

Mensch und globale  
Umweltveränderung

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**Prof. Dr. Siegfried Berninghaus, Karlsruhe (6/97 - 5/99), Prof. Dr. Holzmann, Saarbrücken (6/95 - 5/97) and Prof. Dr. Werner H. Tack, Saarbrücken (6/95 - 5/99)**

**Cooperative management of crisis in environmental commons.**

Disciplines: **Ecological economics, experimental research in economics, financial science**

**Report:**

The emphasis of the research program in total is on describing and explaining behavior in institutions that man has created to operate common pool resources. A special focus is on conditions for a successful adaptation to emerging crises. Behavioral patterns, incentives, and stakes of actors are described in a modeling framework, from which possible consequences are derived and, on a subsequent stage, confronted with data from field studies and experiments. We intend to make a theory-based, empirically founded assessment of possible and probable successful cooperations under alternative institutional settings for an arbitrary collection of common pool resources.

At the heart of our research project lies the investigation of typical institutions designed to handle

conflicts occurring in the use of a common property resource by a group of individuals. On this field, it is planned to carry out and administer theoretical and practical investigations. For the sake of formal analysis, we will produce mainly game-theoretic works, which are to provide the type of conflict, the potential for conflict, and theoretical solutions. Field studies shall serve as a means to observe actual processes as well as behaviorally relevant cognitions; on the other hand, the assessment of alternatives to handle the relevant common pool resource of different users. In order to control for typical patterns of cooperation as well as barriers to cooperations mainly in situations of a crisis, several experiments will be carried out, with conditions for administration and the use of different investigation devices being varied systematically.

The general targets of the project are obvious from making its title more precise, so that it reads as "cooperative crisis management in common property resources". The goal of the examination is: how and how far allow conflicts about the common use of natural resources and their preservation cooperative solution, conflicts that emanate from crises.

The term crisis covers on the one hand internally caused (endogenous) disturbances and, on the other, influences which are exerted by extraneous factors and which are liable to provoke structural changes. From the viewpoint of the agents, it might be fairly unclear what type of conflict underlies an upcoming situation of crisis. Methodically, mainly those approaches which have been used recently in exploring the commons will be applied. In our project, as is usual in these kinds of research projects, we will examine behavioral alternatives, incentives and actual behavior in institutions that man has created and is creating in order to operate common pool resources.

As institutions we will in first instance understand those contracts that the immediate users of the common pool resource have devised, executed and updated. Moreover, we will, in addition, subsume under the heading of institution those systems of rules whose users are involved only indirectly in certain decisions. Thus, certain tasks of management, maintenance, or control may have been delegated, or the common pool resource may have been split up into a hierarchy of substructures for the sake of manageable group sizes.

Efficiency and the potential for development in such institutions are crucially influenced by the practicability and the acceptability of those rules which have a bearing on the use and the maintenance (sustainability) of the resource in question. To determine acceptable contributions for the preservation as well as acceptable exploitation rights consensual assessment methods are of crucial importance. Updating and refinement are done by the users of their delegates in councils, consultations and negotiations. Rule enforcement frequently necessitates controlling and sanctioning procedures.

Within our project, we will look at typical systems of rules for common property resources. Establishment, updating, refinement, and enforcement of rules will be studied as cases in point. The handling of the common property resource manifests is how the partners handle the rules of

their common pool resource. Put differently, the development of the resource is foreshadowed by the intraorganizational relations. Hence, it is not only exploitation and preservation of the resource which determine individual exploitations and contribution behavior but also the values and opportunities which result from the dynamics of the user group.

Research on common property resources tackles the aforementioned questions by means of modeling as well as empirical devices. The empirical methods include experimental investigations and field studies. Moreover, empirical data and modeling assumptions are exposed to simulations in order to investigate potential consequences. The strength of this combined approach lies in the increased validity and applicability of the theoretical results and in a better clarification of the relation between description and model.

