Sk
Net benefit for both mowing	3 454 000 Sk	

At 1999 prices

The Value of Nitrogen Sink

The nutrient sink and especially nitrogen sink is one of the most important ecosystem services of wetlands (Vymazal 1995; Kowalik & Obarska-Pempkowiak 1996; Craft & Richardson 1996). Vegetation uptake of nitrate present within the floodplain is variable in the space (depends from vegetation type) and the time (depends on temperature and light conditions). During growing season, vegetation uptake will be at a maximum in late spring and summer, when temperature and light intensity are at maximum. The uptake of nitrate by vegetation is only a storage process and haymaking will act to remove this nitrate from the ecosystem.

Denitrification is a microbial process in which nitrate is reduced through different intermediate stages NO2, NO, N2O, into gaseous nitrogen (Haycock et al. 1993). This system process constitutes a system of removal, since nitrogen is lost from the ecosystem, and in most cases being trans-formed into non-polluted gaseous end product N2. The activation of these processes depends on the presence of nitrate NO3-N, a suitable carbon substrate and the absence of oxygen. The moisture regime must be variable, that is there must be a wetting and drying cycle of the soil and this will enhance the microbial activity and affect the rate of denitrification. Total nitrogen gaseous losses from different soils measured under field conditions in wetlands can vary from 0.5 to 2.4 kg of N per ha/day (Fustec et al. 1991). All these preconditions are fulfilled in the Morava floodplain region and we can suppose a very high rate of denitrification processes here. These two primary retention/transformation processes, vegetation uptake and microbial denitrification, work together to provide effect-ive ground water purification.

In the Morava floodplain, the nitrogen abatement makes up the biggest part of the Total Economic Value. Table 2 shows us the content of nitrogen in the dry biomass of the grassland parts in the study area. Nitrogen in the form of dry biomass is annually removed from the ecosystem. We did not take into account denitrification processes in the study area. Nitrogen removed from the floodplain through the denitrification process is in addition to the nitrogen abatement in the hay biomass.

Tab. 2. Nitrogen in the dry biomass per type of grassland community in the Morava floodplain (1727 ha of meadows)

	Dry biomass ($t.ha^{-1}$)	Content of N ($t.ha^{-1}$)	Area (ha)	Dry biomass per community (t)	Content of N per community (t)
mesophytic meadows	13.8	0.16	287	3 961	46
moist meadows	17.1	0.26	716	12 244	186
wet meadow	14.3	0.25	516	7 379	129
reed canary grass community	23.6	0.30	64	1 510	19
tall-sedges	20.7	0.28	57	1 180	16
reed grass community	28.9	0.44	87	2 514	38
Total			1727	28 788	434

The amount of 434 tones of nitrogen, which is removed annually by the investigated meadow part of the Morava floodplain in the form of hay, represents a yearly production of around 216,000 equivalent citizens (Drtil & Hutnan 1999; Drtil personal communication). Therefore, the monetary value of the nutrient sink in the study area is equal to the operational cost of a wastewater treatment plant with the capacity of 216,000 equivalent citizens (EC). Operational costs of this kind of wastewater treatment plant are calculated in Table 3.

Tab. 3. Monetary value of nitrogen abatement in the Slovak part of the Morava floodplain (1 727 ha of meadows) is equal to the operational costs of elimination of 434 t of N/year in a WWT plant (216,000 EC)

	Cost per day	Cost per year
Labour	10 000 Sk	3 650 000 Sk
Energy (18100 kWh/day)	36 200 Sk	13 213 000 Sk
Chemicals for cleaning process	7 000 Sk	2 555 000 Sk
Sludge deposit (55 m3/day)	27 500 Sk	10 037 500 Sk
Sludge transportation	1 000 Sk	365 000 Sk
Total	81 700 Sk	29 820 500 Sk

Data - Drtil (pers. comm.) In 1999 prices

The estimated monetary value of the nitrogen sink in the Morava floodplain (1727 ha) is around 29.8 millions Sk (682 860 EUR) per year. Moreover, it should be noted that the building cost of a new WWT plant will reach approximately on additional 300 millions Sk (6 869 704 EUR).

Benefit-Cost analysis of conservation of the floodplain meadows

In the BCA calculations (Table 4.) we decided to use the following categories: hay production, recreation and rearing of wild animals for hunting. Although there are insufficient data about the value of recreation and production of wild animals for hunting we used these categories because these activities play an important role in this area. In the table, these values are expressed as >0 Sk (more than zero). It means that recreation and rearing of wild animals for hunting have significant value and this should be taken into account in the valuation of this area.

Tab. 4. Value of benefits from meadows in the Slovak part of the Morava floodplain (per area 1727 ha)

	Cost	Benefit 1st Scenario good yield	Benefit 2nd Scenario poor yield
Hay production - 1st Mowing	-3 454 000 Sk	8 289 600 Sk	6 217 200 Sk
Hay production - 2nd Mowing	-3 454 000 Sk	4 144 800 Sk	2 072 400 Sk
Recreation	0 Sk	>0 Sk	>0 Sk
Wild animals production	0 Sk	>0 Sk	>0 Sk
Nitrogen sink (434 t.h-1)	0 Sk	29 820 500 Sk	19 880 300 Sk
Total (estimate)	-6 908 000 Sk	Minimum 42 254 900 Sk	Minimum 28 969 900 Sk
Net benefit (estimate, B-C)	-	More than 35 346 900 Sk	More than 22 061 900 Sk
Net benefit per hectare		Around 20 000 Sk	Around 13 000 Sk

In 1999 prices

Scenario 1: 4 t.h-1 of hay for 1st mowing and 2 t.h-1a for 2nd one;
Scenario 2: 3 t.h-1 of hay for 1st mowing and 1 t.h-1 for 2nd one

We assessed two scenarios of benefits because of some uncertainties. The first scenario is an optimistic scenario where we assumed maximal yields of hay (4 tonnes from hectare for first mowing and 2 tonnes for the second one). In contrast, the second scenario is pessimistic and is based on minimal yields of hay (3 t for the first mowing and 1 t for the second one). The net benefit of the first scenario with a good hay yield is around 35.3 millions Sk (809 409 EUR). The net benefit of the second scenario with a pure yield of hay is around 22 millions Sk (511 600 EUR).

As we identified in Table 4, the total social economic benefit from the conservation and sustainable use of the Morava floodplain amounts to 13 000 - 20 000 Sk (300 - 458 EURO) per hectare.

<u>Benefit-Cost Analysis of Floodplain Meadows' Restoration</u>

DAPHNE - Centre for Applied Ecology, is running a project of species-rich meadow restoration in the Morava floodplain. This project has been implemented in the middle part of the Morava floodplain near the village of Gajary. The objective of DAPHNE's project is the transformation of arable land into meadows with a natural species composition. The cost of restoration is calculated in Table 5. The data are based on DAPHNE's project costs. In accordance with these data, the cost of returning 140 hectares of arable land to meadows with a natural species composition is 3 276 000 Sk (75 017 EUR).

Tab. 5. Cost of meadows restoration in the Morava floodplain (140 ha)

	Restoration cost of 1 ha	Restoration cost 140 ha
Seed mixture	5 000 Sk	700 000 Sk
Seeding and turf transplanting	2 600 Sk	364 000 Sk
1st Mowing	2 000 Sk	280 000 Sk
2nd Mowing	2 000 Sk	280 000 Sk
Seeds for 2nd year	2 500 Sk	350 000 Sk
Additional seeding in 2nd year	1 300 Sk	182 000 Sk
Second year mowing 2x	4 000 Sk	560 000 Sk
Third year mowing 2x	4 000 Sk	560 000 Sk
Total	23 400 Sk	3 276 000 Sk

At 1999 prices

Additional seeding in second year will be done only on 50 % of total area (i.e. 70 ha)

Furthermore, to obtain the value of the nitrogen sink of the restored area (140 ha) we estimated the total amount of nitrogen, which can be removed from this area is 22.4 tones per year. We used a similar approach to the one for the valuation of nitrogen abatement across the whole meadow area. The wastewater treatment plant, which is able to remove 22.4 t of nitrogen, has a capacity of about 10 300 citizens. The estimated of value of this ecosystem service over the study area (140 ha) is in Table 7. The net benefit from the nitrogen sink is estimated to 1 514 750 Sk (34 622 EUR).

Tab. 6. The poten-tial value of nitrogen abatement in the restored meadows in the Morava floodplain (22.4 t of N/year from an area of 140 ha) is equal to a wastewater treatment plant's operational costs to eliminate 22.4 t of N/year.

	Cost per day	Cost per year
Labour	1 000 Sk	365 000 Sk
Energy (18100 kWh/day)	1 700 Sk	620 500 Sk
Chemicals for cleaning process	300 Sk	109 500 Sk
Sludge deposit (55 m3/day)	1 000 Sk	365 000 Sk
Sludge transportation	150 Sk	54 750 Sk
Total	4 150 Sk	1 514 750 Sk

At 1999 prices

Moreover, we calculated the potential benefit from corn production over 140 ha in the Morava floodplain. The data used were obtained from the agricultural firm AGRA-M Malacky (Masarovič personal communication). Tables 7a and 7b show the potential benefit from corn cultivation in this area. Due to regular floods, corn yields every year. It are not usual. More often, there is no corn yield and farmers only harvest green corn plant biomass for silage from fields in inundated area. Therefore, we divided the assessment of benefit potential from corn production into two scenarios. The first scenario is optimistic and we assume that there are optimal conditions for corn growing in this area (no floods). The second scenario is pessimistic and we assume a wet year and the flood conditions are unfavorable for corn growth. Consequently, farmers are only able to harvest green biomass for silage, which is not as valuable as corn production.

Tab. 7a. Potential benefit from corn cultivation in an exceptionally dry year when the

1st Scenario - dry year	1 ha Corn	140 ha Corn
Average yield (t)	4,5	630
Average cost of corn production (ha)	5 100 Sk	714 000 Sk
Benefit from yield (3000 Sk/t)	13 500 Sk	1 890 000 Sk
Net benefit	8 400 Sk	1 176 000 Sk

At 1999 prices

Tab. 7b. Potential benefit from corn cultivation in an average wet year when farmers harvest green corn biomass for silage over the meadow restoration area (140 ha)

2nd Scenario - wet year	1 ha Silage	140 ha Silage
Average yield (t)	17,5	2450
Average cost of corn production (ha)	7 950 Sk	1 113 000 Sk
Benefit from yield (650 Sk/t)	11 375 Sk	1 592 500 Sk
Net benefit	3 425 Sk	479 500 Sk

At 1999 prices

There are results of the calculation for the first scenario (dry year) in Table 7a. In a dry year when there are no floods in the cornfields, there is the potential to harvest corn from an area of 140 ha. The potential value of harvested corn is 1 176 000 Sk (26 929 EUR). Furthermore, in Table 7b the potential benefits of the second scenario in a typical wet year are calculated when corn cannot be harvested due to floods. In this case the average net benefit from the green corn biomass for silage is 479 500 Sk (10 980 EUR).

As a support argument for restoration of degraded and converted meadows, we calculated the 10 year BCA of the restoration and after-restoration period in order to work out the real value of the restored meadow with all functioning services. For this analysis we used the outcomes from Tables 5 - 7a and 7b. Again, we decided to assess BCA through two scenarios. Since there are uncertainties in flood frequency and duration during the assessed 10 year period, in scenario A we assumed that each year of the ten year period is dry, without floods and so the potential yield (and also monetary value) of corn expressed in the opportunity cost is very high.

On the contrary, in scenario B, we assume that there are only wet years without corn yield and farmers use the corn biomass only for silage. Of course the monetary value of this production is lower than corn production. The successful process of restoration lasts at least two years, but we can expect fully functioning services after the third year. In accordance with our experiences after one year of restoration, we estimated the values of the assessed ecosystem services (hay production and nitrogen abatement) as 1/3 of the full value. Similarly, in the second year we estimated the values of these services as 2/3 of the full value. The estimates of the ecosystem services in the third year of restoration will have reached their full values.

The calculations of the costs and benefits of restoration for both scenarios are shown in Table 8 and 9. As it can seen from the total net benefit after the tenth year, the social benefit in scenario A amounts to 2.77 million Sk (63 579 EUR). The social benefit in scenario B is over 9.7 millions Sk (223 070 EUR).

Tab. 8. Benefit-Cost Analysis of degraded meadows restoration in the Morava floodplain (140 ha)
Scenario A - each year is dry and the corn yield is good

Year	Costs		Loss of corn production	Benefits		Total Benefit -Cost	Cummulative Benefit - cost
	Mowing (twice a year)	Restoration		Hay production	Nitrogen sink		
1.	-560 000 Sk	-1 064 000 Sk	-1 176 000 Sk	299 970 Sk*	504 866 Sk*	-1 995 164 Sk	-1 995 164 Sk
2.	-560 000 Sk	-532 000 Sk	-1 176 000 Sk	599 940 Sk#	1 009 732 Sk#	-658 328 Sk	-2 653 492 Sk
3.	-560 000 Sk	0 Sk	-1 176 000 Sk	900 000 Sk	1 514 750 Sk	678 750 Sk	-1 974 742 Sk
4.	-560 000 Sk	0 Sk	-1 176 000 Sk	900 000 Sk	1 514 750 Sk	678 750 Sk	-1 295 992 Sk
5.	-560 000 Sk	0 Sk	-1 176 000 Sk	900 000 Sk	1 514 750 Sk	678 750 Sk	-617 242 Sk
6.	-560 000 Sk	0 Sk	-1 176 000 Sk	900 000 Sk	1 514 750 Sk	678 750 Sk	61 508 Sk
7.	-560 000 Sk	0 Sk	-1 176 000 Sk	900 000 Sk	1 514 750 Sk	678 750 Sk	740 258 Sk
8.	-560 000 Sk	0 Sk	-1 176 000 Sk	900 000 Sk	1 514 750 Sk	678 750 Sk	1 419 008 Sk
9.	-560 000 Sk	0 Sk	-1 176 000 Sk	900 000 Sk	1 514 750 Sk	678 750 Sk	2 097 758 Sk
10.	-560 000 Sk	0 Sk	-1 176 000 Sk	900 000 Sk	1 514 750 Sk	678 750 Sk	2 776 508 Sk
Total	-5 600 000 Sk	-1 596 000 Sk	-11 760 000 Sk	8 099 910 Sk	13 632 599 Sk	2 776 509 Sk	-

* 1/3 of full ecosystem services At 1999 prices

2/3 of full ecosystem services

Tab. 9. Benefit-Cost Analysis of degraded meadows restoration in the Morava floodplain (140 ha)
Scenario B - each year is wet and only green corn biomass is utilised

Year	Costs		Loss of corn production	Benefits		Total Benefit -Cost	Cummulative Benefit - cost
	Mowing (twice a year)	Restoration		Hay production	Nitrogen sink		
1.	-560 000 Sk	-1 064 000 Sk	-479 500 Sk	299 970 Sk*	504 866 Sk*	-1 298 664 Sk	-1 298 664 Sk
2.	-560 000 Sk	-532 000 Sk	-479 500 Sk	599 940 Sk#	1 009 732 Sk#	38 172 Sk	-1 260 492 Sk
3.	-560 000 Sk	0 Sk	-479 500 Sk	900 000 Sk	1 514 750 Sk	1 375 250 Sk	114 758 Sk
4.	-560 000 Sk	0 Sk	-479 500 Sk	900 000 Sk	1 514 750 Sk	1 375 250 Sk	1 490 008 Sk
5.	-560 000 Sk	0 Sk	-479 500 Sk	900 000 Sk	1 514 750 Sk	1 375 250 Sk	2 865 258 Sk
6.	-560 000 Sk	0 Sk	-479 500 Sk	900 000 Sk	1 514 750 Sk	1 375 250 Sk	4 240 508 Sk
7.	-560 000 Sk	0 Sk	-479 500 Sk	900 000 Sk	1 514 750 Sk	1 375 250 Sk	5 615 758 Sk
8.	-560 000 Sk	0 Sk	-479 500 Sk	900 000 Sk	1 514 750 Sk	1 375 250 Sk	6 991 008 Sk
9.	-560 000 Sk	0 Sk	-479 500 Sk	900 000 Sk	1 514 750 Sk	1 375 250 Sk	8 366 258 Sk
10.	-560 000 Sk	0 Sk	-479 500 Sk	900 000 Sk	1 514 750 Sk	1 375 250 Sk	9 741 508 Sk
Total	-5 600 000 Sk	-1 596 000 Sk	-4 795 000 Sk	8 099 910 Sk	13 632 599 Sk	9 741 509 Sk	

* 1/3 of full ecosystem services At 1999 prices
# 2/3 of full ecosystem services

The cumulative cost-benefit is depicted in Figure 1. It depicts two curves representing the limits of minimal (scenario A) and maximal (scenario B) estimates of the net social benefit of the restoration of degraded and converted meadows over a ten year period. In all probability, a real net social benefit lies between these two curves.

