D93-17 July 23, 1993

THE EVOLUTION OF NORMS, RULES, AND RIGHTS

by

Elinor Ostrom
Workshop in Political Theory and Policy Analysis
Indiana University

July 23, 1993

© 1993 by author

Paper prepared for presentation at the workshop on "Property Rights and the Performance of Natural Resource Systems, Beijer Institute, The Royal Swedish Academy of Science, September 2-4, 1993. The support of the National Science Foundation (grant no. SES-8921884) is gratefully acknowledged.

Workshop in Political Theory and Policy Analysis
Indiana University, 513 **North Park, Bloomington, Indiana** 47408-3895 U.S.A.
Tel. 812-855-0441 • FAX 812-855-3150 • Internet: workshop@indiana.edu

WORKSHOP IN POLITICAL THEORY AND POLICY ANALYSIS

Beijer Discussion Paper Series No. 39

The Evolution of Norms, Rules, and Rights

Elinor Ostrom

This publication is a part of the Beijer Institute research programme on "Property Rights and the Performance of Natural Systems", mainly funded by the John D. and Catherine T. MacArthur Foundation

Beijer International Institute of Ecological Economics, 1993
The Royal Swedish Academy of Sciences
Box 50005, S-104 05 Stockholm, Sweden
Telephone +46(0)8-673 95 00, Telefax 448(0)8-15 24 64
E-mail: BEIJER @ BEIJER.KVA.SE

ISSN 1102-4941

Abstract

The purpose of this background paper, as I understand it, is to share with colleagues from other disciplines and countries an overview of recent research from one's own field related to the study of natural resources and property rights systems. That is difficult to do within the allotted space, especially given the technical nature of some of the research. In the body of this paper, I will present a broad overview of results without the supporting technical detail or evidence. To provide some of the supporting theory and evidence for the interested reader, a recently published, summary of a considerable body of work undertaken by Roy Gardner, James Walker, and myself is appended.

The establishment of the Panel on Common Property Resources at the National Academy of Sciences during the mid-1980s was an important turning point in this area of research. When the panel was first created, many social scientists interested in natural resource policy problems, presumed that the appropriators (a general term used to describe any person who harvests or withdraws benefits, and thus appropriates from a natural resource systems) were unlikely to develop their own norms, rules and property rights systems to reduce the costs of externalities associated with the use of most natural resource systems. Assuming that no evolution of local norms, rules, or rights would occur, policy recommendations were made that external agents had to impose solutions to these problems on those affected. The imposed solutions were frequently presented as "the only way" to reduce these externalities and increase efficiency. One proposed solution was control of natural resources by a central government agency. The second favored solution was the imposition of private property. Something had to be wrong with the theories, the interpretation of the theories, or the policy prescriptions, if solutions as different as state control and market control were both proposed as the only way to efficiently manage natural resources.

We have come a long way in the past decade.[1] The initial publication of the summary volume of the National Academy of Sciences Panel (National Research Council, 1986), the many important books recently published (McCay and Acheson, 1987; Fortmann and Bruce, 1988; Wade, 1988; Berkes, 1989; Pinkerton, 1989; Sengupta, 1991; Dasgupta and Mäler, 1992; V. Ostrom, Feeny and Picht, 1993; Netting, 1993), the revision of the National Academy of Sciences volume (Bromley, 1992), the influential article by Feeny, Berkes, McCay, and Acheson (1990), and recent important work on property rights (Libecap, 1989; Eggertson, 1990; Bromley, 1991) have all contributed to this progress. Books by those associated with the Workshop in Political Theory and Policy Analysis at Indiana University (E. Ostrom, 1990, 1992; E. Ostrom, Gardner, and Walker, 1993; Blomquist, 1992; Tang, 1992; Martin, 1989/1992; Thomson, 1992) have hopefully contributed as well.

THE EVOLUTION OF NORMS, RULES, AND RIGHTS

Elinor Ostrom

The Emergence and Consequences of Property Rights Systems

The most important findings regarding the emergence and consequences of property rights systems in field settings can be summarized as follows:

1. Overuse, conflict, and potential destruction of natural resources producing highly valued products is likely to occur where those involved act independently due to lack of communication or incapacity to make credible commitments.

