Journal of Institutional Economics (2006), 2: 2, 127–131 Printed in the United Kingdom
 doi:10.1017/S1744137406000300

INTRODUCTION TO THE SPECIAL ISSUE ON INSTITUTIONS AND ECOSYSTEMS

Historical institutional analysis of social-ecological systems

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1. Introduction

Institutions, the rules that govern interactions between people, evolve over time. This special issue presents a number of detailed case studies of human–environment interactions during a significant historical period. With social-ecological systems we mean a set of people, their natural and human-made resources, and the relationships among them (Anderies *et al.*, 2004, Janssen *et al.*, 2005).

Institutions change because of various reasons, but the focus in this special issue, is institutional response in relation to environmental resources. The articles in this special issue show that institutions can change as a response to changes in resource availability, or motivations for efficiency improvements. The five articles originate from a special session organized in June 2004 on historical institutional analysis of social-ecological systems at the 'Workshop on the Workshop 3' conference held at Indiana University. All contributions used the framework proposed by Anderies *et al.* (2004) as a source of inspiration to describe and analyze long-term case studies of social-ecological systems. In this short introduction, I first discuss the concepts behind the articles followed by a brief introduction of each.

We are especially interested in the robustness and resilience of social-ecological systems. The robustness concept we use originates in engineering and is loosely defined as the maintenance of system performance either when subjected to external, unpredictable perturbations, or when there is uncertainty about the values of internal design parameters (Carlson and Doyle, 2002). Resilience, a similar concept to robustness that has been developed in ecology (Holling, 1973)

The author acknowledges the feedback from Marty Anderies, Esther Mwangi, Elinor Ostrom, Theo Toonen on an earlier version of this paper, and the editorial help by Patty Lezotte.

measures the amount of change or disruption that is required to transform a system from being maintained by one set of mutually reinforcing processes and structures to a different set of processes and structures.

Within social science, we do not have well-defined terminology for the dynamics we wish to study and therefore we will use the terms robustness and resilience. We are interested in how social-ecological systems cope with change and perturbations. For example, the archeological record provides us with many examples of systems that have not withstood certain perturbations and have collapsed (Tainter, 1988). Increasing social complexity may have reduced the resilience of social-ecological systems and increased vulnerability to perturbations. Anderies (this issue) discusses an example of such a collapse, namely the prehistoric Hohokam society which flourished for 1,450 years in central and southern Arizona, USA.

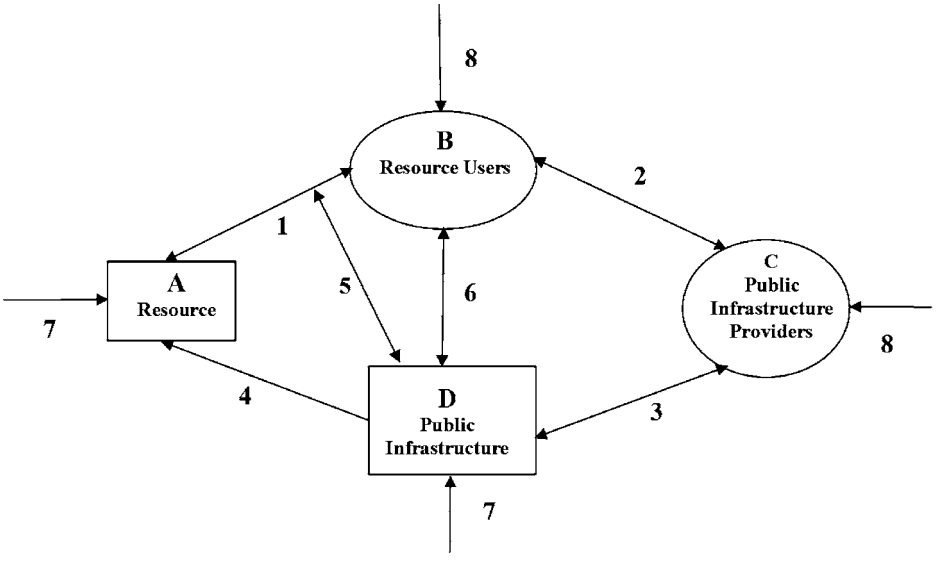
The resilience perspective from ecology has its limitations for the study of social ecological systems, since these systems are affected by the reflexive nature of humans. We can anticipate undesirable developments, design new institutional arrangements, and culturally adapt to changes. This is the reason for including ideas from robustness, which includes the notion of designed components of the system. But, even if systems are designed for robustness, vulnerability cannot be completely removed from systems exposed to variability. Engineers talk about the notion of 'robust yet fragile', which refers to the observation that to generate robustness to a particular set of disturbances, a necessary consequence will be to become vulnerable to a different set of disturbances (Carlson and Doyle, 2002).

Given our focus on social-ecological systems, we use the framework of Anderies *et al.* (2004) who provided a minimal representation that includes the elements depicted in Figure 1. One component is a resource (*A* on Figure 1) that is used by multiple resource users. Two components are composed of humans: the resource users (*B* on Figure 1) and the public infrastructure providers (*C* on Figure 1). There may be a substantial overlap of the individuals in *B* and in *C* or they may be entirely different individuals depending on the structure of the social system governing and managing the SES.

Public infrastructure (*D* on Figure 1) combines two forms of human-made capital – physical and social. Physical capital includes engineered works such as dikes, irrigation canals, etc. By social capital, we mean the rules actually used by those governing, managing, and using the system and those factors that reduce the transaction costs associated with the monitoring and enforcement of these rules. One example of a rule used in many self-organized social-ecological systems is rotating the role of monitor among resource appropriators. In centrally governed social-ecological systems, monitors would be employed and paid by a government agency.