It should be noted that probability of scenario A is around 20 - 30 per cent and probability of scenario B is between 70 - 80 per cent.

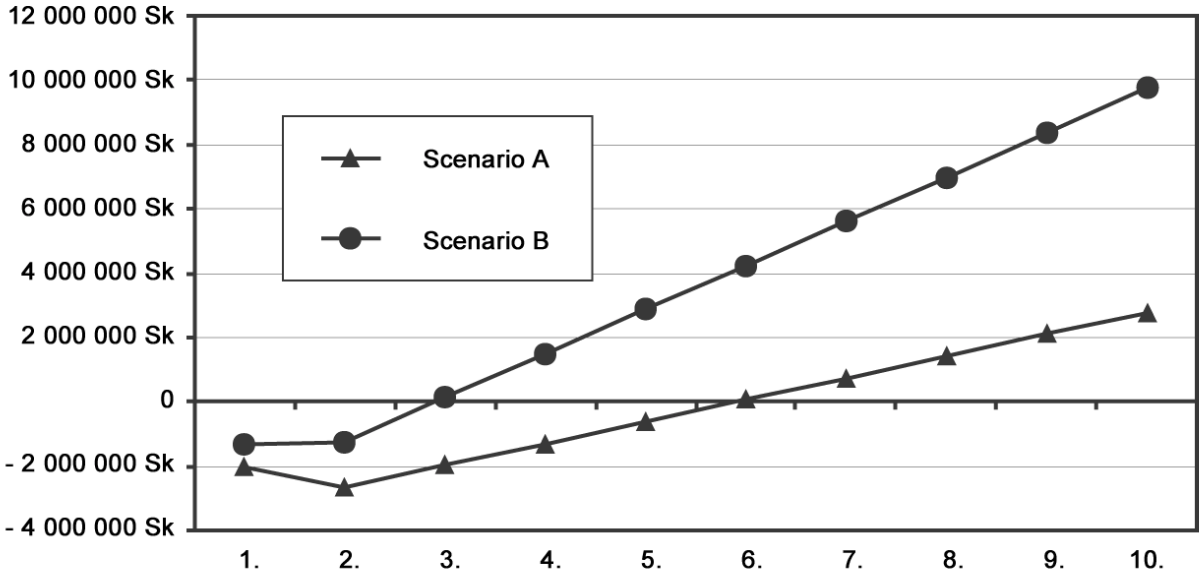


Fig. 1. The cumulative cost/benefit of 10 years' restoration and the after-restoration period for both scenarios (A and B).

Discussion

As was shown in the previous section, conservation and restoration of the Morava floodplain has a significant monetary value. (See Tables 4, 8, 9). The Benefit-Cost Analysis (BCA) of conservation of this area (Table 4) showed that sustainable use of this floodplain also has significant monetary value. Moreover, BCA of floodplain meadows' restoration (Tables 8, 9 and Figure 1) showed that investments into restoration of degraded meadows yield profits earlier than investments into transformation of arable soil. Water purification (nitrogen abatement) is beneficial for society as a whole, yet for farmers it often is not a priority because water purification produces little financial gain.

A more difficult question is whether results of this study are sufficient incentives for farmers and landowners to follow sustainable management and to start restoration of degraded meadows. Nonetheless, successful restoration of 140 hectares of meadows can be a good pilot project for future investment in further restoration in the Morava floodplain.

After economic valuation of nitrogen abatement, outcomes suggest that wetlands (i.e. river floodplains) can play a significant role in fighting non-point source water pollution mainly in agricultural landscape. Moreover, our approach can be used for comparing alternative measures for water purification purposes. A similar approach was used by Gren (1995) in valuation of investing in wetlands for nitrogen sink. She concluded that due to multifunctional use of wetlands, investing in them is the most valuable measure for nitrogen sink for ground water purification.

In the last few years various valuation studies focusing on environmental goods and services were completed. The most similar one to our study is Economic Evaluation of the Danube Floodplains (Andréasson-Gren & Groth 1995). The study is focused on capturing monetary values of forest, grassland and wetland habitats in the Danube floodplain. The following values in different categories in this study were addressed: inputs for production of market goods (wood, hay/grass for cattle and fish production), recreation and nitrogen abatement. Since it is very complicated to undertake a valuation study for such a big and complex area as the Danube floodplain, only rough estimates could be produced from the valuation study. On the contrary, we analyzed more detailed and homogenous data for smaller areas, and especially in the case of nitrogen abatement, we assume that our outcomes are very realistic.

In the general view similar total annual values per hectare of conservation alternatives were identified in both studies. For the Danube floodplain the estimated annual value amounts to 383 EUR (16 700 Sk) per hectare (Anderáson-Gren & Groth 1995); for the Morava floodplain the value is around 300 - 458 EUR/ha (13 000 - 20 000 Sk/ha).

Finally, this method of monetary valuation may play a significant role in conservation of biodiverzity and protected areas; however, this issue is rarely addressed in Slovakia. Furthermore, we can suppose that the identification and estimation of future economic benefits from sustainable use of protected areas may be a positive incentive for restoration of degraded habitats. It is assumed that identification of TEV of an area may help to find financial resources for conservation of unique and valuable localities. Moreover, this approach can be used for evaluating public development projects in natural and other areas.

4.3 Toxic Pollution of Water

Maria Minkova

Heavy metals and pesticides pollution is one of the most important, urgent ecological problems world wide in view of the health risk. One of the main factors, leading to stable pollution of water recourses is the reduced self-purifying ability of the open water currents, as a result of reduced river flow, influenced by climate changes and anthropogenic activity.

The current processes of industry and land privatisation, the transition to market economy and out-of-date legislation in EE countries create conditions for uncontrolled to water pollution. The processes of joining the EU, designing and enforcing environmental legislation, in line with EC requirements will result in complex and sustainable water resources management and decrease of contained toxic products.

The main problems, related to damaging the Danube and its tributaries, could be arranged in the following groups:

- Legislation problems;
- Problems, related to infrastructure;
- Problems, related to industry;
- Problems, related to agriculture;
- Problems, related to improper activities in protected areas and wetlands;
- Problems, related to water recourses consumption

Toxic water pollution sources

Industry is one of the economic branches with strong impact on open water basins and ground water. Main pollutants are oil processing and chemical industries, ferrous and non-ferrous metallurgy, mines and flotation plants, cement, leather and textile industries. These industries produce great amount of waste water, containing ions of heavy metals, chemicals, radio-nuclides, waste raw oil and oil products, salty mineralised solutions, flowing into the rivers and ground waters. Mines and flotation plants in process of liquidation or conservation through their tailing dumps, containing enormous amounts of concentrated toxic wastes after mineral processing, are potential threat to the ground waters and surface water basins – rivers, lakes and dams.

Another branch of the economy, which could potentially pollute natural waters, including drinking water sources, is agriculture. The use of chemical substances for plant protection (pesticides) and different types of fertilizers is inevitable in modern agriculture. Practice shows an ongoing increase of the type and quantity of chemical substances. Pesticides are characterised with high toxicity, persistence and tendency to bioaccumulation, therefore once introduced in the environment, they constitute direct threat to the natural water, soils, biological diversity and human health.

<u>Heavy metals</u>

Due to their toxicity, tendency to accumulate and biological activity, heavy metals are a potential risk to water ecosystems, biodiversity and human health.

The group of heavy metals is diverse. They are bio-cumulative compounds, therefore they deposit in the environment - soils, waters, plants, animals. Therefore with time passing by, their content in organism’s increases, their toxic impact on local ecosystems rises as well. Their specific characteristics – like reactivity and potential toxicity vary. Quite often the relative amount of a single metal in waste water could be much greater than the total amount of the rest of the heavy metals, which requires toxicity analysis, in view of risk assessment and safety measures. Eight heavy metals are in environmental focus: mercury, lead, cadmium, chromium, copper, arsenic, nickel and zinc. During significant industrial accidents big amounts of cyanide compounds could leak in the open water currents – as the incident at Baia Mare, causing environmental disaster in some areas.

River waters - direct recipients of waste water – are very vulnerable to heavy metals pollution and the same refers to ground water in some areas – due to migration process. The high interest of experts and NGOs in heavy metals water pollution research is caused by the constant increase of the heavy metal concentration in the oceans, seas and continental waters, as well as their ability to accumulate in the bottom sediments, to form stable metal - organic compounds, more toxic than the non-organic ones. The lack of self-purifying mechanism of water systems from heavy metals and the formation of zones of priority accumulation (surface micro layer, water organisms and bottom sediments), as well as the diversity of migration forms there (suspended, colloidal, dissolved, ionic etc.), create conditions for secondary water pollution and ecological misbalance.

Most common reasons for water pollution with toxic products

- discharge of waste water from small plants, workshops, laboratory farms without proper purification directly into the sewage system; surface water basins, or more rare, in the soil;
- unsatisfactory effect of the local waste water treatment plants (WWTP) of the industries;
- lack of management and control of rain water on the industries sites, leading to surface and ground water pollution;
- inadequate storage and use of town WWTP and local industrial WWTP sludge containing persisting cumulated toxic organic and non-organic compounds;
- accidental (incidental) waste water pollution in open currents and reservoirs;
- insufficient preparation for prevention of water pollution at industrial accidents and disasters (floods, earthquakes slides, droughts);
- inadequate location of pollution sources referring risk, geological and hydrological(karst, old mines) zones;
- insufficient and inadequate control on sanitation-protective zones for drinking water sources;
- dumping industrial waste, most of which hazardous, in inadequate located uncontrolled sites;
- dumping industrial hazardous wastes, in unprotected depots for solid household wastes;
- inefficient control of old depots for toxic industrial wastes, most often tailing dumps, insufficient monitoring;
- lack of agreement in the actions of state institutions, responsible for problems on a regional level.

Some problems, typical for EE countries need to be mentioned:

- insufficient level of integrating environmental policy in sectoral policies of state institution, responsible for sustainable water management;
- financial shortages;
- lack of systematic and updated information on all levels in the competent state institution;
- insufficient access to IT systems, related to water pollution management;

- lack of relevant and sufficient information for failures in quantity and quality water management, due to mistakes, accidents, disasters etc.;
- community administrations, NGOs and citizens are denied free access to the available information
- no regional information desks available for communication on environmental and health risk, related to water pollution on case by case level;
- media reacting only in cases of disasters, covering vast areas or high number of people.

Environmental impact of heavy metals

Heavy metals, over threshold concentration in surface and ground waters are a potential risk in terms of:

- Ecological status of water systems. The ability of heavy metals to form stable sediments of highly toxic metal-organic compounds has a damaging impact on water ecosystems biological balance;
- Biodiversity in river currents and wetlands;
- Change in the quality of drinking water. The main drinking water source is ground water and dams in some cases;
- Pollution of agriculture water, agriculture areas and production.
- Population livelihood, i.e. fishing or agricultural production for certain periods of time
- Use of river, lake and dam water for recreation purposes;
- Human health – after consumption water polluted with heavy metals or through the food chain, mostly after significant industrial accidents or natural disasters.

Impact of heavy metals on human health

In cases of exogenous intoxication, heavy metals penetrate in human organism through breathing and the food and digestive tract, mucous membrane and skin. The toxic effect depends on the type and qualities of the toxicant, dose swallowed and organism status during the impact. Depending on the exposition to the toxicant and the clinical status, the exogenous intoxications are acute or chronic. Acute intoxication occur in cases of incidental or short exposure of human organism to high doze of the toxic compounds, mostly in professional environment, and the chronic intoxication – at continuous exposure to small dozes (months and years).

In case of heavy metals pollution of water sources acute toxic effect could occur at emergency events - major industrial accidents or natural disasters.

- <u>Lead</u> – In case of chronic penetration in the organism, both in organic or inorganic form, lead is accumulated in bones and the central nerve system (CNS). Out of these depots, lead penetrates periodically into the blood, causing additional damage to the liver and kidneys, haematopoiesis, arterial vessels of the brain and the peripheral nervous system. The impact on the CNS causes weakened brain activity, reduction of concentration ability, anxiety. Lead is a potential human carcinogen (according to the International Cancer Research Agency Classification). The risk group includes mainly children, mostly babies, as they are especially sensitive to the toxic effect of lead. Even small quantity in their body could cause retarded physical and mental development. Lead has toxic impact on flora and fauna – indirect potential threat for humans due to constant consumption of polluted food.
- <u>Cadmium</u> - cumulative type of dangerous metal with systematic toxicity on mammals and humans. It penetrates the body through respiratory and alimentary tract. Toxic effects are related to depressing the activity of lifesaving enzymes, resulting in

phosphorous-calcium exchange and metabolism of many micro-elements in the human body. Cadmium has neuro-toxic effect, it is accumulated in kidneys, releasing cadmium ions, and causing secondary damages. Acute and chronic cadmium intoxication might occur. Acute intoxications are rare clinic conditions and are mainly due to inhaling cadmium ions with very small diameter. In case of more durable penetration trough the food tract chronic intoxications might occur as of kidney, liver, neurology syndromes etc. Cadmium has late effects such as mutagenetic, carcinogenetic (according to International Cancer Research Agency Classification), and toxic impact on reproduction. A strong allergen.

- Chromium – penetrates the body through the respiratory, alimentary systems or the skin. Its compounds penetrate comparatively fast and deposit in lungs, liver, pancreas and the spleen. In case of acute inhalation intoxication some lung symptoms might be observed. In case of chronic exposure – slight changes in the respiratory system; gastritis and ulcer in the alimentary tract; slight functional changes to nephritis in kidneys might occur. Oxidised chromium has a carcinogenic effect. In some cases it causes a negative impact on reproduction. Chromium is a strong allergen. It has toxic impact on flora and fauna, and transmitted through the food chain is an indirect threat to humans.
- Copper – has a negative effect on agricultural crops and livestock. Copper enters human body through inhalation and food. Acute and chronic effects of the metal cause stomach and intestines disorder, kidney and liver failure, anaemia. The acute effects might occur in labour environment or at incidents with copper compounds, for example copper sulphate. The acute intoxication is known as "copper fever". Copper is easily solved, can be found often in river sediments, and is toxic for most water plants and fish.
- Nickel – is a cumulative type of metal, toxic for mammals and humans. It damages the peripheral and central nervous systems, haematopoiesis, liver and kidneys. Nickel is a proven sensibiliser and causes allergic, respiratory and skin diseases. One of the ways it penetrates the body is through the skin – during bathing in highly nickel polluted water.
- Zinc – has a negative effect on agricultural crops and livestock.
- Mercury – may cause acute or chronic toxic reactions in humans only in a highly polluted working environment, through inhaling mercury vapours. Highly toxic for the nervous system and haematopoiesis.
- Arsenic is a highly toxic metalloid, damaging almost all body systems. In case of chronic penetration causes heavy disorders in the activity of stomach-intestinal and nervous systems, haematopoiesis, affects bones, kidneys, and liver.
- Cyanides – are extremely toxic compounds. The impact on humans and animals is instant at very small dozes. Once they have penetrated the body, cyanides block the absorption of oxygen by the cells and block the breathing of the tissues. The symptoms of acute intoxication are strong suffocation, tremor, and fast loss of consciousness. Death is almost instant. In case of chronic effect the symptoms are weight loss, disruptions of the thyroid gland and the nervous system.

