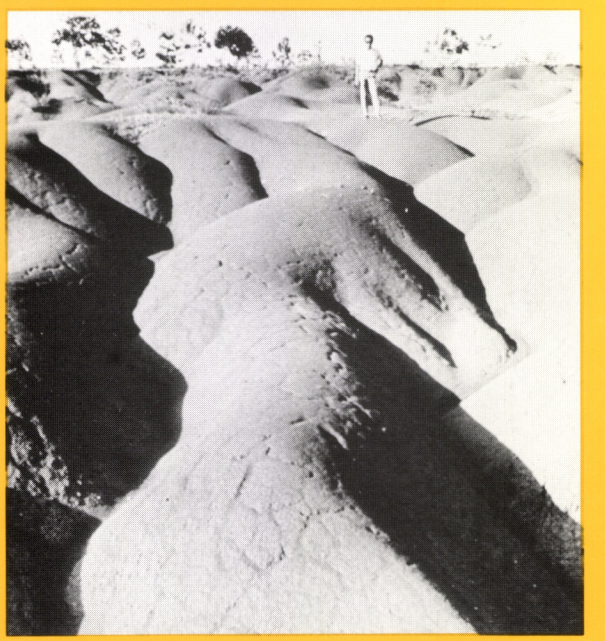
MATTI PALO
GERARDO MERY
(Editors)

DEFORESTATION OR DEVELOPMENT IN THE THIRD WORLD?

VOLUME III



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DEFORESTATION OR DEVELOPMENT IN THE THIRD WORLD?

VOLUME III

Edited by

Matti Palo and Gerardo Mery

Helsinki 1990

ABSTRACT

This report (Volume III) contains the 15 papers presented at the International Seminar on *Deforestation or Development in the Third World ?* The historical duration along with the pace, the traditional knowledge of forest peoples and psychological factors play their roles in deforestation. Monitoring of this process has to be based on scientific methods with adequate ground truth data. Scientific modelling of deforestation for scenario and policy purposes is indispensable. In the case studies of Ethiopia, Brazil, Chile, and China deforestation has common and divergent features. The past and future international and national policy and research actions on the front of tropical deforestation are depicted. The theory of optimal exploitation of non-renewable resources contributes to understanding and control of tropical rain forests. The external debt, poverty and the delay in agrarian reform are some of the key factors of deforestation, which seem to be powered by such driving forces as population growth and domestic demands, international asymmetry and demands as well as by accessibility. Accelerating vicious circles of the process are apparent. Deforestation and development remain strongly interlinked.

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PREFACE

The results of the ongoing research project on "*Deforestation and development in the Third World*" have been introduced in several reports, articles, lectures, press interviews, and seminars (see Prologue). The present publication contains the third volume published in the series "Metsäntutkimuslaitoksen *tiedonantoja*" (Research Bulletins) by the Finnish Forest Research Institute. The purpose of the first report (no. 272, 1987) was to expose pilot findings on deforestation and development, and to submit the plan for future research on those topics. In the second report (no. 309, 1988) the theoretical framework of forest-based development was revisited, and land reform as a policy means to decelerate deforestation was introduced. This third volume contains most of the papers presented at the "*International seminar on deforestation or development in the Third world?*", held at Saariselkä, Finland, on April 26-29, 1989.

The purpose of the Seminar was to make an international review on recent and present research on deforestation and development in the Third World. The program of the Seminar (Annex 1) was composed of reviews by the participants, interactive discussions and reshaping of the present cooperation and financing patterns. The program also incorporated an extensive social component in order to make informal discussions and dialogues possible.

Prestigious scientists and researchers who already were engaged in investigations related to deforestation and/or development in the Third World were invited to participate in the Seminar. Most of them had already actively interacted as an information network - delivering comments by mail, sending their own publications, giving references about other researchers, suggesting collaboration on research plans, etc. - with the ongoing research project (see Prologue). Accordingly, twenty six participants representing 14 countries attended to the Seminar (Annex 2).

The Scandinavian Society for Forest Economics, Working Group for Developing Countries, acted as the main organizer. The group was composed of the following persons: professor Ole Hofstad (Norway), professor P.O. Johansson and Mr. Bengt Kriström (Sweden), professor Matti Palo and Mr. Gerardo Mery (Finland). The practical organizing tasks were implemented by a local ad hoc team of Ms. Arja Honkanen, Mr. Gerardo Mery, professor Matti Palo and professor Ari Siiriäinen. Mr. Mery acted as the executive co-ordinator of the Seminar.

The Swedish Agency for Research Cooperation with Developing Countries (SAREC), the Finnish International Development Agency (FINNIDA), the Academy of Finland, and the Finnish Forest Research Institute were the principal sponsors of the Seminar. Veitsiluoto Corporation (Ltd.), the National Board of

Forestry (Metsähallitus) and the Ministry of Agriculture and Forestry of Finland also provided financial support to the Seminar.

Ms. Eila Iltanen, Ms. Anna-Kaisa Korhonen, Ms. Maija Kuusijärvi, and Ms. Liisa Lankinen kindly assisted us in typing and editing this publication. Special acknowledgements are extended to professor Ari Siiriäinen for his invaluable comments in the editing phase. The English language was checked by Ms. Dorothy Newell and Mr. Mark Waller.

We wish to express our sincere gratitude to all participants and sponsors of the Seminar, to the contributors of these Proceedings, and to the many people who helped us with the implementation of the Seminar and in the editing and publication of these Proceedings.

Helsinki, April 1990.

Matti Palo and Gerardo Mery
Editors

PROLOGUE:

A RESEARCH PROJECT ON DEFORESTATION AND DEVELOPMENT IN THE THIRD WORLD

Matti Palo, Ari Siiriäinen, and Gerardo Mery

INTRODUCTION

Having executed a pilot study during 1986, it was decided to launch a joint research project on the above topic. The pilot study and the project have been undertaken by the Finnish Forest Research Institute and the University of Helsinki. Additional financial support has been allocated primarily by the Academy of Finland, SAREC (Swedish Agency for Research Cooperation with Developing Countries), and FINNIDA (Finnish International Development Agency). Close collaboration with interested international organizations, such as FAO (Food and Agricultural Organization of United Nations) Forestry Department and IIASA (International Institute of Applied Systems Analysis) has taken place and will continue.

The research team of the project has been in close contact with the problems of the forest-based development in the Third World with its consequent deforestation, erosion and social costs. Matti Palo has carried out consultant work for FAO in four developing countries in Asia and Africa. Ari Siiriäinen has performed archeological research in several African countries and in Peru. Gerardo Mery has lived, studied, and conducted professional work in Chile.

PURPOSE

The deforestation and development analyses of the pilot study led to the conclusion that deforestation and forest-based development were closely linked. Accordingly, they have to be investigated within the same framework. This concept was also emphasized in 1987 by The World Commission on Environment and Development (Brundtland Commission), which stated: "*Environment and development are not separate challenges; they are inexorably linked*".

The research project has contributed so far toward increasing the knowledge concerning the forest-based development in general, and about its deforestation constraint in particular. Concomitant aims are to disseminate effectively the research results in order to improve the mechanisms to control deforestation and development as well as to contribute toward increased education, training, and extension on these topics. More specifically, the project has verified the di-

rect and indirect factors which explain the deforestation phenomenon and recognized critical factors of forest-based development.

Case studies of a few countries and comparative country analyses will be executed during the next phase. Refined deforestation scenarios up to the year 2025 will be produced and the social costs and benefits of deforestation will be analyzed. Finally, policy analyses will focus on formulating policy programs to decelerate or halt deforestation and to promote and control development in application of the ideas of Brundtland's Commission both in particular countries and in certain projects.

Our project's main beneficiaries are the developing countries, their governments, institutions and the public at large. However, other national and international organizations also receive benefits from the findings of the project, i.e. universities and other educational institutions, private individuals and newsmedia, forest industry firms and consulting companies, FAO and UNEP, development agencies (FINNIDA, SIDA, SAREC, NORAD, etc.).

RESULTS

The ongoing research project "*Deforestation and Development in the Third World*" has produced three main reports, several papers, two seminars, and some other results. The purpose of the first publications was to serve as discussion and contact papers to find out the appropriate approaches for investigating the problem of deforestation and development in the Third World. Subsequently, papers with more direct implementation value were produced.

The first report (Volume I) comprises five papers which cover topics as pilot findings on deforestation (part I) and forest-based development (part II), and a proposal for a future research project (part III). The second Volume revises the theoretical framework of forest-based development (part I), and introduces a proposal for land reforms as an effective policy means to decelerate deforestation (part II). This third Volume contains the Proceedings of the International Seminar on *Deforestation or Development in the Third World ?*, Saariselkä, Finland, April 26-29, 1989 (see Contents and Annex 1 and 2).

The project has benefited from the discussions and correspondence with a great number of prestigious researchers from different continents. These contacts have been gradually developed towards a fruitful information network (Annex 3). The Seminar of 1989 played a decisive role in promoting this respect.

The team members of the project have also been productive in other fields, such as invited lectures, consultancies and exchange of scientists (Annex 4).

FUTURE ACTIVITIES

The project is working out a new report which will analyze deforestation and development in Chile as a case study. Finland is used here as a case of reference where one time a wide-spread deforestation became controlled and where the positive effects of forest-based development are more evident than in any other country. Gerardo Mery made a successful study visit to Chile in the winter of 1987/88. He established contacts with three counterpart institutes and managed to gather sufficient data and information. Our aim is to expand our research plan by outlining a joint Scandinavian research project on the topic, in order to ensure that more case countries will be studied and more counterpart activities in the case study countries will take place. During 1990 new analyses and scenario-making will take place based on new observations concerning tropical deforestation by the ongoing FAO Tropical Forest Resources Assessment Project.

REPORTS AND PAPERS OF THIS PROJECT

Main reports:

1987 Palo, M. and Salmi, J (eds.). 1987. Deforestation or Development in the Third World? (Volume I). Metsäntutkimuslaitoksen tiedonantoja 272. Helsinki, 258 p.

1988 Palo, M. and Salmi, J (eds.). 1988. Deforestation or Development in the Third World? Volume II. Metsäntutkimuslaitoksen tiedonantoja 309. Helsinki, 182 p.

1990 Palo, M. and Mery, G. (eds.). 1990. Deforestation or Development in the Third World? Volume III. Metsäntutkimuslaitoksen tiedonantoja 349, Helsinki, 190 p.

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1986 Palo, M., Kanninen, M., Mery, G., & Selby, A. 1986. Forest-based socio-economic development and deforestation in developing countries -a feasibility study for a major research project. In the Congress Report of 18th IUFRO World Congress, Ljubljana: 533-551.

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Palo, M. 1988a. Forest-based development or deforestation: an overview. In Palo & Salmi: Deforestation or Development in the Third World? Volume II. Metsäntutkimuslaitoksen tiedonantoja 309: 7-12.

Palo, M. 1988b. Forest-based development theory revisited with a case study of Finland and prospects for developing countries. In Palo & Salmi: Deforestation or Development in the Third World ? Volume II. Metsäntutkimuslaitoksen tiedonantoja 309: 13-156.

Palo, M. 1988c. Export Prospects for the Forest Industries in Developing Countries. Offprint of UNITAS, Finnish Economic Quarterly Review. Vol.60(4): 76-83.

Salmi, J. 1988. Land reform - a weapon against tropical deforestation ? In Palo & Salmi: Deforestation or Development in the Third World? Volume II. Metsäntutkimuslaitoksen tiedonantoja 309: 159-182.

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Palo, M. 1988. Metsäteollisuuden näkymät kehitysmaissa. Unitas no. 4/ Joulukuu: 103-109.

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Palo, M. 1988. Die Exportaussichten der Holzverarbeitenden Industrie in den Entwicklungsländern. Unitas, Wirtschaftliche quartalsschrift, Vol 60(4): 59-66.

OVERVIEW:

SEMINAR PROCEEDINGS ON *DEFORESTATION OR DEVELOPMENT IN THE THIRD WORLD ?*

Matti Palo and Gerardo Mery

This is the third volume published by the Finnish Forest Research Institute under the title *Deforestation or Development in the Third World ?*. Volume III contains most of the papers presented in the International Seminar convoked under the same title, and held at Saariselkä, Finland, on April 26-29, 1989 as well as two contributions by researchers who were registered but had to cancel their participation in the seminar. For an easier reading, the papers have been grouped into five parts.

PART I. Deforestation: history and traditional human awareness

On the historical aspect of deforestation in the tropics by Ari Siiriäinen (Chapter 1) reveals that deforestation may have a surprisingly long history. Cultivation, cattle herding as well as iron and other metal production have played key roles in the historical deforestation processes. In fact, during this era man has never lived any longer period in an equilibrium with his forest environment.

In areas vacated by migration natural deforestation may have taken place but under more permanent inhabitation a slow deforestation process may have continued for hundreds of years, if not for a few millennia. Such processes have become verified through comparisons of palynological and archeological findings. The understanding of the role of historical deforestation helps to explain the factors causing differences in relative and absolute forest covers of individual countries and districts. A conclusion can be deduced from Siiriäinen's paper: the scale of deforestation is determined not only by the actual rate but also by the duration of the process.

Luis Luna's paper (Chapter 2) *Traditional human environmental awareness in the Amazon* is based on the experience gained from two small projects in the Peruvian Amazon. An able local young man with some ethnobotanical field experience has established a garden with over 300 different species of medicinal plants. The success is partly based on frequent contacts with the local Indian groups that posses intergenerational knowledge in this field - essential to their survival in the marginal living conditions of the humid tropics. *The Amazonian school of Painting - USKO-AYAR* - comprises another local project. The school's

aim is observing and painting Amazonian nature. It was established by a local healer who had derived his knowledge from "plant-teachers" and was also a talented artist.

With more migrant forest people the tropical rain forests have ceased for most of them to be a provider of multiple benefits, such as food, medicine and shelter, source of spiritual power and wisdom and aesthetic pleasure. When remaining unknown, the forest becomes a threat with negative loadings. The two projects effectively demonstrate the potential of education and extension among the newly settled forest people missing the traditional forest-related knowledge. An important conclusion can be derived from these experiences: deforestation is not caused only by socio-economic but also by psychological factors.

PART II. Deforestation: monitoring and modelling

An approach for forest inventory and monitoring at a global scale by Simo Poso (Chapter 3) has its background in the situation where tropical deforestation monitoring until today has consisted primarily of the gathering and merging of individual national forest statistics from varying dates. However, there have existed a number of countries lacking any kind of national forest inventory data. Poso aims to create a global framework based on remote sensing, permanent field sampling plots in clusters and two-phase, stratified, systematic sampling.

Risto Päivinen (Chapter 4) reviews *Tropical forest cover monitoring project: a part of the UNEP/GRID activities.* The Global Resource Information Data Base of The United Nations' Environment Program is developing a methodology to map and monitor the tropical forests of the world. The project aims to delimit forest/non-forest boundaries in pilot regions of West Africa and Amazonia. A conclusion is drawn that if the area is too large to be covered by high resolution satellite data or aerial photographs, low resolution data under cloud-free conditions are considered useful by accuracy and costs.

It seems to be a commonplace to introduce tropical deforestation data based on remote sensing without more specification about the method. However, both the accuracy and other applicability of deforestation observations depend heavily on the monitoring method applied. Both Poso and Päivinen, who are distinguished international specialists in the field, stress the cardinal role of the observation method with particular reference to the necessity of *ground truth data.* Monitoring of deforestation has to be based on a scientifically sound and reliable method. The neglect of this principle has produced so far a great deal of national and international confusion about the pace of deforestation.

In *Modelling deforestation in the humid tropics* Alan Grainger (Chapter 5) reviews the findings of his recent doctoral dissertation on the topic. He explains the

deforestation process by grouping the causal factors into two main sets: types of forest exploitation, and mechanisms of deforestation. He uses this approach to build up two different models: a system model of national land use and a simpler model for simulating possible future deforestation scenarios.

An application of the latter model is made for 43 tropical countries, based on individual simulations for each of these countries. Two scenarios are obtained for the period 1980 - 2020. These scenarios result in a reduction in the total area of the tropical moist forest of 20 percent and 10 percent respectively. The scenarios are rather low in respect to the previous findings by the Finnish research project (Prologue above; Volume I). The scenario model applied by Grainger, while being practical, tends to be rather subjective and towards the end of his paper he gives a number of reasons why the scenarios may give too low deforestation rates.

PART III. Deforestation: country cases

Assefa Kuru, Marcio Nahuz, Homero Altamirano and Li Shan Qi review deforestation in their respective case studies of Ethiopia (Chapter 6), Brazil (Chapter 7), Chile (Chapter 8) and China (Chapter 9). The four countries differ a great deal by location, size, history and economic system - however deforestation has common features and deceleration or prevention of deforestation seems most problematic.

Kuru's paper, *Roots of deforestation problems in Ethiopia,* is based on his recent doctoral dissertation on the topic. He found that in one hundred years (until 1980) the forest cover of Ethiopia's land area decreased from about 40 percent to about 3 percent. Accelerated soil erosion and land degradation have become paramount resulting in periodic famines and mass migrations. Kuru points out civil wars and adverse imperial policies of the Ethiopian government as the major root factors of deforestation.

In *Deforestation and development: a compound issue for Brazil,* Marcio Nahuz reviews the agents of deforestation in Brazil and gives fresh estimates of deforestation in Amazonia. The removal of a significant share of Chile's natural forests is examined by Homero Altamirano in his *Deforestation in Chile: a historical review.* He emphasizes the paucity of information concerning the country's forest resources. A historic description of deforestation agents is also presented.

Shan Qi reports in *Tropical forests and their development strategy in China* that the forest area of the two major regions covered by tropical forests has decreased during the past forty years from 26 percent to 10 percent and from 55 percent to 30 percent, respectively. The remaining tropical forest area of the two regions was estimated as 0.9 million hectares. Rapid deforestation has produced serious erosion and soil losses as well as micro-climatic deterioration. Development

strategies to overcome deforestation comprise, for instance, land tenure reforms and creation of markets for forest products. These cures are rarely implemented in the Third World but could be most effective remedies.

PART IV. Deforestation and conservation policies

Peter von Fürstenberg gives *A review of tropical deforestation: development policy and forest research* (Chapter 10). He argues that the velocity of deforestation in the humid tropics may have even accelerated according to the 1980 report "Global 2000" to the President of the United States. Progress in creating sustainable forest management systems in the Tropics has been slow. The rapid deforestation within the recent decades has startled the public opinion and politicians alike. Von Fürstenberg reviews a number of international and national policy, and research projects and programs focusing on tropical deforestation.

Both public and private international organizations and some individual countries, such as the Federal Republic of Germany, France, the Netherlands, the United Kingdom and the United States, have been most actively engaged on this front. For instance, Germany organized a study group in 1986, a Parliamentary Study Commission and a special hearing on "The rescue of the tropical rain forests" as well as a resolution on "Forest development policy", all events in 1988. The Ministry for Economic Cooperation has financed two additional investigations on forestry development in developing countries. Subsequently, the German Agency for Technical Cooperation and the Credit Institute for Reconstruction have launched their policy papers.

While von Fürstenberg reviewed the past international and national actions on the front of tropical deforestation, Franz Schmithüsen focuses primarily on potential future policy measures to solve this actual issue. His paper *Tropical forest conservation and protection: political issues and policy considerations* (Chapter 11) states first the complexity of the deforestation issue. It goes far beyond the forest sector and has to be tackled at the national and international levels. The borderline of physical accessibility seems also to be the borderline between deforestation and conservation!

Balancing of short-term benefits with long term costs of deforestation is mostly intersectoral, often international and intergenerational and thus most problematic. However, the private and public benefits from deforestation are considered by the respective agents as actual and real. In order to omit these benefits and to avoid deforestation various compensative actions to local people are obligatory. A large-scale conservation of tropical forests is often beyond national perception and the problem of compensation becomes an international issue.

Schmithüsen then goes on to give lists of potential issues and proposals to be tackled as international or national policy measures under the following titles:

forest conservation, natural resource protection and integrated land use, forest resources development, sustained forest production, institutional strengthening as well as education, extension and research. He illustrates with cases the inconsistencies of present policies, such as simultaneous acceptance of deforestation of natural forests and adjacent reforestation in order to ensure the future timber supply. Finally, he points out the critical mass of international action that will be required in order to make some effective impact on decelerating deforestation.

In *Conservation through the looking glass: the case of Central America* (Chapter 12), Gina C. Green exposes conservation problems in this region. Costa Rica leads the field in conservation and has designated 10 percent of its total land area as wildland areas of various categories. The region as a whole has created about 350 conservation units. The bitter truth seems to be that throughout the isthmus many parks and reserves exist on paper only, while an average deforestation rate of 3 percent is often as severe inside the parks as outside. The problems that beset the conservation efforts are partly beyond the sector but partly comprise of inconsistencies and inadequacies in the conservation projects. She concludes that successful cases give evidence about the key role of controlled planning and implementation of such projects.

PART V. Deforestation and development

Ole Hofstad describes the *Tropical forests as non-renewable resources: the theory of optimal exploitation* (Chapter 13) and demonstrates the applicability of such a theory into the tropical forest resources. This contrasts with the prevailing idea of viewing tropical rain forests as renewable resources. A traditional classification, however, differentiated exploitative, conservatory and sustained yield forestry, even at temperate zones. Forest resources were also classified into submarginal (P<C) and marginal (P=C) or intra-marginal (P>C) resources by accessibility and logging costs as well as by respective log prices (ex-mill or f.o.b.). Such economic accessibility of forest areas can be extended as a consequence of either technological improvements and lower logging costs or of price increases.

According to this theory, the supply of industrial logs is controlled through the concessionaires and contractors who maximize their discounted profits in competitive markets. The optimal rule requires the exhaustion of the stock of a particular tree species by an individual agent before it becomes submarginal. A rational exploiter keeps creaming from the most highly priced and accessible tree species and exhausting them and subsequently shifting to other logging sites. Forest soils can be exploited for agricultural purposes according to respective non-renewable principles.

The theory contributes to understanding why various economic agents find it optimal to exhaust forest resources under their control. Secondly, the theory can

give normative hints to the society on how to control tropical rain forests. In some cases exhaustion can be optimal even from a social point of view. However, in many cases, when the social costs of exploitation are higher than those experienced by the individual logging agent or the social value of the forest is higher than the exchange price of its timber, the optimal policy can be the conservation of existing forests.

Ole Hofstad has introduced here an old approach in a novel application to improve the understanding of both deforestation and conservation of tropical rain forests. Franz Schmithüsen's paper above in many ways supports the assumptions on which Hofstad has based his paper. The novel application of the theory of optimal exploitation of non-renewable resources may open new avenues for future research on deforestation and development.

Sebastião Kengen exposes *Some reflections on deforestation and development: the Brazilian experience* (Chapter 14). The role of forestry in development can be divided at the conceptual level into two categories: the early "industrialization approach" and the present "forestry for local needs approach". Neither the former nor the latter is the perfect panacea, rather they can complement each other.

Next Kengen describes the paradoxical pattern of development and deforestation followed in Brazil. Due to considerable government sponsored fiscal incentive schemes on both fronts during the recent two decennia about five million hectares of forest plantations were created on one hand while deforested area in Amazonia has increased from 0.5 percent to 12.0 percent of the land area on the other hand. There has been a strong struggle to develop at any cost. The growth of food production can be attributed more to an expansion of the agricultural frontiers than to productivity increase. Lack of long run planning is visible. The external debt, misery, poverty and starvation are some of the other key factors that have strongly promoted deforestation. The delay of agrarian reform and otherwise more equal distribution of income and wealth are other contributors in this process.

Matti Palo analyses *Deforestation and development: roles of system causality and population* in the last paper of this report (Chapter 15). The causal process of deforestation is described as a complicated, interdisciplinary system causality at international, national and local levels. System variables are assumed to have joint causal effects. The role of population growth, in conjuncture with market and government failures which effectively decelerate the diffusion of technology advances and innovations, is critical. Population growth can also be interpreted as a major factor in promoting domestic demands for various goods and services relevant to deforestation.

The roles of international asymmetry and demands in deforestation are described as driving forces along with population and accessibility. Political instability, speculation and wars are linked with low values of forests and short planning horizons, which again promote deforestation via local agents. Accelerating forces of deforestation comprise asymmetric and uncertain tenure, corruption, market and government failures, public incentives, weak traditional common lands and open access conditions. Cumulative causation forces extend from erosion sensitive natural factors to human depression.

Positive feedback loops dominate deforestation systems. They lead into accelerating vicious circles of deforestation and eventually, under a number of tropical and subtropical conditions, into environmental catastrophes. Negative feedbacks may appear only in later stages to decelerate deforestation. The previous provisional theory of deforestation by Palo received additional support through the findings of this paper.

PART I

DEFORESTATION: HISTORY AND TRADITIONAL HUMAN AWARENESS



Excursion to a fell forest (traditional Lapp huts in the background). Photo by Assefa Kuru.

ON THE HISTORICAL ASPECT OF DEFORESTATION IN THE TROPICS

Ari Siiriäinen [1]

ABSTRACT

Deforestation in the tropical forests has a long history stretching in certain areas a few millennia back in time. Cultivation, cattle herding as well as iron and other metal production have been the central factors in the historical processes causing deforestation. Man has never lived in an equilibrium with his forest environment. A two-stage research strategy is proposed including a long-term precolonial era and a short-term colonial era.

Key words: deforestation, forest ecohistory.

THE RELEVANCE OF HISTORY IN DEFORESTATION

As the original tropical deforestation model constituting the starting point of the Project includes the duration of the human impact as a variable (Palo et al. 1987), my task is to sketch a historical background for the man/forest interaction in the tropics. As the first stage of the research I will be examining history in a long-term perspective within a time span of several thousands years to ensure that even the most gradual and hence least obvious - but nevertheless important - processes will be taken into account. The second stage will include a review of the processes which affected the traditional man/environment interaction from the first European contacts to the full colonial situation. Although such a long-term historical background cannot certainly serve as an explanatory model for the current deforestation in the tropics, it is at least an instructive exercise in order to understand some of the central issues in the man/forest relationships still relevant in the tropical forest ecosystems (Burch 1988).

On a very general level, we learn from such a historical investigation at least the following four important facts, relevant for us here:

1. Since the introduction of productive modes of subsistence economies (cultivation and cattle-herding), man has never lived in a homeostatic or equilibrium relationship with his environment; man has always manipulated the environ-

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ment towards artificial ecosystems in order to make the production meet his needs.

2. This manipulation has always, even if it has been slight, changed the environment profoundly, and where it has been continuous due to permanent settlement, the change has been irreversible.

3. The duration of human impact has been considerable, depending of course on the history of habitation in each area. For instance in most parts of Africa and South-East Asia production economies have a history of more than two thousand years, and in the lowland Amazonia it might be considerably longer still (Phillipson 1985, van Heekeren 1956, Harrison 1972, Lathrap 1970).

4. During those millennia man has adapted not only economically but also mentally and culturally to his forest environment, and in the tropics - as in the boreal zone - forests have been regarded by man as an almost endless resource. Therefore, the introduction of "hard technologies" to forest utilization, whether for primary production or, increasingly, for timber production, has not made at least mentally or psychologically any dramatic cultural intervention (technically and economically it has of course had profound effects).

RESEARCH STRATEGIES

On a more specific level, when examining the long-term history of human impact on the forests two kinds of strategies can be followed: (1) to obtain an overall view on the chronology and spread of the production economies, and (2) to select certain case areas in order to detect the particular processes through which forests and woodlands have been utilized. It is obvious that forest clearing and cultivation techniques, means of land tenure, patterns and speed of penetration into new forest areas, and the general effect of human impact have varied according to local factors such as topography, forest composition, edaphic conditions, and even social and demographic factors such as habitation patterns, population densities and increase, etc. Case study areas should include different environments, and we are now starting research within three ecotones: lowland forest (eg. South-Eastern Nigeria or Southern Cameroon), montagne forest with steep topographical relief (eg. central Kenya), and sparse woodland (eg. Zambia with the miombo cultivation systems). In choosing the case areas the important aspect of access to primary information (i.e. to literature, unpublished investigation reports, maps and satellite images) has to be considered.

Information is obtained from three main disciplines: cultural or social anthropology provides models of traditional and recent economies and cultural and demographic adaptations, archaeology can to some extent use these models to detect in archaeological material past processes of migrations, adaptations and innovations, and palaeoecology, especially palynology, reveals such discontinuities in the vegetation history of each area under investigation which cannot be explained by natural development but rather by human impact. By correlat-

ing the palaeoenvironmental data with archaeological findings it has in many regions been possible to show human effects on the forests - I shall return to these issues later.

What then are the basic categories of data needed for a relevant historical man/forest interaction analysis? We have to identify and date past economies (hunting and gathering, cultivation, cattle herding, or mixed economy), economic strategies (swidden cultivation, sedentary agriculture, nomadic herding, transhumance etc.), and technological skills (intensity of metal production, ability to construct field terraces, irrigation systems etc.). Some of these questions are fairly easily answered on the basis of archaeological data but others are not: for instance the essential demographic parameters remain always only unreliable estimates although population trends can perhaps be determined more reliably, i.e. whether a population within a certain area is stable, increasing or decreasing (Shaw 1981). Past migrations are also fairly easily detected.

DEFORESTATION IN A LONG-TERM HISTORICAL VIEW

Population size and density are indirect factors causing human stress on the environment, for instance human-induced deforestation, now as well as in historic times. They affect of course through the intensification of forest clearance for shifting cultivation and through the consumption of wood for building houses and other constructions; iron production has also demanded large quantities of wood (Haaland & Shinnie 1985). Indirect effects include soil degradation of essential nutrients and erosion. Shifting cultivation, a very effective mode of production as such, is now one of the severest threats to the forests at least in large parts of Latin America and South-east Asia and in certain areas of Africa as well (TFE 1978).

Earlier I mentioned the palaeoecological studies, the results of which should be correlated with archaeological data in order to obtain a coherent chronology for the history of human impact to the forests in each area. Unfortunately, such studies have only been carried out in Africa, and even there the work is only barely started; in Amazonia there are some scattered studies which do not yet permit any overall view, and in South-east Asia or India such work is to my knowledge non-existent. In eastern Africa especially, Alan Hamilton is currently carrying out palynological research on the long-term history of the vegetation and on the human land-use effects (Hamilton 1982), but a systematic research is badly needed even there. Some isolated observations have been published from western Africa (Sowumi 1981).

According to such studies it has been possible to detect rapid local deforestation phenomena which obviously have no natural causes but must be interpreted as consequences of human land-use practices. Such observations come at least from Kenya, Ethiopia and Uganda in the eastern part of Africa and from Nigeria in the western part of the continent. According to radiocarbon datings from the sediments from which the pollen evidence comes, these unnatural discontinuities in the forest cover correlate very strongly with what is known about human

settlement intensity from the archaeological material of respective regions. The earliest indicators of forest reduction seem to date to the period of the introduction of cultivation and iron production into each area, that is slightly older than 2000 years in average. The second forest reduction stage dates some 1000 - 1500 years later and corresponds with another stage of population increase and intensification of cultivation and especially of iron production (Siiriäinen 1987).

Good local and regional correlations between palynologically observed forest reduction periods and archaeologically observed periods of increased human activity show that it is safe to interpret archaeological findings of early cultivation and iron production and subsequent intensification in these activities as severe environmental stress factors potentially causing deforestation at least on a local scale, and, where archaeological evidence is intensive, even on regional scale.

It is obvious that the above phenomena concern mostly woodlands and forest fringes which were first colonized by early cultivators and cattle keepers, but in recent archaeological surveys and excavations in Nigeria, Cameroon, Gabon and Congo clear evidence has been found about Late Stone Age and Iron Age (ca. 1000 BC onwards) cultivators even in the central parts of the tropical rainforests (eg. Clist 1987). However, these early forest communities were only small scattered villages, and the extent and intensity of the possible human effect on vegetation remains unknown - palaeoecological studies might eventually give answers to these questions.

Finally, it should be realized that not everywhere was human settlement, and hence the impact on the vegetation, continuous from the initial period onwards: there have also occurred decline periods in the settlement and even complete abandonment of certain areas, although such trends have apparently been exceptional, at least in tropical Africa. However, in some cases forest has been naturally regenerated in previously inhabited areas, but even in these cases the vegetational composition of the forest has changed to a "secondary forest". For instance, in Africa vast areas of originally wooded terrain have been turned permanently into bushland or grassland by human land-use (eg. Trapnell et al. 1976).

To provide historical parameters for our general model, our intention in the next stage of the project will be to concentrate on certain countries or regions in Africa and to define the following crucial land-use discontinuities or time horizons within each area:

I The introduction of cultivation and/or cattle-keeping.
II The introduction of metal production (iron in most cases); in large parts of East, Central and Southern Africa this horizon coincides with horizon I.
III The intensification of both cultivation and iron production.
IV The introduction of specialized modes of cultivation such as terracing and irrigation.

Horizon I dates in West Africa, where cultivation started first, to beyond 4000 years, whereas in areas where it co-occurs with horizon II this combined time horizon dates between ca. 2800 and 1500 years ago becoming younger from north to south, generally. Horizon III is about 600 to 1000 years old but it occurs only in woodland and marginal forest areas, and horizon IV is even more restricted geographically, being represented in mountainous areas where ancient cultivation terraces or water furrow systems can be dated to the fifteenth century or later (Sutton 1984). In the West African forest margins settlement reached very high densities immediately after horizon IV, and it is possible to speak of an initial urbanization process there with some demographic, social and cultural consequences which in turn had considerable environmental consequences (Connah 1987).

A major problem encountered in the research is of course the availability of published or reported archaeological data: it is extremely uneven both quantitatively and qualitatively. There are certain areas in Kenya, Tanzania, Uganda, Zambia and Zimbabwe which are fairly well covered but for instance Zaire, Cameroon and Ethiopia - which would be extremely important in our case - lack almost completely reliable archaeological data. It is probable that we are forced to operate on a very general level and then concentrate on some limited environments as case studies.

In principle, similar analyses could be carried out in other tropical areas like South-East Asia, where - for instance in Kalimantan - archaeological studies have revealed early forest clearing cultures and early extensive and intensive iron production areas as well (Harrison 1972). In Amazonia, a recent report from Venezuela (Sanford et al. 1985) presents interesting localities with layers including large concentrations of charcoal associated with archaeological material showing habitation at the same localities; the oldest of these layers are according to radiocarbon dates ca. 6000 years old. This indicates that forest clearing or burning (shifting cultivation) has affected Amazonian rain forests during a considerable period of time.

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TRADITIONAL HUMAN ENVIRONMENTAL AWARENESS IN THE AMAZON.

Luis Eduardo Luna [1]

ABSTRACT

Native groups in the Amazon have accumulated great knowledge about the environment in which they live. Some of this knowledge is also preserved by gifted individuals among the Mestizo population. They represent a human resource that should be taken into account, particularly in the education of youth. The lessons learned from two small projects, a school of painting and an ethnobotanical garden, lead by local people, are presented here.

Key words: Amazon, education, art, ethnobiology, environmental awareness.

