INTERNATIONAL HYDROLOGICAL PROGRAMME

Ecohydrology

A List of Scientific Activities Of IHP-V Projects 2.3/2.4

Edited by
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CONTENT

INTRODUCTION

Water quality, expressed as secondary pollution and toxic algal blooms, continues to decline in aquatic ecosystems across the world. This decline is sobering evidence that the prevailing approach to catchment-scale water management does not guarantee sustainable water use. Technical approaches to pollution control, such as sewage treatment plants and regulation of hydrological processes for flood and drought control, are crucial but not sufficient. Purely technical controls, without understanding and consideration of biota dynamics, constitute more of a trial and error approach to water management rather than the implementation of a policy toward sustainable use of water resources.

A more efficient approach must be based on understanding of the temporal and spatial patterns of catchment-scale water dynamics. These patterns are determined by four fundamental components: climate, geomorphology, plant cover/biota dynamics and anthropogenic modifications.

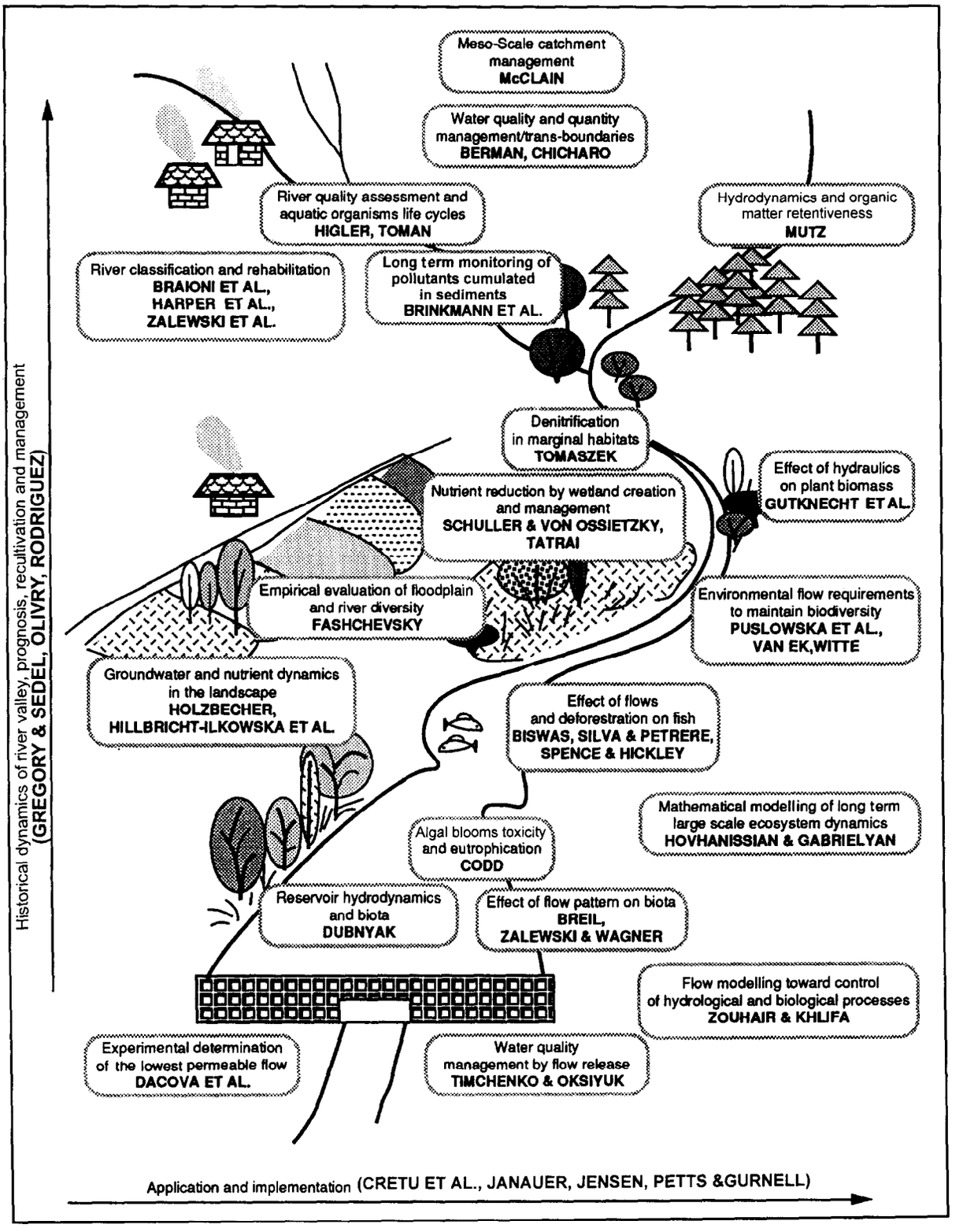
To guarantee the sustainability of freshwater resource use, it is necessary not only to reduce or eliminate pollution emission but, in parallel, to extend the number of potential tools to manage excess nutrients, pollutants, mineral and organic matter dynamics in the landscape. This can be done not only by reducing human impacts but also by regulating the aquatic and terrestrial biota in the catchment. In turn, one of most efficient ways to control biota dynamics is through the regulation of hydrological processes: for example by increasing watershed water retention through reforestation and restoration of land/water ecotones; enhancing in-stream retention of water sediments and nutrients through river renaturisation and wetland restoration; and amplifying biogeochemical cycles such as denitrification through wetland inundation.

Recent and ongoing research has greatly increased our understanding of hydrological dynamics and, in parallel, biotic and biogeochemical dynamics in freshwater ecosystems and land/water ecotones. The integration the above components into a holistic (or superorganism) model should significantly expand the repertoire of management tools which can be applied to freshwater resources. Moreover, the use of biotic processes will facilitate a form of self-purification in aquatic ecosystems and significantly reduce the costs of water quality maintenance.

In consideration of the forgoing issues, the rationale of the UNESCO IHP-V 2.3/2.4 workshop held in May 1998 at Lodz (Poland) and this publication is:

- to introduce the scope of activities which has been developed in the framework of the Ecohydrology Project
- to present progress made toward identifying gaps in our current understanding and charting a course for further activities
- to popularise the concept of Ecohydrology, where the river systems are recognised as "superorganisms" controlled by hydrological processes which to a great extent might be modified by biotic responses and interactions. Integrating our understanding of biotic controls on hydrological processes and investigating their potential to influence water dynamics and quality at the catchment scale are the implicit goals of UNESCO IHP-V 2.3/2.4 Ecohydrology Activities.

Maciej Zalewski, Michael McClain



Structure of UNESCO IHP - V „Ecohydrology"

INTERNATIONAL HYDROLOGICAL PROGRAMME

LIST OF THE PILOT CORE ACTIVITIES OF IHP-V 2.3/2.4 „ECOHYDROLOGY"

Lake Kinneret and its Catchment

International Pressure and Environmentral Impacts

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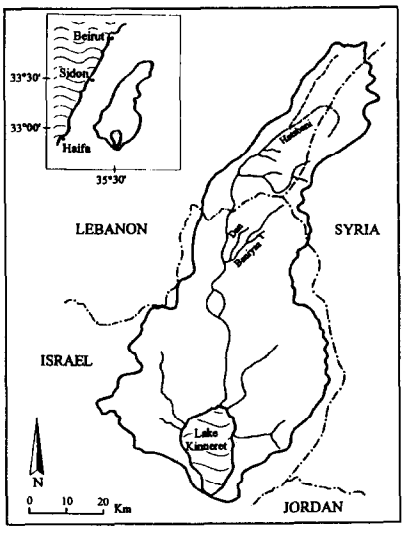
Study area:
Lake Kinnert (sea of Galilee, L. Tiberias, Gennusope sea)
N. Jordan River and catchment



Working Hypotheses:

1. Since 1994 the stability (relative) of phytoplankton populations has been disturbed;
2. Therefore the lake, which is a vital component for water supply, is more susceptible to environmental stress;
3. In this situation it is important to have objective criteria to evaluate „water quality" in the lake;
4. A set of water quality indices has been proposed for this purpose and will serve to guide future monitoring efforts;
5. There is a need to incorporate water quality as well as water quantity in all considerations of regional water allocation which will be required as part of the political agreements stemming from The Middle East Peace Processes. Accommodation will have to be reached between Israel, Lebanon, Syria and the Palestinian Authority. (Israel and Jordan already have agreed on water allocation as part of the 1994 Peace Treaty).

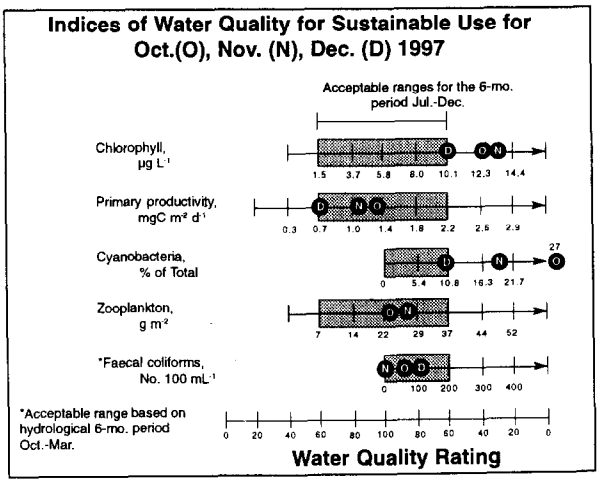
Methods:

Long term monitoring - classical limnological parameters plus addition of DOC, DON, DOP, remote sensing, automatic recording equipment, etc.

Preliminary results, experimental design:

Monthly water quality evaluations based on 11 indices (parameters) to indicate acceptable ranges for water quality for sustainable use.

L. Kinneret is an integrated element in the Israel water supply system. On average 400 × 106 m^3 of water are pumped through out the country supplying about 25 % of total water requirements and a greater percentage of drinking water needs.

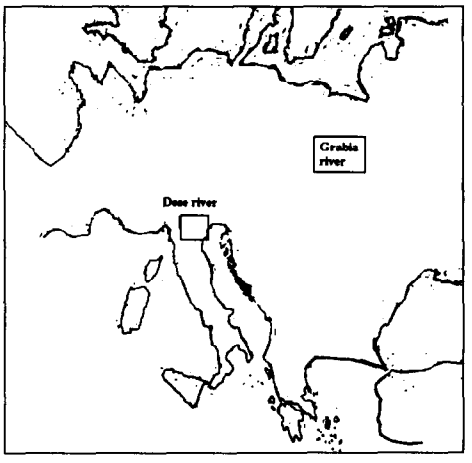


Potential implementation:

Provides objective tool to examine impact on lake water quality of various plan polices for reallocation of regional water resources. Permits addition of „water quality" as a factor in future policy considerations.

Quantification of Biological-Ecological Processes for Planning and Management of River Restoration

The Case of the River Dese (Italy) and of the River Grabia (Poland)



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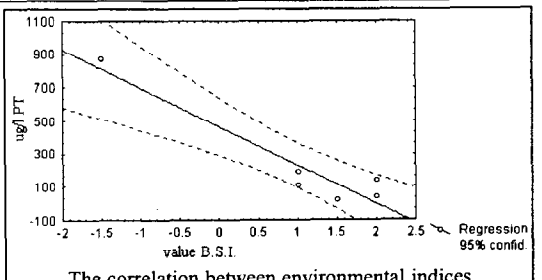
[3] IUAV ITALY, [4] Bologna University ITALY,
[5] Lodz University POLAND, [6] LRALM - Warsaw POLAND

Study area:
River Dese in Italy, River Grabia in Poland. The two rivers are of similar order, but differ in their climate, catchment geomorphology and development, and hydrology and regulation.

Working Hypotheses:
One of the priority goals of sustainable landscape planning must be elimination flood risk, upgrading the quality of water resources and the landscape according to cost reduction/efficiency improvement techniques (Zalewski at al. 1997). The quantification of biological and biogeochemical processes in the catchment and stream channel in relation to environmental indices will provide the tools for 1. restoring the biological structure and function of the river corridor and the cultural, educational and recreational values of the river itself; 2. improving water quality; 3. reducing nutrient transfers to the reservoir and to the Venetian lagoon and Jeziorsko eutrophic reservoir, by increasing the retentiveness of the river corridors; 4. inserting into the legal acts precise procedures for the planning and the management of the river corridors; 5. drawing up user's guides in order to have a continuous comparison with the Local Administrations which will manage the research results.

Methods:
1. the analysis of the range in modifications and the hydrological pattern due to the simplification of the catchment biotic structure; 2. the evaluation of the annual pattern of the nutrient supply to rivers of different stream order, morphoadaphic characteristics of the basin or valley and intensity of agriculture use; 3. the enhancement of the effect of various hydrological patterns of nutrients and organic matter supply on biotic structure of the river and its processes; 4. the survey of the various aspects of the territory and the riverine landscape; 5. the improvement of water quality and restoration of biogeochemical cycles (denitrification, phosphorus filtering uptake, bioaccumulation of nutrients); 6. the construction of sensitivity, functionality and quality maps; 7. the definition of interventions restoring the biotic structure of the river corridors; 8. the elaboration of planning concepts of river corridors at different space and time scales; 9. the integration of biological processes into the planing procedures toward sustainable management of water, land and cultural resources.

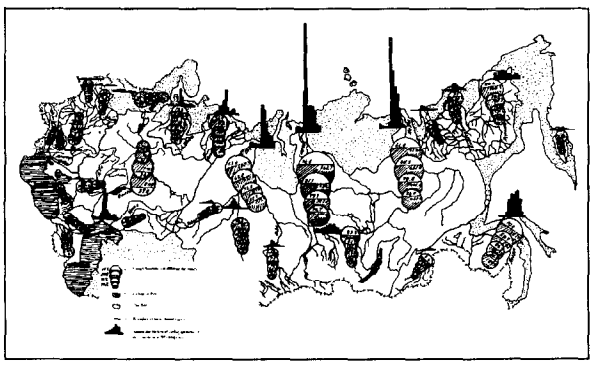
Preliminary results, experimental design:
The two research groups have begun the work of testing the biological, biogeochemical, hydraulic and hydrological methods related to the ecohydrological processes.
This has been done for the quantification of above mentioned processes, which should be considered for application in river restoration and sustainable management schemes



The correlation between environmental indices and phosphorus concentrations in ground waters

Potential implementation:
The application of the developed and standardised methods, integrated procedures in the river restoration projects. focused on: -the elimination or reduction of flood danger, -reducing the load of nutrients and pollutants percolating from the basin. -planning of the river corridors sustainable development - the concordance of the biota restoration with the landscape historical, socio-cultural and urban functions.