Instruments for reducing pollution with heavy ions water

- Design and implementation of sustainable management strategies of water resources and reduction in toxic waste pollution;
- Limitation of industrial toxic and heavy metals emissions by implementing "best available technology " and "successful practices";
- Design and construction of local WWTP for the industries, treating water discharged directly into surface reservoirs or in the community sewage system;

- Rehabilitation, reconstruction and modernisation of the existing industrial WWTP and improving their maintenance;
- Priority construction of new town WWTP where to collect the polluting industrial waste water;
- Control over dumping of town WWTP sludge, containing toxic waste.
- Construction of controlled toxic waste depots;
- Monitoring and design of a methodology for impact assessment of non-point sources on river catchments area;
- Technological improvement of industrial processes – i.e. introduction of closed cycles, reusing waste water etc.;
- Introducing permanent monitoring of toxic waste pollution sources;
- Developing inventory list of past polluting industries, ranging problems in their priority and a general assessment of the resources necessary for their sanitation, health risk included.
- Closing of non-organised landfills;
- Updating the existing national emergency action plan for industrial accidents or natural disasters, as well as emergency plans of industrial plants;
- Strict introduction of administrative and financial instruments, aiming at toxic emissions decrease, i.e. the “pollutant pays” principle;
- Full access to the available information for community administration, NGOs and citizens;
- Integration of the environmental policy in the sectoral policies of the relevant state institutions, responsible for environmental protection.

Problems related to agricultural activities: Pesticides

Use of chemicals for plant protection in agriculture and storage of spare quantities without adequate competence and responsibilities causes negative impact on the environment. Pollution of water basins with these hazardous chemicals causes serious environmental failures and specific problems in using water for drinking, fishing and recreation. Pesticides penetrate the surface and ground waters directly - by introducing chemicals against water weeds; from the atmosphere through rainfalls, by filtering of water through the soil; and after accidents, caused by improper handling. In most cases of incidental surface water pollution there is a fast toxic effect on water organisms on limited territory, even without significant registered pesticide concentrations in water. The hidden threat to humans and nature is related to even small quantities of long term persistent pesticides in the environment, which, without exception are biological active substances. As it is well known, pesticides from the group of the so called “global chlorine-organic pollutants” have significant chemical resistance, and once used, circulate for years, even decades in the environment.

DDT is a striking example - traces of the chemical are still being found tens of years after its ban in all organisms from all parts of the worls, including water oragnisms from the pollar seas.

Thanks to the expereince gathered from the use of strong persisting compounds in the environment, gradually strict environmental and hygenic criteria for their use have been fromed, which lead to gradual limitation and exclusion from practice of the most stable compounds. Practically all surface waters are threatened by pesticide pollution - dams, rivers, sources, seasonal brooks, fish nerseries, as well as ground water, including wells and drinking water drillings.

Pesticides possess high coefficient of bioaccumulation. This phenomen is characteristic for substances with high stability, both in the environemnt and in organisms. Due to their high stability such substances remain unchanged in every other step in the food chain, therefore they present a serious ecological and hyegenic problem. Bioaccumulation is characteristic for chemicals from the group of solid chlororganic pesticides, biphenyls etc, therefore their release in water reservoars is extremeley undesirable.

Soil microflora contributes most to the self-purification of the environment from pesticide traces. Compared to soil, water environment is a relatively less suitable place for microbiological degradation of pesticidess, therefore the half life of these stable substances is longer. Chemicals with longterm half life are definitely unfavourable (risky) for the environment, water ecosystems, biodiversity and human health. Accumulation of stable chemical substances in tissues of water organisms with economic importance has been proved.

Mobility of pesticides between soil horizons is a very important indicator for assessing the risk of pesticides penetrating in and polluting ground water. Mobility is often proportional to water solubility, but for risk assessment however, it is important to note that pesticides are complex organic substances and their transition through soil is related to a number of physical and chemical interactions.

The world agricultural practice is to use a huge number of pesticide, which are classified according to their use, chemical composition, toxicity etc. There is a so called hygenic classification, setting out the criteria for granting permission for the use of pesticides based on health and environmental considerations:

- zero category - chemicals with very high toxicity and stability, with serious negative effects on the environment and people. They are **completely banned**. The Stochholm convention on persistent organic pollutants sests out the so called “dirty dozen”, including especially dangerous substances for nature and people, whose production and use is banned. From the 12 compounds listed, 8 are pesticides - DDT, Aldrin, Dieldrin, Endrin, Chlordane, Mirex, Toxaphen, Heptachlor.

- first category - these substances are not sold in the agricultural drugstores and can only be obtained from qualified specislists on plant protection, directly from the producers or specilised trade companies. They can only be applied by **specially trained persons.**

- second category - chemicals from this group are sold in agricultural drugstores sepcialised on plant protection, but should be used by persons who have completed a special **training course** for working with pesticides;

- third category - these are less toxic and less dangerous chemicals, which are freely sold. Lables contain safety requirements for working with them.

During 1995 - 1997 the PHARE funded “Danube Pesticides Regional Study” Project was implemented. The project objective was to assess the risk of pesticides use on people and life in the aquatory of the Danube river and to recommend adequate measure for pollution reduction. 10 countries participated in the project: Germany, Austria, Slovakia, Hungary, Slovenia, Croatia, Bulgaria, Romania, Moldova and Ukraine. Analysis included 77 types of pesticides, traces from 39 of which were establised in water, mainly from the group of chlororganic compounds (HCH isomers, HCB and DDT). Considerably high levels were establised for some Chlorophenols.

Analysis showed that amounts of DDT and Lindane registered in the Romanian part of the Danube and its tributaries exceeded with one to two orders the values registered in the rest of the countries. This fact shows the uncontroled use of chlororganic chemicals and points out Romania as one of the hot spots along the Danube. In terms of the other countries from the Danube basin, the levels of DDT and lindan are as low as to be ignored. The remains of HCB (hexachlorobenzene) are found in 39% of the positive samples, with most of them registered in the Slovak and Bulgarian sections of the river. Main atrazine pollutants are Austria, Hungary and Romania. Despite of the fact that of water samples analyses were not conducted under the same methodology, the study gave useful general information on the pesticide pollution of the Danube basin.

Most common reasons for environmental pollution and water with pesticides

- Lack of effective control of responsible institutions in terms of pesticides use;
- Non-compliance with legislation and rules for pesticide use;
- Disregard for sanitary protective zones, around drinking water sources and conducting various operations in them;
- Inadequate training and incompetence of persons working with especially dangerous compounds;
- Unpacking, solution preparation and other operations with pesticides carried out close to surface water baisins;
- Cleaning technical facilities for pesticide application, especiallly large facilities like agricultural airplanes, helocopter reservoirs etc in open basins. This is one of the most common cause for water pollution with heavy ecological implications - dead fish, destruction of water vegetation, wildlife poisoning, pollution of drinking water sources.
- Spilling of waste water close to surface water basins or discharging into them.
- ❖ Improper storage of pesticides in use;
- ❖ Inproper storage of outdated or banned pesticides. Lack of strategy for safe destruction.
- ❖ Ejection of pesticides wrapping in surface water basins.
- ❖ Uneven distribution of pesticides on the treated areas.
- ❖ Pesticide dispersal from airplanes or helicopters in unsuitable meteorological conditions;
- ❖ Poor storage of the remains of unused chemicals for plant protection;
- ❖ Location of zones for intensinve agriculture and animal farms on risk spots in terms of surface currents, basins and ground water;

Environmental impact of pesticide

<u>Fish</u> - the toxic effect on fish is greater when falling of pesticides into closed basins, than in fast running water. Sensitivity to pesticides is species relatied. Trout for example is more sensitive than carp. Chlororganic chemicals are more dangerous than phosphoroorganic. Many of the herbicides which are slightly toxic to warm blooded animals are poisonous for fish. The signs of poisoning are:

- ❖ difficult breating (affects gills);
- ❖ excitement with disturbed co-ordination of movement (with chlorine- and phosphorooganic compounds and herbicides);
- ❖ numbing reflexes for fear (gathering along the banks of water basins);
- ❖ mass deaths.

Young fish get sick and die earlier than normal. Chlororganic pesticides, which persist longer in water basins also cause chronic damages - affect reproductive products and heredity.
All water animals are exposed to the toxic impact of pesticides.

<u>Wildlife</u> - game live in the open, in larger areas, therefore immediate contact is too limited. The most common means of wildlife exposure to pesticides is through food and water. In case of pesticide pollution of the environment there toxicological risks have several aspects:

- severe poisoning, resulting in death (sometimes whole herds of wild animals or bird flocks);
- reduction of reproductive functions due to lower fertility and egg hatching;
- remaining amounts of pesticides in wild animal products, which hides an indirect risk for human health.

Plants - water flora is threatened if large concentrations of pesticides flow into water basins (i.e. washing agricultural airplanes).

Wetlands - Overuse of pesticides, incompetent handling and lack of safeguarding measures can have an unfavourable effect on biodivesrity and disrupt environmental balance in some territories.

Health effects of pesticides

Pesticides flow into the organism through the breathing system (intake of aerosols), the alimentary system (in case of incident and consuming polluted food and water) and through the skin (when working with them and swimming in polluted water basisns). Clinical conditions are severe and chronic.

Chronic intoxications hide greater risk for irreversible damage of the organism, because of the no-symptom course of bioaccumulation and late effects that they cause.

Carcinogenicity - high risk of mlignant ilnesses of the hemopoietic system, testis cancer, stomach-intestine tract, liver and brain.

Reproductive toxicity - sterility, miscarriages and still-born children. They are more common when both parents have been significantly exposed.

Inborn malformations - there are data for increased risk of anomalies of limbs, defects of the mouth cavity, malformations of the central nervous system, when the mother lives in areas with more intensive pesticide use.

Late neurotoxicity - some phosphorooganic chemicals can cause muscle feebleness, which can progress into paralysis. Neuro-psychic reactions are possible - anxiety, difficult concentration of attention, weaker memory etc.

Immune defficiency - in cases of longterm exposure to lower doses, immune reaction of higher sensitiviry type (**allergic reactions)**, supressed reactivity, autoimmune reactions might develop.

Safety requirements for pesticide use around water basins

Along with technological requirements for pesticide use, a high number of additional requirements must be followed in view of preventing water pollution:

- Using pesticides only when proved necessary, when distribution of pests has economic implications;
- Use of pesticides, which are technologically efficent and in smaller amounts per surface unit;
- Use of biological protection against pests on agricultural crops
- Observing the defined minimal distances from the water baisins (sanitary protection zones (SPZ)) when treating land with pesticides. There is a complete ban on pesticide use in belt A, around the drinking water sources.
- Safe storage of pesticides. Speciliased storage rooms must in no way be located in areas, defined as SPZ.
- Preparation of pesticide solutions has to be done on specialised sites, in sufficiently remote distances from running water, wells and drillings, and has to be carried out by competent persons;

- Responsible guranting of storage rooms of expired pesticides and prevening access of casual visitors;
- Inventory of banned, expired pesticides and development of strategic plans for their neutralisaiton and elimination.
- Arranging special sites for cleaning and washing technical equipment for pesticide application (airplane reservoirs, helicopter reservoirs etc) in view of preventing waste water spills. Neutralisation of these waters should be carried out under a procedure, established by the competent authorities.
- Ongoing control on cases of illegal use or discarding of pesticide remains, banned or expired trade products;
- Training of private frims owners or cooperations and persons directly involved in pesticide use;
- Informing local authorities for large storage for pesticides, installations for treating seeds, firms for unpacking chemicals from imported active substances, situated on the territory of the municipality;
- Strict control over the production of chemical protection products;
- Training and awareness raising for the proper use of chemicals on professional, branch and non-governmental organisations and other active community groups.

Role of the NGOs for reducing water pollution with toxic products

The main role of the public is to co-operate in the implementation of environmental legislation on national, regional and local level. At the same time, when circumstances require it, they have to play the role of a corrective for the adequate solution of problems. Depending on their potential NGOs can successfully get involved in the process of management of water resources. For this purpose it is necessary those they:

- require full access to the information available for the pollution of surface and ground water by industry and agriculture;
- require particiupation in the decision making process on solving problems related to management of water resources.
- Put pressure from “down -up” for the adequate problem solving, whenever necessary (e.i. EIA procedure, integrated permits, strategic plans etc.)
- search, collect and distribute information for uncontolled and icident spills of toxic products in running water;
- identify and organise inventories of non-point pollutants;
- require full infomration for the hot spots and critical sections in the catchment area of the Danube on the territory of the country;
- participate in setting up and interpretation of the situation analysis for water quality and quantity;
- develop a system for independent monitoring and control of pollution from industry and acriculture, and demand adequate and fast sollution of problems from local authorities;
- develop independent analyses and risk assessments;
- participate in developing and implementing awareness raising programmes on the existing problems and measures - e.g. campaings, public hearings, exhibitions, booklets, information bulletins, radioprogrammes, TV repotrs etc.
- hold training seminars for journalists on topical problems;
- organise special training courses for various professional groups, branch organisations, NGOs and other groups, snall farmes etc. This type of knowledge dissemination has a crucial significance for preventing incident pollution from industry and agriculture and reducing the health risk. Preventing this type of incidents is a question of institutional and legislative arrangements, as well as established responsible individual behaviour;

- develop and implemet programmes for environmental and health education of youth and students;
- support the implementation of plans for the sustainable water management on national, regional and local level through development of projects under key programmes;
- lobbying among leading economic and financial sectors for solving hot problems;
- in cases of incidents, together with the media to inform the community for preventive measures.

Note: Each lector from indivuddal countries can add to the information for the thresholds depending on the national legislation.

5 Case studies

5.1 Restoration of Streams in the Agricultural Landscape (Sweden)

Lena B.-M. Vought

Human influence on streams and rivers

Historical reconstruction of ancient stream systems shows that many of todays streams have little in common with those which existed prior to human impact (Wolf 1960, Sedell and Luchessa 1982). Reconstruction of ancient Swedish streams, for example, suggests that they were typically meandering, had close contact with their floodplains and passed through extensive areas of riparian wetlands. In more recent times these natural streams have been profoundly modified. Tile draining of agricultural fields has had particularly detrimental effects: reducing the stream-land interaction, decreasing groundwater levels and limiting the extent of the hyporheic zone which surrounds streams (see below). Channelisation of streams and drainage of riparian wetlands has exacerbated these processes and resulted in the widespread decoupling of streams and their riparian floodplains.

Reduced contact between the stream and its surrounding environment has led to:

l. Significantly reduced nutriernt retention capabilities of streams (Dahm et al. 1987). This has led to streams becoming little more than trarisport ditches in terms of their nutrient dynamics.

2. Changes in the stream hydrograph. Greater peak discharges have often resulted from installation of more efficient drainage infrastructures (particularly tile-drain networks connected to deep, straightened and unobstructed channels) with concomitant reduction of surface and subsurface water storage areas.

3. A reduction in water transit time. The more rapid movement of both subsurface and surface waters has decreased the self-cleaning capacity of stream ecosystems and resulted in increased transport of nitrogen and phosphorus to the sea.

4. A change in channel stability. After channelisation (channel straightening, deepening and creation of steep slopes) streams are hydrodynamically unstable and they attempt to recreate a more stable form. This instability is compounded by riparian vegetation removal. As a result, bank erosion, sediment transport and often deposition increase in the channel. .

5. An increase in light penetration to the stream. With the removal of trees and bushes along the stream, aquatic macrophyte production is enhanced. Macrophyte growth in turn, slows water flow, increasing sedimentation. Streams may therefore have to be dredged more often to prevent flooding.

