



**Institute
of
Environmental Systems Research**

Report

01/01/2002 – 31/10/2004



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Klaus Brauer - November 2004

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Preface and Highlights

The report includes the period from January 1st, 2002 to October 31, 2004. It is the third one since the Institute of Environmental Systems Research has been established in 1994 to carry out interdisciplinary research of complex problems in the environmental field. The first report published in German had been issued on September 30th, 1998 encompassing the period from the year of establishment in 1994 to September 1998. The second report was published in English and covers the period from October 1st, 1998 to December 31st, 2001. This report also includes the experiences with and developments of the course program "Applied Systems Science" which is closely related to the Institute. In 2004, the Institute celebrates its 10th and the course program "Applied Systems Science" its 15th anniversary.

"The sum is more than its parts." The past 34 months added some new "parts" to the "whole" Systems Science in Osnabrück. First of all, our new colleague, Profⁱⁿ Dr. Claudia Pahl-Wostl completed her working group and expanded it by fundraising of several large projects. Her new established chair denominated as *Management of substance flow* is granted by the Federal Environmental Foundation (Deutsche Bundesstiftung Umwelt) for a five years period and is the first "Stiftungslehrstuhl" of the University of Osnabrück. It also is the first chair of a German university denominated with this new and challenging research field. The working group has just moved to the new building, which is located near the new lecture hall "Ehemalige Reithalle" on the former British military area. Unfortunately, only half of the building could be reconstructed so far. Thus, Prof. Malchow's and my group are staying in the Casino until the whole building is finished. I would like to thank the Lower Saxonian Ministry of Science and Culture and the presidents of the University and the Fachhochschule of Osnabrück for making it available to begin with the conversion of the second half of the building early next year.

In 2002 the "Wissenschaftliche Kommission des Landes Niedersachsen" has evaluated all environmental research activities of the universities in Lower Saxony. Prof. Dr. Rainer Künzel, president of the University of Osnabrück, commissioned the institute to coordinate the presentation of our university. The advisory committee visited the university in June 2002 and discussed with institute members their research projects and future research plans. In the evaluation report from March 2003 the advisory committee acknowledged "the Institute of Environmental Systems Research an outstanding and for the most part internationally highly recognized research output."

On June 14th – June 17th, 2004 the Institute, supported by the German Environmental Foundation (DBU), organised the 2nd International Conference of the "International Environmental Modelling and Software Society" – IEMSS 2004 in the DBU-Centre of Environmental Communication in Osnabrück. More than 300 scientists from 40 countries participated in the conference. Lectures and oral contributions were presented in 24 regular and two special sessions. The proceedings have been edited by Pahl-Wostl, C.; Schmidt, S., Rizzoli, A.E.; Jakeman, A.J. and published electronically 2004.

In winter term 2003/04 the master course *Integrated Assessment* started. This programme is performed in common with the University of Twente in Enschede (The Netherlands). The minimum length of this course is 4 terms. Prerequisite is a Bachelor degree within a related

field. In contrast to the *Applied Systems Science* courses, which are held in German, the MSc course *Integrated Assessment* is held in English.

Research has been continued in the various research and development programs. A major part carried out at the institute was supported by various international and national institutions, e.g. EU, Federal Ministry of Education and Research, Lower Saxonian Ministry of Science and Culture as well as by industry and several foundations. A total amount of approximately 3.300.000,- € was awarded in 2002 to 2004 for the various research projects. During this time 28 Diplom (M.Sc.) and 3 Ph.D. theses have been finished of which the most were carried out at the institute. A large number of refereed publications, contribution to conferences, books, encyclopedia, reports and so on were published reflecting the remarkable activities of the institute members. I appreciate it very much to see how active all members contribute to the success and further development of the institute. This is also demonstrated by the various awards for several diploma and Ph.D. theses.

Thanks to all who are continuously supporting the institute to develop it further to a national and international renowned research place.

November 2004

Michael Matthies
Head of the Institute

1. Organization

1.1 Managing Committee

Michael Matthies, Dr.rer.nat., Professor of Applied Systems Science, Department of Mathematics and Computer Science; Managing Director,
Anselm Kratochwil, Dr.rer.nat., Professor of Ecology, Department of Biology/Chemistry; Vice-Director,
Joachim Härtling, Dr., Professor of Physical Geography, Department of Cultural and Geo-Sciences; Vice-Director.

1.2 Institute Members

1.2.1 Professors

The above mentioned persons and in addition:

Norbert deLange, Dr.rer.nat, Professor of Environmental Informatics and Urban Planning, Department of Geo- and Cultural Sciences.
Helmut Lieth, Dr.Ing.agr., Prof. em. of Ecology, Department of Biology/Chemistry.
Horst Malchow, Dr.sc.nat., Professor of Applied Systems Science, Department of Mathematics and Computer Science.
Claudia Pahl-Wostl, Dr. rer.nat., Prof. of Resource Flow Management, Department of Mathematics and Computer Science.
Bodo Rieger, Dr.Ing., Professor of Business, Department of Economics; Vice-Director,
Eberhard Umbach, Dr.rer.pol., apl. Professor of Social Science

1.2.3 Academic Staff

Volker Berding, Dr. rer. nat., Dipl.-Systemwiss.
Karin Berkhoff, Dipl.-Umweltwiss., doctoral candidate
Maik Bischoff, Dipl.-Ing., doctoral candidate
Bettina Blümling, Dipl.-Ing., doctoral candidate
Ilke Borowski, Dipl.-Ing., doctoral candidate
Klaus Brauer, Dipl.-Math., Akad. Director,
Eva Ebenhöf, Dipl.-Systemwiss., doctoral candidate
Dirk Günther, Dipl. Soz-Wiss, doctoral candidate
Frank M. Hilker, Dipl.-Systemwiss., doctoral candidate
Georg Holtz, Dipl.-Systemwiss., doctoral candidate
Stephan Jätzold, Dipl.-Math.
Kai Kaldrack, Dipl.-Systemwiss., doctoral candidate
Britta Kastens, Dipl.-Geogr., doctoral candidate
Jörg Klasmeier, Dipl.-Chem., Dr.rer.nat.
Sven Lautenbach, Dipl.-Geogr., doctoral candidate
Jens Newig, Dipl.-Geo-Ökol., Dr. iur.
Silke Panebianco, Dipl.-Ing., doctoral candidate
Dagmar Ridder, Dipl.-Ing, Dr. Ing.

Maja Schlüter, Dipl.-Biol., Dr. rer. nat.,
Bianca Schlussmeier, Dipl.-Psych., doctoral candidate
Sonja Schmidt, Dipl.-Ing., doctoral candidate

1.2.4 Technical Staff

Elke Altekruise, Secretary
Jürgen Berlekamp, Dr.rer.nat.
Irene Brink, Secretary
Johannes Wösten, Dipl.-Math.

2. Research Activities

The research activities undertaken at the Institute can be divided into four areas:

1. Environmental Systems Analysis (Prof. Matthies)
2. Ecological Pattern Formation (Prof. Malchow)
3. Resource Flow Management (Prof. Pahl-Wostl)
4. International Ecological Projects (em. Prof. Lieth)

Next the main projects carried out during the period January 2002 – October 2004 are described.

2.1 Environmental Systems Analysis

(1) Georeferenced Regional Simulation and Aquatic Exposure and Risk Assessment

Prof. Dr. Michael Matthies, Dr. Jörg Klasmeier, Dr. Oliver Heß

The geo-referenced regional exposure assessment tool for European Rivers (GREAT-ER) has been evaluated for two large-sized German river catchments, namely the Elbe (from the Czech border to the weir at Geesthacht) and the North-Rhine Westphalian part of the River Rhine basin. A digital river network has been implemented within a geographic information system (GIS). Hydrological parameters, information about point source emitters (wastewater treatment plants) and existing monitoring data have been collected from various authorities and institutions and integrated into the model system. For evaluation model simulations with a number of different chemicals are compared to monitoring data in various sub-catchments. Exemplary discussed are results for boron, EDTA, HHCB and Diclofenac as well as Diuron and NH₄-nitrogen. Results show the applicability of the model system as instrument for analysing exposure of river systems against chemicals mainly emitted via point sources. Comparison of monitoring data and simulation results for boron has been used to localise industrial emission sources and to quantitatively estimate their input. For the herbicide Diuron a relationship between area-related application doses and seasonally varying concentration profiles in rivers could be established for the first time. Within the framework of exposure analysis, an important application of GREAT-ER model system can be revealing cause-and-effect chains between known emission sources, environmental parameters, substance properties and observed environmental concentrations. Further investigations include simulations with a wider variety of compounds, completion of input data sets (especially possible industrial emitters), refinement of the hydrology and more detailed sensitivity analyses. Furthermore, a detailed analysis of the fate of musk fragrances in surface water with GREAT-ER has been carried out in the River main catchment. Simulation results are compared to monitoring data from the Bavarian State Agency for Water Management and basic assumptions on per-capita consumption rates, removal efficiencies in sewage treatment plants and in-stream removal rates have been checked. In cooperation with the Swiss Federal Institute for Environmental Science and Technology (EAWAG) the River Glatt catchment has also been implemented into GREAT-ER and evaluated for two fluoroquinolone antibiotics.

Funding: Federal Environmental Agency (Umweltbundesamt), Henkel KGa, German Cosmetic, Toiletry, Perfumery and Detergent Association (IKW)

The web-site related to this project is:

<http://www.usf.uni-osnabrueck.de/projects/greater/>

(2) Decision Support System (DSS) for the Elbe River Basin

Prof. Dr. M. Matthies, Dr. Jürgen Berlekamp, Sven Lautenbach, Neil Graf, Dr. Volker Berding

A decision support system for integrated river basin management of the German part of the Elbe river basin (Elbe-DSS) is currently under development, which involves taking into account water quantity, chemical quality, and ecological status of surface waters. User needs were identified and refined by repeated consultation of stakeholders. A list of management objectives, measures, and external scenarios turned out, which was taken as the basis for the DSS development. A comprehensive system analysis was carried out to meet the various spatial and temporal scales when dealing with hydrologic, ecologic, economic, and social aspects related to water quantity and quality. System diagrams for the catchments and the river network were worked out, which describe the properties, processes, and data influencing the water flow and substance load. Three models are selected for integration into the Elbe-DSS: MONERIS for the calculation of the long-term nutrient discharges in 132 sub-catchments from non-point and point sources, GREAT-ER for wastewater pathways (point sources) and aquatic fate assessment, and HBV for hydrological dynamics. Diffuse nutrient inputs for the sub-catchments calculated from MONERIS are distributed to the river network provided by GREAT-ER, where further elimination and transport processes are calculated together with inputs from point sources. The interaction of management objectives, external scenarios of climate, agro economic and demographic change, and selected measures to achieve the desired state of good water quantity and quality is investigated. The effects of reforestation and erosion control measures on phosphate loads and concentrations in the river network are simulated as an illustration. The system delivers georeferenced information for long-term water quality improvement. The project is carried out in co-operation with the University of Twente/Enschede and the institutes RIKS and INFRAM from the Netherlands. Such a DSS helps the water managers to formulate policy for river basin management and to take appropriate measures to realise policy objectives. As such it could also be a very useful tool for the implementation of European Water Framework Directive. Furthermore a DSS is especially suited to support participative decision making.