The Methodical Approach to Estimation of Ecological and Free Flow



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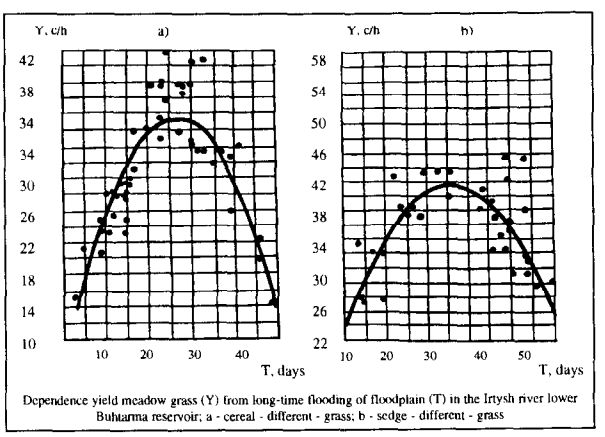
Study area:
The territory of the former USSR (rivers: Ob, Yenisei, Volga, Don, Ural, Irtysh, Dnieper, etc.)

Working Hypotheses:
1. Presentation of river ecosystems;
2. Search and relationship with components of animate and inanimate nature including productivity of fish, grass of floodplain, meadows, phyto- and zooplakton, waterflows, mammals;
3. The elaboration of methods computation of ecological and free flows on the basis of above mentioned relationships.

Methods:
1. Field investigations;
2. Probability-statistical analysis;
3. Correlation-regressional methods.

Preliminary results, experimental design:
1. New criteria: the ratio of the floodplain development is calculated as a weighted mean value along the river length by the formula: $\phi = \frac{B^{1\%}}{B}$, where $B^{1\%}$ is a weighted mean width of the river water surface on the channel edges;
2. Calculated significance of ecological and free flow of different frequency in annual and monthly volumes for the river of the former USSR;
3. Formula for calculation of ecological flow in dependence from natural flow for different frequency:



Dependence yield meadow grass (Y) from long-time flooding of floodplain (T) in the Irtysh river lower Buhtarma reservoir; a - cereal - different - grass; b - sedge - different - grass

$$Q_{ec}^{1-12} = (\alpha + \alpha_1 . P_i + \alpha_2 . P_i^2 + \alpha_3 . P_i^3) . Q_{nat}^{1-12}$$

Where: Q_{ec}^{1-12} - monthly ecological flow in different frequency, years m^3/s;

Q_{nar}^{1-12} - monthly natural flow in different frequency years, m^3/s;

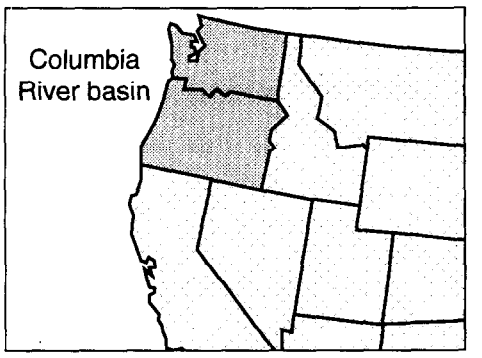
P_i - significance of frequency of flow in diapason 10-95%

$\alpha, \alpha_1, \alpha_2, \alpha_3$ - empirical coefficients;

4. Curves of relationship bioproductivity fish, grass floodplain, meadows, etc with characteristics of hydrological regime (maximum flow, long time flooding, etc.);
5. Curves of frequency of annual and spring snow-melt flow.

Potential implementation:
Under contention of dams, reservoirs, pump stations, allotted canals and so on.

Application of Historical Channel Change and Landscape Pattern in Restoration of Large Rivers



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[2] Pacific Northwest Research Station, U.S. Forest Service, Forest Sciences Laboratory, Corvallis, Oregon, USA

Study area:

1. Willamette River basin
2. Columbia River basin

Working Hypotheses:

Floods are natural processes of ecosystem restoration in rivers. Restoration efforts should recognise network structure of rivers. Because of the network structure more restoration opportunities occur in headwater streams and lowland mainstream rivers have fewer intact systems. Areas of frequent channel change (e.g., multiple channel reaches, tributary, junctions) hypothetically support higher biodiversity because of lower heterogeneity. Links to terrestrial ecosystem can be characterised spatially to identify areas with higher ecological potential and lower socio-economic constraints.

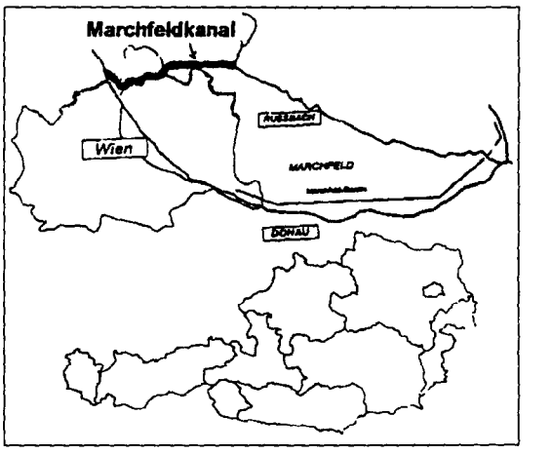
Preliminary results, experimental design:

Long- term studies of Trout populations found that some populations increased after floods and fish numbers increased in restored stream reaches. Areas prone to flooding (e.g., tributary, junctions and anastomosing channels) may provide greater and faster responses to restoration. Links to larger landscape conditions can reveal both ecological strongholds and areas of degraded environmental conditions.

Potential implementation:

This perspective can be used to prioritise conservation and restoration efforts in large rivers. The large scale spatial analysis is currently used by the U.S. Forest Service to design land management activities in the 580.000 km^2 interior basin of the Columbia River in the USA.

On the Interaction Between Flow and Biomass Distribution in a Vegetated Channel



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Study area:

Marchfeld, Lower Austria, Austria

Man-made canal, 18 km long, designed to include a wide variety of features such as backwaters, irregular cross sections, etc.

Working Hypotheses:

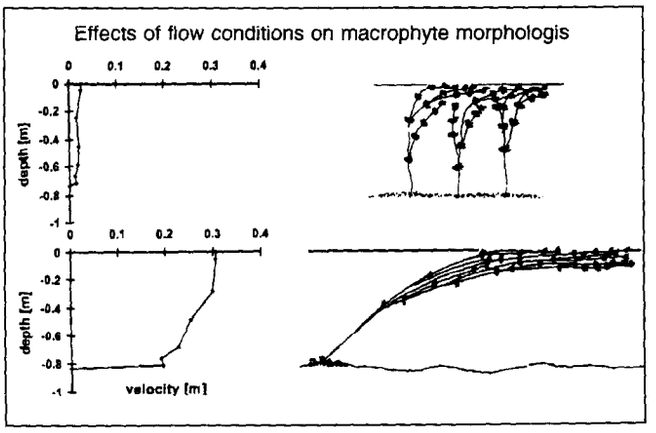
The study was a part of a broader interdisciplinary research project focusing on the understanding of biotic and abiotic interactions in the newly built channel. The subproject reported on in this paper focused on the relation between flow conditions and macrophyte development. Hypotheses were as follows:

1. the occurrence of high and low velocity zones should give rise to differences in macrophyte growth conditions,
2. submerged plants are expected to exert an influence on flow characteristics such as velocity, turbulence, friction.

Methods:

3-dimensional velocity measurements using a 3-D electromagnetic current meter (ALEC ACM-300) in 2 different channel cross sections: straight channel, widened with back water area; biomass sampling in 2 different stands of Myriophyllum spicatum L; comparison of biomass and flow parameter distributions in the cross sections.

Preliminary results, experimental design:

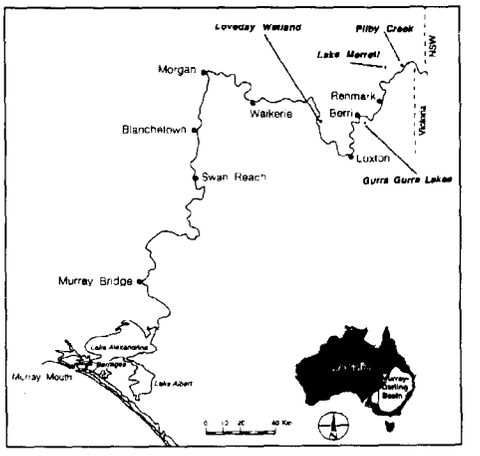


Effects of macrophyte stands on flow conditions: Formation of M. spicatum stands on one side of cross section yields a shift in maximum flow velocity in the direction of the free flow zone; Maximum turbulent energy occurs close to the area of maximum biomass concentration where also the steepest gradient in flow velocity can be observed. This situation also produces shear velocity as high as the highest values produced by bed friction. Effects of flow conditions on macrophyte morphologies: 2 types of M. spicatum morphology can be observed : In the low flow backwater zone a more uniform biomass distribution along the vertical axis developed. Under conditions of higher flow velocities the stands in the straight channel section developed long shoots (up to 2,30 m) depicting long internodes and less whorls thereby offering less resistance to flow.

Potential implementation:

Microhabitat analysis of this sort are intended to highlight specific interactions between the chosen factors. Combined with studies on other factors, e.g. sedimentation, sediment transport, nutrient distribution etc., they can yield a more comprehensive picture of the conditions of macrophyte stands. Merging this information with results derived on a larger, e.g. channel reach, scale may improve understanding the processes also on a scale that is relevant with regard to restoration measures etc.

River Murray Wetland Rehabilitation Package Ecohydrology in Practice



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Study area:
Riverland region, River Murray Valley, South Australia (240 km from Adelaide)

Working Hypotheses:

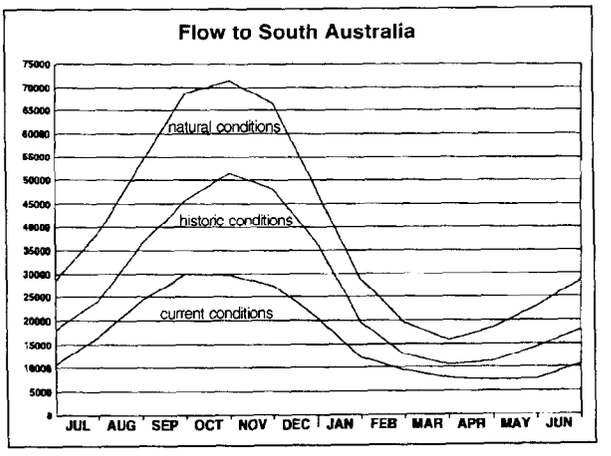
1. Alterations in the water regime of the regulated River Murray below Wentworth are decreasing the biodiversity of the wetlands and floodplains.
2. Introduction of changes to the regulated flow regime to simulate a more natural sequence of wetting and drying will increase biodiversity.
3. Measures to reduce the impact of exotic fish will increase biodiversity of the wetlands and floodplains.

Methods:

1. Identify priority wetland complexes suitable for the construction of flow control structures and initiate wetting and drying cycles.
2. Where possible install fish screens to exclude adult carp.
3. Involve local community groups in development of wetland management plans, implementation of plans and ongoing monitoring.
4. Undertake extensive scientific monitoring of wetland responses to altered water regimes as a basis for adaptive management.

Preliminary results, experimental design:

1. Selection of 10 sites for extensive scientific monitoring;
2. Determination of appropriate monitoring techniques and indicator species with advice of scientific panel;
3. Commencement of 5 wetland management plans;
4. Continued wetting and drying cycles at 4 existing sites;
5. Formation of community groups for each wetland project;
6. Development of monitoring programme based on ecosystem approach including community groups in data collection.

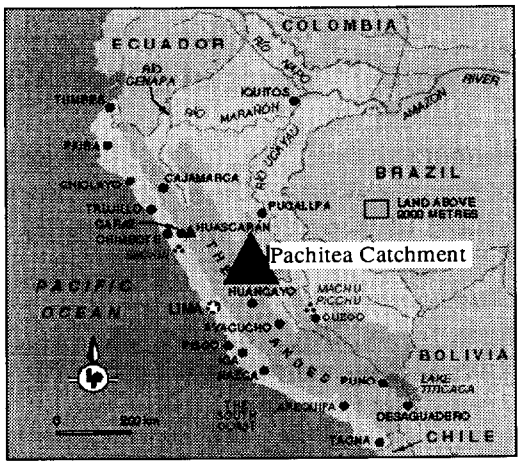


Potential implementation:

by September 2000:

1. Guidelines for best practice management in wetland rehabilitation techniques for Lower Murray Wetlands;
2. Refinement of wetting and drying cycles (e. g. Length, duration, frequency) to target particular communities or species as required;
3. 16 wetland management plans;
4. Practical application of ecohydrological principles to increasing biodiversity in degraded wetland systems.

A Meso-Scale Analysis of Land Use Impacts on Water Quantity and Quality in the Pachitea Catchment, Peru



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Study area:
Peruvian Amazon Basin

Working Hypotheses:
Water quantity and quality in the Pachitea catchment varies in space and time as a function of landscape characteristics, climate, and land use activities.
Variations in water quantity and quality in the Pachitea catchment can be accurately simulated through spatially distributed, deterministic modeling techniques.

Methods:
1. Satellite image analysis and interpretation
2. River gauging, point discharge measurements
3. Chemistry sampling (nutrients, isotopes, organic matter)
4. Field incubation experiments for nitrification/denitrification
5. Spatially distributed, deterministic modeling (HBV and SWIM models)
6. Database management and visualization in GIS

Preliminary results, experimenal design:
Produce basemap of catchment characteristics, land use, and climate variables
Conduct basinwide sampling and monitoring program to define spatial and temporal variability in water quantity and quality.
Conduct site intensive studies to elucidate processes controlling transfers of water, particulates, and solutes from terrestrial to aquatic systems.
Run model to guide field activities and evaluate results.
Work with regional NGOs to translate project findings into viable management tools.

Potential implementation:
This project seeks to provide practical understanding which will directly impact resource management decisions in the Pachitea catchment and, by extrapolation, in the entire Peruvian Amazon. Our final goal is to produce a GIS-based management tool which may be used to evaluate (through scenarios) possible management decisions.

Ecohydrology: Advancing the Scientific Basis of River Management

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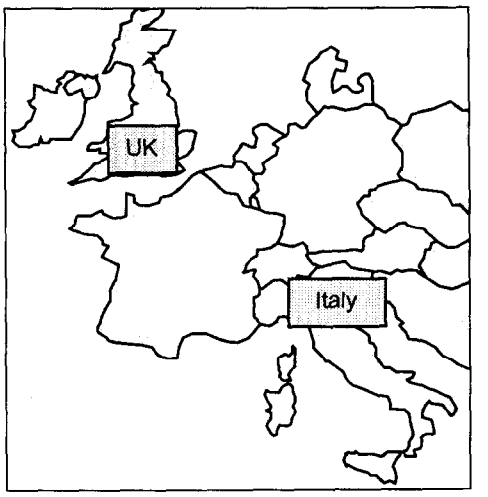
Study area:
River Severn, Dee, Trent Wye, UK
River Tagliamento, NE Italy
River Tame, (Trent basin), UK



Working Hypotheses:

The achievement of sustainable river management goals requires an improved understanding of the key processes that drive fluvial hydrosystems. This knowledge is needed to enable the full integration of water resources, flood control and conservation objectives.