2. If those who directly benefit can communicate, agree on norms, monitor each other, and sanction non-compliance to agreements, overuse, conflict, and the destruction of natural resources can be substantially reduced by the individuals selecting (given the collective choice rules they use) different norms, rules, and property right systems.

3. The variety of locally selected norms, rules, and property rights systems used in field settings is immense, but can be characterized by general design principles (see Table 1).

4. Locally selected systems of norms, rules, and property rights that are not recognized by external authorities may collapse if their legitimacy is challenged or if large exogenous economic or physical shocks occur.

5. Control of natural resources by state authorities is effective in some settings but is frequently less effective and efficient than control by those directly affected especially related to smaller-scale natural resource systems.

6. Efforts to establish marketable property rights to natural resource systems have substantially increased efficiency in some cases and encountered difficulties of implementation in others.

At a very general level these findings can be summarized with two statements. Open access resources — those characterized by no property rights-will be overused, will generate conflict, and may be destroyed. All types of property rights regimes-include private property, common property, and state property whether locally selected or externally imposed — may reduce the costs of open access regimes, but perform differentially depending on the attributes of the resource, the local community, and the specific rules used. Thus, evolved or self-consciously designed property right regimes are needed to regulate the use of natural resource systems, but all such regimes have limits.

Table 1

Design Principles Illustrated by Long-Enduring CPR Institutions

1. Clearly Defined Boundaries

Individuals or households with rights to withdraw resource units from the CPR and the boundaries of the CPR itself are clearly defined.

2. Congruence between Appropriation and Provision Rules and Local Conditions

Appropriation rules restricting time, place, technology, and/or quantity of resource units are related to local conditions and to provision rules requiring labor, material, and/or money.

3. Collective Choice Arrangements

Most individuals affected by operational rules can participate in modifying operational rules.

4. Monitoring

Monitors, who actively audit CPR conditions and appropriator behavior, are accountable to the appropriators and/or are the appropriators themselves.

5. *Graduated Sanctions*

Appropriators who violate operational rules are likely to receive graduated sanctions (depending on the seriousness and context of the offense) from other appropriators, from officials accountable to these appropriators, or from both.

6. Conflict Resolution Mechanisms

Appropriators and their officials have rapid access to low-cost, local arenas to resolve conflict among appropriators or between appropriators and officials.

7. *Minimal Recognition of Rights to Organize*

The rights of appropriators to devise their own institutions are not challenged by external governmental authorities.

For CPRs that an part of larger systems:

8. Nested Enterprises

Appropriation, provision, monitoring, enforcement, conflict resolution, and governance activities are organized in multiple layers of nested enterprises.

Source: E Ostrom (1990:90).

The dominant theories of a decade ago have not been proved wrong; rather their claim to universal applicability has been challenged. Both experimental and field research readily establishes that when those using open access regimes are constrained by diverse factors to act independently, the predictions derived from the "tragedy of the commons," (Hardin, 1968), the finitely repeated Prisoners' Dilemma game (Hardin, 1982), and the logic of collective inaction (Olson, 1965: see also Sandier, 1992) are empirically supported. In the simpler environment of an experimental laboratory, it is possible to impose markets or regulatory institutions that enable subjects to achieve close to optimal results (Plott, 1983). When symmetric subjects are given opportunities in a laboratory to devise their own agreements and sanctioning arrangements, the outcomes also approximate optimality (E. Ostrom, Walker, and Gardner, 1992—appended to this paper).

Because we can create conditions in a laboratory that enable subjects to come close to optimality, however, should not encourage us to think that there are optimal solutions that can be imposed on all natural resource problems within large and diversified countries. The complexity of natural settings is immense. The particular features of a natural setting that might effectively be used by local users in selecting rules cannot be included in general models. The likelihood is small that any set of uniform rules for all natural resource systems within a large territory will produce optimal results. This is unfortunately the case whether or not the particular rules can be shown to generate optimal rules in a sparse theoretical or experimental setting. Rather, theoretical and empirical research can be used to help inform those who are close to particular natural resource systems, as well as those in larger, overarching agencies, about principles they can use to improve performance.

