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11th Magdeburg Seminar on Waters in Central and Eastern Europe: Assessment, Protection, Management

Proceedings of the international conference
18-22 October 2004 at the UFZ

Walter Geller et al. (Eds.)

UFZ Centre for Environmental Research Leipzig-Halle
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Walter Geller, Jan Blachuta, Šarka Blažková, Evelyn Claus, Alfred Dubicki, Hildegard Feldmann, Helmut Guhr, Edeltrauda Helios-Rybicka, Hubert Holzmann, Wiwiana Szalinska, Wolf von Tümpling, Gulay Záray (Eds.)

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Archiv

11th Magdeburg Seminar on Waters in Central and Eastern Europe: Assessment, Protection, Management

Programme

Monday, October 18, 2004

16:00 Registration

18:30 Opening and Get-Together Party in the Foyer of the Leipziger KUBUS

Tuesday, October 19, 2004

Lecture Hall 1 AB

9:00 **Plenary Lecture**
Challenges for river basin management in the Danube basin
A. Zinke (Zinke Environment Consulting for Central and Eastern Europe, Vienna, Austria)

Ecological Impacts of Flooding
Chairperson: P. Heininger

09:40 Effects of extreme flood events on flora and fauna in Middle Elbe floodplains
M. Scholz, J. Gläser, (UFZ Leipzig, Germany), A. Hettrich (BfG, Koblenz, Germany), A. Schanowski (ILN, Germany) O. Deichner, F. Foeckler (ÖKON, Regensburg, Germany), K. Henle (UFZ Leipzig, Germany)

10:00 Pollution of Elbe river flood plains and consequences for future research
F. Krüger (ELANA Soil Water Monitoring, Germany), R. Meissner (UFZ Falkenberg, Germany), A. Gröngröft (Univ. Hamburg, Germany), K. Grunewald (Dresden Technical University, Germany), H. Petzoldt (TZW-Water Technology Centre, Germany), R. Schwartz (TU Hamburg-Harburg, Germany)

10:20 Arsenic and heavy metals in the Mulde river system – evolution and consequences of the August 2002 flood
W. Klemm, A. Greif, U. Knittel (Technical University Freiberg, Germany)

10:40 Variability of metal contamination of floodplain soils of the Elbe River and their risk potential
A. Gröngröft (Univ. Hamburg, Germany) F. Krüger (ELANA Soil Water Monitoring, Germany), G. Miehlich (University of Hamburg, Germany), R. Meissner (UFZ Falkenberg, Germany)

11:00 Coffee break

11:20 Changes in contamination of the River Mulde since 1975 reflected by sediment cores from the river reservoir near Bitterfeld
F. W. Junge, C. Hanisch, W. Czegka. L. Zerling (Saxonian Academy of Science, Leipzig, Germany), H.-C. Treutler, P. Morgenstern (UFZ Leipzig, Germany), M. Magnus (Technical University of Freiberg, Germany)

11:40 The response of a macrozoobenthic community to an extreme flood event
M. Beilharz (Dresden University of Technology, Germany), J.H.E. Koop ([2]Federal Institute of Hydrology, Germany), J. Benndorf (Dresden University of Technology, Germany)

12.00 Resuspension stability of riverine sediments – determined by physical, chemical and biological parameters
S. U. Gerbersdorf , T. Jancke, B. Westrich (University of Stuttgart, Germany)

12:20 Changes in Aquatic Ecosystem of Small Urban Stream after Flood 2002
J. Nábělková, G. Šťastná, D. Komínková (CTU in Prague, Czech Republic)

12:40 Lunch

14:00 Poster Session

Ecological Impacts of Flooding
Chairperson: N.N.

15:00 Ecological Long term effects in the Hungarian Szamos and Tisza river after the Baia Mare Spill (Romania)
W. von Tümpling, M. Mages (UFZ Magdeburg, Germany)

15:20 Rehabilitation of a high risk spot for water contamination in the Upper Tisza basin - the Baia Borsa-Novat tailing pond
A. Zinke (Zinke Environment Consulting for Central and Eastern Europe, Vienna, Austria)

15:40 Sediment input and pollution of floodplains in the Oka river catchment
V. M. Yashin (VNGIIM Moscow, Russia), P. I. Pylenok, R. Meissner (UFZ Falkenberg, Germany), F. Krüger (ELANA, Germany), H. Rupp (UFZ Falkenberg, Germany)

16:00 **Coffee break**

Flood Risk Modelling
Chairperson: H. Holzmann

16:30 Flood simulation and forecasting at European scale: progress and first results of calibration and validation for the Elbe catchment with the LISFLOOD model
M. Gierk, J. Younis, A. de Roo (European Commission, JRC, Italy)

16:50 Flood Hazards in the Upper and Middle Odra River basin
A. Dubicki, A. Hosek, J. Malinowska-Malek, Z. Wozniak (Institute of Meteorology and Water Management, Wrocław, Poland)

17:10 Flood modelling and flood management in the Czech republic during catastrophic flood in August 2002
J. Spatka, M. Svobodová, P. Jiřinec (DHI Hydroinform a.s., Prague, Czech Republic)

17:30 2D mathematical flood flow model and its use for flood protection design and sediment transport study
P. Jirinec, J. Spatka (DHI Hydroinform a.s., Prague, Czech Republic)

Lecture Hall 1 CD

Socio-economic Issues of Water Framework Directive
Chairperson: R. Furrer

09:40 Economic Instruments in the Water Framework Directive -
An Interpretation of Art. 9 WFD and its Implementation
H. Unnerstall (UFZ Leipzig, Germany)

10:00 Identification and implementation of measures in river basin management: How to meet the environmental objectives of the WFD with respect to physico-chemical quality components?
D. Petry, B. Klauer (UFZ Leipzig, Germany)

10:20 Socio-economic Analysis within an Interdisciplinary Spatial Decision Support System for Integrated River Basin Management
J. Hirschfeld, A. Dehnhardt (Institute for Ecological Economy Research, Berlin, Germany), J. Dietrich (Ruhr University Bochum, Germany)

10:40 Top-down versus bottom-upPossibilities and limitations of stakeholder's involvement within the implementation of the WFD in the Havel River Basin
B. Jessel, J. Jacobs (Potsdam University, Germany)

11:00 Coffee break

11:20 Abiotic typology of Polish lakes
A. Kolada, H. Soszka, D. Cydzik, G. Małgorzata (Institute of Environmental Protection, Warsaw, Poland)

N-Transport
Chairperson: N.N.

11:40 Present State of Geographical Research of Lakes in the Czech Republic
B. Janský, M. Šobr (Charles University in Prague, Czech Republic)

12.00 Nitrogen degradation in a shallow groundwater-stream system of a lowland catchment (Saxony-Anhalt)
N. Borges, G. Wriedt, Michael Rode (UFZ Magdeburg, Germany)

12:20 Impact of nitrogen reduction measures on the load in the river Ems and the river Rhine
R. Kunkel (Research Center Juelich, Germany), H. Gömann, P. Kreins (Research Association for Agricultural Policy and Rural Sociology, Bonn, Germany), F. Wendland (Research Center Juelich, Germany), H. Behrendt (Institute of Water Ecology and Inland Fisheries, Berlin, Germany)

12:40 Lunch

14:00 Poster Session

Methods' Development
Chairperson: N.N.

15:00 Integrated assessment of measures in Watershed Management with an DSS-approach: results and experiences
S. Kofalk, M. Scholten, F. Kohmann (Federal Institute of Hydrology, Berlin, Germany)

15:20 Mesoscalic Estimation of Nitrogen Discharge via Drainage Systems
B. C. Meyer, U. Hirt, T. Hammann (UFZ Leipzig, Germany)

15:40 Multi-functional landscape evaluation and multicriteria optimization of land use for the catchment area management
A. König (Saxon Academy of Sciences, Germany), B. C. Meyer (UFZ, Germany)

16:00 **Coffee break**

Sediments
Chairperson: E. Helios-Rybicka

16:30 The relevance of a sound monitoring of particulate matter quality for the objectives of the EU Water Framework Directive
P. Heininger, F. Ackermann, E. Claus, J. Pelzer, B. Schubert (Federal Institute of Hydrology, Koblenz, Germany)

16:50 Presence of Dangerous Substances in Suspended Sediment and Sediment in the Czech Part of the Elbe River
M. Rieder, D. Hypr, J. Halířová (Czech Hydrometeorological Institute, Czech Republic)

17:10 Comparing Study of Heavy Metal Concentration in Sediments and Water Quality in Three Oxbow Lakes of the Labe River and the Influence of Floods in 2002 on Distribution of Some Metals in Sediments in The Oxbow Lake of Obříství near Mělník
D. Chalupová, B. Janský (Czech Republic)

17:30 Sediment dynamics from the drainage area into Lake Mladotice in the western Czech Republic under the influence of pre- to post-communist landscape changes
A. Schulte (Free University of Berlin, Germany), G. Daut (University of Jena, Germany), B. Jansky (University of Prague, Czech Republic), M. Albrecht (Free University of Berlin, Germany)

20:00 Conference Dinner in the former bastion Moritzbastei

Wednesday, October 20, 2004

Lecture Hall 1 AB

9:00 **Plenary Lecture**
Contamination of the Odra River System: Water – Suspended Matter – Sediments (Past and Present)
E. Helios-Rybicka (University of Mining and Metallurgy, Krakow, Poland

[Action Plan –] Flood Protection and Mitigation
Chairperson: J. Schanze

9:40 Nature oriented flood damage prevention - an INTERREG IIIB project
E. Fuchs, V. Hüsing, M. Ostrowski, J. Slikker, A. Winterscheid (Federal Institute of Hydrology, Koblenz, Germany)

10:00 Effect of Vltava River Cascade on 2002 Flood in Prague
J. Daňhelka, J. Kubát (Czech Hydrometeorological Institute, Czech Republic)

10:20 Analysis of potential flood retention measures (polders) at the Elbe River in Saxony-Anhalt
B. Büchele, R. Mikovec, J. Ihringer, F. Friedrich (Technical University of Karlsruhe, Germany)

10:40 Flood control by conservation tillage
W. Schmidt, B. Zimmerling, O. Nitzsche (Saxonian State Institute of Agriculture, Leipzig, Germany)

11:00 **Coffee break**

11:20 Realization by mutual consent of ecologically orientated flood protection by land consolidation – exemplarily shown at the river Lippe
R. Helle (Amt für Agrarordnung, Soest, Germany)

11:40 Enhancement of flood safety, rural and regional development in the Tisza valley (the new Vasarhelyi plan)
L. Szlávik (Eötvös József College, Hungary)

12:00 Support of Decisions in flood Risk Assessment by the Elbe-DSS: results and experiences
Sebastian Kofalk (Federal Institute of Hydrology, Berlin, Germany), Malte Großmann (Technical university Berlin, Germany), Petra Jankiewicz (Federal Institute of Hydrology, Berlin, Germany), Jean-Luc de Kok, Harriette Holzhauer (University of Twente, the Netherlands), Bruno Büchele (University of Karlsruhe, Germany)

12:20 Regional Co-operation for Flood Risk Management
Scientific Approach and Practical Testing in the Weisseritz River Catchment (Saxony)
P. Wirth, J. Schanze (Leibniz Institute of Ecological and Regional Development - IOER -, Dresden, Germany)

12:40 Lunch

14:00 Poster Session

Flood Risk Management
Chairperson: A. Dubicki

15:00 Societal Flood Risk Management – A Theoretical and Methodological Framework with a European Perspective
J. Schanze (Dresden Flood Research Center, Germany)

15:20 Contributions to sustainable flood risk management
W. Buck (Technical University of Karlsruhe, Germany)

15:40 Institutional drivers and constraints of floodplain restoration:
a comparative review of projects and policy contexts in England, France and Germany
T. Moss (Institute for Regional Development and Structural Planning – IRS -, Germany)

16:00 **Coffee break**

16:30 Strategies of Local Government to Increase the Preparedness of Private Households Facing Possible Flash Floods – What Can We Learn from High-Reliability-Organizations?
G. Hutter (Dresden Flood Research Center, Germany)

16:50 Flood protection: dike heightening and/or retention?
C.B. Vreugdenhil, H.G. Wind (University of Twente, The Netherlands)

17:10 Flood loss reduction due to private precautionary measures -
Lessons Learned from the Elbe flood in August 2002
H. Kreibich, A. Thieken, T. Petrow (GeoForschungsZentrum Potsdam -GFZ -, Germany), M. Müller (Deutsche Rückversicherung AG, Düsseldorf, Germany), B. Merz (GeoForschungsZentrum Potsdam - GFZ -, Germany)

17:30 Land use changes as indicator of flood risk
J. Langhammer (Charles University in Prague, Czech Republic)

Lecture Hall 1 CD

Draughts
Chairperson: N.N.

9:40 Assessment of ecohydrological streams habitat
M. Matoušková (Charles University in Prague, Czech Republic)

10:00 Ecological Discharges and Recolonization of Benthic Community in Urban Stream
D. Komínková, G. Šťastná, J. Caletková, D. Stránský (CTU, Prague, Czech Republic)

10:20 Water resources formation and their quality during drought 2003
A. Dubicki, H. Mordalska, T. Tokarczyk, E. Jaśniewicz (Institute of Meteorology and Water Management, Wrocław, Czech Republic)

10:40 The influence of extreme low water flow on the water quality of the Elbe river at Magdeburg monitoring station
M. Baborowski, H. Guhr, O. Büttner, W. von Tuempling, K. Friese (UFZ, Magdeburg, Germany)

11:00 **Coffee break**

Pollutants Impact
Chairperson: W. von Tümpling

11:20 The importance of internal sulfur sources in soils for the recovery from surface water acidification: comparative analyses of forested watersheds in Central Europe and North America
M. J. Mitchell (State University of New York, Syracuse, U.S.A.), K.-H. Feger (Dresden University of Technology, Germany)

11:40 Implications of EU-WFD for the East German Post Mining Landscape Lausitz: coping with a sparse knowledge of the underground
B. Graupner, St. Bürger, F. Werner (DGFZ e.V., Dresden, Germany)

12:00 Pollution of mine waters in the upper silesian coal basin (Poland) in relation to their origin
I. Pluta (Central Mining Institute, Katowice, Poland)

12:20 Impact of coal mining waste dumping sites on ground- and surface water quality
S. Stefaniak, I. Twardowska (Polish Academy of Sciences, Zbraze, Poland

12:40 **Lunch**

14:00 Poster Session

Pollutants Impact
Chairperson: W. von Tümpling

15:00 Strategy Concept Elbe - Passive Water Treatment Methods for the Minimisation of Impacts on Water Bodies by Ore Mining Activities
H. Reincke (ARGE ELBE, Hamburg, Germany), P. Schneider (C&E Consulting und Engineering, Chemnitz, Germany)

15:20 WISMUT`s Environmental Remediation Activities: Examples for Water Protection and Management Approaches
M. Paul, M. Gengnagel, U. Jenk, A.T. Jakubick (WISMUT GmbH, Chemnitz, Germany)

15:40 Mansfeld – the contribution of a mining-affected catchment area to regional riverine pollution
P. Schreck (University of Leipzig, Germany), R. Wennrich, H.J. Stärk, M. Schubert, H. Weiss (UFZ, Leipzig, Germany)

16:00 Coffee break

16:30 Water and Sediment Quality of the Elbe river profile during and after the flood of August 2002
R. Pepelnik, R. Niedergesäß, B. Erbslöh, A. Prange (GKSS-Forschungszentrum Geesthacht, Germany)

16:50 The influence of a regulated river stretch (Saale) on matter transport and metabolism
H. Guhr, M. Baborowski, K.-E. Lindenschmidt, C. Hoffmeister (UFZ, Magdeburg, Germany)

17:10 Quantifying the influence of Dissolved Organic Carbon, Eh, pH, soil moisture, soil temperature, soil matrix potential, and flooding on the mobility and dynamics of As, Cd, Zn, and Pb in soil solution and groundwater of alluvial soils at the Elbe River
J. Rinklebe, A. Stubbe, H.-J. Staerk, R. Wennrich, H.-U. Neue (UFZ Leipzig-Halle, Germany)

17:30 Monitoring of Organic Pollution in the Czech Part of the River Elbe
M. Ferenčík (Povodí Labe, Hradec Králové, Czech Republic)

Thursday, October 21, 2004

Lecture Hall 1 AB

9:00 **Plenary Lecture**
Contamination problems with and after the flooding of 2002 year
W. Geller (UFZ Magdeburg, Germany), V. Jirásek (Povodí Labe, Hradec Králove, Czech Republic)

Integrated Assessment
Chairperson: V. Jirásek

9:40 Effects of potential land use changes on transboundary river basins, water resources and water quality in the Central Eastern European Member States
D. Haase (UFZ, Leipzig, Germany)

10:00 Heading for Effective Approaches in River Basin Management
W. Lahmer (PIK Potsdam, Germany)

10:20 The Czech Elbe Project in its fourth phase – quality of information, uncertainty and risk in environmental decision making
Š. Blažkova (T.G. Masaryk Water Research Institute, Prague, Czech Republic)

10:40 Elaboration of a documentation report of the august 2002 flood event in Austria – Integrated assessment of causes, impacts and consequences
H. Holzmann, H. Habersack (BOKU University for Natural Resources and Applied Life Sciences Vienna, Austria)

11:00 **Coffee break**

Transboundary Problems
Chairperson: N.N.

11:20 Integrative and Interdisciplinary Evaluation of River Basin Management Strategies in the Context of Global Change – Results from the Spree River Basin
F. Messner (UFZ, Leipzig, Germany)

11:40 Trends in Water Quality Variations in the Odra River the Day Before Implementation of the Water Framework Directive
R. Korol, A. Kolanek, K, M. Stronska (Institute of Meteorology and Water Management, Wrocław, Poland

12:00 ELLA: Elbe – Labe flood management measures by transnational spatial planning – The challenge of the running INTERREG III B (CADSES) Project -
P. Heiland (INFRASTRUKTUR & UMWELT Professor Böhm & Partner, Darmstadt, Germany)

12:20 Application of satellite data for flood monitoring
H. Bach, U. Dierschke , (VISTA, Germany), K. Fellah, P. De Fraipont (SERTIT, France)

12:40 Flooding due to local heavy rainfall events
M. Jessen, T. Einfalt (einfalt&hydrotec GbR, Luebeck, Germany)

13:00 **Lunch**

Groundwater
Chairperson: G. Zaray

14:20 Definition of the good groundwater chemical status of groundwater units in Germany
R. Wendland, R. Kunkel (Research Centre Jülich, Germany), H.J. Schenk (Landesumweltamt Brandenburg, Potsdam, Germany), H.-J. Voigt (Brandenburg Univ. of Technology, Cottbus, Germany), R. Wolter (Federal Environmental Agency, Berlin, Germany), S. Hannappel (HYDOR Consult GmbH, Berlin, Germany)

14:40 Agrochemicals in groundwater in agricultural used abstraction zones of waterworks in Northern Germany. Approaches to describe processes, heterogeneity of the nitrogen metabolism and transport
M. Pätsch (Braunschweig, Germany), W. Walther, C. Konrad (Technical University of Dresden, Germany)

15:00 A study on the water balance in the non-saturated soil zone in a region of Bulgaria
Z. Diankov (Bulgarian Academy of Sciences, Sofia, Bulgaria)

Land Use
Chairperson: S. Blazková

15:20 Basis for an evaluation of land use in conservation areas connected with running water systems
J. Reimers (Ingenieurbüro Reimers, Itzehoe, Germany)

15:40 **Coffee break**

16:00 Water quality and sustainable management of forests: Problems and challenges
K.-H. Feger (Dresden University of Technology, Germany)

16:30 Water quality in rural areas: Keys study Šlapanka River Catchment
P. Judová, B. Janský (Charles University Prague, Czech Republic)

16:50 Impact of the land use on the water quality and ecological status of rivers in the Widawa River sub-basin
J. Błachuta, A. Dubicki, B. Marchlewska-Knych, M. Adynkiewicz-Piragas (Institute of Meteorology and Water Management, Wrocław, Poland)

17:10 Influence of land use on the water quality of the Volga river – results of the Volga-Rhine research project
G. Ollesch, R. Meißner, M. Rode (UFZ Magdeburg, Germany), M. Zevaco, F. Frimmel (DVGW Research Centre at the Engler-Bunte-Institute of the University Karlsruhe, Germany), A. Kerzhentsev (Russian Academy of Science, Russia)

17:30 Closing Session

Lecture Hall 1 CD

Modelling
Chairperson: N.N.

9:40 ArcEgmo-URBAN - Urban Water Modelling on the River Basin Scale
M. Biegel (Leibniz Institute of Ecological and Regional Development (IOER), Dresden, Germany)

10:00 Forecast system of flow regime operative control in the Elbe River basin
P. Řehák, J. Petr (Povodí Labe, Hradec Králové, Czech Republic)

10:20 Modelling the dynamics in reservoirs under varying conditions of inflow
S. Rolinski, T. Petzoldt (Dresden University of Technology, Germany)

10:40 Hydrological Aspects of a River Basin Management for the Volga River
M. Helms, O. Evdakov, J. Ihringer (University of Karlsruhe, Germany)

11:00 **Coffee break**

11:20 Model for operational forecast of contaminant transport in rivers - Alarm Model Elbe
H.H. Hanisch (German Federal Institute of Hydrology – BfG)

11:40 Modelling of transport of polluted cohesive sediments from localities of their long-period deposition to river channel and flood plain by catastrophic water discharges
M. Rudiš, P. Valenta, I. Valentová (University, Prague, Czech Republic)

12:00 The impact of river morphology on water quality of two rivers of different stream order
K.-E. Lindenschmidt, D. Wagenschein, M. Rode (UFZ Magdeburg, Germany)

12:20 Coupled nutrient transport and water quality modelling as contribution to integrated river basin management
K. Hennrich, F. Hesser (UFZ Magdeburg, Germany), S. Kralisch (University of Jena, Germany), M. Rode (UFZ Magdeburg, Germany)

12:40 Quantification of diffuse nutrient loadings in mesoscaled watersheds – four different models being comparatively tested in the Jahna river basin
M. Gebel, M. Kaiser, K. Grunewald (Dresden University of Technology, Germany)

13:00 **Lunch**

14:20 Uncertainties in the mesoscale modelling of water and nitrogen fluxes
U. Hirt (UFZ Leipzig, Germany)

14:40 Modelling the development of phytoplankton in the German part of the Elbe River (Km 0 to Km 585) considering the impact of groyne fields.
A. Schöl, R. Eidner, V. Kirchesch (German Federal Institute of Hydrology, Koblenz)

Plankton, fish biota
Chairperson: N.N.

15:00 In-vitro investigation of the trace element accumulation on naturally and artificially grown biofilms
M. Óvári (Eötvös University, Hingary/UFZ Magdeburg, Germany), M. Mages, W. von Tümpling jr., (UFZ Magdeburg, Germany)

15:20 The oligotrophication of drinking water reservoirs – does it cause or counteract the problem of taste-and-odour compounds produced by benthic cyanobacteria?
M. Opitz, H. Petzoldt (DVGW-Technologiezentrum Wasser Karlsruhe, Germany) H. Börnick, J. Benndorf (Dresden University of Technology, Germany)

15:40 **Coffee break**

16:00 Response of zooplankton populations (Cladocera) to nutrient-loading and hydrotechnical manipulation in oxbow lakes near Warsaw (Poland)
M. Gąsiorowski, K. Szeroczyńska (Polish Academy of Sciences, Warszawa, Poland)

16:30 Restoration of shallow hypertrophic lakes in Cujavian-Pomeranian region (Central Poland). How to remove excess seston?
R. Wisniewski, K. Jaroslaw (N. Copernicus University, Torun, Poland)

16:50 Reproductive success of fish communities of the Elbe River, Czech Republic
O. Slavík (T G M – Water Research Institute, Prague, Czech Republic), L. Bartoš (Institute of Animal Production, Prague, Czech Republic)

17:30 Closing Session

Plenary Lectures

Contamination Problems With and After the Elbe Flooding of 2002

WALTER GELLER[1], VACLAV JIRÁSEK[2], KLAUS OCKENFELD[1], MICHAEL BÖHME[1]
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Beyond the direct impacts of the "Elbe-flood 2002" questions appeared about sources, sinks and fate of pollutants. During and after the flood event nearly 30 research groups from different scientific disciplines like space research, geology, biology, chemistry and ecotoxicology cooperated with the concerned ministries and authorities of the Czech Republic (Ministry of the Environment of the CR, 2004, 23.08.2004; Martinek, 2002) and the Federal Republic of Germany (Geller, 2002) to estimate flood-based contaminations in the Elbe-River basin. According to the direction of the Ministry of Environment, an extraordinary monitoring program was organised in the Czech Republic (CR). It was primarily executed by the River Basin Authorities, the Czech Inspection, the Research Institute TGM Prague and the Prague Water Works & Sewage. In the Czech stretch of the Elbe River downstream of the confluence with the Moldau River (from Obristvi to Decin), the first 5 water quality profiles were sampled beginning on 16th August. The first sediment samples were taken from 6 localities on 19th August (Martinek, 2002). Additionally to the basic network of extraordinary monitoring, there were 14 measurement profiles sampled with a frequency of 2 times a week (Ministry of the Environment of the CR, 23.08.2004).

The *water quality* in both Rivers Elbe and Mulde showed a strong increase of concentrations of toxic substances and of the microbial load during the flood. Sources were flooded industrial areas, flushing and erosion of waste dumps of the mining industry, and the remobilisation of contaminated old sediments. In CR, flooding of industrial areas with dangerous matters happened in 13 cases – the most severe situation was in Spolana Neratovice. In flooded areas, 20 or more other outflows of dangerous matter occurred – in spite of the fact that 29 filling stations were flooded, there was no significant outflow of gas (Ministry of the Environment of the CR, 2004).

Water quality predominantly returned to basic levels of contaminations after the end of the flood event, but the mixture of inorganic (mainly As and heavy metals) and organic compounds has been transported down the river, where *flooded urban areas, flooded soils, sediments of rivers and of flowed-through lakes functioned* as sinks. The flood-affected soils and sediments now are potential new sources of contamination as they did in the past during smaller floods. Comparisons between heavy metals in sediments or soils before and after the Elbe-flood 2002 didn't show dramatic enhancements or reductions. Most other results likewise don't indicate flood-based changes. Thus, the flood 2002 does not appear to have severe consequences for the environment, speaking from the point of concentration approach.

The soil-contamination as found in the investigation programme with some toxic substances (As, Cu, Hg, dioxins) exceeded legal guideline values, independently of the flood in 2002. Obviously, these contaminations are long-term effects of smaller floods in the past. Most areas which were flooded for the first time in 2002 did not exceed the guideline limits. The main sources for long-term contaminations are eroded mining waste dumps (heavy metals, As) and industry based emissions.

Areas in front of dikes are polluted with dioxins and mercury along the Elbe, downstream of River Mulde. For assessment of contamination of flooded areas along rivers, there were used 64 samples from localities with longer flood water detention and 6 samples from oxbows

(Ministry of the Environment of the CR, 2004). This load is a result of deposits of many floods past, and there was no significant change by the 2002 deposits.

Flushed-through lakes are long-term sinks of contaminated sediments (Lake Muldestausee), whereas river sediments are often exchanged depending on discharge. Thus, river sediments function as sinks and sources in dependence of the flow velocity. For one well-investigated groyne field the erosion during the flood 2002 of old deposits could be modelled and measured.

Because of mobilizable fractions of different elements (Cd, Cu, Pb, Zn, As) there is a potential threat for ground waters and drinking water supply. This is true for both the Elbe and the Mulde river catchments. Ground water quality was significantly affected in parts of flooded areas within the Elbe and Moldau Rivers in the CR primarily in parameters of organic contamination (Ministry of the Environment of the CR, 2004).

A mixture of different organic and inorganic toxic compounds was found in the Bitterfeld area and in the river-sections between Bitterfeld and the Elbe. Beyond well-known problem materials, a non-target-screening analysis has shown unknown substances to occur in these waters. Changing flow-directions of contaminated ground waters adjacent to the Bitterfeld area presumably will bring about additional future contaminations of surface waters. Results of ecotoxicological experiments with water and sediments from this area underline the problematic condition of the water quality.

A significant portion of the bacteria species were not of riverine origin. Future research should focus on the survival time of pathogenic bacteria in the environment (soils and mud). The fraction of antibiotic-resistant bacteria was surprisingly high. Sources are not yet identified. Most possible sources are agricultural (pastures, liquid manure) and sewage treatment plants. There were, for example, 124 waster water treatment plants out of operation during the flood event in the CR, from which 36 with a capacity of over 10,000 EI – anyway, toxic matter was not found in samples of flood water (Ministry of the Environment of the CR, 2004).

Literature

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Contamination of the Odra River System: Water – Suspended Matter – Sediments (Past and Present)

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At the Odra river catchment area (136 528 km^2, 84.9 % of it lies in Poland, 10.4 % in Germany, 4.7 % in the Czech Republic), industrial activity (mainly coal and copper mining and processing), as well as agricultural production are the most important sources of contaminations. The objectives of this study were: (1) to establish the spatial variability in concentrations of selected contaminants, mainly of the heavy metals (Cd, Zn, Pb, Cu, Ni, Cr, Hg, Mn, Fe) and As in water, particulate suspended matter (PSM) and sediments of the Odra river, (2) to estimate the metals mobility in the river solids and (3) to assess the level and extent of contaminations by comparison with the river classification, and to identify any need for transboundary river monitoring.

Totally about 100 samples from each river component i.e. water, suspended matter and sediments of the Odra river were taken during the five sampling periods: XI'97, V'98, XI'98, VI'99 and V'2000. The main contaminats are biogenic substances, mainly phosphates, and heavy metals, especially Cd, Zn but also Hg, Cu, Pb and PAHs, as well as organic tin components in the Odra harbour sediments.

The metal contents in the Odra river water, PSM and sediments vary in the wide ranges. For all water samples from five sampling periods, the mean metal concentrations ($\mu g/dm^3$) were as follows: 0.161 Cd, 7.27 Cr, 7.91 Cu, 5.84 Ni, 1.74 Pb, 53.72 Zn, 110 Mn, 220 Fe and 2.38 As. According to LAWA classification, water in the Odra river are moderately to highly contaminated with metals. Most of the samples are moderately to strongly and very strongly polluted with Cd, however, slightly decrease of this metal has been observed in V'2000.

The mean concentration of metals in all samples of the Odra river SPM were (mg/kg): 10 Cd, 133 Cr, 100 Cu, 131 Ni, 115 Pb, 1901 Zn, 4098 Mn, 51802 Fe and 63.8 As. In the PSM samples from XI'97 the content of Cd, Cr, Pb was higher (mean values 18.41, 172, 190) than in the samples from later sampling periods. In the samples from May '98 the highest content of Cu (493), Ni (1287), Zn (31369) and As (235) was stated.

The mean contents of metals in the all Odra river sediment samples (< 20 µm) were as follows (mg/kg): 9.4 Cd, 20.3 Co, 73 Cr, 110 Cu, 2.9 Hg, 51.6 Ni, 123 Pb, 1158 Zn, 2670 Mn, 4.11 % of Fe and 91.1 of As. In the samples from V'98 and V'2000 the highest concentration about 20 mg/kg of Cd and 190 mg/kg of As was found.

The metal contents in the PSM and sediment sumples were expressed in terms of LAWA classification. The obtained results showed that the strong to very strong contamination (classes III/IV and IV) with Cd was typical for almost all samples along the Odra river over five sampling periods. Only sporadically the class III was stated. With Pb, Zn and Cu the situation was at no time as critical as with Cd. Strong and moderate contamination for Pb and Cu (II-III, III classes), and very strong and strong for Zn (III-IV, III classes) was typical for XI'97. However, after three years the situation has been improved, and in V'2000, class II - moderate contamination with Cu, Zn, and in the upper river section with Pb, was dominated. The mean contents of Ni and Cr for the SPM are about two times higher, but for the sediments very similar, if compare with their background values. While the contents of As in less than 20 % of studied sediment and SPM samples, were higher than the tentative threshold value

(TTV) of 100 mg/kg for stream sediments, the mean content neither in the SPM (63.8) nor in sediments (92) were higher than TTV value.

The obtained results showed that the metals pollution has been decreased, especially with Zn, Pb and Cu; thus an improvement of these metals situation was observed if compared the results from different sampling periods. For all metals studied in the Odra river suspended matter and sediments the substantial reduction with Cd contamination, neither at the period after '97 flood, nor if compare with the earlier results obtained before '97, has been observed (Fig.1). The pattern of spatial variation of the metals in the river solids indicates that a variety of sources might be responsible for the contamination; very intensive, historical and current mining and smelting activities probably being the most important. In the Odra river system water and suspended matter are responsible for metal transport. It is evident that Cu, As, Cr, Ni and Zn is mainly transported by river water, while Cd, Pb abd Fe by suspended matter.

To estimate the mobility and potential bioavailability of metals in the river solids, the exchangeable metals and bound with carbonates, for the selected samples of river SPM and sediments were estimated. The highest mobile portions were stated for Mn, Cd, Zn and As, up to about 75, 70, 80 and 50 %, respectively. It seems that the considerable mobile portion of Zn, Cu, Cd, Mn and Pb, depends also on the amount and kind of an organic-biological material present in the Odra river PSM.

No essential differences of the metal contents were observed among the samples for the same river compartment, from the same locality, taken within the five sampling periods, thus both selection of the river compartment and sampling strategy optimisation will be propose. The results of four years studies of the Odra river system suggest, that for river monitoring purposes, the frequency and numbers of samples for chemical analysis of water and solids, preferable PSM, could be reduce to twice a year, with few selected sampling sites. Study of mobile metal portion in the river solids seems to be a good indicator for monitoring.

The studies were carried out within the International Odra Project and research activities of the Faculty of Geology, Geophysics and Environmental Protection at the University of Science and Technology in Krakow.

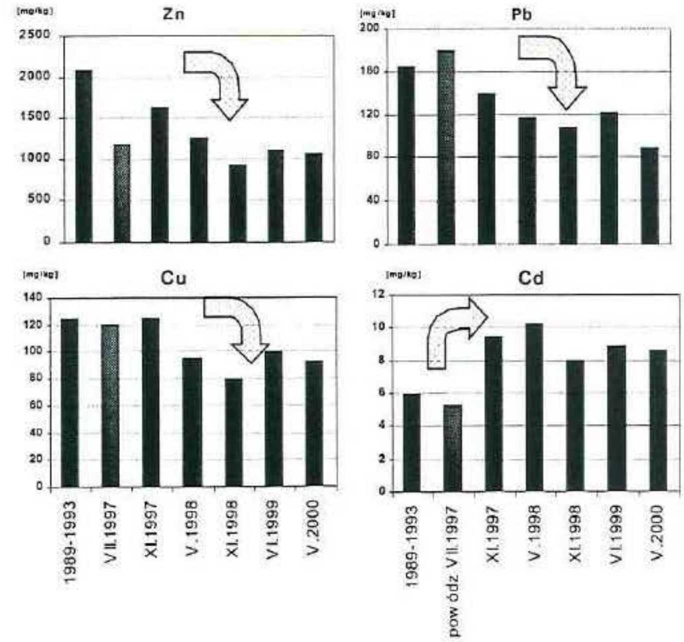

Figure 1: Changes of the mean metal content in the Odra river sediments before and after flood (VII.1997)

Challenges for river basin management in the Danube basin

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The Danube basin as the most international river basin of the world has a very diverse character in nature, culture and economies. Today's major environment issues are water pollution and the impacts from dams and navigation, which - not only in the light of the EU-Water Framework Directive - make transboundary cooperation a crucial and difficult task. The most relevant legal tool is the Danube Protection Convention (1994), which is being implemented through the International Commission for the Protection of the Danube River. Facilitated through its Permanent Secretariat in Vienna and the UNDP/GEF Danube Regional Project (2000-2006), 13 states implement a Joint Action Programme (2001-2005) and regularly discuss in various Expert Groups harmonised ways of water management, water quality monitoring (e.g. Trans-National Monitoring Network, Joint Danube Survey) and a coordinated implementation of the WFD (e.g. Roof Report 2004/2005; WFD pilot implementation in the Sava basin 2003-2006).

Other important activities include wetland restoration and flood management (new ICPDR Action Plan for Sustainable Flood Protection 2004). Examples from the rivers Tisza, Sava and Danube near Vienna illustrate the international importance of the area and the concrete ways in which both subjects are presently being successfully tackled.

Lectures

The influence of extreme low water flow on the water quality of the Elbe River at Magdeburg monitoring station

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The river Elbe with a length of approx. 728 km and a catchment area of 96,932 km^2 in Germany is one of the large German rivers. Its main tributaries in Germany are the Schwarze Elster, Mulde, Saale and Havel.

The Magdeburg monitoring station for the Elbe river is situated near the city of Magdeburg on the left bank at river km 318. This site is part of the monitoring program of the International Commission for the protection of the Elbe (ICPE). The water quality of this section depends on the quality of the upper stretches of the Elbe (input from the Czech Republic and the Dresden industrial region) and primarily on the confluence of the polluted (for example with trace elements) tributaries Mulde and Saale. The confluences of the Mulde and Saale are, respectively, 59 km and 27 km upstream of the sampling site on the left bank. Upstream and downstream of the monitoring station, the Elbe is regulated by groynes on both sides. Characteristic flow rates at sampling point Magdeburg are 1730 m^3/s at mean high water flow, 559 m^3/s at mean water flow and 225 m^3/s at mean low water flow.

After the century flood in August 2002 (caused by heavy rainfall in the upper Elbe and Mulde catchment) and a flood in January 2003 (originated in Saale catchment) the river Elbe saw an extreme low water period from June/July to December 2003. During this period, water samples were taken at river km 318 on a weekly base, starting at the beginning of the low flow period.

The results of water quality measurements during low water periods potentially represent an integral signal of the following processes:

- increasing sedimentation rates of SPM in groyne fields due to lower flow rate of the river water (at the same time less artefacts to the SPM transport because the shipping is hampered).
- Re-solution of trace elements from groyne field sediments due to changes in redox state of sediments during vegetation period, coupled to higher phytoplankton activity.
- higher impact of tributaries to the main stream due to changes in mixing processes.

Results from water quality measurements of suspended particulate matter (SPM), chemical physical environmental conditions, nutrients, phytoplankton (as chlorophyll-a), DOC, POC/PN and their mutual dependences as well as selected heavy metals and As were evaluated.

During low flow, elevated salt concentrations at the sampling location indicate an increasing impact of the salt polluted Saale river on the water quality e.g. chloride (Figure 1, left). SPM concentrations, total particle number concentrations (range 2 - 200 µm) and chlorophyll-a values showed a strong correlation to the water temperature (Figure 2). The contents of dissolved silicate and ammonium consumed temporary until below the detection limit by the growth of biomass (Figure 1, right). Depending on their sources of origin and their redox sensitivity trace elements showed a different behaviour relating to the re-solution out of sediments (Figure 3).

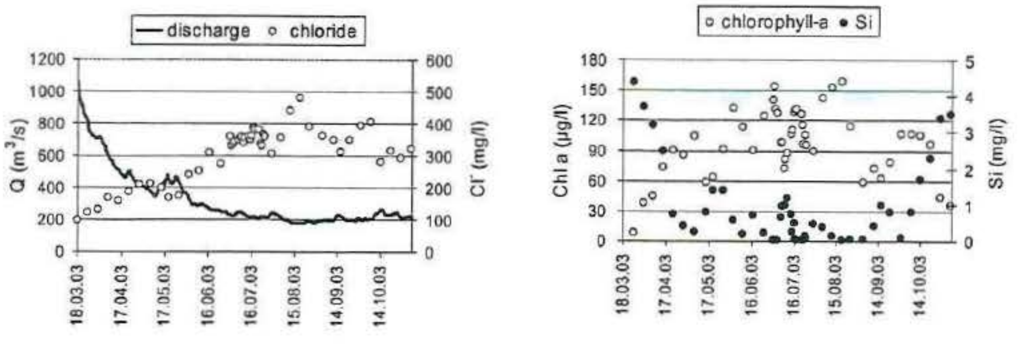

Figure 1: Variability of discharge (Q) and chloride concentrations (Cl^-) (left) as well as chlorphyll-a and dissolved silicate concentrations (Si) (right) at Magdeburg monitoring station 2003.

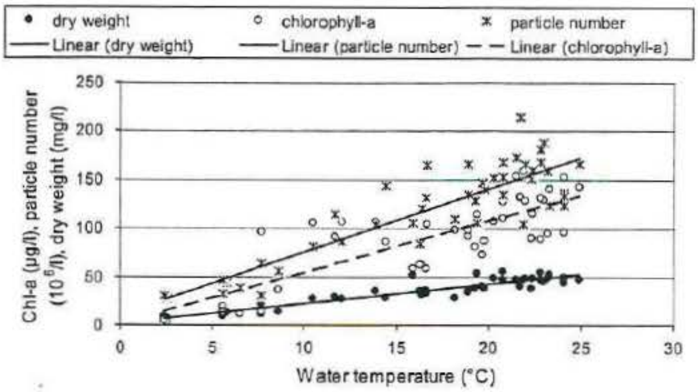

Figure 2: Relation between water temperature and dry weight ($y = 2{,}0279x + 1{,}9028$; $R^2 = 0{,}8606$), chlorophyll-a concentration ($y = 5{,}2758x + 1{,}9963$; $R^2 = 0{,}6745$) and total particle numbers ($y = 6{,}4811x + 10{,}712$; $R^2 = 0{,}7645$).

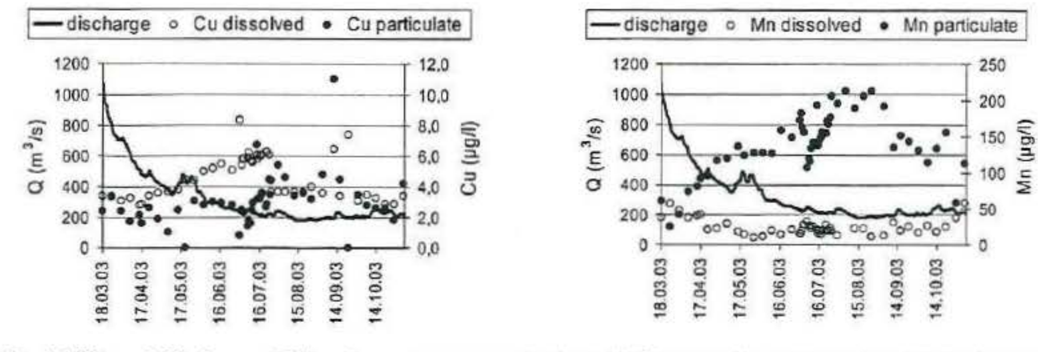

Figure 3: Variability of discharge (Q) and copper concentrations (left) as well as discharge (Q) and manganese (right) at Magdeburg monitoring station 2003.

The results of 2003 are compared to findings from values of a mean water period of the year 2001. Comparing to 2001 higher water temperature, higher chlorophyll-a contents and higher concentration of SPM during the vegetation period were found.

Fluctuations of pollutants during extreme periods have to be known. Increased concentrations of trace elements during long lasting low water periods are of high importance to the ecosystem. They represent a potential risk which should be considered when conducting river maintenance work (e.g. at groynes) during low flow.

The response of a macrozoobenthic community to an extreme flood event

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In 2002 people living in the River Elbe basin suffered from a severe and enduring flood (Figure 1) with catastrophic socio-economic consequences. Our investigations scope the ecological consequences of this natural phenomenon from the view of the macrozoobenthic community.

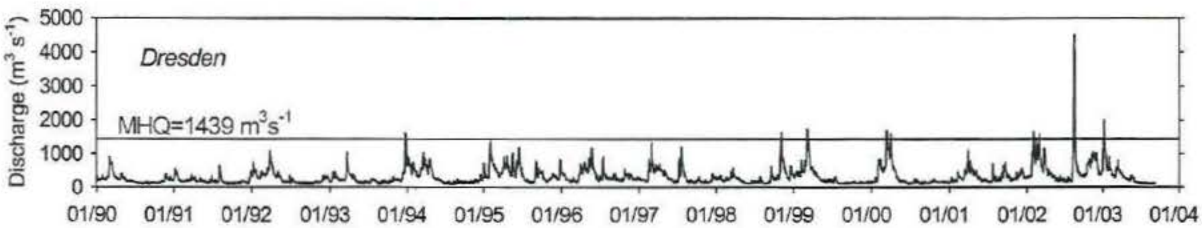

Figure 1: Hydrographical curve of discharge (Elbe/Dresden).

Macrozoobenthic communities of running waters are well adapted to harsh environments and in general these systems feature with great resilience to events of disturbance. If running waters run dry or spate, all these incidents represent stress for their dwellers. In the considered case the organisms had to resist to various physical stress factors as a result of the high current velocity (driftage, movement of stream bed material, abrasion).

To elucidate what happened to the regarded subsystem macrozoobenthos after the flood, we exposed several artificial colonization baskets in a 90 km reach of the upper part of the German stretch of River Elbe (Figure 2). In addition we carried out kick-sampling monthly.

Figure 2: The upper part of the German stretch of River Elbe with sampling sites Schmilka, Krippen, Pirna, Dresden, Gauernitz and Zehren.

The organisms found were determined, counted and measured. These data were treated with multivariate statistical methods to detect possible changes in the structure and function of the biocoenosis before and after the flood.

Preliminary results show that invertebrate species richness, proportion of functional feeding groups, diversity, abundance and biomass of the benthic community were not markedly influenced by the flood. Despite of that extraordinary flood event we only found structural differences pronounced on species level and it seems that the macrozoobenthic system granted its ecological operativeness in the years after the flood.

Urban water modelling for large river basins with ArcEgmo-URBAN

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Following the European Water Framework Directive (WFD; EU 2000) a 'good surface water status' has to be achieved within a set time frame (Art. 4). In terms of physicochemical water quality, nutrients input from both, point and diffuse sources must be analysed (Art. 10). Whereas sophisticated models already exist for diffuse sources (Krysanova et al. 1997, Klöcking and Suckow 2003), only statistical analysis or annual values have been considered so far with regard to point sources on the scale of river basins. For the model presented here, point sources are defined as discharge into a surface water body at discrete points from urban or industrial facilities and activities.

Against this background, a deterministic and spatiotemporal model is developed which calculates phosphorus and nitrogen impacts from urbanised areas on the catchment scale. Due to its overall architecture and focus on urban water and matter fluxes it has been named ArcEgmo-URBAN. This model combines approaches from urban waste water modelling with catchment-wide hydrological modelling. Earlier findings and developments provide a basis like Beichert et al. (1996), Behrendt et al. (1999), Wiese and Schmitt (1999), Franz and Krebs (2002) and Fuchs et al. (2003). This deterministic model approach should be able to balance matter fluxes and identify major pollution sources in the river basin at a higher resolution than that of annual balances.

The model is based on the hydrological model system ArcEgmo© (Becker et al. 2002) and used its algorithms to pre-process the meteorological input data and to describe the rain-runoff-process. It is coupled with a Geographic Information System (GIS), usually ArcGIS©.

One main criterion for the selected input data is their availability and their significance for modelling urban matter fluxes on a river basin scale (Rödder and Geiger 1996). The data are organised in at least six coverages. Information about urban land use and general characteristics of the river basin are based on digital maps, partly generated from remote sensing data. Depending on availability, resolution of input data for urban catchments relates to different spatial levels such as municipalities, districts or neighbourhoods. Required information for each urban catchment are population number, the type of sewer system and the next important installation (storage tanks or treatment facilities). Additional information about water consumption, industrial sewage, parasite water, air pollution (NO_x) and groundwater condition (NO_3-N) can be used in the model. Aside from this, information about waste water treatment plant systems like efficiency of nitrogen and phosphorus reduction must be known.

During pre-processing, homogeneous modelling patches are defined by using GIS algorithms. These so-called "elemental units" (ELU) are the smallest spatial units of ArcEgmo-URBAN. All relevant processes are modelled for each ELU and each time step.

Storm water runoff is estimated using the algorithms based on the ArcEgmo© concept. Remobilisation and dilution effects of accumulated matter depositions and their transport to the receiving water body are estimated taking into account land use, rainfall intensity and runoff volume during the rainfall period.
The sewage flow and sewage load are calculated from the population equivalents, water consumption, data about industrial waste water and parasite water. The model considers the

sewer system type, storage tanks and technology in the waste water treatment plants. For each treatment technology specific efficiency factors can be defined.

Finally, the discharge and matter flux from sub-basins with their ELU's are balanced for the receiving surface water (section). The modelling results can be provided for any user-defined level of spatial and/or temporal aggregation, in space down to the ELU and in time down to the time step of the meteorological data.

ArcEgmo-URBAN is presently applied in a research project dealing with river basin management according the WFD. The project "Management options for the Havel River Basin" funded by the Federal Ministry of Education and Research (BMBF), is dedicated to the implementation of the directive in the Havel river basin. Initial results illustrate the potential of the model to provide more realistic nutrient load results than those assumed by annual values. Next steps will be to compare results for sub-basins with measurement results from river gauges. Validation results will be used for changes or even additions of algorithms. The final version of ArcEgmo-URBAN is supposed to be a new tool for identification of impacts from point sources on water bodies as basis for programmes of measures and river basin management plans according to the WFD.

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Impact of the land use on water quality and ecological status of rivers of the Widawa River sub-basin

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The Widawa river sub-basin (SW Poland; the River Odra basin) covers an area of 1717 km^2. It is occupied by ca 21 thousands of inhabitants (the population density ca 122 residents/km^2, greater than the mean population density within the Odra River basin). Main pressures that impact the status of water ecosystems in the Widawa river sub-basin are diffuse and point sources of pollution as well as alterations of hydromorphological structure of rivers. In the sub-basin, there are two agglomerations with more than 15 thousands EP (Oleśnica – 23.5 thousands and Namysłów – 20.5 thousands EP), and three classified within the range of 2-15 thousands EP (Bierutów – 7.0 thousands, Dobroszyce and Długołęka, each of them with 2.5 thousands EP). The sub-basin is intensively utilized for agriculture purposes. Plough-land equals 54.7% of its area, meadows – 7.6%, pastures – 3.0%, forests – 23.2%, and the remaining 11.0% are covered by urbanised areas and infrastructure of communication. The balance of nutrients and of substances affecting oxygen conditions is mainly under impact of diffuse sources of pollution. These sources discharge about 73% of BOD_5, 98% of nitrates, 86% of the total nitrogen and ca 56% of the total phosphorus loads. Point sources contribute respectively: ca 19%, 2%, 13% and 14% to the loads. The state of physicochemical indicators supporting biological elements has been evaluated, and as critical magnitudes, the values of indicators that satisfy conditions to maintain cyprinid fish were accepted. Exceeding the critical values that indicated the bad state were detected in case of nitrates, phosphates and of the total phosphorus (Table 1)

Table 1. Physicochemical indicators supporting biological elements in the river Widawa sub-basin (at the Widawa mouth into the Odra River), according to data of WIOŚ Wrocław, from the year 2003; for the pH – a range of values is given.

Indicator	Metric unit	Critical value	Mean value	Percentile 90%	Assessment of the state
Dissolved oxygen	mgO_2/dm^3	> 7.0	7.9	6.2	good
BOD_5	mgO_2/dm^3	< 6.0	3.0	4.6	good
Chlorides	$mgCl/dm^3$	< 100	68	120	good
Sulphates	$mgSO_4/dm^3$	< 150	102	116	good
Total suspended matter	mg/dm^3	< 25	9	14	good
Ammonium nitrogen	mgN_{NH4}/dm^3	< 0.78	0.37	0.72	good
Nitrates	mgN_{NO2}/dm^3	< 0.030	0.049	0.073	bad
Total nitrogen	mgN/dm^3	< 6.0	3.35	3.84	good
Phosphates	$mgPO_4/dm^3$	< 0.4	0.65	1.01	bad
Total phosphorus	mgP/dm^3	< 0.3	0.31	0.41	bad
pH		6-9	-	6.9-7.6	good

The length of the Widawa equals ca 103 km. The river and its tributaries with a sub-basin area of more than 100 km^2 are regulated. In the upper and middle sections of the river Widawa, two small dam reservoirs are present– Stradomia reservoir situated at 94.2 km and Michalice reservoir at 70.2 km of the river course. Apart form reservoirs, the continuity of the river break 5 vertical obstacles (barriers) –gate valve weirs– of the height from 1.3 m to 2.6 m, located between 25.6 km and 68.2 km of the river course. None of these weirs is equipped with fish passages. In spite of intensive land cultivation within the sub-basin, 30 species of fish and lampreys, and 44 families of macrozoobenthos occur in waters of the river Widawa and its tributaries. On the basis of fish and macrozoobenthos communities, impacts of pressures resulting from diffuse and point sources of pollution, and from barriers against migration of water organisms have been assessed. As metrics of fish diversity, the number of species [FSPNO] and the ratio of a number of rheophilous species to the total number of species [RHEO] were used. As a metric for macrozoobenthos, slightly modified BMWP index (Wright et al. 1988) was applied. An example of assessment of the river Widawa and its two tributaries: Dobra and Graniczna having sub-basins of a similar area is presented in Table 2. Between the Odra and Dobra rivers fish may migrate easily, while the river Graniczna is separated from the Odra by the weir in Kiełczówek.

Table 2. Assessment of the status of Widawa, Dobra and Graniczna rivers on the basis of fish and macrozoobenthos. Explanations: B:h [m] –number and height [m] of vertical obstacles; EP–point source of pollution > 2500 EP [EP]; A – % of plough-land in a sub-basin of a section; FSPNO – the number of fish species; RHEO – the ratio of a number of rheophilous species to a total number of fish species; BMWP –index BMWP.

River: section [km of a river course], % of regulated banks	B:h [m]	EP	A [%]	FSPNO	RHEO	BMWP
Widawa: the mouth into Odra – Kiełczówek [0.0-25.6], ca 30%	0	None	< 50	17	0,41	98
Widawa: Kiełczówek – Zbytowa [25.6-45.9], < 10%	**2:** 1.3; 1.2	30500	50-60	12	0,33	106
Widawa: Zbytowa – Namysłów [45.9-68.2], ca 50%	**2:** 1.3; 1.9	20500	> 60	12	0,25	94
Widawa: Namysłów – Michalice [68.2-70.2], 100%	**1:** 2.6	None	> 60	10	0,20	37
Dobra: right tributary of Widawa [in 14,3 km of a course]; ca 50%	0	5000	< 50	19	0,42	93
Graniczna: left tributary of Widawa [in 32.7 km of a course]; ca 50%	**1:** 1.3	None	< 50	10	0,20	67

The number of fish species FSPNO as well as RHEO index reflected well breaking the continuity of rivers by vertical obstacles. Barriers against migration caused a decrease of the total number of fish species, particularly of rheophilous ones. BMWP index should well evaluate pressures of point and diffuse sources of pollution. In the Widawa river sub-basin, good results of that index, i.e. high values, have been obtained for the sections loaded by large point pollution. The share of plough-land being a source of pollution by nutrients influenced the BMWP values insignificantly. On the other hand, distinct correlation between BMWP and hydromorphological structure of rivers was found. Sections with great parts of regulated banks were characterised by poor macrozoobenthos and low values of BMWP index.

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The Czech Elbe Project in its fourth phase – quality of information, uncertainty and risk in environmental decision making

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The Czech Elbe Project financed by the Ministry of Environment of the Czech Republic came into being in 1991 as a major contribution to the description of water pollution in the Czech Elbe, evaluation of pollution sources, setting priorities, suggesting measures and monitoring improvements as those measures were gradually implemented. It has been playing an important role in the cooperation within IKSE-MKOL (International Commission for the Elbe River Protection). This role is by no means diminished by the present situation of much cleaner Elbe River. The focus has moved to ecosystem problems and management for sustainability in coincidence with the all European effort to meet the demands of the Water Framework Directive (WFD). The proportion between surveys for documentation of trends and high quality science has also changed in favour of the latter.

In the current (fourth) phase the project deals with: physical habitat of fish and characteristics of fish communities (Slavik and Bartos, 2004), telemetering of fish migration, space-time changes of phytoplankton as depending on hydrological and meteorological conditions (Desortova, 2004), potential effect of old industrial sites on groundwater, pollution incidents, ecotoxicology, the dynamics of contaminated sediments in the channel and the floodplain (Rudis et al., 2004), chemical biomarkers (Randak et al., 2004), evaluation of extreme hydrological events on the basis of continuous simulation using experimental data for constraining uncertainty, using isotopes ^{15}N a ^{18}O for studying runoff generation and origins of nitrate, description of development on the basis of environmental indicators. The Elbe Project also integrates the results of other Czech and international projects.

In respect of WFD there is a need to provide decision support facilities based on hydrological and ecological modelling and monitoring using (in future) the exciting possibilities of the modern technology (GRID middleware; see e.g. Beven, 2003). The research question here, however, is how this should be done. Whenever results of science are going to be used in decision making the issues of quality of information and uncertainty are involved. The project examines various building blocs (see above) of the environmental monitoring and modelling as to the quality of information, space and time characteristics (see e.g. Slavik and Bartos, 2001), the uncertainty in predictions and the possibilities of constraining it with various kinds of data (for flood predictions see e.g. Blazkova and Beven, 2002). Risk and uncertainty analysis is a cross-cutting research priority of the Elbe Project that touches on all the specific topics given above.

The crucial problem of the near future decision support facilities is the communication across the engineering/science - policy/management interface. The aim of the contribution is to highlight the problem on the Czech Elbe Catchment case.

One example of such a communication is our research into the origins of nitrates (Figure1). The interpretation of the results will be used by the water company.

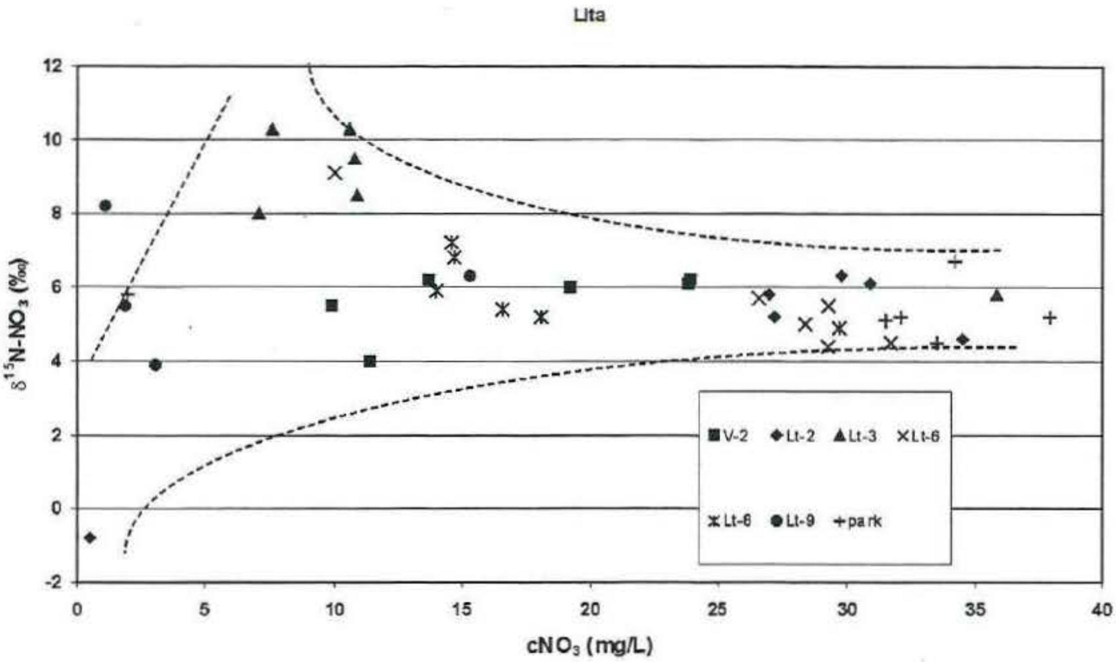

Figure 1: Relation of isotope composition of nitrogen to the nitrate concentration in the Lita region. Water resources in the Lita region show inputs from three sources of nitrates: low concentrations in groundwater with value $\delta^{15}N$ around –1 ‰, shallow infiltrated water with a mixed source of organic and inorganic nitrogen around 4 – 6 ‰ and surface wash with values $\delta^{15}N$ around10 ‰.

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Nitrogen degradation in a shallow groundwater-stream system of a lowland catchment (Saxony-Anhalt)

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1. Introduction

Diffuse nitrogen pollution in ground and surface waters is of concern especially in regions with intense agricultural activities. Observed nitrogen loads in surface waters often do not reflect the actual input situation. This apparent retention of nitrogen can be explained by various chemical transformations and hydrological processes in soil, groundwater and surface water. The quantification of these processes and their interactions was investigated by using isotope hydrology and mathematical process modeling.

2. Material and Methods

The investigations were carried out in the "Schaugraben" catchment located in the north of Saxony-Anhalt. The study site is a Pleistocene lowland catchment of 20 km², with mainly agricultural use.

Nitrogen sources and dominating in-stream turnover processes were identified by natural isotopic abundances of nitrate and DIC. Therefore stream and seepage water as well as shallow groundwater was analysed. N-turnover in soilwater and shallow groundwater was examined through field scale tracer experiments. For theese experiments 15N-nitrate was used as a reactive tracer and bromid as a conservative tracer.

In-stream N-turnover was investigated in a newly developed in situ benthic flow chamber. Conventional benthic chambers do not allow assessing the effect of flow velocities on denitrification rates. To ensure a laminar flow above the sediment surface in the 20*30 cm chamber, water was pumped in a closed cycle through the system by means of a peristaltic pump. To determine the denitrification rate water was enriched with $^{15}NO_3^-$. Nitrate fluxes into the sediments lead to the generation of $^{29}N_2$ and $^{30}N_2$ within the sediment (NIELSEN, 1992). From the generated N_2 isotopes the denitrification rate was calculated.

The complete nitrogen transport from the soil through the shallow groundwater and into the surface water drainage system was simulated by loose coupling of suitable models describing water fluxes and nitrogen turnover in soil and groundwater. The soil-water and nitrogen model mRisk-N was developed combining basically the soil water storage model SIMPEL (HÖRMANN, 1998) and the analytical soil-nitrogen model RISK-N (GUSMAN & MARINO, 1999). The model was used to calculate groundwater recharge and nitrate leaching as input data for subsequent groundwater modelling. Groundwater flow is simulated using Modflow (MCDONALD & HERBAUGH, 1988), groundwater solute transport is simulated with RT3D (CLEMENT, 1997). A specific reaction-module was developed to simulate various chemical processes in groundwater, such as degradation of organic matter by oxygen, nitrate, sulphate or pyrite oxidation by oxygen and nitrate, including the various denitrification reactions. In-stream processes are simulated with the river compartment module of AQUASIM (REICHERT, 1994).

3. Results

Nitrogen degradation in the unsaturated soil zone doesn't occur. The spatial distribution of nitrate concentrations in the uppermost groundwater layer is consistent with the spatial distribution of N-leaching from the soil. The surface near groundwater zone shows quiet high degradation-rates, hence nitrogen input will be degraded after short distances. In a broad band along the drain channels nitrate is completely removed. In these areas, the content of soluble organic matter is considerably higher than in the rest of the catchment, allowing for an effective removal of nitrate.

A comparison to observed nitrate concentrations and natural isotopic abundances in the Schaugraben drain channel suggests that groundwater contribution can not be the only source of nitrate to the surface water system. A significant contribution of other sources, such as drain flow and direct inputs of nitrate through fertilization, needs to be taken into account in order to explain elevated nitrate concentrations during winter.

Within a stream section nitrogen input as well as nitrogen degradation processes occur . In-stream degradation can be identified as a dominating process only in warm and dry periods in summer. Experiments with benthic-flow-chamber show higher in-stream nitrogen degradation than nitrogen degradation calculations based on stream nitrogen load measurements.

4. Conclusions

Conventional nitrate monitoring investigations do not allow the identification of in-stream denitrification processes in the study site, since there is continuous nitrate input into the stream system. In general, neither the nitrate input nor the nitrate degradation is known. This leads to an underestimation of both processes.

The distributed modelling approach and the implementation of a full reactive groundwater transport model allow the study of spatial and geochemical interactions at the catchment scale. The heterotrophic as well as the autotrophic denitrification will cause a reduction of reactive pools and thus should carefully be considered as an integral part of sustainable management strategies.

The overall share of in-stream denitrification of total nitrogen degradation on the catchment scale still remains unclear. For the interactions between terrestrial and in stream nitrogen turnover a coupling of a reactive transport groundwater model and a surface water quality model is required, implementing hyporheic zone processes.

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Contributions to sustainable flood risk management

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In accordance with the 2002 Budapest Initiative on Sustainable Regional Development the present contribution deals with sustainable flood risk management leading to practical suggestions for central and eastern European rivers.

Long before the 2002 Elbe and Danube floods occurred, the question arose: What is the appropriate use of flood-endangered areas? In the course of time natural flood plains have been occupied partly or entirely for human purposes like agriculture or building development. The other side of the coin is the high damage suffered when the design level of flood protection structures is exceeded. Although the trivialized term 'residual risk' stands for a rather small probability of exceedance, it implies considerably higher damage than in the undeveloped flood plain.

An appropriate level of protection should be chosen suitably to the corresponding positive and adverse effects. Prevented monetary damage is part and parcel of the benefits of flood control measures, which can consist of various actions, e. g. structural measures and/or land use regulations.

In terms of an integrative view, attempts are proposed to assure a planning and management approach that considers all relevant aspects of flood plain land use. For sustainable solutions better information and enhanced participation of the stakeholders is essential. It will be pointed out that conflicting issues should be disclosed both to competent authorities, involved disciplines and to concerned citizens. Otherwise further intensification of land use in 'protected' flood-prone areas that are not equipped with appropriate flood-safety provisions can hardly be prevented, and environmental enhancement will be difficult to achieve.

Experiences with the derivation of monetary water stage – flood damage functions for different building types will be discussed. As basis for informed decisions on flood control and flood management measures, recommendations are made for appropriate and reliable flood damage estimation.

In many cases the flood stage will determine the extent of monetary flood damage. Besides, in a certain flood-prone area, there is a positive correlation between water stage and other factors such as flow velocity, flood duration, and sediment transport.

Concerning the compilation of stage-damage relationships for single buildings in a so-called microscale approach (small to medium areas up to approximately 10 km^2) the following procedures will be distinguished:

- Synthetic determination of stage-damage relationships for individual buildings in the project area
- Synthetic determination of stage-damage relationships for typical buildings in the project area
- Statistical derivation and application of average nationwide stage-damage curves for specific building types
- Site-specific modification and application of average nationwide stage-damage curves for specific building types

The Working Committee of the German Federal States' Water Resources Administration (LAWA) stores in their data base HOWAS flood damage data, which have been collected in Germany over the past two decades after several flood events. Some 3,600 cases of damage concerning buildings and other structures are grouped according to 8 sectors (e.g. dwellings, farm buildings, infrastructure, services, and industry). For example residential buildings (around 2,000 damage events) are distinguished by 4 construction periods, with – without basement, and with – without garage.

The software package HOWAS_N, provided by the Water Resources Administration, facilitates the determination of average amounts of losses, standard deviations etc. and, finally, stage-damage curves. For convenience a root function $\mathbf{D} = \mathbf{a} \cdot \mathbf{W}^{1/2}$ is recommended, where D = Flood Damage, W = Water Stage and coefficient 'a' denotes the damage to be expected for a water stage of one metre. It has been shown to give plausible results (IWK 1999).

Mesoscale approaches, usually applied for flood damage estimation in larger areas of around 10 km^2 or more, are based on statistics of the national economy. It is understood, that they have to be calibrated. For reasons of expenditure planners sometimes may be obliged to restrict calibration to subareas.

Flood damage data are provided for the economic appraisal of flood control projects. These data are also used for informing the inhabitants of flood-prone areas and the general public on possible flood losses. Natural flood plains, independently of the presence of flood control measures such as dikes, bear a certain risk of flooding. Such areas will not be protected against the maximum possible flood event. Therefore a certain residual risk remains. Not only the damage to be prevented by a flood protection measure and the residual risk have to be taken into account in a decision by calculating expected annual monetary values (DVWK 1985) but also the absolute damage values to suffer in case of exceedance of the design flood event.

These remarks are intended to call our attention to the sword of Damocles overhanging flood plain users. Although sometimes high flood protection degrees (corr. high design return periods) up to some hundred or even more years are provided, a certain probability of failure is remaining. Due to intensification of land use because of the better degree of flood protection, the damage mostly will be much higher than in case of lower flood protection degrees.

Finally, the problem will be addressed that especially river embankments like dikes entail the 'residual' risk of structural failure by overtopping with a suddenly activated high damage potential. The necessity will be explained for not only providing storage reservoirs and detention basins with devices like spillways to safeguard structural safety, but also river stretches with fairly high dikes.

Stage-damage curves have to be derived and project appraisals for sustainable flood protection and structural safety have to be applied with both analytic expertise and common sense.

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Analysis of potential flood retention measures (Polders) at the Elbe River in Saxony-Anhalt

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In consequence of the extreme flood event 2002, the reactivation of retention areas along the Middle Elbe River is a major topic of discussion. Since extensive research activities have shown the effects of different measures on the flood situation along the river (see Merkel et al. 2002, Helms et al. 2002 and 2004), the need of areas for controlled retention (polders) is emphasised by the international „Actionplan Flood Protection Elbe" (IKSE 2003).

Around 300 km of the water course of the Middle Elbe belong to the German federal state of Saxony-Anhalt, mostly with dikes on both sides of the river. The regional flood situation is also influenced by the tributaries Mulde and Saale. In 2002, large areas behind the dikes suffered damages due to several dike breaches. Regarding this situation, the future installation of polders to mitigate the residual risk (e.g., overtopping of dikes) is an important component of the flood protection concept and related activities of the state authorities.

A first step of the planning process of polders was carried out in the scope of a hydrological study (Ihringer et al. 2003). Seven potential polder areas were identified in the river section Torgau-Dessau (see P1–P7 in Figure 1, with some variants a–c). They could serve as operational measures to reduce the water levels in extreme situations when a dike failure is imminent.

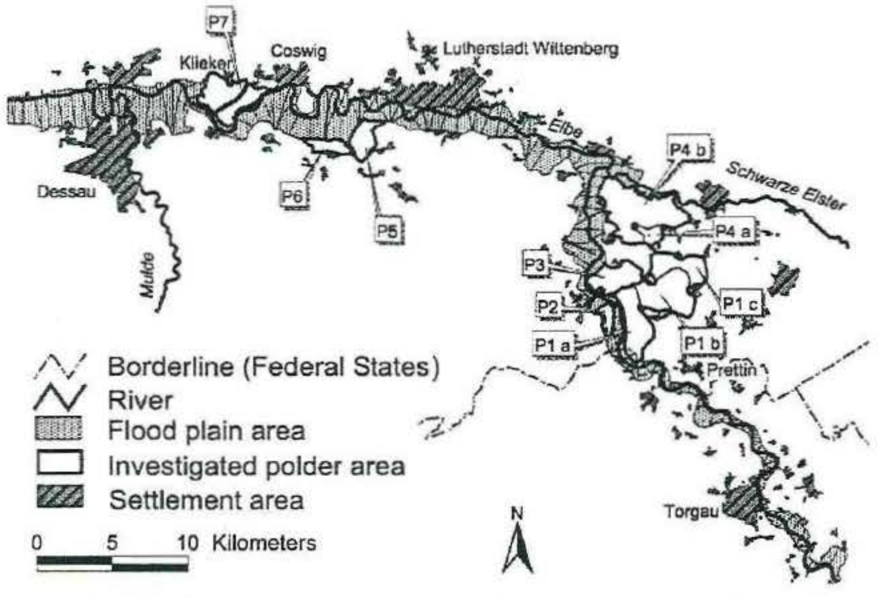

Figure 1: Map of investigated polder areas at the Middle Elbe River (Ihringer et al. 2003).

In the study, different extreme flood scenarios were simulated using a hydrological model. The model consists of flood-routing components coupled with specific retention modules for the polder sites. The principal scenario is the event 2002 which first had to be reconstructed in order to validate/improve the model for extreme events and to quantify the effect of the dike breaches. The reconstruction (simulation with dike breaches) shows good model results in comparison to the observations at the main gauging stations along the river. Furthermore, the reconstruction reveals that the peak water levels were reduced about 15-18 cm due to the dike breaches. Beside the event 2002, five other extreme events with different characteristics in terms of peak flow (> 4000 m³/s) and event shape were analysed. These synthetic floods were generated by an established stochastic model for daily flows (see Treiber 1975).

The simulation of the effect of retention measures included the six flood events and different polder variants (V1–V4 with increasing storage volume of approx. 55 to 216 millon m³). The model results show a considerable cut of the flood peak (see Figure 2), depending on the specific conditions (event characteristics, storage volume and combination/operation of the measures). Thus, a reduction of the peak water level of about 20 to 50 cm can be expected downstream. In 2004, these results were discussed with stake-holders (authorities, local representatives). The overall recommendation is to continue the investigations more in detail, with a concentration on the areas with the highest retention potential (V3, in particular P1).

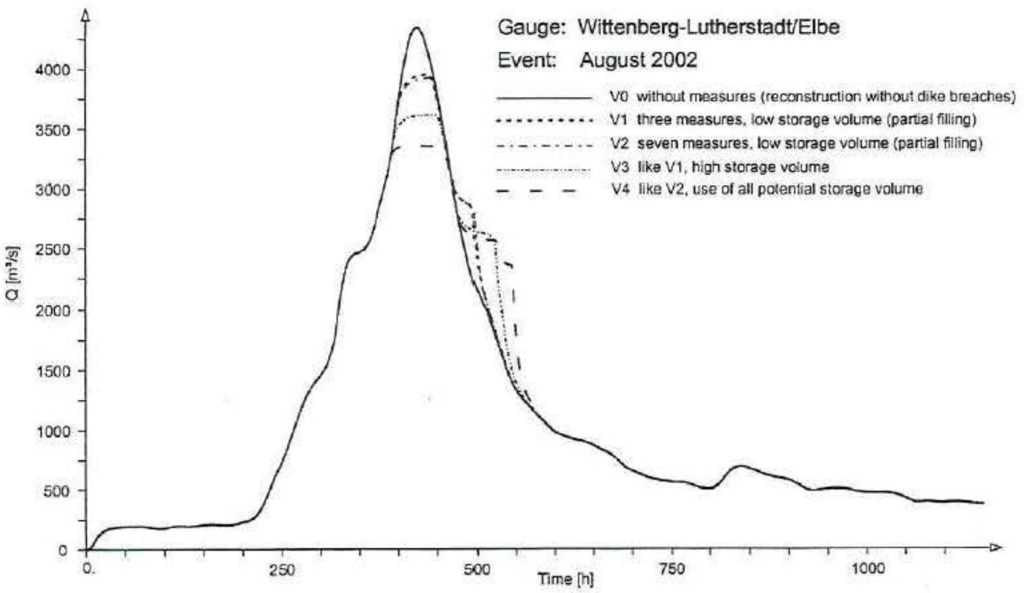

Figure 2: Potential retention effect of different polder variants (V1–V4) on the flood event 2002 at gauge Wittenberg (Ihringer et al. 2003).

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Comparing study of heavy metal concentration in sediments and water quality in three oxbow lakes of the Labe River and the influence of floods in 2002 on distribution of some metals in sediments in the oxbow lake of Obříství near Mělník.

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1. Introduction

During the years 2000 and 2002, the investigation of three oxbow lakes of the central part of the Labe River was carried out. The first lake Labiště pod Opočínkem is situated a few kilometres to the west of Pardubice, the second lake Doleháj is near Kolín and the last one Obříství is located near the town of Mělník. All these towns have largely developed chemical industry and the lowlands along the Labe River are one of the most intensive agriculture areas of the Czech Republic. We chose these three localities to evaluate the state of nature, and the anthropogenic impact on the environment. As we used the same analytical methods for all analyses and we collected the samples at the same time, we could compare the experimental results to see the differences among these oxbow lakes. The research was focused on water quality (physical and chemical parameters), quality of sediments (content and distribution of heavy metals, grain structure) as well as hydrobiological analyses, bathymetric measurements and hydrological conditions. Another aspect of these limnological studies was to evaluate the importance of the oxbow lakes during the period of food as polders.

2. Results

All three oxbow lakes came into existence during the canalization of the Labe River in the 19^{th} and 20^{th} century. Doleháj is the oldest and the most separated one and has a very restricted communication with the river. It is the largest (7,75 ha) and the deepest lake (mean depth 2,7 m) (Jansky et al. 2003). In the contrary of that, the area of the lake Opočínek is the smallest (1,75 ha) and it is also the shallowest lake (mean depth 0,87 m).

Owing to small depth of the lakes, the temperature fluctuated during the year quite a lot and there was not established any thermic stratification. The transparency of water correlated with the development of planktonous organisms. The conductivity was higher in Obříství (mean value = 854 μS/cm). pH declined in all three lakes (moderately alkaline water) in the vegetative period because of usage of CO_2 by primary producers.

The oxygen saturation correlated with higher photosynthetic activity during the vegetation period (in Doleháj and Obříství more than 100 %) and biomass decomposition in autumn. The oxygen insufficiency which was recorded in Opočínek was probably associated with large decomposition of organic compounds there, which made the main pollution in this lake (mean BOD_5 = 17,73 mg/l; mean COD_{Mn} = 20,12 mg/l). However, higher amount of organic pollution was determined in Doleháj too. Nutrients and their seasonal variability (nitrate, nitrite, ammoniacal nitrogen and phosphate phosphorus) differed in each lake. Higher concentrations of nitrate nitrogen occured in Obříství (mean value = 8,5 mg/l), ammoniacal nitrogen was determined in a larger amount in Doleháj (mean value = 1,20 mg/l) and in Opočínek, there we measured four times higher concentrations of phosphate phosphorus (mean value = 0,41 mg/l) than in the other lakes. During the vegetation perion, we found reduction of dissolved inorganic nitrogen and phosphate phosphorus in Doleháj and Obříství.

Different situation was in the lake Opočínek, where the concentrations of dissolved inorganic nitrogen fluctuated at the same level during this period and the concentrations of phosphate pohosphorus increased rapidly in autumn, when they could release from sediment in anoxic conditions. Low concentrations of phosphate phosphorus in Doleháj and lack of nitrate nitrogen in Opočínek (which is preferred by phytoplankton biomass) could limit the development of primary production in these lakes. Analyses also showed higher concentrations of calcium (mean value = 150 mg/l), as well as higher hardness of water in the lake Obříství. The source for this enrichment probably is the catchment of the Černavka tributary, where a sugar factory worked in the past (Chalupová 2003).

In November 2001, we also took samples from each lake to determine following heavy metals - Ag, Cd, Co, Cr, Cu, Fe, Hg, Mn, Ni, Pb and Zn - in two grain fractions - 63μm and 20μm. Finer fraction was used for comparing the results. Each sample was divided into two or three parts (upper, middle, lower) according to the thickness of sediment. The lowest concentrations of all measured elements were determined in Doleháj, perhaps because this lake is the oldest, most separated one and the Kolín district is not as largely developed industrial centre as other two localities are. The sediments of Opočínek were enriched by Ag, Co, Cr, Fe and Zn. High concentrations of Cd, Cu, Hg, Mn and Pb occured in Obříství (Table 1).

Table 1: Mean concentrations of heavy metals in sediment in mg/kg (November 2001)

Sampling site	Ag	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
Labiště pod Opočínkem	15,57	3,97	20,5	255,3	87,0	25520	1,78	569	44,7	114,3	1021,7
Doleháj	13,00	2,25	17,5	94,0	34,0	16200	0,41	247	32,5	71,8	168,0
Obříství		4,33	19,3	240,7	132,7	22833	5,80	1950	44,7	184,0	943,3

The relation of concentration to the depth (age) of sediment was similar only for Cd and Pb at all three localities. Samples from Opočínek contained higher concentrations of Ag, Co, Cr, Cu, Fe, Hg, Ni and Zn in the upper part, in Doleháj, there was this part enriched only by Ag and Mn. Higher concentrations of Co, Cr, Fe and Ni were determined in the upper part of sediment in Obříství. The explanation for this fact is that the localities were contaminated at a different time in the past. For the quantitative measure of metal pollution, we used the Index of Geoaccumulation introduced by Müller in 1979. The sediments of all three lakes were mostly strongly polluted by Ag, Cd, moderately by Pb and Zn. We also collected samples from Obříství after big flood in September 2002 (Table 2).

Table 2: Mean concentrations of heavy metals in sediment in mg/kg (September 2002)

Sampling site	Ag	Cd	Co	Cr	Cu	Fe	Hg	Mn	Ni	Pb	Zn
Labiště pod Opočínkem	8,40	6,44	15,23	200,9	115,1	28741	3,58	1030	35,5	375,8	777,5

The sediment contained higher concentrations of Cd, Fe and Pb, but the analyses showed smaller content of Co, Cr, Cu, Hg, Mn, Ni, and Zn. All measured heavy metals (except Co) had higher concentration in the upper part of samples. This fact could be associated with slow sedimentation of very fine fraction, that probably contained more of these elements. After the flood, the Index of Geoaccumulation increased only for Pb and decreased for Hg. Ag was not analysed before. These results show, that in September 2002, the big flood did not bring any relevant contamination.

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Effect of the Vltava River cascade on 2002 flood in Prague

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The Vltava river cascade was build during 20^{th} century (from 30ties to 90ties) as a multipurpose reservoirs system. The most important purposes are the hydropower production, water storage and subsidizing of discharges during dry periods, and flood protection as well. Totally 74.126 mil.m^3 of reservoirs storage is determinate for flood protection in two major reservoirs - Lipno (12.056 mil.m^3) and Orlík (62.07 mil m^3). Before the flood in August 2002 all the flood protection storage was empty and available for flood wave transformation. Also another significant volume (110.559 mil.m^3) of active storage of Vltava river cascade reservoirs was empty. It means that together 184.685 mil.m^3 of storage was free before the flood.

August 2002 flood consisted of two waves. Vltava river cascade reservoirs fully transformed the first flood wave and protected the area downstream, including the capitol of Czech Republic – Prague. The first flood period fulfilled part of the free storage, but in the time between two waves the volume of free storage increased again. As a result there was about 141.5 mil.m^3 of free storage in reservoirs before the second flood episode.

Inflows into the cascade reservoirs were extreme during the second flood period. As a consequence water levels in all reservoirs exceeded the maximal designed level by 7 centimeters (Lipno) up to 1.57 m in the case of Orlík reservoir. Nevertheless the safety of the dams was not endangered. Additionally by filling the space above the maximal designed water level another nearly 54.5 mil.m^3 of water was there. That means that totally nearly 236 mil.m^3 of reservoirs storage was used for flood transformation.

Possible other scenarios of reservoirs operations and initial conditions were researched in the Project on 2002 Flood Evaluation. For that purpose the hydrological modeling system AquaLog was enhanced by detailed definition of reservoirs (Orlík, Kamýk, Slapy, Štěchovice and Vrané) and rainfall-runoff models of the middle part of the Vltava river.

The water level in the most important reservoir Orlík was at the altitude 348.5 m a.s.l. before the flood. Simulation proved that even reasonably lower initial water levels (347.6 m a.s.l. and 345.6 m a.s.l.) would not be sufficient for significant decreasing of peak flow discharge of Vltava river in Prague – maximal decrease accorded to 5 % of observed discharge. In addition this difference is approximately on the same level of possible modeling accuracy.

On the other hand if the initial water level in Orlík was 351.2 m a.s.l. (top of the active storage) reservoirs wouldn't be able to fully transform even the first flood wave and the second wave peak discharge in Prague could reach of 4.4 % more than observed value of 5 160 $m^3.s^{-1}$.

Another scenarios were simulated, for example the "perfect" hydrological forecast of second flood wave or all time operation of hydropower plant, which was in reality flooded and destroyed before peak outflow.

Neither perfect forecast of second flood wave nor follow-up more intensive emptying between two flood periods couldn't provide significant additional storage. The emptying of reservoir is limited by the capacity of outflow structures. Therefore result of this variant was more or less the same as the reality.

On the contrary the simulation with the Orlík power plant operating during the whole second flood wave led to increase of peak discharge of Vltava river downstream (in Prague to 5 500 $m^3.s^{-1}$, what means + 6.7 %).

Also so called zero variant of simulation (the nonexistence of reservoirs) was made. In this case the hydraulic model was used. Unfortunately the density of available geometrical data (cross sections taken from the old historical study of the original Vltava river valley) is not sufficient for detailed modeling therefore the result must be consider as rough. Also calibration and verification of 1890 flood proved that. Generally we can assume that in case of nonexistence of reservoirs the course of flood in Prague would be approximately similar to the one really observed.

The evaluation showed that reservoirs of Vltava river cascade protected Prague during the first flood wave and provided time for flood protection activities before the beginning of second flood wave. But reservoirs couldn't affect significantly the peak phase of the second wave of flood.

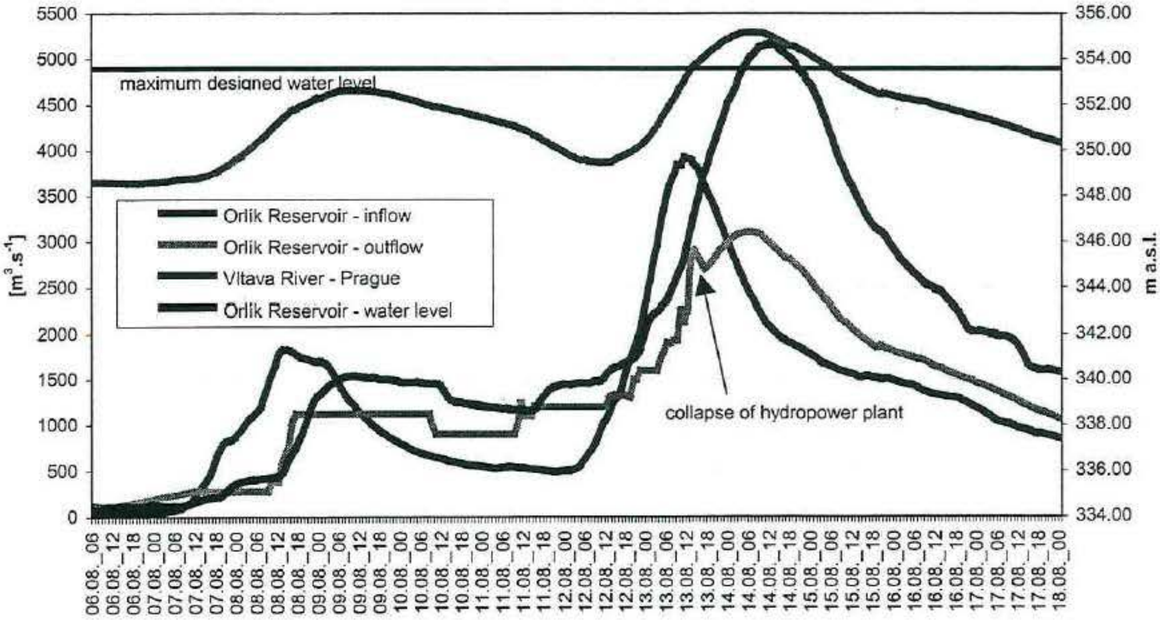

Figure: Flood hydrographs of the Vltava river at Orlík and Prague. Figure illustrates the transformation of both flood waves.

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A study on the water balance in the non-saturated soil zone in a region of Bulgaria

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The investigations on the water balance in the non-saturated soil zone for a given agricultural territory represent an interest from methodological point of view for both acquisition of concrete data about the processes in the considered area and for the assessment and further development of the method used.

The described investigations in the present work were carried out in the Chelopechene Test Melioration Field, situated in the Sofia kettle (cinnamon forest soil type). In two points in the field – "EAST" and "WEST", soil samples were collected periodically using a manual sound at each 10 cm to the depth of the groundwater level, which varied within the range of 1.5-2.4 m. The sampling frequency depended on the changes of the meteorological factors, at intervals of 1.5-2.5 months. The soil surface had a natural grass cover in the course of the exploration period.

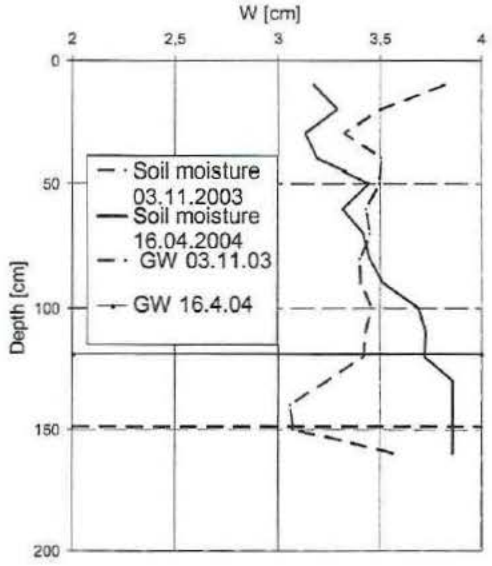

Figure 1: Measured data for the initial and final soil water quantity of the soil profile for the time period 3.11.2003-16.04.3004 (Chelopechene WEST). Precipitation: 127 mm.

The water balance equation for the accepted soil layers ($i = 1 \dots n$) at each 10 cm, represents the basis for the analysis of the moisture regime:

$$W_i' + Q_{i-1} - E - Q_i = W_i'' \tag{1}$$

where W_i' и W_i'' are the calculated water quantities for the i-th layer in the beginning and in the end of the measured time interval (example in Fig. 1); Q_{i-1} is the incoming volume from upper layer and Q_i – the volume flowing to the lower layer. (For the first layer $Q_{i-1}=P$ – the precipitation amount during the interval Δt).

After introducing $\Delta W_i = W_i' - W_i''$ and summing up the equations to m-th layer ($1 \geq m \geq n$), and grouping the unknown variables, the following relation is obtained:

$$\sum_{i=1}^{m} E_i + Q_m = \sum_{i=1}^{m} \Delta W_i + P \tag{2}$$

When referring this relationship (2) to the different depths m of the soil profile, it is possible to analyze the total amount due to evapotranspiration $\sum_{i=1}^{m} E_i$ and due to water exchange with the lower soil layer Q_m. The values

$$R_m = \left(\sum_{i=1}^{m} E_i + Q_m \right) / \Delta t \qquad (3)$$

show the total intensity of the water discharge to the depth of the i-th layer during the interval Δt (example in Fig. 2).

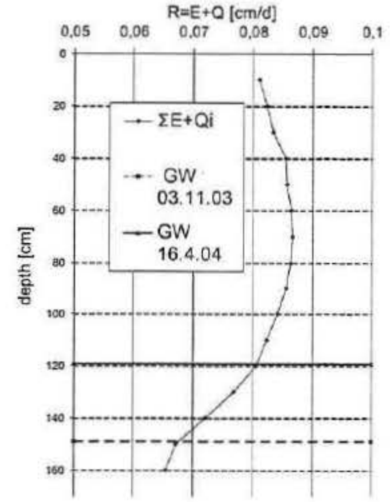

Figure 2: Total soil moisture release (ΣE+Q) for different depths of the soil profile for the time period 3.11.2003-16.04.3004 (Chelopechene WEST). Precipitation: 127 mm).

The interpreting of the results obtained from the relationships (1), (2) and (3) for the subsequently investigated time intervals elucidates the soil moisture regime in a given soil profile of the non-saturated zone. For layers at the depth of the groundwater level (m=n) the determination of the component $\boldsymbol{Q_n}$ values is of special interest. Such values could be defined for periods, for which it is accepted that the values of the evapotranspiration term $\sum_{i=1}^{n} E_i$ are minimal.

The investigations in the months of October – March were aimed mainly at studying this topic. The table below presents the results from the determination of the total amount $\boldsymbol{R}$ to the level of groundwater in the two points "EAST" and "WEST".

Time interval		Precipitation	Test point WEST		Test point EAST	
No	Dates	[mm]	Groundwater depth [m]	***R*** [mm/d]	Groundwater depth [m]	***R*** [mm/d]
1	08.05. - 13.06. 2002	39.26	1.47	1.0	2.25	1.8
2	13.06. - 16.08.2002	133.90	1.57	2.2	2.36	3.2
3	16.08. – 22.10.2002	222.60	1.35	3.2	2.18	0.8
4	22.10. -03.12.2002	50.5	1.13	0.3	2.08	0.0
5	03.12.2002 – 20.03.2003.	56.65	1.1	0.6	1.94	0.7
6	20.03. – 16.05.2003	27.50	1.44	1.18	1.98	0.7
7	16.05. – 10.06.2003	166.5	1.42	5.6	1.91	6.0
8	10.06. – 13.08.2.2003	104.2	1.29	3.0	2.05	3.0
9	13.08. –0 3.11.2003	186.0	1.55	1.0	2.32	1.1
10	03.11.2003 – 16.04.2004	127.2	1.22	0.7	2.15	0.2

The experimental investigation in annual cycles of the water balance on the non-saturated zone of the mentioned Chelopechene region proves that:

1) During the period of minimum vegetation (autumn-spring) the amount of the total water discharge $\boldsymbol{R_n}$ is dominated by the feeding of the groundwater ($\boldsymbol{Q_n}$). During this period, $\boldsymbol{R_n}$, respectively $\boldsymbol{Q_n}$, are of the order of 1 [mm/d], or less; 2) During the period of vegetation and increased temperature, it is seen from the data that the deeper soil layers do not receive and are not able to transfer water to the groundwater zone. Single intensive precipitation events might provoke short-term feeding. But the total feeding of groundwater $\boldsymbol{Q}$ during this period could be reduced to zero; 3) When modeling and predicting the processes in an underground flow, it is important to reflect the fluctuating inflow of soil water on a seasonal scale. This fluctuating flow exerts its impact on the regime and propagation of incoming substances.

Application of satellite data for flood monitoring

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Flood monitoring from satellite data provides the opportunity to quickly and precisely overview flooded areas also across borders. The extent of the flooding and affected areas can be delivered to authorities, civil protection agencies or insurances. Products also can be used for e.g. damage assessment shortly after the flood event. Further evaluations include information to better estimate risk in future and to prepare for protection measurements.

The Elbe flood (08/2002) was mapped using satellite data. For the evaluation of flood areas between Dresden and Neu Darchau (450 km), satellite data of different systems (Landsat, SPOT, ERS) were used to derive a "complete" flood extent data set. For different sections, satellite data of different dates, from 17.08. – 25.08. 2002, were used to perform the best fit to the flood peak along the river. The use of data from radar-satellites, as ENVISAT and ERS, even allows the view through clouds.

Some technical information regarding the resulting flood extent products for the Elbe event in 08 / 2002:

- **The flooding areas have been produced from 10 satellite images.**
- **The total flooded area mapped amounts to almost 1000 square kilometers.**
- **The length of the mapped river section is approximately 450 km.**
- **The number of affected ZIP-areas are approx.: 100**

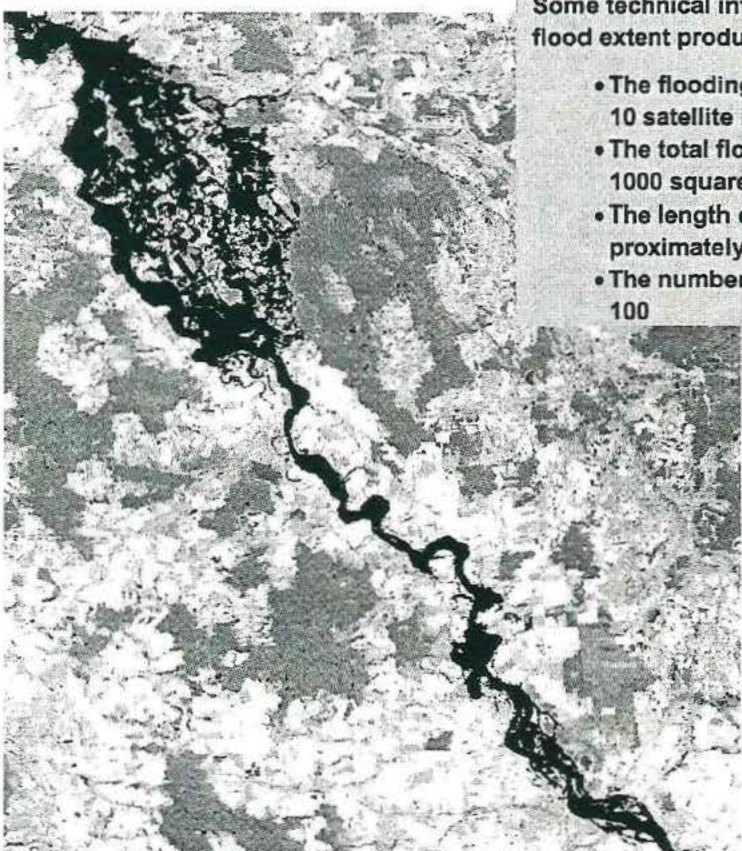
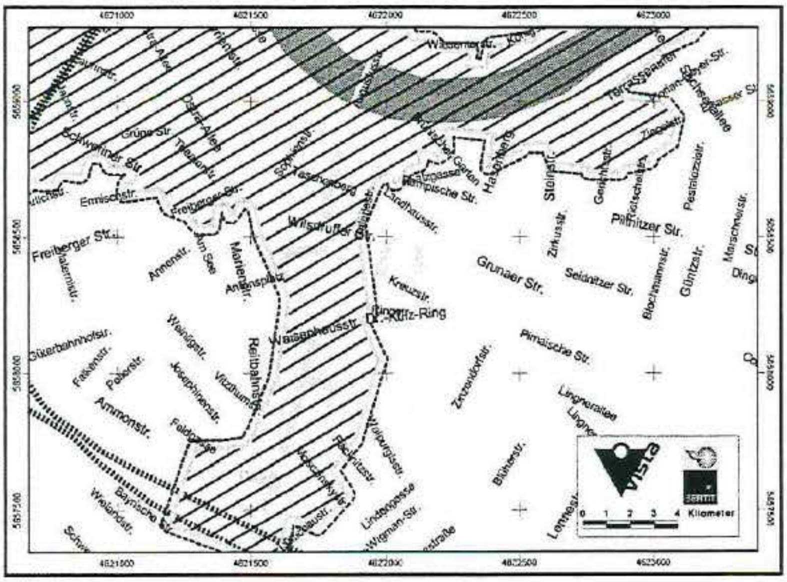


Figure 1 shows a section of flooding along river Elbe at Torgau (center of image) with a Landsat TM7 image from as background. Impressive is the effect of broken dams, that can be seen in the upper part of the image, where flooding broadens up to approx. 13 km.