Funding: Federal Institute of Hydrology (Bundesanstalt für Gewässerkunde). Federal Ministry of Education and Research (Bundesministerium für Bildung und Forschung)

The web-site related to this project is:

<http://www.usf.uni-osnabrueck.de/projects/DSS/>

(3) Environmental long-range transport potential and overall persistence

Prof. Dr. M. Matthies, Dr. Jörg Klasmeier

The occurrence of persistent, toxic and bioaccumulative compounds in remote areas such as

the Arctic has provoked international and national activities to protect the local human population and their environment from unjustifiable chemical hazards. International protocols and national chemical regulations have determined groups of persistent organic substances under global, continental, or national control. Most prominent among these agreements is the UNEP Stockholm Convention from 2001, which designated an initial set of twelve “persistent organic pollutants” (POP) for global bans or phase-outs. Undoubtedly, POPs have reached the Arctic via long-range transport from temperate or even tropical climate zones and this redistribution of the global contaminant burden is continuing. Multimedia models have been proposed as screening and assessment methods to evaluate whether a substance qualifies as a potential POP. This is done by using two descriptors, namely long-range transport potential (LRTP) and overall persistence (P_{ov}). LRTP is a model-derived measure of the spatial behavior on a continental or global scale, whereas P_{ov} describes the temporal behavior of a substance in the environment. LRTP indicators make the distinction between transport- or target-oriented models. Since there are several models of this type available, it is important to know what differences in the results for P_{ov} and LRTP are caused by different model designs (model geometry, selection of compartments and processes, process descriptions). With a set of 3175 hypothetical chemicals covering a broad range of partition coefficients and degradation half-lives, we systematically analyze the P_{ov} and LRTP results obtained with eight multimedia models. We have developed several methods that make it possible to visualize the model results efficiently, to identify differences in model results, and to relate these differences to mechanistic differences between models. If the hypothetical chemicals are ranked according to P_{ov} and LRTP, these rankings are relatively similar among models, i.e. they are largely determined by the chemical properties. Domains of chemical properties in which model differences do lead to different results for given chemicals are identified and guidance on model selection is provided for model users. To determine whether a substance is POP-like, both parameters should be calculated with the emission scenario, either in air, soil or water that maximizes them. This ensures that model results are the best surrogates for the remote state. Substances are then positioned on a P_{ov} -LRTP plot according to their calculated P_{ov} and LRTP. A set of ten reference chemicals has been selected as standards to which the model results for other compounds can be compared. Five of them are substances with strong observed evidence for transport to the arctic and high persistence in the environment (POP references); five others are moderate to non-persistent substances, which do not display long-range transport. Model-specific classification borderlines for persistence and LRTP have been defined by the lowest model results obtained for one of the POP references. Comparison to the single-media half-life classification proposed by the UNEP Stockholm convention reveals that the model based approach delivers more detailed information for screening and assessment of organic chemicals according to LRTP and P_{ov} . Perfluorinated compounds are discussed as a new class of potential POPs. The model ELPOS, developed by the Institute, was used to evaluate the long-range transport and degradation behaviour of these compounds.

Funding: Organization of Economic Cooperation and Development (OECD), Federal Environmental Agency (Umweltbundesamt), Telomer Research Program (AGA Chemicals, Clariant GmbH, Daikin America Inc., duPont de Nemours & Co.)

<http://www.usf.uni-osnabrueck.de/projects/elpos/>
The model ELPOS can be downloaded from this web-site free of charge.

(4) Veterinary medicines in soil: Modelling of fate of antibiotics and resistant gene transfer

Prof. Dr. M. Matthies, Dr. Jörg Klasmeier, Andreas Focks

A consistent simulation model integrating the chemical fate in soil, bioaccumulation in soil fauna and subsequent effects on soil microorganisms of veterinary medicines after application with manure is developed. Processes are parameterized for three different antibiotics. The direct mutagenic antibiotic effect on the formation of resistant bacteria is discriminated against the influence of mobile genetic elements (MGE), which are simultaneously introduced with manure from treated animals. Changes of the structural diversity (species abundance) and the functional diversity (N-metabolism, antibiotic's degradation) are considered as causal feedback loops. Sorption, degradation and sequestration of the antibiotics and their active metabolites are taken into account as time-dependent processes, which may affect resistance formation and bioaccumulation. Interaction processes of the antibiotics with soil micro-organisms are considered to be spatially homogeneous. The simulation model is implemented as a simulation module open for integration into a heterogeneous transport model.

Funding: German Research Foundation (Deutsche Forschungsgemeinschaft) (positive evaluation)

2.2 Ecological Pattern Formation

(1) Impact of biotic and abiotic factors on the dynamics of spatially and physiologically structured populations in large aquatic ecosystems

Prof. Dr. H. Malchow

The principal goal of this research project is to investigate the spatiotemporal dynamics of aquatic populations in a large marine ecosystem both physiologically and/or spatially structured due to trophic and fertilization interactions, and due to the existence of relatively stable mesoscale temperature gradients, e.g. associated with cyclonic rings and ocean fronts. The dynamics of the biological community will be considered subject to the interplay of processes acting on different spatial scales: a small "fine" scale (from hundreds meters to kilometers) controlled by biological processes and mesoscale (from dozens to hundreds of kilometers) dominated by the inhomogeneity of hydrophysical fields. (Cooperation with Moscow/Pushchino, Marseille).

Funding: German Research Foundation (Deutsche Forschungsgemeinschaft), 2001 - 2004.
<http://www.usf.uni-osnabrueck.de/~malchow/Research/Projects/>

(2) Study of pattern formation in plankton populations under the effects of toxin producing phytoplankton, infection and environmental factors

Prof. Dr. H. Malchow, Dr. R. R. Sarkar

The aim of this research project is to develop mathematical and stochastic models of the phytoplankton-zooplankton system to understand the mechanisms of planktonic blooms, pulses and succession in the presence of toxic and/or infected phytoplankton and to suggest

some control measure of harmful phytoplankton blooming. (Cooperation with Moscow, Bordeaux).

Funding: Alexander von Humboldt Foundation (Alexander von Humboldt Stiftung), 2004 - 2005.

(3) Patterns in the Spatiotemporal Spread of Infectious Diseases and Biological Invasions

Frank M. Hilker, Prof. Dr. Horst Malchow

Infectious diseases have ever been one of the greatest threat of man, animal as well as plant populations and the functioning of ecosystems. Mathematical epidemiology has identified several mechanisms (e.g. spatial seasonal forcing, heterogeneity, or stochasticity) which are responsible for specific patterns in the spatiotemporal dynamics. Fatal diseases may dramatically regulate the host population density. Hence, the vital dynamics become important. This research mainly investigates reaction-diffusion models with an Allee effect in vital dynamics. Moreover, the impact of pathogens on the fate of biological invasions is investigated. Infectious diseases are often suggested as explanation for a spontaneous collapse of a successfully established alien species, but detailed data and studies are lacking. Model results predict that pathogens can slow-down, stop or reverse invasion fronts of their host population, provided that the latter is subjected to an Allee effect. (Cooperation with Bordeaux, Moscow, Hiroshima, Edmonton).

Funding: JSPS 2004, German Research Foundation (DFG), 2004

(4) Modelling Approaches to Metapopulation Dynamics

Frank M. Hilker

Models are essential tools in understanding the dynamics of spatially structured populations and deriving management measures in the context of population viability analysis. However, very often the question arises which type of model architecture is appropriate for a given situation, which is mostly characterized by a shortage of data for parameterization. This research is concerned with the comparison of different approaches such as individual-based models and patch occupancy models. (Cooperation with Würzburg).

2.3 Resource Flow Management

(1) Resources management – new conceptual approaches

Prof. Dr. Claudia Pahl-Wostl

Management of resource flows is devoted to developing innovative concepts of managing societal transformation processes towards sustainability with an emphasis on an improved understanding of dynamics and management of actor networks and the development of indicators for environmental, economic and social sustainability.

One focus is to improve the representation of the human dimension in integrated models and management processes. A promising method is agent based modelling. Agents in this

context are autonomous software systems that describe the behaviour of social entities (individuals, organizations). A big advantage of the method is that it allows a more realistic representation of social and cognitive processes. This allows to explore the complex spatio-temporal dynamics of human-technology-environment systems and thus the development of the basic foundations to manage transformation processes in such systems. In particular, agent based modelling is very well suited for participatory model development and application in processes of social learning with different stakeholder groups. It is the goal to increasingly couple tools from network analysis to calculate sustainability indicators with agent based models representing the dynamics. New integrated concepts for water resources management need to take the human dimension more explicitly into account. Adaptive integrated management concepts are more appropriate to deal with the complex resource management problems society faces nowadays. Another important area of research is the development of general concepts for interdisciplinary work and integrative systems approaches. To strengthen innovative approaches in inter- and transdisciplinary research activities in international scientific networks are of paramount importance.

Funding: German Federal Foundation for Environment (Deutsche Bundesstiftung Umwelt, DBU)

(2) Agent based modelling of socio-economic processes

Prof. Dr. Claudia Pahl-Wostl, Eva Ebenhöh, Georg, Stephan Jätzold.

In the PhD thesis of Eva Ebenhöh a new approach to represent human behavior based on attributes and heuristics is developed and implemented in agent based models. The models are validated against data from experimental economics where predictions from economic theory on resource allocation decisions are tested in experimental settings. Currently the conceptual model derived from these approaches is transferred to empirical observations from case studies to investigate the influence of context, history and group processes. The final goal is to develop what one may call an “adaptive tool box” for the representation of different types of agent rationality. In the PhD thesis of Georg Holtz an agent based model is developed to investigate the diffusion of innovations (technologies). Particular emphasis is given to improve our understanding how lock-in-effects can be overcome. The modeling approach starts with simple models that can still be solved analytically to introduce in a stepwise fashion more realistic representations of processes and network structures.

Quicksilver, a simulation environment for agent based modelling for research and teaching was further developed over the past years. A tutorial and a teaching module was developed.

Funding: German Federal Foundation for Environment (Deutsche Bundesstiftung Umwelt, DBU), Volkswagen Foundation (Lower Saxonian ex ante fund), 2002 – 2006

(3) Case studies for sustainable water resources management using actor based analysis and modelling frameworks – China and the Elbe basin

Prof. Dr. Claudia Pahl-Wostl, Silke Panebianco, Bettina Blümling

In the PhD thesis of Bettina Blümling a conceptual model is developed to investigate the effectiveness of the combination of different types of measures – technology, economic incentives, institutional settings – to improve the efficiency of water use in agriculture.

Empirical data on farmer decision making is derived from interviews and surveys in different villages in the Haie river basin in China. An agent based model is currently developed to simulate scenarios of the implications of different water governance regimes. The project is a collaboration with EAWAG, Switzerland and partners in China.

The PhD thesis of Silke Panebianco investigates decision making processes in the choice between centralized and decentralized waste water treatment technologies. Empirical data based on stakeholder interviews and document analyses have been collected in the area of Brandenburg. Currently the data are implemented in an agent based model representing major actors and the dynamics decision making processes in a spatially explicit environment. The model will help to improve the understanding for relevant processes and can be later used for regional planning. Results from the model simulations will be discussed in stakeholder meetings.