1. The flood regime determines species composition and ecological processes in the riparian zone.
2. The retention of woody debris is a key process in the structuring of natural rivers.
3. In urban rivers, channel form and sediment quality have a major influence on ecological processes, even in rivers of very poor water quality.

Methods:

All three studies integrate hydrology, geomorphology, environmental chemistry and plant and invertebrate ecology. They involve field investigations using clearly defined protocols for nested spatial surveys, supported by experimental (=manipulated) sites; Monitoring of temporal variations even seasonal and „event" timescales and modelling

Preliminary results, experimental design:

1. An ecologically distinct riparian zone is flooded, on average, for at least 20 days each year
2. (a) Characterisation of channel types shows a down-stream pattern dominated by valley form in the upland sector and by longitudinal changes in sediment load in the lowland sectors.
   (b) The retentiveness of the channel for woody debris relates to changes in channel type and unit stream power

Potential implementation:

Findings from the a) and b) studies are being applied to the R Tame within the urban conurbation of the West Midlands (population of over 5 million) leading to the restoration of this heavily engineered and polluted river system.

Back to Sustainable Land Use the Sustainability Effect of Partial Renaturation of an Agricultural Misused Landscape by a Patch - Network Concept

„Conservation in the Area"

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Study area:

Brockhausen. Conservation in the area. Ecological engineering.

Interdisciplinary co-operation: natural scientists, civil engineers for landscape planning, social scientists, economists, authorities.

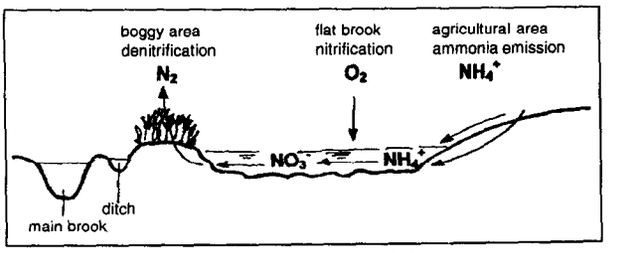
Working Hypotheses:

1. Even smaller reserves may have considerable effects on conservation if they are connected with at least linear structures enabling migration of organisms.
2. Running waters (and lakes) could be protected against high charges of nutrients by water - accompanying, preferably wet stripes in non-productive use.
3. Considerable elimination- effects on nitrogen compounds in running water will be made possible through a water reconstructed in a natural way, combining nitrification and denitrfication zones.

Methods:

1. Landscape analysis, including historical review of development.
2. Research for hidden ecological potentials and parts of networks yet present in the area.
3. Detailed analysis of pollution in the landscape, including research for point- and non-point sources. Risk assessment and analysis of potential source elimination.
4. Definition of environmental quality goals for the landscape including creation of social acceptance by investigation of ecological feasibility. Political discussion of the regional quality goals and political decision.
5. Planning of landscape reconstruction. Environmental risk assessment and permission for realisation of the reconstruction plan by the authorities.
6. Technical realisation of the reconstruction plan.
7. Success - control by long- term technical monitoring (biological, chemical and physical development analysis) socio-economic monitoring concerning economical stability and social acceptance.

Preliminary results, experimental design:

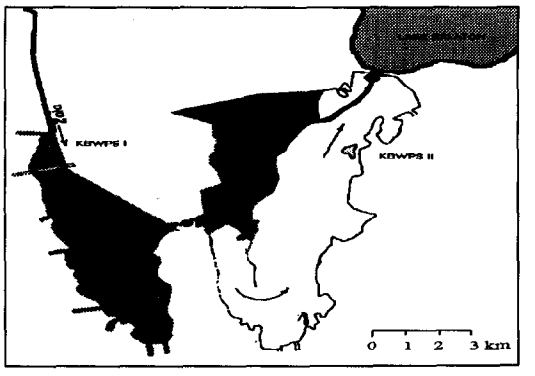


In a thousand - hectare area, being in very intensive agro-industrial use, a row of measurements have been taken to redeveloping ancient situations in a natural way in about 10% of the whole area. The patchy renaturation is completed by connecting the different sub-areas (between 1 and 25 hectares) with linear (hedgebank-) and broader (water - accompanying) structures. Part of the main-brook has been redeveloped to a typical nitrification- denitrification system, which is working very satisfactorily concerning nitrogen elimination. Phosphate shows clearly a tendency to break through. The brooks have conquered back their floodplains presenting a multitude of different natural habitats. It seems that these floodplains, together with redeveloped network together with redeveloped network of hedgebanks and other non-productive linear structures enable good migration of organisms in the whole area.

Potential implementation:

Point 4 of the methods mentioned above, has not yet been well performed. There is always a need of intensive political discussion of the environmental quality goals for the region and too to persuade of the long- term feasibility and stability of the economic conditions under these environmental quality goals.

The Role of the Kis-Balaton Water Protection System in the Regulation of Water Quality of Lake Balaton



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Study area:
Kis-Balaton water protection system and Lake Balaton

Working Hypotheses:

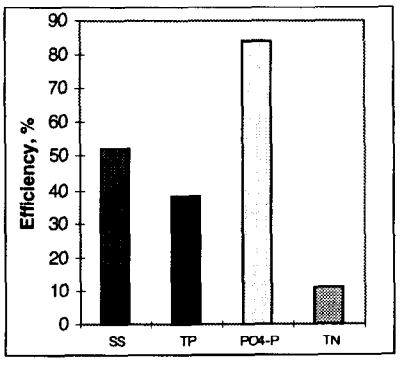
To approaches are being used for the management purposes of shallow eutrophic lake. To reverse eutrophication processes simultaneous reduction of external nutrient load by trapping nutrients in the reconstructed wetland system at the main inflow to the lake. Biological approaches includes regulation of flood web by manipulation of fish communities in order to reduce internal nutrient loading and also ecological effect of toxins produced by cyanobacteria during summer algal blooms.

Methods:

Hydrological - daily measurements of discharges.
Ecological - water chemistry, modelling of loads (external and internal), measuring the trophic level dynamics (from algae to fish) and interactions trough carbon flow and analysis of cyanobacteria toxins.

Preliminary results, experimental design:

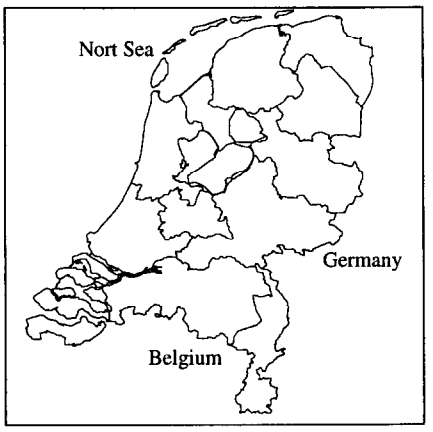
The KBWPSI with vegetation cover of 10% retained on average more than half of suspended solids and phosphorus and on the tenth of TN. The reservoir in a few years became hypertrophic. Internal load became as important as the external one. Preliminary food web manipulations showed that there is a possibility even in hypertrophic system to improve water quality by manipulation of fish population and this integrate hydrological and ecological measures.



Potential implementation:

Combined application of the two approaches, wetland reconstruction as ecological approach and ecological - as food web manipulation, can be used as effective tool in water quality management.

The Botanical Quality of Ecosystems in The Netherlands



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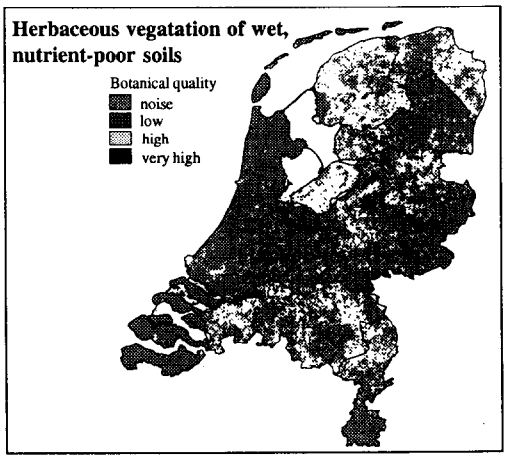
Study area:
The Netherlands

Working Hypotheses:
National records of indicator species may be used to map ecosystem types that are susceptible to water management measures. Moreover, they may be used to obtain a nation-wide picture of conservation values associated with groundwater.

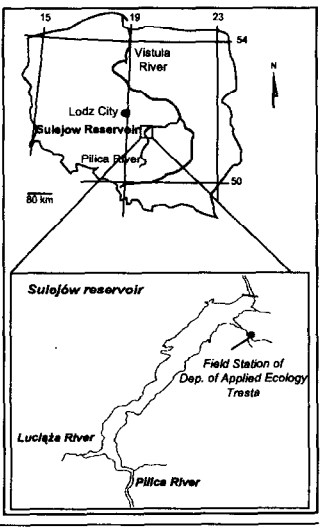
Methods:
Statistics, GIS, expert judgement, gap-filling.

Preliminary results, experimental design:
Nation-wide maps of ecosystem types and associated conservation values. Methods to compute botanical quality classes of ecosystem types for grid cells of different sizes.



Potential implementation:
Input to policy - supporting models concerning water management and environmental problems, like e.g. the ecohydrological model DEMNAT (Van Ek et al., 1998; Witte, 1998).

The Effect of Hydrological Pattern of Tributaries on Biotic Processes in Lowland Reservoir



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Study area:
Sulejów Reservoir and its tributaries, Central Poland

Working Hypotheses:

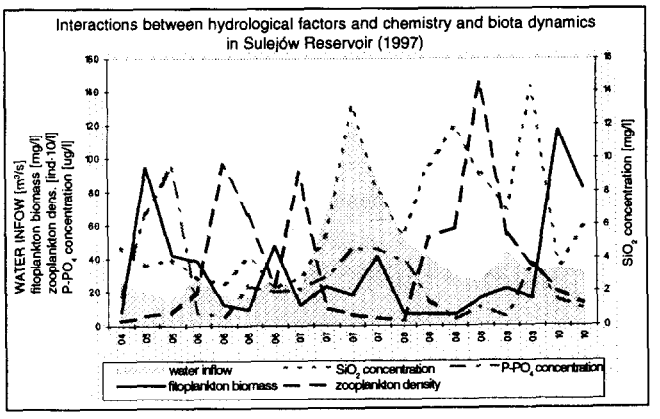
1. Hydrochemistry of affluents depends on climate, hydrology and catchment characteristics;
2. Hydrology of affluents to various extents influence biological processes and consequently water quality in the reservoir;

Methods:

1. Long-term monitoring of affluents:
   - standard sampling methods
   - hydrochemical parameters (P-PO4, TDP, TP, N-NO2/NO3, N-NH4, SiO2, Ca, SH, susp. matter)
   - physical parameters (temperature, pH, conductivity, oxygen concentration)
2. Long-term monitoring of the reservoir:
   - standard sampling methods
   - hydrochemical and physical parameters as mentioned above
   - hydrobiological parameters (phyto-, zooplankton and fish biomass and species composition)

Preliminary results, experimental design:

1. At low inflow ecosystem dynamics are controlled mostly by biological interactions;
2. At high inflow ecosystem dynamics are controlled mostly by hydrological factors, e.g. dynamics of flooding are significantly correlated with diatom biomass occurring after spring floods pulses in Sulejów Reservoir



Potential implementation:

1. Restoration and sustainable reservoir management

INTERNATIONAL HYDROLOGICAL PROGRAMME

LIST OF THE CORE ACTIVITIES OF IHP-V 2.3/2.4 „ECOHYDROLOGY"

Some Basic Concepts to Interpret Hydrological Regimes for Ecological Goals

Author:

PASCAL BREIL

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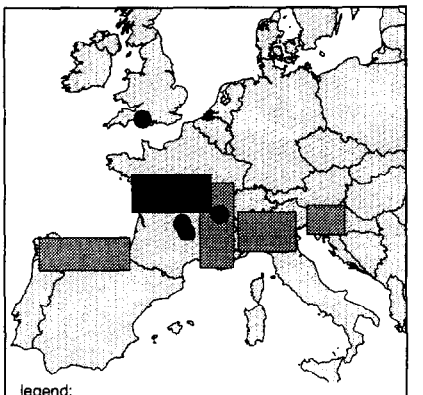
Study area:

France (on course), UK (submitted project), Slovenia, Spain, Italy (interested)



legend:
rectangular zones=region of interest (dark=on course of study, clear=future)
points: specific rivers of long term pairedrecords

Working Hypotheses:

1. Flow „carries" a great part of temporal physical determinants of the instream ecosystem dynamics;
2. Frequent flow (or dependant) conditions control maximal instream habitability;
3. Infrequent flow (or dependant) conditions control long-term level of the instream ecosystem;
4. Rare flow conditions could result in a shift of the instream ecosystem.

Methods:

1. Flow conditions are described by ecologically relevant flow characteristics (efc) based on intensity, duration, predictability, rate of change,...computed from hydrometric records;
2. Instream ecosystem is described by relevant biological index (bi) like density, diversity, community strategy;
3. A conceptual framework linked flow (and dependant) conditions frequencies to temporal evolution of a biological index;
4. efc local validation analysing real time biological index response to efc when long-term paired records are available in a same reach;
5. efc regional validation analysing spatial dependency between biological index and efc when large area data set of both information overlap;

Objective: to define efc ranges and frequencies to support downstream hydraulic works ecosystems dynamics, which lead to definition of a **vital flow regime** rather than a vital base flow.