Figure 1: Flooding at river Elbe at Torgau, with broken dams in the upper part of image; background image: Landsat TM7 from 20.08.2002



Support of damage assessment can be conducted using flood extent overlayed with a city map in high resolution. Figure 2 shows an example for the city of Dresden. The hatched area is the flooded area; which has been expanded by 50 m with a dashed buffer-line in order to show the spatial accuracy. Maps of complete Dresden as in Figure 2 have been requested by a German insurance company to conduct damage assessment.

Figure 2: Map showing the flood extent overlayed with a map of the city of Dresden (flood area is displayed as hatched signature).

The evaluation of flooded areas enables improvements for planning as e.g. the declaration of risk areas. Large area evaluations allow to verify and improve model calculations. By adding further information, various applications open up. Additional information, as landuse (industrial areas, settlements, agriculture, forest) are intersected with flooded areas. This intersection results into the detection of affected areas (and economic values), which have to be protected against flood events in future. E.g. the evaluation of affected settled areas per ZIP-code area, allows an insurance to estimate losses for a certain flood event. Multitemporal evaluation of flood events (using a set of images of different days in succession) document the spatial and temporal dynamic of a flood event. They allow to better rate damages (e.g. contamination of soils) as well as consequential costs (e.g. production loss, caused by impassable access roads).

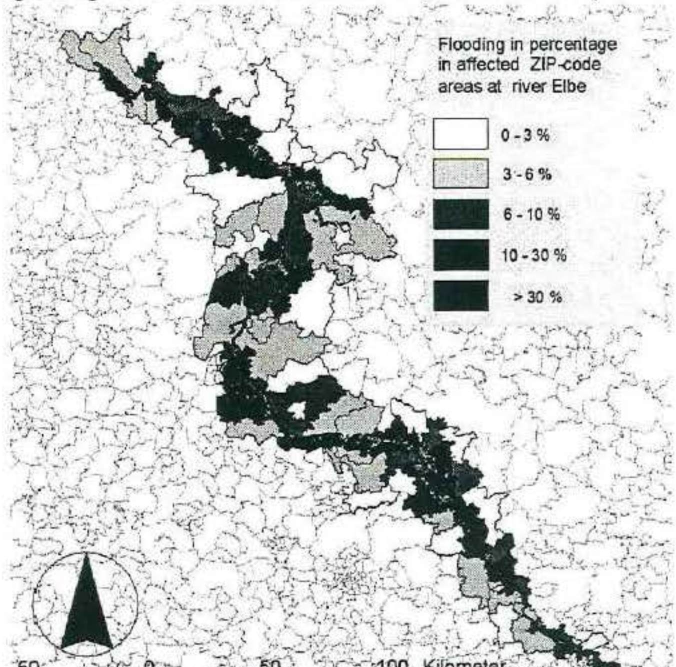


Figure 3: Evaluation of flooding per ZIP-code areas along river Elbe

This work is part of the project "Plain Flood Monitoring", supported by ESA, where products and services in respect to flood events are developed and offered. Product and service definitions are developed in partnership with addressed user groups (i.e. civil protection agencies and insurance companies). As French partner SRTIT supplies a 24-hours hotline to make flood monitoring available in best time.

Flood hazards in the upper and middle Odra River basin

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1. Repeatability of flood events and conditions favoring their formation

During the analyzed 736 years (1118 – 1834), in the Odra River and its tributaries as well as in the rivers of Western and Southern Europe, 90 flood events of different intensities and ranges were noted. The analysis of the frequency of flood events occurrence indicates that 44.5% of flood events of the investigated data set occurred one or two years after the enormous flood, and 20% - after three and five years. The occurrence of flood hazard and flood events depends on many inter-related hydro-meteorological and morphological aspects i.e.: orography of the area, afforestation, agricultural use of land, the condition of soil retention, filling up of river beds, spatial distribution and volume of precipitation, and superficial discharge from the river basin during a given period of time. The morphological system of the upper and middle Odra river basin is divided into four subregions: Karpaty, Sudety, Sudety Piedmont and Silesian Lowland. The Odra divides this area into: the right-side part (mostly of lowland character) and the left-side part (mountainous and submontane area). The hypsometrical diversification of the river basin is considerable, and ranges from 112 to 1603 m above sea level. Significant declines of slopes and valleys (12-20%) are typical of these areas. The orographic differentiation of the area predisposes it to considerable spatial diversification of precipitation. Rivers of the left-bank part of middle Odra river basin flow off from the area of Sudety Mountains and Sudety Piedmont. The right-bank part of the river basin is created by catchment areas flowing out from lowlands and uplands of Polish Middlands. The Odra River and most of its tributaries are characterized by declines characteristic of mountainous rivers (1.5-90%). In these conditions (during intensive rain), a superficial run-off occurs as soon as 3 – 8 hours after the beginning of heavy rain. The run-off concentric system causes the discharge swell in valleys surrounded at all sides with mountains e.g.: Valley of the upper Odra River, Raciborska Valley, Kłodzka Valley and Jeleniogórska Valley. The level of the catchment area retention capacity, being a function of the volume of precipitation occurring before critical intensive rain, is a very important parameter causing the discharge increase. Research has shown that precipitation of the level of 60 mm and of small intensity may not produce discharge at all when the catchment area retention capacity is low. The state of the catchment area retention is the more significant and determining the volume and the flood wave level that even during high precipitation and small river basin saturation (e.g.: indicator No 1) the discharge may amount to as little as one third (1/3) of the amount of precipitation. The average values of run-off coefficients resulting from the discharge to precipitation amount ratio for the upper Odra River and bigger tributaries of Sudety origin varied from 0.25 to 0.40, and maximally from 0.56 to 0.73. The flood of July 1997 is an exception when precipitation was very high and intensive, and the run-off coefficients oscillated between 0.40 and 0.96.

2. Impact of physical-geographical and circulation parameters

The complex physical-geographical system, and the direction and velocity of the humid air mass inflow also contribute to the occurrence of high and intensive precipitation. The orographic barrier created by Sudety and Beskidy is also an important element of precipitation formation in the river basin of the Odra River. The most dangerous flood events in the region of the Odra river basin were caused by prolonged heavy rains and storm rains of a local character. However, they did not always include the whole river basin of the upper and middle Odra; sometimes they occurred in its part only. Then, they mainly included the river basins of: Nysa Klodzka, Bobr and Nysa Luzycka or some smaller tributaries. The high and intensive rains connected with the low pressure center and atmospheric fronts are the main reason for the occurrence of flood events. The cyclone routes identified by Van Bebber in 1891 are still valid. In summertime, the occurrence of heavy precipitation in the Sudety and Karpaty area is a result of cyclone movement from above the lowland of Hungary along track Vb (Van Bebber's). A route similar to track Vb was demonstrated by the low pressure centers of July 1903 and August 1925, and also of 1970 and 1977, and to some extent also of the flood of the year 1997. Rains of the storm type occur locally as a rule. Their unusual intensity causes violent swell of water in rivers and streams as well as the run-off directly along the slope surface. In recent years, the increase of their frequency has been observed. The frequency of the storm-type precipitation occurrence with twenty-four hour precipitation totals above 100 mm also increases. It is very dangerous both for man and his economy. It has caused many dangerous floods in Europe and in Poland, too. We should highlight the following storm-type precipitation, with regard to the effects it caused, which occurred in: Bystrzyca Dusznicka Valley in July 1998, in the catchment area of the upper Bystrzyca River and Kaczawa River in July 2001 and 2002 as well as in the river basin of the Bobr River and Kwisa River in August 2002. The reason for the flood event occurrence is not only high precipitation, but also the time of its occurrence in different parts of the river basin, the discharge sequence from particular catchment areas and their function in the flood wave formation.

3. Spatial distribution of intensive precipitation and flood events in the catchment area

The area of the upper Odra River to the Olza River estuary inclusive are the basic sources of the Odra floods formation. Another discharge source of flood waters is the Nysa Klodzka River. The flood waves of the upper Odra River and Nysa Klodzka River cause huge flood events in the upper and middle Odra River (the year 1902 and 1970). A flood risk and then the flood wave formation can occur during flood waves in the upper Odra River and its right-side tributaries up to the Barycz River inclusive (the year 1985). The Warta River does not play a significant role in the culmination building, even during a disastrous flood. The Warta River only influences the longer stay of high water levels. A flood on the Odra River can also occur during huge flood waves on the Bobr River and the Nysa Luzycka River. In the case mentioned above, the flood wave on the Nysa Klodzka River and on the tributaries of the middle Odra River can be moderate. The tributaries of the middle Odra River can also cause a flood on the Odra during a moderate flood wave of the upper Odra River (the year 1977). Skilful control of hydro-technical equipment also plays an important role in the river basin of the Odra River. Water management of retention reservoirs can cause a sooner occurrence of the wave culmination, the level increase of its top or the culmination occurrence in some part of the rising wave. The level and volume of the Odra River wave depend on the extent to which the swelling waters of Nysa Klodzka will feed the Odra flood wave. The overlapping waves of the Odra River and the Nysa Klodzka River are very dangerous for towns and settlements situated in the river basin of the Odra River (1997). The biggest floods of the Odra River occurred in the following years: 1902, 1903, 1977, 1985 and 1997, and as for XIX century: in 1813, 1831 and 1854. As results from the review of floods of XIX century recorded in chronicles, and of the years of: 1813, 1831 and 1854 as well as of XX century, a common feature of these floods was constituted by intensive precipitation in the upper Odra River and in the left and right river tributaries of the Odra.

Water resources formation and their quality during drought of 2003

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Drought in 2003 occurred in the whole upper and middle Odra basin. It was particularly severe in warm season in period from June to the end of October. The critical impact for water resources formation have the water income from atmosphere (precipitation) and water losses due to evaporation. Long-lasting precipitation deficiency with accompanying usually relatively high air temperature that increase evaporation lead to the meteorological drought. Derivative of the meteorological drought is in the first step agricultural drought and than hydrological droughts. During this period rivers are supplied by subsurface water. In this paper droughts were estimated in climatological and hydrological approach as: precipitation deviation from average total sum of multiyear by Kaczorowska, frequency and time duration of no rainy periods by Schmuck, time duration and quantity of precipitations by Šamaj and Valovič, index of climatological water balance, number of days without precipitation, three-parametric model of hydrological drought, where low flow is described by three parameters: minimum discharge, time duration and deficit volume. Taking into account precipitation totals from summer season of 2003 in terms of precipitation totals from multiyear, the west and north part of middle and upper Odra basin were very dry or locally extremely dry (Świecie gauge). The rest part of basin was generally dry and precipitation constituted 75-89% of the norm. According to criterion of days number without precipitation in individual months the percentage of such days was high in the whole region. The driest months were June, August and September. The monthly average of days number with no precipitation in each catchments exceeded 20 with the maximum of 24-26 days in August in Nysa Łużycka catchment and in Barycz catchment. The absolutely maximum of days number without precipitation (27) in individual months were registered in August at gauges: Zielona Góra, Polkowice, Turków and Sieniawka. However the minimum amount of 7 days were registered at Zieleniec and Istebna gauges. According to Schmuck criterion expressed as the longest time duration period with no precipitation, the atmospheric drought characterized by the most frequenct and intensity occurred in Ślęza and Barycz catchments and in the north-west part of middle Odra basin. According to Šamaj and Valovič criterion, long-lasing drought were distinguished in Nizina Śląska and Obniżenie Milicko-Głogowskie regions, while the shortest in Sudety region.

The maximum deficit volume of low flow in 2003 which was given from three-parametric model were the largest in multiyear 1966-2003 in middle Odra river and its tributaries such as Kłodnica, Ruda, upper Bóbr and Kwisa river. Its time duration was the longest in 12 subcatchments. Comprising values of maximum deficit volume of droughts in 2003 and multiyear 1966-2002 one can state that drought in 2003 was deeper and more intensive. In rivers: Ruda, Kłodnica, Widawa, Barycz, Bóbr, Kwisa and Nysa Łużycka values of deficit volumes were significantly larger in comparison to runoff. The average of deficit volume in 2003 was higher than in multiyear. Also values of minimum discharges in low flow period in 2003 were lower than in multiyear in many rivers as: upper Odra, Kłodnica, upper Nysa Kłodzka, Bystrzyca and Kwisa.The low-flow regime of rivers controls industrial, agricultural and domestic water resources and has decisive impact for surface water maintaining, dilution of effluents and for providing an adequate freshwater habitat for a wide range of flora and fauna. Analysis of water quality changes in 8 rivers has shown that in the low flow period the amounts of organic pollutants (BOD5), total nitrogen and total phosphorus ranged respectively from 35 to 50440 kg/d, from 17 to 14844 kg/d and from 2 to 916 kg/d. Compared to the preceding period, these values are noticeably lower. The loads of relevant pollutants measured before and during the drought of 2003 are shown in Table 1.

Table 1: Comparison of pollutant loads prior to and over the drought period of 2003.

River	Average load of pollutants, kg/d					
	BOD_5		**Total nitrogen**		**Total phosphorus**	
	before drought	during drought	before drought	during drought	before drought	during drought
Mała Panew, km 29.2	1728	259	2393	924	104	35
Nysa Kłodzka, km 111.4	9478	873	7128	1020	484	95
Bystrzyca, km 50.7	1037	164	1927	380	112	86
Kaczawa, km 3.2	5305	415	6895	648	276	35
Barycz, km 115.2	320	35	242	17	35	2
Bóbr, km 77.4	14515	2998	15077	2886	596	207
Odra, km 530.6	104319	50440	106972	14844	4052	916
Nysa Łużycka, km 12.0	11889	6636	14731	2195	527	35

The comparison of riverine water pollution from the low-water periods of 1992 and 2003 has revealed a remarkable decrease only in the concentration and load of total phosphorus. The patterns of variations for BOD_5 and total nitrogen are not clear enough, as it can be inferred from Table 2.

Table 2: Comparison of pollutant loads and concentrations for the low-water periods of 1992 and 2003.

River	Average load in the low flow period, kg/d						Average concentration in the low flow period, g/m^3					
	BOD_5		**Total nitrogen**		**Total phosphorus**		**BOD_5**		**Total nitrogen**		**Total phosphorus**	
	1992	2003	1992	2003	1992	2003	1992	2003	1992	2003	1992	2003
Mała Panew, km 29.2	708	259	527	924	52	35	3.9	1.2	3.0	4.4	0.29	0.15
Nysa Kłodzka, km 111.4	2307	873	-	1020	372	95	5.6	2	4.7	2.3	0.84	0.22
Bystrzyca, km 50.7	1806	164	-	380	242	86	36.6	2.9	-	7.0	5.0	1.6
Kaczawa, km 3.2	674	415	613	648	276	35	5.2	2.4	4.3	3.6	1.9	0.22
Barycz, km 115.2	17	35	14	17	2	2	2.9	4.5	2.4	2.2	0.36	0.28
Bóbr, km 77.4	2696	2998	2246	2886	423	207	2.5	2.6	2.1	2.4	0.41	0.18
Odra, km 530.6	78996	50440	57741	14844	3923	916	10.1	7.0	7.4	2.0	0.50	0.12
Nysa Łużycka, km 12.0	5504	6636	5486	2195	276	35	6.7	7.0	6.5	2.3	0.32	0.04

Water quality and sustainable management of forests: Problems and challenges

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The paper reviews key factors and processes which influence water quality in forest ecosystems. Examples from case studies in managed forests in Central Europe are given. A crucial role plays the historical use of forests by the society. In many regions the excessive removal of plant biomass had led to a severe degradation of forest soils which from their natural conditions had been poor before (acidification, decrease in pools of soil organic matter). Since the beginning of industrialization the emission of acidifying compounds has accelerated soil acidification with distinct effects on water quality (loss of ANC, increased concentrations of Al and heavy metals). However, soils have mediated negative effects on the hydrosphere as they retained considerable amounts of the atmospheric input (notably S, N, and heavy metals). Hence, forest management must consider the element pools in the soil and their potential mobilization. Since atmospheric N inputs into forests are still on a high level the potential 'N saturation' of forest ecosystems may also negatively affect water quality. Potential risks consist in elevated concentrations of nitrate, but also a stimulation of humus mineralization. Notably in sandy soils the buffer and filter functions of soils are mainly linked to the soil humus. With respect to an increasing N availability soil liming (which has become a common practice to counteract soil acidification) might become critical since liming stimulates microbial transformations in the topsoil. An alternative to liming could be the application of base silicate rock materials.

The conversion of monocultural stands of even-aged conifers into unevenly-structured mixed stands is expected to create long-term positive effects also on water quality. However, in the transition phase strong thinning in order to favor planted deciduous trees in the understorey may bear some risks with respect to excess mineralization. Therefore, smooth silvicultural techniques should be applied. On the other hand, in most cases the growth of an abundant ground vegetation has appeared to compensate for excess leaching of nutrients.

Monitoring of organic pollution in the Czech part of the river Elbe

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Department of watermanagement laboratories of Povodí Labe is in charge of analysing the quality of the River Elbe. Even though its quality has improved significantly since 1989, there are still many organic pollutants present. This pollution is caused by diffuse sources (agriculture, urban areas, etc) and point sources (unsufficiently working community sewage works and especially chemical plants).

Our laboratory analyses not only compounds required by the Czech Hydrometeorological Institute (CHI) and the International Commission for the Elbe Protection (ICEP) like volatile organic compounds (VOCs), polychlorinated biphenyles (PCBs), organochlorine pesticides (OCPs), but also other compounds relevant for the Elbe. Process of searching for new relevant compounds involves using information about production of chemical plants located in the Elbe basin, information about used pesticides from the List of the Registered Plant Protection Products published by State Phytosanitary Administration and amount of used pesticides (http://www.srs.cz) and from the analytical point of view screening by gas chromatography with mass spectrometric detection (GC-MS) is used. Knowledge of physical and chemical properties of pesticides, like water solubility, vapour pressure, soil sorption coeficient, soil half-life (persistence), and acid and base ionization equilibrium constants, is essential for water pollution potential of a pesticide. (Hornsby et al., Pesticide Properties in the Environment, Springer 1996). Of course site conditions (weather, soil, application mode) are important aspects.

Utilizing this approach we enlarged group of monitored pesticides (organochlorine pesticides, triazines) by Alachlor, Metolachlor, Metazachlor and Trifluralin and this year by Acetochlor and Pendimethalin. Some of the findings are present in poster (Dolenek, 2004).

Our laboratory monitors not only surface waters of the Elbe and its tributaries, but also waste water effluents and treated waste waters from main industrial plants and sewage treatment plants located in the Elbe basin. Data received from these analyses led us to start routine monitoring of nitroaromatics and anilines in the outlet from Synthesia Pardubice and the Elbe downstream Pardubice (19 compounds), carbon disulfide from Lovochemie Lovosice, tetrachloropropylethers from Spolek Usti nad Labem. Number of monitored compounds is steadily increasing.

Derivatization techniques were introduced in order to monitore not only unpolar compounds, but also medium polar and polar compounds, difficult or even impossible to analyse by gas chromatography. Once before used in situ acetylation technique for phenolic compounds (phenol, cresols, naphtholes and chlorophenols) was applied on monitoring of octyl- and nonylphenols. Another derivatization technique, methylation by a solution of diazomethane in methyl-terc.buthyl ether, was validated for analysis of chlorophenoxy acids (2,4-D; MCPA, mecoprop (MCPP), dichlorprop, MCPB), bentazone and nitrophenols. Dinitrophenols are present in effluent of Synthesia Pardubice and the Elbe downstream. Esterification of complexones (EDTA, NTA, PDTA) with butanol and acetyl chloride is routinely applied. Variety of polar compounds could be analysed by liquid chromatography, but because of complexity of the samples, selective detector (fluorescent detector) or better specific detector, like mass spectrometric detector, are needed to analyse them without possibility of false positive results.

Nature oriented flood damage prevention - an INTERREG IIIB project

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nofdp

While in the last decades prevention of flood damage mostly referred to technical measures the occurrence of severe flood damage in recent time led to a more comprehensive view on that topic. Nowadays the European Water Framework Directive urges on the necessity of sustainable development of river corridors and provides a binding time schedule for implementing respective measures within the river basin.

The river basin itself as a compound of water-, ecological- and human-system is affected by plannings of numerous administrative sectors having in mind their specific goals. Especially transboundary river systems are exposed to various interferences as planning culture differs throughout different countries. In this context sustainable river basin development strongly needs innovative integrated planning methodologies resulting in sound multi-sectoral as well as multi- objective management strategies.

Against this background the EU-funded INTERREG III B Community Initiative aims at promoting a cohesive, balanced and sustainable development within the European territory. Prevention of flood damage is one priority addressed at in the North-West-Europe co-operation area (NWE) focusing land use and water systems.

The project "Nature oriented flood damage prevention" (nofdp) aims at implementing an information and decision support tool (IDSS) compiling transnational demands on spatial planning, flood damage prevention and ecological improvement of river corridors to a multi-sectoral and multi-objective planning instrument assisting decision makers of the NWE-region in taking optimum decisions in riverine planning.

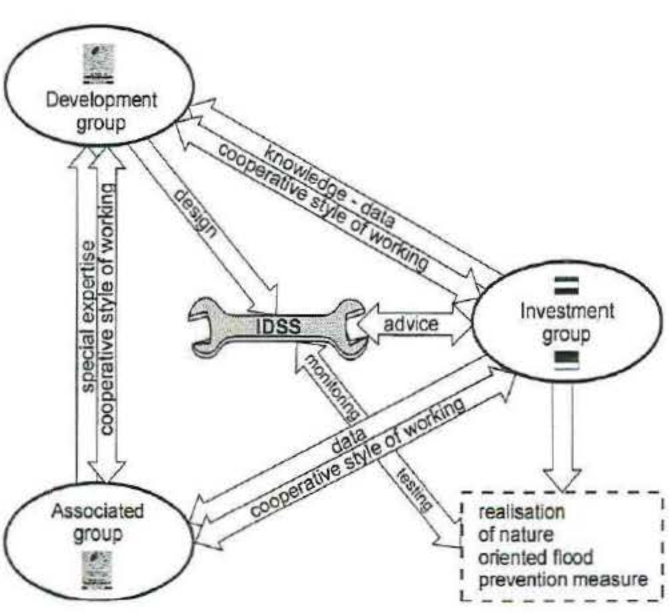

Figure 1: communication and interaction

This ambitious target is supported by four real world investment projects located in The Netherlands (waterboards of river Mark/Vliet, river de Aa, river de Dommel – all province Noord-Brabant) and Germany (waterboard of river Mümling, State of Hesse) having well developed scenarios for flood damage prevention plannings. An interactive process among this investment group and the development group (Darmstadt University of Technology, German Federal Institute of Hydrology, Province Noord-Brabant and the Hessian Ministry of Environment, Rural Development and Consumer Protection) will form the IDSS (Figure 1).

The IDSS represents a combined software toolbox of hydraulic, hydrologic and ecological models operating on catchment scale as well as on project scale. Additionally a multi-sectoral knowledge base including national conventions and EU-regulations related to various sectors (e.g. spatial planning instruments, ecological demands) will serve as basic input for assessing flood damage prevention scenarios.

An initial step in building the database is turning to all executive waterboards of the NWE-region by a questionnaire elaborating their experience in realising flood control measures and their focus on ecology. Analysing the feed-back will give clear signals on stakeholder related deficits in issues of riverine sustainability. At the same the results of the questionnaire indicate the basic structure of the multi-sectoral database.

Related to the content the knowledge base is shaped by an inquiry on the contribution that spatial planning has on the realisation of flood damage prevention measures focusing on ecological conservation and improvement. An aggregation of planning methodologies and instruments applicable to the NWE-region will be implemented in the database. Additional input will be given by a compilation of EU-directives and national legislation that must be considered in the joint implementation of both flood damage prevention and ecological development. Suggestions for ecological target values resulting from legal requirements will be available in the nofdp-knowledge base.

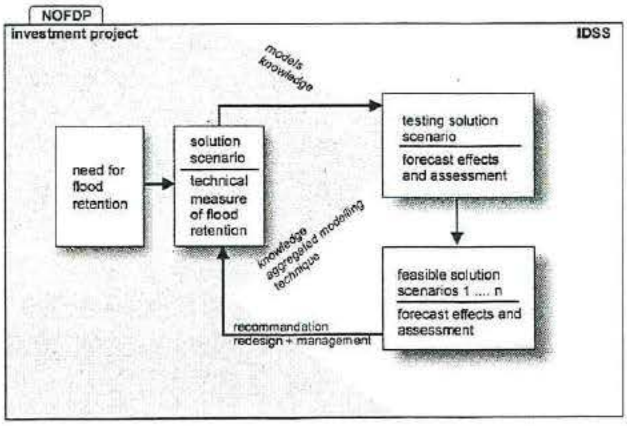

Figure 2: iterative process of IDSS application

In a latter phase of nofdp the IDSS is tested and refined by applying it to present planning scenarios of the investment projects. Application phase then will result in generating future scenarios of planning alternatives. Evaluating these scenarios by multi-sectoral transnational assessment pattern will then give recommendations on that planning scenario meeting best the demands of both flood damage prevention and ecological improvement of river corridor (Figure 2).

Future application of the IDSS in the NWE-territory then will help in establishing a coherent network of de-central flood control measures as part of an integrated river basin management considering ecological, economical, administrative as well as technical aspects on local, regional and transnational scale.

For a term of four years the project will get results by realising seven work packages. Start of the working phase was spring 2004.

Response of zooplankton populations (Cladocera) to nutrient-loading and hydrotechnical manipulation in oxbow lakes near Warsaw (Poland)

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Oxbow lakes are very important elements in a river system. They play a major role as ecological niches for many plant and animal species *e.g.* juvenile fishes dwelling in river. Therefore, their status could give information about ecological condition about all floodplains and may be helpful in tracking sources of disturbance on the natural environment.

Many oxbow lakes exist in the Vistula valley in the Warsaw region. These lakes had an human impact for many centuries. Therefore, the history of human activity in the Warsaw region could be derived from the analysis of its sediments. The paleolimnological studies allow the definition of past environmental changes. The Cladocera fauna is dominant among the zooplankton and the group is well preserved in the fresh-water sediments. Therefore, the subfossil cladoceran analysis allows the reconstruction of the lake history (Frey 1986, Korhola and Rautio 2001, Szeroczyńska 2002).

Short sediment cores from four small oxbow lakes (Kazuńskie Górne Lake, Kazuńskie Dolne Lake, Lisowskie Lake and Powsinkowskie Lake) in the Vistula river valley were analysed for Cladocera remains and pollen (only Kazuńskie Lakes). The cores were collected with a Kajak-type gravity corer and divided into one-centimeter-thick samples. The sediments were dated by the Pb-210 method. This analysis showed, that collected sediments were deposited during the last 100-200 years and the sedimentation rate was very variable during this period.

Cladocera assemblages were very specific in each lakes, and differed significantly even in close-located Kazuńskie Górne and Kazuńskie Dolne Lakes. However, in all cases *Bosmina longirostris* was dominant among subfossil Cladocera. It indicates a high trophic state of all lakes. In the beginning of our record, all lakes had temporary contact with the river. The pattern of sedimentation was mixed with periods of biogenic deposition during low river level and periods of mineral deposition during floods. Cladocera communities were dominated by cosmopolitan species with a wide ecological tolerance. However, the total sum of cladoceran remains was low. The changes in sedimentation character, Cladocera and water plants composition and concentration, along the time scale suggest a significant increase in the lakes' trophic state since the 1940'. This date could be correlated with construction of a flood dam along the Vistula and the isolation of the studied water bodies from the river. This event changed the land use pattern around the lakes. Meadows and pastures were transformed into fields with intensive cultivation of cereals and vegetables. Intensive fertilization caused an additional inflow of nutrients and the ensuing eutrophication of the lakes. This process is clearly reflected by the cladoceran and pollen record. The first is mirrored by the increase of the total sum of cladoceran remains and diversity. However, the community is very quick dominated by species preferring a high trophic state (*e.g. Bosmina longirostris, Chydorus sphaericus, Alona rectangula*). We observed similar changes for the water plant community. The most significant observation is the decrease in submerged macrophytes and the increase in some species of green algae (Jankovska and Komarek 2000) and rush plants. The lakes became more shallow and the rush zone was very well developed.

Some changes in the species composition are in opposition to recent studies. The increase in *Bosmina coregoni* followed by the construction of flood dams and its appearance is sometimes related to the reconnection of oxbow lakes (Illyova 1999). Mesotrophic species like *Monospilous dispar* also presents an unusual pattern of occurrence and was founded in the periods of the highest eutrophication.

During the last two decades, some Cladocera species, which prefer a higher trophic state (*e.g. Leydigia spp.*), declined in the Kazuńskie Lakes. Green algae also significantly decreased. Possibly, it indicates a lower state of the lakes' trophy and the re-naturalization of these water bodies. A similar process was not observed in the Lisowskie Lake, where the increase of eutrophic species is continuing.

This study shows that small water bodies are especially sensitive to local disturbances by human activity and could be reliably indicators of floodplain conditions. However, oxbow lakes are very specific and even close-located lakes may have a different sedimentation pattern as well as different plant and zooplankton compositions.

Processes of natural recovery are also very dynamic in these lakes.

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Quantification of diffuse nutrient loadings in mesoscaled watersheds – four different models being comparatively tested in the Jahna River basin

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The identification and quantification of significant diffuse nitrogen and phosphorus loadings in river catchment areas is necessary to develop measurements of cultivation management and control. This is an important assumption in order to preserve and protect soil and water quality standards according to the requests of the water framework directive. Due to the very complex system, the interactions between factors of soil, water, vegetation, geology, climate and human impacts have to be considered in a sufficient way. Thereby it is necessary to derive sources and pathways of these nutrient inputs within the whole river basin. Indeed the modelling in mesoscaled watersheds with a dimension up to several thousands of square kilometers needs some simplifyings which correspond to the resolution of the input parameters. The same applies to the management of transfers and processes, which must be derived by available indicators, if a numeric calculation is not possible. In the following contribution some results of a comparatively testing of the four mesoscale models MOBINEG 2001, MODIFFUS, MONERIS and STOFFBILANZ in the Jahna river basin (Saxony) will be shown. The investigations are part of a bigger research program by order of the LAWA in the year 2002/2003 in cooperation with the Institute of Water Quality and Waste Management, University of Hannover. It has been responsible for the testing in three other river basins and has additionally done a final evaluation and rating (Scheer et al. 2004), which came to the following results for the modelling of N- and P-loadings:

Table 1: Results of the testings in four river basins according to Scheer et al. (2004) on a scale from 1 (high value) to 6 (low value)

	MOBINEG 2001	STOFFBILANZ	MODIFFUS	MONERIS
nitrogen	5,11	3,56	4,22	3,97
phosphorus	5,12	4,16	3,84	4,16

All further views in this paper are limited to the investigations in the Jahna catchment area in Saxony, done by Gebel et al. (2003). This region is characterized by silty soils in combination with a hilly landscape and a very dominant agricultural land use. The comparison in the Jahna river basin will be discussed in respect to the validation results at first (table 2).

Table 2: Results of the modelling in the Jahna catchment area by Gebel et al. (2004)

	Diffuse N-emission [t/yr]				Diffuse N-Immission[1)] [t/yr]	
	dissolved		particle-bound			
	N	P	N	P	N	P
STOFFBILANZ	430	4,4	17	11,9	307	6,2
MONERIS	530	6,3	8	8,8	318	3,8
MODIFFUS	428	2,9	7	1,5	306	2,5
MOBINEG 2001	250	1,1	19	6,2	205	3,8
measured loading	-	-	-	-	330[2)]	12,2[2)]

[1)] Sum of diffuse and particle-bound emissions less model-internally derived retentions in the waters system / [2)] including punctual immissions (estimate with 15 t N/yr and 1,8 t P/yr)

For nitrogen the calculations of STOFFBILANZ, MODIFFUS and MONERIS are quite well in the comparison of computed and measured immissions. Underestimations can be seen in the calculations of the MOBINEG model in a significant way. Concerning the phosphorus computation the model results are clearly below the measured ones.

The plausibility of the computation, the comfort of using, the data availability, the necessity of external calculations and the considering of sources and pathways are other important criteria for the evaluation of the models (following to Scheer et al. 2004), shown in table 3.

Table 3: Criteria and most important results of the evaluation in the Jahna catchment area (positive evaluations in white boxes, negative evaluations in grey boxes)

	STOFFBILANZ	MONERIS	MOBINEG	MODIFFUS
plausibility of computation	particle-bound path is insufficient	particle-bound path is insufficient	particle-bound and dissolved paths are insufficient	particle-bound path is insufficient
considering of paths and sources	reconsidering of sources is possible	reconsidering of sources is insufficient	reconsidering of sources is possible	reconsidering of sources is possible
data availability / necessity of external calculations	all data are available / external calculations are not necessary	runoff data are not available / external calculation is necessary	soil erosion data are not available / external calculation is necessary	evaporation and n-surplus data are only available for Switzerland / external determi-nation is necessary
comfort of using	more comfortable (Access-based)	less comfortable (Excel-based)	more comfortable (Access-based)	less comfortable (Excel-based)

The plausibility, which determines the using of the models in general, seems to be rather insufficient for the computation of particle bound inputs by all four models. Sediment and P-inputs are computed by USLE-modifications (sediment- and p-input as percentage of the soil erosion), which are not able to make an acceptable decision whether an area has a link to the receiving stream network or not. In an improvement of the STOFFBILANZ model it is now possible to make this decision (Halbfass & Grunewald 2003). If this link is missing, the transferred sediment and particle-bound phosphorus does not reach the waterway, but will be retained in the area. Comparatively an existing link leads to a higher sediment- and p-input. At the moment this improvement will be tested in several catchment areas, but it has not been evaluated in the present comparison.

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Resuspension stability of riverine sediments – determined by physical, chemical and biological parameters

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Many river reservoirs still store large quantities of hazardous contaminants accumulated within the sediments. Due to the significantly reduced sewage discharge into riverine systems over the last decades, relatively unpolluted sediment surface layers cover the old contaminated horizons at river sites of small flow velocities. Nevertheless, increasing bottom shear stress along with enhanced water discharges or flood events might lead to the re-mobilisation of the underlying contaminated sediment layers as was shown in August 2002 during the Elbe flood in Germany. Consequently, the ecological risk of polluted sediment resuspension is important for river management. In the past, investigations on the sediment stability concentrated mostly on hydraulic sediment parameter although the biological influence has been proven to be significant in recent years. Hence, a comprehensive assessment of the stability of contaminated aquatic sediments has to consider the interdependence of all physical, chemical and biological parameters. Consequently, our interdisciplinary research within the unified project SEDYMO (Sediment Dynamic and Mobility, BMBF Germany) covers both hydraulic and biological parameters in order to (A) evaluate the erosion risk of polluted river sites and determine the important parameters as well as (B) recommend master-variables for an efficient and reasonable testing of sediment stability.

The critical shear stress for erosion ($\tau_{c,e}$) measured by the SETEG-flume showed only low correlations ($r < 0.5$) with other single parameters such as bulk density, water content, TOC or plasticity index at different seasons and study sites. Sporadic correlations ($r > 0.5$) to the critical shear stress could be tested for particle size, cation exchange capacity (CEC), extracellular polymeric substances (EPS) concentrations, algal biomass and the consistency index determined by the above named parameters. Obviously, this indicates the variety and mutual influence of the single parameters on sediment stability in space and time. Consequently, the next step will be a multivariate approach as the only way to detect and present the major parameters responsible for resuspension of aquatic sediments. Moreover, other data not evaluated yet such as macro / meiofauna settlement and algal species composition, will be included as well.

Some of the parameters considered to be most important for sediment stability are time-consuming such as the determination of EPS. Therefore, the present study aims to find indicators for these parameters. Presumably the microphytobenthos is the main producer of EPS in the riverine sediments, however, no continuous correlations could be found neither between different study sites nor at one study site at different seasons. Therefore, not only algal biomass but also changes in algal species composition and microbial degradation activity causes the varying pattern of EPS production / decomposition, and hence chlorophyll is by no means an indicator for EPS.

Flood simulation and forecasting at Eropean scale – progress and first results of calibration and validation for the Ebe catchment with the LISFLOOD mdel

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Increasing numbers of natural disasters have demonstrated to the European Commission and the Member States of the European Union the paramount importance of the natural hazards subject for the protection of the environment and the citizens. The flooding experienced throughout central Europe in August 2002 is the most recent example of the damage caused by unforeseen weather driven natural hazards. There is a strong scientific evidence of an increase in mean precipitation and extreme precipitation events which imply that weather driven natural hazards may become more frequent. In response to the Rhine/Meuse floods of 1993 and 1995 and the Oder flood in 1997, a flood research activity has started at JRC in 1997 in order to develop hydrological alert system for mitigating the destructive consequences of floods. Following the guidelines of the Secretariat-General (SEC(2002)907/2) a communication from the European Commission on The Community response to the flooding in Austria, Germany and several Applicant countries' in 2002 paved the way for the development and testing of European Flood Alert System and towards impact assessment studies on flood risk for transnational water basins (SEC(2002)907/2); COM (2002)481 final).

A clear time- schedule is given for the JRC (Joint Research Centre) to work towards these high level objectives. Several EU/EC initiatives will be supported by the proposed action. Contacts with the relevant services within the Commission (DG ENV, DG REGIO) have been taken in drawing up the action. On a medium term the expected results of this JRC action will contribute to the envisaged EU strategy on prevention, preparedness and response to natural risks, as announced in the work program of the European Commission.

In most European countries the National Water Authorities produce flood forecasts with lead times of 1-3 days. Their predictions are often based on point measurements from a number of rain gauging stations and upstream discharge measurements or short-term weather forecasts. In many cases, however, an increased lead-time could be beneficial to civil-protection agencies and the water-authorities responsible for forecasting and warning. Therefore, the Joint Research Centre of the European Commission is developing and testing a modelling system to simulate floods in large European transnational catchments.

Following the Elbe and Danube floods in 2002, the Joint Research Centre of the European Commission is developing and testing a European Flood Alert System towards a pre-operational stage. The aim of the European Flood Alert System is to provide early flood alerts with a lead time from 3 to maximum 10 days, depending on the reliability of the weather forecast, to support the national authorities with additional information. In combination with a flood forecasting

model on a European scale, national authorities can potentially increase the lead time for qualitative early flood warnings up to 10 days in advance. The aim of EFAS is to simulate the larger European river basins at a 1km grid scale. Focus areas during the development and testing are the Elbe, Danube, Meuse, Oder and Po river basins. 1km resolution data of the flow network, soil and land use parameters are used, with for land use also more detailed information based on 100m data, together with data provided by the river basin authorities, such as river cross sections, and data on reservoirs, lakes and polders.

Besides forecasting for early alerts, the JRC is using the LISFLOOD modeling system to evaluate scenarios in transnational catchments for evaluation of flood prevention and mitigation plans in major European transnational drainage basins through scenario modeling of the effects of engineering measures, land-use change including regional development (e.g. urban expansion) and climate change effects on flood risk, with emphasis on the Elbe and Danube. Herewith, the JRC aims to provide independent advice to national authorities and international river conventions.

Figure 1: Elbe River Basin

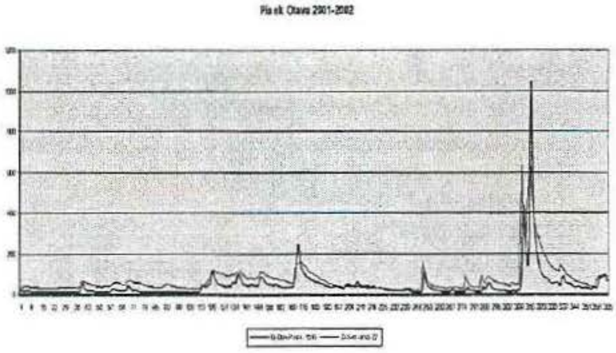

Figure 2: Simulation Results using New Model Version

For both activities the JRC tries to work closely together with Member States services. Detached National Experts from Austria, Czech Republic, Germany, Hungary and Slovak Republic are developing, testing and evaluating the modeling system for the Elbe and Danube river basins.

The International river conventions like IKSO/MKOO (Oder/Odra), IKSE/MKOL (Elbe/Labe) and IKSD/ICPDR/ (Danube), to which the European Commission is a contracting party, are the main structures in handling these transboundary items. The European Commission is represented in the relevant flood expert groups which guarantee the necessary links to specialized services of Member-States and Accession countries in order to complement ongoing work at national level.

Recent results of model calibration and validation of the river Elbe will be demonstrated, as well as ongoing activities concerning early flood alerting and planned scenario calculations, in cooperation with the flood working group of the Elbe Commission (IKSE).

Hydroacoustical monitoring of aquatic ecosystems: fish, plankton, submerged macrophytes and bottom classification.

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The sustainable management and restoration of aquatic ecosystems requires cost-effective methods for the reliable, large-scale monitoring of ecosystem quality, and has been emphasised with the recent introduction of the EU Water Framework Directive. In this respect, rapidly developing hydroacoustical methods deserve more attention that they have been given so far. Thanks to the fast technical development over the last years hydroacoustics became a promising tool for an integrative aquatic habitat research. Nowadays it enables assessing a large number of important aspects of aquatic environments, such as fish, plankton, submerged macrophytes and classification of bottom substrata. Traditional point measurements methods for the assessment of ecosystem quality are time-consuming and expensive, and are not easy to integrate over large areas. Since hydroacoustical methods provide high resolution, area-based, synoptic, GPS-integrated data, they are particularly suitable for GIS presentations. The latter technique enables rapid and efficient visualisation, evaluation and comparisons of surveys from different water bodies on the seasonal and annual basis. The possibility to retrieve and analyse large amounts of information at low cost and in a short period of time thus makes hydroacoustics a useful tool for monitoring the dynamic changes of aquatic ecosystems. The paper presents a series of case studies performed using Biosonic and Simrad echosounders and different software packages, giving examples of different kinds of environmental applications that can be performed with hydroacoustical techniques.

Implications of Eu-WFD for the East German post mining landscape Lausitz: coping with a sparse knowledge of the underground

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The Water Framework Directive (WFD) demands good chemical conditions for all groundwater bodies. Limiting values for concentrations of different substances that define such a good chemical condition were suggested by LAWA (German Working Group of the Federal States on water issues). The value for sulphate was set to 240 mg/l. Groundwater in the East German post mining district is to some extend polluted through mining activities. Especially downstream of dumps sulphate concentrations with values above 1000 mg/l exceed the suggested limiting values. The maximum impact of the mining activity on the water bodies can not be expected before the groundwater levels have reached their steady state levels. According to WFD it is necessary to describe the current conditions of groundwater. If pollutions are encountered the WFD requires to outline a pathway to good conditions. A detailed description of the pollutant source is a fundamental precondition for. This needs to encompass the qualitative and quantitative composition of the source as well as the expected future development.

Mining dumps are due to there large area non-point pollutant sources. All dumps of the Lausitz combined cover about 20 percent of the area, explaining their major influence on the groundwater system. Considering their heterogeneity, it wont be suitable to quantify the pollutants only on the basis of new boreholes and geochemical analysis of samples. In this paper experiences with a method for determining the amount of sulphate in the dump based on all geochemical and geological data from the original exploration are presented. The area of investigation is the former mining site Bärwalde.

Over 3000 borehole datasets from lignite exploration were used to create a geological model of the former mine site. The geological layers were combined to 14 model layers, which represent the different hydraulic and geochemical properties of the site. GMS (Groundwater Modelling System) and some self programmed tools were used to build a verified 3D pre-mining geological model from the original data. Combining it with the base layer of the dump and the current digital terrain model leads to an actual geological model of the site. During a pre-mining investigation in 1981 geochemical parameters, such as sulphur and carbonate content, were determined for a number of boreholes and condensed to average values for representative layers. The concentrations of these layers were converted to the 14 model layers. Linking this geochemical data of each layer with the geological models allows to calculate concentrations of these parameters in the mining dump. The percentage for each layer of the model on the dump was calculated by comparing the pre-mining and the actual geological model. In this case 52 percent of the dump is made up from quaternary material. Using the proportion and the geochemical concentrations of the model layers the average concentration of the dump was calculated. The spatial distribution of the parameter concentration was computed based on the pre-mining thickness of each layer.

Outcome of these operations are averages and distributions for geochemical parameters that reflect the conditions after mass transfer during excavation of overburden. Figure 1 shows the distribution of total sulphur concentration of the dump Bärwalde. The total amount of sulphur in the dump is approximately 5.9 million tons. Influences on sulphur content through pyrite oxidation processes need to be estimated with turnover rates. These turnover rates are integral values that are based on the assumption of analogy within the mining area. They are strongly dependent on the mining technology used in the area. Several authors estimated total pyrite oxidation rates caused by excavation and deposition processes to be in the range of 4 and 7 percent (Berger et al. 1999, Uhlmann et al. 1999, Hoth 2002). Applying these rates to historical pyrite oxidation leads to a map of the spatial distribution of the pollutant sulphate. Ongoing pyrite oxidation as well as sulphide reduction may be included.

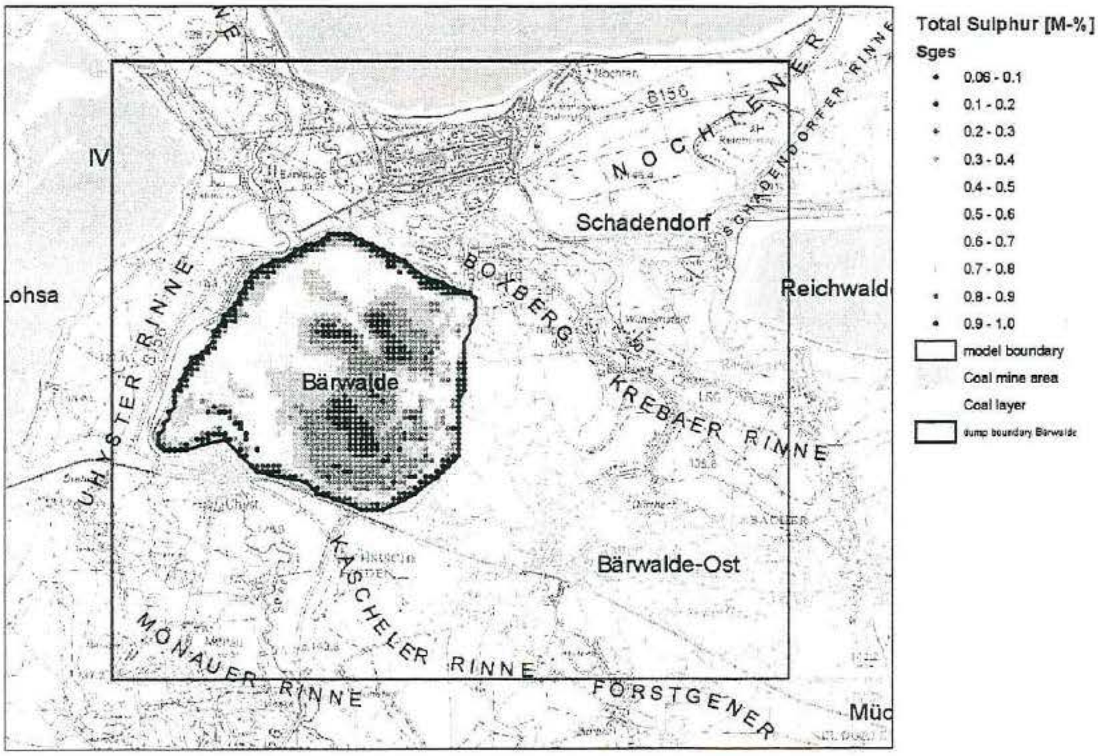

Figure 1: Distribution of total sulphur concentration in the dump Bärwalde

The main result of the presented work is an estimated composition of a dump with respect to the parameters sulphur and carbonate, which are very important for pollution and buffering of groundwater. Total amounts of the parameters as well as there distribution was calculated. The latter will be important for local interpretations of possible pollutions. Quantification of the dump as source of pollutants is fundamental for estimating discharge to groundwater bodies. The chemical condition of the groundwater will not reach a good level until the source is depleted. Furthermore, the development of surface water bodies is often controlled by the influx of pollutants from groundwater. First calculations of the discharge resulted in a time scale that extends several times the permitted time scale of the WFD. Therefore exceptions in time or in chemical conditions might be necessary.

One major advantage of the presented method is to use all existing data from former coal exploration. The combination of geological and geochemical data of the original layers results in a areal knowledge of the pollutant sources. Considering heterogeneity of the dumps, it is unlikely to get similar geochemical information from new explorations. The disadvantage of the method is the error in the geochemical data itself. Little is known about conservation, preparation and analysis of the samples. Nevertheless parameters like total sulphur are not affected by reactions like oxidation. Correlating this data to current analysis will help to overcome this problems.

To apply this method with a coarser grid on the whole mining area seams to be a feasible strategy to get good information of the chemical quality of the groundwater body.

Variability of metal contamination of floodplain soils of the Elbe River and their risk potential

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1. Aim of the study

A number of studies have indicated that the recent floodplain soils of the Elbe River have become contaminated with heavy metals and organic pollutants in the past. The studies showed that within one site the contamination varied to a large extend with maximum values exceeding action values of the Federal Soil Protection Act. After the summery high flood in 2002 the questions should be answered (1) if the contamination with heavy metals has been increased due to the sedimentation of suspended solids, (2) which factors are responsible for the large variability of contamination within the flooded areas and (3) how is the risk potential correlated to soil contamination.

2. Investigated sites and methods

The study was conducted at four sites: **W:** Wörlitz (Elbe river position: at km 242 above the Mulde mouth, use: pasture and woodland, left side, width from river to dike: 1,62 km), **S:** Steckby (km 285 between the Mulde and Saale mouth, mostly pasture, right side, width from river to natural elevation: 0,61 km); **G:** Glinde (km 301 below the Saale mouth, pasture, left side, width to dike 0,39 km); **P:** Pötnitz (at lower Mulde River 9 km before the confluence in the Elbe, use: pasture and woodland, right side, width from river to dike: 1,16 km).

At each site a transect of soil profiles was surveyed to 2 m depth, the surface elevation in relation to mean water level was measured and the top soils from 0-0,1 m were sampled. Additional at each site 4 to 6 monitoring sites of 256 m^2 area were chosen on selected and comparable morphological situations (levees, first channel near river, plateau areas). The areas were permanently marked, the top soils sampled by mixing 16 subsamples from 0-0,1 m depth and an adjacent soil profile sampled to 2 m depth. From the monitoring sites a mixture of the above ground vegetation was sampled at August and October 2003.

The soil and plant samples were analyzed using standard methods (e.g. aqua regia digestion acc. to DIN ISO 11466, measuring of heavy metal concentrations with GF-AAS and FIMS, additional XRF-analysis of total element concentrations).

3. Results

Table 1 gives the ranges and the coefficients of variation (cv, in % of mean) for the total concentrations of heavy metals and arsenic in the top soils of the studied sites. For the elements Hg and Cd the cv is largest, as for these elements the background concentrations are relatively the smallest. The variation of trace element concentration is highest at the lower Mulde site (P), as here the flooding is not as regular as at the Elbe and upper parts of the floodplain have been contaminated only a bit.

Table 1: Total concentrations of trace elements (mg/kg) in top soils of studied sites (n : number of samples, cv: coefficient of variation in % of mean)

	W			P			S			G		
	n	range	cv	n	range	cv	n	range	cv	n	range	cv
As	16	35 – 73	23	5	56 – 345	83	28	25 – 83	22	4	25 – 55	33
Pb	58	89 – 188	15	41	93 – 399	43	52	47 – 198	20	19	124 – 300	26
Cd	16	1,5 – 6,7	39	5	1,2 – 14,2	85	28	1,0 – 9,4	53	4	4,2 – 10,3	34
Cr	58	74 – 193	15	41	37 – 303	70	52	24 – 184	29	19	75 – 196	28
Cu	58	54 – 165	26	41	31 – 231	73	52	29 – 173	29	19	85 – 343	38
Ni	58	32 – 65	13	41	19 – 65	32	52	6 – 60	29	19	36 – 96	27
Hg	16	0,6 – 2,4	34	5	0,4 – 13,3	149	28	0,8 – 4,2	46	4	7,4 – 20,1	40
Zn	58	266 – 852	28	41	182 – 902	50	52	42 – 834	41	19	400 – 1343	33

Figure 1 gives an example of the ground level (GL), the distribution of top soil properties and the metal contamination for site W. As channels and depression are longer flooded they are typically more contaminated than levees and plateau areas. For all sites this is true for the channels near the river. The contamination between elements is strongly correlated ($p<0,001$) with some shifts in element-relation between sites. The topsoil concentration of zinc is regarded as an indicator for contamination with other substances. With multiple regression analysis on data of all Elbe sites, the zinc content could be predicted with $r^2=0,764$ using the independent variables GL, TOC, pH and distance from river (D) ($Zn=-370 + 60,5*TOC - 116,0*GL + 146,5*pH - 0,217*D$). The observed variability of topsoil metal contamination thus can be reduced markedly, if simple topographical and pedological factors are taken into account.

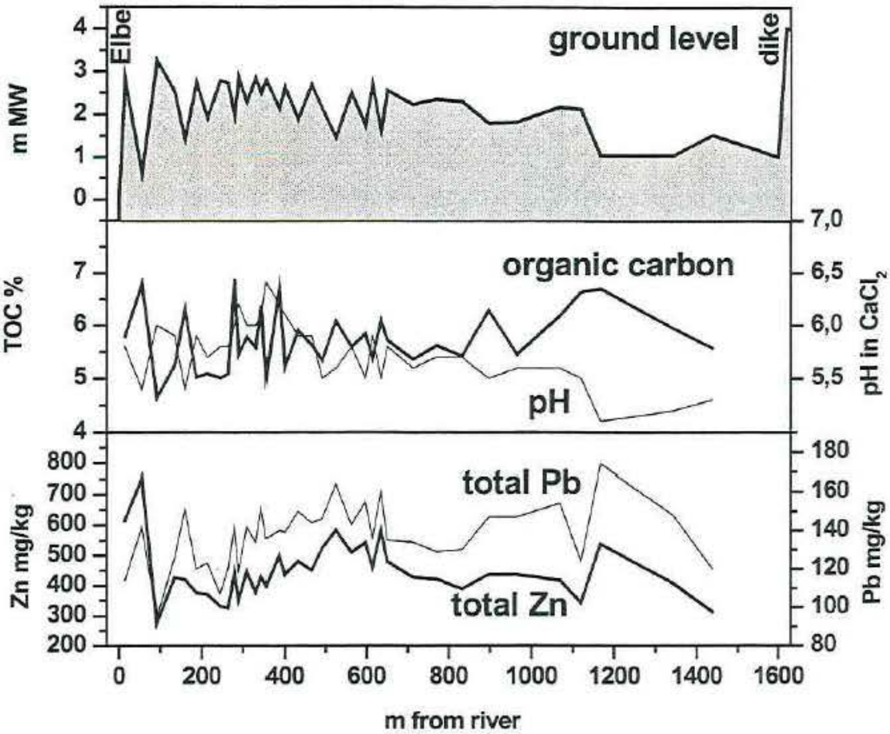

Figure 1: Ground level, top soil properties and contamination with Pb and Zn at site W

4. Meaning for risk potential

The transfer of metals in the food web is correlated with the mobility of the elements in the soils being measured by NH_4NO_3-extraction. For the example of Cd the mobile proportion exceeds 40 % of the total content at the lowest pH of 4.0. Four processes of metal uptake are responsible for the contamination of plants and foodstuff in the floodplains. In comparison with the EU directive on maximum levels for contaminants in foodstuff the contamination of plant samples is critical for As, Cd, Hg and Pb. The variability of soil contamination as well as of the transfer processes has to be known to react with effective actions on the soil use by measures being required by law.

The influence of a regulated river stretch (Saale) on matter transport and metabolism

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Due to a large component of its catchment land use contributed to industrial and agricultural use, the Saale (catchment area = 24 079 km^2) is one of the most heavy-loading tributaries of the Elbe pertaining to water quality. The river is strongly loaded with salts due to both natural background sources and anthropogenic activities (mining and industry). The implementation of the EU water framework directive requires the holistic view of the activities in the river catchment influencing both water quantity and quality. This investigation, which also considers the influence of the Saale's tributaries, shall elucidate the at present dominant substance turnover processes that occur in the Saale river water. This is in light of the significant reductions of point loads that have been obtained in the last 14 years. The research firstly concentrates on the water column of the lower reach of the Saale with special attention of quantifying the influence of control structures on the substance turnover and transport. The nutrient regime, due to its effects on the river Elbe is also emphasised. In this study, the results of the surveys in the last 3 years are discussed in comparison of concentrations, loads and hydrological conditions.

The river is 413 km in length and records a mean flow of 115 m^3/s near the confluence to the Elbe. Sampling took place on the downstream reach from the lock Halle-Trotha (km 89.2). This reach has 6 lock-and-weir structures. The stretch from the confluence (km 0) to the harbour Halle-Trotha (km 87) is designated as a federal water way.

Since 2001, intensive sampling programs were carried out in each year. In 2001, the reach was investigated 14 days; in the following years, the surveys were carried out to the flow rate of the water parcel on its pathway. A nearly continual increase in both the chlorophyll concentrations (3 fold) and loads (4 fold) along the flow direction is evident, indicative of an intensive algal production (Figure 1). In the other years the meteorological conditions influenced the development of chlorophyll-a. The tributaries, other than the Bode, do not significantly contribute to the load. There exist well pronounced correlations (only Saale samples) between chlorophyll-a and the nutrient components silicate, dissolved bound nitrogen, dissolved phosphate, and particulate organically bound carbon. The nitrate content forms the main portion of dissolved nitrogen. The phytoplankton analyses verify the chlorophyll development by their increase in biomass from Halle-Trotha to the mouth. Dominant in biomass and in cell numbers are solitary centric diatoms and Chlorophycae, respectively. From the metazooplankton analyses (22 - 31 ind./l) indicate that grazing played a subordinate role in the dynamics.

The comparison of the water quality up- and downstream of a weir shows differences. In the tailwater (1.8 km downstream of the weir), we can document an increase in the concentration of particular bound components such as suspended matter, POC, total content of some heavy metals (e. g. Cr, Zn, Pb) (see Figure 2a). But the contents of several dissolved heavy metals (e.g. Cu, Mn, As) also showed higher values in the down-stream water than in the headwater (1.4 km in front of the weir) in 2001 (s. Figure 2b). These results can be caused by the erosion of the sediment upstream or downstream of the weir. During this processes, a change in the redox potential can be expected, which causes a release of soluble metal ions. During the measuring campaign 2002 the differences in the contents of dissolved metals between upstream and downstream samples were more balanced. The backwater areas of the control structures act as sinks and sources of matter. For the river basin management the interrelations must be investigated.

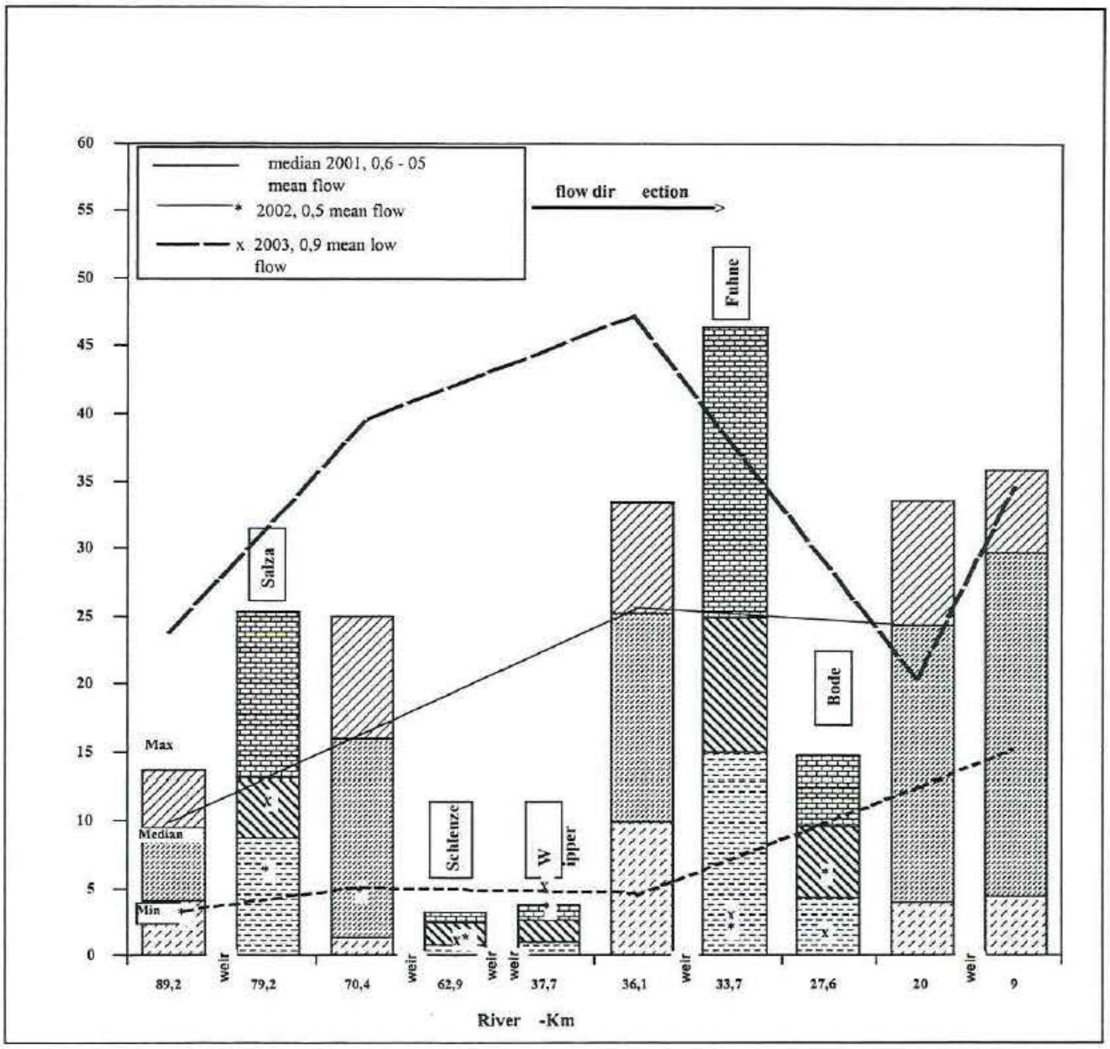
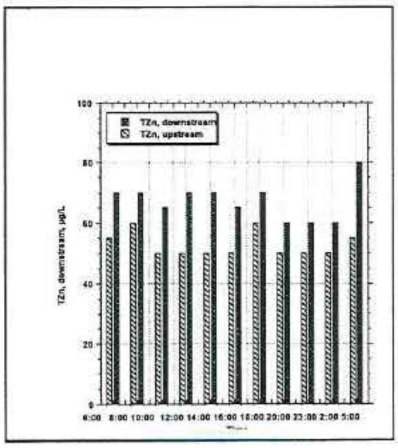
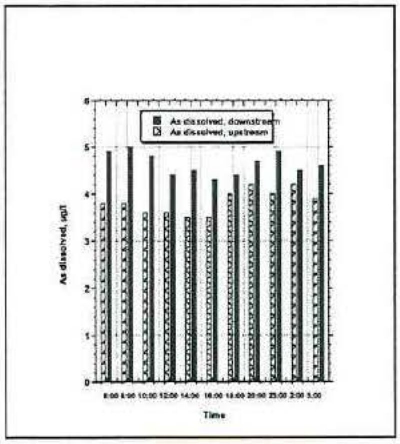


Figure 1: Concentration of chlorophyll-a in the River Saale (lower part) and its tributaries at different spring and summer situations



a)



b)

Figure 2: Influence of impounding Saale/Calbe on the content of total zinc (TZn) and dissolved arsenic (diurnal investigation: a: 2002, b: 2001)

Effects of potential land use changes in transboundary river basins in the Central Eastern European Member States

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1. Introduction: European Integration and transboundary issues

After successfully growing to 25 members this year and first steps towards political cohesion, the European Union is now also asked to strengthen the environmental policy of the new member states (http://europa.eu.int/comm/enlargement/arguments/index.htm). As one of major challenges for an integrative European environmental development the integrated management of water resources in order to secure a sufficient availability of clean water has to be seen. Thus, methodical designs are necessary which refer to the complexity of the river basins to be managed and the difficulty to predict the factors or driving forces influencing them. Generally, water management must become more responsive to processes of land use change. Besides that, large European river basins are extending oftentimes over the national boundaries of several countries with different political status (Haase and Volk 2002). An efficient trans-national land use related water resources and river basin management according to the requirements of the EU Water Framework Directive and flood risk management (http://www.munichre.com/default_e.asp) therefore needs (i) a sound prognosis and reliable indicators for potential land use (distribution) changes based on different scenarios for transboundary river basins, (ii) a harmonisation of the existing databases and monitoring programmes to assess the environmental situation in relation to occurring land use changes and, finally, (iii) an analysis of the specific and nationally different competencies of the relevant environmental and planning authorities and institutions. These issues become especially obvious regarding the new member states of the EU and their Eastern neighbours (e.g. Ukraine, Belarus, Romania, Bulgaria), where a transboundary investigation of the environmental situation and deficits of spatial planning are of particular importance for Europe as well as a methodical and political challenge (Haase and Volk 2002, Mysiak et al. 2004).

2. Land use related impacts on water resources

In comparison to the Western and Central parts of the EU the new member states share partly different land use pattern with a high percentage of arable land and forested area. Whereas in Western Europe a proportion of arable land of about 30% goes along with a high degree of (sub-)urbanisation (>80-95%) within the Central Eastern and Eastern member states we find relatively large areas of arable and forest land (Table 1). Due to conventional farming and cultivation practices the high proportion of arable land use leads to considerable nutrient and pesticide inputs into surface and groundwater (Table 2). (Post-)socialist industrial complexes in the neighbourhood of urban areas as well as mining activities are the reasons for an enormous pollution (heavy metals, organic pollutants) of large transboundary river basins. Shortness of water often occurs, too. As another severe problem regular flood events in the plains resulting enormous financial losses of >10 Millions of Euro have to be considered. Increasing demands on land utilisation (settlements, trade) within the floodplains are the main reason therefore. An adequate example is the Tisza catchment. It is part of the Ukraine, Romania and Hungary, partial densely populated with high share of industry, trade, urban settlements, which mostly not dispose of adequate (waste) water treatment facilities. The major ecological problem of Tisza catchment in the Ukraine is the enormous industrial and communal pollution, the agricultural drainage as well as the large volume of waste water input.

Table 1: Land use pattern throughout Europe (in %)

Country	arable land[1]	forested area[2]	urbanisation degree[3]
France	33.3	27.9	78.4
Germany	33.9	30.7	89.9
Netherlands	26.5	11.1	91.1
United Kingdom	26.4	11.6	90.8
Poland	45.8	29.7	66.5
Estonia	26.5	48.7	71.3
Hungary	52.2	19.9	69.4
Czech Republic	40.0	34.1	76.4
European Union	*30.95*	*29.12*	*78.26*

[1] CIA World Factbook 2003, [2] estimated by FAO, [3] UN 2002. World Urbanization Prospects: The 2001 Revision.

Crossing the national borderline, there are two main issues of environmental interest in Hungary: the annually occurring floods and the serious water contamination coming from Romania and the Ukraine. The most serious issue was the cyanide (accident) pollution from Romania in February, 2000, which exterminated most of the higher animals in the river. The significant fluctuation of the water quantity is caused by deforestation in the Ukraine and Romania and deficient flood protection as well as water control works. Therefore new water management techniques and practices have to be developed. Such an initiative is the Vásárhelyi Plan which is based mainly upon temporary water stores created along the river sides. Besides natural hazards threatening this area, the Upper Tisza Region belongs to the economically declining parts of Hungary with high unemployment rates and serious social problems. Therefore, it is in the focus of both regional politics and the public.

Table 2: Eastern European transboundary river basins and land use related impacts on the environment

Catchment	*Size (km^2)*	*Countries*	*Environmental situation and impacts*
Western Bug River	73,500	Ukraine, Belarus, Poland	coal mining and chemical industry, water scarceness, extreme pollution of surface and groundwater, related illness of children
Dnister River	72,100	Poland, Ukraine, Moldova	hydro-technical engineering, extreme water use, timber purchasing, industry/transport in the floodplains, erosion processes, extreme floods events, destruction of settlements, communication networks, surface and ground water pollution
Morava River	21,145	Czech Republic, Austria, Slovakia	rural settlement, metallurgical and chemical plants, quality of drinking water, flood problems
Tisza River	157,000	Hungary, Ukraine, Romania	poor water quality due to heavy metal pollution, hazard accident 2000, regular floods

3. Challenges for research and issues of presentation

As one of the spatial relevant consequences of the new EU membership of the former Candidate States in 2004 and as response of global socio-economic trends fundamental land use changes will occur. Moreover, European guidelines and framework directives enforce spatial planning in order to reduce land consumption, to improve the water quality, to maintain floodplains and to reduce point source as well as diffuse pollution related to the agrarian land use. The following scenarios will be relevant for the future land use shaping in the EU: the going-on of the status quo (industrial growth, intensification), the increase of organic farming (extensive development), the stagnation of urban sprawl due to a shrinking population and an extensive afforestation. In the lecture special attention will be paid to the evaluation of potential land use changes and related environmental processes in transboundary river basins in Central Eastern Europe. The methodical approach presented here is among others issue of an Integrated Project NEWATER).

4. Literature

Haase, D. & M. Volk (2002): Transborder river basin management on the basis of the EU-Water-Framework-Directive, Expression of Interest. http://www.cordis.lu/fp6/.

Mysiak, J., M. Rosenberg, U. Hirt, D. Haase, D. Petry, K. Frotscher (2004): Uncertainty in spatial data transformation for the implementation of the water framework directive, proceedings of the 10th EC-GI & GIS Workshop Warsaw 2004 (CD version)

Model for operational forecast of contaminant transport in rivers - Alarm Model Elbe -

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1. Introduction

Accidental spills of contaminants into surface waters require the rapid and reliable prediction of the transports of these substances to trigger alarm and to initiate protective measures for the downstream dwellers. Forecasting models have become an essential component in all warning and alarming plans of the River Commissions on the Rhine, the Danube, and also the Elbe.

The development, operation, and reliability of a forecasting model are illustrated by the example of the River Elbe. This Alarm Model is operating in three languages and allows for damage mitigation over more than 835 river kilometres between Němčice (CZ) and Geesthacht (D).

2. Modelling approach and graphic user interface

The transport and mixing processes are described by a so-called dead-zone model, i.e. a Taylor model supplemented by a dead-zone and decay term. The transport equations are solved by a numerical method. The dead-zone model ensures a detailed description of the transport processes in the canalised Upper Elbe and in the Middle Elbe that is predominantly trained by groyne-fields.

The solution method is embedded as a numerical code in the graphic user interface. The essential inputs "flow" and "velocities" are available in databases. This applies accordingly to data on contaminants and potential pollution hot spots. The computational results, that are obtained as contaminant concentrations in space and time can be handed out in the form of graphic files or tabular presentations for interpretation of the considered contaminant spill.

3. Tracer tests for model calibration

The determination of mixing and transport parameters, which are dependent on the river geometry and hydraulic conditions, must be obtained by measurements of artificial tracers, because suitable analytical methods are not available. An optimal dye tracer is the intensively fluorescenting Sulphorhodamine G, which also proved to be safe in toxicological regard and a very low rate of decay. This substance can be detected by opto-electronical probes or by laboratory analysis still in the nanogram range and is consequently very suitable for tracer tests over very long flow distances. Altogether seven such large-scale tests were made in the Elbe in the Czech Republic and in Germany. The time-concentration curves thus obtained provide the basis for identifying the river-flow-dependent transport coefficients of the model.

4. Calibrating and testing of the model

In preparation of the model calibration a completely new calculation of the relations between water levels and flow times with an one-dimensional computation routine was necessary, because the existing values were not complete and relatively uncertain.

The evaluation of tracer experiments revealed the dominating influence of flow velocity on the transport of dissolved substances. For this reason it is essential that the computation of flow velocities yields appropriate results for the River Elbe. Comparative measurements with an acoustic Doppler current profiler (ADCP) confirm the quality of the flow velocities calculated by the Manning-Strickler formula, as they are used on a reach-by-reach basis as averaged cross-sectional values in the transport computations. Occasional local deviations remain within acceptable limits, so that the predictions of contaminant transport for the flow range of mean low flow (MNQ) to mean floodflow (MHQ) can be taken as rather reliable according to our present knowledge.

The calibration was then possible through reach-by-reach quantification of the three transport coefficients with the help of a trial-and-error method to determine the "longitudinal dispersion coefficient", the "ratio of dead-zone volume and total flow-zone volume", and the "dead-zone coefficient". These coefficients affect the shape of the contaminant cloud.

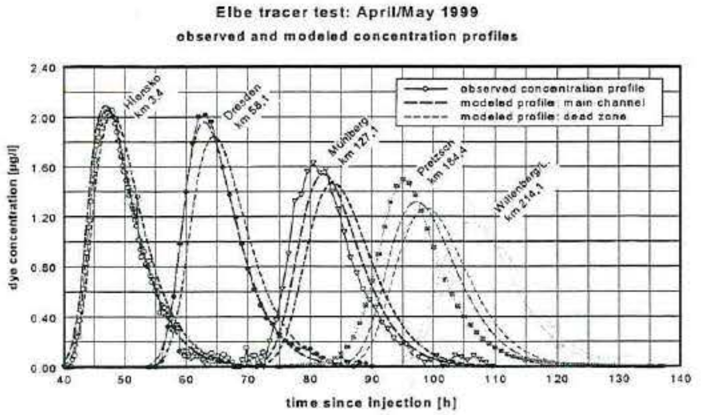

Figure 1. Dye concentrations measured and computed at five sites on the River Elbe

The model computation shows that whith a total flow time of 250 hours and mean river flow conditions the modelled maximum concentration deviated less than six hours from the measured tracer profiles. Relatively wide deviations occurred in the values of the peak concentrations depending essentially on the sampling site in the cross profile (Figure 1).

5. Optional extensions

The modular construction allows to eliminate easily the recognised weak spots for an improved forecast of the alarm model. To take the dynamics of the River Elbe into account the forecast must be carried out in real-time flow behaviour. Through this the temporal and spatial development of the contaminant concentrations can be predicted more precisely with several days of lead time for future flow conditions. Moreover, a contaminants database and a directory of protection zones and potentially hazardous sources in the Elbe basin were integrated into the graphic user interface to obtain more details concerning the accident and the pollutant. It is also envisaged to include the major tributaries Vltava and Saale into the program structure for a later version.

6. Conclusions

The concept of an international alarm model for the River Elbe produced an efficient tool for reliable predictions. After a first experimental version, a modern and user-friendly alarm model has become available for operational use. The considerable investments in this development will be recovered in case of an accidental spill when potential damages can be counter-acted because of precise forecasts. The model structure and the multilingual graphical user interface facilitates an unproblematic exchange of all relevant river data, so that the model can be recommended for general application on other national or international rivers. The alarm model Elbe may support the requirements listed in the catalogue of actions of the EC Water Framework Directive to curb negative impacts of accidents – e.g. after pollution disasters in the rivers Rhine and Theiss – by timely and targeted activities.

ELLA: Elbe – Labe flood management measures by transnational spatial planning - The challenge of the running INTERREG III B (CADSES) Project -

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1. Projectpartners and funds

The ELLA project is an INTERREG III C initiative of 23 Projectpartners from throughout the Elbe River Basin. Altogether, ten partners both from the Czech Republic and Germany and one partner each from Austria, Hungary and Poland participate in the project to develop and realise a joint strategy. The Lead Partner is the Saxon State Ministry of Interior. The project is part financed by the European Community in the framework of the European Regional Development Fund (ERDF).

2. Background

ELLA focuses on the contribution of spatial planning to preventive flood management. The challenge of the project is the transnational co-operation of nearly all regional spatial planning authorities in the Elbe basin. This includes the spatial and sector planning, water management, agriculture and forestry which are focal points of the ESDP (1999); Guidelines of the United Nations (2000); Budapest initiative (2002) and the Action plan on flood defence of the ICPE (2003).

The ELLA project aims to realise almost full spatial coverage of the catchment area of the Elbe and even neighbouring regions. Thus the aims of EU water policies and the EU spatial planning perspective can be obtained under the INTERREG III B project. National and regional partners that are responsible for spatial planning, water management and agriculture, assure the implementation of the far reaching integrated transnational approach in many different regions at the same time. ELLA is designed to complement the water management measures that are in the responsibility of the ICPE members.

3. Objectives

Driven by this, the ELLA - objectives are as follows:

a) The promotion of integrated water management and its implementation in regional plans:

- Transnational development and regional implementation of a common spatial planning strategy.
- Evaluation and improvement of spatial planning settings, instruments and policies.
- Improvement of several regional and local land use plans in flood prone areas.

b) The prevention of floods:

- Risk analysis and mapping, basic realisation steps for retention measures, impact analysis.
- Retaining measures for rainwater in the fields of regional planning, agriculture, forestry etc.

- Solutions for downstream - upstream burden balancing to speed up the realisation of measures.

4. Working Programme and intended results

The working programme is comprised of four expert work packages including transnational cooperation structures, the project steering and coordination module (see figure).

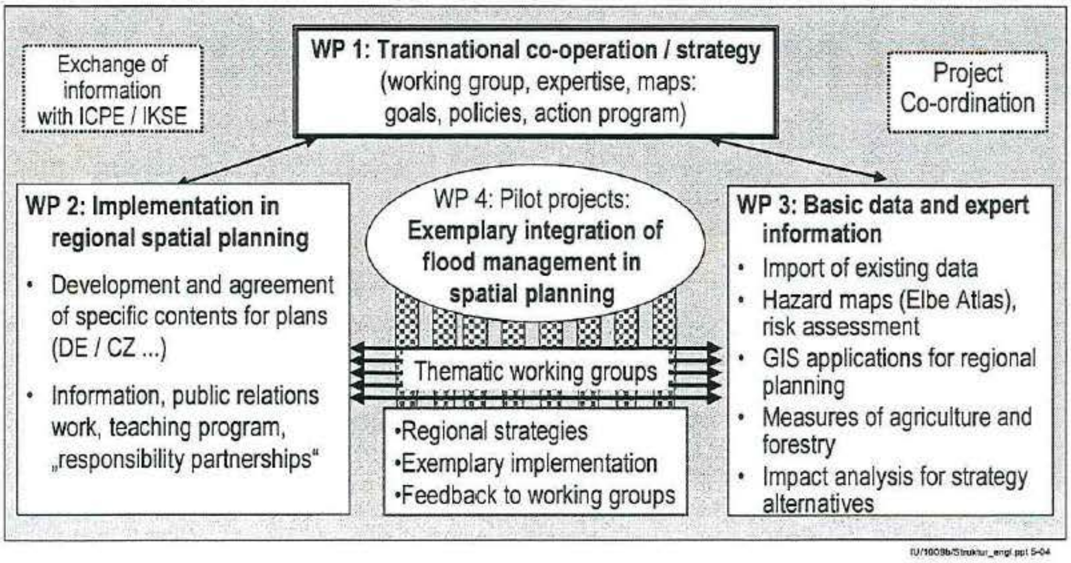

Figure: Project structure and working packages (WP) in Elbe/Labe (ELLA)

The intended ELLA - results are:

- Hazard maps ("Atlas"), agreement on retention measures, land use options (e.g. agriculture, forestry).
- Production of a transnational strategic plan for the entire river basin.
- Exemplary improved regional plans, regional strategies etc. following the transnational needs.
- An efficient transregional network of authorities regarding spatial planning and flood management.
- A transnational strategy for burden sharing incentives (compensation funds, negotiations).

5. Note / Author

The presentation will focus on the objectives, starting points and intended results. So far, results can not be presented since the author was contracted for the INTERREG application. Further formal steps will not have been made to date of the Seminar.

The author was responsible for the ELLA project application in 2003 (in co-operation with Dr. G. Janssen, IÖR) on behalf of the Lead partner Saxon State Ministry of Interior (SMI) and other project partners. Since 1996 he is working on different transnational flood management issues (Rhine, Oder, Elbe) related to spatial planning, especially on INTERREG projects.

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The relevance of a sound monitoring of particulate matter quality for the objectives of the EU Water Framework Directive

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1. Introduction

The European Water Framework Directive (WFD) aims at achieving a good ecological and chemical status of the surface waters in the European river basins until 2015. The central idea of the Treaty is that the environment should be protected to a high level in its entirety. The central operational instrument of the WFD to control and reduce pollution is the combined approach using emission standards on the source side and quality standards on the effects side. Adequate monitoring concepts are required to establish a coherent and comprehensive overview of water status within each river basin district.

2. Environmental Quality Standards (EQS)

The WFD requires that quality standards are established. Compliance checking with these standards will be one of the major elements of a comprehensive strategy against water pollution. According to the WFD quality standards are to be set for water, sediment or biota. Currently, EQS derived from (aquatic) NOEC data are proposed for the water phase (AMPS 2004). Whereas for trace metals, dissolved concentrations are compared to the EQS, for organic contaminants total concentrations in unfiltered water samples including suspended particulate matter (SPM) are to be assessed. Numerous priority organic contaminants are predominantly bound to particulate matter. This approach would not take into consideration the different degrees of bioavailability of contaminants from the water phase and from particulate matter. Furthermore, total contaminant concentrations in unfiltered water samples will depend largely on the content of SPM. When SPM contents are high, total concentrations in whole water samples will be elevated even if dissolved concentrations are low, and reported concentrations for different rivers will not be comparable as SPM contents might vary widely. Benzo-a-pyrene (B-a-P) is taken for an example. The particle-bound concentration of B-a-P amounts to 0.2 mg/kg for each of the tidal reaches of the rivers Elbe and Ems. With mean SPM concentrations of about 100 mg/l in the Elbe and 1000 mg/l in the Ems and, respectively, the total concentrations of B-a-P are different by one order of magnitude, and the proposed EQS of 0,05 µg/l would be exceeded in the tidal Ems but not in the Elbe. In addition, particularly in estuaries, SPM concentrations can vary strongly with time, and EQS may be exceeded at times of high SPM levels. As a consequence, for a proper assessment of the chemical status of water bodies, the water phase and SPM should be analysed separately, according to the real behaviour of contaminants.

In cases where EQS have been violated, one of the sources of pollution might have been the release of contaminants from contaminated sediments to surface waters. This demonstrates the connectivity between both phases. However, compliance monitoring of sediment quality is not yet feasible because of the lack of valid Sediment Quality Standards.

3. Sediment monitoring

Sediments have an impact on ecological quality because of their quality, or their quantity, or both. They are subject to transport, deposition and erosion, thus forming a dynamic part of the hydrological system. At the same time they have specific significance as habitats of different biocoenoses and as the place where manifold transformation processes occur. Because of their high potential for accumulation of non-polar, persistent, and toxic compounds, sediments are particularly sensitive to anthropogenic impacts, which may disturb the natural state of waters. Therefore, sediment monitoring should include quantitative as well as qualitative and ecological aspects.

Quantitative sediment monitoring programs should address geo-morphological processes within the river system, including those operating in floodplains, wetlands and coastal zones. The temporal-spatial resolution depends on the specific request. For investigations aiming at the detection of morphological alterations on larger scale, concepts are designed with relatively low temporal-spatial resolution, while in tidal estuaries a high resolution in space and time is required.

Qualitative sediment monitoring programs should address the *risk* coming from contaminated sediments and the temporal and spatial changes in sediment quality. The presence of contaminated sediments might be one of the obstacles to achieving "good ecological status" for a waterbody, even if point source emissions have been dramatically reduced. One widely accepted way of obtaining an initial information of the likely causes of a poor ecological status is the sediment quality Triad (Chapman 1996). The assessment of *in situ risks* at sites where sediment quality is to be considered is part of monitoring programs (den Besten et al. 2003). *Trend monitoring* will provide an indication of temporal changes in sediment quality over a prolonged period, and facilitate to assess compliance with the no deterioration objective of the WFD. Before starting a trend monitoring programme it is essential to establish the quantitative objectives. It is the duty of the program manager to specify the size of the changes the monitoring program is expected to identify. Sediment samples should be collected taking into account the sedimentation rate and hydrological conditions. For inland reaches of large rivers like the Elbe, a typical sampling frequency would be once every year. The locations for sediment trend monitoring should be representative of a waterbody or a cluster of waterbodies. They should represent non-erosion areas, to obtain sediment with a relatively high content of clay and silt that will probably contain measurable levels of contaminants and reduce normalisation problems. For dynamic systems, as tidal estuaries, it might be useful to collect suspended matter for monitoring purposes. *Spatial monitoring* will provide an indication of the horizontal spread of a contaminant over a river basin, and possibly to locate its source. It will provide basic information for appropriate sediment management. Historic contamination at hot spots is often reflected in the deeper sediment layers. Temporal and spatial trends in sediment contamination and toxicity are described for the river Elbe by Heininger et al. (2003) and Ackermann (1998).

Macrozoobenthos is a sensible indicator for the ecological state of many waterbodies. Due to their much lower mobility - in contrast to the fish fauna – macrozoobenthos organisms are ideal to monitor the ecological status of a sediment.

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Realization by mutual consent of ecologically orientated flood protection by land consolidation – exemplarily shown at the river Lippe

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In the past, rivers were straightened and the former flood plains were used intensively. As a result most of these flood plains are no longer available for flood protection.

Supporting the ecologically orientated flood protection is one of the aims of the federal state of North Rhine-Westphalia. Therefore a support programme exists which is called "Gewässerauenprogramm". Flood plains are to be developed as retention areas again and the results are to be permanently secured. The realization of the programme takes the principles of cooperation, consensus and social acceptance into account.

The key to a realization by mutual agreement is the resolution of existing land use conflicts by rural land reorganisation. The agricultural holdings in the flood plains need their parcels of land as a basis of their livelihood. Usually they don't want to sell these parcels. But in the context of procedures pursuant to the Land Consolidation Act it is possible to receive arable land in exchange, if these parcels of land are for sale.

Negotiations to solve the land use conflicts are conducted with the land owners by mutual consent. The Amt für Agrarordnung, the administration of rural development, works as a mediator in the concerns of all stakeholders. If there is enough land available for flood protection, public works will be planned and the plan will be officially approved.

This procedure and especially the role of the Amt für Agrarordnung as an experienced stakeholder in rural areas is accepted by the land owners. For example the activities at the river Lippe are demonstrated.

The river Lippe is a medium size river in North Rhine-Westphalia. It flows from the East to the West and it is about 215 km long. The upper reaches of the river pass through rural areas, the lower reaches flow through a more urban area on the edge of the Ruhr-Area. Since the beginning of the nineties, several stakeholders operate on ecologically orientated flood protection in the context of the "Gewässerauenprogramm". All activities are coordinated by two public corporations, namely the Staatliches Umweltamt Lippstadt and the Lippeverband

In a rural area near Lippstadt, the so called "Hellinghauser Mersch", an eight kilometres stretch of the river Lippe is to be restored to its original state and the flood plains are to be developed as retention areas again.

In 1991, long before sophisticated piblic works were planned, the Staatliches Umweltamt Lippstadt charged the Amt für Agrarordnung to acquire land in the context of several procedures pursuant to the Land Consolidation Act.

Until today it has been possible to get about 290 hectares arable land and grassland for the project. Some of these parcels were for sale. The major part was received in exchange. One farmer was the owner of about 54 hectares lying in the flood plains. He received arable land in exchange at a distance of 16 kilometres as the crow flies. Another land owner, the Catholic Church, received arable land in exchange, too. Furthermore substantial public works were stipulated with a view to protect the church against disadvantages caused by the restoration of the river.

Sometimes the negotiations took a very long time until all persons involved came to an agreement by mutual consent. All agreements were codified in the land consolidation plan.

Public authorities assumed ownership of the acquired parcels of the flood plain. The Amt für Agrarordnung undertook the task of leasing these sites.

After enough parcels had been acquired the first public works were planned. The plan will be officially approved this year and the construction works in the Hellinghauser Mersch will start in the year 2005.

In the areas of the upper reaches of the river Lippe it was possible to acquire about 700 hectares in the flood plains in all. About 75 percent were received in exchange. Meanwhile the Staatliche Umweltamt Lippstadt, as project executing organisation, has completed the first works in the context of the renaturation of the Lippe and some more are being planned.

Land consolidation is not only a useful instrument in rural areas but also in more urban areas. On the edge of a conurbation like the Ruhr-Area there are urgent needs existent to use the remaining plots of land which have not been developed yet. If more projects are being planned to develop flood plains as retention areas then the last existing agriculteral holdings are at risk.

In the year 2000 another procedure for land consolidation was instituted in the area of Werne and Lünen with the objective to acquire land in the flood plains by mutual agreement. The Lippeverband, as project executing organisation, estimates that about 370 hectares of arable land will be affected by the public works for renaturation and flood protection and their effects.

In contrast to the examples of the upper reaches of the river Lippe mentioned previously, the plannings of the public works in the Werne area and the negotiations to acquire land run in a parallel manner. Therefore it is necessary that all participants are in close contact.

Until today it has been possible to acquire a large number of parcels of arable land. One agricultural holding has been purchased. Another holding, lying in the flood plain, got arable land in exchange with the aid of a separate procedure pursuant to the Land Consolidation Act. The current tasks now are to readjust the land in the flood plain and to make sure that the land which the farmers are to get in exchange is not affected by the renaturation and their effects.

In general, it is an advantage that due to the procedures pursuant to the Land Consolidation Act land can be acquired in a larger surrounding area. Hence the prices to purchase the land might be at a lower level and often more parcels are for sale. On the other hand, due to the obligation to act by mutual consent the procedures take a fairly long time. But this time is useful to convince the landowners of the plannings or the alternative solutions.

It is an obvious fact that due to the renaturation of rivers or other projets like that arable land is lost. Additionally, large areas of the flood plains are special protection areas, classified pursuant to EU-directives. With the aid of land consolidation it is not possible to solve these problems at all. But it is possible to reduce their effects on the agricultural holdings.

The flexible procedures laid down in the Land Consolidation Act make it possible to solve land use conflicts, to make required land available and to secure the result permanently. With the help of these procedures, which closely involve the landowners and the planning authorities, large-scale projects, for example to provide areas for water retention, can be implemented by mutual consent.

Hydrological aspects of a river basin management for the Volga River

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The Volga, Europe's largest river, is closely associated with the Russian origin, culture and economical development and with the ecological conditions in a large area. Regarding various demands in this river system an integrated research is required to provide decision support for the development of concepts for the sustainable use of enormous water and energy resources. This is the goal of the German-Russian cooperation project "Volga-Rhine", which is funded by the German Federal Ministry of Education and Research and the Ministry of Industry, Science and Technologies of the Russian Federation. The project consists of seven sub-projects dealing with the hydrologic processes in the tributary catchments, the hydrodynamics of the Volga river, the operation of the reservoirs of the Volga cascade, the restoration of hydraulic structures, the balance and transport of mass in catchments, river channels and sediments, the water quality in rivers and the supply of drinking water. The flow process is the main natural boundary condition of the river system. Therefore, the hydrological sub-project providing information on this process (statistics and forecasts using simulation tools) has a key role. Two approaches beginning at different scales (bottom-up and top-down) are pursued:

Bottom-up (from meso-scale to macro-scale): simulation tools for the precipitation-runoff (PR) process are developed and applied in order to achieve an understanding of the hydrologic processes and their statistics and to provide operational tools for the river basin management. For a first application of the tools, the Kostroma catchment (16000 km^2, see Fig. 1 and 2) with the complex properties of a glacial series was chosen, since a variety of its surface properties is representative for large surfaces of the Upper Volga basin and thus enables a regionalisation of model parameters in this area. The modules of the simulation technique correspond to the main PR-process complexes: precipitation, snow-cover development, runoff generation, runoff concentration and channel flow. In the scope of the modular structure of the "Flussgebietsmodell" (coupled with a GIS) alternative modules may be evaluated and discussed with the Russian partners. Furthermore, we developed a stepwise procedure controlling uncertainty for the specific natural conditions and for a low spatial density of data. It begins with the (reliable) simulation of homogeneous hydrological situations, i.e. events with spatially and temporally homogeneous distributions of the input variables and hydrological states in meso-scale catchments with homogeneous properties. Based on derived informations/model parameters the investigations are then extended in time and space, i.e. to complex hydrological situations and to the macro-scale. For selected flood events we were able to simulate the hydrographs of a mostly non-observed catchment part of 6000 km^2 with a good fit to the observed hydrograph (Figure 1). In a future project phase the analyses will be extended to the Oka basin (245000 km^2, Figure 2), where different properties (soils on sand and loess) occur.

Top-down (from the overall basin to the main tributary basins): time series analyses of the flow process in the scale of these basins aim at a sophisticated regional resources management. This paper emphasises the long-term behaviour of the flow process. Using a combined periodogram a complex oscillation structure of mean annual flow values MQ of the 20th century was identified for the overall basin (gauge Volgograd). Detailed analyses revealed that this structure resulted from a superposition of oscillations with a period of approx. 30 years in the Western basin part (Upper Volga, Oka and residual part without Kama) and a complex oscillation structure with periods between 13.7 and 21.5 years in the Kama basin

(Figure 2). More or less these oscillatory phenomena compensated each other most of the time. However, synchronous minima or maxima occurred in the 1930-ies or 1970/80-ies, respectively. Regarding the Volga-Caspi problem these are the periods of corresponding, drastic water-level changes causing damage at the Caspian-Sea coast (Figure 2). It can thus be assumed that they occurred mainly due to the described mechanism. In addition, the results may serve as a contribution to a regionally differentiated long-term planning base for the resources management in the Volga basin. However, further research is required, especially regarding the complex oscillation structure of the Kama basin.

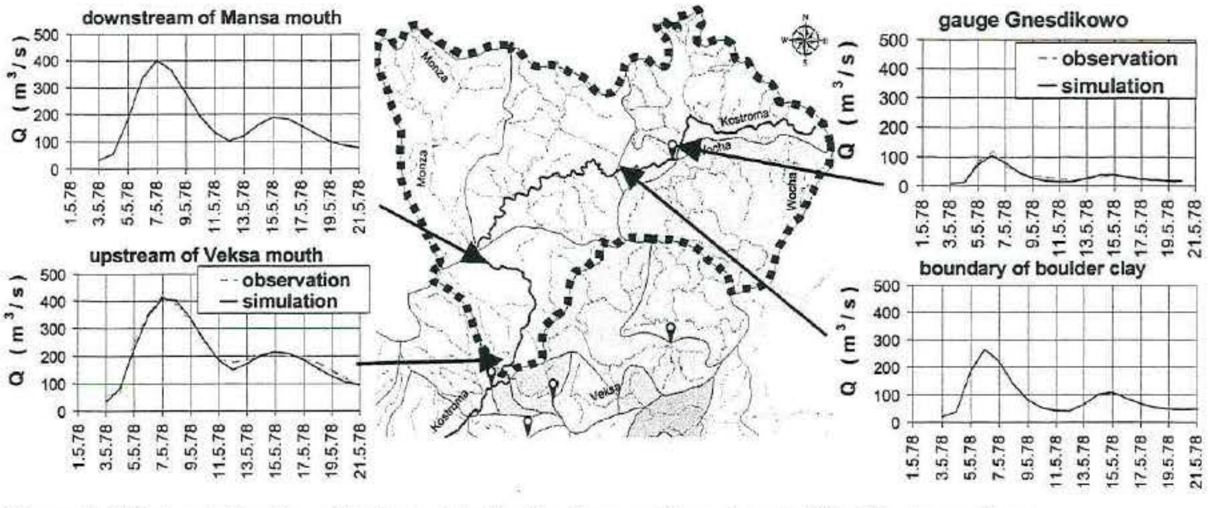

Figure 1: PR simulation for a flood event in the Northern catchment part of the Kostroma river.

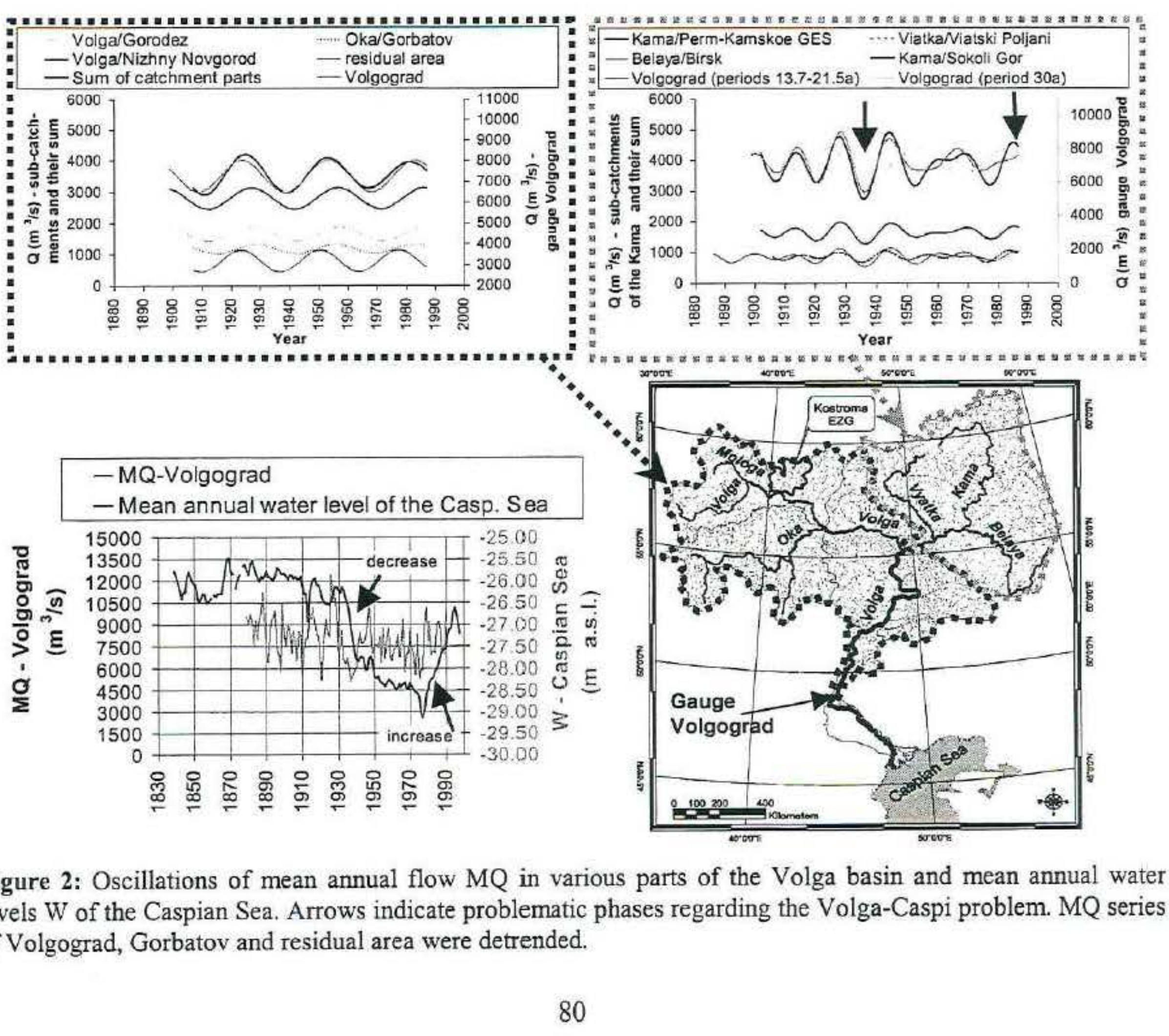

Figure 2: Oscillations of mean annual flow MQ in various parts of the Volga basin and mean annual water levels W of the Caspian Sea. Arrows indicate problematic phases regarding the Volga-Caspi problem. MQ series of Volgograd, Gorbatov and residual area were detrended.