INTRODUCTION

In 1981 I arrived in the Peruvian Amazon with the intention to make a film about a local healer and to study a hallucinogenic brew locally known as *ayahuasca*, which is prepared by cooking together the stem of *Banisteriopsis caapi*, a jungle vine, and the leaves of *Psychotria viridis*, a small tree. These plants are considered by shamans to be intelligent beings from which it is possible to acquire knowledge and power. I gradually realized that the plants involved in the preparation of *ayahuasca* were only but part of many other plants considered to be *"doctors"*, plants that teach (cf. Luna 1984). According to the worldview of the Amazonian Indians (as for certainly that of many other cultures around the planet, both past and present) human beings are only one among many different intelligent beings on the planet. Humans occupy a middle position in a complex world of intelligent exchange with higher and lower body-minds, some plainly visible in the form of plants, animals, rocks or meteorological phenomena; some invisible to the untrained eye.

Western modern conceptions of life and death is the opposite of that held by *"primitive"* people. As Hans Jonas (1966) remarked, for science the cosmos is primarily dead, life is but an exception to be understood, a thin layer covering our planet. We try to find signs of life elsewhere, in a universe which is basically dead. The opposite is found in the cosmologies of many so called *"primi-*

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tive" cultures: the Universe is populated by myriads of intelligent beings, inhabiting forests, mountains, lakes, rivers and constellations. 'Dead' is something almost inconceivable that has to be explained in terms of life.

KNOWLEDGE OF NATURE OF INDIGENOUS PEOPLE

The complex spirit world of Amazonian people is not an abstraction disconnected from their natural environment. On the contrary, it is a symbolic representation that reflects the intricate processes that sustain life in one of the areas of greatest biological diversity and complexity on this planet. They have developed tremendous skills in adapting to their environment, and adapting the environment to fulfill their biological and cultural needs. As Reichel-Dolmatoff (1976: 310) has pointed out, referring to the Tukano of northwest Amazon, *"the Indian's ethnobiological knowledge of the natural environment is not casual and is not something he assimilates through gradually increasing familiarity and repeated sense experience; it is structured, disciplined knowledge which is based upon a long tradition of enquiry and which is acquired of necessity as part of his intellectual equipment for biological and cultural survival."*

Only recently have Western scientists become aware of the great knowledge accumulated by non-literate societies. Native people have developed ingenious classifications of ecosystems; they know the relations between various types of soils and the plants and animals that live on them, are aware of microclimatic variations, and have agricultural systems that succeed in improving, rather than degrading soils (Hecht & Posey, 1987). This comprehensive ethnobiological knowledge must reflect an intense ecological awareness fundamental to their adaptative responses (Berlin & Berlin 1983:301). It is regrettable that governments (and the general public) still regard Indians as backward people devoid of culture who should be integrated in the national development plans. The result of this attitude is the rapid disappearance of indigenous groups or their cultural disintegration. As Posey (1987/1988:13; 1983) remarks, *"with the decimation of each indigenous group, the world loses thousands of years of accumulated knowledge of adaptation to tropical ecosystems. Such precious information is overlooked without the least consideration: the rapid pace of economic development cannot be halted even long enough to take note of what is about to destroy."*

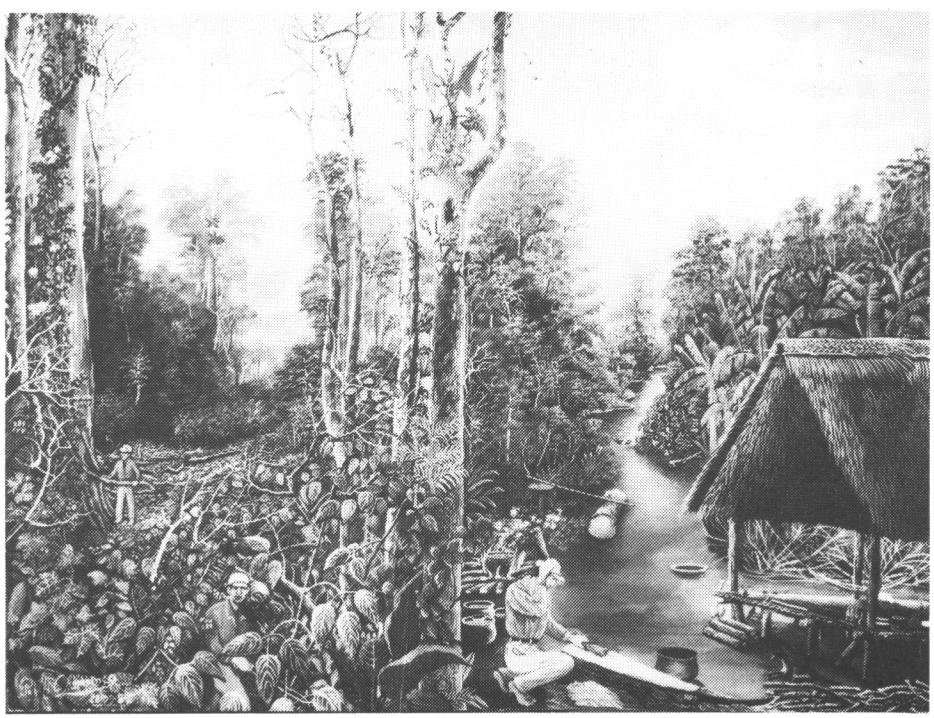
TRADITIONAL KNOWLEDGE OF MESTIZO POPULATION

Although the acculturation process in the Amazon is advancing rapidly, a great deal of knowledge is still preserved in the minds of gifted individuals also among the Mestizo population of the Amazon. Shamans, herbalists, story tellers, people of many talents are found here and there. They often have Spanish as their mother tongue, do not identify themselves as Indians, but they carry with them precious learning derived from their indigenous ancestors. It is a tremendous waste of human resources not to give these people a chance to use their skills and experience in national development programmes.

I wish to present here some of the lessons learned from two modest and related projects I have been engaged in the area of Pucallpa, the second largest city of the Peruvian Amazon.

While doing fieldwork in Pucallpa in 1985, I met Pablo Amaringo, a man of many talents. He has Lamista, Cocama and Piro Indian ancestors, is fluent in Spanish and Quichua, and has some knowledge of Cocama, Amahuaca and Shipibo. He also has solid knowledge of English, as he has worked as a free lance English teacher in Pucallpa. During his life he has made his living as a farmer, fisherman, carpenter, lumberman, and hair dresser. From 1969 to 1975 he was a *vegetalista* (a healer who derives his knowledge from plant-teachers), and expert in the use of ayahuasca, a technique he learned from his father, who was a shaman. I interviewed him several times, and was impressed by his knowledge of medicinal and psychotropic plants, and of local mythology. He also showed me some skillfully made Amazonian landscapes which convinced me that he also was a talented artist. I decided to help him financially by sending him materials and selling his art. In four years of collaboration he has produced interesting pieces of art that reflect the Amazonian environment, and the beliefs of the people who inhabit it.

But it is a parallel development which I want to bring to your attention. Once Amaringo understood that he could dedicate himself solely to painting he had the idea to accept pupils in his home so that they would learn to paint.



An Amazonian healer gathering and prepearing his medicines.
Painting by Pablo Amaringo, director of the School Usko-Ayar.

The result has gone beyond what any of us expected. *The Amazonian School of Painting* ***USKO-AYAR*** has today over 100 students who pay no fee. The aim of the school is on the one hand to rise environmental consciousness in the youth of Pucallpa, so that by observing and painting Amazonian nature they will learn to respect and preserve it. On the other hand there is the intention to document in painting the flora and fauna of the Amazon in a dynamic way, showing plant/animal interactions. Even though the school barely survives financially through selling the art produced in it, with no help from the part of the authorities, it has begun to have some local impact. Several of the students are in turn art teachers in primary schools. The school has organized exhibitions that have attracted the interest of local people, and has participated in cultural events in several cities of Peru. More and more youngsters are seduced by the idea of using some of their time to document artistically the Amazonian environment in which they live.

Also in 1985 I met Mr. Francisco Montes, a young man who in 1983 had worked with ethnobotanists Dennis and Terence McKenna, while they were carrying out fieldwork in the Huallaga river area. Francisco had helped the McKenna brothers to collect specimens of medicinal plants. He has since developed a real passion for the ethnobotanical lore of the Peruvian Amazon. Although he has very limited formal education, he has a great understanding of plants, is a good local taxonomist, and is able to collect, dry and preserve specimens of Amazonian plants. He has had contact with Indian groups, learning from them about the properties of plants, and of his own accord is developing an ethnobotanical garden on the shores of Yarinacocha lake, some kilometers from the city of Pucallpa. He called it *Jardín Etnobotánico Chullachaqui*, and has already over 300 different species of medicinal plants. The garden can be easily visited by boat and is open to the public.

By collaborating in these two projects and observing their development, I have understood how important it is to support low budget projects carried out by gifted local people. It is not necessary to have university degrees or high academic qualifications to do important work. Local people are often highly motivated and know the setting very well. With relatively little help they may be able to accomplish a lot. I also realized how art may be used among the youth to promote healthy ideas. I have witnessed the enthusiasm and dedication of young people discovering hidden possibilities in themselves and in their environment. Artistic work leads easily to reflection and understanding, contributing to a positive mental attitude towards nature.

Francisco's example has shown me that with very little money it is possible to train local Amazonian people as ethnobotanists. From the onset they are at home in the tropical rain forest. They are able to reach with ease places that for a Western botanist would be a hazardous and expensive trial. They are also culturally much closer to Indian shamans, and can serve as bridges to preserve, transmit and apply indigenous knowledge of the Amazonian environment.

CONCLUSION

Forests are disappearing, but knowledge about the forest is disappearing even more rapidly. The tropical rain forest has ceased to be at the same time the provider of food, medicine and shelter, source of spiritual power and wisdom and aesthetic pleasure. Unknown, it becomes a threat. Deprived of sacrality, it becomes only the object of immediate exploitation. Our technological advance doesn't seem to take us closer to deep understanding. We should examine again our past history to find how our ancestors related to nature. At the same time we should be aware of the views of indigenous groups on the place of the human species on this planet. Shamans of today still retire to the jungle for long periods of time to receive messages from the spirit of plants and animals. But the sound of electric drills is being heard almost everywhere, and when the trees are cut, with them go the animals that dwell in them and the spirit world of the aboriginal people that took care of this environment for centuries.

Education is one of the most important factors in raising environmental consciousness among the general public. If the people living in the tropics do not feel the urgency to keep the forest, all international efforts will be in vain. The Western idea of development has inflicted enormous damage on the appreciation of the forest by the local population. The urban models of Amazonian cities are totally inadequate for the climate. The main plazas of Iquitos, Pucallpa, Florencia and other Amazonian towns previously had plazas with trees giving shadow, and good places for conversation and leisure. Trees have recently been replaced by cement, with the result that nobody is using them anymore because of the terrible heat. Attempts to reforest cities like Iquitos have been impaired by the mechanical reflex by which many are impelled to vandalize the plants for no reason, even without thinking, as they go by. Vegetation is not considered as something valuable. For most people development means westernization in every respect, and, sadly Western cities the ideal model they try to emulate.

Deforestation depends not only on economic but also on psychological variables. We should facilitate situations in which young people are able to have contact with old wise people aware of the traditions and the symbolic meaning by which the environment has been traditionally imbued. It is meaningful to establish recreational parks lead by talented local people where the youth will learn about their plants and animals. The artistic education of people in the Third World countries could be a factor contributing to the preservation of traditional concepts and values, and to rise environmental awareness.

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PART II

DEFORESTATION:

MONITORING AND MODELLING



A session of the International Seminar at Saariselkä. Photo by Francisca Nassol-Dayrit.

AN APPROACH FOR FOREST INVENTORY AND MONITORING AT A GLOBAL SCALE

Simo Poso [1]

ABSTRACT

Global forest inventory and monitoring have until now consisted mainly of the collection and merging of national forest statistics. The problem is that there are many countries in which no forest inventory has yet been performed. Thus, a worldwide framework should be defined and created in order to assess and monitor the most important forest data on a global scale. The methodology recommended here is based on remote sensing, permanent field sample plots and two-phase sampling.

Key words: Global forest inventory, monitoring, two-phase sampling, remote sensing

INTRODUCTION

The need for forest inventory and forest monitoring has increased as "tropical forests are disappearing at an alarming rate resulting in losses of soil productivity, valuable plant and animal species, and ultimately human welfare" (Caballero Deloya and Lund 1987). Forest decline in the northern hemisphere has also caused similar needs.

Recommendation 25 of the UN Conference on the Environment held in Stockholm in 1972 stated:

"It is recommended that the Secretary-General take steps to ensure that continuing surveillance, with the co-operation of Member States, of the World's forest cover shall be provided for through the programme of the Food and Agriculture Organisation of the United Nations and the United Nations Educational, Scientific and Cultural Organisation.

(a) Such a World Forest Appraisal Programme would provide basic data on the balance between the world's forest biomass and prevailing environment and on the changes in forest biomass considered to have a significant impact on the environment;

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(b) The information could be collected from existing inventories and on-going activities and through remote sensing techniques;

(c) The forest protection programme described above might be incorporated within the effort, through the use of advanced technology, such as satellites which use different types of imagery and which could constantly survey all forests" (FAO 1975).

The reliability of worldwide forest resource data is all in all rather weak. According to Persson (1977) improvements are needed especially on the national level since international statistics will mainly rely on national statistics.

The objective of this paper is to present a general outline for a statistically sound and effective method for global forest inventory and monitoring on a global scale. Emphasis will be placed on tropical conditions.

SYSTEM DESIGN

General aspects

There are several levels of inventory and monitoring systems that are interdependent in design and implementation. At all levels, it is necessary to consider both the national objectives and the regional necessities of the involved population when designing the inventory. Ecological, economic, and social requirements should all be considered.

The efficiency of an inventory method is usually measured by the cost required to reach an appropriate accuracy level. For this purpose, it is necessary to define the characteristics of which the inventory should be made. For example, one important task could be the estimation of forest and land cover types and the corresponding change dynamics. Another task could be the assessment and analysis of quantitative and qualitative properties within each cover type. As inventory data and preferences vary greatly the system should be flexible enough to meet varying specifications.

Pure forest characteristics alone may not be of great help in applying inventory results on a national or international level. To be able to encourage the development within a nation or forest area, an inventory should be made of socio-economic characteristics. Data should be locatable, i.e., each piece of data should be presented in an x, y, z coordinate system and distances from nearest towns, villages, roads and so on should be detectable.

Obviously, a new global forest inventory and monitoring system should be in accordance with earlier and prevailing policies and decisions made by the United Nations.

Remote sensing, especially satellite systems, have developed rapidly during the past years. These systems are expected to be of decisive importance in building global inventory and monitoring systems.

Special attention should be paid (as proposed by FAO 1980) to those areas where deforestation is either occurring or has a strong possibility of occurring (Grainger 1984). The inventory should lead to a forest resource data base, incorporating a coordinate system supplemented by information on other natural resources and overlaid with other economic/geographic data bases (Lanly 1983, Grainger 1984).

The general aims which should be considered in designing a global inventory method are as follows:

(a) The method should be statistically sound without subjectivity or systematic errors;
(b) The method should be able to cover all land and forest resources;
(c) Inventory data should consist of ecological, economic and social aspects;
(d) Emphasis should be placed on change detection and on factors affecting changes and damages;
(e) Inventory results should benefit of integrated planning of resource use (multilevel, multiresource, multilocation, multidate and multivariable integration (Lund 1986)) and national development programmes;
(f) Development of remote sensing activities should be encouraged on a national basis (cf. FAO 1980);
(g) An up-to-date information service on a continuous basis should be arranged.

Although each country's implementation of the method may vary, emphasis should be laid on the necessary standardization of terms and classifications to be able to create consistent statistics over large areas from national results.

In order to achieve good results, co-operation between international organizations and member countries seems imperative. The world co-ordinators, however, should be prepared for the situation in which all countries are not willing to co-operate. In this case, satellite imagery may be the only source for data. Thus, co-operation ought to be made beneficial to countries by offering suitable data and techniques for planning forest and other natural resources.

Statistical frame (two-phase sampling)

There are naturally several methodical alternatives for a global inventory system. One choice is to stratify the whole population of pixels on the basis of topographic maps and remote sensing (Päivinen and Witt 1988). Supervised classification techniques with field control areas could be applied for the purpose.

Another choice is to use two-phase or double sampling. Basic statistics on this method is described by Cochran (1977) and a practical example of the method is presented by Poso et al. (1987), Poso (1988) and Räsänen (1989).

The final method might also be a combination of various approaches. Multiphase sampling for multiresource vegetation inventories was, for example, introduced by LaBau and Winterberger (1988). As multiphase designs are not well known, the two-phase design, which offers good promises is the only one dealt with here thoroughly.

In two phase sampling all data are categorized into two groups:

(1) auxilliary or ancillary or first-phase data
(2) ground truth or second-phase data.

The content and the accuracy of ground truth data reflect the purposes of the inventory. First-phase data can be any data which fulfill some specific properties. It should be easy to obtain and its unit cost should be low in relation to that of ground truth data. In addition, there should exist a distinct correlation between first and second-phase data.

Possible sources for first-phase data are satellite imagery, aerial photographs, scanning products, video imagery and topographic maps, land-use maps, forest maps, etc. There are several choices in sources for ground truth data also. The best data are usually obtained by direct ground measurements. However, some variables may also be reliably assessed from maps and aerial photographs.

First phase units are usually defined by a systematic point sample of the area where the inventory should be made. The number of first-phase units should be some 10 ... 1000 times higher than the number of second-phase units. Each first-phase unit is supplied with first-phase information such as spectral radiation values and topographic data. Then all first-phase units are stratified into homogeneous strata according to first-phase data.

First-phase units being stratified some 2 to 20 units are drawn from each stratum for ground truth determination after which stratumwise ground truth results are calculated. The results of a certain stratum can then be enlarged to represent all first-phase units of the respective stratum which in turn enables the calculation of results for any sub-population of first-phase units. Accuracy estimations can be based on the techniques described by Cochran (1977) for two-phase sampling with stratification.

Methodological aspects

In order to carry out the inventory successfully one should specify the following items:

- type of first and second-phase sample units;
- size of first and second-phase sample units;
- location of first-phase sample units;
- location of second-phase sample units;
- definition of permanent sample plots;

- variables to be assessed in the second-phase;
- calculation of plotwise and samplewise results.

As conditions and preferences vary greatly in different parts of the world, it is not advisable to fix these items. The system should be able to accept all kinds of sample units and data. Some system is however required to connect the gathered data.

An idea for a global data gathering system is illustrated by an example. First, a set of equidistant points are defined and identified in a global coordinate system. These plots are called reference points.

The distance from plot to plot could be 4 km, for example. This would mean that some 2.5 million dots would fall in forested areas. One reference point would represent an area of 4km x 4km. These areas are called reference areas.

Reference points and areas can be used to generate first-phase data as follows:

1) Take a reference point;
2) Note general administrative data (country, inventory variables, type of first and second-phase sampling unit, etc.);
3) Define the first-phase sampling unit (cluster of plots in relation to reference point);
4) Find and store first-phase data for the plots of the first-phase sampling unit (from satellite imagery, maps, etc.);
5) Go to the next reference point (to step 1).

The calculation of inventory results is based on ground truth data. In theory, first-phase units are stratified into homogeneous strata and some units are then drawn for ground truth measurements. Proportional allocation is recommendable. In practise, it may be impossible to obtain good quality ground truth data. Thus, use of the ground truth data measured in other areas could be taken into consideration.

Ground truth plots should be concentrated into clusters and some of the plots should be established as permanent plots. Especially in tropical conditions the measurement of certain individual trees successively is the only way to obtain information on changes and growth with reasonable accuracy.

Estimates for the necessary ground truth variables being calculated for each ground truth sampling unit can be transferred to first-phase sampling units by strata. The calculation of the results for any first-phase sub-population is then rather simple.

In reality there are many exceptions to the ideal case. First-phase data cannot be obtained for every plot as some plots may be covered by clouds, while others may be out of photo coverage etc. These short-comings may exist fairly frequently. There are, however, several alternatives to treat them in the analysis.

For the calculation of the results it is important that all material: plots, pixels, air photos, maps etc., are in the same coordinate and time system. The correspondence of different data should be tested. In satellite imagery studies it has been shown that discrepancies of some 20 m may cause severe errors. This problem originates often from unreliable maps. Thus, it may be advisable to substitute maps for satellite imagery in the tropics.

Some difficulties originate from the date of the data. The date of first and second-phase data may differ. Procedures for up-dating second phase data are thus required.

Differences in inventory methodology among countries can be accepted when gathering data for international purposes. Some countries carry out forest inventories on a continuous basis with acceptable reliability. For these countries a specific additional inventory may not be necessary. In many cases national inventory data are, however, quite unreliable and deficient (Grainger 1984) and a special sampling is thus necessary.

Field inventory problems are greatest in tropical conditions. A single hectare of closed tropical forest may, for example, include more than 100 tree species each with its own interdependent colony of plants and animals. According to Birdsey et al. (1986) tropical species tend to have a clustered distribution. Accordingly, the use of clusters as sampling units is recommended (e.g. Vázquez Soto 1987). Another general recommendation for the tropics is the use of permanent sampling units (e.g. Schreuder and Singh 1987).

The inventory process should usually be carried out by separate countries. It may however prove difficult to obtain ground truth material for a certain country or region. In this case, the results are to be based on models designed for the interpretation of necessary data from a relevant neighbouring area.

DISCUSSION

There is an urgent need to create and establish a statistical framework for collecting and analysing land and forest resource data on a global scale. The framework should be flexible enough to meet the prevailing diverse environmental and forest conditions. A design based on two phase sampling may offer an attractive alternative for the purpose.

The framework described, offers possibilities to monitor changes using the combination of remote sensing and ground truth data. The role of international organisations should be that of a co-ordinator and co-operator in the development of data collection and use for national and global purposes.

The implementation of the inventory and monitoring design requires practical solutions to several problems. One issue is the role of the UN in acquiring the necessary remote sensing material (Landsat, SPOT, later also satellite radar imagery). Another is how to make local organizations and people positively

interested in co-operating to build a global system for coordinated inventory and monitoring suitable for national and global aims.

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TROPICAL FOREST COVER MONITORING PROJECT: A PART OF THE UNEP/GRID ACTIVITIES

Risto Päivinen [1]

ABSTRACT

UNEP/GRID, in conjunction with other national and international agencies, is developing a methodology to map and monitor the tropical forests of the world. The first stage involves using 1-km resolution NOAA/AVHRR satellite data and the GIS capability of GRID in order to delimit forest/non-forest boundaries in two regions: West Africa and the Amazon basin. The study also makes use of high resolution satellite data, and will incorporate information to be gained from field trips.

Key words: monitoring system, resource database, large-area inventory, satellite data.

UNEP-GEMS-GRID

UNEP/GRID, the Global Resource Information Database, is a system designed to provide information to people making decisions that affect the health of the Earth. As a part of the United Nations, GRID is useful to planners working to manage the natural resources rationally.

GRID is a part of GEMS, the Global Environment Monitoring System, and its task is to provide an environmental data management service throughout the United Nations. GEMS works through the other UN agencies by enlisting their support in the five key areas defined by the 1972 Stockholm Conference on the Human Environment: climate,long-range transport of air pollutants, renewable resources, the oceans, and human health. The conference led to the establishment of the United Nations Environment Programme, UNEP.

GRID is designed to be a distributing system comprised of a network of interlinked nodes. Currently it is comprised of a GRID-unit in Nairobi, Kenya, and another in Geneva, Switzerland. Establishment of a new node is in progress in Bangkok, Thailand.

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GRID/Nairobi is primarily responsible for international operations and overall policy. It is well sited for the introduction of GRID technology to developing countries, and serves as a prototype regional node for Africa. In Geneva, the major functions are global data acquisition, data distribution, modelling and training.

GRID is currently run with a small core of UNEP staff who collaborate with individuals and groups of international specialists, from a variety of co-operating agencies and national organizations.

Most of the resources necessary to establish GRID - hardware, software, personnel, accommodation and training opportunities - have been donated by governments, agencies universities and private companies. The major donors have been the governments of Denmark, Finland, France, Norway, Switzerland, and the United States, the Canton of Geneva, University of Geneva, NASA, ESRI, the ERDAS corporation, Perkin-Elmer, Prime, and the IBM computer corporations.

GRID uses a range of sophisticated technology to manipulate acquired data into forms suitable for its users. All relevant information is processed and presented so that the inter-dependence and interaction between environmental components can be easily understood.

Table 1. Global and regional dataset held by GRID (GRID News 1988)

Parameter	Coverage	Source
Political boundaries	Global	US State Department
Natural boundaries	Global	US State Department
Elevation	Global	NGDC, USA
Soils	Global	FAO/Unesco Soil map
Vegetation	Global	Goddard ISS, USA
Vegetation index (weekly)	Global	NOAA, USA
Vegetation	Africa	DMA map
Vegetation	Africa	Unesco/AETFAT map
Cultivation intensity	Global	Goddard ISS, USA
Watersheds	Africa	UNEP/FAO
Rainfall	Africa	UNEP/FAO
Wet days	Africa	UNEP/FAO
Wind speed	Africa	UNEP/FAO
Precipitation anomalies	Global	CAC, NOAA/WMO
Temperature anomalies	Global	CAC, NOAA/WMO
Population density 1960	Africa	Philips Series
Tse-tse fly distribution	Africa	IBAR/OAU
Protected Areas	Africa	IUCN/CMC
Endangered species	Africa	IUCN/CMC
Ozone distribution	Global	NASA,TOMS

GRID data are geographically referenced using Geographic Information Systems' (GIS) software. A GIS enables every item of environmental information to be related to a position on the Earth's surface.

Table 1 contains some global and regional datasets held by GRID (GRID News, 1988). As one can see, the forest cover map is not included in the list. To fill this void, a methodology-oriented UNEP/FAO co-operative project has been established.

THE TROPICAL FOREST COVER MONITORING PROJECT

Information on the tropical forests is tedious to acquire, and thus for large-area inventories it is necessary to use aerial photography and/or satellite data. The latter can be relatively inexpensive and with experience, easy to process, and are particularly useful when detailed ground surveys are too time-consuming. For instance, the FAO/UNEP tropical forest assessment of 1980 was carried out using visual interpretation of Landsat MSS images for 13 countries, where adequate inventory data were not available (Tropical Forest Resource Assessment Project, 1981). For large areas, however, the high-resolution data provided by Landsat (30 m) or SPOT (20 or 10 m) satellites is quite costly to acquire and process.

For remote sensing studies examining vegetation patterns over very large areas, NOAA/AVHRR-LAC data has often been favored due to the relatively low data volume, high temporal frequency, and low cost (Agrawala and Sharma 1983, Townshend and Tucker 1983, Justice et al. 1985, Malingerau and Tucker 1987).

The aim of the project at GRID is to test the applicability of one-kilometer resolution NOAA/AVHRR-LAC data in tropical forest cover mapping in western Africa and the Amazon basin. During the year 1988, a map of closed forest for West Africa was prepared.

The data used consisted of two AVHRR data sets (13 January 1987 and 10 December 1986) and smaller portions of some other dates. In order to verify the AVHRR-based map, Landsat TM images of Nigeria, Ghana and the Ivory Coast were employed (Päivinen and Witt, 1988).

During the ground truthing trip in August, almost one hundred sites were located in the field and on the Landsat TM color composite prints, and then photographed and assessed using field forms. The main co-operating agencies were the Forestry Research Institute of Nigeria, the Environmental Protection Council and the Forestry Department in Ghana, the Societe de Developpement des Plantations Forestiers, the Direction et Controlle des Grand Travaux in the Ivory Coast, and the Botanical Garden of the University of Geneva. Without the assistance of these agencies any kind of field checking would have been impossible in a short period of time. During the field trip, different kinds of maps were collected to aid the satellite data interpretation.

Several digital processing techniques were tested to separate closed forest areas from surrounding mixed vegetation, agriculture, grassland and plantations. These include multi-channel density slicing, unsupervised and supervised classification with maximum likelihood classifier, and principal component analysis.

The final map was produced by supervised classification, where training sites were selected using field experience and interpretation of the Landsat TM images. Both of the AVHRR datasets were classified in three sections, and some cloudy areas were replaced by cloud-free data from other dates, using the GRID GIS capability to select non-cloud pixels.

Landsat TM data and one SPOT image were classified using field plots as reference data. A 70 km by 70 km TM test site in Ghana yielded a correspondence of 82 percent and another in Nigeria of 73 percent, the lower percentage of the latter being influenced partly by clouds and haze.

Generally, wherever clearings in closed moist forest areas have taken place, the AVHRR data demonstrates the same pattern shown by much more detailed TM data. But in the case of gradual forest degradation the lower resolution of AVHRR data may give a biased result.

The area of the closed forest in Ghana, where the most cloud-free AVHRR data were available, is very close to the 1,7 mill hectares estimated in the 1980 FAO/UNEP assessment. The entire closed forest area from Nigeria to Sierra Leone was estimated to be 15,2 mill ha in 1980, while on the map derived using the more current AVHRR data it is about 10 percent less.

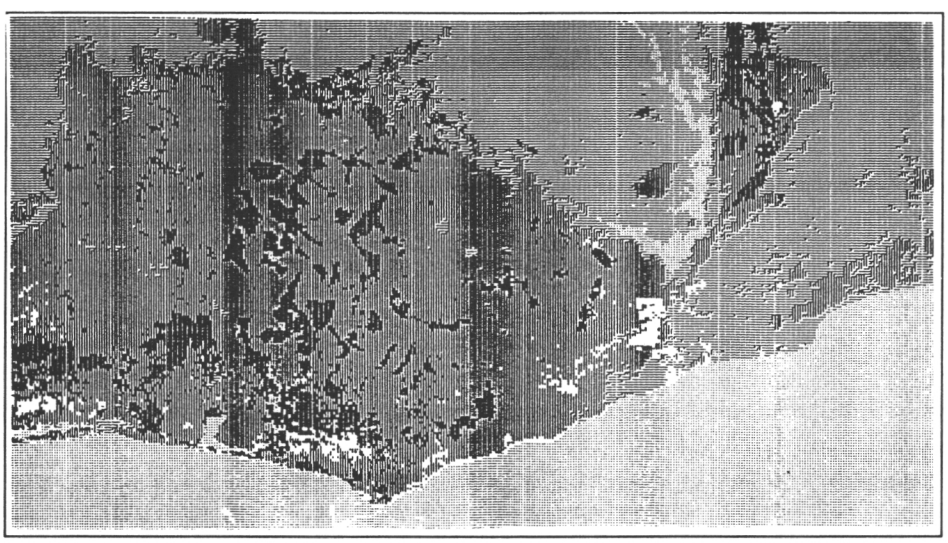

Figure 1. A Forest map of Ghana derived using 1-km AVHRR data, (black = closed forest).

MONITORING

The mapping of the forest coverage is not, however, the ultimate goal of the project. The objectives of the work carried out at GRID address the two aims of the project, that of mapping the existing forest on a global basis, and monitoring the rate and location of deforestation. These two aspects are clearly related. In the simplest case the latter objective could be achieved by repeated application of the former. However, a special methodology for monitoring deforestation can be developed as well.

In conclusion, one can believe that if the area is too large to be covered by high resolution satellite data or aerial photographs, and if cloud-free data are available, AVHRR data are useful in both mapping and monitoring tropical closed forest.

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MODELLING DEFORESTATION IN THE HUMID TROPICS

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ABSTRACT

Deforestation is explained theoretically in terms of two main groups of factors: types of forest exploitation- the land uses which replace forest cover; and mechanisms of deforestation- the underlying socio-economic and physical factors which promote or control deforestation. This theoretical approach is used as the basis for two formal models: a systems model of national land use, and a simpler model for simulating possible future deforestation scenarios. The latter model is tested for 43 countries in the humid tropics, accounting for 96 percent of the total area of the tropical moist forests. Based on individual simulations for each of these countries, between 1980 and 2020 the aggregate deforestation rate for the humid tropics falls from 6.6 to 3.7 $ha.10^6.a^{-1}$ in the High Scenario, and from 4.1 to 0.9 $ha.10^6.a^{-1}$ in the Low Scenario. These scenarios result in a reduction in the total area of the tropical moist forests of 20 percent and 10 percent respectively over that period.

Key words: deforestation, tropical moist forests, modelling, scenarios.

INTRODUCTION

Tropical deforestation has aroused much international concern over the last twenty years, but we still know very little about it. Global estimates of deforestation rates have improved but are still very inaccurate. Much that has been written about deforestation has been anecdotal in character, often biased according to the background of the author, and sometimes making use of emotive language. Despite the widespread impression that we know all there is to know about deforestation, surprisingly little empirical research has been carried out on deforestation as a spatio-temporal phenomenon. This has resulted in confusion and disagreement on terminology, and has limited attempts to model deforestation processes.

It was against such a background that in 1981 this author began a research project at the Oxford Forestry Institute, University of Oxford, with the aims of (a) clarifying the various processes involved in deforestation; and (b) developing a model that could be used to simulate future trends and form the basis for

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better planning techniques for tropical countries. This paper describes some of the results obtained in the part of that project which dealt with deforestation. It introduces the basic theoretical approach adopted towards deforestation; describes the two formal models which resulted; and summarises the scenarios for future trends in deforestation that were simulated with one of these models. This latter model was included as part of a comprehensive model of the human impact on the tropical moist forests, called TROPFORM, which simulated long-term trends in logging and world trade in tropical hardwoods. The results of simulations with TROPFORM will be referred to briefly. The complete results of the project are reported in Grainger (1986).

This paper, and the modelling work it describes, are confined to addressing the subject of deforestation in the humid tropics (Sommer 1976). The forests in this region are called the tropical moist forests, and consist mainly of two types: tropical rain forests and tropical moist deciduous forests. Global statistics on forest areas are presently inadequate to distinguish between the areas of the two forest types but the tropical rain forests are thought to account for two thirds of the total area of the tropical moist forests (Persson 1973), estimated at 1,081 million ha in 1980, with a deforestation rate of 6.1 million ha per annum (Table 1) (Grainger 1983). Although deforestation is endemic throughout the tropics, the particular mix of factors causing deforestation in the dense closed forests of the humid tropics is different from that found in the open wood-lands of the dry tropics and in montane forests, such as those in the Himalayas. We therefore need to be selective in the way in which we study and model tropical deforestation. This does not mean that we cannot use similar analytical approaches in humid, dry and montane tropical regions (Grainger 1989) - but numerical relationships will be different and so we should avoid aggregating the regions in our modelling work.

Table 1. Areas of tropical closed forests and tropical moist closed forests (1980) and annual rates of deforestation (1976-80).

	Forest Areas		**Deforestation Rates**	
	All Tropical[a]	Moist Tropical[b]	All Tropical[a]	Moist Tropical[b]
	($ha.10^6$)		($ha.10^6.a^{-1}$)	
Africa	217	205	1.3	1.2
Asia-Pacific	306	264	1.8	1.6
Latin America	679	613	4.1	3.3
Total	1,201*	1,081*	7.3*	6.1

NB. *Totals are not the sum of regional figures due to rounding. Tropical moist forest areas refer to the complete set of countries in Table 5, but deforestation rates to only 55 countries. Sources: a. Lanly (1981); b. Grainger (1983), based on Lanly (1981).

