Book Reviews

The Economics of Non-Convex Ecosystems. Edited by Partha Dasgupta and Karl-Goran Maler. 2004. Kluwer Academic Publishers, Dordrecht, the Netherlands. 187 p. US$43.00 cloth. ISBN 1-4020-1945-9.

Economists have long been interested in the mathematical analysis of resource allocation mechanisms for which the intratemporal and intertemporal transformation possibilities between goods and services can be represented by a convex set. In contrast, although ecologists have conducted mathematical analyses of ecological systems (ecosystems) for quite some time, these analyses, until recently, have not focused explicitly on the ways in which nonconvexities affect the intertemporal behavior of managed and unmanaged ecosystems. Fortunately, this unsavory state of affairs has now begun to change. As the editors of this book point out, economists and ecologists now recognize that many of the basic processes that affect the dynamics of ecosystems are, in fact, nonconvex. Because this recognition has been very recent, we still know very little about the economics of nonconvex ecosystems. Consequently, the purpose of this edited book is 1) to shed light on what is presently known about the ways in which nonconvex ecosystems might be formally analyzed and 2) to show how these methods have been used by researchers to shed light on the management of actual ecosystems such as rangelands.

The first chapter, by the editors themselves, helpfully sets the tone for the subsequent discussion in the book and this chapter makes 3 useful points. First, it notes that ecosystems as diverse as rangelands, boreal forests, and shallow lakes contain thresholds and (often several) basins of attraction. What this means is that if a threshold is crossed then it is quite possible for a particular ecosystem to switch from one basin of attraction to another basin of attraction. Second, we are told that this sort of a switch may be reversible or irreversible. Moreover, even if the switch is reversible it may display hysteresis. In other words, it may be very difficult to reverse the switch by reversing what appears to be the underlying cause for the switch. Finally, we are told that the above 2 attributes of ecosystems mean that mistakes in management are likely to be a lot more costly than has been recognized thus far. For instance, in the context of shallow lakes, this means that "once the eutrophic state is reached, it may be impossible to bring the lake back into an oligotrophic state" (p. 18).

Ecosystems containing mixtures of trees and grass in general and savanna ecosystems in particular are the subject of this book's third chapter. The author rightly points out that if we are to manage savanna ecosystems successfully, then we must first grasp some of the key properties of such ecosystems. One key property is the relationship between grass production and the basal area of trees. We are told that in "almost all cases this relationship is convex over its entire range; i.e., the grass production declines more rapidly for the initial increments in tree basal area than it does for subsequent increments" (p. 62). What is the practical implication of this convex relationship? The author nicely explains that the economic value of savanna ecosystems lies primarily in grass products. In addition, because fires—the principal means of regulating the balance between grass and trees—are dependent on grass, the above-mentioned convex relationship between grass and trees often results in 2 grass and tree configurations that are stable. The first configuration has very few trees and a lot of grass and the second configuration has relatively little grass and more trees. The management implication of this state of affairs is that only the first configuration of grass and trees is able to support grazing. Although this chapter is both informative and interesting, it is, regrettably, a little too brief. As a result, the author does not say much about interesting related notions such as the resilience of the alternate stable configurations; similarly, more could have been said about the basis for the stated optimal pattern of tree-clearing in savanna ecosystems.

The focus of this book's fifth chapter is on shallow lakes. The authors point out that prolonged phosphorus deposition into shallow lakes eventually alters their state. In particular, shallow lakes often flip from an oligotrophic state with clear water to a eutrophic state with turbid water. The problem is that these 2 states of a lake are desirable to different groups of people for different reasons. As such, the authors pose and analyze a dynamic problem in which the objective is to determine whether active managerial intervention can induce the various users of a lake to undertake actions that will lead to what the authors call "an optimal management path" (p. 107). Interestingly, the analysis that is undertaken shows that, among other things, for "a small number of communities, a constant tax on the loading of phosphorus can induce optimal behavior and a return to a clear state, but for a large number this policy may not work" (p. 123).

The penultimate chapter in this book focuses on nonconvexities in the context of boreal forests with many species. This stimulating piece of work contains 4 main findings. First, it is shown that results obtained from the analysis of shallow lakes apply in the case of boreal forests as well. Second, the author shows that these forestry results are independent of the specific manner in which threshold effects are modeled. Third, the "existence of multiple steady states [in the model] reveals the exploited ecosystem's dependence on history" (p. 144). Finally, it is noted that managers might "try to detect the thresholds between the basins of attraction of the different steady states. This means that they need to identify the Skiba manifolds or at least find a way to approximate their location" (p. 144).

In conclusion, let me make 5 points. First, for the most part, this is an interesting book that contains thoughtful discussions of salient issues in contemporary ecosystem management. However, some of the treatment here is long on discussions of technique and short on meaningful discussions of practical problems. Second, some familiarity with dynamic analysis, particularly the analysis of optimal control models, is a prerequisite for comprehending the contents of this book. Third, a particularly useful point made in this book is that nonconvexities characterize most ecosystems of interest and hence the methods of analysis delineated in this book have wide applicability. Fourth, even though uncertainty is a key issue confronting ecosystem managers, this book unfortunately has very little to say about tractable ways of accounting for uncertainty in the context of nonconvex ecosystems. Finally, given the avowed focus of the editors on the ways in which nonconvexities affect the world's poor, it would have been nice to have included a chapter on the management of agro-ecosystems. This notwithstanding, there is no gainsaying the fact that the editors of this book have done a good job of selecting competent researchers to write instructive chapters on various aspects of ecosystem management. Consequently, I recommend this book to all readers who wish to learn more about how rigorous mathematical analysis can provide useful insights into the complex behavior exhibited by nonconvex ecosystems.—*Amitrajeet A. Batabyal,* Rochester Institute of Technology, Rochester, NY.