Coupled nutrient transport and water quality modelling as contribution to integrated river basin management

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For integrated river basin management (IRBM) to be successful, new modelling tools are required. For a sustainable management of water resources, IRBM aims to address the needs and requirements of all users of a river basin that is water suppliers and industries as well as agricultural activities or communities (flood control).

In order to assess the effect of the actions of one stakeholder group the impact of their action on the hydrologic cycle and river water quality must be modelled. These actions can be both very small scale, e.g. point sources, as well as large scale such as widespread erosion. And whereas phosphorus is being transported in overland flow to rivers during events in a matter of hours, nitrate in groundwater may take decades to reach the receiving waters. To quantify the relative importance of each water user and evaluate the effect of measures to reduce adverse impacts, there is a need for integrated modelling of river basin processes, at different temporal (days to years) and spatial (meters to thousands of square kilometres) scales.

Within the framework of the BMBF project "decision support system for integrated river management of the Weiße Elster river", two catchments at different scales (Weiße Elster: 5300 km³; Weida/Zeulenroda: 100 km² being a sub-catchment of the Weiße Elster river) are investigated. It involves a two way modelling approach, top down and bottom up. The nested modelling approach on hydrologic nutrient transport processes is carried out to verify the regional hydrological modelling. It ultimately helps to determine the necessary degree of detail in process description as well as the adequate spatial discretisation at the large scale. The nutrient transport results are passed on to a water quality model to assess the transport of sediments and turnover of nutrients in the river.

Furthermore, the Object Modelling System (OMS) is being developed allowing to couple different process components at different temporal and spatial scales. The hierarchic composable temporal and spatial context is build up in and controlled by the OMS. Therefore an OMS Model can be composed of lean single process components which are held in an open library of alternate science. This architecture facilitates the assembly of a modelling package, tailored to the problem, data constraints and scale of application. Results of both modelling approaches can now be compared.

Socio-economic analysis within an interdisciplinary spatial decision support system for integrated river basin management

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Integrated river basin management consists of three main components: ecology, economy and equity. As it is specified in the European Water Framework Directive (WFD), public participation becomes a key element within planning and decision making processes, ensuring fairness, social justice and acceptability. For the Werra river basin in Germany an interdisciplinary research project (financed by the German Federal Ministry for Education and Research) is planning measures and management strategies to reach the objective of a good ecological status until the year 2015. The hydrological and ecological consequences of the planned measures are predicted by simulation models. Their social and economic consequences are assessed by socio-economic analysis including an agricultural sector model. All aspects have to be integrated to ensure a comprehensive decision support.

This paper focuses on the socio-economic assessment and the development of a spatial decision support system (SDSS) with the aim to select efficient and feasible strategies. Economic analysis encompasses on the one hand the assessment of costs (and cost-effectiveness) of potential measures to achieve the good ecological status. On the other hand the assessment of related benefits is necessary to evaluate whether costs are disproportionate or not. Based on the concept of the Total Economic Value the benefits will be measured in monetary terms (as far as possible). The costs and benefits of alternative measures are calculated referring to a baseline-scenario incorporating the most likely demographical, technological, economic and policy developments until 2021.

The costs of measures designed to ameliorate river structure are calculated on the basis of similar projects already accomplished or estimations by local authorities: They lie between 50,000 and 250,000 € for removing weirs and minor dams or building fishpasses. Widening the river-bed costs between 50 and 300 €/m, removing embankment structures and flattening the slope of river-banks between 90 and 250 €/m. Establishing a 10m wide strip of initial riverside vegetation costs 45 to 60 €/m. The costs for reducing immissions from point sources vary widely according to capacity and are calculated per project individually.

Emissions from diffuse sources are tackled with a variety of measures: Convert arable into grassland or even forest, reduce the spreading of manure and mineral fertilizer (below a nutrient surplus of 50 kg N/ha) or spatially specified bans on cultures with high nutrient intensity and run-off potential from sensitive areas. To reflect the farmer's management options to adapt to these measures a linear optimisation model is applied. The BEMO model was originally developed to predict consequences of changes in national and EU agricultural policies on the German agricultural sector (see e.g. Kleinhanss 1996). In the course of the current Werra project and an ongoing PhD-project (see Hirschfeld 2003) it was modified and extended to test environmental policy. Optimisation under different management restrictions leads to altered production programs and mostly to reductions in gross margins which represent the economic costs of the environmental measures. The losses in gross margins lie for example between 350 and 600 €/ha per year for conversion of arable into grassland and 100-250 €/ha per year for restrictions concerning crop rotation options. The effects of management changes on cultivation practices and nutrient application are passed to the models of the other project partners and integrated into the SDSS.

Although the WFD primarily focuses on the cost-side (by assessing the cost-effective measures for reaching a good water status), an assessment of the benefits associated with improving water quality and the restoration of the river and the riparian wetlands is necessary to meet the requirements of the WFD. From an economic point of view the justification of possible derogation (time and objective) and the designation of Heavily Modified Water Bodies requires the assessment of costs as well as benefits to estimate whether or not measures to reach a good status entail disproportionate costs (Meyerhoff & Dehnhardt 2004). Accordingly, different benefits of the regarded measures are considered: the values that would arise from an increased nutrient retention and biodiversity protection as well as the potential effects concerning the recreational value of the river Werra. To determine the value of the nutrient retention function of additional riparian wetlands the replacement cost approach will be used (Dehnhardt 2002). For the latter effects the benefit transfer approach will be applied which assign economic values of certain ecosystem services by transferring results from one valuation site to the policy site regarded. As site-specific studies are time and cost intensive, the benefit transfer might become an important tool within the WFD. Within the SDSS the assessed benefits are regarded as attributes of the potential measures.

Additionally, the acceptance of the WFD objectives and measures was evaluated in the course of a dynamic actor network analysis. It identified relevant regional actor groups and their preferences. A 'cooperation index' reflecting the conflict potential of a measure, the economic importance of the affected water use and the extent to which the water use is restricted was deducted and integrated into the SDSS.

The SDSS will be designed to integrate, generalize and evaluate information from all disciplines involved (hydrology, ecology, sanitary engineering, social sciences). A structured design ensures linkages of information in a dynamic context of driving forces, pressures, state, impacts and responses. Here a common interdisciplinary data and workflow model was developed. Special emphasis was put on the different functional and spatial scale of socio-economic, ecological and hydrological data. Software tools will support the workflow of river basin managers and decision makers. A special component for multi-criteria analysis will support an interactive visual exploration of the decision space and trade-off analysis in a group decision situation, e.g. in a focus group meeting. It follows a learning based approach, which is considered to be suitable for participatory negotiation and decision support.

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Uncertainties in the mesoscale modelling of water and nitrogen fluxes

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Water and nutrient fluxes have to be modelled in order to implement the EU Water Framework Directive. The models are needed to determine the probability of nutrients entering the groundwater and surface water.

The snag is that the error rate of model findings is usually unknown. A distinction needs to be drawn between uncertainties about the way processes are modelled internally and uncertainties caused by inaccurate model parametrisation. Here, the latter are dealt with in connection with a study of water and nitrogen fluxes in the 1980s and 1990s in the catchment area of the middle Mulde (2700 km², Hirt 2003). The study is part of the project "Ecological research in the riverine landscape of the River Elbe, No: 0339586", funded by the German Ministry of Education and Research.

The following water and nitrogen models were employed successively:

1. ABIMO, to determine the *total runoff* (Glugla & Fürtig 1997);
2. The *separation of the runoff components* into direct and groundwater runoff after Röder (in BASTIAN & SCHREIBER, 1994) and drainage runoff using a method to determine proportions of drainage area (Behrendt et al. 1999);
3. Linking nitrogen fluxes to the runoff components using a modified method developed by Feldwisch & Frede (1998).

The following calculations of nitrogen losses were carried out while varying the input data:

Calculation 1: Changing the effective field capacity

The effective field capacity was derived using an alternative method based on medium-scale agricultural site mapping (Mittelmaßstäbige Landwirtschaftliche Standortkartierung, MMK) (Hirt 2003). The values were derived for each layer from substrate figures using Method A, and for each horizon of the respective soil type using Method B. The average deviation of the results of both methods is 15%.

Result: Changing the method of derivation the effective field capacity increases N losses by 5% (Figure 1, AC1).

Calculation 2: Changing the amount of precipitation:

The mean annual precipitation was reduced and increased by 7% in line with the error calculated by Kunkel & Wendland (1998).

Result: The changes in the annual precipitation caused a nearly 10% decrease and a 9% increase in the N losses. This alteration of the results is one third higher than the change in the parameter precipitation (Figure 1, AC 2 and 3).

Calculation 3: Changing the nitrogen balance:

Of all the components used to calculate the N balance, the most difficult one to determine is N deposition. Previous investigations (Gauger et al. 2000) take into account both wet and dry deposition. Using the ^{15}N isotope dilution method (integral total nitrogen method) allows to measure total atmospheric nitrogen deposition in the soil-plant system for the first time (Weigel et al. 2001). The results were on average 30 kg/ha*a higher than previous deposition measurements. As regional differentiation is not yet possible, the figures reported by Gauger et al. (2000) were all increased by 30 kg/ha*a. This raised the N balances in the 1980s by 32% and in the 1990s by 71%.

Result: The losses rose considerably – by 41% for 1986-1989 and 105% for 1997 1999. The higher increase in the 1990s loss can be attributed to the lower N balance in that decade and the higher influence of the additional 30 kg/ha*a, as well as to the calculation of the denitrification, which increases subproportional with increasing N balance. The rise in the total nitrogen losses in both decades is superproportional to the increase of the parameter values. Nitrogen losses are therefore highly sensitive to the input parameter *nitrogen balance* (Figure 1, AC 4 and 5).

t/a

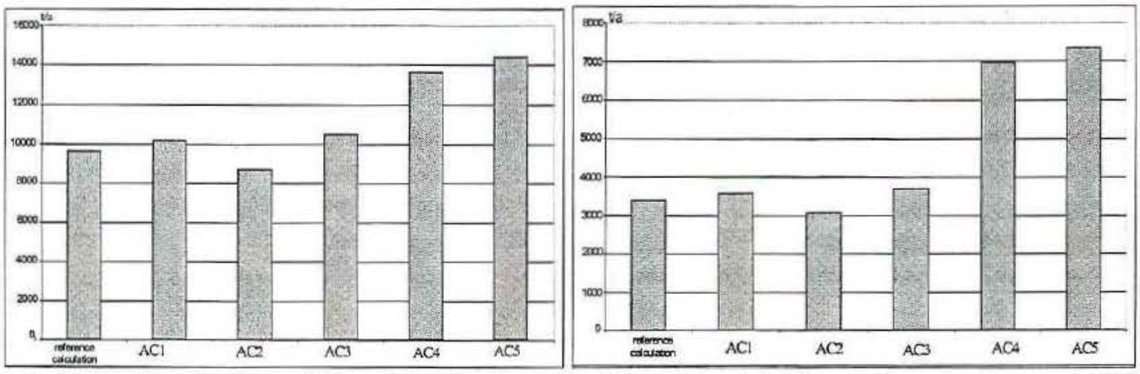

Figure 1: Alternative calculations (AC) to determine the width of fluctuation of the N losses from the soil zone in 1986–89 (left) and 1997–99 (right) (AC 1: Derivation of FK using method B; AC 2: precipitation –7%; AC 3: precipitation +7%; AC 4: N balance increased by 30 kg/ha*a and derivation of FK using method A; AC 5: N balance increased by 30 kg/ha*a and derivation of FK using method B).

Summary: Nitrogen losses have a different sensibility to the input parameters *effective field capacity, precipitation* and *nitrogen balance*. Altering *effective field capacity* leads to subproportional changes in N-losses, while changes in *precipitation* and *nitrogen balance* affected N-losses superproportionally. Especially the calculation of the *nitrogen balance* and its input parameter *atmospheric nitrogen deposition* is very uncertain, because it is on one hand very influential for the results and on the other hand can still not be accurately determined. Thus its quantification provides the highest uncertainty in comparison to other model parameters

Due to the uncertain quantification and the strong effect on nitrogen loss modelling *atmospheric nitrogen deposition* is still burdened with high uncertainties. N-deposition monitoring devices need to be installed in different natural regions and in the presence of different crops so that regional input parameters can be accurately determined.

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Elaboration of a documentation report of the August 2002 flood event in Austria
Integrated assessment of causes, impacts and consequences

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In August 2002 the entire Central Europe suffered from the catastrophic flood event. Also the northern and western part of Austria were effected. Intensive rainfall amounts with the accumulation of the mean quarterly annual sum fell during several days and lead to tremendous increase of the water levels in rivers and brooks. Local and areal flooding caused damages of infrastructure, of industrial facilities, and of private and agricultural properties. During the flood the catastrophe management was done by local services like water management boards, fire police, red cross and private volunteers. Some shortcomings in the coordination of the different institutions and the provision of the relevant information were evident.

After the immediate impression of the flood event, the BOKU University for Natural Resources and Applied Life Sciences Vienna decided to contribute to the conclusions and raising demands for the improvement of flood management for future events. As the university is hosting all relevant disciplines and focusing the competences in natural sciences, it was decided to elaborate a documentation booklet including the following aspects:

- Description of the extreme meteorological situation
- Collection of all loss components
- Analysis of the flood events (ascent, duration, hydrological behaviour, hydraulic aspects)
- Documentation of shortcomings
- Provision of recommendations for flood management improvement

The oral presentation will report the circumstances for the documentation preparation, in particular the incorporation of the public administration, the institutional demands and efforts of the university and the benefit of the integrative perspective of the booklet for decision making. An important issue and a prerequisite for the success of the documentation was the willingness of the authorities and surveys to contribute by provision of data like protocols, loss inquiries, reports of civil services etc. In a surprisingly short time period (half a year) the documentation report could be produced. Now the booklet serves as a wide spread informal document which brings together the broad range of disciplines, sectoral experiences and conclusions to assist in future decision making and formulation of demands for improved water management.

Strategies of local government to increase the preparedness of households facing flash floods – What can we learn from high-reliability organizations?

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Introduction: Various actors of regional and urban development (see Wirth & Schanze, this issue) formulate strategies – more or less explicitly – to be prepared during the next flood event. The paper focuses on strategies of local authorities attempting at strengthening the capability of households to cope with floods. It aims at defining requirements for effective strategies to increase the preparedness of households in flood-prone areas. The cognitive and behavioural patterns of the so-called high-reliability organizations (HRO) serve as a frame of reference to consider the specific features of flash floods within strategy development.

Preparedness strategies as components of pre-flood risk management: An integrated flood risk management encompasses strategies to increase the preparedness of citizens in flood-prone areas. (To simplify the argumentation, the terms "households" and "citizens" are interpreted as interchangeable.) In a general way, preparedness can be defined as the ability of an actor to react in an appropriate and timely manner to situational requirements, especially unexpected events. The unexpected can take on two basic forms (Weick & Sutcliffe 2001, pp. 33-41). Either an actor expects something, and it does not happen, or an actor experiences an event he or she did not expect. With regard to flood risk management, preparedness can be understood as capability for timely and effective actions to avoid the loss of lives and to reduce the damages of flooding during the event. This capability contains cognitive components (e. g. knowledge about basic features of different flood types) as well as the ability to act on the basis of this knowledge (e. g. measures of evacuation). The development of capabilities requires time and resources. Strategies, simply speaking, can be defined as consistent patterns of physical measures, instruments and resources to implement the basic long-term goals of an actor. Therefore, we focus on strategies of local government as consistent attempts at strengthening the capability of citizens to cope with floods during their occurrence. These strategies are closely related to event management. Nevertheless, they are part of pre-flood risk management ("Verhaltensvorsorge").

What is a flash flood? Flash floods are usually the result of spatially and temporally restricted extreme precipitation events in small and middle sized river basins. They are characterised by short warning time (max. few hours) and very high dynamics of discharge. Flood peaks are often reached within hours. Flash floods can be caused by sudden snowmelt or dam failure.

Routines and information as elements of preparedness strategies: Compared to slow-rise floods, preparedness strategies for coping with flash floods face some specific problems. For example, seasonal slow-rise floods simplify the development of routines to prepare the citizens for future flooding (see Parker & Handmer 1998, p. 57). As part of the complex set of routines for flood risk management in Cologne, local government disseminates flyers regularly in co-operation with private initiatives in flood-prone areas. This example of a regular dissemination of information is remarkable in at least two aspects: Firstly, the example is interesting because of the aim to develop routines which enable local authorities and initiatives to keep alive the public awareness about flooding in a pro-active manner. Secondly, the development of routines for pre-flood risk management allows long-time residents to act as informal local experts and new residents to be socialized according to the demands of the specific situation in flood-prone areas. The development of routines is much more difficult in the case of flash floods. They cannot be interpreted as regular events. They have to be anticipated with regard to the specific meteorological, hydrological and hydraulic circumstances of each singular flood event. Furthermore, the time to react is very short. Hence, effective and timely actions of citizens rely less on collective decisions within event management and more on isolated individual decisions during the event. Examples of strategies to increase the preparedness of households facing flash floods are to be found especially in America. Publications, flyers and internet information use a vivid language ("...it is better to be wet than dead, and to take flash flood warnings seriously ...", Gruntfest & Ripps 2000, p. 388) for communicating to citizens how to react swiftly during a flash flood event ("If flooding occurs, get to a higher ground!"), what not to do ("Do not drive your car into low-water crossings!") and which physical resources one should have in preparation (e. g. "warm clothes"). But local governments in Germany concentrate on preparedness strategies for coping with slow-rise floods. With regard to the Weisseritz flash flood in August 2002 (With & Schanze, this issue), it becomes clear that local authorities in Germany should develop strategies to strengthen the capability of citizens for coping with floods under extreme time pressure.

Preparedness strategies of HROs: HROs are specialists for problem solving under time pressure (Weick & Sutcliffe 2001). Examples are organizations managing nuclear aircraft carriers and wildland firefighting crews. HROs use highly flexible behavioural patterns to react swiftly to the unexpected: Firstly, people know with whom to communicate regardless of formal rank. Secondly, they act on the basis of a broad interpretive and behavioural spectrum of routines. Thirdly, HROs are capable of seeing the significant meaning of weak signals and to give strong responses to weak signals. Therefore, they combine instruments of rational strategy development with narratives ("stories") to develop and maintain the capability of preparedness. Stories help to memorize the development and consequences of catastrophic events or "near misses" because of their concrete sequential quality. Nevertheless, it shouldn't be expected that households could behave as HROs. The latter develop professional competence for coping with hazards. Hence, local authorities should support constantly the attempts of citizens to be prepared for the next flood event.

Conclusion: Learning how to prepare for an event that nobody wants to experience is difficult. Learning is even more difficult if events happen suddenly and rapidly as flash floods. The paper suggests some specific features of strategies to increase the preparedness of households facing flash floods. Despite the high degree of turbulence of this flood type, it seems reasonable to develop routines on local level to maintain a high state of awareness for future flooding. The substance of local strategies should possibly emphasize not only abstract knowledge (e. g. if-then-propositions, physical models) but also narrative knowledge about successful and unsuccessful ways of coping with flash floods to strengthen memory and to suggest appropriate actions under time pressure.

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Top-down versus bottom-up: Possibilities and limitations of stakeholder's involvement within the implementation of the WFD in the Havel River basin

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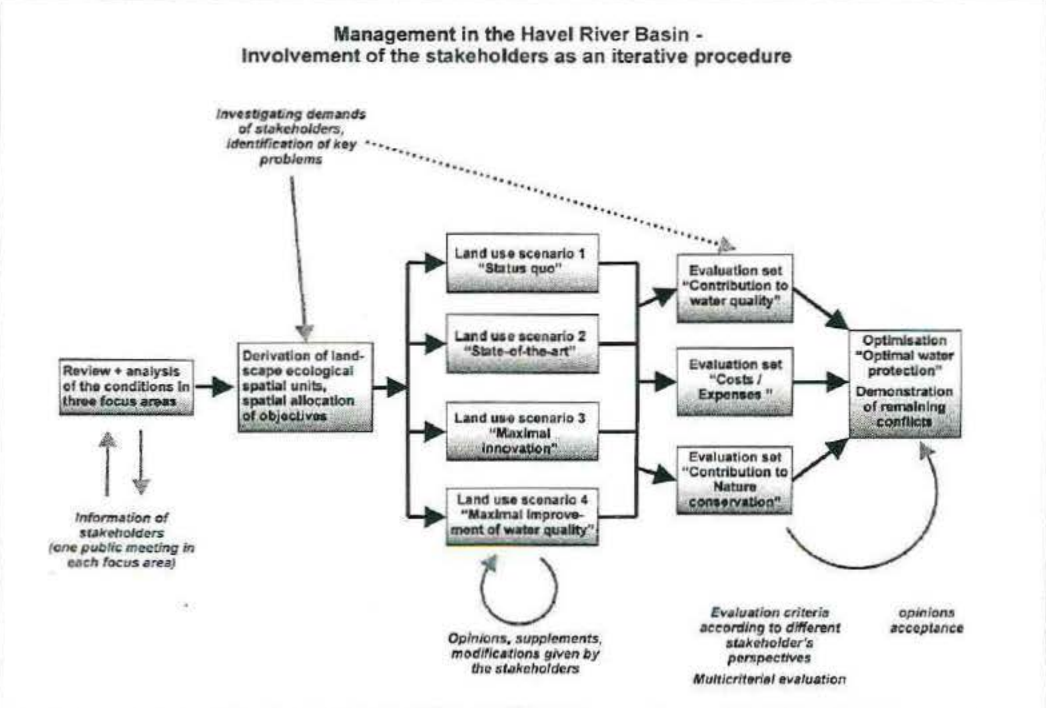
By setting up a strict frame of objectives for the quality of surface and ground water bodies the European Water Framework Directive (WFD) provides a typical top-down approach. On the other hand, Art. 14 WFD demands "the active involvement of all interested parties" in the process of its implementation. Thus the question evokes how the promise given by this antipodal bottom-up approach can be fulfilled in practice without challenging the superior objectives of WFD, as one prerequisite for true participation is that the results are not yet fixed in advance.

Within the research project "Management in the Havel River Basin" (funded by the Federal Ministry of Education and Research – BMBF) alternative management options to improve the water quality of the Havel River are developed. The study is performed at different scales, covering the total Havel Basin, meso-scale sub-basins and so-called focus regions, representing sub-basins with different characteristics of natural conditions (domination of agriculture, forestry or protected areas). As a first step, in three focus regions a detailed survey was carried out to investigate the various interests of the stakeholders (covering cultivators, forest officials, representatives of local tourism, water management, nature conservation and of the different municipalities within each area). The interview guideline included aspects such as an appraisal of the qualitative and quantitative availability of water resources within each focus area given from the different stakeholder's perspectives. Further the stakeholders were asked about their own proposals of improving the situation and about their respective attitudes towards possibilities of communication and cooperation among each other.



The results of the interviews allowed to compile and systematize the key problems of each area, but also to define common grounds. For instance in some areas it proved that there was great agreement on the necessity of water retention among the stakeholders, but rather different opinions of how to manage this in detail. The results also allow to establish evaluation criteria to assess possible developments of land use from different points of view: Such criteria may be the contribution of a scenario to reduce nutrient imports into surface and ground water and thus obtain a good water quality (that would be the perspective of WFD), the expenses for management measures and necessary compensation for land use change (this aspect would be important for the cultivators) and the optimal realisation of the requirements of resource and species protection (i.e. the perspective of nature conservation). The gathered information about the stakeholders was accounted for as boundary conditions for the development of land use scenarios each of them representing a different step on the way of achieving the aims of the WFD. Built up on landscape-ecological spatial units these scenarios demonstrate possible changes of land use necessary to obtain a better water quality. The following land use scenarios were put up:

- "Status quo": The current state in the watershed areas is considered and extended into the future, taking into account predictable changes e.g. in agricultural policy and settlement areas, i.e. in general conditions that are not linked with WFD.
- "State-of-the-Art": All relevant guidelines are put into practice according to the legal requirements, e.g. requirements of "good practice" in agriculture and forestry, legal requirements in protected areas etc.
- "Maximal innovation": Includes the maximum utilisation and implementation of all professional requirements referring to nature conservation (including protection against erosion, species conservation and ground water protection).
- "Maximal improvement of water quality": All management options are focused on one single aim, the improvement of water quality.

The results of the scenarios which demonstrate different specifications of land use also serve as input information for modelling the effects on water quality and for calculating economic effects. They thus represent an important interface within the different disciplines involved in the project.

In a second survey the results of the scenarios together with those of the modelling and the economic valuation are presented to the stakeholders to get hints for an optimisation of management options taking into account sociocultural aspects. The results of this survey will become part of a decision support system but also a source for a multi-criterial evaluation of the scenarios. As a final step in this iterative procedure a scenario which is called "optimal water protection" shall be developed trying to bring the requirements of WFD into agreement with sociocultural aspects like the requirements of land use and nature conservation but also identifying those fields where conflicts remain and further solutions (like financial compensation) have to be developed.

The contribution will outline the involvement of the stakeholders within the Havel River Basin Management Project, demonstrate the role land use scenarios can play to communicate spatially relevant effects of the WFD and will finally discuss the possibilities and limitations of public consultation within the implementation of the WFD. Thus it appears that though the superior frame of WFD itself is not at disposal, within this frame margins for implementation can be detected and illustrated by this approach. The interviews carried out in the three focus areas also showed that the main reason for problems of water and land use management often are deficits in communication among the stakeholders. Land use scenarios can demonstrate spatial effects that may occur when implementing WFD in a comprehensible way and can thus provide a common basis for discussion within the implementation process.

Flooding due to local heavy rainfall events

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1. Introduction

In the summers of 2001 and 2002 heavy rainfall events caused large damages in five locations of North Rhine-Westphalia. These events were very localised and damage such as landslides and flooding in urban and rural areas occurred. The North Rhine-Westphalia State Environment Agency requested the analysis of the five events with the following objectives:

- quantification of the precipitation with raingauge and radar data,
- determination of the spatial extent of the extreme precipitation,
- analysis of the damage locations in relation to the reasons of damage,
- preparation of time series for areal precipitation.

2. Available data

For the analysis of the five rainfall events radar data from one up to four locations, raingauges with daily and continuous values, flow gauge measurement data, geographic data like catchment boundaries and reports from the German Weather Service (DWD) and other institutions were used.

3. Quality Check

An intensive quality check of the radar and raingauge data was the first step and necessary to reach reliable results. Different data errors could be recognised and partly be corrected for.

4. Adjustment of radar data

Radar measurements are rainfall measurements by an indirect method which is not linearly related to rainfall rate. Therefore the use of point measurements is required for the best possible determination of the precipitation volume. There are many possible adjustment and correction techniques to obtain adjusted radar data. As adjustment method for the further analysis was chosen the adjustment factor matrix based (Wilson/Brandes, 1979) on uncorrected radar data.

5. Damage report

For each of the five events the damage points were located and analysed. A comparison between the events revealed that few common damage reasons exist for all events and locations, like problems with the dimension of outlets and canalisation.

6. Results

The results show that the spatial extent of the precipitation areas can be identified with a combination of radar and raingauge data or an adequate quantity of raingauges. In three events the centre of the precipation area had only a spatial extent of less than 15 km². Not in all cases the raingauges could observe the maximum of precipitation (table 1).

Table 1: Maximum values of adjusted radar data and raingauge stations

affected region	maximum adjusted radar value [mm]	maximum raingauge value [mm]
Warburg	100	74.5
Bad Driburg	110	81.8
Gummersbach	138	110.5
Eitorf	104	73.5
Siegen	134	115.4
Ahlen - Beckum	96	86.0
Soest - Welver	64	35.1

Further results of this work are preparation of catchment and pixel time series, images of accumulated rainfall for the rainfall events (figure 1), classification of the events on the basis of extreme value statistics and maps with the damage locations for each event.

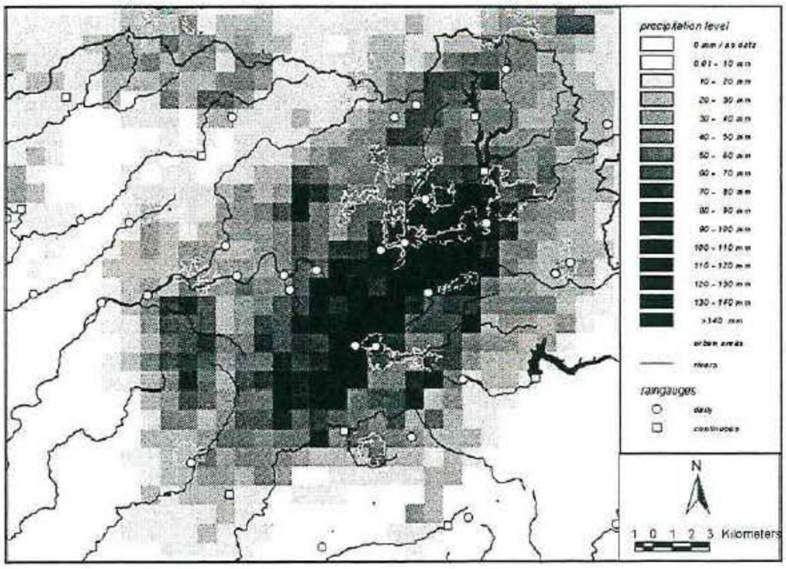

Figure 1: Accumulated radar image for the rainfall event of 3 May 2001

Consequences for the use of radar data are:

- Outlets, bridges and other buildings near rivers and creeks are problematic points for damages
- The quality of the radar images varies between the different radar stations and has to be checked and – where feasible – corrected carefully,
- for the adjustment of radar data, a high densitiy of raingauge stations (continuous and daily values) is helpful.

The produced catchment and pixel time series will be used in hydrological models for planning purposes and for scenario simulations of extreme rainfall.

7. Literature

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2D mathematical flood flow model and its use for flood protection design and sediment transport study

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The method of two-dimensional mathematical modeling was used for study "Flood Flow Model of Elbe River". Detailed hydraulic characteristics (water levels, water depths, directions and values of velocities vectors, specific discharges), which are important for flood dangerous assessment, were determined by the model in the river as well as in the flood plain.

Mathematical model MIKE 21C (DHI Water & Environment, Hørsholm, Denmark) was used for calculation. The whole 110 km long modeled reach Melnik – Hrensko was represented by curvilinear computational grid of size 11032 x 342 points; distance among computational points (i.e. density of calculated results) were from 2 up 15 m.

Very precise simulation results were also used for classification of flooded areas between flood periods. Flooded areas were divided into four safety levels (according to water depth and velocity). Moreover conceptual design of flood protection measures (dikes, walls, etc.) was proposed based on computed hydraulic characteristics and impact of proposed flood protection measures on flow characteristics was evaluated by new calculation. Quite new design of "West bridge near Litomerice town" (level of the road in entire flood plain may not be flooded in the time of high water as in August 2002) was evaluated by the model. Impact of the bridge and roads on high causeways on flow characteristics was minimalised having used results of many computed variants.

Safety of moving vessels in Elbe River was studied on 2D mathematical model, especially in areas of entrances into and exits from approaches of navigation locks and also in many places in a free river where ships could be drifted from their course by transversal flow velocities.

Sediment transport and morphological changes were studied in the 40 km long Elbe reach between Strekov and Hrensko after construction of Male Brezno and Prostredni Zleb barrages under flood condition. Simulations of unsteady flow were applied for period of 6,5 days under real catastrophic flood situation from August 2002 and also for two theoretical floods Q_{20} and Q_5. Geometry of Elbe river channel, embankment and floodplains were changed based on proposed plan on aforementioned barrages including proposed river bed dredging. Grain size distribution of river bed material was detailed described by map of textural classes, based on sediment samples taken from river channel and their granulometric analysis.

Mathematical model has described future sediment transport regime of Elbe reach down Strekov after construction of designed barrages which can be expected, mainly in fairway, during and after flood events. In all river reaches no continuous sediment transport was observed, only local morphological changes appeared. These remarkable morphological changes are linked to the corridor sections proposed for dredging and likewise are connected with high values of vertical velocities and also with the transverse velocity values, which were ascertained in previous research in this locality. Simulation results demarcated areas for necessary fairway dredging and can be used as recommendations for optimum realization of deepening of river channel.

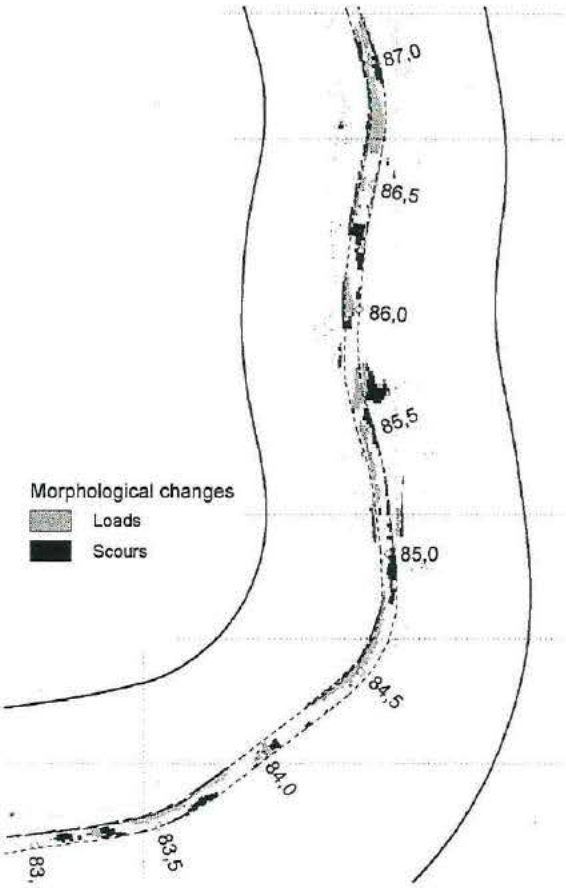

Figure 1: Simulated morphological changes in river section Techlovice – Jakuby; the August 2002 flood

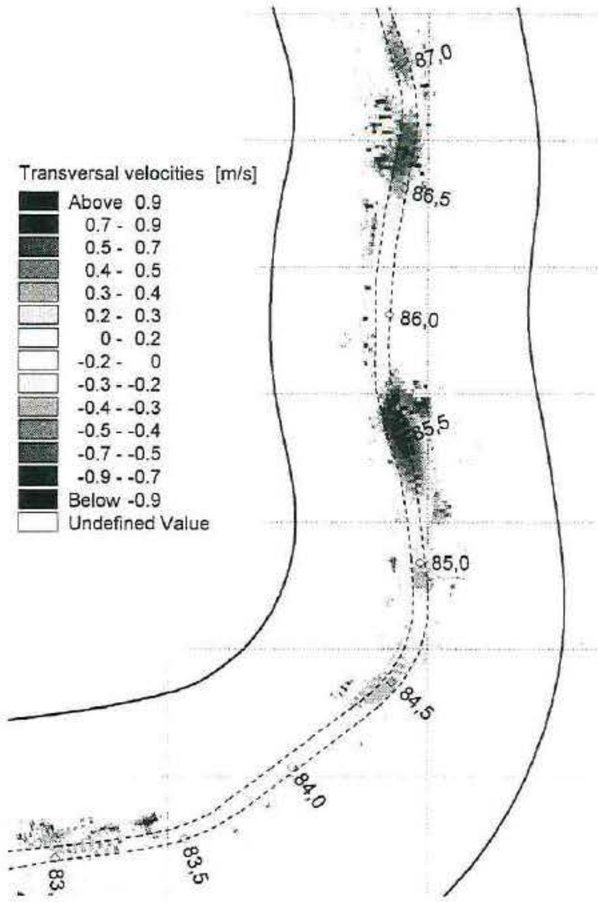

Figure 2: Simulated transversal velocities in river section Techlovice – Jakuby; the August 2002 flood

The results of the 2D mathematical model from the entire 100 km long river reach are also used in order to improve the discharge rating curves in the gauging stations, as boundary conditions for tasks resolved on physical scale models and as necessary input data for the mathematical model of shipping and the effects of the current on moving vessels.

Water quality in rural areas: Keys study Šlapanka River catchment

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Much has been already said and written about water quality during the 1990s. However, researches have been done mainly into big rivers, quality of which has been partly improved by constructing and reconstructing waste water treatment plants triggered off by pressure of neighbouring countries and inhibition of some agricultural activities. The quality of small rivers, running through rural areas, which is still very low, was not properly loked into. Although after 1989 the intensity of agricultural production (especially the amount of fertilizers) has been reduced, the concentration of pollutants produced by agriculture is still very high. Also small settlements - point polluting sources - still conduce to a low quality of surface water. The water quality will probably not improve or it will worsen, because the Czech government asked for an exception from EU Council Directive 91/271/EEC concerning urban wastewater treatment. The term day has been postponed for implementation of the requirements for waste water treatment for aglomerations between 2 000 and 10 000 p.e. and for introduction of more stringent level of treatment required for waste water treatment plants in sensitive areas. The Czech Republic requests a transitional period until 31 December 2010.

The river Šlapanka, a leftside affluent of the river Sázava in Českomoravská highland, was chosen as an example of a river running through a rural area. The river Šlapanka is 33.7 km long and its catchment covers the area of 256.28 sq km. The landscape in the catchment is intensively used. More than 60% of the area serves for agriculture, from which 76% is used as an arable land although the conditions for intensive agriculture are not optimal. The soil productivity is low and the climate is quite cold, therefore high dose of nitrogen and phosphate fertilizers must be used. The population density of the catchment is relatively low. The settlement is of a rather rural nature represented by a large number of small municipalities. The population is a huge source of pollution, because there are only 4 waste water treatment plants there.

This area was studied during 2001 – 2003. During this period samples were taken (monthly – twelve times) from 11 profiles, which are located in the catchment. Chemical analyses (nitrate, nitrite, ammonia nitrogen, chemical oxygen demand (COD), biological oxygen demand (BOD), temperature, pH, conductivity) were made. The results were classified according to ČSN 75 7221 (Czech state norm). There is also a profile (Mírovka) of state observing network there coming under ČHMÚ. It has been continually observed since 1976. Graphs of contrentation development of observed parametres during 1976 – 2001 and dependence analyses on flow and season were made.

The surface water of the Šlapanka river basin is generally of low quality. The concentration of $N\text{-}NO_3$ and $N\text{-}NO_2$ can be considered critical – 10 of 11 profiles belong to the 5^{th} class – very strongly polluted water. The concentration of organic matters below the settlements without the waste water treatment plants, given as BOD_5, is very high, as well (5^{th} class). In the last ten years the concentration of all pollutants has been sinking. Data from profile Mírovka 1976 – 2001 have shown that in the last 10 years the concentration of all pollutants had been sinking. The biggest decrease has been observed in BOD_5 and COD. The reason was building of the waste water treatment plant in town Polná and 3 small villages. Although the amounts of nitrogen fertilizers decreased, the concentration of nitrate decreased least in last ten years. The reason of this small decrease is probably loads from the period where nitrogen fertilizers were used excessively. These fertilizers decompose very slowly and are constantly infiltrating into surface and subsurface water.

To improve the water quality is necessary to support constructing of sewage and waste water treatment plants not only in settlements with more than 2000 p.e., but also in smaller settlements especially by financial subsidies. It is also necessary to change the methods of cultivation of arable land – better way of aplication of fertilizers, effective soil conservation measures, change in land use – changing arable land into meadows, pastures or forests, making infiltration belts alongside streams, support of non-producing functions of agriculture – making use of EU subsidies, etc.

Table 1: Classes of waterquality of choosen profiles

profile	class	profile	class
Věžnice	V.	Dobronín - Zlatý p.	V.
Věžnička	V.	Dobronín - Mlýn. p.	V.
Dobroutov	V.	Dobronín below v.	V.
Polná - Sapeli	V.	Šlapanov	V.
Polná - ž. h.	V.	Mírovka	V.
Věžnice u Šlap.	V.		

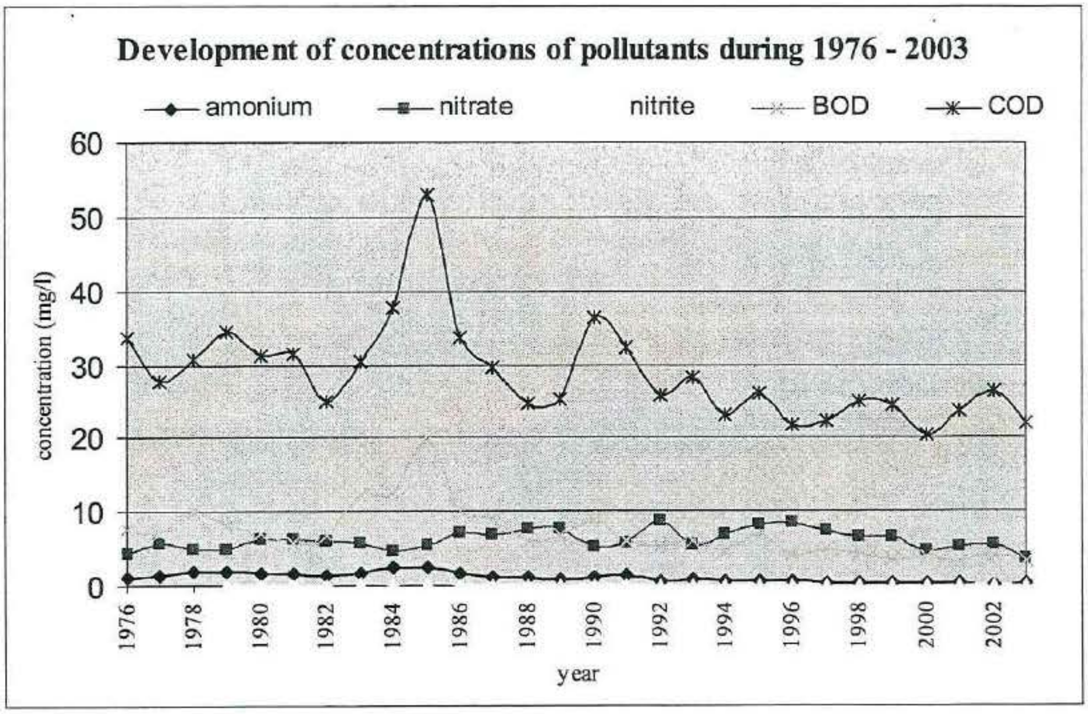

Figure 1: Development of concentrations of pollutants during 1976 – 2003

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Changes in contamination of the River Mulde since 1975 reflected by sediment cores from the river reservoir near Bitterfeld

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The River Mulde has flowed through the Bitterfeld Mulde river reservoir (Saxony-Anhalt, Germany) since 1975. The reservoir acts as a main sediment and pollutant trap for the suspended matter transported by the Vereinigte Mulde ("United Mulde"). Sediment cores extracted in 2002 from various parts of the river reservoir (Friedersdorf basin, main basin) proved to be an excellent geological archive when it came to understanding how the quality of the suspended matter transported by the Mulde including the inorganic contaminants attached to it has developed over time. The extensive lamentation of the reservoir sediment can be attributed to the alternation of dark, highl bioproductive organically rich layers and light event layers with sizeable clastic fractions.

Using various methods and time markers (radiometry: ^{137}Cs, ^{238}U; geochemical trends of the declining pollution of rivers and lakes since the process of German reunification in 1989/90; flow data of the Mulde), the sediment cores from the Bitterfeld Mulde river reservoir can be divided into four different sedimentation periods: (a) the sediment substrate (the surface of the former opencast mine), (b) the period prior to German unification (1975–1989/90), (c) post-reunification (1989/90–2002) and (d) the flood in August 2002. The sediment deposited during these periods varies in terms of the elements it contains (total grain, <20µm fraction). The sediment deposited in the Mulde river reservoir during East German times mostly contains higher concentrations of in particular nutrient indicators (loss on ignition, total phosphorus) and pollutant elements (e.g. As, Pb, Sn, Zn, Cd, Cr, Ni, Cu and U). The sediment deposited during the major flood in August 2002 is characterised by significantly higher concentrations of the elements As, Pb and Sn in the surface sediment stemming from material washed away from the industrial waste heaps by the Freiberg Mulde during flooding.

Alongside their temporal classification, the geochemical data obtained from the cores is discussed in connection with the structure of sediment layers and the position of the cores within the reservoir.

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Arsenic and heavy metals in the Mulde River system – Eevolution and consequences of the August 2002 flood

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1. Introduction

The Mulde river is a tributary of the Elbe river, and results in the confluence of Freiberger Mulde, Zwickauer Mulde, and Vereinigte Mulde. Due to its high metal load, the Mulde is one of the dominating source of contamination of the Elbe river. The Mulde catchment area is characterized by anomalous element concentrations from geogenic and anthropogenic sources. Research campaigns in 1991 and 1993 were conducted to assess the pollution situation (Table 1). Subsequent studies established the temporal evolution of metal pollution and led to conclusions for the future.

Table 1: Occurrence and intensity of metal pollution in the Mulde river system

I_{geo}-class (Müller 1979)	4 highly polluted	5 highly – excessively polluted	6 excessively polluted	7 extremely polluted
Freiberger Mulde	Cu			As, Pb, Zn, Cd
Zwickauer Mulde	Pb, Cu	As, Zn	U	Cd
Vereinte Mulde	U	Pb	As, Hg, Zn	Cd

2. Characterization of flood sediments

The extreme flood in August 2002 resulted in the highest known water level and influenced the river system tremendously. Sediments and overbank material were suspended by the flood and large amounts of polluted material were transported downstream and into the Elbe river. These flood sediments are characterized by extremely high concentrations of As, Cd, Pb, Zn, and partly U. Geochemical and mineralogical analyses identified sediment particles and material from industrial dumps as the main components of these flood sediments. Comparison of the contents of critical elements in the fine sediment fraction (< 20 µm) and the fraction < 2 mm shows that the coarse fraction is also enriched in metals. The X-ray amorphous part of the coarse fraction amounts to up to 40 % in the Freiberger Mulde river. It contains glassy slags, iron hydroxides, and organic components such as charcoal.

3. Chemical availability of elements in flood sediments

Sequential leaching experiments showed that elements related to pollution are bound differently to geogenic material. In the extremely polluted sediment samples (<20 µm) from the sites Hilbersdorf (FM17HI) and Halsbrücke (FM15HA) in the first step of four-stepped extraction (BCR method) already mobilized high amounts of Cd (72 %), Zn (41 %), Mn (44 %) and Pb (10 %) With respect to the high total concentrations of these elements in the flood sediments (Cd up to 74 mg/kg, Pb up to 14,400 mg/kg), it is a great potential to produce high concentrations in seepage water during the soil passage. From the elements with lower total concentrations Ni, Co, and Cu up to 40 % were mobilized. In the second step Pb (62 %), Ag, As, Tl, Mn, and Cu (30 - 45 %) were dissolved preferentially. Treatment with aqua regia in the last step of leaching led to dissolution of more than 50 % of the remaining contents of Sb, Al, Cr, Fe, Tl, Ni, and As.

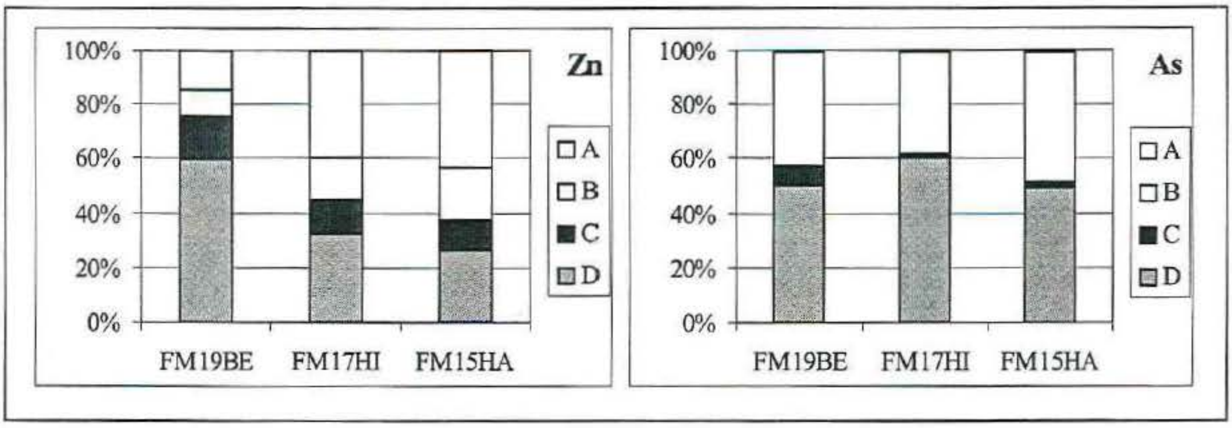

Figure 1: Sequential extraction (BCR method) of flood sediment samples (< 20 µm) from the Freiberg region: Percentage of the fractions (Treatment with A – acetic acid, B – hydroxylamine hydrochloride, C – hydrogen peroxide/ammonium acetate, D – aqua regia) of the overall content soluble in aqua regia.

4. Temporal development in highly polluted river sections

Intense studies of the input and output situation in the highly polluted river sections „Freiberg" (Freiberger Mulde) and „Aue and Zwickau" (Zwickauer Mulde) indicated a permanent discharge of toxic elements into the river. River sediments deposited 2–3 months after the flood were more polluted than sediments from 1992 for several elements.

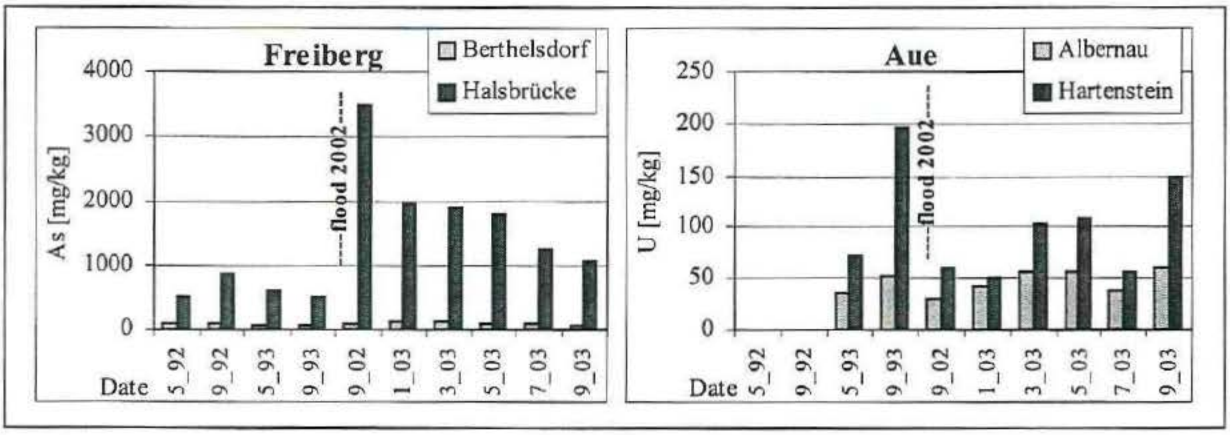

Figure 2: Temporal development of As in sediments (< 20 µm) in the highly polluted area Freiberg/Freiberger Mulde and U in area Aue/Zwickauer Mulde.

The elements As, Cd, Pb, Cu, and Zn in the Freiberger Mulde river at the exit of the highly polluted river section Freiberg show a high increase in concentration in the sediment as well as in dissolved and particulate matter (enrichment factors for example Zn dissolved up to 100, Pb particular up to 20). At the exit of the region Aue/Zwickauer Mulde significantly increased concentrations of elements As, Ni, and U indicate the permanent pollution of the river section. At the region Crossen/Zwickauer Mulde no further increase of the element contents occurs. In consideration of the current geochemical situation in the river sections transport of heavy metals and arsenic will continue from Mulde river into Elbe river. A number of discrete and diffuse sources can be identified by detailed monitoring of the highly polluted river sections. To reduce the entry from these sources of metal pollution is the great intention for Elbe river. Based on geochemical reactions with so-called passive procedures at the source and in the river system itself, an economical improvement of the pollution situation can be achieved. First results of a successful in situ experiment in a closed tin ore mine are being presented in the lecture.

Multi-functional landscape evaluation and multicriteria optimization of land use for the catchment area management

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The procedure presented contributes to solving the land use decision problem, which is necessary for river catchment management. Methods for the derivation of ecological targets, the assessment of environmental functions, scenario technologies, and integrative procedures for decision support are combined for this approach.

The main objective of the project „Analogy of methods of the decision making of function-related goals of the landscape evolution in heterogeneous spatial units" carried out by the Saxon Academy of Sciences and the Centre for Environmental Research (UFZ) is the formulation of ecological targets for areas on the meso-scale. Meso-scale areas form the spatial basis of the project. They relate to natural units (micro-geochores) and landscape units of lower order which are determined by land use. Micro-geochores are natural units of lower order assembled within altitudinal belts according to petromorphic parameters (substrate, relief, hydromorphy) (Sandner 2002). Landscape units are classified according to land use (Krönert 1999). Data availability differs for the two types of reference areas. A data base containing a wide range of aggregated data for Saxony is available for micro-geochores. Whereas, different public digital data sets are used for the assessment of landscape units.

The method to elaborate ecological targets, called "Leitbildmethode Westlausitz" (Bastian 1999, 2002) (Figure 1), was linked with the method of "Multicriteria Optimization of Land Use" (LNOPT by Grabaum 1996, Grabaum et al. 1999, Meyer und Grabaum 2003) in a study area. The size of this area, situated in the south-east of Leipzig, is almost equivalent to the catchment area of the river Parthe.

Apart from the hydrological functions such as water retention capacity, ground water recharge, and ground water protection, the multifunctional assessment of landscapes also includes the potential biotic yield, the habitat function, the resistance to soil erosion and the function of recreation. Based on evaluations, an interference analysis and the determination of actual and potential risk areas of landscape functions and landscape components will be continued. In the course of the identification of mono-sectoral goals, the achievement of targets or differences between state and goal for current and future decisions of land use are shown. A balanced landscape-ecological concept for conservation and development contains both the combination of function-related aims for integrated comprehensive complex targets and recommendations to reduce differences between targets and state. By means of a decision tree the multicriteria optimization program LNOPT will compile land use scenarios for the conflict area.

This optimization represents the ideal compromise between different land use options for the whole catchment area while enhancing the capacity for the natural balance at low "social expenses". A heterogeneous mosaic of land use would meet these requirements. In a final step areas with identical or similar landscape-ecological problems/goals will be classified.
The method described offers the possibility to outline conflicts between environmental goals and actual states in a quantitative and qualitative way. For the management of catchment areas results are presented as GIS-based scenarios. Thereby aims for land use decisions can be integrated. This methodology can be very helpful for policy consulting and some planning instruments.

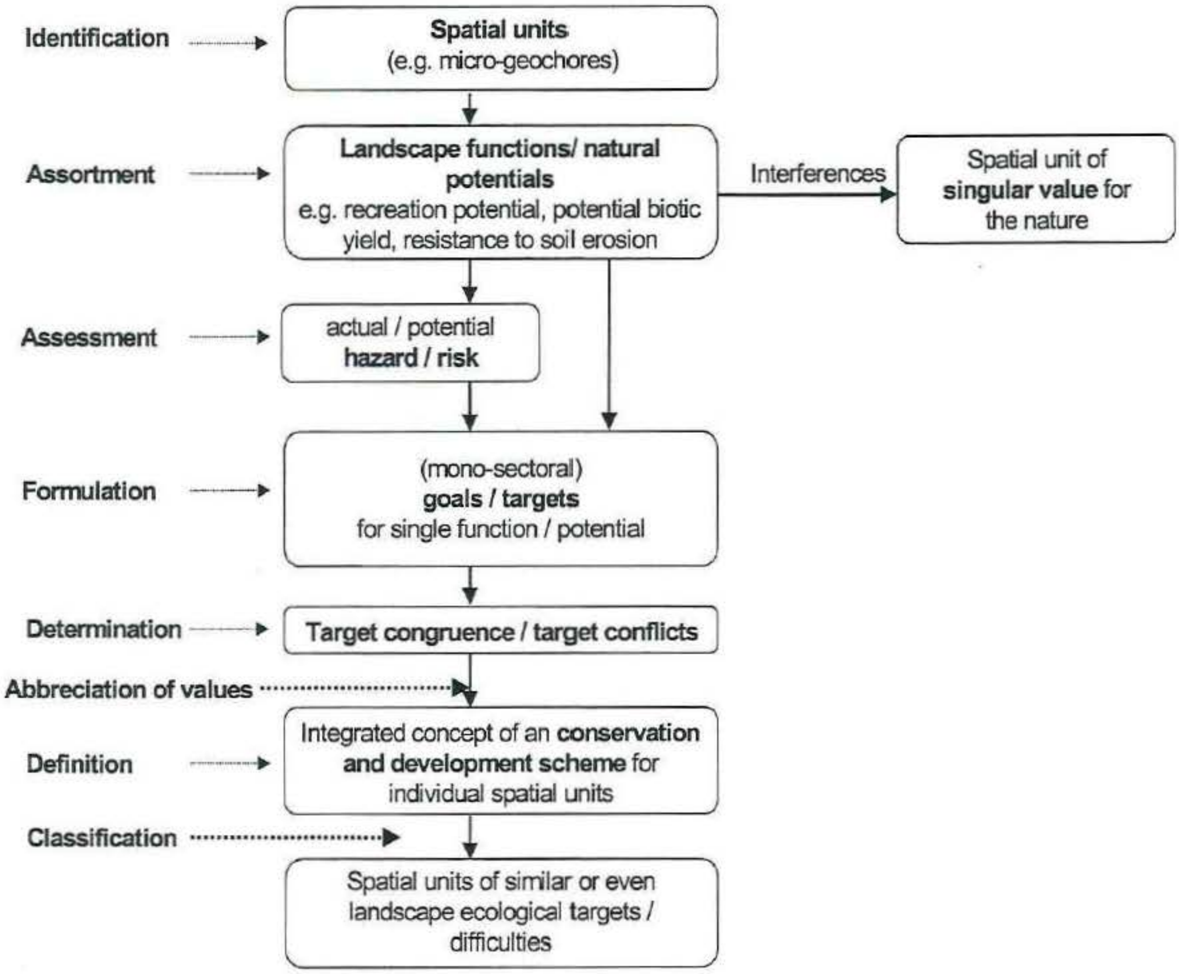

Figure 1: Algorithm to elaborate ecological targets (Leitbildentwicklung) for spatial units (Bastian 1999, changed)

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Integrated assessment of measures in watershed management with an DSS-approach: Results and experiences

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Increasing demands of society regarding use and protection of water bodies, new aspects and strategies towards (the making of) policy for river basin management call for multidisciplinary approaches. River basin management demands answers on complex questions. To give answers and first to achieve a better understanding of these complex relationships a decision support system (DSS) for integrated river basin management of the German part of the Elbe river basin is currently under development (Kofalk et al. 2004). This contribution tells about approach, results and experiences of the DSS-design process.

First the stakeholders and potential users, their roles and interests in the watershed management system were identified. Based on this knowledge relevant management objectives and measures were defined. To make modelling results operational the indicators, oriented on disciplinary demands and used in daily decision processes, had to be set up. The user integrating development resulted in a modular concept, structured to deal with hydrologic, ecologic, economic and social aspects related to water systems at different spatio-temporal scales of the processes involved: catchment, river network, main channel and floodplain.

Main concern of the lecture is to present the first prototype of the DSS. We will demonstrate the set up of the conceptual work (Figure 1). Recent integrated functionalities demontrate how the DSS gives an impact assessment and an evaluation for the user taken measures (e.g. on water quality, ecological quality of floodplains, navigation or flood prevention).

Furthermore experiences on the participative process of building up the systemdiagram and on the formulation of the user oriented interface are results of the project itself. From the technical point of view the modeling uncertainties by coupling models of different scientific disciplines, scales and data qualities had to be faced. References to the experiences of the model developers to solve consistency problems e.g. in the precipitation-runoff and discharge relations to connect related functionalities are given.

An outlook on the planned use of the DSS (-concept) within policy making decision processes closes the presentation.

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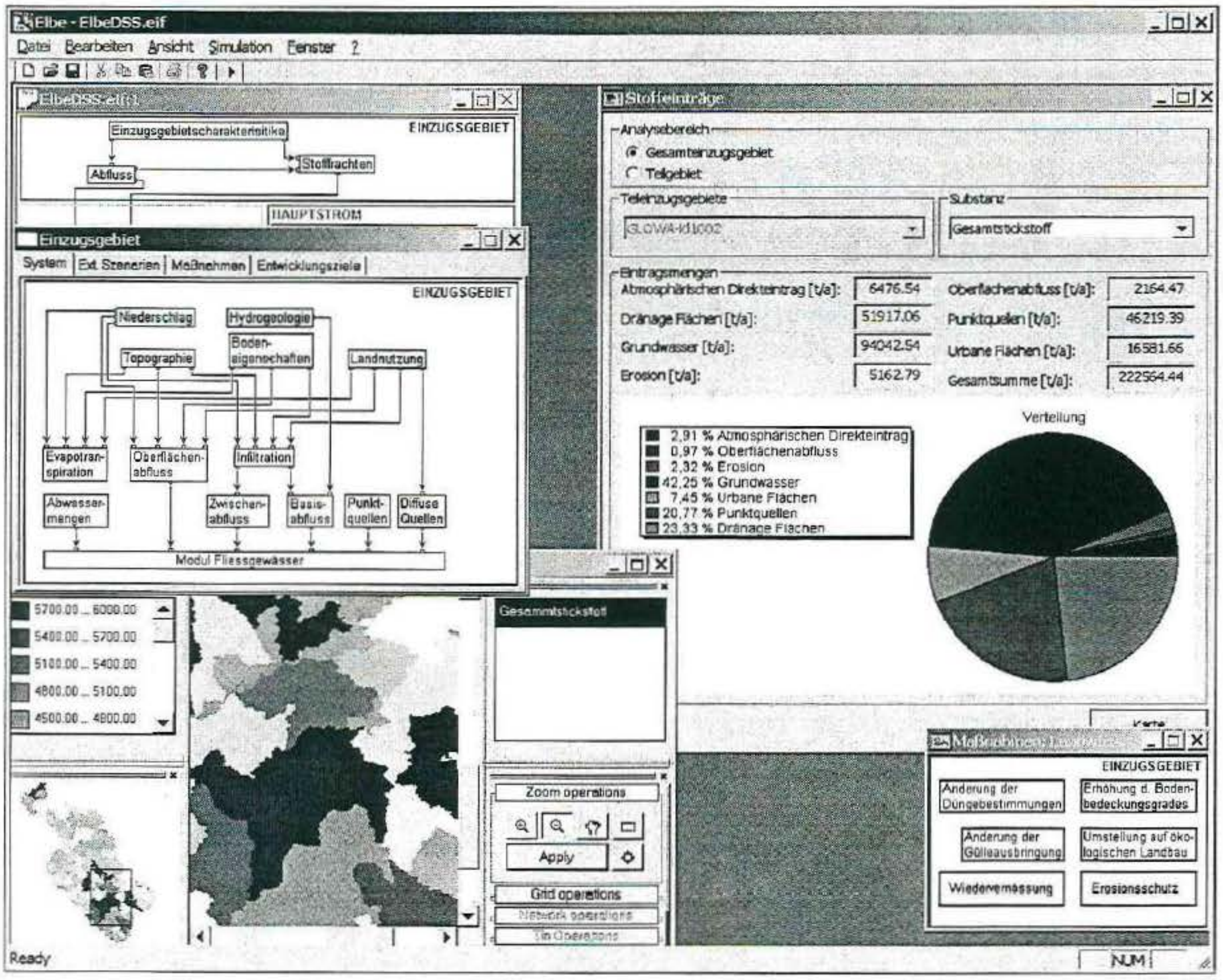

Figure 1: User-interface with activated windows of functionalities related to the waterquality (loads of pollutants from the watershed and some related measures to decrease)

Support of decisions in flood risk management by the Elbe-DSS: Results and experiences

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The increasing demands of society for flood risk reductionand risk assessment call for a multidisciplinary approach for river-basin management. This was illustrated by the Elbe flood catastrophy of 2002. To achieve a better understanding of the complex relationships between river engineering works, flood risk, and ecology, the Federal Institute of Hydrology (BfG) took the initiative to develop a prototype decision support system (DSS) for integrated river basin management of the German part of the Elbe river (Kofalk et al. 2004). Based on the management objectives and measures identified by committee of end-users, the functionalities of the Elbe-DSS were defined.

The lecture will address the technical and organizational aspects of modelling and data collection related to the flood risk functionality of the Elbe-DSS. First, an overview on available data in the federal states is given, e.g. on digital elevation models (DEM) and dike information (Figure 1). Methodological aspects of the necessary data transformation steps for georeferenced combination of the data for different modelling approaches will be explained. Examples of the presentation of the information for decision makres will be given (Figure 2). The experiences of the model developers and required further steps will be discussed.

Second, the possible application of the DSS in the context of strategic assessement of basin-wide flood mangement options will be dicussed. A current focus of the DSS is to provide a longitudinal assessment of costs and benefits of flood protection measures related to dikes and creation of additional retention capacity. The DSS approach allows for the assessement of the distribution of costs and benefits between upstream and downstream river sections and federal states. This kind of information is important for basin wide cooperation in flood risk reduction and burden sharing. Benefits are not only described in terms of avoided damage, but also in terms of ecological indicators. Possible trade-offs and complementarities between goals of flood protection and nature conservation can be made explicit. This kind of information is important for developing an integrated river basin management strategy encompassing both flood risk and floodplain management goals.

The examples demonstrate how the a (Elbe-) DSS can offer information to the public and how model outcomes could be presented in a useful way to decision-makers, whilst keeping in mind the DSS is not a forecasting tool but a strategic instrument.

Literature

Kofalk, S., Scholten, M., Boer, S. de Kok, J.-L., Matthies, M., Hahn, B.(2004) Ein Decision Support System für das Flusseinzugsgebiets-Management der Elbe. In: Möltgen, J., Petry, D. (Hrsg.) Interdisziplinäre Methoden des Flussgebietsmanagements, Schriftenreihe des Instituts für Geoinformatik der Westfälischen Wilhelms-Universiät Münster, Workshopbeiträge 15.-16. März 2004, Band 21, S. 1-10, Münster 2004.

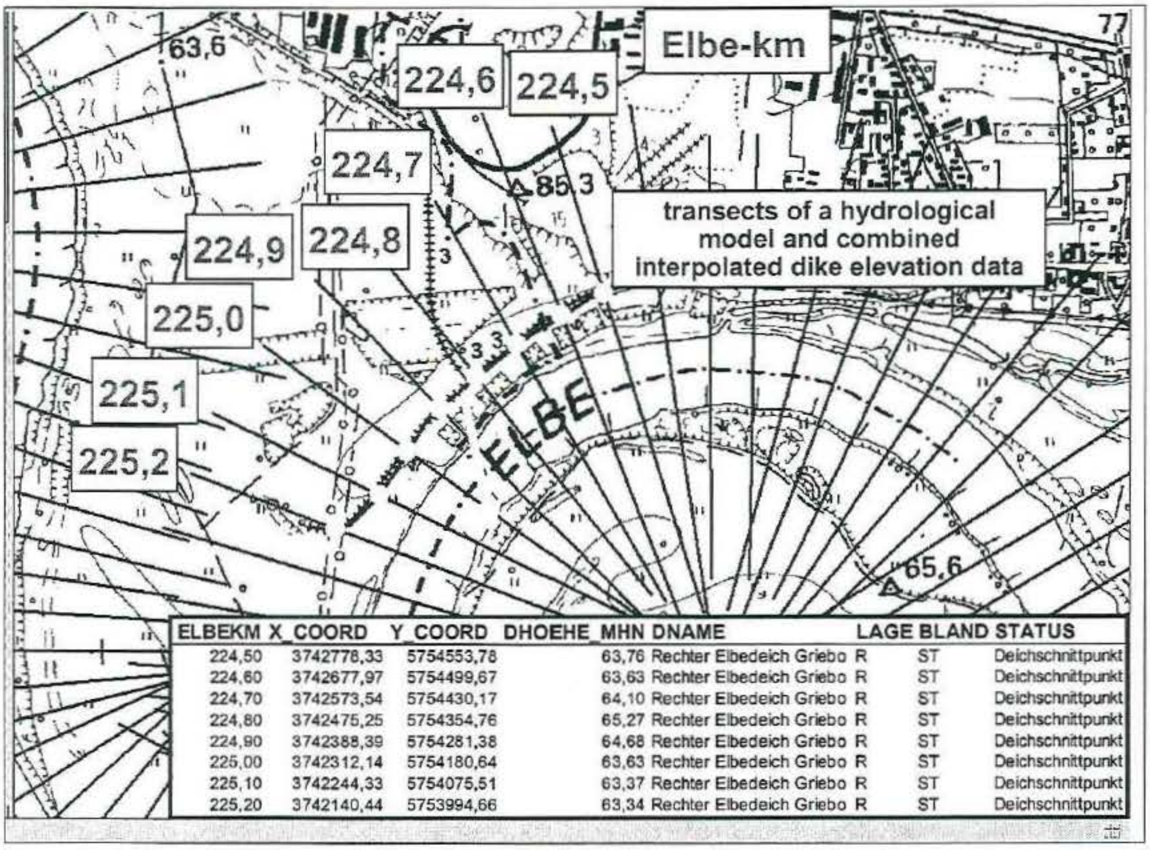

Figure 1: Combining transects of a hydrological model and interpolated dike elevation data

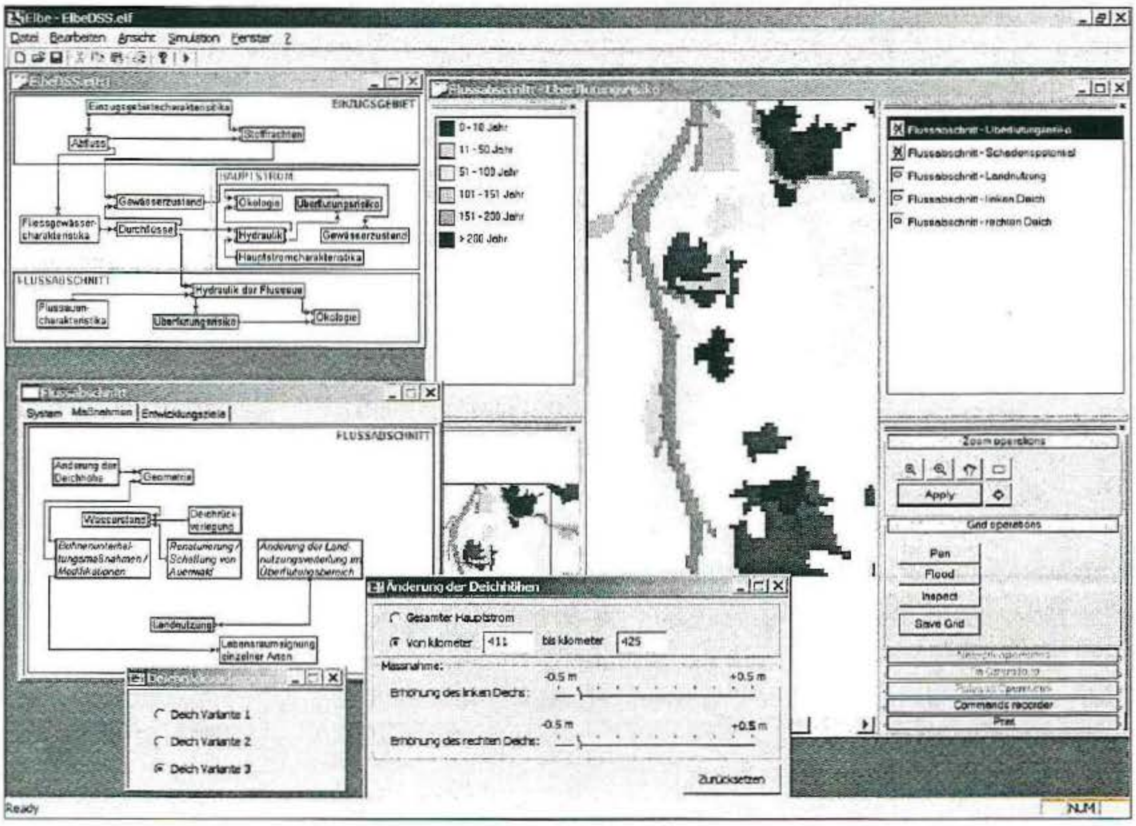

Figure 2: Draft of the user-interface with activated windows of functionalities related to the flood risk management of the pilot-DSS for the Elbe.

Abiotic typology of Polish lakes

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1. Introduction

According to the Water Framework Directive (OJEU 2000), surface water bodies have to be identified and assigned to the type by each member state. The typology is mainly aimed at the definition of type-specific reference conditions for hydromorfological, physico-chemical and biological elements.

Poland has a population of some 9000 lakes with a surface area of more than 1 ha. The distribution of lakes in Poland is quite uneven. The greatest number of lakes is located in the northern and the central parts of the country in the limit of last glaciation. The lakes form several well distinguished lakelands. There is also a small group of lakes in the eastern part of the country, of which only 16 have the surface area exceeding 50 ha. Also, in a small group of lakes near Legnica, only two of them have area greater than 50 ha. In Tatra and Sudety Mts. ten small and deep mountain lakes of surface area not greater than 40 ha are situated.

2. Material and methods

Typology of Polish lakes has been established based on data set from monitoring network. Lake monitoring in Poland, which has been carried out for almost 30 years, provides extensive data on quality of waters, as well as morphometric, hydrographic and catchments area characteristics of lakes. Generally, lake monitoring programme has been implemented on lakes greater than 50 ha. At the moment working data set comprises over 1000 Polish lakes, of which 749 have the surface exceeding 50 ha (Cydzik 2003). Because of the availability of data, the typology of large lakes (>50 ha) was considered in the first place. All morphometric and physical as well as some chemical data were analysed using simple descriptive statistical methods together with expert judgement. Also some quality parameters of waters were used in the determination of class boundaries of the typology factors.

3. Typology criteria according to Annex II of Water Framework Directive

Lake types have been differentiated using criteria of System A of Annex II WFD in combination with selected criteria of System B. They were the following:

(i) Ecoregions: According to Illies (1978) referred in Annex XI WFD, Poland shares four ecoregions. Since ecoregions distinguished by Illies are not exactly adequate to Polish conditions, physico-geographical regionalization of Poland was applied (Kondracki 1998), based on geomorphological features, climatic and geobotanical conditions. All Polish lowland lakes are situated in two regions: Niż Środkowopolski belonging to the western part of Europe, and Niziny Wschodniobałtycko-Białoruskie belonging to the eastern part of Europe.

(ii) Size: As mentioned above, for the time being, the typology of large lakes only is considered.

(iii) Altitude: All Polish lakes of surface area greater than 50 ha are situated <200 m asl and fall into lowland class. Only 10 small and deep mountain lakes are situated above altitude of 800 m and belong to the high altitude class.

(iv) Mean depth: Mean depth of 25 % of lakes greater than 50 ha does not exceed 3 m. The share of lakes of mean depth greater than 10 m constitutes some 14 %. The majority of Polish lakes have mean depth between 5 and 10 m and belong to shallow lake class. This class comprises both stratified and unstratified lakes. For Polish lake typology purposes it was reasonable to distinguish two types of water mixes, stratified and fully mixed lakes, instead of depth classes.

(v) Geology: Although the majority of Polish lakes are situated in the area of postglacial deposits of mixed geology, they can be described as hard water ecosystems. Thus, geology was considered by parameters which reflect its influence on hydrochemistry i.e. content of calcium and alkalinity, as well as conductivity and water colour. The content of calcium in lake waters ranges from 1.2 to 202.2 mgCa/l, being most frequently in the range of 40-70 mgCa/l. Only in a 3,5 % of ecosystems, well known as *Lobelia*-lakes, the content of calcium is lower than 25 mgCa/l. Also, alkalinity not exceeding 1 mmol/l occurs only occasionally. In the majority of lakes, values of this parameter reach 2-3 mmol/l. For Ca content the border of 25 mgCa/l was expedient to distinguish two classes of Polish lakes: low and high calcium ecosystems. In case of alkalinity, it refers to the value of 1,3 mmol/l.

Conductivity was used to distinguish a small group of costal lakes with influences of saline waters. Water colour of lakes greater than 50 ha exceeds 60 mgPt/l only in 1,2 % of lakes. Therefore, all Polish large lakes were considered light water ecosystems.

(vi) Additional criteria: Optional factor considered as important for lake functioning, was the intensity of the catchment area impact upon the lake expressed as the ratio of catchment area and lake volume (Schindler's ratio SR). Lakes with low values of Schindler's ratio are considered to susceptible to a smaller extent to degradation due to their favourable morphometric, hydrologic and catchment conditions. For this factor the border of 2 was expedient to distinguish two classes of lakes: with low and high susceptibility to degradation.

4. Typology of lakes in Poland

On the basis of the combination of two regions (Niż Środkowopolski and Niziny Wschodniobałtycko-Białoruskie), one altitude class (<200 m asl), one size class (>50 ha), two calcium content classes (Ca>25 mg/l and Ca<25 mg/l), two classes of Schindler's ratio (SR<2 and SR>2) and two classes of mixing conditions (stratified and unstratified lakes), all 749 lakes from the Polish database were attributed to the following types:

Ecoregion: Niż Środkowopolski (the western part of Europe)
Subregion (hydrological landscape): lakelands on postglacial deposits
1. lowland, low calcium content, stratified (a) and unstratified (b)
2. lowland, high calcium content, low Schindler's ratio, stratified (a) and unstratified (b)
3. lowland, high calcium content, high Schindler's ratio, stratified (a) and unstratified (b)
4. lowland, high calcium content, with influences of saline waters
Ecoregion: Niziny Wschodniobałtycko-Białoruskie (the eastern part of Europe)
Subregion (hydrological landscape): lakelands on postglacial deposits
5. lowland, high calcium content, low Schindler's ratio, stratified (a) and unstratified (b)
6. lowland, high calcium content, high Schindler's ratio, stratified (a) and unstratified (b)
Subregion (hydrological landscape): lakeland on Równiny Poleskie in the eastern part of Poland
7. lowland, high calcium content, stratified (a) and unstratified (b).

The second task will be to verify this typology using biological elements and to check if the differentiation of abiotic conditions corresponds with the variability of biological assemblages.

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Ecological Discharges and Recolonization of Benthic Community in Urban Stream

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1. Introduction

The most important impacts of urbanisation are changes in hydrological cycle and runoff processes. The balance between underground water and surface water is disturbed. The runoff during rain is very fast and the water volume in stream and the water flow increase unnaturally and exceed the natural maximum. On the other side the water which left the watershed by fast runoff is missing in the groundwater balance during dry periods and the water flow decrease below the natural minimal flow. The trend of high urbanisation and consequently manipulation of the water flow in urban streams brings the necessity to define ecological discharges. The Directives 2000/60/EC defines the ecological discharges as a range of the discharges which make possible good living condition for aquatic organisms.

2. Methodology

The methodology IFIM- Instream Flow Incremental Methodology (Bovee, 1998) was used to define the ecological discharge for macrozoobenthos community. Physical simulation of habitats is done by a software component PHABSIM – Physical HABitat SIMulation system. This program is used especially for ecological modelling of predictive changes in physical habitats for individual organisms and their life stages, which are dependent on discharge. This methodology was used to assess ecological discharges for most common species of benthic community in urban stream in Prague agglomeration, the Kunraticky creek. The Kunraticky creek is a tributary of the Vltava River and an observed part was situated below two ponds, where lot of meanders are present. There is one storm outlet and sampling places were chosen to record influence of this outlet. Sampling place K1 was located above this outlet and we supposed that its benthic community would not be affected so strongly as community below the outlet.

The second part of the project was focused on situation when the ecological discharges are not kept and the benthic community is impacted by hydraulic stress and consequently disturbed. When the hydraulic stress is finished the organisms started to recolonize habitat from which other organisms were wash out. The process of recolonization was observed with help of samplers filled with artificial substrate. These samplers were put in to the stream and weekly collected. Organisms in and on samplers were collected, determinate and counted. During the experimental period hydraulic parameters (water depth, velocity) were continually monitored and the discharges were calculated.

3. Results and discussion

The results obtained by using methodology IFIM showed the ecological discharges for the most common species of benthic community and for benthos feeding groups. The suitability curves identified optimal microhabitat parameters (depth, substrate and velocity) for different feeding groups of benthos. Variation among species and feeding groups were observed and show seasonal variations (Figure 1).

Taylor and Kovats, 1995, presented that total recolonization is finished in 28-45 days. The complete recolonization was not observed on the study stream due to rain events, which in most cases decrease number of individuals and species on sampling sites.

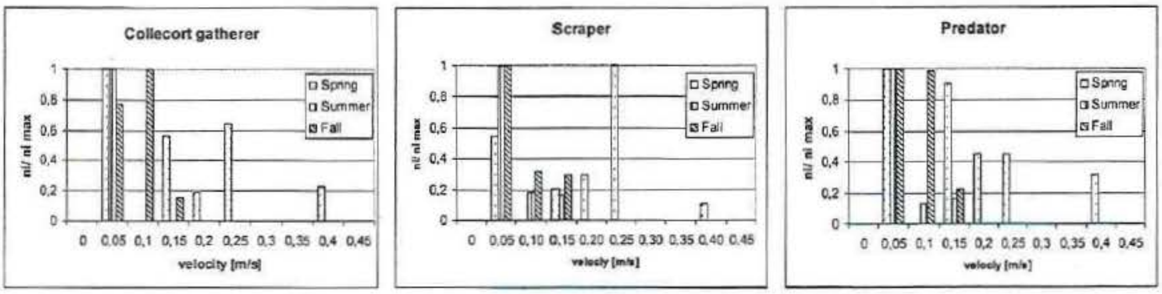

Figure 1: Velocity habitat suitability indexes for different feeding groups of benthic community and ist variation during vegetation season

The result of recolonization experiment showed, that number of individuals is a very good indicator of colonization, because it is strongly influenced by discharge (Komínková, 2004). During recolonization experiment differences among species and feeding groups were observed, the group of collector –gatherer had the highest speed of recolonization and the number of individuals in this group was significantly higher than in case of other species as predator, scraper and collector-filterer. The group of collector-gatherer was most sensitive to increase of discharge after rain events (Figure 2).

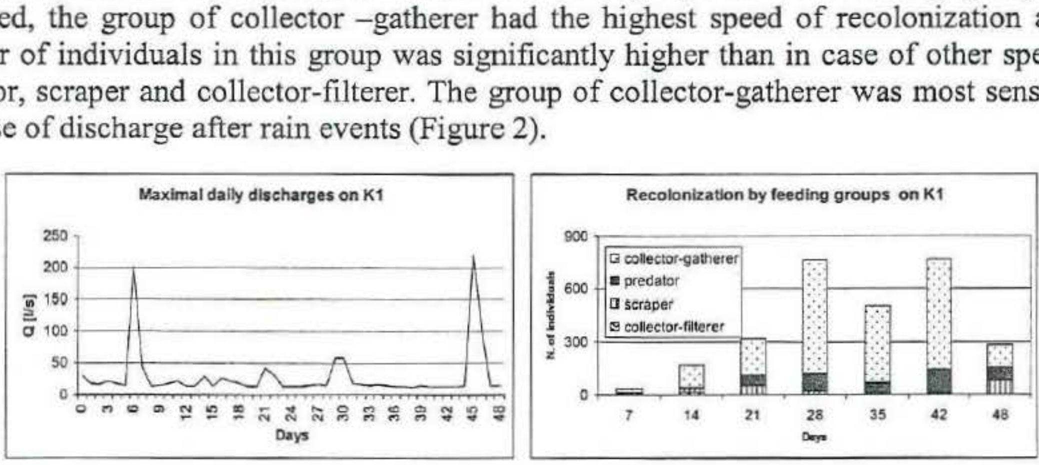

Figure 2: Maximal daily discharges and recolonization process by feeding groups on site K1

4. Conclusion

The storm sewer outlet caused that the optimal ecological discharge is exceed during rain events and organisms are washed out and the community is disturbed. The community needs 28-45 days to regenerate. In case that other heavy rain event comes before the recovery is finished the community is not able regenerate completely and becomes more disturbed and the recolonization period is extending.

Program PHABSIM showed that different feedings groups required different values of microhabitat parameters as substrate, velocity and depth and also seasonal variation was observed. The recolonization experiment showed that the ability to colonize new habitat varies among benthos feeding groups and that the group collector –gatherer is most successful.

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Trends in water quality variations in the Odra River the day before implementation of the Water Framework Directive

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Owing to the wide variety of water quality monitoring and assessment methods that are in use [Korol et al. 1997] no reliable comparison of riverine water quality could be carried out, even for Europe's largest transboundary rivers. This is what triggered the need to unify the monitoring, assessment and classification methods.

The Guidelines on Water Quality Monitoring and Assessment of Transboundary Rivers (established for the UN/ECE Task Force) [Report 1996] have identified 50 transboundary streams, including 8 transboundary rivers (Danube, Elbe, Meuse, Mosel, Odra, Rhine, Saar and Schelde), for which international commissions on environmental status assessment have been appointed. A further unification step was the establishment of the International Water Assessment Centre (IWAC) at The Netherlands Institute for Inland Water Management and Waste Water Treatment (RIZA) in the year 2000. In their Draft Report of March 2001, IWAC assessed the environmental status of 10 transboundary rivers in Europe [Draft Report 2001], which shows that Poland's two transboundary rivers (Odra and Bug) do not differ in water quality from the other assessed boundary rivers in Europe (Table 1).

Table 1: Average annual values of some water quality parameters measured in 10 European rivers [Draft Report 2001].

River	Average annual concentration								
	mg/l								µg/l
	BOD_5	**O_2**	**P_{tot}**	**N_{NH4}**	**N_{NO3}**	**N_{tot}**	**Cd**	**Zn**	**lindane**
Danube	3.0	8.2	0.07	0.4	1.48	n.d.	0.003	0.021	0.04
Rhine	n.d.	10.2	0.21	0.07	3.2	4.33	0.0008	0.023	0.0027
Elbe	n.d.	8.6	0.18	0.24	3.6	4.9	0.0001	0.033	<0.0025
Daugava	1.9	11.3	0.06	n.d.	n.d.	1.6	n.d.	n.d.	n.d.
Odra	**3.9**	**11.1**	**0.25**	**0.068**	**2.4**	**3.75**	**b.d.**	**0.006**	**0.0055**
Tagus	3.3	8.6	0.18	0.18	4.4	n.d.	n.d.	n.d.	n.d.
Tisza	1.9	9.3	0.24	0.12	1.54	2.06	0.0007	0.105	0.012
Meuse	n.d.	9.2	0.19	0.17	4.15	4.83	0.0003	0.034	0.005
Bug	**5.2**	**11.8**	**0.22**	**0.41**	**1.83**	**3.9**	**0.001**	**0.011**	**0.002**
Morava	5.8	n.d.	0.6	1.95	5.67	n.d.	n.d.	n.d.	n.d.

Note: n.d. = not determined, b.d.=below detection.

In Poland, the environmental status of the river Odra and its tributaries has been assessed since 1962, and the results have been published in the form of atlases of riverine pollution [Korol 1994]. Use has been made of a unified assessment method, and the list of the pollutants that were to be determined has been increased from 8 to 52. The first atlas was published in 1973, and this year has been adopted as the starting point to the analysis of water quality variations up to 2002 in the Polish part of the Odra basin (9 rivers of a total length of 2668 km). In this time span the following parameters and pollutants have been determined: dissolved oxygen content, BOD_5, COD_{Mn}, suspended solids, chlorides, sulphates, dissolved substances, and phenol compounds. The water quality variations observed in the past three decades are shown in Table 2.

Table 2: Water quality variations in the river Odra and its tributaries in the time span of 1973 to 2002.

Class of purity	Length of purity class							
	1973		1983		1993		2002	
	km	%	km	%	km	%	km	%
I	130.9	4.9	143.2	5.4	695.4	26.1	969.6	34.8
II	704.8	26.4	535.1	20.0	1238.1	46.4	1432.5	51.3
III	847.8	31.8	790.3	29.6	365.7	13.7	301.9	10.8
out of class	984.5	36.9	1199.4	45.0	368.8	13.8	85.9	3.1
Total	2668.0	100	2668.0	100	2668.0	100	2668.0	100

Analysis of the Odra river pollution due to organic substances and biogens (whose concentrations have to be reduced to meet the requirements of the Baltic Sea Water Protection Act) has revealed a substantial improvement in riverine water quality along the entire length of the Odra over the last decade.

Table 3: Average annual values of some water quality parameters measured in the river Odra in 1993 and 2002.

Odra	Average annual concentration, mg/l							
	O_2		BOD_5		N_{tot}		P_{tot}	
	1993	2002	1993	2002	1993	2002	1993	2002
km 20.0	8.0	9.4	10.6	5.7	7.5	4.0	0.61	0.25
km 126.2	10.3	10.8	8.5	3.7	9.9	4.2	0.64	0.26
km 249.0	10.2	11.1	8.6	4.1	8.9	4.5	0.42	0.20
km 428.8	9.4	10.3	6.5	4.2	9.2	4.2	0.45	0.21
km 530.6	10.1	11.1	6.5	4.5	8.2	3.9	0.40	0.19
km 615.0	10.1	11.0	5.4	3.5	4.5	2.9	0.37	0.19
km 701.0	11.9	11.4	5.8	4.3	4.5	3.4	0.39	0.24

The decrease in the concentrations of particular pollutants, especially that in the concentration of total phosphorus, results from the implemented programme of enhanced wastewater treatment in the whole Odra basin [Dubicki et al. 1999].

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Flood loss reduction due to private precautionary measures - Lessons learned from the Elbe flood in August 2002

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The best strategy to avoid flood damage is certainly to avoid settlements and infrastructure in flood prone areas. Building houses and accumulating values in inundation areas is always a risk, since absolute flood protection is impossible. Where settlements already exist, flood damages must be kept as small as possible. Examples like the Mosel area in south-west Germany, where people are well prepared for frequent flooding and thus hardly face any damages, show that private households can do a lot to reduce their losses. But people need to know how to protect themselves and their property.

To improve the knowledge about efficient precautionary measures and their benefits, approximately 1200 affected private households along the Elbe and its tributaries were interviewed about the flood damages of their buildings and inventory as well as about their precautionary measures. In the affected areas, a building-representative random sample of households was generated, and always the person with the best knowledge about the flood damages in the household was questioned. The standardised questionnaire comprised around 180 questions. An average interview lasted about 30 minutes. The computer aided telephone interviews were undertaken by the SOKO-Institute, Bielefeld during April and May 2003.

The people affected by the 2002 flood in Saxony and Saxony-Anhalt had little flood experience. In the Ore Mountains 22%, along the Elbe only 10% of the households had experienced a flood before. Furthermore, for most people the remembrance has faded, since their last flood experience was more than 15 years ago. The majority of the flood experienced people has been affected by the 1974 flood. Thus, people were not well prepared in 2002: only 11% had used and furnished their houses in a flood adapted way, and only 7% had water barriers available (Fig. 1). However, the flood motivated a relatively large number of people to implement private risk reduction measures. But, elaborate, expensive measures were accomplished only by few people. For example, after the flood 2002 only 11% of the people put their heating and electrical utilities in higher storeys, yet 40% collected information on flood protection. The least considered measure is to move to a flood save area (Figure 1).

Measures of precaution are mainly effective in areas with frequent, small floods. But also during this extreme flood event in 2002 building retrofitting significantly reduced the flood loss. Our study shows for example, that flood adapted use, adapted furnishing and the installation of heating and electrical utilities in higher storeys reduced the mean damage ratios of buildings by 8%, 9% and 6%, respectively (Fig. 2). Adapted use and furnishing means that mainly cellars are not used cost-intensively and no expensive upgrading is undertaken. In cellars and ground floors only waterproof building material and mobile small interior decoration and furniture should be used.

The motivation of the people to undertake precautionary measures after the flood should be further stimulated by information campaigns and financial incentives. Therewith, preparedness should be kept over time.

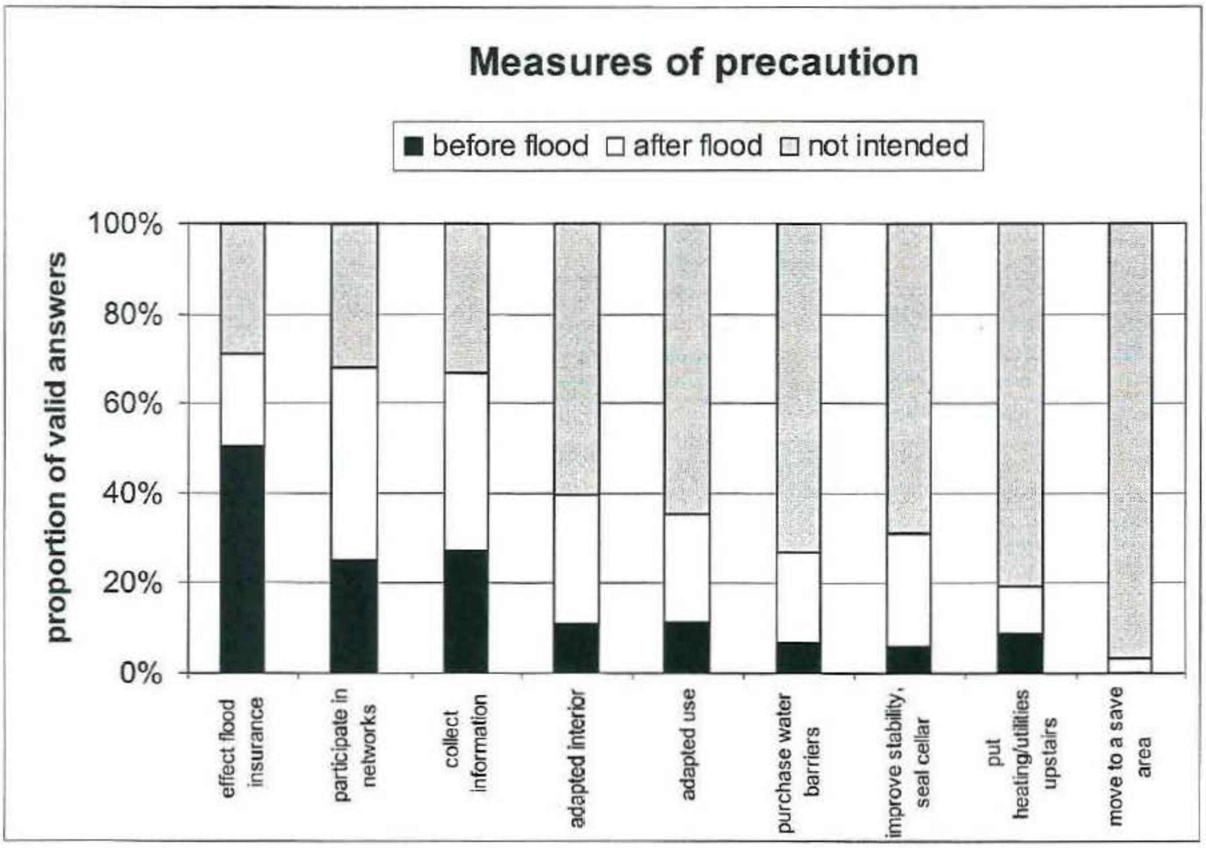

Figure 1: Proportion of the people who undertook measures of precaution before or after the flood, or who did not intend to undertake the measures (n = 869 - 1232).

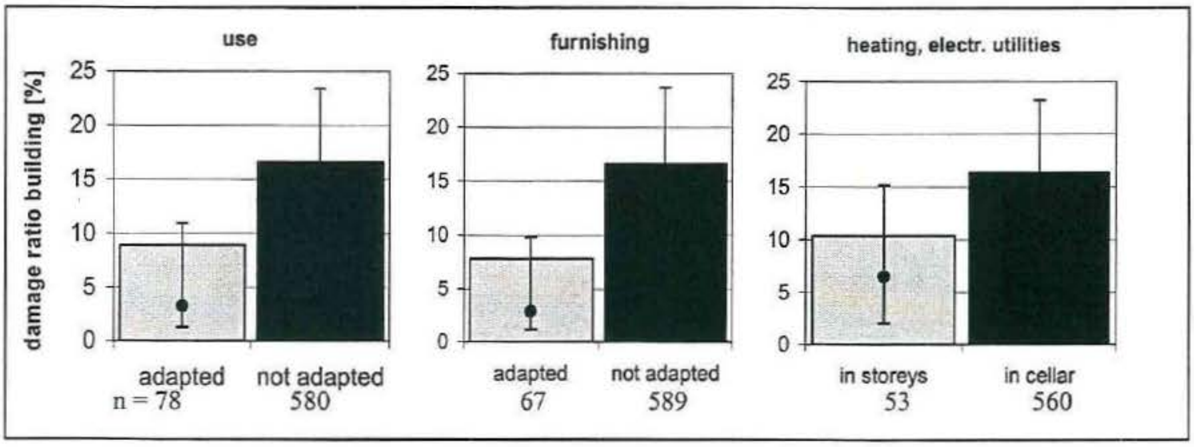

Figure 2: Flood damage mitigation due to different measures of precaution (means, medians and 25-75% percentiles).