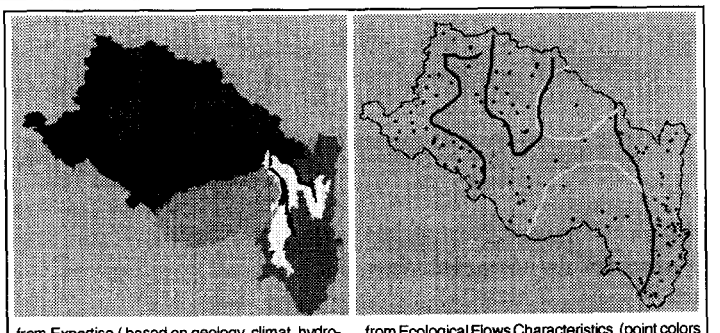
Preliminary results, experimental design:

Validation using regional information:

- Loire basin (110 000 sq.km) based on efc temporal statistics on each record station

Validation using local information:

- long term records of concomitant flow and biological index - (3 French rivers where we started data collection in 1986) where real time efc calculations are performed for live conditions linked to each biological index sample.



from Expertise (based on geology, climat, hydrogeology, relief, kind of instream ecosystems)

from Ecological Flows Characteristics (point colors defined homogeneous ranges of efc values)

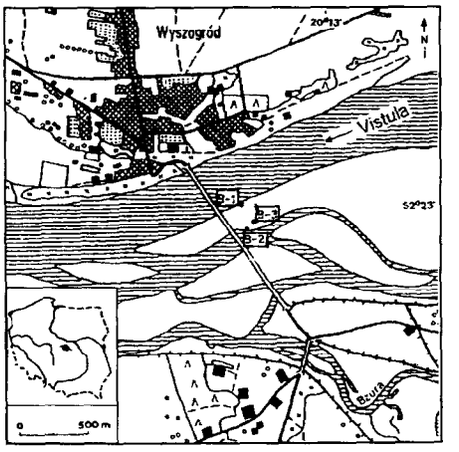
Major Hydro-Ecological regions in the Loire basin (110 000 sq.km)
a cross validation of two methods to define ecohydrological regions

Potential implementation:

1. Local validation objectives: gathering long term records of paired data (ecological and hydrological in a same reach) by the way of international collaboration;
2. Regional validation objectives: linking UNESCO IHP V Ecohydrology am and FRIEND Program (**F**low **R**egime from **I**nternational and **N**etwork **D**ata, started in 1991) to cross large area (broad scale) covered by ecological and hydrological information;
3. Already submitted proposal for bilateral collaboration with UK;
4. Discussing bilateral collaborations with Slovenia (existing funds to start) and Spain;
5. Ongoing contacts with Italy.

River Floodplain Structure and Function

Vistula River Case Study



Authors:

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[2] Warsaw University, POLAND

Study area:

Middle reach of the Vistula River near the city of Plock

Working Hypotheses:

1. Floodplain (structure and land use) can modify the ground water quality;
2. The flood plain is an important reservoir for sediments transported in the fluvial system;
3. The floodplain has a complex structure and its function is determined by paleohydrology.

Methods:

Ad 1. Ground water vulnerability model and chemical analysis of the selected sampling wells;

Ad 2. Study of heavy metals distribution in the recent alluvial sediments as a tracer for understanding the sedimentation pattern;

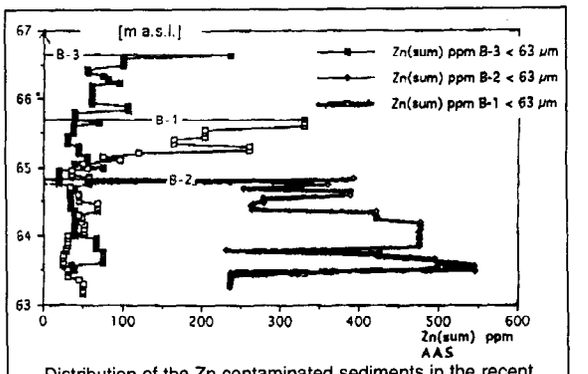
Ad 3. Modelling of the ground water and surface water relationship, flooding pattern by means of DTM.

Preliminary results, experimental design:

Distribution of heavy metals in the recent fluvial deposits on the in channel islands and banks in the selected profiles;

Paleohydrology studies of the older terras and recent channel forms;

Validation of the ground water vulnerability model by the chemical analysis of water quality



Distribution of the Zn contaminated sediments in the recent floodplain of the Wyszogrod Island on the Vistula River

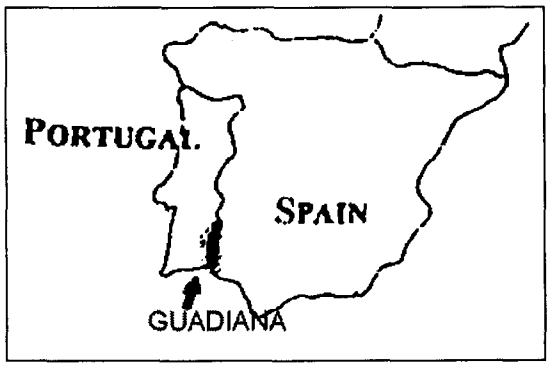
Potential implementation:

Flood plain area protection against surface pollution;

Understanding the heavy metals concentration patterns in the recent channel forms;

Background for the spatial planning of the floodplain area in the context of settlement and infrastructure allocation.

Hydrological and Ecological Data Collection for Management of the Guadiana Estuary (Portugal)



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Study area:
The Guadiana Estuary

Working Hypotheses:

1. How does the change in freshwater input influence the estuarine ecosystem balance?
2. What will be the influence for the estuarine ecosystem of the construction of a very important dam?
3. How do hydrological factors affect the ecological systems?

Methods:

1. Sampling the characteristics of the water that enters the estuary and several other stations until the mouth of the river.
2. Analysis of physico-chemical parameters, sedimentation processes (transport, erosion), discharge regime and also the biotic communities: planktonic, benthic and microbial.

Preliminary results, experimental design:

Forecasts for Guadiana estuary:
In the near future pressure on the Guadiana estuary is expected to increase since there are plans to build several tourist resorts, some with golf courses. This will increase both the organic and inorganic material loads to the estuary. Moreover, the increasing need of water for these populations and for agricultural purposes (including the golf greens), together with the reduction of the flood due to the use of water in dams, may have implications on the sediments both as suspended matter in the water (with implications on turbidity and primary production) and on the bottom (increase or decrease of sediment discharges and changes on the bottom topography).
Anticipation of results:
Results expected will allow:

1. Understanding processes in the natural system.
2. Evaluation of their response to natural and anthropogenic changes.
3. Prediction of the environmental response to changes.
4. Establishment of management systems which can mitigate the unacceptable effects

Potential implementation:

depending on funding

References:

CHÍCHARO, M. A., L. CHÍCHARO, H. MARQUES, I. GOUVEIA, P. BARROS, E. ESTEVES, A. BARBOSA, H. GALVÃO (1998). Diel and tidal variation of mesozooplankton in the Guadiana estuary (South Portugal). In: EOS Transaction American Geophysical Union 79(1): 24.
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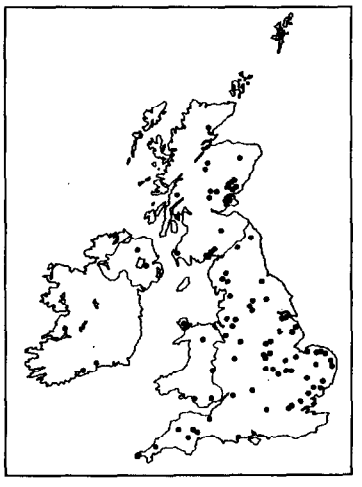
Cyanobacterial (Blue-Green Algal) Toxins and Water Quality

Analysis, Risk Assessment and Countermeasures in Natural and Controlled Waters



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Study area:
University of Dundee; eutrophic waters in the UK; sites of UNESCO/ UNDP Ecohydrology Partners including lakes, reservoirs, rivers and estuary locations

Working Hypotheses:

„Knowledge of cyanobacterial toxins (CTs), their analysis, risk assessments and the application of associated management actions are key components in the planning, provision and protection of water supplies and resources which are prone to cyanobacterial population development."
This hypothesis is derived since:

1. CTs present acute and chronic hazards to human health;
2. CTs cause deaths of wildlife and domestic animals, birds and fish ;
3. CT production is a cosmopolitan and annual phenomenon;
4. countermeasures are being developed and successfully applied in a limited number of countries.

Methods:

Will include:

a) hazard identification and risk assessment of projected and existing cyanobacterial populations;
b) sampling and toxin analysis using Dundee toxicity and molecular methods;
c) identification and collaborative implementation of countermeasures (including awareness-raising, training, CT reduction, removal and detoxification procedures).

Preliminary results, experimental design:

The Dundee laboratory has investigated CTs for 16 years, and human, animal, bird and fish CT poisonings in e.g. UK, mainland Europe, Brazil and S. Africa. Analytical methods have been developed at Dundee including physicochemical, enzyme and immunoassay procedures with transferable techniques emerging.
Dundee based UK-training in CT hazard identification and countermeasures is in progress, as is participation in cyanobacterial control strategies.

Potential implementation:

This project would:

1. Increase awareness among scientists, engineers, water-planners and - users about cyanobacterial toxins with reference to proposed and extant water supplies, resources and health;
2. Increase access to advanced CT analytical methods;
3. Contribute to rational decision - making in the anticipation, avoidance and reduction of CT problems in water supplies and resources.

References:

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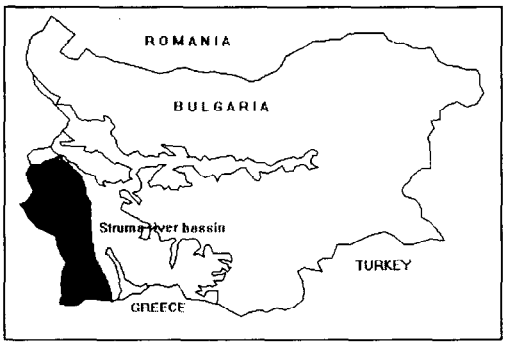
Codd, G.A. and Bell S.G. Cyanobacteria: The global view. in: Proceedings of the 1998 Watertech Meeting, Brisbane, April 27-28, Australian Water and Wastewater association, Artarmon, NSW Australia, pp. 1-14 (1998)

Low Flow- the Rivers Ecosystem Limiting Factor



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Study area:

1. Hydrology: low flow, water resources management, environmental hydrology
2. The ecological state of the rivers, composition and structure of the bentic invertebrate communities of the rivers

Working Hypotheses:

It is possible to determine relationships between water discharge and biological indices. Based on that it is possible to identify those values of minimum flow at which each hydrological parameter meets the value of a given category for quality and biological sufficiency of water according to the national standards;

Methods:

Synchronous measurements of water discharge and biological material collections. Analyses of the available information by two approaches: 1) temporal - by determination of the relation between the biotic indices and water discharge as a result of the processes which have been realised at the moment of their registration. 2) spatial- the river is divided into sections, by discrete study of specific river areas/stretches dominated by one or another specificity of the anthropogenic impact on the natural flow regime and/or on the water quality.

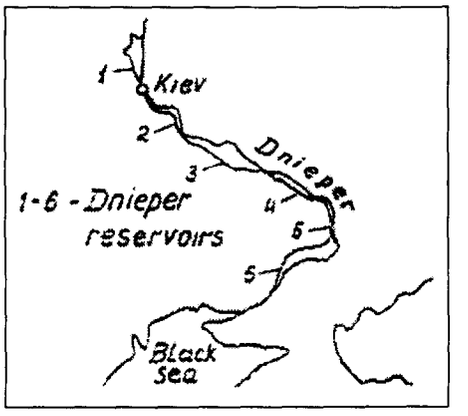
Preliminary results, experimental design:

The low flow phase is of critical importance for the state of the river ecosystems, while the drastic discharge fluctuations in the same time do not significantly influence the water ecosystems. The relationship between water discharge and the individual species variety (HIND), the dynamics of equability (EVNS), dominance indicator (DOMN) and the senotic indexes (SPOT) or (SPUB) are the most significant. The extent of relationship between the cenotic parameters and the water discharge grows with stabilisation of the saprobiological state around the optimum b- mesosaprobity.

Potential implementation:

Trough the defined relationships it is possible to obtain water discharge which should be available in the river to ensure each one of the categories according the acting regulatory documents.

Ecological Role of Hydrodynamic Processes in the Dnieper Reservoirs



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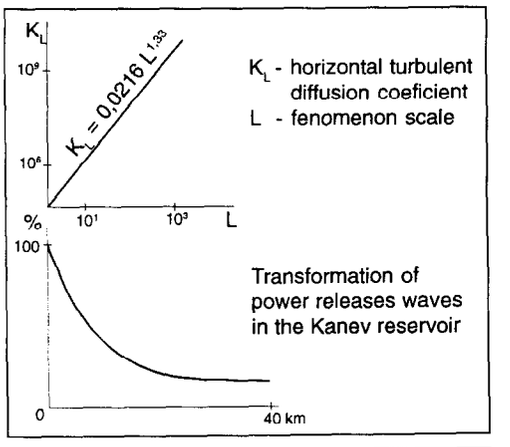
Study area:
Reservoirs of Dnieper river in Ukraine

Working Hypotheses:
Hydrodynamics is one of the key (most ecologically significant) hydrogeologic factors of aquatic ecosystem functioning. In the Dnieper reservoir, the main elements of hydrodynamics are: currents, turbulant mixing, water level fluctuation and wind waves.
Hydrodynamics plays the separate (limiting for hydrobions) role in the shallows of reservoir.
Only one real way to improve ecosystem state and water quality in the Dnieper reservoir is the hydrodynamic management by means of regulation of hydropower station releases (in the upper parts of reservoirs) and ecologically grounded seasonal lowering of water level (in lower part of reservoirs).

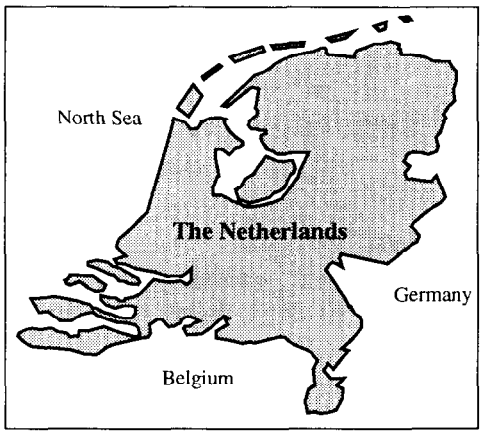
Methods:
1. Observation in nature;
2. Calculations;
3. Mathematical modelling;
4. System analysis.

Preliminary results, experimental design:
Investigation of the Dnieper reservoirs (including shallows occupied by macrophytes) has found and estimated the following:
1. The peculiarities of current regimes;
2. The regularities of turbulent mixing processes;
3. The power releases waves transformation;
4. The inner water exchange causing by currents and water level fluctuation under the water power releases and its influence an organic mater balance (by BOD_{tot}) in the shallows;
5. Influence of the large seasonal lowering of water level on the macrophytes functioning;
6. Possibilities of hydrodynamic regulation for improvement of ecosystem state and water quality.



Potential implementation:
Our results are used for Dniepre reservoir monitoring which is carried out by the Ukrainian State Committee for Water Management and will be useed for elaboration of ecologically grounded exploitation plan of the Dnieper reservoirs.