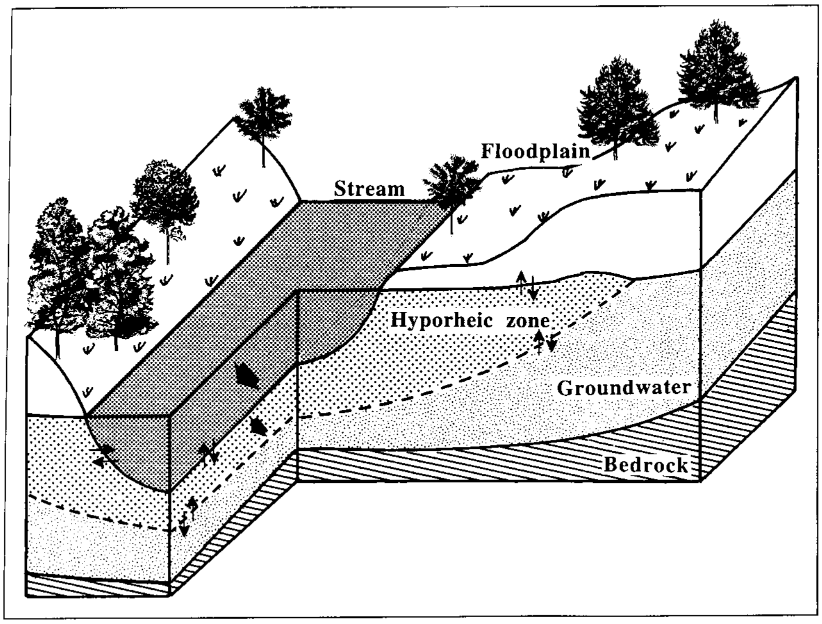
6. A depletion of the flora and fauna around and within the stream. Drainage and channelisation allow riparian areas to be converted to farmland destroying marginal wetland habitats. Benthic stream habitats are simplified and repeatedly disturbed by siltation and subsequent dredging.

7. Decoupling of the land/water interaction. As a result of drainage, most surface runoff enters streams directly without passing through a riparian buffer strip. This reduces groundwater recharge. Subsurface flows are altered due to the lower groundwater table. Important areas for nutrient uptake are destroyed, increasing the downstream transport of nitrogen and phosphorus.

The importance of the hyporheic zone

Contemporary river ecology is based primarily on biochemical and geochemical models of the river channel and its interactions with riparian vegetation. An area that is not commonly included in these conceptual models are the extensive floodplain aquifers that are hydraulically connected to the open-channel and the true groundwater (Stanford and Ward 1988). These aquifers are an interface between the basin ground waters and the stream water, and are referred to as the hyporhe ic zones (Figure 1).

Figure 1. Conceptual model of the groundwater-surface water interface.



The volume of the stream hyporheic zone often considerably exceeds the volume of stream channel. For example, in the Flathead River (USA), the volume of the water in the hyporheic zone was 3 x 10^8 m^3 compared to 1.2 x 10^5 m^3 for the stream channel (Stanford and Ward 1988). Similar ratios have been found in Sweden (Vought et al. 1991).

Streams with heterogeneous substrata, and permeable, unconsolidated beds, have been shown to provide transient storage of nutrients for periods of hours or days (Triska et al. 1989). There is also evidence that the streambed/hyporheic zone transition area may be an extremely active site for denitrification (Bencala et al. 1984, Bencala 1984, Williams 1984 Vought et al. 1991, 1994). The streambed/hyporheic area therefore plays a significant role in nutrient recycling because it acts both to increase the time lag between rain 'event' and surface runoff, and to provide an increased surface area for nutrient conversions.

Methods for stream restoration

In the following section four of the principal measures used to restore rivers are discussed:

- recreation of buffer strips;
- alteration of tile drainage;
- creation of riparian ponds and wetlands;
- in-channel modifications.

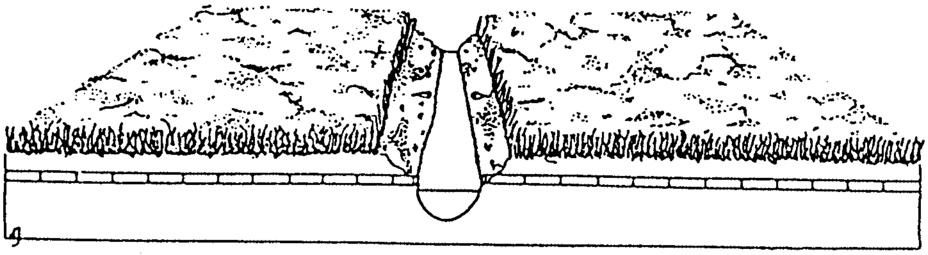
Buffer strips

Developments in freshwater ecology have increasingly emphasised the strong links between terrestrial and freshwater environments and focused attention on the importance of the riparian ecotone: the transition zone between the terrestrial and the aqutic ecosystems.

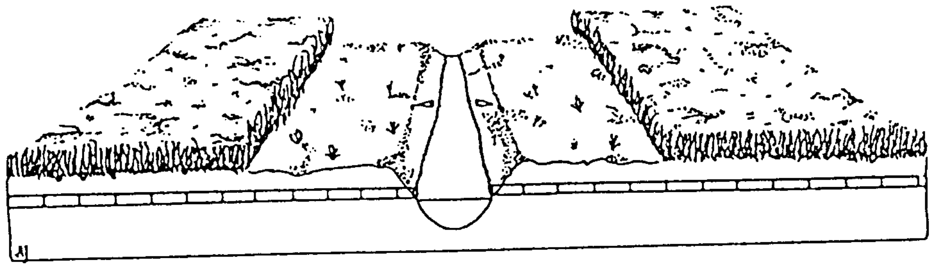
Most water entering or leaving a stream, passes through the riparian ecotone. It usually does so via one of five pathways: surface runoff, seepage, shallow subsurface flow, deep subsurface flow and through drainage tiles. The unique physical and biogeochemical properties of a riparian ecotone influence the flux of water, nutrients and other exogenous substances both from the catchment areas to the stream and within the stream and its immediate surroundings.

Because the riparian ecotone is an active and important area of any stream, appropriate restoration of this area - as for example a grassland (Figure 2B), scrub or native woodland (Figure 2C) buffer strip - can be a particularly valuable part of river restoration (Vought et al. 1994).

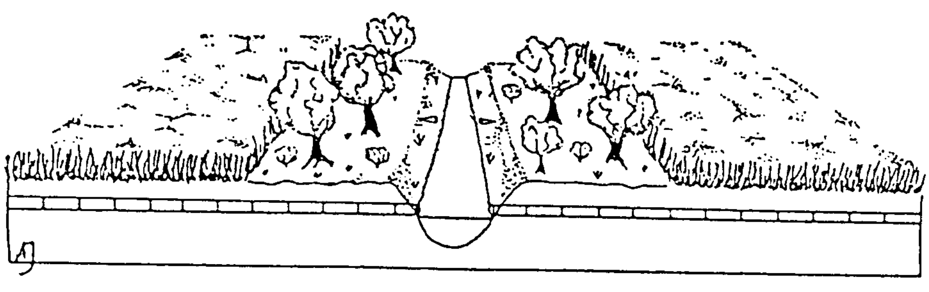
Figure 2.
A buffer strip as it looks today in the agricultural landscape



Stream with a 10 m wide riparian grass buffer strip



C. Stream with a 10 m wide riparian tree buffer strip



Nutrient removal in buffer strips

One of the most significant effects of the reintroduction of riparian ecotones along the margins of a river is that it can reduce input of nutrients entering streams by surface and subsurface flow (Figure 2A-C). Phosphorus mainly enters streams through surface flow. The extent of phosphate uptake from surface flows will depend on factors such as slope, water transit time, vegetation and season.

However, literature sources provide fairly consistent evidence, where most of the phosphorus is removed with a buffer strip of 10 m width. Nitrogen mainly enters streams through subsurface flows, and again studies show that the major part of the nitrate is removed with a 10 m buffer strip. This efficient removal of nitrate may be explained by the recent work of Duff and Triska (1990) who show that much denitrification occurs in the stream hyporheic zone.

Wooded buffer strips

The reintroduction of trees along stream banks can be a valuable technique in river restoration because woody vegetation can stabilise stream banks, provide habitats for fish and invertebrates in amongst their roots, and shade the stream itself.

Many lowland streams have a dense macrophyte vegetation due to high nutrient and light levels. In Denmark, experiments to reduce macrophyte growth in lowland streams led Dawson and Kem-Hansen to suggest that the growth of bank vegetation should be increased to reduce light levels to about half that in unshaded sections (Dawson and Kern- Hansen 1978, 1979, Kern-Hansen and Dawson 1978).

There are some suggestions that alder (Alnus sp.), one of the most common riparian trees in many parts of Europe, may act as a significant nitrogen source in nutrient poor streams and lakes (Dugdale and Dugdale 1961). Alder possesses an endophytic actinomycetal fungus in root nodules, and like leguminous plants, is able to fix nitrogen. Rates of nitrogen fixation of up to 225 kg N ha^{-1} yr^{-1} or 22.5 g N m^{-2} yr^{-1} have been measured (Wetzel 1975), however it is likely that such rates predominantly occur in waters naturally low in nitrate. Preliminary results from riparian alder woodlands in Sweden, for example, show no evidence of elevated nitrogen levels. It seems likely that in waters with higher nitrogen levels, alder uses this in preference to the more energy-costly process of nitrogen fixation.

The effects of buffer strips on fish

The reported effects of marginal shade and cover on fish are varied. Work on forested streams in westem USA showed that clear-cut areas adj acent to streams increased both the biomass and the density of cutthroat trout (Salmo clarkii) by a factor of two (Aho 1977). This increase in trout was explained by the greater food abundance in the unshaded clearcut sections (Hawkins et al. 1983). Streams in the USA had, however, very low nutrient status and very dense tree cover compared to most European streams. Other work by Bousse (1954) and Burton and Odum (1945) have shown contrary trends: that removal of natural cover decreases populations of trout because it allows summer stream temperatures to rise too high. Similar results have been obtained by Barton et al. (1985), who in describing the habitat and physiological requirements of trout, found a 10 m buffer strip to be optimal for supporting trout populations.

Combining the results from the data summarised above it is sugested that for the instalation of buffer strips:

- buffer strips providing moderate vegetation shade can be suitable as a means of both reducing stream vegetation and benefiting trout populations; '

- combining evidence of faunal requirements, nutrient reduction demand and the farmers´ need for land, a minimum riparian buffer strip width of 10 metres seems a realistic suggestion; .
- one of the main problems with buffer strips, is that the roots of the woody vegetation can penetrate and clog drains as they pass under the buffer strip. The solution is either to replace the tile drains with a solid pipe or to open the pipe and excavate a small wetland buffer which filters water before it enters the stream (see below).

The likely benefits from restoring buffer strips will be:

- reduction of the amount of nutrients entering the aquatic system;
- improved channel stability;
- decreased light penetration to the stream thereby reducing macrophyte growth in the stream;
- enhanced fauna and flora.

Amelioration of agricultural point-source pollution by alteration of tile drainage

Many agricultural lands in northern Europe and temperate North America, were originally developed from floodplain wetlands. To facilitate agricultural land drainage, rivers and stream channels were frequently lowered and the surrounding lands underlain by tile drains. These drains now carry nutrient-laden waters below the floodplain to empty directly into streams. In doing so they effectively create numerous point sources for nutrient pollution and bypass the natural filtering systems of marginal land areas.

A method which can be used to decrease point-source pollution is to open up the drainage pipes before they enter the stream. This can be done in one of several ways dependent on the topography of the landscape.

Opening pipes

Where valley slopes are moderate, pipes can be opened at the valley edge to allow water to filter through the riparian wetland before entering the stream (Figure 3A). For example, the drain pipes can be opened up to allow water to flow into a ditch running parallel to the stream at the base of the break of the slope. The ditch will disperse the water along the length of the valley and allow the water to trickle through wetland to the stream. This method of using the riparian wetland as a trickle-filter is similar to that of water meadows, which have for centuries, taken advantage of the nutrients in stream water to fertilise the land. The main concern using this method is to ensure that the water is dispersed and slowed, and that drainage water does not simply run across the floodplain as channelised overland flow.

Riparian wetland horseshoes

Another solution is to use riparian wetland horseshoes (Figure 3B). These are semicircular shaped excavations which are excavated into stream buffer strip to expose each drainage tile. The horseshoe is generally dug 8 m into the buffer strip to create a mini-wetland, allowing water from the pipes to flow over a grassy, shrubby section before entering the stream. An altemative method is to dig-out small ponds at the stream edge. Both methods will enhance the self-cleaning capacity of the water and reduce the amount of nitrogen and phosphorus entering the stream from each point source.

Where land is flat, pipes can simply be opened up allowing water to filter out naturally; the distance the water flows before entering the stream can be extended by meandering the ditch channel.

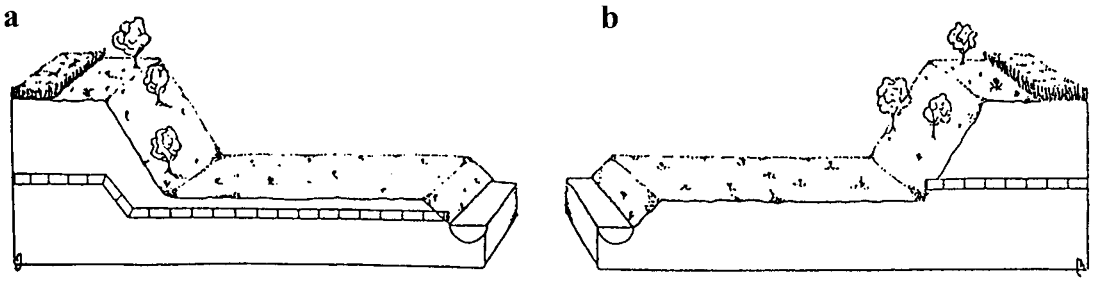
Although each interception area is small, where a large number of wetland horseshoes are placed along the length of a stream this can have a large impact on total nitrogen inputs. The effects are greatest during the peak runoff periods of the late fall and early spring when drains are flowing. This is also the time when most nitrogen and phosphorus is exported from catchments (Petersen et al. 1987) .

The main benefits of intercepting and ameliorating point sources of agricultural drainage will be:

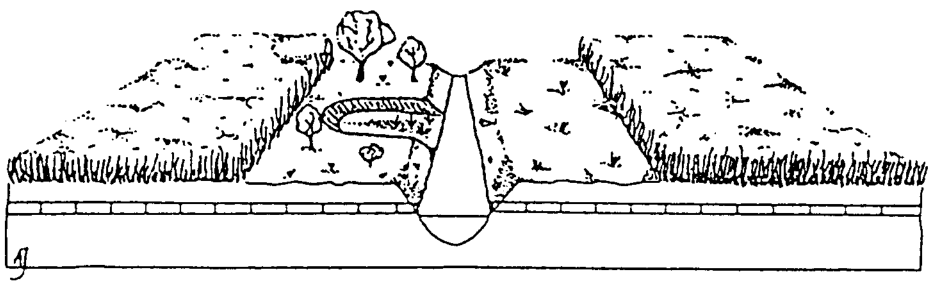
- reduction of nutrients lost to the aquatic system;
- stimulation of the growth of the wetland plants along the stream valley.

Figure 3.

A. Drainage tiles opened up at the stream bank (a) and at the beginning of the stream valley (b) .



B. Horseshoe built within the riparian buffer strip.



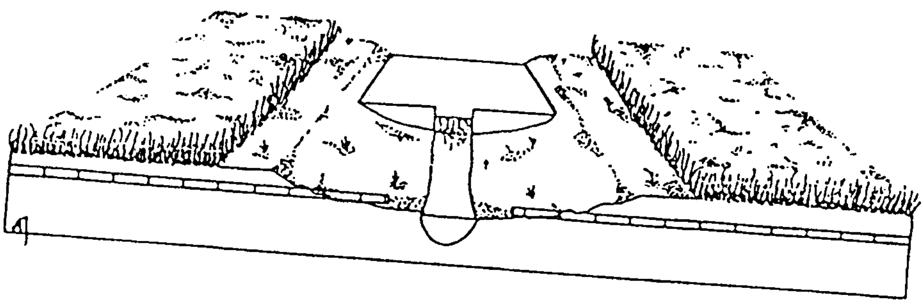
Riparian ponds and wetlands

Small ponds created either along the stream valley or within the stream channel are an economical and multi-use restoration measure (Figure 4). Ponds will collect particle bound phosphorus and sediment. In addition, organic material will build up which will enhance denitrification in these areas. Larger ponds can be used for irrigation or for different types of low intensity aquaculture including the rearing of crayfish, eel, carp and ducks. Intensive aquaculture is not recommended since it is likely to add to nutrient enrichment problems.

