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Tropical Forested Watersheds

Hydrologic and Soils Response to Major Uses or Conversions

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Preface

In attempting this state-of-knowledge synthesis on tropical forest influences and effects of forest alterations, the workshop participants and the author were dismayed at the paucity of reliable data. It was therefore necessary to rely to some extent on professional judgments based on information from small plots and short time periods. Sorely needed are more studies on entire small- and medium-size watersheds having measuring weirs or flumes and good instrumentation, with periods of calibration and records over periods of 5 to 25 years. Such long-term experiments are extremely rare in the developing countries where most of the world's tropical forests are found. Sir Charles Pereira has pointed out that four such experimental catchments were begun in the decade 1955–65 in East Africa, West Africa, Indonesia, and India. Unfortunately those in West Africa and Indonesia succumbed to the stresses of the transition to independence. Fortunately, some excellent work has been initiated in the 1970s in Australia's tropics and subtropics, and within the past two years, some complete watershed studies have been installed in Malaysia. A recent watershed installation in Taiwan is shown in Figure 1.

It was therefore necessary to fall back at times on research results from temperate zone watersheds (Coweeta, United States; Kamabuchi, Japan; Melbourne Water Supply, Australia; etc.) and to suggest that the hydrologic processes should not be different. Again, professional judgments are required and were made in order that the ultimate objective be realized, namely, providing information to those making land-use policies for tropical watersheds. It is our opinion that too many of the land-use policies for tropical uplands are being made on the basis of misinformation and mythology and that imperfect information is being used in cases where there is more information available. For this reason, each chapter is concluded with a summary that attempts to put the forest land-use activity and its effects into a form that speaks to policymakers.

Grateful acknowledgment is rendered to the workshop participants, who provided much of the material for this report and reviewed the manuscript. Their names and affiliations are listed in Appendix A. When spe-

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cific unpublished information is attributed to one of them, it is cited in the text as personal communication (e.g. "Manan 1981, Pers. Comm.").

Special thanks also to Peter King who helped synthesize this material in its early stages and who provided his own expertise. I acknowledge members of the East-West Center Publications Office staff for their contributions toward bringing this book to its published form.

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This synthesis and activity is part of a larger project on watershed land use being conducted as part of a program area in Human Interactions with Tropical Ecosystems at the East-West Environment and Policy Institute.

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Introduction

THE RESEARCH PROBLEM

Tropical forests are different from temperate forests. But are they so different in their hydrological functions, their role in protecting soils from erosion, or in their nutrient cycling that they respond quite differently when "disturbed" or converted to other uses? Most scientific evidence indicates that differences are "more in degree than in kind." Conventional wisdom, political statements, and land-use policy formulation would, however, all seem to indicate that the situation is markedly different.

For instance, a 1981 issue of *World Water* carried an article about India's Chipko (tree hugging movement), which originated in the state of Uttar Pradesh. It suggested that trees can prevent monsoonal floods and subsequent droughts, and quotes the movement's leader as saying, "Tree-planting particularly of broadleaved varieties creates water" (*World Water* 1981). Research results from several temperate watershed research stations give quite different findings. They show that trees generally use more water than do lower forms of vegetation, particularly on deep soils, and that tree planting generally results in reduced total water yields from catchments. There have been no experimental findings showing increased rainfall following afforestation.

As far as floods are concerned, experimental evidence from temperate areas shows that small storm peakflows and upstream flooding on small streams are reduced following afforestation. For major storms in large watersheds, afforestation or deforestation had only a minor impact on flood peaks and duration. Again, this has not stopped statements to the contrary. In early 1981 when Philippine newspapers carried graphic accounts of the repeated and disastrous Agusan River floods, a political leader blamed "denudation of the forests by logging as responsible for about 30% of the flooding" (Corvera 1981). Even though flooding is an annual event, this particular flood was given a return period of 20 years. Furthermore, Openshaw (1974) has stated, "The principal cause of the recent floods in the Indian subcontinent was the removal of tree cover in the catchment

areas for fuelwood (and shifting cultivation)." The section of this report on Harvesting Fuelwood and Lopping Fodder deals with the effects of fuelwood cutting on water, and this is preceded by a section on the effects of shifting agriculture. There seems to be little evidence supporting Openshaw's unqualified statement, though the impacts of long-term, large-scale land abuse have indeed not been researched.

Elsewhere in the tropics, afforestation is being recommended as official government policy in order to rejuvenate springs and small streams. It is being suggested that *Imperata* and *Themeda* grasslands be planted with trees to increase dry season flows so that there is more water available for irrigation. Research on several temperate experimental watersheds would lead one to question whether this objective can be met solely through afforestation. In fact, most available research evidence suggests lower dry season flows following conversion to forest.

Other forest watershed policies being promulgated and implemented in developing countries effectively close the forest to many forms of human use. For instance, total bans on logging and shifting cultivation have been incorporated into some national policies, although they are frequently impossible to implement. Is total exclusion of human activity really necessary to protect the desirable hydrologic functions of watersheds? Experience and research in temperate forests would indicate that controlled and managed use may be a better policy for maximizing net social benefits.

Are the processes so different in tropical versus temperate watersheds that different policies and land management strategies are required? It is well established that the infiltration, storage, and release of water; the detachment, transport, and deposition of soil particles; and the cycling of nutrients depend on complex interactions between topography, climate, soil, geology, vegetation, and human manipulation of natural systems. There is no intrinsic reason why tropical systems should respond to different laws of nature than do temperate ones. Yet it must be recognized that both the nature of the driving variables (e.g., precipitation intensity or temperature) and the response of a system (e.g., sediment yield or evapotranspiration loss) may be quite different in the tropics.

As watershed experiments are generally long-term, expensive, and require a high degree of technical competence, most research evidence to date comes from the temperate, industrialized countries. Direct extrapolation of results to different combinations of climate, soil, and vegetation, even within the temperate zone, always has been problematical, so we should not be surprised that direct transfer of research to an entirely different climatic zone is fraught with uncertainty. There is no reason to believe that the basic processes are different. The research to prove it, however, must be carried out under a wide range of conditions so that a set of generalizations can be made for the range of conditions that exist in the tropics.

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