Pollution of Elbe River flood plains and consequences for future research

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The presented investigations are part of a research cluster which is focused to the evaluation of damages caused by the extreme flood event of the Elbe river in August 2002, sponsered by the BMBF.

The german Elbe river flood plains measures nearly 80.000 ha. Almost 70 % were agricultural used. Results will be presented about the contamination of topsoils and plants in flood plains along the river Elbe from the Czech-German border up to investigation sites in Lower Saxony. Heavy metals, dioxins and the amount of pathogenes were analysed. It was the first time, that one sampling strategy for topsoils along the hole river course was realised. The sites were arranged in cross sections through the flood plains, taking always the same typical morphological positions into account. The sites were marked for future investigations.

The results confirm, that large parts of flood plains are highly contaminated with heavy metals and organic contaminants and they are enriched with pathogens. The measurements of contaminants in high flood sediments and topsoils show, that in general the flood event in August 2002 did not change the status of topsoil pollution. The exceedance of topsoil action values of the Federal Soil Protection and Contaminated Site Ordinance is common along the hole river Elbe (Figure 1) and the exceedance of threshold values for fodder, according to European guideline 2002/32/EG, can not be excluded (Figure 2).

Future research activities should focus on the development for a sustainable agricultural management for the contaminated areas. Following points should be considered:

- Is a regionalisation of contamination about all morphological forms inside the flood plains possible?
- Which are the main mechanisms controling heavy metal uptake of plants in flood plains in times without flooding?
- Do heavy metals have any indicator function for organic contaminants?
- Which are the main mechanisms for contaminants to enter the human food chain?
- Which alternative forms of land use are possible?
- Development of a scaling system for pathogens in flood plain soils.

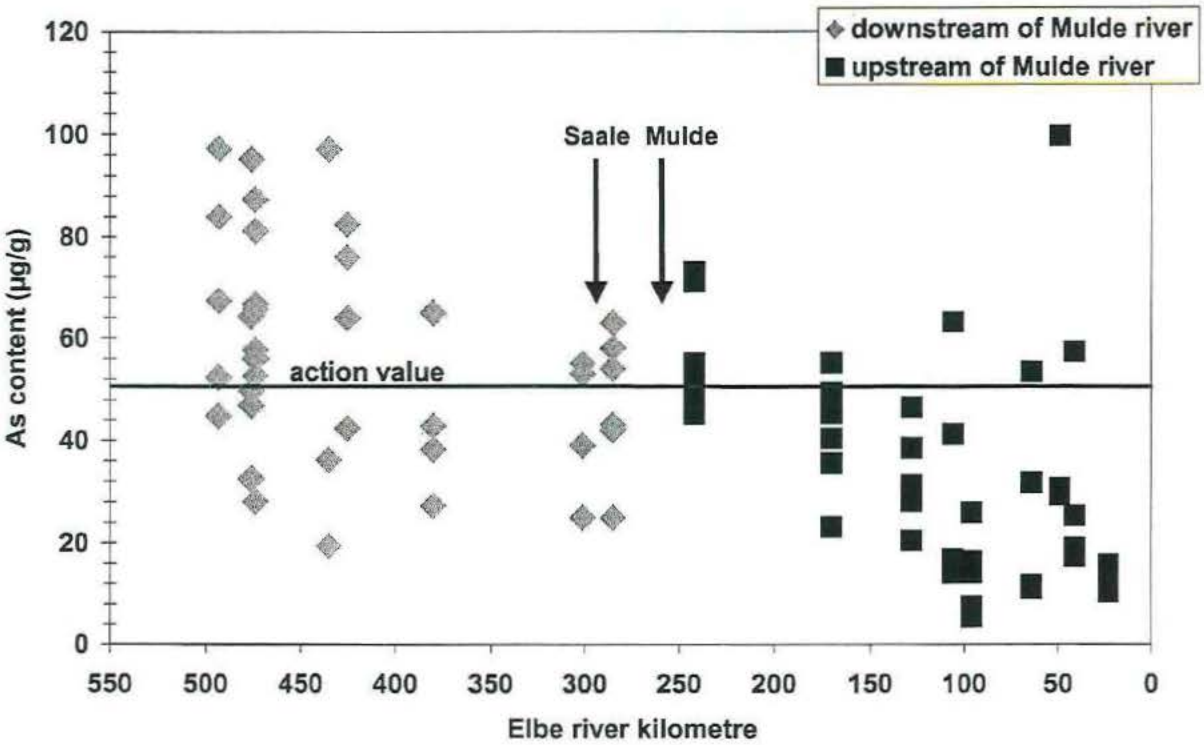

Figure 1: Arsenic contamination of Elbe river flood plain topsoils in comparison to the action value of the Federls Soil Protection and Contaminated Site Ordinance (BBodSchV).

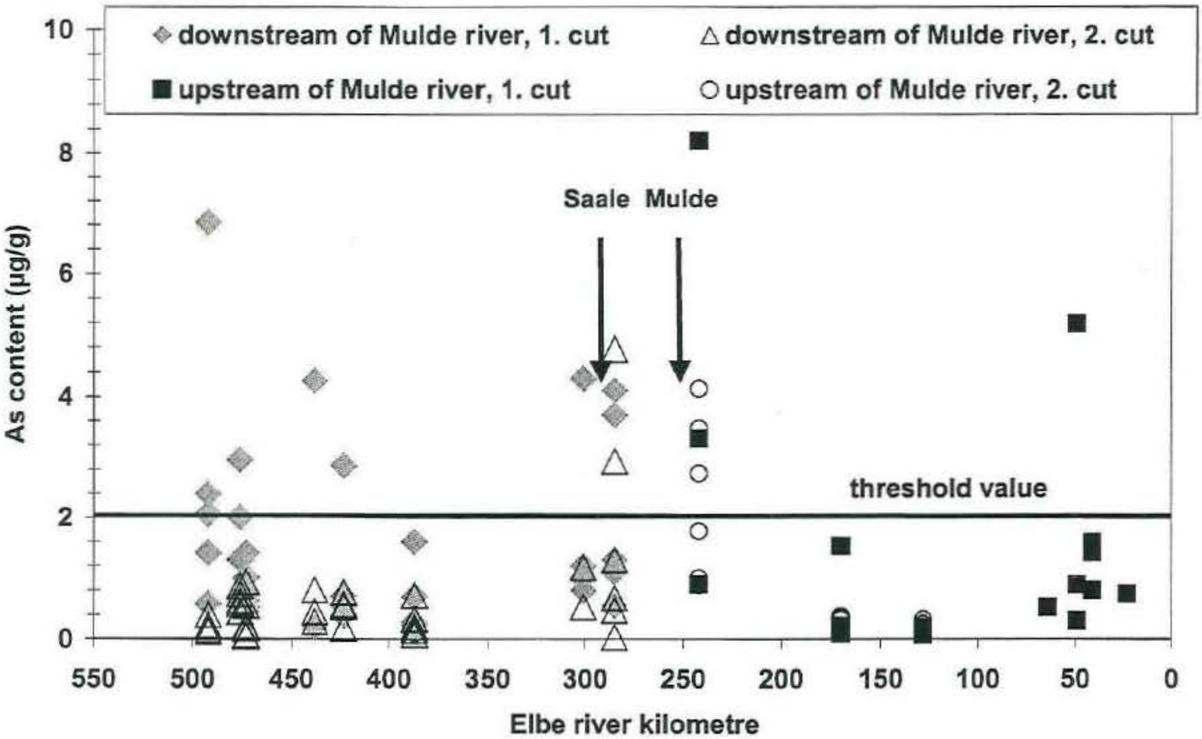

Figure 2: Arsenic contamination of grassland fodder in Elbe river flood plains at two harvesting times in 2003 in comparison to the threshold value of the European guidline 2002/32/EG.

Impact of Nitrogen reduction measures on the Nitrogen load in the river Ems and the river Rhine

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Commissioned by Germany's Research Ministry within the research programme "River basin Management" the REGFLUD project was started in 2001. In the framework of this project an integrated model system is developed to estimate the impact of nitrogen reduction measures on the nitrogen load in river catchment areas. The core of this model system is composed of an agri-environmental sector model, a runoff model and a residence time/nitrate degradation model.

As a starting point of the analysis actual nitrogen surpluses in the soil were quantified using the RAUMIS-model by balancing the most important nitrogen inputs into the soil (manure, inorganic fertiliser, atmospheric deposition) and N-removals from the soil through crop harvest. The most important pathways for diffuse nitrogen inputs into river systems are direct runoff and groundwater runoff. These runoff components are modelled with the water balance model GROWA. The time–dependent nitrogen degradation along the nitrogen pathways in soil and groundwater are modelled using the WEKU-model. Coupling these model tools allows the quantification of nitrogen loads in surface waters. Through combination with information on riverine nitrogen retention and nitrogen inputs from point sources given by the MONERIS model the calculated nitrogen inputs into the rivers were validated and consequently taken as reference values for the scenario analysis on the impact of nitrogen reduction measures on the nitrogen load in the river systems.

Two study areas in Germany, both with size of about 25000 km^2, were selected. The river Ems basin is located in the North-German Plain. Because of the less fertile sandy soils in the basin, land use is dominated by intensive animal husbandry. High groundwater tables and artificial drainage leads to nitrogen inputs into surface waters, which are mainly caused by fast discharging direct runoff components. The situation in the investigated subcatchment areas (Sieg, Wupper, Erft, Ruhr) in the river Rhine basin is quite different. Parts of the catchment are located in consolidated Palaeozoic rock areas, which are characterized by less fertile soils, an extensive agricultural land use and high total runoff levels, dominated by direct runoff. Other parts of the investigated areas in the Rhine basin are located in the Lower Rhine Bay, a fertile loess region, which is dominated by an intensive agricultural use and large groundwater recharge levels.

As a consequence of the different hydrological, hydrogeological and socio-economic characteristics of the investigated area, actual nutrient problems are different in both study areas. In this contribution it will be shown that identical political nitrogen reduction measures (e.g. calculation of environmentally effective regional nutrient surpluses considering land use and live stock changes, the development of production intensity, agricultural income changes as well as the employment of labour and capital) may have different impacts on the nutrient load in the surface waters of the two catchment areas.

Heading for effective approaches in river basin management

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Anthropogenic pressure on the environment as well as climate change strongly influence the regional water cycle, both with respect to water quantity and quality. The flood event in the Elbe river basin in 2002 demonstrated that climate change impacts in combination with river regulations effect the natural flow dynamics, resulting in the loss of property and life (Lahmer 2003a). On the other hand, the extreme summer drought in 2003 clearly showed that water availability and management issues represent a challenge also in Central Europe. Thus, there are strong future scientific needs in the field of water protection and river basin management. Integrated water resources management (IWRM) is a suitable concept to study the above mentioned impacts and their socio-economic consequences (Lahmer and Bronstert 2003).

Figure 1: Overview of the Havel river basin, the German part of the Elbe river basin and the State of Brandenburg.

One of the ongoing research programs dealing with river basin management is the BMBF-project 'Management Options in the Havel River Basin' (www.havelmanagement.de, Lahmer et al. 2003), embedded in the EU-Water Framework Directive (WFD). It aims at the implementation of the WFD in the Havel river basin (see Figure 1), one of the largest German lowland river basins, characterized by numerous natural and anthropogenic deficits. One important step towards the assessment of complex processes in river basins is the integration of knowledge on the temporal and spatial dynamics in natural and socio-economic systems as well as an improved understanding of the feedbacks between sectoral processes, including disciplines like e.g. hydrology, ecology or socio-economics. Therefore, a basic aim of the project is the development of suitable methods for water management at the regional level, applicable to policy formulation.

The contribution outlines basic elements of this multi-disciplinary approach, including effects of land use changes on water quantity and quality, the management of flow regimes, socio-economic issues and conflicts, the participation process, and the results of multicriterial analyses. Besides costs and benefits, approaches for an adequate transfer of results to stakeholders and decision makers will be discussed.

An important element of the project is the development and implementation of a decision support system (DSS). The process of decision-making as well as the implementation and acceptance of river basin management plans can be considerably supported by a DSS. In addition, a DSS will enhance the exchange of ideas and results between scientific institutions, decision makers, water managers and the public (Lahmer 2003b). Since policy makers are often not able to decide between different management options, a DSS stands at the interface of scientific research, practical application and policy and forms the basis for an effective and comprehensive management of water resources. Integrating both quantitative and qualitative information, it enables decision makers and water authorities to evaluate alternative management options and their influence on water quantity and quality. It also helps to clarify the question, why certain management strategies are recommended and others are not, taking into account the needs of various water users and the goals of the regional planning authorities. What decisions will be supported by a DSS strongly depends on the general (technical) concept, the available finances and manpower, and the demands of the end-user.

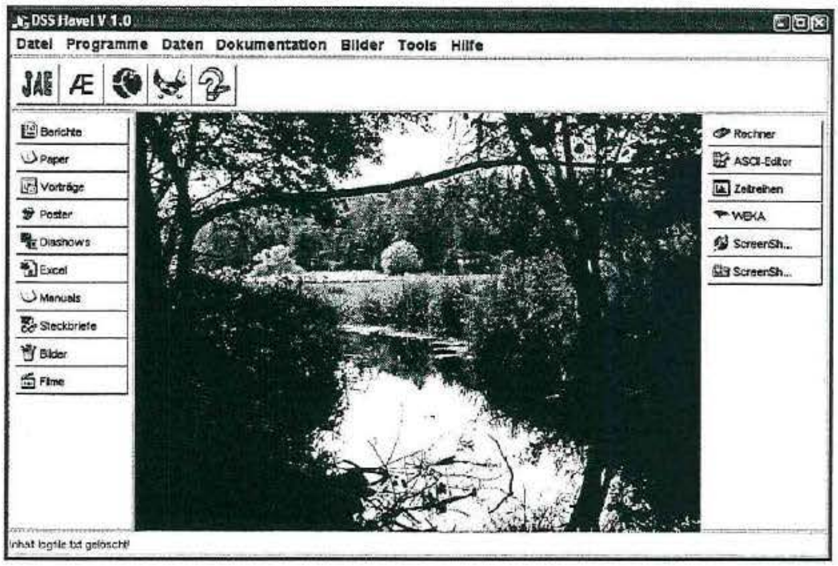

Figure 2: Graphical User Interface (GUI) of the DSS-Havel (version 1.0.2, July 2004)

Figure 2 outlines the present status of the 'DSS-Havel'. A important element of a user-friendly DSS is a graphical user interface (GUI), which ensures an intuitive interaction between the user and the system. The general aim of the DSS is to illustrate the influences of different measures on the study object 'Havel' and to make the feedbacks between various management options transparent. Basic functions are a close-to-reality representation of the actual state of the Havel river basin, the integration of results from both socio-economic studies and dynamic deterministic simulation models, the comparison of results obtained for the actual state and the simulated states (according to the WFD), and the support of scenario analyses, covering concrete management options. Costs and benefits of management alternatives can be compared by multicriterial analyses (MCA) and ranking methods, in order to decide, whether the derived management options are sufficient and economically applicable. Besides tools for data visualization and analysis, support is provided by various help systems and documentation files to guide the user and to illustrate the development, definition and use of the scenarios as well as the results of the applied models. Integrating the results of all subprojects, the DSS can demonstrate the consequences of different management options to users and decision makers.

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Landuse changes as indicator of flood risk

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Floods as the extreme rainfall-runoff process are the natural part of the environment and are one of the important factors of landscape forming. After the exceptional floods in 1997 and 2002 in Central Europe the following questions are often rising: How much the flood level was affected by anthropogenic transformation of the environment and landscape, whether such catastrophic events may repeat and if so what could be their scale and territorial limits and if there are efficient ways to protect the landscape against extreme rainfall-runoff events like floods via its restoration.

The extreme flood events in the last decade in Central Europe served as a unique opportunity to evaluate the role of such indicators, to test the methods of their efficient assessment and to determine their applicability in effective flood protection measures.

Presented research project evaluated the impact of man-made changes in environment to the flood occurrence, run and effects in the core zone of the 2002 floods on Otava river basin located in Šumava mts. with total area of 3000 km^2.

Assessment draws on selected indicators of landscape vulnerability as one of the key components of the flood risk. There were selected key indicators related to rainfall-runoff processes, flood wave formation and transformation, and retention capacity of the watershed.

Figure 1: Main components of the flood risk

The following processes were investigated as indicators of landscape vulnerability in regard to the flood risk:

- change of land-use structure and intensity,
- changes in vegetation cover quality,
- historical river network shortening,
- current transformation of river bed,
- flood plain structure and landuse,
- land drainage, soil degradation and others.

The solution was based on complex geographical approach combining information derived from current geodatabases, remote data, historical maps and thematic field mapping. This information was integrated and analyzed using GIS and geoprocessing techniques.

The research of environmental changes impact on flood risks points to evident links between physiogeographic characteristics of river basins and their hydrographic networks, anthropogenic transformation, and responses to extreme runoff situations. However the results hasn't proved the current intensity of river network shortening, riverbed transformation or floodplain and landscape modifications to be the main driving force of extremely severe floods, occurring in 2002 in Central Europe.

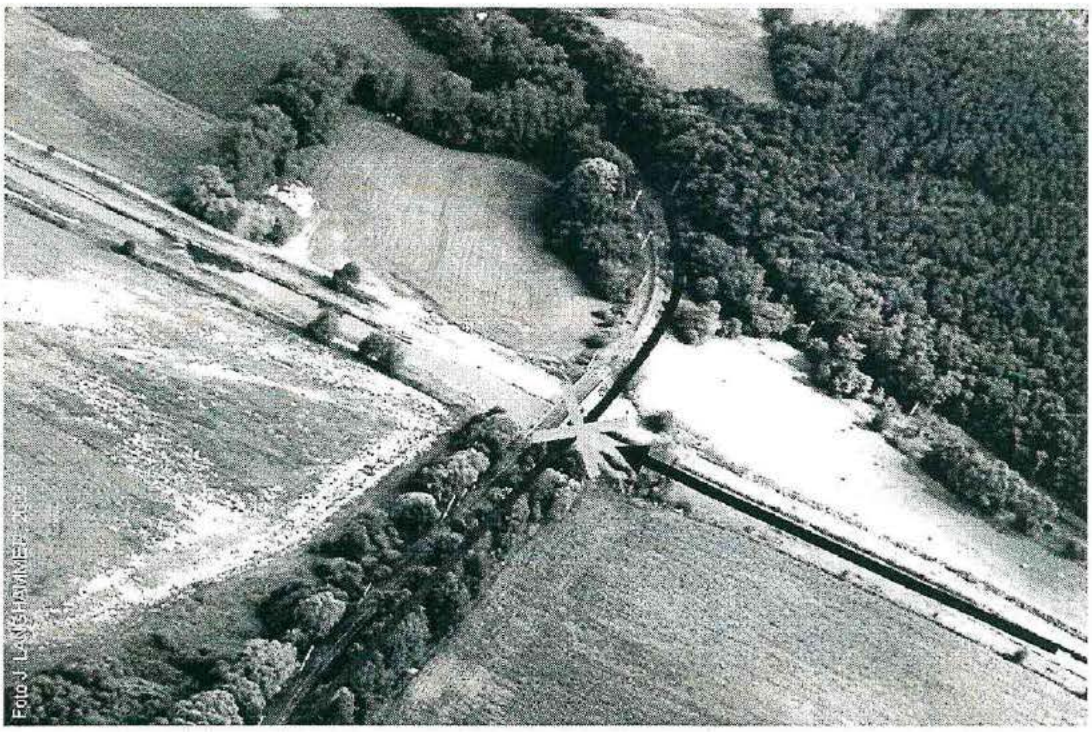

Figure 2: Impact of Improperly placed objects on flood consequences. Bridge closing large walley was functioning like dam during the 2002 flood. Aftrer exceeding critical limit the flood wave from damaged bridge endangered stability of the dam at the low course.

The results indicate that that shortening of river systems, river-bed modifications and systematic drainage of agricultural areas have only limited impact on flood consequences. Their impact even falls down as the flood repetition period grows and the critical point marking their minimal impact is the 5-10-year flood repetition interval.

On the other hand, floodplain use and mainly structures impeding free water flow represent a significant factor the importance of which grows even further with increasing flood severity. Facilities placed in floodplain areas, e.g. railway embankments or undersized bridges or culverts can significantly worsen flood consequences due to artificial accumulation of water and subsequent fast water discharge.

It is also important to stress the negative impact of intensive agricultural use of floodplain areas impeding effective retention and flood wave transformation.

The watercourse typology, drawing on a geostatistic analysis in the GIS environment, classified watercourses into groups by their characteristics and related responses to extreme floods. It can further stimulate differentiated flood control policies that with respect to environmental variability are the most effective.

The impact of river morphology on water quality of two rivers of different stream order

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Although the treatment of waste water has significantly improved in Germany, it appears a limit has been reached in the degree of improvement that can be attained in river water quality. This is due to the high loads of nutrients still being emitted into the waters from non-point sources. Reduction of this source is slow and cumbersome and the pool of nutrients on land surfaces ist still quite high. In particular to nitrogen, even if the supply of this nutrient pool is reduced, long lag times in its transport to the river cause minimal improvements in the water quality and only after significant time has passed. Another important factor that has limited the melioration of water quality is the heavy extent of discharge control by the contruction of levies, dykes, weirs and locks and modifications by straighting river meanders. The objective of this contribution is to investigate the impact of these morphological river changes on water quality, especially on nitrate concentration.

An efficient method to investigate which morphological changes have greatest impact on the water quality is a computer modelling exercise. In this study, two models, a hydrodynamic (DYNHYD) and an eutrophication (EUTRO) model, were coupled together in the Higher Level Architecture (HLA) platform. DYNHYD dynamically simulates the propagation of a wave through a river estuary one-dimensionally by solving the full dynamic wave equation. Important parameters that describe the river morphology are the roughness coefficient, bed slope, hydraulic radius and the weir discharge coefficient. EUTRO simulates the phyto-plankton-nutrient dynamics in water bodies with variables and parameters that regulate the process in this cycle. Examples of some of the more important parameters are the oxygen reaeration, phytoplankton growth or nitrification rates.

It is the aim of this study to see the effect that both the hydrodynamic and the eutrophication parameters have on water quality constituents, such as oxygen and chlorophyll-a levels. Monte Carlo Analysis (MOCA) complemented the study in that probability distributions of the model output variables could be determined given certain probability distributions of the input parameter settings. The HLA environment provided the synchronisation of the simulation time-step sequence of the two models necessary for a MOCA to be carried out. An additional goal in this study is to see if the morphological effects on water quality constituents accentuates in smaller rivers. Hence, the analysis was carried out on two different rivers: the Saale (5^{th} order, MQ = 115 m^3/s) and the Weisse Elster (4^{th} order, MQ = 25,2 m^3/s). The results show that morphological changes towards more natural recovery improve the quality of the water. For the Saale, the effect of the eutrophication parameters on water quality overshadow the effect from changed morphological parameters; the overshadowing diminished for the Weisse Elster.

Diversifying structures in poorly structured aquatic environments by means of technical textiles

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The output of technical textiles in Germany has increased in the last 10 years. Speaking of the last 20 years, technical textiles have reached about 40% of the total production of textiles in Germany. They are often used for geosynthetic purposes. Additionally, technical textiles become more important in aquatic ecosystem management and environmental engineering.

Technical textiles often provide the base for organisms to grow (e.g. plants or benthic macro-organisms). Textile fabrics may diversify poor aquatic environments, increase the inner surface of water bodies, and thus give additional substrate for the colonisation by invertebrates and macrophytes

New technologies make use of textile structures for biofiltration (waste) water treatment, e.g. the prevention of hydraulic short circuiting, and for biomanipulation.

The warp-knitting technology allows the production of extremely coarse mat structures. The KEMAFIL technology allows to manufacture rope-like (hollow) structures which may be assembled into mats.

Textile plant-bedding mats (REPOTEX) for helophytes (*repo*-plants) are easy to handle (typically about $1.2 \times 8\ m^2$) and very flexible. The mass per unit areas vary between 500 and $2{,}000\ g{\cdot}m^{-2}$ at a thickness of up to 25 mm. The mats usually consist of non-decomposable material, but decomposable materials are also possible. Floating textile structures can be assembled by combination of self-floating materials up to 40 Nm. Sprouts (of helophytes) laid upon the textile structure may accrete with the substrate within a week forming a complex system of plants and textile material. The textile structure allows helophytes planted on it to take roots intensively, which may increase the inner surface.

For the recultivation of mining landscapes, planted islands are suitable to create initial biotopes. The artificial islands offer hide-away zones for resting and breeding birds. The dense root curtains may assume the function of shallow water providing hide-away zones for zoo plankton and/or juvenile fish.

Embankment erosion caused by the impact of waves may be avoided by means of artificial peninsulas.

According to the high specific surface, technical textiles provide colonisable substrate for organisms in the pelagial of lakes. The additional surface may be colonised by diverse filtering organisms, these organisms finding nearly ideal living conditions, which raises their biological activity.

Mats 0.5 m in width and 7 m in length were suspended vertically in a small gravel-pit (Leuben, near Dresden, Germany). The mats span from about 1.5 m over the bottom of the gravel pit up to about 1.5 m under the water surface. The experiment focused on the advancement of macro zoobenthos. After an exposure period of 18 weeks (June to October 2003) samples of substrate were taken from four depths (2.0-2.3; 2.7-2.9; 4.2-4.4 and 5.2-5.4 m). Most of the species found in the samples showed a gradient of abundance with growing depth. The predominant species was the zebra mussel (*Dreissena polymorpha*), which reached 29,000 mussels per square meter and an ash free dry weight of about 109 g m^{-2} (means over all depths). In correspondence with the thermocline of the water a gradient of colonisation was observed. While the substrate up to a depth of 3-4 m was densely colonised (62,707 and 42,342 ind./m^2) by zebra mussel, their densities were much lower below the thermocline (8,568 and 2,373 ind./m^2). Here colonies of moss animals (*Plumatella fructicosa*) became predominant. The abundance of the freshwater polyp *Hydra* sp. was very remarkable (7,769; 1,520; 2,387 and 109 ind./m^2). Species of caddis fly were also more abundant in the first two sampled depths. But *Ecnomus tenellus* was found in all depths (2,707; 5,462; 1,804 and 55 ind./m^2) while much lower densities of *Orthotrichia* sp. were found only in the first two depths (150 and 56 ind./m^2). The mayfly *Caenis* sp. showed a gradient (150, 56, 53 and 55 ind./m^2), the same as the flies of the chironominae-family (1,053; 507; 424 and 246 ind./m^2). *Chironomus pulmosus* was found only in a depth of 4.2-4.4 m (106 ind./m^2). *Stylaria lacustris* showed a gradient in abundance with growing depth (2,857; 169; 53 and 27 ind./m^2). Other Oligochaeta did not show such a strong gradient in abundance with growing depth (3,759; 282; 2,546 and 327 ind./m^2). Leeches (*Glossiphonia heteroclita)* were only found in depths from 4.2 to 4.4 m (53 ind./m^2). The pattern of colonisation mirrors two main groups of reproduction strategies: Firstly, taxa which start the colonisation by adult animals depositing eggs upon the substrate, and a following colonisation of deeper zones by mobile larvae or by species emerging after their larval phase (insects). Secondly, taxa with pelagic living larvae (e.g. *Dreissena*). But also a passive colonisation by drifted organisms (e.g. *Stylaria* or small Naididae) has to be taken into account.

Preliminary results of sediment trap analyses suggest higher rates near the well colonised mats than in a sample site more distant.

Modules are known of artificial substrates and cages of intermediate bulk containers (IBC 1,000), which may be used as filtering units in polishing ponds. Such modules (1x1x1 m^3) were exposed to colonisation at a depth of 5 m in Lake Constance. Each module contained a stack of 25 m^2 of technical textile.

The colonisation of these modules was examined after an exposure period of 37, and 67 weeks respectively. The species that had grown amounted to an ash free dry weight of about 480 g m^{-2} (88 % zebra mussels) with zebra mussel densities of about 75,000 m^{-2}. 38 taxa (invertebrate organisms). Single counts were found on the artificial substrate.

After the colonisation of these modules a transfer into polishing ponds or similar systems for the clarification of polluted water seems to be possible. However, the water quality must meet the minimum requirements of the living conditions. As most important parameters (for surveillance of zebra mussels) we found the pH (6.9 – 8.5), content of Ammonia (< 10 mg/L), Saturation of Oxygen (> 40 %) and Hardness (> 0.6 mmol/L) in a complex system of interdependence and of coarse (organic) suspended solids (> 1.0 mg/L). High loads of suspended solids may be tolerated temporarily. We suggest a filtration capacity of about 90 m^3/d of each module. Such filtering units may enhance the efficiency of polishing lagoons, reducing secondary pollution by phytoplankton blooms, and the microbial pollution, respectively.

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Assessment of ecohydrological streams habitat

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1. Introduction

The aim of the research project is to elaborate a method fitted for ecohydrological monitoring of streams. The main task is a definition of main reference types of central European streams. Principal for elaboration of this method are also studies on ecohydrological methods in European region.

The new European Water Framework Directive (2000/60/EC) underlines the significance of ecohydrological methods. Watercourses are evaluated according to an ecological statute, which is determined by biological, hydromorphological and physical-chemical parameters. The Water Framework Directive is aimed both at the state of the streambed and at its riparian belt. The ecological state of water ecosystems is classified in the Directive by three degrees: high, good and fair. Individual degrees are described only in a general way, as it is problematic to specify and to quantify the properties of ecosystems in different regions of Europe. For that purpose, evaluation procedures and water streams typologies are elaborated in different countries.

2. Methods

The first aim was to elaborate a method fitted for ecohydrological monitoring of streams and its verification on the model study areas. Principal for elaboration of these method were studies on fluvial-morphological characteristics of natural or near-natural streams. The research includes also analyses of the existing evaluation ecohydrological methods LAWA 1998, Niehoff 1996, NRA 1995, Barbour 1999.

Within the work on Ph.D. Thesis (Matoušková 2003) the method of ecomorphological assessment of stream habitat quality was elaborated. This evaluation method deals as a basis for creation of a suitable method for ecohydrological monitoring of streams in the Czech Republic and Central European region. The method of ecomorphological monitoring is composed of several separate evaluating parameters that get mutually integrated during the evaluation. It includes the analysis of fluvial-morphological features of the channel, of the anthropogenous transformations of the hydrographical network, of the quality of surface water, of the state of bank vegetation, of the land use in riparian belt and of selected ecohydrological features of the basin. The ecomorphological evaluation is based on the so-called "reference state" which is the state of a stream that is getting formed during the given physical-geographical development of the given area without significant negative anthropogenous impacts in the landscape. For the definition of the reference state for the given type of stream is useful to find segments with natural or near natural state. Ecomorphological mapping is done in determined segments. Individual parameters (Table 1) are classified by point evaluation in the interval <0; 5> or by verbal description. All ecomorphological zones have the same importance for determination of the so-called ecomorphological state, which is calculated as the arithmetical average of the evaluated ecomorphological zones. The ecomorphological state is then classified on the basis of assignment of numerical result into one of the five defined ecomorphological classes.

3. Key study areas

The key study areas for verification and application of the described method are the Rakovnický Brook basin (the Berounka River basin, Matoušková 2003), the Habrový Brook (the Berounka river basin, Garkischová 2002), the Košínský Brook (the Lužnice river basin, Bicanová 2002), the Blanice river (the Otava river basin) and the Liběchovka river (the Labe river basin). These catchments were chosen, because they fulfil two basic requirements: 1) natural state in some parts of the stream run and 2) anthropogenic transformation in some segments of the hydrographical network. At the same time, a sufficient quantity of monitored input data and of other information was available for the given territory.

4. Results

Application of the method of ecomorphological monitoring in the chosen model basins has confirmed the possibility to evaluate the ecological state of water ecosystems and also allows to identify anthropogenically-influenced segments of watercourses and basin areas fitted for possible restoration measures. This method has brought good results. Stříbrský (2002) compared two methods - the BfG Koblenz one (LAWA, 1998) and the method of ecomorphological monitoring (Matoušková, 2002) on several model segments of Rakovnický Brook. The obtained outputs are similar, which documents the objectivity of the method of ecomorphological monitoring.

An incontestable advantage of the ecohydrological evaluation of water ecosystems is a complex view on streams. It is important to take into account the ecological situation of a larger background of the stream, possibly of the whole basin, as a basic hydrographical unit. The obtained outputs are mostly quantifiable which enables their objective comparison. The results of ecomorphological monitoring may serve especially as a source of information for integrated control of water ecosystems and for targeted planning of restoration measures.

Table 1: Ecohydrological parameters

Ecomorphological zone	*Main ecomorphological parameter*	*Partial ecomorphological parameter*	*Evaluation (Point P /Verbal V)*
Stream channel	Fluvial-morphology and meandering	Type of river valley	V
		Meandering	V, P
		River bed (character and shape)	P
		Deepening of river channel	P
	Longitudinal profile	Existence of steps	P
		Canalisation	P
		Riffles and pools (depth variability)	P
		Man made changes in outflow	P
	Cross section profile	Type of cross section	P
		Depth (average)	V
		Degree of width variability	P
		Type of river training	P
	River bed	Character of substrate	V
		Type of bed training	P
		Substrate diversity	P
		Microhabitats	P
	Bank structures	Vegetation	P
		Type of bank structures	P
		Unstableness of banks	P
	Water quality	Hydrochemical parameters	P
		Hydrobiological parameters	P
		Sewage outfalls	V
Vegetation belt		Existence of riparian belt	P
		Character of riparian belt	P
		Retention of riparian belt	
Flood plain		Land use in flood plain	P
		Flood control measures	P
		Retention potential of flood plain	P
Water basin		River training	P
		Susceptible to erosion	P
		Land cover	P
		Drainage areas	P
		Retention areas	P

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Integrative and interdisciplinary evaluation of river basin management strategies in the context of global change – Results from the Spree River basin

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1. Summary

In the context of the interdisciplinary analyses in the GLOWA Elbe project different river basin management strategies were analysed and evaluated in an interdisciplinary way, taking different scenarios of global change into account. The evaluation was performed by integrating socio-economic and hydrological evaluation and transfer functions directly into the water management model ArcGRM. The results indicate that the current water management strategy in the Spree River basin is not optimal and could be improved by complementary policy options like additional water transfers and/or changes in water allocation priorities. Furthermore, the research results reveal that different water users in the Spree River basin are affected very differently by potential alterations due global change or policy reform.

2. Results

Starting point of the integrated evaluation of water management strategies for the Spree River basin were hydrological and water management analyses using the model ArcGRM to reveal the impact of global change and policy change on water availability. Based on these results the socio-economic impacts of changing water availability were examined for the most important water users in the basin. In a first step of the socio-economic analyses the dependence of the water users on water availability was examined qualitatively, using literature reviews and stakeholder interviews. After that socio-economic evaluation functions were created, among others by means of benefit-cost methods, to estimate major welfare effects of changing water availability.

In most cases socio-economic evaluation functions do not show a direct relation to the variable *certainty of water availability*, which is the most important variable of the water management model ArcGRM. Therefore, transfer functions were defined in order to create the link between relevant economic variables and the model ArcGRM. E.g., for inland fisheries the size of fish ponds filled with water during the year is a relevant economic variable to calculate the yields of economic actors. Thus, in the respective transfer function this pond size is calculated, using the results of the water management model as input data.

The creation of the linkage between the water management model and the transfer and evaluation functions paves the way to link socioeconomic evaluation directly to water management modelling. As a consequence, it becomes possible to simulate scenarios with regard to water availability in a river basin and, simultaneously, to assess the resulting socioeconomic effects. However, it should be mentioned that this integration did not work optimally for all water users due to methodological inconsistencies between the methods of socioeconomic evaluation and the water management model. Therefore, in some cases only second-best solutions regarding economic evaluation were used.

a) The particular results of modelling and evaluating policy and global change scenarios with the model ArcGRM can be figured out as follows: It was revealed that the effects of five different water management strategies for the Spree River were each similar under different conditions of global change with regard to its general trend and direction. Considering the results for different water users, there is not a single case showing that one policy strategy would perform totally different under different global change conditions. This general result makes it easier to choose the best policy strategy because the uncertainty connected to global change processes proved to be smaller than expected.

b) However, at the same time it must be stated that considerable differences in modelling and evaluation results can be observed concerning the extent of impacts under different conditions of global change. E.g., water availability in the regions of Berlin and the Spreewald wetland is significantly lower in all scenarios with climate change compared to the scenarios with stable climate conditions. Furthermore, it was revealed that water users who are heavily dependent on societal and economic conditions (like tourism and inland fisheries) are also very vulnerable with respect to socioeconomic change (like changing national or EU subsidies). As a consequence, the sensitivity of some water users is higher with regard to climate and socioeconomic change than to changes in water management strategies.

c) Finally, as regards the assessment of the most favourable strategy of water management in the Spree River basin under conditions of global change, it must be stated that the current strategy is not optimal at all and should not be further pursued in the long term. Rather it should be considered to complement the current strategy by policy options like additional water transfers from the Oder River or to change the water allocation priorities in favour of accelerated filling of mining ponds and securing the ecological minimum flows. A most favourable strategy cannot be derived from the scientific results, but must (and will) be found in cooperation with the stakeholders and decision makers of the region, by taking their specific preferences into account.

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The importance of internal sulfur sources in soils for the recovery from surface water acidification: comparative analyses of forested watersheds in Central Europe and North America

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Sulfate, in the form of sulfuric acid, is a major source of acidity contributing to the acidification of surface waters in those regions of North America and Europe that have a low ANC of soils and bedrock and that have simultaneously been affected by acidic deposition. Although biogeochemical research during the last thirty years has improved considerably our knowledge of S cycling in forest ecosystems, important questions remain unresolved that hinder our ability to understand and predict how changing atmospheric S inputs will affect S losses from ecosystems and water quality. Notably, the mobility of S pools in the soils (inorganic *vs.* organic) plays a crucial role. There is considerable speculation on the sources of this internal sulfur and a variety of sources have been implicated. For example, adsorbed sulfate delays the response of S cycling and streamwater output to decreasing S emissions due to the desorption of this previously deposited sulfate-S. More recently the possible role of organic sulfur and sulfur minerals as other sources of internal sulfur have been identified. Evaluating the importance of any internal S source is critical for evaluating how surface waters will respond to decreases in sulfur deposition. Such information is needed by both scientists and policy makers for evaluating how changes in atmospheric deposition of sulfur will improve water quality. Understanding the relationships of atmospheric sulfur deposition and the response of surface waters to both spatial and temporal patterns of deposition has been generally evaluated using three approaches: 1) *Mass balance analyses*; 2) *Simulation using biogeochemical models*; and 3) *analyses using isotopes of sulfate*. In some cases, combinations of these same approaches have been used within the same study.

The paper will review and compare major findings from long-term case studies which have been conducted in forested watersheds in Central Europe (e.g. Black Forest, Ore Mtns.) and NE USA (Adirondacks, Hubbard Brook). The identified processes of S cycling and their controlling site factors are discussed and the consequences for the temporal development of surface quality are outlined.

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Institutional drivers and constraints of floodplain restoration: a comparative review of projects and policy contexts in England, France and Germany

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The task of restoring floodplains, as a means of improving flood protection or providing other benefits, poses multi-dimensional challenges to policy-makers and project managers alike. Involving essentially a reconfiguration of the interaction between a river and adjacent low-lying land, floodplain restoration affects a wide range of institutions – or rule systems – designed to secure a variety of private and public goods associated with water and land use. These institutions relate to water protection, nature conservation, flood defence, navigation, recreation, urban and rural development and the protection of historical landscapes, to name but a few of the most significant. The institutions for each of these policy fields comprise a complex arrangement of codified norms (such as laws, regulations and contractual obligations), planning instruments and funding mechanisms, organised and individual actors responsible for, or to, these rule systems as well as standardised procedures of operation, values and accepted practices. A scheme to restore a floodplain requires the successful enrolment of these institutions and organisations in such a way as to create a result acceptable to the principal stakeholders who operate according to spatial remits and time scales which only very rarely match those of a floodplain ecosystem. This is a highly complex process.

Those who address these challenges encounter a number of institutional constraints to floodplain restoration. In the context of an EU-funded research project, FLOBAR 2, our policy analyses and case studies in France, Germany and England have identified several of these constraints which – individually or in conjunction – prevent flood restoration schemes taking place or limit the scope and effectiveness of those implemented. The most important constraints include: conflicting claims for the use of floodplains; land ownership and the inadequate incentives for landowners/farmers to accept changes to land use; inadequate protection of floodplains from urban development; adverse financial incentives; the dominance of hard engineering solutions to flood defence strategies; difficulties of coordination between the multiple policy fields and actor groups affected (problems of interplay); difficulties of considering the human and environmental needs of the whole catchment (problems of scale and spatial fit).

Since the late 1990s shifts in policy content and style in the fields of flood protection, nature conservation and agriculture at EU and national levels are, however, creating new openings for floodplain restoration of a more comprehensive, integrated kind. Our research has revealed many new institutional drivers that are creating 'windows of opportunity' for floodplain restoration, encouraging the emergence of a larger number of significant schemes. In the field of flood protection the policy analyses and case studies have demonstrated how recent major flooding events in France, Germany and England have accelerated the willingness of the authorities to entertain catchment-oriented approaches and soft-engineering techniques of flood protection, creating new opportunities for floodplain restoration. The sheer cost of improving and maintaining physical flood defences, in particular in rural areas, is raising interest in alternative strategies. Water protection agencies, concerned at water shortages and motivated by the EU Water Framework Directive, are showing growing interest in water flow regimes across whole catchments and in the (disputed) potential of floodplains to improve water quality. For nature conservationists restored floodplains represent important habitats that can contribute to meeting biodiversity targets in accordance with the EU Habitats and Birds Directives. Political pressure is growing for more environmentally sensitive forms of agriculture and forestry, creating new funding opportunities for extensive practices more suited to floodplain restoration. Finally, land-use planning regulations are being modified to offer more effective protection of existing floodplains and, in some instances, earmarking land for the future restoration of floodplains. Spanning these sectoral policy shifts is a general trend towards greater policy integration and stakeholder participation over schemes of this kind, informed in part by debates on sustainable development and new forms of governance.

In response to these institutional drivers a new generation of floodplain restoration schemes is emerging which are of a quite different scale and scope to those of the early to mid-1990s. These schemes, three of which were studied in detail by the FLOBAR 2 project, set out to address some of the complex challenges to large-scale, integrated floodplain restoration outlined above. Distinctive features of the new generation schemes are their multiple objectives (covering, for instance, flood defence, biodiversity, rural development and water quality management), their wide actor engagement (including the relevant policy fields, local authorities, NGOs and the general public), their use of various instruments from different policy fields (e.g. joint funding from flood defence and agri-environment budgets) and their interaction with policy-making, serving for instance as pilot projects for national policy development. Since these new generation schemes were only launched from the late 1990s onwards it is at present impossible to judge their effectiveness. They would at least appear to have the potential to overcome some of the principal institutional constraints to floodplain restoration that have thwarted or curtailed efforts in the past.

Our research findings, however, caution against over-optimistic expectations from the new generation projects. Early signs suggest that the sheer complexity of the tasks they are tackling is posing a major problem for project management. The requirement to consult widely costs time and resources. Accessing multiple funding sources obliges restoration projects to adapt their objectives to satisfy different funding agencies. Attempts to enrol instruments from different policy fields reveal incompatibilities and inconsistencies of policy objectives. Our research demonstrates how these innovative features of the new generation schemes, although each justifiable in its own right, are having the combined effect of hindering effective project implementation – and policy delivery.

We can conclude that recent shifts in problem awareness and problem-solving approaches in a number of relevant policy fields are creating new 'windows of opportunity' for floodplain restoration. At the same time there is a growing willingness amongst local and regional actors in restoring floodplains to address a variety of localised issues, ranging from flood risks and loss of biodiversity to agricultural restructuring. This interest at both the strategic and operational levels has combined in several instances to stimulate the emergence of a new generation of floodplain restoration schemes which address policy integration, actor engagement and the multiple functions of a floodplain from a catchment or, at least, river reach perspective. Early evidence suggests, however, that a policy delivery gap continues to exist. On the one hand recent policy rethinking within key (national) agencies is often not filtering down effectively to the operational level. On the other hand there is a tendency of policy makers to overlook the implications of policy that encourages integrated, cross-sectoral and multi-agency action for operational practices on the ground. In the design and implementation of future policy greater sensitivity towards local contexts of action and the complexities of floodplain management would significantly enhance the prospects for the effective restoration of floodplains in the future.

Changes in Aquatic Ecosystem of Small Urban Streams after Flood 2002

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Flood situation (August 2002) in small urban streams radically changed status of water ecosystem, which had been created naturally and anthropogenically for a long time. The aim of the after-flood research has been to record development of a creek recovery in positive as well as negative sense: recovery of bentic community and reloading of contaminants (heavy metals) in bottom sediment. The Botic creek (its one section) was chosen as an experimental stream. This section of the creak is influenced by combine sewer system (two overflows – CSOs) as well as storm sewer system (one outlet –SSO). Comparison of creek ecological status before and after flood can better assess impact of extreme water stage on a small stream.

Heavy metals (Cu, Cr, Ni, Pb, Zn) concentrations in water, bottom sediment and benthic organisms as well as bentic community quality of the Botič creek have been monitored since 1998. Before-flood and after-flood concentrations of heavy metals (HM) have been compared and three coefficients have been used within the risk assessment: The distribution coefficient (Kd), which gives information about what medium (water or solid phase of sediment) is crucial for the risk assessment (Page 1999). The Hazard Quotient (HQ), calculated as ratio of measured concentration in stream and a toxicological criterion (Barnthouse 1982). The biota sediment accumulation factor (BSFA), calculated as a ratio of measured concentration in body tissue and concentration in sediment (Rand 1995). Biological assessment was based on kick sampling and calculation of biological indexes (Si, ASPT and diversity). Si assesses water quality by the organic pollution and ASPT is based on occurrence species with different tolerance to pollution (Kokes 1999).

For the observed metals log Kd in the Botic creek has been measured within interval from 3 to 5. It means that HM prefer binding into solid phase (sediment). Concentrations of HM in water of the Botic creek (90 percentile of not exceeding) indicate no ecological risk according to HQ during the whole monitored period.

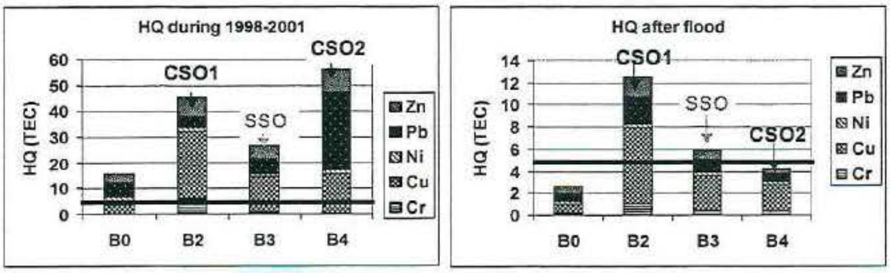


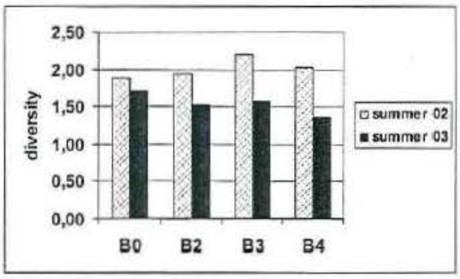
Figure 1: Risk assessment of HM in sediment according to HQ before flood and after flood. HQ>5 for 5 metals indicates risk

Concentrations in sediment during period 1998-2001 have been found out highly risky (Figure 1 left). Serious risk has been indicated in all sampling sites. The highest risk has been monitored below CSOs. Cu toxicity is dominant practically in the whole study section of the Botic creek but mostly below CSO1. Pb toxicity is significant in profile B4 impacted by CSO as well as SSO. Heavy metals concentrations in sediment decreased after flood (Figure 1 right). Cu is still major pollutant and the highest risk is still indicated below CSO1, but the risk is significantly lower according to TEC and by using PEC, even no risk is estimated.

No expected trends of graduated increase of HM concentrations in sediment after flood have been observed.

Concentrations of HM in body tissue of all present species were measured. The BSFA shows that there are differences between values measured before and after floods. Organisms collected after the flood had lower values of BSFA and mostly also lower body concentrations than organisms collected before the flood. Exception was observed in case of few metals (Cr, Pb and Zn) in case of organisms collected below CSO, concentration after the flood were slightly higher than before the flood.

Biology indexes show differences before and after the flood and are in agreement with chemical analyses results. Shortly after the flood the benthic community was strongly decimated and diversity decreased (Figure 2 left). This can be explained by washing out of organisms as well as substrates. Especially, fine particles were washed out from the riffles zones and settled in the pools, and the aquatic environment became more uniform and number of acceptable habitats decreased and the stream became suitable for less number of species. Indexes indicating organic pollution, Si index (Figure 2 right) and ASPT index, showed after flood improving situation. It can be interpreted by wash out of organic pollution. Consequently, more sensitive organisms appeared on all study sites.



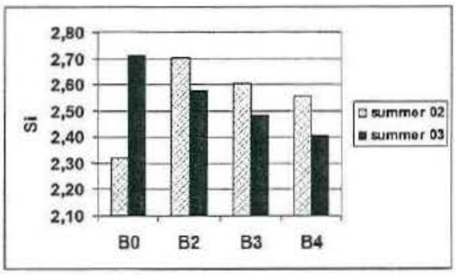


Figure 2: Biological indexes

Conclusions: The catastrophic flood negatively impacted the stream in the short term perspective; destruction of habitat, decimation of benthos community, probably high acute toxicological risk. But in long term perspective the flood had positive effect; wash out of pollutants –heavy metals, organic material, nutrients, improving Si and ASPT indexes and more sensitive species appeared after the flood. The negative long term effect of the flood is mostly socio-economical, but not ecological.

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Acknowledgement

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Influence of landuse on the water quality of the Volga River – results of the Volga-Rhine research project

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The protection of surface water bodies is of central importance for the provision of drinking water in the european part of Russia. More than 2/3 of the consumed water is processed surface water. Drinking water quality is temporary reduced because of intolerable concentrations of ammonium, trihalogenemethanes (THM) and turbidity. Within the frame of a joint Russian-German research project detailed investigations about the surface water quality and nonpoint source pollution in the Volga catchment are conducted to characterise nutrient concentrations and loads. Although the heavy metal load of the Volga river is comparable low, the concentrations of phosphorus and nitrogen in the river is seasonally high and leads to distinct signs of eutrophication. Additionally, the concentration of dissolved organic carbon (DOC) is very high and reaching up to 15 mg L^{-1}. Hence, the purification and chlorination of water results in critical concentrations of THM in drinking water. An exemplary study and detailed modelling is carried out in the 20 km² Lubazhinkha catchment 100 km south of Moscow to characterise the source areas and transport pathways of major nutrients.

Table 1: Characterisation of winter conditions and erosion from plot experiments in the Lubazhinkha catchment, Russia (italics-field crop rotation, bold-soil conservation crop rotation)

Year	Water equivalent of snow [mm]	Runoff [mm]	Soil erosion [t/ha]	Frost depth before snowmelt [cm]	Date of end of snowmelt
1986	*80.6*	*34.2*	*0.32*	-	31.03
	85.3	**36.3**	**0.34**		
1987	*44.6*	*14.8*	*1.12*	*152*	02.03
	50.0	**15.3**	**1.31**	**132**	
1988	*74.1*	*26.8*	*1.21*	*95*	01.04
	79.2	**37.5**	**1.32**	**100**	
1989	*64.6*	*0*	*0*	*17*	19.03
	63.6	**0**	**0**	**15**	
1990	*35.0*	*0*	*0*	*45*	17.03
	35.5	**0**	**0**	**35**	
1991	*42.5*	*0*	*0*	*30*	25.03
	43.8	**0**	**0**	**30**	
1992	*58.5*	*23.1*	*0.51*	*40*	26.03
	67.2	**27.3**	**0.52**	**41**	
1993	*30.1*	*16.8*	*2.00*	*90*	23.03
	32.6	**19.6**	**2.20**	**85**	

Main erosion process is rill development that occurs during snowmelt events and is strongly linked to frozen soil conditions. Results from plot experiments indicate the importance of winter grain to reduce this erosion which can achieve values up to 2 t ha^{-1} (Tab.1).

Additionally, the temporary pasture which is located on slopes near the main channel is an area of erosion. The forest is characterised by shallow and wide overland flow in depressions. The nutrient and organic matter loads are particularly high from these locations. The model system WASIM/SMEM/AGNPS is applied to characterise specific measures to reduce the nonpoint source pollution in the catchment and to evaluate future trends in land use. The results show the potential to reduce the in-field erosion but also the unsteady equilibrium of slope processes to channel erosion (Fig. 1). A growing tourism may increase the pressure on the catchment, because of vegetable production and uncovered fields during snowmelt periods.

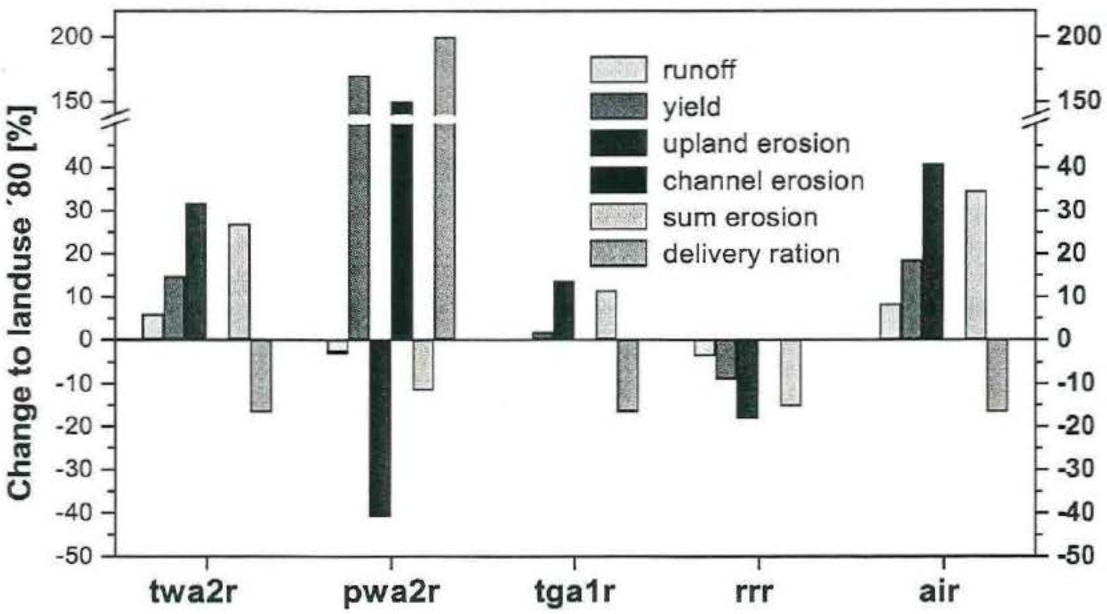

Figure : Results for different landuse scenarios for erosion and sediment delivery in the Lubazhinka catchment, Russia

The results of the project show the importance of a dual strategy to ensure the drinking water supply in the Volga catchment: *i)* improvement of drinking water treatment techniques and *ii)* better control of nonpoint nutrient sources.

The oligotrophication of drinking water reservoirs – does it cause or counteract the problem of taste-and-odour compounds produced by benthic cyanobacteria?

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After the political changes in East Germany, the sudden and almost complete substitution of P-containing detergents, the improvement of sewage treatment as well as changes in the agricultural use of catchment areas the nutrient loads to drinking water reservoirs decreased markedly. This was, beyond doubt, a very enjoyable development.

But now it is argued, that exactly this development could have caused a new problem. There is apparently a more frequent appearance of earthy / musty odours in the raw water gained from several drinking-water reservoirs in Saxony (Germany) in summer. The example of Klingenberg Reservoir, which is important for the drinking water supply of Dresden, is shown in Figure 1.

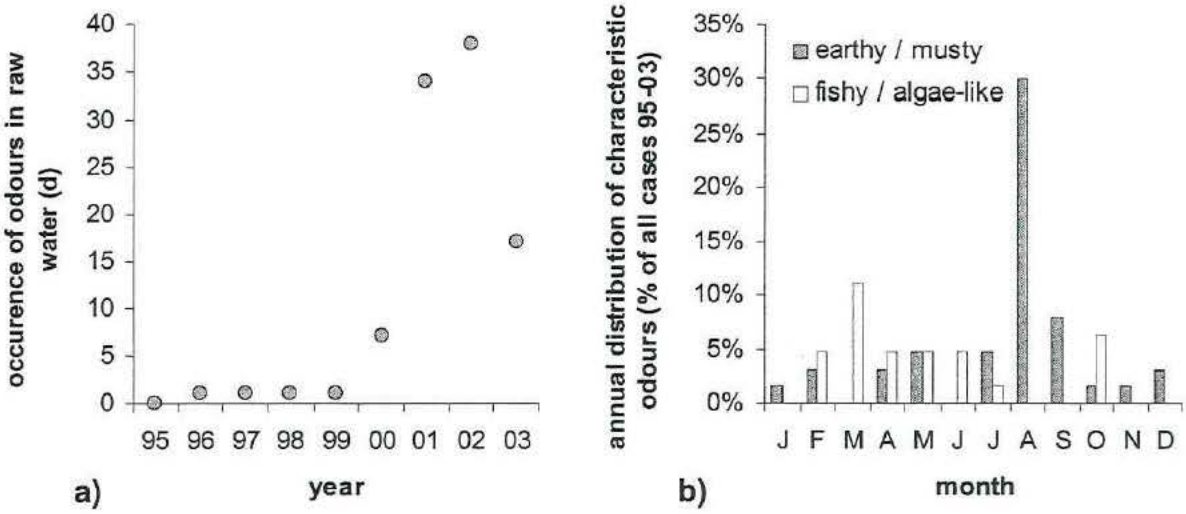

Figure 1: a) Occurence of odours in the raw water of the water works Dresden-Coschütz, (Germany, Saxony) which gains water from the Klingenberg Reservoir in the course of the last nine years. b) Annual distribution of the two primary kinds of odours, which occurred in the raw water of Klingenberg Reservoir.

Benthic cyanobacteria are well-known for producing earthy / musty odorous compounds, such as geosmin, 2-methylisoborneol and β-ionon. In the course of investigations in 2003, dense mats of benthic cyanobacteria (genera *Leptolyngbya, Oscillatoria, Phormidium, Tychonema*) have been found in the littoral of two important drinking water reservoirs (Saidenbach and Klingenberg reservoir). It could be shown that some of the members of these phytobenthic communities were able to produce taste-and-odour compounds. For example a strain of *Tychonema* spec. was able to produce very high amounts of geosmin up to a biomass-specific concentration of 3.2 $\mu g\ mg^{-1}$ dry weight.

Thus, the question arose, if the process of oligotrophication, favours the occurrence of odour producing benthic cyanobacteria like *Tychonema* spec. in Saidenbach and Klingenberg Reservoir.

Comparing the two reservoirs, we found a denser colonisation by benthic cyanobacteria in the lesser eutrophic Klingenberg reservoir in 2003 and 2004. In 2003 the share of species, which have produced high amounts of odorous compounds in laboratory cultures, was there not higher than in Saidenbach Reservoir (see Figure 2). In 2004 no odorous species were found in Klingenberg reservoir whereas the share of the odorous *Tychonema* spec. in Saidenbach reservoir were higher in 2004. From this data it could not be clearly concluded, that oligotrophication led to the observed odour problems. Beyond the trophic conditions in the water body, the density and species composition of the microphytobenthic community seems to be influenced by the interaction between light supply, light transmission and sediment quality.

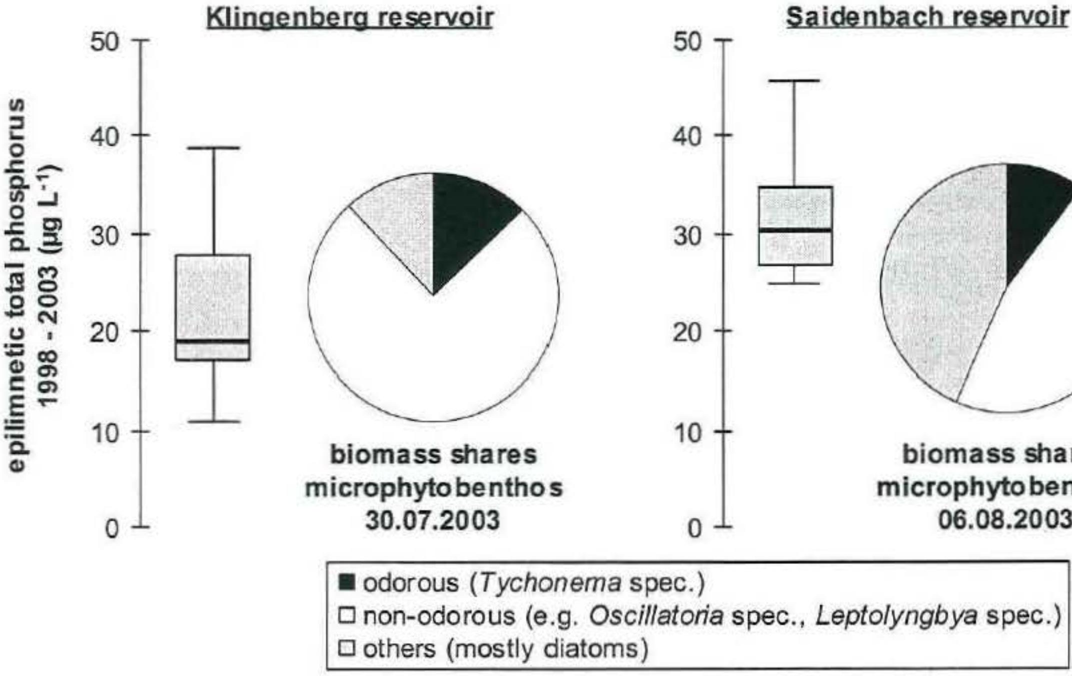

Figure 2: Epilimnetic total posphorus concentrations in the years 1998 – 2003 and shares of odorous and non-odorous species in the micorphytobenthic community of Klingenberg und Saidenbach reservoir (Germany, Saxony)

Laboratory experiments with the main species of benthic cyanobacteria of the investigated reservoirs showed, that in oligotrophic reservoirs non-odorous species should dominate. The results will be discussed with regard to the expected ongoing oligotrophication of the reservoirs and possible management measures which could control the odorous species.

In-vitro investigation of the trace element accumulation on artificially grown biofilms

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Monitoring of pollutants in the aquatic environment is an important topic, since many pollutants enter the trophic chain via aquatic biota. Biofilms (periphyton communities) are quite ubiquitous and very abundant in many freshwaters and they represent a very early stage of the trophic chain. Since biofilms are highly capable to absorb trace elements, they play an important role to bring the pollutants into the trophic chain. For this reason, biofilms are widely used in biomonitoring studies (Jang, 2001; Mages, 2004)].

Often mining activities are combined with the emission of high amounts of various pollutants, especially metals and metalloids into surface waters. In the Elbe river catchment area of German Democratic Republic heavy metals and Arsenic have been deposited as sediments in the rivers from former mining activities. During flood events like in 2002 at the Elbe river and main tributaries these sediments have been mobilized and transported among the rivers. In the case of the "century flood" furthermore erosion from arsenic and heavy metal containing tailings have been observed in the upper part of Freiberger Mulde near Freiberg (Hofmann, 1992; Kluge, 1995).

To investigate the hazardous potential of Arsenic in the Mulde surface water in relation to the biofilm freshwater from the river Freiberger Mulde, Germany, was filled into a reactor and biofilms were cultivated completely in-vitro, on artificial polycarbonate supports. After reaching the plateau phase, As was dopped, and the bio-accumulation determined using the total reflection X-ray fluorescence (Petterson, 1998; Friese, 1997). To investigate, which role has the chemical form, As(III) and As(V) was added in parallel experiments. The addition was carried out at two different concentration levels for both species. With a blank experiment we have established that the reactor walls eliminate about the half of As(V), for this reason, we have doped this species at double concentration as As(III), which was only slightly adsorbed.

Investigation of the original surface water of the Freiberger Mulde have shown that about three quarters of As was present as As(V), and more than 80 % of the total As was bound on suspended matter.

The bioaccumulation experiments have shown that biofilms accumulate arsenic mostly as suspended matter. Using the confocal laser scanning electron microscopy (CLSM), we have established that the biofilms had high number of embedded particles originating from the highly abundant suspended matter of the water. We did not found any regular influence of the doped dissolved arsenic on the measured mass fraction in the biofilms.

On the basis of the results we can conclude that the surface water of the Freiberger Mulde is highly polluted with suspended arsenic. This suspended matter will be taken up by the biofilms, however, only as embedded particles into the extra cellular polymer matrix (EPS). An uptake of dissolved arsenic could be not observed.

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Agrochemicals in groundwater in agricultural used abstraction zones of waterworks in Northern Germany. Approaches to describe processes, heterogeneity of the nitrogen metabolism and transport.

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1. Introduction

1.1. Context of the paper

In Germany the groundwater abstraction areas of waterworks are mostly used by farming and forestry. The agricultural production is on a high level. With this type of land use often high emissions to groundwater of macronutrients are connected. But also plant-protective agents and recently animal drugs can be observed in shallow groundwater. From the view of groundwater contamination nitrogen is one of the most important nutrients.

1.2. Problem definition

Today, in various regions of Europe a water supply from groundwater is often only possible

(a) because water is abstracted, which is older than 40 years or
(b) in the case of nitrate loads, because mainly denitrification decreases the concentration below drinking water standard.

Denitrification depends on available reactive material as org. C (heterotrophic denitrification) and sulfide sulphur (autotrophic denitrification). Under the same loading conditions from agricultural land use the nitrate content in groundwater may vary due to the subterranean distribution of the amount of reactive material. Furthermore it can be assumed that the lifetime of reactive material is limited. From this it follows that the decomposition capacity of the aquifer and the lifetime of waterworks with their equipement for water supply is subject to time limitation. The following questions arise:

(a) In which manner the utilisation of soils must be changed in order to minimize the emissions onto the groundwater?
(b) Which kind of tools are necessary to predict the effects of changing the utilisation of soils on the emissions to groundwater or to the raw water of the waterworks before the change is carried out?
(c) Which kind of processes decreases the concentration of the substance?
(d) How are these processes distributed in the underground?
(e) How is the lifetime of these processes?

1.3. Objectives of our paper

We intend to present some results of research which describes the fate of nitrogen in an agricultural used abstraction zone of a waterworks. Our work is performed on two levels:

(a) Process-studies in the field and in the laboratory (batch and column tests on core material gained from drillings).
(b) Test of suitable commercial available tools that depict the flow and the nitrogen metabolism processes in unsaturated and saturated zone on the scale of the catchment area.

We will show aspects about metabolism processes, their distribution, interparameter correlation and their consideration in suitable software tools.

2. Investigation Area

Our investigation area is situated near by Cloppenburg-Vechta, a region with intensive plant production and livestock farming with a high level of emissions. In the observation wells nitrate concentrations changes between 1 and 300 mg/l in short distance of the subterranean space. Today the nitrate front reaches 30 m below ground. Up to now nitrate concentrations less than 1 mg/L are found in the abstraction wells of the waterworks (screened from 30 -80 m below ground).

3. Results

3.1. Nitrate concentrations / Groundwater age versus Depth

Using CFC concentrations it was possible to calculate the residence time of groundwater. We found the age of groundwater straight proportional to the depth of the aquifer. The vertical field velocity was disposed to 1 m/a (horizontal field velocity approximately 80 - 100 m/a). Using groundwater age and corresponding nitrate data we determined the reaction kinetics of a possible metabolism process: reaction constant → $k_{NO_3^-} = 0.2 - 0.5$ 1/a.

3.2. Sediment – depth profiles

We found physical and geochemical parameters like hydraulic conductivity (K-value), loss on ignition, total carbon and total sulphur highly heterogeneous distributed in subterranean space. Collected values of measurement followed normal or lognormal distributions. Reactive material like organic carbon or pyrite were found in multiple amounts in the deeper regions of the aquifer than in shallow regions.

3.3. Sediment – batch tests

The results of batch tests for denitrification show low degradation up to 20 m below surface. In the deeper aquifer up to 40 m below surface an increasing tendency of degradation with the depth was ascertained. In general the degradation of nitrate increases with the depth up to 40 m which correlate positively with the amount of total sulphur respectively pyrite.

3.4. Interparameter correlations

In correlation-analyses we found strongly positive correlations between loss on ignition versus organic carbon and total carbon, total sulphur versus sulphidic sulphur. Poor correlations were found between loss on ignition versus. sulphur and sulphidic sulphur, total carbon versus. sulphur and sulphidic sulphur. These results show the possibility to represent reactive materials like organic carbon and sulphidic sulphur by means of simply and economically determined parameters like loss on ignition and total sulphur for the local aquifer.

3.5. Modeling

Merging all information and derived data from field and laboratory investigations we could derive up a characteristic vertical zoning of reactivity in the local aquifer. We execute a flow and transport simulation. We will present the results of two scenarios of agricultural land use which indicates the influence of changes of soil use on groundwater quality.

WISMUT's Environmental Remediation Activities: Examples for Water Protection and Management Approaches

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1. Introduction

The Uranium mining and milling activities in Eastern Germany were suspended in 1990 following the german reunification. The WISMUT Remediation Program which was launched in 1991 comprises the full scope of mine environmental remediation activities, i.e. remediation of underground mines, waste rock dumps and tailings ponds, open pit backfilling, area cleanup, decommissioning and demolition. All the WISMUT sites (Ronneburg, Aue, Königstein) are located in the catchment area of the Elbe system (Fig. 1).

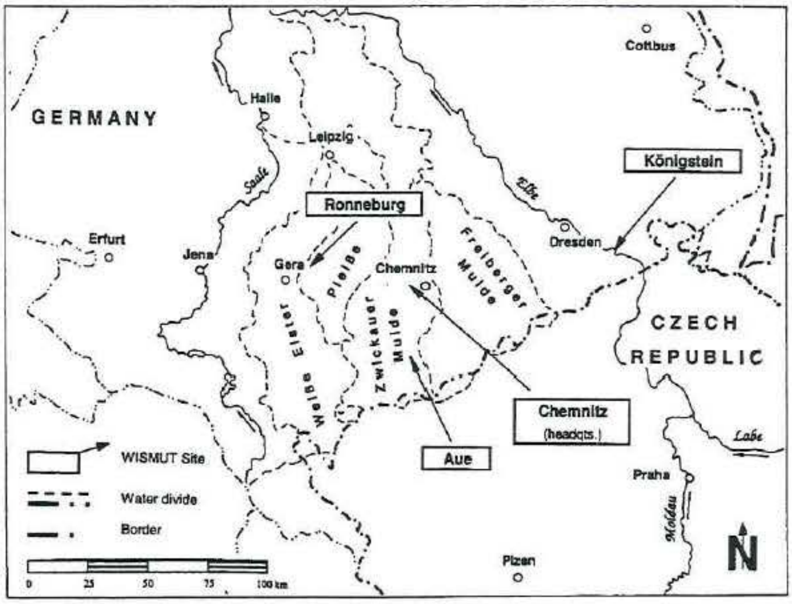

Figure 1: Outline Map of Main WISMUT Sites

Water protection and management approaches represent a central part of WISMUT's closure plans. Crucial activities comprise

- flooding of five large underground mines (1.53 M m^3),
- stabilization of four tailings ponds (160 M m^3),
- mine waste rock pile remediation (311 M m^3),
- open pit remediation (84 M m^3),
- operation of water treatment plants of different technological types.

Large scale mining activities typically go along with commensurate interference in local and regional water conditions. Surface water and groundwater resources can be affected by these influences. The paper describes the complex water protection consequences the required remediation measures include. The presentation outlines some typical remediation strategies and technologies since 1991. It will be completed by a prospect on further tasks and boundary conditions.

2. Examples for approaches at the Ronneburg site

The Ronneburg mine in Eastern Thuringia accounted for about 50 percent of WISMUT's total uranium production of about 220.000 tonnes. The Ronneburg site has been located on both sides of the water divide between the Weiße Elster and the Pleiße river (Fig. 1). In an area of about 60 km^2 the following results of mining activities have to be considered:

- underground mine workings (area about 50 km^2, maximum depth about 1 km),
- open pit mine (area about 2 km^2, maximum depth about 240 m),
- regional groundwater depression cone as a result of the mine drainage system,
- mine waste rock piles (volume about 94 M m^3, area about 5 km^2).

As a result of conceptual considerations of the mine remediation and a water protection concept a combined measure with the following central elements has been realised since 1990:

- backfilling of an open pit mine with waste rock from surrounding piles,
- flooding of the underground mine,
- construction and operation of water catchment systems and a water treatment plant.

This combination of different types of remediation measures enabled WISMUT to minimize the construction and operational costs for the water catchment systems and the water treatment plant. The capacity goal for those water management systems has a dimension of 450 m^3/h in terms of water discharge.
Typical for WISMUT's strategy are furthermore extensive monitoring activities concerning mine water, groundwater and surface water. In the case that any monitoring results are going to show specific necessity, the option for realization of supplementary technical systems is a central part of WISMUT's water protection and management approaches at the Ronneburg site.

3. Examples for approaches at the Königstein site

The Königstein mine near Dresden is situated within a sandstone aquifer in an ecological sensitive and densely populated area. The uranium was extracted from the sandstone using an underground in situ leaching method (sulphuric acid). Approximately 19,000 t Uranium had been produced till 1990.

Especially due to the reactions of the oxidizing sulphuric acid the geochemical status of the deposit was substantially changed with a high pollutant level remaining within the deposit, mainly sulphate, heavy metals and natural radionuclides.

In the case of uncontrolled flooding it highly polluted water would flow into the overlying aquifer through natural or man-made hydraulic connections. To prevent this, WISMUT developed the concept of controlled mine flooding. A major element of this approach is a so-called control drift system which allows the collection of the draining flooding water during and after the flooding process.

Controlled flooding will allow a reduction of the pollutant concentrations to acceptable levels restoring hydraulic conditions to nearly what they were before mining, and to prevent pollutant migration into the aquifer lying above the mine and further downstream. Flooding water, which is collected in the control drift system will be treated and discharged to the Elbe river.

The method of controlled flooding was conceived as a process limited in time. Once residual pollutant concentrations have reached tolerable levels, the control drift system will be abandoned and natural hydrogeological conditions will develop within the mine area.

The flooding process of the Königstein mine started January, 29, 2001. The next step, decommissioning of the underground mine and utilisation of the control drift system as a horizontal well, is applicated.

Water and sediment quality of the Elbe-River profile during and after the flood of August 2002

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The extreme flooding of the river Elbe in August 2002 led to the resuspension and transportation of large amounts of polluted sediments. To evaluate the changes in the pollution levels of the river water and the sediments, GKSS-research centre carried out five new sampling campaigns along the Elbe-river – one during and four after the flood. Three longitudinal profiles of more than 30 elemental concentrations of dissolved and particulate material and two profiles for sediments were determined and compared with the situation before the flood.

The alkaline elements as well as S, Mo and U were found to be dissolved (> 90 %) in the Elbe water. On the other hand, more than 70 % of the elements Cd, Zn, Cr, Mn, Pb and Fe are bound to suspended particulate matter (SPM). During the flood considerably more U was bound to SPM.

The concentrations of some anthropogenic pollutants were increased during the flood, as compared to 1998 (Prange et al 2001). In the Elbe filtrates, the concentrations of Cu, Ni and As were higher over the whole course of the river. The concentrations of Mn and Zn were increased only below the influx of the river Saale. Above the mouth of the river Saale the concentrations of Mn and Zn and also Cd and U were decreased in the filtrates.
In the SPM the concentrations of As, Pb and U were higher to a minor degree over the whole course of the river Elbe. Below the influx of Saale merely the concentrations of Ag, Sn and Hg were increased. Above the mouth of the river Saale however, the concentrations of Mn, Cu, Zn, Cd and Hg were decreased in the SPM.

Two months after the flood the contamination decreased to the concentration levels of 1998 for most elements. Only above the mouth of the river Saale were the concentrations of Zn and Pb in the filtrates higher than formerly. In SPM the concentrations of Cd were increased. In the sediments the concentrations of As, Mo, Sn, W, Bi and U were higher compared to previous samplings (Pepelnik et al, 2004).

New sources of pollution are located in the storage reservoir above the weir at Strekov (mainly of Zn, Cd) and in a dumpsite near Dresden (mainly of W, Bi, As).

During the last campaign in August 2003 with an extreme hot and dry weather an unusual algae bloom produced a biogenous decalcification. Due to this effect the concentration of Ca in SPM and in recent sediments increased in the middle river section (Elbe-km 90 to 615) by about six times. A comparison with previously measured values suggested that the pollutant concentrations of were reduced, giving rise to an apparent amelioration or reduction in contamination. In order to correct for this virtual reduction, the concentration values of the SPM were normalised with respect to their content of Sc. This normalisation revealed an increase in the contamination of SPM in this river section by most heavy elements especially Zn, Cd, and Hg. As an example, Figure 1 displays the content of Hg in SPM from 1998 to 2003 over the longitudinal Elbe river profile. The concentrations show large variations. Above the mouth of the river Saale the highest values of Hg were found in 1998, below the influx of Saale the concentrations of Hg were greatest during the flood. In August 2003 due to the dilution by Ca and organic material the lowest values were detected. The normalisation with Sc corrects this effect and results in an increase of the contamination by Hg in the section below the influx of Saale to Hamburg.

The previously observed continuous reduction in contamination of the river Elbe seems to have been halted by the extreme flood in August 2002. The median values of the concentrations of Zn, Cd, W and Bi in surface sediments were higher in August 2003 than in 2002 and 1998.

The variations in the contamination levels of different heavy metal pollutants before and after the flood will be discussed. Also the temporal variation of pollution in terms of quality classes (LAWA) over the Elbe river profile will be shown.

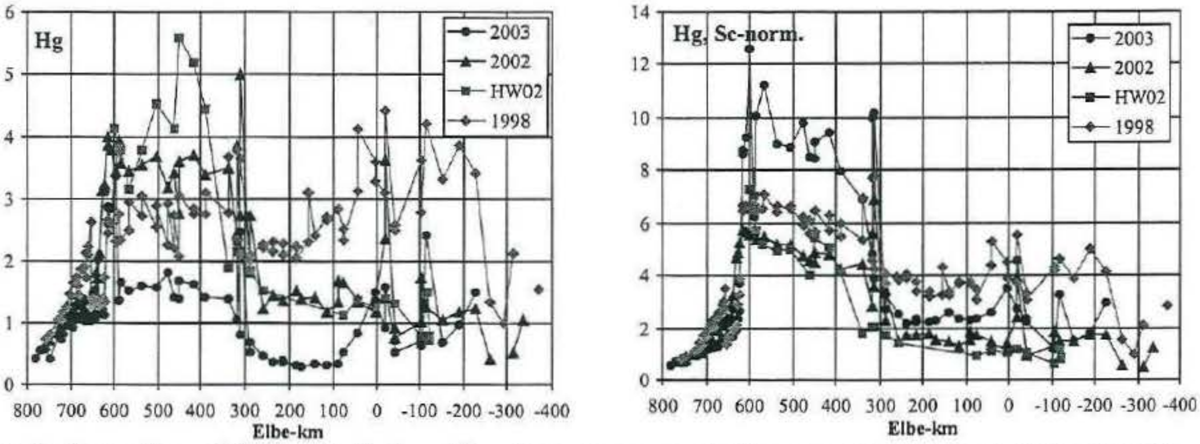

Figure 1: Comparison of the longitudinal profiles of mercury concentrations in suspended particulate matter of the river Elbe from the source to the mouth (Sept. 1998, flood 2002, Oct. 2002, August 2003) left: absolute values, right: Sc-normalised values $c_{Hg}^{norm}=c_{Hg}/c_{Sc}*c_{Sc}^{0}$ with $c_{Sc}^{0}=13.5$ mg/g

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Identification and implementation of measures in river basin management: How to meet the environmental objectives of the WFD with respect to physico-chemical quality components?

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Within the interdisciplinary research project "Integrated River Basin Management – Conflict Assessment and Possible Solutions for the River Weisse Elster Example" a decision support system (DSS) for the setting up und implementation of programmes of measures according to the WFD is conceptualised. The focus is on non-point source pollution and methodical as well as institutional requirements of river basin management as a decision making process.

We present an assessment procedure for identifying the most cost-efficient combination of measures under consideration of the cost-recovery and the polluter-pays principle. Therefore, a typology of measures distinguishes between actor-oriented measures (e.g. legislation, economic incentives, fees) and environment-oriented measures (e.g. change in agricultural practice, buffer strips along watercourses). Actor-oriented measures affect the behaviour of water users and lead to the implementation of environment-oriented measures, which are directly changing the status of nutrient emissions. Measures of both types are interacting in a restricting or supporting way, which must be made explicit in the decision making process.

Supplementary to the cost-effectiveness-analysis (CEA) undertaken, a multi criteria analysis (MCA) of ecological and economic effects of those measures[1], proved to be of potential relevance in specific conflict situations, are assessed. Furthermore, for each measure its institutional environment, in which implementation takes place, is analysed. The analysis comprises the specific institutional arrangement of river basin management in a certain basin district, the interaction of RBM with other policy fields relevant for conflict solution (e.g. agriculture, nature conservation, spatial planning), and the range of legal, financial and planning instruments available for supporting the implementation of the selected measures for achieving a good ecological status of water bodies.

Finally, the presentation refers to problematic issues and open questions towards the setting up and implementation of programmes of measures. Especially, how and to which extent can environmental and resource costs be integrated and methods for their assessment be made operational? What legislative and instrumental requirements are necessary for such a fundamental policy change?

[1] see complementary abstract from Hennrich et al. presenting the modelling system for the identification of the ecological effects of measures.

Pollution of mine waters in the Upper Silesian coal basin (Poland) in relation to their origin

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According I. Pluta and A. Zuber (1995) and I. Pluta (2004) a combined isotope and hydrochemical approach allows to identify the following types of mine waters in the Carboniferous formations of the Upper Silesian Coal Basin (USCB) in Poland:

- the oldest brines which resulted from the infiltration of a very hot climate, most probably during Permian and early Triassic,
- brines which resulted from different processes, particularly: the infiltration and transpiration during in the Triassic and/or the Tertiary,
- the Tertiary waters which resulted from meteoric waters prior to the sea transgressions in the Tortonian,
- the post- Tortonian waters which resulted from meteoric waters after the last sea transgression in the Tortonian,

These waters contain different of heavy metals: Ba, Sr, Zn, Cu, Pb. Concerning the different types of waters the concentrations of Ba and Sr are maximal in oldest brines. These brines occur in the whole the USCB, but in particular in the coal mines located in the southern region. The concentration in mine waters of barium reaches to 2,5 mg/dm^3, strontium to 1 g/dm^3. The brines resulting from different processes contain the highest concentrations of Zn, Pb and Cu. These waters occur locally, the specially in western and central region of USCB. The concentration of zinc reaches to 5,5 mg/dm^3 , lead to 1,5 mg/dm^3 and copper to 0,6 mg/dm^3.

Depending on the origin of waters and their inflow rates, particular groups of coal mines discharge different mine waters. In consequence, there are differences in contamination of surface waters and river sediments in the Upper Silesia in Poland.

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Forecast system of flow regime operative control in the Elbe River basin

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1. Introduction

In last years floods affected great part of our republic and caused extensive floodings and huge damage in areas along watercourses. In flood situation on watercourses, prognosis of meteorological and hydrological development, monitoring of meteorological and hydrological phenomena in real time, operative evaluation of all information and subsequent warning of inhabitants and other subjects have principle importance for elimination or reduction of damage extension. Actual information about situation on watercourses and water structures including the prognosis of presumed development is provided by the Czech Hydrometeorological Institute (CHMI) and the administrators of watercourses. These subjects were joined into the Forecast and Warning Flood Service and their information serves for flood and crisis authorities that control security and rescue operations in affected area during the flood.

2. Data and information sources

Mutual connection of meteorological forecasts, monitoring systems and forecast hydrological systems is the basic condition for operational evaluation of rainfall-runoff relationships in river basins. This activity is provided by forecast workplaces of the CHMI and the administrators of watercourses. CHMI has the central forecast workplace in Prague – Komorany and regional forecast workplaces in regional branch offices of the Institute. The state enterprises Povodi as administrators of watercourses have their dispatching centres, in our case it is the dispatching centre in Hradec Kralove that is closely connected with central and regional forecast workplaces of CHMI. For mutual distribution of data and information, standard communication ways as e-mail, fax and also an automatical connection through the FTP server are exploited.

2.1. Meteorological forecasts

The main tasks of the meteorological service by weather forecasting is to observe the weather situation, create the weather forecasts and issue warnings against dangerous meteorological phenomena, especially against great and intensive rainfalls, hailstorms etc. The rainfall forecast is the primar information about rainfalls entering into the system. This forecast is a task for the department of meteorological prognosis of CHMI.

2.2. Monitoring system

Reliable monitoring system with optimum density network of measuring stations on water structures, watercourses and in the river basin that ensures data transmission to the dispatching centre in automatic regime is the most important condition for all forecast systems working in real time. The measuring stations network in this country is realized in close cooperation with CHMI. From the final stage of 235 stations (70 of them CHMI), nowadays 190 station were automated (45 of them CHMI).

3. Forecast model Hydrog

Mathematical model HYDROG that is exploited in the dispatching centre of Povodi Labe, created by Mr. Milos Stary, simulates the rainfall-runoff process. It means that the only input for the solution (by given start state of the system) is the distribution of rainfalls in time and room in the river basin (in winter period also information about temperature and snow cover). The whole process is then simulated on base of these information and the output is created by hydrograms of the river basin in any stream profile in the river network.

The model means was fully connected with the monitoring system from which it takes all measured data and in the same time it was connected with the meteorological model ALADIN provided by CHMI from which we get twice a day rainfalls and temperatures forecasts with 48 hours timing advance. Thanks these facts we can prepare discharge forecasts for 48 hours and during the flood we are able to repeat the whole process on base of new information for more accurate results. Optimum period for model using during the flood is from 3 to 6 hours.

As next step for providing better information from the dispatching centre of Povodi Labe we prepare presentation of information about awaited extension of the flooded area based on the actual development of the rainfall and flood situations. This activity supposes that the whole area administered by Povodi Labe will be included in the rainfall-runoff model, hydrodynamical models will be prepared for the most important streams and then the rainfall-runoff model will be connected with models of flows in river beds. In the first stage, one of in advance prepared maps with plotted border line of flood areas of Q_5, Q_{20}, Q_{50} and Q_{100} will be presented. In future, the on-line connection of the rainfall-runoff and hydrodynamical models with following projection of gained results into DMT and vizualization of this way determined flood area border on chosen map can be supposed. Probably it will be not an automatic process and the supervision of the processor will be necessary.

4. Conclusion

Experience gained from the operation of the model Hydrog that has been exploited at dispatching centre of Povodi Labe since 1999 entirely in flood situations can be evaluated as very positive. Development and introduction of forecast systems into common practice contributed to the shift of given problematics on a higher level not only from the internal point of view but also form the view of wider and better links to the state authorities and general public during flood situations.

The most important factor affecting outputs is the quality of meteorological forecasts that can reduce the rate of uncertainty of hydrological forecasts. Regarding to the probability of its successfulness, there is suitable to create different versions of the development of hydrological situations in river basin and currently predict these versions based on the real development and new forecasts.

Main objectives that still remain are to improve the forecast system, this way to improve the output information about the posible flood situation as well as about passing flood and also to enable warning of inhabitants and reduction of flood damage to the minimum level. To this aim it should contribute:

- prolongation of the forecast period (prolongation of the rainfalls forecast);
- on-line connection of workplaces of CHMI and state enterprises Povodi and mutual evaluation of single forecast models;
- ensuring of forecasts for more forecast profiles including mountain areas where the travel times are very short;
- interconnection of the operative model with hydraulic models and determination of the flooded areas and water levels for areas endangered by floods.

Basis for an evaluation of land use in conservation areas connected with running water systems

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1. Introduction

Environmental planning increasingly faces challenges as a result of growing demands in relation to the environment and greater public involvement. Discussion therefore plays a part in the establishment of goals for individual projects, and in planning the actions resulting from these goals. Those involved in the practical side complain particularly of the lack of a comprehensible and convincing basis for evaluation and for the identification of objectives. This clearly indicates that the planning process lacks a central guiding principle by which critical parameters can be identified.

Interventions in and around running water systems, such as restoration, revitalization, building of dykes to include and exclude areas, creation of riverine forests and flooding areas, often take place without any overall plan. BUSSE (1994) remarked that decisions are often made against a background of topical political concerns.

Recent natural phenomena in running water systems (the catastrophic flooding on the Elbe in Germany in 2002) have shown that only all-inclusive plans can produce a solution acceptable to everyone involved. In future it will be essential, above all, to work out forward-looking plans for utilization and development, which not only maintain the ecological functioning of rivers, but actually improve it. This requires comprehensive knowledge about both the varied natural interactions between the river, its flood plains and its catchment area, and those that have been altered by human intervention.

2. Example: the situation on the middle Elbe

Around the mid-section of the Elbe in the German state of Saxony-Anhalt, a varied landscape has survived over time. The landscape is in a constant and dynamic state of change, influenced by human activities. Major problems on the Elbe are erosion of the riverbed in some sections of the river, the fact that the designation of the Elbe as a waterway means that no new backwaters can be formed and existing successions disappear, and the lack of riverine forest in extensive sections of the floodplain. All these problems are parts of processes that lead, in the long term, to the limitation or disappearance of the structures typical of floodplains. For many years the great rivers of Europe were looked upon only as water transport routes for shipping. Ecological aspects were not considered.

There is therefore a need for a comprehensive approach. This would encompass not only the identification of areas for revitalization but also the use of measures, radical where necessary, to increase the ecological value of already valuable areas. It would also allow economic factors to be taken into account.

3. Possible methods

The situation as described above means that, in order to be able to carry out a restoration or revitalization, it is necessary to find a hierarchy for decision-making that includes and compares all possible parameters. At the present state of knowledge there are two procedures available for this purpose: Utility Analysis and the Analytic Hierarchy Process (AHP). The Analytic Hierarchy Process is a process by which complex decisions can be structured so that a systematic, optimal and rationally comprehensible decision can be reached (MEIXNER / HAAS 2002). It is "hierarchic" because the criteria upon which the solution of the problem is based are always incorporated into a hierarchical structure. These criteria are described as features, attributes etc. as required. The AHP is "analytic" because of its ability to analyse a problem comprehensively in all its dependencies. It is a "process" because it dictates the course of events by which decisions are structured and analysed. This course of events always remains the same, making the AHP in repeated use into an easily used decision making tool that is similar to a routine procedure. This procedure can be applied in the present example to achieve a decision.

4. Decision making and parameters

Many parameters must be taken into account for a comprehensive view of a running water system. They may be of ecological or economic origin. Parameters can be use-oriented and simultaneously have a political background. There are, equally, parameters that are clearly related to hydraulic engineering (utilization of the running water system and securing the surrounding areas against floods).

A few ground-rules must first be formulated for following the basic course of the Analytic Hierarchy Process. The starting point for considering how to structure and solve the problem is always an overall goal. Sub-goals can be derived from it. These are then referred to as attributes or features. To reach the goals, measures (alternatives) are selected. An important feature of the AHP is that both quantitative and qualitative information can be incorporated into the decision making process.

For example, if we apply this procedure to the Elbe river system already mentioned (see the section Example: the situation on the middle Elbe), the overall goal could be taken as the creation of riverine forests and the restoration of backwaters. Sub goals in the area of ecology would then include: moving beavers into new sections of the Elbe; planting appropriate trees to form new riverine forests; increasing the size and diversity of the fish population by creating running water from what, prior to revitalization, was standing water.

The creation of additional riverine forest, and the associated building of dykes to exclude further low-lying riverbank areas, produces additional retention or flooding areas. These can be brought into use when levels of flood water in the river system are high, helping to minimize high economic costs resulting from severe or extreme flooding. Damage to public and private buildings could similarly be prevented.

In this example the model would then be taken through the Analytic Hierarchy Process (AHP) and would reach a decision that had an objective and constructive basis. This process could be applied in the designation of a conservation area on a running water system to ensure comprehensive consideration. Political interests, like other non-competent interests, would then no longer play a part in the designation process.

5. Summary

The designation of nature conservation areas on running water systems can in future be subjected to a decision-making process that is objective, value-free and based on parameters (critical levels). The choice of an appropriate decision making procedure makes it possible to perform a consistent and comparative analysis even though many different features from different disciplines need to be investigated. One or more overall goals need first to be established. In addition further sub-goals must be identified. The whole is then subjected to decision making according to the Analytic Hierarchy Process (AHP), which allows only decisions that are clear and logical. This goal-oriented "central guiding principle" does not permit any other form of solution.

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Strategy Concept Elbe - Passive Water Treatment Methods for the Minimisation of Impacts on Water Bodies by Ore Mining Activities

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The River Elbe is the third largest river of Central Europe after the Danube and the Rhine, both according to length and to the size of the catchment area. Contamination of the river and its water has been occurred since the Middle Ages when, for example, Bohemia became a centre of industrial activity. From the 14th to the 19th century silver and iron were mined extensively in the Ore Mountains (Erzgebirge). Tanning and paper-making also did not improve water quality. But of course there is no data available relating to these times.

With industrialization many heavy and chemical industries settled were established in the Elbe area. The first recorded investigations of water quality are concerned with chlorine levels and they document a sharp increase in the second half of the 19th century because of the use of sodium for industrial purposes.

In 1989, when the Iron Curtain fell, the water quality of the Elbe was comparable to that of the severely polluted Rhine of the early 1970s. For decades it was the recipient of untreated or insufficiently treated wastewater from urban centers, industry an agriculture. During that period, 82 % of the East German industrial production and the entire western Czechoslovakian industrial region. Major industrial point sources included pulp and papermaking, chemical, and pharmaceutical facilities. For example, the chemical complex at Bitterfeld was a major source of mercury pollution in the Elbe. It released 200,000 m^3 of untreated industrial sewage into the Elbe every day. In the transition zone between freshwater systems and the marine environment, ports like Hamburg still have to bear this burden of history.

The Strategy-concept Elbe contains an integrated project to improve the water and sediment quality reducing the impacts of heavy metals and organic pollutions from the old mining and organic industries.

With respect to the costs of mining remediation passive water treatment systems are the only possible methods for a longterm treatment of waters from mine sites. The passive treatment methods should be applicable with a minimum of energy, manpower and without the need of permanent renewal of chemicals. The effective fixation of heavy metals on the surface above the watertable is not simple to realise. For very big and diffuse emissions of reservoirs with often more than 10 – 100 years residence time, especially from mining (mine-buildings, surface mining, deposites, tailings) costly technical solutions are not tenable of economical reasons. In many cases there must be realised a combination of monitoring, based on a fixing of the sources (isolation of the contaminant species, pH-rising, multi barrier system) and a handling afterwards in similar-to-nature systems (wetlands).

Presence of dangerous substances in suspended sediment and sediment in the Czech Part of the Elbe River

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1. Overview

Dangerous substances are matters which are in the water ecosystem toxic for water fauna, bioaccumulative, persistent, carcinogenic, mutagenic and teratogenic. This presentation shows up information about the presence of dangerous substances in solid matrixes of the water ecosystem, it means suspended sediment and sediment in the Elbe catchment, based on monitoring results in the national monitoring network and results of the project "Presence and migration of dangerous substances in the hydrosphere of Czech republic", both provided by Czech Hydrometeorological Institute. Presented sampling sites are part of the complex monitoring network with extended chemical status monitoring in compliance with requirements of 76/464/EC, 2000/60/EC(WFD) directives and daughter directives.

Beside the overview of list of relevant substances in both matrixes is also presented comparison of concentration with proposed and valid environmental quality standards in the Czech republic. In this paper is also evaluated space-time evolution of concentration of dangerous substances. For the information about the flux pollution transport in the Elbe river is also presented detailed balance of priority substances flux.

2. Dangerous substances monitoring in the national monitoring network

Dangerous substances monitoring in suspended sediment and sediment as a part of the national monitoring network was established in compliance with the EU legislation requirements on 20 selected sampling sites in 1999, as a part so called complex monitoring network. Since 2000 was this monitoring extended on 45 sampling sites on the Elbe river, Vltava river, Morava river, Odra river, Dyje river and their main tributaries. In the Elbe catchment involve the Debrné, Němčice, Valy, Lysá nad Labem, Obříství, Liběchov and Děčín sampling sites on the Elbe river and sampling sites on tributaries Nemošice (Chrudimka), Nepasice (Orlice), Předměřice – Tuřice (Jizera) Sány (Cidlina) Zelčín (Vltava) Louny (Ohře) Ústí nad Lavem (Bílina), Benešov nad Ploučnicí (Ploučnice). Sampling and analytic methods are based on EU legislation, international norms ISO, Czech norms CSN and recommendations of the WMO and they are methods accepted for the CHMI monitoring (Rieder et al. 1999). Sediment sampling frequency for analysis of heavy metals and specific organic compounds is twice per year – in spring and autumn months. In the case of suspended solids are monthly sampled point samples for heavy metal analysis and 4x per year centrifuged by a mobile centrifuge for specific organic compounds and heavy metal analysis. Beside the routine monitoring in the complex monitoring network was important step further in the research of dangerous substances the project "Presence and migration of dangerous substances in the hydrosphere of Czech republic". This project was solved in Czech Hydrometeorological Institute in years 2000 – 2003 (Rieder et al., 2003). One of the main goals was to define relevant dangerous substances for Czech republic by virtue of their possible presence in the aquatic environment and consecutively investigative monitoring in different parts of the aquatic environment – water, suspended sediment, sediment and biota. Partial result of this project was proposition of surveillance and operational monitoring of the aquatic environment in the national monitoring networks of surface water and groundwater in compliance with requirements of legislation acts of EU and Czech republic. Part of the project was the list of dangerous substances with the priority ranking based on COMMPS procedure

(Hypr, Halířová, Beránková,2003). By the extent of presence every concrete dangerous substance (exposition) and it's specific toxicity were all dangerous substances sorted to the priority list of substances which characterize their presence and necessity to monitor.