Implications of Catchment Hydrology for Ecosystems in Small Streams



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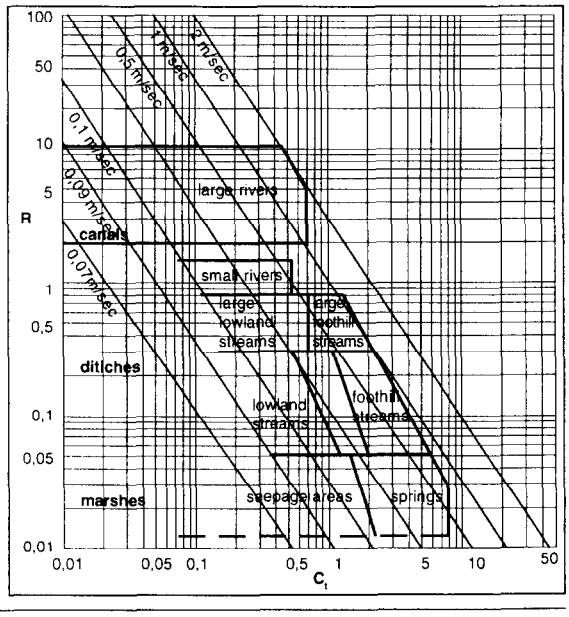
Study area:
The Netherlands

Working Hypotheses:
Quality and Quantity of water in small streams are influenced by changes in the deeper groundwater reservoirs either directly or indirectly. Examples of different types of influence are given and others must be investigated

Methods:
Hydrology/groundwater
Ecology/hydraulics

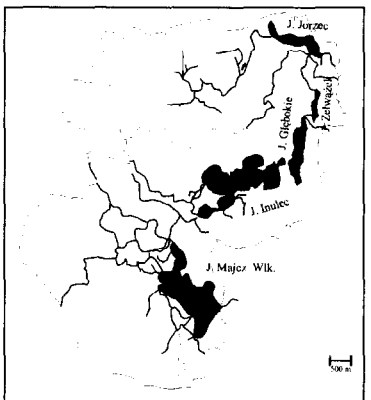
Preliminary results, experimental design:
The distribution of the brook Lamprey and its extinction in some streams are related to changes in quality and/or quantity of regional, subregional and local groundwater reservoirs.



Potential implementation:
Management of small streams shall have to take in to consideration the source of water quantitatively and qualitatively. If not considered, management shall be useless.

Ecohydrological Research of Lake - Watershed Relations in Diversified Landscape (Masurian Lakeland, Poland)

Main Hypotheses, Preliminary Results



The outlines of the river Jorka watershed and its hydrographic network

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Study area:

Lakeland area in north-eastern Poland, river Jorka catchment (about 65 km^2) and its stream-lake system

Working Hypotheses:

1. Due to mosaic pattern of: relief, land use, land cover, erosion potential and infiltration condition, the transformation of nutrients on catchment scale in surface and ground waters is strongly variable on a seasonal and long-term basis. What are the best predictors (precipitation, discharge, land use, landscape structure indices) to explain this variation ?
2. Wetland patches and zones close to lakes function as seasonal sink or sources for nutrients. What is their relationship to hydrological conditions (longevity of freshet period, discharge pattern, moisture conditions) ?

Methods:

The concentration of nutrients (TP, DP, N-NO_3, TKN) as well as Cl is monitored in 15 subcatchments (small stream and rivulets) (area 10-100 ha) on a seasonal and year to year basis.
Wetland zones are equipped with grid of piezometers and water quality (chemical species as above) is monitored on a seasonal and year to year basis.
Discharge, precipitation and lake water level are measured constantly.

Preliminary results, experimental design:

1. Concentrations of TP and N-NO_3 fluctuate strongly and randomly between seasons and years (1992-1997).
2. The export rates from different subcatchments are mostly related to discharge. The vernal values are several times higher than the summer values. Long-term trends (during period 1992- 1997) were not detectable.
3. Wetland zones are sinks for nitrogen only during vernal freshet and sinks for TP only during drought periods

In surface waters (average values for 11-17 streams):
- *concentration (most frequent range, seasons and years):*
  TP: 0,08 - 0,5 mg/l;
  N-NO3: 0,1 - 0,8 mg/l;

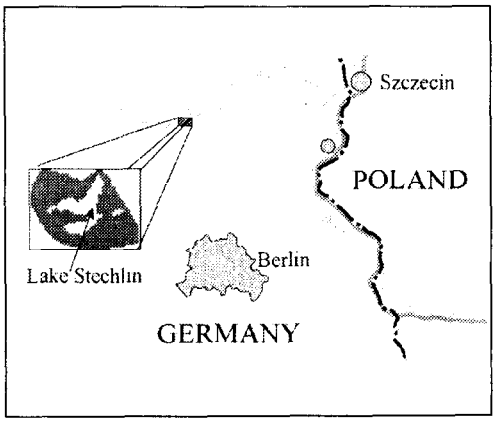
- *export rates (92-97): [kg/ha/month]*
  spring : TP below 0,12; N-NO3 below 0,15
  summer: TP below 0,01; N-NO3 below 0,08

Changes in wetland zones (10-15 m wide):
- TP [mg/l]: April (97): 2-12, decrease slight or no change
  August (97): decrease from 30-40 to 5-6
- N-NO_3 [mg/l]: April (97): decrease from 15-30 to 2-5
  August (97): 1-2, no change

Potential implementation:

The management of lake catchments and wetland zones (lacustrine ecotones) should be based on the knowledge of the most effective transport of nutrients in the given landscape and removal potential of wetlands. The results of the above studies can be implemented in protection and restoration of buffer zones around the lakes.

Influence of Subsurface Watershed on Eutrophication



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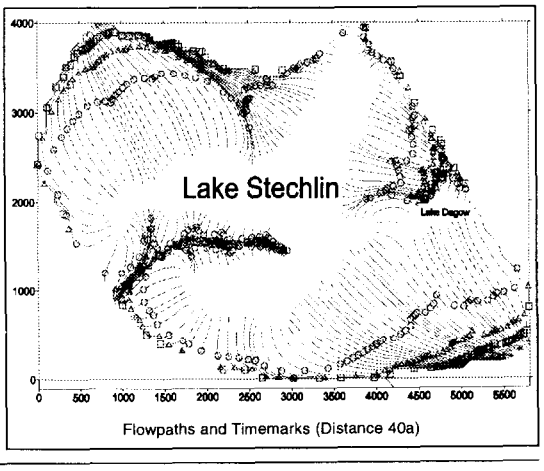
Study area:
Lake Stechlin and Lake Dagow Watershed

Working Hypotheses:
The trophic state of lakes is mainly influenced by subsurface water inflow (in hardwater lakes with major groundwater contribution from typical sandy aquifers originating from fluvioglacial deposits)

Methods:
1. Field Measurements, transect set-up
2. Transport and geochemical modelling
3. Conceptual model with compartments: unsaturated zone - groundwater - surface water

Preliminary results, experimental design:
The influence of groundwater on trophic state is high (for Lake Stechlin)
C, Ca - load in lake water originates mostly from groundwater
2-dimensional model for flow in aquifer (see: Box 2)
2-dimensional transport model (needs to be extended to account for geochemistry - details in paper presented)



Potential implementation:
1. Model software can be applied to simulate other cases where the same or similar processes are relevant.
2. Guide for implementing the technology of induced calcite precipitation to prevent eutrophication or improve trophic state in hardwater lakes

Habitat Scale Ecohydraulics

Authors:

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[2] Universita' degli Studi di Milano, Dipartimento di Scienze dell'Ambiente e del Territorio, Via Emanueli, 15 - 20126 Milano, ITALY

Study area:

The Deben, Welland, Nene and Great Ouse catchments in the English Midlands and East Anglia

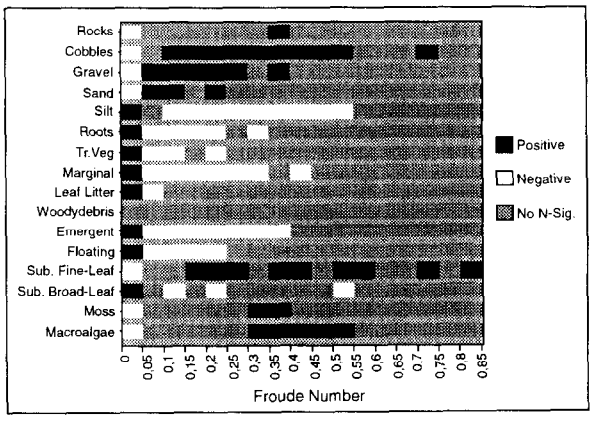
Working Hypotheses:

1. That the distribution of «functional habitats» is related to in-stream hydraulic variables, in particular, the Froude number (links to hypotheses 9 & 11).
2. That the use of the Froude number simplifies the transition of ecological principals into hydraulic guidelines.

Methods:

1. Point recordings of depth, velocity and functional habitat type were made.
2. Froude number was calculated for each.
3. The ACTUAL proportion of times a habitat was found in a particular Froude number class was compared with the EXPECTED proportion (expected = the proportion that would be found if habitats were distributed at random and not with Froude number). If the 95% confidence limit of an ACTUAL proportion was above the expected value then that habitat was said to be significantly positively associated with that Froude number class. If the 95% confidence limits were below the expected value then that habitat was negatively associated with that Froude number class.

Preliminary results, experimental design:

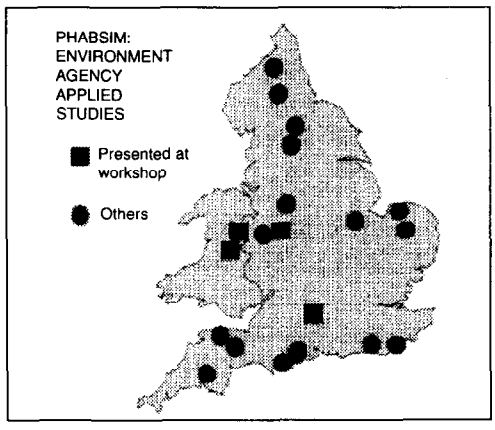


The distribution of all the functional habitats (except woody debris) was significantly different to that expected if Froude number had no influence. There were two distinct types of habitat response to Froude number: those that were significantly associated with only the lowest Froude number class and those that were associated with Froude numbers greater than 0.05. Low Froude number habitats were «silt», «roots», «trailing vegetation», «marginal plants», «leaf litter», «emergent macrophytes», «floating-leaved macrophytes» and «submerged, broad-leaved macrophytes». The other habitats had a gradient of preference with increasing Froude number going from «sand» to «gravel» to «moss» to «macroalgae» to «cobbles» to «submerged», «fine-leaved macrophytes».

Potential implementation:

Hydraulic variables, such as Froude number, could be manipulated, as part of river rehabilitation projects, in order to alter habitat provision.

The Benefit of PHABSIM to the Management of Water Resources and Fisheries in England and Wales



Authors:

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[1] Environment Agency, Sapphire East, 550 Streetsbrook Road, Solihull, West Midlands B91 1QT, UK

[2] Environment Agency, National Coarse Fisheries Centre, Arthur Drive, Hoo Farm Industrial Estate, Worcester Road, Kidderminster, DY11 7RA, UK

Study area:

River systems in England and Wales

Working Hypotheses:

Transference of PHABSIM methodology to the river systems of the UK will enable improved and substantive input to the development of water resource management and control regimes.

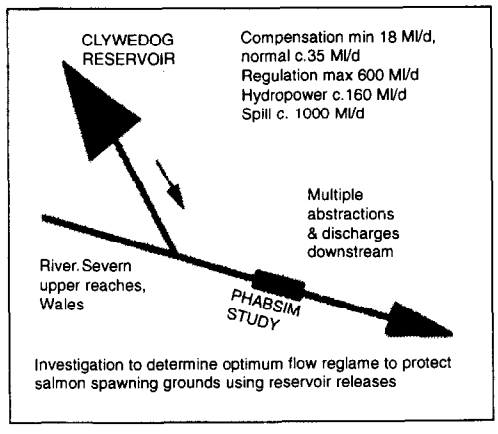
Links to Hypotheses 2, 3 and 9

Methods:

The PHABSIM technique has been tentatively used by the Environment Agency to support water resources decision making in England and Wales. Applications to date have concentrated mainly on fish habitats, investigating the potential relative impacts of changing reservoir and borehole releases, abstractions and water transfers.

Preliminary results, experimental design:

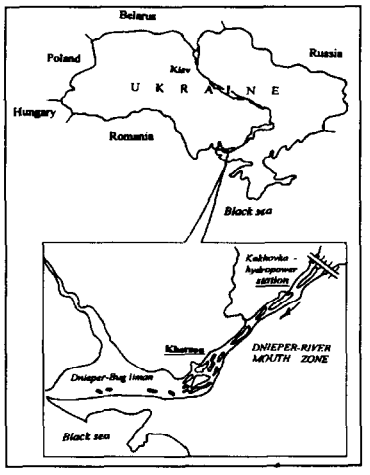
The Environment Agency applied studies are shown in Box 12 with an example application for the River Severn being given in Box 2. Although the application is expensive and time consuming, its use can be valuable under the correct circumstances. PHABSIM can assist decision making and give ecology a voice to defend itself against detrimental changes to flow regimes resulting from resource demands. However, the outputs are river reach, species or lifestage specific and a considerable amount of interpretation of results is required to manage water resources and fisheries appropriately. Further research is about to commence to validate the techniques, concerning hydraulic predictions, physical habitat preference curves and the relationship of physical habitat to population and biomass.



Potential implementation:

Full implementation will be influenced by ongoing research to validate the studies. However, the use of PHABSIM should not be mechanistic but should be part of properly scoped, appropriately designed studies and be used to complement other techniques and evidence.

Ecosystem State and Water Quality Management in the Dnieper River Mouth Zone



Authors:
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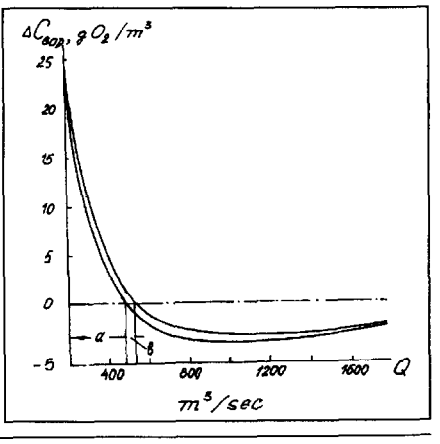
Institute of Hydrobiology, prosp. Geroev Stalingrada 12, Kiev - 210, 254210, UKRAINE

Study area:
The Dnieper river mouth zone (Ukraine)

Working Hypotheses:
The ecosystem state management of regulated river sections below hydroelectric power stations can be carried out by means of their water regime regulation. This aim is realised by means of quantitative assessment of production - destruction process balance and oxygen content dynamics under the different release regimes of upper situated hydropower stations.