Along many channelised agricultural streams there are areas which are seasonally wet and often difficult to plough. These swamp areas are usually relicts of former wetlands or swamp forests, and where it is possible to reclaim them, they can be valuable enhancement sites for both wildlife conservation and nutrient retention. These areas, similarly to the hyporheic zones described above, may enhance denitrification. Vegetation from the seasonally wet areas along the stream will build up areas with high organic content, which together with low oxygen levels will provide conditions ideal for denitrification.

Strategically, considering the nutrient cycle as a whole, the most cost-effective place to create pond/wetland areas are close to the sea where nutrient concentrations are at their highest. Given the magnitude of the problem however, a corridor of pools and wetlands higher in the catchment may be more effective and have considerably greater overall benefits. wetlands/ponds placed in the headwaters can also reduce peak flow and retain water for dry periods. Overall, the restoration of wetlands along whole streams, can enhance water quality throughout the catchment and will improve the stream ecosystem.

Figure 4. Pond built in the channel of a stream



Benefits of the wetland/pond will be:

- sedimentation of phosphorous-laden particulate material;
- denitrification within the wetland/pond system;
- reduction of peak flows where ponds/wetlands are placed in the headwaters;
- increased water storage which will reduce the occurrence of extreme low flows;
- creation of habitats suitable for wildlife such as ducks, other birds and fish;
- similarly to the hyporheic zones described above, these areas may enhance denitrification;
- recharge of the water table within the valley which increase the area available for biological self-cleaning processes;
- an increase in the length of time that water remains in the valley which will aid selfcleaning
- growth of wetland plants and development of wetland habitats which will improve the overall aesthetic value of the valley.

In-channel modifications

Side slope reduction

In channelised streams, bank failures along the channel sides are a major source of stream sediment. Sedimentation can be so great that channelised water courses often have to be dredged every few years to maintain flood capacity. Inputs of sediment can also considerably increase phosphorus levels since most phosphorus enters streams bound into, or adhering to, particulate matter.

In many channelised streams bank slopes are steep; usually at least 50% (i.e. 1:2). Reducing these slopes to a maximum of 25% (1:4) (Figure 5A) and stabilising them with vegetation can have several benefits.

Firstly, reduced slopes lower the frequency of bank failure and the amount of soil directly entering the channel. Secondly, reducing slopes will increase the width of the stream channel creating an area that will function like a floodplain. This allows the stream to dissipate its energy during peak flow, reducing erosion of the channel walls. The reduction of water velocity will also enhance deposition on the channel slopes and prevent sediment transport into downstream receiving waters.

Riffle-pool sequences

Another feature which can increase the physical complexity of streams are riffle-pool sequences within the channel (Figure 5B). In natural rivers, riffles and pools occur at more or less regular intervals, usually with a frequency of 5-7 times the stream width. Construction of riffle-pool areas has long been the major tool of stream management for trout and other fisheries. These practices include providing shelter, pools and small barriers to diversify the stream bed and provide a greater abundance of invertebrate food for trout (Tarzwell 1935). In some areas riffles have simply been constructed from excess stone material collected from the surrounding agricultural lands. Exact placement has not been critical since the stàeam resorts the material over the next 5-10 years. Hynes writing in 1970, regarded the provision of riffle-pool sequences as the basis of stream management and regretted that their retention and creation may have gone out of fashion. More recently, as streams have become increasingly valued as landscape features the importance of riffles and pools are becoming realised once again.

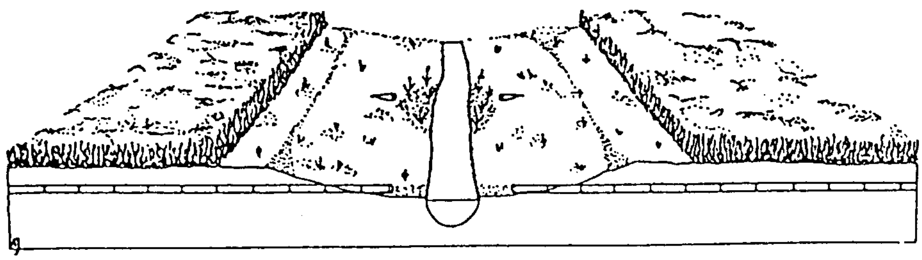
Recreating meanders

Where streams run across lands of low gradients the most hydrodynamically stable stream path is the meander (Figure 5C). Reconstruction of meanders is not always easy, particularly since the original straightening of channels was often accompanied by channel deepening.

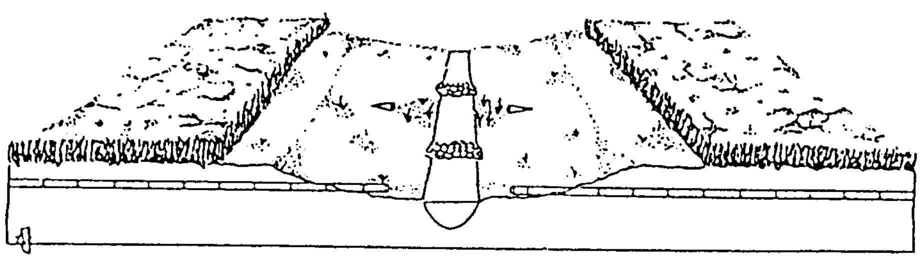
Sometimes recreation of meanders requires the provision of land to give room for the meanders. In other cases water levels have been raised which have simplified the process. Reconstruction of meanders is a major undertaking and requires expert hydrological and geomorphological advice in order to create meander widths and amplitudes which are appropriate for the substrate type and hydrological regime.

Figure 5.

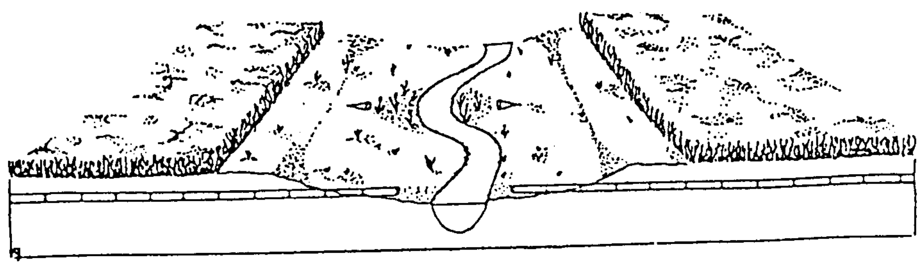
A. Side slope reduction along a stream.



B. Riffle-pool section within the channel



C. Meandering stream



The benefits of channel modification will be:

- decreased bank erosion;
- increased flooding of floodplain which will allow sedimentation of the suspended load;
- increased complexity of the stream bottom which will enhance the habitat for the macroinvertebrate and fish fauna;
- increased retention of organic matter due to increased stream complexity, which will increase available food for macroinvertebrates;
- increased water retention time in the valley which is achieved by a longer stream channel due to meanders.

5.2 Restoration of Streams and their Riparian Zones (South Jutland, Denmark)

Mogens Bjorn Nielsen

Background

Rivers and streams are an important component of the Danish landscape, with about 1.5 km of stream length per square kilometre of land and a total watercourse length of approximatel 65,000 km. A little over half of these streams and rivers are considered to be natural in origin, the remainder are man-made ditches and drainage canals (Danish Ministry of Environment 1992). Nearly all streams, man-made or natural, have been straightened, deepened and suffered rigorous maintenance practices which aim to avoid flooding and to increase drainage efficiency on farmland.

The county of South Jutland covers an area of 4,000 km^2 and is predominantly low lying, with streams of relatively low energy. The riparian zones have largely been given over to agricultural grassland grazed by livestock. Stream restoration projects, including restoration of riparian zones, have been in progress in South Jutland for 10 years, and during this time more than 200 schemes have been undertaken. The main objectives of these schemes have been:

- to reduce nutrient losses from catchments; and

- to protect biodiversity.

Restoration projects have varied from the introduction of single structures (such as gravel spawning beds) to more holistic measures involving integrated catchment management policies to reduce pollution, remeander straightened channels, and to restore active floodplains.

Causes of degradation of streams

<u>The effect of agriculture on streams in Denmark</u>

In Denmark, as in much of Europe, the condition of streams and their riparian zones is closely linked to the development of agriculture. Up to the 1970s, streams were channelised, straightened and deepened allowing riparian zones to be drained for intensive farming. These engineering works have now affected most natural stream channels in Denmark, leaving them straight and deeply incised with collapsing banks. Many streams also transport large amounts of eroded sand giving them soft, uniform stream beds, without pebbles, cobbles or vegetation. Destroying the physical structure of streams in this way has, in turn, had a detrimental effect on the number and variety of stream biotopes, resulting in reduced fish and invertebrate diversity. In particular, in the channelised and steepbanked streams, salmonid breeding grounds have been much reduced and undercut-bank cover (an inherent property of meandering streams) is now sparse. Substrates for invertebrates have been either removed by dredging or buried in fine sand. In addition, nearly all South Jutland's streams have, in the past, suffered from rigorous management practices (such as desilting and cutting of stream vegetation) which had been introduced to reduce the frequency of flooding and to increase drainage efficiency on farmland in the riparian zone.

The intensification of stream management in Jutland has been accompanied by extensive changes in the surrounding land. At the beginning of the l9th century, semi-natural habitats, such as meadows and heathland, covered almost half of Denmark. Today this figure has declined to only 5 %. In the same period, the area covered by lakes and wetlands was reduced by over 50%.

Recent changes

Until recently, the only official function of streams in Denmark was to drain excess rainfall as quickly as possible from farmland and urban areas. During the 1980s, attitudes began to change and concern about the environment has led to additional and quite different demands being made on streams. Now the requirements for streams and their riparian zones are that they must also:

- have a varied fauna and flora;

- be a natural part of the landscape; and

· be aesthetically and recreationally attractive.

This has resulted in the initiation of a great variety of projects to restore channelised streams to a more „natural" form and to raise groundwater levels in stream valleys.

Legislation on freshwater protection

Administrative structure in Denmark

Environmental protection and nature conservation in Denmark is controlled by national, county and municipal authorities. Each of these three authorities is elected for a four-year period under the system of proportional representation.

The role of national authorities in water management

National authorities are responsible for developing policies to protect the water environment and for drawing up legislation, regulations and guidelines for this purpose. National authorities also collate results from county and municipal environmental programmes to produce nation-wide surveys and reports. Decisions made by county and municipal authorities can sometimes be appealed to the Ministry of the Environment or the National Protection Board of Appeal.

The role of county authorities in water management

The 14 county councils in Denmark are responsible for the practical implementation of water protection and nature conservation legislation (Association of County Councils in Denmark 1993). As water authorities, they also have responsibility for maintaining the ecology, water quality and water flow of all larger rivers.

The necessary basis for county policy-making and administration is assured by measuring environmental quality, both on land and in the water. Nationally, there are 1500 highly qualified staff employed by the counties to promote environmental protection including: biologists, geologists, hydrologists, engineers, planners and surveyors. In the county of South Jutland alone there are about 110 staff employed in these areas.

The county authorities have a wide range of responsibilities. For example they:

- - supervise and license production in industries potentially dangerous to the environment;

- - lay down the rules governing the amount of waste materials which may be discharged into both water and the air;

- - limit noise pollution; and

- - may demand the introduction of clean technologies.

One of the most crucial roles undertaken by the county authorities is to act as „environmental watchdogs". The authority sets regional environmental quality objectives for the quality of streams, lakes and coastal waters. These targets act as the basis for the local authorities' decisions regarding wastewater disposal and for the county councils' licensing of discharges into streams, lakes and marine waters.

For most Danish streams (78%) these quality objectives relate to fish and 45 % of these, particularly to salmonids. Environmental objectives relating to fish have proved particularly useful because they are easily understood by the public and, by using specific fish species, can give a good indication of the „ecological health“ of streams.

The role of municipal authorities

The 275 municipal authorities in Denmark are responsible for implementing county policy guidelines in the form of municipal and local plans that more precisely define future policy. Municipal authorities are, for example, responsible for implementing measures to reduce pollution such as sewage and wastewater treatment, refuse disposal and recycling programmes. In addition, they are responsible for the environmental approval and supervision of all small, and potentially polluting, private sector enterprises, including farms.

Legislation on streams and riparian zones

Laws regulating the use and protection of Danish streams are contained in 7 Acts:

The Watercourse Act 1982

The Environmental Protection Act 1973/1991

The Water Supply Act 1978

The Nature Protection Act 1992

The Ochre Act 1985

The Nature Management Act 1989

The Freshwater Fisheries Act 1992

The overall objective of this legislation is, as noted above, to ensure that streams have a diverse flora and fauna, that they are a natural part of the landscape, and that they are aesthetically and recreationally attractive.

Maintaining high quality streams requires that three conditions are fulfilled simultaneously: (1) that there is clean water, (2) there is sufficient water and (3) physical habitats are varied.

To provide these conditions it is therefore necessary:

- to ensure that wastewater from sewage plants and septic tanks is adequately treated; - to control outlets and discharges from agriculture (e.g. liquid manure and silage),

- to ensure that stream maintenance (e.g. cutting stream vegetation and removal of sediment) is undertaken in a way which is environmentally sensitive; and

- to restore physical habitats in streams which have been severely engineered.

Restoration methods

In Denmark, stream restoration started in about 1980. Physical restoration has followed two tracks: the introduction of more ecologically appropriate maintenance practices and one-off restoration schemes (Iversen et al. 1993).

Changed maintenance practices using „soft engineering“

In Denmark, a realisation of the damaging effect that river maintenance practices can have on stream ecology, led to the Watercourse Act (1982). This resulted in a revision of existing river maintenance practices and the provision of new regulations which consider both the need for flood protection and the needs of the environment. The act states, for example, that stream maintenance must not conflict with the fulfilment of the strearn environmental quality objectives.

Modified maintenance regimes are a valuable part of stream restoration because:

- they can result in considerable ecological improvements;

- they are relatively inexpensive to change in relation to the possible improvements for wildlife; and

- they can be part of a sustainable solution for managing the stream.

One-off restoration projects

One-off restoration projects can be divided into two types: single-structure restoration and stream channel restoration.

Single-structure restoration

Folowing single-structure restoration techniques have been successfully implemented in Denmark:

1. Artificial overhanging stream banks to provide cover for fish
2. Stream deflectors to enhance stream velocity
3. Rows of large stones placed along the stream margins to narrow the channel and increase stream velocity
4. Soft engineering for stream bank protection
5. Fish passes
6. Introduction of gravel beds
7. Introduction of large stones and boulders to increase heterogenity
8. Replacing weirs and dams by rapids
9. Establishing a bypass channel alongside a dammed stream

Selected examples of these single-structure restoration techniques are described below.

Introducing gravel beds

Re-establishment of salmonid spawning grounds is a widespread restoration activity in Denmark, used to counteract the removal of natural, coarse-grained sediments by traditional dredging practices and channelisation work. In South Jutland alone, more than 100 stream sections have been restored in this way.

Biological, geomorphological and chemical investigations of these restorations have shown that they can have immediate benefits. However, in the long term, their successful implementation relies on control of the factors which cause excessive sediment transport from upstream, such as channelisation and subsequent maintenance, agricultural practices and urban runoff.