### Focus: Water Commons

The combined approach also implies limits in certain aspects. Instead of looking at a variety of different common pool resources, we will confine our attention to water as a resource. Water is subject to various uses and damages. If we look at user communities of current water and ground water, we perceive a large variety of types of organizations as well as organization sizes. The purposes of the organizations are widespread: Watering and drainage, provision of water for industrial and mining purposes, preservation as a fishing ground as well as recovery site, recycling of clearing, dams to prevent floods, enhancement of the transportation system or the generation are only sum out of a whole bunch of potential targets of water user communities. Furthermore it can be the intention of a group of users to strike a balance between several ways of exploitation (damages).

In order for the potential for conflict or cooperation inherent to a number of such common pool resources to be covered, the works in the project will be assigned to one of the following (not strictly mutually exclusive) scenarios, each.

1. exploitation through a small group of users,
2. exploitation through an agency,
3. control measures and sanctions in the case of abuse,
4. negotiations over user statutes.

With the aid of scenarios 1 and 2, standard systems of rules as we can find them in practice shall be compared with each other, especially with regard to the negative incentive structure, the institutional scopes, the views which are grounded on them, and, finally, the respective quality of conflict management.

As regards scenario 3, the project will serve as a base for examination of the question which rules of sanctioning, and in combination with which conditions for control turn out to be effective, and under which circumstances and to what extent they are established and thereupon accepted.

Concerning scenario 4, it is to be investigated how, under various circumstances, an efficient

change in the set of operating rules can be negotiated.

## Documentation

### Publications:

Albert Hart & Axel Ostmann (1995): A Low-Cost Implementation of Computer-Assisted Game-Theory Based Experiments. Discussion Paper B-9510, Department of Economics, University of Saarland.

Axel Ostmann (1995): Water Management on the Eve of Crisis - The Case of the Canary Islands. Discussion Paper B-9511, Department of Economics, University of Saarland.

Axel Ostmann (1995): Determining Bargaining Behaviour in Three-Person Characteristic-Function Experiments. Discussion Paper B-9512, Department of Economics, University of Saarland. Central European Journal of Operations Research 4, 85-101.

Axel Ostmann (1996): Representing Interactional Judgements in Multilateral Bargaining. Small Group Research 27, 450-470.

Axel Ostmann (1996): When to Defect in Commons. In: P. Kleinschmidt et al. (eds.) Operations Research Proceedings 1995, 505-510. Berlin: Springer.

Axel Ostmann, Werner W. Pommerehne, Lars P. Feld & Albert Hart (1997): Umweltgemeingüter? Zeitschrift für Wirtschafts- und Sozialwissenschaft.

Axel Ostmann & Ulrike Leopold-Wildburger (1996): On Styles of Relating to Bargaining Partners. In: W. Albers, W. Güth, P. Hammerstein, B. Moldovanu & E. van Damme (Eds.): Understanding Strategic Interaction. Essays in Honor of Reinhard Selten. pp.430-443, Springer 1996.

Axel Ostmann & Johann F. Schneider (1996): Assessing the appropriateness of item-responses: the case of the Symlog Rating Scales Discussion Paper 181, Department of Psychology, University of Saarland.

Martin Beckenkamp & Axel Ostmann (1996): Cognitive and socio-cognitive representations of commons. In Chr. Roland-Lévy (Ed.): Social And Economic Representations, IAREP 1996. 1203-1220. Université René Descartes, Paris.

Holger Meinhardt & Axel Ostmann (1996): Competition for the first move in cooperative TU-CPR games. Discussion Paper B-9605, Department of Economics, University of Saarland.

Axel Ostmann (1997): External control may destroy commons. Rationality and Society.