3. Assessment of presence and loading

Sediment assessment is based on results of chemical analysis of heavy metals on fraction 20 µm and specific organic compounds analysis from whole fresh non cohesive sediment sample. In the case of suspended sediment are presented results of heavy metal concentration from filtrated samples and since 2001 also centrifuged samples. Specific organic compounds were included into the assessment only from centrifuged samples. In the Czech republic are not defined quality standards for solid matrixes as well as in the EU. In directives 76/464/EHS and 2000/60/EC is only required non increasing concentration trend of dangerous substances in time series. Therefore in this presentation are concentration of dangerous substances compared with limits of Methodic direction of Ecological damages division of MoE – Criteria for soil and groundwater pollution, 1996. Exceeding of limit value of B category is qualified as pollution, which may has negative influence on human health and individual compartments of ecosystems. Because of wide range list of monitored dangerous substances, we have made selection of presented dangerous substances based on following criteria:

- Priority dangerous substance Annex X of WFD
- Relevant dangerous substance for the Czech republic based on results of COMMPS procedure
- Relevance of dangerous substance for solid matrixes by Log_{Kow} , $K_{susp.sed\text{-}water}$, and <DL

For more detailed assessment were selected substances which 90% concentration percentile or maximum concentration exceeded on any monitored sampling site at least limit value of B category (added or risky concentration) at the Elbe catchment in period 1999 – 2003 – As, Cr, Cd, Pb, Hg, Zn, benzo(a)pyrene a hexachlorbenzene. Sediments in closure profiles of tributaries of the Elbe catchment are not so polluted and loaded in comparison with suspended sediment. The most polluted profile is traditionally Bilina river in Usti nad Labem profile, however on this river exists indication of positive trend of dangerous compounds concentration.

Table 1: Overview of relevant dangerous substances selected for sediment and suspended sediment assessment.

látka	skupina	MIN	MEDIAN	PRŮMĚR	P75	P90	MAX	počet	pod MS	A1	A2	B	C
arsen	kovy	0,5	18,00	32,51	28,5	51,84	519	255	0,4	78,0	14,1	0,0	7,8
beryllium	kovy	0,5	2,00	2,70	2,985	4,7	19	255	9,8	91,4	7,1	1,6	0,0
chrom veškerý	kovy	18,7	76	94,08	98	152	697	255	0,0	86,7	11,8	0,4	1,2
kadmium	kovy	0,2	2,70	3,74	4,5	7,66	37	255	0,0	6,3	89,0	3,5	1,2
měď	kovy	13	77,00	145,66	121	207,4	8910	255	0,0	42,0	56,5	0,4	1,2
nikl	kovy	11	51,70	58,90	67	86	323	255	0,0	65,1	33,7	0,4	0,8
olovo	kovy	15	77,30	89,42	105	149	543	255	0,0	56,5	42,0	0,8	0,8
rtuť	kovy	0,05	1,20	2,13	2,1	3,67	70,9	254	0,4	13,4	67,7	16,9	2,0
zinek	kovy	120	567,00	675,28	798,5	1156	2560	255	0,0	1,2	92,5	5,9	0,4
hexachlorbenzen	Chlorbenzeny	0,5	0	15,77	5	7,65	470	56	69,6	91,1	8,9	0,0	0,0
p,p' - DDT	Chlorované pesticidy	0,5	12,80	106,60	37	67,5	4300	56	17,9	89,3	8,9	0,0	1,8
aldrin	pesticidy	2,5	2,50	2,50			2,5	3	100,0	100,0	0,0	0,0	0,0
endrin	pesticidy	0,5	0,50	0,50			0,5	6	100,0	100,0	0,0	0,0	0,0
tetrachlormethen	TOL	10	10,00	39,17	110	110	110	24	100,0	0,0	70,8	29,2	0,0
antracen	PAU	0,5	52,5	79,45	96	167,5	347	56	19,6	76,8	23,2	0,0	0,0
benzo(a)antracen	PAU	0,5	337,5	520,46	606	844	2600	56	10,7	12,5	87,5	0,0	0,0
benzo(a)pyren	PAU	17	361,00	449,36	474,75	802	2390	56	5,4	12,5	83,9	0,0	3,6
benzo(b)fluoranthen	PAU	25	427	584,91	565,75	708,5	3610	56	5,4	7,1	92,9	0,0	0,0
benzo(g,h,i)perylen	PAU	25	215,5	301,25	289,75	459,5	1640	56	5,4	7,1	92,9	0,0	0,0
benzo(k)fluoranthen	PAU	25	224,50	330,21	339	417	2210	56	7,1	10,7	89,3	0,0	0,0
dibenzo(a,h)antracen	PAU	0,5	50,00	66,02	84,5	133,5	278	56	19,6	78,6	21,4	0,0	0,0
fluoranthen	PAU	50	760,50	1023,34	1018,75	1560	5400	56	5,4	12,5	87,5	0,0	0,0
fluoren	PAU	0,5	67,50	124,43	144,25	188,5	1200	56	19,6	78,6	21,4	0,0	0,0
chrysen	PAU	0,5	366,50	497,91	539	775,5	2840	56	5,4	5,4	94,6	0,0	0,0
indeno(1,2,3-c,d)pyren	PAU	25	202,00	321,27	313	588,5	1880	56	10,7	19,6	80,4	0,0	0,0
naftalen	PAU	5	117,00	241,04	429	581,8	1190	49	8,2	20,4	79,6	0,0	0,0
pyren	PAU	0,5	643	847,23	975	1485	3970	56	5,4	12,5	87,5	0,0	0,0

Qualitative readings refer to suspended sediment (heavy metals mg/kg, orgaqnic compounds µg/kg).

4. Transport of suspended sediment and pollutants in suspended sediment

Calculation of transported pollutants in suspended sediment presents orientational view on total amounts of dangerous substances transported by river. It's based on daily monitoring of suspended sediment concentration. It's clear that increased precision of calculation of total transported amounts of pollutants is essential for good knowledge of river regime, measure and dynamics of aquatic ecosystem pollution by dangerous substances.

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Quantifying the influence of dissolved organic Carbon, Eh, pH, soil moisture, soil temperature, soil matrix potential, and flooding on the mobility and dynamics of As, Cd, Zn, and Pb in soil solution and groundwater of alluvial soils at the Elbe River

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Alluvial soils are underlying largely fluctuations in water table and therefore various moisture, Eh- and pH- conditions. We monitored and quantified the influence of flooding, soil redox potential (Eh), pH, dissolved organic carbon (DOC), electric conductivity, soil moisture, soil matrix potential (ψ) and soil temperature on the mobility and dynamics of Cd, Zn, Pb and As. We measured extremely high concentrations of zinc (4239 ppm), lead (768 ppm), arsenic (758 ppm), and cadmium (47 ppm) in alluvial soils of the Elbe River. These concentrations exceed the critical limits, set by the German Soil Conservation Law. We used Eutric Fluvisols, Mollic Fluvisols and Eutric Gleysols, which are widely spread soils at the Elbe River. Our sites are located on streamkilometer 242, 284 and 290 (Germany).

We measured heavy metals and arsenic approximately every 3 weeks in soil solution in three depth and three replications of five reference wetland soils, as well as in groundwater and in precipitation. Furthermore we observed water level and soil moisture, Eh, ψ and soil temperature in three depth and three replications every two hours with data loggers over several years. During flooding periods we found peaks of DOC and several heavy metals, while Eh and ψ were in minimum and moisture in maximum.

Multiple regression analyses help us to find out controlling factors and to quantify relationships between them. Soil moisture, DOC and pH are the most important factors controlling the mobility of many heavy metals in alluvial soils, they explain 90 % of the temporary variability of arsenic, 95 % of cadmium, and 98 % of zinc in soil solution.

Modelling the dynamics in reservoirs under varying conditions of inflow

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Requirements on river basin management have permanently expanded in the last years and meanwhile cover all the involved compartments, e.g. lakes and reservoirs integrated into the catchment system. Those represent innate reaction centres showing dynamics mostly decoupled from the connected streams. Due to the substantially longer residence time and spatial extension, mainly in the vertical direction, an entirely different species community may establish itself. Associated are different turnover processes that are investigated by means of extensive measuring campaigns and model developments. The latter range from basic process models to complex food web models which cover different spatial and temporal scales.

Within the project GETAS (Coupled reservoir simulation) existing hydrodynamical and ecological models were coupled and their spatial and temporal resolution was refined to time steps of hours. Thus, on the one hand interactions of physical and biological processes are accounted for and one the other hand investigations of transition periods are enabled, e.g. during spring when the water body stratification begins. For model validation, data sets in a high temporal resolution (1.5 to 3 hours) of several measuring campaigns lasting 72 hours are available from two entirely different reservoirs in Saxony (Germany). The drinking water reservoir Saidenbach is mesotrophic, deep (42 m), trenchlike and stratified throughout the summer, whereas Bautzen reservoir is eutrophic, shallow (13 m), exposed to the wind and unstable stratified.

First results with the spatially refined model show the expected vertical differentiation of phyto- and zooplankton biomass due to nutrient and food limitation, respectively. In a stratified water body, the phytoplankton development is limited by nutrients and light. During summer, when the epilimnetic concentrations are low, the supply by affluents has the strongest influence on the dynamics. Here not only the affluent concentration is important but equally the temperature and thus, the depth in which the affluent water will mix. Several scenarios of nutrient concentration and temperature of the inflow show that the total biomass in the reservoir is reduced to 80 % when the water mixes into the temperature gradient rather than into the epilimnion. Here, of course, the internal mixing is a crucial factor, enhancing the biomass in each scenario.

In conclusion, the model enables predicting the water quality in the reservoir, and thus of the outflowing water, under different inflow conditions. For instance, the size of predams determines not only the phosphorus elimination capacity but also the inflow conditions into the water body. The management of reservoirs and predams could be improved when using the results of such scenarios.

Modeling of transport of polluted cohesive sediments from localities of their long-period deposition to river channel and flood plain by catastrophic water discharges

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In the past, the authors solved the problem of modeling of re-suspension of deposited cohesive sediments in time from localities of their deposition to river channel using the two-dimensional mathematical model FAST 2D. To this aim, the model was transformed by imputation of a term conveying the relation between the velocity of sediment erosion and the local mean velocity of the flow. Thus the authors were able to predict the time course of the re-suspended amount of sediments from a locality under consideration to the river flow during some defined event of a catastrophic flood. The following step of modeling just presented here follows the course of re-suspended sediments not only in the river channel however even during inundation of the flood plain where the model is able to predict the sedimentation. To express this, the model was extended by two new terms, one representing the relation between the step of turbulence of the flow and the local mean velocity and the second expressing the sedimentation.

The mathematical model FAST 2D set up this way was then used to predict sedimentation of polluted sediments eroded from reservoirs in flood plains situated downstream.

Societal flood risk management – A theoretical and methodological framework with a European perspective

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Floods traditionally have been of major concern for hydrological science and administrative water management. As consequence knowledge on modelling the flooding processes and efforts to protect flood-prone areas by technical measures were growing rapidly. According to the aim of trying to control floods this perspective could be characterised as paradigm of "flood protection". After a series of serious flood catastrophes all over Europe (e.g. rivers Rhine, Mosel, Meuse 1993, 1995, rivers Morava, Odra 1997, river Vistula 2001, rivers Moldawa, Elbe, Danube 2002; cf. Schanze 2002) it became evident that floods cannot be considered as merely an issue of water science and management. Increasing damages (Munich Re 1998) show the meaning of societal vulnerability as one of the main factors of natural catastrophes. Basic awareness in this respect has been provided during the International Decade of Natural Disaster Reduction (IDNDR; UNISDR 2002).

Due to the impact on society, flood control *and* steering of vulnerability require the inclusion of private or public actors into decision-making. The decisions mainly have to deal with interests of utilisation, limited resources for mitigation as well as uncertainty of flood prediction. Moreover, residual risks through failure of mitigation and defence measures or extreme events which exceed the design floods have to be focussed. Thus, society needs to weigh benefits of using flood-prone areas and costs of vulnerability and mitigation activities taking uncertainty of all prognoses into account (Wynne 1992). For this understanding of dealing with floods an alternative paradigm is required. Here it is named "Societal flood risk management" and defined as *all research and practical activities for a comprehensive analysis, evaluation and mitigation of flood risks. Both, research and practical activities are dedicated to respectively embedded in a continuous societal decision-making and development process. With respect to its relevant factors, flood risk management varies depending on the type of water and flood as well as the natural and societal conditions* (Schanze 2004).

The paradigm of societal flood risk management is based on a comprehensive view of all flood related aspects and considering the whole flooding process from atmospheric drivers to flood damages with their social, economic and ecological impacts. Spatially, it covers catchments of inland rivers, cohesive estuaries, homogeneous coastal segments as well as urban areas with flood risks coming from heavily rainfall. Temporally, a continuous cycle of pre-flood, event and post-flood activities is assumed (Samuels 1999, DKKV 2003).

To structure this complex perspective of societal flood risk management a theoretical framework is required. In this respect first of all three textual components can be distinguished: risk analysis, risk evaluation and risk mitigation. *Risk analysis* consists in the determination of hazards and vulnerability as well as in combinations of both referring to events with certain recurrence intervals and areas with a specific vulnerability (Plate 1999). *Risk evaluation* weighs the benefits of using flood-prone areas with potential damages and costs for mitigation. It depends on the perception of real risks held by persons or groups with their respective cultural and personal values, experiences and feelings (ISDR 2004). Benefits and costs comprise monetary and non-monetary criteria. *Risk mitigation* deals with all activities of flood control, flood prevention, flood defence, relief and maintenance. It is systematised according the temporal cycle of flood catastrophes.

According to the overall interpretation of flood risk management the three components are put into a framework of a continuous decision-making and development process. Thereby, risk analysis is seen as the construction of the physical system. It refers to the whole chain of processes which is generating flood disasters, starting in the atmosphere (esp. precipitation, storms, temperature) and ending with the physical damages. Furthermore, it provides the prerequisites to ex ante-analysed effects of future mitigation activities. Risk evaluation is the main component for weighing within societal decision-making. Values and aims are representing social, economic and ecological criteria of sustainability. Weighing is referred to the current estimation of flood risks and also includes uncertainty. In terms of mitigation it allows to include predicted future risks. The component of risk mitigation comprises physical measures as well as political, regulatory, financial and planning instruments. These are combined to strategic alternatives for pre-flood, event and post-flood activities. Moreover, in a long-term perspective planning scenarios considering global change issues are addressed.

Operationalisation of these textual components of flood risk management needs a comparatively complex methodology. *Risk analysis* requires a model system with approaches for the meteorological, hydrological, hydraulic and hydrogeological as well as the physical damage processes. The model system also requires the ability to simulate previous and future flood events. An example for such a model system is shown for the Elbe river. The requirements of *risk evaluation* could be dealt with multiple attribute cost-benefit-approaches (cf. Yoon & Hwang 1995). Approaches have to be even more sophisticated in case of a wide range of monetary and non-monetary criteria for costs and benefits. The database for costs and benefits necessitates the appliance of various empirical methods from social sciences. *Risk mitigation* on the one hand rely on knowledge and experience of the effectiveness of mitigation measures and instruments (Hooijer et al. 2002). On the other hand prognoses or estimations of trends of factors influencing flood risks are necessary. Most important are regional climate changes as well as societal changes (e.g. demography, land use change). Normally, these trends are not explored in the scope of flood risk management, but existing knowledge on trends has to be agreed as basis for further simulations.

As already stated all three components need to be dedicated to a societal decision-making and development process of flood risk management. Within this process risk analysis, evaluation and mitigation serve as textual dimension of the required decisions. Hutter (2004) emphasis that the decision-making and development process is based on further dimensions and cannot be understood simply as static, uniform and only build upon cause analytical findings. Beside this *content*, two additional dimensions of flood risk management need to be considered: the process itself as well as the context of decision-making. Regarding the *process* certain phases (formulation, implementation) and modes (e.g. contingency planning, preparedness strategies) can be differentiated. The *context* takes into account that there are always internal constraints and conditions such as limited resources, personal capabilities, cultural background and political beliefs. In addition, the context is externally determined by political and legal bindings from higher (e.g. European, national) or adjacent (e.g. trans-boundary) levels of decision-making.

Because of the complexity of the decision-making and development process comprehensive approaches from strategic planning and transdisciplinary research are required. They should aim at an inclusion of decision makers of flood risk management on the respective level of the decision-making process. Regarding strategic planning research the conditions of formulation and implementation of strategies (cf. Pettigrew & Whipp 1991, Hutter 2004) and different modes of strategies (cf. Volberda 1997) are of main interest for accompanying investigations. Transdisciplinarity of research design (cf. Nowotny et al. 2000) allows a more comprehensive understanding and interpretation of key factors of decisions. This is especially important for processes which are explicitly oriented to co-operative collaboration, a long-term perspective and knowledge based learning (Wirth & Schanze 2004, Hutter & Schanze 2004).

Against this background the 6. Framework Programme of the European Community contains an Integrated Project to develop "Integrated Flood Risk Analysis and Management Methodologies (FLOOD*site*)" (www. FLOODsite.net). After funding of about 100 research projects the EC is aiming at an integration and joint development of results which have been provided under the 4. and 5. Framework Programme (cf. www.EU-MEDIN.org). With exception of a transdiciplinary research in a narrow sense the project deals with all aspects of the framework presented above. The Project-Team covers 36 partner institutions from 12 Member States. FLOOD*site* has been launched in March 2004 and will least till February 2009. Beside baseline research it includes testing of the methodology in seven European pilot sites as well as the development of training activities for students, professionals and the public. The project will provide one main contribution to operationalisation of the current initiative of the EC to strengthen flood risk management (EC 2004).

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Flood control by conservation tillage

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Overflowing of a river is frequently the consequence of rapid surface water runoff from soils in the watershed due to reduced water infiltration. However surface runoff is not the normal case, because the soil retains infiltrated water. A part of the soil water evapotranspirates or flows via interflow and chiefly via baseflow to the creeks in the watershed. These runoff components are slower than the surface runoff. Hence, a runoff retardation will be achieved by improved rain water infiltration.

It is assumed, that more rainwater infiltrates into soils cropped by conservation tillage (soil tillage without plough) or direct seeding (tillage without soil preparation) in comparison with conventional tillage with plough (characterised by a soil-turning action to a depth of 30 cm). Soils cultivated by conservation tillage or direct seeding are characterised by higher soil aggregate stability and a higher degree of soil cover compared to ploughed land (Table 1). Therefore, the formation of soil surface crusts which impede the infiltration will be prevented or retarded. Conservation tillage also leads to a higher macroporosity such as earthworm channels (Table 1) in the soil which means that a part of rain water can infiltrate directly in these macropores. In the case of infiltration excess, the continuous macropores rapidly drain surface water in deeper soil layers. The water flows almost only under the influence of gravitation. In opposition ploughing destroys the macropore continuity and disturbs the soil fauna. Therefore, a change in the applied tillage method on arable land from conventional to conservation tillage leads to a significant increase in water infiltration during heavy rain storms (Table 1) and a watershed-wide use of conservation tillage contributes to runoff control by improving the utilization of the water holding capacity of the soil. In addition conservation tillage or direct seeding methods also reduce the amount of soil erosion drastically (Table 1).

Table 1: Mulch coverage, soil aggregate stability (SAS), abundance and biomass of earthworms, proportion of anectic species, density of macropores with diameter > 1 mm, rate of infiltration and loss of soil in the course of a rainfall simulation experiment with 38 mm total rain in 20 minutes as affected by tillage system

	Plough	Cons. Tillage	Direct Seeding
Mulch coverage [%]	1	13	77
SAS [%]	20	22	25
Earthworms [No.* m^{-2}]	125 a	312 ab	358 b
Anectic species [% of No.]	3 a	12 b	8 ab
Biomass [g * m^{-2}]	42,1 a	171,9 b	150,3 ab
Macropores [No. * m^{-2}]	264 a	493 ab	775 ab
Infiltration rate [%]	40,3	69,5	86,2
Eroded soil [rel. %]	100 (536,3 g/m²)[1)]	19,6	2,1

[1)] total values

Statistics: Kruskal-Wallis analysis and Nemenyi test

In a research project, funded by the German Environmental Foundation, 20 comparable infiltration measurements on soils that are endangered by surface sealing were conducted on side by side plots with a portable rainfall simulator (rain intensity: 1.9 mm min^{-1}, duration: 20 min). One plot was ploughed and the other was treated with long-term conservation tillage. A significant retardation of surface runoff (median value: 2.2 min) and a higher final steady state infiltration rate (median value: 0.29 mm min^{-1}) were responsible for the better infiltration on soils where long-term conservation tillage was applied. This is due to changes in the physical topsoil properties, a reduced trend of soil surface sealing and an increased macropore number (Table 1) combined with an improved macropore continuity.

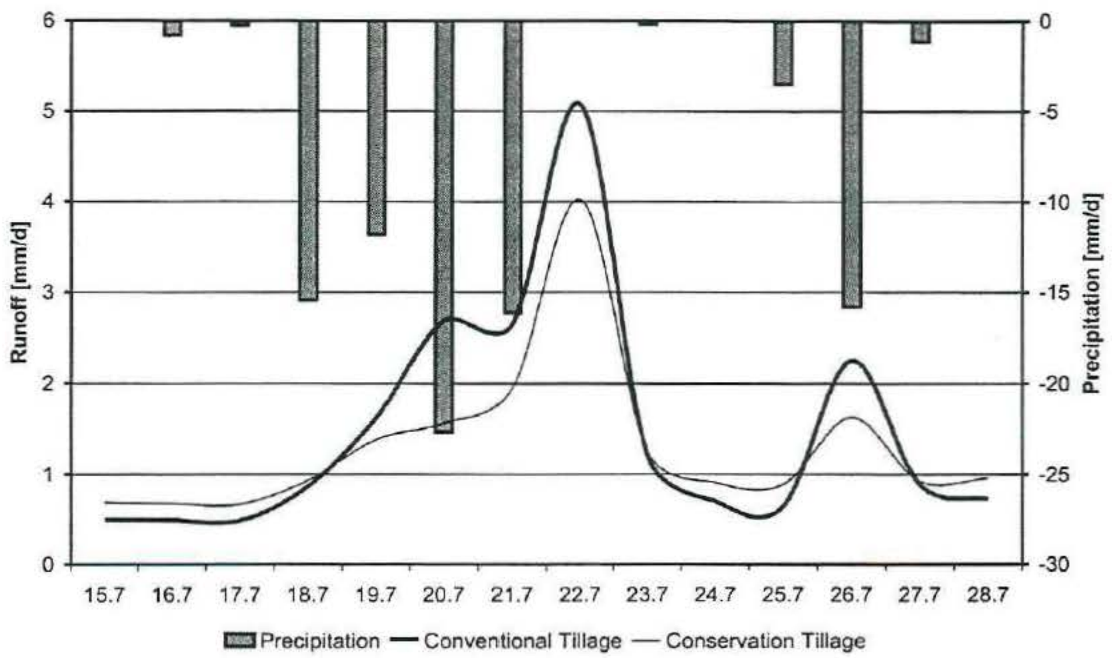

Figure 1: Simulated stormwater runoff in a meso-scale watershed for conventional and conservation tillage during a heavy rainfall period in summer 1997 (estimated with the hydrological model NASIM)

Based on the infiltration differences measured, the stormwater runoff generation in a meso-scale watershed (162 km^2) was estimated with the hydrological model NASIM for both tillage methods on arable land which covers more than 50 % of the watershed area. During a rainfall period in summer of 1997 conservation tillage on cropland soils would have been able to mitigate flood peaks up to 20 % (Figure 1). Hence, the application of long-term conservation tillage on a large scale can contribute to flood control, especially in rural watersheds with a high degree of arable land.

In this context, a broad implementation of conservation tillage in the whole catchment area is an important prerequisite to reduce flooding. It is assumed that this can be achieved in Saxony. As vast areas of Saxony are endangered by water erosion (60 % of the arable land, equivalent to 450.000 ha), it is required that conservation tillage which promotes infiltration and erosion control is introduced on a broad scale. Therefore, the agricultural extension services advice conservation tillage techniques and the program for environmentally friendly farming funded by the Free State of Saxony and the EU offers financial incentives for their uptake. In 2002/2003, after a ten year period of the environmentally friendly farming program, the mulch seeded area reached nearly 195.000 ha and covered 26.9 % of the arable land in Saxony. At present, in some regions conservation tillage methods are applied to various crops on over 50 % of the arable land. These figures show that the extent of long-term conservation tillage applied in Saxony may already have an effect on flooding in catchment areas.

Modelling the development of phytoplankton in the German part of the Elbe River (km 0 to km 585) considering the impact of groyne fields

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The investigated upper and middle part of the lowland River Elbe reaches from the German-Czech border at Schmilka (km 4) to Geesthacht (km 585). Along this stretch the Elbe is a free-flowing river, while its morphology is strongly altered by human activity. About 6900 groynes between Riessa (km 120) and Geesthacht form a chain of groyne fields on both sides of the river.

The River Elbe is characterised by high algal biomass during the vegetation period. As a consequence, phytoplankton activity strongly influences many water quality parameters and the ecological state of the pelagic compartment of the River Elbe. To investigate the influence of the groyne fields on the development of the phytoplankton biomass, the water quality model QSIM of the German Federal Institute of Hydrology was adapted to the morphological constraints of the River Elbe by incorporating the groyne field structures into the hydraulic module of the model. The model application is done on a daily basis for the year 1998. Driving forces of the model are the discharge and water quality parameter concentrations at the upper border of the model area at Schmilka and the input of the main tributaries, Schwarze Elster (km 198), Mulde (km 259), Saale (km 290) and Havel (km 438). In addition, the meteorological constraints such as solar radiation and air temperature are important input parameters for modelling.

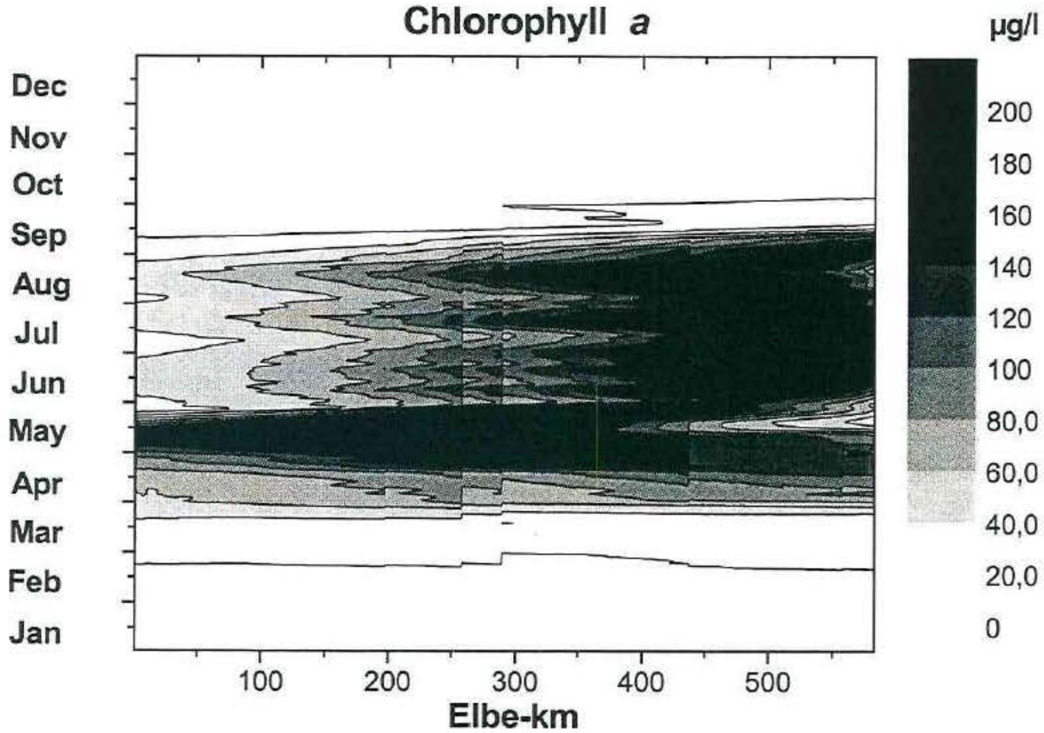

Figure 1: Temporal and spatial distribution of modelled chlorophyll a content in the River Elbe in the year 1998.

In 1998, the modelled seasonal development of algal biomass (Figure 1) only showed one peak in the upper reach from Schmilka (km 4) to the input of the River Saale (km 290) during spring, while downstream the input of the River Saale in August a second peak was calculated. Further downstream (below km 450) the chlorophyll a content was on a high level (> 100 µg/l) during the whole period from May to August. In 1998, the algal development in the River Elbe was diminished by the input of a lower algal biomass by tributaries.
Figure 2 shows the comparison of the continuously measured chlorophyll a fluorescence measurements at Cumlosen (km 470) with the modelled daily mean chlorophyll a values. The curves show strong agreement between measurement and model result. This consistency is most demonstrative at the end of May around the 20.5.1998, when the model results reproduce the measured strong decrease of chlorophyll a. According to the modelling, this decrease was caused by zooplankton grazing.
The high algal biomass in the River Elbe in summer caused strong oxygen oversaturation and a longitudinal decrease of nutrients, ortho-phosphate, dissolved silicium, and nitrate. The zooplankton development strongly depended on the algal biomass.

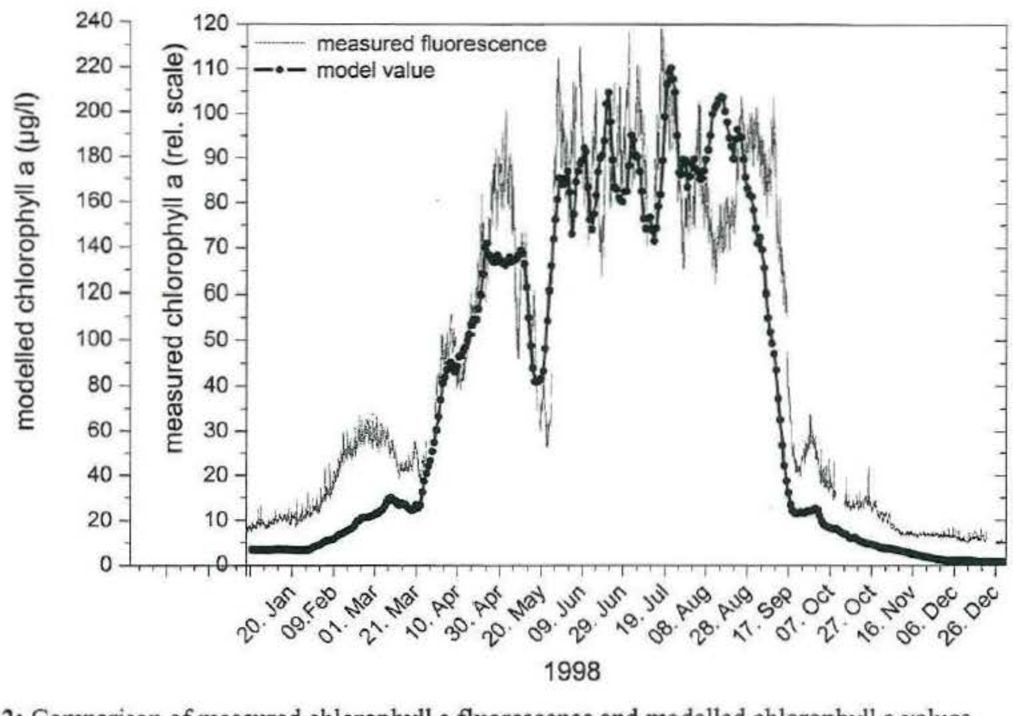

Figure 2: Comparison of measured chlorophyll a fluorescence and modelled chlorophyll a values at Cumlosen (km 470) (Data: Landesumweltamt Brandenburg).

As the general model outcome the autochthonous phytoplankton development in the flat and well-mixed River Elbe is a consequence of the favourable light conditions and sufficient nutrient supply. In addition, the lower water depths in the groyne fields in comparison to the main stream even stronger promote primary production due to better light conditions. Nevertheless, modelling results and measurements only show small cross-sectional differences for the state variables such as algal biomass, oxygen, and nutrients between main stream and groyne fields. These resulting small differences are due to high water exchange rates between main stream and groyne fields, vice versa low water retention times in the groyne fields of a few hours.

Effects of extreme flood events on flora and fauna in Middle Elbe floodplains

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In Central Europe floodplains belong to the most complex ecological systems and have a very high biodiversity. The Elbe flood 2002 and the drought in 2003 are two extreme events, which had huge impacts not only on man, but also on fauna and flora. The project HABEX (Auenhabitate nach Extremhochwasserereignissen am Beispiel der Mittleren Elbe- Floodplain Habitats after Extreme High Water Events by Example of the Middle Elbe), funded by the BfG and the UFZ, aims to investigate the ecological impact of extreme flood events on fauna and flora. The very well established plot-base of the preceding RIVA project (Übertragung und Weiterentwicklung eines **R**obusten **I**ndikationssystems für ökologische **V**eränderungen in **A**uen – Development of a Robust Generally Applicable Indicator System for Ecological Changes in Flood Plain Systems – funded by the German Federal Ministry for Education and Scientific Research 1997 - 2000) enables the repeated survey of the same plots for flora, carabids, and molluscs in the autumn of 2002, early summer and autumn of 2003. The surveyed species and their abundances add to the extensive RIVA-database. First analyses' results show that the effects of the extreme flood varies very much between the different species-groups:

Vegetation: Compared with the results of 1998/99 many species, for example *Arrhenatherum elatius*, have become rarer after the extreme flood event. On the other hand *Alopecurus pratensis* shows a higher occurrence in the same area.

Carabids: In autumn 2002 the results compared with the years of 1998/99 were very different considering the number of specimens (16 %) and species (41 %) as well. The extreme flood affected both dry habitats as well as wetland inhabiting species. In 2003 the number of species recovered, but only up to around 75 %, the number of individuals only up to 25 % of the former results.

Molluscs: The number of species has considerably increased, from fall of 1999 to fall 2002 almost by 30 %, from early summer 1999 to 2003 by 55 %. In contrast to the previous years the aquatic species dominate over the terrestrial molluscs in terms of species numbers. Their numbers increased by 180 to 200 % from autumn of 1999 to 2002 resp. early summer of 1999 to 2003. Also their populations are larger than those of the terrestrial molluscs.

Summing up it is apparent that after the flood conditions were very different from those of 1998/99. These considerable changes are definitely consequences of the extreme flood of August 2002. Similar effects, probably dramatic losses both of species and of individuals within the autumn of 2003 are expected, according to survey, as consequence of the extraordinary long drought of 2003.

The results will be integrated in the BfG model-system INFORM. This system serves as a tool for predicting ecological impacts due to changes in the hydrological system. This decision support tool will be extended to terms of high flood events and support can be given to stakeholders in riverine management.

This report presents preliminary results of the investigation of flora and fauna after the extreme Elbe flood in the year 2002 from selected sites of the floodplain of the Middle Elbe with the use of data for validation of ecological risk-assessment, and risk modeling. For thorough and careful evaluation of the models set up so far it is essential to follow the long-term development of the studied biocoenoses in the field for at least two more years (2004 and 2005) in order to achieve an optimal data-set.

Mansfeld – the contribution of a mining-affected catchment area to regional riverine pollution

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The Saale is one of the most polluted rivers in Germany and affects noticeably the water quality of the Elbe river down to the North Sea. Many and diverse anthropogenic sources are held responsible for the pollution of the Saale river: waste water from salt mining dumped into the tributaries Unstrut and Bode; seepage from uranium and base metal mining along Weisse Elster river and from the area of Mansfeld; effluent from the carbochemical, petrochemical, and metallurgical industries, from sewage treatment and from agriculture (Schreck, 1998; Müller, 2003). Although most of these sources of pollutants have been studied in detail (Müller, 1998; BMBF, 2000), very little is known about the environmental significance of restricted catchment areas and their share in regional riverine pollution. This deficit in knowledge may result from a lack of long-term studies on the intake of pollutants to the Saale river. In this study, a comprehensive estimation is given of the total metal and salt outputs of the Mansfeld mining district in Central Germany into the Saale, and the importance is shown of this catchment area for the regional riverine pollution.

The Mansfeld mining district is generally considered to be a source area for the release of heavy metals and salt. In this area, base metal and salt mining took place for many hundreds of years. Nowadays, low grade ore and smelting waste heaps mark the scene. The mining residues are eroded by extensive precipitation and the debris is flushed into local rivers and brooks (Schreck, 2004). Leachates from metallurgical waste products pollute the surface waters and lead to the formation of metalliferous precipitates. The Mansfeld lakes, fed by the surface water affected by mining, act as geochemical sinks for metals and stream sediment. The mining district is drained by two rivers and one major adit system: the Böse Sieben/Salza passes through the mining district and flows through the Mansfeld lakes. The Wipper has its source in the Harz Mountains, crosses the mining district between Mansfeld and Hettstedt and becomes enriched in pollutants from ore treatment. Both rivers run off to the East to feed the Saale. Ground water, contaminated by salt and metals is drained from the western and southern parts of the mining district by a major adit, the Schlüsselstollen, to the East, and flows into the Saale.

This survey is based on a 13-month sampling and monitoring campaign in 2002/2003. Included are the suspended and dissolved metal loads in the water of all significant rivers and brooks in the mining district, together with the major adits from metal mining. In detail, 18 sampling points were selected along the rivers Saale, Böse Sieben, Salza, Wipper and their tributaries. Water samples were collected on a monthly base and the river discharge rates determined. The water samples were analysed by ICP-OES, AAS graphite furnace and IC for 19 cations and 5 anions. Suspended matter was filtered (0.45 µm) from the samples, dissolved by total digestion, and analysed by ICP-MS for 43 elements.

The major results of the study are:

- By passing through the Mansfeld mining district, the Saale river water quality declines considerably. The content in NaCl increases by 60%, in Zn by 300% and in Cd by 35%.
- The discharges of the Salza and Wipper rivers vary on a short timescale, causing very variable loads of pollutants. In contrast, the flow rate of the adits remain almost constant over the year.
- The major source of pollutants in the mining district is ground water from the central drainage adit, the Schlüsselstollen, followed by the rivers Böse Sieben/Salza (salt) and Wipper (metals).
- Over the years 2002/2003, 4,900 t/a of suspended matter were flushed into the Saale river.
- More than 90% of the pollutants are transported as chemically dissolved components; only a few metals show affinities to suspended matter (Pb).
- The Böse Sieben, although passing through mining landscape, does not contribute significantly to the pollution of the Saale. Most of the dissolved and suspended load is immobilised by flowing through the Mansfeld lakes.
- The total annual contribution of the mining district (dissolved and suspended loads) to the pollution of the Saale river is about 310,000 t NaCl; 304 t Zn; 10.2 t Pb; 0.57 t Cd; and 0.42 t U (Table 1).

Table 1. Dissolved and suspended annual load of pollutants in drainage waters from the Mansfeld mining district (figures for 2002/2003) (n.d. = not determined).

Water system	*NaCl [t/a]*	*Zn [t/a]*	*Pb [t/a]*	*Cd [kg/a]*	*U [kg/a]*	*Zn [t/a]*	*Pb [t/a]*	*Cd [kg/a]*	*U [kg/a]*
Böse Sieben/Salza	28,000	62.15	0.05	6.57	n.d.	0.66	0.13	2.02	5.09
Wipper	10,000	4.80	0.15	23.24	n.d.	2.49	0.90	14.75	1.43
Schlüsselstollen (Central adit)	270,000	253.25	5.10	523.99	404.80	1.66	3.86	0.92	7.94
	Dissolved load					Suspended load			

The results make it clear that even 15 years after the cessation of mining, ore processing, and the complete flooding of the mines in the Mansfeld area, heavy metals and salts are still a threat to the local environment and contribute significantly to the pollution of the Saale river. The release of pollutants in the mining district depends mainly on local precipitation events and on ground water circulation. Suspended matter, seemingly, does not play a key role in the transport of pollutants.

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Sediment dynamics from the drainage area into Lake Mladotice in the western Czech Republic under the influence of pre- to post-communist landscape changes

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The Mladotice Lake is a unique genetic type of lake in the Czech Republic. Extremely heavy precipitation in entire West Bohemia in May 1872 was the most important cause of a slide (sandstone strata) that dammed the valley bottom of the Mladotice creek. First bathymetric measurements of the newly created lake were carried out in 1972. The lake covered an area of 5.8 ha and its maximum depth was 7.7 m (Jansky 1977). Depth measurements of the lake were repeated in 1990; at that time the lake surface was 4.3 ha and its maximum water depth had decreased to 6.0 m (Jansky 1994). By comparing both surveys the sediments can be estimated over a depth of several metres.

The changing landscape in the drainage area is particularly interesting in the context of the yearly and event related balance of the lacustrine deposits. The communist rural economy in the 1960s and 70s was associated with a strong impact on the dynamics of landscape change which may reflect a high sedimentation rate of the lake.

Neither the lacustrine sediments have been analysed yet nor are other quantitative data about soil erosion and sediment dynamics related to the drainage area available. Furthermore in that period the use of agricultural chemistry increased heavily, probably polluting hydrological systems. Absorbed by suspended particles, pollutants were also floated into the lake, thus being archived in the sediment.

Within this project, drilling and further bathymetric measurements as well as sediment coring were made in Lake Mladotice in May 2003. Several piston cores were taken at the lake basin, four piston cores were drilled down to the old creek deposits. The present aim of the project is to analyse this 'geo-archive' of Lake Mladotice by means of sediment stratigraphical, physical, chemical and micropalaeontological methods to detect the influence of changing land use.

In some areas a sediment thickness of four metres was detected. Hence, the average sedimentation rate is about 3 cm per year. Macroscopic inspection of lacustrine deposits shows a large variety of sedimentation dynamics. Thin sections for further information are in process. Also the geochemical composition of the reference core changes significantly at 180 cm depth. To determine event-related deposits ambient data will be interpreted and isotope dating (^{137}Cs, ^{210}Pb) is under way. Data of extreme precipitation and flood runoff are used to assign prominent sediment layers to extreme events.

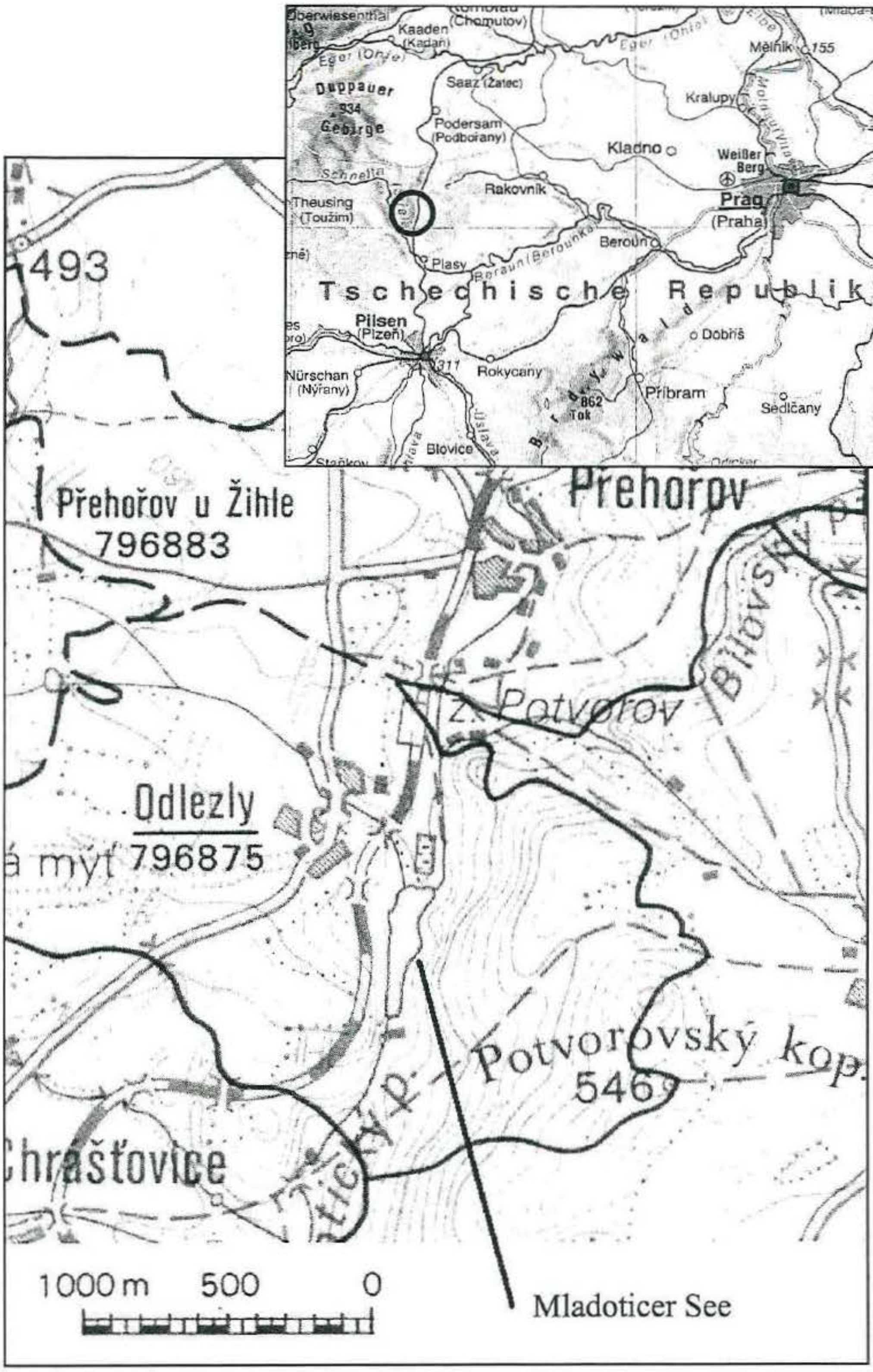

Figure 1: Mladoticer Lake area
(Zakladni Mapa CR 12-31 Plasy, 1: 50 000, 1998; Diercke Weltatlas, 1996)

Reproductive success in fish communities of the Elbe River, Czech Republic

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Reproductive success is a significant parameter describing development of fish communities in ecosystems of the riverine environments (Copp 1989). Specific habitats are occupied by different fish species during the period of reproduction and further development of juvenile stadia; according to reproductive requests, species are dissected into the reproductive groups (Balon 1975). Frequency of occurrence, presence and/or absence of reproductive groups tended to show a quality of riverine habitat and stadium of its development (Copp et al. 1991). Furthermore, it is possible to classify fish species into the ecological groups according to velocity and habitat diversity preference (Schiemer and Waidbacher 1992). In general, frequency of occurrence of different reproductive and ecological groups in a fish pattern indicates physical habitat changes in riverine environments, e.g. an impact of river channelization process (Copp 1990, Jurajda 1995, Slavik and Bartoš 2000).

Young-of-the-year fish from 8 locations of the Elbe River were collected during the period 1995 – 2003. For statistical analyses of YOY communities, annual patterns were nested into the three-year periods, and study locations into the three stream orders. Number of successfully reproducing species significantly decreased during the study period (Fig.1). Other characteristics of YOY communities (as abundance, specie diversity, number of reproductive or ecological groups) did not show any significant changes across the period. Achieved data reflected lasting unsuitable conditions for spontaneous fish reproduction in the Elbe River. Stream order represented the main predictor of changes in YOY communities. Number of successfully reproducing fish species increased according to stream order (sixth to eighth order, the Horton-Strahler system), however, ratio among specialized reproductive groups varied.

Significant decrease in occurrence of species using sandy and gravel sediments for spawning (psammophilous and lithophilous group) has been recorded in the middle stream of the Elbe River (seventh-order, Czech Republic, Fig. 2). The decrease probably reflected lower reproductive success in the consequence of recovering the original spawning substrata with muddy sediments. The construction of weirs causing a decline of original river slope results in the process of relatively rapid sedimentation. On the contrary, in the lower part of the Elbe River (eighth-order, Czech Republic), where the river has been only partly channelized, occurrence of psammophilous and lithophilous species reached a maximum within the whole studied stretch.

Similar changes occurred in abundance of rheophilous ecological group, species of which prefer habitats with higher velocities. In the middle stream of the Elbe River (seventh-order, Czech Republic), occurrence of stretches with higher velocities is reduced to very short stretches below weirs, and therefore rheophilous species have not sufficient availability of suitable habitats. Their abundance increased again in the flowing stretches of the Elbe River (eighth-order, Czech Republic), close to the frontier with Germany.

It can be summarized, that in the longitudinal profile of the Elbe River, Czech Republic, reproductive success of fish communities is determined by original stream geomorphology predicted by the stream order, and however, spontaneous reproduction is also significantly affected by river bed channelization and stream fragmentation by weirs.

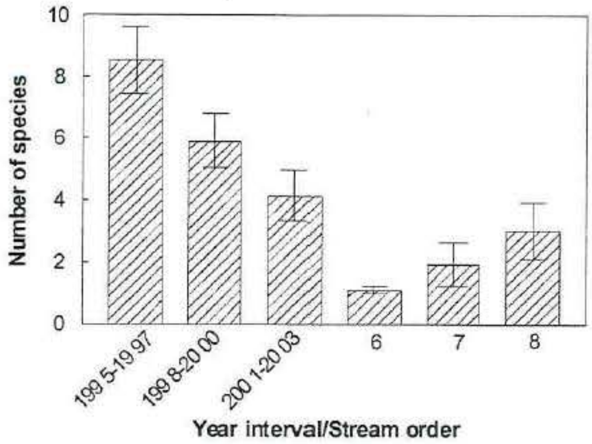

Figure 1: Number of species in longitudinal profile of the Elbe River, Czech Republic, accross the study period/according to stream order

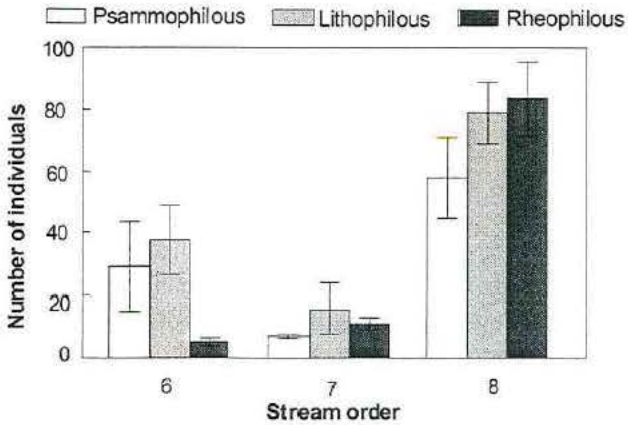

Figure 2: Abundancy of reproductive groups and rheophilous species in the longitudinal profile of the Elbe River, Czech Republic, according to sream order

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Flood modeling and flood management in the Czech Republic during catastrophic flood in August 2002

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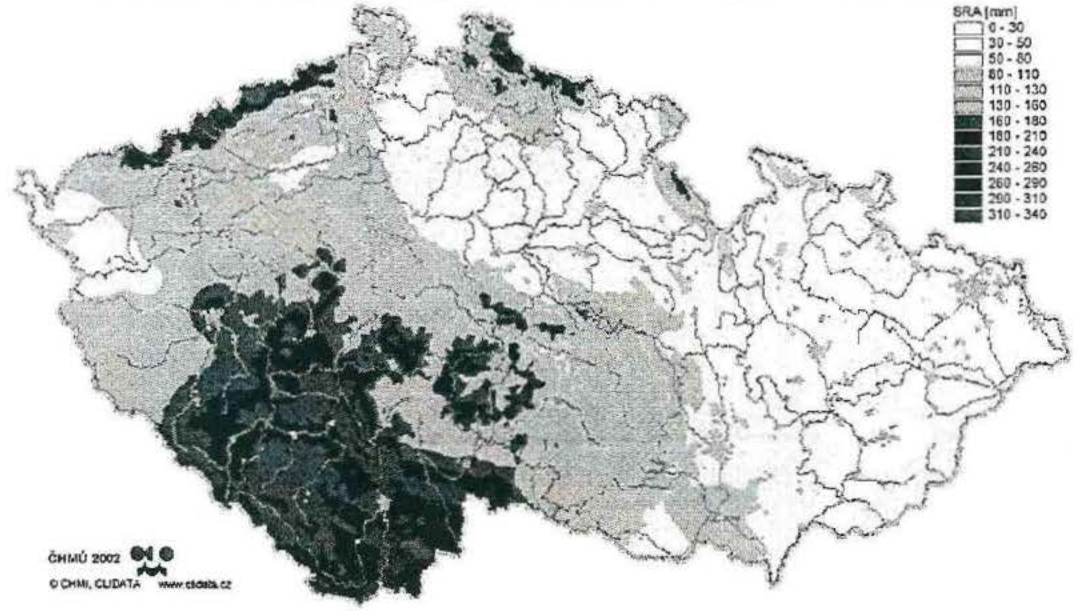
History of mathematical modeling in water management sector in the Czech Republic is longer than 15 years. Real boom of extensive use of mathematical hydrological and hydraulic models in the field of flood protection, flood management and flood measures analyses and designing becomes just after catastrophic flood in June 1997 in Moravia territory. This flood situation was in the history of Czech republic, after long time (more than 100 years) without such serious flood, earnest notice for permanent threat of flood, which has been forgotten by most people here after relatively long and peaceful period.

Thanks to above mentioned flood in 7/1997, which really strongly signalized catastrophic situation about preparedness of Czech Republic for flood situation, several government programs for financing of flood issues were initialized. It means flood protection studies, flood models preparation, realization of warning and prediction systems and actualization and precision of current flood mapping studies. Based on this support huge number of application of modern technologies for flood management, mathematical models and other hydroinformatic tools were applied also by DHI Hydroinform. Those instruments were further used for evaluation of flood risks and as support toll for decision-making and planning in water management.

From mathematical modeling point of view, a lot of 1D and 2D hydrodynamic models on whole area of Moravia and Bohemia were realized. Unfortunately mainly models created for Bohemia area suffered from insufficient of calibration and verification data till August 2002. Last significant historical flood in Vltava river catchment before was observed in 1890.

Precipitation total [mm] in August 2002 from 06 to 13 (preliminary data)

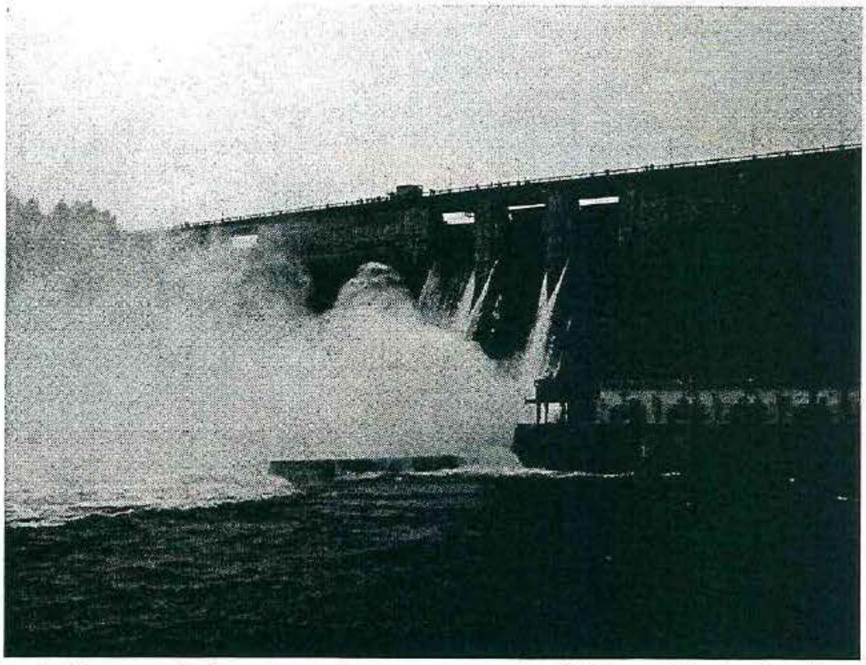


Only in August 2002 was possible to prove applicability and precision of existing models for real catastrophic flood, which corresponds to a flood of Q_{500} approximately.

Causal rainfall of August flood was fallen mainly to area of Vltava and Berounka rivers basins and caused historical flood in cities like Prague, Ceske Budejovice, Melnik, Usti nad Labem, Decin and moved off further to Germany.

In the area of Czech Republic, which was hit by flood 8/2002 were available and during flood situation were actively operated hydrodynamic flood models created by DHI Hydroinform in this areas:

- 1D+ (1D+ means one-dimensional looped network schematization) flood model of Ceske Budejovice city (approx. 350 000 enhabitants)
- 1D hydrodynamic model in combination with neural networks for managing of manipulation on Vltava cascade (approx 200 km of river with 5 dams)
- 1D+ flood model of Prague city (capital of Czech republic, more than 1 mil people)
- 1D+ flood model of Vltava river between Prague and junction with Elbe river (approx. 50 km of river)
- 1D flood model of Elbe river between junction with Vltava river up to state border with Germany (approx. 140 km of river)
- 2D detailed hydrodynamic flood model of Prague city
- 2D detailed hydrodynamic flood model of Elbe river including all flooded villages on Elbe river (approx. 120 km of river)



All above-mentioned mathematical models were, during flood situation 8/2002, applied operatively and progressively in compliance with flood wave propagation and with utilization of available predictions new and new actual flood maps were generated. Those maps were consequently used as the basic data for decision of general and local crisis committees for warning of people, preparation and execution of evacuation plans, for saving of inhabitants lives and for general management of this critical situation. Logical, the lower regions had more time for such data preparation, precision and successful dissemination than the upper ones, but also upstream many materials were prepared. Nevertheless this flood situation was such extreme, whole flood wave passed through the area of Czech Republic during 6-7 days. Within these few days were done hundreds of operational calculations and simulations and thousands of square kilometers of different flood maps were generated and printed out. Thanks to this data, whole organization and management of flood situation 8/2002 was much smoother and better organized than flood 7/1997 in Moravia, even this last flood was bigger.

This paper describes situation of mathematical models in the Czech republic before flood 8/2002 and their practical application day by day during the biggest observed flood within 2 centuries in CR and further application after this flood for post analyses and flood evaluation. This paper is some kind of chronological calendar and diary of water engineer, administrator and operator or dispatcher of mathematical model plant into real extreme situation of true historical flood in the heart of Europe.

Impact of coal mining waste dumping sites on ground- and surface water quality

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Considerable part of the Upper Odra River catchment area comprises Upper Silesia coal mining basin (USCB) with many coal mines of different age that have their waste dumps in the close proximity of the Odra River or its tributaries. These dumps, all of them unlined, were invariably located in abandoned sand and gravel quarries, in unprotected feeding areas of Quaternary aquifer often used as a source of drinking water and hydraulically connected with surface watercourses. Because of the lack of generally available knowledge, aquatic environment protection was, in fact, never considered when these facilities were sited. Their common features that make them environmentally problematic can be briefly summarized as follows: (i) coal mining waste dumps geometric dimensions, area and volume are, as a rule, the largest among all dumping sites and landfills; (ii) they can be considered as anthropogenic vadose zone; (iii) despite of compaction, dumps are permeable to water and air that gives rise to oxidation and leaching processes within the dump; (iv) mining waste that are disposed of at these dumps represent geochemically unstable sulfidic material that generates acid and sulfate loads, as well as secondary pollutants; kinetics of sulfide oxidation is specific for a given seam and may vary in a broad range; (v) most of mining waste from this area displays a high chloride salinity; (vi) construction of a dump and exposure of new portions of freshly disposed waste lasts many years; (vi) waste dumps post-closure reclamation generally inadequately considers water protection; (vii) wastes from old dumping sites are often subject to reuse in civil engineering as common fill or for coal recovery that causes considerable alteration of the environmental impact of both dumps and wastes. The effect of an old coal mine waste disposal site in the post-closure period was exemplified in over 100 years old Dembiensko mine dumping site of total area 140 hectares and total volume about 37 million tons, which comprised five historical conic tips (red shale), three slurry ponds and a contemporary flat dump closed in 2000 along with the mine. The area belongs to the Bierawka River catchment area, the tributary of the Odra River. Dumping site caused deep adverse transformation of ground- and surface water quality making it unfit for any use. The major constituents distribution in groundwater was presented as equipotential maps. The alteration of ground- and surface water quality was discussed at the backround of coal mining waste properties and analyzed with use of PHREEQC v 2.8 geochemical computer program. The overall impact of Dembensko dumping site on water bodies in the area was compared with the impact exerted by two other coal mining dumping sites (Szczyglowice and Bukow) located in the same catchment area of the Odra River. Coal mine dumping sites were proved to cause deep long-term deterioration of water bodies lasting for decades.

Enhancement of flood safety, rural and regional development in the Tisza Valley (the new vasarhelyi plan)

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Following a virtually decade-long sequence of arid years, four abnormal flood waves have passed down the River Tisza over a period of only four years from 1998 to 2001. These floods, which required close to HUF 120 billion (EUR 450 million) of total costs for flood fighting, emergency measures and reconstruction during these four years, have entailed highly adverse public, political consequences.

The concept of enhancing the level of flood safety in the Tisza Valley, as adopted by the government, is based on the following principles:

- the Tisza floods must be conveyed between the defences built to the required level of safety. For this reason the conditions of flow and conveyance must be improved – with due regard to conservation requirements;
- the statistically very rare flood waves surpassing the level of safety afforded by the defences and liable to cause a levee failure with subsequent flooding must be reduced to the conveying capacity of the flood bed by diverting part of the peak flow to emergency storage reservoirs on Hungarian territory;
- the flood abatement scheme, which comprises the structures and reservoirs serving the controlled diversion and - where necessary - return to the river (or transfer to an area of scarce supply) of the excess flood flow must be designed and operated so as to contribute also to the attainment of the objectives envisaged in the National Agro-Environmental and Tisza Valley Development programs, as well as to the expansion of natural habitats – without interfering in any way with the flood control function.

The new concept of enhancing flood safety in the Tisza Valley is based on the scheme designed by the famous Hungarian engineer Pal Vásárhelyi in the 19^{th} century and implemented since. The present updating of the original concept consists of diverting the harmful part of the flow conveyed by extraordinary, especially dangerous floods to designated areas in the flood plains and using this water to open new development perspectives and a change to a new type of land management (agro-ecological farming) in the Tisza Valley. This is the reason why the concept is referred to as the New Vásárhelyi Plan (NVP). The entire program is likely to take ten years to complete; implementation of its first stage is being tackled now.

NVP is expected to raise the level of flood safety along the Tisza in harmony with the overall flood control improvements in Hungary by focusing on two problems, viz. increasing the conveying capacity of the flood bed and the use of emergency reservoirs.

The study on the emergency storage scheme in the Tisza Valley (flood plain revitalisation by means of controlled diversion) has revealed no obstacle to establishing the reservoirs at the proposed sites. Under the implementation schedule formulated for the 2004 – 2007 period the five reservoirs would be built (total volume: 737 million m^3.). In the event of the thousand-year flood the impact of the five emergency reservoirs identified would extend to the full length of the Hungarian Tisza section. The local and cumulated effect would lower the peak stage by the set target of 60 cm. Preparatory studies have included detailed ecological mapping and exploration of cultural heritage in the project area.

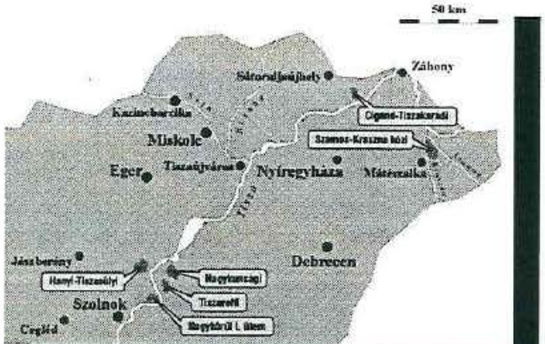
In the interest of gradual, continuous and organic harmonisation of the regional development issues with those of flood control development, the basic principles of an environmental management concept of rural- and regional development have been drawn up in preparation of a changeover to a new type of area-, land- and water use. This concept recognises the urgent need of providing, besides a higher level of flood safety, a chance of improving the living standards to a marginalising rural population plagued by grave social, economic and environmental problems.

Controlled flow diversion and rehabilitation of the conveying network capable of routing the water to an as wide as possible an area would open opportunities of converting under the present use poor lands to uses more suited to their properties and thus of deriving higher income levels therefore.

These basic principles fit into the European set of values and objectives. The concept and programs based thereon are therefore expected to gain the support needed to arrest further degradation of the environment, economy and society, and to restore the population supporting capacity of the landscape, as well as the healthy functioning of its settlement and natural systems. Regional development in the predominantly agrarian Tisza Valley has no true chance of success without a radical change in land- and water use.

The works scheduled for the 2004-2007 period, Stage I of the program, include projects aimed at clearing the flood bed to improve its conveying capacity and the development of six reservoir sites for the controlled diversion and retention storage of abnormally high peak flood flows. These have been justified by the experiences, which demonstrated the inadequacy of the traditional approach of raising the levees, further by the tremendous losses incurred in the wake of abnormal floods. Neither have these succeeded in reducing the permanent hazard to the people living in the flood plains. The government has passed a decision in favour building the Szamos-Krasznaköz, Cigánd-Tiszakarád, Nagykúnság, Hany-Tiszasüly, Tiszaroff and Nagykörű in Stage I. At the Cigánd-Tiszakarád and Nagykörű reservoirs environment management pilot areas will also be established.

The government laid down the principles of the physical planning- and rural development concept of the region influenced by the VTT program. These principles have defined at the same time the economic and societal settings with which regional development must be compatible.



Reservoirs scheduled for Stage I.

The other sectors of regional development are accordingly required to serve, as before, retention of the rural population, the creation of job opportunities and improvement of the quality of living. Along with the change in land use, outstanding attention must be devoted to programs, which take also the population pattern into consideration, like education, training, integration, employment and social gap closing, together with processing the products of changed land use, promotion of tourism and other services.

NVP should be regarded a complex scheme based on the harmonisation of water-, environmental, rural- and regional development projects. The total costs of Stage I scheduled for the period 2004 to 2007 have been estimated at HUF 130 billion:

Economic instruments in the Water Framework Directive – An interpretation of Art. 9 WFD and its implementation

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Almost for the first time in European environmental legislation the WFD in Art. 9 urges the member states to use economic instruments in order to reach the environmental objectives laid down in the Directive. The current wording is a compromise of different approaches taken by the European Parliament and the Council. In fact Art. 9 WFD contains three different tasks, whose relationship is rather unclear:

- Cost recovery for water services
- an adequate contribution of water uses to the recovery of the costs of water services,
- water-pricing policies shall provide adequate incentives for users to use water resources efficiently

Different types of measures are necessary to implement these provisions adequately in national law.

1. History of Art. 9 WFD and its interpretation

Art. 9 WFD has been a major issue in the evolution of WFD and therefore has been contested from the beginning owards. The controversy was around the degree of obligation, the extent of exception from the obligation and the conceptual orientation.

As the Conciliation Committee composed of the Members of the European Parliament and the European Council could not enter into an agreement over a common text, they simply merged their particular proposals to a new version. The final adopted version is the following:

> Article 9: Recovery of costs for water services
> 1. Member States shall take account of the principle of recovery of the costs of water services, including environmental and resource costs, having regard to the economic analysis conducted according to Annex III, and in accordance in particular with the polluter pays principle.
>
> Member States shall ensure by 2010:
> – that water-pricing policies provide adequate incentives for users to use water resources efficiently, and thereby contribute to the environmental objectives of this Directive,
> – an adequate contribution of the different water uses, disaggregated into at least industry, households and agriculture, to the recovery of the costs of water services, based on the economic analysis conducted according to Annex III and taking account of the polluter pays principle.
> Member States may in so doing have regard to the social, environmental and economic effects of the recovery as well as the geographic and climatic conditions of the region or regions affected.

Art. 9(1) 1st subp. WFD stems from the Council and Art. 9(1) 2nd subp. stems from the Parliament and the 3rd sub. from the Council, but has hardly been disputed by the Parliament. The interpretation of Art. 9 WFD has therefore to start with the hypthesis, that each paragragh has to be read as being "isolated" and complete to identify the overlappings and differences between the 1st and the 2nd subpara. These approach reveals that the both the cost recovery for water services and the adequate contribution of water uses to the recovery of the costs of water services can be found in the 1st and the 2nd subpara. either directly or be interpretation of the reference to the polluter-pays-principle. Art. 9 WFD contains a step within the degree of obligation: from "taking into account the principle [immediately; H.U.]" to "ensure by 2010". Only the idea of using water pricing policies as an instrument can only be found in the 2nd subpara. On this instrumental basis water prices may be raised beyond the level of cost recovery, which is important as the proper calculation of costs and the distribution of the costs among the users according to the polluter-pays-principle is rather difficult.

The WFD contains no definition of costs, especially not of environmental and resource costs. The European Commission has tried to define these costs.

Equally important is the question of the scope of "water services". The LAWA has restricted the scope of application mainly to public water supply and municipal water-disposal. Industrial-commercial water supply (own production), agricultural water supply (irrigation) and industrial-commercial waste-water disposal (direct discharger) are no water services unless they have a significant (considerable) influence on the water balance. The LAWA also excludes impoundments for the purpose of electricity generation and navigation and any measures for flood protection from the "water services". These restrictions are not in accordance with the guidelines of the CIS-WATECO. There is no difference between publicly and privately run services in the WFD and "impoundments" are explicitly mentioned in the definition of "water service" in Art. 2 no. 38 WFD.

2. Implementation options in Germany

For the implementation of the cost recovery principle different approaches according to the different levels of costs have to be considered. Financial costs of public water supply and wastewater disposal are best recovered by "public" local rates or "private" prices. These instruments are not suited to recover environmental and resource costs. Their recovery has to be settled on a higher level. The water extractions charges of some of the federal states ("Bundesländer") are a possible starting point. Although they are nationally (as to the Basic Law) not justified with reference to environmental and resource costs, they allow for the necessary differentiation and of water charges according to the regional water balances and different water uses. The Waste Water Charge Act is the appropriate instrument to recover the environmental and resource costs of wastewater disposals, but it has to be revised in several aspects and a regional differentiation has to be invented to fulfil the task adequately. For water services beyond water extraction and wastewater discharge "new" instruments have to be developed, like a charge on the use of waterways that were widely used in Germany till the middle of the 19th century.

Beyond those well-established instruments the implementation of the adequate contribution of those water uses, that are not water services, to the recovery of costs of the water services require new instruments beyond the traditional water law. Activities producing diffuse pollution of waters, like agriculture or individual transport traffic, and therefore increasing the cost of the provision of water services, have to bear these additional costs. A charge on organic or mineral fertilizers has been discussed for 30 years, but hasn't become reality. There are some highly controversial questions as regards the integration in the system of public dues and the relevant competencies laid down in the Basic Law have to be solved for the introduction of these instruments.

Ecological long term effects in the Hungarian Szamos and Tisza River after the Baia Mare Spill (Romania)

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1. Introduction

After the accident in the Arul gold processing company of Baia Mare in January 2000 approx. 100 000 t of cyanide-contaminated mud from gold leaching processes entered the Theiss river via the Szamos river. The eco-toxicity of these extremely high cyanide concentrations were immediately observed through high fish mortality rates in the river. Additionally, heavy metals, which are associated with the gold ores and therefore with the spilled mud, entered the Szamos river and, subsequently, the Theiss. In March 2000 during extreme spring flooding a re-mobilisation in combination with a re-suspension of sediments in the river areas took place. Approx. 3 months after this flood water, surface sediment, and depth profile sediment samples from 13 sites along the Szamos and Theiss rivers (longitudinal profiles) were investigated. To get information about the ecological long term effects in February 2002 a detailed sediment campaign has been done and 2003 natural Biofilms and macro zoobenthos have been investigated.

2. Material and methods

For the determination of the dissolved trace element concentration the taken surface water samples have been filtered in the field (0.45µm) and have been stabilized with HNO_3. The taken surface sediments were stored in plastic boxes and the sediment cores, taken with a Mondsee corer had been discriminated according to visible layers bevor storing in plastic bags under nitrogen atmosphere (Kraft et al 2003). For the sample transport cooling boxes have been used.

The macrozoobenthos (chironomid larves) were collected ca. 100m below the confluence of the Szamos and Tisza and stored in polypropylen tubes on site (Woelfl et al 2004).

Biofilms have been collected from natural supports like stones or wood with a ceramic tweezers. Attached sediment or particles wer washed our with filtered river water. The samples were stored in PTFE vials and frozen in lquid nitrogen transported into the laboratory (Mages et al. 2004).

For getting information about the main bounding characteristics of the trace elements in the sediments the sequential leaching procedure after (Jacob et al. 1990).

For the trace element determination after the sample preparation ICP OES, ICP MS and TXRF Systems have been used.

3. Results

The results definitively show that mining industry activities influence the elemental water quality of the Theiss river downstream of the confluence with the Szamos. By interrupting the inlet in the Tisza lake over the period during which the mud wave passed, the extreme inputs of heavy metals to the lake sediments could have been avoided.

For several elements like Cu, Cd, Pb and Zn the detected total concentration in the sediment fraction less than 20 µm of Szamos and Tisza river exceeds the investigated regional background value for more than 8 times.

During the March 2000 spring flood, the heavy metals were distributed on a large surface in the flooded region and were also deposited as surface sediment in the Tisza lake, although these are in a form that may be regarded as an uncritical increase.

In the confluence area of the Szamos and Theiss rivers, eco-toxicity of the sediments was proven to create long term effects in agreement with investigations of the Environment Department of Rheinlandpfalz from July 2000.

The calculated sediment bioaccumulation factors for the Tisza sediment are low compared to literature data. This may indicate al low bioavailability of trace metals in the Tisza sediment. For example Zn anc Cu are only 2-2.5 times bioaccumulated in Chironomus sp. compared to literature data which are 10-20 times higher.

For several elements like Cu, Cd and Zn detailed results of the sequential leaching procedure and the biofilms have shown that depending on the bioavailability of the trace element accumulation rates in the biofilms up to 1000 higher in comparison to natural accumulation rates and gives first information about the ecological risk.

4. Literature

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Flood protection: dike heightening and/or retention?

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Dike heightening as a measure of flood protection is meeting more and more opposition due to conflicts of interest with values of landscape. Perhaps more importantly, higher dikes may provoke increasing investments in the protected regions, leading to higher vulnerability if inundation would occur. Other flood protection measures are therefore receiving attention, an important one being the application of retention basins in which part of a flood wave can be stored and released later. Also, combinations of such measures are being considered, the presence of a retention basin allowing lower dikes downstream. In this paper, we consider the question whether such combinations are useful.

Although several aspects (such as safety perception, ecology, landscape) play a part in making choices between options, the financial aspect will always be important. The cost of dike heightening is a simple function of dike length and design height. The cost of a retention basin contains a component proportional to its surface area and one proportional to its circumference (because, normally, dikes will be needed to contain the retained water); moreover, adjustable inlet and outlet constructions will be needed, as a passive inlet (such as a fixed overflow weir) will lead to suboptimal use of the basin .

The cost of construction and maintenance of protection works needs to be balanced against the (reduction of) damage in case of failure. Obviously, complete safety or absence of flooding cannot be realized. A (hopefully small) probability of dike failure remains. Damage (interpreted as expected damage weighted by frequency of occurrence) is largely determined by the exceedance frequency of critical levels, which can be derived from hydrologic statistics for the river concerned. Normally, the frequency distribution of peak discharges can be approximated very well by a negative exponential distribution. However, additional aspects such as base flow and flood duration also influence the rate of possible flooding. If a retention basin is used, the peak level and volume of a flood wave will be reduced, leading to a decrease or vanishing of downstream damage.

If we indicate dike level (made dimensionless) by x and retention volume by y, the sum of cost and damage (up to a constant) can be written as

$$K = K_1 x + K_2 y^2 + K_3 y + \exp(-y^2 - x^{3/2})$$

where K_1, K_2, K_3 are dimensionless parameters involving the cost of dikes, space for retention basins and dikes around them, respectively. This total cost function can be evaluated for any combination of the parameters. An example is given in Figure 1. This shows some interesting features.

1. For fixed dike level x there may be an optimal retention volume y and conversely.
2. For high dike levels (large x), there is no optimum and adding a retention basin will only increase total cost, and conversely.
3. There is no global optimum lower than the marginal optima for each of the separate measures (i.e. $x = x_l$, its minimal value, or $y = 0$). The cost surface only has a saddle point. This would mean that a combination of dike heightening and application of retention basins on a single river is not useful from a cost point of view.

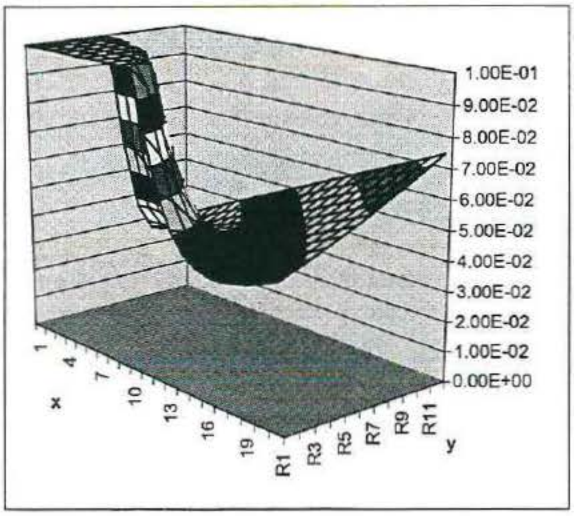

Figure 1: Example of total cost as a function of dike level x and retention volume y.

Conclusion 3 appears to be valid over the whole range of possible values of the parameters K_1, K_2, K_3. This means that for a new application, it would be better to consider single measures and compare their total costs. Optimal values of dike level x depend only on dike cost K_1, those of retention volume y on the cost K_2 of making space available (see Figure 2). The associated cost also involves (some of) the other parameters.

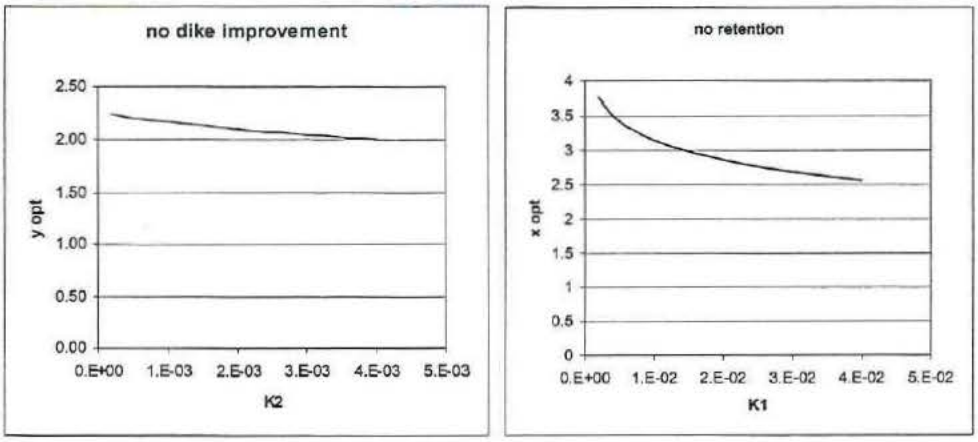

Figure 2: Optimal values of isolated actions retention (left) or dike heightening (right)

An important aspect in making the choice is *uncertainty* in all of the parameters, which is considerable. This means that optimal values of the parameters and associated total cost may also involve a significant uncertainty. Making a choice between options is then only possible if the probability distributions of this uncertainty do not show too much overlap, an example of which will be given. If there is a considerable overlap and if it cannot be reduced by acquiring better information on the uncertain parameters, one must conclude that a rational choice based on cost criteria is not possible. This is perhaps not the desired situation for decision makers, but it is useful to acknowledge that it *is* the situation. Other criteria must then be invoked (such as the number of casualties in case of flooding). However, one should keep in mind that these might be even more uncertain.

Definition of the good groundwater chemical status of groundwater units in Germany

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Because of the high importance of groundwater protection a complementary Groundwater Directive is currently developed. In this context the EU member states are invited to propose criteria for assessing a reference state for a "good groundwater chemical status". Commissioned by the Working Group of the Federal States of Germany on water problems (LAWA) the authors developed a procedure to define the "good groundwater chemical status" in Germany based on existing data from groundwater monitoring networks provided by the Federal States.

Germany was subdivided into 17 groups of aquifers, each with comparable petrographic and hydrodynamic properties (e.g. limestones, sandstones, Loose-rock sediments, magmatites etc.) using digital hydrogeological maps. Before assessing natural groundwater concentrations the individual heterogeneous data sets from the federal states were joined together in one data base with unified structure and referenced to the group of aquifers. Based on groundwater monitoring data from ca. 50000 groundwater monitoring stations, 30-40 different hydrochemical (inorganic) parameters were separated and the range of natural groundwater concentrations have been identified for each group of aquifers. The number of evaluated observations for each parameter in each group of aquifer was in the range between 400 and about 4900, allowing a statistically relevant analysis. The parameters evaluated include environmental and redox parameters (O_2, pH), summary parameters (electric conductivity, DOC), main substances of content (Na, K, Ca, Mg, Cl, HCO_3, SO_4), adjoining substances of content (Fe, Mn, NH_4, NO_3) as well as trace elements (Pb, Cd, Hg, Cu, Zn, etc.).

For each of the investigated parameters the concentration distribution in the individual groundwater bodies are separated into a natural and an influenced component. This is done by representation of the observed concentration distribution by the sum of two statistical distribution functions, describing the natural and the influenced component. The good groundwater chemical status is characterized by confidence intervals of the distribution function of the natural component.

In the contribution, the methodology developed will be described and selected results of the project will be presented. This will be followed by the discussion of possible consequences for water resources management issues arising from the requirements formulated in the EU water directive with regard to the definition of the "good groundwater chemical status" in Germany.

Regional Co-operation for flood risk management
Scientific approach and practical testing in the Weisseritz River catchment (Saxony)

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Flood risk management is an approach based on societal decision making weighing reachable benefits of utilization of source and flood-prone areas with potential damages and cost for mitigation measures (Schanze 2004). It deals with the reduction of probable anthropogenic intensification of flood hazards in source areas and pathways, the minimisation of vulnerability in receptor areas as well as measures for the event management and maintenance. Due to the flooding process decision making for flood risk management has to refer to river basins. But these hydrological defined areas aren't spatially congruent with administrative boundaries of municipalities. Therefore, approaches for the collaboration of municipal actors and other stakeholders within river basins have to be developed.

The contribution deals with the project "Co-operative Flood Risk Management using a Decision Support System – the Example of the Weisseritz River Catchment" of the Leibniz Institute of Ecological and Regional Development Dresden (2003-2006). The Weisseritz is a left tributary of the river Elbe in Saxony with a catchment size of 386 sq.km. In August 2002 the Weisseritz inundated large urban areas and the countryside along the river. The city centres of Dresden and Freital were heavily affected by this flood event.

The aim of the Weisseritz project is to develop and test a theoretically and methodologically framework of regional informal co-operation in terms of flood risk management in river catchments, especially such concerned by flash floods. The co-operation should be based on the collaboration of all actors either concerned by floods or able to contribute to flood prevention.

Therefore, first of all the co-operation process between municipalities, state authorities and land users in the Weisseritz river catchments was initiated and goal-oriented structured. The most important stakeholders in the case of flood prevention were identified. 25 institutions agreed to work together:

- the Weisseritz County (Landkreis)
- 14 local authorities, including the City of Dresden
- the Regional Planning Office
- 5 institutions of the Free State of Saxony
- 3 non-governmental organisations and
- one scientific institute.

The co-operation of these institutions is based on a common declaration, signed in March 2004. In the paper the members express there willingness to collaborate voluntarily towards the improvement of flood prevention in the Weisseritz area. As the nature of the co-operation is informal only a few rules are stipulated. So the members declared to provide the needed information and to nominate staff in the co-operation bodies.

The guidance of the project is based on the method of "Regional Management". This approach has been developed in Germany and Austria in the 1980th and 1990th. It embraces the co-operation of different stakeholders with a common objective in a regional context. The method contains a two-level system of interaction (Figure 1). On the one hand there is the group of political stakeholders, responsible for decision making in the co-operation. Here it is called "Assembly of Members". A steering group guarantees a stepless co-ordination of work. On the other hand experts from several institutions prepare the decisions in working groups. In the Weisseritz case four of these groups do already exist or be under way (see Figure 1). The advantage of this method is that preparation of decisions by experts guarantees the consideration of alternatives before decisions are made by the political representatives. As the concept of Regional Management was successful in a lot of different cases (e.g. structural change in old industrial regions and in rural regions; Wirth et al. 2003) the assumption is that it will also be effective in flood prevention.

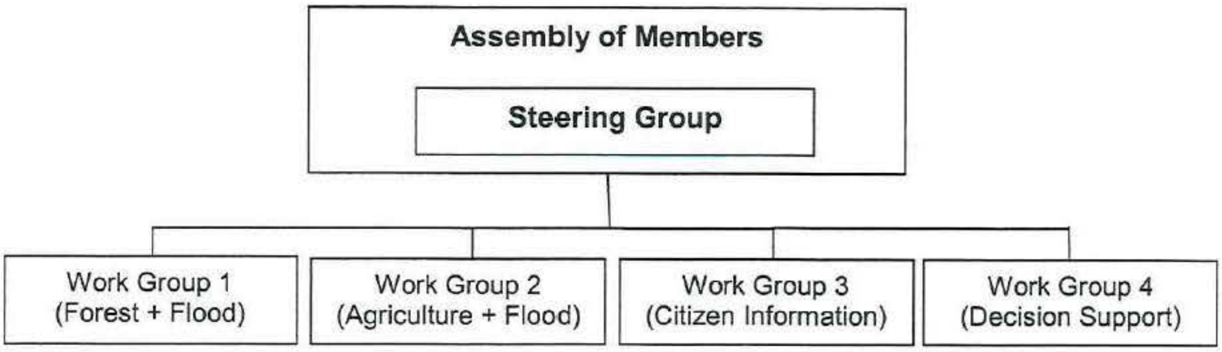

Figure 1: Organizational scheme of regional co-operation in the Weisseritz river catchment

Decision making within this process is facilitated by a certain user-friendly decision support system (DSS). It provides all necessary information of current flood risks and also allows simulations of scenarios. Constituents of the DSS are allocation and quantification of the site-specific meaning of source areas, pathways and receptor areas in terms of flood risks as well as the efficiency of mitigation measures.

The co-operation process in the Weisseritz river catchment is accompanying investigated. General questions are: How to organize an informal co-operation process concerning flood prevention? How is it possible to determine the effectiveness of regional co-operation in flood risk management? Whereby co-operative learning is characterized in flood prevention? The project is oriented towards theories of organizational and co-operative learning (Hutter and Schanze 2004). In this connection the main hypothesis is that local actors involved in a structured process of flood prevention like this are able to open up new options of thinking.

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Restoration of shallow hypertrophic lakes in Cujavian-Pomeranian region (Central Poland). How to remove excess seston?

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Many shallow lakes, especially small urban ones, have reached a state of extreme hypertrophy, with phosphate concentration exceeding 1 mg PO_4 L^{-1}, and in some cases even 4 mg PO_4 L^{-1}. It results in severe blue-green algal blooms and poor water quality, below all quality criterions.

For several years efforts leading to improve the situation in the watersheds of such water bodies have been made, e.g. reduction of nutrient and pollutant inflow from point and diffuse sources. Attempts of various in-lake restoration measures have also been made, the most popular of them being the artificial aeration of water. Reasonableness of this method is rather questionable, as only short-time and weak water quality improvements have been observed even after 10 years of continuous application.

Our earlier investigations (Wiśniewski 1999, 2000, 2002) aimed at reducing phosphate concentration in the water column through its immobilisation in sediments. We have shown that application of $FeCl_3$ directly to the sediments during a controlled resuspension allows for 7-fold reduction of PO_4 concentration in the interstitial water (Table 1). We have also found that applying $FeCl_3$ before sediment dredging reduces the subsequent PO_4 concentration in the drainage water by more than 40 times (Wiśniewski 2003) (Table 2). Studies of $FeCl_3$ impact upon living organisms have demonstrated no adverse effects on chironomid larvae and *Daphnia* sp. survival and development, even at high concentrations (Wiśniewski 2003).

Table 1: Inactivation of PO_4 in resuspended sediments by $FeCl_3$ addition at different pH. Sediments from Łasińskie Lake (depth: 6 m). N = 3.

Initial pH	PO_4 released after 1 h (mg L^{-1}) (control - no $FeCl_3$)	Addition of 8 ml $FeCl_3$ L^{-1}	Final pH	Conductivity µS cm^{-1}
4.1	1.43	0.39	6.2	1410
4.6-4.9	1.30	0.31	6.5	1220
5.9-6.2	1.32	0.29	6.5	1185
7.1	0.71	0.14	6.5	970
8.5	0.96	0.24	6.3	1020
9.5	0.98	0.28	6.8	1030

Table 2: Effect of $FeCl_3$ addition before sediment dredging on PO_4 concentration in drainage water. The field experiment carried out in Łasińskie Lake. N = 3.

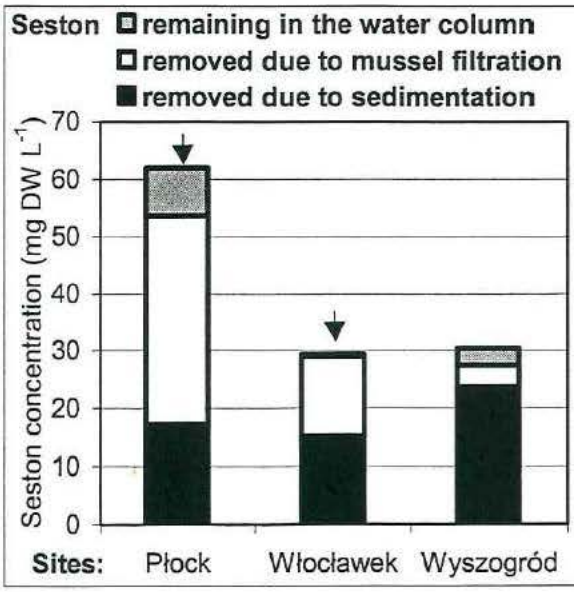
Feature	Control (sediments without $FeCl_3$ addition)	Sediments with earlier $FeCl_3$ addition (8.5 ml L^{-1})
PO_4 (mg L^{-1})	15.70	0.42
pH	7.10	6.00
Conductivity (µS cm^{-1})	900.00	1480.00

The still remaining problem is high concentration of seston, especially of allochtonic origin. Its removal is essential for obtaining better water transparency necessary to restore macrophyte stands. Also recent EU norms for recreational waters require water transparency to be at least 1 m of Secchi disk visibility.

Earlier investigations of Wiśniewski (1990) showed that a bivalve *Dreissena polymorpha*, the zebra mussel, could survive and filter seston after transplantation to large, shallow lake Druzno. Our laboratory experiments have shown that *Dreissena polymorpha* could effectively filter even very fine-grained suspension, remaining in the water column after 6 day of sedimentation (Table 3, Figure 1). It was also able to remove phosphates adsorbed on these particles. Our recent studies deal with the possibility of introducting this mollusc on artificial substrata to turbid water bodies, and using it as an efficient seston controller (Kobak & Wiśniewski 1998; Kobak et al. 2002; Kobak 2004). In the field study carried out in the Włocławek Dam Reservoir (the Vistula River), the best substrata for mussel recruitment were phenoplast plastic, glass, aluminium, acrylic and PVC. Low recruitment density was found on rubber, Penaten cream-coated plastic, zinc and brass (Kobak 2004). Additional experiments have shown that these differences were caused mainly by surface properties of the substrates and not by the waterborne chemicals. Concave surface shape and protection from the excessive flow also promoted mussel recruitment. Similar results were found in the laboratory study of mussel attachment strength on these materials. The above findings would help choose the most appropriate substratum for transplanted mussels.

Table 3: Removal of coloidal seston from the water column of Łasińskie lake by *Dreissena polymorpha* (t-test: $t = 9.03$, $df = 4$, $p = 0.0008$).

Treatment (N = 3)	Suspension (mg DW L^{-1}, ±SD)	
	Initial	After 144 h
Control beakers (1 L)	31.9 ±3.2	25.6 ±3.4
4 mussels (mean length 25 mm) in a 1-L beaker	32.4 ±4.1	5.3 ±1.9



Beakers with mussels: 4 individuals (mean shell length = 30 mm) placed in an 800-ml beaker (sedimentation + filtration)

Control beakers: no mussels, sedimentation only

Seston from 3 sites in the Włocławek Dam Reservoir, particles remaining in water after 24 h of sedimentation (assumed as < 0.45 μm).

Sampling time: after 12 h of exposition

N = 3

2-factor ANOVA: Interaction between sites and treatments: $F_{2,12} = 9.92$, $p = 0.0029$

Arrows indicate sites where mussels significantly removed seston from the water column (Tukey test)

Figure 1: Removal of coloidal seston from the water column of the Włocławek Dam Reservoir (the Vistula River) by *Dreissena polymorpha*.

Sediment input and pollution of floodplains in the Oka River catchment

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Investigations about the influence of flood events on the floodplain pollution are presented. The research activities have been carried out in the Oka-river floodplain area near the city of Ryazan in the frame of international Russian-German cooperation at two experimental sites.

The first one is located within the Oka-river floodplain near settlement Solotcha. This river site crosses grasslands, hay harvests, new-channel bush and small forests. The second river site is situated 13 km downstream. It crosses the floodplain opposite the city of Ryazan and expands thought an anthropomorphic agro-landscape (the reclaimed arable lands and meadows). During the six years study (1997-2003) a wide range of spring floods were observed: from anomalistic low in 1997 and 2002, up to comparatively high in 1999 (643 cm), when the average high flood was exceeded by about 93 cm.

The investigation included a complex study of landscape components- the soil stratification, configuration and quality; the quality of river and subsurface water; the input and quality of high flood sediments. The sampling of high flood sediments was carried out with artificial lawn sediment traps according to the method of the German partners at the Elbe river.
Table 1 shows the quantity of deposits of the natural and agro-landscapes.

Table 1: Sediment freights on the floodplain landscape area of the Oka-river near the city of Ryazan

Location of observation points	Sediment Freight, g/m^2					
	1998	1999	2000	2001	2002	2003
River site No 1						
Meadow, 4 km from the river channel (Oka)	8	371	26	720	-	28
Drained meadow 2.95 km from the Oka-river channel	4	501	20	114	-	-
The old dry channel, 0.5 km from the Oka-river	1	356	-	-	-	-
River site No 2						
Draining arable land, 3.8 km from the Oka-river	617	-	-	303	-	681
Draining arable land, 2.9 km from the Oka-river	656	1290	790	482	-	729
Drained meadow, 2.5 km from the Oka-river	421	-	359	-	-	-
Grassland, 1.6 km from the Oka-river 71	-	71	-	-	-	-
Meadow behind the dam,4.3 km from the Oka-river	-	48	38	-	-	28

Flood sediments showed a pH close to the neutral point and up to 70% clay particles content. The total organic content was between 12% and 52%. The sediments exceed the K content (in 4-12 times) and P content (in 2-3 times) of the zonal soils. Cr, Ni and Cu concentrations exceed available standard concentrations, Zn content is close to ESC. Heavy metals concentrations in sediments exceed their concentrations in unaffected soil by 20-25%. The alluvial soils are differentiated with irregular distribution of the metal concentration distribution through the soil depth profile. At the unimproved meadows the first maximum of the metal content is met within the humus layer and below it is decreased up to depth 50-60 cm by 10-50%. In the deeper layers the gradual increase of metal content is observed. On the reclaimed arable lands maximum concentrations were marked in the layer 40-50 cm. Maximum Hg concentrations (up to 0.15 mg/kg) were observed in the humus layer of all profiles. It is allowed to consider flood sediments as the major source of floodplain pollution with metals.

Hydrosphere pollution was first time studied for floodplain landscapes with biogen elements on the base of integrated characteristics of quality: soluble organic carbon (DOC) content; adsorbed AOX content, according to European river guidelines. The values for the above mentioned parameters for the different components of agrolandscapes are shown in the Table 2.

Table 2: Organic pollutant content for soluble compunds within floodplain landscapes (r. Oka, Rjazan, flood 2000)

№	Hydrosphere element	Date	DOC, mg/l	AOX, µg/l
1.	Snow 1 site	22.03.00	2	5.8
	2 site		1.2	54.5
2.	R.Oka: - before flood	22.03.00	5.9	9,7
		5.04.00	3.0	17,0
	- during flood	12.04.00-29.04.00	4.3-9.3	26.0-70.1
	- after flood	5.05.00-22.05.00	9.5 – 5.9	61.0 – 30.3
3.	R. Solotcha (after flood)	22.05.00	22.5	52.5
4.	Drainage flow	5.05.00-22.05.00	5.4 – 9.0	51.7 – 80.4
5.	Subsurface water	22.05.00	3.0 – 15.0	40.5 – 70.4
6.	R. Voga (after flood)	12.05.00	29.0	44.3

Data from the Table 2 shows the high level of AOX pollution in Oka river floodplain agrolandscapes. As to compare DOC standard value for the Rhein river is 3.0 mg/l, AOX is the same standard for all river and equal 25µg/l. The comparison of DOC and AOX concentrations in river surface water and in floodplain soil drainage flow indicates the high mobility of analysed organic compounds. The mean values for DOC and AOX concentrations were 7.6 and 0.005 mg/l and in flood flow 7.7 and 0.0053 mg/l in drainage flow, respectively.

Rehabilitation of a high risk spot for water contamination in the Upper Tisza basin - the Baia Borsa-Novat tailing pond

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The Upper Tisza region was subject to two major pollution incidents in January (cyanide pollution due to breach of the Baia Mare-Aurul tailing pond) and March 2000 (heavy metal pollution due to breach of the Baia Borsa-Novat tailing pond) in North-western Romania. The local and international response in the year 2000 (i.a. UNEP-OCHA expert missions, UNDP-Romania response project, EU-Baia Mare Task Force, ICPDR Risk Spot Inventory, REMIN repairing works) brought about a lot of public attention, political concerns and expert reports. The actual environment problem was solved at the Aurul pond through major investments of the Australian operator but at the Novat pond in fact remained non-resolved.