As a rule, stretches with large sediment transport should be avoided because excess sediment transported from upstream rapidly swamps the gravel spawning grounds, rendering them useless. However, it may sometimes be possible to create hydraulic conditions that will enable at least some of the gravel areas to remain free of sand.

A short-term solution in lieu of controlling sediment input is to widen and deepen the stream over a short distance. This creates a simple sediment trap with reducing flow velocities. Although sediment traps may be useful, they are more generally undesirable both because they are artificial and because they require regular maintenance.

Removing obstacles to migrating fish and invertebrates

In-stream structures such as weirs and dams can form obstacles to faunal migration, particularly fish. Since 1980, stream restoration work in South Jutland has involved about 120 improvement schemes which have removed or modified in-stream obstacles.

In about 60% of restoration projects the barrier effect was ameliorated by modifying weirs to create extended riffles. To do this a wedge of stones and boulders is placed immediately downstream of the weir, changing the fall into a riffle and considerably enhancing faunal passage.

Often, however, dams cannot be removed, either for historical or cultural reasons (e.g. water mills, electricity power plants) or because of economic or legal constraints (e.g. fish farming). In such cases fish ladders have frequently been used, but more innovatively, restoration projects have sometimes diverted part of the flow alongside the dammed stream, thereby satisfying cultural, historical and economic interests while facilitating faunal migration.

<u>Stream channel restoration</u>

Typical methods of stream channel restoration used in Denmark are:

1. Multiple use of single structure elements
2. Establishment of two-stage channels
3. Reopening of piped streams
4. Recreating of old meanders in straightened streams
5. Raising the water level in riparian areas

Selected example, recreation of meanders, is described below.

Recreating meanders

The most radical step in stream restoration is to remove the straightened, channelised stream and recreate a new meandering channel and at the same time raise the groundwater level in the adjacent riparian zones in the whole stream valley. Traces of old meanders can often be seen in the form of small, water-filled depressions.

Planning of restoration schemes starts with the use of old maps, aerial photographs and existing data on the local geology and the stream hydrograph. After a levelling survey of the stream and its surroundings, the hydraulic consequences of different restoration measures are modelled using computer-based hydraulic models. In Denmark, the computer programme MIKE 11 is widely used to calculate the consequences of the proposed changes. MIKE 11 simulates unsteady onedimensional flow in stream channels and adjacent floodplains and is therefore suitable for use in designing and managing all kinds of streams including restored stream channels.

Attempts are made in these schemes to re-establish the natural riffle-pool rhythm, i.e. length of riffle 2-3 x channel width at intervals of 5-7 x channel width. This is done by excavating five typical cross-sections, including one with a point bar on the inside and a pool on the outside of a bend.

Wooden pegs in different colours mark the new meandering course, showing to the operators of the excavation equipment which form is to be created where, with a precision of a few centimetres. This prevents an unnecessarily large transport of sand in the new, unvegetated and therefore very vulnerable stream bed.

At the downstream end of a new reach temporary sand trap limits the downstream damage caused by restoration work. This sand trap is made simply by making a 50-100 m stretch about 1 m deeper and 2 m wider than usual to trap the sediment transported.

Planning of restoration schemes also takes account of the following factors:

l. The remeandered stream course should ideally cross the old straightened section at many points, in order to enhance the recolonisation of stream plants and animals.

2. Larger stream restoration projects involving major excavation work should be undertaken during the period with lowest average discharge (in Denmark, this is July-September) and should be completed before the trout spawning season in autumn.

3. Larger stream restoration projects should also incorporate a primitive sediment trap at the bottom end of the restored reach to retain the bed load and part of the suspended sediment which will be transported downstream as a result of excavation.

Redevelopment of the catchment

Until now there have been only a few cases where more holistic restoration projects have been possible, involving redevelopment of the whole catchment. Holistic schemes are ideal for river restoration, because they allow multiple objectives to be fulfilled simultaneously. However, they may be hard to realise in practice because of the many interests involved. In two catchment areas in the County of South Jutland the essential elements of holistic redevelopment of catchment areas have been fulfilled. These catchment areas are the River Torning (catchment area of 105 km^2) and the River Brede (catchment area of 465 km^2).

In both schemes the prime objective of the work has been to recreate better ecological conditions, particularly by reducing sand transport and raising water levels in the stream itself and adjacent meadows.

Improvements in water quality have been achieved by:

- recreation of wet stream-side meadows which, research shows, may reduce nitrogen leaching by an average of 400-600 kg per hectare per year (Danish Environmental Protection Agency, 1995)
- investment in improved sewage treatment
- reduction in nutrient-pollution from farmland by policy constraints, for example, specifying that extensive areas of fields must remain green in the winter season
- linking allocation of EU farming subsidies to the protection of surface and groundwater. For example, grants which encourage low-intensity cultivation on land adjacent to streams and lakes, and subsidies for reducing fertiliser use in nitrate-sensitive areas

Thus, by a combination of planning policies, allocation of subsidies, modification of physical structure and water quality improvements, both stream channels and broader catchment areas have been improved. Changes in management practices have enhanced this process.

General recommendations for catchment restoration schemes are that:

1. Restoration projects should try to include the whole stream or river valley wherever possible.
2. Schemes should assess existing habitats which may be affected by the restoration scheme and ensure that those of value are adequately protected.
3. Restorations should try to recreate dimensions and discharge capacities to secure a hydrological contact between the stream and its valley.
4. In order to design appropriate restoration schemes it is important that existing information about the river valley is obtained and used, e.g. planform of the old stream course, existing stream dimensions and conditions (slope, discharge, water level and existing infrastructure such as pipes), must be obtained.

Documentation and evaluation

Some of the restoration projects undertaken in Denmark have been accompanied by intensive monitoring programmes. The following section describes the lessons learnt from our experience to date, with particular reference to the monitoring of the River Gels (1989-1994) described by Kronvang et al. (1994). The effects on the macroinvertebrate community is described in Friberg et al. (1994).

Recommendations on monitoring the effects of stream restoration

To get the best results from monitoring restoration schemes, it is essential that the monitoring programme is planned very early in the project or even before!

Monitoring should include not only assessment of the restored reach itself, but also sections upstream and downstream. The upstream section acts as a reference reach, which enables one to establish and eliminate the effect of other factors which could be affecting the stream (such as climate or the effects of routine river maintenance). The downstream reach enables one to assess the possible detrimental effects of higher sediment or nutrient release resulting from the restoration work.

To provide a good baseline it is also important that monitoring of significant variables (including sediment and nutrient transport, hydrology and ecology) starts at least one year, and preferably two years, before the start of restoration work on the ground. Monitoring should also continue for as long as possible after restoration.

Other recommendations are:

1. It is important that sediment mobilisation, transport and retention are monitored because they have significant effects on phosphorus transport and on the ecological quality of the restored and downstream reaches.

2. For studies of mass balance it is important that monitoring samples should be taken simultaneously at upstream and downstream stations.

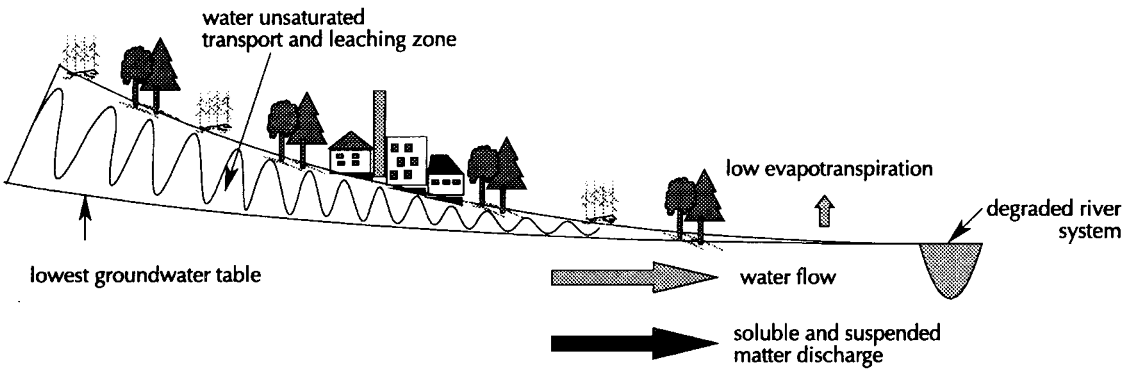
3. Monitoring should include measuring changes in groundwater levels/drainage in the riparian zones by, for example, a series of dip-well transects.

4. Ecological monitoring must use standardised methods and ensure that seasonal changes are assessed. The minimum requirement is usually two samples (spring and autumn).

Figure 1. Model for the sustainable restitution of a catchment.

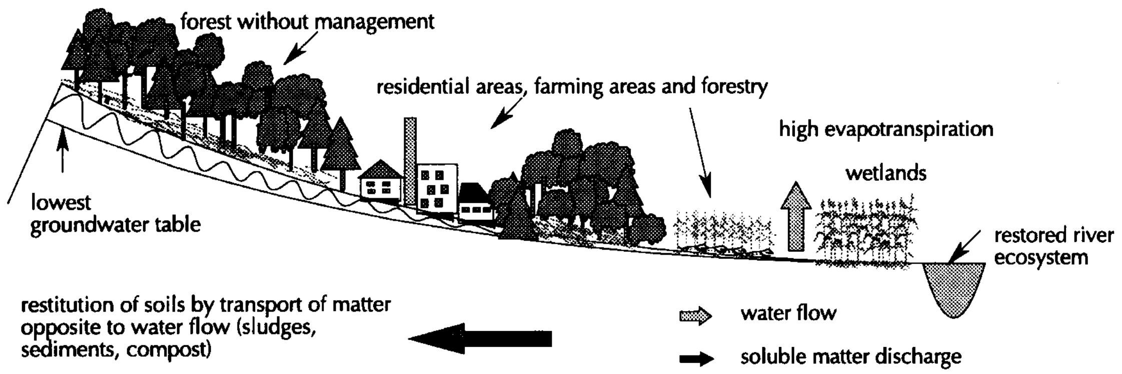
Present situation

Arbitrary distribution of land use –
erosive system, high losses of matter.



After restructuring the catchment

Phase-related distribution of land use, conservative system,
minimised losses of matter and improved energy dissipation by
enhanced organism structure (parallel energy processors).



Objectives of the restitution

1. to improve the vegetation cover
2. to reduce air pollution (CO_2, particle emissions)
3. to improve soil structure by nutrient and mineral retention
4. to restore microclimate and short-circuited water cycle
5. to detoxicate soil by vegetation growth
6. to protect the groundwater and improve water quality

Conclusion

Streams and rivers, like the landscape as a whole, are constantly changing. The forces of nature have an impact but today the most significant influence on nature comes from humans. People have changed from being a part of nature, to becoming the manager of nature. This has brought us many benefits but also many problems.

In Denmark, the detrimental effects of river channelisation, dredging and weed-cutting have been so obvious that, for more than a decade, Danish river authorities have worked to restore rivers and change management practices. Some of the methods and practices now used have developed from the results of research projects, others are really only applied common sense. The central philosophy is simple: if it is harmful to wildlife to destroy stream biotopes, re-establishing them should be expected to be beneficial.

It is not possible for humans to restore the landscape to its original natural state. Once disturbed or destroyed habitats can never be completely recreated. It is, however, possible to rehabilitate features and habitats in a way that brings conservation benefits: a restored river with diversity of habitats is better than a channelised stream with little diversity. It is better still to protect habitats of existing value than to have the difficulties and expense of attempting to recreate them once destroyed. So as much effort as possible should go to securing and protecting undisturbed streams and riparian zones. The lesson from Denmark and other countries is that the requirements of „agricultural and economic development“ are no longer sufficient excuses for a modern society to disturb or damage its streams and wetlands.

It needs to be stated that, quantitatively, the restoration efforts in Denmark have so far contributed little to the general improvement of the environment. However, restoration projects are valuable for creating public interest in the environmental quality of streams. Moreover, even though the total length of stream channel physically restored may seem insignificant, other restoration measures such as removing or rebuilding obstacles for faunal passage, can affect species movement along whole streams and have a more significant impact (Iversen et al. 1993).

At the beginning of the stream restoration era 15 years ago we were happy just to introduce a single-structure restoration feature into a stream. In subsequent years we have realised that some single-structure methods have their negative sides. Structures such as artificial overhanging banks constructed with planks have successfully provided cover for fish but they are not a natural part of the stream or landscape. In combination, such features can change the river's sports fishery into a kind of „put-and-take“. This may be acceptable in specifically designed man-made habitats such as former gravel pits, but it is certainly not acceptable in natural streams.

Some of the projects from South Jutland described in this chapter have been very successful in achieving multiple objectives. The results from the River Brede and the River Torning in particular show that, with effort, it is possible to bring nature conservation and ecosystem benefits across whole catchments. To do this the disparate interests along the whole of the stream must be considered. Normally it is not possible to meet all needs and demands at the same time. Society has to choose its priorities. This choice must be done on a democratic basis which considers all interests, but at the same time, it is essential that the choice made ensures a sustainable future for our rivers.

5.3 Case study: Large-scale Restoration of Species-rich Meadows (Morava River, Slovakia)

Ján Šeffer, Mirka Čierna, Viera Stanová, Rastislav Lasák, Dobromil Galvánek

Introduction

The development of agriculture since the 1940's has caused substantial damage to natural environments. During the socialist period, a high number of subsidies for ploughing and intensification of grasslands destroyed several species rich meadows throughout Slovakia's mountain and lowland areas. Traditional private land use was almost destroyed and replaced by co-operatives and state farms. The use of hybrid seed mixtures, over-fertilisation and intensive grazing resulted in habitat degradation and destruction. As a result of such fierce cultivation, the biodiversity value was strongly diminished, some vegetation types almost disappeared and many plant and animal species have become rare and endangered. Historically, there have been substantial losses throughout Slovakia, especially in the area of wet grasslands. Extensive floodplain meadows existed throughout the southern parts of Slovakia, in the floodplains of bigger rivers like Danube, Morava, Ipeľ, Latorica, and lowland sections of Hron and Bodrog rivers (Ružičková 1994). Floodplain meadows of alliance *Cnidion venosi* are disappearing mainly due to regulation of watercourses in lowlands; except the Morava River, the last remnants can be found at Latorica and Ipeľ rivers in Slovakia.

River regulation and dike building were the principal causes of grassland loss outside the Morava floodplain area. In the floodplain area 493 ha of meadows was ploughed during socialism and former floodplain meadows were changed to arable land and used for intensive farming. The ploughing was concentrated on the middle section of what is now the Ramsar site, and the arable land was regularly fertilised with herbicides. Some fields are still active, but most fields have been abandoned for a few years and are now under invasion from weed and alien species, especially *Aster novi-belgii* agg. Intensive use of chemicals has caused an increase of pollution in the Morava River and a decrease of species richness. These fields have low biodiversity and have become a barrier for nesting and migrating bird species. For example, the occurrence of Corncrakes was not registered in that section of the river.

Presently, meadows and arable land in the Morava River floodplain are owned either by private owners or by the Slovak State land fund. Farmers having the statute of co-operative of stakeholders or private company can rent the land, but ownership relationships are modified often because the re-privatisation process has yet to be completed.

There are a variety of methods available for the reinstatement of grassland vegetation, ranging from the wait-and-see approach of natural regeneration, to the use of commercially or locally produced seed, or turf translocation (Manchester et al. 1999). In the Austrian part of Morava-Dyje floodplain, a regional seed mixture was prepared on special multiplication fields in order to gain sufficient amount of seeds for the restoration of 74 ha of meadows (Wurzer 1999). The arable land was transformed and is managed as grassland.

Considerable experience has been gained by testing two restoration methods in experimental plots: sowing of native seeds and turf transplantation. Based on the results from the small-scale experiment and from detailed mapping, in 1998 DAPHNE, in co-operation with local farmers, started big scale restoration on 140 ha. The area for restoration was selected according to the field mapping results and negotiations with farmers. The experiences and recommendations of farmers were considered during the preparation and implementation phase. Phare Programme funded preparation and implementation of restoration plan.