### Conference and Congress contributions:

#### *September 1995:*

Passau: Symposium on Operations Research: Presentation of Models and experiments from the field of common pool resources

#### *October 1995:*

Tucson, Arizona: Conference on Game Theory and Behavioral Sciences: Lecture on Experiments on cooperative game settings

Tucson, Arizona: Meeting of the Economic Science Association: Lecture on Water crises on the Canary Islands and presentation of an experimental overexploitation model

March 1996:

Nuremberg: Annual Meeting of the European Association for the Advancement of Social Sciences: Lecture on Assessing adequate item-responses - the case of the Symlog rating scales (in cooperation with Johann Schneider)

July 1996:

Gmunden, Austria: Annual Meeting European Association of Experimental Social Psychology: Lecture on Individuals Evaluating the Development of Commons: Problems, Rules and Traps (in cooperation with Martin Beckenkamp)

Santiago de Compostella, Spain: Meeting of the Economic Science Association, Game Theory and Politics: Lecture on Cooperative Water Games

September 1996:

Paris, France: IAREP 96: Lecture on Cognitive vs. socio-cognitive styles in managing commons (in cooperation with Martin Beckenkamp)

October 1996:

Bloomington, Indiana: Indiana University, Workshop for Political Theory and Policy Analysis: Colloquium Presentation: How Members of a Common Deal with Inspection and Overcrop.

Tucson, Arizona: Meeting of the Economic Science Association: Lecture on Experiments on the Behaviour in Water Crises

December 1996:

Bielefeld: Workshop: NTU-Games and Markets: Lecture on Cooperative Games of Commons

March 1997:

Zürich: Case Study Klettgau: Lecture on Game-theoretical Approaches to Common Property Institution

### **Products:**

Software for the carrying out and analysis of experiments and simulations concerning commons.

### **People:**

Martin Beckenkamp

Holger Meinhardt

Axel Ostmann (leader),

Bodo Schirra

Beate Wojtyniak.

### **Address:**

Universität Karlsruhe (TH)

Projekt Umweltgemeingüter



Forschungszentrum Umwelt  
76128 Karlsruhe  
**e-mail:** axel@cops.uni-sb.de  
**http://**www.wiwi.uni-sb.de/lst/ec/home.html

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# **Prof. Dr. Siegfried Berninghaus, Karlsruhe & Prof. Dr. Werner H. Tack, Saarbrücken**

## **Cooperative Management of Crisis in Environmental Commons**

**Scientific Disciplines:** Ecological economics, experimental research, financial science

### **Project Overview (4/97 - 5/98)**

The emphasis of the project in total is on describing and explaining behavior in institutions that man has created to operate common pool resources. A special focus is on conditions for a successful adaptation to emerging crises. Behavioral patterns, incentives, and stakes of actors are described in a modelling framework, from which possible consequences are derived and, on a subsequent stage, confronted with data from field studies and experiments. We make a theory-based, empirically founded assessment of possible and probable successful co-operations under alternative institutional settings for an arbitrary collection of common pool resources. At the heart of our research project lies the investigation of typical institutions designed to handle conflicts occurring in the use of a common property resource by a group of individuals.

For the sake of formal analysis, we have produced mainly game-theoretic works, which provide the type of conflict, the potential for conflict, and theoretical solutions. Field studies serve as a means to observe actual processes as well as behaviorally relevant cognitions; on the other hand, the assessment of alternatives to handle the relevant common pool resource of different users. In order to control for typical patterns of co-operation as well as barriers to co-operations mainly in situations of a crisis, several experiments have been carried out and will be carried out, with conditions for administration and the use of different investigation devices being varied systematically.

Efficiency and the potential for development in institutions are crucially influenced by the practicability and the acceptability of those rules which have a bearing on the use and the maintenance (sustainability) of the resource in question. To determine acceptable contributions for the preservation as well as acceptable exploitation rights consensual assessment methods are of crucial importance. Updating and refinement are done by the users of their delegates in

councils, consolations and negotiations. Rule enforcement frequently necessitates controlling and sanctioning procedures. Within our project, we will look at typical systems of rules for common property resources. Establishment, updating, refinement, and enforcement of rules will be studied as cases in point. The handling of the common property resource manifests is how the partners handle the rules of their common pool resource. Put differently, the development of the resource is foreshadowed by the intraorganizational relations. Hence, it is not only exploitation and preservation of the resource which determine individual exploitations and contribution behavior but also the values, social cognitions, and opportunities which result from the dynamics of the user group.