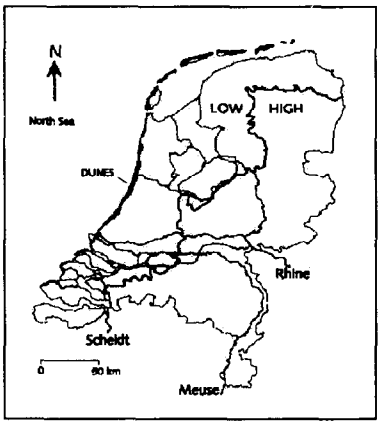
Methods:
The dynamic of production - destruction process is estimate by index BOD_{tot}. This index and oxygen content are calculated on the base of estimation of functional possibilities of different hydrobionts and hydrodynamic condition.

Preliminary results, experimental design:
Regularities of organic matter content dynamics (by BOD_{tot}) in the canal of the Dnieper river mouth zone under different releases of the Kakhorka hydropower station have been found. The methods for estimation of *ecosystem*, *ecological* and *extremal releases* have been worked out.



Potential implementation:
Our results are used by water management organisation of Ukraine for planing the Kakhorka hydropower station operational regime.

Predicting Ecological Effects of Changes in Water Management in The Netherlands



Author:
REMCO VAN EK
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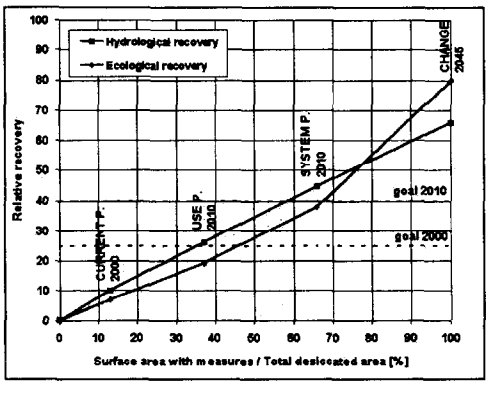
Study area:
The Netherlands

Working Hypotheses:
What type of measures on water management is most effective to allow economic activities as well as restoration and development of nature?

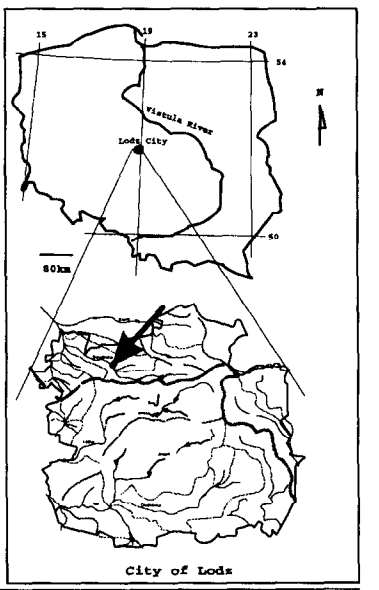
Methods:
Nation-wide policy scenario analyses using GIS models of hydrology, ecology and economy

Preliminary results, experiments design:
Our current policy will not achieve it's goal. More restoration measures are needed for hydrology and ecology to achieve the policy goal set for 2010 - a reduction in the present desiccated surface area by 40%.



Potential implementation:
In the Fourth National Policy Document on Water Management.

Renaturisation of the Municipal River of the Łódź City (Poland)



Authors:
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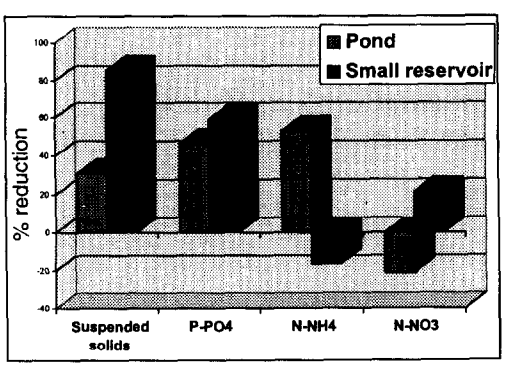
Department of Applied Ecology, Center for Ecohydrological Studies; University of Łódź; Banacha 12/16; 90-237 Łódź, POLAND

Study area:
The Łódź City is a large industrial city situated in Central Poland, on the I order watershed, between two catchments: The Vistula River and The Odra River.
The Sokołówka River - one of the local watercourses - flows across the northern district of the city . Its length amounts to 13 km and the catchment area - 44km^2. The average natural river discharge at its estuary is only 0.17 m^3/s and $Q_{10\%}$ - 7.5m^3/s.

Working Hypotheses:
Restoration of the biological structure and processes of the river valley in urban areas by integration of hydrological, hydrobiological, technical, and legislative aspects. The Sokołówka River valley in the past was channelised by concert cemented slabs for the purpose of receiving and detention of stormwater. However, the valley structure in the studied section of river course is still natural with patches of pine, alder, and oaks trees, macrophytes and seminatural meadows. For reducing flow variability, sediment load and pollutants carried with stormwater, restoration at the channelised section of rivers by a series of wetlands and small impoundment's has been planed.

Methods:
1. Standard analyses of hydrological, hydrochemical, biological conditions in the river and its valley.
2. Indices analyses of bank quality.
3. Hydraulic processes simulation for variability flow conditions.- co-operation with Technical University of Łódź.

Preliminary results, experimental design:
The efficiency of nutrient reduction was measured in ponds and the reservoir. It was shown that reservoir improves water quality more effectively and stabilises abiotic conditions throughout the year. The reduction of variability in the abiotic condition enhances biological productivity of river valley, water quality and biodiversity.

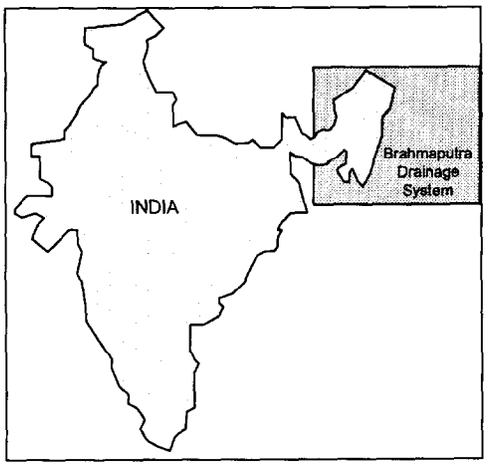


Potential implementation:
Integration seemingly contradictory functions: stormwater management, restoration biodiversity and landscape of river valley, enhancement recreational quality and capacity.

INTERNATIONAL HYDROLOGICAL PROGRAMME

LIST OF THE ASSOCIATED ACTIVITIES OF IHP-V 2.3/2.4 „ECOHYDROLOGY"

Fisheries Ecology of North Eastern Himalayas with Special Reference to the Bramhaputra River



Author:
SHYAMA PRASAD BISWAS, SANCHITA BORUACH
Dept. of Life Sciences, Dibrugarh University Assam
786 004, INDIA

Study area:
Brahmaputra Drainage System (North-Eastern Part of India)

Working Hypotheses:
What is the pattern of fish species distribution in different segments of the river?
What are the patterns of river flow/discharge, flood level, sedimentation rate and their bearing on fish yield?
What are the practical steps necessary for restoration of beel (flood plain lake) habitats?
Suggestive measures for conservation of aquatic fauna including River Dolphin.

Methods:
Fish species diversity (Shannon-Wiener index);
Standard limnological methods (A. P. H. A., 1995);
Collection of fish specimens from different landing centres and recording of catch statistics following Gulland (1975);
Recording of flow data and siltation rate (in collaboration with Central Water Commission - India).

Preliminary results, experimental design:
Block net and rotenone method has been used for sampling fishes from the rapids whereas catches from the prominent types of fish gears viz. cast, lift, seine nets are used for assessment of fish yield from rivers and beels (flood plain lakes).

1. 141 fish species recorded so far - and their distribution pattern and fish yield from different lentic and lotic systems.
2. About 50 species of ornamental fish identified.
3. Productivity and water balance of certain selected flood-plain lakes are under study now.
4. Migratory behaviour of certain fish species and the river dolphin being studied.

Potential implementation:
Optional utilisation of fish resources, thereby checking over-exploitation of certain prized fishes like mahseer (Tor spp.) Notopterus chitala etc. A data-base for ornamental fishes of the region, habitat restoration of flood plain lakes and checking for eutrophication of lenthic water bodies

Ecological Problems Related with Use and Management of Biological Resources of Lake Sevan

Author:
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Study area:
Lake Sevan - Hydrobiology/Ichthyology; Biodiversity Conservation

Working Hypotheses:

Further eutrophication of Lake Sevan may lead to irreversible misbalance of its biodiversity, particularly, valuable fishes (Coregonidae, Salmonidae) may be replaced by less valuable ones of lower quality (such as Carassius auratus);
An unregulated fishery may upset the balance between different trophic levels of the lake's ecosystem, increasing eutrophication;
Probable "blooming" in the lake by blue-green algae will lower the lake's water quality.

Methods:

Mathematical modelling and statistical analysis:
Virtual-Population analysis (VPA) on determination of fish stocks;
Commonly used methods of hydrophysical, hydrochemical, and hydrobiological investigations.

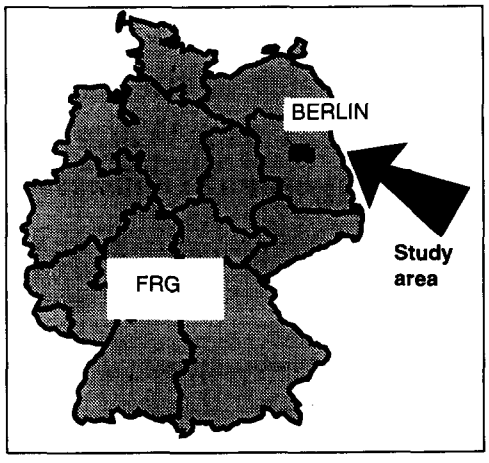
Preliminary results, experimental design:

1. General mechanizms of eutrophcation of the lake are identified;
2. Regression analysis is conducted and relationships between various parameters of the lake's ecosystem are determined;
3. Long-term dynamics of biomass and production of phytoplankton, zoolplankton, zoobentos, and fish is obtained;
4. It is planned to conduct hydroecological monitoring on some alpine lakes, including Lake Sevan, during two years.

Potential implementation:

Preparation of annual predictions on commercial fishery from Lake Sevan;
Preparation of recommendations to Ministry of Agriculture on rational agricultural activity within the basin of Lake Sevan;
Preparation of functions on de-eutrophication of Alpine lakes which have undergone large scale hydrotechnical conversion;
Preparation of recommendations on biodiversity conservation and rational use of natural resources of alpine limnosystems (based on the pattern of Lake Sevan).

Benthic Organic Matter and Near Bed Flow in Natural Lowland Streams, Assessment of the Small Scale Dimension



Author:
MICHAEL MUTZ
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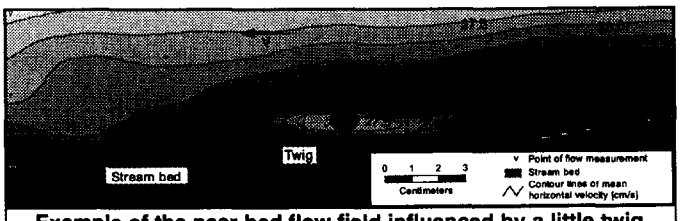
Study area:
Germany, Federal State of Brandenburg

Working Hypotheses:
Sand dominated lowland streams do have specific morphological elements generating specific flow in the near-bed distance.
At the scale of stream segments the flow field is diverse in regard to the distribution of morphological features.
The near-bed flow field determines the spatial pattern of retention and metabolism of particulate organic matter and herewith the magnitude of these processes.

Methods:
Stream morphology is assessed by electronic distance measurement and close-up photographs. The 3-D nature of stream bed is modelled by use of a GIS. Near-bed flow is registered with an acoustic doppler velocimeter. All data are coupled in the GIS for analysis.

Preliminary results, experimental design:
Quasi natural sand dominated lowland streams do have high complexity of stream bed morphology, causing high diversity of flow within stream segments.
Near-bed flow exhibits high complexity at the point scale which is related to distribution of small woody debris causing skin-roughness.

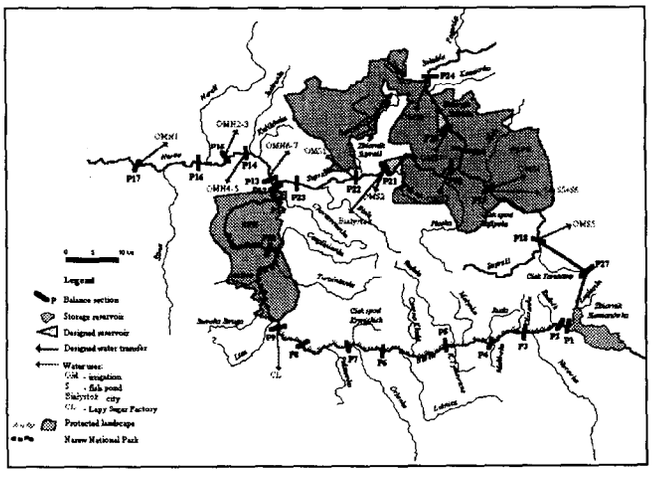


Example of the near-bed flow field influenced by a little twig

Further measures and modelling will interpolate point measures of near-bed flow and generate an extensive model of near-bed flow covering typical stream segments. Analysis will obtain interdependent pattern of morphological and hydrodynamic features.

Potential implementation:
Retention and benthic metabolism of organic carbon are basic processes of self purification in small streams and major goals of water quality management. Detailed knowledge of parameters governing these processes could enable directed management measures. Retention and benthic metabolism could be enhanced by controlling the stream's morphological features e.g. simply by changes in management of riparian vegetation, macrophytes and/or supply of woody debris in its different forms.

Protection of Natural Character of the River Valley as a Water Management Objective



Authors:

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[1] Institute of Environmental Engineering Systems, Warsaw University of Technology, ul.Nowowiejska 20, 00-653 Warsaw, POLAND

[2] Warsaw Agricultural University, ul. Nowoursynowska 166, 02-787 Warsaw, POLAND

Study area:

Upper Narew River Basin, Poland

Working Hypotheses:

In prevailing water balance analysis, performed for water management purposes, water requirements of a lowland river and its valley were most often represented only in a form of biological flow requirement (which means that certain minimum flow has to be left in the river in order to maintain river hydrobiological activity). Still, for the preservation of riparian ecosystems their requirements should be represented in a not so simplified way. Several hydrological features should be considered. The main problems are:

1. to select features that are crucial for conservation of valley ecosystems,
2. to express them in a form of desired flow in particular river stretches during the year,
3. to develop a model of valley ecosystems that is able to co-operate with balance simulation model of the whole water management system,
4. to define the criteria assessing the degree of satisfying specific ecosystems requirements.