DEFINITIONS AND MODELLING APPROACHES

The word "*deforestation*" is often used very loosely to refer to all forms of human impact on forests, but this can be a hindrance to reaching a clear understanding of the various processes involved. Particular confusion arises concerning logging. In the tropical moist forests logging is mainly selective, involving the removal of only 2-10 trees per ha, rather than clearfelling. It is therefore better to restrict "deforestation" to describing forest clearance and use the term "logging" to refer to the variety of lesser impacts on the forest caused during timber extraction. Deforestation is therefore defined here as "the temporary or permanent removal of forest cover for agricultural or other purposes". Naturally, in the occasional instances where logging does involves clearfelling, then deforestation does occur. The total area of forest affected in any one year is therefore approximately the sum of the area deforested and the area logged. Deforestation and logging have to be modelled separately (see below) and the areas in any country affected by them each year also need to be estimated separately: deforestation can be easily measured using remote sensing techniques, whereas measuring logged areas is more difficult, although they can be estimated on the basis of national removals data. There is as yet no universally accepted term to refer to the sum of all forms of human impact on forest. "*Disturbance*" would be one candidate, but unfortunately FAO has used "*disturbed forest*" to refer to logged forest (Lanly 1981). Myers (1980) employed the term "*conversion*" to refer to the sum of all forms of human impact, but this conflicts with Poore's use of "*conversion*" to refer to a temporary impact (such as logging or clearance for shifting cultivation) in which the forest's capacity to regenerate is retained. This in contrast to "*transformation*" in which forest is replaced by permanent agriculture (Poore 1976). This author prefers, for clarity, to refer to the two main impacts of deforestation and logging separately, but where an all-embracing term is inevitable, as in the concept of "*types of forest exploitation*" introduced below, then the term "*exploitation*" is used.

The convenience of a distinction between deforestation and logging becomes apparent when we have to model the two phenomena. Deforestation occurs in all countries in the humid tropics, mainly in proportion to the rate of increase in domestic demand for food. Because of the importance of international trade in tropical hardwoods (which accounts for about half of all removals) logging is at any time more important in some countries than in others, occurring preferentially where the forests contain tree species that are in demand on the world market and obtainable at internationally competitive prices. Forest clearance for ranches and cash crop plantations, the produce of which is destined mainly for export, is important in some countries, but this project showed that, at a first approximation, current deforestation rates can be adequately modelled on the basis of internal demand for food only.

There are three other reasons for modelling deforestation and logging separately. First, agriculture and forestry represent two distinct economic sectors at national and international level, and two distinct land uses in a land capability classification. Second, there are a number of important linkages between deforestation

and logging. Once a forest has been logged it can, at a later time and in a quite separate process, be cleared for agriculture and therefore be deforested. This is not inevitable, but happens because farmers take advantage of the logging roads to gain access to forest. We need to be able to model this interaction. (Because of such consequential deforestation the total area of forest affected in some way by human impact over a period of time cannot be calculated as a simple multiple of the sum of the annual rates of deforestation and logging). Third, to model deforestation and logging we need to use different kinds of techniques and employ different sets of data for estimating model parameters. The TROPFORM model, for example, estimates international demand for tropical hardwoods using standard econometric techniques and satisfies this using a spatial equilibrium international trade model (Grainger 1986).

GENERAL THEORETICAL APPROACH TO MODELLING DEFORESTATION

The first major step in modelling either deforestation or logging comes in the development of conceptual models, for here we take an abstract theoretical approach to actual social and physical processes and assume that all processes of a certain kind, in whatever country they take place, can be described using a fairly restricted set of parameters and treated essentially in the same way. Only when these conceptual models, and their underlying assumptions, have been clearly stated can they be tested against real world phenomena and various parameters estimated by means of empirical data.

In this study, deforestation is explained in terms of two main types of factors:

1. Mechanisms of deforestation: the social and economic factors which provide the driving forces for the reduction of forest cover, e.g. population growth, economic growth etc.; and other controlling factors, e.g. the degree of accessibility of an area of forest (Table 2).

2. Types of forest exploitation: the land uses which replace primary forest. These include various forms of shifting and permanent agriculture, but also logging (Table 3). Other non-agricultural causes of deforestation, such as mining and the construction of hydro-electric dams, could also be included but have been omitted here for convenience.

Table 2. Mechanisms of deforestation

A. Socio-economic
Growth in population
Growth in per capita GNP
B. Physical
Availability and distribution of remaining forest cover
Proximity to rivers
Proximity to roads
Topography: height and slope
Land suitability: soil fertility, drainage

Table 3. Types of forest exploitation

A. Shifting agriculture
Traditional shifting cultivation
Short-rotation shifting cultivation
Encroaching cultivation
Pastoralism
B. Permanent agriculture
Permanent field crop cultivation
Government sponsored resettlement schemes
Commercial ranches
Cash-crop plantations
C. Logging

Mechanisms of Deforestation

In any area deforestation occurs because basic driving forces, such as population and economic growth, called here the "mechanisms of deforestation", promote the expansion of either shifting or permanent agriculture into forested areas. The simplest way for a country to increase its food supply in response to rising population is by increasing the area of farmland rather than the intensity of land use. At one extreme, growing rural populations relying on a subsistence lifestyle and not experiencing economic development would tend to favour shifting cultivation. On the other hand, a growth in urban population would probably lead to an expansion in permanent agriculture because of a reliance on market-oriented farming to supply the necessary food.

The role of economic growth is more complex. As a country becomes more developed and its per capita income increases, food consumption per capita and demand for traded food rise, and the area of land under permanent agriculture increases. However, economic development also helps to reduce deforestation rates by allowing increased investment in farm inputs like fertilizers and advanced cropping techniques which can produce the same amount of food on smaller area of land than before. We might expect that with economic development will come a gradual trend from shifting to permanent agriculture, or at least to a more settled or localised type of shifting agriculture, although there is some debate as to just how far and how fast this trend is likely to proceed (Grainger 1986). Agriculture could also expand from purely commercial motives, to supply external markets for food and other raw materials. There are often great incentives to establish cash crop plantations and/or ranches for simple monetary return or foreign exchange earnings.

Deforestation is a spatial phenomenon and the diffusion of populations into previously underpopulated forested areas may be enhanced or constrained by a number of physical factors which provide either "corridors" for population flows or obstacles that prevent the expansion of settlements and cultivation. The clearance of forest should be easier where there is a long boundary between

forest and non-forest, as on a long, narrow island, such as Sumatra, or where forest borders directly onto savanna, as in West Africa. The ease of access to forests by river and road is also an important factor. Rivers remain the dominant means of communication over large areas of the humid tropics and agricultural settlement is often found concentrated along them because of the ease of transport and the higher fertility of alluvial soils. Until recently access to many areas in the humid tropics was very limited because there were few roads. The building of new roads, either as part of new highway systems (as in Amazonia) or to facilitate logging operations, makes previously remote forested areas easily accessible for the first time and can therefore lead to substantial forest clearance for agriculture.

We can test the relevance of the various mechanisms of deforestation by means of cross-sectional correlation tests (Grainger 1986, Palo et al. 1987). Tests by this author show, for example, that population growth rate is an important contributing factor (r= 0.56 for the humid tropics). On the other hand, GNP per capita growth rate has a poor correlation coefficient (r=0.30). One of the reasons for this, as discussed above, is that economic growth can both increase deforestation rates (due to increased food consumption per capita) and decrease it (due to increased yield per ha because of greater investment in agriculture).

Types of Forest Exploitation

Mechanisms of deforestation, however, are insufficient to explain deforestation. There is also a need to take into account "types of forest exploitation"- the land uses which replace forest (Table 3). The extent and timing of the deforestation that occurs as a result of a unit increment in population will differ according to the way in which the land use morphology of a country responds to this stimulus. The increased demand for food could be satisfied by either an increase in the area of farmland or an increase in the intensity of food production. Either of these two alternatives could be satisfied by either shifting or permanent agriculture (or a combination of both). Consider a hypothetical situation in which the response to higher population and food demand was to increase only the area under shifting cultivation. A small area of forest would be cleared in the first year, a similar area in the second, and this would continue for twenty years or more. If instead the response was to increase only the area under permanent cultivation, then there would be quite a large clearance in the first year, but afterwards the deforestation rate would drop to zero. Actual trends in deforestation rates would be a composite of these trends due to shifting and permanent cultivation. Thus, even if two countries have similar population and economic growth rates their deforestation rates in a particular year could be quite different.

However, deforestation can also occur independently of any population or economic growth if a particular type of land use is not sustainable at the degree of intensity at which it is being practised. Yields will fall and ultimately more forest clearance will be required to maintain food production. Such instability can affect both shifting cultivation, e.g. when it becomes too intensive, and

permanent cultivation, e.g. when it is introduced on a site not suited to intensive cropping. Deforestation caused in this way would change the ideal time sequence of forest clearance referred to in the preceding paragraph: the forest area cleared every year for shifting cultivation would increase, and in the case of permanent cultivation another substantial clearance might occur some years after the first.

The stability of one land use can also be affected by the expansion of another. Because it is such an extensive practice, shifting cultivation is very susceptible to being affected as other land uses, such as permanent cultivation or logging, expand into territories traditionally cropped on a long rotation. Thus shifting cultivation may become unstable not from any inherent limitation but because of the impact of another land use. Land uses (types of forest exploitation) can therefore contribute to deforestation, independently of the effects of mechanisms of deforestation, by virtue of their own instability or the interactions between different land uses.

The advantage of the concept of types of forest exploitation is that: (a) it allows all land uses, including logging, to be represented within the same analytical framework; (b) the symptoms of deforestation can be separated from theunderlying causative factors; (c) it can be applied in different countries with different land use morphologies: in the Amazon Basin, over the last 20 years the major type of forest exploitation has been cattle ranching, but this is poorly represented in Africa and S.E. Asia; (d) types of forest exploitation can be represented in spatial terms on a map and studied in the field and by remote sensing techniques.

Conclusions

This theoretical approach to deforestation differs from many other analyses of deforestation, which are usually based solely on land use considerations, and therefore focus on the symptoms rather than the basic causes. Here changes in land use, and hence in forest cover, are seen to be primarily the result of underlying socio-economic driving forces, called mechanisms of deforestation. Nevertheless, even in the absence of such driving forces, a type of forest exploitation (i.e. a land use) can itself contribute to deforestation through its own instability or the impact of other types of forest exploitation. To understand the processes causing deforestation therefore requires a model which contains both mechanisms of deforestation and types of forest exploitation. This approach to modelling deforestation was originally conceived in spatial terms and could be used to study deforestation taking place in the field. The link between the underlying mechanisms of deforestation and types of forest exploitation, and therefore with changes in land use morphology, is not necessarily a direct one.

A whole range of policy or institutional factors, e.g. government policies on food pricing, agricultural credit and other subsidies, land tenure, land use and regional planning, forest management and conservation, and overseas trade promotion, affects access to land and the way in which it is used. Policies not

apparently connected with the agriculture and forest sectors, e.g. those which affect the distribution of national income and therefore the extent of poverty, also have a major impact on deforestation because they influence the mechanisms of deforestation, determining population and economic growth rates.

Although the contribution of these policy factors is acknowledged, many are regarded as exogenous variables in the two formal models which follow because: (a) the factors cannot easily be quantified; (b) it is difficult to generalise for the large number of countries in the humid tropics; (c) the models are intended to be used to investigate processes in the field, and so variables are restricted to those which can be observed empirically; (d) the models are also intended for use as planning tools to test the impact on deforestation of a range of policies, and so (as far as possible) policy-makers should not be treated as endogenous.

A SYSTEMS MODEL OF NATIONAL LAND USE

Combining mechanisms of deforestation with types of forest exploitation was accomplished in this project by means of a systems model of national land use (Fig. 1). The model is divided into forest and agricultural sectors, and deforestation occurs when the agricultural sector expands in area at the expense of the forest sector. The driving forces for changes in national land use morphology are the two main mechanisms of deforestation as described above, i.e. population growth and economic growth. In the forest sector there is also an exogenous overseas demand for timber exports. For the sake of simplicity, the types of forest exploitation are represented here only as permanent cultivation and shifting cultivation, but in an operational model these could be disaggregated even further.

The national land use systems model contains numerous feedback loops. Positive loops can increase deforestation rates, as when logging roads improve access for farmers who can then clear forest. Negative loops can decrease deforestation rates, as when an increase in the area under permanent agriculture means that less land is required to grow the same amount of food. Eventually, after a period of development, we would expect national land use morphology to come into a long-term balance and for deforestation rates to approach zero. This is a crucial assumption in the modelling approach adopted here. Put at its very crudest, forest area cannot be negative, and we would not expect it to even reach zero. Instead, economic and political forces would work to ensure that at least some minimum area of forest remains to satisfy some or all of domestic needs for forest products. The size of this minimum area, and indeed the validity of this assumption, need to be established by research, but preliminary studies suggest that it could be of the order of 0.1 ha per capita (Grainger 1986).

The national land use systems model shows just some of the many factors causing deforestation to take place or ultimately bringing it under control. Clearly a large number of functional relationships would need to be estimated before

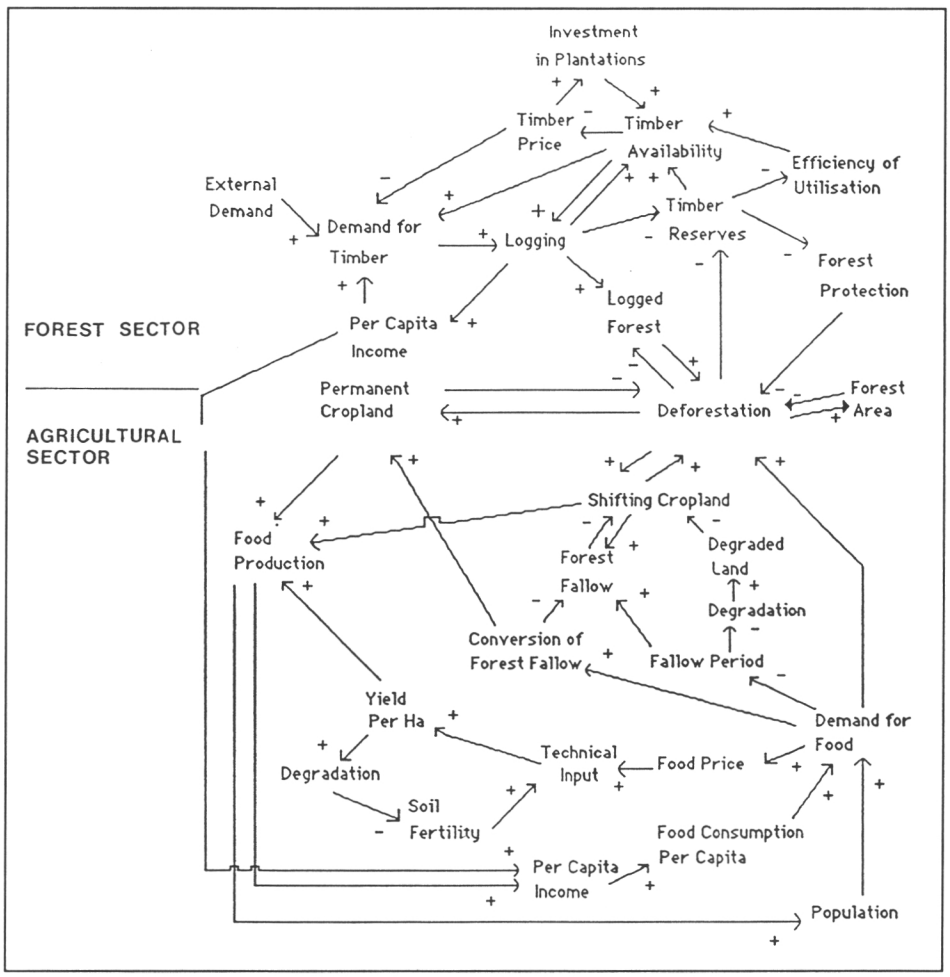

Figure 1. Causal loop diagram of a systems model of national land use.

such a model could be run. For quite a few of the parameters, different estimations would probably have to be made for each country. This would clearly require substantial fieldwork, so it was decided to leave this task to a future project, and develop a derivative model with fewer parameters.

SIMPLE MODEL FOR DEFORESTATION SCENARIOS

Model Structure

The national land use systems model contains two main driving forces, growth in population and per capita income. These respectively lead to rises in demand for food and food consumption per capita, and to an expansion of cropland and investment in technical inputs to permanent agriculture (increasing yield per ha).

Cropland expansion takes place at the expense of forests, either under the relatively extensive shifting cultivation or the relatively intensive permanent cultivation.

To simulate possible future trends in deforestation a simpler model was designed, using similar principles. In this model, farmland area **A** varies as a function of population **P**, per capita food consumption and yield per ha. "Farmland" includes both cropland and permanent pasture, as defined for FAO statistical purposes. Population grows logistically (not exponentially), initially at average 1970-80 rates, but only up to a limit of P_{max}, the hypothetical estimated stable population (World Bank, 1982). If the annual growth rates of population, per capita food consumption and yield per ha are π, α and $ß$ respectively, and k_1, k_2 are constants, the area of farmland **A** in year **t** is given by:

$$1. \qquad A_t = \frac{k_2 . P_{max} . e^{(\alpha - ß)t}}{(1 + k_1 . e^{-\pi t})}$$

Deforestation rates will normally be equal to the additional area of farmland required each year. However, since all countries are expected to retain a certain minimum area of forest it is assumed that deforestation will become zero when forest area per capita reaches 0.1 ha c^{-1} (an arbitrary limit estimated by empirical analysis), after which increased food production can only be gained by raising yield per ha and obtaining extra farmland from non-forest land.

Scenario Design

Two alternative scenarios, "High" and "Low", were tested with the model, using initial population growth rates π which were the same as those for 1970-80, and growth rates in food consumption per capita (α) and yield per hectare ($ß$) estimated on the basis of average regional values for 1970-80 (Table 4). An optimistic view was taken of Africa: in the Low Scenario food consumption kept pace with population growth and exceeded it by 0.5 percent per annum in the High Scenario, but in both scenarios average yield per ha only increased by 1 percent per annum. It was thought that continued economic growth in Asia-Pacific would allow food consumption per capita to rise at up to 1.5 percent per annum, but that yield per ha would only rise at 2.0 percent per annum in the Low Scenario and 1.5 percent in the High Scenario.

Table 4. Assumed increases in per capita food consumption (α) and yield per ha ($ß$) ($\%.a^{-1}$)

	High Scenario			Low Scenario		
	α	$ß$	α-$ß$	α	$ß$	α-$ß$
Africa	0.5	1.0	-0.5	0.0	1.0	-1.0
Asia-Pacific	1.5	1.5	0.0	1.5	2.0	-0.5
Latin America	1.5	2.0	-0.5	0.5	1.5	-1.0

These rates are still high, because of the likely availability of capital for agricultural investment and the growing scarcity of new agricultural land. In Latin America, the Low Scenario assumed food consumption per capita rising at 0.5 percent per annum and yield per ha at 1.5 percent per annum. In the High Scenario a more optimistic view was taken of economic growth, with these parameters set at 1.5 percent and 2.0 percent respectively.

The model was simulated for 43 individual countries in the humid tropics between 1980 and 2020. The 43 countries are a subset of the 63 nations containing tropical moist forests listed in Sommer (1976) (Table 5). They account for 96 percent of the total area of tropical moist forests and 92 percent of the total deforestation rate shown in Table 1. To ensure that the subset is as typical as possible of the humid tropics, 20 countries were excluded from this subset on the basis of three main criteria (more than one criterion applies to some countries):

1. Absence of forest resource and deforestation data in Lanly (1981): Reunion, Australia, Fiji, Hawaii, New Caledonia, Solomon Islands, Vanuatu, Puerto Rico.

2. Area of tropical moist forest low or uncertain, representing a small part of national land area and land use patterns, the latter being more typical of those of other biomes, e.g. savanna areas: Angola, Benin, Kenya, Senegal, Tanzania, Togo, Mexico, Jamaica, Trinidad and Tobago.

Table 5. Nations wholly or partially located in the humid tropics

AFRICA: Angola*, Benin*, Cameroon, Central African Republic, Congo, Equatorial Guinea, Gabon, Ghana, Guinea, Guinea Bissau, Ivory Coast, Kenya*, Liberia, Madagascar, Nigeria, Reunion*, Senegal*, Sierra Leone, Tanzania*, Togo*, Uganda, Zaire.
ASIA-PACIFIC: Australia*, Bangladesh*, Brunei, Burma, Fiji*, Hawaii*, India (part)*, Indonesia, Kampuchea, Laos, Malaysia, New Caledonia*, Papua New Guinea, Philippines, Solomon Islands*, Sri Lanka*, Thailand, Vanuatu*, Vietnam.
CENTRAL AMERICA; Belize, Costa Rica, Cuba, Dominican Republic, El Salvador, Guatemala, Honduras, Jamaica*, Mexico (part)*, Nicaragua, Panama, Puerto Rico*, Trinidad and Tobago*.
SOUTH AMERICA: Bolivia, Brazil, Colombia, Ecuador, French Guiana, Guyana, Peru, Surinam, Venezuela.

* Countries marked with an asterisk were not included in simulations with the deforestation model. Source: Based on Sommer (1976).

Table 6. Modified values of α-ß for selected countries (%.a^{-1})

	High Scenario	Low Scenario
Gabon	-0.2	-0.5
Madagascar	-1.0	-1.5
Brazil	-0.5	-0.8
Colombia	-0.5	-0.8
French Guiana	+0.5	-1.0

3. Outside the three main contiguous regions of tropical moist forest in West and Central Africa, S.E. Asia and Pacific, and Latin America: Bangladesh, India, Sri Lanka.

The same parameter values were used for all countries in a region except for five countries where minor variations were used (Table 6) , since the standard values gave deforestation rates considered too low for Gabon and French Guiana, too high for Madagascar, and with too wide a spread between Low and High Scenarios for Brazil and Colombia.

Results of Simulations

The results of simulations with the model predicted deforestation rates in 1980 for the tropical moist forests as a whole to be 4.1 million ha per annum in the Low Scenario and 6.6 million ha per annum in the High Scenario (Table 7), a range which compares well with estimates by Lanly (1981) for the same 43 countries of 5.6 million ha per annum between 1976-80. In the High Scenario, the rate of deforestation fell from 6.6 million ha per annum in 1980 to 3.7 million ha per annum in 2020 (Fig. 2). By the end of the simulation period deforestation was therefore still occurring at a substantial rate in all three regions with Latin America accounting for a half of all deforestation as in 1980. In the Low Scenario the overall deforestation rate fell from 4.1 million ha per annum to just 0.9 million ha per annum over the period 1980 to 2020. It ended close to zero in Latin America where in a number of countries the increase in agricultural productivity in the Low Scenario could make possible a net return of land to forest, mostly towards the end of the simulation period. Projections were made on an annual basis, but Tables 7 and 8 contain only the simulated values for 1980, 2000 and 2020.

In both scenarios a substantial area of tropical moist forest remained by the year 2020. The High Scenario predicted a reduction of about 20 percent in total forest area to 831 million ha compared with a fall of less than 10 percent to 936 million ha in the Low Scenario. If deforestation rates were to continue unchanged at current estimated levels the overall reduction would be 23 percent (Table 8). Thus, on the assumptions stated and beginning with deforestation rates of the same order as those estimated to be currently occurring, deforestation would not have as devastating effect on the tropical moist forests as has been feared by some commentators.

Table 7. Regional trends in deforestation rates ($ha.10^6.a^{-1}$)

	High Scenario			Low Scenario		
	1980	2000	2020	1980	2000	2020
Africa	1.6	1.2	0.9	1.0	0.7	0.4
Asia-Pacific	1.7	1.2	1.1	1.1	0.7	0.4
Latin America	3.3	2.7	1.7	2.0	1.1	0.0
Total	6.6	5.1	3.7	4.1	2.5	0.9

Table 8. Regional trends in forest area ($ha.10^6$)

	High Scenario			Low Scenario		
	1980	2000	2020	1980	2000	2020
Africa	198.9	170.3	151.6	198.9	181.1	170.1
Asia-Pacific	239.4	209.5	185.8	239.4	220.8	210.2
Latin America	598.0	537.5	493.8	598.0	566.7	555.8
Total	1036.3	917.2	831.1	1036.3	968.7	936.1

The scenarios summarised in Tables 7 and 8 are regional aggregates of individual simulations made for 43 countries, and although regional deforestation rates decline throughout the simulation period, national deforestation rates rise initially in about half of the countries. The national simulations suggest that in Africa there would be considerable reductions in forest area in Cameroon and the Congo (by a half in the High Scenario) and Madagascar (only 15 percent remaining by the year 2020 in the High Scenario). Deforestation rates would fall to zero in Ghana, Guinea, Ivory Coast and Sierra Leone as forest area per capita fell to 0.1 ha c^{-1} and would start at zero for Nigeria and Uganda which were already below this limit: all these countries would need to expand their intensive forest plantations as populations grew and forest area per capita diminished even further. Zaire's deforestation rate rose slightly in the High Scenario, but stayed around 300,000 ha per annum, with forest area falling from 105.7 to 93.6 million ha over the period (to 98.6 million ha in the Low Scenario).

Deforestation rates in the Asia-Pacific region are set to fall to the lowest of all the three regions according to both scenarios. Trends would be dominated in the High Scenario by fairly steady deforestation rates in Burma, Indonesia and Malaysia, with forest area declining by about a quarter in all three countries. In the Low Scenario deforestation rates in 2020 would be about half those in 1980. Indonesia would retain 83 million ha in the High Scenario and 98 million ha in the Low Scenario. Deforestation rates would fall to zero in the Philippines, Thailand and Vietnam as rising population density forced equilibrium between different land uses. While all three countries have substantial areas of forest plantations, more might be needed as forest areas decline.

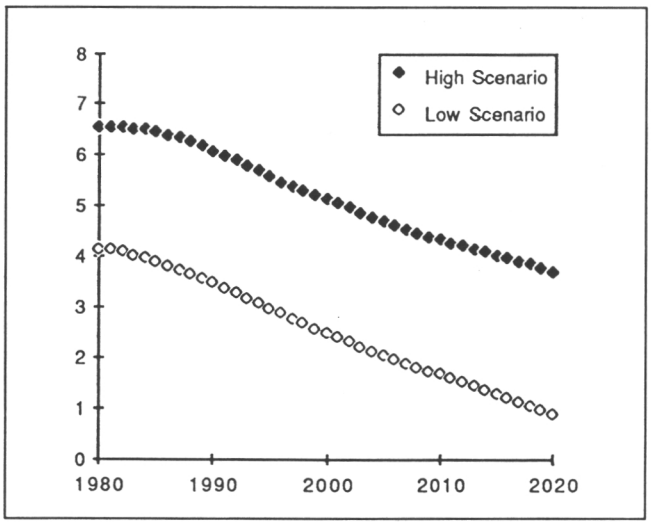

Figure 2. Two scenarios for deforestation rates in the humid tropics 1980-2020 ($ha.10^6.a^{-1}$).

Latin America would account for a half of the total reduction in tropical moist forest area in both scenarios- between 43 and 106 million ha. In the High Scenario deforestation rates would gradually decline in Brazil, Colombia, Peru and Venezuela, but stay high in Bolivia and Ecuador. In the Low Scenario there is the prospect, givensufficient growth in agricultural productivity, of a net return of land to forest in Brazil and Venezuela toward the end of the simulation period. This would occur throughoutmost of the period in Cuba and Panama. Of all the three regions, there is therefore considerable uncertainty about future deforestation rates in Latin America (and South America particularly), the actual values being very sensitive to the relationship between growth in food consumption per capita and yield per ha. Deforestation rates should fall to zero very quickly in Cuba, Dominican Republic, El Salvador as forest area per capita limits are reached and there will be an incentive to expand the area of forest plantations. Deforestation would continue at low levels in Belize, French Guiana and Surinam.

These scenarios are not as dramatic as other forecasts, but being based on a mathematical model they are more rigorous than predictions which simply involve extrapolations of current estimates of deforestation rates. Like all models, however, this one has limitations. It is quite possible that deforestation rates could exceed those in the High Scenario. Agricultural productivity, for instance, might not increase as rapidly as predicted in Africa- admittedly an optimistic assumption. Forest protection might not come into force at the arbitrary forest area per capita limit so that deforestation could continue unrestricted. However, those countries which in the model are predicted to move to zero deforestation rates have relatively little forest remaining, so even if this assumption does not hold, overall deforestation rates might not be too different from those predicted.

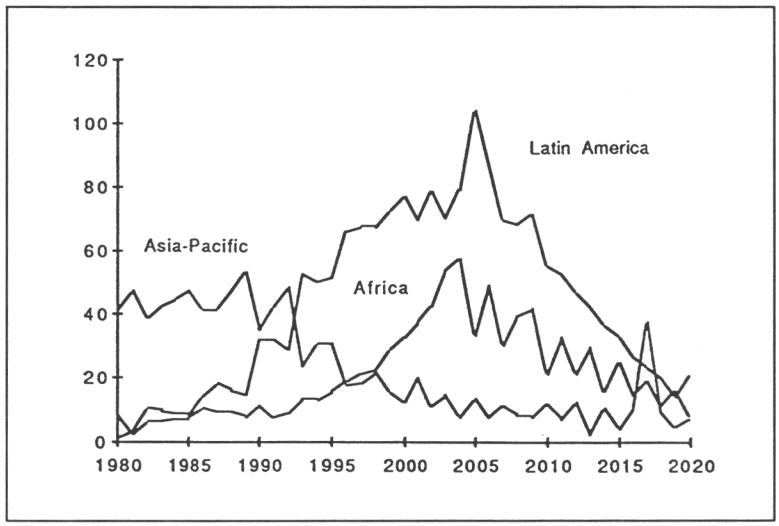

Figure 3. TROPFORM Base Scenario: Trends in Regional Exports of Tropical Hardwoods 1980-2020 (m^3 . 10^6).

Four notable omissions from the model could also lead to higher deforestation rates. First, it did not take into account the fact that rising demand for cash crop exports, such as beef, palm oil, sugar etc., could lead to deforestation rates greater than those needed to supply domestic demand for food. Second, a major unknown factor is the role of logging in catalysing deforestation. If logging expands in Africa and Latin America in the next 20 years, as predicted by simulations with TROPFORM (Fig. 3), it would provide farmers with access to previously remote areas, catalyse deforestation, and lead to much higher rates than those predicted here. Third, the model did not explicitly include the possibility of any additional deforestation due to the need to maintain food production when yields fall on land being cropped too intensively. Fourth, the clearance of forest for mining and hydroelectric power reservoirs was omitted. These would be difficult phenomenon to model but although they only account for a fraction of the area cleared for agriculture their contribution is not insubstantial.

Deforestation and trends in tropical hard-wood supplies

Compared with an annual rate of deforestation in the humid tropics of 6.1 million ha between 1976 and 1980 (Grainger 1983), the annual area of tropical moist forest affected by logging was about 4 million ha (author's estimate). The corresponding drain on forest reserves caused by deforestation in 1980 was equivalent to between a fifth and a half of all removals (based on various assumptions), far exceeding any growth in reserves by the regeneration of logged forest or the maturing of intensive plantations.

The simple deforestation model described above was included as one of the modules of TROPFORM, a comprehensive model of the human impact on the tropical rain forests. In TROPFORM's Base Scenario, it was assumed that deforestation would follow the Low Deforestation Scenario described above. In an alternative ("High Def") Scenario, the High Deforestation Scenario was used instead, all other factors in the Base Scenario remaining the same. The result was an average decrease in annual exports of tropical hardwoods of about 17 million cubic metres after the turn of the century. By 2020 the level of exports was only two thirds of that obtained in the Base Scenario. Thus controlling deforestation could play a major role in ensuring the sustenance of supplies of tropical hardwoods.

THE NEED FOR FUTURE RESEARCH

If deforestation is to be controlled we need to learn far more about it, and this will require further research. Even though the problem is an urgent one, it makes no sense at all to devise costly and elaborate international schemes to supposedly control deforestation if they are based on inadequate knowledge and are destined to fail or be ineffective. Models, such as those described here, provide logical structures for defining the problem better, designing field studies and analysing the results obtained. They can also serve a practical purpose in providing the basis for better land-use and agricultural project planning techniques. The simple model described above could be used to simulate the likely effects on deforestation of different options for national economic development in a tropical country.

To improve the simple deforestation model and make the national land use systems model operational will require detailed research, involving field and remote-sensing studies, so that the many functional relationships influencing trends in deforestation can be properly quantified. Field research will also shed light on the most appropriate choice of parameters. For example, while in this project population was a key parameter in the model, Palo et al (1987) chose population density instead. Both approaches agree in proposing an eventual stabilization of land use and tailing off in deforestation, but should the threshold at which this occurs be represented in terms of population density (as in Palo et al. 1987) or forest area per capita (as in Grainger 1986)? The only way to answer to this question is through more research.

In addition to relatively localized field research we also require time-series data on deforestation trends at national and international levels (Grainger 1984). At the moment we lack reliable estimates of even current deforestation rates for most countries. Data on long-term trends are usually non-existent, yet without such data policy-makers in tropical countries have no sound basis for planning future agricultural and forestry development, and modellers will be unable to validate their models. Well-planned research is therefore not a luxury, but absolutely essential if the role of deforestation in development is to be properly understood, and improved models are to be developed so that the likely long-

term consequences of deforestation are properly appreciated and more effective techniques can be developed to bring the problem under control.

Many people in tropical countries would claim that deforestation has benefits as well as disadvantages, and that it is part of a national land use transition which most temperate developed countries experienced a long time ago. One of our main aims as researchers should be to provide the governments and peoples of tropical countries with the information and the tools they need to ensure that the way in which they utilise their natural resources can be planned for their own long term benefit. Sustainable development provides a sound foundation for securing the future of the world's richest ecosystem.

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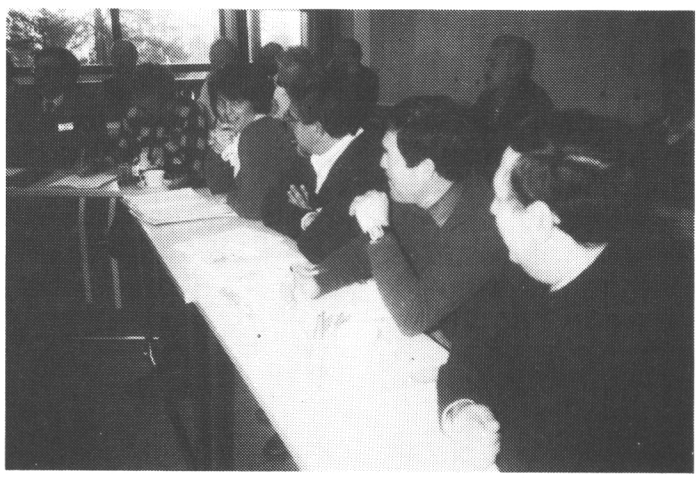
PART III

DEFORESTATION:

COUNTRY CASES



Another seminar session in action.
Photo by Francisca Nassol-Dayrit.