Funding: German Federal Foundation for Environment (Deutsche Bundesstiftung Umwelt, DBU), European Union, 2002 - 2006

(4) Ecological and Economic Assessment of Management Systems with Flow Based Approaches

Sonja Schmidt, Prof. Dr. Claudia Pahl-Wostl

Sonja Schmidt develops in her thesis an approach for the assessment of bio waste management systems taking into account spatial factors and uncertainties. A model for the resource flows has been implemented in the software UMBERTO. The comparative evaluation of different options is based on an LCA framework. It is foreseen to combine this approach with actor analysis and develop models that combine agent based approaches (see 2) with flow based modeling.

Funding: German Federal Foundation for Environment (Deutsche Bundesstiftung Umwelt, DBU), 2002 – 2005

(5) PartizipA (Partizipative Modellbildung, Akteurs- und Ökosystemanalyse in Agrarintensivregionen)

Britta Kastens, Karin Berkhoff, Kai Kaldrack, Bianca Schlussmeyer, Dr. Jens Newig, Prof. Dr. Claudia Pahl-Wostl

PartizipA is funded under the umbrella of the programme „Socio-ecological research“ of the BMBF (Federal Ministry of Education and Research). The interdisciplinary project investigates societal and ecological processes in regions with intensive agriculture (case studies in Germany and Austria) in the context of changing political and economic boundary conditions. Specific emphasis is given to the implications of the European Water Framework Directive for current agricultural practices. The German case study is located in the area around Osnabrück with very intensive pig and chicken farming. The project uses and further develops the method of actor based analysis and modelling, a type of participatory action research. The main instrument for analysis and participatory problem solving is a so-called actors platform with representatives from all stakeholder groups in the region. The PhD thesis of Britta Kastens focuses on an actor and institutional analysis at different scales to better understand the institutional context into which the process of the

actors platform is embedded. Bianca Schlussmeier explores in her thesis the importance of trust in the learning process in the actors platform. Kai Kaldrack employs different knowledge elicitation and participatory model building techniques for the development of agent based models to facilitate and improve our understanding of processes of social learning. Karin Berkhoff develops a spatial model of the nutrient dynamics to simulate scenarios that allow to compare the effect of different measures. The project is embedded in a network of all projects funded under the umbrella of socio-ecological research by the BMBF to promote progress in this interdisciplinary field.

Funding: Federal Ministry of Education and Research (BMBF), 10/2003 – 09/2006.

(6) The Effectiveness of New Forms of Environmental Governance from Authoritative to Participative Decision Processes

Dr. Jens Newig

Against the background of current international and EU legal developments, new forms of governance, consensual and participative processes become increasingly important, especially in the field of environmental policy. An important motive is (along with considerations of democracy and legitimacy) the more effective implementation of policy measures. To what extent, however, the underlying notion empirically applies, is still poorly understood. The project therefore aims at a comprehensive understanding of the effectiveness of participative compared to authoritative administrative processes and thus to help improve the design of such processes in administrative practice. The basic assumption is that different forms of governance are not per se (un)suitable to support effective implementation but that this largely depends on the issue and the (societal) context of the decision process. Based on a theoretically motivated model, both a comprehensive secondary analysis of existing empirical studies and selected case studies will generate data of the context, the process itself and its results. These data will validate and, where appropriate, broaden or simplify the hypothesis-based model, and allow for conclusions regarding the design and the application of different forms of governance contingent upon different cases situations.

Funding: German Federal Foundation for Environment (Deutsche Bundesstiftung Umwelt, DBU), 2004 – 2008

(7) HarmoniCOP (Harmonized Collaborative Planning) and HarmoniCA (Harmonizing Modelling Tools at Catchment Scale)

Dr. Dagmar Ridder, Ilke Borowski, Prof. Dr. Claudia Pahl-Wostl

With the advent of the European Water Framework Directive (WFD), European Water Policy entered into a new phase. The WFD introduces for all member states the river basin as scale for integrated management plans. Stakeholders and the public at large have to be. Within the EU project HarmoniCOP (www.harmonicop.info - coordinated by USF) the importance of processes of social learning are investigated in nine countries, to improve the interface between decision making processes and formal models and decision support systems. A new concept for social learning has been developed and has been investigated in a number of case studies. HarmoniCOP is the first project that investigates systematically processes of social learning and the influence of cultural, legal and institutional factors. 15

institutes from 9 countries participate in this interdisciplinary project. One product will be a handbook on rules of good practice for stakeholder and public participation in integrated resources management, in general, and water resources management, in particular.

The concerted action *Harmoni-CA* (www.harmoni-ca.info) has as its goal to improve the use of models and IC tools (developed in the projects of the *CatchMod* cluster) for the implementation of the European Water Framework Directive. Workpackage 5 on the Science-Policy-Interface (coordinated by USF) has organized a social learning process between policy makers and researchers to find out differences in the expectations of the use of models in river basin management and the role of stakeholder participation as base to improve the dialogue between the two groups.

Funding: European Union, 2002 - 2007

(8) WASAMED and WADEMED

Bettina Blümling, Dirk Günther, Prof. Dr. Claudia Pahl-Wostl

The projects *WASAMED* (Water Saving in the Mediterranean) and *WADEMED* (Water Demand Management in the Mediterranean) are both concerned with improving the efficiency of water use mainly in agriculture in the Mediterranean region (Europe and North Africa). *WASAMED* is a thematic network and aims at capacity building, developing a data base on current policies and indicators for their sustainability. USF contributes concepts and information on sustainability indicators. *WADEMED* is a concerted action and aims at identifying the major factors that influence the efficiency of water use. USF is a major contributor to the conceptual framework and methods for the elicitation of knowledge from farmers.

Funding: European Union, 2004 - 2009

(9) Sustainability-A-Test

Dirk Günther, Prof. Dr. Claudia Pahl-Wostl

The projects *Sustainability-A-Test* has as its goal to provide a comprehensive methodological framework for the characterization of the sustainability of policies. Tool teams develop state of the art reports, recommendations for the combination of methods for different problem areas and illustrative examples from case studies. USF is focusing on actor based analysis and scenarion development and the distinction between actor and system based sustainability indicators with emphasis on the social pillar of sustainability.

Funding: European Union, 2004 – 2006

(10) Book project: Industrial Society and Systems Science

apl. Prof. Dr. E. Umbach

In a text to be published as a book, the dynamics of Industrial Society is analyzed as the result of the structural dynamics of pre-industrial society in Europe and of the dynamics of actions of institutions and persons. Methodological bases are:

- qualitative interdisciplinary systems science in the tradition of J.G.Miller (Living Systems, 1978),
- evolutionary epistemology,
- social science theories of decision and action.

The aim is the delineation of a sufficient number of measures to reach a sustainable state for industrial societies.

Drafts for six chapters were elaborated:

1. Setting of the problem: Systems Science as the method to network the disciplines
2. What is systems science ? – Concepts, structures, methods, examples
3. Basic structure of the person–environment relationship
4. Theory of action: Routine behaviour and problem solving behaviour in the context of needs, norms, values, targets
5. Basic structure of social systems
6. Industrial societies as insufficiently optimized social systems

A chapter 7 is planned: Necessities and possibilities for further optimization of industrial societies in the direction of sustainability. In chapter 2, the results of the project “Epistemological foundations of systems science” of the years 2000-2001 are integrated. Chapters 1 to 5 were translated into English. In this process, chapters 1 to 3 were revised and expanded. The International Society for the Systems Sciences (ISSS) is working on a presentation of systems science in the internet. On the basis of chapters 1 to 3 of the above mentioned text for a book, a contribution was formulated comprising several levels of abstraction.

(11) European and International Projects in the Phase of Implementation

Two major project proposals have been evaluated positively by the European commission in spring 2004. These projects are expected to start January 2005. The institute coordinated the project **NEWATER** and is in the steering group of the project **AQUASTRESS**.

The institute represents one programme within another international project, the **GLOBAL WATER SYSTEM**.

These projects are supervised by *Prof. Dr. Claudia Pahl-Wostl*

(a) NeWater

The **NEWATER** (New methods for adaptive water management) project aims at a paradigm shift in water resources management in both research and practice. **NEWATER** will develop new methods for integrated water management taking into account the complexity of the river basins to be managed and the difficulty to predict the factors influencing them (e.g. climate, socio-economic developments). **NEWATER** will focus in particular on the transition from current regimes of water management in a river basin to more integrated, adaptive approaches with strong stakeholder participation. The project has case studies in Europe, Africa and Central Asia, where new methods are developed and tested in participatory settings. The project involves forty partner organizations. The project has a duration of 4 years, an EU contribution of 12 Million Euro and 40 partners.

(b) AquaStress

The **AQUASTRESS** (Mitigation of Water Stress through new Approaches Integrating Management, Technical, Economic and Institutional Instruments) project will generate scientific innovations to improve the understanding of water stress from an integrated

multisectoral perspective to support diagnosis and characterisation of sources and causes of water stress, assessment of the effectiveness of management measures and development of new options and the development of a participatory process to implement solutions tailored to environmental, cultural, economic and institutional settings. The project has case studies in the Mediterranean region in Europe and North Africa. The project has a duration of 4 years, an EU contribution of 10.3 Million Euro and 35 partners.

(c) Global Water System Project

The Global Water System Project (GWSP www.gwsp.org) is a newly established joint project of the international program of biodiversity science DIVERSITAS, the International Geosphere-Biosphere Program, the International Human Dimensions Program, and the World Climate Research Program, which together form the Earth System Science Partnership (ESSP). It aims at providing a sound base for understanding the global dimensions of the influence of human activities on the water system. Over the past two years the science plan was developed and the project has now entered the phase of implementation. The institute represents the International Human Dimension Programme in this process.

2.4 International Ecological Projects

(1) Amudelta - Restoration and Management Options for Aquatic and Tugai Ecosystems in the Northern Amudarya river delta (Uzbekistan)

Prof. em. Dr. Helmut Lieth, Dr. Maja Schlüter, Nadja Rüger.

In the Amudelta project a group of six teams from four countries (Uzbekistan, Russia, France & Germany) compiled existing and new data to develop a GIS based integrated modelling system to support the planning of ecologically-sound water management in the Northern Amudarya delta under varying water supply alternatives. The spatio-temporal water distribution, the optimal management of water for irrigation, the proportion split between usage for agriculture, fisheries and environmental purposes, as well as the water quality, are used as major driving forces for the models within the given environmental setting. Field studies provide actual data on water and soil contamination, state and productivity of aquatic ecosystems, fish ecology and health risks for the local population. Missing information on major processes and interrelationships have been gathered, also through analysis of historical data and elicitation of expert knowledge. A GIS-based integrated simulation tool has been developed to analyse the impact of different water management strategies on the riverine Tugai forests. The tool was used for scenario development and analysis to determine different potential development paths of the delta region with respect to the riverine forests. Investigation of a two year drought period and the following restoration phase have revealed that the aquatic ecosystems recovered very fast. The important role of the Tyuyamuyun reservoir at the entrance to the delta region as reserve of fish offspring was determined. A GIS databank has been developed to support management for ecologically sound water management in the delta region. Recommendations for management of water and fish resources as well as for further research activities are being worked out. Within the framework of the project one PhD thesis and one diploma thesis have been worked out.