A new assessment of Greenpeace in 2001-2003 used an innovative campaign approach which included the offer of cooperation and support to the main non-private polluter, the state mining company REMIN, owner of numerous industry sites and high risk spots. Result was an investment portfolio, presented to various international and bilateral donors. In spring 2003, the Austrian government decided to finance one of six projects: the rehabilitation of the Novat pond. After contract signing in December 2003, the Austrian risk spot rehabilitation project is being implemented until tentatively October 2004. It addresses the uncontrolled water cycle around the tailing pond by investing into new pump capacities, an independent power supply and better access roads in the remote mountain area. The project serves as a model for various other high risk spots still waiting for international commitment.

Posters

Trace metals in suspended – an indicator of the anthropogenical contamination of the river system

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The aim of the study was to determine heavy metals distribution in the Odra River System focusing on suspended matter. Obtained results allow to assess the level and extent of contamination by comparison with LAWA classification and to identify any need for monitoring. Additionally estimation of the mobility and potential bioavailability of metals in the river suspended matter was performed.

In the Years 1997 – 2001 very wide investigations of the Odra river system were carried out within the framework of the International Odra Project. About 100 samples of suspended matter were taken in five sampling campaigns: November '97, May '98, November '98, June '99 and May 2000. Suspended matter concentrations are very variable; the lowest of 1 mg/dm^3 and the highest of 116 mg/dm^3 were found in the samples from Opole taken in May'98 and November'98 respectively. The detected levels of metal contamination, mainly Zn, Cu, Pb and Cd, in many suspended matter samples of the Odra river were found to exceed the geochemical background values. Concentrations of studied metals in the all suspended matter samples varied in wide ranges and their statistical parameters from five sampling campaigns are presented in the table.

Table 1: Statistical parameters of suspended matter and heavy metals concentrations in the suspended particulate matter of the upper and middle Odra river (November 1997- May 2000).

Parameter n= 101	Suspended matter concentration mg/l	As	Cd	Cr	Cu	Ni mg/kg	Pb	Zn	Mn	Fe
min	1,2	8,0	1,8	42,4	6,2	22,1	24,4	351	1152	20806
max	116	302	39,8	351	493	1287	401	31369	11010	121316
arithm.mean	28,9	63,8	9,3	131	98,4	133	110	1867	4168	50679
geom.mean	23,0	50,5	8,0	120	77,9	88,9	98,0	1321	3637	47929
median	26,5	52,9	7,3	125	79,2	81,6	97,2	1221	4051	48822
SD	18,9	47,4	6,2	57,4	76,3	165	55,9	3430	2060	17309

Highest Cd, Cu and Zn concentrations were observed particularly in middle part of the Odra River at the Lubin - Legnica Cu-mining and processing region. High metals concentration is caused mainly due to industrial activities such as: petrochemicals, petroleum refining, steel works foundries and non-ferrous metal-works and agricultural activities.

The obtained results classified into LAWA classes (Irmer, 1997) showed that the strong to very strong contamination (classes III/IV and IV) of the suspended matter with Cd was typical for almost all samples along the Odra river over two sampling periods. Only sporadically the class III was stated, thus slight improvement of Cd contamination in the SPM from May 2000 could be observed. With Pb, Zn and Cu the situation was at no time as critical as with Cd. Strong and moderate contamination for Pb and Cu (II-III, III classes), and very strong and strong for Zn (III-IV, III classes) was typical for '97. However, after three years the situation has been improved, and in 2000, class II - moderate contamination with Cu, Zn, and in the upper river section with Pb dominated, (Adamiec and Helios-Rybicka, 2002)

The results for the Odra river showed that the dilution, re –suspension, and re –deposition processes at extreme high water events in 1997 have caused additional increase of heavy metal concentrations in the suspended matter. In the SPM samples taken in November '97, the concentration of Cd, Cr, Cu and Pb was higher (mean values - 18.41, 175, 173, 185, respectively) than in the samples from later sampling periods. From all elements studied, Cd, Zn and Cu appear to be of particular concern because of the high level, that appear to be bioavailable and their high mobility.

Suspended matter seems to be an optimal indicator for chemical river monitoring. Additional arguments for selection suspended matter is easy sampling procedure and better homogenity of the material. Besides the determination of total metal concentration, it is recommend for monitoring purposes to evaluate the most mobile portion of metals, which can be easy release as soluble and bioavailable fraction. This mobile portion of metals are crucial for river quality assessment and remediation method selection, if require.

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Mobility of heavy metals in the Mala Panew River sediment depth profiles and their migration in to the groundwater system

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In this study we have selected the Mala Panew River at the Upper Silesia region (Figure 1), as one of the most polluted river in Poland, due to very long mining and processing of Zn-Pb ores. The study of the sediment depth profiles can provide information on the metals contamination history and long-term potential environmental impacts. The obtained knowledge can be used to describe vertical distribution of metals in sediment cores and their migration in to the groundwater system.

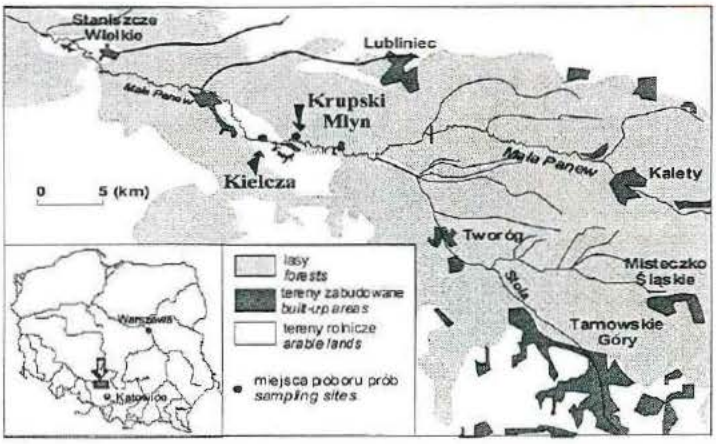

Figure 1: Map of the research area in Upper Silesia, Poland

The heavy metals concentration (Cd, Co, Cr, Cu, Fe, Mn, Ni, Pb and Zn) in the different depth sections of sediments is very variable and depends on both the metal and the sampling locality. The metal contents in surface sediment layers are generally higher than in the deeper profile sections, and their vertical distribution depends on the river channel morphology as well as the fluvial processes. The high content of metals was detected for Cd, Cu, Pb and Zn and ranged [mg/kg]: 0.2 - 559; 4 - 483; 26 - 3309; 126 – 11153 respectively (Tab. 1). High metals concentrations were also determined in pore waters from the samples of selected sediment profiles, and their max. contents [ug/l] were: Cd 320, Cu 116, Pb 80, Zn 4400.

The results of total metal contents in both pore waters and sediments and their chemical forms were used in order to evaluate the metals mobility in the sediment-water system. The most mobile metal forms in the studied sediment samples i.e. exchangeable, carbonatic and easily reducible are typical for Zn and Cd while Pb and Cu are mainly associated with the moderately reducible fraction (Figure 2). The relative portions of metals form are not significantly varied with depth in the sediment profile.

Table 1: Statistical parameters of the metals concentration in the Mala Panew River vertical sediment profiles.

Metal	Statistical parameters	*Metals in sediment profiles [mg/kg]*				
		MP1a n=23	MP2a n=12	MP1b n=7	MP2b n=6	MP3b n=3
Cd	*minimum*	3.1	0.2	108	1.5	20
	maximum	275	57	559	140	145
	arithmetic mean	111	6.9	255	59	100
Cu	*minimum*	17	4.0	98	26	63
	maximum	278	131	483	89	196
	arithmetic mean	137	16	238	67	114
Pb	*minimum*	66	36	374	26	254
	maximum	4788	539	1199	368	2453
	arithmetic mean	816	120	676	181	1055
Zn	*minimum*	704	126	2201	304	811
	maximum	10402	778	11153	1532	1500
	arithmetic mean	2364	314	5455	1251	1042

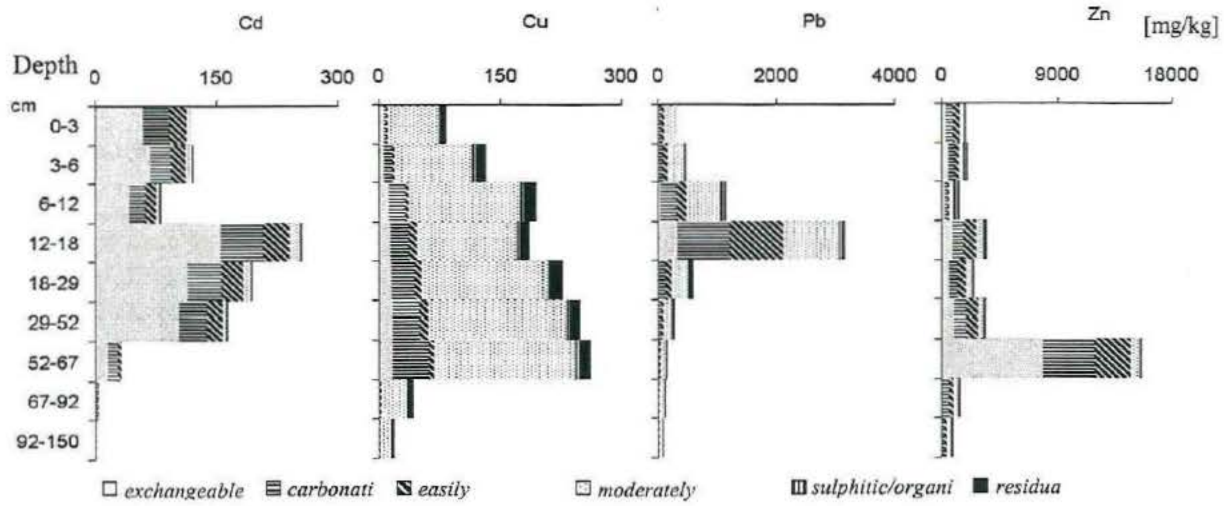

Figure 2: Vertical distributions of metal chemical forms in the Mala Panew River sediment profile.

Obtained results allowed to draw the following conclusions:

- Vertical distribution of metals in the Mala Panew River sediment profiles is very variable but in surface layers of sediments their contents are generally higher than in deeper profile sections.
- The high content was stated for Zn, Pb, Cu and Cd.
- Zinc and Cd are associated with the most mobile forms thus they migration in to the groundwater system should be considered.
- Investigation of the short sediment profiles is proposed as very representative for river geochemical monitoring.

Effect of a lock-and-weir system on suspended particulate matter (SPM) in the river Saale (Germany)

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The river Saale (length 413 km, catchment area 24 079 km^2) is one of the most important tributaries of the river Elbe. The Saale affects the lower course of the Elbe both, in water quantity and quality. The lower Saale reach (87 km) is regulated by five lock-and-weir systems to allow navigation. Typically, water flow through a lock-and-weir system of the Saale is divided into three pathways: over a weir, through a lock gate (for shipping), and via a diversion (used for powering water mills in pre-industrial times). The last lock-and-weir system is located at Calbe, approximately 20 km upstream from the mouth of the Saale into the river Elbe.

The spatial and temporal variation of SPM concentration and composition plays an important role in pollution transport. Therefore the influence of hydrological and morphological stress on SPM concentration and composition as well as the structure of aggregates was investigated at the lock-and-weir systems Calbe. From January to June nine random samples ware taken at two sampling points above (km 20,8) and below (km 18,5) the lock-and-weir system.

Results from chemical analyses (dry weight, loss on ignition, particle concentration, POC, PN, silicate, chlorophyll-a concentration) and laser microscopy analysis (bacterial biomass, polymer biomass, algal biomass, architecture of aggregates) were evaluated.

During the sampling period the flow rate of the river Saale was between mean water flow (115 m^3/s) and mean high-water flow (374 m^3/s). Chemical analyses showed in the majority of samples that the concentration of dry substance (Figure 1, left site), POC, PN and particle numbers below the lock-and-weir system was higher than above. The lower current velocities above the system may have allowed the coarse mineral particles and aggregates to settle. This is indicated by the loss on ignition of SPM which was higher above than below the system (Figure 1, right site). In general the chlorophyll a content was higher below the system than above. The most probably reason may be the oxygen input by the weir. Chlorophyll a was also higher in the second half of the sampling period, which was confirmed by higher water temperature. Conductivity measurements proofed the high salt concentrations in the river which was also indicated by the presence of diatoms in the phytoplankton.

Diatom growth was also reflected by the decreasing silicate concentrations due to the incorporation into diatom frustules (Figure 2, left site). However, the fraction of algae in the aggregates was not corresponding to the presence of diatoms in the water column. Polymer concentration in the aggregates (Figure 3) seems to be related mainly to the presence of bacteria as algal concentration in the aggregates was low. Nevertheless, the decrease of chlorophyll a and the increase of polymer in the aggregates by the end of the sampling period (Figure 2, right site) may be related to the release of polymer by dying algae and the subsequent incorporation into aggregates.

Thus under mean flow conditions, the flow over the weir and through the diversion represents the main flow through and thus had the largest effect on downstream material transport. During mean high flow the weir became more important due to the fact that the flow through the diversion backed up. The flow through the lock gate is negligible as shipping was very rare. In conclusion, it is suggested that in both cases the erosion downstream from the weir became important for SPM quality and quantity.

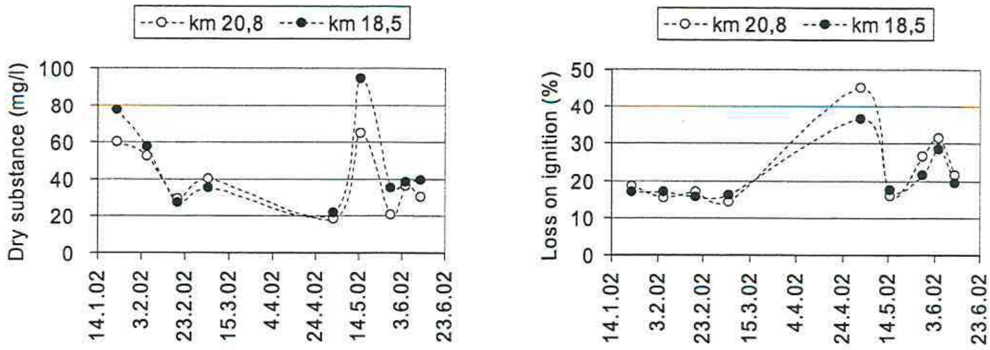

Figure 1: Dry substance (left site) and loss on ignition (right site) above (km 20,8) and below (km18,5) the lock-and-weir system Calbe, river Saale.

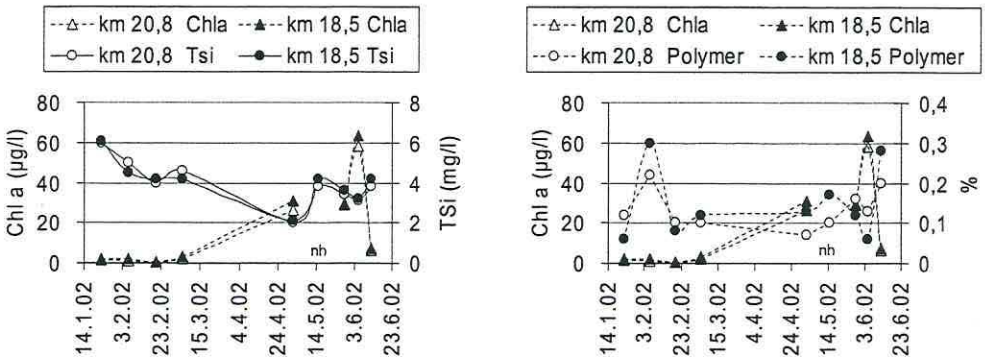

Figure 2: Trend of chlorophyll-a and silicate concentrations (left site) as well as chlorophyll a concentrations and polymer content of the aggregates (right site) above (km 20,8) and below (km18,5) the lock-and-weir system Calbe, river Saale.

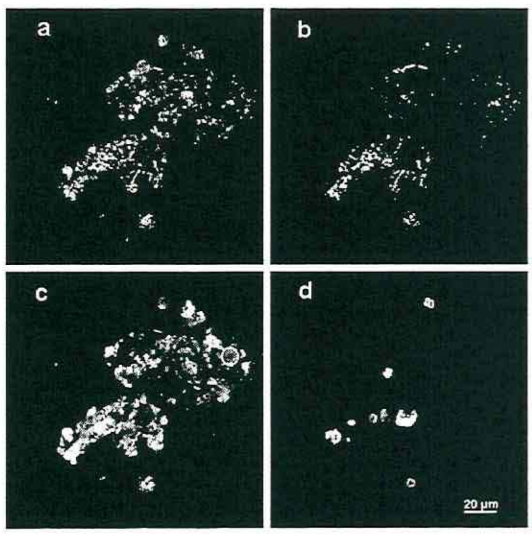

Figure 3: Confocal laser scanning microscopy of river Saale aggregate. The signals were collected from one aggregate in 4 separate channels. a) reflection signal, b) nucleic acid staining of bacteria, c) polymers after lectin staining, d) autofluorescence of chlorophyll a

Causes and consequences of the flood in the year 2002 in the Třeboň region

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The Třeboň region is situated in the eastern part of southern Bohemia. The Lužnice River, the largest right-side branch of the Vltava River in southern Bohemia, flows through the region.

In the 16th century, the largest Czech pond, Rožmberk, with an area of 489 hectares was established on the Lužnice River. The optimum economy level volume of water was 6.3 mil.m^3. To protect the pond against floods, New River, a man-made channel with a length of 13.5 km was built in the same century, which leads excessive water away to the neighbouring Nežárka River reception basin. The flow is divided at the Novořecké splavy Weirs. The Třeboň region contains also several sand pits. The largest one, Cep, is located approximately 10 km above the Novořecké splavy Weirs, on the left bank of Lužnice River, and its protective levee is situated ca 60 m far from the river.

The intensive rainfall of August 2002, which occurred twice shortly after each other, caused excess flow and extensive floods along the entire river. The first occurrence of heavy rainfall brought more than 120 mm in the area, which led to a full saturation of the soil and increase of the Lužnice River flow to over the 100-year water. The second heavy rainfall started on 11 August 2002 and did not stop until the afternoon of 13 August 2002. The volume (280 mm) and territorial extent in combination with the high saturation of the river basin resulting from the first occurrence of heavy rainfall caused an extremely high flow exceeding the level of a 500-year water. In total, the two waves brought 350 – 400 mm of rainfall, which is nearly five times more than the average rainfall for the period in question (79 mm) and nearly 60 % of the total annual average (690 mm). The progress of the flood wave on the upper stream of the Lužnice River is shown in fig. 1.

Due to the excessive water in Lužnice River, the protective levee of the Cep sand pit between Lužnice River and the sand pit was overflowed and subsequently destroyed. Thus, a considerable part of the Lužnice River stream was flowing to the area of the sand pit. The levee at the Pilař Weir was promptly cut through in order to lead the water away from the sand pit. Yet, the sand pit was inundated, as a result of which a gap of 50 m appeared in the village of Majdalena. A road and public utilities networks were destroyed. A house in Majdalena was destroyed and several others were seriously damaged.

Prior to the occurrence of the flood, the water level at the Novořecké splavy Weirs and Rožmberk pond had been usual. The water level of Rožmberk pond was at 426.01 m asl. The total available volume was ca 8.5 mil.m^3. During the first wave of the flood, the entire available area was filled and the water was partly discharged via the safety spillway. The flow of the New River was increased in order to reduce the flow into the Rožmberk Pond and to maintain the largest possible retention space for the transformation of the expected high flow. In addition, the pond's discharge was opened to the maximum safe level. Based on the development of the situation, screens were removed from a part of the safety spillway of the pond, the mobile closures at the Novořecké splavy Weirs were fully opened and the Novořecká Levee was cut through at km 1.000. Despite the aforesaid measures, virtually the entire Novořecká Levee was flooded. In the afternoon hours of 13 August 2002, a gap of 125 m between km 3.350 – 3.475 of the levee appeared, as a result of which the flow from the upper Lužnice River to Rožmberk pond became uncontrolled. Virtually the whole flood discharge (the culmination balance flow is estimated at 500 $m^3.s^{-1}$) fed the pond. The water level of the pond rose to 430.12 m asl, the volume of water exceeded 60 $mil.m^3$., i.e. was ten times higher than when the water level is at the optimum economy level. The progress of filling the pond is shown in fig. 2. The pond significantly contributed to the transformation of the flood wave on the Lužnice River.

Repairs of the burst levees were commenced already during the flood (Larsen walls and provisional barriers were constructed). The works continued after the water got lower. The basic sealing of the Novořecká Levee was achieved through a sheet pile screen. Piling sheets with a length of 5.5 to 8.0 m (according to the height of the levee) were used. The top of the sheets is at Q_{100} + 25 cm. Where this was impossible to do due to the growth of protected oak trees, a clay-cement sealing material was jet-injected. This involved a high-pressure application of a mixture from a borehole of ca 150 mm into the soil. The mixture was mixed with the surrounding soil. After hardening thereof, a column of compacted, low-penetration soil was produced. The minimum diameter of the column is 140 cm. The axis distance of the boreholes is 115 cm, thus the columns overlap, creating a consistent, virtually impenetrable wall. A clay-cement bar with a width of 1.4 m and height of 0.75 m was installed at the top of the levee. The upper side of the bars is at Q_{100} + 25 cm. The profile grade of the levee is set at Q_{100} + 50 cm, to which the levee was raised. The stability of the levee is secured with wooden supports hidden inside the levee. The top of the levee is provided with a macadam layer.

All the repairs were made, at considerable costs, quickly and properly thanks to a good cooperation between the management of the stream and building companies.

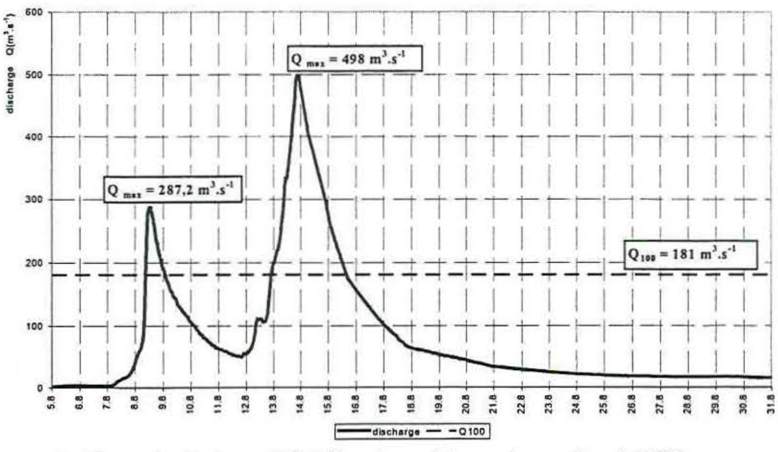

Figure 1: Upper Lužnice – Pilař limnigraphic station – flood 2002
Data source: Czech Hydrometeorological Institute

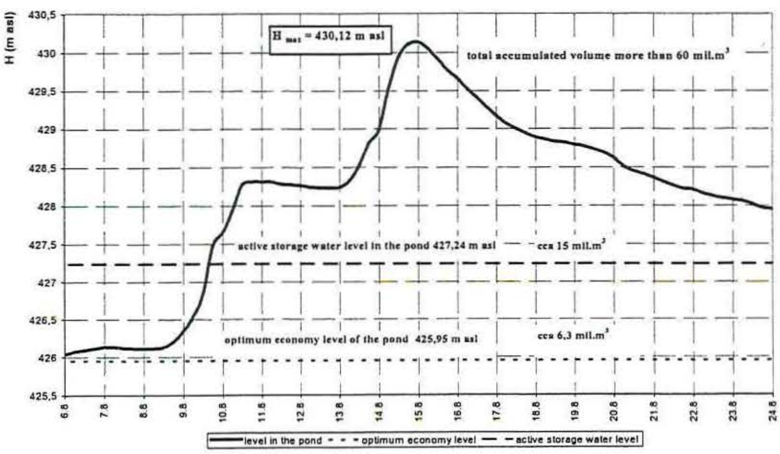

Figure 2: Progress of filling the Rožmberk Pond – flood 2002

Macrozoobenthos of the River Elbe in the course of reduction of external load

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In the course of reduction of external load (mainly oxygen-consuming and xenobiotic substances) macrobenthic biocoenosis of large rivers get the chance to recover. This process took place in the River Rhine after 1970 as well as in the River Elbe after 1990.

In 2000, 2003 and 2004 (10, 13 and 14 years, resp. after load reduction) we sampled macrozoobenthos with qualitative (kick-sampling) and quantitative methods (colonization baskets) in a 90 km reach of the upper part of the German stretch of River Elbe (Figure1). These data were compared with former investigations (one year before and 4 and 5 years, resp. after load reduction) to document the process of recovery of the macrozoobenthic community.

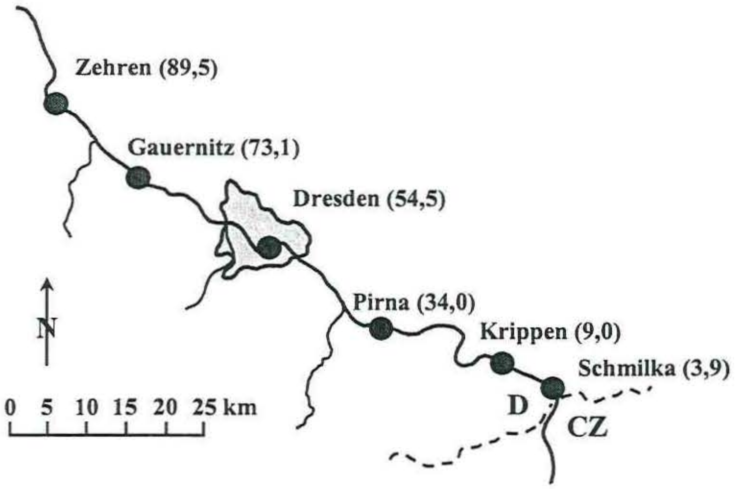

Figure 1: The upper part of the German stretch of River Elbe with sampling sites Schmilka, Krippen, Pirna, Dresden, Gauernitz and Zehren.

Our investigations demonstrate the development of a impoverished macrozoobenthic community to a complex food web with typical proportions of functional feeding groups, sensitive stenoxy- and rheobiontic taxa (*Oligoneuriella rhenana*, *Aphelocheirus aestivalis*) and representatives of large rivers (*Potamanthus luteus*, *Heptagenia flava*, *Unio pictorum*). Beyond this the invasive distribution of non-indigenous taxa (*Dikerogammarus villosus*, *Jaera istri*) show the dynamic process of recolonization. However typical potamobiontic species of Plecoptera (e.g. *Taeniopterygidae*, *Leuctra geniculata*), Ephemeroptera (*Ephoron virgo*) and Molluscs (*Neritidae*) were still absent.

The detected process of regeneration of the benthic community in River Elbe lasted about a decade and was considerably faster as documented for River Rhine (Figure 2). This shows that the period to establish a species rich biocoenosis takes much longer as quick-appearing improvements of water quality.

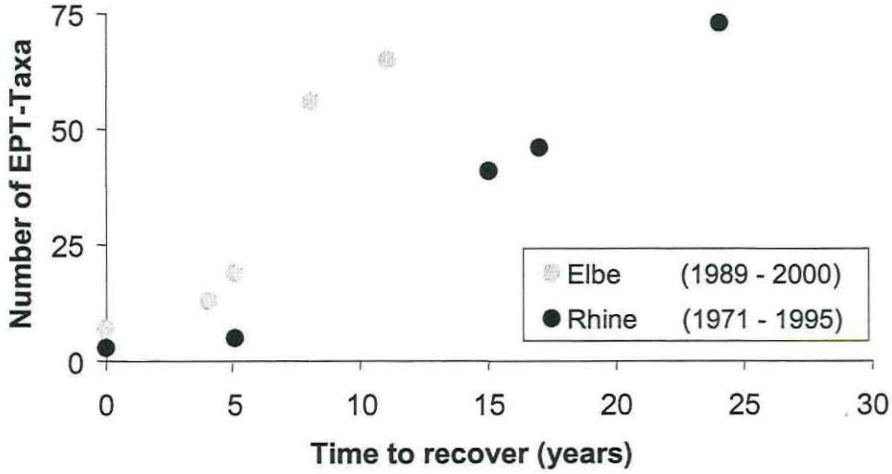

Figure 2: Course of regeneration documented for River Rhine and River Elbe on the basis of number of EPT-Taxa (Ephemeroptera, Plecoptera, Trichoptera).

River dangerous substances pollution and its trends in the last decade

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Morava River, presenting one of the three greatest Czech rivers, drains waters from the eastern part of the republics territory to the River Danube. Due to relatively low flows and high concentration of larger municipalities, processing and chemical industries as well as to agricultural activities negatively influencing its quality Morava River has been also ranked among the most polluted rivers within the mentioned area. Substantial political changes in 90^{ies} brought about significant improvement in the approach to nature protection that found reflection in limitation of water pollution discharges into rivers and subsequently as well as in the surface water quality enhancement.

Since 1992 national water protection project aiming at analysis and complex amelioration of waters and ecosystems status in the Morava River basin - Project Morava has been launched. In the part referring to surface waters qualitative status it has been oriented on dangerous substances monitoring and assessment in the most critical stretches of major watercourses downstream important sources of the pollution. Within the decade of the Project run not only actual results but also development trends were evaluated. At present monitored parameters cover spectrum of more than 120 dangerous substances (heavy metals, PCBs, OCP, PAH and VOC) measured in water, in sediment and in the indicative fish tissue samples.

In spite of the fact that the results from the first years of the project were not much promising it can be stated that all measured parameters fulfilled the requirements of the relevant EU Directive (76/464/EEC) and mostly also of the national legislative requirements. According to the new Governmental Decree 61/03 Coll. where for the major part of parameters more severe values are given only in the mercury content a few values are higher. The long-term trend of heavy metals content in the final Morava monitoring site upstream the border with Slovak Republic showed positive trend (Figure1). Also a cumulative indicator expressed as the ratio of three heavy metals (Hg, Pb, Cd) to their limit values. Indicator values under 1.0 express that the limit values have not been exceeded. Formerly high concentrations of PCBs as well as some values of VOC have not been approved in the last period. Only a few single values in some stretches mostly in the upper or middle part of the river overcame the given limits (Hg, Pb, tetrachlorethen, DDT). According to the results of the standing monitoring within the Project all the results were fully in compliance with the given limits.

Likewise, majority of heavy metals in measured sediments e.g. mercury, cadmium, and also PCBs and PAH demonstrate evident improvement within the monitored period. Nevertheless, the higher load of sediments by cadmium and lead is still outlasting in the major part of the river. Assessment using Igeo index indicates moderate up to higher load of the sediments – esp. in the lower parts of the river run. PCBs and PAH content is continuously overcoming background values while all other parameters are mostly bellow determination limits.

As a final link of accumulation of the micropollutants in the water environment the content of these matters in the fish mussel tissue has been monitored. Actual bioaccumulation of dangerous pollutants in the representative marker fish - chub (Leuciscus cephalus) from the age group of 3-5 years still indicate higher concentrations above the acceptable limit given by the national legislation in the upstream part of the Morava River. In the period of 1993-2002 all measured qualitative parameters excluding mercury content were fully in compliance with the Ministerial Decree regulating content of contaminants in consumables. The mercury content showed mostly evident decrease since 1995. Only in the upper stretch of the Morava River the higher average values were sometimes found while in the lower part decrease of the values has been indicated. As far as the trend of the average values in the lower part of its run it is generally positive. It is supposed that the major part of this pollution comes from the old loads spread within the basin. Further details will be given in the tables and pictures in the prepared poster.

The main results from this part of the Project summarized in the last synthesis report point out that the overall improving trend started in the Morava River basin at the end of the 90ies is continuing and the mercury content in the fish tissue (Figure2) as the most problematic task of the river basin is continually reducing.

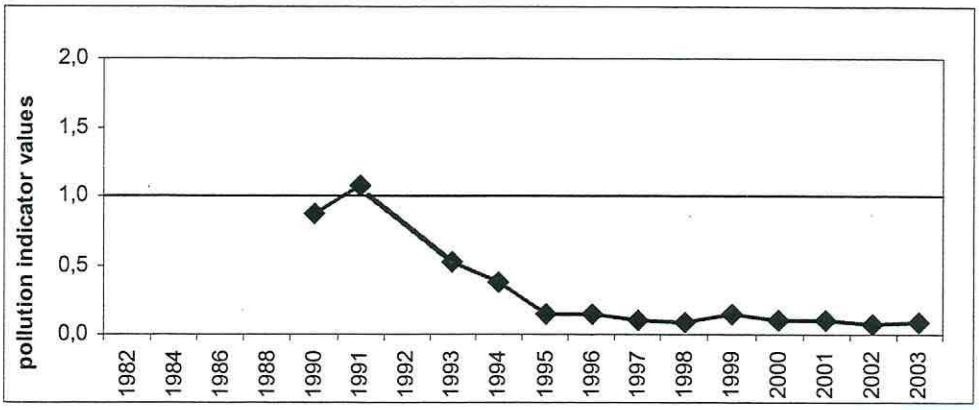

Figure 1: The heavy metals (Hg, Pb, Cd) pollution indicator trend
- final monitored site of the Morava River in CR (Lanzhot).

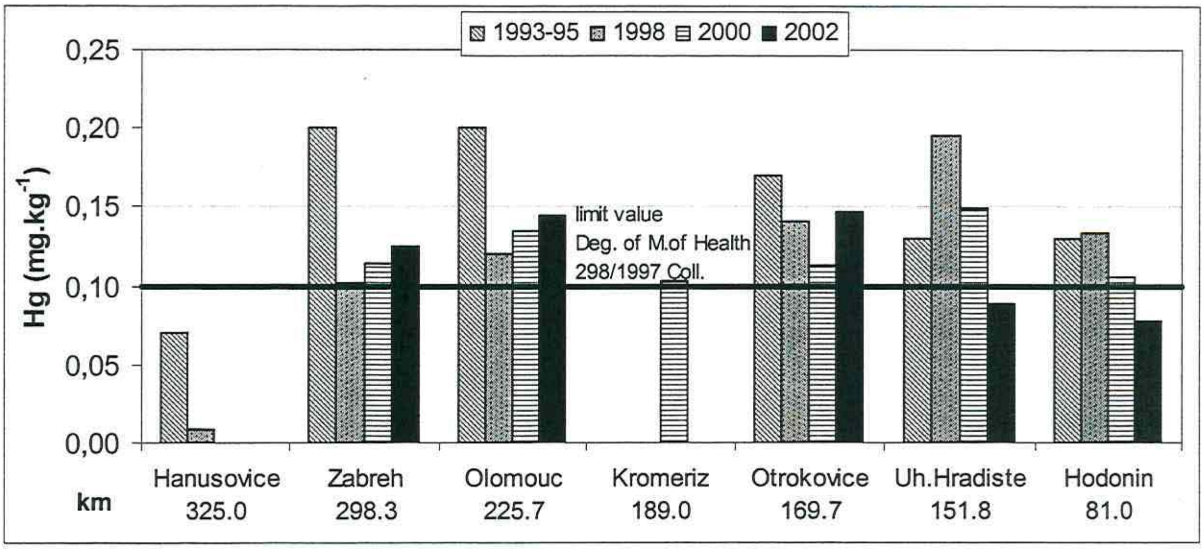

Figure 2: Average values of the mercury content in fish mussel tissues in the Morava River

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The flowing of nitrogen in a soligenous sloping mire in the German national park *Hochharz Mountains*

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The objective of the research was a quantification of water and nitrogen fluxes in the soligenous sloping *Ilsemoor* located in the spring area of the Ilse stream, German *Hochharz Mountains*, under the hypothesis of increased nitrogen inputs. N-fluxes were analyzed in order to determine the N retention in the mire and thus to come to conclusions about the effects of atmospheric N inputs on the moor ecosystem. N balancing based on the sampling of N inputs with consideration of different paths of surface water input, field and forest deposition as well as the quantification of the N output into flowing water. Field depositions were determined using two different methods: the bulk deposition method and the ^{15}N-isotope-dilution method (ITNI: Integral Total Nitrogen Input). The ITNI system registers the whole N input in a soil-plant system. Compared with the bulk deposition method, also the gaseous N input is considered and the direct N uptake by the plants (Böhme and Russow 2002). Inputs into forest stands were handled as bulk deposition. The N input with slope surface water was determined by measuring the discharge rate in situ and calculating the N concentration by sampling the surface water input points. N output from the moor catchment region into flowing water was continuously monitored by measurements of the discharge rate at a sampling weir with subsequent determination of the N concentration at the sampling point. In addition to this hydrochemical parameters of the moor water, soil physical and chemical parameters of the peat and the nutrient content of the above-ground biomass were determined. The sampling period extended over the hydrological years 2002 and 2003 and for the ITNI measuring system from 05.07.01 to 23.10.02.

In the hydrological year 2002, open field deposition with the recorded precipitation of 2106 mm was of 31 kg N ha^{-1} a^{-1}. In the hydrological year 2003, precipitation reached 1373 mm and thus was markedly lower. In that year, open field depositions amounted to 29 kg N ha^{-1} a^{-1}.

The atmogenous net-N input into the vessels determined by the ITNI measuring system has been demonstrated in Table 1.

Table 1: Results obtained by the ITNI-System AN: atmogenous N input

Pot	Dry matter g	N-content /Pot mg	AN_{netto} mg	AN_{netto} Plants (%)	AN_{netto} mg Pot^{-1} d^{-1}	AN_{netto} g ha^{-1} d^{-1}	AN_{netto} kg ha^{-1} a^{-1}
1	8.57	373.1	167.2	11.5	0.4	92.6	**33.8**
2	4.21	294.0	124.6	9.3	0.3	69.0	**25.2**
3	4.33	368.6	146.3	10.2	0.3	81.0	**29.6**

Since one pot (No. 4) has developed a very poor and thus neglectible plant growth, only the remaining three vessels were evaluated. It becomes clear that biomass production was generally poor due to the difficulties in plant cultivation and growth as a result of extreme weather conditions. For the period of one year, deposition rates of about 34, 25 and 30 kg N ha^{-1} were obtained. They yielded an average value (arithmetical mean) of about 30 kg N ha^{-1}

a^{-1}. The bulk deposition analysis showed an input of 27 kg N ha^{-1} a^{-1} for the same period. The small differences between both methods can be explained by a minimum biomass development in the ITNI test, which involved only a slight uptake of gaseous N by the plants from the atmosphere. The dependence of atmogenous N input on biomass production as observed in the measurements suggests, however, that stronger plant growth involves also increased N uptake and thus increased net N input to the system. More investigations are required to come to significant findings.

Compared with field deposition, forest deposition at the sampled site was clearly increased. In the hydrological year 2002 with a forest precipitation of 1814 mm, the N input into the stand amounted to 53 kg N ha^{-1} a^{-1}. In the hydrological year 2003, precipitation in the forest reached 960 mm carrying a deposition of 63 kg N ha^{-1} a^{-1}. The N levels in fog exceeded those in rain by the manifold and explain the much higher N inputs in the forest due to interception of fog by the stand.

The nitrogen output in runoff water was 17 kg N ha^{-1} a^{-1} in the hydrological year 2002 and 21 kg N ha^{-1} a^{-1} in the following year. Runoff quantities of 1676 mm (2002) and 1218 mm (2003) were recorded. Runoff rate and N loading in the water showed a highly significant relationship to the quantity of surface water input and its N loading on the slope at comparable N dynamics and composition of the N load. The reason are particularities in the hydrological regime of the *Ilsemoor* which is characterized by pronounced erosion gullies allowing surface water and precipitation flow off very fast.
The N retention of the mire in the sampling period has been demonstrated in Table 2.

Table 2: N retention of the mire in the hydrological years 2002 and 2003

	Hydrological years	
	2002	**2003**
N retention (%)		
NO_3-N	60,9	69,6
NH_4-N	97,9	95,5
N_{org}	52,9	-10,0
$\sum N_t$	**68,8**	**64,9**

High N retention rates of 69 % and 65 % were established in the *Ilsemoor* in 2002 and 2003 resp. in regard of the fact that N_2 outputs were not subject of balancing. Thus, the moor represents an N sink. Sorption of N in peat and uptake of nitrogen by plants are reasons for the high N retention in the mire. This shows also ascertained high N concentrations and close C/N ratios in peat and above-ground biomass. The highest retentions, i. e. 98 % in 2002 and 96 % in 2003, were recorded for ammonium, the lowest for organic N compounds (53 % in 2002 and –10 % in 2003).

The recorded N input in the sampling period is critical for the long term development of mires. Changes in the composition of plant populations in favour of N tolerant species are suspected.

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Data management in the Ad-hoc Flood project (Data of the Elbe flood in summer of 2002)

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1. Introduction

A large number of samples was collected in the flooded areas and analysed with different objectives during and after the flood of the century of the river Elbe (in August 2002). An Ad-hoc research project (BMBF FKZ: 0330492) was established to coordinate the activities and to collect the data of 14 participating institutions and co-operating authorities [Geller et al. 2004]. At the end the majority of all measured data is available in an uniform database.
This paper gives a short overview of the structure of the data, the amount of data collected in the last 2 years and access options exist.

2. Material and Methods

The data are physically stored in an Oracle database at the Environmental Research Centre (UFZ). The data model is based on the relational model that worked well for the lakes and rivers research departments in the UFZ [Büttner et al. 2002, www.ufz.de/gefo]. The data model was extended according to the requirements of the Ad-hoc flood project (Figure 1). Access from outside the UFZ was made possible by a Web interface (http://www.ufz.de/hochwasser). The user rights are strictly managed among the project partners involved and implemented in the database. The coordination office of the Ad-hoc-project imported the data supplied by the project partners into the database. Additionally, data of co-operating authorities were integrated into the database. The data can be queried by sample site (city, catchment area, river, etc), by time, by sample class (mud, sediment, sediment core, soil, pore water, surface water) and by group of elements (pesticides, nutrients, heavy metals,...).

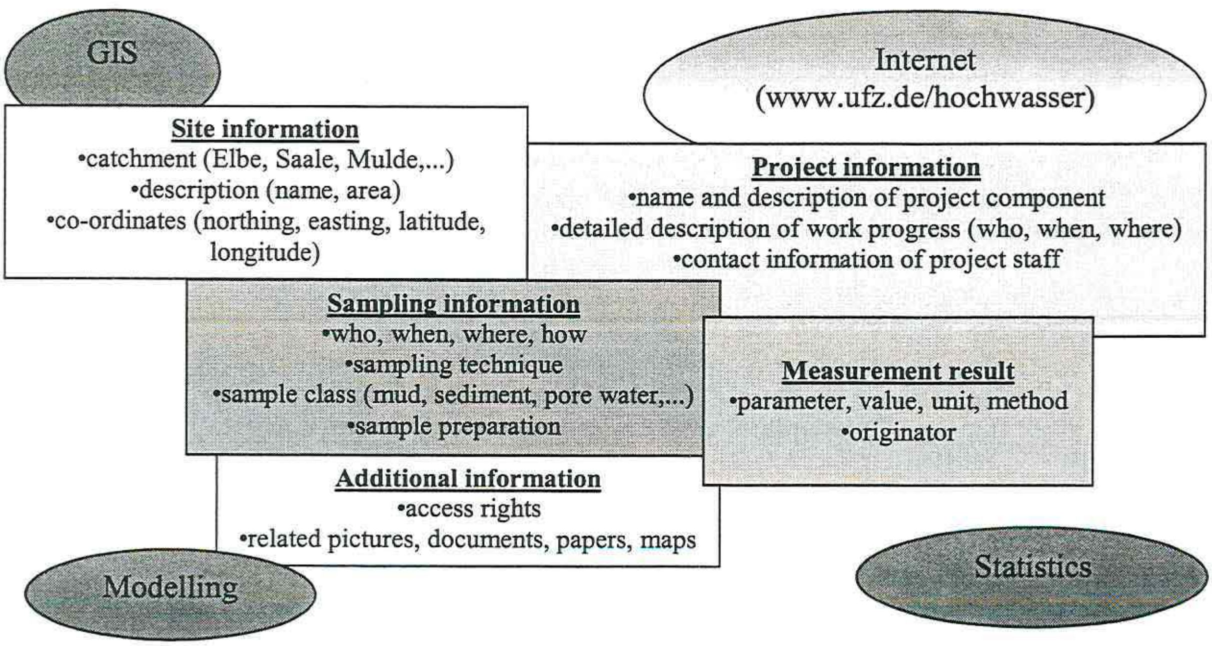

Figure 1: Schematic structure of Ad-hoc database

3. Results

At present approx. 1200 sampling sites within Czech Republic and Germany are registered along the rivers Elbe, Mulde and its tributaries. A connection to a GIS is possible using the saved coordinates. Approx. 50.000 single values were acquired from soil and mud samples, sediment cores as well as pore waters and surface waters during the period of November 2000 (for the purpose of comparison) until March 2003. These values come from approx. 1400 samplings. Altogether 274 different chemical parameters and soil characteristic values can be queried. Methodology and/or a partner for detail questions for sampling techniques and analytic are indicated for each individual value. Unfortunately information on sampling preparation are missing for a part of the values, but can be inquired from the respective person if necessary.

Table 1: Number of analyses and sample sites available in the Ad-hoc database

	analyses			sample sites		
	Before flood	After/during flood	total	Before flood	After/during flood	total
soil	9567	7008	16575	780	132	912
high flood sediments		13598	13598		166	166
surface water	3038	15844	18882	13	90	103
pore water		888	888		13	13
sediments bounded to suspended particulate matter	5493	3513	9006	13	12	25
sediment core	680	748	1428	5	1	6
total	18778	41599	53387	811	414	1225

It is still an open question, how the access of the interested public to the stored data should be organised in the future. At present, only members of the Ad-hoc flood project are allowed to look to the data. A regulation should be found soon.

4. Literature

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www.ufz.de/hochwasser –Ad-hoc Project Website

Use of benthic macroinvertebrates to assess the biological status of the lower Nysa Kłodzka river system (Poland)

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Biological assessment methods based on macroinvertebrates have been widely used as an integral part of river water quality monitoring in many countries. The present day method of determining river water quality in Poland is based mainly on the physical and chemical characteristics of water. Since 1999, an attempt has been made at elaboration of the biological method, in relation with European Union requirements, for assessing the quality of running water. Results from the investigation, which was carried out all over Poland, has led to adaptation of the Biological Monitoring Working Party score system (BMWP) which was originally developed in the U.K.

The purpose of this study is to present (1) an overall picture of the macroinvertebrate communities along the streams and rivers in the lower Nysa Kłodzka river system, (2) the biological water quality of the investigated rivers. The performance of the modified procedure, called Polish Biotic Index (PBI), in accurately classifying the investigated sites has been assessed through comparison with other biological methods, such as taxa richness, saprobic, diversity and biotic indices.

The research was carried out within the catchment area of the lower Nysa Kłodzka river of 729 km^2 , below two retention reservoirs of Otmuchów and Nysa (southern Poland). 26 sites were assigned along the Nysa Kłodzka river and its six tributaries. The study area included both pristine and modified streams and rivers affected by urban and agricultural effluents. The main water hazard in the investigated area is caused by an excessive inflow of biogenic compounds due to, first of all, agricultural usage of the catchment. Results of physical and chemical analyses of river water confirm the higher content of pollutants, such as phosphorus, phosphates and nitrites.

Sampling was carried out during spring, summer and autumn seasons in 2001-2002. The benthic macroinvertebrate community was collected by means of a Surber net. Then, the content of each sample was washed in the field by a sievie with the mesh size of 0.5 mm and preserved with 70% alcohol. Identification was made up to the species level when possible. A total of 156 samples were qualitatively and quantitatively analyzed. Several existing biological methods for water quality assessment were applied. These are: taxa richness index of Mergalef, diversity index of Shannon and Weaver (Washington, 1984), saprobic index in Friedrich's modification (Friedrich, 1990), Belgian Biotic Index (BBI) (De Pauw and Vanhooren, 1983), Biological Monitoring Working Party score system (BMWP) (Armitage et al., 1983) and Polish Biotic Index (PBI). Correlation among the saprobic, diversity and biotic indices were computed using the non parametric Spearman rank coefficient of correlation.

The analysis of the benthic community revealed the presence of numerous representatives of the following invertebrate groups: *Oligochaeta, Hirudinea, Crustacea, Ephemeroptera, Trichoptera, Odonata, Coleoptera, Heteroptera, Megaloptera, Diptera, Gastropoda* and *Bivalvia*. A total of 44 families were recorded from seven streams and rivers. However, the number of identified families varied between 8 and 22 among particular sites. The dominant taxon occurring in the majority of the investigated sites (14) were larvae of dipterans from the family of *Chironomidae* and the subdominant one were leeches *Erpobdellidae*. Whereas, among the remaining 12 sites, macroinvertebrates showed greater differentiation in the community structure and the most abundant taxa were caddies larvae belonging to the family of *Hydropsychidae* and *Limnephilidae*, mayflies *Baetidae*, dipterans *Simulidae*, crustaceans *Asellidae* and oligochaetes *Tubificidae*.

Changes in the number of recorded taxa among particular sites as well as presence or lack of organisms sensitive to pollution had a direct impact on the results obtained during the water quality assessment. Values of the PBI index varied from 27 to 93 scores which, according to Polish classification, corresponded with the range of the IV-II class of water quality. According to the PBI values, most of the analyzed river stretches revealed moderate level of water pollution (III class). Lower values (IV class) were registered mainly in case of the direct water exposure to the point-sources of pollution. Whereas, higher values (II class) were registered within the water-head area as well as along the river stretches displaying suitable conditions for the autopurification of rivers.

PBI values were correlated with the other biological indices examined, particularly with the BMWP (correlation coefficient 0.9430, $p<0.001$), BBI (0.8394, $p<0.001$), saprobic index (0.7888, $p<0.001$) and Mergalef's index (0.5158, $p=0.014$).

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Impact of low flow induced by extreme drought on phytoplankton dynamic in running waters

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Results of long - term investigation of phytoplankton assemblages and nutrient concentrations along the important rivers in the Czech Elbe watershead do not indicate nutrient limitation of phytoplankton growth. However, a marked difference of chlorophyll-a concentrations (phytoplankton biomass) was found among the years with the more or less similar levels of nutrient concentrations but characterised by different hydrological and meteorological conditions. Thus the development and periodicity of phytoplankton biomass along the streams depend rather on detention time of water (caused by flow rates) and climate conditions than on nutrient concentrations.

Seasonal development of phytoplankton biomass in climatically and hydrologically different years 2001 and 2003 is demonstrated on Fig.1. The results from phytoplankton monitoring at the Zelčín site on the Vltava River, near the confluence with the Elbe, are used for comparison. Basic meteorological and hydrological characteristics of the compared years are given in Tab.1. As concerns precipitation (on the area of the Czech Republic), the year 2001 was characterised by the high amount of precipitation as compared with the year 2003, when the mean value of precipitation amount from April - September reached only 75% of precipitation normal. This is also obvious from the comparison of month average precipitation amount with the precipitation normal (i.e.mean value of 1961-1990) at Fig. 2. Consequently, a significant difference in flow rates of compared years occurred as indicated by the ratio of the flow rate seasonal mean values 2001: 2003, which is 1: 0,37.

In 2003, hot and extremely dry weather during summer caused a relatively long period of high water temperature (above 20 °C - Fig.1), which resulted in very fast growth of phytoplankton, above all in the middle and downstream stretches of rivers.

Table1: Meteorological and hydrological characteristics of the compared years [Data on precipitation, air temperature and flow from database of the Czech Hydrometeorological Institute]

year	precipitation amount, CR		air temperature, CR °C		water temperature at Vltava-Zelčín °C		flow at Vltava-Zelčín m^3/s	
	mean III.-X. **mm**	% [1.]	mean III.-X.	deviation from normal	mean III.-X.	max. in III.-X.	mean III.-X	max. in III. -X.
2001	617	124	12,0	0,7	13,8	20,7	211	570
2003	370	75	12,8	1,3	17,0	24,5	77,5	231

[1.] mean precipitation amount as percentage of precipitation normal

The chlorophyll-a concentrations at the Zelčín site did not drop down below 100 μg/l during the period of April – September (Fig. 1) and seasonal mean (III. – X.) of chlorophyll-a reached the value of 112,4 μg/l. In 2001, only two values of the chlorophyll-a concentration were above 100 μg/l (in the spring period, Fig. 1) and the seasonal mean was only 55,7 μg/l.

High water temperature, as well as low flow rates and water level in 2003 lead also to the changes in the phytoplankton species composition. At the Zelčín site, the coccal cyanobacteria obviously dominated in the phytoplankton biomass during the summer months of this year whereas the species of chlorococcal algae prevailed in river phytoplankton in the years with higher flow rates.

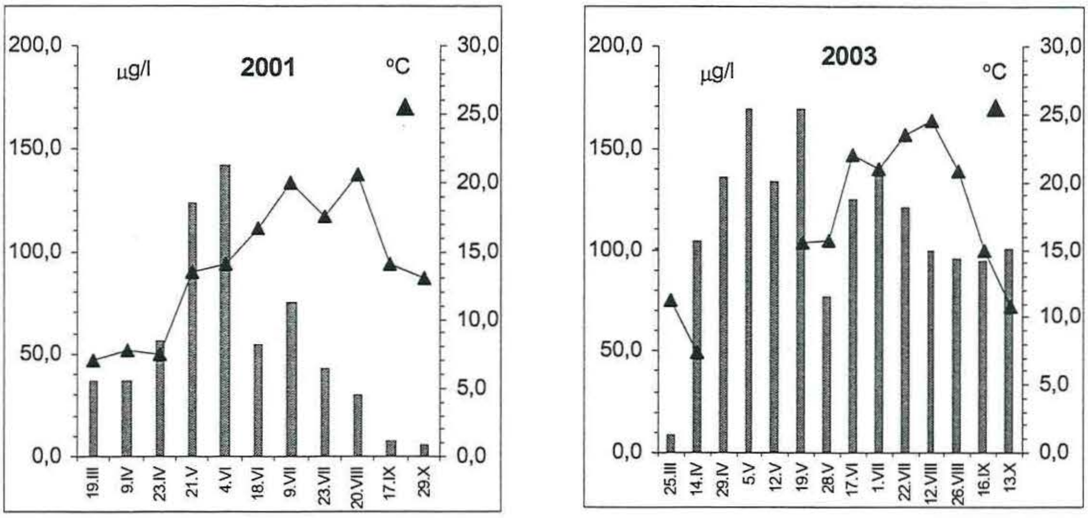

Figure1: Seasonal changes of chlorophyll-a concentration (μg/l) and water temperature (°C) at Zelčín site on the Vltava River

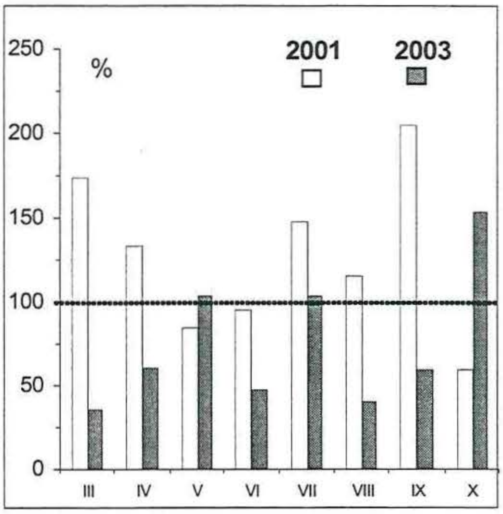

Figure 2: Month average precipitation amount (%) in 2001 and 2003 expressed as percentage of precipitation normal

Monitoring of selected Nitrogen and Phosphorous pesticides in the Czech part of the river Elbe basin

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Together with already traditionally monitored important group of triazine pesticides are analyzed other nitrogen and phosphorous pesticides in the laboratory of Povodí Labe, státní podnik. The occurence of these pesticides leads to involvement of these compounds into measuring programs. This is the question of herbicides: chloroacetanilides (acetochlor, alachlor, metolachlor, metazachlor), triazinones (hexazinone), uracils (lenacil), dinitroanilines (trifluralin, pendimethalin) and insecticides: thiophosphates (chlorpyrifos). They are introduced into the aquatic environment by agricultural application: chloroacetanilides (mode of action (m.a.): Inhibition of cell division, applied on (a.on): dicotyledonous weed and annual and perennial weed in potatoes, maize, onion, rape culture etc.), hexazinone (m.a.: inhibition of photosynthesis at photosystem II, a.on: annual and perennial weed in coniferous and wood species, lenacil: (m.a. as hexazinone, applied on annual weed in red beet and sugar beet culture), trifluralin and pendimethalin: (m.a.: microtubule assembly inhibition, applied mainly on monocotyledonous and dicotyledonous weed in vegetables culture, chlorpyrifos (an insecticide applied on wire-worms (lat. Elateridae larvae) in red beet and sugar beet culture, on aphids on vegetables and fruit, on Colorado potato beetle on potatoes, on spruce bark beetle in forestry, etc.

From historical point of view, MA-group of International Commission for the Elbe Protection (ICEP) initiated monitoring of seven triazines (atrazine, simazine, propazine, prometryne, terbutryne, terbuthylazine, sebuthylazine) in 1994. Laboratory Povodí Labe carried out sampling and measurement at six sampling sites on the Elbe (Labe: Valy, Lysá, Obříství, Děčín, Schmilka right and left bank) thirteenth times per year. In 1995 next compounds were added (desethylatrazine, lenacil and hexazinone) and next sampling sites on main Elbe tributaries (Jizera, Orlice, Chrudimka, Cidlina, Metuje, Upa) were included into measuring program of Povodí Labe. Chloracetanilides (alachlor, metolachlor and metazachlor) were regularly monitored at thirty-six sampling sites of the Czech Hydrometeorological Institute (CHI) and five sampling sites of Povodí Labe since 2003. Trifluralin and chlorpyrifos were analyzed at fourteen CHI's sampling sites, eight out of them on the Elbe River.

Analytical method is based on a simple extraction procedure (0,8 l of sample, 10 μl of surrogate solution (azobenzene, sebuthylazine-d_5), tetraboritane buffer (pH 8,5-9), approximately 20 g of sodium chloride and 60 ml of dichloromethane are added, thirty minutes of shaking. Dried extract is evaporated to 700 μl and 1 μl is injected into GC/MS. An Agilent (former Hewlett-Packard) 6890 gas chromatograph coupled with Agilent 5973 mass selective detector and autosampler was used for a gas chromatographic analysis. Separation was performed on a capillary column 30 m x 0,25 mm (ZB-5, 0,25 μm film thickness, Phenomenex) coupled with 5 m x 0.32 mm retention gap (J&W). Operating chromatographic conditions were following: oven temperature program: 60 °C, 2 min, 40 °C/min, 150 °C, 4 °C/min, 240 °C, 20 °C/min, 280 °C, 10 min, injector temperature 250 °C, transfer line temperature 280 °C, carrier gas (helium 99,9995 %), injection techniques: pulse splitless (250 kPa, 1 min), constant flow 0,9 ml/min. The mass selective detector operating conditions were: ion source temperature 230 °C, quadrupole temperature 105 °C, electron ionization energy 70 eV, selected ion monitoring mode. Values of m/z for compounds were following: acetochlor (146, 162), alachlor (160, 188), metolachlor (162, 238), metazachlor (211, 209), lenacil (153, 234), hexazinon (171, 252), trifluralin (306, 264), chlorpyrifos (197, 199), pendimethalin (252, 281). Limit of quantitation was 5 ng/l for all compounds.

Significant concentrations of chloracetanilides (tenth to hundredth ng/l) were found at some profiles after pesticide application this year. For example acetochlor: 50 ng/l at Cidlina Sány on 4 May, 200 ng/l at Chrudimka Nemošice on 4 May, 45 ng/l at Divoká Orlice Čestice on 11 May, 114 ng/l at Dědina Třebechovice on 11 May, 46 ng/l at Jizera Tuřice on 3 May. Metolachlor was found in the Elbe starting at profile Labe Němčice (see graf 1) and in the Orlice River and its tributaries (534 ng/l at Orlice Hradec Králové on 7 June 2004, 263 ng/l at Tichá Orlice Žďár on 8 June 2004, 141 ng/l at Orlice Nepasice on 7 June 2004).

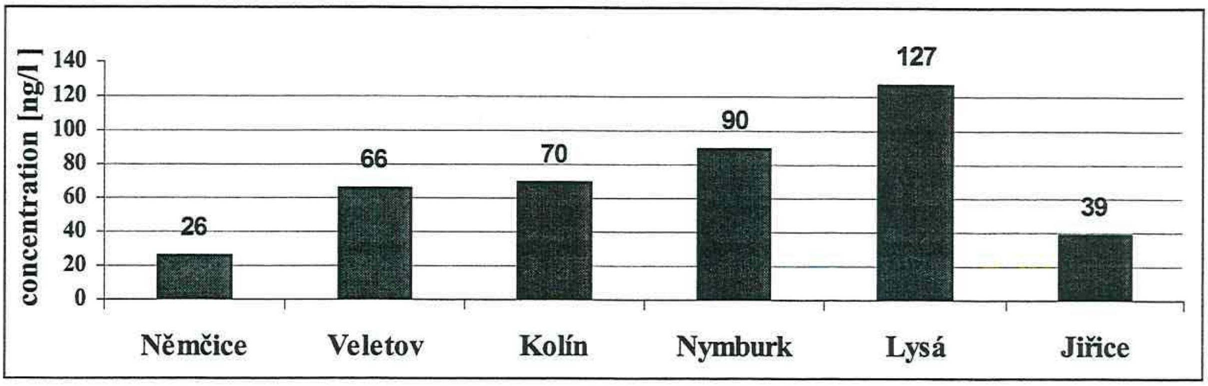

Figure 1: Longitudinal profile of Metolachlor concentrations [ng/l] in the Elbe in June, 2004.

Occurrence of alachlor and metazachlor was found at many profiles in the second part of the year 2003 (222 ng/l at Stěnava Otovice on 12 August). Hexazinon regularly appears in the Vrchlice reservoir (39 ng/l on 19 June, 131 ng/l on 15 March, 198 ng/l on 17 May 2004). Lenacil was found only at Cidlina Sány (766 ng/l on 9 June 2003, 70 ng/l on 14 July 2003). Chlorpyrifos was found as exeption (44 ng/l at Cidlina Sány on 19 May 2003, 12 ng/l at Lužická Nisa Hrádek on 20 May 2003, 23 ng/l at Jiřice Tuřice on 8 July 2003). Pendimethalin was found at concentration 49 ng/l at the profile Chrudimka Nemošice on 4 May 2004.

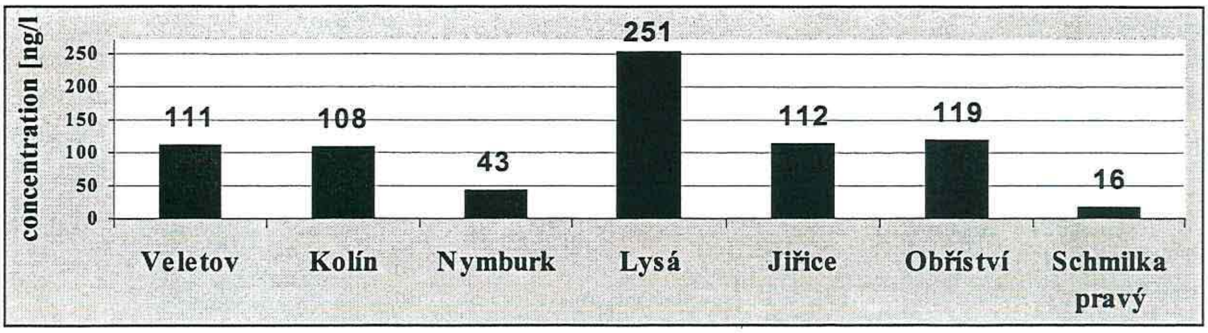

Figure 2: Longitudinal profile of Acetochlor concentrations [ng/l] in the Elbe in April, 2004.

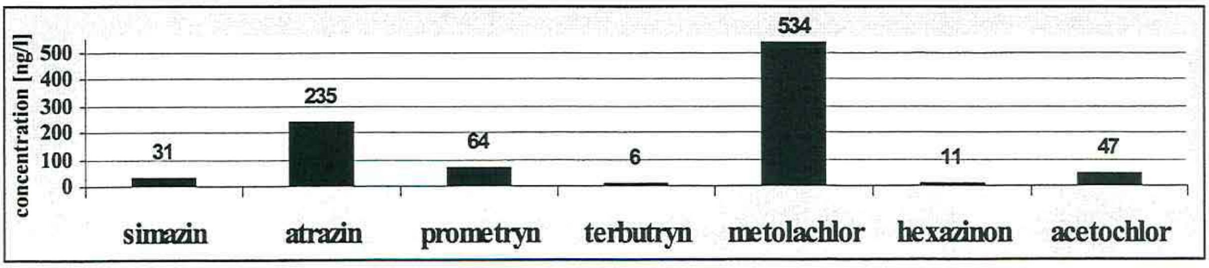

Figure 3: N, P- pesticides [ng/l]at the profile Orlice Hradec Králové on 7 June 2004

Effects of high frequency disturbance on a macrobenthic community (especially Chironomidae) in a lowland river

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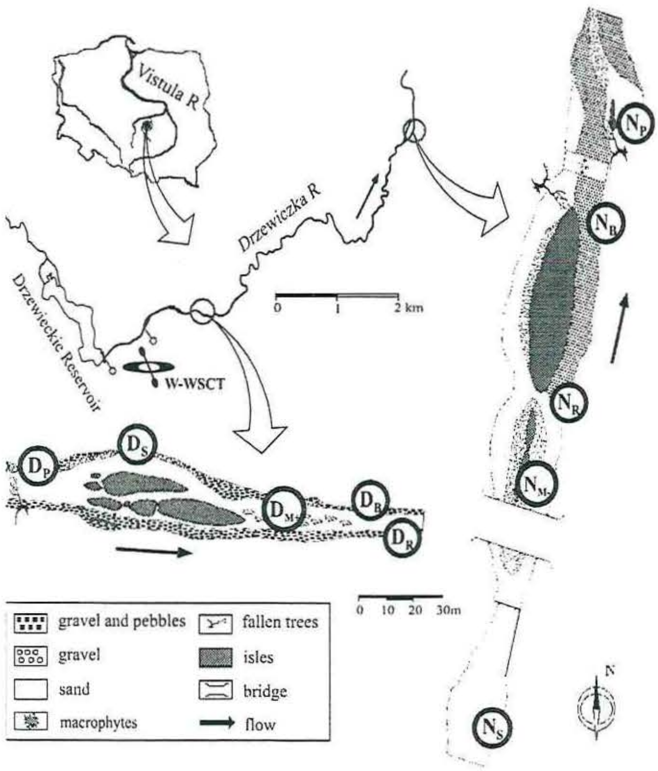

Figure 1: Map of the study area with marked habitats at disturbed (D_L) and undisturbed (N_L) sites.

Damming rivers exerts the strongest, usually negative, impact on the running water biota. Especially "peaking" hydropower dams are believed to seriously affect aquatic life because of extreme daily fluctuations in discharge. A dam producing a similar flow pattern is constructed in the fourth-order stream section of the Drzewiczka River and causes releases of water that abruptly start in the afternoon (3-5 times higher in volume than median), but last for 2-3 hours each. However, this pattern is necessitated by intensive training of canoeists along a wild-water slalom canoeing track (W-WSCT), which has been carried on for the recent 20 years. This track is located downstream of the dam reservoir. To estimate the impact of this type of discharge on the biocoenosis of the river's abiotic and biotic variables two sites were established: one just downstream of the wild-water track (close to the town of Drzewica - D); the other, the former's control, close to the village of Nieznamierowice - N, 10 km further downstream, in which no flow fluctuations were observed. Over an annual cycle at the disturbed site 5 dominant habitats were investigated; at each of these variables that have the greatest impact on the microdistribution of lotic macroinvertebrates, such as: current velocity, water depth, substratum composition, presence of macrophytes and availability of food resources (BPOM, TPOM, periphyton) were estimated (Matthaei and Townsend 2000). Similar habitats were found at the located nearby undisturbed river site (N); note that suitable habitats were found along a longer section of the river than that at D (Figure 1). Their selection was determined first of all by the hydraulic parameters and inorganic substrata. These habitats at both sites were: a pool habitat (D_P at disturbed site and N_P at undisturbed one), stagnant one (respectively D_S and N_S), macrophyte-dominated at site D one (D_{M+}; note that at site N the river bottom was not overgrown by submerged macrophytes so this was a similar habitat but due to no macrophytes was called N_{M-}), bank one (D_B and N_B) and riffle one (D_R and N_R). As you can see in Figure 2A the chosen habitats are not quite adequate ones.

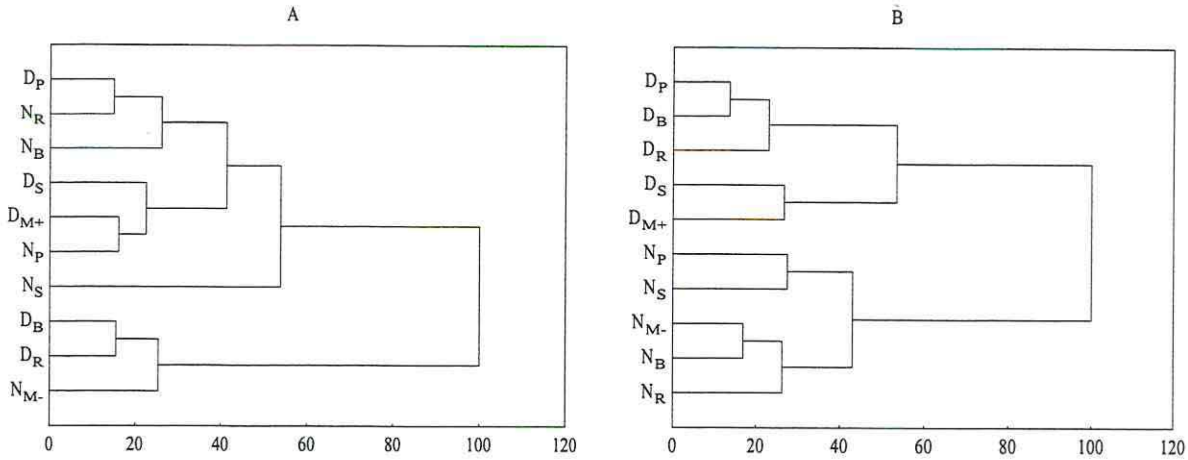

Figure 2: Cluster analysis demonstrating: A. separation distance between habitats based on environmental variables; and B. separation distance between habitats based on dominant taxa of macrobenthos.

In the impoundment site of the Drzewiczka River the flow fluctuation pattern produced a mosaic of bed patches with different stabilities (Szczerkowska et al. 2004). Accordingly to some papers streams having more physically – heterogeneous environments should contain a greater diversity of species than streams with less heterogeneous habitats (Minshall and Robinson 1998). Our data confirmed this statement. At the located nearby undisturbed river site macrobenthos was 2-4 times less abundant (Figures 2B, 3), similarly as its biodiversity (Tszydel, trichopteran materials in prep.) in comparison with the impoundment site. The highest abundance of zoobenthos was recorded at the high-flow area (D_R and D_B) and in the mid-river zone covered by submerged macrophytes (D_{M+}), whilst the lowest abundance was recorded at the depositional, stagnant habitat (D_S).

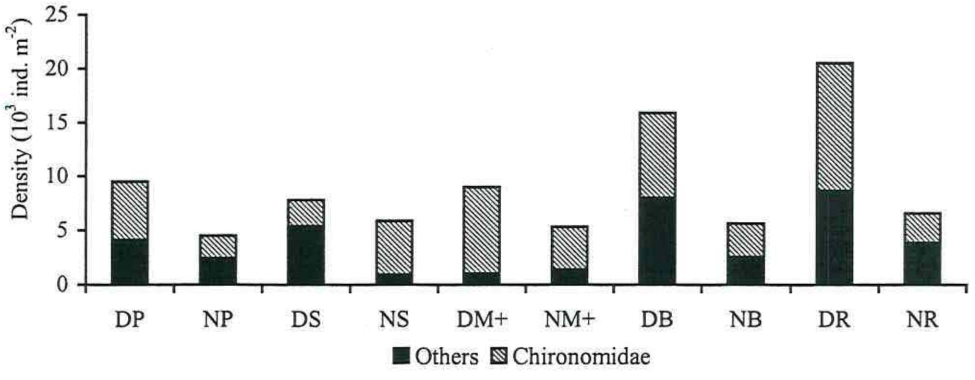

Figure 3: Mean annual density of macrobenthos at given habitats of the disturbed (D_L) and undisturbed (N_L) site of the Drzewiczka River.

Two groups dominated the macrobenthos at both sites: Chironomidae, at all habitats, and Oligochaeta, at the stagnant and macrophyte habitats; Trichoptera, Ephemeroptera and Simuliidae were the next most abundant among insects depending on the habitat. Although Chironomidae dominated at both river sites, they were represented by taxa belonging to various functional feeding groups; at D chironomids were mainly periphyton scrapers, Orthocladiinae, while at N Chironomini deposit feeders connected with either silty sediment or sand.

Rehabilitation of alluvial forests by dike replacement in the Middle Elbe floodplain

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The Elbe floodplain between the confluences of Mulde and Saale River is still characterised by sub natural flooding dynamics and typical floodplain habitats, e.g. large hardwood forests, riverine meadows and oxbow lakes. The alluvial hard wood forests are belonging to the largest floodplain forest complex in the Elbe river valley. The whole area is part of the „Riverine Landscape Middle Elbe" UNESCO Biosphere Reserve (Saxony-Anhalt). Nevertheless, in the last centuries large parts of the former floodplain have been cut off from the hydrological functioning through dike constructions and hydrological drainage networks. The idea behind these activities was primarily flood protection for habitation, but also the use of wide areas for intensive forestry and agricultural production. Not surprisingly these actions affected the ecological situation in these areas, leading to the loss of many essential habitats.

For a better protection of the current values and to improve existing deficits, a national conservation and rehabilitation project has been established. The main objective of the project is to protect and to rehabilitate the alluvial forests and typical species and habitats. The main actions are:

- acquisition of land (ca. 1000 ha) to avoid conflicts in management of valuable habitats
- re-establishment of natural hardwood forest
- reconnecting of flood channels
- the rehabilitation of a former floodplain forest by dike replacement (Steckby-Lödderitzer Forst - potential size ca. 600 ha of reconnected floodplain for retention – part of the regional Elbe floodwater protection program).

The project is funded by the federal Agency for Nature Conservation, carrier of the project is the WWF Germany. The project is running for 10 years (2001 to 2010). For the realisation a lot of stakeholders are involved in the project. A moderation process will guarantee their participation.
For the database establishment a first draft of the management plan is finished. The actual ecological situation can be described. The process to discuss and to realise different management measures has started.

The action 'dike replacement' has been tested in the European joint research project EVALUWET (European Valuation and Assessment tooLs supporting Wetland Ecosystem legislaTion) with a tool for decision support in wetlands. Here, a functional approach allows to analyse and to assess the status quo and different management option.
This paper presents an overview of the project and is giving first results. The action dike replacement is taken as an example to show the decision support tool for wetlands and is giving a first idea of the pros and cons of this measure for decisions making.

Ancient and recent woodland species composition in the floodplain forest in the Middle Elbe area

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1. Introduction

Today cover of European woodland includes many secondary stands of formerly open areas. Plants of stable habitats such as woodlands generally have seeds with low persistence in the seed bank. The most of typical woodland species use mechanisms of short-distance dispersal (myrmechores and autochores) and rarely colonize recent woodland.
In this study we compared the species composition between ancient and recent woodlands in our study area which is located in Saxony-Anhalt. Floodplain forest in the Middle Elbe area has continuously existed for at least 200 years. According to the definition of Wulf (1994) it is ancient woodland. Parts of the floodplain forest and their adjacent areas have been afforested during the last 100 years.

2. Methods

Vegetation sampling was carried out on randomly located plots with a size of 3 x 3 m in the year 2001. Because of the high amount of geophytes the vegetation cover was estimated in spring and summer with the Londo-scale. 50 plots of ancient and 108 plots of adjacent recent woodlands were studied.

We studies three types of species, namely typical woodland, indifferent and non-woodland species as defined by Ellenberg et al. (1992). Differences between types of species in ancient and recent parts of the woodlands were tested with the Mann-Whitney U-Test.
Dispersal mode according to Müller-Schneider (1986).

3. Results

3.1. Frequency of species

Compared to recent woodland, ancient woodland has a significant higher frequency of typical woodland species. Recent woodlands are characterised by a higher abundance of indifferent species and non-woodland species (Table 1).

Table 1: Frequency of species in ancient and recent woodland in floodplain forest in the Middle Elbe ($n_{\text{ancient woodland}} = 50$; $n_{\text{recent woodland}} = 108$) (Mann-Whitney U-Test).

types of species	Frequency of species in ancient woodland	Frequency of species in recent woodland	p-value
typical woodland species	24	21	p = 0.009
indifferente species	11	13	p = 0.310
non-woodland species	17	18	p = 0.313
	∑52	∑52	

Taking into account the abundance of species demonstrate typical woodland species are significant more abundant in ancient woodlands ($p < 0.031$). No differences show indifferent ($p = 0.834$) and non-woodland species ($p = 0.156$) between ancient and recent woodlands.

3.2. Dispersal mode

The hemerochores is by far the most frequent dispersal mode in both types of woodland with a proportion of about 47% in the ancient woodland and about 43% in recent woodland. Zochores are the second prominent group with values from 31% in both types of woodlands. In total, the group of species with low abilities of dispersal over long distances (myrmechores and autochores) reach values between 5 and 8% in ancient and recent woodlands. All types of dispersal modes don't show significant differences between both types of woodlands (Table 2).

Table 2: Proportion of different dispersal modes in ancient and recent woodlands.

Dispersal mode	ancient woodland	recent woodland	p-value
Anemochores	9.9 %	10.3 %	p = 0.430
Hemerochores	46.9 %	43.4 %	p = 0.345
Zoochores	31.1 %	31.5 %	p = 0.475
Hydrochores	0.1 %	0.5 %	p = 0.848
Myrmechores	5.1 %	6.4 %	p = 0.889
Autochores	6.9 %	7.9 %	p = 0.920

It seems that lack of differences between dispersal modes in ancient and recent woodlands can not explain the difference in species composition in these two types of woodland.

4. Discussion

The ancient and recent woodland in the Floodplain forest in the Middle Elbe show significant differences in frequency and abundance of typical woodland species but do not differences for indifferent, non-woodland species and dispersal mode. This conclusion is different by the recent study of Wulf (1997), Brunet and Oheimb (1998) and Kühn (2000).

Often important reason for the absence of typical woodland species in recent woodlands was meant to be linked to dispersal abilities (Brunet and Oheimb 1998). Most of the typical woodland species use myrmecochorous or autochorous dispersal mechanisms of short-distance dispersal. In this study was the proportion of species with myrmecochorous or autochorous dispersal very low. It seems that these types of dispersal mechanisms are very unsuitable in a floodplain forest; it dominated mechanisms with long-distance dispersal in both woodlands. The reason is the annual flooded. This situation is very unsuitable for example ants (Schlaghamersky 2003).

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Bonding capacity of suspended particulate matter for heavy metals and arsenic in the rivers Freiberger and Zwickauer Mulde

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1. Introduction

Besides the dissolved phase particulate matter is an active medium of transportation. Because of various processes of exchange (accumulation, dispersion) it represents a link between sediment and water. Owing to its high specific surface particulate matter as a mixture of mineral and organic particles is a very important adsorbing agent for heavy metals and other hazardous substances.

2. Results of analyses in major areas of contamination

Sampling at the beginning of the 1990's showed major areas of heavy metal and arsenic contamination (Beuge et al. 1994). At the entrances and the exits of following river sections traps for particulate matter were installed after flood 2002 and accumulated suspended particulate matter was investigated monthly:

- Freiberger Mulde, mining region Freiberg: points Berthelsdorf and Halsbrücke
- Zwickauer Mulde, mining region Aue-Schlema: points Albernau and Hartenstein
- Zwickauer Mulde, uranium processing region Crossen: points Zwickau and Glauchau.

After sampling, wet sieving (fraction < 20 µm), drying, and extraction with aqua regia according to DIN 38414 S7 samples were analyzed (heavy metals and arsenic) by means of ICP-AES, ICP-MS, and Hydride-AAS respectively.

The following enrichment factors (means) were founded in the particulate matter of Freiberger Mulde river during passage of the metal mining and smelting region of Freiberg (section Berthelsdorf – Halsbrücke): Ag (67), Sb (44), Sn (23), Zn (18), Pb (17), As (17), Cd (13), Cu (12), Hg (10), Tl (8), Co (3), Ba (3), and Mn (2). The enrichment factors in particulate matter during passage of section Albernau up to Hartenstein (Zwickauer Mulde) are substantially smaller: Ni (6), Cu, As, Sb, Hg, U, Cr, Cd, and Co (2 – 3). In the section Zwickau up to Glauchau (Zwickauer Mulde) the element U was enriched by a factor of 1.1.

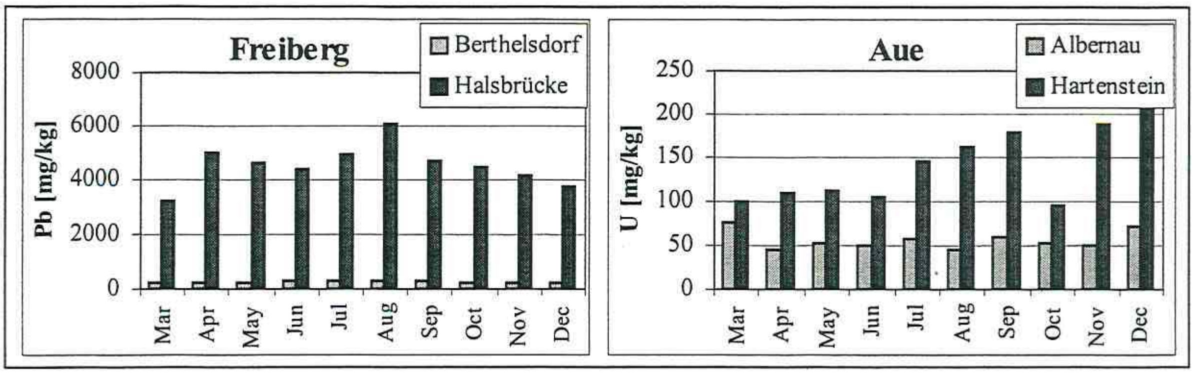

Figure 1: Temporal development (2003) of lead contents in particulate matter (< 20 µm) in the major area of contamination Freiberg, uranium contents in the major area of contamination Aue.

3. Experiments for determination of bonding capacity of heavy metals to particulate matter

An evaluation of the enrichment factors (entrance/exit) shows particulate matter to accumulate and transport large amounts of heavy metals. For the sampling site Halsbrücke/Freiberger Mulde laboratory experiments on the bonding capacity of particulate matter for heavy metals were carried out. With respect to the natural conditions of the river Mulde the content of particulate matter in test solutions was adjusted to 5 mg/l. The elements As, Cd, Cu, Cr, Ni, Pb, U, and Zn were investigated at first in single element tests with concentrations of 1 mg/l. Change of pH were simulated between 5.0 to 8.0. The experiments show the elements U, Cu, Cr, and Pb are bonded to particulate matter dependent on pH with variable strength. The elements Cd, Ni, Zn and As stayed almost completely dissolved. Addition of several elements in one step leads to concurrent reactions between them as well as hydrolysis and precipitation.

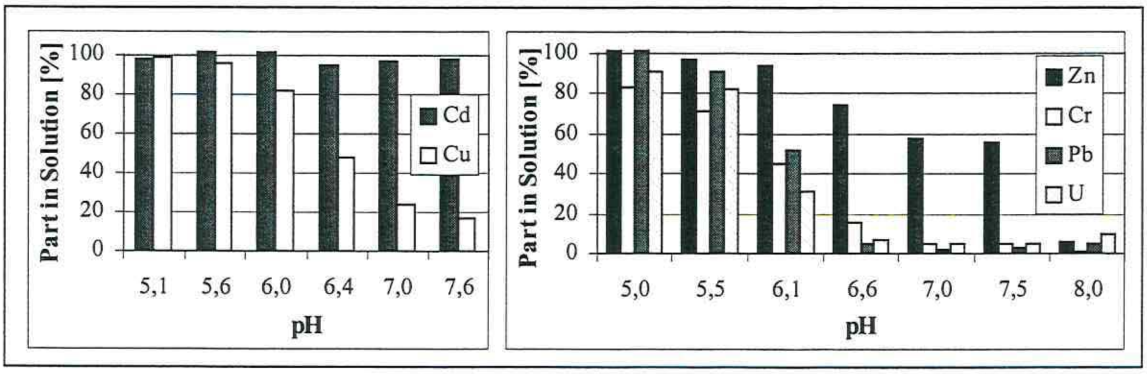

Figure 2: Dependence of remaining part of elements in solution as a function of pH.

4. Experiments for determination of preferred bonding forms

To determine the preferred bonding forms of the elements to the particular matter the method of sequential extraction of original and spiked samples according to Salomons and Förstner (1984) was applied. Particulate matter from the point Berthelsdorf/Freiberger Mulde spiked with As, Ni, Cd, Cu, Pb and Zn. The elements added to these synthetic mixing were bonded between 72 to 98 %. In the original sample the elements Cd and Zn were mainly found in the exchangeable fraction, As, Cu, and Pb to a large amount in the moderately reducible fraction and Ni in the residual fraction. In the spiked sample the elements Cd, Ni, Zn, and Cu were found almost complete in the exchangeable fraction. Pb and As were found to 30 % in the carbonate fraction, As additionally to 30 % in the moderately reducible fraction.

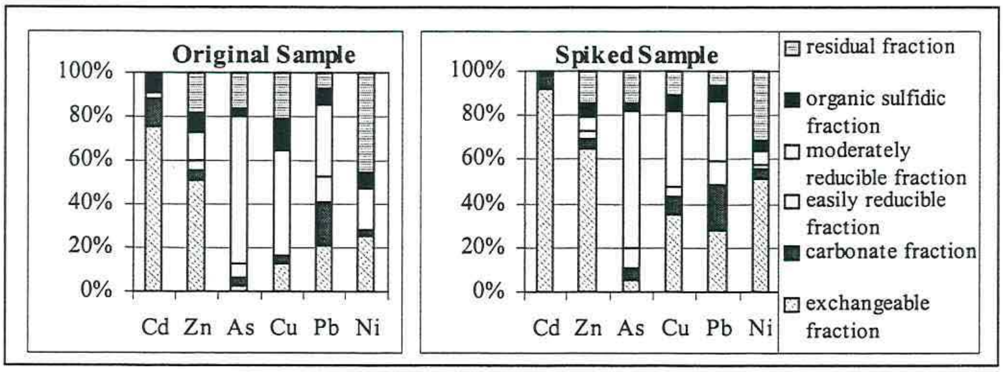

Figure 3: Percentage of preferred bonding forms after the sequential extraction.

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Integrated water resource management of the Mesta-Nestos transboundary river basin (Bulgaria-Greece)

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The Mesta-Nestos watershed difines a transboundary water basin overlaying both Bulgaria and Greece. The headwaters originate in the Bulgarian Mountains of Rila, Pirin and Rhodopes. They are characterized by an abundant precipitation induced flow out of these natural water towers (tab. 1). High mountains vegetation in the upper ranges contrast with intra-mountain basins and valleys with steppes and cultivated fields. Down river, passing the boundary with Greece, more typical Mediterranean climatic conditions regulate the runoff regime of the Nestos river. Towards its end the stream is flowing through a delta into the Aegean Sea while defining the boundary between the Western Macedonia and Thrace regions.

Table 1: short characteristic of Mesta-Nestos watershed (6.280 km² incl. Dospat river)

	Mesta (Bulgaria)	Nestos (Greece)
length of the river	128 km	102 km
average annual rainfall	850 mm	700 mm
population in basin	135.000	42.000
average per capita income	1.800 €/y	9.400 €/y

The Mesta-Nestos river is used for irrigation, domestic use, energy production, fishery, tourism and waste disposal. Land use conflicts in this water scarce region cover a wide spectrum of activities (fig. 1). Nevertheless, the Mesta-Nestos river and its wetlands is more natural and in a better state than many found in other parts of Europe, and may have less difficulty than expected in complying with the EU requirements, new standards and Water Framework Directive. Cross-border cooperation between Greece and Bulgaria has become relatively developed since 1990 with the help of INTERREG, Euroregion, PHARE and other EU programs (Bournaski and Ivanov 2003). For instance a fully automated gauging station with continuous sampling has been recently completed in the Northern part of the Mesta basin with international support. It collects data on accidental pollution and warn of possible transboundary pollution as a part of EUROWATERNET. In 1992 Bulgaria signed and ratified the Helsinki Convention for protection of transboundary water flows and international lakes. Greece ratified it and is in force since 1996. The two governments signed an agreement for managing the watershed end of 1995. This specifies among other, that Greece will have not less than 29% of the water in the Mesta.

The catchment administrative diversity is an obstacle to the spatial integration throughout the basin of significant parameters which affect surface and groundwater, such as geology, pedology, agriculture, land use, etc. Remote sensing by satellite offers opportunity to survey in a uniform fashion such a multinational area (e.g. CORINE LandCover database). Surface-groundwater coupled models of watersheds need to be integrated with a wide variety of tools simulating the meteorological, soils and farming inputs, among others. Due to its progressive grid system, the MODCOU hydrological model is well suited to such schemes, especially in the Mesta-Nestos region. It is used to evaluate the annual discharge of fresh water entering Greek territory.

Special measures of the water quality have been done in the upper basin (Grunewald et al. 2003). Results will be illustrated by the example of the environmental situation in the alpine region of the Pirin National Park as well as in the Basin of Razlog with a stronger anthropogenic impact and pollution around a former uranium mine near the village of Elešnica. The analysis performed in the upper mountain areas indicates relatively low background pollution. Settlements, industrial areas and extensive agricultural land use at the bottom of the mountain slopes (e.g. Valley of Razlog) induce higher matter contents in the runoff. But the self-purification process in the river network buffers this inputs as shown by bio-ecological water investigations. Although the Elešnica uranium mining plant and tailings induce radioactive traces in the runoff water with decade median concentrations which are below the Bulgarian standard limits, the mine dumps and tailings are still a potential environmental hazard and the impact on neighbouring ecosystems must be monitored.

The social and economic development of this transboundary region is a recently set priority for the future. It will mean an increase in water usage and more stress for the water resources if predicted global climate change regional impacts are verified. A problem focused management of the catchment area as a whole is needed for the future. Water professional need a better understanding of the broader social, economic and political context, while politicians need to be better informed about water resource issues.

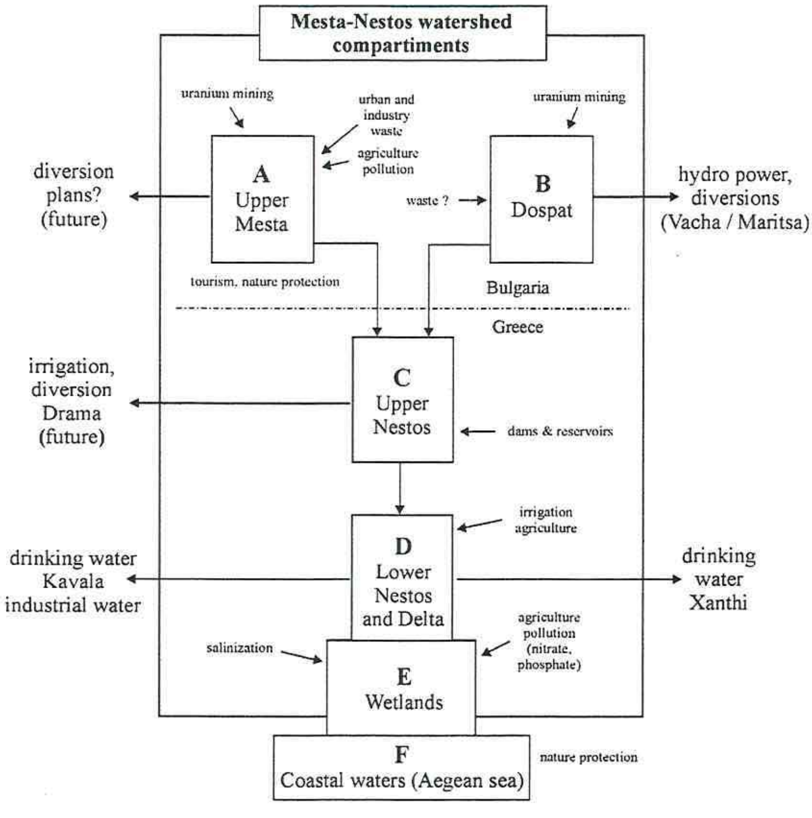

Figure 1: human pressures and ecological risks in sub-catchments of Mesta-Nestos river system

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Complex monitoring of water quality in the border part of the Labe River on the territory of the Czech Republic

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1. Introduction

The closing monitoring of water quality on the stream of the Labe on the territory of the Czech Republic (CR) is profile Děčín - Hřensko. From 1963 it is a part of the state network of water quality monitoring. On the basis of new knowledge and information about the occurrence and influence of polluting substances on water ecosystems and also in agreement with requirements of the EU in the area of water protection, from 1999 the monitoring of surface water quality here was widened by the monitoring of new matrices, namely suspended solids, sediments and biota. The profile is a part of the state-wide network of Complex monitoring of water quality on streams with widened monitoring of the chemical state from the point of view of the presence of dangerous and priority dangerous substances in the sense of Directive of the Council 76/464/EEC and Directive 2000/60/EC. The aim of the contribution is to show the differences in distribution, accumulation and transport of monitored substances in the individual matrices of the aquatic system, and thereby document the significance of monitoring of contents of pollutants in the quoted matrices for the gaining of complex information about the pollution of the water environment. For the information about quantitative parameters of pollution transported to neighbouring states, the balance of the yearly transport of pollutants in water and in suspended solids is quoted.

2. Method

Methods of sample collection and chemical analyses are based on the EU directives, international norms ISO, CSN and recommendations of the WMO, and are methods accepted for CHMI monitoring (Rieder et al., 1999). The frequency of monitoring of contents of heavy metals, metalloids and specific organic substances in sediments is 2 times a year in spring and autumn. In the case of suspended solids, point samples are collected once a month for the determination of heavy metals and metalloids contents, and 4 times a year samples are separated in a flow-through centrifuge for the determination of both heavy metals and specific organic substances. The accumulation of pollutants in water organisms is monitored 1 to 2 times a year during the vegetation period. The evaluation of the loading of the individual matrices was made in the case of water by classification according to CSN 75 7221 – Classification of quality of surface waters, in the case of suspended solids and sediments according to Methodical directive of the Ministry of Environment (ME) from 1996 "Criteria of pollution of soil and groundwater". At the same time, a comparison was made with the goal intentions of the MKOL. For the biological matrix, with the exception of fish, criteria are not stated.

3. Selection of evaluated substances

The selection of substances for the evaluation was made according to the following criteria:

- priority dangerous matter according to Appendix X of EU directive (WFD)
- relevant matter for the territory of CR according to procedure COMMPS
  - relevance of matter for solid matrix according to Log_{Kow}, $K_{susp.sed\text{-}water}$, a<MS (under the limit of detection) (Hypr, Halířová, Beránková 2003)

- substances monitored in the biota matrix

4. Conclusion

From the mutual evaluation of occurrence of selected heavy metals, metaloids and specific organic substances in the monitored matrices for the period of 1999-2003, from the analyses of the main components and from cluster analysis these conclusions follow:

- there are significant differences between individual matrices in the contents of the monitored substances
- metals are generally better identifiable in the suspended solids and sediments matrix, where, as opposed to in water, they always occur in measurable quantities
suspended solids show larger contents of monitored substances than do sediments
- specific organic substances, especially indicator polymers PCB and chlorinated pesticides accumulate more in the biota matrix (according to the cluster analysis especially in the group where Dreissena Herpobdella, Hydropsychidae and Leuciscus cephalus).
- growths in the cluster analysis joined into the cluster of sampled sediments and suspended solids. They show medium to high values of both As, Pb, Cd and p,p-DDE, PCB 101, PCB 138, PCB 153 and PCB 180.
- higher contents of metals (As, Pb, Cd) are bonded to the matrix of suspended solids and sediments than to the biota matrix.
- loading of individual matrices is in most cases at the most at the level of slight anthropogennous pollution, only in the suspended solids are there isolated cases of exceedance of of risk pollution of the contents of As, Ni, Pb, Zn and hexachlorbenzene, and limits of increased pollution for Hg, Cd and benzo(a)pyrene.
- In solid matrices, only the contents of Cr, in suspended solids also Pb and hexachlorbenzene satisfy the goal intentions of MKOL. The limits slightly exceede the contents of Cu and Ni. Many times higher contents were though recorded for Cd (2x), Hg (2x) and Zn (up to 4x) in both matrices. In the contents of As, the value of the median of suspended solids in 2003 is satisfactory, and on the other hand in sediments a slight worsening over the limit occurred. In the water phase, the more stringent limits for aquatic communities are satisfied only by Cr, TOL, chlorbenzenes and NTA. In fish, the hygienic limit for Hg is being continually exceeded.
- by comparing the yearly transport of substances in water and in suspended solids we find, that the transported amounts of dangerous substances bonded to suspended solids are usually comparable order-wise. For Cd and Pb, their ratio transported in the suspended solids is many times higher. Usually quoted release of dangerous substances only in water is non-representative and significantly underestimating the overall transport of substances in water environment. This information is best supplemented by evaluation of matter transport in suspended solids.

The evaluation of the loading of the water ecosystem only on the basis of data from point samples of water often does not afford an objective information about the overall quality of surface water. Only a complex approach to monitoring enables the reliable control of the influence of antropogenous contamination on the river environment and its ecosystem, and the control of the effectivity of programs of measures, accepted within the framework of lowering and gradual elimination of dangerous substances in the water environment, as required by EU.

