

SPECIAL ISSUE

THE HUMAN ACTOR IN ECOLOGICAL-ECONOMIC MODELS

On modeling human behavior and institutions in simple
ecological economic systems

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Abstract

The use of stylized dynamical systems models and bifurcation analysis in modeling individual and collective behavior in two traditional societies, the Tsembaga of New Guinea and the Polynesians of Easter Island, is explored. The analysis is used to isolate key aspects of individual behavior that open up the possibility of resource overexploitation and key aspects of institutions capable of preventing overexploitation. An extension of the Brander and Taylor [Am. Econ. Rev. 88 (1998) 119–138] Easter Island model with a more realistic model for individual behavior is presented. This induces significant changes in the model dynamics which share many similarities with the Tsembaga model of Anderies [J. Theor. Biol. 192 (1998) 515–530]. Namely, in both models, the ability of agents to intensify the exploitation of the resource base to attempt to meet demands is a fundamentally destabilizing force. The model implications for present day policy issues are explored. © 2000 Elsevier Science B.V. All rights reserved.

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1. Introduction

Some years ago, Garrett Hardin (1968) argued that users of a common property resource are locked in an irreducible tension between individual and collective action. Because individuals ignore the costs their decisions impose on others, the resource is overexploited. If achieved, collective action would allow more efficient use of the resource. The difficulty is, of course, in achieving

collective action among the group of users of the resource. The most commonly proposed solutions for this problem are either central control imposed on the users of the resource or privatization of the resource in some way. Ostrom (1990) has made the point that these extremes are not the only options available and that solutions will vary greatly from situation to situation. The existence of many varied successful solutions among both past and present traditional societies has led to the recognition of the value of indigenous resource management knowledge and practices, and the fact that there is much to learn from the

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experiences, both positive and negative, of past societies (e.g. Berkes and Folke, 1998; Ostrom et al., 1999).

What one can learn from studying traditional societies is under what conditions they can solve common property resource dilemma's effectively. History is full of examples of societies that did not (Tainter, 1988), and offers some examples of those that have or may have (Berkes and Folke, 1998; Rappaport, 1968; Ostrom, 1990) (on some time scale). Important objectives in studying traditional societies are discovering fundamental aspects of human behavior that predispose human populations to overuse their resource base and fundamental building blocks for institutional arrangements common to societies that successfully manage common property resources over some relevant time scale.

To some extent, these questions have already been addressed. Ostrom (1995) has provided a set of seven design principles that characterize most institutions that manage common pool resources successfully. She also comments on the importance of the underlying assumptions about human behavior, i.e. humans as selfish, norm-free, short-run utility maximizers, versus beings capable of establishing and adhering to social norms, cooperating, etc. (Ostrom, 1999). However, even with these guidelines, it is very difficult to design rules that prevent common property resource degradation. In many cases, these rules may have evolved over long time periods. They can be exceedingly complex and may not be the products of self-conscious design. In her study of the historical record, Ostrom (1990) notes that some individuals have been able to avoid destroying their own resource base while others have not, and raises the question of what differences might exist between these groups. In this case, modeling can be of some help in elucidating key drivers that (partially) account for these differences and thus help guide the design of effective rules.

The aim of this paper is to present a specific approach to improving our understanding of how rules that govern individual and collective behavior might mediate the interaction of human populations with their environment. The idea is to develop stylized models of human-ecosystem in-

teractions and study their behavior under different management/behavioral regimes using bifurcation analysis. Key ingredients (that may not be at all obvious) that lead to the success or failure of a particular institutional structure can thus be isolated.

The approach is illustrated in two parts. First, two recent models that use this approach are discussed and compared. The first model due to Anderies (1998a) focuses on a careful analysis of the destabilizing effect of particular human responses to environmental change in a stylized model of the Tsembaga of New Guinea, and how their ritual cycle can re-stabilize the system. The second model due to Brander and Taylor (1998) focused on developing a simple model using tools from neoclassical economic theory to explain the rise and fall of the Polynesian culture on Easter Island. Next, the method is applied to an extended version of the Brander and Taylor model to explore how different assumptions about individual behavior can lead to different interpretations of why institutions may not have developed to prevent the overshoot and collapse supposed to have occurred there.

The paper is organized as follows. Section 2 gives a very brief summary of the motivation for the models. Section 3 outlines the modeling approach. Section 4 illustrates the approach for the Tsembaga and Easter Island. Section 5 develops and analyzes the extended version of the Easter Island model. Section 6 discusses possible principles for present day policy that emerge from the model analysis. Finally, Section 7 concludes.

2. Background

At the root of common property resource problems is the tension between individual and collective behavior. Two important components of individual behavior focused on here are related to population growth and the ability to utilize the resource. If agents are limited in their ability to harvest the resource and the population is low, the total pressure on the common property resource will not cause excessive degradation to occur. In this case, there is no need for collective

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