ROOTS OF DEFORESTATION PROBLEMS IN ETHIOPIA

Assefa Kuru [1]

ABSTRACT

An overview of the problems related to deforestation, accelerated soil erosion, and land degradation process in Ethiopia is given. The problems are shown to be more complex than a casual observer might at first suppose. It is argued that problems can no longer satisfactorily be divided into a few simple generalizations: natural process and man-made damages; nor can attention be confined to the treatment of the symptoms. The paper discusses the importance of the state policy in promoting judicious watershed management, analyzes the problems of deforestation and soil degradation in Ethiopia on account of the expansionist policy that created the modern Ethiopian empire, and pinpoints the root causes. Possible solutions to the problems are considered.

Key words: Ethiopia, soil erosion, soil degradation, deforestation, watershed management, expansionist policy.

INTRODUCTION

Deforestation, accelerated soil erosion, and land degradation are serious problems in Ethiopia. They are symptoms of land resources mismanagement. These problems are related to land use planning in general and to the judicious watershed management in particular. Watershed management is concerned with control of water, and particularly with control of water transfer from upper to lower parts of a river's catchment area. Generally speaking, the amount of water transferred or moving out of upper part depends on the difference between the rainfall and evapotranspiration, and the evapotranspiration itself depends on the *vegetation*, the depth, and the water holding capacity of the soil, and the surface run-off. Thus both the amount of the forest/wood-land cover (vegetation cover) of the watershed area, and the amount of water leaving the area (including the seasonal flow variation of the river) are dependent on the prevailing *land use management* there.

Not only in Ethiopia but also globally deforestation is much a common problem for a "simple fact" that the area under forests is decreasing by about 20 million hectares each year (Kunkle and Dye, 1981).

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Forests are cleared for a variety of reasons, some of which are: to acquire construction materials to erect dwelling structures; to provide materials as a source of energy; to make space for grazing, farming, building and lay-out of infrastructural net-works; and to provide raw materials for industry.

The needs and requirements of forests and forest resources are made complex and complicated with advance in technology and science. But even for a "*primitive*" biological existence at a subsistence level human beings need *natural resources*: air, water, food, and energy, adequate in quality and quantity. The management practices prevalent in a given country: the policy - *affects the quality, quantity, and sustainability* of the available natural resources. For the complex interaction of socio-economic activities, population growth and environmental deterioration see Palo (1987).

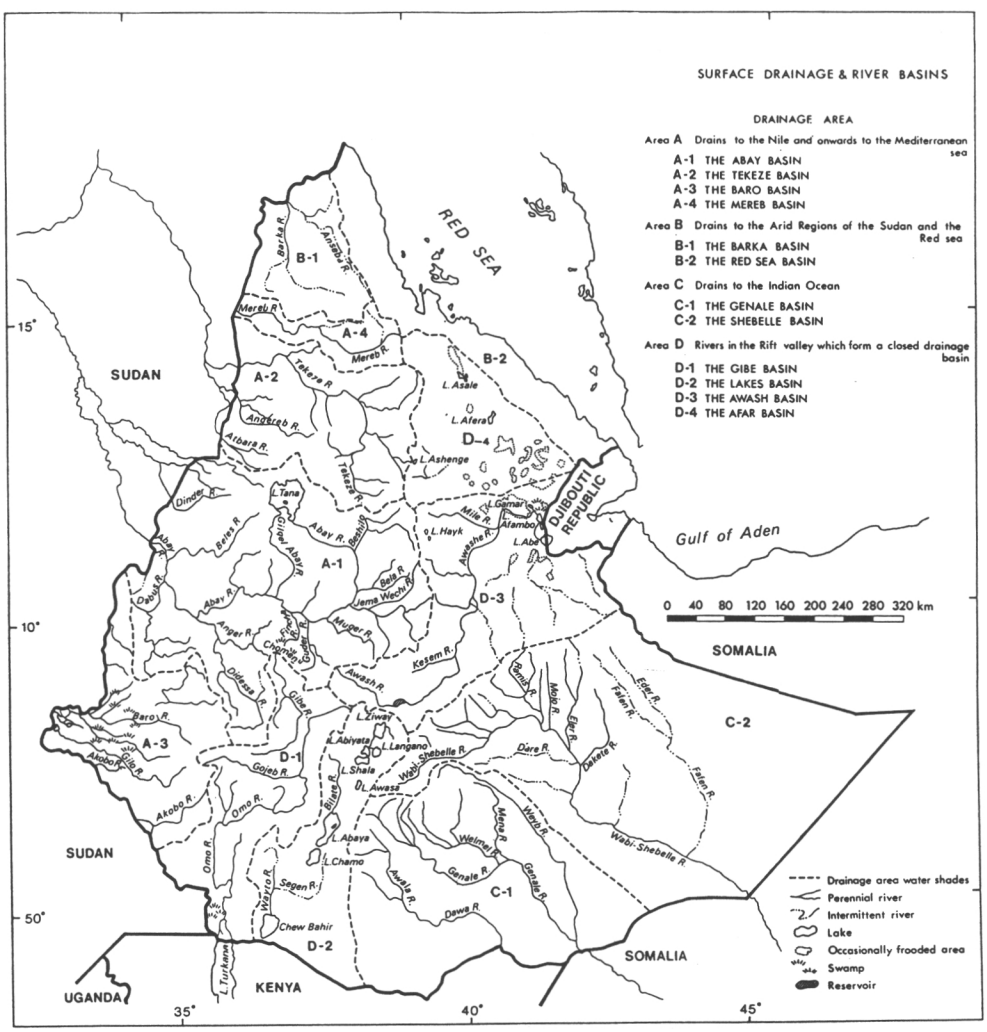

Figure 1. Main catchments and river basins in Ethiopia.

ETHIOPIA'S DRAMATIC DEFORESTATION

One of the most dramatic examples of deforestation processes is occurring in Ethiopia. The four major watersheds that feed run-off into twelve river basins (Fig. 1) throughout Ethiopia were originally covered with forest.

Only a hundred years ago about 40 percent of Ethiopia's 122,3 million hectares land area was covered with forests and woodlands (Breitenbach 1961, Fig. 2 A). As recently as three decades ago, 16 percent of the land surface in Ethiopia was under forest/ wood-land, but by 1982 this area had dwindled to 3.1 percent (UNEP, 1983).

Estimates of the distribution of forest/woodland areas made by the present author on the basis of information from LANDSAT imagery (1979) reveal that 2.8 percent of the land surface is under forest/woodland (Kuru, 1986; Fig. 2 B). Wherever forests / woodlands have virtually disappeared problems of accelerated soil erosion and land degradation have become paramount.

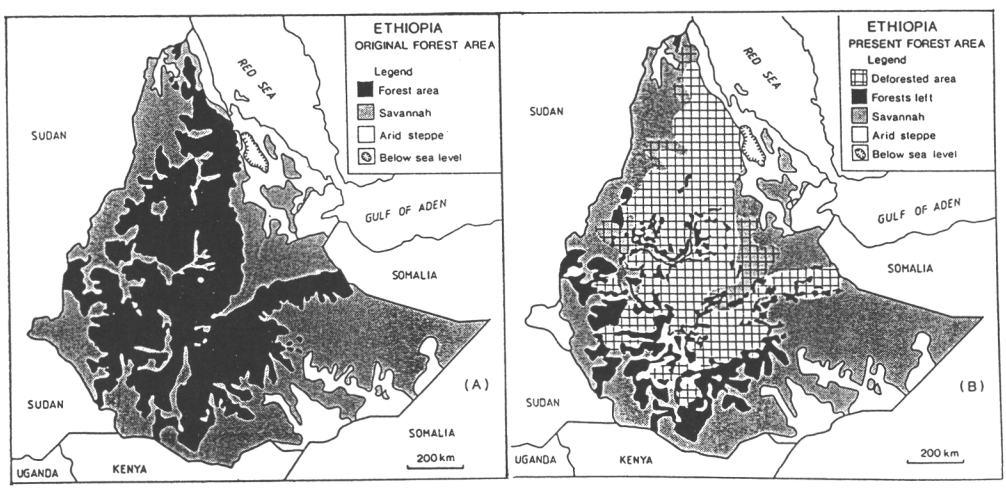

Figure 2. **2-A**: Extent of original forest and woodland areas in Ethiopia. Source: Breitenbach, 1961. **2-B**: Estimated extent of forest/woodland in Ethiopia by 1979, (estimate made by Kuru 1986, from 1979 LANDSAT imagery).

LAND DEGRADATION BY ACCELERATED SOIL EROSION

Soil erosion is generally attributed to physical factors denoted by the functions of *erosivity and erodibility*. Erosivity is related to the intensity of eroding forces (eg. actions of wind, running water, rain, waves, glaciers) whose effects could be evaluated by calculations based on kinetic energy. Erodibility is a quantitative measure of resistance to erosion whose effects could also be calculated from

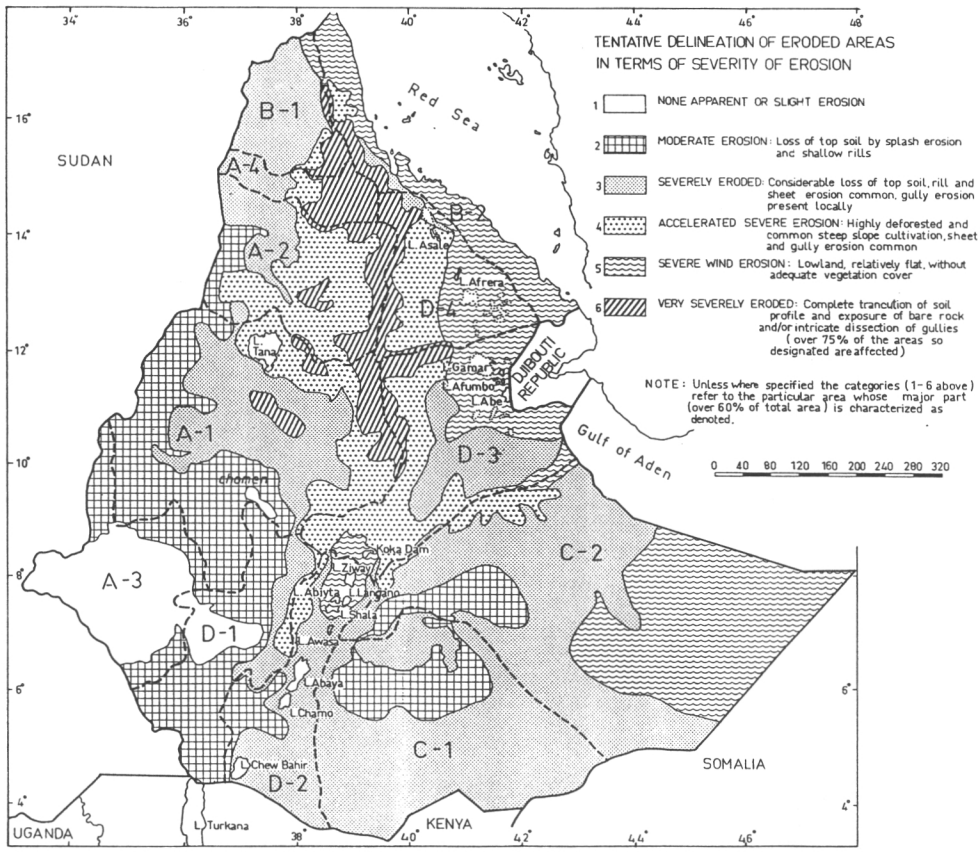

Figure 3. Tentative delineation of soil erosion severity zones.

measurable soil properties (eg. cohesive forces, soil structure) and the resistance could be influenced by natural relief (slope, shape, and length), quality of the protecting natural vegetation, and land and crop management.

Accelerated soil erosion is different from the natural soil erosion process. What is vital here is that the problems of accelerated soil erosion are mainly *induced* by changes in natural vegetation cover through human actions.

The degree of soil erosion severity and its spatial distribution is shown in Fig. 3. A comparison of Fig. 3 with that of Fig. 2 B reveals an interesting correlation. As can be seen from the two Figures the degree of soil erosion severity tend to have a close relationship with the degree of deforestation: *all areas depicting the highest degree of soil erosion are denuded of vegetation.*

From a study of spatial distribution of soil erosion severity throughout Ethiopia (Kuru, 1986), whereas on the one hand areas of very severe soil erosion (the highest rank according to the increasing degree of severity) are characterized by

widespread profile truncation and extensive exposure of parent material, advanced common gullies/channel erosion where vegetation cover has been completely denuded; on the other hand, areas of no apparent or slight soil erosion (the lowest rank according to the increasing degree of severity) are characterized by a very good forest/woodland cover.

EXPANSIONISM: RESOURCES DEVASTATING POLICY

Horvath, writing back in 1969, recognizes that: "Throughout history, the Abyssinian empire was known for its capital mobility continuum". The temporal and spatial features of capital settlement starting from the ancient roots of the Abyssinian empire and until the present Ethiopian empire are illustrated in the synopsis and sketch map.

The extent and degree of deforestation severity and ensuing accelerated soil erosion tend to have a close relationship with the "capital mobility continuum" - roving/wandering capitals. Succinctly summarized the motives and consequences were put by Horvath as follows:

> *Military considerations brought in to being the wandering capital which, in turn, allowed or influenced the practice of imprudent forest exploitation. Residents of the capitals knew they would be in the locality for but a short time, and it was therefore unnecessary to conserve the wood.*

This simplistic cause and effect explanation, if one does not carefully consider the nature of the *susceptible* physical environment (geology, relief, physiography, soil, climatic factors,...etc) prevalent in the region the conclusion may sound like gross exaggeration. Slopes prevalent in the region are too steep to prevent erosion. The physical environment is fragile and prone to erosion. This coupled with the watershed mismanagement - accelerated deforestation - that converts the productive land into waste land at an accelerated rate, soil fertility could be depleted to the extent that the soils become nearly *sterile.*

Look at it from other realities! Through the slow process of weathering and decomposition of rocks, it takes nature nearly one hundred years to form one cencentimeter of soil layer; but it takes only a split second to wash it off with a storm given that the vegetative cover that protects the soil is not there. *Good land with rich fertile soil becomes bad land with poor sterile parent material, mainly because green plants synthesis their food from simple substances taken out of the air and the soil. Once the organic matter and the essential micro-organisms are destroyed, desertification becomes inevitable.* The properties of soil depend not only on its parent material but also, as shown by the Russian investigator V.V. Dukuchaev already back in 1883 (cited by Russel, 1973 p.21) in particular, on the climatic, vegetation and other factors to which it has been subjected.

The deforestation and the ensuing accelerated soil erosion problems in Ethiopia are induced by human activities and are to a large extent influenced by the natural physical phenomena. But the problems can not just simply be generaliz-

Synopsis of capitals in Ethiopia
(source : Horvath, 1969)

Capital	Period
Axum and neighbourhood	? B.C. - 12th cent.
Lasta capitals	12th cent - 1268
Teguelat (transition to roving capitals)	1268 - 1412
Roving capitals	1412 - 1636
Gondar	1636 - ca. 1755
Reginal capitals	1755 - 1855
Megdella	1855 - 1868
Mekelle	1886 - 1889
Addis Ababa	1890 - present

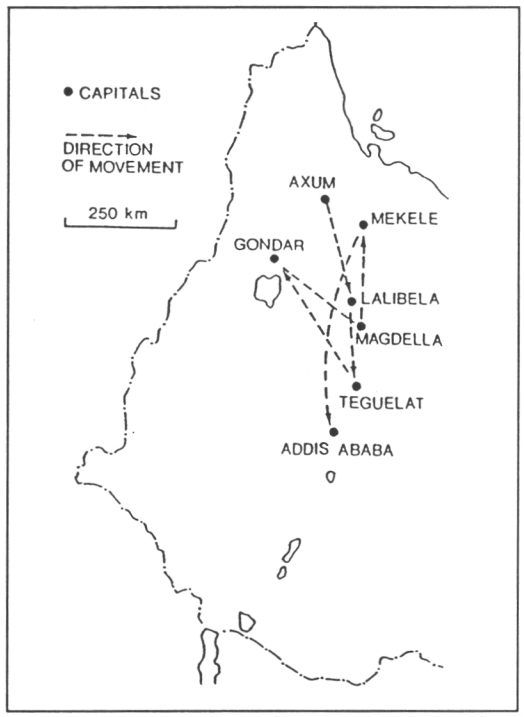

Figure 4. Ethiopia's capital city mobility (source: Horvath 1969).

ed as: *man-made damages, and natural processes.* In order to understand the historical roots of the problem it is not enough to limit ones investigation *only* to the physical phenomena one must also see into the prevailing contradictions of the strategic state policy *vis-a-vis* the allocation and usage of resources.

EXPANSIONISM A DRIVING FORCE?

Problems related to the social relations and available resources utilization are complex and more complicated than a casual visitor might at first suppose. It is imperative that in order to understand sufficiently even problems related to specific cases of deforestation and land degradation and intricate relationships and their interactions and to promote management practices which may bring about effective resources utilization, there is an urgent need for developing Ethiopia's indigenous skills by giving a high priority to research and education. It is also evident that neither substantial improvement can occur nor effective measures be improvised in the *absence of peace.* In order to seek lasting solution problems have to be recognized by the people especially by those authorities whose policy and decisions greatly affect the implementation of efforts.

Unfortunately situations in Ethiopia were not and are still not conducive to work. The government is at war with the people. There is no social peace and

security. Ever since the creation of the empire during the late 19th century, Ethiopian ruling authorities do not see judicious resources management as a point of priority. Certainly deforestation, soil erosion, land degradation, and desertification have not been points of high priority in the policy issue.

However the strategy of safe-guarding the empire that was created at the turn of the 19th century by force and maintaining it by force has consumed a lot of resources and energy. It has always been a high priority. This priority has required and incurred a high cost, often on debt funds and assistance from foreign sources. The policy has been to invest (rather to waste) more on armaments and military equipments to safe-guard the empire. According to this policy the forcibly incorporated peoples must, under all circumstances be controlled and denied any chance of independent development of themselves and their resources.

In order to control the conquered peoples settled colonizers are needed. Currently, as it was the case during the early stages of Minilek's occupation in the late 19th century, direct control by settled colonizers is emphasized. Under the cover of "environmental refugee" people from the north are being transferred *enmass* to the south; these places were incorporated into the empire at the turn of the 19th century and still possess some fertile and forest land.

This massive transfer has been accelerated by a state declaration in December, 1984 and the objective of the new scheme was to settle some 2.5 million inhabitants equipped with fire-arms to control the local people with and axes to clear the forest within the shortest time possible. This scheme alone, if implemented as planned, and assuming five hectares per settler, a forest / woodland area of

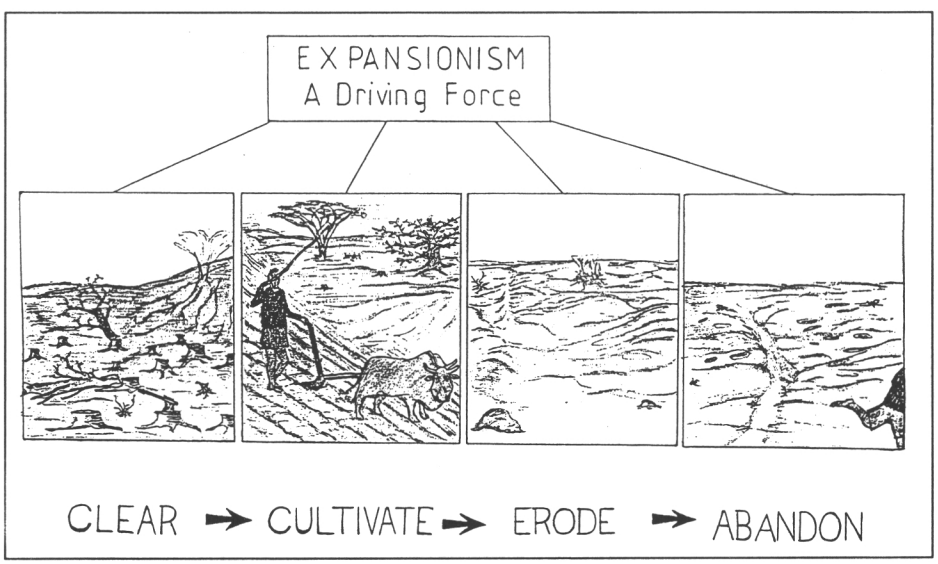

Figure 5. Expansionism as a driving force for deforestation.

12.5 million hectares is to be cleared just at once. Most of the scheme has been implemented but there is a scarcity of data as for the exact figure.

Looking at this policy in its general context something of the kind depicted in Fig. 5 seems to be the guiding principle. This sequence of land use, triggered by an expansionist policy, simple as it was, proved capable of becoming the framework for the phenomenal expansion which began under the various rules of kings of the ancient Abyssinian empire. The result was deforestation and land degradation. Will it benefit the Ethiopians to pursue the same path indefinitely?

CONCLUDING REMARKS

Problems related to deforestation and ensuing accelerated soil erosion and land degradation are enormous threats to the peoples in Ethiopia. Unless the problem is recognized by the authorities, who have overall control of the policy, a piecemeal perception of the problem cannot provide a national solution to the problem. There is an urgent need to study and distinguish forces that play a dominant role in setting priorities for action as regards the utilization, allocation, and conservation of resources in the country. Based on this in-depth study it is necessary to reformulate a strategic policy that appreciates the fact that *all around development cannot be attained if soil and plant resources are allowed to deteriorate.*

If Ethiopian forests and soil resources are to be saved from irreversible damage there is an urgent need for a vision to see the root causes of the problems: what was wrong and still goes wrong in the setting of the priorities of action? Setting priorities, of course, is not sufficient by itself. As much as setting a frame of practical policies are necessary, it is also important to endure the patience, skill and tact to carry out the objectives for a sustainable development. And that can only be attained by first recognizing the problems and setting accordingly defined goals and ordered priority of planned actions on education, research, and judicious resources management and conservation.

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DEFORESTATION AND DEVELOPMENT: A COMPOUND ISSUE FOR BRAZIL

Marcio A.R. Nahuz [1]

ABSTRACT

Deforestation and development are faced as a compound issue in terms of Amazonia, Brazil. A brief review of causes of deforestation in the region shows that development and forest alteration are interrelated processes. Recent estimates of the altered forest areas in Amazonia are given and measures taken to curb the problem are mentioned.

Key words: Brazil, deforestation agents, deforestation estimates, remedial measures.

DEFORESTATION AND DEVELOPMENT

Can these two apparently conflicting issues co-exist in the same region of a Third World country?

The immediate answer appears to be no - at least this is what is felt through the pressure of many and varied organizations throughout the industrialized world, affecting even traditionally cool-headed decision-makers like the international bankers.

Policy-makers in Third World countries must feel confused, for the same institutions which funded infrastructure, settlement and agricultural projects a few years ago, are now vociferating against these same projects, on the grounds that they may be environmental unsound.

Therefore, an impartial view of the causes and the *status quo* of deforestation in a country such as Brazil - nowadays in the front pages of all major newspapers - is needed before an immediate answer is agreed upon.

AGENTS OF DEFORESTATION

All possible agents of deforestation in Brazil, and especially in Amazonia, have been extensively discussed and analyzed but can be summarized in the following four groups:

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Land occupation

Amazonia extends over 500 million hectares, about 60 percent of the Brazilian territory, but houses some 9 million people - a little less than 6 percent of the Brazilian population, even after a decade of population growth of 4.1 percent *per annum*, compared to 2.2 percent *per annum* for Brazil (IBGE, 1987).

In the last 25 years there has been a massive immigration drive towards the vast lands of the north, originating from the densely populated south and southeast and the impoverished northeastern regions.

Many resettlement projects were encouraged by government agencies, as a solution to the increasing population of the south and the sparsely inhabited north, with free distribution of land. From 1979 to 1984, the Roraima government distributed 1 million hectares of land to ten thousand families, more than doubling the territory's population in the period (Fearnside, 1984).

Resettlement involves the need for subsistence crops, which in turn requires clearing by fire of land not always suited for agriculture, thus initiating a process of shifting cultivation. Furthermore, an old-fashioned legislation, legacy from our Iberian ancestors, still considers forest-clearing beneficial to the land, increasing its value for potential re-sale, and a guarantee of land tenure.

Quite frequently, the settler - a small land-owner, is pushed on, sometimes expelled, by a large farmer or cattle-rancher. Deforestation increases, either by a more intensive application of capital, or by the move of the early occupants to some new area.

Food production

The fast-growing population of southern Brazil, and more recently of other regions including the north, demand increased food production, especially grain and beef, for domestic consumption but also for export. The already high-productivity agricultural lands of the more populated regions do not seem to fulfill the ever-growing demand, thus requiring expansion of the cultivated ones.

Tax incentive programmes encouraged the implementation of agricultural and cattle-raising projects in most of Amazonia and also in the wooded savannas of west-central Brazil, requiring land-clearing of large tracts of land. These are concentrated in the south of Para and north of Mato Grosso, not only in areas of transition forests but also in regions of high forest, cleared by bulldozers and fire.

Deforestation to establish subsistence crops for settlers is unimportant in comparison with that practiced in extensive agricultural and cattle-raising projects. However, this will be substantial in the future, if the region's population continues to grow.

In both cases, deforestation is triggered by the need to open up new areas when production ceases or is reduced below the accepted levels of productivity, if only primitive agricultural techniques are employed.

Infrastructure

Industrial growth in southern Brazil and more recently, also in the north, expanded manifold the demand for energy and raw materials originating from Amazonia, increasing the pressure for easier access to the region.

Intensive road construction in Amazonia started in the 60's with the Brasilia-Belem highway cutting through savannas and forested areas. Following quickly, the Trans-amazonica and other highways were built through regions of dense forests thus facilitating access to areas previously reached only by river. As an immediate consequence, settlement along these roads was quickly and disorderly established, with the expected road-side deforestation.

The country's demand for energy, no longer fulfilled by the existing hydroelectric plants, resulted in an ambitious hydropower programme to be implemented in Amazonia, exploiting the region's endless water resources. The plain topography of the river basins however, caused the artificial lakes to cover much larger areas than desirable, thus eliminating substantial areas of forest, from which little timber had been extracted.

Extraction of raw materials

Of these, mining is definitely the most deleterious process to the environment, particularly to the forest.

Amazonia is rich in mineral deposits, including iron, tin and gold. Iron and tin are strip-mined, a process in which deforestation is the first step. The sites of the extensive deposits of iron-ore in Carajás, cassiterite in Rondônia and bauxite in the Trombetas River attest to the fact that the forest is far less valuable than the minerals that lie under it.

Strip-mining of gold is restricted to a few sites but alluvial gold is extracted throughout the region by a very primitive and water-polluting process in which mercury is used.

Timber extraction is not a major deforestation factor since this is done selectively. From about 200 species occurring in any one hectare, some 20 are of commercial value and thus exploitable, and of these, only 4 or 5 can be exported.

This brief account of the causes of deforestation in Amazonia shows an underlying factor to all mentioned causes: the struggle of a region to achieve the concept understood as development.

The means and practices used in the process may have been exaggerated and certainly there has been a lack of long-term planning and accurate evaluation of consequences in the long run. But risks and costs have been assessed, understood and underwritten. Brazilians are alert to the present situation and its implications. A recent major public opinion poll showed that the environment is the third main issue of concern to the society, coming after inflation and violence. The domestic pressure is quickly building up, compelling the government to take a firmer stand on the issue and causing positions and policies to be reviewed. But Brazilians also take upon themselves the responsibility to design and implement the policies deemed necessary to develop Amazonia, modifying or correcting them whenever needed.

DEFORESTATION IN AMAZONIA

Assessment of deforestation in Amazonia, aiming to identify, evaluate and monitor critical areas in the region, was carried out in 1980, based on 1975, 1978 and 1980 LANDSAT imagery. From a total area of 503 million hectares, 12.4 million hectares (2.46 percent) were found to be altered, at rates varying from 1.6 to 2.3 million hectares per annum (IBDF 1983, see Annex 1).

In the years that followed, deforestation rates in Amazonia were the object of various estimates, ranging from 1 to 8 million hectares per year, but none based on hard evidence. Some of these speculative rates may have been induced by data on burning areas detected by the NOAA-9 satellite, used for meteorological purposes but inadequate to evaluate deforested areas. Due to NOAA's low resolution (900 m vs. 30 m of LANDSAT), and the saturation of its heat sensors, burning areas of savannas and pastures were overdimensioned and misinterpreted for tropical forest areas (INPE, 1989; VEJA, 1988).



Figure 1. Location of the Brazilian Amazon within the geographical limits of Brazil.

More recently, on the inauguration of the Brazilian "Our Nature" programme (6 April 1989), INPE released the latest data on deforestation in the region. Based on LANDSAT 5 imagery, INPE detected that out of the 490.7 million hectares of the so-called Legal Amazonia (for tax purposes), 25.1 million hectares of forests had been altered, corresponding to 5.12 percent of Amazonia. Altered areas include areas which have been deforested, degraded, burnt or not, with or without forest regrowth, and areas under water from the artificial lakes of hydroelectric dams.

By comparison with the 1980 figure, deforestation reached 12.8 million hectares from 1980 to 1988, at an average rate of 1.4 million hectares per year (INPE 1989, see Annex 1), a figure below the rates detected between 1975 and 1978.

The area of 25.1 million hectares of altered forests detected in Amazonia in 1988 does not include old clearings, i.e., areas deforested before the 1960's and abandoned to secondary forest growth. These are concentrated in eastern Amazonia, close to the more populous centres, and in addition to 9.3 million hectares. If these areas were added to those of more recent alteration, only then would the total altered area reach 7 percent of Amazonia.

The deforestation rates and the extent of altered areas in Amazonia have been for some time, controversial issues at the international forum. Much of the controversy, apart from the gravity of the problem, deals with its dimensions, and is caused by a lack of precise information. The data now released by INPE, based on recent imagery and obtained with appropriate methodology, seems to fill this requirement, and is expected to prevent future misinterpretations.

MEASURES TO REDUCE DEFORESTATION

Although deforestation in Amazonia now seems to be progressing at a slower pace, the problem has acquired proportions serious enough for society to start demanding policy changes and strict measures to curb the problem.

Much is due to the increasing awareness of the average Brazilian, especially in the lower age brackets, of the importance and value of the environment, and its role in life. The new Brazilian Constitution promulgated in 1988, includes a comprehensive chapter on environment conservation and protection, reflecting society's concern with nature and natural resources.

At a more immediate level, institutional changes are being implemented in the administration of natural resources, emphasizing the role of protection to the environment.

On a more practical level, an economic and ecological zoning of Amazonia is being designed, to allocate areas for agricultural, settlement, mining, logging, cattle-raising and other projects, with a view to the region's sustained development in harmony with the environment.

In accordance with the main issue of planning for a rational occupation of Amazonia, development projects are envisaged for the region, co-existing with extractivist reservations, where practices such as Brazil-nut gathering and *hevea latex*-tapping are maintained and encouraged. These areas are to act as a protection belt around forest reserves.

Management of tropical forests aimed at a sustained yield of raw materials for the timber industries established in the region is another measure to be implemented. In this respect, several institutions are researching for methods and species.

Some of these measures will take long to be implemented and their effects, longer to be felt. One cannot expect that the deforestation process already established in Amazonia for so long will cease or be drastically reduced overnight. However, this is the first time serious measures are being taken to curb deforestation in the region, resulting from a new posture of society. Indeed, in this there is a great hope.

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ANNEX 1

DEFORESTATION IN AMAZONIA 1975 - 1989

(million hectares)

State	Total Area	Cumulative area of deforestation				
		1975[1]	1978[1]	1980[1]	1987[2]	1989[3]
Acre	15.26	0.12	0.25	0.46	1.42	
Amapá	14.03	0.02	0.02	0.02	0.11	
Amazonas	156.71	0.08	0.18	0.18	0.73	
Tocantis/Goiás[4]	28.15	0.35	1.03	1.15	2.87	
Maranhão[4]	28.56	0.29	0.73	1.07	2.78	
Mato Grosso[4]	88.10	1.01	2.84	5.33	10.88	
Pará	124.80	0.87	2.24	3.39	8.60	
Rondônia	24.30	0.12	0.42	0.76	2.43	
Roraima	23.01	0.01	0.01	0.01	0.10	
Total	502.92	2.86	7.71	12.36	29.93	25.14
Percent	100.00	0.57	1.53	2.46	5.95	5.00

Notes:

1 Source: IBDF 1983.
2 Source: Estimates based on rate of 2.5 million hectares per year (FUNATURA 1988).
3 Source: INPE 1989 (partial figures are not available).
4 State not totally included in Amazonia.

DEFORESTATION IN CHILE: A HISTORICAL REVIEW.

Homero Altamirano [1]

ABSTRACT

Deforestation exists in Chile as in other countries and poor attention has been given to it by the Government and the population in general. This paper introduces the subject, giving information available on forest resources and factors causing deforestation. Lack of reliable information is noted and progress in afforestation with exotic species and the classification of forest cover is reviewed. A historic account of factor causing deforestation is given.

Key words: Chile, deforestation, forest resources, population, forest history.

INTRODUCTION

This paper was produced after the contact between CEDFOR (Centro para el Desarrollo Forestal - Chile), and the Department of Forest Economics of the Finnish Forest Research Institute, namely the team set up by professor Matti Palo, professor Ari Siiriäinen and Mr. Gerardo Mery.

Through reading Deforestation or Development in the Third World?, edited by M. Palo and J. Salmi (1987), we obtained a point of reference for introducing ourselves to the subject of deforestation that has caused and is causing today big losses to the national economy, limiting socio-economic development and provoking serious imbalances in the ecosystems in our country.

In Chile, little attention has been given to the problem of deforestation by official institutions of the Ministry of Agriculture, and, except for the isolated efforts of some researchers from the Universities and non-governmental organizations, there is no precise knowledge on the subject.

CEDFOR-Chile has designed a research project that intends in two years to quantify the deforestation process in Chile, evaluate its impact on socio-economic development and on the environment and propose the basis for a

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long-term policy to revert the process and reduce its effects, mainly in the area covered by natural forests.

This paper aims to give a historical review on the past deforestation process in Chile.

ASSESSMENTS OF FOREST RESOURCES

In Chile as in the tropics, according to the research of Palo (1987), basic information about forest coverage and deforestation is scarce. In 1956, the Ministry of Agriculture concluded that 37 million ha (48,8 percent) of Chile's territory should be classified as forest soil, including bare areas, scrub forest, open and closed forest (Altamirano 1987). In fact, the attempts to quantify Chile's forest resources have been limited and incomplete. Attention has been concentrated on man-made forest.

At the beginning of this century, F. Albert (1914a, 1914b), a German agronomist hired by the government, estimated the total forest cover in the country at 15.74 million ha.

Thirty years later, an American consultant evaluated the forest resources and concluded that there was still 16 million ha of natural forest in very deteriorated condition so that only 4.37 million ha were usable for industrial purposes (Haig 1946).

In 1966, INFOR (the Chilean Forest Research Institute) concluded that the total forest coverage from Arauco[2] to Chiloé amounted to 3.1 million ha. Research carried out by IREN (Research Institute of Natural Research of Chile) in 1967 reported 2.17 million ha of *commercial forest* for the southernmost provinces of Aysén and Magallanes. Later in 1977, IREN gave the figure 5.5 million ha for the same area, including bare land, regeneration, scrub forest, open and closed forests (CORFO et al. 1979). Finally, in 1984 INFOR Statistic Bulletin published a table covering all Chilean territory which stated a total of 7.6 million ha covered by natural forests and 1.1 million ha of industrial plantations (CORFO-INFOR 1984).