Methods:

Upper Narew River system was studied. Four riparian ecosystems were selected by ecologists as a reference. Ecologists defined also the hydrograph of desired water levels above and below ground level in particular ecosystems during the year. After analysis of this hydrograph two basic requirements of riparian ecosystems were selected: spring flood and avoidance of overdrying of sites in summer. Desired water levels were transformed into flow rates with the use of a hydraulic model and were assigned as water needs of a river valley which was treated as one of the users in the water management system.

Preliminary results, experimental design:

After a series of simulation computations, a main conclusion may be formulated that Siemianowka storage reservoir may be used to protect the natural character of Narew River valley. The reservoir may enforce spring flooding of the valley in the years when natural but too small floods occur, with the restriction that enough water should be preserved for other users in the system.

A very important issue in the proposed methodology is that lowland river valley is treated as one of the water users in the systems with its own water demands, which allows to consider water requirements of riparian ecosystems in water balance analysis.

Potential implementation:

Proposed methodology enables quite detailed consideration of environmental requirements in balance analysis. This methodology may be applied in the basins where natural character of rivers and its valleys are worth preservation or there is a need to restore lowland river character.

References:

T. Okruszko, D. Puslowska, W. Dembek: 'The Water Management Rules in the Upper Narew River Basin', Proceedings of International Conference on Aspects of Conflicts in Reservoir Development and Management, London, 1996; p. 525-530.

Deforestation in Central Amazon and its Effects of Stream Hydrology and Fish Communities

Authors:

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[2] Universidade Estadual Paulista - UNESP, Campus de Rio Claro - IB/ Ecologia, Avenida 24A, 1515, Rio Claro - SP, BRASIL

Study area:

Central Amazon, 65 km North of Manaus.

Working Hypotheses:

In this project we want to study the influence of deforestation on stream hydrology and on fish community.

Our hypothesis:

In streams where riparian vegetation was removed, some problems may occur; increase of nutrients, algae and sedimentation on the stream bed consequently the channel shallows and enlarges and spatial heterogeneity diminish. These changes occur gradually and aquatic community react in different ways according to the degree of deforestation.

Our questions are:

1. What hydrological changes on streams can occur when the riparian vegetation is removed?
2. How does the fish community react to these changes?
3. Are aquatic communities capable of recovering after secondary vegetation is restored?

Methods:

1. collect fish with different samplings;
2. measure the abiotic factors (hydrological and limnological parameters);
3. measure the biotic factors (diversity, structure and composition of fish community);
4. correlate between abiotic and biotic factors

Preliminary results, experimental design:

First stage: Control area

Second stage: recent-deforested area

Third stage: Secondary forest restored

We intend to choose two streams to represent each one of these stages. We will collect during the dry and wet season, twice each season, during two years totalling 48 samplings.

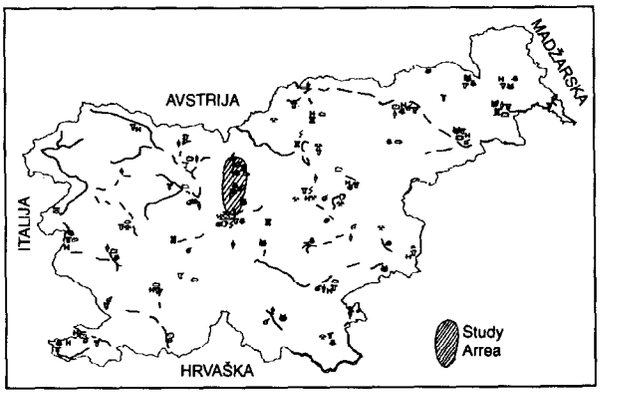
Potential implementation:

This project will be developed in an area which has been studied since 1983 by PDBFF (National Institute of Research of Amazonia / Smithsonian Agreement). We have basic physical infrastructure and part of this project (1 year) will be support by this joint agreement.

References:

Silva, C.P.D. (1995) Community structure of fish in urban and natural streams in the Central Amazon. *Amazoniana* 13(3/4): 221-236.

Stream Water Quality Assessment in Slovenia



Author:
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Univ. of Ljubljana, Biotechnical Faculty, Dept. of Biology, Vecna pot 111, SI-1001 Ljubljana, SLOVENIA

Study area:
Benthic community in rivers - natural and polluted ecosystems
Macroinvertebrates in relation to hydrology in streams

Working Hypotheses:

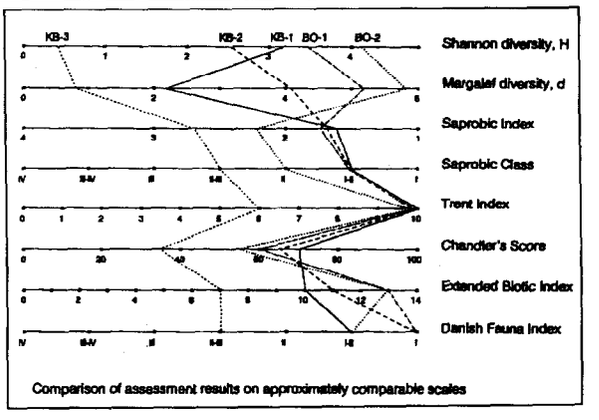
Biological responses of biocenoses to different kinds of pollution is of crucial importance and it is based on fundamental knowledge of biology (ecology) and hydrology of the running water environment as a whole. Self-purification processes can be understood if hydrological characteristics of the stream ecosystem are used as an abiotic basis determining community organisation.

Methods:

Kick-sampling procedure is a semiquantitative method which provides representative samples of benthic community. Diversity and biotic indices application as a tool for water quality assessment.

Preliminary results, experimental design:

Preliminary results of selected rivers confirm our hypothesis that different biotic and diversity indices show us diverse results in head water area (turbulent, well oxygenated conditions) and do not rank the pollution degree in the same way. All tested indices only clearly separate organically rich locations from slightly polluted sites. But it seems that the Chandler Score System after its modification according to occurrence of macroinvertebrates would presumably be adequate for Slovenian running waters in mountain areas.



Comparison of assessment results on approximately comparable scales

Potential implementation:

Results of biological assessment and actual monitoring programme confirm that a major limitation of the present approach is in the narrow range in assessment, which does not reflect overall pollution conditions. How to improve this? What should be done in future? First, new saprobic values (other than Sladecek e.g.) are necessary to be applied; second, new taxa/species have to be introduced in the Chandler Score System; and third, the kick-sampling methodology (transect modification) must be standardised. The basic knowledge for the mentioned implementation will require intensive research of the natural background of rivers, mainly from ecohydrological point of view.

Determining Reservoir Retention of Nitrogen by Denitrification and Mass Balance Methods

Comparative Studies of Different Types of Reservoirs

Authors:
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Study area:
Reservoirs in south-eastern Poland (headwaters of the Vistula catchment)

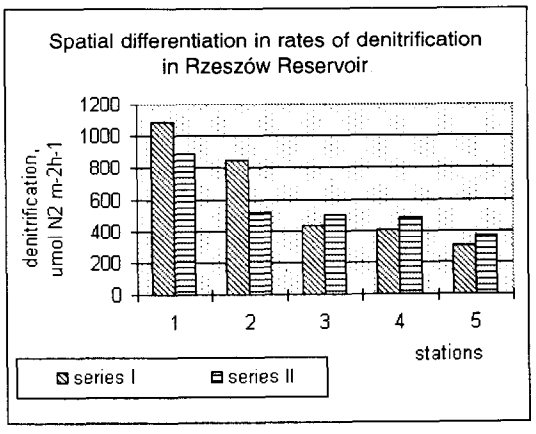
Working Hypotheses:
Is the denitrification process an important sink of nitrogen in aquatic ecosystems?

Methods:
Estimation of nitrogen reservoir retention based on estimates of sediment N2 fluxes, terrestrial input of inorganic nitrogen and determination of ecosystem mass balances.

1. Measurements of sediment N2 fluxes using two methods:
   - in situ chamber measurements of N2 - the final product of denitrification,
   - isotope pairing technique.
2. Estimation of nitrogen mass balance established on the bass of hydrological modelling.

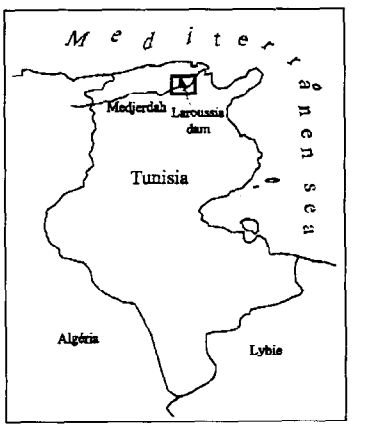
Preliminary results, experimental design:
In situ chamber denitrification rate measurements in reservoir sediments. Rates in the upstream part of Rzeszów reservoir are 3 times those in the lower part.
Design:

1. Measurements of denitrification rates using two methods:
   - in situ chamber (continuation),
   - isotope pairing technique (co-operation with Aarhus University, Denmark and Łódź University).
2. Investigations of monthly nitrogen input, output and its retention in reservoirs. The annual nitrogen balance.



Potential implementation:
Values for nitrogen retention obtained with denitrification rate and mass balance method, two different and truly independent methods support the validity and reality of both approaches in investigated ecosystems. Both methods should be useful in comprehensive assessments of ecological processes in reservoirs and should be good tools for sustainable management of reservoirs.

Flow Modelling in the Laroussia Dam's Reservoir on the Medjerdah River in Tunisia



Authors:
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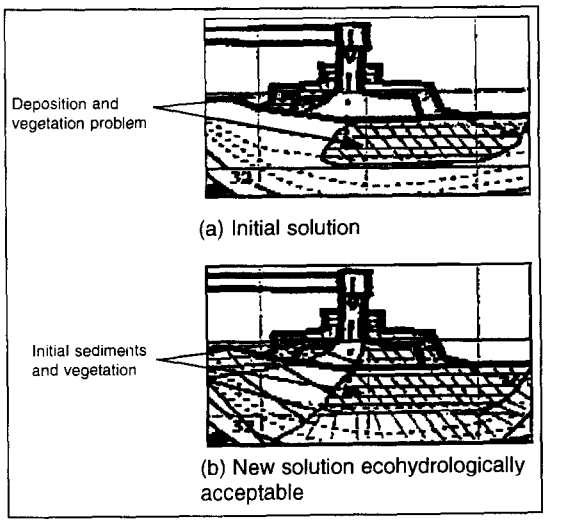
ENIT hydraulic Laboratory B.P. 37, Tunis - Belvedere, 1002, TUNISIA

Study area:
Lower Valley of the Medjredah river basin in the north of Tunisia

Working Hypotheses:
Medjezdah - Cap - Bon Canal water intake, constructed upstream of Laroussia dam, is expected to be responsible of ecological changes within the reservoir. These changes are illustrated by vegetation and sediment elimination in front of this intake placed in the inner side of a curve of the river.

Methods:
Physical and numerical modelling are applied to identify the origin of the hydrological and ecological problems and to suggest solutions.

Preliminary results, experimental design:
The suggested solution is to restore the original sediment deposition and vegetation growing zone formation upstream and in front of the intake. It was proven, by both physical and numerical modelling of the hydrodynamics behaviour of the system, that this could be accomplished by modifying the shape and the orientation of the intake structure.

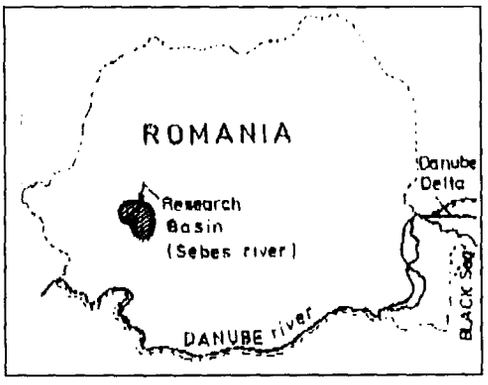


Potential implementation:
Physical and numerical modelling of the hydrodynamics of similar systems may be combined to analyse such ecohydrological problems wherever it seems there is a conflict between hydrological and ecological goals or needs.

INTERNATIONAL HYDROLOGICAL PROGRAMME

CONCEPTUAL CONSIDERATIONS OF IHP-V 2.3/2.4 „ECOHYDROLOGY"

Optimisation Models for Correlation Between Ecological and Hydrological Parameters



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Study area:
Hydrological basin of Tebes River with further extension to other basins from Romania

Working Hypotheses:

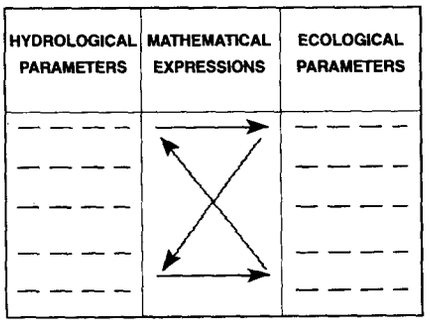
1. For an experimental research basin, mathematical expressions must link the most important ecological and hydrological parameters (taking into account characteristic periods of droughts and floods, natural and accidental);
2. Research in-situ on the experimental hydrological basin with variation of ecohydrological parameters;
3. Transformation of a hydrological basin into an ecohydrological one using appropriate equipment.

Methods:

1. Statistical and deterministic methods to establish correlative relationship and experimental verification (GIS, computational methods, etc.).

Preliminary results, experimental design:

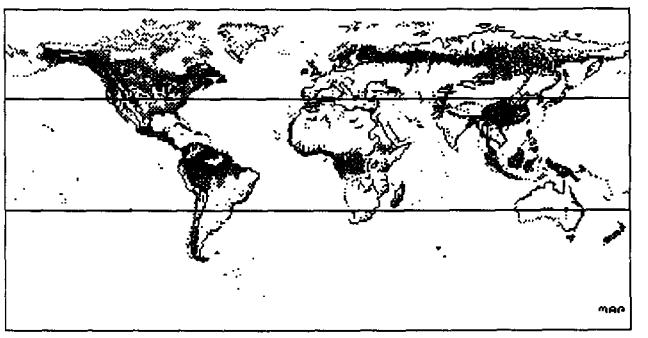
1. The inventory of ecohydrological input factors from the hydrological basin using the systems theory.



Potential implementation:

1. To the hydrological basin of interior Danube River and to the Danube Delta with the co-operation of the National Institute of Meteorology and Hydrology, the Geographical Institute of the Romanian Academy, the Research Institute for Environmental Engineering, the National Water Authority.