Design Principles and Robust Institutions

In addition to knowing that various types of property rights regimes can be used to reduce the externalities usually involved in the management and use of natural resource systems, we also are beginning to understand the design principles used by robust institutions. Robust institutions are those

in which the systems have survived for very long periods of time and where operational rules have been devised and modified over time according to a set of collective-choice and constitutional choice rules (Shepsle, 1989). Robust institutions tend to be characterized by most of the design principles listed in Table 1. Fragile institutions tend to be characterized by only some of these design principles. Failed institutions are characterized by only a few of these principles. Initial analysis also finds that farmer-governed irrigation systems that are characterized by most of these principles are associated with higher agricultural yields and crop intensities, controlling for the physical characteristics of the systems (Lam, Lee, and E. Ostrom, 1993). The theoretical reasons why these design principles work in practice has been presented elsewhere and will not be repeated here (see E. Ostrom, 1990; Weissing and E. Ostrom, 1991, 1993; E. Ostrom and Gardner, 1993; E. Ostrom, Gardner, and Walker, 1993).

The design principles are stated generally. The specific way that individuals have crafted rules to meet these principles vary in their particulars. Successful, long-enduring irrigation institutions, for example, have developed different ways of meeting the second design principle of achieving congruence or proportionality between the costs of building and maintaining irrigation systems and the distribution of benefits. Some examples will illustrate the diversity of specific rules that meet the second design principle.

The *Zanjeras* of Northern Philippines

These self-organized systems obtain use-rights to previously unirrigated land from a large landowner by building a canal that irrigates the landowner's land and that of a *zanjera.* At the time that the land is allocated, each farmer willing to abide by the rules of the system receives a bundle of rights and duties in the form of *atars.* Each *atar* defines three parcels of land located in the head, middle, and tail sections of the service area where the holder grows his or her crops. Responsibilities for construction and maintenance are allocated by *atars,* as are voting rights. In the rainy seasons.

water is allocated freely. In a dry year, water may be allocated only to the parcels located in the head and middle portions. Thus, everyone receives water in plentiful and scarce times in rough proportion to the amount of *atars* they possess. *Atars* may be sold to others with the permission of the irrigation association and they are inheritable (see Siy, 1982; Coward, 1979).

The *Thulu Kulo* in Nepal

When this system was first constructed in 1928, 27 households contributed to a fund to construct the canal and received shares to the resulting system proportionate to the amount they invested. Since then, the system has been expanded several times by selling additional shares. Measurement and diversion weirs or gates are installed at key locations so that water is automatically allocated to each farmer according to the proportion of shares owned. Routine monitoring and maintenance is allocated to work teams so that everyone participates proportionally, but emergency repairs require labor input from all shareholders regardless of the size of their share (see Martin and Yoder, 1983; Martin, 1986).

The *Huerta* of Valencia in Spain

In 1435, 84 irrigators served by two interrelated canals in Valencia gathered at the monastery of St. Francis to draw up and approve formal regulations to specify who had rights to water from these canals, how the water would be shared in good and bad years, and how responsibilities for maintenance would be shared. The modern *Huerta* of Valencia, composed of these plus six additional canals, now serves about 16,000 hectares and 15,000 farmers. The right to water inheres in the land itself and cannot be bought and sold independently of the land. Rights to water are approximately proportionate to the amount of land owned as are obligations to contribute to the cost of monitoring and maintenance activities (see Maass and Anderson, 1986).

These three systems differ substantially from one another. The *zanjeras* are institutional devices for landless laborers to acquire use-rights to land and water and could be called communal systems.

The *Thulu Kulu* system comes as close to allocating private and separable property rights to water as is feasible in an irrigation system. The *Huerta* of Valencia has maintained centuries-old land and water rights that forbid the separation of water rights from the land being served. The Valencian system differs from both "communal" and "private property" systems because water rights are firmly attached to private ownership of land. Underlying these differences, however, is the basic design principle that the costs of constructing, operating, and maintaining these systems are roughly proportional to the benefits that irrigators obtain.