In our examination of robustness, we address two types of disturbances. External disturbance can include biophysical disruptions (Arrow 7) such as floods, hurricanes, earthquakes, landslides, and climate change that impact the

Figure 1. A conceptual model of a social-ecological system (Anderies *et al.*, 2004)



resource (*A*) and/or the public infrastructure (*D*) or socioeconomic changes (Arrow 8) such as population increases, economic change, depressions or inflations, and major political changes that impact on the resource users (B) and the public infrastructure providers (*C*). Internal disturbances refer to rapid reorganization of the ecological or social system induced by the interactions between subsystems of the ecological or social system.

An example of a simple social-ecological system is an irrigation system in a village where farmers make decisions regarding water rotation and maintenance among each other. They may come together once a month to discuss the most important issues related to the performance of the irrigation system. The resource users and public infrastructure providers are the same persons. When such a system is changed by introducing professionals to make the decisions on public infrastructure provision, and the farmers pay a fee to such an irrigation association, the distance between resource users and public infrastructure providers increases. This may affect the performance of the social-ecological system (Anderies *et al.*, 2004).

The articles in this special issue all discuss some interesting aspects of the robustness of social-ecological systems at different temporal and spatial scales. Anderies (this issue) illustrates that an adaptation of the Hohokam, a prehistoric society in the southwestern United States, to drought by building complex irrigation systems, led to population growth and increasing social complexity and, as a consequence, may have made the system more vulnerable to droughts and floods of different frequency. Another long-term social-ecological system dealing with water problems (floodings) is the Netherlands

https://doi.org/10.1017/S1744137406000300 Published online by Cambridge University Press

and their waterboards. Toonen *et al.* (this issue) discuss how the currently changing challenge and nature of water management in the Netherlands due to climate change, urbanization, and broader European development has effectively changed the nature of resource (water) management. To preserve the resilience and increase the robustness of the institutional system a drastic enlargement of scale has been introduced in the ancient, historically small-scale water board system. The functionally required redesign is largely studied and evaluated in terms of centralization of water boards and is motivated by efficiency reasons. For most current citizens of the Netherlands, the water boards are only a cost (tax), and we observe an increasing distance between resource (waterways) and resource users (citizens), as well as an increase between resource users and public infrastructure provision (water boards). Toonen *et al.* argue that this lobsided orientation may reduce the resilience of the adequate functioning of the water boards. They discuss strategies to preserve the community-based nature of Dutch water boards under the current conditions of scale enlargement in order to preserve the one major institutional characteristic which may account for the longstanding history, resilience, and adaptive capacity of the Dutch water board system.

A path-dependent development of institutional change can also be observed in the privatization of Kenya's Maasailand. In pastoral systems, institutions of land access and management have evolved to enable pastoralists to move their livestock in response to resource variability in an environment that is characterized by low and variable rainfall. Mwangi (this issue) demonstrates the potential reduction of resilience within pastoral systems as a consequence of privatization of Kenya's Maasailand. She argues that the current drive to individualize the Maasai group ranches is part of a broader process of Maasailand privatization that began in the early 1900s with the settlement of European immigrants. Early privatization of the wider Maasai range and recent individualization of the group ranches were responses to increasing tenure insecurity. This general drive to privatize Maasai land is a poor fit with the ecological dynamics of a semi-arid area where pastoralism is a primary adaptational response to low and variable rainfall that results in a variable distribution of critical water and pasture resources. It is also a poor fit with Maasai cultural and political institutions that are largely based on a cyclic age-grade system of authority.

The last two papers discuss the effect of top-down interventions in southeast Asian irrigation systems. Shivakoti and Bastakoti (this issue) analyzed the effect of a top-down intervention in two irrigation systems in northern Thailand over a period of 20 years. The imposed modernization of the irrigation infrastructure has reduced the effectiveness of collective action and contributions to the maintenance of the irrigation system. Nevertheless, the irrigation systems continue to function, due to adaptation of the local communities, especially the increased importance of local leaders.

Lam (this issue) discusses irrigation systems in Taiwan that have experienced many socioeconomic and political challenges at the macro level. Rice production has not been a particularly productive activity during recent years, but politization of irrigation systems in the last two decades made the irrigation systems more embedded into the rest of the political economy of Taiwan. Like Thailand, Taiwanese irrigation systems persisted, but they had to adapt their local organizations to deal with changes at the macro level. Given the well-functioning local communities, this has been possible in many situations.

The case studies described in this special issue all have in common the struggle and conflict of institutional change between spatial scales and organizational levels that is an inherent part of institutional change. Larger-scale governance of the social-ecological systems might be desirable (efficient) in the more competitive globalized world of today. On the other hand, local knowledge and involvement of resource users are necessary to make the institutions functioning and robust to changes in social and ecological conditions. The case studies suggest that we cannot focus on one level of governance but need to balance the various levels of governance equally in order to maintain the robustness of social-ecological systems.

References

Anderies, J. M., M. A. Janssen, and E. Ostrom (2004), 'A framework to analyze the robustness of social-ecological systems from an institutional perspective', *Ecology and Society*, **9**(1): 18. [online]: http://www.ecologyandsociety.org/vol9/iss1/art18

Carlson, J. M. and J. Doyle (2002), 'Complexity and robustness', *Proceedings of the National Academy of Science* **99** (suppl. 1): 2538–2545.

Holling, C. S. (1973), 'Resilience and stability of ecological systems', *Annual Review of Ecology. and Systematics*, **4**: 2–23.

Janssen, M. A., J. M. Anderies, and E. Ostrom (2005), 'Robustness of social-ecological systems to spatial and temporal variability', Under review.

Tainter, J. A. (1988), *The Collapse of Complex Societies*, Cambridge: Cambridge University Press.