It is difficult to draw a clear conclusion from all these figures, but doubtless to say that in the course of this century, there has been a serious reduction in the national heritage of natural forests and a vast area of industrial plantations has been established.

DESCRIPTION OF FORESTS AND PLANTATIONS

Despite the fact that no accurate figures on the coverage of natural forests are available, quantitative information on the location and the floristic composition has been accumulated. In 1981, FAO-CONAF "*Forest Development and Research*"

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[2] *All geographical names in the text may be consulted in map of Annex 2.*

Project (CHI-76-003) elaborated a classification of natural forests growing on Chilean territory. This information, together with data for industrial plantations gives a complete picture of the type of cover and floristic composition (Donoso 1981).

Natural forests grow along the country from 30°50'S to 55°30' S. Patches of *Prosopis tamarugo* (18 000 ha) exist in the Atacama desert area. The classification of natural forests made by CHI-76-003 Project, identifies 12 forests types growing along the coastal and Andes mountains (see Annex 1).

In 1930, the Chilean government initiated an aggressive afforestation and reforestation policy. Taking into account the success in growing exotic species obtained by the silvicultural programme of the Ministry of Agriculture and some private companies, the government passed a bill giving a subsidy for every hectare planted. Even though the programme was developed under some financial limitations, the area planted was sufficient for the installation of an industrial infrastructure in sawmilling, plywood and other boards mills, and pulp and paper factories during the 1950's.

New efforts during the last 40 years have resulted in a strong forest industry consuming more than 10 million cubic meters of raw material (95 percent of which comes from man-made plantations), and exporting an important amount of forest products (e.g. about 700 million USD in 1988).

The area actually covered by man-made forests is about 1.3 million ha, which consists of 90 percent *Pinus radiata* plantations, whereas the remaining 10 percent includes *Eucalyptus sp., Populus sp.* and other exotic species. Accurate forest inventories have been made for industrial plantations.

A HISTORICAL REVIEW OF DEFORESTATION

As Palo et al. (1987) have pointed out, deforestation is a complex ecological and socio-economic process caused by a number of human and natural factors. In Chile, as in other countries, natural factors caused deforestation in the past, and, even today earthquakes, floods and drought are responsible for losses in forest cover. Some abrupt changes in the climatic conditions were responsible for the disappearance of closed and evergreen forests in the central region of Chile, as the remnant of the *Fray Jorge* forest in the northern province of Coquimbo (30°S) testifies. No systematic information on deforestation caused by natural factors is available in Chile today, therefore we will now pay attention to human actions that have caused loss of forest cover.

Before the Spanish invasion (XVI century), the total population in the country has been estimated at 600 000 inhabitants, settled in the coastal area and valleys of the central region. They did not cause major damage to the forest. According to Spanish chronicles, all the valleys from the province of Coquimbo to the southernmost part of Chile were covered by dense closed and open forests when the first conquerors arrived.

As the settlement of the Spaniards progressed to the south, pressure on forest resources for building and fuel grew so much that in 1557, a fine was imposed by law against people who cut trees without permission. During the XVI, XVII and XVIII centuries, and even after independence in 1810, the population was concentrated in the central region from Copiapó to the Maule river, developing agriculture and cattle breeding. Mining was developed in the north during the XVIII century. Population growth was slow up to the beginning of the XIX century when no more than 1 million people inhabited the territory.

On the other hand, heavy fighting between Araucanos and Spaniards lasted more than 300 years causing destruction of important forest areas, as the Spanish army burnt the forests where Araucanos lived and hid to attack their enemies. Thousands of hectares were destroyed during the *Arauco War*.

We can assume that population size was an important factor in deforestation only in the last 150 years when the population grew from 2.5 million to 12 million. The graphic of Fig. 1 shows an estimate of how the total population grew in Chile from 1542 and how forest resources diminished. We can assume that in the beginning of the period not less than 20 million ha had some type of forest cover (Elizalde 1958, Astorga 1977).

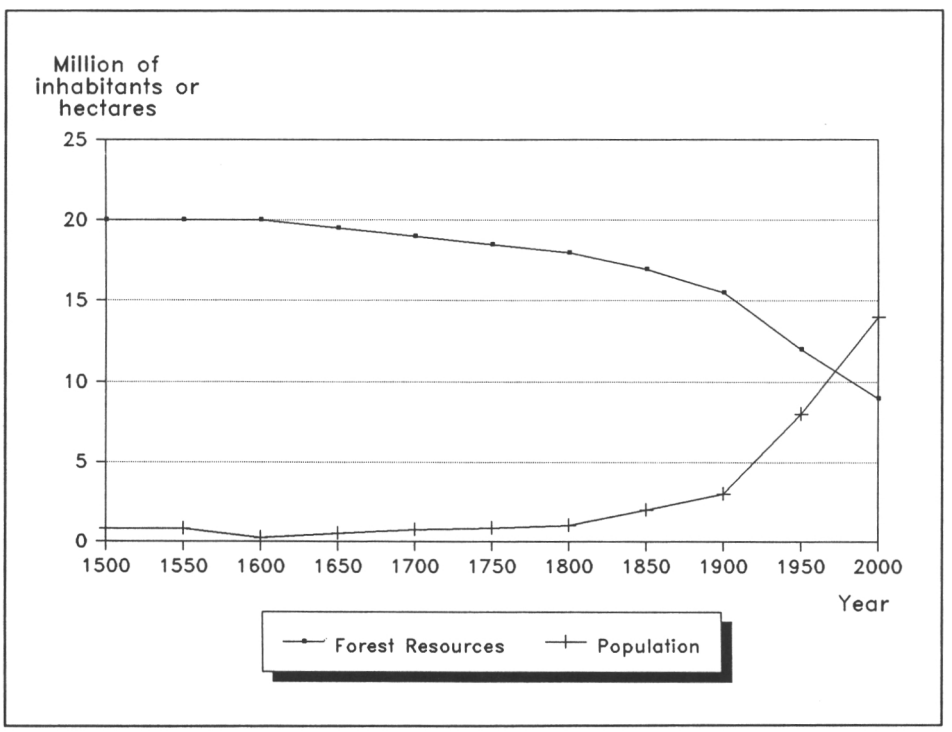

Figure 1. Estimate of population growth and forest resources decrease from 1542 to date.

Mining activities intensified towards the end of the XVIII century, demanding large amounts of fuelwood that caused the total disappearance of scarce treesin the northern provinces, to such an extent that Claudio Gay wrote (1833), referring to Coquimbo province: "*The forest no longer exists, the remaining trees are small, weak and disperse. Only rock can be seen on the surface*" (cited by Elizalde 1958).

All vegetable matter existing in the area was burnt: algarrobos (*Prosopis chilensis*), tamarugos (*Prosopis tamarugo*), small scrub and even algae were used as fuel. Mining promoted railroad construction, demanding a huge amount of wood for sleepers.

Apart from wood for building and fuel, the main factor of deforestation and depletion of natural forests in Chile have been forest fires. As already mentioned, the Arauco War was responsible for losses in the forest cover through indiscriminate burning of forests from the Maule river to the south, and the Spanish chronicles refer to it only in qualitative terms.

The problem of forest fires is still actual, affecting natural and man-made forests. According to statistics of the Forest Institute, more than 0.75 million ha of forests have been damaged by fires in the last 25 years (CORFO-INFOR 1984).

In 1848, the government of the Republic initiated an immigration programme to weaken the Araucano resistance, and thousands of German colonists (8 000 up to 1855) were given land in the southern provinces of Llanquihue, Osorno and Valdivia. The settlers burnt thousands of ha to incorporate land for agriculture and cattle breeding. The territory given to the German colonists is 90 percent of the total area of these provinces (4.5 million ha). The Arauca-nos succeeded in keeping for themselves about 0.4 million ha in the coastal and Andes mountains.

All the area, even the flat zone between both chains of mountains, was at that time covered by dense forests. According to present figures on forest cover in the region, the settlement process initiated in 1848 meant the total disappearance of at least 2 million ha to date.

The settlement programme continued later to the north with immigrants coming from Italy, France and Switzerland, and from Yugoslavia to the southern province of Magallanes. Later in 1935, settlement of Chilean citizens was initiated in Aysén province. All foreign and Chilean settlers repeated what the Germans had done, and more than 6 million ha were burnt in the territory located from Malleco province to the south.

CONCLUDING REMARKS

In the case of Chile, according to the above information, and taking into account the poor quality of the statistics, we can conclude that deforestation does not always serve development. Economic development to satisfy the needs of a

growing population and to create welfare, means pressure on forests and can result in the loss of forest cover, if we do not take into account the biological and economic rules of forest management. Deforestation as we have seen it in our country, is simply the definitive loss of forest resources and a heavy economic and social cost.

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ANNEX 1

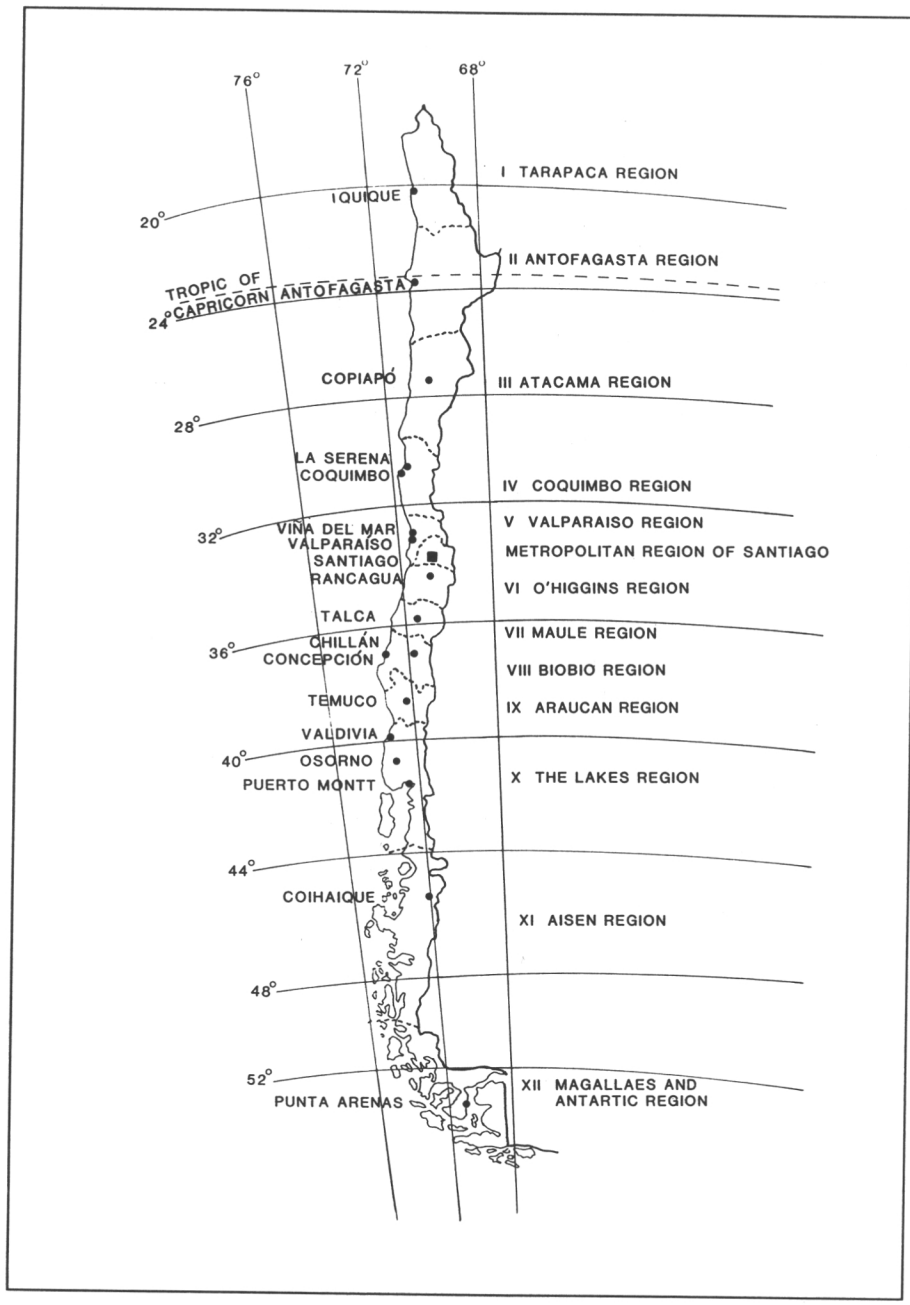
Table 1. Classification of the Chilean natural forests in forest types, according to the dominant species.

Forest Type	Location	Main tree species
Esclerófilo	30°50'S - 38°S	Quillay, maitén, espino, peumo
Palma Chilena	32°50'S - 34°30'S	Palma chilena, peumo, quillay
Roble-Hualo	32°50'S - 36°30'S	Hualo, peumo, quillay
Ciprés Cordillera	34°50'S - 44°S	Ciprés de la cordillera, radal, roble
Roble-raulí-coigüe	36°30'S - 40°30'S	Roble, raulí, coigüe
Lenga	36°50'S - 45°S	Lenga, coigüe, raulí
Araucaria	37°40'S - 40°40'S	Araucaria araucana, lenga, coigüe
Coigüe-raulí-tepa	37°S - 40°30'S	Coigüe, raulí, tepa
Siempreverde	38°30'S - 43°30'S	Coigüe, Ulmo, tineo, olivillo
Alerce	39°50'S - 43°40'S	Alerce, mañío, tepa
Ciprés Guayteca	40°S - 54°S	Ciprés de las guaytecas
Coigüe Magallanes	47°S - 55°30'S	Coigüe de Magallanes, tineo, tepa

Table 2. Common and botanical names of tree species of Chile mentioned in Table 1.

Alerce	Fitzroya cupressoides
Araucaria	Araucaria araucan
Ciprés de la cordillera	Austrocedrus chilensis
Ciprés de las guaytecas	Pilgerodendrum uviferum
Coigüe	Nothofagus dombeyi
Coigüe de Magallanes	Nothofagus betuloides
Espino	Acacia caven
Hualo	Nothofagus glauca
Lenga	Nothofagus pumilio
Mañío	Podocarpus sp
Maitén	Maitenus boaria
Olivillo	Aextoxicum punctatum
Palma chilena	Jubaea chilensis
Peumo	Cryptocaria alba
Quillay	Quillaja saponaria
Radal	Lomatia hirsuta
Raulí	Nothofagus alpina
Roble	Nothofagus obliqua
Tepa	Laurelia philippiana
Tine	Weinmannia trichosperma
Ulmo	Eucryphia cordifolia

ANNEX 2



Political map of Chile.

TROPICAL FORESTS AND THEIR DEVELOPMENT STRATEGIES IN CHINA

Li Shan Qi [1]

ABSTRACT

The paper describes briefly the present state of the remaining tropical forests in China. The problems of excess exploitation, shifting cultivation, deforestation, and erosion are described. A rapid diminution of the tropical forests has taken place. The ecological and social functions of the forests have sofar become neglected. Finally, strategies for protection and development of the tropical forests are introduced.

Key words: Tropical China, forest resources, deforestation, development strategies.

STATE OF THE TROPICAL FORESTS

There are 48 million ha of land in China belonging to the tropical area, including the southern parts of Taiwan, Fujian, Guangdong, and Guangxi Provinces, the south and southwest of Yunnan Province, and the island of Hainan in the South China Sea (see Fig. 1). In fact, the remaining tropical forests of China are distributed on Hainan Island, Taiwan and in the Xishuanbanna district, Yunnan Province. The total area of tropical forests (including primary and secondary forests) in Hainan and Xishuanbanna district in the early 1950s was 0.863 million ha and 1.057 million ha respectively and the forest cover occupied 26 and 55 percent respectively (Gou 1985, Ma 1987).

After the foundation of the People's Republic of China, large-scale exploitation of tropical forests began. Since then, overcutting for timber, reclamation for rubber tree planting, shifting cultivation and unrestricted deforestation for fuelwood and other uses have led to severely damaged tropical forests. The remaining area of tropical forests in the above two regions has dropped down to 0.331 million ha and 0.567 million ha respectively, the forest cover decreased to 10 and 30 percent, respectively (Gou 1985, Ma 1987). The acute diminution

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Editors' note: *The article has required more editing work than the others due to English language problems. It may therefore include some misinterpretations.*

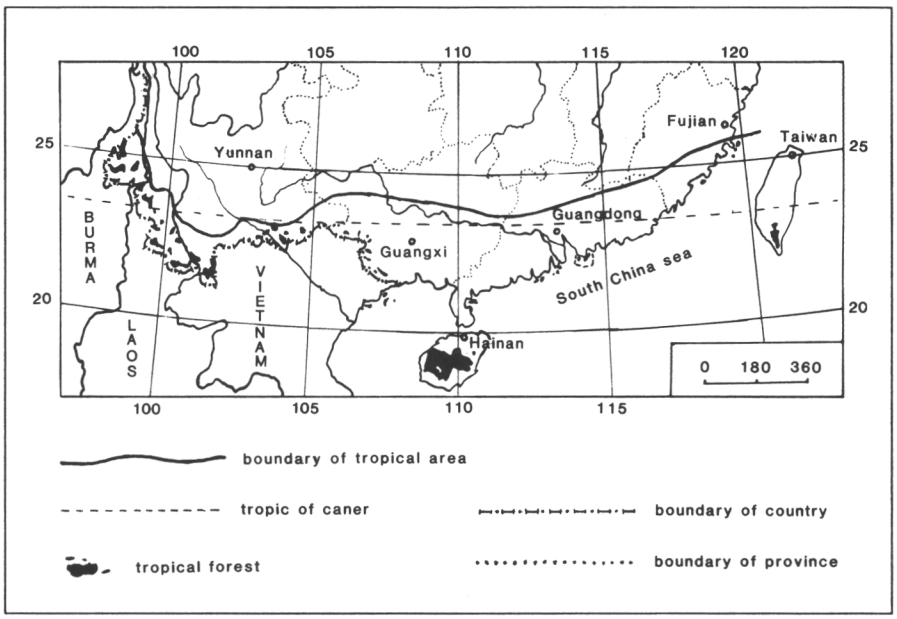

Figure 1. The location of the tropical forests in China

of tropical forests has also resulted in deterioration of the ecological environment.

The major types of tropical forests in Hainan Island are semi-deciduous monsoon forests, evergreen monsoon forests and mountain rain forests, the latter two types cover the largest area. About 4000 species of vascular plants are found in Hainan Island (Ma 1987) 1400 species of which ar arbors and bushes, and 3500 species of vascular plants are found in Xishuanbanna district (Gou 1985). The major tree species of Hainan Island are Magnoliaceae, Lauraceae, Theaceae, Myrtaceae, Tiliaceae, Euphorbiaceae, Fagaceae, Meliaceae and Symplocaceae.

In forest management, the main cutting methods are clearcutting and selective cutting. The former method was found to cause great destruction of forests and environment. Consequently, it was eliminated since the 1960's. In forest utilization side, no wood processing industries were set up in the tropical forest area. Therefore, all of the logs have to be transported to the city or the mainland. Only 35 percent of the wood cut was finally used.

PRESENT PROBLEMS

With expansion of cities and the rapid development of industries in Hainan Island, the need for various types of timber and fuelwood is increasing continuously. A great deal of tropical forests was eliminated because of unrestricted deforestation for fuels and other uses. It was estimated that fuelwood consump-

tion alone is up to 1.75 million m^3 per year occupying 50 percent of the whole roundwood consumption in Hainan Island. Civil timber consumption is 0.5 million m^3 per year, cutting area more than 10 000 ha. Shifting cultivation was estimated about 2 000 ha per year. Owing to deforestation, micro-climatic conditions became worse, air and soil temperature increased and the humidity decreased: soil and water losses were up to 32 t/ha/a and 2 810 m^3/ha/a respectively. These figures were 590 and 26 times higher than those of forest land. Nutrient losses were measured as 65 Kg N/ha/a, 8 Kg P/ha/a, 25 Kg K/ha/a, 47 Kg Ca/ha/a, 12 Kg Mg/ha/a, 947 Kg organic matter/ha/a (Lu and Zeng 1986).

According to surveys, the annual volume increment in Hainan Island is 2.09 million m^3, the annual timber production is 2.07 million m^3, and the total consumption of roundwood is up to 6.21 million m^3. There is a big gap between the supply of and demand for roundwood. Rubber tree planting is another factor of deforestation, although rubber plantations constitute a certain degree of forest canopy, the function of single storey, pure forest could not be compared with mixed, multi-storey tropical forest.

Since 1950, 3.72 million m^3 of timber has been produced by the forestry administration on Hainan Island. It has provided the country with much income but the investment for developing forestry (including logging and silviculture) has been only USD 1.6 million. The investments in agriculture, to develop mainly rubber tree plantations and other tropical crops, has been up to USD 576 million (Ma 1987). Due to the lack of sufficient funds it has not been feasible to improve the extensive management.

The tropical forests have not only provided massive economic benefits; they have also had a tremendous ecological and social importance. Most people, even the staff of the forestry administration, did not know that the forests have multiple functions, the indirect effects of which are more important than the wood itself. People only wanted to get more wood from the forests and they neglected the 'forest culture'. This resulted in the forestry economy "taking much and giving little". The problems mentioned above have caused a rapid diminution of the tropical forest resources of China.

STRATEGIES FOR DEVELOPMENT

The major problems confronting China in tropical forestry amount to a crisis of the remaining resources and a deterioration of the ecological environment. This means that effective remedial measures have to be adopted.

The preservation and development of forest resources must be given the first priority. The full understanding of the versatility value of the tropical forests and their ecological fragility are very important. Once the forests have become severely degraded it is difficult to restore them. At present, the remaining natural forests should be protected, except for small areas of special timber pro-

duction which may be allocated for selective cutting. Large scale cutting should be prohibited.

In reforming the forestry system the following points should be adopted: establishing of a compensation system for forest resources; developing multi-management systems including state forest farms, cooperative-based peasants and individuals; introducing of a contract responsibility system; rectifying the confused status of the timber market.

In order to increase the forest resources, large areas of high-yield plantations should be established with fast-growing tree species such as Eucalyptus, Acacia, tropical pines and some potential domestic tree species. Fuelwood plantations are very important. Their management should not be rested only on the state, but also the local people should be encouraged to establish their own small forest plantations around their houses and villages.

In order to increase the percentage of timber recovery, a full utilization of the residuals is an urgent need. Wood processing in local areas is an active measure which not only increases the price of the timber itself but also provides an opportunity for local employment.

Rational and coordinated joint investments for agriculture and forestry are needed. The forestry development must be kept up with national economic development. Thus forestry could be diverted step by step from extensive management toward intensive management.

Forestry is very important for the national economic development. It is necessary to give a wide publicity to the issue. Technical training of forestry staff is important in raising the quality of management. The Forest Law must be enforced strictly, any destruction of the forest should be punishable. Therefore, strengthening ideological education of the people as a whole is a difficult and a long-term task.

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PART IV

DEFORESTATION AND CONSERVATION POLICIES



A tree nursery in Mozambique. Photo by Matti Palo.

A REVIEW OF TROPICAL DEFORESTATION: DEVELOPMENT POLICY AND FOREST RESEARCH

Peter Freiherr von Fürstenberg [1]

ABSTRACT

The vertiginous velocity of conversion and degradation of tropical forests in recent decades is summarized and some opinions on the chain of causes behind this phenomenon are given. Repercussions of public concern over the decline of forests in the tropics on international development policy are then enumerated and recent activities in the field of tropical forest research are listed. Finally, a current review of national German activities regarding tropical deforestation is given.

Key words: deforestation, tropics, development policy, tropical forest research activities.

FOREST CONVERSION AND DEGRADATION

Introduction

The following statements on deforestation in the tropics are based partly on a state of knowledge report prepared in 1986 by a study group of the Committee for International Cooperation in Forestry of the German Forestry Association (Deutscher Forstverein 1986). The ad-hoc study group was directed by the present author, and the data on forest areas in the tropics were mainly taken from the FAO/ UNEP- Tropical Forest Resources Assessment Project (1981). The findings of this theoretical study were checked in recent years by the present author in several tropical countries like Brazil, Cameroon, Ecuador, Ethiopia, Guatemala, India, Indonesia, Mexico, Paraguay and Togo.

Between 1976 and 1980 the annual deforestation rate for tropical forests was calculated by FAO/UNEP (1981) at an average of 7.4 million hectares (57 percent in tropical America, 25 percent in Asia and 18 percent in Africa). The highest absolute annual losses of forest area occurred (in decreasing order) in Brazil, Columbia, Indonesia, Mexico, Thailand, Ecuador, Peru and Malaysia. In relation to the forest area of tropical countries annual rates of over 3 percent of forest conversion to other uses have been reported from countries like Ivory Coast, Nigeria, Nepal, Paraguay, Costa Rica, Haiti, Thailand, Benin and El

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Salvador. This is confirmed by the latest "*World Resources Report*" (1987), which indicates that tropical countries with especially large increases in wood removals between 1966 and 1984 include Papua New Guinea, Indonesia, Liberia, Brazil, Paraguay, Nicaragua, Panama, Nigeria, Cameroon, Kenya and Malaysia.

According to recent reports based on monitoring programs and interpretation of satellite images the velocity of deforestation in the humid tropics may have even accelerated. So it is to apprehend that the pessimistic predictions made in 1980 by the report "Global 2000" will become true (i.e. a long-term annual decline of tropical forest area by 1.8 percent or a decrease of 40 percent of the original wooded area between 1978 and the year 2000). This frightening pace of deforestation in the tropics is not matched by reforestation activities in the different tropical continents. The afforestation programmes executed in the past have been concentrated in few countries and amount in Latin America to only 9.7 percent, in Africa to 7.1 percent and in Asia to 23.3 percent of the tropical forest area destroyed.

Main causes of deforestation

Normally only the effects of tropical forest destruction are seen: the agents causing its decline but not the forces pushing them and the frequent international connection behind the scene. Encroaching cultivation by millions of poor landless peasants struggling for survival with axe, fire, and chain-saw is the main direct cause of tropical forest destruction. These transient agricultural subsistence activities and uncontrollable forest fires are very often accelerated by ill defined government resettlement, transmigration or colonization schemes or eased by forest roads left behind after selective wood exploitation has passed over an area. Contrary to the opinion of many authorities the latter activity in most cases has only a minimal direct impact on the persistence of tropical forests, if it is not repeated several times in short cycles.

On the other hand, clear-cutting of large forest areas for industrial uses (e.g. chipboard), conversion of forest land to extensive cattle-farming or for agricultural development schemes are often a major cause of tropical soil degradation. Other important factors within the chain of deforestation in the tropics are overgrazing and overexploitation of firewood, especially in the drier tropical zones, major industrial development schemes (e.g. hydroelectric dams), exploitation of mineral resources and finally urbanization.

REPERCUSSIONS OF DEFORESTATION ON DEVELOPMENT POLICY

Public awareness

Since the early 1970's tropical deforestation has become of growing concern to public opinion. The steps which led to this public awareness are well known. It were mainly popular versions of scientific studies and scenarios like Meadows et al.'s "*Limits to Growth*" (1972), Mesarovic & Pestel's "*Man at the Turning Point*" (1974), Gruhl's "*Plundering a Planet*" (1975), the report to the President of

the US "*Global 2000*" (1980) as well as the "*World Resources Reports*" (1987) of the Washington D.C. based World Resources Institute (WRI), which had a major impact on the public's opinion.

The awakened public awareness on environmental issues in general and tropical deforestation in particular has finally pressured politicians worldwide to act. One of the early results was the United Nations' Conference on the Environment in 1972 in Stockholm. More specifically tropical forest orientated was the "*Silva*" Conference of 1986 in Paris but also part of UNESCO's Programme on Man and the Biosphere (MAB), the World Conservation Strategy proposed by IUCN, UNEP and WWF, the Environmental Action Plan (EAP) of the World Bank and especially the Tropical Forestry Action Plan (TFAP) coordinated by FAO and prepared in cooperation with WRI, IBRD and UNDP, which was promulgated in 1985.

Recent events regarding tropical deforestation

Partly, as a result of public pressure and of lobbying by non-governmental organizations and by professional associations at present there is quite a multitude of plans and there are many recent and even sometimes sporadic political activities regarding deforestation in the tropics or concerning the field of tropical forest research. There has to be a certain concern that many of these praiseworthy initiatives are not well coordinated between each other. So dissipation of efforts may become a new danger in the battle to conserve at least part of the tropical forests.

Here is a list of the main events in chronological sequence:

- The German Foundation for International Development (DSE) in December 1985 organized a regional seminar for the French speaking countries containing tropical rain forests. The idea of this interdisciplinary workshop on "*Planning of Development and Utilization of Forest Resources within the Tropical Forest Region of Africa*" has been mainly to exchange experiences between foresters, agronomists and land use planners of the region and to prepare recommendations on future sustained management of tropical forests.
- A tropical forest research programme, initiated by the Dutch Government and called "*Tropenbos*", organized in October 1986 an international consultation in the Netherlands to formulate a programme of research activities mainly in the field of tropical silviculture and to suggest mechanisms for international cooperation to conserve and develop tropical rain forests.
- The Commission of the European Communities agreed to finance forestry research as part of its programme entitled "*Science and Technology for Development*". In 1987 the commission asked the French Centre Technique Forestier Tropical (CTFT) to prepare a study on the "*Contribution of Scientific Research to Forestry Development in the Arid and Humid Tropics*" as a basis for programming decisions. The study concluded that it was important to disseminate existing research information, e.g. by practical handbooks, to

establish priorities for research projects, to encourage cooperation between researchers, to establish an European Committee on tropical forests and to strengthen and develop research networks.

- The Committee for Forestry Development in Africa (CFDA) a technical co-ordinating group of European and North-American donor countries had a statement paper prepared in March 1988 by a consultant which advocated a concerted action and a better coordination in future between TFAP, CFDA an other donors in Africa.
- In November 1988 the International Tropical Timber Organization (ITTO) presented a pre-project report of five volumes on *"Natural Forest Management for Sustainable Timber Production"* which was prepared by the International Institute for Environment and Development (IIED). This in depth study was based on visits by consultants to all tropical wood producing countries, and with a bibliography of nearly 200 pages, it presents the state of the art in the 3 tropical regions Africa, Asia and Latin America. Some of its alarming main conclusions are:

  " Progress in establishing stable sustainable forest management systems in the tropics is so slow that it is having very little impact on the general decline in quantity and quality of the forest.*

  ** Comprehensive and urgent measures are absolutely necessary if the tropical timber trade is to continue in the long term to handle material which even approaches the quantity and quality that it has become accustomed to.*

  ** The future existence of large areas of tropical forest, and of the highly significant ancillary goods and services of the forests, depends equally on the establishment of sustainable systems of management, many of which must have timber production as their basis."*
- In a special session the advisory group of the IUCN Tropical Forest Programme discussed in Gabon in November 1988 a draft action plan for conservation of forests in seven countries of Central Africa.
- The second so called *"Bellagio"*-meeting of multilateral agencies, donor countries, foundations and participants of developing countries held in Southern England in December 1988 focussed primarily on strengthening tropical forestry research, through the dissemination of existing substantial forestry research knowledge, by establishing priority research areas and took favorable note of progress in research by IUFRO's Special Program for Developing Countries (SPDC).
- The World Bank sponsored Special Programme for African Agriculture Research (SPAAR) produced a report for its Tropical Forestry Working Group in December 1988 entitled *"Tropical Forestry Research - Problems, Perspectives and Donor Acceptability"*. This report suggests that efforts should be concentrated on the development of data bank of relevant research information and initiation of forest policy studies.
- In January 1989, the German Foundation for International Development (DSE) organized in Bavaria an International Symposium on *"Management of Tropical Rain Forest Utopia or Chance of Survival"* for discussion of case studies of tropical forest management in Latin America, Africa and Asia. The participants concluded that enough technical and biological information

is already available to implement basic forest management in the tropics but more research is needed for optimizing management and land use policy in general.

THE ISSUE OF TROPICAL DEFORESTATION IN GERMANY

The following is a review of the political and technical activities and discussions regarding tropical deforestation presently being conducted in Germany. This overview will be restricted to the last two years mentioning the most important events.

In my country public discussion has concentrated on deforestation in the humid tropics and the effects and repercussions of this decline in tropical forests on the world atmosphere, and its possible impacts on global climatic changes.

At the moment the most important activity at the political level consequently is the Study Commission of the German Parliament on *"Preventive Measures to Protect the Earth's Atmosphere"*. The commission pointed out in its first interim report (of nearly 600 pages published in late 1988) that it would specifically deal with the issue of tropical deforestation in a separate report. In order to be thoroughly informed about this topic the commission is holding three public hearings, each lasting two days, and involving the participation of a number of national and international experts, non-governmental organizations as well as representatives from the tropical countries and groups concerned. To prepare these hearings three extensive lists of questions were sent in advance to a large number of selected experts on:

A) The extent and causes of the destruction of Tropical Forests,
B) The climatic, ecological, sociological and economic effects of the destruction of Tropical Forests, and
C) The measures to protect Tropical Forests.

It has to be mentioned that this is only one, certainly the most important commission of the German Parliament concerned with tropical deforestation; there are two other sub-commissions and a third of the leading political party which are discussing the same issue. In January 1989 the German Parliament discussed 3 different motions on the issue tropical deforestation.

Moreover, the German National UNEP Committee had already organized in December 1988 a special hearing to revise a position paper entitled *"The Rescue of the Tropical Rain Forests"*. Two months earlier in plenary session in Munich the German Forestry Association had passed unanimously a resolution on *"Forest Development Policy"* which has had a very positive response from ministries and government institutions concerned.

At the technical level in the past our Ministry for Economic Cooperation (BMZ) has financed three major studies on forestry development in tropical countries. The first one has already been mentioned at the beginning of this presentation, the state-of-knowledge report *"Conservation and Sustainable Use of Tropical Rain*

Forests" (1986). Another research project was financed to study "*Results and Conditions for Success of Reforestation Projects in Developing Countries*" and a last one is entitled "*Cross-section Evaluation of 16 Development Projects with Forestry Components*".

The executing agency of the German Technical Assistance programmes, the German Agency for Technical Cooperation (GTZ), is trying to develop an economic scanning pattern for projects in the forestry sector, and has recently presented a paper on "*Communal Wildlife Management*" in Africa. The latter is certainly an important but still inadequately used chance to halt deforestation specifically in semi-arid tropical regions.

Finally the bank responsible for the financial assistance of the German Government, the Credit Institute for Reconstruction (KFW), commissioned a policy paper on "*Conservation of Tropical Forest Resources by Financial Cooperation*" to a consultant in tropical forestry at the beginning of this year. The main reason for this commission has been the fact that the bank had to invest by order of the German Government more than 166 million US$ in projects to conserve and develop tropical forests but did not have forestry expertise in its staff.

CONCLUSIONS

Deforestation or development in the Third World is the topic of this interdisciplinary and international seminar. The rapid decline of the area of tropical forests within the recent decades is a fact which has startled the public opinion and politicians alike.