It is important to keep these differences in mind when making policy prescriptions. Slogans such as "privatization" may mask important underlying principles rather than providing useful guides for reform. Strict privatization of water rights is not a feasible option within the broad institutional framework of many countries. On the other hand, authorizing the suppliers and users of irrigation water to participate in the design of their own systems-Design Principles 3 and 7 combined — is a feasible reform within the broad institutional framework of many countries.

Factors Affecting Institutional Change

Not only is there substantial variety of rules used to reduce the cost of externalities from unregulated use of natural resources, but neighboring systems that appear to face similar situations frequently adopt different solutions. Within a few miles of Valencia is Alicante where irrigators long ago adopted rules separating water from the land and participate in an active weekly market for water.

Adjacent to Thulu Kulo, is Raj Kulo where the allocation of water (and labor responsibilities) is according to the amount of land owned. Near to the Zanjeras of Northern Philippines are many irrigation systems with quite different rules for distributing water and input responsibilities.

The variety of rules selected by local users who appear to face similar circumstances, raises the question whether institutional change is an evolutionary process involving a selection process that picks more efficient institutions over time. In an important article, Alchian (1950) demonstrated how

the pressure of competitive markets would select surviving firms that used profit maximizing strategies whether they had chosen these strategies self-consciously or not. Some advocates of spontaneous orders (von Hayek, 1967; Schotter, 1981; Sugden, 1986) have argued that individuals will slowly establish new and more efficient institutions through a series of spontaneous individual decisions. The improved group outcome is conceptualized as an unintended result of individual learning and adjusting behavior over time. It is not quite clear, however, what is the selection principle at work outside of competitive markets.

Others, including Knight (1992) and Ostrom (1990), point out that changes in rules usually occur within a meta set of rules at a collective choice or constitutional level and within settings that vary in terms of pressure for survival or excellence. The meta rules may assign differential advantages to participants in the rule changing process.

Those with the most voice in collective choice processes may not benefit from rule changes even though the aggregate benefit is greater. Thus, to explain a change in rules, one needs to analyze not only the status quo distribution of costs and benefits, but also the distributional effects of proposed rules (Libecap, 1989) and how these relate to the meta rules used for making and changing rules.

Thus, to explain institutional change, one needs to analyze the relationships between variables characterizing the resource, the community of individuals involved, and the meta rules for making and changing rules. Sufficient theoretical and empirical research has been conducted on this and the closely related theory of collective action to enable one to specify important variables and the direction of their impact. The following variables appear to be conducive to the selection of norms, rules, and property rights that reduce the externalities:

1. Accurate information about the condition of the resource and expected flow of benefits and costs are available at low cost.

2. Participants are relatively homogeneous in regard to asset structure, information, and preferences.

3. Participants share a common understanding about the potential benefits and risks associated with the continuance of the status quo as contrasted with changes in norms and rules that they could feasibly adopt.

4. Participants share generalized norms of reciprocity and trust that can be used as initial social capital.

5. The group using the resource is relatively small and stable.

6. Participants do not discount the future at a high rate.

7. Participants have the autonomy to make many of their own operational rules and if made legitimately, they will be supported by, and potentially enforced by, external authorities.

8. Participants use collective choice rules that fall between the extremes of unanimity or control by a few (or even bare majority) and thus avoid high transaction or high deprivation costs.

9. Participants can develop relatively accurate and low cost monitoring and sanctioning arrangements.

Many of these variables are in turn affected by the type of larger regime in which users are embedded. If the larger regime is facilitative of local self-organization by providing accurate information about natural resource systems, providing arenas in which participants can engage in discovery and conflict resolution processes, and providing mechanisms to back up local monitoring and sanctioning efforts, the probability of participants adapting more effective norms and rules over time is higher than in regimes that ignore resource problems or presume that all decisions about governance and management need to be made by central authorities.

Future Research on Institutions

We now have a relatively good understanding of the emergence of norms, rules, and property rights regimes in simple, small, and isolated natural resource systems characterized by:

- A small and stable set of users able to communicate on a face to face basis,
- Predictable and easy to measure flows of benefits and costs, and
- Symmetry of information, asset structures, capabilities, and preferences.