Funding: INTAS, 2001 – 2004

<http://www.usf.uni-osnabrueck.de/projects/ara1>

(2) NATO Collaborative Linkage Grant for cooperation between scientists from Uzbekistan, USA and Germany

Dr. Maja Schlüter

The aim of the linkage grant was to strengthen cooperation between scientists working on the development of hydraulic and ecological models for water and ecosystem management in the Amudarya river. Within the framework of the grant a meeting of Prof. Daene McKinney, Dr. Andre Savitsky and Dr. Maja Schlüter has been conducted at the University of Osnabrueck. The main aims of the meeting were to (i) finalize a joint publication on a multi-objective water management model that was jointly developed for the Amudarya river and (ii) to plan future joint work on the integration of ecology and hydrology in decision support tools, but also on methods to include the human dimension into modelling of water allocation in the Amudarya river delta. There will be another meeting of all participants at Texas University to finalize the work and prepare a new proposal.

Funding: NATO, 2002 – 2005

(3) DAAD - workshops Christian-Islamic Dialogue

Prof. em. Dr. Helmut Lieth

Three workshops funded by the German Academic Exchange Service (DAAD) in Osnabrueck, Tashkent and Nukus were organised to discuss the perception of nature in Christian and Islamic religions and their influence upon the secular operating administration. The workshops were attended by various scientists from humanitarian and natural sciences fields.

Funding: German Academic Exchange Service (DAAD), 2003

(4) Solving Differential Equations/ Computer Algebra Systems

Akad. Dir. Klaus Brauer

Within the scope of the programme *GoEast* of the German Academic Exchange Service (DAAD) two major speeches were held at O'zbekiston Davlat Universiteti (National University of Uzbekistan)/ Tashkent on Sept. 2nd, 2002 and at Urganch Davlat Universiteti (National University at Urganch/ Uzbekistan on Sept. 3rd, 2002 in the field of Numerical Treatment of Differential Equations using CA-systems with main emphasis on interdisciplinary aspects. With scientists from the Faculty of Mathematics and the Faculty of Computer Science (National University of Uzbekistan), the Scientific Institute of Irrigation and the Faculty of Mathematics (Urganch University) several aspects of teaching Numerical Mathematics to “non-mathematically-educated” persons were investigated.

Funding: German Academic Exchange Service (DAAD), 2002

(5) GIS Training course

Prof. em Dr. Helmut Lieth, Dr. Maja Schlüter, Dr. Jürgen Berlekamp, Sven Lautenbach

A GIS training course for PhD and postdoctoral students and scientists of universities and institutes of Uzbekistan, Kazakhstan and Kyrgyzstan has been carried out in Tashkent, Uzbekistan in 2004. The aim of the workshop was to train the participants in the use of GIS and to transfer knowledge and experience about the use of GIS in research, resources management and decision support. The vast experience of the Institute of Environmental Systems Research (USF) in developing GIS applications for water management issues and decision support in river basin management (e.g. the GREATER and DSS Elbe projects) has been shared with the participants and they have been encouraged to apply GIS to their own research and management questions. The training will enable the participants to independently work with GIS and apply the technology to their own research in future.

Funding: Alexander von Humboldt Foundation/ Humboldt Club of Uzbekistan, 2004

2.5 Research Fundraising

The Institute was successful in fundraising research projects from various institutions. The list compiles the sum of all projects running in the report period. Only amounts greater than 10,000 € are listed. Since 2001, the Deutsche Bundesstiftung Umwelt (DBU) supports the Chair of Substance Flow Management (Stiftungsprofessur Stoffstrommanagement) over a period of five years (not listed).

Institution	Sum (€)
European Union	1,635,898.-
Telomer Research Project	35,400.-
OECD	22,300.-
MWK	506,497.-
BMBF	489,209.-
Bundesanstalt für Gewässerkunde	318,647.-
DAAD	119,990.-
Alexander von Humboldt-Stiftung	48,500.-
Potsdam Institut für Klimafolgenabschätzung	30,100.-
VW-Stiftung	12,300.-
Diverse	78,653.-
Total Sum	3,297,694.-

3. List of Publications

3.1 Environmental Systems Analysis

3.1.1 Contributions to periodicals (with review-process)

- Beyer, A.; Wania, F.; Gouin, T.; Mackay, D.; Matthies, M.: Selecting internally consistent physical-chemical properties of organic compounds. *Environ. Toxicol. Chem.* 21(5), 941-953, 2002.
- Schröder, R.; Schulze, C.; Matthies, M.: Concentration of LAS and Boron in the Itter. Comparison of measured data with results obtained by simulation with the GREAT-ER software. *Environ. Sci. & Pollution Res.* 9(2), 130-135, 2002.
- Berding, V.; Matthies, M.: European Scenarios for EUSES regional distribution model. *ESPR-Environ.Sci. & Pollut.Res.* 9(3), 193-198, 2002.
- Schröder, A.; Matthies, M.: Ammonium in Fließgewässern des Saale-Einzugsgebietes. Vergleich von Messwerten und Modellrechnungen in GREAT-ER. *UWSF - Z.Umweltchem. Oekotox.* 14(1), 37-44, 2002.
- Matthies, M.; Schröder, A.: Verdünnung von kommunalen Abwässern im Einzugsgebiet der Elbe. *Wasser & Boden* 54(6), 33-36, 2002.
- Beyer, A.; Wania, F.; Gouin, T.; Mackay, D.; Matthies, M.: Temperature Dependence of the Characteristic Travel Distance. *Environ. Sci. Technol.* 37, 766-771, 2003.
- Matthies, M.: Exposure assessment of environmental organic chemicals at contaminated sites: a multicompartment modelling approach. *Toxicology Letters* 140-141, 367-377, 2003.
- Matthies, M.; Beyer, A.: Role of vegetation on the overall persistence and long-range transport potential. *Stoch. Environ. Res. & Risk Assessm.* 17(4), 252-255, 2003.
- Matthies, M.; Berding, V.; Beyer, A.: Probabilistic Uncertainty Analysis of the European Union System for the Evaluation of Substances Multimedia Regional Distribution Model. *Environ. Toxicol. Chem.* 23(10), 2494-2502, 2004.
- Rüger, N.; Schlüter, M.; Matthies, M.: A fuzzy habitat suitability index for *Populus euphratica* in the Northern Amurdaya delta. *Ecological Modelling* 2005 (in press)
- Matthies, M.; Berlekamp, J.; Lautenbach, S.; Graf, N.; Reimer, S.: System Analysis of Water Quality Management for the Elbe River Basin. *Environmental Modelling & Software* 2005 (accepted)
- Berlekamp, J.; Graf, N.; Hess, O.; Lautenbach, S.; Reimer, S.; Matthies, M.: Integration of MONERIS and GREAT-ER in the Decision Support System for the German Elbe River Basin. *Environmental Modelling & Software* 2005 (accepted)
- Lessmann, K.; Beyer, A.; Klasmeier, J.; Matthies, M.: Influence of Distributional Shape of Substance Parameters on Exposure Model Output. *Risk Analysis* 2005 (accepted).
- Fenner K., Scheringer M., MacLeod M., Matthies M., McKone T. E., Stroebe M., Beyer A., Bonnell M., Le Gall A.-C., Klasmeier J., Mackay D., van de Meent D., Pennington D., Scharenberg B., Suzuki N., Wania F.: Comparing Estimates of Persistence and Long-range Transport Potential among Multimedia Models. *Environ. Sci. Technol.* (submitted).
- Klasmeier J., Matthies M., Fenner K., Scheringer M., Stroebe M., Beyer A., Le Gall A.-C., MacLeod M., McKone T. E., Pennington D., Suzuki N., van de Meent D., Wania F.: Long-range Transport Potential and Overall Persistence in Screening and Assessment of Organic Chemicals. *Environ. Sci. Technol.* (submitted).

Schlüter, M.; Rüger, N.; Savitsky, A.; Novikova, N.; Matthies, M.; Lieth, H.: An integrated simulation tool for ecological assessment of alternative water management strategies – a case study of the Amudarya river delta. *Ecological Applications* (submitted).

3.1.2 Articles and contributions to handbooks and encyclopaedia

Matthies, M.: Multimedia Fate and Transport of Organic Pollutants. In: *Encyclopedia of Life Support Systems (EOLSS), Part Environmental and Ecological Chemistry* (Ed. A. Sabljic), UNESCO Paris, 2003.

3.1.4 Monographs, Special Issue

Beyer, A.; Matthies, M.: Criteria for Atmospheric Long-range Transport Potential and Persistence of Pesticides and Industrial Chemicals. UBA Berichte Nr. 7/02, E. Schmidt Verlag, Berlin, 2002, 244 p., ISBN 3-503-06685-3.

Matthies, M.; Ostendorf, B.; Guppioni, C. (Eds.): Environmental Decision Support Systems. *Environmental Modelling & Software*. Special Issue 2005.

3.1.5 Contributions to Conference Proceedings

Matthies, M.; Berlekamp, J.; Lautenbach, S.; Graf, N.; Reimer, S.: Decision Support System for the Elbe River Water Quality Management. In: Post, D.A., (Ed.), *Integrative Modelling of Biophysical, Social, and Economic Systems for Resource Management Solutions MODSIM 2003*. Modelling and Simulation Society of Australia and New Zealand, Canberra, Australia, pp. 284-289.

(<http://mssanz.org.au/modsim03/modsim2003.html>)

Matthies, M.; Klasmeier, J.: Geo-referenced Stream Pollution Modelling and Aquatic Exposure Assessment. In: Post, D.A., (Ed.), *Integrative Modelling of Biophysical, Social, and Economic Systems for Resource Management Solutions MODSIM 2003*. Modelling and Simulation Society of Australia and New Zealand, Canberra, Australia, pp. 666-671. (<http://mssanz.org.au/modsim03/modsim2003.html>)

Berlekamp, J.; Graf, N.; Lautenbach, S.; Reimer, S.; Matthies, M.: Aufbau eines Entscheidungsunterstützungssystems (DSS) für ein Integriertes Flusseinzugsgebietsmanagement am Beispiel der Elbe. In: Strobl, Blaschke, Griesebner (Hrsg.), *Angewandte Geographische Informationsverarbeitung XV*, Wichmann, Heidelberg, 41-46, 2003.

S. Meinert, J. Berlekamp, C. Pahl-Wostl: Ein Framework zur Kopplung von Multi-Agenten-Systemen und GIS. In: Strobl, Blaschke, Griesebner (Hrsg.), *Angewandte Geographische Informationsverarbeitung XV*, Wichmann, Heidelberg, 286-291, 2003.

Lautenbach, S.; Berlekamp, J.; Matthies, M.: Einsatz von GIS & Geländevisualisierungssoftware in der Umweltbildung - Visualisierung der Deponie Piesberg. In: Strobl, Blaschke, Griesebner (Hrsg.), *Angewandte Geographische Informationsverarbeitung XV*, Wichmann, Heidelberg, 262-267, 2003.

Lautenbach, S.; Berlekamp, J.; Graf, N.; Reimer, S.; Matthies, M.: Modelle zur Managementunterstützung im Einzugsgebiets- und Gewässernetzmodul des DSS Elbe. In: H.-B. Kleeberg (Hrsg.): *Klima, Wasser, Flussgebietsmanagement - im Lichte der Flut*. Hydrologische Wissenschaften - Fachgemeinschaft in der ATV-DVWK, Forum für Hydrologie und Wasserbewirtschaftung Heft 4, Band 2, S. 135-138, 2003.