Sustainable Management of Shallow Tropical Lakes and Lagoons



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Study area:
Tropical zone

Working Hypotheses:
Ecology of shallow waterbodies is driven by unpredictable dynamics of catchment hydrology. There is very little synthesis of ecohydrology from tropical regions, yet water is under increasing pressure from population and agriculture.

Methods:
In order to effectively conserve shallow waterbodies, the science of ecohydrology must be harnessed and rapidly transferred to management bodies. The proposed conference, for which UNESCO support is sought, will seek to do that.

Preliminary results, experimental design:
International conference Naivasha Wildlife Training Institute, Naivasha, Kenya, April 11-16 1999, is proposed in association with UNESCO regional co-ordinator for Africa, Julius Wellens- Mensah.
Organisational support already provided by IUCN, ICIPE, KWS, KMFRI, NMK, LNRA, and the Universities of Leicester, Nairobi and East Anglia

Potential implementation:
Management publication (small handbook) and symposium volume.

Ecohydrology: Fusing Concepts and Scales

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Study area:
Europe

Working Hypotheses:
Hydrological studies must consider information on the biota in the investigation. Furthermore, ecological studies should contain real hydrological inputs, at best, by a hydrologist devoted to the project. Only this way will lead to real ecohydrological results in the strict sense of this hypothesis.

Methods:
A Geographic Information System is one of the most prominent tools in achieving ecohydrological results and for the task of bridging the gap between hydrology and ecology and of eliminating the differences in scales used in both specific investigations.

Preliminary results, experimental design:
Integrate hydrology and ecology on an interdisciplinary basis on running projects.

The Point of View of Some Hydrologists on the New Paradigm „Ecohydrology"

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Study area:
All countries of Western Europe and North America and also some projects in co-operation with Latin American, African and Asian countries.

Working Hypotheses:
In the context of Sustainable Water Resource Management (Agenda 21,Ch.18 and IHP-5), concerning: geosphere, biosphere and human sphere, the majority of studies consider the 3 themes in the perspective of an integrated management (and also to obtain a financial support). To find legitimacy like a scientific paradigm, Ecohydrology could concern a restricted area of the physical and biological spheres with links inside clearly defined for different water bodies and different spatio-temporal scales.
It is supposed that the specialised studies on the landscape sphere can be the inputs of ecohydrology of water bodies (hydroclimatology to ecology), and, below, the output of ecohydrology gives a contribution to the integrated management (with the economic context of human activities and societies).

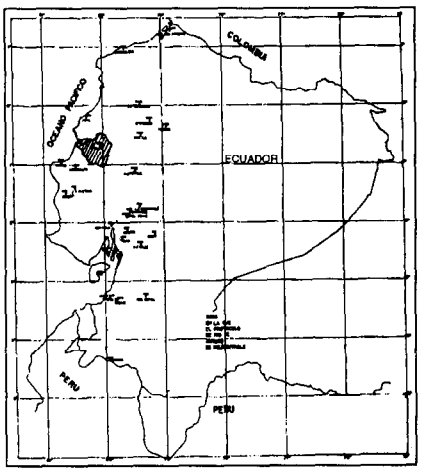
Methods:
The main goals of the „ecohydrology" could be

1. Knowledge of the hydrosystems (water bodies) and understanding of their relationships between climatology, hydrology, chemistry, toxicology, biology, physical and biological processes. (and if large human activities: economy and social sciences).
2. Integrated models based on that knowledge
3. Forecasting changes of hydrosystems (simulations and scenarios) with changes in the inputs (hydroclimatology, chemistry, biology) and output (management policies and risk assessment).

Preliminary results, experimental design:
A lot of results have been published in reports of the International Association of Hydrological Sciences and of the Friends/IHP networks of UNESCO (cf. list).

Potential implementation:
Implementation in Western Europe, North America and also on the Amazon river basin and on the Inner Delta of Niger river in Africa

Contingent Plan to Evaluate Ecohydrological Surface Process Caused by „El-Nino" Phenomenon Equatorial Littoral Region



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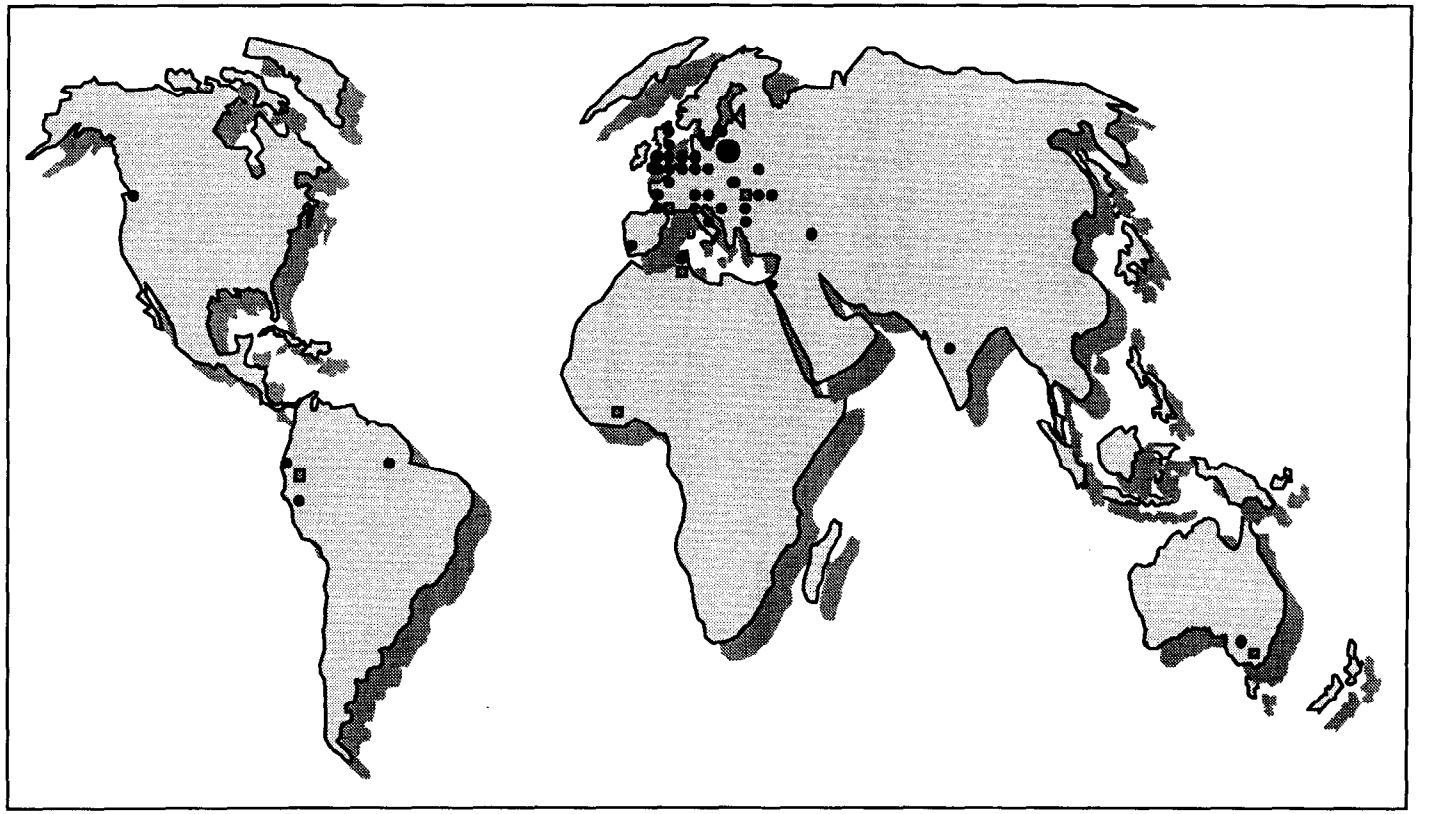
Study area:
Equatorial littoral region

Working Hypotheses:
1. Environmental problems assessment in the region as relates to socio-economical activities responsible for environmental impact
2. Definition of vulnerable areas, delineating the role of environmental and now governmental organisation.

Methods:
1. Setting up policies and strategies.
2. Defining detailed plans both administrative and technical; definition of detailed responsibilities of the staff, communication network, and authority according to different management steps, geographic location, communication links with different organisations (public and private)

Preliminary results, experiments design:
In process. Recompilation of information.

Potential implementation:
An assessment methodology for risk. Evaluation will be introduced to identify and classify different risk levels



Location of the Institutions Involved in the Scientific Activities of 2.3/2.4 IHP-V "Ecohydrology"

- ■ Regional Co-ordinators of IHP-V 2.3/2.4 "Ecohydrology"
- ● Co-ordinators of Activities of IHP-V 2.3/2.4 "Ecohydrology"

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AUSTRALIA	River Murray Wetland Rehabilitation Package Ecohydrology in Practice	**Jensen A.**	phone/fax. 618 8363 1374 ajensen@cphonecom.au
AUSTRIA	On The Interaction Between Flow and Biomass Distribution in a Vegetated Channel	**Gutknecht D. *** **Stephan U. *** **Janauer G. **** **Wychera U.****	*phone431 58801 3222, fax. 431 5056 212 gutknech@bimb.tuwien.ac.at ustephan@bimb.tuwien.ac.at ** phone431 31336 1486, fax. 431 31336 776 JANAUER@pflaphy.pph.univie.ac.at
	Ecohydrology: Fusing Concepts and Scales	**Janauer G. A.**	phone 431 313361486, fax. 431 31336776 JANAUER@pflaphy.pph.univie.ac.at
BRASIL	Deforestation in Central Amazon and Its Effects of Stream Hydrology and Fish Communities	**Silva C. P. *** **Petrere M. Jr.**	*phone/fax. 5519 289 28 25 nelclau@obelix.unicamp.br
BULGARIA	Low Flow- The Rivers Ecosystem Limiting Factor Contingent Plan to Evaluate Ecohydrological Surface	**Dakova S.*** **Uzunov Y.**** **Mandadjiev ***	* fax 359 2 884 494 ** fax 359 2 705 498
EQUADOR	Process Caused by " El Nino" Phenomenon Equatorial Littoral Region	**Rodriguez L. F.**	phone 593-2-433936, fax. 593-2-433934 inamhi1@ecnet.ec
FRANCE	Some Basic Concepts to Interpret Hydrological Regimes for Ecological Goals	**Breil P.**	phone 33 472 208781, fax. 33 478 477875 pascal.breil@cemagref.fr
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	Influence of Subsurface Watershed on Eutrophication	**Holzbecher E.**	phone 49 30 6392 4704, fax. 49 30 6392 4482 holzbecher@igb-berlin.de
	Benthic Organic Matter and Near-Bed Flow in Natural Lowland Streams, Assessment of The Small Scale Dimension	**Mutz M.**	phone 49336312028, fax. 49336315200 m.mutz@t-online.de
HUNGARY	The Role of The Kis-Balaton Water Protection System in The Regulation of Water Quality of Lake Balaton	**Tatrai I.**	phone 3687448244, fax. 3687448006 tatrai@tres.blki.hu
INDIA	Fisheries Ecology of North-Eastern Himalayas With Special Reference to the Bramhaputra Rive	**Biswas S. P.**	phone 91 373 21216, fax. 91 373 20714 dulib@unidib.ren.nic.in

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MINSK REPUBLIC OF BELARUS	The Methodical Approach to Estimation of Ecological and Free Flow	**Fashchevsky B.**	phone 375 172646305, fax. 375172335577 cmrvaler@open.minsk.by
PERU	A Meso-Scale Analysis of Land Use Impacts on Water Quantity and Quality in The Pachitea Catchment, Peru	**McClain M. E.** **Llerena C. A.**	phone 511-349-5647, fax. 511-349-2041 mcclain@lamolina.edu.pe
POLAND	The Effect of Hydrological Pattern of Tributaries on Biotic Processes in Lowland Reservoir	**Zalewski M.** **Wagner I.**	phone 4842 6354438, fax. 4842 6790621 mzal@biol.uni.lodz.pl iwwag@biol.uni.lodz.pl
	Ecohydrological Research of Lake - Watershed Relations in Diversified Landscape (Masurian Lakeland, Poland): Main Hypotheses, Preliminary Results	**Hillbricht-Ilkowska A.** **Rybak J.** **Rzepecki M.**	phone 4822 7514046, fax. 4822 7513100 ekolog@warman.com.pl
	Renaturisation of The Municipal River of the Łódź City (Poland)	**Zalewski M.** **Bis B.** **Bocian J.**	phone 4842 6354438, fax. 4842 6790621 mzal@biol.uni.lodz.pl barbis@biol.uni.lodz.pl bocian@biol.uni.lodz.pl
	Protection of Natural Character of The River Valley as a Water Management Objective	**Puslowska D. *** **Tyszewski S.** **Okruszko T.**	*phone 4822 6605301, fax. 4822 6254305 dorotap@iis.pw.edu.pl
	Determining Reservoir Retention of Nitrogen by Denitrification and Mass Balance Methods. Comparative Studies of Different Types of Reservoirs	**Tomaszek J. A.**	phone 4817 625 406, fax. 4817 8541260 tomaszek@ewa.prz.rzeszow.pl
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SLOVENIA	Stream Water Quality Assessment in Slovenia	**Toman M. J.**	phone 386611233388, fax. 38661273390 mihael.toman@uni-lj.si
THE NETHERLANDS	The Botanical Quality of Ecosystems in The Netherlands	**Witte J. P. M.**	phone 31317484180, fax. 31317484885 Flip.Witte@USERS.WHH.WAU.NL
	Implications of Catchment Hydrology for Ecosystems in Small Streams	**Higler L. W. G.**	phone 31 343 455 290, phone 31 343 455 288 L.W.G.HIGLER@ibn.dlo.nl
	Predicting Ecological Effects of Changes in Water Management in the Netherlands	**van Ek R.**	phone 320298520, fax. 320249218 R.vEk@RIZA.RWS.minvenw.nl

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UK	Ecohydrology: Advancing The Scientific Basis of River Management	**PETTS G. E.** **GURNELL A. M.**	g.e.petts@bham.ac.uk a.m.gurnell@bham.ac.uk
	Cyanobacterial (Blue-Green Algal) Toxins and Water Quality: Analysis, Risk Assessment and Countermeasures in Natural and Controlled Waters	**CODD G. A.**	phone 441382 344272, fax.441382 344275 G.A.CODD@dundee.ac.uk
	The Benefit of Phabsim to the Management of Water Resources and Fisheries in England and Wales	**SPENCE R. *** **HICKLEY P. **	*phone 44121 7112324, fax. 44121 7115824 **phone44156268975, fax.44156269477 phil.hickley@environment-agency.gov.uk
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