This public awareness of the world wide impact of tropical forest degradation and the political will to control deforestation which we find at present especially in Europe and North-America is a irretrievable chance we now have. To induce development by sound sustainable management of tropical forests is a challenging endeavour for foresters of countries with a long standing tradition in forestry and forest research. It is one of our tasks to demonstrate to political decision makers and land use planners that there are operational concepts for the preservation and sustainable use of tropical forests if the real economic value of tropical forest resources is taken into account.

But, at the same time we have to point out that forest professionals can not solve the problem just by technical measures. We should stress the urgency of political and socio-economic changes at the international level as well as in tropical countries concerned which are the basic prerequisites for controlling the actual pace of deforestation.

To be successful foresters have to cooperate in future much more than it has been done in the past with other professions in an interdisciplinary way. Within our profession there has to be a much stronger national, bilateral and international coordination in issues regarding tropical forest development to avoid duplication of efforts and waste of financial resources.

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TROPICAL FOREST CONSERVATION AND PROTECTION: POLITICAL ISSUES AND POLICY CONSIDERATIONS [1]

Franz Schmithüsen [2]

ABSTRACT

The paper emphasizes political aspects of forest conservation with regard to public awareness, involvement of the local population and socio-economic compensation. It summarizes policy issues related to natural resources protection, and forest development. Its final part deals with inconsistencies of present land development policies and the critical mass of international action required for a comprehensive approach in tropical forest conservation.

Key words: forest policy, tropical forest conservation, deforestation.

FOREST CONSERVATION AS A MAJOR POLITICAL PROBLEM

Complexity of the Issues Involved

The complex issues of forest conservation, natural resources protection and sustained forest production in the tropical forest zone require a thorough analysis of the available factual information as well as an interpretation of the numerous interlinkages between political, economic and social aspects. Moreover, the specific situation of the tropical forest resources, the future rate of deforestation and the opportunities for an improvement of forest conservation and utilization vary from country to country.

The following statements are not meant to replace such an analysis. They summarize some fairly elementary issues which emerge when one asks oneself, why are tropical forests destroyed or misused in spite of ample evidence that such a behaviour is harmful and short-sighted, and that it is followed by unproportionately high direct and indirect costs which must be borne by the present and future generations.

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[1] *This papers is based on statements made by the author at the public hearing on the destruction of tropical forests of the Committee on Agriculture of the Council of Europe on March 9, 1989 in Lausanne, Switzerland.*

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The statements point in particular to the fact that the problems involved go far beyond sectorial forest policies, that they imply major political decisions at the national and international level, and that it will be a very long process demanding a whole range of actions and considerable investments if something is to be changed for the better. The statements are mostly opened in order to provide a basis for discussion. As all general observations on a highly complex material they would have to be differentiated and elaborated if applied to particular conditions. There exists considerable literature which may be consulted for a more detailed argumentation. Among the more recent bibliographies which facilitate access to the available documentation, the ones in Palo and Salmi (1987 and 1988), and that in Repetto (1988) may be mentioned.

Political Aspects of Deforestation

Decisions and actions which lead to wasteful use and to the destruction of tropical forest ecosystems are national, regional and local ones in the countries concerned. They are determined by short sighted economic consideration, justified frequently for social reasons and part of clearly stated or of unreflected options of the prevailing political decision making process.

To my knowledge there exist at present only a few examples where tropical forest ecosystems have been conserved in their primary stage in areas which are accessible to forest exploitation and/or to agricultural uses. The borderline between untouched tropical forests and the steadily advancing zone of deforestation *is the borderline of physical accessibility*. This implies that the decision to open up forest areas with large scale infrastructural investment in road building, railway construction, river access and port improvement is de facto also a decision to speed up the process of deforestation. *Admittedly many of these decisions do not aim at such a process.*

There exist short-term economic and financial benefits which result from timber utilizations and from the subsequent forest destruction. In a national context these benefits may be small and in comparison to the long term socio-economic consequences they are certainly very costly. But the benefits are real, in some cases substantial, quickly to realize and they can contribute to the solution of pressing social, economic and political problems. The private and public financial benefits resulting from creaming off valuable tropical timber species, the existing or artificially induced pressure for more land for agriculture and pasture, and the possibility to transform publicly owned forest land into some form of private land tenure during the deforestation process are powerful reasons against the preservation of accessible forest ecosystems. From a conceptual point, such an evolution could be counterbalanced by appropriate policy, planning and implementation measures.

It is the weakness of the political system and its lack of regional and local participation which does not allow the population to articulate their interests. These may well be in line with a consistent conservation of the forests in their surroundings. On the other hand, it is that same weakness, which does not provide

social and economic compensation to local people if forest conservation for national reason is not, or at least seems not to be in their immediate interests. And it is the lack of awareness of the long-term social and economic consequences of large-scale deforestation, and the weakness of the institutional framework for an efficient long-term and integrated land management that lead to the negative results which one must recognize in countries that still have larger zones of untouched tropical forests.

Political Aspects of Forest Conservation

The conclusions which may be drawn from the briefly described reasons for the process of deforestation are manifold. The following are singled out for the purpose of the discussion.

It *requires important political decisions at the national level* if the remaining area of untouched tropical *forests should be preserved totally or partially*. Tropical forest conservation has only a chance to succeed if it is treated as one of the vital problems in the countries concerned. Forest conservation is *a matter of national politics* and not only of governmental *policies*.

A change in the ongoing process of forest destruction can only result from modifications of the economic and social perspectives for national, regional and local use of the remaining forests. Such change must be based on a more realistic evaluation of short-term benefits versus long-term costs and of the losses of the natural resources potential. This requires a change in public awareness and a reassessment on all levels of the political decision-making process of present sector policies.

Decisions on tropical forest conservation go far beyond the conventional forest sector and even beyond the usual efforts for integrated rural development. They are part of the central issues of environmental conservation and long-term national development. Primary tropical forest ecosystems, which for what ever reasons should be preserved, must remain inaccessible.

National political decisions on tropical forest conservation cannot be made or at least cannot be effectively implemented if they are not understood, accepted and supported by the population which is directly or indirectly affected by them. Decisions on forest conservation must be coupled with decisions on compensation for the foregone benefits from forest destruction. Such socio-economic compensations are of utmost importance for the consent and active involvement of the rural population in tropical forest conservation programmes.

Where the need for a large-scale conservation of tropical forest ecosystems is principally of concern to the international community and goes - at least at the present stage - beyond the national perception, the problem of compensation becomes an international one.

POLICY ASPECT OF FOREST CONSERVATION AND DEVELOPMENT

Change of Sectorial Policies

The following list of issues and suggestions is a fairly long one and could obviously be made much longer. It contains statements which could be used not only in the context of forest and forestry but in many other fields. One of the important points which comes out of a summary of necessary measures seems to me, the following one:

We must stop looking at the still existing tropical forests as a gift of nature only, and on its destruction as a fait-accompli, which we can notice in annual statistics and deforestation scenarios. If we change our approach, we will realize that there are many very specific reasons for the presently ongoing process of forest destruction. We will also realize that it takes the same effort as in any other field of development to redress the situation, both at the national and international level.

In this respect, the present worldwide concern about the destruction of tropical forest as a process of growing awareness is necessary and helpful, but certainly not enough. It will require fundamental political decisions by the governments of the countries concerned well as by the international community, if anything at all should be achieved in government policies, and not only in the forest sector itself. It will require massive efforts of investments, institutional strengthenning, education and research in order to stop the process of deforestation and to give positive momentum to the use of trees and forests.

Only if we start to look at forests and forestry as at any other renewable resource and productive sector, will it be possible to implement political decisions, policies and programmes. We will then discover that the scale of the necessary efforts are entirely comparable to those of which we know in agricultural development, public infrastructure and urban development or in the realization of industrial and technological achievements.

Forest Conservation

- Monitoring of annual deforestation rate by major categories of forest ecosystems.
- Evaluation of the negative economic and social impacts of deforestation and of the positive effects of forest conservation.
- Feed back on the monitoring and evaluation results to the national political system and to the governmental policies related to natural resources conservation.
- Creation of a positive land-use status for primary forests to be preserved e.g. in the form of totally protected ecosystem reserves, nature reserves, national parks, national monuments.
- No public investment in order to improve the accessibility of such areas if it threatens the existence of the protected forests.

- Revision of existing land tenure regulations and practices which allow the de facto change of public ownership of forest land into private land after deforestation.
- Revision of land use concepts which imply, that reforestation programmes can be a cheap and politically attractive substitute to the efforts of implementing conservation programmes for primary forest areas.

Natural Resources Protection and Integrated Land Use

- New concept of the protective values of forest land in relation to agricultural and infrastructural development in adjacent areas.
- No public investment in agriculture, pasture and irrigation development as well as in road construction, river improvement, hydrological development and tourism if the necessary protective functions of the adjacent forest cannot be ensured on a sustained basis.
- Massive promotion and investment in agroforestry programmes and increasing integration of such programmes into agricultural development projects.
- Complementary investment in adjacent forest land in relation to agricultural and rural development projects.
- Complementary measures in land rehabilitation and watershed management programmes for already degraded forest areas in order to protect the development areas for agriculture and the existing public infrastructure.

Forest Resources Development

- Combined policies for conservation of remaining primary forest ecosystems and for forest resources development.
- Systematic participation of the rural population in the political decision-making process on forest resources conservation and/or development.
- Economic and social compensation for the local population in connection with forest conservation programmes in particular, through increase investment in other areas for forest, agriculture and infrastructural improvements.
- New concept of the present and potential contribution of forestry in particular with regard to combined agriculture and forestry production systems, agroforestry, rural forestry for wood energy, protective values of forests and with regard to the recreational and cultural aspects of trees and forest land.
- Specific investment in multipurpose forest development programmes related to the use of primary forests, reforestation and land rehabilitation.

Sustained Forest Production

- Change of the concept that forests are an exploitable resource yielding principally short-term benefits.
- Acknowledgement of the fact that, as any renewable resource, forests and forestry development need massive reinvestment or new investment in order to provide protective values, sustained timber production and other long-term benefits for rural communities.

- Acknowledgement of the need to measure the necessary replacement costs against the anticipated short term benefits from timber harvesting in primary tropical forests.
- Denial of forest exploitation and timber harvesting rights in forest areas in which such exploitation is the start of an uncontrolled deforestation process.
- Denial of timber harvesting right in areas set aside for long-term forest production if the rational use of the available raw material and the necessary reinvestment in sustained forest production cannot be ensured.

Institutional Strengthening

- Revision of existing forest laws and regulations but also of land and agricultural legislation in order to remove discriminatory rules against improvements of land use, forest protection and forest development.
- New concepts for the role of public forest administrations as agencies providing assistance and services to the rural population and as agents for promoting the sustained use of the existing or of new forest resources.
- New concept of the contribution of other public administrations concerned with the rural space, and in particular with agricultural development, to the protection and development of forest land.
- Reorganization, build-up of the managerial capabilities and investment for the necessary facilities and operational means of public forest administration and of other governmental services engaged in forest development operations.

Education, Extension and Research

- Build-up of forest education systems at all educational levels and for all aspects of forest conservation protection and production.
- Integration of substantive elements on the importance of forests and forestry at all levels of the agricultural educational systems.
- Build-up of forest extension and educational programmes related to the importance of trees notably forest and forest lands.
- Build-up and investment in research systems related to forest conservation, sustained forest production, and to combined agricultural and forest production systems.
- Strengthening of socio-economic research on the importance of trees, forests and forest land, and on the obstacles to their rational use and sustained development.

IMPLICATION AT THE INTERNATIONAL LEVEL

Inconsistencies of Present Policies

In many cases international action may have a considerable impact on the overall national economic development and on development planning. Large-scale investment programmes on public utility infrastructure, agriculture, forestry and forest industries as well as technical assistance projects act as a focal point or

initial force for the change or expansion of national policies, programmes and projects. Moreover, such action tends to absorb significant national resource in the commonly envisaged policies and programs.

In this respect, the existing or potential inconsistencies that one can observe between international action related to natural resource utilization and the equally advocated objectives of tropical forest conservation may have unintended but far reaching negative effects. Just to quote a few and fairly elementary examples. It is inconsistent, for instance, to advice the countries with tropical forest resources, to increase rapidly tropical timber exploitation for exports and balance of payment reasons, if the most apparent results are environmental degradation, and waste of valuable raw material. Other considerable external costs may frequently be connected to the short-term, usually private, benefits from such and exploitation.

Furthermore, it is inconsistent to finance major access roads which open up new tropical forest areas and to advocate at the same time environmental concern, if an efficient operation in order to preserve part of such forest ecosystem is not foreseen. It is inconsistent to spend considerable national and external funds to build hydroelectric installations, reservoirs, or to invest in costly agricultural and irrigation projects, if, on the other hand, the complementary funds for ensuring the necessary protective functions of the adjacent forest land are not available or not even thought of.

It is inconsistent to accept the ongoing forest destruction in the same area of a country in which costly and in part externally financed projects for reforestation are made in order to ensure the future timber supply. It is inconsistent to launch projects for rehabilitation against the expanding soil erosion on one hill and to face the ongoing deforestation on the one opposite. It is inconsistent to carry out detailed forest inventories on the available timber stock for building up of forest industries, if the inventoried forests have a major protective role to play and/or will be destroyed shortly after. It is also inconsistent to invest heavily in forest plantations, if at the same time no funds for replacement costs in neighboring natural forests that have been logged, will be made available.

Just by avoiding some of these inconsistencies a substantial contribution to an improved natural resources utilization could be made. But this will not be easy. It calls for a fundamental change of thinking on the side of development economists and natural resources planners, because it means looking at the tropical forests in their own right and not as a marginal residual of the rural space which are bound to disappear.

It also calls for a systematic assessment of the present and future role of trees, forests and forest land before national and regional development is planned for environmental impact studies in connection with infrastructural projects to be carried out in forested areas, as well as for a more realistic distinction between the planned targets and the actual results of internationally financed natural resources projects.

Dialogue with Governments

The growing preoccupation of the international community can only make significant contributions to the conservation and better use of tropical forests if it leads to an increasing awareness in the countries concerned. More specifically, it should, in order to determine which areas of primary tropical forest ecosystems shall be conserved, which forests are to be maintained for their important protective functions and which other forests and forest lands are to be developed for sustained production of firewood, timber and other goods and services. The central element of such a dialogue is obviously the question of to what extent multilateral and bilateral donors and the international community as a whole can effectively support such national programmes and regional or local development projects.

The technical assistance and investment programmes related to forests and forestry have experienced a considerable change during the last two decades. In view of what has been indicated in the previous chapter, it is obvious that this change must continue both from a conceptual point of view as well as in terms of magnitude, size of available funds and time periods committed to such programmes.

As an illustration of what could be understood under the concept of forestry programmes directed to forest conservation and improved forest resources utilization the following examples are mentioned:

- Forest conservation programmes aiming principally at demonstrating the need, usefulness and possibility of preserving certain forest ecosystems in their primary stage, assisting in the necessary participatory process for national and local decisions, and supporting compensatory investments in adjacent areas.
- Forest utilization programmes focussing more consistently on sustained protection of timber, firewood and other goods and services.
- Programmes on forest, soil and water protection including watershed management and rehabilitation of forest lands.
- Rural forestry programmes providing an increased output of firewood, fodder, food production and other goods.
- Agroforestry programmes using systematically the use of trees and shrubs as a complementary element for an improved production in agriculture and grazing.
- Programmes related to wildlife management, national park development and nature conservation.

One point should be underlined in the context of such programmes. The protection or use of tropical forest ecosystems is particularly complicated, and all of the real issues are related to human customs, perception and attitudes, as well as to the daily preoccupation of rural people in order to ensure their livelihood.

This means that such programmes are difficult, their success uncertain, long-term by nature and much less attractive from a short-term success point of view than many other programmes.

Critical mass of international action

If one considers the present structures and the volume of technical and financial assistance to forest conservation and development within the international system, one becomes quickly aware that it is almost insignificant if measured against the total volume of assistance. The intention to redress the situation of tropical forest destruction thus implies the need to reason on the critical mass of international action that would be required in order to make some meaningful impact. The Tropical Forestry Action Plan gives some global indications for such requirements. But these are only rough aggregates which may need considerable modifications when it comes to a real programme for reducing the pace of tropical deforestation.

There is also the question of the critical mass of professional expertise on forest conservation and forestry development, that is required in those countries that plan increased development programmes. There exists a very substantial shortage of professional staff that is required to design, launch, implement and monitor such programmes. The lack of qualified professionals and the lack of sufficiently staffed forestry units in the international and bilateral development agencies is at present one of the major bottlenecks in promoting more forcefully the conservation of tropical forests within the international system.

This raises another point which is the weakness of research in most of the European countries on tropical forests and in particular on the socio-economic aspects of their conservation and utilization. A similar argument refers to the educational side and to the possibilities to train and specialize qualified professionals in these fields. *Both aspects are obviously connected.*

It is regrettable that the tremendous efforts, which were made some 20 to 30 years ago in the field of tropical forest research and education has not grown and sometimes has even diminished. At a time when there is a real opportunity to develop a new approach to forests and forestry in the context of the technical and financial international assistance, the expertise in forestry and related subjects is more limited than ever. This situation calls for a considerable strengthening of the European research and educational capabilities on the manifold aspects of tropical forests.

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CONSERVATION THROUGH THE LOOKING GLASS: THE CASE OF CENTRAL AMERICA

Gina C. Green [1]

ABSTRACT

The paper briefly summarizes the environmental, social and economic factors which prevent conservation from achieving recognition as an established land use practice. The central contention, however, is that many problems that beset conservation projects are the result of contradictions and inconsistencies in the project cycle, chiefly in the realm of donor-recipient relations and project expectations. Attention is drawn to some of the more common areas where problems arise, and tentative approaches to the allocation of these problems are sketched.

Key words: Central America, conservation, sustainable development, projects, donor/recipient relationship.

INTRODUCTION

At the heart of the world conservation movement lies a recognition, whether based on aesthetic or scientific arguments, of the importance of preserving and protecting the remarkable diversity of the planet on which we live. Central America is in the vanguard of this movement, for despite its size, (the entire Isthmus is only 540 000 km^2), its location between the Americas ensures that it acts as a land bridge and mixing ground for flora and fauna from both north and south (Fig. 1). It is this geographical quirk of fate that makes Central America one of the most varied and biologically rich regions in the world. Costa Rica and Honduras, which in this regard are representative of the region, house over 9 000 vascular plants, 100 mammals and 700 species of birds (Campanella & et al. 1982, Hartshorn & et al. 1982). Even the relatively small forests have assumed a great importance.

Approximately 80 percent of the pine species used in tropical reforestation programmes throughout the world originate from Central America, the Caribbean and Mexico.

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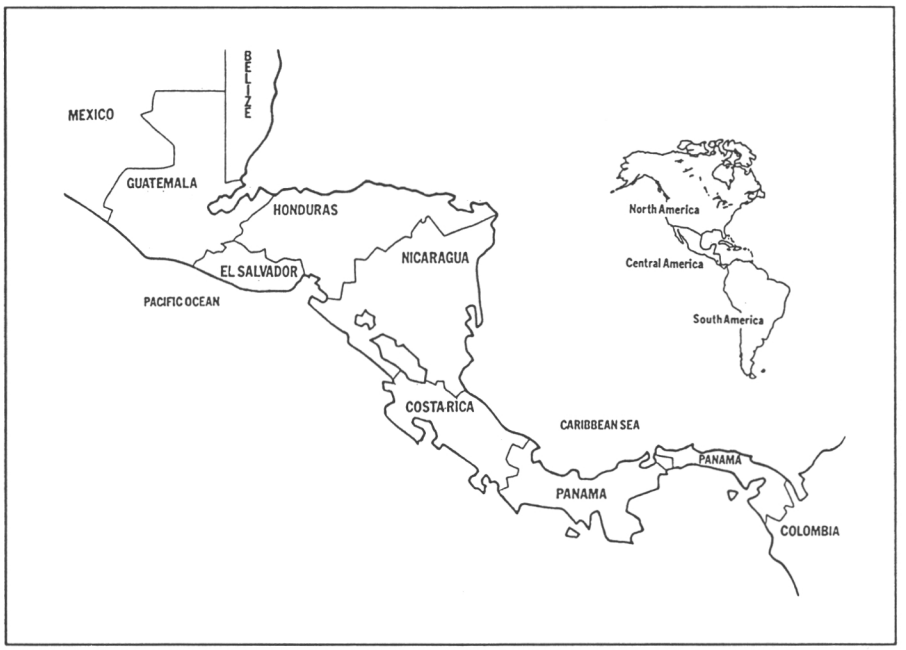

Figure 1. Central America: a land bridge between the Americas.

The conservation movement has made tremendous advances since systematic conservation was initiated at an IUCN conference in Costa Rica in 1974, where it was agreed to establish pilot parks in six of the seven countries.

Since then, numerous protected areas have been established all of which, despite differences in nomenclature, conform to IUCN's ten management categories, as follows:

IUCN category

1. Scientific Reserve
2. National Park
3. Natural Monument
4. Biotope or Biological Reserve or Wildlife Sanctuary
5. Cultural Monument
6. Interim Reserve
7. Anthropological Reserve
8. Forest Reserve
9. Biosphere Reserve
10. World Heritage site



Figure 2. Wildland areas of Costa Rica.

Costa Rica leads the field in this regard and has designated 10.3 percent of its total land mass as wildland areas (Fig. 2), (Boza 1987). But success has been well distributed, and since 1974, the number of protected areas in the region as a whole has grown by 800 percent to approximately 350 conservation units (Barborak 1987).

DEFORESTATION THREAT

But while this dramatic growth in the number of protected areas is obviously desirable, and while it is a fair reflection of growing international awareness about the dangers of deforestation, the success of the conservation movement should not be measured solely by the number of parks and reserves. In the first place, little has been done to stem the tide of deforestation. FAO figures reveal that between 1970 and 1980 15 percent of Central America's forests, an area approximately equal to the size of Belgium, were destroyed (Leonard 1987). The current rate of destruction is estimated at 3 percent per annum.

Secondly, and more significantly, the steady growth in the number of parks and reserves has created the illusion that stretches of forest have been rescued from the onslaught of shifting agriculture. But there is an enormous gulf between legislating reserve status and enforcing it. Honduras and Guatemala, for example, struggle to manage two national parks apiece, while their numerous other protected areas are by and large abandoned to their apparently inexorable fate.

Indeed, the bitter truth is that throughout the isthmus many parks and reserves exist on paper alone, and the assault on the forest is often as severe within the parks as without. And this despite the large amounts of money that are invested annually by national and international bodies to prevent precisely this eventuality.

There is a tendency among beleaguered conservationists to attribute the problems that beset their efforts to forces beyond their control. There is unquestionably much truth in this assertion, as should be evident from even the most cursory glance at the international section of any respected newspaper. The social and economic conditions of Central America hardly provide the ideal setting for a conservation movement. The engine of forest destruction is rapid population growth. The population now stands at more than 25 million, but at the current growth rate of 2.8 percent per annum it will double by the end of the century; already more than 44 percent of the population is under the age of fifteen (Leonard 1987).

The situation is compounded by economic and political instability. Central America has experienced recession since the early 1970's, when inflated oil prices and the decreasing value of the chief exports created economic hardship. In 1977, for example, Costa Rica exported 26 kilos of coffee to buy one barrel of oil, in 1981 it had to export 130 kilos for that same barrel (Leonard 1987). Beef production too has increased 9 fold to compensate for changing world market conditions (Williams 1987). Simultaneously, the willingness of foreign banks to dispose of their petro-dollar balances in the form of loans to Central American governments has created huge public debts that can only be serviced through increased sales abroad, at a time when the terms of trade continue to disadvantage primary producers.

The need to grow more just to maintain the standard of living has fueled the demand for both arable and pasture land. The economic downturn, coupled with rapid population growth and the historical pattern of land ownership, has created an army of dispossessed campesinos which has tripled in size since 1960, and there is little prospect of improvement (Leonard and Nations 1986). Most of the land is privately owned by a wealthy elite - in Guatemala 80 percent of the farmland is held by 2 percent of the population - which specializes in cattle ranching. They have already brought 65 percent of the agricultural land under pasture, and miss no opportunity to expand (Nations and Komer 1987, Green and Hyland 1989). Those peasants who do not wish to join the ranks of the urban poor, have no choice but to migrate to the virgin forests which they clear and cultivate. But lacking the legal title that would allow them to take advantage of government land improvement schemes, they are forced by declining productivity to move again, leaving behind a trail of destruction. About 400 000 ha of forests are cleared in this fashion annually (Nations and Komer 1983).

It is, however, unquestionably the case that many of the errors that afflict conservation and natural resource management projects are of their own making. They are the product not of wider socio-economic conditions, but of inconsisten-

cies and inadequacies in the projects themselves. All projects are composed of elements which, taken together, comprise the project cycle, these include project selection, timing, funding, planning, implementation and monitoring. In almost every case, the failure to achieve the stated goals can be attributed to a breakdown in the logical sequence of developments that, in theory, comprise the life of a project. It is my contention that if conservation is to have a long-term beneficial impact, then the people who are invested with responsibility for the design and implementation of projects must arrive at a more sophisticated and systematic understanding of the difficulties that can arise at the various stages of the project cycle, and of the steps that can be taken to prevent and alleviate them. The object of the rest of this paper is to point to three of the areas in which problems most commonly arise, and to suggest ways in which they might be averted.

DONOR - RECIPIENT RELATIONS

The first series of problems that arise can be classified under the heading of Donor-Recipient relations. Problems in this area normally result from a failure on the part of the contracting parties to establish an identity of understanding both on the precise objectives of the project, and the manner in which it is to be put into action. During implementation, it transpires all too often that the donors and recipients have developed radically different interpretations of the project plan. This, in turn, is a reflection of the fact that each institution is motivated by distinct political and financial considerations, all of which heavily influence their attitude towards conservation generally.

Donor agencies, for their part, provide funds for particular projects for a specified period of time, and naturally expect that the money provided will be used to meet the project targets within the funding period. Implementing agencies, on the other hand, are motivated by different criteria; their concern is not to disburse funds but to acquire them. Agencies like CATIE[2], for example, which are dependent on external funding, must acquire as broad a base of support as possible, even at the cost of exaggerating their expertise and misleading donors. It would be easy to condemn this as a fraudulent practice, but that would be to ignore the structural necessity for such agencies to adopt a floating system of priorities. Their attitude towards any given problem must be governed by broad considerations which, on occasion, may demand a significant alteration to short term plans.

Such conflicts of interest, by fostering an atmosphere of mistrust and frustration between the key participants, pose an obvious threat to the success of the conservation movement. They could perhaps be avoided if conservation planning was subjected to the rigorous scheduling that characterizes other development work. But such an approach is, in my opinion, unsuitable to conservation. A

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[2] *CATIE acronym for the Tropical Agriculture Research and Training Centre in Turrialba, Costa Rica*

viable solution will only emerge when implementing agencies are relieved of their financial dependence on the donor agencies, and are able to concentrate their energies on the task in hand.

PROJECT PROPOSAL

A different set of problems arise under the general title of Project Proposal, the first of which is Problem Identification. Conservation project designers often fail to employ sufficient rigor when formulating the precise issue that they intend to tackle. All too often planners are obsessed by the problem confronting them, and allow themselves to be swept along without considering if the desired objectives are within their means. It is ultimately self-defeating to create diffuse umbrella projects that aspire to solve a complex of problems, but which degenerate through a lack of direction and at the end of the day accomplish next to nothing.

Equally problematic, is the case where project designers oversimplify the problems before them, and fail to address the underlying social and economic causes that alone would make a solution possible. Take the case of a project proposal with the single objective of evicting alien invaders from a protected area. The condition is far more complicated than the project proposers anticipated, and simple eviction would be a completely inadequate response to the problem of slash and burn agriculture. Any permanent solution requires the active support of the local community, and this can only be achieved over time through the implementation of a range of education and eco-development schemes illustrating the benefit of the reserve or park to the local community.

A secondary issue that must be mentioned here concerns the relationship between project life and project funding. At one level what should be two distinct issues are rendered virtually synonymous by the financial dependency of projects which can only survive for as long as the donor is willing to advance funds. It is unfortunate that, on occasion, projects are bankrupted by forces beyond their control - as was the case fairly recently with USAID sponsored projects in Panama when the government in Washington took the decision to suspend aid to that country.

But of more immediate relevance is the case when donors grant funds for a stated length of time in the expectation that the projects will achieve financial self-sufficiency within the funding period. USAID, for example, financed the Fundación PA.NA.MA.[3] project for five years on the understanding that, at the expiration of that period, the foundation would be self-supporting. But, this was an unrealistic expectation; Panama has no tradition of private support for conservation activities, and self-sufficiency could only have been achieved through a fundamental change in Panamanian society that was clearly beyond

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[3] *Fundación PA.NA.MA. Fundación de Parques Nacionales y Medio Ambiente: A Panamanian conservation foundation.*

the scope of the project (Green and Hyland 1989). This raises further questions about the nature of donor-recipient relations that must be solved if long term conservation projects are to succeed.

THE PROJECT PLAN

The Project Plan, as distinct from the Project Proposal, has for the purpose of analysis to be subdivided into four sections: Planning, Appraisal, Purpose, and Objectives and Goals. In each of these areas conservation projects encounter difficulties that frustrate the realization of their objectives. Problems will often arise if the task of planning the project is entrusted to individuals who, whatever their technical expertise, are unfamiliar with local conditions. For example, although it seems an elementary oversight, the project document for the six million dollar USAID sponsored Tropical Regional Watershed Management Project was written in English and never translated into Spanish, even though this was the *lingua franca* of the implementing team, and the only language of the Project Manager.

Errors of this sort may seem trite, but they can have the most serious consequences, and they occur time and again. A safety net to catch such mistakes is built into the project cycle in the form of a Plan Appraisal stage which donor agencies are supposed to conduct prior to implementation. But, here again, the cycle breaks down, and in several cases inappropriate management plans have reached the implementation stage because donors, whether for financial considerations or as a result of staff shortages, have failed to carry out essential feasibility studies.

In view of this breakdown in the Project Cycle, it is not surprising that serious problems arise during implementation. One recurrent difficulty concerns the long-term purpose of the plan. Granted plans should be ambitious in scope, but it is also manifestly evident that they must be in line with the social and economic conditions of the implementing country, if they are to have any chance of winning public support. Fortunately, the unrealistic ambitions of the project's purpose are sometimes compensated for by the project team's decision to pursue concrete and realistic objectives and goals vital to the success of the project.

Generally speaking, the population of Central America is resistant to the basic dogma of the conservation movement, and this places on the conservationist the burden of demonstrating the tangible benefits of conservation to the native population. Grassroots development projects like the Gandoca Manzanilla Integrated Sustainable Development[4] project have been successful in this regard, but in many cases conservation projects have failed to change local land use practices because the implementation team pursues goals beyond its capabilities and resources.

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[4] *Gandoca Manzanilla Sustainable Development Project is an integrated development and conservation project implemented in Talamanca of Costa Rica.*

CONCLUSIONS

The results of my research in Central America suggest that the conservation movement faces an uphill struggle in its efforts to conserve the remarkable diversity of this narrow belt. In the first place, the conscience of conservation is located primarily in the first world, and has been imposed on a skeptical Central American population. This gulf between the cultures, whether it is termed an industrial-pre-industrial conflict, or a north-south divide, is expressed in many ways, the most obvious of which is the donor-recipient relationship, which has clear parallels with the paternalism of 19th century imperial rule.

Moreover, the economic circumstances of Central America dictate that deforestation will continue unchecked, despite the best efforts of conservationists. Nevertheless, it is evident from the projects that have been implemented successfully that the good intentions of conservationists can yield remarkable results if implemented in a controlled and considered manner. At present, however, too many of our efforts fail through negligence and poor project design. Perhaps if more resources were channeled into research on the theory and practice of conservation projects, we might find that we already possess many of the ingredients for success.

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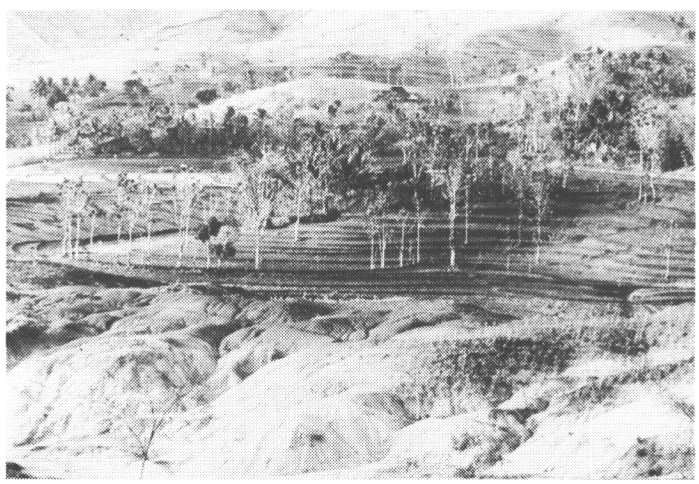
PART V

DEFORESTATION

AND DEVELOPMENT



Deforestation, non-sustainable agriculture and erosion. Photo courtesy of FAO Forestry Department.

TROPICAL FORESTS AS NON-RENEWABLE RESOURCES: THE THEORY OF OPTIMAL EXPLOITATION

Ole Hofstad [1]

ABSTRACT

In certain cases tropical rain forests can be considered non-renewable in practical terms. Exploitation of their timbers can be understood in terms of the theory of economic exhaustion. If alternative timber is available at a higher price, optimal exploitation of the rain forest will exhaust the resource at the point of time where the prices of the two categories of timber are equal. If cost of exploitation increases as the resource becomes scarce, it can be optimal to leave the most inaccessible parts of the rain forest unexploited. If social costs of exploitation are higher than those experienced by the exploiter, or the social value of the forest is higher than the market price of its timber, the optimal policy of the society can be conservation of the remaining rain forests.

Key words: non-renewable resources, rain forest exhaustion, optimal exploitation.

DEFINITIONS AND EXAMPLES

Risvand (1979:46) defines non-renewable natural resources as reserves that cannot be increased, but can be exhausted or destroyed. They consist of material which has been created and concentrated in large, continuous occurrences over very long periods. This description fits mineral and oil deposits better than virgin, tropical rain forests, but is not all irrelevant to the deforestation of the latter. The definition also corresponds to Hotelling's (1931) term: exhaustible resources. Herfindahl & Kneese (1974), however, write that exhaustion should be viewed as a process taking place over time. Exhaustion occurs when cost rises to the point at which none of the product is demanded. This point is dependent on the demand for the product and the cost of exploitation, which in turn depends on technology and prices of inputs. The idea of this paper is to combine the economic theory of exhaustion with the problem of tropical deforestation.

Grφn (1931:385-400) defined three types of forestry:
i) exploitive forestry, which exploits what nature gives free, ii) conservatory forestry, which maintains a given state of the forests, and iii) reproductive

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forestry, which is sustained utilization of the productive forces of land and trees. He also divides forest resources in two categories: a) sub-marginal ones where costs of exploitation are above the price of wood (P<C), and b) marginal and intra-marginal ones where costs of exploitation are equal to, or below, the price (P≥C).