- Lautenbach, S.; Berlekamp, J.; Graf, N.; Reimer, S.; Matthies, M.:* Aufbau eines Entscheidungsunterstützungssystems zum Flussgebietsmanagement für das Einzugsgebiet der Elbe. In: J. Wittmann und D.K. Maretis (Eds.): Simulation in Umwelt- und Geowissenschaften, Berichte aus der Umweltinformatik, ASIM-Mitteilung AMB 85. Shaker Verlag, Aachen, 67-80, 2003.
- Berlekamp, J.; Graf, N.; Hess, O.; Lautenbach, S.; Reimer, S.; Matthies, M.:* Integration of MONERIS and GREAT-ER in the Decision Support System for the German Elbe River Basin. In: Pahl-Wostl, C., Schmidt, S. and Jakeman, T., (Eds.) iEMSS 2004 International Congress: "Complexity and Integrated Resources Management". International Environmental Modelling and Software Society, Osnabrück, Germany. (<http://www.iemss.org/iemss2004/pdf/dss/berlinter.pdf>).
- Lautenbach, S.; Berlekamp, J.; Graf, N.; Reimer, S.; Matthies, M.:* Integration von MONERIS und GREAT-ER in das Elbe-DSS. In: Möltgen, J. und D. Petry (Hrsg.): Interdisziplinäre Methoden des Flussgebietsmanagements. Schriftenreihe des Instituts für Geoinformatik, Westfälische Wilhelms-Universität Münster, Band 21, S.317-324, 2004.
- Klasmeier, J.; Beyer, A.; Matthies, M.:* Screening for Cold Condensation Potential of Organic Compounds. DIOXIN 2004 Conference Berlin. (<http://dioxin2004.abstract-management.de/pdf/p513.pdf>)
- Matthies, M.; Berlekamp, J.; Lautenbach, S.; Graf, N.:* Entscheidungsunterstützungssystem für das Gewässergütemangement der Elbe – Konzept und Systemgestaltung. In: Perspektiven der Ingenieurökologie in Forschung, Ausbildung und Praxis (Eds. V. Lüderitz, M. Voigt), Verlag Peter Lang 2005 (in press).
- Berkhoff, K.; Lautenbach, S.; Berlekamp, J.; Pahl-Wostl, C.:* GIS-basierte Ermittlung des Grundwassergefährdungspotentials zur Maßnahmenplanung in einer agrarischen Intensivregion. Mittellungen der Deutschen Bodenkundlichen Gesellschaft (submitted).

3.1.6 Reports

- Heß, O.; Schröder, A.; Klasmeier, J.; Matthies, M.:* Modellierung von Schadstoffflüssen in Flusseinzugsgebieten. Texte 19/04, Umweltbundesamt Berlin, 2004. ISSN 0722-186X.

3.2 Ecological Pattern Formation

3.2.1 Contributions to periodicals (with review-process)

- Medvinsky, A. B., Tikhonova, I. A., Tikhonov, D. A., Ivanitsky, G. R., Petrovskii, S. V., Li, B.-L., Venturino, E., Malchow, H. (2002).* Spatio-temporal pattern formation, fractals, and chaos in conceptual ecological models as applied to coupled plankton-fish dynamics. *Uspekhi Fizicheskikh Nauk* **172**(1), 31-66.
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- Medvinsky, A. B., Tikhonova, I. A., Petrovskii, S. V., Malchow, H., Venturino, E. (2002).* Chaos and order in plankton dynamics. Complex behavior of a simple model. *Journal of General Biology* **63**(2), 149-158.
- Petrovskii, S. V., Malchow, H. (2002).* Dynamical stabilization of an unstable equilibrium

- in chemical and biological systems. *Mathematical and Computer Modelling* **36**, 307-319.
- Medvinsky, A. B., Petrovskii, S.V., Tikhonova, I. A., Malchow, H., Li, B.-L.* (2002). Spatio-temporal complexity of plankton and fish dynamics in simple model ecosystems. *SIAM Rev.* **44**(3), 311-370.
- Tikhonov, D. A., Malchow, H.* (2003). Chaos and fractals in fish school motion, II. *Chaos, Solitons & Fractals* **16**(2), 287-289.
- Medvinsky, A.B., Tikhonova, I.A., Li, B.-L., Malchow, H.* (2003). Interdependence of plankton spatial patterns and temporal oscillations: mathematical simulation. *Biophysics* **48**(1), 104-110.
- Petrovskii, S.V., Li, B.-L., Malchow, H.* (2003). Quantification of the spatial aspect of chaotic dynamics in biological and chemical systems. *Bull. Math. Biol.* **65**(3), 425-446.
- Tikhonova, I.A., Li, B.-L., Malchow, H., Medvinsky, A.B.* (2003). The impact of the phytoplankton growth rate on spatial and temporal dynamics of plankton communities in a heterogeneous environment Interdependence of plankton spatial patterns and temporal oscillations: mathematical simulation. *Biophysics* **48**(1), 891-899.
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- Petrovskii, S.V., Li, B.-L., Malchow, H.* (2004). Transition to chaos can resolve the paradox of enrichment. *Ecol. Complexity* **1**(1), 37-47.
- Medvinsky, A.B., Tikhonova, I.A., Li, B.-L., Malchow, H.* (2004). Time delay as a key factor of model plankton dynamics. *C.R. Acad. Sci. Paris, Sér. B* **327**(3), 277-282.
- Medvinsky, A.B., Morozov, A.Y., Velkov, V.V., Li, B.-L., Sokolov, M.S., Malchow, H.* (2004). Modeling the invasion of recessive Bt-resistant insects: an impact on transgenic plants. *J. Theor. Biol.* **231**, 121-127.
- Malchow, H., Hilker, F.M., Petrovskii, S.V.* (2004). Noise and productivity dependence of spatiotemporal pattern formation in a prey-predator system. *Discrete and Continuous Dynamical Systems B* **4**(3), 705-711.
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- Malchow, H., Medvinsky, A.B., Petrovskii, S. V.* (2004). Patterns in models of plankton dynamics in a heterogeneous environment. In *Handbook of Scaling Methods in Aquatic Ecology: Measurement, Analysis, Simulation* (Seuront, L., Strutton, P.G., eds.), pp. 401-410. CRC Press, Boca Raton.
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3.3 Resource Flow Management

3.3.1 Contributions to periodicals (with review-process)

- Pahl-Wostl, C., Hoff, H., Meybeck, M. and Sorooshian, S.* (2002). The role of global change research for aquatic sciences. Editorial to the special issue of Aquatic Sciences on: Vulnerability of Water Resources to Environmental Change - A Systems' Approach. *Aquatic Sciences*: **64** (4).
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- Pahl-Wostl, C.* (2002). Polycentric Integrated Assessment. *Integrated Assessment*, **3**, 220-233.
- Pahl-Wostl, C.* (2002). Participative and Stakeholder-based policy design, analysis and evaluation processes. *Integrated Assessment* **3**, 3-14.
- Hare, M. and Pahl-Wostl, C.* (2002). Stakeholder categorization in participatory integrated assessment processes. *Integrated Assessment*, **3**, 50-62.
- Pahl-Wostl, C., Schönborn, A., Willi, N.; Muncke, J. and Larsen, T.* (2003). Investigating consumer attitudes towards the new technology of urine separation. *Water, Science and Technology*, **48**; 57-65.
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- Ebenhöh, E. and Pahl-Wostl, C.* (2004). An adaptive toolbox model: A pluralistic modelling approach for human behaviour based on observation. *JASSS*. **7**,1.
<http://jasss.soc.surrey.ac.uk/7/1/3.html>
- Newig, J.* (2004): Symbolische Gesetzgebung: Umweltpolitik unter gesellschaftlichen Macht- und Informationsasymmetrien, *Zeitschrift für Politikwissenschaft* **14** (3), 813-852.
- Newig, J.* (2004): Public Attention, Political Action: The Example of Environmental Regulation, *Rationality and Society* **16** (2), 149-190.
- Pahl-Wostl, C.; Hare, M.* (2004): Processes of Social Learning in Integrated Resources Management. *Journal of Applied and Community Psychology* **14**, 193-206.
- Pahl-Wostl, C. and Ridder, D.* Mega Cities, Climate Change and Water - Increased Vulnerability of the Poor. *Climate Change* (in review).
- Kottonau, J., and Pahl-Wostl, C.* Simulating political attitudes and voting behavior. *JASSS* (in press).
- Pahl-Wostl, C.* Implications of complexity for Integrated Resources Management. *Environmental Modelling and Software* (accepted).
- Ebenhöh, E. and Pahl-Wostl, C.* Heuristics to characterize human behaviour in agent based models, *Environmental Modelling and Software* (accepted).
- Pahl-Wostl, C.* Participation in scenario development; *Scenarios of the Future, The Future of Scenarios*, (J. Alcamo, Ed.), Springer Verlag (in press).
- Pahl-Wostl, C.* Information, Public Empowerment and the Management of Urban Watersheds. *Environmental Modelling and Assessment, Environmental Modelling and Software* (in press).
- Tillman, D. E., Larsen, T., Pahl-Wostl, C., and Gujer, W.* Simulation for strategy

development in water supply systems. *Hydroinformatics* (in press).
 Ebenhöf, E.; Pahl-Wostl, C. Agent-based models of ultimatum games using experimental data and theory, *Games and Economic Behaviour* (in review)

3.3.2 Contributions to Conference Proceedings, Monographs

- Pahl-Wostl, C. (2002): Agent Based Simulation in Integrated Assessment and Resources Management. In: Rizzoli, A. and Jakeman, T. (eds). *Integrated Assessment and Decision Support. Proceedings of the 1st biennial meeting of the International Environmental Modelling and Software Society*, Vol 2, 239-250.
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<http://www.uvp.de/welcome.html?http://www.uvp.de/report/report.htm>.
- Pahl-Wostl, C. (2004): The implications of complexity for Integrated Resources Management, Complexity and Integrated Resources Management in: *Transactions of the 2nd Biennial Meeting of the International Environmental Modelling and Software Society*, iEMSs, Pahl-Wostl, C.; Schmidt; S., Rizzoli; A.E.; Jakeman, A.J. (eds.), Manno, Switzerland.
- Newig, J.; Hesselmann, J. (2004): Modelling the Dynamics of Public Attention towards Environmental Issues. In *Transactions of the 2nd Biennial Meeting of the International Environmental Modelling and Software Society*, iEMSs, Pahl-Wostl, C.; Schmidt; S., Rizzoli; A.E.; Jakeman, A.J. (eds.), Manno, Switzerland.
- Panbianco, S.; Pahl-Wostl, C. (2004): Obstacles in launching a participatory group discussion and modelling process. In *Transactions of the 2nd Biennial Meeting of the International Environmental Modelling and Software Society*, iEMSs, Pahl-Wostl, C.; Schmidt; S., Rizzoli; A.E.; Jakeman, A.J. (eds.), Manno, Switzerland, Vol. 1, pp. 240-246.

3.4 International Ecological Projects

- Schlüter, M., Rüger, N. (2004) Application of a GIS-based simulation tool to analyze and communicate uncertainties in future water availability and their implications for a degraded river delta. Contribution to the annual meeting of the “International Environmental Modelling and Software Society”, June 2004
- Schlüter, M., Savitsky, A., Rüger, N., Lieth, H. (2003). Simulation der großräumigen Grundwasser- und Überflutungsdynamik in einem degradierten Flußdelta als Basis für eine ökologische Bewertung alternativer Wassermanagementstrategien. S. 437-443. In: Strobl J, Blaschke T, Griesebner G (Herausgeber) *Angewandte Geographische Informationsverarbeitung XV. Beiträge zum AGIT-Symposium*

Salzburg 2003. Wichmann, Heidelberg.