In field settings approximating the above conditions, those involved are highly likely to agree on their own norms and rules leading to the assignment of rights and duties to enhance efficiency.

Many natural resource problems occur in settings, however, that are not so conducive to self-organization. Large natural resource systems, particularly those that cross national borders (Young, 1982; Keohane, 1989; Dasgupta and Mäler, 1992; McGinnis and Ostrom, 1992; Haas, Keohane, and Levy, 1993), involve substantial difficulties. These are associated with large and heterogenous numbers of individual and corporate actors and the difficulties of making credible commitments. Further many natural resources, particularly multi-species fisheries and forests, involve complex transformation functions whose structure is hard to determine. No one—not even those directly involved nor external officials-has good enough models and sufficient, accurate data to estimate future flows of benefits and costs accurately. And, resources such as forests and the atmosphere, involve such long time horizons that the value of future benefits and harms is difficult to assess.

Consequently, in future work, it will be important to pursue theoretical and empirical studies that specifically address how heterogeneity of participants, multi-species or multi-product resource systems, and long time horizons affect the selection and performance of institutions. We are currently developing a theoretical and empirical program of research that will tackle these questions. The International Forestry Resources and Institutions database is part of this program.

We are planning to conduct original field research on the types of local forestry institutions and their performance in India, Bhutan, Nepal, and Uganda (and, in other countries depending on the availability of funding). These data will be archived and analyzed using a relational database structure (see E. Ostrom, Huckfeldt, Schweik, and Wertime, 1993). We have started a closely parallel research program in the experimental lab and will continue to use game theory and other formal methods of theoretical development and explanation.

Understanding the emergence and performance of forestry institutions does not automatically answer questions about very large-scale natural resource systems. The complexity, long time horizons, and involvement of heterogeneous actors in the use of forests, should enable us to move from the simpler environments of our prior work, however, toward the analysis of ever more difficult and complex environments. Further, forests are linked to the global atmospheric commons through their impact on greenhouse gases. If we are to reduce the level of deforestation so as to reduce the quantity of greenhouse gases in the atmosphere, we must learn more about how institutions affect the incentives and behavior of those who rely on forests for most of their livelihood.

Endnotes

1. Of course, the progress of this decade draws on the immense scholarly work that already had existed in diverse sources. The theoretical breakthroughs would not have been likely if many scholars in different disciplines had not undertaken the in-depth and detailed studies of particular natural resource systems. See Martin (1989/1992) for a bibliographic overview of this immense literature.

References

Alchian. Armen. 1950. "Uncertainty Evolution and Economic Theory." *Journal of Political Economy* 58:211-221.

Berkes, Fikret. ed. 1989. Common Property Resources. Ecology and Community-Based Sustainable Development. London: Belhaven Press.

Blomquist, William. 1992. *Dividing the Waters: Governing Groundwater in Southern California.* San Francisco: Calif.: Institute for Contemporary Studies Press.

Bromley, Daniel W. 1991. *Environment and Economy: Property Rights and Public Policy.* Oxford: Basil Blackwell.

Bromley, Daniel W., ed. 1992. *Making the Commons Work: Theory, Practice, and Policy.* San Francisco, Calif.: Institute for Contemporary Studies Press.

Coward, E. Walter, Jr. 1979. "Principles of Social Organization in an Indigenous Irrigation System. *Human Organization* 38(1) (Spring):28-36.

Dasgupta, Partha, and Karl Göran Mäler. 1992. *The Economics of Transnational Commons.* Oxford: Clarendon Press.

Eggertson, Thrainn. 1990. *Economic Behavior and Institutions.* Cambridge, Mass.: Cambridge University Press.

Feeny, David, Fikret Berkes, Bonnie J. McCay, and James M. Acheson. 1990. "The Tragedy of the Commons: Twenty-Two Years Later." *Human Ecology* 18(1): 1-19.

Fortmann, Louise, and John W. Bruce, eds. 1988. *Whose Trees? Proprietary Dimensions of Forestry.* Boulder, Colo.: Westview Press.