He also gave some geographical illustrations: "*In Siberia, Canada, and even more so in the tropics there are still (1931) extended forests where both standing trees and land are sub-marginal. As late as 1880 even the forests of northern Sweden could be put in the same category*". Streyffert (1938:137) still considered the forests of the least accessible parts of northern Sweden to be exploited rather than under sustained management during the 1930's. Grφn continues: "*On the Malaga peninsula, in Brazil and in other overseas countries where rubber, cocoa, coffee, or cotton plantations are established, or land is cleared for other purposes, virgin forests are burned without any concern of the utilization of available wood. This must be taken as an indication that the wood resources are sub-marginal, while land is intra-marginal. In the USA 34 mill.ha of fallow, deforested land indicate that there have been and still exist intra-marginal wood resources on sub-marginal land. The forests of Swiss valleys are examples of intra-marginal wood resources on intra-marginal land since there is a sharp conflict between foresters and internal colonization movements demanding these forests cleared*". It is not difficult to see how these zones have moved across the globe since then, but the fundamental economic reality behind the definitions is still tangible.

Forests are normally considered as a renewable resource. Most forest planning is based on this assumption. Early forest economists did, however, discuss the economics of exploitive forestry as distinct from sustained forestry. Streyffert (l.c. :154) compared the forests of Swedish Lappland to the iron ore of the same region: "*We readily discuss the way of giving these mineral resources their maximum value. This is fundamentally a question of speed of exploitation. In the same way the question of the 'unprofitable' forest in the north mainly is a matter of the optimal period of exploitation. The problem, in both cases, is to adapt this period so that maximum capital value is gained from the natural asset in question*".

Decisions on harvesting tropical rain forests are often made on the assumption that they are non-renewable in practical terms. This is partly due to their complex regeneration processes which are not well known and extremely difficult to imitate and manipulate. However, the assumption that virgin rain forests are exhaustible is never completely true. They have probably reached a climax stage in which increment equals natural die-back, at least if the area in question is not too small, but seeds sprout and saplings grow when trees are cut by man. If clearfellings are practiced, the topsoil may be eroded and regeneration made impossible for long periods in certain places. If selective felling is carried out, regeneration is often better, although not always easy. If the wood resources as well as the land are intra-marginal, peasants and farmers would be interested in utilizing the area. In such cases road construction and commercial exploitation open up the forests for cultivation or grazing. Forest regeneration is then effectively hindered. Therefore, non-renewability is not absolute, but quite often a

reasonable description of the actual situation. Sometimes rather fundamental changes of social conditions are required to alter this fact.

EXTRACTION IN A FREE MARKET

We shall look at the economic theory of the exploitation of non-renewable resources (Førsund & Strøm 1980), and interpret the results in view of the implications they may have on forestry. Let us assume that a supplier controls a tropical rain forest. The forest is a stable ecosystem with net production of commercial timber equal to zero. The supplier's production is always so small that his supply does not influence the market price of logs. We also assume that the supplier adapts his production, so that discounted profit is maximized. The person always confronts a problem of investment: What is most profitable in taking capital out of the forest and reinvesting it in some other business (or bank), or saving the forest capital and reap a profit due to price increase.

Let P(t) be the price of timber, and C(t) the unit cost of exploitation. r(t) is the rate of return on alternative capital investments (or bank deposits). We assume that, all these variables have to be adjusted for inflation, or expressed in real prices.

Assume that one m^3 of timber is harvested at time t. Net income at time t is then P(t) - C(t). If this income is reinvested, it will grow to

$$[P(t) - C(t)][1 + r(t)\,\Delta t] \tag{1}$$

after a period of t. If the producer leaves this m^3 in the forest, both the price and the cost of harvest may change. He can, therefore, get the following profit (or loss):

$$P(t + \Delta t) - C(t + \Delta t) \tag{2}$$

The producer will be indifferent if both strategies give equal profits. This means that

$$\frac{P(t+\Delta t) - C(t+\Delta t) - P(t) - C(t)}{\Delta t} = r(t)\,(P(t) - C(t))$$

If t -> 0, this becomes:

$$\frac{\dot{P}(t) - \dot{C}(t)}{P(t) - C(t)} = r(t) \tag{3}$$

We shall simplify by including C(t) in P(t) and assume that C(t) is independent of harvested quantity. In that case (3) can be written as follows:

$$\frac{\dot{P}(t)}{P(t)} = r(t)$$

Assuming the rate of return on alternative investments to be constant over time, we can write:

$$P(t) = P_o\, e^{r\,t} \qquad (4)$$

In a so called free market the price of timber can be expressed as a function of total supply:

$$P(t) = P(x(t)) \qquad (5)$$

where the right hand P is a symbol of the functional relationship, and x(t) is the sum of production from all suppliers at time t. The price described by (3) and (4), is an equilibrium price and must be the same as the one described by (5). Combining (4) and (5) gives:

$$P_o\, e^{r\,t} = P(x(t)) \qquad (6)$$

Since r is given exogenously, (6) determines the production at any time when P_o is given. What then, determines P_o?

In order to answer this question, we must study the demand function. A tropical rain forest consists of many tree species, some yield fine hardwoods well established both on local and international markets. Other species, often termed secondary, are considered less valuable and normally left in the forest as long as primary timbers are readily available. Fine hardwoods from various parts of the tropics compete on the same markets, e.g. Japan, North-America, and Europe, and if the price of one species increases, it will easily be substituted by another species. From the above mentioned supplier's point of view, each species growing in the forest he controls can be considered one resource.

When one of them is substituted for, he can switch to another more abundant and cheaper species to harvest. Hardwoods from natural rain forests can also be substituted by plantation hardwoods, e.g. teak. They would be more expensive due to necessary investments in primary production.

From (4), or (3), we find that it is just a matter of time before the price P(t) reaches the "*back-stop*" price $\bar{P}$, at which the wood of the species in question will be substituted for. At that time the resource left in the forest has no value. A rational policy of extraction would then be to empty the forest of that species just at that time, T. Then we can rewrite (4) as follows:

$$\bar{P} = P(T) = P_o\, e^{r\,T} \qquad (7)$$

At the same time $x(T) = 0$

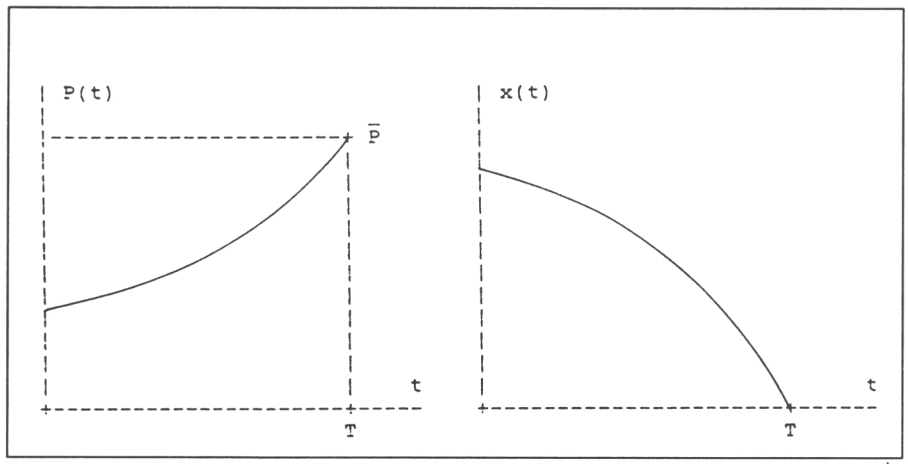

Figure 1. Development of price and extraction of a non-renewable forest resource in a free market.

Let S_o be the initial, known growing stock of the species in question. If this is exhausted at time T, we have

$$S_o = \int_0^T x(t)\, dt \qquad (8)$$

The equations (4), or (3), (5), (7), and (8) determine the unknown variables P(t) and x(t) for all $0 \leq t \leq T$, and T as functions of the parameters S_o, r [or r(t)], and $\bar{P}$. The development of price and extracted volume under these conditions is illustrated in Fig. 1.

DECREASING COSTS OF EXTRACTION OVER TIME

Logging technologies develop continuously, and this process tends to reduce costs of extraction as time goes. If we knew the pace of cost reduction to be expressed as

$$C(t) = C_o\, e^{-i\,t} \qquad (9)$$

where i is the rate of cost reductions over time, we could rewrite (6) as

$$P(x(t)) = (P_o - C_o)e^{r\,t} + C_o e^{-i\,t} \qquad (10)$$

The effect of technological development would then depend on the rate i compared to r. An example of how P(t) and x(t) could develop if such a technological development is assumed, is given in Figure 2.

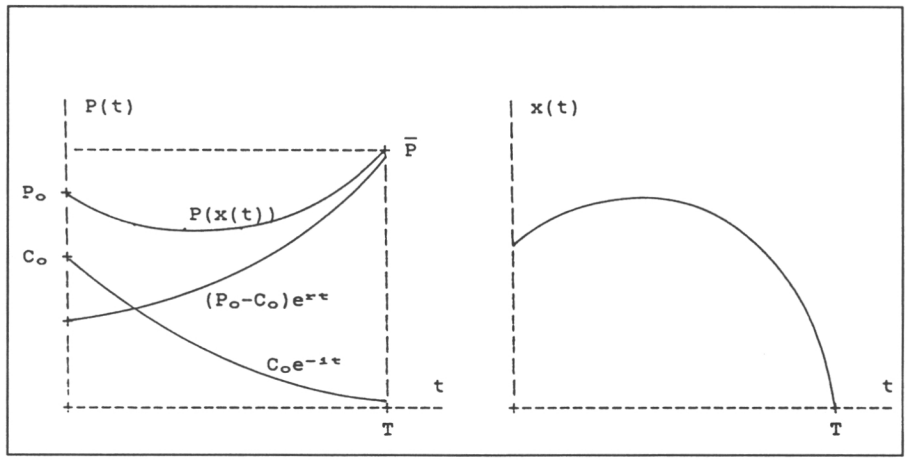

Figure 2. Development of price and harvest of a non-renewable forest resource with decreasing costs of extraction.

SOCIALLY OPTIMAL EXTRACTION

Let U(x) be the social utility of x volume units of a given tropical hardwood. If the objective of the society is to maximize the discounted utility, we have the following problem:

$$\text{Max} \int_0^T U(x(t))\, e^{-r\,t}\, dt \qquad (11)$$

by choosing optimal values of x(t) and T, under the conditions

i) $\dot{S}(t) = - x(t)$

ii) $S(T) = S_o - \int_0^T x(t)\, dt \geq 0$

iii) $x(t) \geq 0$

iv) $U'(0) = \bar{U}'$

Condition iv) implies that the wood has a perfect substitute. We would have $\lim_{x \to 0} U'(x) = + \infty$, if so was not the case.

(11) Is in fact the same problem as the one facing the individual producer in the free market except that the price is substituted by the utility. If there were no differences between market price and social utility, the optimal extraction from a social point of view would be the same as in the case of a free market. Normally there are differences between the two due to skewed income distribution and indirect effects of the exploitation. Examples of such indirect effects can be:

A) The exploitation can lead to erosion or other environmental consequences with a number of negative effects on other economic activities, often for very long periods.

B) If several logging companies harvest in the same forest, the extraction of one of them influences how much the others can harvest. This results in very high extraction rates initially, and exhaustion much faster than socially optimal. In case of increasing costs of extraction when the resource dwindles, unregulated exploitation of the same forest will lead to higher extraction costs initially compared to the socially optimal path.

C) A positive utility can be tied to the existence of the forest as such. This can be motivated by tradition and psychology, but also by the freedom to choose how to use the resources at a later point in time. However, the last argument must consider that wood production could result in investments of higher value to the society in the future than standing timber.

D) The rate of discount, r, could also be different from an individual and a social point of view.

EXTRACTION COSTS VS. PRODUCTION AND GROWING STOCK

So far we have simplified the analysis by assuming that the cost of extraction is independent of volume harvested. Neither have we included the fact that cost of extraction increases as the growing stock of the species in question is reduced. We shall look at the problem when these complications are considered:

$$\text{Max} \int_0^T [P(t)\ x(t) - C(x(t), S(t))]\ e^{-r\,t}\ dt \qquad (12)$$

given the conditions

i) $\dot{S}(t) = - x(t)$

ii) $S(0) = S_o$

iii) $S(T) = S_o - \int_0^T x(t)\ dt \geq 0$

iv) $x(t) \geq 0$

In addition we assume the market to be in equilibrium:

$$P(t) = \bar{P} - ßx(t) \qquad (13)$$

What is new here is the cost function C(x,S). If marginal costs increase with production, and extraction costs also increase as the growing stock of trees is reduced, we can specify the following:

$$C'_x > 0 \ , \ C'_s < 0 \ , \ C''_{xx} \geq 0$$

A cost function which satisfies these specifications is

$$C(x,S) = 1/2 \ (x/S)^2 \qquad (14)$$

This function also has the characteristic of

$$\lim_{S->0} C'_x(x,S) = + \infty \qquad (15)$$

which means that the cost of extraction rises without limits when the growing stock of trees goes towards zero.

The conditions solving the problem in (12) are:

a) $P(t) - C'_x(x(t), S(t)) = q(t)$

b) $\dot{q}(t) = r \ q(t) + C'_s(x(t), S(t))$

c) $e^{-r \ T} \ q(T) \ S(T) = 0$

d) $e^{-r \ T} \ \{[P(T)x(T) - C(x(T), S(T))] - q(T)x(T)\} = 0$

From a) follows that the difference between price and marginal extraction cost shall be equal to the shadow price q(t) of the growing stock of trees S(t). From (15) follows that it is economic to substitute for the wood in question long before the resource is emptied. This implies that $S(T) > 0$. Consequently, from c) follows that $q(T) = 0$, and then

$$P(T) = C'_x \ (x(T), S(T)) \quad \text{and}$$

$$P(T) \ x(T) = C(x(T), S(T))$$

These two conditions are only fulfilled at the same time if $x(T) = 0$.

From (13) we then have $P(T) = \bar{P}$, which means that production at T shall be zero and the price equal to the "*back-stop*" price $\bar{P}$ of the substitute. These results are the same as we found earlier.

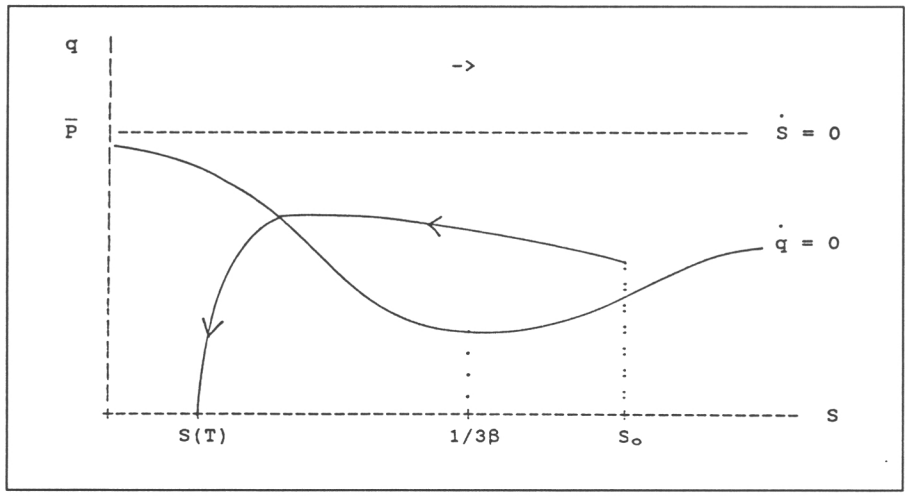

Figure 3. Development of growing stock and shadow price when the cost function depends on growing stock

Let us now study the development of the most important variables. From (12) i), (13), and (14) we can rewrite a) as

$$\dot{S} = \frac{q - \bar{P}}{ß + 1/S^2} \tag{16}$$

and on the same basis we can rewrite b) as

$$\dot{q} = \frac{(q - \bar{P})^2}{(ß + 1/S^2)^2 \, S^3} \tag{17}$$

Figure 3 is a result of setting $\dot{S} = 0$ and $\dot{q} = 0$ in (16) and (17), thereby finding two functions $q = f(S)$ and $q = g(S)$. The figure illustrates a situation where harvest starts at an initial growing stock of S_o. The shadow price $q = P - C'_x$ increases in the beginning, phase 1. Production, x(t), decreases while the price, P(t), increases. When the trajectory passes the $\dot{q} = 0$ function and enters phase 2, q decreases towards zero at time T. The growing stock of trees is still being reduced.

The price increases towards the "*back-stop*" price $\bar{P}$. Production eventually stops at time T. The fundamental conclusion is that the resource will be depleted over time, but not to the degree of extinction. Non-renewable rain forests will be left where exploitation is most expensive. We also notice that if the shadow price is above the "*back-stop*" price, the growing stock of trees should increase, but this is impossible if our fundamental assumption that tropical rain forests are not

renewable, is correct. Therefore, the right thing would then be to stop exploitation and leave what is still left. The shadow price can be very high if all indirect environmental effects of tropical rain forests are included.

CONCLUSIONS

If the climax stage of a rain forest is defined as one type of resource, and the forest is classified as another type of resource when it has been cutover and contains an artificially high proportion of primary species, climax forests are non-renewable almost by definition (Jacobs 1988:12). Even with less strict definitions tropical rain forests, or many of the climax species that they contain, can be considered non-renewable in practical terms. Although some species are very specific and cannot be substituted, most tree species even from tropical rain forests have substitutes and a "*back-stop*" price. The theory of optimal extraction of non-renewable resources is, therefore, applicable to the exploitation of such forests.

This theory serves two purposes. Firstly, it contributes to the explanation of why people and organizations involved in timber exploitation often find it optimal to exhaust forest resources which they control. Secondly, it can also be used in a normative way, i.e. to indicate how the society ought to control its rain forests. Under certain conditions exhaustion can be optimal even from a social point of view, but several factors which are not well enough documented in economic terms could lead to the opposite conclusion that the rain forests should be preserved. It would be most interesting if some economic studies of this kind could be carried out for particular forests in the tropics.

The theory of optimal extraction of non-renewable resources explains quite well the exhaustion of timber resources. However, there exist also another types of exploitation problems, for example, cases where timber resources are sub-marginal but soil resources are intra-marginal. The theory may also contribute towards explaining the clearing of forests for various agricultural uses but it is outside the scope of the present paper.

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SOME REFLECTIONS ON DEFORESTATION AND DEVELOPMENT: THE BRAZILIAN EXPERIENCE

Sebastião Kengen [1]

ABSTRACT

Development as well as deforestation have been subjects of great debate which have led to conflicting paradigms, which in turn have generated some theories. This paper reviews the process of deforestation, its causes and effects, the concept of development and its penetration into forestry circles. The Brazilian process of development and forestry development in this country are then dealt with. Finally, some conclusions are drawn which are followed by suggestions regarding to aspects, such as terms of trade, foreign debt, struggle to develop and poverty, among others, which are not frequently discussed in studies on deforestation and/or development in the Third World. These aspects are considered to deserve more attention in further studies on the theme.

Key words: Brazil, deforestation, development, fiscal incentives, forestry development.

INTRODUCTION

In the record of humankind's history there has been an interaction between man and forest. This interaction can be translated, in short, in terms of food, fuel and shelter that forest has afforded to man throughout history. Meanwhile this importance has not been fully grasped as such, deforestation has always figured centrally in the march of civilization. The serious consequences of this have been known more than two thousand years ago. However, it seems that man has been unable to learn from past lessons and, increasingly, human activities, specially in the recent decades, have placed vast areas under heavy environmental stress due to their depletion. This has been more intensive in tropical regions where forest boundaries have receded at an alarming rate contributing to an environmental disaster.

Within this context, a number of scholars, research centres and international institutions have centered their efforts on studying causes and effects of deforestation and how to avoid or at least minimize them. A vast literature has been produced while there are daily news on the subject in the international press.

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All are unanimous in affirming that this process has contributed to an expanding and alarming environmental degradation. However, no one actually knows "*how severe the damage really is, nor how irreparably we may have already disturbed the tropical rain forests*" (UNU 1985:1). In fact, no one can expect any single solution to the problem, since it is too complex and comprises many peculiarities.

This paper is divided into six sections. The first reviews some causes and effects of deforestation according to most of the literature. The second deals with development in a broad sense. The third presents an overview on the theme of forestry in development. The fourth deals briefly with Brazilian development. The fifth describes forestry development in Brazil. Finally, the sixth presents conclusions and suggestions. It is important to bear in mind that it by no means claims to be exhaustive. In fact, this would be a pretension to discuss and/or find answer to this theme with which we are concerned in a single paper. So, it is expected that it can contribute to deepening the discussion on the subject.

DEFORESTATION

The harmful effects caused by the process of deforestation are widely recognized. Thus, the necessity of continuous studies which can contribute to reversing or at least minimizing them is unquestionable.

It has been common place throughout literature to point out population growth, shifting cultivation and problems of commons among other as the major causes of deforestation. This, most of the time, has been approached from a "*globalization*" perspective, i.e. taking totals or average data of the entire tropical world. Within this context, the social, economic, cultural and historical backgrounds of each country are left aside. Although these aspects commonly mentioned in literature can make some contribution to the process of deforestation, it seems to be more important to go deeper into an understanding of what the causes are which lead or contribute to these situations. For example, lack of education, health, increasing poverty and so on, underlie these causes pointed out above. In other words, they are interlinked.

Regarding the effects, this process has greatly contributed to an environmental degradation allied to social and economic costs. It is fair to assume that some of these effects are more tangible than others. In the former can be grouped for instance, erosion, diminishing soil fertility, displacement of indigenous populations, as well as other people who live in or depend on the forest (e.g. rubber trappers). These effects, in general, demand a short period of time to become evident and some of them take place following the deforestation. The latter are those which though they also occur, are not easily perceived, require more complex studies or can take more time to become evident. Among these can be mentioned climatic alterations, extinction of many species from the flora and fauna as well as communities and ecosystems.

From this brief summary, it is clear that there is a series of undesirable effects caused by this alarming rate of deforestation. However, it seems necessary to deepen studies on causes in order to understand them within a larger context, i.e. taking into account socio-economic, political and historical backgrounds and avoid "*globalization*".

DEVELOPMENT

For the purpose of this paper, development is understood as being an upward worth of the entire society. Thus, it was chosen without the use of an adjective.

Development is a set of complex concepts and perceptions which covers the whole spectrum of ideologies. The interest in the issue of development, which had fluctuated since the eighteenth century, revived to become a major concern after the Second World War. This revival can be attributed to increasing awareness of international inequalities and experiences of successful economic development, such as the economic recovery throughout Europe. It was centered on economic problems and development was studied primarily as a matter of economic analysis.

By the early 1970's, this interest in development had transcended the disciplinary boundaries of economics to become a concern of other social scientists, specially sociologists. Along with the extension of the boundaries of economic science it also created a controversy regarding interest and after several decades of thinking and action about development, controversy still persists over the objectives that should be pursued and the means that should be adopted in order to ensure it. Actually, it has been this controversy that has stimulated the debate on the subject of development and consequently promoted its advance.

Notwithstanding the controversy, at least one point became a matter for general consensus: that development is something more than just economic growth, i.e., economic growth is a necessary but not yet sufficient condition for development. However, despite this, economic growth continues to be a major preoccupation in most countries, especially in the Third World, regardless of the implications of their social and political diversity. It continues to be assumed that the benefits of economic growth "*trickle down*" to the entire population. However, empirical studies in a number of countries have achieved results which suggest quite the opposite conclusion, that only a small proportion of the population takes advantage from economic growth, while a large proportion is not affected or even worse-off.

Over three decades since the 1950's, development studies have become a complex and diverse field of academic research and policy analysis. Development problems are so multifaceted and complex that no single discipline can hope to encompass them, let alone offer ideal or comprehensive solutions. Both scholars and practitioners were forced to transcend the boundaries of their own disciplines and enter a large and interdisciplinary area.

The process of development is multi-dimensional, so that its dynamics makes useless any proposed "*blue-print* or "*panacea*" to promote development on a worldwide scale. So, simply to copy the process of development of the developed nations with complete disregard for the historical and sociological backgrounds which led to a diversity of cultural traditions, costumes, languages, racial groups and the like, does not seem to be the solution. This is supported by authors such as Portes and Ettema. Portes argues that "*development is a relative. Most western nations were never underdeveloped since no advanced model existed as a point of comparison*" (Portes 1973:253), and Ettema went further to argue that "*the economist Kuznets, in 1954, tried to find in European economic history a phase comparable to the present state of underdeveloped countries. His efforts were not successful and his results cut in advance any effort to seek a parallel between the development of the western countries to that of the underdeveloped ones*!" (Ettema 1979:678).

This brief and partial review suggests that the understanding of the reality becomes a necessary condition. However, to transform, a strong commitment by the government in power is necessary. Without this, any real development will not proceed, even if foreign aid is given, development in its broader sense will be restricted to an endless rhetoric or a dialogue of deaf.

FORESTRY IN DEVELOPMENT

Throughout forestry literature planning forest development has been characterized by economic one-sidedness as to goals. They have generally paid little or no attention to the interactions which exist within social and political aspects, world system and so on. Such an approach assumes that forestry development takes place in a vacuum, or is uninfluenced by these factors. Within this context, the rest of the world is usually considered only as a large external market into which forest outputs will be sold at an exaggeratedly determined world price.

The revival of interest in development in the last decades, briefly reviewed above, was embraced in forestry circles. The question of how the forestry sector could contribute to development became a matter of concern. The theme of development was debated at World Forestry Congresses, at international conferences especially held for this purpose and for academic studies. Following the pattern dictated by changes in the general concept of development, the approach regarding the role of forestry in development can be divided into two major phases, the early "*industrialization approach*" and the present "*forestry for local needs approach*". However, it is important to remark that this division does not mean that there was a replacement of one approach by another, or that these are the only two approaches. Rather, this created a second direction to follow and the two approaches may be blended. Forestry for local needs is not the perfect panacea, nor is industrialization, for every country.

Similar to development, it is apparent that despite this considerable change in approach or in some cases relative emphasis, and the emergence of social concerns, industrial forestry still continues to play an important role.

On the other hand, these efforts of the forestry circles to study forestry in development, it is fair to assume have not been able to keep up with the vigorous debate on the theme of development. As such, the forestry sector has lagged behind in the advance of the theme. However, this realization does not mean any sort of criticism or anything like that, on the contrary, this shows that there is plenty of room for expansion of the debate regarding the theme forestry in development. However, this expansion can only occur if foresters become more aware of the necessity to conceive forestry more broadly. Paraphrasing Westoby (1975): "*Foresters should understand that their profession is to serve people, not trees*".

THE BRAZILIAN PROCESS OF DEVELOPMENT

Brazil is located in South America. It lies between parallels 5° 16′ 19″ latitude North and 33° 45′ 09″ latitude South and meridians 34° 45′ 54″ and 73° 59′ 32″ West. It covers a total area of 8 511 965 km^2 (it is the fifth largest country in the world). It is a Federal Republic which comprises 25 states, one Federal Territory and the Federal District where its capital - Brasilia - is located.

A complete review of the Brazilian process of development would be both an exhaustive task and beyond the scope of this paper. So, this section will concentrate on presenting those aspects of the overall Brazilian process of development which have in some sense been influential in the Brazilian forestry sector.

The Brazilian economic formation was characterized by a mercantile capitalist economy which was dominated by the production of primary products - agricultural and mining - for export. The period lasted for about four centuries, i.e. from the sixteenth century to early 1930's. From the 1930's onwards, Brazil gradually started its industrialization. The Import Substitution Industrialization - ISI model played an important role in the evolution of this industrial economy. The ISI model can be broadly divided into two phases, the first from the 1930's to the mid-1950's and then from the mid-1950's onwards.

It was in this second phase of the ISI model, that the major penetration of the multinationals occurred, and the Brazilian economy became more tied to the international capitalist circuit. Simultaneously, the triple alliance - state, foreign and domestic capitals - began to emerge and became stronger. The present day Brazilian process of development evolved in this context and was consolidated from 1964 onwards. The crises which began in 1974 still continue.

Thus, Brazil, nowadays, presents a complex situation of being industrialized and no longer solely a primary-export economy, but is still underdeveloped. This complexity places Brazil in a situation which is not merely an intermediary one between development and underdevelopment, but rather a position of being an industrialized underdeveloped economy (Pereira 1982). It also displays a tendency to exacerbate the trade-off between growth and social equity. The progress, with technological change, has been promoting continuous transformations of the economic, social and political structures, yet it has not been able to create a more just and equitable society.

FORESTRY DEVELOPMENT IN BRAZIL

Forestry as an activity organized on a professional basis is relatively new in Brazil. Until the 1960's agronomists, some specializing in silviculture, performed the foresters' tasks. The first Brazilian-trained foresters took place in 1964.

Given the diversity of climate and soils, Brazilian forests are very diverse ranging from tropical rain forest to subtropical forest. The former is the largest type, almost all of it in the Amazon basin. It covers more than 3 000 000 km^2 or over 30 percent of Brazil. It used to cover most of the land along the coast from the north-east to the southeast. The latter occurs mainly in the south.

Magnanini (1959) estimated that the total area covered with forests at the time of Brazil's discovery (1500), was about 5 228 million km^2 which corresponded to 61,4 percent of its territory. He estimated that by 1958-59 this area had declined to 3 523 million km^2, or 41,4 percent. Most of this removal occurred close to the coast, since it was in this area where most settlement followed the expansion of agricultural and mining activities. Besides forest resources Brazil has other types of vegetation, such as Cerrado (savanna) and Caatinga (thorn-bush).

The historical exploitation of forest resources follows a similar pattern of disregard for the forest resources which was in other countries of the so-called "*New World*". In the USA and Australia, for example, the pioneer cleared away forest for agriculture and to supply his wood requirements. In fact, this exploitation was necessary to meet the settler's basic needs for shelter and food. It is also true that for the pioneer the forest resources seemed to be endless.

The Portuguese Crown made some attempts to preserve, such as the restriction on the use of "*topinoma*" for shipbuilding, because of its scarcity. It is argued that this awareness of the adverse effects of over-exploitation of forest resources or even of particular species was above all motivated by economic considerations (Delson & Dickenson 1984).

Despite these attempts to preserve, or at least to avoid over-exploitation of the forest resources, mercantile system prevailed. Forest continued to be cleared to provide land for agricultural expansion. The climax of this occurred during the nineteenth century with the expansion of coffee production under the plantation system. In this case again deforestation had much to do with the increasing integration of the Brazilian economy into the world economy. The impact of this integration upon the forest resources is well put by Tucker & Richards (1983: xii) who argue: "*One major result of global political and economic integration must have been the steady destruction of the world's woodlands and forests, especially in the regions which were being newly integrated into that economy*". This contrasts strongly with a generalized tendency of many technical foresters to perceive deforestation as caused, for example, by shifting cultivators or by the increase in population.

Brazil's search for economic progress and the utilization of its resources has been characterized by the paradox between a tendency to exploit and attempts

Table 1. Rate of Change of forest cover in the Amazon Basin.

Period	Area Cleared (1 000 ha)
1975-77	4 857.6
1978-80	4 629.5
1975-80	9 487.1

Source: IBDF/DE 1983:16

to conserve. In a territory which is still endowed with virgin land and diverse resources it is a difficult paradox to resolve. An example is the policy adopted by the post-1964 governments of expanding Brazil's agricultural frontier, especially for cattle raising towards North and Center-West regions in the Amazon basin (Table 1).

This process of deforestation was encouraged by governmental policies of fiscal incentives for development in the Amazon basin and of settling colonists along roads built in the region. The fiscal incentives scheme encouraged many enterpreneurs to establish large farms, especially for cattle raising.

In response to deforestation, an internal conservation lobby emerged. It has exerted pressure on the government to adopt measures on its programme, plans and projects which minimize the ecological damage and promote a rational use, i.e. avoiding the exhaustion of the country's resources.

On the other hand, the emphasis of the Brazilian development model has been on moving from an agricultural economy to an industrialized one. To reach this end the government sought to attract and funnel large amounts of foreign and domestic capital into key growth export sectors of the economy. Extremely generous terms and conditions were offered to both foreign and domestic investors through a fiscal incentives system for programme of regional development with emphasis on the northeast and the Amazon regions and for the development of specific economic sectors, such as forestry, fishery and tourism (for more details about fiscal incentives to the forestry sector see, for example, Kengen 1985, 1987). In short, as a consequence of this concession about five million hectares, mainly with Eucalyptus ssp and Pinus spp, were planted. Due to this grant the Brazilian forestry sector became virtually based on the fiscal incentives schemes. This in turn contributed to its vulnerability. This is an aspect which should be borne in mind in order to avoid this problem occurring in other places where fiscal incentives are proposed or already granted.

While obviously important in the current setting, short-run economic advantage may be offset over time by less favorable socio-economic consequences, some of which have already become discernible. These include higher land prices,

conflict generation, land concentration, questionable employment generation and associated migration effects, and income benefits primarily for a selected wealthy group. Besides these deficiencies the fiscal incentives scheme for large-scale industrial forest plantation has faced many other criticisms, such as high per hectare costs. However, these pitfalls have been justified in the name of social benefits, but few have been investigated to determine whether the benefits actually occur or occurred.

From above one can note a paradox, i.e. at the same time that about five million hectares were planted, thanks to the fiscal incentives scheme, tropical forests have been devastated at a considerable rate, e.g. from about 0,5 percent of the total Amazonia area in 1975 to 12 percent in 1988 (Funatura 1989). It is interesting to note that in some states of the region these figures can be doubled. This deforestation can be attributed to facts, such as a great migration, mining, livestock development and so on.

Governmental policies greatly stimulated this move towards the Amazonia, e.g. concession of fiscal incentives which was decisive in the expansion of cattle ranching in the region. The average size of these ranches ranges from one state to another; according to Yokomizo (1988), from 7 000 to 31 000 ha, on average. On the other hand, soils of the region have a great fragility and, consequently a short pasture life. According to Hecht et al. (1983) the carrying capacity under traditional technology and appropriate grazing ranges from two animals per/ hectare in the second year to 0,20 animals per hectare in the twelfth year (the first year is the establishment of the pasture). This carrying capacity is better under improved technology, but worse under overgrazing which, according to the same authors, seems to be the strategy commonly used (Hecht et al. 1983). This can give an idea regarding the dimension of the problem and the contribution to deforestation. So, the government in an attempt to minimize these impacts and due to an increasing pressure, took the decision to temporarily halt the concession of fiscal incentives for livestock development.

On the other hand, the government continues to encourage some other projects in the region, such as the establishment of pig-iron plants which are being located close to the Carajás iron ore. These plants utilize charcoal as the reducing agent. Considering that to produce one metric ton of pig-iron 3.1 m^3 of charcoal is necessary, and if we expect a production of 2.5 million metric tons of pig-iron, this means that about 610 thousand hectares have to be deforestated. Besides these facts there are others, such as the land speculation and great value of the land which is inherent to the Brazilian development model and its process of capitalist accumulation.

As a final remark, one should bear in mind that the observations presented above do not aim to discuss the validity of the Brazilian development model, at least at this stage, but to contribute to deepening the discussion regarding the causes of deforestation and to a re-thinking, specially about those common places as population growth and shifting cultivation, among others, as well as to avoid a "*globalization*" of the process of development.