Schlüter, M. (2003). Development of an integrated GIS-based simulation tool to support ecologically sound water management in the Amudarya river delta. University of Osnabrück. Department of Mathematics/Computer Science. 202 pp.

Schlüter, M., Savitsky, A.G., McKinney, D.C., Lieth, H. (in press). Optimizing long-term water allocation in the Amudarya river delta - A water management model for ecological impact assessment. Environmental Modelling and Software

3.5 Other Publications and Contributions to Conferences

Brauer, K. (2004): The Korteweg – de Vries Equation: History, exact Solutions, and graphical Representation, Enlarged and improved 2nd version.

<http://www.usf.uni-osnabrueck.de/~kbrauer/solitons.html>,

Umbach, E.: Die Studiengänge Angewandte Systemwissenschaft an der Universität Osnabrück, Wirkungsbereich von Manfred Peschel 1990-92, mit einem Brief von ihm über Systemwissenschaft vom 6.3.1999; in: Betrachtungen zur Systemtheorie, Gedenkband zum Leben und Schaffen von Prof. Manfred Peschel, IPM, Hochschule Zittau-Görlitz, 2003, S. 373-386 (ISBN 3-9808089-3-9)

Matthies, M.: Das Institut für Umweltsystemforschung. Mitteilungen der GDCh-Fachgruppe Umweltchemie und Ökotoxikologie, Wiley-VCH, 4/2004 (in press).

3.6 Scientific Contribution Series

Editor: *Prof. Dr. Michael Matthies*; ISSN 1433-3805

The reports No. 1 to 6 have been issued up to September 30th, 1998.

The reports No. 7 to 23 have been issued from Oct. 1st, 1998 to Dec. 31st, 2001

During the period Jan. 1st, 2002 to Sept. 30th, 2004 four reports have been issued. Since the start of this report period these reports are no longer available in printed form, but may be downloaded from the internet via <http://www.usf.uni-osnabrueck.de/usf/beitraege/>.

Reports subsequently listed have been issued:

No. 24: *Kai Lessmann* (Diploma Thesis): Probabilistic Exposure Assessment. Parameter Uncertainties and their Effects on Model Output. November 2002.

No. 25: *Frank M. Hilker* (Diploma Thesis):
Parametrisierung von Metapopulationsmodellen. March 2003.

No. 26: *Nadja Rüger* (Diploma Thesis): Habitat suitability for *Populus euphratica* in the Northern Amudarya delta - a fuzzy approach. June 2003.

No. 27: *Claudia Pahl-Wostl, Eva Ebenhöh (eds.)*: Komplexe Adaptive Systeme. July 2003.

4. Research Cooperations

The institute cooperates with several departments within the University of Osnabrück as well as with other universities and research centres on a national and international basis.

In addition to that Technology Transfer has taken place (Theses in cooperation with non-university institutions and manufacturing companies). A list of scientists visiting *the Institute of Environmental Systems Research* for longer research periods is added as well.

4.1 Cooperations within the University of Osnabrück

- Department of Biology (Prof. Altendorff): Horizontal transfer of antibiotic resistant genes in soil
- Department of Physics (Prof. Rühl): A parallel project in cooperation with the Federal Environmental Agency (Umweltbundesamt) concerning the chemical bond and the photolysis of semivolatile organic pollutants from environmental aerosols

4.2 Cooperations on a National Basis

- Potsdam Institut für Klimafolgenforschung: HBV Calibration for the Elbe River Basin (Dr. V Krysanonova)
- Umweltforschungszentrum Leipzig/Halle: Georeferenced simulation of Arsen in the river Mulde (Dr. von Tümpling)
- Institut für Landschafts- und Umweltplanung, Technische Universität Berlin: Economic evaluation of measures and scenarios inside the Decision Support System for the Elbe River Basin (M. Grossmann)
- Institut für ländliche Räume, Bundesforschungsanstalt für Landwirtschaft (FAL): Adaptation of RAUMIS scenarios for implementation inside the Elbe-DSS (Dr. Gömann)
- Umweltforschungszentrum Leipzig/Halle: Populationsdynamik (Dr. Frank)
- Institut für Landschaftsökologie und Ressourcenmanagement, Universität Gießen (Dr. Röpke) und Bayer. Landesamt für Wasserwirtschaft (Dr. Lackhoff): Georeferenced modeling of the pesticide Bentazon in a specified sub-catchment of River Main.
- Department of Waste and Wastewater Management, University Duisburg-Essen (Dr. Bester): Georeferenced modeling of musk fragrances and phosphonated flame retardants in River Ruhr catchment.
- Institute for Plant Virology, Microbiology und Biosafety, Federal Biological Research Centre for Agriculture and Forestry, Braunschweig (PD Dr. Smalla): Antibiotic resistant genetransfer in soil.
- Ecological Research Station, Bavarian Julius-Maximilians-University of Würzburg: Metapopulation models (Prof. Dr. H.J. Poethke)

4.3 Cooperation on an International Basis

- University of Twente (NL): Decision Support System for the River Elbe Basin (Dr. Jan-

- Luc de Kok), Spatial agent based simulation (Prof. Anne van der Veen)
- ETH Zürich (CH): Overall Persistence and Long-range Transport Potential (Prof. Hungerbühler, Dr. Scheringer)
 - University of Toronto (CAN): Global transport of persistent organic pollutants (Prof. Dr. Frank Wania)
 - RIKS Institute Maastricht (NL): Decision Support System for the Elbe River Basin (Dr. Engelen, B. Hahn)
 - Institute of Water Problems and Institute of Bioecology, Uzbek Academy of Sciences (Uzbekistan): Restoration and Management Options for the Northern Amudarya Delta, Uzbekistan (Dr. Karimov)
 - National Institute of Public Health and Environmental Protection, Bilthoven (NL): Environmental Exposure and Risk Assessment (Prof. Dr. Dik van de Meent)
 - Shirshov Institute of Oceanology Moscow (Russia): Pattern Formation in Reaction-Diffusion Systems (Dr. S.V. Petrovskii)
 - Institute of Experimental and Theoretical Biophysics Pushchino (Russia): Modelling marine plankton dynamics (Prof. A. B. Medvinskii)
 - Laboratory of Ichthyology, Department of Biology, Moscow State University, Moscow, Russia Fish school dynamics (Prof. Dr. E. A. Kriksunov, Dr. A. Bobyrev)
 - Laboratory of Microplankton, Institute of Biology of the Southern Seas, Ukrainian Academy of Sciences, Sevastopol, Ukraine: Data processing (Dr. I. G. Polikarpov)
 - University of California at Berkeley and Lawrence Berkeley Laboratory, Berkeley (USA): Long-range transport modelling (Prof. Tom McKone, Dr. Matt MacLeod)
 - Trent University (Canada): Regional multimedia fate modelling (Prof. Don Mackay)
 - University of Leeds (Great Britain): Modelling marine plankton dynamics (Prof. J. Brindley)
 - University of Marseille (France): Biological-physical interactions in aquatic systems (Prof. J.-C. Poggiale)
 - University of Torino (Italy): Numerical analysis (Prof. Dr. E. Venturino)
 - Hiroshima University (Japan): Analytical treatment of reaction-diffusion problems (Prof. M. Mimura, Prof. H. Seno)
 - Nara Women's University (Japan): Biological invasions (Prof. N. Shigesada)
 - University Victor Segalen Bordeaux 2 (France): Mathematical epidemics (Prof. M. Langlais)
 - Eidgenössische Anstalt für Wasserversorgung, Abwasserreinigung und Gewässerschutz (EAWAG): Georeferenced Simulation of Human Pharmaceuticals in the River Glatt (Dr. Fenner, Prof. Giger), Modellierung von Akteuren in der Wasserversorgung (Dr. Tove Larsen, Prof. Willi Gujer), Bewertung von neuen Technologien in der Siedlungswasserwirtschaft durch BürgerInnen (Dr. Tove Larsen), Management von Wasserressourcen in China (Dr. Hong Yang, Dr. Peter Reichert, Prof. Alexander Zehnder).
 - Center for Policy Modelling, University of Manchester (UK): Participatory Agent Based Social Simulation (Prof. Scott Moss).
 - University of Surrey (UK): Internet based gaming for stakeholder coordination (Prof. Nigel Gilbert).
 - University of Oxford (UK): Participatory Agent Based Social Simulation (Dr. Tom Downing).
 - University of Maastricht (NL): New approaches in Integrated Assessment (Prof. Jan Rotmans).

- University of Athens, Georgia (USA): New concepts in urban water management (Prof. Bruce Beck).
- University of Santa Barbara (USA): Importance of organizational structure for the economic performance of companies (Prof. Stephen Decanio).
- International Center for Advanced Mediterranean Agronomic Studies Italy: Sustainable Halophyte Utilisation in the Mediterranean and Subtropical Dry Regions (Prof. Hamdy)
- Desert Research Center Egypt: Sustainable Halophyte Utilisation in the Mediterranean and Subtropical Dry Regions (Prof. El Shaer)
- Nutrition Mineral Lab, Institut National de Recherche Scientifique et Technique Tunesien: Sustainable Halophyte Utilisation in the Mediterranean and Subtropical Dry Regions (Prof. Abdelly)
- Institute of Zoology, Russian Academy of Sciences (Russia): Restoration and Management Options for the Northern Amudarya Delta, Uzbekistan (Prof. Aladin)
- University of Alberta (Edmonton, Canada): Modelling biological invasions (Prof. Dr. M.A. Lewis)

4.4 Technology Transfer

4.4.1 Counseling and Cooperation

- *OECD Paris* (2003-04): Benchmark Procedure for Pov- and LRT Classification of Chemicals.
- *Intevation GmbH* (2002-04): Decision Support System for the Elbe River Basin (S. Reimer); GREAT-ER II (F. Koormann)
- *TRP - Telomer Research Program (AGA Chemicals; Clariant GmbH; Daikin America, Inc.; duPont de Nemours & Co.)* (2003-04): Evaluation of Long-Range Transport (LRT) Properties and Associated Environmental Exposure for Fluoro Telomer Substances
- Advisory Board of Lower Saxony and Bremen regarding the Implementation of the Water Framework Directive (Beirat Niedersachsen/Bremen zur Umsetzung der Wasserrahmenrichtlinie). Representative of the University of Osnabrück: Dr. Jens Newig.