5. Literature

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Natural background of radium radioisotopes in the river bottom sediments of Czechia and their radioactive contamination due to uranium industry

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1. Introduction

In the Czech region, the uranium mining was extensive, therefore, the monitoring of uranium mine water and milling wastewater impact to the surface water quality has a long tradition (Hanslík et al. 2002). In 1999, the systematic monitoring of river bottom sediments has been started as a part of a Czech Hydrometeorological Institute (CHMI) program (Hanslík et al. 2002). This monitoring also includes gamaspectrometric analysis and its goal is gaining more detailed knowledge of natural radionuclides background and of anthropogenic influence assessment possibilities.

2. Methods

Within this CHMI monitoring, in 1999, 22 samples of river bottom sediments were taken by state enterprises Povodí. Since the year 2000, the samples have been taken at 44 sampling sites twice a year. These sampling sites cover the entire Czech Republic region. The samples were homogenized immediately; their grain size was lower than 2 mm.

Further, the samples were processed at the radiological laboratory of T. G. Masaryk Water Research Institute. The gamaspectrometric measurement was performed at CANBERRA-PACARD instrument with semiconductor germanium detector. The results were given in Bq/kg of dry matter. The minimum detectable activities were about 2 Bq/kg for radium-226 and radium-228 in sediments at the significance level 95 %. For further assessment, especially the radium-226 and radium-228 concentrations were used.

3. Results and discussion

Annual average, minimum and maximum concentrations of radium-226 and radium-228, measured in the period 1999-2003, are shown in the 0. The maximum values of radium-226 concentrations correspond with profiles, evidently contaminated by uranium industry. Radium-226 gets into the water environment from uranium mining and milling. On the other hand, radium-228 corresponds with the natural background in water streams. Contamination by this radionuclide is very improbable because in the region of the Czech Republic, the thorium ores are not mined.

Table 1: Annual average, minimum and maximum concentrations of radium-226 and radium-228 in the river bottom sediments in the period 1999-2003.

River bottom sediments		1999	2000	2001	2002	2003
$a(^{226}Ra)$ [Bq/kg]	Average	68,6	77,9	70,7	66,0	67,8
	Minimum	23,7	20,4	16,3	20,9	17,9
	Maximum	381,3	1374,9	584,7	427,2	291,5
$a(^{228}Ra)$ [Bq/kg]	Average	52,6	44,1	49,7	52,6	53,4
	Minimum	19,0	20,1	15,5	20,1	17,6
	Maximum	211,3	114,6	126,6	133,5	127,2

It turned out that the radium-226 and radium-228 concentrations ratio is more convenient to assess the level of radium-226 contamination than only the radium-226 concentration itself. The radium-226 and radium-228 concentrations ratio approximates to one in natural samples that have not been influenced by the uranium industry. Conversely, in the areas of the uranium mining and milling, the ratio values rate far higher due to higher radium-226 concentrations. Based on this hypothesis, in the Water Research Institute, the sediment purity classification was suggested. The sediments, sampled in the monitored profiles during the period 1999-2003, were classified into the radium-226 contamination classes (see 0). Most of the profiles were classified in the first class; they were not contaminated. However, some of the monitored profiles were classified as contaminated, strongly or even very strongly contaminated. These profiles are especially at the rivers of Ohře and Ploučnice, where the uranium industry contamination is obvious.

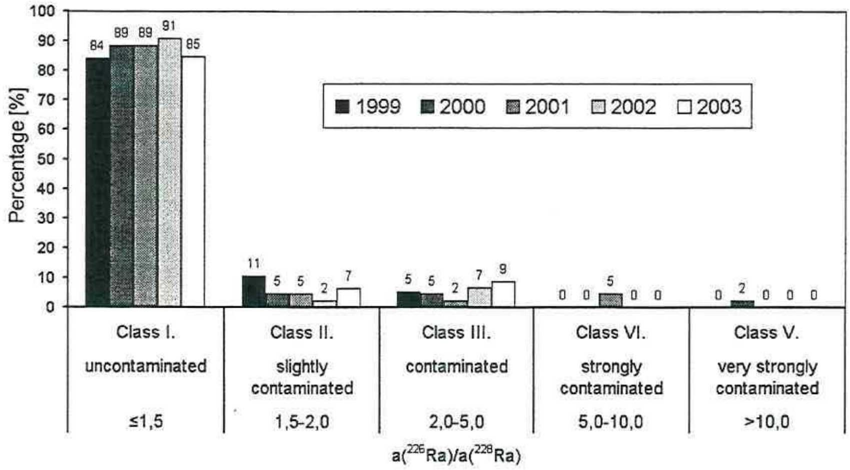

Figure 1: The river bottom sediments classification into the radium-226 contamination classes I - V based on the radium-226 and radium-228 concentrations ratio.

The data, gained in the monitoring, were also used to evaluate natural background concentrations of radium-226 and radium-228 in the Czech Republic. For the radium-226 background evaluation, only the data from the I. class (not contaminated) profiles were included into the evaluation. For radium-226, the average value of the natural background concentration was 48,2 Bq/kg and for radium-228 it was 50,5 Bq/kg (all profiles included). These values of the natural background concentrations correspond with the natural ratio of both radionuclides, which is approximately one in the Czech Republic region.

4. Conclusions

Within the CMI monitoring, the concentrations of natural radionuclides radium-226 and radium-228 were monitored in the river bottom sediments. The natural background of these radionuclides and human activity influence to the water environment were evaluated. It turned out, that the sediments are very good indicators of radioactive contamination, including the old loads, especially the radium-226 contamination due to former uranium mining and milling. The radium-226 contamination rate can be conveniently assessed according to the radium-226 and radium-228 concentrations ratio.

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Assessment of riparian stands

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1. Introduction

Riparian stands are dendrocoenoses of natural or man-made origin and are ecologically and functionally connected with a watercourse or reservoir. The following functions of riparian stands are deemed to be of the greatest importance: ecological function; climatic function; water management function that above all includes the shading function (control of overgrowth and of sediments accumulation); filtration function and connected stands' influence on the water quality in the stream; erosion control function (control of undesirable effects of water current); biological function; aesthetic and landscape forming function; health and recreation issues function; and, on a reduced scale, also the production function. The above-mentioned functions can be best carried out by original stands or restored stands whose vegetation species and their spacing closely correspond to stands that would grow in the locality by nature. The riparian stands care should thus include only such interventions that are aimed at removing deficiencies and at strengthening the functionality and natural characteristics of riparian stands.

2. Assessment methodology

To prepare a suitable restoration and care plan for the riparian stands, it is first necessary to evaluate the stands' existing condition. In the Czech Republic, there is no unified methodology to assess the riparian stands condition. Based on literary background material and experience, Povodi Labe, statni podnik prepared own riparian stands assessment process methodology.

The methodology evaluates the existing state of riparian stands in respect to the watercourse characteristics and the following is studied: stream channel (natural, regulated, lined, man-made), watercourse bottom (boulder, rock, gravel, sand, soil, paved), stream bank (bluff, slope, clean flat, landscaped, natural), stream current (slow, moderate, swift), floodplains (adjacent vegetation, elevation, channel depth, soil and climatic conditions), and riparian stands (stand composition, presence of invasive neophyte species, desirable species, dominant old trees, plant spacing, vegetation stratification, mosaic of area cover, health issues, age, territorial system of ecological stability).

Data collected in field and recorded in a written form are used to assess the existing state of individual sections of riparian stands and to determine appropriate class of care. In order to compare individual watercourses and their sections, five classes of riparian stand care have been proposed:

1 – woody stand is natural and shows no damage, only running maintenance (small scale tree training, sanitary intervention) and care for young vegetation is necessary.
2 – woody stand has desirable species composition and structure, is partially damaged and, in some places, must be partially restored (i.e. removal of undesirable woody plants, additional planting).
3 – woody stand is thin (stand gappiness is greater than 50%, respectively the woody stand is altogether missing and also in case if there has been a negative impact of construction work on the stand); new stand must be planted.

4 – woody stand is of desirable species composition and structure, its larger area is damaged (flood wave passage, disease occurance); extensive restoration is necessary (removal of undesirable woody plants, additional planting).
5 – woody stand is not of desirable species composition and structure (poplar monocultures); the stand must be regenerated (removal of existing trees and planting of new specimens).

Each assessed area is delineated in a map and assigned a color that matches corresponding class. The color code complies with the classification and depiction scale for ecological status of biologic monitoring in accordance with Directive 2000/60/EC (1 – blue, high; 2 – green, good; 3 – yellow, moderate; 4 – orange, poor; 5 – red, bad).

When assigning a care class to certain locality, it is necessary to observe both operational and ecological perspectives. From the ecological point of view, it is necessary to make sure that the spatial distribution and species mosaic of the riparian stand follow the natural pattern of any given locality as closely as possible. In order to make such determination, we must know what type of vegetation grows by nature in each particular locality, i.e. we must determine the type of habitat. This determination of habitat is carried out through phytocenological, biogeocenological and forest typological classifications.

3. Conclusion

The surveys that had been carried out proved the great importance of riparian stands assessment process. The obtained data provide groundwork for the preparation of riparian stands restoration and care plans whose objective is to create fully functional riparian stands that will closely correspond with the natural character of the particular locality. The care plan should include the proposal for arrangement of plants within the riparian stand (target spacing, bank placing, vegetation density, the width of woody species belt) and the proposal for desirable species composition. The latter proposal should be based on a determination process that assigns species membership in a particular habitat (species natural representation in the given locality, expressed in percents). The care plan recommends necessary interventions to maintain and to restore riparian stands (logging, cut cleaning and thinning, planting, care for young vegetation, removal of invasive species, etc.). The care plans are timeless documents that deal with any given locality as a whole; sectional specific documentation, which should be prepared prior to any implementation, must follow the care plans.

The proposed riparian stands assessment methodology can also be used during the implementation process of Directive 2000/60/EC into Czech legislation. The color coding of the riparian stands care classes enables us to make general maps that can be included in the "Reports on the characteristics of the river basin district" or in the "River basin management plans".

Evaluation of the flood situation along the Elbe river before and after the extreme flood event 2002

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Not only the extreme flood event of August 2002 revealed that the understanding and management of the flood situation along the Elbe River is an urgent and difficult task.

According to this, hydrologic and hydraulic analyses were carried out in the scope of the joint research project „Morphodynamics of the Elbe River" (1996-2001; Nestmann and Büchele 2002). For funded and regionalised flood statistics two periods were derived by the application of a stepwise procedure consisting of various, complementary hydrological tools: 1964-1995 (first step), a reference period with low data uncertainty for analyses of the hydrological status quo (human impact due to large reservoirs and diking measures, climate conditions of the last decades); 1936-1995 (second step), a representative period for analyses of variable conditions occurring in the 20th century (Helms et al. 2002). Fig. 1 shows longitudinal sections of the peak flows HQ-T of selected recurrence intervals T [a] along the German part of the watercourse for the series 1964-1995 (reference) and corresponding gauge values for the series 1936-1995. The latter are still not regionalised due to obvious non-consistencies of historical flow data, especially in the area downstream of the gauge Barby. Meanwhile, it could be verified that the HQ-T of gauge Dresden based on the series 1936-1995 are representative for those of the whole 20th century (series 1904-2003, August 2002 replaced with January 2002). Hence the statistics – excluding the event of August 2002 to be analysed seperately – are still valid (for details see Nestmann et al. 2004). Furthermore, water levels corresponding to these flood statistics were calculated for the major part of the watercourse (507 km) using hydraulic-numeric models (Otte-Witte et al. 2002 in Nestmann and Büchele 2002). Finally, these methods were combined with a flood-routing model using parameters of the flood-forecast system ELBA and with local, conceptual reservoir models representing potential retention areas. This coupling enabled the analysis of the impact of diking measures: it was found that a significant reduction of flood peaks may be achieved if the operation of the retention areas (polders) is controlled (Merkel et al. 2002 in Nestmann and Büchele 2002). In fact, the retention effect is similar to the observed effects on the flood peak 2002 due to dike breaches and retention measures at the Havel mouth (see below).

Using these tools the extreme event 2002 could be reconstructed with and without retention effects (see Fig. 1). This was realised in the scope of a study on behalf of the State of Saxony-Anhalt analysing the impact of potential flood-retention measures (Büchele et al. 2004). The reconstruction was mainly based on gauges with reliable peak flow data. Comparing the (event-specific) simulated longitudinal sections with the observed values it can be recognized that the data consistency at some gauges is obviously not satisfactory (Fig. 1). Better funded results require the use of combined hydrological and hydraulic approaches (see below).

Among other aspects these differences reveal that further research on the flood situation of the Elbe River is required (Nestmann et al. 2004). In a scientific view the event 2002 may be considered as the chance of a complementary evaluation of the event using the available tools and vice versa. In practice, the research should support the derivation of a consistent data base with emphasis on design criteria for the flood protection along the Elbe River. In addition to the event 2002, advanced analyses should involve the following aspects. The large-scale superposition effects (of the main tributaries) of the event 2002 showed that the overall river basin has to be considered in German-Czech cooperation and coupling of their modelling systems. Further on, the event 2002 had a magnitude that may be suitably evaluated only compared to the reference of similar extreme events of the 19th century (final stage of the Little Ice Age). For this, relevant historical data have to be collected and included in extended flood statistics (third step of the above mentioned procedure). In order to check the data consistency, to homogenise such time series (e.g., concerning reservoirs) and to analyse different scenarios of climate change and human impact, the existing simulation tools have to be generalised. First steps for the Czech basin part have been carried out by Mikovec (2004).

These hydrological results (i.e., longitudinal sections of HQ-T and simulation tools) may then play a key role in an interdisciplinary quantification in the process chain of extreme flood events between the meteorological cause and the local impact (flood risk along the river). This enables a funded and efficient flood-risk management with both: long-term planning (e.g., design of the dike system) to be coordinated in the overall basin; event-specific decisions in a large-scale context based on the flood forecast and the evaluation of the impact of operational retention measures (reservoirs, polders).

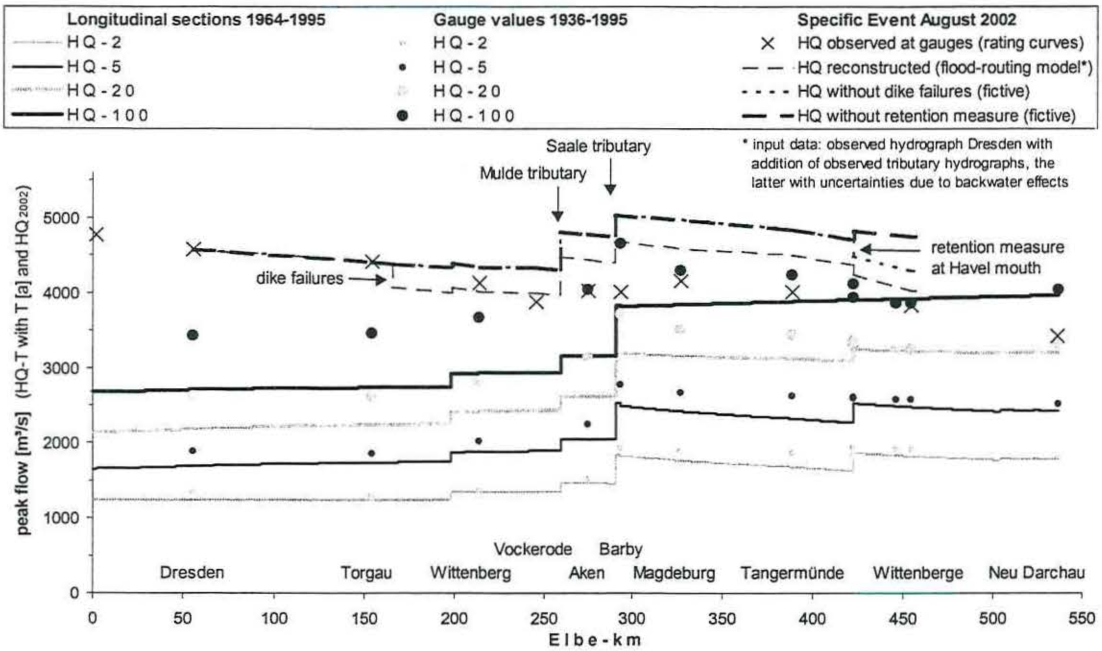

Figure 1: Peak flow values HQ along the Elbe River: comparison of flood statistics (HQ-T, see Helms et al. 2002) with observed/reconstructed HQ from the specific extreme event 2002 with and without the main retention effects (see Ihringer et al. 2003 in Büchele et al. 2004).

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Changes of benthic macroinvertebrate diversity in the Czech part of Labe River

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Research on water macroinvertebrates has been carried out in 3-years intervals since 1993 to evaluate the early recovery stage of the Czech part of the Labe River. The macroinvertebrates were sampled with a focus on taxonomic diversity, in contrast to the regular monitoring.

An ordination (DCA) based on qualitative data from the years 1996, 1999 and 2002 divided the investigated sites into three groups that differ mainly in habitat characteristics (flow regime): group I consisting of lenitic potamal sites, group II of lotic potamal sites and group III of a rhithral site. This suggests that the differences in composition of water macroinvertebrates within sites are most influenced by hydrological conditions and the corresponding physical-chemical attributes of water.

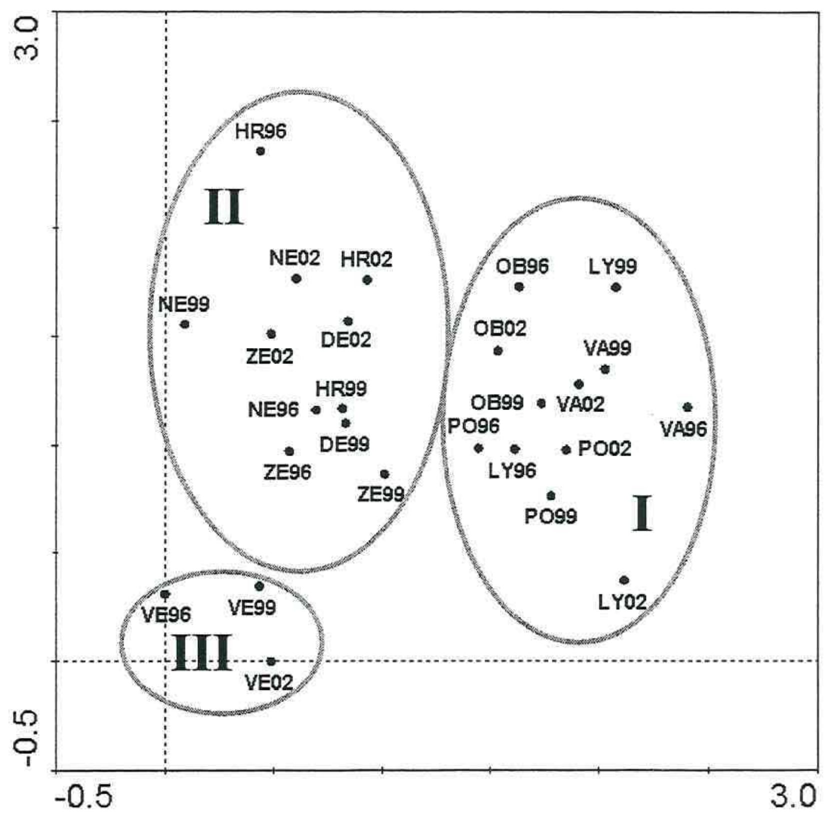

Figure 1: Ordination plot based on qualitative species data from years 1996, 1999, 2002. Method: DCA, detrended by segments, time as covariable. Sites according to distance from source of the Labe River (VE: Verdek, NE: Němčice, VA: Valy, LY: Lysá, OB: Obříství, DE: Děčín, HR: Hřensko) and the Vltava River (PO: Prague-Podolí, ZE: Zelčín).

The increase in taxa present is apparent in most taxonomic groups and at all the sites studied, with the exception of some that were flooded in 2002. This change was most pronounced for Crustacea, Ephemeroptera and Trichoptera. In addition to the definite influence of water quality improvement (e.g. Adams et al. 2001), an expansion of suitable biotopes in littoral vegetation has taken place in the lenitic parts of the river. Thus, for example, the number of vegetation has taken place in the lenitic parts of the river. Thus, for example, the number of sites inhabited by *Radix ampla* and *Platambus maculatus* increased since 1996 by 5, that of *Sphaerium corneum* s. lat., *Piscicola geometra, Cyrnus trimaculatus*, and *Atherix ibis* by 4, and that of *Pisidium supinum*, *P. henslowanum*, and *Gomphus vulgatissimus* by 3.

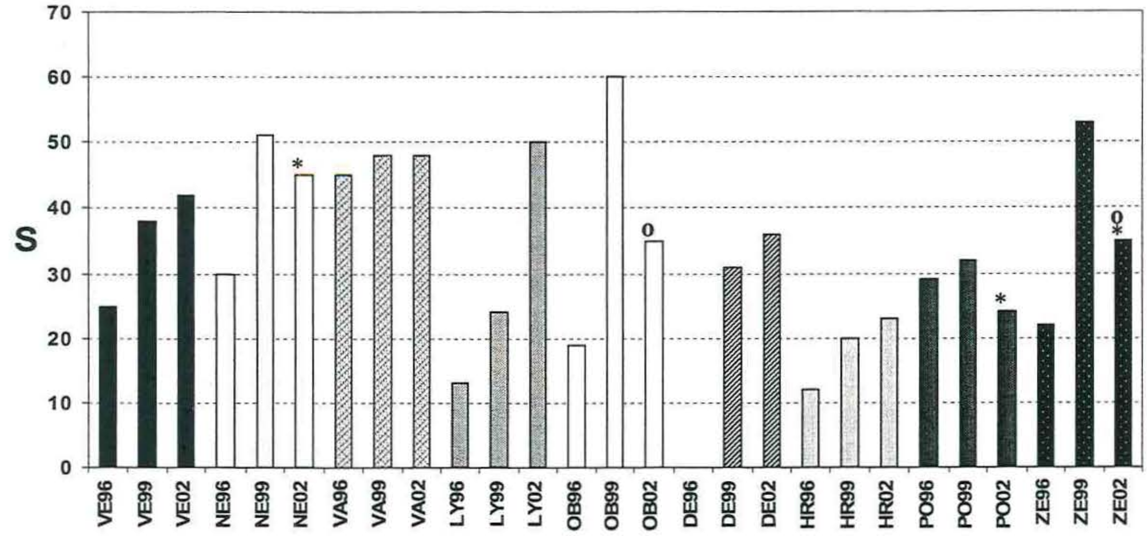

Figure 2: Number of taxa (S) registered at study sites of the Labe River and the Vltava River in 1996, 1999 and 2002. Oligochaeta and Chironomidae were excluded from this plot due to data inconsistency. Prominent changes of either biotope (*) and/or water quality (**o**) after floods in 2002 are highlighted. For abbreviations see Figure 1.

Two concurrent ecological processes are in progress in the Czech part of the Labe River at present: 1) reintroduction of the original pollution sensitive species (e. g. molluscs *Sphaerium rivocola, Unio pictorum*, and *Viviparus viviparus,* mayfly *Potamanthus luteus*, and water bug *Aphelocheirus aestivalis*), and 2) expansion of invasive species (neozoa) - mainly crustaceans *Gammarus roeselii* and *Dikerogammarus villosus* recorded in 2002 (Stuchlík et al. 2002) and molluscs *Dreissena polymorpha, Ferrissia clessiniana, Menetus dilatatus, Physella acuta, Potamopyrgus antipodarum,* and *Corbicula fluminea* (Beran 2000, Stuchlík et al. 2002). Aquatic molluscs of the lower part of the Labe River were also studied by Beran (2003) and compared with historical records. The invasion of several non-native species was documented and populations of endangered or vulnerable molluscs were found.

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Using zooplankton for monitoring of lowland reservoirs

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Biomonitoring usually is done three-dimensionally: 1, investigation of physico-chemical parameters in the water; 2, quantitative and qualitative analyses of organisms living in the water; 3, observation on behaviour of aquatic organisms.

Organisms can indicate the water quality when its presence, number, behaviour and chemical compound are changing under influence of environment conditions. Other mainly practical demand for the investigated group of organisms is to be easily collected and identified and they must be representative for the examined type of water bodies, in our case this type means shallow lowland reservoirs

Actually zooplankton is rarely used for biomonitoring water quality in Hungary, but it gives us a lot of complementary information especially for stagnant waters.

As every aquatic association used in biomonitoring (e.g. phytoplankton, benthic macroinvertebrates) zooplankton give us information about saprobial state of water, too. Some authors wites that zooplankton can give us information about destructivity state of waters, beacause they are a well researchable groups at the second level of food-web.

In our study we show, how we are using zooplankton for monitoring in seven lowland reservoirs in eastern part of Hungary since 2001 till 2003, five or six time in every year.

We took filtrated samples and conserved them. This method determines the groups of zooplankton which could be identified and those which couldn't. So we analysed Rotatorians (exclusing Bdelloidea) and Crustaceans (*Cladocera, Copepoda and Ostracod*) as a well identifiable part of zooplankton, but we excluded two numerous groups, which are so difficult to identify: Protozoans and Gastrotrichas. The resultsof analyses were calculated and transformed into indexes (diversity, saprobity, aboundances) and biomass. The presence of taxa or their absence at different times, gave us additional informations about ecological state of reservoirs (halobity, state of trophy, etc.).

Table1: describing the investigated reservoirs:

name	capacity	district	main water supply
Oláhréti-tározó	0,783 Mm^3	Császárszállás	VIII. számú főfolyás
Nagyréti-tározó	3,570 Mm^3	Császárszállás	VIII. számú főfolyás
Harangodi-tározó	1,2 Mm^3	Nagykálló	VIII. számú főfolyás
Leveleki-tározó	5,28 Mm^3	Levelek	IV. számú főfolyás
Rétközi-tározó	10,0 Mm^3	Rétközberencs	XV., XVI. számú csatorna, Tisza
Székelyi tározó	0,883 Mm^3	Székely	IV. számú főfolyás
Vajai-tározó	0,807 Mm^3	Vaja	III. számú főfolyás,

The list of most present genera in the reservoirs:

Rotatoria: *Anuraeopsis sp., Asplanchna sp., Brachionus sp., Cephalodella sp., Colurella sp., Euchlanis sp., Filinia sp. , Keratella sp., Lecane sp., Polyarthra sp., Synchaeta sp., Trichocerca sp..*
Cladocera: *Alona sp., Bosmina sp. , Chydorus sp., Moina sp..*
Copepoda: *Cyclops sp..*

Table 2: showing amount of zooplankton in the investigated reservoirs (ind./10l):

	Oláhréti	Nagyréti	Harangodi	Vajai	Leveleki	Rétközi	Székelyi
2001.02.13.	1520	2210	1873	613	1122	1016	311
2001.04.21.	1160	978	770	908	1245	1287	152
2001.06.19.	8870	3029	10480	4800	3484	80791	24730
2001.07.17.	3209	13056	10594	2392	2651	2685	
2001.08.28.	2438	4408	3712	2508	2065	13373	2663
2001.10.24.	7832	42336	24829	9247	4170	77020	1259
2002.02.12.	1549	1675	42	4983	4125		221
2002.04.23.		12429	4305	2627	9682	17712	2268
2002.06.18.	40731		12816	12240	16644	35713	45949
2002.07.16.	8237	26636	39680	5917	12783	38903	16518
2002.08.28.	8614	33476	38448	10584	23587	24859	11424
2002.10.08.	1922	59766	26917	6283	2910	23092	5092
2003.03.11.	3540	12920	90	390			669
2003.04.15.	4619	2173	5389	10044	8742	6281	11210
2003.07.15.	60147	35975	23808	57259	11270	78426	7803
2003.08.26.	52272	16482	39312	38720	18432	37539	17361
2003.09.23.	59472	12312	49522	8387	18951	67568	

(the blank cells show impossible sampling caused by weather)

These amounts above show that zooplankton as group for analyses of water quality is acceptable according its presence during every season in year.

Finally we try to find answer, how to integrate zooplankton into a monitoring system required by EU-Water Framework Directive, because this group is well adaptable into biological parameters of stagnant waters.

Can be the zooplankton useful for the monitoring of lowland rivers

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In the practice of European countries we didn't find any, which use the zooplankton for the monitoring of rivers. Why? Because the lot of rivers are too lotic or too small to have stabile formed zooplankton and to be useful the investigated group must be found in representative scale every time in the investigated water.

Biomonitoring usually is done three-dimensionally: 1, investigation of physico-chemical parameters in the water; 2, quantitative and qualitative analyses of organisms living in the water; 3, observation on behaviour of aquatic organisms. The zooplankton analyses can give us parameters belonging to second and third dimension.

So organisms can indicate the water quality when its presence, number, behaviour and chemical compound are changing under influence of environment conditions. Other mainly practical demand for the investigated group of organisms is to be easily collected and identified and they must be representative for the examined type of water bodies.These are the basic requirements for zooplankton as an association used in biomonitoring.

In our study we try find answer on the tittle question basing on zooplankton results from Upper-Tisza and its tributaries in Hungary since 2000 till 2003. It means 9 sampling points: 4 on the Tisza-river, 2 on the Szamos-river and 1-1 on the rivers Kraszna, Túr and Lónyai-channel. One sampling place by Tisza-river called Tiszabecs is lotic and another one by the Lónyai-channel is rather stagnant than flowing water but the rest of places can be described as lenitic or slowly running.

We took samples from surface layer and filtrated them. The next step was conservation by formaldehyd at final concentration about 3-4%. This method determines the groups of zooplankton which could be identified and those which couldn't. So we analysed Rotatorians (exclusing Bdelloidea) and Crustaceans as a well identifiable part of zooplankton, but we excluded two numerous groups, which are so difficult to identify: Protozoans and Gastrotrichas.

We made quantitative and qualitative analyses too. These gave us the next results: total number of zooplankton, list of present organisms, their quantifiable proportions and biomass. Presence of taxa can be characteristic for different ecological state, the state of trophy (combined with quantitative results), pollution level etc..

In our samples the most present genera were the next:

Rotatoria: *Asplanchna sp.,Brachionus sp., Cephalodella sp.Colurella sp.,Encentrum sp., Epiphanes sp., Euchlanis sp., Filinia sp., Keratella sp., Lecane sp., Philodina sp., Polyarthra sp., Proales sp., Rotaria sp., Synchaeta sp., Testudinella sp., Trichocerca sp., Trichotria sp..*
Cladocera: *Bosmina sp., Chydorus sp..*
Copepoda: *Cyclops sp..*

However the total number of identified different zooplankton forms was over than 170. Most of them can be used similarly to algae as indicators of saprobity, eg.: Brachionus angularis which well indicates alpha-beta-mesosaprobic state of water.
The number of entities (individuum/10l) were oscillating between 0 and near to 10.000, depending on temperature of water and water level. Highest number s were registrated in late

spring and the summer period. Lower temperature and higher flood caused lower amount of entities, which made useless our analyses because being non-representative samples.
So our answers for the previous questions:

- zooplankton is easily collectable from lowland rivers like investigated
- parts of zooplankton are easily identifiable (Rotatorians, Crustaceans) but other part of zooplankton are very difficult to be identified (Protozoans, Gastrotricha and some of Rotatorians).
- zooplankton is changing its own number, biomass, quality and behaviour according to environmental parameters in investigated rivers.
- lowland rivers which are less lotic with a slow stream have well formed representative zooplankton only in vegetational period without rising of water level.
- winter and rising of water level makes the zooplankton rare and less representativeas it is needed.
- different indexes and calculations can be made on zooplankton base and bring us added informations to ecological status of rivers (eg. saprobity, diversity, trophy, aboundances etc.).

So the zooplankton can be useful but only in vegetational period without higher tide, which in investigated rivers means seven months yearly, from april to october. This sensibility to water level (stream velocity) makes the zooplankton inconvenient to permanent monitoring, but investigations on it can bring useful, additional information into monitoring of these rivers.

Identification of crop types and crop rotations in agriculture using satellite data

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In the modelling of water quality, in particular the chemical quality parameters, in river catchment areas in the sense of the EU-Water Framework Directive (WFD) the land use in the entire catchment of the river plays a substantial role. The essential none point nutrient entries originate from agriculture, that occupies large surfaces, the urban sewage systems have to be regarded as the most important point sources. Based on the fact it results the necessity to analyse the land use in strong spatial differentiation and high temporal resolution. At present data for land use are received as static surface description into the modelling, on the fields a rotation of crop types according to coincidence principle is simulated at best. That is unsatisfactorily considering the very different fertilization quantities and dates for the different crop types.

For the solution of this problem in the represented procedure the potentials of remote sensing for the monitoring of land surfaces were used, resulting from high spatial resolution and the recurrent simultaneous mapping of wide landscape cut outs. Principle solutions on this are established in different landscape areas of Europe. The transfer of the classifier for the spectral characteristic of individual cultures, won at exemplary times in the few regarded years, to other cultivation years and areas fails due to the weather- and soil-caused variance of the annual growing conditions.

In order to be able to recognize the crops in the satellite image in each phenological status and differentiate between it and others as well as to derive crop rotations, the creation of standard curves of the phenological process of the plant development is necessary. These curves are associating every phenological status during the growth of the crop type with a typical spectrometric information.

The satellite data used for the land use classification must be attributed according to the weather processes to the actual phenological situation during the aquisition. On the basis of agricultural-meteorological weather reports, phenological information and management data of the agricultural process 40 Landsat-TM/ETM datasets of Brandenburg of the years 1987 to 2002 were fit into a phenological standard year after atmospheric and geometric correction. Spectral signatures for the occurring crop types were won with GIS techniques from the satellite data (NDVI) on the basis of concrete cultivation information of selected agrarian companies with about 400 acre parcels. Thus the connection between phenological status and spectral characteristic of crop type was manufactured and deduced a spectral standard curve for every crop for the overall phenological development time and the growth-break. Figure 1 shows the computed NDVI-curves for several crop types.

These spectral standard curves form the classifier for the multi-temporal classification of arable land, which is accomplished in cultivation years. As a function of the availability a different number of satellite datasets can be included. Using the CIR-based biotope type mapping of Brandenburg the satellite data were masked, to use only the arable land in further process. Without extracting data from areas of interest in the images, as typically done in supervised classifications to form the classifier, the parallelepiped classification results in the distribution of crop types on the acre parcels. The succession of the year's information about the crop type won in that way allows the recognition of the crop rotations actually practiced in the agriculture and their integration into the nutrient balance for the water quality modelling.

With the development of the standard curves of the spectrometric-phenological correlation the possibility of transfer to coming cultivation years and to other landscape areas was created.

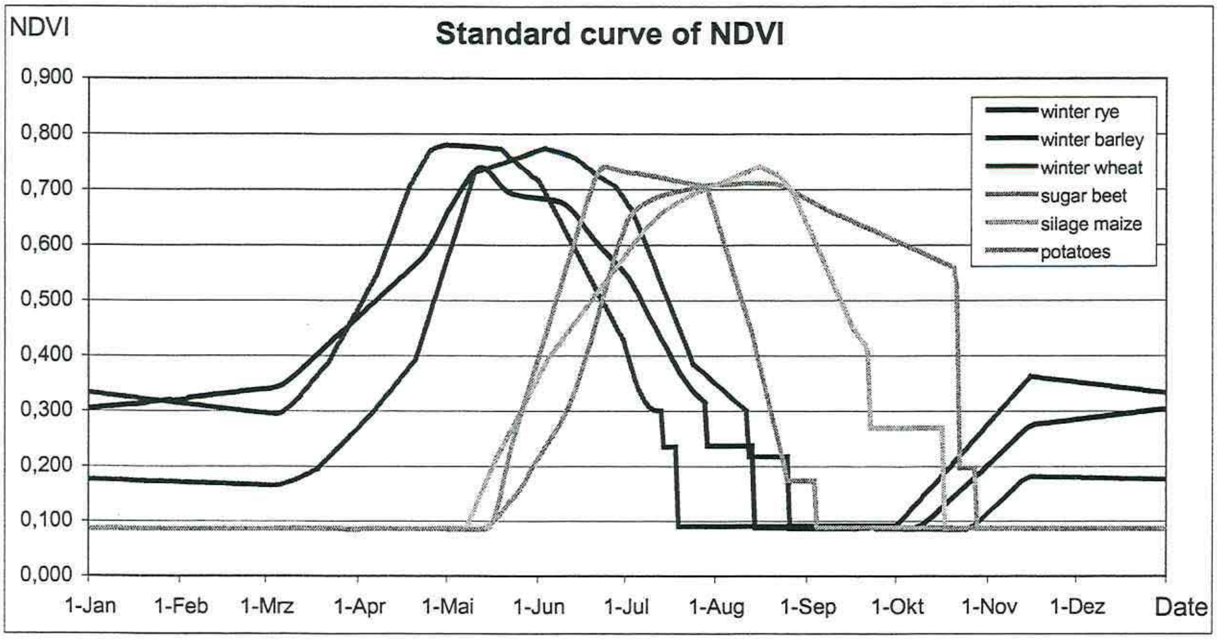

Figure 1: Standard NDVI-curves of typical crop types in Brandenburg

Construction of a large-diameter dug well in the profile of unsaturated zone as a good database of percolating water composition.

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The large-diameter dug well is localized on the Major Groundwater Basin (MGWB450 – Vistula river valley) near HTS Metallurgical Plant east of Kraków (South Poland). HTS Metallurgical Plant is the the principal source of SO_2 and heavy metals emissions in the study area. Emissions are entering the unsaturated zone as wet and dry deposition since 1955.

The Quaternary sandy-gravel aquifer (Fig. 1) exploited in the area is covered by loess loam 9–12 m thick. The large-diameter dug well in the loess loam (8 m deep), equipped with 5 quasi horizontal PVC tubes with the ceramic suction cups (vacuum lysimeters) was used as a monitoring station since 1993.

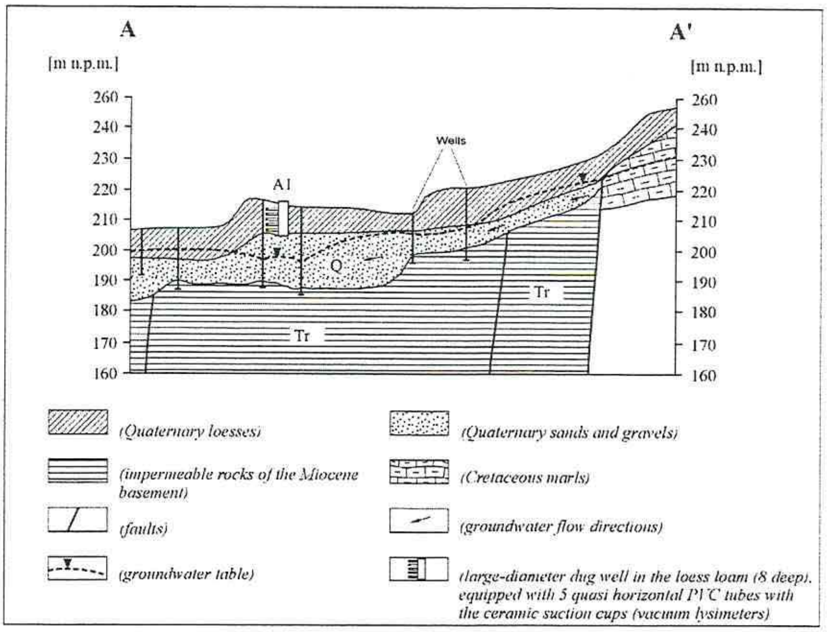

Figure 1: Simplified hydrogeological cross-section by study area (Zuber et al., 1985, modified).

Until this year 5 soil moisture samplers with large ceramic cup were used, everyone 90 cm long. They were situated horizontally and collected percolating water from five depths. Nowadays three more samplers are installed in the well (Fig.2). One of the added samplers has teflon/quartz probe. The samplers material influence on water composition has been recognized in the laboratory by flushing the samplers with demineralized water.

Migration of pollutants within unsaturated zone is a complex process. Recognizing them is essential for estimating a groundwater vulnerability to contamination (Apello, Postma, 1999). The large-diameter dug well with vacuum lysimeters is a very useful tool to observe a pollution migration across the unsaturated zone in loesses. This information may be useful for reconstruction of the past anthropopression in the study area. It may also help to formulate prognosis with regard to groundwater quality changes.

The average velocity of the conservative tracers through loess cover was 0.34m per year and has been confirmed using the position of the bomb tritium peak {Bury, 1995). Mean residence time of water in the loess unsaturated zone is about 20-30 years. It means that in the investigated profile the history of infiltrating water composition over the study area for the past thirty years can be obtained.

Figure 2: Large-diameter dug well with soil moisture samplers

The unsaturated zone is built by loess.The loess is the typical cover of many groundwater basins of Southern Poland so the results may be used to better understanding of processes which take place in other water basins in Poland or in the similar regions.

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Occurrence of predatory fungi in the surface waters of Podlasie Province of northeastern Poland

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Fungi found on dead substrate thouht, there are several species which are parasites algae and aquatic organisms both invertebrates and vertebrates (Dick 2001). A separate group of aquatic fungi is that of predatory species which grow freely in an aquatic environment and catch invertebrate animals in their surroundings in their prey (Czygier and Boguś 2001). These fungi are saprobionts at conditions of a good nutrient level. Being short of nitrogen, they become predacious (Barron 2003). The main aim of the present study was to establish the biodiversity of predatory fungi found in different water reservoirs in Podlasie Province of northeastern Poland, and to demonstrate the effect of physic-chemical factors on the growth of fungi. The water was collected from reservoirs: springs (Cypisek, Dojlidy Górne, Dolistówka, Jaroszówka, Sobolewo), ponds (Akcent, Białowieża, Dojlidy, Palace), lakes (Hańcza, Komosa, Wigry) and rivers (Biała, Bug, Czarna, Czarna Hańcza, Sokołda, Supraśl). Physical and chemical water parameters of the above sampling sites were conducted using standard methods according to Dojlido 1995. Bait method was used to isolate the predacious fungi. The following baits were used: onion skin, hemp-seeds, spawn, and snake skin. The fungi were identified according to the publications of Batko 1975 and Dudka 1974. During the many years' studies of organisms in water reservoirs the presence of several species of predacious fungi were found (Table 1). In surface waters of Podlasie Province occurred such species of predatory fungi as: *Arthrobotrys brochopaga* (Drechsler) S Schenck W.B Kendr and Pramer, *Arthrobotrys oligospora* Fresenius, *Zoophagus insidians* Sommestorff, *Sommerstorffia spinosa* Arnaudov, *Euryancale sacciospora* Dreschler and *Zoopage phanera* Drechsler. The commonly of these was found to be *Zoophagus insidians*, the presence of which was noted in all reservoirs. *Euryancale sacciospora* occurred hardly ever and was marked only in the river Biała. Physical and chemical parameters of waters in various types of bodies did not prove important effect on existence of fungi.

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Table:1 Predatory fungi and fungus –like organisms in the waters of north-eastern Poland

Class and species	Reservoir
Peronosporomycetes	
Sommerstorffia spinosa Arnaudov	Lake: Komosa River: Czarna, Sokołda
Zygomycetes	
Euryancale sacciospora Drechsler	River: Biała
Zoopage panera Drechsler	Pond: Palace Lakes: Hańcza, Komosa, Wigry, River: Czarna, Supraśl
Zoophagus insidians Sommerstorff	Springs: Cypisek, Dojlidy Górne, Dolistówka, Jaroszówka, Sobolewo, Ponds: Akcent, Białowieża, Dojlidy, Palace Lakes: Hańcza, Komosa, Wigry Rivers: Biała, Bug, Czarna, Czarna Hańcza, Sokołda, Supraśl
Anamorphic hyphomycete	
Arthrobotrys brochopaga (Drechsler) S Schenck W.B Kendr and Pramer	Lake: Hańcza Rivers: Biała, Bug, Czarna Hańcza, Supraśl
Arthrobotrys oligospora Fresenius	Spring: Dolistówka Ponds: Białowieża, Dojlidy, Pałacowy, Lakes: Komosa, Wigry, Rivers: Biała, Czarna, Czarna Hańcza, Supraśl

Ecohydrological evaluation of the drainage area - Case study on the Luční potok drainage area

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1. Methodology of the ecohydrological evaluation of the drainage area

The poster deals with the methodology of ecohydrological evaluation of the small catchment area. There has been suggested an own general methodical way of ecohydrological evaluation of the drainage area. This evaluation is divided into three parts which follow each other (fig. 1). The first part is presented by basic characteristic of the drainage area, which defines specific features of the drainage area. Consequently, these specifications influence the choice of specialized methods in analytical part.

The second part of this methodology has an analytical character. Generally, it involves three related analytical evaluations: (1) of fluvial system, (2) of anthropogenic changes and (3) ecohydrological condition.
The third part results from principles of intergrated evaluation and geographical synthesis and it is deduced from methods used in landscape-ecological planning (Ružička a Miklós 1982) with the fact that the methodical steps are thematically adjusted to ecohydrological evaluation. Ecohydrological evaluation of the drainage area is in an accord with principles of sustainable development, in point of integration of knowledge, as an example or inspiration served some works (Janauer 2000, Aspinall a Pearson 2000, Matoušková 2003).

2. Ecohydrological evaluation of the drainage area of the Luční potok stream

The use of concrete methods was made by the example of the drainage area of the Luční potok stream (1-10-02-103).

Basic ecohydrological characteristics of the drainage area of the Luční potok stream, made on the basis of geographical approach to landscape studies, has enabled to define specific features of the drainage area. There belong above all low specific outlet, complicated historical development, large changes of fluvial system and inside diversity of the drainage area according to the landscape typology. Presented features have led to the choice of specific analytic methods. The methodology of analytic part has been influenced by accesible data sources about the area, too. The process has been complicated especially by the absence of a hydrological station in the drainage area. On the other hand, it has been possible to use a study for special purposes, which evaluates the results of anthropogenic activities in this area (coal mining, motorway constructions, storage piles, quality of the basin České údolí).

There has been made a field research and selected analyses. According that, there have been found out new knowledge about fluvial system of the dranaige area (hydrological regime, morphometry of the drainage area and streambed, extreme conditions and processes).

There have been systematically analysed some anthropogenic changes of the drainage area (changes of hydrography, development of the land use in the drainage area and along the water streams, anthropogenic outlet).

The ecohydrological condition of the drainage area has been investigated and there have been defined the main problematic topics (the quality of the water environment, the ecohydrological quality of water stream corridors and the ecological stability of the drainage area).

The ecohydrological quality has been considered mostly in the longitudinal profile of the corridors of the main streams, resp. each particular homogenic sector. The problematic sectors of hydroecological quality have been defined in this way.

Syntetical characteristic consists from three parts: (1) evaluation of vulnerability of the drainage area, (2) evaluation of ecohydrological importance of landscape elements and (3) evaluation of the endurance of the drainage area.

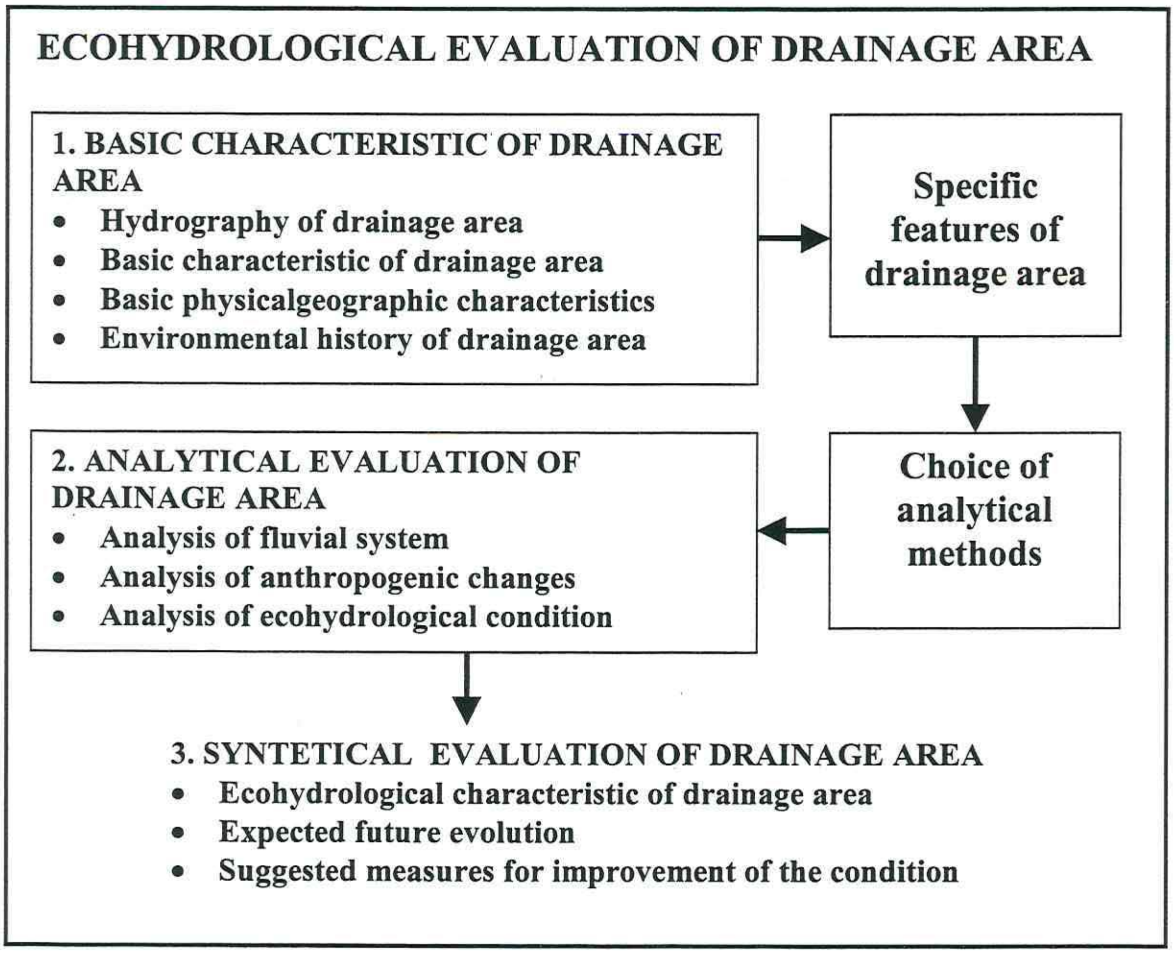

Figure 1: Scheme of ecohydrological evaluation of a drainage area Source: own elaboration

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Bioassessment of Polish rivers based on macroinvertebrates

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1. Introduction

Over the years, the classification of rivers in Poland was only use-related and based mainly on the physical and chemical characteristics of waters. In accordance with EU Water Framework Directive crucial significance is ascribed to biological assessment. The review of biological methods applied in monitoring of rivers in European countries reveals the most of them being based on macroinvertebrate analysis (De Pauw et al. 1992). That is why in Poland we decided to introduce, first of all, the standard biological method based on macroinverterates. The article presents main results of the project launched to fulfill this task.

2. Material and methods

Benthic macroinvertebrate samples were taken in the spring period from 49 Polish rivers at sites above and below point sources of pollution: namely – control and impacted sites respectively. Rivers were evenly located all over the whole territory of the country. Among them there were 9 mountain rivers, 6 upland rivers and 34 lowland rivers. Quantitative samples of macroinvertebrates from dominant bottom substrate were taken using Surber sampler (for stones and gravel) or Ekman-Birge grab (for sand or silt). Qualitative samples were also taken with the view to extend the list of taxa richness. We analysed macrofauna density, taxa richness and dominance structure. Moreover we tested several biotic indices functioning in water quality assessment in Europe.

3. Biological method of river assessment adapted in Poland

The most suitable system to be adapted to Polish condition is the British BMWP score. Considering the results of our investigations, literature data and opinions of a group of national experts, a modification of standard BMWP table (NRA 1994) was prepared (table 1). This modification includes: (1) the verification of usefulness of taxons scored in the original British system in Polish conditions, (2) supplementing the list of families with several taxons which do not occur in GB due to zoogeographical isolation, but in Polish conditions constitute good indicators of water quality, (3) the change of score assigned to several taxons (in comparison with the original BMWP). The ranges of BMWP-PL scores assigned to 5 classes of water quality are the following: I class >100, II class 70 – 99, III class 40 – 69, IV class 10-39, V class <10.

Polish BMWP score (BMWP-PL) is verified by the Diversity Index (d):

$$\mathbf{d = S/\log N}$$

where **S** is the number of taxa (families) and **N** is the density (ind/m^2) of macroinvertebrates (transformed into common logarithm). In many cases, moderate pollution does not influence the taxonomic composition of macrofauna but causes the changes in its dominance structure and the increase of abundance. Biotic indices in such situations do not show any significant differences. The use of diversity index in the assessment procedure includes abundance aspect. The following ranges of diversity index values were established: I class >5,50; II class 4,00-5,49; III class 2,50-3,99; IV class 1,00-2,49; V class <1. Where the values of both assessment elements are not consistent, the worse value decides on the final classification.

Relying on used biological classification based on macroinvertebrates, 9 sites were assigned to class I, of which all were control sites. Class II embraced 33 sites, the majority of which belonged to the control group (21). In class III there were 34 sites (control and impacted in balance). Class IV included 19 sites, mainly impacted (14). In class V there were 7 sites, all of them impacted.

Table 1: Standard table of BMWP-PL

Families		Score
Ephemeroptera *Trichoptera* *Diptera*	Ameletidae Glossosomatidae, Molannidae, Beraeidae, Odontoceridae, Leptoceridae Blephariceridae, Thaumaleidae	10
Ephemeroptera *Plecoptera* *Odonata* *Trichoptera*	Behningiidae Taeniopterygidae Cordulegastridae Goeridae, Lepidostomatidae	9
Crustacea *Ephemeroptera* *Plecoptera* *Trichoptera* *Diptera*	Astacidae Oligoneuriidae, Heptageniidae (genus Epeorus and Rhithrogena) Capniidae, Perlidae, Chloroperlidae Philopotamiidae Athericidae	8
Ephemeroptera *Plecoptera* *Odonata* *Trichoptera* *Coleoptera* *Heteroptera* *Gastropoda* *Bivalvia*	Siphlonuridae, Leptophlebiidae, Potamanthidae, Ephemerellidae, Ephemeridae, Caenidae, Perlodidae, Leuctridae Calopterygidae, Gomphidae, Rhyacophilidae, Brachycentridae, Sericostomatidae, Limnephilidae Elmidae Aphelocheiridae Viviparidae Unionidae, Dreissenidae	7
Hirudinea *Crustacea* *Ephemeroptera)* *Plecoptera* *Odonata* *Trichoptera* *Diptera* *Gastropoda*	Piscicolidae Gammaridae, Corophiidae Baetidae, Heptageniidae (with exception of the genus Epeorus and Rhitrogena) Nemouridae Platycnemididae, Coenagrionidae Hydroptilidae, Polycentropodidae, Ecnomidae Limoniidae, Simuliidae, Empididae Neritidae, Bithyniidae	6
Crustacea *Trichoptera* *Coleoptera* *Heteropera* *Diptera* *Gastropoda*	Cambaridae Hydropsychidae, Psychomyidae Gyrinidae, Dytiscidae, Haliplidae, Hydrophilidae Mesoveliidae, Veliidae, Nepidae, Naucoridae, Notonectidae, Pleidae, Corixidae Tipuliidae Hydrobiidae	5
Diptera *Gastropoda* *Bivalvia*	Ceratopogonidae Valvatidae, Planorbidae Sphaeriidae	4
Hirudinea *Crustacea* *Megaloptera* *Diptera* *Gastropoda*	Glossiphonidae, Erpobdellidae, Hirudinidae Asellidae Sialidae Chironomidae Ancylidae, Physidae, Lymnaeidae	3
Oligochaeta *Diptera*	all Oligochaeta Culicidae	2
Diptera	Syrphidae, Psychodidae	1

4. Acknowledgements

We are grateful to the regional inspectorates of environmental protection in Poland who helped us to assemble macroinvertebrate data-sets.

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The effect of August 2002 floods on the heavy metals and organic contamination of river sediments in the Berounka River basin

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Presented project was a follow-up of the basic monitoring led by the state administration of the Czech Republic. The project brought additional information about the pollution of river sediments with heavy metals (As, Cd, Cr, Cu, Hg, Pb and Zn) and specific substances (PCB, OCP, PAH). The paper was aimed on the influence of the great flood in 2002 that strongly effected river ecosystems, especially in the Berounka River basin.

Samples were taken at twenty localities on the Berounka River and its tributaries during April - June 2002 and April - June 2003. At first, at each locality the places for representative sampling, where sediment was depositing during last year were chosen. Then the surface layer of sediment (1 – 5 cm thick) was taken from the depth max. 2 meters by the means of the manual shovel or special vessel on the telescopic bar. After homogenization the sediment sample was divided into four same parts, which were processed parallely according to instructions IKSE-MKOL. Samples were immediately deep-frozen and afterwards lyophilized, subsequently were sieved at the fraction (i) 2000 μm for analyses of organic compound and (ii) 20 μm for determination of heavy metals. From both fractions loss on ignition was determined. The results are presented in TABLE I and II as median (n=4, distant results were excluded). The 2002 concentrations of individual parameters (before the flood) were compared to the values from 2003 (after the flood). Next both the data were compared to (i) values introduced in the target plans of IKSE-MKOL and (ii) the criteria for soil contamination (instructions of Department of the Environment, division for ecological risks). There were found no extreme concentrations indicating serious damage of the Berounka River ecosystem due to the flood in 2002. It appeared that in some regions the concentrations after the flood decrease, but in some cases an increase was recorded. The contamination has been reduced in localities where the former more polluted sediments were taken away by the flood. The most considerable PCB and OCP concentration decrease has been found in the Úhlava River in the locality of Plzeň - Doudlevce (source of drinking water for 350.000 inhabitants). There was found the concentration of six PCB indicatory congeners 49 $\mu g.kg^{-1}$ in 2002, this parameter was bellow the method determination limit (< 5 $\mu g.kg^{-1}$) in 2003. The decrease of the concentration of cadmium by 50 – 70 % has occurred in the Radbuza River, by 80 % in the Klabava River. On the contrary, an increase of heavy metals concentrations was reported predominantly from localities where intensified erosion of contaminated watershed enriched the river beds with fresh material. Annually were found the most increase in the localities Litavka - Beroun (e.g. Pb from 350 $mg.kg^{-1}$ to 1100 $mg.kg^{-1}$), Červený Stream - Komárov under sewage water treatment plant (Hg from 0,99 $mg.kg^{-1}$ to 3,37 $mg.kg^{-1}$).

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TAB I: Diversity (*d*) of heavy metals concentration before and after floods in 2002

	Cd			Pb			As			Cu			Zn			Hg		
	2002	2003	*d*	2002	2003	*d*	2002	2003	*d*	2002	2003	*d*	2002	2003	*d*	2002	2003	*d*
	mg.kg^{-1}		%	mg.kg^{-1}		%	mg.kg^{-1}		%	mg.kg^{-1}		%	mg.kg^{-1}		%	mg.kg^{-1}		%
Mže Oldřichov	2.8	2.1	-25	62	68	10	24	25	4	39	48	23	330	400	21	0.46	0.40	-13
Mže Milíkov	1.9	0.6	-71	59	98	66	29	28	-3	49	43	-12	280	250	-11	0.32	0.25	-22
Mže Stříbro po ČOV	2.3	1.4	-39	240	220	-8	25	31	24	56	58	4	600	480	-20	0.58	2.01	247
Berounka Nad ČOV Plzeň	2.4	1.2	-50	96	120	25	18	46	156	55	53	-4	380	410	8	0.60	0.75	25
Berounka Bukovec	2.7	1.6	-41	77	95	23	20	30	50	59	61	3	380	340	-11	0.58	0.53	-9
Berounka Srbsko	4.6	4.1	-11	120	160	33	28	23	-18	58	44	-24	680	640	-6	0.40	0.50	25
Střela Nebřeziny	1.2	1.1	-8	37	37	0	18	37	106	82	87	6	300	270	-10	0.35	0.21	-40
Klabava Rokycany pod ČOV	15	2.0	-87	73	59	-19	29	43	48	300	238	-21	880	390	-56	1.70	0.91	-46
Litavka Trhové Dušníky	98	59	-40	1600	2800	75	220	330	50	73	107	47	5200	5500	6	1.30	2.15	65
Litavka Libomyšl	70	37	-47	1600	1200	-25	120	143	19	84	67	-20	8300	4400	-47	1.10	0.96	-13
Litavka Beroun	18	29	61	350	1100	214	46	130	183	47	70	49	2800	3500	25	0.46	1.05	128
Příbramský potok Trhové Dušníky	31	65	110	1700	3600	112	110	250	127	105	118	12	4800	7200	50	2.30	3.47	51
Červený potok Komárov pod	2.2	4.1	86	36	39	8	7	17	143	40	80	100	450	530	18	0.99	3.37	240
Červený potok Kotopeky	2.3	0.9	-61	31	39	26	7	8.8	26	44	52	18	470	420	-11	0.70	1.13	61
Červený potok Zdice	1.6	0.5	-68	46	37	-20	7.8	20	156	52	38	-27	450	280	-38	0.55	0.58	5
Úhlava Tajanov	1.6	0.8	-49	33	30	-9	20	12	-40	38	32	-16	260	230	-12	0.17	0.13	-24
Úhlava Svrčovec	2.3	2.9	26	51	46	-10	23	40	74	64	47	-27	410	360	-12	1.20	0.52	-57
Úhlava Doudlevce	2.1	0.6	-73	32	30	-6	17	22	29	46	38	-17	270	210	-22	0.53	0.23	-57
Drnový potok Klatovy pod ČOV	1.0	0.6	-36	53	56	6	25	55	120	62	56	-10	370	370	0	0.93	1.10	18
Radbuza Holýšov	1.2	0.6	-48	58	42	-28	19	31	63	41	35	-15	290	250	-14	1.05	0.21	-80
Radbuza Dobřany nad	2.5	0.7	-71	41	32	-22	13	19	46	35	26	-26	360	270	-25	0.25	0.15	-40
Luční potok Valcha	1.6	1.4	-13	36	38	6	28	54	93	49	45	-8	370	400	8	0.49	0.40	-18
Target plans of IKSE - aq. community	1.2			100			40			80			400			0.8		
Target plans of IKSE - agricult. utilization	1.5			100			30			80			200			0.8		
Criterium "A" for soil contamination	0.5			80			30			70			150			0.4		
Criterium "A" for soil contamination	10			250			65			500			1500			2.5		

TAB II: Diversity (*d*) of PCB's, OCP's and PAH's concentration before and after floods in 2002

	PCB			HCBenzene			p,p'-DDE			p,p'-DDD			p,p'-DDT			PAH		
	2002	2003	*d*	2002	2003	*d*	2002	2003	*d*	2002	2003	*d*	2002	2003	*d*	2002	2003	*d*
	μg.kg^{-1}		%	μg.kg^{-1}		%	μg.kg^{-1}		%	μg.kg^{-1}		%	μg.kg^{-1}		%	μg.kg^{-1}		%
Mže Oldřichov	15.1	<5	-83	<1	<1	*	2.7	<1	-81	1.5	<1	-67	2.4	1.5	-38			
Mže Milíkov	<5	6.1	144	<1	<1	*	2.1	4.2	100	1.1	1.9	73	1	8.9	790			
Mže Stříbro po ČOV	8	7	-13	<1	<1	*	2.5	1.9	-24	1.8	1.7	-6	1.3	2.6	100			
Berounka Nad ČOV Plzeň	257	75.5	-71	2.6	2.5	-4	13.4	8.3	-38	3.3	4.6	39	20.7	10.6	-49			
Berounka Bukovec	45.9	56.2	22	1.6	2.4	50	7.6	9.4	24	3	8.1	170	6.7	11.9	78			
Berounka Srbsko	37.1	22.6	-39	4.2	2.4	-43	7.5	8.2	9	3.2	4.3	34	2.3	5.6	143			
Střela Nebřeziny	59.5	59.8	1	1	2.1	110	5.5	11.6	111	1.5	4.9	227	3.3	13.8	318			
Klabava Rokycany pod ČOV	22.4	20	-11	2.1	1.4	-33	6.4	3.7	-42	4.6	3.1	-33	6.9	8.8	28			
Litavka Trhové Dušníky	108	90.1	-17	4.1	9.7	137	13	9.8	-25	11.8	4.1	-65	8.7	18.6	114			
Litavka Libomyšl	9	<5	-72	3.9	7.2	85	2.8	2.1	-25	1.7	1.4	-18	1.8	4.2	133			
Litavka Beroun	70.8	17.9	-75	4	2.8	-30	13	5.1	-61	5.8	3.2	-45	2.8	9.1	225			
Příbramský potok Trhové Dušníky	81.4	49.9	-39	4.1	3.3	-20	9	5.2	-42	8.1	7.9	-2	3.7	11.5	211			
Červený potok Komárov pod	375	446	19	6.2	7.2	16	33	27.2	-18	8.5	9.2	8	8.1	10.1	25			
Červený potok Kotopeky	133	69.7	-48	4.8	3.3	-31	22.1	9.2	-58	9.3	5.1	-45	6	4.9	-18			
Červený potok Zdice	33.7	46.5	38	2.2	3.1	41	7	7.7	10	4.4	3.1	-30	2	14.6	630			
Úhlava Tajanov	37.5	35.7	-5	6.8	2.9	-57	10.6	17.1	61	3.2	9.1	184	5.2	14.3	175	6055	10713	77
Úhlava Svrčovec	127	132	4	6	4.2	-30	25.4	18.2	-28	18.2	11.4	-37	35.7	41.9	17	13087	12949	-1
Úhlava Doudlevce	49	<5	-95	1.4	<1	-64	8.2	2.9	-65	2.3	1.1	-52	7	1	-86	1578	992	-37
Drnový potok Klatovy pod ČOV	77.2	47	-39	4.8	5	4	9.7	9.4	-3	4.8	5.3	10	11.7	22.5	92	7793	8609	10
Radbuza Holýšov	5.4	7.9	46	<1	1	100	1.2	2.7	125	<1	2.1	320	<1	3.1	520			
Radbuza Dobřany nad	14.6	10.6	-27	<1	1.4	180	2.1	10.7	410	<1	4.1	720	<1	6.3	1160			
Luční potok Valcha	22.8	29.5	29	2.3	3	30	7.4	12.8	73	6.9	15.6	126	3.2	7.1	122			
Target plans of IKSE - aq. community																		
Target plans of IKSE - agricult. utilization				40														
Criterium "A" for soil contamination	20			50			50			50			50			700		
Criterium "A" for soil contamination	2500			2000			2000			2000			2000			79500		

The quality of water and sediments in the Litavka River drainage area

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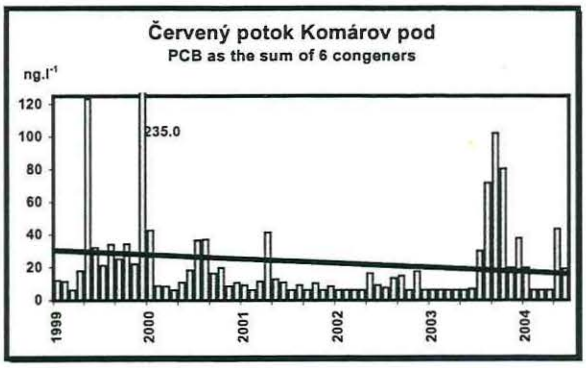
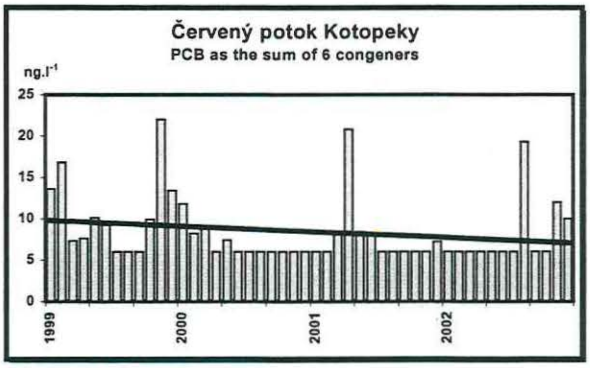
The quality of water and sediments in the Litavka River and its tributaries was evaluated on the basis of data obtained through the seven years of monitoring. The Litavka River, the right-side inflow of the Berounka River, was strongly polluted by heavy metals (Pb, Cd, As, Zn) that came from the non-ferrous metal mining and processing in the area of Příbram town. Although no mining continues at the present time and the worst industrial activities have been stopped, there is almost none positive trend to reduction of heavy metal concentrations both in the surface water and sediments.

Close attention is further paid to the long-term pollution of the Červený Stream. This most important inflow of the Litavka River is polluted by polychlorinated biphenyls (PCB) from the Komárov sewage water treatment plant. According to its physical characteristic PCB accumulate in the river sediments. For this reason the high concentrations of PCB have been found in the sediments downstream the Komárov village. There were found maximum concentrations of six indicatory congeners PCB in the sediments over 400 $\mu g.kg^{-1}$ and in the surface water over 200 $ng.l^{-1}$.

Although the previous ecological loads were taken away by the flood in 2002, the concentrations of harmful substances both in the Litavka River and the Červený Stream remained on the same level or they have even risen. For example the concentration of lead in the Litavka-Beroun profile was three times higher in 2003 than in 2002, the concentration of the sum of six indicatory PCB congeners in sediment of the Červený Stream in Komárov village under sewage water treatment plant has increased from 375 $\mu g.kg^{-1}$ to 446 $\mu g.kg^{-1}$ after the flood in 2002 etc.
On the bases of our data it could be concluded that both almost constant concentrations of heavy metals in the Litavka River and increased concentrations of PCB's in the Červený Stream were not the previous loads of riverbed sediments, but the reason was the continuous contamination (i) from the point source (PCB) or (ii) from the erosive activity of the antropogenously disturbed area (heavy metals).





Figurel – 2: Concentrations PCB in surface water as the sum of 6 congeners and their trends for years 1999 – June 2004 in Červený Stream Komárov pod and 1999 – 2002 in Červený stream Kotopeky

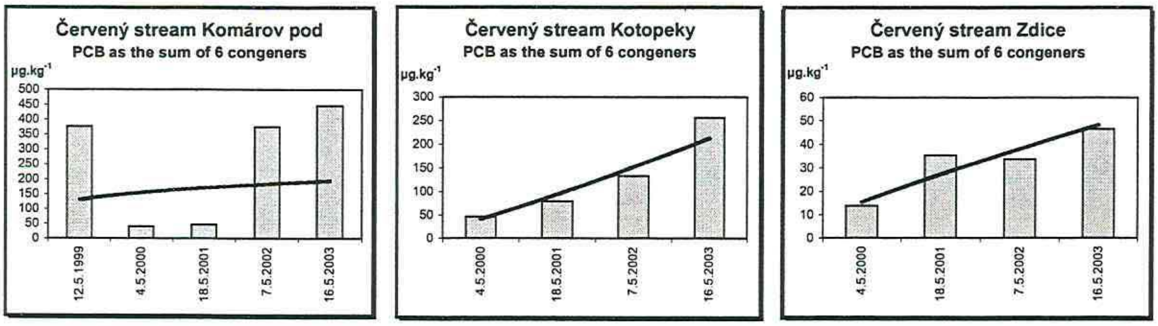


Figure 3 – 5: Concentrations PCB in sediment as the sum of 6 congeners PCB and their trends for years 2000-2003 in Červený Stream

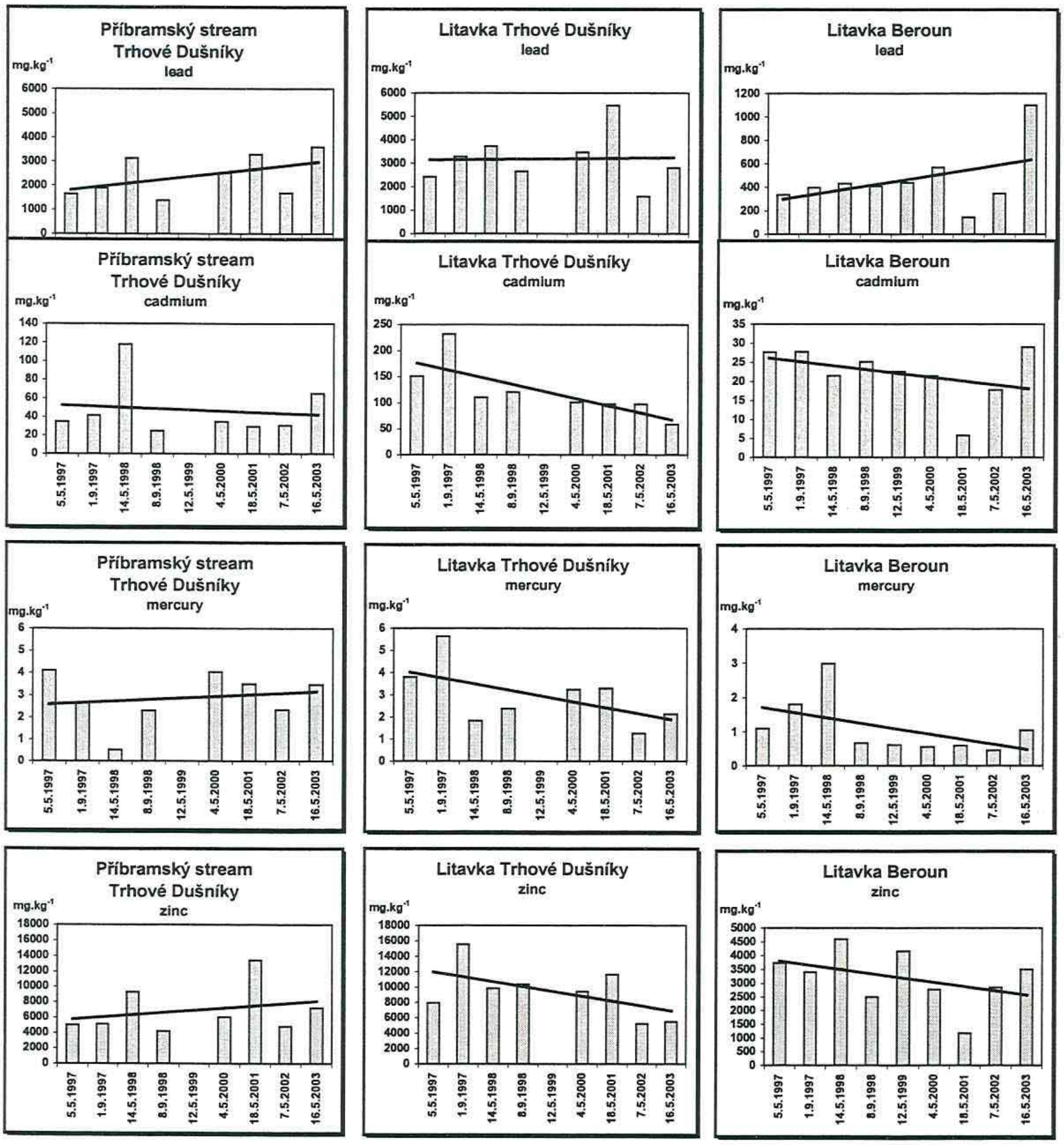


Figure 6 – 17: Concentrations of lead, cadmium, zinc and mercury and their trends for years 1997 – 2003 in sediments of Litavka river and Příbramský Stream

Influence of natural and constructed wetlands on the water quality improvement in small river basins

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The wetland systems have a lot of important functions in the river landscape. Except for their ecological function such as diversification of the landscape, refuges of the wetland animal and plant species, and component of the ecological stability network, an interest has been aimed at their ability to improve the water quality of flowing polluted waters. This function, which is especially considerable for the organic, microbial and nutrient pollution removal, finds its practical application in alternative ways of the wastewater pollution treatment.

In the frame of long-term tasks realised in the Water Research Institute Prague, Brno branch office, the problems of wetland effects on the quality of flowing waters are solved in two levels: an influence of natural wetlands and the influence of constructed wetlands (mainly reed beds and ponds treatment systems) on the water quality.

The poster deals with the natural and constructed wetlands and compares their impact on the flowing water quality in indicators of both organic and nutrient pollution.

The research works have been done at the different kind of natural wetlands in the south-east part of the river Morava basin, in the Breclav town region. The natural wetland, presented on the poster, occurring in the place of a former pond consists of different success stages of the wetland communities and is situated close to the Uvaly village (about 160 citizens). Detailed monitoring was made in 2000. The first part of it is broad belt of reedswamp and willow bush. The pond takes about 10% of total area currently. Wetland is reached by the polluted water from a stream (lenght of the stream is 850 m, average flow rate is 1-3 $l.s^{-1}$). The quality of stream water exceeds 4. and 5. classes of pollution rate assessment (the worst quality). Average water retention in the locality is a few days and the only water outflow is through an old leaking dam. (Kupec, 2000-2002)

The constructed wetland situated in the both villages (Drazovice-780 PE, Hostetin-280 PE) consists of mechanical pre-treatment, sand trap and sedimentation tank, two or three filtration reed beds with macrophyta vegetation (mainly common reed-*Phragmites australis* and reed grass-*Phalaris arudinacea*) and also with an aerobic pond. Design load was a few hundred mg $BOD_5.l^{-1}$. But the observed load is much lower at the both constructed wetlands. Time of the water retention in the locality depends on the hydraulic load and takes a few days, too. The average flow rates are 2.0 $l.s^{-1}$ in Drazovice and 0.6 $l.s^{-1}$ in Hostetin. The influence of localities on the flowing water quality was expressed as percentage difference of concentrations of water quality indicators at the inflow and outflow, using long-term databases. These localities have been monitored since 2000. (Kupec, Rozkosny, 2004)

Based on the comparison of all the ecosystems it is possible to formulate the following conclusion: in case of the natural wetland is the efficiency of the organic pollution removal more than 98 % (BOD_5) and 75 % (COD_{Cr}), the efficiency of the nutrient removal reaches 34 % (ammonia nitrogen), 45% (nitrate) and over 50% (phosphorus). For the constructed wetlands wasa observed the efficiency of the organic pollution removal up to 85 % (BOD_5) and 79 % (COD_{Cr}), for ammonia nitrogen it was up to 63 % (but it is only approx. 30% commonly) and for total phosphorus it was about 30 % in Hostetin (it is less in general, only a few % in Drazovice). There is also high efficiency to remove bacterial pollution of water, more than 90%. (Kupec, Rozkosny, 2004)

From the results of the investigations it is obvious that the impact of wetlands on the flowing water quality is wholly positive. While in natural wetlands the wastewater treatment processes are spontaneous during the water retention, in constructed wetlands these processes are controlled by service regulations in such a way to reach the most effective treatment. Lower efficiency of the organic pollution removal in constructed wetlands is at the given conditions sufficient to meet the qualitative standards of the flowing off surface water.

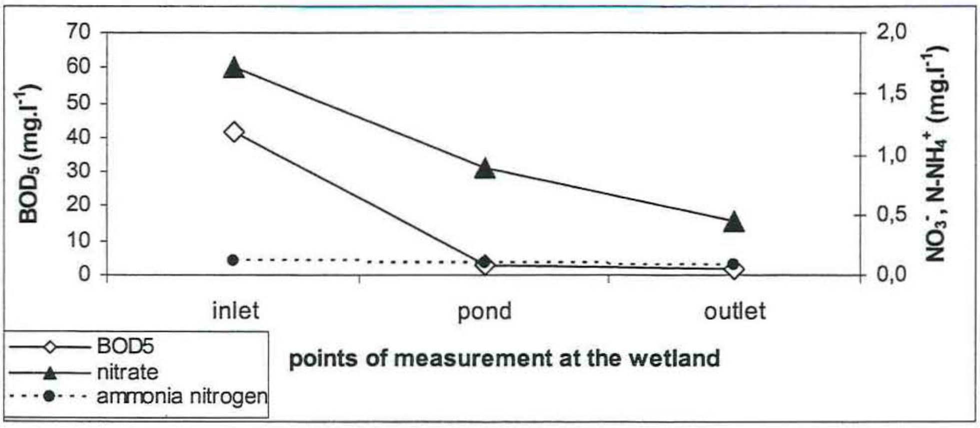

Figure1: The course of pollution decreasing through the village Úvaly natural wetland

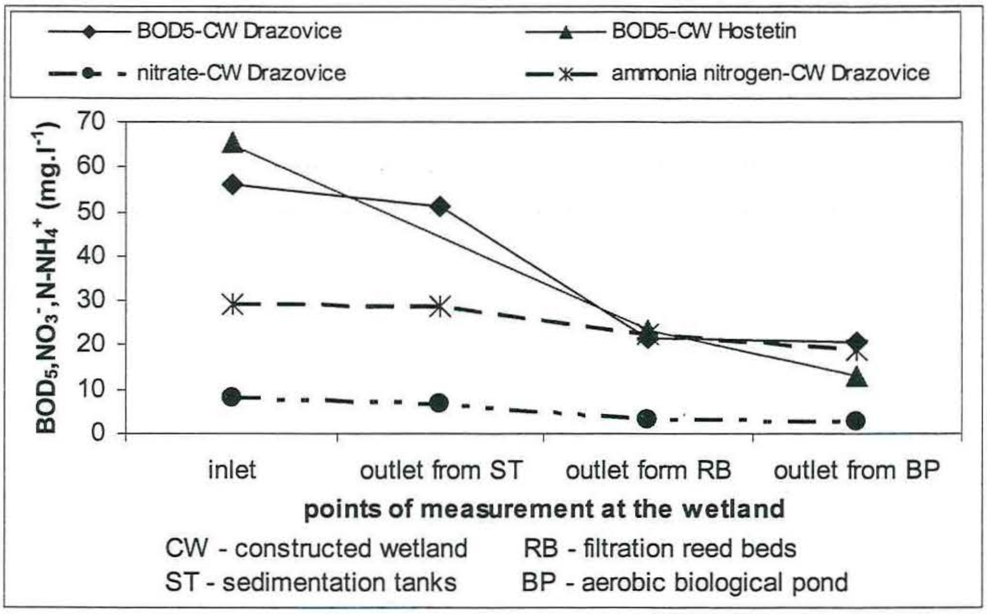

Figure 2: The course of pollution decreasing through the constructed wetlands in the villages Drazovice and Hostetin

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Mouthparts deformities in chironomid larvae (Chironomidae, Diptera) in Labe river basin in years 1993, 1996, 1999 and 2003.

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We have studied the occurences of mouthpart deformities in chironomid larvae, which are regarded as a sublethal effect resulting from larval exposure to toxicants. These endpoint have been used in several cases as bioindicator for sediment pollution. Material for the study was collected from eight localities of the rivers Labe and Vltava (six and two localities, respectively) in 1993, 1996, 1999 and 2003.

We selected two common chironomid genera, *Chironomus* and *Glyptotendipes,* for the analysis of morphological abnormalities. We investigated two types of abnormalities: 1) apparent mechanical damage, and 2) abnormal deformities such as mentum gaps, split or missing teeth on the mentum, etc. We found a different occurence of deformities between the two genera.We detected higher frequencies of deformities in populations of *Chironomus* larvae (0 – 57%) than in populations of *Glyptotendipes* larvae (0 – 19%). We suggest that the genus *Chironomus* is a more sensitive indicator of toxic stress. The highest frequency of mouthpart deformities in chironomid larvae was detected in the middle part of the river Labe which is contaminated by various agricultural and industrial chemicals.

The long-term trend of macrozoobentos contamination by heavy metals, PCB and OCP in the Labe river basin (results in years 1993 – 2003)

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The use of benthic macroinvertebrates to the study of the contamination of aquatic environment is known from the beginning of 20th century (Phillips, 1980). The incidence and the accumulation of „heavy metals" and specific organic compounds in the biomass of the benthic fauna refer to availability of this substances for other links of the food web (Balogh, 1988, Lower and Kendall, 1990).

The biomonitoring of heavy metals in biomass of macrozoobentos has been pursued in the Labe river basin since 1993. The PCB and OCP has been studied since 1999. Following bentic species: *Erpobdella octoculata, Asellus aquaticus, Bithynia tentaculata, Sphaerium corneum* and *Hydropsyche sp.* were selected for the study. The study was conducted on the following Czech and Moravian rivers: Labe, Vltava, Sázava, Berounka, Otava, Lužnice, Ohře, Morava, Dyje, Svratka, Jihlava, Odra and Olše.

The highest mercury contamination was measured in the midle part of Labe river (Figure 1) between towns Pardubice and Mělník (the confluence of rivers Labe and Vltava). The high content of cadmium was detected in Krkonoše foothills, probably in acidification consequences. The situation in the contamination with specific organic compounds is confused, highest values PCB and OCP were measured in the biomass of leech *Erpobdella octoculata* and caddisfly *Hydropsyche sp.* in Labe river near Děčín and in Dyje river (Figure 2).

The content of trace elements (Cd, Pb, Hg) in the biomass of benthic animals depends on the species of organism. In the biomass of *Erpobdella octoculata* were regularly measured higher values of cadmium and mercury concentration then in the other animals (*Hydropsyche sp., Sphaerium sp., Bithynia tentaculata*).

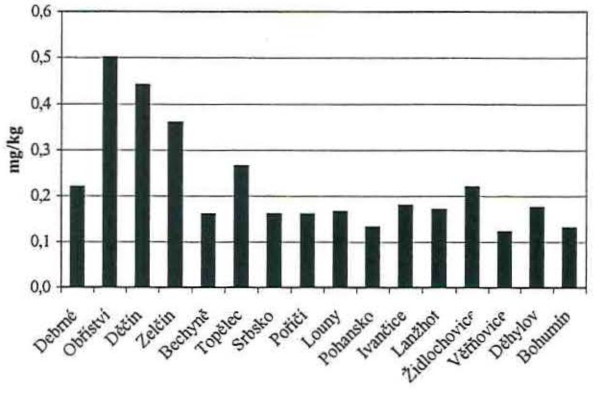

Figure 1: Content of mercury in biomass of Herpobdella octoculata

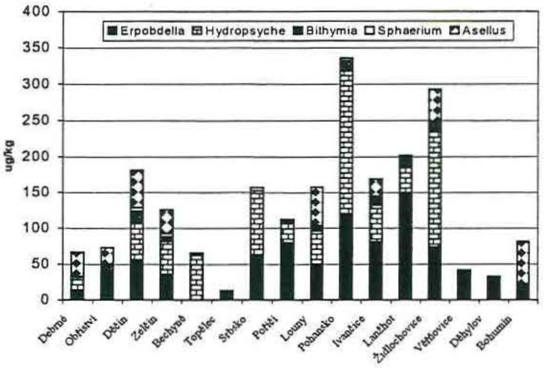

Figure 2: Content of p,p-DDE rate for 5 bentic species

For the monitoring of organic compounds (OCP, PCB) are convenient aquatic larvae caddisflies *Hydropsyche sp.*, in wiev of fat content in the biomass. Caddisflies

Hydropsyche sp. content higher concentrations of PCB and OCP than biomass of other species. For the mercury in the biomass of *Herpobdella octoculata* and *Bithynia tentaculata* was described the significant dependence, but in the biomass of *Herpobdella* were measured times order higher values then in the biomass of *Bithynia tentaculata.*

Decrease of the mercury concentration in the biomass of benthic fauna is obvious in the long-term trend (1993 – 2003). There are increase of the long-term trend (1993 – 2002) in the cadmium concentration in the biomass of *Asellus aquaticus* (Figure 3), *Erpobdella octoculata* (Figure 4) and *Bithynia tentaculata* in the midle part of Labe river (locality Obříství and Hřensko).

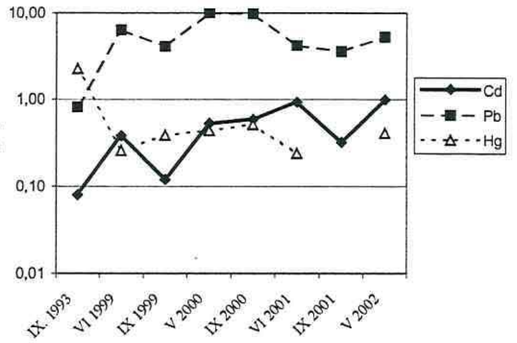

Figure 3: Cd, Pb, Hg long term-trend
Hřensko - Asellus aquaticus

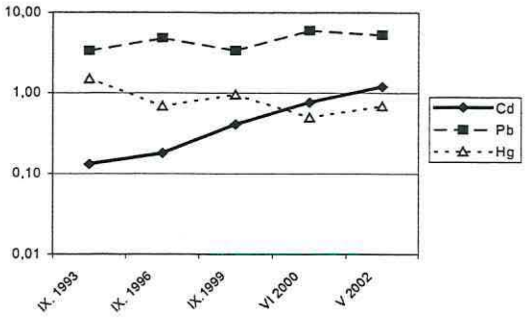

Figure 4: Cd, Pb, Hg long term-trend
Obříství - Erpobdella octoculata

In the material taken from the Labe river catchment was found a negative correlation between content of cadmium ($y = -0,7431x - 0,2561$, $r = 0,71$) and lead ($y = -0,409x + 0,578$, $r = 0,66$) in the biomass and average dry weight of individual (Figure 5). For the mercury this correlation was not confirmed.

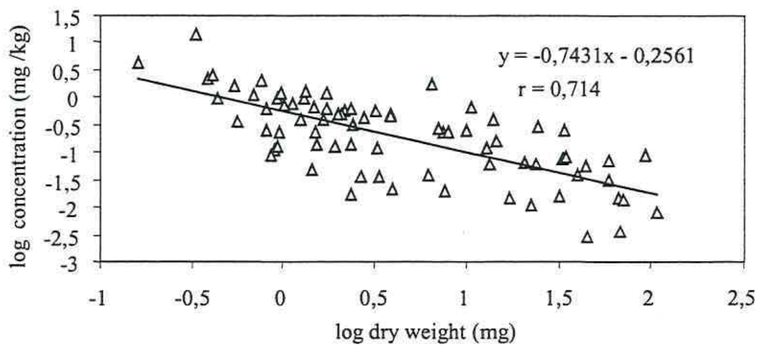

Figure 5: Negative correlation betveen content of cadmium in biomass and dry weight

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Occurrence and composition of humic substances in waters of the catchment area of Fláje Reservoir (Ore Mountains)

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Since the beginning of the last decade in 1990 a significant increase in natural organic matter-concentration (NOM) in surface waters, especially in drinking water reservoirs in the mountains of Central Europe, can be observed. With these changes consequent problems with water treatment in water plants are connected (color, DOC, COD, higher biodegradability in the water net-work, building of carcerogenic THM compounds as a consequence of desinfection etc.) . In the framework of the Czech-German bilateral (BMBF) project „Humine Substances in the Ore Mountains“ (cooperation of 4 institutes: DVGW TZW-Karlsruhe, TU-Dresden, VÚV-TGM-Prague and ČVUT-Prague), aimed at the issue of occurrence, causes and subsequences of increased contents of humine substances in water-supply reservoirs in the Ore Mountains, concentrations of 18 basic chemical parameters in waters of the catchment area of the Fláje reservoir have regularly been monitored (since June 2001) at one-month intervals. In the tributaries of the reservoir there have been found relatively high concentrations of dissolved organic carbon (DOC), aluminium and iron, owing to the occurrence of humine substances, which fluctuated considerably during the period of monitoring. The highest concentration values of the DOC could be found during the thaw in the spring period, the lowest at low themperatures and presence of ice and snow in winter. However despite of these significant fluctuations in the tributaries, in the reservoir itself a reduction of these fluctuations comes about. At time mean concentrations of (6mg/l DOC) in water samples of the reservoir could be found. This is twice-size value of the concentrations that could be detected 20 years ago (Micka et al.1985). To identify, in more detail, the composition of the present organic carbon, the technique of gel chromatography has been applied (Huber und Frimmel 1996). The results of this monitoring have so far shown a high share of humine substances amounting to 60-80%, as well as the presence of other groups of substances, such as polysacharides, building blocks, amphiphilic substances, and some others (Fig.1) In the process of water treatment from the Fláje reservoir, preferably the fractions of bigger molecular size are being removed (Fig.2).

Simultaneously with chromatographic determinations, the biodegradable (BOM) and assimilable (AOC) organic carbon-fractions in the water reservoir and its tributaries were analysed. Both these parameters play an importaint role in assuring optimal disinfection of the treated water and its long-term stability in water net-work. About 10-30% of DOC in raw water, in the reservoir and its tributaries consist of biodegradable DOC fractions, in the treated water approximately half-size values are found. Absolute concentrations of BDOC correlate very well with relevant contents of DOC.

Present results of the project have shown, that the input of humic substances into drinking water reservoirs seems to be of very complex nature. Factors of climatic and ecological changes play an importaint role at these processes. To reach the relevant quality of drinking water in the waterwork-nets, preferently the application of more progressive technology can be recomanded.

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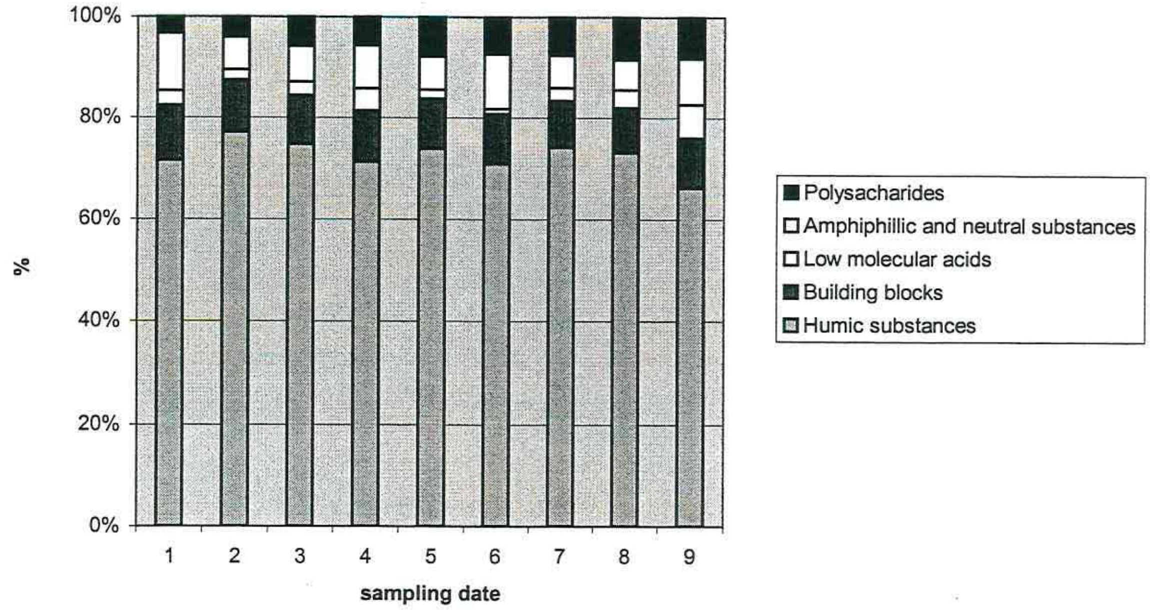

Figure 1: Composition of the natural organic matter in water samples of the Fláje reservoir in %

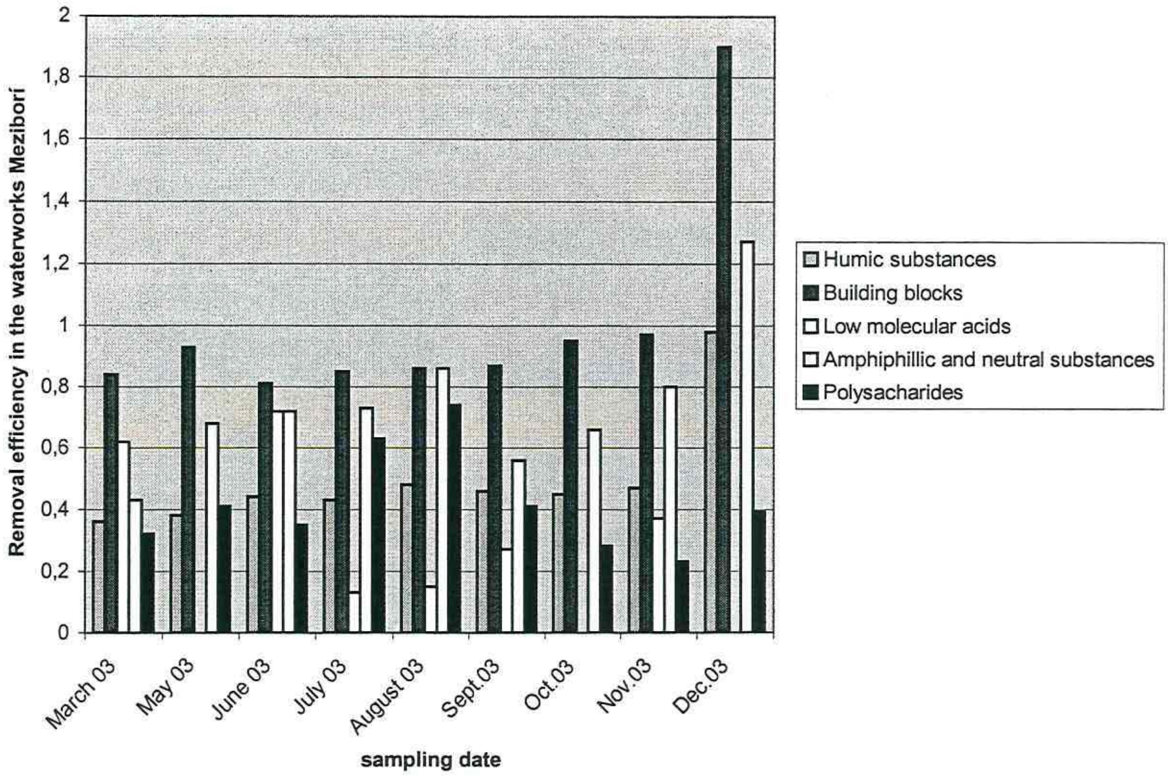

Figure 2: Removal performance of individual fractions of the organic substances at the waterworks Mezibori

Investigations on groundwater quality of the quaternary aquifers beneath the city of Dresden after the August 2002 flood events

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During a single week in August 2002 the city of Dresden, Germany, was hit by heavy rainfall, about 215 mm within 30 hours, followed by two consecutive floodings, first by the tributaries of the Elbe river and second by the Elbe river itself. These events also had a huge impact on groundwater within the quaternary aquifer. Groundwater levels were raised beyond historic records and it was suspected that the massive recharge also affected groundwater composition, especially in regard to contaminants. To investigate this problem was the aim of the work package "groundwater composition" of the research project "Impacts of the Flood August 2002 on the Shallow Aquifers in the Dresden Region - Approaches and Recommendations", which was financed by the German Ministry of Education and Research (BMBF). Partners in the work package were the Dresden University of Technology, represented by the Institute for Groundwater Management, the local water supplier DREWAG, the Dresden office for environmental affairs, and the Dresden Groundwater Research Center (DGFZ).