Haas, Keohane, and Levy, 1993. *Institutions for the Earth. Sources of Effective International Environmental Protection.* Cambridge: MIT Press.

Hardin, Garrett. 1968. "the Tragedy of the Commons." *Science* 162:1243-48.

Hardin, Russell. 1982. *Collective Action.* Baltimore, Md.: Johns Hopkins University Press.

Keohane, Robert O. 1989. *International Institutions and State Power. Essays in International Relations Theory.* Boulder, Colo.: Westview Press.

Knight, Jack. 1992. *Institutions and Social Conflict.* Cambridge, Mass.: Cambridge University Press.

Lam, Wai Fung, Myungsuk Lee, and Elinor Ostrom. 1993. "An Institutional Analysis of Irrigation Performance in Nepal." In *Policy Analysis and Management in Developing Countries: From*

Information to Impact, ed. Derek Brinkerhoff. JAI Policy Studies and Developing Nations Series, vol. 15. Greenwich, Conn.: JAI Press. Forthcoming.

Libecap. Gary D. 1989. *Contracting for Property Rights.* Cambridge, Mass.: Cambridge University Press.

Maass, Arthur, and Raymond L. Anderson. 1986. *...and the Desert Shall Rejoice: Conflict, Growth and Justice in Arid Environments.* Malabar, Fla.: R. E. Krieger.

Martin, Edward G. 1986. "Resource Mobilization, Water Allocation, and Fanner Organization in Hill Irrigation Systems in Nepal. Ph.D. diss., Cornell University.

Martin, Edward G. and Robert Yoder. 1983. "The Chherlung Thulo Kulo: A Case Study of a Farmer-Managed Irrigation System." In *Water Management in Nepal: Proceedings of the Seminar on Water Management Issues, July 31-August 2,* Appendix I, 203-17. Kathmandu, Nepal: Ministry of Agriculture, Agricultural Projects Services Centre, and the Agricultural Development Council.

Martin, Fenton. 1989/1992. *Common-Pool Resources and Collective Action: A Bibliography.* Vols. 1 and 2. Bloomington: Indiana University, Workshop in Political Theory and Policy Analysis.

McCay, Bonnie J. and James M. Acheson. 1987. *The Question of the Commons: The Culture and Ecology of Communal Resources.* Tucson: University of Arizona Press.

McGinnis, Michael, and Elinor Ostrom, 1992. "Design Principles for Local and Global Commons." In *Proceedings of a Conference on Linking Local and Global Commons,* ed. Robert Keohane, Michael McGinnis, Elinor Ostrom, 16-65. Bloomington: Indiana University, Workshop in Political Theory and Policy Analysis.

National Research Council. 1986. *Proceedings of the Conference on Common Property Resource Management.* Washington, D.C.: National Academy Press.

Netting, Robert McC. 1993. *Smallholders, Householders: Farm Families and the Ecology of Intensive, Sustainable Agriculture.* Stanford, Calif.: Stanford University Press.

Olson, Mancur. 1965. *The Logic of Collective Action. Public Goods and the Theory of Groups.* Cambridge, Mass.: Harvard University Press.

Ostrom, Elinor. 1990. *Governing the Commons: The Evolution of Institutions for Collective Action.* Cambridge, Mass.: Cambridge University Press.

____. 1992. *Strategies of Political Inquiry.* Beverly Hills, Calif.: Sage Publications.

Ostrom, Elinor, and Roy Gardner, 1993. "Coping with Asymmetries in the Commons: A Challenge for Development." *Journal of Economic Perspectives* Fall 93/Winter 94. Forthcoming.

Ostrom. Elinor, Roy Gardner, and James Walker. 1993. *Rules, Games, and Common-Pool Resources.* Ann Arbor: University of Michigan Press.

Ostrom, Elinor, James Walker, and Roy Gardner. 1992. "Covenants With and Without a Sword: Self-Governance Is Possible." *American Political Science Review* 86(2) (June):404-17

Ostrom, Elinor. Sharon Huckfeldt, Charlie Schweik, and Mary Beth Wertime. 1993. "A Relational Archive for Natural Resources Governance and Management." Paper prepared for presentation at the "Conference on Applications of Advanced Information Technologies for the Management of Natural Resources," Spokane, Washington, June 17-19, 1993.