Research on common property resources tackles the aforementioned questions by means of modelling as well as empirical devices. The empirical methods include experimental investigations and field studies. Moreover, empirical data and modelling assumptions are exposed to simulations in order to investigate potential consequences. The strength of this combined approach lies in the increased validity and applicability of the theoretical results and in a better clarification of the relation between description and model.

The combined approach also implies limits in certain aspects. Instead of looking at a variety of different common pool resources, we will confine our attention to water as a resource. Water is subject to various uses and damages. If we look at user communities of current water and ground water, we perceive a large variety of types of organisations as well as organisation sizes. The purposes of the organisations are widespread: Watering and drainage, provision of water for industrial and mining purposes, preservation as a fishing ground as well as recovery site, recycling of clearing, dams to prevent floods, enhancement of the transportation system or the generation are only sum out of a whole bunch of potential targets of water user communities. Furthermore it can be the intention of a group of users to strike a balance between several ways of exploitation (damages). The project's focal examination up to now has been the examination of the question which rules of sanctioning, and in combination with which conditions for control turn out to be effective, and under which circumstances and to what extent they are established and thereupon accepted.

## **Prospect**

Research area "edblbase;scenarios":

Main task in this area is the development of a unifying system of description for the cases found in field. Within this frame reports have to be written on the cases studied up to now (water management in the Netherlands, groundwater extraction in the Saarland, the Ogallalah aquifer, water crisis in the Canary Islands, water conflicts in the Near East, the cross-border aquifer of Klettgau. As an additional case study we have planned to examine groundwater anti-pollution measures (case Weierweiler, Saarland).

### Research area "edblbase;games":

Interdependence and incentive structures of the scenarios under consideration can be represented by a variety of games. In addition to our existing analysis of such games we extend our studies by including asymmetry, co-operation and dynamics. With respect to policy measures changing the incentive structure (and the respective game) up to now we have focused on control and sanctioning regimes. Since our experimental data shows a low efficiency of some of those regimes we like to compare the efficiencies of these regimes with other the efficiency of other measure (costly communication, declaration/report duties, taxation, market for pollution, etc.). For preparing experiments for such a task the corresponding games have to be analysed.

### Research area "edblbase;experiments, interviews/questionnaires, simulations":

In the third research period four experimental series are planned. Additional data will come from questionnaires and interviews. In simulation studies we try to construct agent-internal rules and processes that are apt to model the behavior empirically observed.

### Research area "edblbase;tools":

A first task in this area is to document the various programs of the experimental software. Next adaptations for other operations systems resp. net softwares are needed. Some scales for measuring attitudes (scales developed by the Workshop "edblbase;Multidisciplinary Approaches to Behavioral Change") will be integrated in the on line questionnaires. Updating of the software has to be done to include the special features of the experimental series planned. Additionally we develop an internet version of our experimental software.

## Documentation

### Publications (within the 2nd period, i.e. since July 1997):

A. Ostmann, W. W. Pommerehne, L. Feld und A. Hart: Umweltgemeingüter? *Zeitschrift für Wirtschafts- und Sozialwissenschaften* 117 (1997), 107-144.

A. Ostmann, B. Wojtyniak & M. Beckenkamp: Control and Sanctions May Destroy Commons: Experimental Results and Some Microanalytical Explications. Working Paper in Game Theory and Experimental Economics 7. Universität Karlsruhe.

A. Ostmann: External Control may Destroy Commons. *Rationality and Society* 10 (1998), 135-154.

H. Meinhardt: Common Pool Games are Convex Games. Working Paper in Game Theory and Experimental Economics 8. Universität Karlsruhe. Submitted to *Journal of Public Economic*



*Theory.*

M. Beckenkamp & A. Ostmann: Missing the Target? Sanctioning as an Ambiguous Structural Solution. Chapter (accepted) in a survey book to appear (Social Dilemma Group).