Concrete steps leading to restoration

Mapping and elaboration of restoration plan

During 1997 and 1998, extensive floodplain mapping was conducted to identify arable land and abandoned fields in different stages of succession. The total number of mapped polygons was 97 with an area of 493 ha. Each polygon is supported by list of species with estimation of dominance (1 - rare, 2 - <50 %, 3 - >50 %). After inputting the data into GIS, the second step was to develop classification criteria for the mapped polygons. All plots were classified into three classes and six subclasses according the following criteria:

1. Succession - the rate of occurrence of dominant meadow and ruderal species with value 3 was evaluated
   - 1.1. Arable soil
   - 1.2. Initial - minimally two weed species had value three and all meadow species were less than three
   - 1.3. Medium- maximally one weed species had value three or all meadow species were less than three
   - 1.4. Advanced – minimally one meadow species had value three or three meadow species had two
2. Weed infestation - the dominance of invasive plant *Aster novi-belgii* agg. was the criterion. Abandoned fields in the floodplain area were under heavy infestation from *Aster novi-belgii* agg. It is an ornamental herbaceous perennial native to the eastern United States and Canada (Jelitto et al. 1985). Since the 1960's, the species has spread throughout the alluvium of the Morava and Danube rivers, and at present it is abundant, common to mass spread and belongs to the most aggressive invaders, neoindigenophytes (Uherčíková 1997). According to its ecological requirements, it is strongly nitrophylous, heliophytic hemicryptophyt demanding soil humidity and it is indicator of floods (Ellenberg et. al. 1992). It is strong competitor with k-strategy, which found excellent conditions in abandoned fields with high amounts of nutrients and lack of management.
   - 2.1. Heavy - Aster novi-belgii agg. had value three and grass species were less than two
   - 2.2. Medium- Aster novi-belgii agg. had value three and minimally two grass species were more than one
3. Depressions - were identified according to microrelief and occurrence of native hygrophilous species
   - 3.1. Minimally one hygrophilous species had three or bare bottom habitat was present

Description of restoration measures

1. Restoration scheme was proposed for the arable land, initial succession stages and for the polygons with heavy infestation of *Aster novi-belgii* agg.

1st phase

In spring and summer

- Selecting of source plots for seed collection from suitable ecological conditions in the floodplain. Two different sites representing moist meadows of alliance *Cnidion* were selected.

- Harvesting of ripe seeds in two periods according to phenological phases of target species. The first focused on grass and sedge species and later on herbs. The exact date is specified according to phenological monitoring of source meadows.
- Processing of seed mixture – drying, cleaning and preparation for transport.

2nd phase

In autumn or spring

- Seedbed preparation – ploughing and harrowing.
- Distribution of collected seed mixture together with nurse crop on the surface and rolling (oat is used to established the vegetation cover quickly and to block invasion of weeds).
- Creation of “islands of high diversity” by transfer of turf sections from good quality meadows. The turfs, 0.5 m wide, several metres long and 0.1 m thick, were ploughed from the species rich meadows. Then the turfs were placed on small open trailers and were cut into small pieces, 10 by 10-cm. The island is planted with size 4 by 2 m (from 1 m^2 chopped turfs). Turfs were spread out over eight times the area of ground they had previously occupied and approximately one island is created per one hectare.

3rd phase

- In spring or in summer (according to time of sowing) the biomass is removed.
- The frequency of mowing depends on the extent of weed invasion.
- In the case of low effectivity, seed germination follows restricted additional input of meadow seeds.
- Monitoring plots are established and the restored area is monitored regularly.

4th phase

The area is mowed and biomass is removed at least twice a year. In exceptional cases, for instance heavy weed invasion, it is necessary to re-seed some plots.

2. Special mowing scheme is proposed for areas where native grassland species are present and where there is no strong infestation of *Aster novi-belgii* agg.

- The frequency of mowing depends on the extent of weed invasion. Mown vegetation should be removed after mowing.
- In exceptional cases sowing some plots is realised.
- Entire restored area is regularly monitored.

3. Mowing – traditional mowing frequency (twice a year) is recommended in depressions where there is good potential for restoration because of the presence of native hygrophilous species.

<u>Evaluation of area according to classification and proposed restoration measures</u>

The total mapped area identified as arable and abandoned land is 493 ha. 273.75 ha has been proposed to be restored by restoration scheme, 185 ha by special mowing scheme and 34 ha in depressions will be regularly mowed. The most affected is the river floodplain’s middle section.

Implementation of restoration plan

Public participation

In order for management or restoration plans to be successfully implemented, it is necessary to co-operate with stakeholders, particularly, farmers and local authorities. It is important to remember that local people are physically and emotionally connected with nature and their comments, recommendations and needs have to be taken into account when developing restoration plans. By emphasising farmers' involvement in restoration, there is a shift away from the "top down" activity that is so often imposed on local people. To create a working environment that will yield success, it is critical to learn to communicate in a style and language that will be effective with local people.

In 1995 a public opinion poll focused on determining local people's attitude toward the floodplain area. It was indicated that most people considered the area to be valuable and that they realise the importance of conserving the natural resources in terms of economic development. However, it was also concluded that many people have a lack of information about the environmental value of the area. DAPHNE initiated "Meadows for People", an information campaign aimed to increase the public's knowledge about the Morava River floodplain meadows. Lectures were organised for the public and brochures were distributed. In 1996, our awareness activities continued with the local and national campaign "Wetlands for Life". The aim was to explain the function and importance of wetlands and to inform people about ongoing activities and trends.

All farmers and mayors working in the area were contacted in 1995 and available environmental and agriculture data were collected to help define the possible problems and advantages of the restoration plan. Through personal meetings and conferences, a platform has been provided for discussion and exchange of experiences on ecological agriculture and many agri-environmental topics.

After including farmers into the preparation stage of the Morava River floodplain's restoration plan, communication with farmers has positively developed. Farmers have been regularly consulted, their recommendations considered and their concerns such as the area proposed for transformation, restoration methods used and financial conditions were addressed. The negotiation process resulted into the invitation of five farmers for closer co-operation and finally three of them were actively participating in seed collection from species rich meadows and arable land transformation. The following criteria were considered during the selection process:

- Land was identified as either being restorable or being seed collectable.
- Professional and technical experiences either in arable land transformation or in seed collection.
- To ensure technical equipment of appropriate standard.
- Flexible and dynamic approach in problems solving.

Collection of seed material

Since the restoration method uses original seeds from floodplain meadows, the large-scale restoration requires an efficient method for seed collection. Identifying resource meadows in the Morava River floodplain and determining methodology for collecting and storing seeds were a result of consultations with local farmers and adapting to their technical possibilities (the seed collection was done by private farm AGROVYS s r. o. from Vysoka pri Morave).

The seeds were collected according to ripening of dominant grass and herb species. The best time for grass species is early June. A harvester cultivated meadows and then the seed mixture was cleaned for it to be used by the sowing machine. The seed mixture was dried out on warm wind and then sieved for further purification.

The sieve that was used for purification was one-cm²; however, the one-cm² sieve was still too big for the seeding machine and thus, the seed mixture was distributed with a fertiliser broadcaster. Taking into account the possible losses during the cleaning process, it is more effective to take dry primary seed mixture from the combine machine and to put it on prepared arable land and roll it into the land.

Collection of seasonal herb seeds

The collection of herb seeds by the method described above is complicated because the size of seeds, the high of herbs and the ripening time is more variable than grass species. The following method is more effective:

- Meadow is mowed in the time of ripening of needed herb species.
- Hay is dried out and cut into small pieces.
- Hay is distributed by fertiliser-spreading machine on prepared arable land and rolled into land.

First phase of restoration was started by:

1. Collection of seeds by combine harvester with main focus on target grasses from 100 ha.
2. Use of hay-seeds with main focus on dicotyledonous plants (herbs) from 20 ha

The advantages of seed collection by the described method include low financial costs, no special requirements for machinery, the presence of original gene pool and the use of natural resources without making new fields for planting of grass or herb species.

Composition of seed mixture and effectiveness of harvesting

Collecting seeds by a harvester without special adaptation was tested for its effectiveness and for comparison manual collection of seeds in four quadrates (1 m^2) was completed. Seeds were dried, weighed and counted. The result was a rough estimation of total yield per hectare – approximately 114.75 kg of seeds. This data became a basis for evaluating the effectiveness of collection by harvester.

Ten samples were taken from the seed mixture after harvesting to evaluate the species composition and effectiveness. The seeds were separated from the mixture and divided according to quantity into six principal groups: (1) seeds of *Alopecurus pratensis,* (2) seeds of *Poa pratensis*, (3) seeds of *Elytrigia repens*, (4) other grass seeds, (5) sedge seeds and (6) herb seeds. Seeds were weighed and the number of seeds in the sample was estimated.

Although using a harvester to collect grass and sedge seeds was not the most efficient, am ample number of seeds were still collected without any special adaptations and any additional costs. This method yields approximately 20 kg of seeds from each hectare of species rich meadows. The effectiveness of harvest for dominant species is as follows: *Carex* sp. div. 36,84 %, *Alopecurus pratensis* 15,47 %, *Poa pratensis* 12,48 % and *Elytrigia repens* 7,61 % (Fig. 3). The analyses of pure seeds from harvested seed mixture showed the presence 75 % of grass species, 17 % of sedges and 8 % of herbs (Fig. 2).

Physical restoration of 140 ha of arable soil

After considering mapping outputs, negotiation results and financial conditions, 140 ha were identified to be transformed in the first phase of restoration Many factors influence the success of transformation; for instance it is important to choose partners that have the necessary experience and professional background. AGRA-M, a successful and economically stable private farm, is managing 145 ha of arable land and 30 ha of meadows in the floodplain area out of 3700 ha of its total agriculture land.

The soil quality is a significant factor and it is important to be aware of the area's history. The proposed arable land has been located in the most effected part in the middle section of the Morava River floodplain (*see map*). The area consisted of four main fields that were intensely utilised by applying pesticides and fertilisers to grow silage corn. Two years before the start of restoration work, an unofficial pre-agreement between farm owners and DAPHNE stated that the use of intensive inputs in the floodplain area should be stopped.

Floodplains are dynamic ecosystems and restoration plans require careful preparation for a suitable time framework. After reviewing flood frequency, weather conditions and seasonal agricultural works, it was determined that transformation work commence in the beginning of October 1998. Unfortunately, due to permanently wet soil, transformation work was postponed to 1999 after the spring floods. Both spring and autumn sowing can be successful, however, an autumn sowing must be carried out early enough to allow adequate preparing of seedbed and seeding growth before the winter.

Some technical difficulties arose in seed planting. Specifically, since the non-homogenous seed mixture combined with oat was unable to be spread by a seed machine, a fertiliser broadcaster was used. The mixture was distributed on arable land and rolled into the soil two times, and then the "islands of biodiversity" were established (one island - 4 by 2 m in size per hectare) using the turfs from the nearest species rich meadows. In the same year the area was mowed two times and biomass consisting of the nurse crop (oat) was used as forage for cows.

Careful management by cutting is required to control competition from undesirable, ruderal species at restored plots.

Non-sustainable forms of agriculture and poor management have led to the degradation of ecological integrity in floodplain. The conversion of arable land back to managed wet meadow systems will create a purification system that decreases soil erosion and decreases the inputs of organic nutrients into the ground and the surface water. The conversion of land will also increase the species richness of the area and improve the habitat for many species of rare plant and animal species.

5 NGOs' Communication Activities in the Danube River Basin

Stanislava Boshnakova with support Milena Dimitrova and Petko Kovatchev

5.1 Components and Objectives of the Presentation

Definition of the goals of the presentation:
The definition of the workshop's objectives is recommended by Holger Nauheimer in "Quality Guidelines for training and Consultation Workshops" under DRP. In this sense we recommend definition of presentation's goals.

The objective of this presentation is to enable NGOs from the Danube River Basin to manage and implement successful communication activities in order to establish cooperation with local stakeholders, to provide access to information to the general public, and to stimulate sustainable use of the natural ecosystems in the region.

***Components of the presentation*:**
The presentation consists of 8 elements and is divided in two parts. Both components have theoretical and practical module. The theoretical module of the first part concentrates over basic information-related activities: environmental information, public participation and communication activities. The exercise trains the participants in preparation of media release.

The theoretical module of the second part of the presentation concentrates over strategic planing, in particular planing of communication activities. The participants are stimulated to master planing through application of the proposed model of planing through preparation of organized communication activity - information campaign.

Part 1- 45 minutes

1. General concepts, concerning information flow
2. Access to environmental information: legislation and practical approaches
3. Participation in decision-making on local level
4. Communication activities of E-NGOs: publications, workshops, open door activities
5. Group dynamics – preparation of news-release about the current event

Part 2 – 45 minutes

6. NGO communication strategy
7. Environmental information, available on the Internet – each DEF representative should schoose info to be included in the list
8. Group dynamics– planning of information campaign (non-compulsory)

Useful tips, concerning slide-show presentation by Jim Stevenson

- Aim to use about two slides a minute
- For a 25 minute talk you should have 30 to 50 slides
- Try not to mix slides in portrait (vertical) format with slides in landscape (horizontal) format
- Leave your contacts and collect contacts of the participants to make long-term evaluation of the training

Giving the talk

- Switch on the projector but leave the lights on

- Stand at the side of the screen, face the audience
- Introduce yourself with the lights on
- Explain who are you, what you do and what your message is
- Keep your face turned to the public while you talk
- Encourage feedback - tell the workshop participants when they can raise questions
- Repeat or enlarge explanations about particular part of the presentation if necessary

5.2 General Concepts Concerning Information Flow

In order to make the presentation more user – friendly it is necessary to present few concepts in the very beginning.

Public Relations – establishment of cooperation of **mutual interest** between the organization and its target audience. It is needed for both sides to define their communication needs and develop further activities.

Integrated NGO Communications or just *Communications* – management of the information flow, concerning the activities of the organization towards its audience. It is a part of the organizations’ strategy, which refers to exchange of information and information logistics.

Public Participation Principle – involvement of the civil society in the governmental decision-making and decision-implementation (local government, national government, international institutions). NGOs play an important role in offering a public voice to the public debate on policy issues and helping to create consensus between governments, institutions and civil society.

Democratic Decision Making - to ensure relevant representation of all stakeholders and groups who will be affected by the implementation of the decision in the process of making of the decision. It provides fair involvement and guarantees optimal relevance of the decisions to the needs and interests of all segments and groups of interests of the civil society.

<u>Access to environmental information: legislation and practical approaches</u>

This part of the presentation is aimed at preparation of the participants for further public participation activities.

National legislation: Point out the relevant national legislation for your country

International conventions, signed by your country (ex – Aarhus Convention), which provide the legal frame to access to environmental information.

Reccomendation to the workshop participants: Recommend to the workshop participants to find out all relevant local regulations in the municipality/ties their NGO operates in and this way to acquire the information needed and to improve their public participation.

Types of public participation:

- Informing – people participate by being informed what has been decided or has already happened
- Consultation – People participate by being consulted or answering questions
- Implementing – people participate to meet the objectives decided by the selected majority (government, parliament)
- Shared decisions – people participate in development of an action plan
- Self determination – when people want to change decisions – plans, policies, etc.

Problems in applying public participation in CEE

- There is often lack of public participation in the early stages of the decision-making process
- Not all relevant information is provided to the public
- Comments of the public or NGOs are not as seriously taken into account as the comments of governmental officials
- Few CEE countries have legal reguirements for involving the public
- There is no clear definition about precisely who 'the public' is
- Most of the countries do not consider draft legislation subject to public disclosure
- There is no obligation to take the comments from the public seriously, and to inform the public about the extent to which their comments were taken into account

Participation in decision-making on local level

This part of the presentation is aimed at enhancing workshop participants participation in the sub-basin region of Danube River where they operate in.

NGOs have a 'watch-dog role", they can give expertise, to voice the public opinion or empower public responses to governmental actions.