Ostrom, Vincent, David Feeny, and Hartmut Picht, eds. 1993. *Rethinking Institutional Analysis and Development: Issues, Alternatives, and Choices.* 2d ed. San Francisco, Calif.: Institute for Contemporary Studies Press.

Pinkerton, E. 1989. *Co-operative Management of Local Fisheries. New Directions for Improved Management and Community Development.* Vancouver: University of British Columbia Press.

Plott, Charles R. 1983. Externalities and Corrective Policies in Experimental Markets." *Economic Journal* 92 (March): 106-127.

Sandier, Todd. 1992. *Collective Action.* Ann Arbor: University of Michigan Press.

Schotter, Andrew. 1981. *The Economic Theory of Social Institutions.* Cambridge, Mass.: Cambridge University Press.

Sengupta, Nirmal. 1991. *Managing Common Property: Irrigation in India and the Philippines.* London: Sage.

Shepsle, Kenneth A. 1989. "Studying Institutions. Some Lessons from the Rational Choice Approach." *Journal of Theoretical Politics* 1:131-149.

Siy, Robert Y., Jr. 1982. *Community Resource Management: Lessons from the Zanjera.* Quezon City: University of the Philippines Press.

Sugden. Robert. 1986. *The Economics of Rights, Cooperation and Welfare.* London: Basil Blackwell.

Tang, Shui Yan. 1992. *Institutions and Collective Action: Self-Governance in Irrigation.* San Francisco, Calif.: Institute for Contemporary Studies Press.

Thomson, James T. 1992. *A Framework for Analyzing Institutional Incentives in Community Forestry.* Rome: Food and Agriculture Organization of the United Nations.

von Hayek, Friedrich A. 1967. "Notes on the Evolution of Rules of Conduct." In *Studies in Philosophy, Politics, and Economics.* Chicago: University of Chicago Press.

Wade, Robert. 1988. ***Village Republics: Economic Conditions for Collective Action in South India.*** **Cambridge University Press.**

Weissing, Franz, and Elinor Ostrom. 1991. "Irrigation Institutions and the Games Irrigators Play: Rule Enforcement without Guards." In ***Game Equilibrium Models II: Methods, Morals, and Markets,*** **ed. Reinhard Selten, 188-262. Berlin: Springer-Verlag.**

Weissing, Franz, and Elinor Ostrom. 1993. "Irrigation Institutions and the Games Irrigators Play: Rule Enforcement on Government- and Farmer-Managed Systems." In ***Games in Hierarchies and Networks: Analytical and Empirical Approaches to the Study of Governance Institutions,*** **ed. Fritz W. Scharpf, 387-428. Frankfurt: Campus Verlag; Boulder, Colo.: Westview Press.**

Young, Oran. 1982. ***Resource Regimes: Natural Resources and Social Institutions.*** **Berkeley: University of California Press.**

Beijer Discussion Papers 1991-1994

February 1994

1. **The Ecology and Economics of Biodiversity Conservation: Elements of a Research Agenda**
   Charles Perrings, Carl Folke and Karl-Göran Mäler. 1991.

2. **Towards an Ecological Economics of Sustainability**
   Mich Common and Charles Perrings. 1992

3. **Aspects Stratégiques des Négotiations Internationales sur les Pollutions Transfrontières et du Partage des Côuts de l'Épuration**
   Parkash Chander and Henry Tulkens. 1992.

4. **Multiple Use of Environmental Resources: The Household-Production-Function Approach**
   Karl-Göran Mäler. 1992.

5. **Nested Living Systems**
   Folke Gunther and Carl Folke. 1992

6. **The Tragedy of the Commons and the Theory of Social Overhead Capital**
   Hirofumi Uzawa. 1992.

7. **Harvesting Semelparous Populations and Variability in the Life History of Salmon**
   Veijo Kaitala and Wayne M. Getz. 1992.