4.4.2 Master Thesis

- *Kötter Consulting, Rheine*; Matthias Peußner: Entwicklung und Implementierung eines numerischen Verfahrens zur Berechnung der instationären Gasströmungen in Rohrleitungen mit Kolbenverdichtern, 2004, (Referees: Dr. A. Brümmer, Kötter Consulting, Akad. Director K. Brauer, University of Osnabrück)

4.5 Visiting Scientists

- *Prof. Dr. Evgeni A. Kriksunov*, May 2002
Laboratory of Ichthyology
Institute of Biology
Moscow State University
Moscow, Russia

- *Prof. Dr. Alexander B. Medvinskii*, May 2002, May 2004
Institute of Experimental and Theoretical Biophysics
Russian Academy of Sciences
Pushchino, Russia
- *Dr. Dmitrii A. Tikhonov*, April 2002
Institute for Mathematical Problems in Biology
Russian Academy of Sciences
Pushchino, Russia
- *Dr. Sergei V. Petrovskii*, May/June 2002, March/April 2004
Shirshov Institute of Oceanology
Russian Academy of Sciences
Moscow, Russia
- *Prof. Dr. Dik van de Meent*, June – August 2002
National Institute of Public Health and Environmental Protection,
Bilthoven (Niederlande)
- *Prof. Dr. Ezio Venturino*, November 2003
Dipartimento di Matematica
Politecnico di Torino
Corso Duca degli Abruzzi 24
10129 Torino, Italy
- *Prof. Dr. Hiromi Seno*, March 2004
Department of Mathematical and Life Sciences
Graduate School of Science
Hiroshima University
Kagamiyama 1-3-1
Higashi-Hiroshima 739-8526, Japan
- *Dr. Ram Rup Sarkar*, since May 2004
Embryology Research Unit
Indian Statistical Institute
Kolkata, India
- *Dr. Bertram Ostendorf*, April – June 2004
University of Adalaide, SA
Australia
- *Dr. Aydar B. Nasrulin*, October/November 2004
Institute of Water Problems
Uzbek Academy of Sciences
Tashkent (Uzbekistan)
- *Dr. Farrukh Shaazizov*, October/ November 2004
Institute of Water Problems
Uzbek Academy of Sciences
Tashkent (Uzbekistan)

5. Other Activities

5.1 International Conference on Complexity and Integrated Resources Management iEMSs 2004

The Institute supported by the German Environmental Foundation (DBU) organised the second International Conference of the “International Environmental Modelling and Software Society” – iEMSs 2004 on June 14th – June 17th, 2004. More than 300 scientists from 40 countries participated in the conference. Lectures and oral contributions were presented in the following sessions

Artificial Intelligence Techniques for Integrated Resource Management
Biocomplexity and Adaptive Ecosystem Management
Ecological Modelling
Econometric Modelling of Environmental Systems
Economic Modelling of Kyoto Protocol Related Issues
Environmental Decision Support Systems
Environmental Informatics Towards Citizencentred Electronic Information Services: the Urban Environment Example
Evolutionary Computing Methods for Environmental Modelling and Software Development
Human Behaviour and Agent-Based Modelling
Hydro Environmental Modelling and Operational Management
Information Management in Complex Interactions
Landscape Patterns: Simulating Changes, Identifying Driving Forces and Calibrating Models
Model Integration and Development of Modular Modelling Systems
Modelling Eco-tourism and Sustainability
Modelling Hydrological Responses in Ungauged Catchments
Participatory and Group Model Building for Natural Resource Management
Physics and Modelling of Transport and Transformation Processes at Environmental Interfaces
Pollution Modelling and Impact Assessment
Regional Dynamic Modelling
Risk Analysis and Environmental Finance
River Basin Management
Scenario Development and Integrated Scenario Modelling
Uncertainty in Life-Cycle-Assessment
Volatility and Uncertainty in Environmental Systems

Special Sessions have been devoted to:

ERCIM: Information Technologies for Integrated Resource Management
Harmoni-Qua: Support for Model Based Water Management

The proceedings have been published electronically 2004:

Pahl-Wostl, C.; Schmidt; S., Rizzoli; A.E.; Jakeman, A.J. (eds.), Complexity and Integrated Resources Management, *Transactions of the 2nd Biennial Meeting of the International*

Environmental Modelling and Software Society, iEMSs: Manno, Switzerland, 2004.
The three-volume proceedings are available as PDF-Files via
<http://www.iemss.org/iemss2004/>

5.2 Advisory and Editorial Boards

- OECD Expert Group on Multimedia Models (Matthies)
- Scientific Advisory Committee of the Course Program “Geoecology” at the Technical University Braunschweig (Matthies)
- Scientific Advisory Committee of the “Leibniz-Zentrum für Agrarlandschafts- und Landnutzungsforschung (ZALF) e.V., Münchenberg
- Ecological Complexity, Associate Editor (Malchow)
- Environmental Science and Pollution Research; Editorial Board (Matthies)
- Evangelische Studienwerk Villigst (Malchow)
- Environmental Modeling & Assessment; Editorial Board (Malchow)
- Integral Science Institute (ISI) in Chapel Hill/NC, U.S.A. (Advisory board, E. Umbach)
- Zeitschrift für Ernährungsökologie (Klasmeier)

5.3 Supervision of theses in other fields than Applied Systems Science

Julia Hesselmann (2004): A cognitive-based approach to the dynamics of public attention in a multiagent simulation. Bachelor-Thesis in *Cognitive Science* (completed). Referee: Dr. Jens Newig.

5.4 University programme Environment – Development – Peace

Prof. Dr. E. Umbach was an active member of the interdepartment working group *Environment - Development - Peace (Umwelt – Entwicklung – Frieden)* during the whole reporting period. The task of that group is the planning and realization of a program of general studies "Environment - Development - Peace", which is part of the lecture programme of the University for students from all disciplines.

Prof. Dr. E. Umbach contributed two lectures to the program

- Winter term 2001/02: Globalization - current concepts for analysis and design
- Winter term 2003/04: Sustainability - concepts, realizations, perspectives, strategies.

6. Teaching

6.1 General

The University of Osnabrück offers two diplom programs in *Applied Systems Science*. At the beginning of the winter term 1989/90 the main diplom program started. The minimum length of that program is 9 terms. The course program consists of 4 major subprogrammes: Systems Science, Mathematics, Computer Science and one or two Application Subjects (the latter may be chosen from Physics, Chemistry, Biology, Economics, Business Management, Geography, Social Sciences, Psychology). Since winter term 1990/91 a postgraduate diplom program is offered. Prerequisite to start this study program is a diplom, bachelor or master degree (or any comparable) in a science discipline, engineering discipline, social science or any related area. The minimum length of this program is 4 terms.

In winter term 2003/04 the master course *Integrated Assessment* started. This programme is performed in common with the University of Twente in Enschede (The Netherlands). The minimum length of this course is 4 terms. Prerequisite is a Bachelor's degree within a related field. In contrast to the *Applied Systems Science* courses which are held in German, the MSc-course *Integrated Assessment* is held in English.

Subsequently the courses held and the projects supervised by staff members for students of the diplom programmes *Angewandte Systemwissenschaft (Applied Systems Science)* and *Integrated Assessment* are listed (the period is summer term 2002 to summer term 2004, the list of lessons in winter term 2001/02 had been published already in the second report of the institute):

6.2 Summer Term 2002

- *E. Umbach*: Environmental Systems, 6 ECTS
- *H. Malchow*: Systems Science II, 9 ECTS
- *M. Matthies*: Water- and matter-balance in catchments, 3 ECTS
- *J. Klasmeier*: Data Recruitment and Data Evaluation, 3 ECTS
- *J. Berlekamp*: Geographical Information Systems I, 6 ECTS
- *J. Berlekamp*: Geographical Information Systems II, 3 ECTS
- *C. Pahl-Wostl*: Selected problems from modeling of social systems, 3 ECTS
- *K. Brauer*: Numerical treatment of ordinary differential equations, 9 ECTS
- *H. Malchow*: Project: Systems Science and the Internet, 3 ECTS
- *H. Malchow*: Project: Modelling of Hysteresis Vibrations, 3 ECTS
- *M. Matthies*: Project: Water- and matter-balance in catchments, 3 ECTS
- *J. Klasmeier*: Project: CemosS 2 (Chemical Exposure Modelling System), 3 ECTS
- *J. Klasmeier*: Project: Laboratory for Environmental Assessment, 3 ECTS points
- *K. Brauer*: Project: Numerical treatment of mathematical models, 3 ECTS
- *E. Umbach*: Project Colloquium, 3 ECTS

6.3 Winter Term 2002/2003

- *M. Matthies*: Introduction to Applied Systems Science, 6 ECTS
- *K. Brauer*: Systems Science I, 9 ECTS
- *J. Klasmeier*: Environmental System Assessment, 6 ECTS
- *J. Berlekamp*: Geographical Information Systems III, 3 ECTS
- *C. Pahl-Wostl*: Agent based modeling, 6 ECTS
- *C. Pahl-Wostl/J. Newig*: Actor-based analysis in the environmental context, 3 ECTS
- *K. Brauer & E. Umbach*: Project: Systems Science Excursion, 3 ECTS
- *M. Matthies*: Project: Environmental Modelling, 3 ECTS
- *H. Malchow*: Project: Systems Science and the Internet, 3 ECTS
- *J. Klasmeier*: Project: CemosS 2 (Chemical Exposure Modelling System), 3 ECTS

6.4 Summer Term 2003

- *E. Umbach*: Environmental Systems, 6 ECTS
- *H. Malchow/F. Hilker*: Systems Science II, 6 ECTS
- *M. Matthies*: Environmental Risk Assessment, 6 ECTS
- *J. Berlekamp*: Geographical Information Systems I, 3 ECTS
- *J. Berlekamp*: Geographical Information Systems II, 3 ECTS
- *K. Brauer*: Applied Statistics, 6 ECTS
- *K. Brauer*: Partial Differential Equations – Basics and numerical methods, 9 ECTS
- *H. Malchow*: Project: Systems Science and the Internet, 3 ECTS
- *J. Klasmeier*: Project: CemosS 2 (Chemical Exposure Modelling System), 3 ECTS
- *J. Klasmeier*: Project: Laboratory for Environmental Assessment, 3 ECTS
- *E. Umbach*: Project Colloquium, 3 ECTS
- *C. Pahl-Wostl/J. Newig*: Seminar: Actual issues of resource flow management, 3 ECTS
- *J. Newig*: Interdisciplinary seminar on the EU water frame guideline, 3 ECTS

6.5 Winter Term 2003/2004

- *M. Malchow/V. Berding*: Introduction to Applied Systems Science, 6 ECTS
- *K. Brauer*: Systems Science I, 9 ECTS
- *J. Klasmeier*: Environmental System Analysis, 6 ECTS
- *K. Brauer*: Boundary value problems and Eigenvalue problems for ODEs, 3 ECTS
- *J. Newig*: Actor-based analysis in an environmental policy context, 3 ECTS
- *E. Umbach*: Modern societies – basic conflicts and chances of arrangement, 3 ECTS
- *E. Umbach*: Theory of science and systems science , 6 ECTS
- *H. Malchow*: Project: Systems Science and the Internet, 3 ECTS points
- *C. Pahl-Wostl*: Agent based analysis and modeling in resource management, 3 ECTS
- *J. Klasmeier*: Project: CemosS 2 (Chemical Exposure Modelling System), 3 ECTS
- *C. Pahl-Wostl/J. Newig*: Seminar: Actual issues of resource flow management, 3 ECTS
- *C. Pahl-Wostl/J. Newig/A. v.d. Veen*: Integrated Assessment: Introduction, 6 ECTS
- *C. Pahl-Wostl/J. Newig*: Planning the master course Integrated Assessment, 3 ECTS
- *M. Matthies*: Introduction into System Science, 3 ECTS