Using chemical records between 1998 and 2003 of more than 250 groundwater monitoring wells within the quaternary aquifer (about 118 km²) this study tries to identify substantial changes in groundwater chemistry after the flood events. Therefore post-flood records of parameters are compared to the range of these parameters in each well during the reference-period spring 1998 until the floodings in summer 2002. For this analysis only wells are used which were sampled at least 5 times before the flood. Records are classified as within pre-flood range, above pre-flood maximum or below pre-flood minimum. In addition relative changes of post-flood measurements compared to the sampling in spring 2002 are identified.

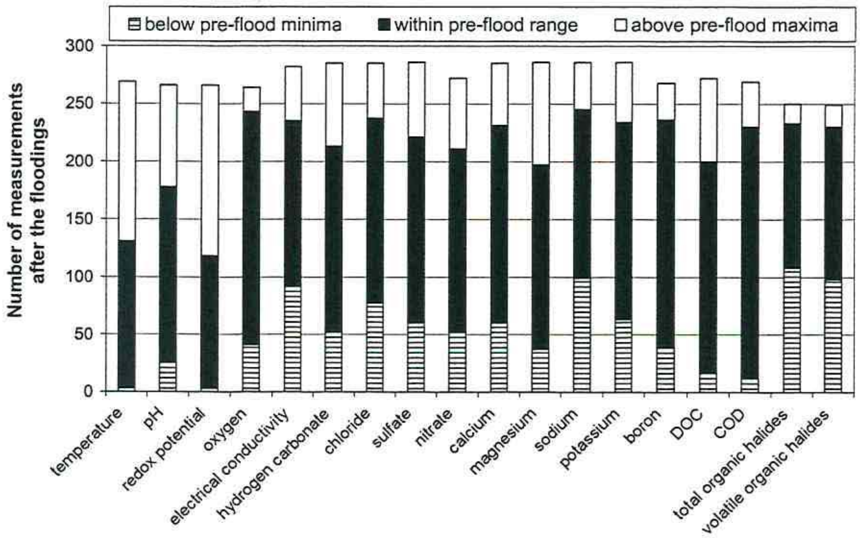

Figure 1: Post-flood records in relation to pre-flood ranges for each sampling well.

Compared to the reference period several changes of single chemical parameters can be seen after the flood (Figure 1). Most obvious is an increase in groundwater temperatures and redox-potentials. Although a general increase can be noticed 2 years before the flood, fall 2002 shows a strong increase of temperatures, especially in the uppermost part of the groundwater body. In 2003 this increase declined. Meanwhile redox-potentials, which started to rise in 2001, continue their trend. Also a less strong increase of pH can be seen. In figure 1 also a decrease of organic halides (halogenated hydrocarbons) can be noticed. Although this continued a trend of decreasing organic halides, which started before the flood, the flood might have accelerated this process. Besides the strong trends of the parameters mentioned above many other parameters in figure 1 also show high percentages of measurements outside their pre-flood ranges. However, changes do not show the same strong preference towards very high or low values. For example magnesium shows a trend towards higher, sodium, chloride or electrical conductivity towards lower values. Other parameters like sulfate, nitrate, calcium and potassium also show high percentages outside pre-flood ranges but reveal almost no trends.

Increases and decreases of concentrations are often located close to each other. Neither local nor vertical preferences can be noticed. This, however, is not true for dissolved organic carbon (DOC). Although DOC shows rather few extreme concentrations, it does show a strong preference towards high concentrations. If compared to concentrations in spring 2002 post-flood concentrations show single extreme increases. They often amount to more than 100%. Looking closer at those extreme DOC-increases it can be noticed that most of them were detected in fall 2002, especially in September 2002, in the uppermost part of the groundwater body. One example is shown in figure 2. In 2003 only very few extreme concentrations were detected.

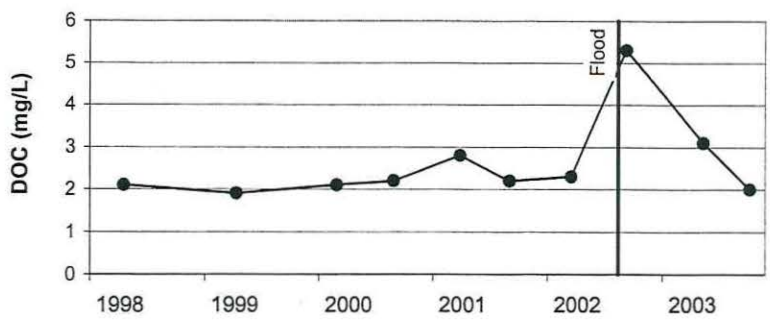

Figure 2: DOC concentrations in one strongly affected well

The increase in water temperatures, the decrease of organic halides and to some degree the changes in electrical conductivity, of some ions and of DOC can be attributed to the infiltration of large volumes of rain and surface water from flooded areas. This water was comparably warm, low in organic halides and dissolved solids but comparably rich in DOC. Decreasing oxygen-concentrations in figure 1 could be explained by oxygen-depletion in standing water on flooded surfaces. Surface waters passing through preferential pathways like flooded wells might have played a major role in local DOC-increases. The high percentage of changes of other parameters suggests that they were also affected by the flood events. Almost equal numbers of very high and very low values further point towards more than one process which might have caused changes. Infiltration of surface water probably has reduced concentrations except for DOC by dilution while solution processes in the previously unsaturated zone or from contaminated areas led to increasing concentrations. So apart from a few exceptions changes mostly cannot be attributed to a single cause. Immediately after the flood the groundwater quality slightly decreased. This, however, did not prevail, since in 2003 groundwater-quality was up again at the pre-flood level or even better. Also looking at strongly affected wells, parameters showing changes in fall 2002 were often back to normal in 2003 as can be seen in figure 2.

Concluding the findings above it can be noticed, that several parameters changed sufficiently after the flood, but no lasting negative effect on groundwater quality can be detected. Several sources for these changes seem possible, but only in very few cases those changes can be attributed to a single source.

Effect of climatic and hydrologic factors on the Elbe River water quality between 2000 and 2003

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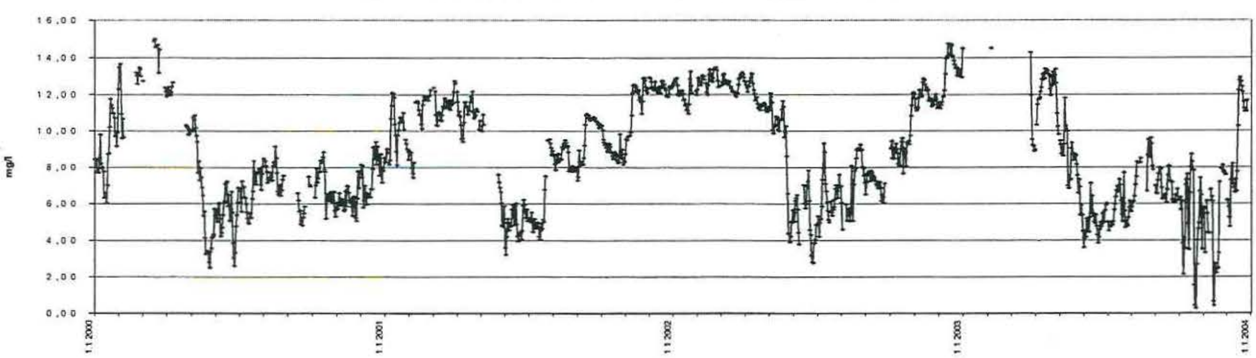
Povodi Labe, s.p. operates four automated water quality monitoring stations (MSs) on the Elbe River – Valy MS, Lysa nad Labem MS, Obristvi MS, Decin MS. The following indicators are measured continually: dissolved organic carbon content, dissolved oxygen content, ammonia nitrogen content, phosphatic phosphorus content, pH value, conductivity, turbidity (water cloudiness), UV absorbance, temperature, and exposure to light; the Valy and Obristvi MS also monitor the flow rate.

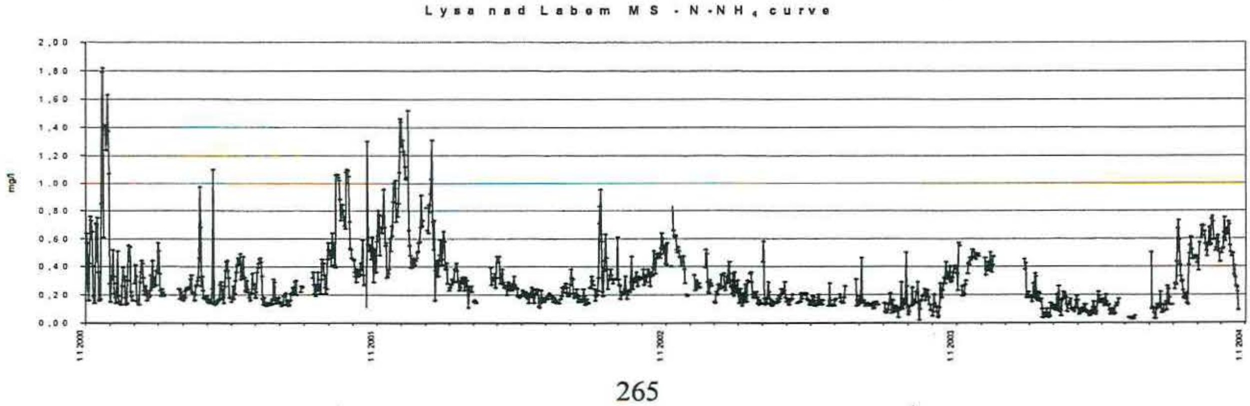
Within the last two years, the Elbe River flow regime has experienced two extremes – unusually high discharges in August 2002 that were grater than a 550-year water passage and long-lasting periods of very low discharges in the second half of 2003. Full analysis of the selected indicators observations from the continual 2000 – 2003 monitoring was carried out to determine the impact of temperatures and flow patterns on the water quality curve during individual years.

Temperature considerably influences the contents of dissolved oxygen and ammonia nitrogen. Transport of suspended solids and formation of turbidity are closely tied with the river flow rate. The composite action of changing temperatures and flow regimes leads to water quality anomalies. When the temperatures are favorable, in periods between April and October, the nitrification processes are intensive and the content of ammonia nitrogen reaches minimum values; however, there is a secondary effect – a significant withdrawal of dissolved oxygen. Watercourse sections, in which the re-aeration process is limited, experience critical deficit of oxygen during certain combinations of unfavorable circumstances as was recorded at Lysa nad Labem MS at the end of long-lasting drought in 2003. The ammonia nitrogen content in winter is several times higher than in summer.

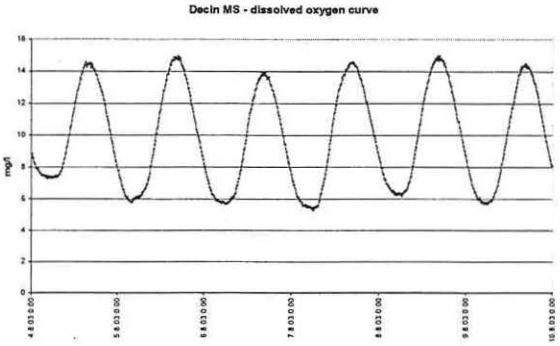
Lysa nad Labem MS - dissolved oxygen curve

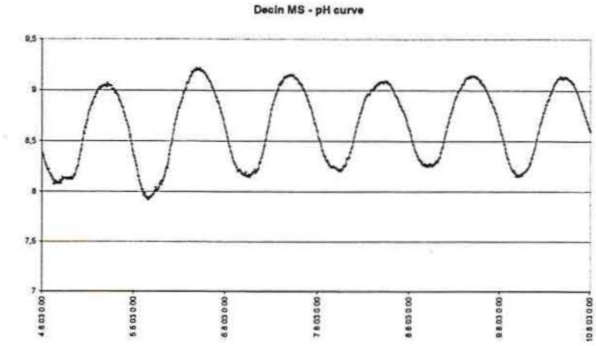


Lysa nad Labem MS - N-NH_4 curve

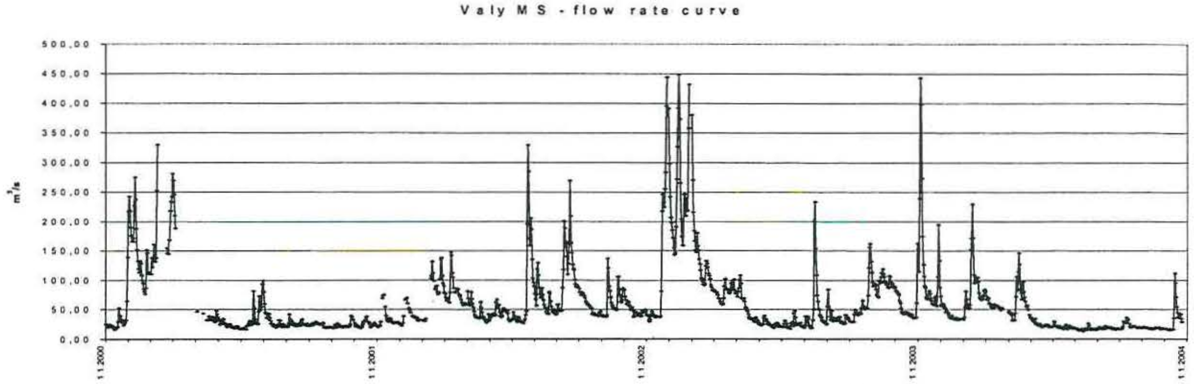


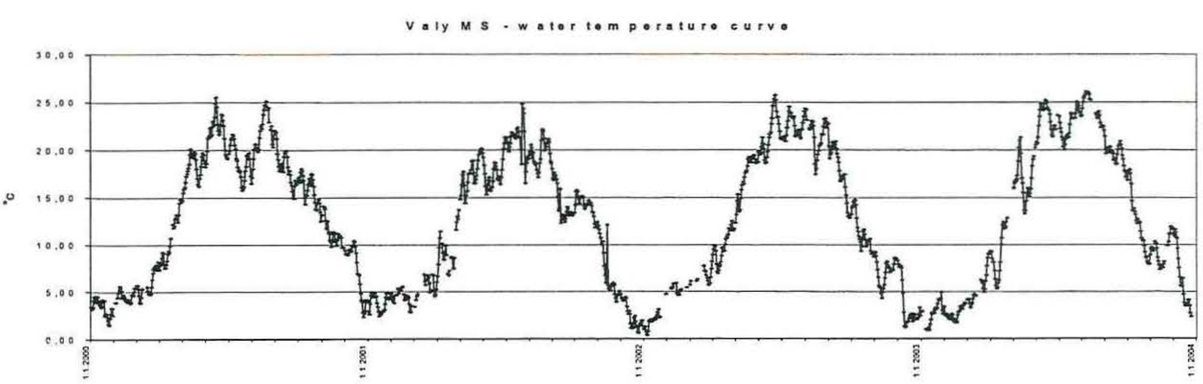
The dissolved oxygen concentration curve is significantly influenced by photosynthesis process. Especially favorable conditions for development of organisms that benefit from photosynthesis occurred on the Elbe River downstream the confluence with the Vltava (Moldau) River in 2003. During continually low flow rates and good light and temperature conditions of the summer season, the development of organisms peaked in August. In Decin, the difference in the content of dissolved oxygen between the morning minimum and the afternoon maximum peaked at 9mg/l. Previous years, the content difference had not exceeded 4 mg/l. Photosynthesis also influences the daily cyclic variation of water pH value up to one unit and, on a smaller scale, has an impact on other WQ indicators as well.





The yearly temperature sequence is usually regular and fairly undisturbed; however, the flow rates are unstable and ambivalent. Spring seasons are usually more water abundant. Higher flow rates help to decrease the ammonia nitrogen water pollution and to improve the oxygen regime.





Our own model for microbiological evaluation of water in small municipal lakes exemplified by Rusałka Lake

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The studies aimed at evaluation of water samples originating from a small (area of 3.7 ha) municipal lake, Rusałka, in Szczecin according to our own model protocol. In many towns, municipal lakes are located in recreational areas or parks. Despite such a localization, water in the reservoirs remains, unfortunately, out of any control of the Polish legal system(Program Państwowego Monitoringo Środowiska na lata 2003-2005). The binding in Poland system of monitoring surface waters bypasses small water reservoirs. The voivodship of West Pomerania includes 1031 lakes, every of 1 to 10 ha in area. In 1997-1998, the monitoring included 32 lakes but just two of an area below 10 ha, in 1999 nine lakes were examined but just one of an area below 10 ha, in 2000 and 2001 among 15 lakes examined just one showed an area below 10 ha.

Rusałka lake remains situated in a valley between hills of Park Kasprowicza in the centre of Szczecin. Area of the container is 3.7 ha. The lake is elongated, its maximum width is 40 m and maximum depth is 2 m. In the lake no stratification of wave formation is observed. The lake is supplied with the stream of Osówka. Excess of its water is drained by a subterranean pipe to Odra river.Unfortunately the water container is supplied with water streams carrying various contaminants (mainly sewage), which necessarily turns the lake into water cleaning stations. Thus, the water containers may pose a threat to humans and animals, acting as reservoirs of potentially pathogenic bacteria (Deptuła, 1995) and viruses (Kocwa-Haluch, 2001), therefore the monitoring of water purity in small municipal lakes is regarded necessary. On the basis of ecological interview and analysis of the terrain shape, two sites of water sampling were selected, including site A close to the inflow of Osówka and site B on the opposite side of the lake, close to its outflow.

The studied followed a model of our own for evaluation of aquatic environment which was worked out at the Department of Microbiology and Immunology and encompasses 13 microbiological parameters in contrast to just one such a parameter in the official procedure: the titre of fecal type E. coli. The model was worked out when Poland was at the beginning of the road to joining EU and the aim of the undertaking was to create a model of water monitoring more coherent to the standards of EU which impose limitation of chemical parameters in favor of biological parameters.

The studies were performed between January and December, 2002, collecting water samples once a month at two sites (A and B). Microbiological studies comprised the following analyses: the number of determined pollution degree indicator bacteria (TVC 20°C and TVC 37°C) and for sanitary state indicator bacteria (total coliforms - TC, fecal coliforms - FC, fecal streptococci - FS) and bacteria of physiological groups – denitrifying, ammonifying, sulphate and sulphite-reducing bacteria. At the site of sampling water and air temperatures were measured. The study allows to evaluate degree of pollution in the container and also allowed to track a process of self-purification of water in the container.

Results of microbiological tests obtained in the analysed water are presented in the two tables 1 and 2.

Table 1: Results of microbiological studies (sanitary bacteria) originating from Rusalka lake

Sampling site		Temp. of water (°C)	Temp. of air (°C)	MPN total coliforms	coli titre	MPN faecal coliforms	faecal coliforms titre	MPN faecal streptococci	TVC 37°C	TVC 20°C
A	range	0.5 – 20.0	-10.0 – 19.0	230 - 13000000	0.4 – 0.00008	37 – 230000	3.0 – 0.0004	0 – 11000	300 – 185000	620 – 23000
	average	**9.5**	**8.8**	**146586**	**0.046**	**42665**	**0.335**	**2308**	**16973**	**11733**
B	range	0.5 – 21.0	-10.0 – 19.0	23 -13000	4.0 – 0.008	13 - 6200	8.0 – 0.02	0-8200	30 - 5600	750 - 61000
	average	**10.6**	**8.8**	**3031**	**0.568**	**584**	**2.84**	**1033**	**1000**	**11358**

Table2: Results of microbiological studies (bacteria of physiological groups) originating from Rusalka lake

Sampling site		MPN denitryfying bacteria	MPN amonifying bacteria	MPN sulphite reducing bacteria
A	range	93000-11000000	21000 - 110000000	3 - 2300
	average	**4768677**	**17043417**	**492**
B	range	3 - 2300000	3 – 240000000	3 - 1500
	average	**492584**	**21584417**	**149**

Analysis of the obtained data permitted to conclude that the highest values of most of the parameters were noted in September at site A and in February and September at site B. The lowest levels of „the physiological group bacteria" were detected at both sites in August but no such a regularity could be noted at any of the sites in cases of TVC 20°C, TVC 37°C and sanitary bacteria.

It remains difficult to compare our own results with results of other authors since literature of the subject contains no studies on analogous microbiological testing of municipal lakes (Niewolak, 1972; Niewolak, 1989). Basing on the number of sanitary state indicator bacteria we can state the that water in the studied container is very polluted. Analysis of mean values at the studied sites and the examined period of time demonstrated higher levels of the examined parameters at site A as compared to site B, which seemed to be linked to draining of organic substances to the reservoir. The presence of high number of the bacteria of physiological groups indicate on the progress of the process of self-purification of the water

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Occurence of some dangerous substances in surface waters in Czech Republic

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In the years 2000 – 2002 we participated in solution of project VaV 650/03/00 „Occurence and movement of dangerous substances in hydrosphere of Czech Replublic“. Target compounds - some chlorinated substances (HCBD, OCS), sulfonated naphthalenes, synthetic complexing agents (EDTA, NTA, PDTA), synthetic musk compounds (musk xylene, musk ketone, Galaxolide (HHCB) and Tonalide (AHTN)), Boron and Anthimony, alkylphenols (octyl and nonyl phenols) were monitored in selected sampling points all over the Czech Republic. Since all results of determination of alkylphenols were completly destroyed during high flood in 2002, we continued in monitoring of these compounds also in the years 2003 and 2004.

Hexachlorobutadiene and octachlorostyrene were determined by gas chromatography with electron capture detection. HCBD were found at concentrations between < 0,1 ng/l and 26,8 ng/l, OCP were detected at low ng/l levels.

Sulfonated naphthalenes were determined by SPE and IP-HPLC with fluorescent and UV detection. Sulfonated naphthalenes represented point pollution.

Gas chromatography with NP detection was used for determination of synthetic complexing agents. They were found in all samples of surface water in concentrations up to 28,4 µg/l (NTA) and 33,1µg/l (EDTA).

Analytical method for the determination of alkylphenols was GC-MS. Nonyl phenol was found in levels 40 ng/l – 12 000 ng/l.

Synthetic musk compounds – for determination of these compounds was used GC-MS. Polycyclic musk compounds were found in concentrations from 17 ng/l to 551 ng/l (HHCB) and from 3,7 ng/l to 73 ng/l (AHTN).

On the basis of obtain results were recomended regularly monitored hexachlorobutadiene and octachlorostyrene, complexing agents and polycyclic syntetic musk compounds. There is the overland surface water pollution on contaminants listed above.. Alkylated phenols, especially nonyl phenol, were also found in most of surface water samples.

Examples of the contamination of the Elbe river are on next figures.

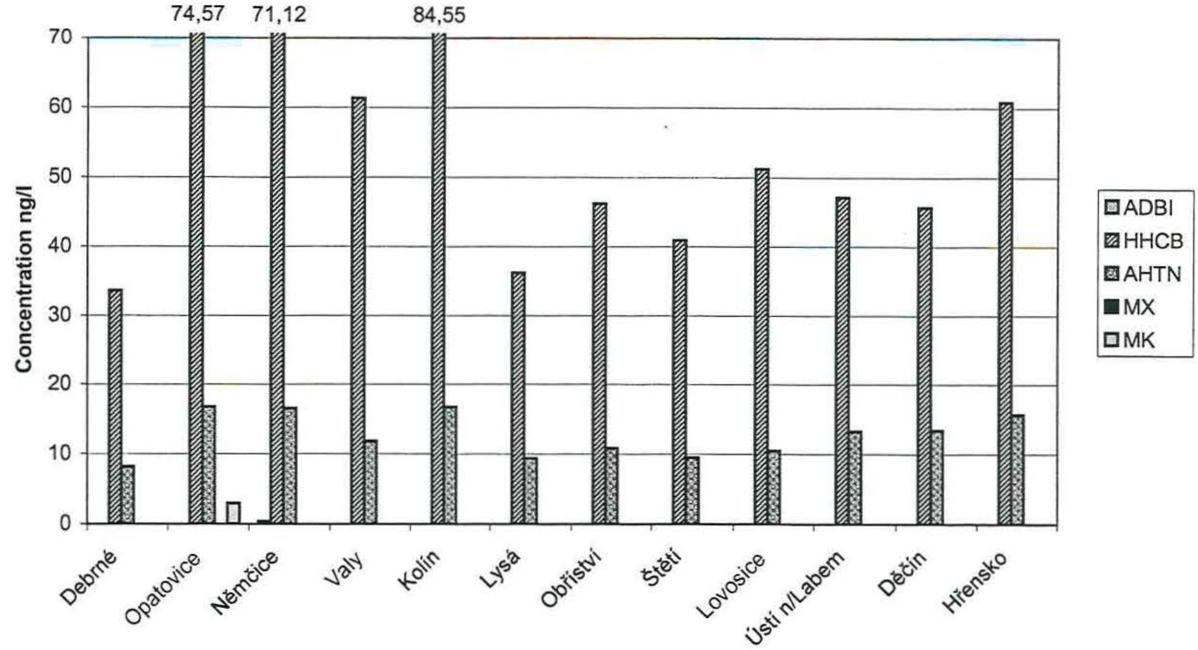

Figure 1: Syntetic musk compounds - the Elbe river – stream profile (ADBI – Celestolide, HHCB – Tonalide, AHTN – Galaxolide, MK – musk ketone, MX – musk xylene)

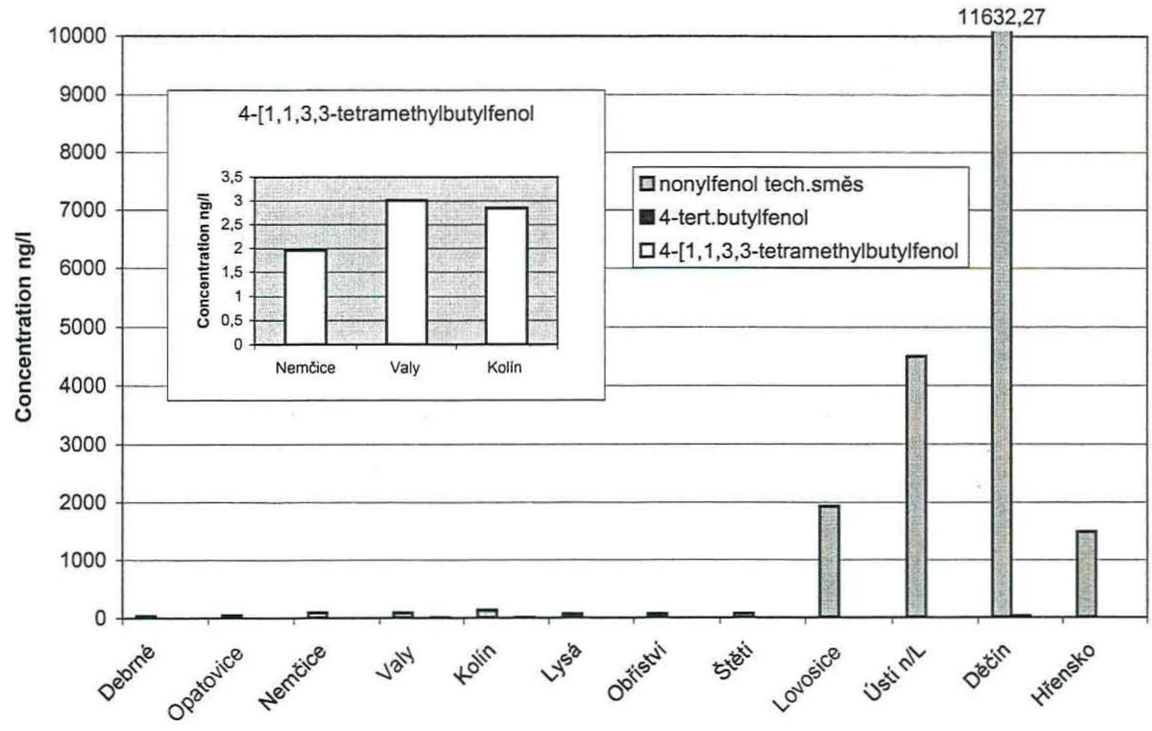

Figure 2: Alkylphenols – the Elbe river – stream profile

The application of biomarkers detected in chub (*Leuciscus cephalus* L.) to evaluate contamination of the Elbe and Vltava Rivers, Czech Republic

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In territory of the Czech Republic, the middle reach of the Elbe river and the lower reach of the Vltava river downstream Prague are the most polluted aquatic ecosystems. Heavy metals and organic coumpounds have been deposited here. They accumulate in the food chain and negatively affect the aquatic biota. The chub (*Leuciscus cephalus* L.) was selected as a suitable bioindicator for the field study. Blood plasma and tissue samples were collected from wild chub (*Leuciscus cephalus* L.) from 9 localities of the Elbe and Vltava rivers and from 1 locality of the Blanice river (control locality), Czech Republic, in 2003 (Figure 1). Samples of blood plasma were analyzed for the yolk protein precursor vitellogenin (VTG), a biomarker for estrogen exposure, and for sex steroid – 11 – ketotestosterone (11-KT) to investigate for evidence of endocrine modulation. Liver samples were analyzed for EROD activity, biomarker of aquatic environment contamination by a large spectrum of industrial pollutants. Bile samples were analyzed for 1-hydroxypyrene (1-OHPY), a biomarker of aquatic environment contamination by PAH. Fish muscle samples were analyzed for toxic metals (Hg,Cd, Pb, As), persistent organochlorine pollutants (PCB, DDT, HCH, HCB, OCS) and alkylphenols.

Figure 1: Localities monitored

Ten specimens of chub were analyzed from most localities. Altogether 90 fish were analyzed in total. Carp vitellogenin EI kit (Biosense Laboratories, Norway) was used to determine the concentration of vitellogenin (Vtg) in blood plasma. The 11-ketotestosterone EIA kit (Biosense Laboratories, Norway) was used to determine the concentration of 11-ketotestosterone (11-KT). The 1-hydroxypyren was determined by HPLC/FLD method using enzyme hydrolysis to release the analyte from conjugate (Hosnedl et al., 2003). Content of alkylphenols in fish muscle was analyzed by means of GC/MS method using isotope-labelled standard correcting the matrix effects. Persistant organochlorine pollutants were determined by means of gas chromatography. The determination of cytochrome P450 and of EROD enzyme activity was performed spectrofluorometrically. The determination of total mercury content in fish tissues was performed by means of AAS method on AMA-254 single-purpose mercury analyser. Determination of Pb and Cd was carried out by AAS method, and that of As was performed by means of AAS – hydride method.

The highest values of the content of vitellogenin (Vtg) in blood plasma of chub males were found at Zelčín (locality on lower reaches of Vltava river, affected by Prague agglomeration), Obříství (locality downstream from Spolana Neratovice chemical enterprise. Parts of territory of this enterprise are contaminated with dioxines, mercury, chlorinated aliphatic hydrocarbons, organochlorine pesticides, etc.) and Valy (locality downstream from Synthesia Pardubice chemical enterprise. Territory of this enterprise is an example of a very large complex ecological load. The territory is partly located in inundation zone of the Elbe river. A whole series of substances represents contamination: toxic metals, oil products, PCB, PAH, chlorinated aliphatic hydrocarbons, etc.) localities. The lowest values of 11-ketotestosterone content were found at Zelčín locality. It could be concluded from the results gained that the highest load of endocrine disruptors was at Zelčín and Valy localities. Load of Obříství and Lysá nad Labem localities could not be determined unequivocally due to insufficient number of males caught. A relationship between the concentration of vitellogenin and 11-ketotestosterone in blood pasma of males, assessed as a total sample from all localities, was statistically proven in terms of inverse proportion. It confirmed results of laboratory studies reporting that exposure of fish to various substances with effects of endocrine disruptors decreased the concentration of sex steroid hormones, thus also of 11 –ketotestosterone. It was also reconfirmed again that the presence of higher concentrations of vitellogenin in blood plasma of males indicated the occurrence of substances with effects of endocrine disruptors in the aquatic environment.

The highest values of EROD parameter were found at Zelčín, Valy, Obříství and Lysá nad Labem localities and it was confirmed by statistical analysis. The level of EROD parameter in fish from the control locality was significantly lower that those from all other localities studied. It can be therefore stated that all localities studies on the Elbe and Vltava rivers showed presence of substances causing the activation of CYP 450 and EROD. Results of the chemical monitoring also showed that localities with the highest CYP 450 and EROD parameters were also most contaminated with xenobiotics, mainly with persistant organochlorinated pollutants. Above all the EROD parameter is of very good reporting value when assessing the load of aquatic environment with xenobiotics.

The highest findings of 1-OHPY were at Zelčín and Děčín localities. Increased values were also detected at the control locality. Prague and its surroundings may be considered an important source of contamination of the aquatic environment with PAH.

The results of chemical analyses indicated the highest contamination of localities downstream the major chemical factories (Obříství, Valy) and agglomerations (Zelčín). Increased values of biomarkers mostly corresponded with increased values of pollutants monitored.

Acknowledgements

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Internet and the reservoirs water quality

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The water quality monitoring at the major reservoirs that are managed by Povodi Labe, statni podnik began more than fourteen years ago. Before that date, only the water quality in the reservoirs' tributaries had been evaluated systematically and the information on processes taking place within the reservoirs was very limited. Most of the time, the information was available only in the outputs of short-lasting studies that had been performed by specialized scientific units.

The development of field analyzers enabled Povodi Labe to set constant verticals within the reservoirs along which operational monitoring is carried out on regular basis. The number of verticals used depends on the size, morphology and importance of each individual reservoir and varies between three and ten. Our technicians measure along each of the verticals, 1 m apart in depth, basic parameters important to the science of lymnology – oxygen and temperature conditions, pH value, turbidity, conductivity, redox potential, and dissolved substances content. The degree of illumination is also observed. In recent months, this method has been employed to fluometrically determine chlorophyll-a (*the algae and cyanobacteria presence indicator*). In addition to field *"in situ"* measuring, water samples from selected verticals are collected and analyzed in more detail in laboratory. These procedures are employed at the majority of our reservoirs during most of the vegetation period, i.e. from the beginning of April to the end of October. If necessary, the monitoring is also carried out in wintertime. Since this kind of measuring is a very demanding task, it has not been carried out so far more often than once a month.

This type of monitoring is carried out at all of our reservoirs where the water quality standard requirements are higher. Such reservoirs include water supply reservoirs and reservoirs utilized for recreational purposes. However, for the broader expert and secular public, the interpretation of the monitoring observations used to be rather complicated. The gathered information was stored in large files that could be easily viewed only after the introduction of a unique piece of browser software – ReViewer.

Starting this spring, *www.pla.cz* website has been offering the most important reservoirs water quality overview updated on regular basis. In addition to the basic information on the type of monitoring and evaluation, the site also offers skeleton map data.

The progress of the water quality values is published in two separate forms.

a) Data that signalize changes within 24-hour period, or within the period of max. 3 days, are marked as progressive and are measured by the hydraulic structure staff on regular basis. Surface temperature and clarity of the water near the reservoir dam is evaluated in such manner. Daily changes also reflect in the so-called "change coefficient (CC)". This parameter is expressed in percentage, where the CC value of 100% represents the situation during which the original accumulation of the reservoir has been completely replaced by the inflowing water within a 20-day period. The 20-day period was determined empirically. As the major criteria to determine the length of this period, the length of the reproduction cycles of floating organisms was selected. Within the scope of continuous monitoring work, we also publish the chlorophyll-a concentration value that is determined on monthly basis from the water samples collected near the reservoir dam.

b) The other type of visual display projects qualitative changes of six parameters onto the entire water surface, onto selected cross sections of the reservoirs and onto lengthwise sections over the deepest parts of the reservoirs. A multi analyzer helps us to determine the selected parameters *(water temperature, oxygen content, pH value, turbidity, chlorophyll-a content)* in field.

The former type of presentation depicts the development trends in a graphic way; the latter type uses color scale to show the changes. Progressive parameters are available from fifteen reservoirs. The data of the latter presentation type are not available from five reservoirs of the fifteen mentioned.

The entire system is still in the testing stage. However, as early as today, we can say the system could become an understandable source of information for environmental officers, public health officers, waterworks operators, fishermen, holidaymakers and campers. The principle of this system is currently considered to provide a possible springboard for building up a unified monitoring network for the whole of the Czech Republic. In the nearest future, the Czech Ministry of Agriculture should be publishing our monitoring observations on its web pages.

Water quality changes in small catchment after water treatment plant building

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In the Czech Republic were builted many sewage treatment plants in big towns and factories in last few years. That's the reason why water quality in big rivers is still improving. But situation in small catchments is different. Many (or almost all) of them still haven't sewage treatment facilities. It effects water quality in these catchments. Water has high level of organic compounds and rarely isn't effected by eutrophication. Because of new laws brought by EU this situation is going to change. There are many small water treatment plants (up to 2000 citizens) under construction now all over the Czech Republic. But only building such a facility doesn't always have to mean that state of water quality will be better.

Similar situation as written above is also at Pyšelský brook catchment (2,45 km^2) in central Bohemia. This watercourse is 2,2 km long and has average flow of 7,3 l/s. There are 3 ponds on the brook, 45% of the basin contain a built-up area and infrastructure, 31% agricultural areas, 20% forest and 4% meadows. Brook was polluted with sewage water from about 650 citizens of village Pyšely until September 2002, when new sewage treatment plant (planned for 2 050 citizens) was started up.

In context with building treatment plant several analyses were done in this catchment. Samples were taken in total eleven times at 12 spots between March 2001 and May 2002. Following indicators were analyzed: temperature, conductivity, PH, COD_{Mn}, O_2, BOD_5, water hardness, Ca^{2+}, Cl^-, Fe^{3+}, N-NO_2, N-NO_3, N-NH_4 and P-PO_4.

Evaluated indicators reached various values, but most of the spots on the brook were judged from III. to V. water quality class (scale of 5 classes, fifth one is the worst). Analyses also showed that water self-purification is significant in ponds and brook (Rödlová 2002).

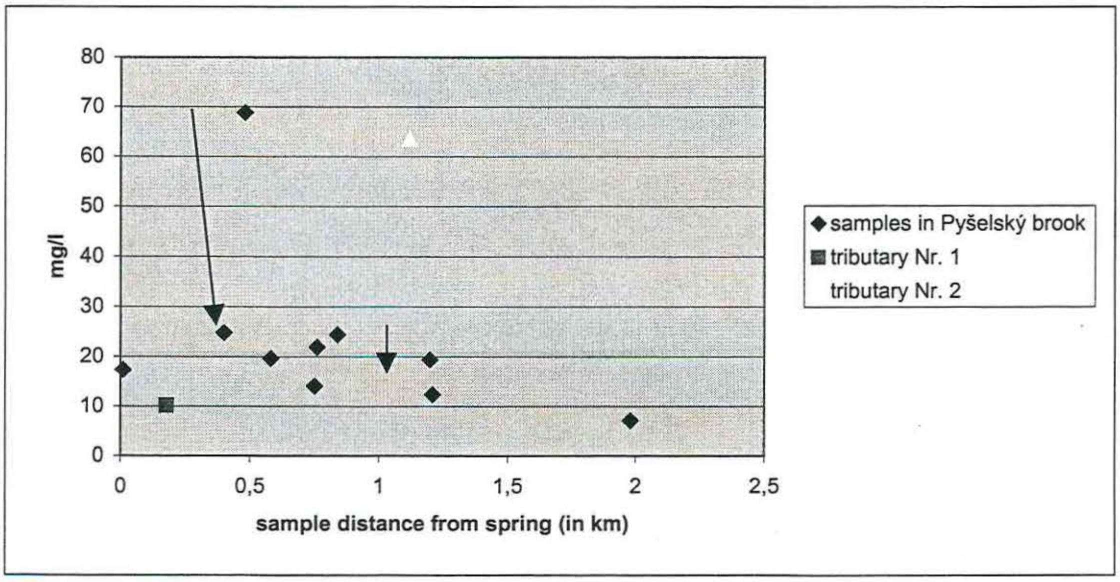

Figure 1: Evaluation of COD_{Mn} in longitudinal flow profile through characteristic value C_{90} (given in norm). Arrows show COD_{Mn} reduction in pods.

Calculations which were based on treatment plant technology projects (Holíková 2000, Jarolím 2000) showed that full used treatment plant will be not able to clean the sewage water to desired purity (Rödlová 2002). The norm says that water quality under the treatment plant must be in worst case in III. quality class. Hypothetical water quality (I. class) was used for calculations – influence of sewage water in brook was taken out, because it will go through the treatment plant and inherent pollution was neglected. In these conditions the water quality down-stream from treatment plant was assessed as IV. quality class. Unexpected situation comes about - after sewage treatment plant starting water quality in catchment gets worse.

This situation is caused by excluding self-purification from the system (all 3 ponds are up the streem from treatment plant). Concentration of polluted water to one place in the brook will lead to worse state of water quality down from the treatment plant. Even the water quality up from the treatment plant will not be obviously better although there will be no more income of pollution, because previous contamination is bounded in considerable amount of sediments.

Table 1: Comparing of some indicators before and after sewage water treatment plant starting in Pyšelský brook catchment. Samples were collected 17.4.2001 and 21.4.2004, treatment plant was started in September 2002. Samples up-stream from treatment plant: Nr. 3 – 1st pond, Nr. 5 – 2nd pond, Nr. 10 – 3rd pond, sample Nr. 12 is down-stream the treatment plant. Grey background shows indicators increases.

sample	BOD_5		COD_{Mn}		$P\text{-}PO_4^{3-}$		$N\text{-}NO_3^-$	
date	2001	2004	2001	2004	2001	2004	2001	2004
3	1,64	18,13	40,80	18,56	0,01	0,07	1,75	1,28
5	12,23	12,90	16,8	12,00	0,01	1,04	2,26	2,3
10	16,33	-	23,4	26,4	0,38	1,02	0,85	2,2
12	8,86	3,95	15,2	5,6	0,36	1,00	1,70	17,44

Improve of water quality in ponds and under the treatment plant isn´t very distinct. It could be supposed, that organic copounds will be removed (as table confirms). But between outfall from treatment plant and location of sample nr. 12 is wetland with growth of reed which works as a biological treatment plant and removes part of organic pollution. Furthermore treatment plant processes now only about 1/3 of planned sewage water. It means that sewage tratment is now much more effective than it will be in future. Elements which couse eutrophication (P and N) will not be removed in treatment plant (it can be done only with some special technologies). All ponds contain these elements in sediments, which must be removed to improve the water quality in catchment.

Situation of Pyšelský brook indicates two problems with new treatment plants. First one concerns treatment technology. There can be good organic compounds removal, but usually there is no third level of purification – phosphorus and nitrate removal which means need to add this type of cleaning in future. In addition to missing phosphorus and nitrate removal it must be said that even not every treatment plant have satisfactory organic compounds disposal. The other problem deals with improving of water quality state in upper catchment (up from treatment plant). It can't be reached without other effective actions.

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The reduction of persistent organic pollutants (POPs) in the Baltic Sea environment: possible or not?

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Persistent organic pollutants (POPs) are a group of chemicals which are very resistant to natural breakdown processes and therefore extremely stable and long-lived. POPs are not only persistent in the environment but many are also highly toxic and bioaccumulate in the tissues of animals and humans. Most do not occur in nature but are synthetic chemicals released as a result of anthropogenic activities. Vast amount of POPs have been released into the environment and due to long-distance transport on air currents. POPs have become widespread pollutants and now represent a global contamination problem.

The marine environment of the Baltic Sea, a semi-enclosed coastal sea with a water residence time of approximately 20 years (Reiheimer 1995), is contaminated with many POPs. There have been substantial inputs of POPs into the Baltic, from numerous sources, over the past 50 years. The sources include industrial discharges, such as the organochlorines in effluent from pulp and papers mills, runoff from farmland and dumped wastes. Currently, the use of DDT is banned for this area, but it is still used by tropical and sub-tropical countries in great amounts. The long-range transport of DDT from lower to higher latitudes is supported by the general atmospheric circulation pattern, and by the temperature gradients which facilitate evaporation in the tropics and condensation and precipitation in the colder regions (Bignert et al.1998, HELCOM 1996, Koziol and Pudykiewicz 2001). Of the world-wide production of about 1 million t PCBs, about one third ends up in mobile environmental reservoirs. Axelman et al. (2001) on the basis of semi-empirical mass balance with measured concentrations in different compartments of the Baltic Sea calculated a net deposition of 600 kg/year for seven congeners. Wania et al. (2001) estimated wet and dry deposition from air to constitute 47% of the annual input to the Baltic Sea. Other sources where direct discharges (21%), riverine inflow (18%) and inflow from the North Sea (14%).

The measurements executed within Integrated Monitoring Programme of the Baltic Sea Environment HELCOM/COMBINE confirm that declines in the levels of PCBs and DDT have occurred in some fish from the Baltic Sea over the past 30 years. In herring muscle PCBs have decreased to about 15% of levels of the early 1970s and DDT to 5% of 1970s levels. Now it is very important to answer the question: it is possible and when to reduce the level of POPs contamination to the concentrations e.g. from the North Sea?

In this paper organochlorine pesticides (DDTs, HCHs, HCB) and polychlorinated biphenyls (PCBs) are analysed in pelagic herring (*Clupea harengus*) caught in the Baltic Sea. Historical time trends of POPs from the 1970s to the year 1998 are calculated on the ground of the HELCOM Database. The data over the period 1998-2000 come from the own analysis.

The temporal trend for ΣDDT in herring is a decrease over the entire period. The longest time series going back to the late 1960s/early1970s reveal an annual decrease of about 7% in herring from the southern Bothnian Sea and off 11-12% in herring from the Baltic Proper (Figure 1a) (Olsson et al. 2002). Time series starting in the early 1980s or latter all show a similar decrease in the range 9-14% in the Bothnian Bay and Bothnian Sea and 5-11% in the Baltic Proper. The decrease in concentration is statistically significant during the last 10 years for pelagic biota, like herring. The ΣDDT concentration also decreases at a similar rate in long-term monitoring studies going back to the late 1960s in Swedish fresh waters from the south to the northern most Subarctic regions of Sweden (Olsson et al. 2002). This indicates that decreases in atmospheric deposition probably also play an important role in explaining the processes in the Baltic (Bignert et al.1998, Olsson and Reutergårdh 1986). Concentrations of DDT and its metabolites in herring caught in the Polish part of the southern Baltic Proper over the period 1998-2002 showed consequently downward trend. However, the DDT concentrations in the Baltic Sea are more than five times higher than in the open ocean (HELCOM 1996). The annual decrease in α-HCH concentration ranges from 12 to 22 % in herring during the 1980s and 1990s (Figure 1b). With lindane the annual decrease is more varied, ranging from 6 to 8% for herring from the Kattegat and 8 to 24% for herring in the Bothnian Bay and the Baltic Proper (Olsson et al. 2002). The annual rates at which the concentration of HCB in the Baltic Sea is decreasing ranges from 6 to 18% (Olsson et al. 2002). The decrease is generally lower in the Baltic Proper (Figure 1c). Biota PCBs concentrations have been decreasing over the past 30 years. The longest time series going back to the late 1960s/early 1970s thus reveal an annual decrease about 4% in herring from the southern Bothnian Sea and about 9% in herring from the Baltic Proper (Figure 1d). Shorter time series for the pelagic herring starting in the early 1980s or later also reveal an annual decrease ranging from about 10% in the Bothnian Bay to only about 3% in the Baltic Proper (Olsson et al. 2002). The relative amount of less chlorinated and less persistent PCB congeners increased in Baltic herring samples during 1990s, thus indicating recent discharge of less persistent and more volatile congeners to the Baltic environment (Bignert et al.1999). In herring from the Polish part of the southern Baltic Proper no significant changes in concentrations of PCBs were observed during the period 1998-2002. Despite a decline, the PCB content of herring muscle samples from the Baltic Proper is about twice that in the Bothnian Bay and still several times higher than in similar samples from the open North Sea and open ocean (HELCOM 1996).

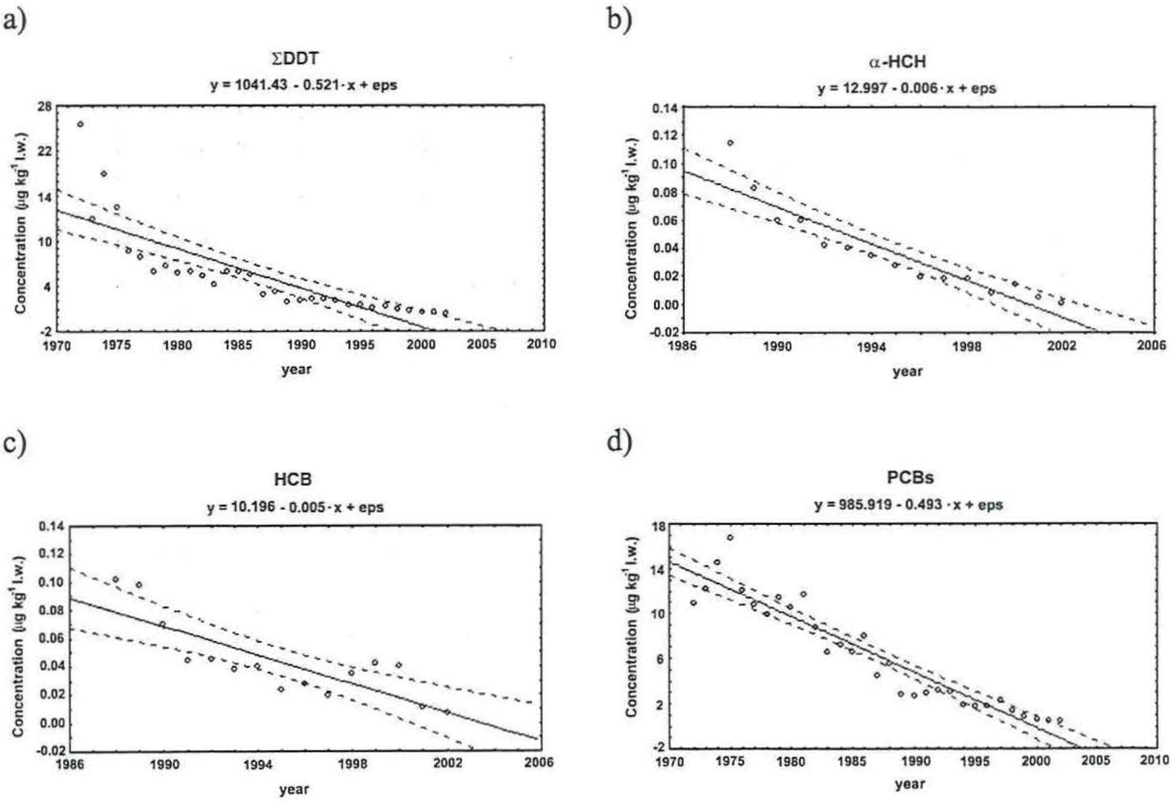

Figure 1: The temporal trends of POPs concentrations in the southern Baltic Sea

Transboundary analyses and management strategies in the catchments of drinking water dams in the Ore Mountains (Germany, Czech Republic)

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The Ore Mountains are situated at the borderline between Saxony (Germany) and Bohemia (Czech Republic), in the former so-called "Black Triangle" in Central Europe. In the 1970' and 1980' the acid rain affected very strongly the predominantly forest-economically used upper altitudes. Deforestation, soil and water acidification were the result. In this mountain range there are numerous dams. They serve for to the flood protection and drinking water treatment. Many brooks and rivers, which feed these dams, mark the course of the border or cross the border, mostly from Germany to Czech Republic. Human interferences or natural changes in the catchment of the one country can affect the water quality of the surface waters in the neighboring country. Therefore those analyses and management of the catchments are a transnational affair.

Since the beginning of the 1990's a changed transport of natural organic matter (NOM) in transboundary brooks and rivers from their catchments in the upper Ore Mountains has been observed, even in other regions in Central Europe (Heizlar et al. 2003). E.g. in forested catchment areas with a high proportion of peat bogs, high loads of NOM would be expected. The responsible factors concerning a changed NOM transfer into surface waters in the Ore Mountains are not completely known. To research the differences in NOM export from catchments, soil and water investigations were carried out (Grunewald et al. 2003). The three German drinking water reservoirs "Rauschenbach", "Muldenberg" and "Carlsfeld" and the Czech dam "Flaje" were selected to investigate the relationships between catchment characteristic, environmental changes, land use impacts and NOM output (see figure 1).

drinking water reservoir	Rauschen-bach (A)	Flaje (B)	Mulden-berg (C)	Carlsfeld (D)
catchment size (qkm)	26,3	41,6	18,4	5,3
average altitude (m a.s.l.)	730	815	770	930
area of forests (%)	78	89	98	99
peat soils (%)	10	25	31	50

Figure 1: location and general characteristic of the 4 catchments in the Ore Mountains

The phenomenon of a different NOM output from catchments can be described as a synthesis of carbon stocks (C pool), differently degraded peat bogs and a dependence on climate impacts (Scheithauer and Grunewald 2004). The C pool of peat bogs and histic soils make it possible to show that 90 % of the C pool correlates with the dissolved organic carbon (DOC) load (R^2 = 0,928) in catchments of surface waters and drinking water reservoirs of the German and Czech Ore Mountains (see figure 2). Consequently it is possible to predict the NOM output by the correlation to the area distribution of peat bogs. Catchments with a low proportion of peat bogs and therefore lower C pools show relatively low NOM loads in relation to the size of the catchment.

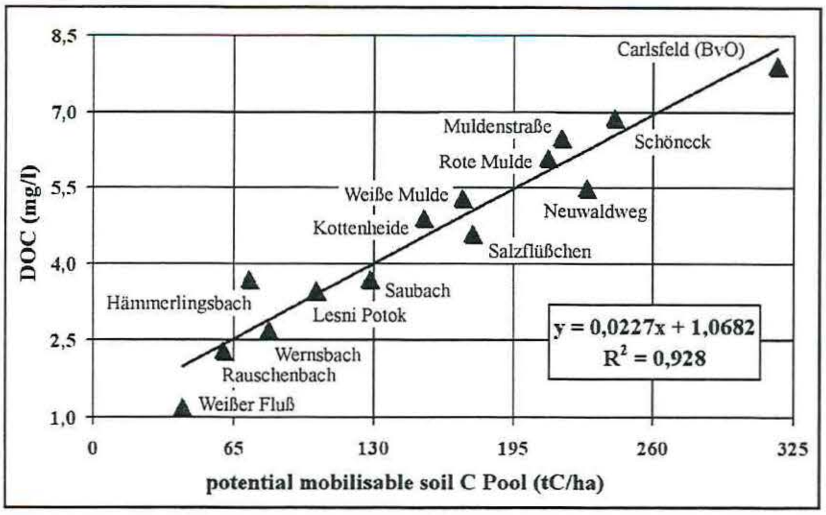

Figure 2: correlation between "potential mobilisable C pool" of investigated sub-catchments and annual average DOC concentration in the catchment runoff

Depending on the bog types and the degree of degradation the NOM output has a different value. In catchments with the same C pool but different bog types the NOM transfer possesses different quantities and qualities. Ditches regulate the water balance of most of the peat bogs. A close connection exists between peat conditions, operation of ditches and dissolved humic matter export. Thick bogs with overgrowing ditches provide a great amount of NOM to the recipients. If this bog type dominates a catchment, a high level of NOM output is to be expected in the area. Furthermore, it was shown by the comparison of the catchments, that the NOM transfer is influenced in a different way by seasonal weather variation. The proportion of peat bogs and histic soils in catchment areas determine the total amount of NOM transfer.

The given studies are part of a transboundary analyse and evaluation of guidelines for catchments, for instant the European Water Framework Directive (WFD). In co-operation between German and Czech universities and authorities comparable results and instructions were found to estimate and control the water quality of the surface waters and dams. A standardized Geographical Information System (GIS) with catchment informations was developed. Based on these GIS the modelling of matter tranfer into surface waters can be done. Modelling and prognoses is a prerequisite to determine future tendencies of humic matter flux from catchments and peat bogs, and to support this, it is important to find out additional suitable measures to improve the quality of drinking water. Nevertheless, recommendations regarding handling peatlands and other organic soils should follow the principles "Wise Use" and "Sustainability". The differences in catchment structures, carbon balances and dissolved export show clearly that each decision making is to examine for management strategies.

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Natural retention of pollutants in the Spittelwasser floodplain - overview

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1. Introduction

Near all of the large European Rivers have been and are being used as disposal pathways for unwanted substances. Emitted compounds and elements become bound to suspended particulate matter and are transported downstream. Deposition of the contaminated solids occurs in regions of slack water and also during floods in adjacent floodplains. While the freshly settled sediment in the river bed can be easily remobilised, there normally is only a marginal output of sediment from the floodplain (Schwartz and Kozerski 2004, Förstner and Jacobs 2004). As a result of the recurrent input, the floodplains of central Europe mostly represent a significant sink of manifold inorganic and organic pollutants, the composition of which is characteristic of the industrial activity in the particular catchment area (e.g. Krüger et al. 2004). The soils in these rare semi-natural floodplain habitats are contaminated on a large scale. There is considerable interest in the mobility of the pollutants present in order to assess the potential transfer to groundwater and plants. Ideally, attenuation processes occur which improve binding strength with time. The aim of this project is to demonstrate the natural retention potential for inorganic and persistent organic pollutants and their ecotoxicological relevance in contaminated floodplain soils.

2. Study site and general aspects

As an old industrial site the Spittelwasser region near Bitterfeld is one of the highest contaminated floodplain locations in Germany (Hille et al. 1992, Lindemann 2000). It is affected by pollutants such as HCH isomers, DDT and other chloro-organic compounds, distillation residues, dyes and salts. Although the actual input has been reduced significant, inorganics and persistent organic pollutants remain in the alluvial soils (Neumeister and Ruske 1995, Krüger and Neumeister 1999). The mobility status, trends and ecotoxicological relevance of the most important inorganic and organic pollutants in the alluvial soils are the major tasks of the KORA project 'Methods of detection, assessment and prognosis of intrinsic/temporally amplified retention of pollutants in contaminated soils and sediments' which is based on the considerations of Förstner at al. (2001) and Gerth et al. (2001). The project includes the following experimental sections:

- Soil profiles are investigated in detail to show depth functions and the association of different inorganic and organic pollutants with soil compounds characteristic of the Spittelwasser floodplain.
- Using chemical extraction techniques the mobile and immobile pollutants are determined to differentiate between temporary and sustainable retention effects.
- The mobile fraction of organic compounds is determined by direct probing of the pore water using solid phase micro extraction (SPME).
- Colloidal substances are analysed in the pore water to assess their role in pollutant transport.
- Mineralogical thin sections and structural analyses are used to identify recent formations of mineral phases as proof of early diagenetic processes in the soil profiles.
- Column experiments under non-saturated conditions and temperature control are conducted to simulated natural leaching and to measure the pollutant source

properties of the materials at variable water saturation and pH. Methods are devised to reduce pollutant concentrations in the leachate.
- Geochemical data combined with data on ecotoxicity of substrates and leachates provide the basis for the assessment of the environmental compatibility and measures to be taken.

In order to identify the dominant mobilisation and immobilisation processes in the soil profile during phases of inundation and dehydration the reaction conditions in lysimeter columns are controlled with respect to water saturation, temperature and redox potential. In a second step the irrigation water will be amended with alkali, acid and soluble organic matter, respectively. Thus, "labile" pollutant fractions are identified and measures can be derived to improve retention effects. The results shall contribute to a decision support system for the future use of contaminated floodplains in central Europe.

3. Acknowledgements

The project is a part of the KORA joint research programme 'Natural retention and controlled decomposition of pollutants for the remediation of contaminated ground water and soils'. It is funded by the Federal Ministry of Education and Research (BMBF), Germany under the registration number is 033 0519. We thank to Dr. F. Walkow and colleagues of the Landratsamt Bitterfeld for advice on sampling locations and help during the preparation of this project.

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An integrated concept for surface water management in a new building area in the "Eifel".

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1. Introduction

One important part of planning new building areas is to create concepts for managing the rain water occuring on sealed surfaces. The aim is to retain and ooze away the occuring surface water decentral in the private building areas or more central in a large basin for the whole terrain. (Richter 1999, Sieker 1996) Thereby the water streams reaching the next brook or river should be minimized.

For oozing the collected water in private area a minimal permeability of the soils is required by prescription. But soils and underlaying substrates in the Rhenish Shield are often less or not permeable for water because of strong compaction caused by solifluidal displacement during pleistocene. For consequense integrated and adequate concepts for retaining surface water in new living areas have to be acquired (ATV-DVWK 2002).

The aim of the investigations was to develop a surface water management plan for a new building area in the "Eifel" in cooperation with an engineering office.

2. Investigation site, soils, modelling

The investigation site is located in the "Eifel" 20 km north of Trier. Mesozoic silty sandstones, limestones and marl are dominating, covered by pleistocene solifluidal displaced mixed layers of bedrock and loess.

Nearly the whole area is influenced by waterlogging. The soils are dystric gleysol and cambisols. The measured infiltration capacities of the topsoils reach up to 20 mm/h. In the compacted subsoils the rates are only 0 to 1 mm/h.

Modelling based on soil mapping, soil physical measurements in field and laboratory, topographic situation was done with STELLA 7 Research. In cooperation with the responsible engineers, several concepts dealing with the problems of the area were constructed to handle the surfacewater. Rainwater retention, oozing and storage for private use were compared in several combinations paying attention to economy and ecology to minimize flood causing discharge.

3. Results

The non-permeability of the subsoils prohibits decentral waterretention and infiltration on the single building plots.

In the Table the volume of "overflow water" and percentage of rain of the different tested concepts for the whole test area are shown calculated by STELLA simulation. This water could not be stored in the retention area during one year and would flow to next receiving stream. Depending on the concept the water discharge for current retention concepts (retention basin, retention hollow with gravel, porous underground retention plastic boxes) differs between 2000 and 5000 m^3/year. Only infiltration and percolation of surface water in a bigger grassland area in the neigbourhood reduces the water discharge to zero. But the subsoil compactions have to be deep loosened with special machinery prior to flooding.

The size of the retention area is the factor with maximum influence for the substracting components "evaporation" and "oozing away". By now the results of the STELLA-simulation give the advice to use maximum area for water retention.
The choice for the right way to retent as much water as possible can be based on ecological, economical and optical factors.

As a final result a concept for sustainable surface rai-water management built from several components can be presented.

- A central retention area will be created on an existing ecological compensation area. It will be devided in three parts to test water retenting constructions in an uniform environment und to review the results of the STEELA ® -Simulation.
- Additionally a cascade run-over-and-retention-system and an appending seepage- and retention-area on grasland has to retend the overflow and the rain water from the area that has to be drained seperately to minimize the water discharge to the next brook.
- Rain-water use especially for toilettflush and watering the garden is a central recommendation for all building owners. Advices should be given to investors and private building owners forcing the acceptance of private rain-water use in house and garden.
- Rain-water retention on deep loosened grassland shall be tested on leasehold-land if possible

Table 1: Overflow and Percentage of rain of 6 different surface rain-water retention concepts (infiltration capacity 7 mm/d)

concept	technical details	overflow water [m³/y]	percentage of rain [%]
1	central retention basin	3146	37
2	private rain-water use and overflow to central retention basin	1767	21
3	2/3 private rain-water use and central retention basin 1/3 decentral in deep loosening area	2508	30
4	1/3 private rain-water use and central retention basin 1/3 central basin 1/3 decentral deep loosening area	3470	41
5	1/3 central basin 1/3 decentral deep loosening area 1/3 underground porous plastic box	4899	58
6	deep loosened grassland	0	0

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Trace metals distribution in the water – suspended matter – sediment system of the Rożnów Lake; use of hydrological model.

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The aim of our studies was to determine the trace metals concentration in the water, suspended matter and sediment samples of the Rożnów Lake. In July 2003 about 150 samples of water, sediment and particulate suspended matter (PSM) were taken in 42 sampling points of the Rożnów Lake. Metals from the sediment and suspended matter (the concentration of PSM was measured) samples were extracted with aqua regia, and concentration of Cr, Cu, Cd, and Pb in all solution samples was measured by ICP-MS. Statistical parameters of PSM and metals concentration are shown in table 1. In our studies a hydrological model using Surface–water Modeling System (version 8.1) was build to identify a flow velocity and the distribution of predicted trace metals contamination in the Rożnów Lake.

Table 1: Statistical parameters of SPM and heavy metals concentrations in water, SPM and sediments of the Rożnów Lake.

Parameters	Water (n = 41)				Suspended matter (n = 41)					Bottom sediment (n = 42)			
	Cr	Cu	Cd	Pb	Density	Cr	Cu	Cd	Pb	Cr	Cu	Cd	Pb
	$\mu g/dm^3$				mg/dm^3	mg/ kg				mg/ kg			
Mean	0.100	1.241	0.011	0.387	21.69	58.86	40.01	0.65	36.95	52.37	32.00	0.42	23.30
Standard deviation	0.096	0.165	0.007	0.420	22.04	22.35	12.20	0.26	11.78	21.87	5.41	0.15	4.38
Variance	0.009	0.027	0.000	0.176	485.55	499.42	148.87	0.07	138.88	478.17	29.22	0.02	19.16
Kurtosis	2.987	1.441	3.696	12.035	12.34	-0.50	3.84	-0.43	2.17	0.64	0.80	12.92	-0.49
Skewness	1.909	1.209	1.812	3.145	3.18	-0.40	0.88	-0.10	0.99	1.13	-1.25	2.88	0.16
Minimum	0.013	1.024	0.004	0.056	4.18	16.87	17.95	0.19	17.83	21.10	17.94	0.21	14.33
Maximum	0.392	1.747	0.032	2.353	125.65	98.70	85.77	1.20	77.99	107.15	38.82	1.15	32.43
Variation Coefficient %	96.5	13.3	62.7	108.5	101.6	38.00	30.5	40.1	31.9	41.8	16.9	35.9	18.8
Background value	0.5[1)]	6.0[1)]	0.02[1)]	0.2[1)]	—	—	—	—	—	5.0[2)]	6.0[2)]	0.5[2)]	10.0[2)]
Permissible value	10.0[3)]	4.0[3)]	0.072[3)]	3.4[3)]	—	320[3)]	80[3)]	1.2[3)]	100[3)]	320[3)]	80[3)]	1.2[3)]	100[3)]

[1)] (Kabata – Pendias & Pendias 1999;) [2)] (Bojakowska & Sokołowska 1998); [3)] (LAWA 1998)

Most of the obtained results showed that the Rożnów Lake is in some parts uncontaminated and in some moderately contaminated with trace metals (tab. 2). Their concentration found in the SPM and sediment samples are classified (each of metals) in the classes I, I-II and II of LAWA classification (LAWA 1998). In German class II is recommended as permissible values of river sediment and suspended matter contamination.

For water samples class II–III is typical and the metals content never exceed the limit of this class (tab. 2). The detected maximal content ($\mu g/dm^3$) for Cd (0.032) and Pb (2.353) only in few water samples exceed the natural content for surface waters i.e., 0.02 and 0.20 $\mu g/dm^3$ respectively. The other metals content do not exceed the background values for surface water.

The comparison of coefficient of variation (CV) for metals concentration in water system (tab. 1) lead to the conclusion, that mainly Cr but also Cd are the most variable metals in each compartment of the Rożnów Lake; the most uniform distribution have showed Cu.

The spatial variability of metals is very difficult to generalization. The distribution of each trace metal concentration in water, SPM and sediments is different. Considering the sediments, the highest metal concentration was found in a north narrowing part of the Rożnów Lake. A hydrological model has shown that in this part of lake water flow is the fastest. It causes both the settling of suspended matter and increase of trace metals concentration.

Table 2: Number of samples fulfilling qualitative given class of LAWA classification (LAWA, 1998). (Classes III, III-IV and IV were not meet).

Purity classes	Water (n = 41)				Suspended matter (n = 41)				Bottom sediment (n = 42)			
	Cr	Cu	Cd	Pb	Cr	Cu	Cd	Pb	Cr	Cu	Cd	Pb
	number of samples meet purity class											
I uncontaminated	41	—	22	30	35	1	7	7	35	2	7	29
I – II uncontaminated to moderately contaminated	—	—	19	7	6	16	9	30	7	40	33	13
II moderately contaminated *	—	41	—	3	—	23	25	4	—	—	1	—
II – III moderately to strongly contaminated **	—	—	—	1	—	1	—	—	—	—	1	—

* recommended permissible value of sediment and suspended matter pollution, ** recommended permissible value of water pollution

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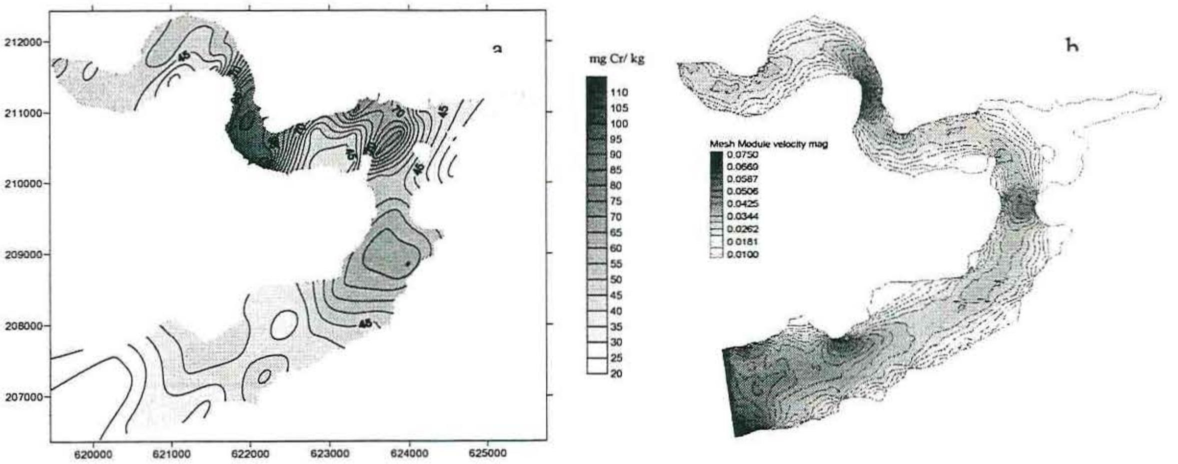

Figure 1: Concentration of Cr in sediment of the Rożnów Lake (a) and SMS velocity contour plot for total flow 330 m^3/ sec and dam level equal 269 m above see level (b).

Functions of bankside trees and shrubs - Pre design of the bankside vegetation

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Bankside trees and shrubs are one of the building blocks of territorial systems of ecological stability (TSES). It is part of an ecologically balanced landscape, a form of spread green vegetation growing outside integrated forest complexes. It is created by tree species and herbs growing along streams. In relation to stream regulation, linear building along water streams etc., a lack of riparian and accompanying stands started to manifest negatively. We can say that only once it decreases, will we start to realise its indispensability in our landscape.

To avoid errors resulting from the misunderstanding of the essence of the function of streamside trees and shrubs in the future, it is necessary to realise that streamside trees and shrubs, requirements for their spatial arrangement and quality of the biological function are among the basic aspects of the stream regulation draft conception. This means the issues related to the vegetation design will be of equal importance for a designer as the issues of capacity and stability of the designed riverbed.

To design suitable riparian and accompanying stands, it is important to understand the division of riparian zones according to the best prospering types of vegetation:

profundal zone: a continuously flooded part of banks, colonised by freely floating, immersed, rooted or not - duckweed, pondweed etc.
sublitoral zone: it is often called the reed zone – reed, calamus, flowering rush and others.
eulitoral zone: a wide range, in lower parts knotweed, reed, cattail flag, near the surface soft tree species - willow, alder, poplar
supralitoral zone: above the level of the design surface, rare flooding, area of accompanying stands of English oak, ash, maple, lime tree…

1. Generally Valid Recommendations for a Suitable Design of Accompanying Vegetation:

1. To achieve a quality riparian or accompanying stand, it is advisable to leave part of indigenous stands, even if they are less suitable, possibly groups of fully-grown tree species, and to carry out the new planting in relation to them and under their protection.
2. Species for new planting shall be selected with a view to their future prevailing function, in particular taking into consideration whether they function as an accompanying stand (planting behind the riverbed bank line, on berm slopes as a maximum) or as a riparian stand (planting within the stabilisation of the riverbed and creating a direct relationship between the stand and the stream within the flow profile, on riverbed slopes). Or, especially in the case of smaller streams, a combination of both.
3. Monostichous, basically alley planting is not the most suitable solution either from the environmental or from the landscaping point of view and the value of such stands being part of the accompanying vegetation is low. In this case, we plant tree species on such side of the stream where they can partially shade the riverbed and we try to use, wherever possible, unexploited areas adjacent to the stream for additional planting which will increase the value of the accompanying vegetation.

4. Within the design of vegetation species structure, we should not forget shrubs, which have their indisputable place, and vital grassland, which is basic protection against the occurrence and development of erosion on the bank slope.
5. We propose in particular autochthonous species; other species only in special and justified cases. The planting of species unsuitable from the phytocoenological or landscaping point of view (exotic species, species more of collection importance...) may have a disturbing effect on the surrounding landscape.
6. When designing in particular riparian stands, it is necessary to realise the low reinforcing effect of young stands (this mostly does not concern sprouts).
7. Over-aged plants, windthrows, dry plants, or plants intended to be disposed of for any other reason must be removed prior to starting the planting of newly designed species so as not to damage new young plants.
8. When newly establishing riparian stands of a regulated riverbed, first plant above the level of approx. Q_{150} - (eulitoral zone, soft tree species zone).
9. To plant new tree species, use only healthy, vital plants of prescribed parameters (species, plant age, minimum height of saplings...) and time-tested planting processes. To ensure better growth, provide the plants with wooden poles and protection against browsing)
10. The pre-condition for good functioning of riparian and accompanying stands are regular examinations, tending cuts and the thinning of stands. In particular, care for stands in the first years after planting is very important.
11. When establishing or renewing streamside vegetation, always respect ownership relations and the minimum distance from parcel limits. In urban areas, follow green community vegetation in an appropriate manner.
12. The objective of planting is to create vertically distributed and diversified stands occupying the maximum space in the floodplain.

2. Final Recommendations

It is extremely important to mention that all works in the recovery of bankside trees and shrubs could misfire if we fail to ensure at least basic after-planting care. First of all, it is watering and protection against forest weed, especially at an early stage of growth, further protection against browsing, against inadequate anthropogenic intervention, etc. Care for stands is always necessary, not only at the moment of planting or tending interventions. Regular checks after winter months, topping, etc. should be among the routine activities of administrators of individual streams.

However, it is necessary to consider not only recommendations by professionals but also possibilities of stream administrators who are often not able, with the best will in the world, to provide for due and continuous care of riparian and accompanying stands.

In addition, it should be pointed out that in the case of more extensive interventions in the accompanying vegetation, project documentation of the intervention concerned must be developed in liaison with professionals from related fields. If the recovery of stands is performed within stream regulation, this project should be part of the project documentation concerning the stream regulation itself. Again, we have to remember that the accompanying vegetation includes the herbs layer as well. Suitable grass mixtures are able to protect the slope against water erosion to a great extent.

Methodology of determination potencial flood damages – basic informations

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1. Introduction

Problems of floods is due to a last years events still very actual now. Our working place is joined in some research projects and grant tasks concerning flood problems. In poster which we set forward we will focus on two tasks about work out of methodology of determination potencial flood damages.

1. Basic task is creating of database so-called „standart objects" that will be judged according to presumed damage made by flood wave.
2. Definition of chosen hydrologic characteristics of a potencial flood

2. The solution

The first step is introduction of standart objects. For the first part of solution there were chosen 17 groups of building objects that could be exposed to effect of a potencial flood (its hydrological characteristics will be presented later)

- rented, office buildings, residential buildings – closed blocks – for example: town centre, office buildings, shopping centres etc.
- concrete housing estates
- half-closed blocks of residential houses
- family houses – terrace houses, suburban and country dwellings
- detached houses with gardens, villas
- uninhabited buildings – barns, small stores
- garden cottage colonies
- residential houses – country houses
- greenhouses
- stores (masonry construction – for sport, railway, industry)
- stores (assembly construction)
- football playgrounds
- swimming pools
- tennis courts
- courts for volleyball
- bridges
- city parks

These watched objects in the first phase, were specified in details in order to an average standart item, representing each of above mentioned groups, could be defined for our needs. As an example could be shown: a detached house in a garden:

3. Detached house standing in garden, villa – characteristic of standart unit

- standing on a land surrounded by a fence
- 2 floors
- cellar

- saddle roof
- connection – water, waste, electricity, gas, telephone
- garage inside the groundfloor
- a buildings from bricks
- age – 20 – 60 years
- on bearing subsurface
- built-up area – 150 m^2

So all bulding objects would be defined in this way. According to necessity and after consultations with experts (economists etc.) definitions will be completed and accurated. In case of considering a particular considerable superior or inferior object will be object multiplied by coeficient.

In the second part we will focus on the definition of potencial flood that standart objects will be affected. We assume gradual creation of combination of these parametres:

Specification of flood:

A. speed of flow

- to 1,0 m/s
- 1,0 to 3,0 m/s
- more than 3,0 m/s

B. depth of water (height of water column in object)

- to 0,5 m
- to 3,0 m (average height of groundfloor)
- over 3 m

C. duration of floods (water on object surface)

- up to 1 day
- 2 – 7 days
- more than 7 days

Also we could count with:

D. season of the year (water temperature)

E. water pollution, running sediments

4. Close

Proposal of introduced methodology is now in phase of preparations and checking partial results. First of all we are trying to obtain maximum quantity of basises from afflicted areas and to work them out to form that could be used for our next work and mostly to verify its results.

Proboscis worm (*Prostoma graecense* Böhmig) in Czech Republic

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Nemertean are marine freshwater and terrestrial worms. Nemertean worms are benthic predators that use an eversible, sticky or barbed, and sometimes poisonous proboscis to capture prey.

1. Identification

Prostoma graecense is freshwater predator with typical proboscis with stylets and poisonous gland. Cylidrical body is most 11 - 25 mm long. Color is white, yellow, grey or red. On head are 3 doublets of ocelli. Species identification by vertical longitudinal sections through the cephalic region. Typical attributes on rhynchodaeal longitudinal musculature and the nature of the oesophagus.

2. Habitat

Prostoma graecense common in clean still or slow moving waters in filamentous algae or submerged plants, under the stones or in detritus.

3. Feed

small freshwater invertebrates – Oligochaetes, Crustaceans, Chironomidae.

3. Global distribution

Australia, Austria, British Isles, Bulgaria, Czech Republic, Denmark, Germany, Hungary, Israel, Italy, Japan, Kenya, New Zealand, North America, Poland, Russia, South Africa, Sweden, Switzerland, Tasmania.

4. Historical and recent collects in Czech Republic

1900 – basin in frame of Charles University Botanic Garden in Prague - MRÁZEK
1902 – Rokytka Brook, Prague – Hloubětín - MRÁZEK
1907 – Labe River pools near Poděbrady - VÁVRA,
1912 – Vltava River pools, Prague – Braník - MRÁZEK
1918 – Vltava River, Prague – Braník - SEKERA
1938 – Vltava River, dead channel in Stromovka, Prague - SEKERA
70th years – Svratka River, under Brněnská barrage, Brno – HRABĚ
1998 – Rivers: Vltava, Stropnice, Malše, Nežárka, Lužnice– det. KUBÍČEK (project PERLA)
2000 – Ohře River - det. KUBÍČEK (project PERLA)
2001 – Svratka River, under Brněnská barrage, Brno - det. ŠPAČEK
2003 – Rivers Labe, Bílá Nisa, Chrudimka and cover quarry Chabařovice - det. ŠPAČEK
2004 – Chrudimka River , Vltava River, Prague – Komořany - det. ŠPAČEK

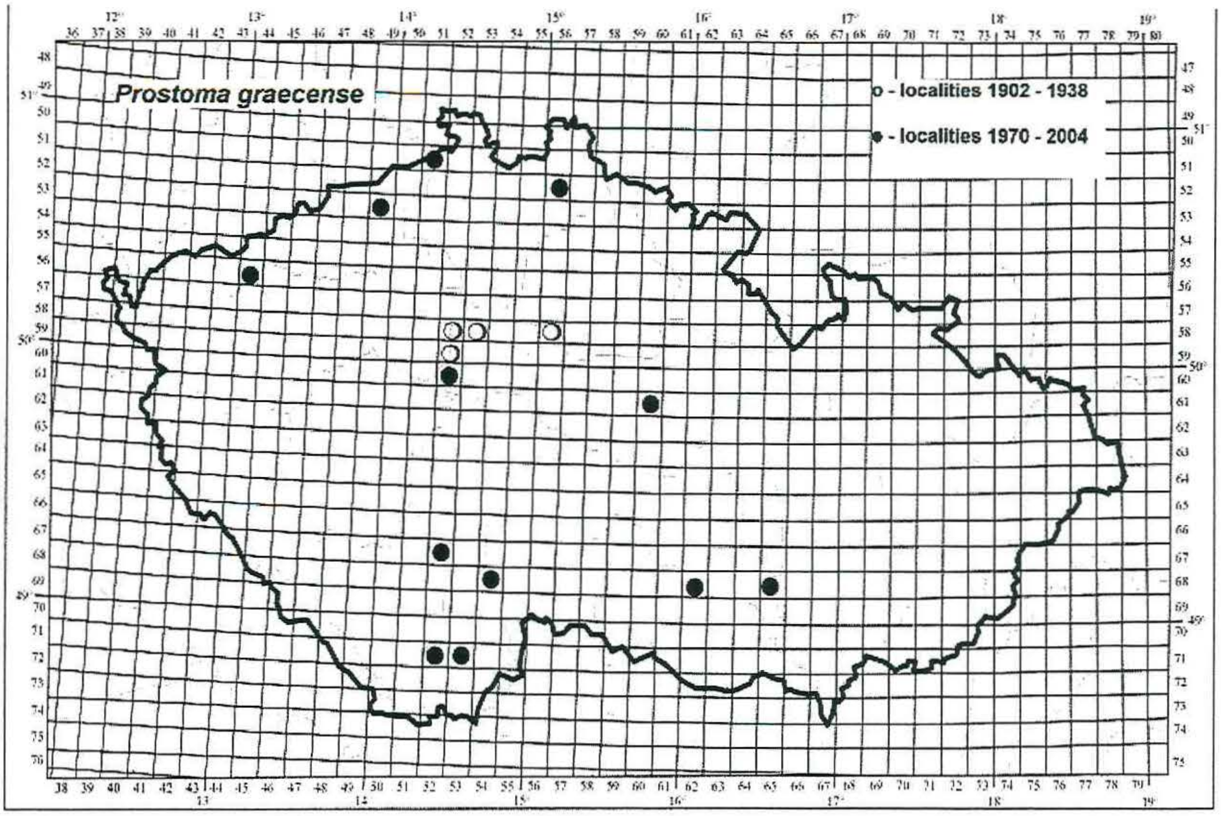

Figure 1: Map of localities in Czech Republic

Web-based GIS and a measure-data-base as tools for a Decision Support System for integrated Water Resource Planning in small catchment areas.

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The European Water Framework Directive (WFD) asks for river basin management plans as a basis of integrated water resources planning. A multitude of water-management measures and also computer-based models to simulate the effects of these measures are available today. Nevertheless integrated planning for small catchments is rather the exception and well-founded support for decision-makers facing multi-objective problems is lacking. For these reasons a Decision Support System (DSS) for measure planning in small catchments up to 300 km^2 is being developed. It addresses decision-makers in water and land resources management practice. The project is sponsored by the German Environmental Foundation. Three different case studies are carried out to verify and improve the DSS in different catchments. More information can be found via the Internet through the link www.wsm300.de. This abstract refers particularly to the case study `Saidenbach´ in the mountains "Erzgebirge". This is a catchment area of a drinking water dam which has a strongly agricultural character. The objective of the poster-presentation is to show the possibilities of two different tools which were developed and will be tested in this case study.

One problem of integrated planning is the lack of data and information about achieving these data. A web-based GIS was developed for the solution of this problem (Figure 1). The software used ArcIMS© is a framework for publication of geodata and geoservices on the internet and can be a uniform platform for distributed GIS. With the help of this interactive tool the decision makers will be able to get an overview about the spatial and thematic specification of the data basis. It is also possible to use this tool for information of the public, environmental education and for improving the acceptance of measures and the commitment referring to results achieved by computer models and intended plannings. The created environment information system is an enhanced GIS, which was built for the description of the status of the environment regarding loads and risks. It shall be used to improve the utilisation of existing information through supporting the communication about environmental facets (Bill and Fritsch 1991). The advantages of the used software ArcIMS© are lower time and financial input for the clients, accessibility of the information for the general public, the use of the Open GIS Consortium standard and the possibility of a central information update (ESRI 2003). Otherwise the disadvantages are the limited functional range through the specialisation oft the software and a reduced rate of the data transfer in comparison to a local GIS.

For the case study `Saidenbach´ available information at present are the location of the catchment area (subcatchments, receiving stream, water bodies), the administrative structure (cities, administrative district), the soil (soil classification, type of soil, depth etc.), the climate (distribution of the precipitation), the relief, the land use and the results achieved by computer models (risking of soil erosion and nitrogen leaching). The potential user of the system needs no own GIS software but simply a standard Internet-browser. The use of this system through the Internet will be available in october of 2004. The current use is only available via the Intranet of the Saxon State Ministry for the Environment and Agriculture (SMUL) by the use of the hyperlink http://smul-as-021.smul.sachsen.de/Website/wsm300.

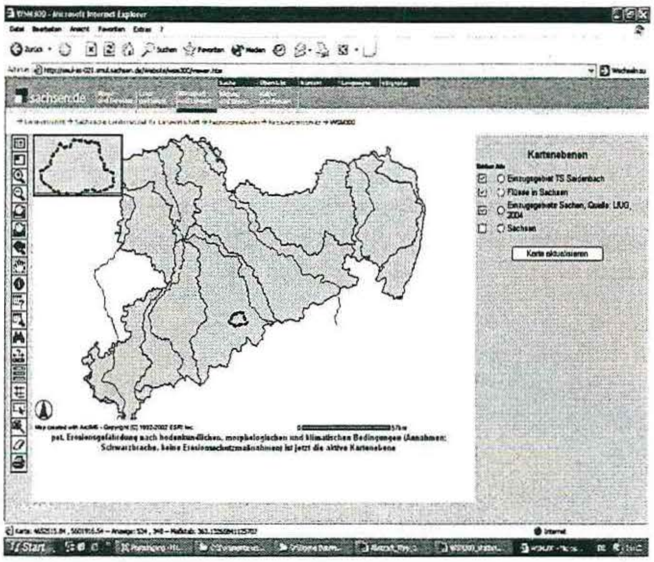

Figure 1: Web-based GIS `Saidenbach´

The used technology of the web-based GIS offers good possibilities for the supply of nearly every interested user with geographical information with high up-to-dateness. In comparison to a conventional map the client can use the map in any way due to the fact that the section and the measuring unit are free selectable. This allows combining of information in many ways. Through these new forms of using maps (e.g. results achieved by computer models) you can also involve user-groups who were not interested in maps formerly (Herrmann 2001).

Another problem in the moderation process of river basin management is to find the optimal measure or scenario for the improved development of water and soil resources management in a catchment. For the most measures detailed information (specialized books, publications etc.) is available. Comprehensive and comparative descriptions are rare. For this reason a data-base of measures (based on MS ACCESS) was built, containing information about preconditions, effects, cost - level etc. (Figure 2). It is also connected with information about legal aspects and government support. The intention of this tool is to provide the users (decision-maker, engineering company etc.) with an overview about the potential available information from different parts of agriculture based on an integrated soil and water resource protection. The 73 actual available measures are divided in the parts soil erosion, soil structure, reduction of nutrient leaching and crop protection products. These parts are divided in the partitions management (external), technique and planning (internal). At present this database is only a local application but in the future it will be integrated in an Internet application.

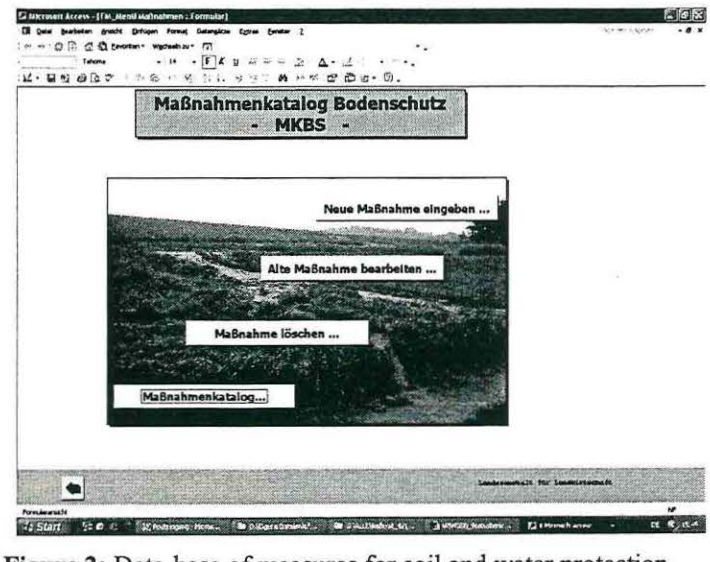

Figure 2: Data-base of measures for soil and water protection

The core of this data-base is the search for an optimal measure on the basis of cost-level, efficiency ratio, acceptance-level and a keyword. With this tool also less-known and new or innovative measures will be highlighted and discussed to improve catchment development plans. Through the measure data-base one can get a comprehensive look at the latest recommendations on best management practises.

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Development of an adaptive flood forecasting model for the White Elster catchment – concepts and methods

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Extreme floods are the result of extreme rainfall events. Magnitude and frequency of such events has increased during the last 30 years in low mountainous areas. Consequently, a continuation of this trend will increase the frequency of extreme flood events. The forecast of discharge and water levels during extreme events is still afflicted with considerable uncertainty, as could be seen during the flood event in the Elbe basin 2002.

The objective of this work is i) the development of a real-time flood forecasting model implementing a run-time calibration algorithm and ii) to update flood probabilities by the aid of precipitation-runoff modelling, using actualized distributions of extreme rainfall events. This contribution focuses on the conceptual approach and the methods to be used.

For rainfall-runoff modelling the hydrologic model WASIM-ETH (Shulla 1999) will be used in combination with the hydraulic river model FEQ (Franz & Melching 1997). The models are set up for batch and real-time simulations. In the batch mode, the simulations transform a given rainfall distribution into a discharge distribution. In the real-time mode, the simulation period is incrementally moved in time and new observations and new forecasts of weather information are incorporated into the model. In this application, the forecasts are taken from historical data series.

In our opinion, advancing the simulation of extreme hydrologic events, needs to consider the following issues. 1) In real-time flood forecasting, model results are generally corrected by a gain factor based on the deviation to observed discharge values. This method fails, however, if gauging stations or signal transmission collapse, as it is not based on an appropriate representation of the physical processes involved. 2) Model parameters are assumed to be time-invariant, which does not necessessarily be the case. However, little is known about time-variant parameter behaviour in hydrologic models. 3) The uncertainty associated to model predictions is a key information to increase credibility of the models.

The key idea of our modelling approach is to perform parameter optimisation, sensitivity analysis and uncertainty analysis in a moving window context, i.e. an "observation" period beeing incrementally moved along the time axis. For each move, a new optimization run and uncertainty and sensitivity analyses are started. The combination of these moving-window simulations shall reveal changes of parameters, sensitivities and uncertainties during the total simulation period. A complementary analysis of model behaviour in "batch" mode will provide a reference for comparison purposes. The moving window scheme will also provide the framework for real-time simulations with a continuous update of weather forecasts and discharge observations. Depending on the results of the preceding analysis, the results can be incorporated into a real-time forecast model in two possible ways: If parameter variance can be related to state variables in a functional form, this relations can be incorporated into the model as a rule for parameter update during run-time of the model. If this is not the case, the model has to be corrected according to observed data by changing parameters or parameter groups according to their sensitivity.

For optimization, sensitivity analysis and uncertainty analysis we use various methods and software packages being developd during the last years, e.g. UNCSIM (Reichert 2003) and Parasol-Sunglasses (Van Griensven & Meixner 2003).

The calculation of flood probabilities is based on the continuous precipitation-runoff simulation using stochastically generated rainfall data. This approach allows to create an arbitrary number of realistic precipitation scenarios. The continous simulation leads to a large amount of hydrologic events determined by precipitation on the one hand and the associated catchment response on the other. Frequency distributions will be adapted to multiple scenarios allowing a statistical analysis of peak discharges for given return periods.

The simulation studies are carried out for the White Elster basin (5300 km^2), a tributary to the Saale/Elbe river system covering parts of Saxony-Anhalt, Saxony and Thuringia and Czech republik.

The methods applied introduce the concept of parameter uncertainty in discharge prediction and the concept of non-static parameter values. We expect that the results of this approach enable hydrologists to generate consistent model predictions and information on the uncertainties of these predictions.

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Implementation of the Nitrate Directive in Poland from hydrogeological point of view

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The Nitrate Directive (91/676/EC) is one of the regulations, which Poland is to implement during the EU accessing process. The Polish Water Law Act (Dz.U.2001/115/1229) puts Regional Board for Water Management under obligation to identify nitrate vulnerability zones (NVZ) till the end of 2002. In December of 2002 the Minister of the Environment published a regulation on the criteria of identification of water vulnerability to nitrates from agricultural sources (Dz.U. 2002/241/2093). The methodology presented in this regulation was very simplified, as it considered only pedological and hydrological criteria, and has met the wide criticism of hydrogeologists. In this paper the author discuss the proposed idea of the NVZ and present some modification of the methodology proposed by the regulation mentioned above. In the case of the nitrate-caused risk, two scenarios of this hazard are considered: changes of the quality status of groundwater, and eutrophication of surface water in which the baseflow is depended on groundwater.

1. Scenario - changes of the groundwater quality status

Groundwater is being contaminated *via* infiltrating waters, which percolate through the soil profile and leach nitrogen compounds, mainly nitrates that are non-absorbed. These chemicals originate from mineralization of the organic matter of the soil and directly from mineral and organic fertilizers, while their additional load comes from infiltrating rainwater.

Delineation of the zones vulnerable to leaching of nitrates into groundwater should be based on evaluation of **the concentration of nitrates in infiltrating water.** It can be done utilizing sophisticated conceptual and computer models (for instance GLEAMS, DAISY, STONE, POPPIE and models tested for EUROHARP EU project) or assuming that approximately a constant fraction of the fertilizer used is leached. In the Regulation of the Ministry of the Environment - Dz.U. 2002/241/2093 is assumed that 15% of the fertilizer rate is leached to groundwater. In this simplified method, the concentration of nitrates in infiltrating water is calculated according to the equation:

$$C_{NO_3} = \frac{0,15 \times L_N}{I_e} \times 443$$

where:

C_{NO3} – concentration of nitrates in infiltrating water [mg/dm^3];
L_N – fertilizer load of nitrogen [kg N/ha*year];
I_e – effective infiltration [mm/year].

It should be noticed that the simplified evaluation of the amount of nitrates leached from the soil does not take into account a hazard represented by non-fertilized areas (fallows) and by the areas where drastic changes in cultivation have taken place such as ploughing up pastures, deforested areas, drained swamps. In the scenario map a significantly higher risk in such area should be considered..

Nitrates are the most mobile and stable nitrogen compounds in the soil-water environment. Denitrification is the only process that can considerably lower the groundwater content of nitrates and should be considered in NVZ identification procedure.

The simplified methodology mentioned above can't be used in fracture-karstic regions. In that areas, the infiltration is very intensive, reaching even up to 50% of rainfall, and groundwater flow rates are very high. In the most of fracture-karstic aquifer recharge areas the elevated contents of nitrates are observed and for this reason the fracture-karstic regions should be *a priori* considered as NVZs.

In any assessment of a risk caused by the infiltrating nitrates, their **travel time trough the vadose zone** is an important factor. It depends mainly on the thickness and permeability of the strata of the vadose zone. For the most shallow and most vulnerable groundwater, the thickness of the vadose zone is measured as the depth to the water table. The travel time (t_a) may be described by the following equation, assuming the piston flow model:

$$t_a = \frac{m_a \times w_o}{I_e}$$

where:

t_a – travel time through the vadose zone [years];
m_a – thickness of the vadose zone [m],
w_o – average volumetric water content in the vadose zone [-]; for the soil profile the values of the field storage coefficient, typical of the soil categories distinguished in the Regulation of the Ministry of the Environment (Dz.U. 2002/241/2093) can be accepted,
I_e – effective infiltration [m/year]

2. Scenario- eutrophication of surface water in which the baseflow is depended on groundwater

Surface waters are vulnerable to an inflow of nitrates from **groundwater recharge** and from the **surface run-off.**

The load of nitrates reaching surface waters ***via* groundwater** is expressed by the coefficient of renewable water resources or the infiltration rate (assessed in the 1st scenario) and the concentration of nitrates in the groundwater. A long travel time of groundwater results in a retarded reaction of surface waters to any changes of the contamination load introduced to groundwater. Thus, a load of nitrates carried away by groundwater in the first decade of the 21st century is controlled by the intensity of fertilization in the past, i.e. in the late 1970s and in 1980s. For this reason, determination of the NVZs on the basis of the current statistical data on nitrogen fertilization and of the quality of the shallow groundwater is not fully justified. Unfortunately, such approach disregarding hydrogeological practice is presented in the Regulation of the Ministry of the Environment (Dz.U. 2002/241/2093). The retardation resulting from the "age" of groundwater should be taken into account.

Nitrogen compounds from washed out fertilizers and soil reach the river with the **surface run-off**. The determination of nitrogen losses attributable to surface run-off is difficult from the methodological point of view. The value of the surface run-off may be evaluated as a difference between the value of the net precipitation (i.e. the difference between the precipitation and evapotranspiration) and the groundwater outflow. It must be remembered that the "ages" of the waters from surface run-off and groundwater outflow are different. Thus the load of nitrates reaching surface waters as a result of surface run-off should be calculated separately.

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