Watch-dog activities towards institutions – E-NGOs should ensure that :

- The institutions implement and enforce the environmental lows;
- The institutions bring forward new environmental legislation;
- The integration of environment in other policies is ensured;
- Sustainable development policies are actively pursued;
- The national government plays relevant role in the world affairs;
- The citizens are able to play a full part in reducing the damage to Earth's ecosystems.

E-NGOs activities:

- Representing and bringing the concerns of the citizens to decision-makers
- Integrating and strengthening environmental content across all sectors
- Promoting and monitoring implementation of EU law in the candidate-countries, in particular of the Water Framework Directive in the Danube river Basin
- Providing political, legal and technical expertise
- Awareness-raising among the citizens and the decision-makers on environmental problems
- Development of public opinion and strengthening of the civil society
- Proposing new legislation or regional regulations
- Exchanging information with other organizations
- Training in different areas among other public groups

5.3 Communication Activities of E-NGOs

The module is aimed at improvement of communication activities of the participating NGOs through implementation of some "key-tricks", recommended by PR experts worldwide. It is expected the trainees to enlarge the number of communication techniques in their everyday work and to improve their quality as well.

Communication is a two-way process. The effective message should be relevant to the public interests and knowledge. Always search for feedback.

Useful tips:

- Adapt the information to the public needs, give more details which could be useful for your target audience (ex. details concerning the health or safety of the public, economic profits/efficiency of environmental activities)
- Use a simple language, explain all abbreviations and quote more than one source of information (this makes info look more reliable)
- Give some figure and data, but not too much
- Supply your arguments with practical examples
- Use visuals – tables, pictures, maps, video. Supply your NGO with a relevant photo and videoarchieve
- Implement inquiries among general public or selected group of people (ex. journalists, teachers, accademic professionals, children, etc.) in order to supply a feedback to your activities
- Provide contacts -always put your logo, name of NGO, webpage, mailing contacts on a visible place

Indirect communication

Communication, which is established through an information tool (ex. handbook, leaflet, poster) or channel (ex. webpage, mass media, internal or professional media). This approach does not include face-to-face contact to the public. It excludes instant feedback.

Direct communication

Face-to-face communication to the public. This approach includes instant feedback. If the person/s who present your NGO have good communication skills, it could be more effective than the indirect method. If the person/s who present your NGO lack communication skills or experience, this method might not be as effective as you expect it to be.

Indirect communication tools/channels:

- Printed materials – publications (handbooks, leaflets, magazines), posters, stickers, news-releases, etc.
- Other tools – videofilms, CDs, CD-ROM, Multimedia, etc.
- Information channels - webpages, mass media, internal or professional media

  Internal tools/channels – information flow could be ruled. This type of communication offers access to limited number of people.

  External tools/channels - information flow could not be controlled. This type of communication offers access to larger number of people than the previous one. The authority of the channel is transfered to the information sourse (ex. If a popular TV show praices your NGO, its oppinion is taken into account by the viewers.).

Direct communication tools/methods

- Presentations – may include slide shows, videofilms, competitions, games
- Workshops/trainings
- Receptions
- Open door activities (expeditions, happenings, concerts, etc.)

Useful tips:

- In order to influence more effectively your audience (so called 'targeting'), you should combine both communication methods (indirect and direct)
- Plan your activitie according to the problems you want to solve, the audience you have to reach (it is usually the core 20% of the people who will be influenced by your activities) and last but not least - the available resourses: human, finantial, time (hint – communication strategy frame to be presented at the second part of the presentation)

Group dynamics – preparation of news-release about the current event

25 minutes exercise

The task: Divide the workshop participants in 4 groups of 4-6 people. Give 15 minutes to each group to prepare news release about the current event (not more than 20 lines long) . Read the releases together and ask the other participants to comment on the performance of their colleagues. Add supplementary comments if necessary. Ask them to stick to the scheme of news release structure given by you, check for the technical details (structure) and language (style). After the completion of the task make a break.

Structure of news-release

- Organization's logo, name and contacts in the top
- Short headline (do not try to be pathetic – most journalists are *skeptical*)
- Inverted pyramid structure – the most important in the first paragraph
- Your release should answer to the "who, what, where, when, why" – the five obligatory questions for a media report
- List your organization's name several times
- Names, titles, organizations spelled correctly and all abbreviations explained
- Photo opportunities listed
- Contact person's name and contacts (phone, e-mail)in the end
- Reccomended length : 1 or 1,5 pages

NGO communication strategy

This module is aimed at improvement of efectiveness of communication activities through strategic planing of each step of them. The model is universal and could be also applied at project planing and implementation cycle as well.

Public relations are part of the managerial process. NGOs are **public structures**, build on the democratic principle of transperanncy and in this sense communications should be integrated in each activity of the nongovernmental organization.

- Problem's deffinition – what do we want to do?

Collect and analyse as much information as possible about the the current state of the environmental issue/problem you want to solve. Needs accessment.

- Planning of the NGO's activities – what to do?

Plan your activities according to the goals you want to fulfill and the audience you want to reach. Agenda setting - set a single (or multiple) activities for all objective/s, the order of their completion, the time necessary for their implementation and the person/s in charge of the activities. Set all communication methods you are going to use. Provide necessary resourses – financial, human, technical for the completion of tasks.

Communication – what, where and when are we going to do?

Implementation of the planned activities according to the time-schedule, the available budget and the involved personnell. Report and record (videotape or photograph) all your events, make a media-archieve, list contacts of participants, contributors, volunteers, journalists. Implement feed-back activities (inquiries, interviews). If a method/activity you have planned appears to be unsuccessful, replace it with something else or repeat the activity with particular changes.

- <u>Key NGO communication activities to be implemented</u>

Indirect communication activities

Correspondence

Publications

Media events

Direct communication activities

Workshops and meetings

Receptions

Open door activities

- <u>Key groups to be reached on local level:</u>

Local authorities and national government

Local and national mass media

Unformal leaders (businessmen, artists, intellectuals)

Other NGOs

Nature lovers

- <u>Evaluation of the program – what are we doing and what have we done?</u>

Analyse your reports, archieve or any other materials to evaluate your program and develop furher activities. Implement not only final, but also mid-term evaluations, staff meetings or even meeting with external communication/strategic planning experts (if you can afford it).

<u>Group dynamics – planing of information campaign</u>

30 minutes exercise

The task: Again divide the workshop participants in 4 groups of 4-6 people. Give 15 minutes to each group to prepare plan of an information campaign about Danube related issues. Analyze the results using the same method as in the first exercise. Ask them to stick to the given scheme of strategic planing. This exercise could be useful for development and synchronization of further activities under DRP and REC’s for CEE grants program.

Evaluation of the presentation perfomance and effectiveness

<u>Attainment Indicators:</u>

Short term indicators (to be measured during the workshop)

- Evaluation sheets – prepare evaluation sheets on the flipcahrt and ask the participants to mark with X (using markers) their impression in the appropriate box during the break while trainers are not watching them. You can use this method for the other presentations during the workshop. If a presentation's module is evaluated badly, discuss this with the workshop participants and try to improve the results.

Activity: **NGO's communication activities**	☺	😐	☹
General concepts, concerning information flow	*XX*	*X*	
Access to environmental information: legislation and practical approaches		*XX*	*X*
Participation in decision-making on local level	*X*	*X*	*X*

☺ - excellent

😐 - good, but not clear enough

☹ - bad

Long term indicators (to be measured within 6 months after the workshop):

- Participants have developed further public participation activities
- Participants have improved their participation in decision-making in the sub-basin region of Danube River where they operate in
- Participants have improved their communication activities and enlarged the number of communication techniques in their everyday work and improved their quality as well
- Participants have improved the efectiveness of their communication activities through strategic planing and raised funds for fuurther communication activities

Information sources

The presentation is based on information from the following sources:

1)Cutlip Scott, Center Allen, Broom Glen. Effective Public relations
2) Introducing European Environmental NGOs. Their role and importance in European decision-making. Edition of EEB (www.eeb.org)
3) Nauheimer Holger. Quality Guidelines for training and Consultation Workshops (www.icpdr.org)
4) Public Access to Environmental Information and Data. Edition of Mulieucontact Oost Europa (available at REC for CEE offices)
5) Public Participation, NGOs and the Water Frameworks Directive in CEE. Edition of WWF (www.panda.org)
6) Public participation in practice. Edition of REC for CEIE (available at REC for CEE offices)
7) Stevenson, Jim. Presenting a Slide Talk. Edition of Birdlife Seashells (Not available on the web site. For more information contact BirdLife international through: www.birdlife.org)
8) WWF's preliminary comments on Public Participation in the Context of the Water Frameworks Directive and Integrated River Basin Management (www.panda.org)
9) Public Participation in Environmental Decision Making. Edition of Black Sea NGO Network (only in Bulgarian)

For additional information search the given web sites of contact the sources of information.

Materials to be distributed among the participants

1. News release instructions
2. Strategic planing scheme
3. Useful online sources of environmental information (to be added additionaly by each NFP)
4. Hardcopy of the prezentation (3 slides on page)

Structure of news-release

- Organization's logo, name and contacts in the top
- Short headline (do not try to be pathetic – most journalists are *skeptical*)
- Inverted pyramid structure – the most important in the first paragraph
- Your release should answer to the "who, what, where, when, why" – the five obligatory questions for a media report
- List your organization's name several times
- Names, titles, organizations spelled correctly and all abbreviations explained
- Photo opportunities listed
- Contact person's name and contacts (phone, e-mail)in the end
- Reccomended length : 1 or 1,5 pages

5.4 NGO Communication Strategy

- Problem's deffinition – what do we want to do?

Collect and analyse as much information as possible about the the current state of the environmental issue/problem you want to solve. Needs accessment.

- Planning of the NGO's activities – what to do?

Plan your activities according to the goals you want to fulfill and the audience you want to reach. Agenda setting - set a single (or multiple) activities for all objective/s, the order of their completion, the time necessary for their implementation and the person/s in charge of the activities. Set all communication methods you are going to use. Provide necessary resourses – finantial, human, technical for the completion of tasks.

Communication – what, where and when are we going to do?

Implementation of the planned activities according to the time-schedule, the abailable budget and the involved personnell. Report and record (videotape or photograph) all your events, make a media-archieve, list contacts of participants, contributors, volunteers, journalists. Implement feed-back activities (inquiries, interviews). If a method/activity you have planned appears to be unsuccessful, replace it with something else or repeat the activity with particular changes.

- Key NGO communication activities to be implemented

Indirect communication activities

Correspondence

Publications

Media events

Direct communication activities

Workshops and meetings

Receptions

Open door activities

- Key groups to be reached on local level:

Local authorities and national government

Local and national mass media

Unformal leaders (businessmen, artists, intellectuals)

Other NGOs

Nature lovers

- Evaluation of the program – what are we doing and what have we done?

Analyse your reports, archieve or any other materials to evaluate your program and develop furher activities. Implement not only final, but also mid-term evaluations, staff meetings or even meeting with external communication/strategic planning experts (if you can afford it).

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Annex I. Templates

Template 1: General Information and Workshop Objectives

Status: mandatory, to be submitted to DRP for endorsement of workshop	
Intended workshop title	
Choose any 4-letter/number acronym	
Consulting (C) or Training Workshop (T)?	
Intended date of workshop	from to
Intended place of workshop	
Name of organizer	
What are the short term objectives of the workshop? At the end of the workshop, what will be achieved?	
How will you measure the achievement of the short term objectives? Please specify at least one milestone/indicator for each short term objective.	
What is the medium term objective? What do you expect to happen after the workshop completion?	
When do you want to achieve your medium term objective?	in months
What will be indicators for measuring the medium term objectives (please specify for each medium term objective)? Please specify who exactly is involved in the achievement	
Who will be responsible for the measurement of the indicators for medium term objectives?	

Template 2: The Workshop's Direct and Indirect Target Groups

Status: mandatory, to be submitted to DRP for endorsement of workshop	
Workshop acronym	
Who needs to be involved and why? Who are the end beneficiaries of the expected medium term outcome?	
How big is the final target group (e.g., those who are supposed to agree to something, to benefit, or to learn)?	
If you can not invite the final target group because of size, who are potential mediators? On which base will you choose them? Do they have this mediating role already, or will it be created through the workshop (e.g. in the case of new trainers)?	
If you invite mediators, what are the institutional arrangements which insure that they will execute their role after the workshop (e.g., act as multiplicators, facilitate decisions, assure participation in planning processes, act as trainers for the final	

Template 3b: Methodology (Training Workshops)

Status: mandatory, to be submitted to DRP before the start of the workshop **This template might be filled together with the trainer(s)**	
Workshop acronym	
Will the workshop be knowledge, skill or behaviour oriented?	
What assumptions do you have about the knowledge level of the participants? Did you test these assumptions?	
How much of the syllabus will be (i) theoretical input (ii) practical exercises	theoretical input % practical exercises %
Which methods will you apply to assure that the intended objectives will be achieved?	
How many trainers do you intend to have for the workshop? If you have more than one, will they have different technical or methodological know-how? Will participants act as resource	

Template 7b: Evaluation of the Workshop – Training Workshop
(to be handed out to participants)

<table>
<tr><td colspan="8">Please fill out and return to workshop organizer or trainer</td></tr>
<tr><td colspan="2">Workshop title</td><td colspan="6"></td></tr>
<tr><td colspan="2">Date of workshop</td><td colspan="6">from to</td></tr>
<tr><td colspan="2">How long before the workshop start did you receive the</td><td colspan="6">weeks</td></tr>
<tr><td colspan="2">With the invitation, did you receive the agenda and the objectives?</td><td colspan="6">agenda ☐ yes ☐no
objectives ☐ yes ☐no</td></tr>
<tr><td colspan="2">Were the objectives spelled out at the beginning of the</td><td colspan="6">☐ yes ☐no</td></tr>
<tr><td colspan="2">Did the workshop fully meet its predefined</td><td colspan="6">☐ yes ☐ partly ☐ no</td></tr>
<tr><td>If not, please tell us, why.</td><td colspan="7"></td></tr>
<tr><td>Please score the following criteria with 5 being the best and 1 being the lowest mark</td><td></td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td></td></tr>
<tr><td>Overall quality of the training</td><td>excellent</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>very poor</td></tr>
<tr><td>How was the level of participation?</td><td>very high</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>very low</td></tr>
<tr><td>Were the training methods appropriate?</td><td>very appropriat</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>not at all</td></tr>
<tr><td>What is the applicability of the training content to your working context?</td><td>very applicable</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>not at all applicabl</td></tr>
<tr><td>Which part of the training content was most important for you?</td><td colspan="7"></td></tr>
<tr><td>Please give us some recommendations of what could be improved next time such a training</td><td colspan="7"></td></tr>
</table>

Template 8: Workshop report

<table>
<tr><td colspan="9">Status: mandatory, to be filled by the organizer and submitted to DRP together with participants' workshop evaluation</td></tr>
<tr><td>Workshop title</td><td colspan="8"></td></tr>
<tr><td>Workshop acronym</td><td colspan="8"></td></tr>
<tr><td>Date and Place of workshop</td><td colspan="8">Date Place</td></tr>
<tr><td>Name and address of venue</td><td colspan="8"></td></tr>
<tr><td>Number of participants invited / present</td><td colspan="8">invited present</td></tr>
<tr><td>Did you have external moderators or trainers?</td><td colspan="8">yes ☐ no ☐</td></tr>
<tr><td>Please score the following criteria with 5 being the best and 1 being the lowest mark</td><td></td><td>5</td><td>4</td><td>3</td><td>2</td><td>1</td><td></td></tr>
<tr><td>Achievement of objectives</td><td>fully</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>not at all</td></tr>
<tr><td>Quality of moderators / trainers</td><td>excellent</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>very poor</td></tr>
<tr><td>Quality of training venue</td><td>excellent</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>☐</td><td>very poor</td></tr>
<tr><td>Lessons Learned (1): What did you like in particular about the workshop?</td><td colspan="8"></td></tr>
<tr><td>Lessons Learned (2): What needs to be improved in the future?</td><td colspan="8"></td></tr>
</table>