6.6 Summer Term 2004

- *E. Umbach*: Environmental Systems, 6 ECTS
- *H. Malchow/ F. Hilker*: Systems Science II, 9 ECTS
- *M. Matthies*: Sustainability – Sketches, methods, applications, 6 ECTS
- *K. Brauer*: Applied Statistics, 6 ECTS
- *K. Brauer*: Numerical treatment of ordinary differential equations, 6 ECTS
- *J. Berlekamp*: Geographical Information Systems I, 3 ECTS
- *C. Pahl-Wostl*: Complex adaptive systems, 6 ECTS
- *C. Pahl-Wostl*: Model building and participatory approaches, 6 ECTS
- *H. Malchow*: Project: Systems Science and the Internet, 3 ECTS
- *M. Matthies*: Project: Environmental modelling, 3 ECTS
- *J. Klasmeier*: Project: CemosS 2 (Chemical Exposure Modelling System), 3 ECTS
- *J. Klasmeier*: Project: Laboratory for Environmental Assessment, 3 ECTS
- *E. Umbach*: Project Colloquium, 3 ECTS

6.7 Colloquium Systems Science

Each winter term a colloquium is held which is open to the public. Efforts are being made to win experts from the diverse sub-disciplines of systems science. The date, the name of the lecturer and the title of each presentation are listed below:

6.7.1 Winter Term 2001/ 2002: 8th Colloquium

- 08 Nov. 2001: *Prof. Dr. Hans-Joachim Poethke* (University of Würzburg)
Walkings in Vitual Universes – Simulation Studies for Dispersion Behaviour of Insects.
- 15 Nov. 2001: *Prof. Dr. Michael Jischa* (Technical University of Clausthal-Zellerfeld)
Civilization Dynamics.
- 22 Nov. 2001: *Prof. Dr. R. Hegselmann* (University of Bayreuth, Institute of Philosophy)
Modelling Social Dynamics – A Pleading for radically simplifying Models
- 29 Nov. 2001: *Dr. Wolfgang G. Kreyling* (GSF Neuherberg/München)
The Impact of ultra-fine Aerosol Particeles to Human Health.
- 06 Dec. 2001: *Prof. Dr. Wolfgang Durner* (Technical University of Braunschweig)
Prognosis of Leachate: Vison or Utopia?
- 13 Dec. 2001: *PD Dr. Matthias Liess* (Centre for Environmental Resarch – Halle-Leipzig)
Effects of Insecticides on the Level of Landscape.
- 20 Dec. 2001: *PD Dr. Frank Jöst* (University of Heidelberg)
Population Growth, Environmental Problems and Economical Development: A Dynamic Perspective.

10 Jan. 2002: *Dr. Alfred Becker* (Potsdam Institute for Climate Impact Research)
GLOWA Elbe – An integrative interdisciplinary Research Project for the Effects of
Global Change in the Region of the River Elbe.

17 Jan. 2002: *Prof. Dr. Dietrich Dörner* (University of Bamberg)
The Simulation of Emotions

24 Jan. 2002: *Prof. Dr. Sabine Hoffmeister* (University of Lüneburg)
Sustainable Development of Regions

6.7.2 Winter Term 2002/ 2003: 9th Colloquium

31 Oct. 2002: *Dr. Markus Klein* (GKSS, Geesthacht)
Flood prediction: Model systems for planning and admonition.

07 Nov. 2002: *Prof. Dr. M. Ehlers* (University of Vechta)
Remote sensing

14 Nov. 2002: *Dr. P. Reichertl* (EAWAG, Dübendorf/Switzerland)
The benefits of Bayes' methods for decision support.

21 Nov. 2002: *Dr. G. Lammel* (Max-Planck Institute of Meteorology Hamburg)
Global dispersion of persistent organic pollutants.

28 Nov. 2002: *Dr. H. Lange* (University of Bayreuth)
Eco-systems as interactive multi-agent systems.

12 Dec. 2002: *Prof. Dr. U. Feudel* (University of Oldenburg)
Climate models: Nonlinear response and thresholds.

19 Dec. 2002: *Prof. Dr. J. Filser* (University of Bremen)
Risk estimation and theoretical concepts behind it.

09 Jan. 2003: *Prof. Dr. A. van der Veen* (University of Twente/ The Netherlands)
Spatial patterns and location behaviour. ABLOOM: An explanation based on agent
based modelling.

16 Jan. 2003: *Prof. Dr. G. Schüürmann* (Centre for Environmental Research – Halle-
Leipzig)
Structure-impact relations within the chemical eco-toxicology.

6.7.3 Winter Term 2003/ 2004: 10th Colloquium

30 Oct. 2003: *Dr. Johannes Ranke* (University of Bremen)
Spatial Model Building in Ecology: New Approaches and their Potential for
Theory Formation and Application.

06 Nov. 2003: *Dr. Dr. Thomas Brenner* (Max-Planck Institute, Jena)
Consumers' behaviour and the dynamics of fashion.

- 13 Nov. 2003: *Prof. Dr. Ortwin Renn* (Institute of Social Sciences, University of Stuttgart)
Glamour and calamity of technical prognoses.
- 27 Nov. 2003: *Prof. Dr. Andres Ernst* (Centre for Environmental Systems Research, University of Kassel)
Simulation of players as a part of an integrated multidisciplinary network of models.
- 11 Dec. 2003: *Prof. Dr. Peter Wycisk* (Institute of Geological Sciences, University of Halle-Wittenberg)
Construction of geological spatial models in areas which are implicated by industry and mining and their importance for hydro-geological and environmental geological questions.
- 15 Jan. 2004: *Prof. Dr. Harald Horn* (University of Applied Science, Magdeburg-Stendal)
RIONET – Applications of the modeling of the quality of waters for the management of river catchments.
- 29 Jan. 2004: *Prof. Dr. Manfred Voigt* (University of Applied Science, Magdeburg-Stendal)
Environment squared – Percipience and actions of social systems within “their” environment as a tool for problem solving.
- 05 Feb. 2004: *Dr. Karl-Otto Wenkel* (Zentrum für Agrarlandschafts- und Landnutzungsforschung (ZALF) , Müncheberg)
Multifunctional sustainable development of the landscape – a challenge to the research of landscape systems.

7. Theses and Awards, Jan. 2002 to Oct. 2004

7.1 Ph.D. Theses (Dr. rer. nat.)

Beyer, Andreas: Criteria for Atmospheric Long-range Transport Potential and Persistence of Pesticides and Industrial Chemicals, January 2002, Referees: Prof. Dr. M. Matthies, Prof. Dr. F. Wania (University of Toronto).

Hess, Oliver: Modellierung, Analyse und Bewertung des chemischen Gewässerzustandes in Flussgebieten, August 2003, Referees: Prof. Dr. M. Matthies, Prof. Dr. J. Härtling.

Schlüter, Maja: Development of an integrated GIS-based simulation tool to support ecologically sound water management in the Amurdarya, August 2003, Referees: Prof. Dr. M. Matthies, Prof. Dr. H. Lieth.

7.2 Diplom Theses (Diplom-Systemwissenschaftler/in)

During the period January 2002 to October 2004, 28 diplom theses in Systems Science (Systemwissenschaftler/in) have been finished. Five of these theses have been completed within the supplementary master course (marked with the letter “E”), the other 23 have been completed within the diploma course which corresponds to a bachelor course with subsequent master course.

These 28 theses have been:

2002

Bojer, Thorsten: Maschinenüberwachung mit Methoden des maschinellen Lernens, September 2002

Centler, Florian: Deterministische und stochastische Simulation eines Sensorkinase-Antwortregulator-Systems, August 2002

Haubrock, Sören: Entwicklung eines verteilten Klassifikationssystems für Fernerkundungsdaten, February 2002

Hilker, Frank: Parametrisierung von Metapopulationsmodellen, July 2002

Ibrahim, Abubakr [E]: Bromid-Tracer Versuch im Großlysimeter St. Arnold unter Anwendung des Modells LYFE, October 2002

Kopperschmidt, Kai: The Central Limit Theorem under Random Censorship and Reporting Delays with an Application to Purchase Timing Behaviour, January 2002

Leßmann, Kai: Probabilistic Exposure Assessment -- Parameter Uncertainties and their Effects on Model Output, August 2002

Meyer, Christian: Adaptive Kontrollarchitekturen für komplexe Systeme am Beispiel eines sechsbeinigen Roboters, March 2002

Reinecke, Michael: Trägt die Arbeitslosigkeit zum Wiederanstieg der selbständigen Erwerbstätigkeit bei? Empirische Untersuchung auf Grundlage des Mikrozensus der Jahre 1989-97, August 2002

Rüger, Nadja: Habitat suitability for *Populus euphratica* in Northern Amudarya delta - a fuzzy approach, November 2002

Schunk, Daniel: The Impact of a Carbon Tax Policy on Income Development of Northern and Central Illinois Grain Farms - A Dynamic Simulation Model, June 2002

Siemer, Anja: Attraktoreffekte bei der Beurteilung von Personen, July 2002

Tluk von Toschanowitz, Katharina: Der Einfluss von Straßennetz und Verkehrsfluss auf die "Überlebensfähigkeit von territorialen Wildtierpopulationen – eine Modellanalyse, May 2002

2003

Graf, Neil: Integration von ereignisbezogenen Nährstoffflüssen in das Pilot-DSS Elbe, April 2003

Grobe, Alexander [E]: Entwicklung und Implementation eines Stofftransportmoduls für das Wasserhaushaltsmodell LYFE, September 2003

Holtz, Georg: Ein agentenbasiertes Modell der Diffusion von Technologien, July 2003

Kaldrack, Kai: Nachhaltige Landwirtschaft im nördlichen Landkreis Osnabrück - Eine Akteursanalyse mit dem Schwerpunkt Nitratbelastung im Grundwasser, September 2003

Köhne, Jens: Mit EMAS II zu einem integrierten Umweltmanagementsystem, February 2003

Meinert, Stefan: Ein Framework zur Kopplung von GIS und Multi-Agenten-Systemen, September 2003

Schniederberend., Tanja: Cross Media Publishing von Lehrmaterialien mit XML Schema & XSL-Transformationen, June 2003

Zylka, Peter: Untersuchung des dynamischen Verhaltens von multimedialen Umweltmodellen, June 2003

2004 (Jan. – Oct.)

Gros, Andreas: Aggregierbarkeit populationsdynamischer Modelle, January 2004

Gursky, Peter: Vergleichende Ökobilanz von drei Gebäuden, May 2004

Lüdeke, Alexander: Computerbasierte Modellierung musikalischer Metrik, January 2004

Meister, Konrad [E]: Erzeugung kompletter Aktivitätenpläne für Haushalte mit genetischen Algorithmen, August 2004

Peußner, Matthias: Entwicklung und Implementierung eines numerischen Verfahrens zur Berechnung der instationären Gasströmungen in Rohrleitungen mit Kolbenverdichtern, January 2004

Reußner, Dominik [E]: Relating Choice of Agent Rationality to Agent Model Uncertainty, April 2004

Wippermann, Birgit [E]: Mathematische Auswertung des Abbauverhaltens von Pflanzenschutzmitteln in Wasser-Sediment-Standardtestsysteimen, October 2004

7.3 Scientific Awards

Academic year 2002/2003:

- Andreas Focks, Frank M. Hilker, Christian Hüser, Andreas Manz, Alexander Meyer, Tobias Niemann, Matthias Peußner, Irina Prinz; Ole B. Schroeder, Ba Kien Tra: Innovationspreis der Intevation GmbH

Academic year 2003/2004:

- Dr. Maja Schlüter, Promotionspreis des Rotary Clubs Osnabrück, 185. District
- Jan Baudisch, Andreas Manz, Verkehrsverein Stadt und Land Osnabrück e.V.
- Ralf Kunze, Marcus Lunzenauer u.a. Intevation GmbH