8. **Cultural Capital and Natural Capital Interrelations**
   Carl Folke and Fikret Berkes. 1992

9. **Imputed Prices of Greenhouse Gases and Land Forests**
   Hirofumi Uzawa. 1992

10. **Regulating the Farmers' Use of Pesticides in Sweden**
    Ing-Marie Andréasson-Gren. 1992

11. **The Population Problem**
    Partha Dasgupta. 1992

12. **An Ecological Economy: Notes on Harvest and Growth**
    Gardner Brown and Jonathan Roughgarden. 1992

13. **Towards a General Theory of Social Overhead Capital**
    Hirofumi Uzawa. 1992

14. **Benefits from Restoring Wetlands for Nitrogen Abatement: A Case Study of Gotland**
    Ing-Marie Gren. 1992

15. **Trade, Tropical Deforestation and Policy Interventions**
    Edward B. Barbier and Michael Rauscher. 1992

16. **Foreign Trade and Renewable Resources**
    Michael Rauscher. 1992

17. **Sensitivity of Willingness-to-Pay Estimates to Bid Design in Dichotomous Choice Contingent Valuation Models: A Comment**
Barbara J. Kanninen and Bengt Kriström. 1992

18. **Debt-for-Environment Swaps: The Institutional Dimension**
Tomasz Zylicz. 1992

19. **Modeling Complex Ecological Economic Systems: Toward an Evolutionary, Dynamic Understanding of Humans and Nature**
Robert Costanza, Lisa Wainger, Carl Folke and Karl-Göran Mäler. 1992

20. **Welfare Benefit Estimation and the Income Distribution**
Barbara J. Kanninen and Bengt Kriström. 1992

21. **Internalizing Environmental Costs of Salmon Farming**
Carl Folke,, Nils Kautsky and Max Troell. 1992

22. **Resource leasing and optimal periodic capital investments**
Andy Nowak, Veijo Kaitala and Gustav Feichtinger. 1993

23. **Improving Environment through Permit Trading: The Limits to Market Approach**
Tomasz Zylicz. 1993

24. **Cost-Effectiveness of the Baltic Sea Clean-Up: Will Wetlands Reconcile Efficiency with Biodiversity?**
Tomasz Zylicz, Ing-Marie Gren. 1993

25. **Economic Growth and the Environment**
Karl-Göran Mäler. 1993

26. **Environmental Impact of Government Policies and External Shocks in Botswana,** Lena Unemo. 1993

27. **Poverty, Institutions, and the Environmental-Resource Base**
Partha Dasgupta and Karl-Göran Mäler. 1993

28. **The acid rain game as a resource allocation process with an application to the international cooperation among Finland, Russia, and Estonia**
Veijo Kaitala, Karl-Göran Mäler, and Henry Tulkens. 1993

29. **Ecological limitations and appropriation of ecosystem support by shrimp farming in Columbia,** Jonas Larsson, Carl Folke and Nils Kautsky. 1993

30. **Wetland Valuation: Three Case Studies**
R.K. Turner, C. Folke, I-M. Gren and I. J. Bateman. 1993

31. **Traditional Ecological Knowledge, Biodiversity, Resilience and Sustainability**
Fikret Berkes, Carl Folke and Madhav Gadgil. 1993

32. **The Acid game II**
Karl-Göran Mäler, 1993

33. **Investing in Natural Capital: Why, What, and How?**
Carl Folke, Monica Hammer, Robert Costanza and AnnMari Jansson, 1993

34. **The Economic Management of High Seas Fishery Resources: Some Game Theoretic Aspects**
Veijo Kaitala and Gordon Munro, 1993

35. **Discontinuous Change in Multilevel Hierarchical Systems**
J. Barkley Rosser, Jr., Carl Folke, Folke Günther, Heikki Isomäki, Charles Perrings, Garry Peterson and Tõnu Puu. 1993

36. **Comparing Ecological and Social Systems**
C.S. Holling, Lance Gunderson and Garry Peterson, 1993

37. **The Interface Between Natural and Social Systems**
Fikret Berkes, 1993

38. **Management Regimes**
Bonnie J. McCay, 1993