A. Ostmann & M. Beckenkamp: Agentenmodelle zum Umgang mit vollständig erneuerbaren Gemeingütern. In C. G. Jung, K. Fischer & S. Schacht (Hrsg.): Working Notes of the First German Workshop on Distributed Cognitive Systems, S. 20-38

**Congresses, Meetings, Lectures (within the 2nd periode, i.e. since July 1997):**

*Cairns, Australien (July 97):* 7th International Social Dilemma Conference. Lecture of A. Ostmann: Does External Control (De)Stabilise Commons? Lecture of M. Beckenkamp: Modelling Cognitive and Socio-Cognitive Processes in Experimental Commons

*Toulouse (August):* 52nd European Meeting of the Econometric Society (ESEM '97). Lecture of H.Meinhardt: Common Pool Games are Convex Games

*Freiburg (September):* 21. German Annual Meeting on Artificial Intelligence; Workshop Distributed Cognitive Systems: Lecture of Ostmann/Beckenkamp: Agent Models on the Management of Perfectly Renewable Commons

*Kingston, RI (September):* University of Rhode Island. Dept. of Environmental and Natural Resource Economics. Lecture of B. Wojtyniak: Sanctioning Systems for Commons

*Tucson (September):* Fall Meeting of the Economic Science Association. Lecture of B. Wojtyniak: Control and Sanctions may Destroy Commons - Experimental Results and Some Microanalytic Explications

*Saarbrücken (Oktober):* Annual Meeting of the Wilhelm-Wundt Society. Lecture of A.Ostmann: The Commons Dilemma

*Karlsruhe (October):* Lecture of H.Meinhardt: Co-operative Games on Commons

*Karlsruhe (December):* Lecture of B.Wojtyniak: An Asymmetric Experimental Public Good.

*Saarbrücken (January 98):* German Research Center for Artificial Intelligence (DFKI). Lecture of A.Ostmann: Aspirations, Claims, Proposals for Forming Coalitions in Conflicts of Interests

*Saarbrücken (March):* German Research Center for Artificial Intelligence (DFKI). Lecture of B. Wojtyniak: Caution and Foresight in Commons Dilemma Situations

*Enschede (March):* Universität Twente. Research Stay of Holger Meinhardt at the Institute of Applied Mathematics. Lecture: Common Pool Games are Convex Games

*Marburg (April):* TEAP (Annual Meeting of Experimental Psychologists). Lecture of Beckenkamp/Ostmann: Does Measured Action Enhance Co-operation?

*Marburg (April):* TEAP (Annual Meeting of Experimental Psychologists). Lecture of Wojtyniak/Beckenkamp: On the Nitrate Dilemma - Strategic Behavior at Asymmetric Estates

### **Other Products:**

Various sets of experimental software

### **Staff Members:**

Dipl.Vw.Holger Meinhardt, PD Dr. Axel Ostmann,

Corresponding members: Dr. Martin Beckenkamp (SB), Dr. Martha Saboya (Madrid/KA)

### **Thematic Work Group:**

Multidisciplinary Approaches to Behavioral Change (since June 97)

Global Change and the Commons Problem (since November 97)

### **Project Address:**

PD Dr. A. Ostmann, Environmental Research Center (FZU), University of Karlsruhe (TH), P.O. Box 151150, D-76128 Karlsruhe

Tel.: +49-721-608-7584

Fax: +49-721-608-3491

E-mail: [axel@cops.uni-sb.de](mailto:axel@cops.uni-sb.de)

URL: <http://www.wiwi.uni-sb.de/1st/ec/home.html>

If you have any suggestions or questions, please send an email to [umwelt-spp@psychologie.uni-freiburg.de](mailto:umwelt-spp@psychologie.uni-freiburg.de)