CONCLUSIONS AND SUGGESTIONS

From what was briefly reviewed one can observe that:

a) There has been a struggle to develop at any cost. This process has implications for the process of deforestation. However, it now seems to be important to have prudence or even to avoid any comparison between the process of development of a developed country with one from the Third World. As referred to above, this is recommended, since no parallel seems possible to be traced between both processes. Therefore, it is suggested that in studies on deforestation the development model to be considered and comparisons between processes of development be done with prudence or even avoided.

b) Underdeveloped countries are, in general, primary-product exporters. Among these products are agricultural commodities and tropical forest products and services. They have generally never received remunerative prices. In fact, terms of trade are unfair. So, each time it is necessary to increase exports in order to earn foreign currency. It is important to bear in mind that most of the time the growth of food production in the Third World can be attributed more to an expansion of the agricultural frontier than to some increase in productivity. So, to carry out this expansion, more forest land needs to be cleared. Therefore, this should be another aspect to be considered and not merely in terms of shifting cultivation.

c) Lack of long run planning. This is another point which has effects on forestry activities. It cannot be said about other countries, but this is true for Brazil. Considering forestry as an activity which demands long maturation, this lack can have serious and harmful effects on it. So this is another aspect which deserves some attention in further studies.

d) The external debt which is at present a nightmare in Third World countries. To pay their debt these countries need to export everything. When one considers that most of the time these exports are primary products and taking into account what was mentioned in item b) above, there is a relationship between this debt and deforestation. This requires further and deeper studies.

e) Misery, poverty and starvation have strongly contributed to an increasing pressure on forest resources. They have increased in countries like Brazil, thanks to its development model, which has contributed to a concentration of income and wealth (including land concentration) and the delay in proceeding with structural reforms, such as agrarian reform, in order to avoid this concentration.

If this report contributes to opening a debate and, consequently to the advance of theme, the principal aim of this paper will have reached [2].

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DEFORESTATION AND DEVELOPMENT IN THE THIRD WORLD: ROLES OF SYSTEM CAUSALITY AND POPULATION

Matti Palo [1]

ABSTRACT

The process of deforestation is described as a complicated, interdisciplinary system causality at international, national and local levels. System and local variables are assumed to have a joint causal effect. The role of population growth, in conjuncture with market and government failures which effectively decelerate the diffusion of technology advances and innovations, is critical. Positive feedback loops dominate deforestation systems. They lead into accelerating vicious circles of deforestation and eventually, under a number of tropical and subtropical conditions, into environmental catastrophes. Negative feedbacks may appear only in later stages to decelerate deforestation. The previous provisional theory of deforestation by the present author received additional support through the findings of this paper. Finally, remedial policies are revised based on the system causality model.

Key words: The Third World, deforestation, development, causality, population.

DEVELOPMENT WITHOUT DEFORESTATION?

The concepts of deforestation and development are strongly interlinked. Paradoxically, in the Third World, when forests are cleared for just about any purpose they are said to be cleared for *'development'*. On the other hand, the concept of development has recently been broadened to include, inter alia, environmental aspects, such as high forest cover or sustainable management of forests (as a counterconcept to deforestation). Accordingly, protection of forest from deforestation, conservation and deceleration of deforestation have become legitime objectives of national and international development efforts (e.g. The World Commission...1987). The concepts of deforestation and development were recently revisited by the author elsewhere (Palo 1989; Palo & Mery 1989).

'Development' is adopted here as a process of coevolution with the changing forest environment, while itself being a source of environmental change. Therefore, deforestation is viewed as being closely linked with development. In

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countries with relatively high forest cover initial clearing of forests to mobilize development is often unavoidable, when economic development implies structural transformation within the economy.

Excess deforestation can be interpreted to refer to counterconcepts of various definitions for sustained yield forestry. In the weakest formulation deforestation occurs, when the present forest area cannot be sustained for future generations under tree growth. In other words, when the present forest area will decrease in the future or when the present forest area has decreased from the past, the process is here called deforestation. Numerous other deforestation concepts prevail matching, mostly implicitly, as counterconcepts to other definitions of sustained yield forestry (Palo 1989).

The purpose of this paper is to revise the process of system causality in deforestation and in particular to describe the role of human population pressure in this context. Then the roles of international demands and asymmetry as well as logging are discussed. A few new arguments to support the provisional theory launched by the author previously (Palo 1984, 1987) will finally be introduced and discussed. Also parallel support for the accelerating character of deforestation was discovered by the present author only now (Repetto & Holmes 1983; Barbier 1989) and introduced in the final discussion. In this paper no further discussion on the contents of sustainable forestry, sustainable agriculture or sustainable development (e.g. Pearce 1988; Schramm & Warford 1989; Barbier 1989; Palo 1989) will be introduced. Development is considered here only as a part of the regressive deforestation process, which mainly prevails in the Third World. The idea and the process of progressive forest-based development was described earlier (Palo 1988). This kind of development has appeared so far only in a few cases.

ROLE OF SYSTEM CAUSALITY

The role of direct local variables on deforestation (Figure 1) has been analyzed by various authors. Simple linear regression functions have been experimented in the construction of explanatory models for tropical deforestation (e.g. Palo, Mery & Salmi 1987). They strengthened the hypotheses that more shifting cultivation and more agricultural land (with a statistical significance at 1 percent risk level) and increased gathering of fuelwood (at 5 percent) tend to decrease forest cover in a large number of developing countries, whereas increased industrial wood production and total production (GNP) have no statistical significance (Palo 1988).

What causal connotations do such results on local causal variables convey? The activities of these local agents with statistically significant relationships are visible even to a casual observer. However, even if industrial logging has a minor direct effect on deforestation, its indirect effect via opening up previously inaccessible forest areas through logging road construction plays a decisive role in promoting deforestation. Accordingly, a novel concept in this context - system causality - has to be introduced.

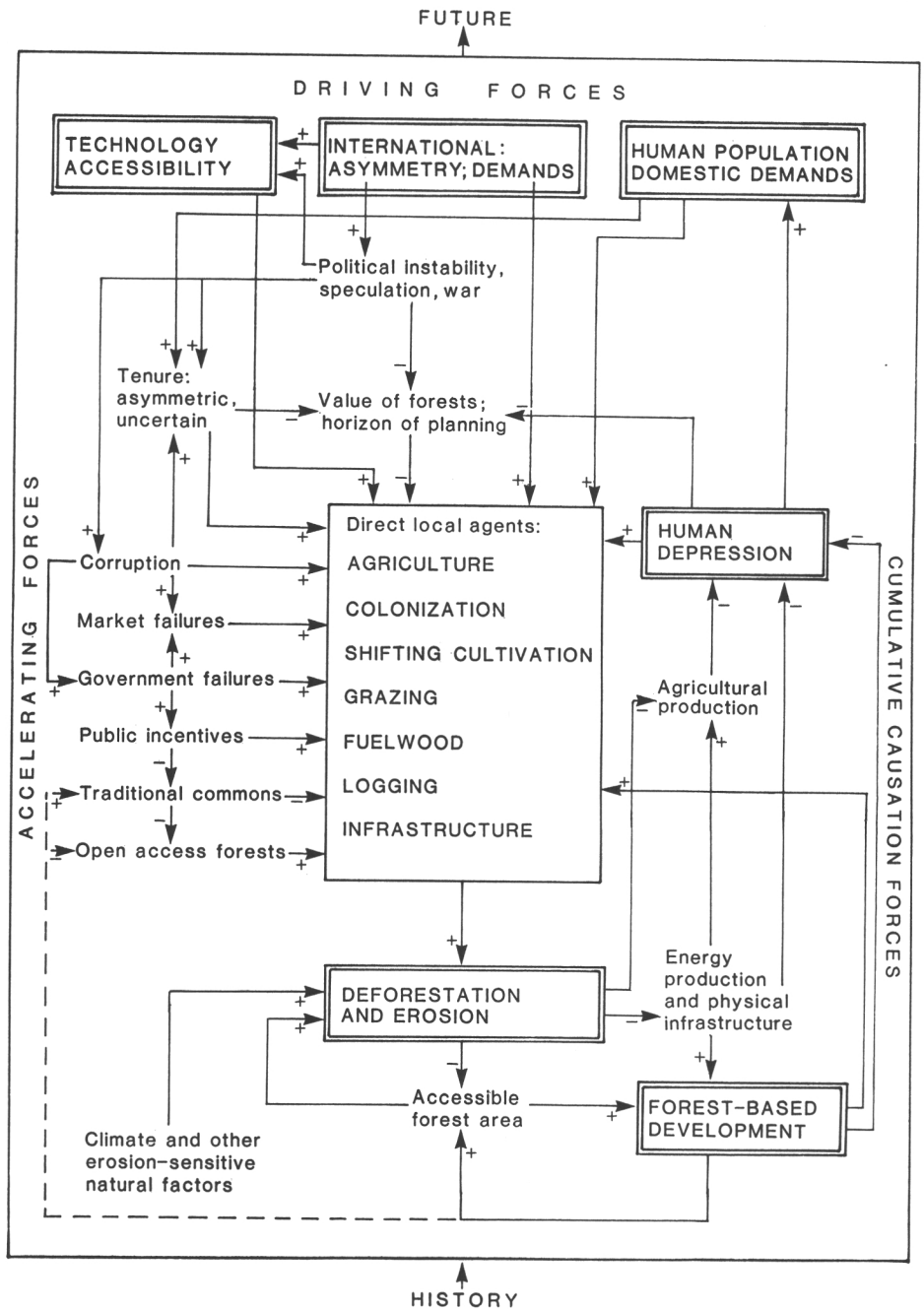

Figure 1. System causality of deforestation and regressive development process in the Third World (modified from Palo 1987; plus-sign = positive and minus-sign = negative correlation).

A fundamental feature of this phenomenon is that the causal factors of deforestation are linked together as various chains or mechanisms into a causal system (Figure 1). The mechanisms comprise positive feedback loops which tend to accelerate the process of deforestation. The only effective negative feedback loop is caused by the inaccessibility of forests and by the successive reduction of forest areas. Sustainable forest management has been so far successful only on a small scale in the Third World. More advances have been gained by creating forest plantations, but **they only rarely** decelerate deforestation in natural forests. Inaccessibility has been gradually overcome by technological and medical progress and appears to be a braking force only in the later stages of the deforestation process.

The provisional theory of tropical deforestation as formulated by Palo (1984, 1987) appears as a vicious circle. Population growth along with consequent domestic demands, international demands and asymmetry as well as access roads appear as driving forces or external shocks in the causal system (Figure 1). Environmental deterioration in the form of deforestation, soil erosion and other detrimental consequences, forest-based development and human depression compose the other key functional factors in this causal system.

Automatic control by market ("invisible hand") and planned control by government are two primary mechanisms expected to control socioeconomic development toward social well-being within national economies. Both of them fail to control deforestation in the tropics. Market mechanisms provide no negative feedback loops to check deforestation and governments are neither motivated nor able to control deforestation (Palo 1984).

In general, markets play a minor role in the distribution of forest-based commodities in the Third World. Furthermore, they are often ineffective because of widespread market failures, such as external effects (erosion, siltation, extinction of species, etc.), lack of competition, administratively fixed timber prices at low levels in comparison with market values (Palo 1987). Vaguely defined and unequal tenures of land add a complicating dimension here (Salmi 1988). Most publicly owned forest in the Third World is an open access resource. Open access resources in the form of forests create further market failures (Pierce 1988). Under such conditions increasing scarcity of forest does not raise its price enough (if at all) in order to mobilize adequate management or substitution.

Asymmetric and uncertain tenure conditions prevail in the Developing World. Property and tenure are systems of authority established by cultural traditions, colonial powers and national governments. They form a set of right-to-control land assets. They strongly affect the bargaining powers of various parties and thereby the distribution of income and wealth. (Palo 1987.) The rural poor are effectively prevented from borrowing from the credit markets in the absence of guarantees due to lack of tenure or uncertain tenure. Also monopolistic or oligopolistic credit markets tend to prevail in the rural regions. This is one more market failure to prevent intensification of agricultural production on existing

arable land. Credit markets and interlinked transactions should be more intensively focused in the context of deforestation (a general review on credit markets, see e.g. Bell 1988).

In Finland, for example, where farmers have been traditionally dominant forest owners, increasing forestry incomes trickled automatically into agricultural intensification in parallel with rapid forest-based development which has taken place for about a century. (Palo 1988.) Wide-scale public ownership of forests and low timber pricing jointly obstruct this potentially effective financing channel in present developing countries.

Market failures are frequently accompanied by government failures (the concept, see e.g. Stern 1989) in forestry management. Political instability and speculation with a short horizon of planning, corruption, lack of trained forestry staff, funds and necessary tools as well as intersectoral division of responsibilities over forests all undermine effectiveness and efficiency of various public administrations. (Palo 1987.) On the other hand stable and able governments have over time been found to play a key role in successful general development (e.g. Reynolds 1985).

Large forest areas are located in *'commons'* or *'common lands'* of various categories. Traditionally their control mechanisms were mostly effective and able to prevent excess deforestation and environmental degradation. Shifting cultivation in a number of tropical localities as well as a sophisticated highland communal farming and herding systems in the Andes from Colombia to Chile serve as examples. However, colonization, commercialization and public ownership by national governments have often disrupted the effective control mechanisms of the traditional commons. Public forests have often become transformed practically into open access resources. Also the traditional controls on the remaining common grazing lands, for example, have weakened. (E.g. Repetto & Holmes 1983.)

Such reasoning leads to a question of system causality connected with complex, intersectoral transformation processes with positive feedbacks prevailing over the negative ones (Toffler 1980, Capra 1982). Most natural scientists and econometricians have applied the Cartesian, reductionistic and analytical view of science. In such analyses local variables are assumed to have cause-effect relationships. System causality relies on a holistic and synthetic view where local and other system variables are assumed to produce joint causal effects.

Discussion on causality in econometrics has even recently taken place (e.g. Aigner & Zellner 1988), but mostly under equilibrium situations. Some consideration on the role of feedback and dynamism in causality was devoted by Simon & Iwaski (1988). Skyrms (1988) is among the few econometricians in the discussion of causality who estimates on deterministic and probabilistic causality and links the non-local causation of the quantum physics to the latter. According to Capra (1982) *"whereas in classical mechanics the properties of the parts*

determine those of the whole, the situation is reversed in quantum mechanics: it is the whole that determines the behavior of the parts". This, by the way, has been the most common approach in general system theory since the 1950's.

This kind of system causality applies most appropriately to the intersectoral non-equilibrium (accelerating) deforestation process in the Third World.

The causal analysis of deforestation is based on an interdisciplinary system model and system causality (Figure 1). The structure of system causality has been viewed as hierarchic in terms of international, national and local factors. *In this way system causality can be interpreted as having a consistent global structure and functioning, although a high variation may prevail in the intensity of all individual causal factors.* Most other authors tend to consider the causal factors of deforestation only nationally and locally. The system causation model of Figure 1 has been supported by empirical research (Palo 1984, 1987, 1988; Palo & Mery 1986; Palo, Mery & Salmi 1987; Repetto 1989; von Fürstenberg 1990; Schmithüsen 1990), although the model's integrated empirical testing remains problematic.

Even if surprising to some readers a number of global similarities within the Third World does exist among deforestation factors. First of all various public ownerships of forests are prevailing with concomitant government failures in administration (e.g. corruption) that tends to lead to open access forests. The weakening of the traditional systems of the commons has similar effects. The various equivalents to stumpage prices are mostly administratively fixed at relatively low levels. Forestry being a joint production process most other goods and services (except logs) tend to remain unpriced. (e.g. Palo 1987.)

Appropriate silvicultural regimes and forestry management measures will still mostly remain to be discovered by future research and development. Insufficient resources have so far been devoted in this field. Here is one more reason why natural forests mostly have been regarded as non-renewable resources (cf. Kuru 1990; Schmithüsen 1990; Hofstad 1990). Various countries have adopted a number of similar public incentives to effectively promote deforestation (Repetto & Gillis 1988).

Human populations are growing fast in all developing countries. This leads to growing domestic demands for basic goods and services. The Third World is also globally facing international asymmetry syndromes (indebtedness, remnants of colonization, transnational corporations etc.) and growing international demands for forest and agricultural products. Technology advancements and asymmetry promote access into previously inaccessible forests.

ROLE OF POPULATION

Population pressures play a decisive indirect role as one of the driving forces in the deforestation process (e.g. Palo 1987; Palo, Mery & Salmi 1987). Growing human population creates increasing domestic demands for food, energy, shelter

and services of health and culture which again increase pressures on the various direct agents of deforestation (Figure 1) either directly or via more asymmetric and uncertain tenure.

The world's absolute population is growing and will continue to do so in the foreseeable future, although the relative growth rate is forecasted to decline (Figure 2). This is particularly true in the Third World, where the age structure is strongly skewed towards the young, which makes for faster population growth. Even immediate effective birth control could not change the trend in the short run.

The optimum feasible size of human population has attracted a widely spread concern. Also the potential effects of growing human populations on accessibility and sustainability of natural resources have been frequently debated (FAO 1976; Repetto & Holmes 1983; Blaxter 1986; Woods 1987; Findlay A. & A. 1987; Birdsall 1988; Stern 1989).

There are different schools of thought concerning population analysis (Birdsall 1988). A number of neoclassical economists argue that more people means more demand and lower production and distribution costs. They also argue that overpopulation can be avoided by the further advancement of technology (Figure 3). The optimum size of human population can move along with increasing population and income per capita - from point P_1 of the technology function t_1 to point P_6 of t_6. If one assumes along with neoclassical economists, technological advances feasible even in the Third World, then functions t_2-t_6 become appropriate. (Woods 1987.)

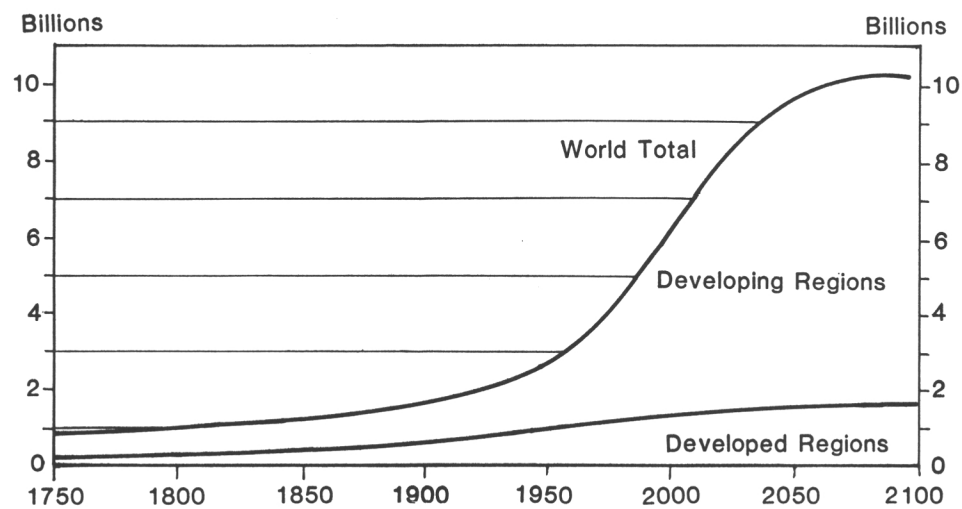

Figure 2. World population 1750-2100 (source: The World Resources Institute et al. 1989)

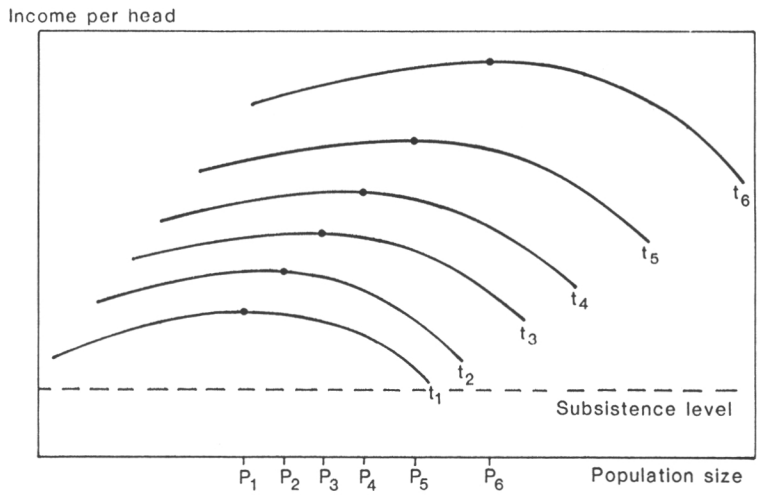

Figure 3. The influence of technological advance on the relationship between income per head and population size. (Woods 1987)

However, in a number of developing countries advances in technology are either too slow in relation to population growth or the simultaneous existence of market failures in exploitation of natural resources makes fast population growth an obstacle to sustainable development (Birdsall 1988). The unequal income distribution in the Third World (The World Bank 1989; Palo 1989) also effectively prevents new technology from being adopted by the mass of poor people. In this simple case the plain scarcity of income can often be the preventive factor. Other reasons also exist.

As the environment deteriorates, poor rural households are constrained by the resulting uncertainty and risk to shorter planning horizons (ct. Figure 1) and more restricted choices. For example, the depletion of fuelwood supplies causes poor households to divert dung for use as fuel rather than fertilizer. Lack of fertilizers and the increased uncertainty and risk over livelihood security in general will tend to make poor households reluctant to adapt new technology, for example, *'green revolution'* species, other farming practices or grazing patterns. In the short run these technology advances are perceived as adding to the risk burden. (Barbier 1989.)

The idea of bounded rationality or 'satisfying' entrepreneur instead of a maximizing 'Homo economicus' was launched long ago by Herbert Simon. This view was recently expressed as "*individuals may not act as to maximize anything either implicitly or explicitly*" and identified as one reason for market failures (Stern 1989, p. 616).

The bounded rationality idea was also combined into a perceived socioeconomic environment. Traditional (Gemeinschaft) and modern (Gesellschaft) typologies of

such environments were introduced by Selby (1984; originally by Tönnies) as follows:

- a low level of division of labor and a lack of occupational differentiation,
- strong family ties and the importance of personal interaction,
- a strong pressure to conform to social norms,
- a poorly developed communication media.

These typologies were interpreted by Rogers (originally) to represent various degrees of acceptance of innovations. Traditional and modern societies were considered to be the extremes in a continuum of innovativeness. (e.g. Selby 1984 & 1989.) A typology of the traditional perceived socioeconomic environment matches the conditions perceived by rural households farming on marginal lands in the Third World (Barbier 1989). The image of the traditional society adds one more obstacle in the diffusion of innovations and technology advances among the marginal farmers of the Third World.

The small-scale farmers in most developing countries have to utilize their land efficiently whenever the other factors allow it, whereas the owners of large holdings often leave significant portions of their arable land non-cultivated or under low productive conditions due to the largeness of their properties. The asymmetric tenure conditions also tend not to motivate to adaption of innovations; the same is due to uncertain terms of tenure (Figure 1; Salmi 1988). Small-scale and marginal farmers' unfavorable credit situation (e.g. Bell 1988) tends also to eliminate diffusion of innovations.

The present author, while launching the provisional theory of deforestation (Palo 1984 & 1987), has emphasized the **indirect** role of population pressure on deforestation: population growth was spotted as one of the driving forces but its causal effects were always identified in the context of the other factors of the provisional theory. Accordingly, the basic idea about the role of population has been right in the light of the supporting facts of this paper.

Repetto and Holmes (1983) introduced similar ideas even earlier, although their contribution remained unnoticed by the present author until now. Together with population growth they took up the parallel roles of open access, deterioration of traditional controls of common lands, asymmetric tenure and commercialization with increasing international demands. These factors, they concluded, operating in conjunction with population growth, are leading to considerably more rapid deforestation than a demographic increase alone would cause. This view supports the provisional theory (above).

Kengen (1990) pointed out a few times that it has been a commonplace to regard population growth as one causal factor of deforestation. He concluded that this cannot be true and he is right, if we think population growth as a direct deforestation factor. However, as an indirect factor the case is different as shown above. Kengen (ibid.) referred to a low population density and a high deforestation rate of Brazilian Amazonia to falsify the population argument.

Here, however, population has to be considered as a driving force at the national level and from the system causality point of view (Figure 1).

Now and then it has been pointed out that two countries may have the same population densities but different states of deforestation or vice versa. Such realities, the arguments go on, falsify the role of population growth as a deforestation factor. Those situations, however, may appear as a consequence of differences in the intensities of the variables of the causal systems or in historical differences of deforestation (its duration, place and scale) or in diverging conditions of erosion sensitivity or of initial natural forest covers.

ROLES OF INTERNATIONAL ASYMMETRY AND DEMANDS

International asymmetry relevant to deforestation can take several forms. Wars represent extreme cases. Ethiopia and Vietnam provide illustrations. The lengthy war in Ethiopia has promoted deforestation, erosion, food shortages, famines and human depression. A high number of Cuban soldiers and Soviet military advisers have supported the socialist government in this war. (Kuru 1986 & 1990.) It is argued that in Vietnam 1.25 million hectares of forests became seriously degraded due to herbicides and defoliants and about 4 million hectares were damaged by shells (Lanly 1982, p. 90). USA and China were the strongest international parties engaged in this war during 1960's and 1970's.

Even shorter wars and conflicts tend to weaken the political stability of the respective national governments and to increase speculation with lands and other national resources. Under such circumstances planning horizons also tend to decrease which again increases deforestation through the various direct local agents (Figure 1). During recent decades wars and conflicts in the Third World have abounded.

Colonialism provides another extreme example of international asymmetry with strong linkages to deforestation. Even if colonialism today belongs to history, some symptoms it has created still remain. South Africa, Mozambique, Philippines, and the Caribbean region, for example, with different past colonial masters, all provide illustrative cases how most suitable lands were separated to the colonialists. The native populations were forced to more remote, often mountainous areas. The practice has led to asymmetric tenure conditions which under population pressures accelerate deforestation (Figure 1). (Palo 1987, p. 127.)

The transnational corporations have been actively engaged particularly in logging operations in Southeast Asia, the Pacific, Africa and Latin America. A tendency has been found in their activities to favor log exports instead of local processing. (Contreras 1987.) Apparently this procedure has deprived development potentials and caused additional requirements for exports and deforestation in respective countries. The transnational corporations' active role in the Third World has speeded up technology advances in logging and transportation and thus promoted accessibility into previously inaccessible forests. Accord-

ingly, industrial logging and agricultural clearing of forests have been feasible in larger scale than when relying only on domestic firms (Figure 1).

The external indebtedness has become a nightmare to a number of Third World Countries. In order to manage their debts the countries have to export nearly anything they have. Kengen (1990) argues that there is a relationship between external indebtedness and deforestation. The international lending organizations and banks have promoted this indebtedness orientation through their various financing operations. The same institutions have also supported the creation of easier access to natural forests through a number of highway and other infrastructural investment projects.

Industrial countries have set tariffs much higher on imports of processed forest products than on logs, in order to protect their own industries and promote raw material inflows. For example in 1985 Australia, EEC, Japan and USA had no tariffs on roundwood, wood chips and wood pulp, but 0-10 percent on sawnwood, 0-15 percent on veneer, 4-40 percent on plywood. 5-30 percent on furniture, 0-7 percent on newsprint, and 0-14 percent on other paper and board. (Repetto & Gillis 1988, p. 26-27.) Such tariff protection prevents or slows down developing countries in their industrialization and thereby promotes deforestation.

The key role of international demands for forest and agricultural products in relation to deforestation (Figure 1) has been frequently illustrated. The "Hamburger connection" has been mentioned, for example, as a major factor in deforestation of Brazilian Amazonia, where large-scale beef producing ranches have been favored by the government.A rationally behaving profit maximizer takes the advantage of these growing foreign markets and by applying optimal exploitation criteria he tends to exhaust either the timber resources or the soil resources. (e.g. Hofstad 1990; Repetto & Gillis 1988.)

ROLE OF LOGGING (ACCESSIBILITY)

The role of industrial logging in the deforestation process is frequently either exaggerated (often by conservationists) or belittled (often by foresters). Industrial logging plays only a minor role in deforestation of various categories of open forests and woodlands. Lanly (1982, p. 61) reported that 13 percent of the total volumes of industrial logging in the tropics originated from open forests. Here the discussion is focused particularly on the role of industrial logging in the closed natural forests, and in closed rain (broadlevel) forests in particular since they cover 98 percent of the total log production. Logging of plantation forests is also out of scope here.

Industrial logging has been promoted in the Third World, especially since the 1960's. Previously logging was aimed primarily for exports but from the end of the 1970's an increasing share of logs have been allocated for domestic processing of sawnwood, veneer and plywood. The final aim of increased logging has been to promote "development". However, industrial logging so far has promot-

ed primarily the wealth of the concessionaires and contractors. Financial returns to the governments or local development have been negligible (e.g. Repetto & Gillis 1988).

On the contrary, industrial logging has played its major role as a driving force in the causal system of deforestation by creating new access roads for the other direct local deforestation agents (Figure 1). Accordingly the effects have been primarily indirect but also considerable direct deforestation effects have occurred, particularly in Southeast Asia where logging quantities per hectare have been higher than in Africa and Latin America (e.g. Lanly 1982, p. 88). No direct effects of industrial logging on deforestation were found through simple regression models (Palo 1988, p. 119).

Tropical forestry, when mobilized through industrial logging, seems to have a dominating character to the exploitation of forests as non-renewable resources (Lanly 1982; Nectoux & Kuroda 1989; Schmithüsen 1990; Hofstad 1990). While the new access has been created to previously inaccessible forest areas various forest farmers and other deforestation agents will take the subsequent steps to clear these forests. The calamity of this process is increased by the sad fact that the various agricultural uses of previous forest soils are mostly on a non-sustainable basis for a variety of reasons (e.g. Grainger 1990; Hofstad 1990; Kuru 1990).

Technological advances have decreased logging costs and costs of opening up new frontiers of natural forests (e.g. Hofstad 1990). Medical improvements have allowed more people and domestic animals to live in the hot moist tropical forests which may have been uninhabitable before.

The missing markets (at the stump or in the forest) for logs, fuelwood, bamboo, rattan, medical plants, latex, nuts, fruits, mushrooms, berries, game, animals, other wildlife, protection of water catchment and erosion, landscapes etc. effectively undervaluate the natural rain forests. This promotes poor control of logging operations and the fact that increasing scarcities do not raise the respective prices. Hence, no automatic control in the form of the market ("invisible hand" by Adam Smith) will increase the logging costs and thus decelerate the subsequent deforestation.

The rational contractor, in order to maximize his discounted profits, will increase his logging to the point where marginal logging costs equal the selling price of logs. The "creaming" of most highly priced logs first can be attributed also to the theory of optimal exploitation of non-renewable resources (e.g. Hofstad 1990). It is most profitable to the contractor to try to exhaust the stock of a particular highly priced tree species before shifting over to a lower priced species (ibid). A number of government and international financial incentives have promoted industrial logging operations and thus also the subsequent deforestation (Repetto & Gilles 1988).

DISCUSSION

The provisional theory of deforestation in the Third World (Palo 1984 & 1987) has already proved useful in guiding observation (FAO 1989), in scenario-making (e.g. Palo, Mery & Salmi 1987) and in the search of effective policy instruments to control deforestation (Palo 1987, p. 81; Palo & Mery 1989). In this paper the causality process was revisited and the idea of system causality in deforestation described further from the previous papers (Palo 1989; Palo & Mery 1987).

More support was found for the cumulative causation principle of deforestation in parallel conditions of marginal farmers. "*The socio-economic factors that induce rational, individual household decisions to expand populations can easily lead to cumulative and unsustainable demographic pressures on a fragile resource base. Once the threshold level of carrying capacity is breached, the 'cumulative causation' of poverty and environmental degradation is hard to reverse.*" (Barbier 1989, p. 14-15.)

Most interesting support to the accelerating character of deforestation according to the system causality model of Figure 1 (above) was found by Repetto and Holmes (1983). They demonstrated through simulation experiments over the span of a generation the time path of the natural resource stock. The simulations were based on a simple renewable resource management model. Experiments consisted of the effects of population growth operating purely as a force expanding subsistence demands with the effects of such growth combined with a commercial demand and open access resource (see above). **These factors, while operating in conjunction with population growth, led to considerably more rapid, even accelerating, resource deterioration than population growth alone.**

A more recent report based on the case studies confirms these early findings. "This report has shown that many governments of countries endowed with rich forest resources have created economic incentives that powerfully accelerate the rate of deforestation" (Repetto & Gillis 1988, p. 37). Repetto (1989) has even gathered statistical evidence to show that during the 1980's the pace of tropical deforestation accelerated. Increasing real prices of timber in the international markets and governments' inability to collect due stumpage revenue have resulted in monopolistic profits and timber booms all over the tropics and are another conclusion of this recent paper supporting the present authors earlier findings (Palo 1987).

Enough evidence has accumulated to falsify the previous prevailing linear concept of tropical deforestation process as expressed in various FAO reports: "*the most expedient solution would be to suppose a linear development, at the global level, up to the year 2000, by deducting 20 times the area cleared yearly between 1981 and 1985, from the area of forest formations existing in 1980*" (e.g. Lanly 1982, p. 101).

Deforestation often creates an accelerating process where no short run equilibrium is found before running out of all accessible forests. Prevailing market failures and persistent lack of time series data prevent or undermine effective application of standard econometrics on analyses of deforestation. However, in rare cases an econometric time-series analysis has been executed as in a recent study by Penayotoy and Sungsuwan (1989) of Northern Thailand. They conclude that data availability and reliability was a problem. They pooled cross-section and time-series data and applied a covariance demand model with ordinary least squares estimation and some dummy variables. Population density emerged as a single most important cause of deforestation. The finding is a further support to this paper. The other significant and most important independent variables were wood price, income and distance from Bangkok.

The revised roles of accessibility as well as domestic and international demands for various goods and services to promote deforestation (see above) may give new chances for applying econometrics in this field. The approach could be based on the theory of optimal exploitation of non-renewable resources (Hofstad 1990). The improved data base after the 1990 Assessment of Tropical Forest Resources (FAO 1989) transforms the situation into the same direction.

The system causality view on deforestation opens new avenues to control the phenomenon (see also Palo & Mery 1989; Schmithüsen 1990; Epilogue of this report). Traditionally, the search for remedial actions has started from the bottom, that is from the direct, local deforesting agents. The novel view of causality suggests a holistic approach from the top down or an effective interaction of the two. A scientific understanding of the deforestation process, as the case is here, leads to an effective evaluation and formulation of remedial strategies on deforestation (e.g. Tinbergen 1966; Skyrms 1988).

According to the model of system causality (Figure 1; Palo 1984 & 1987), deforestation in the tropical forests will expand at an accelerated speed until the existing negative feedback loops strengthen at a later stage of the process. This forecast will be valid unless corruption and actual forest policy and population growth can be checked, land reforms can be mobilized, agriculture on existing arable lands and pastures can be sustained and intensified, or controlled economic growth per capita with more equal distribution can be mobilized within other industries and urban regions. In the tropical countries most liable to extensive future deforestation these reservations are not valid in the foreseeable future, unless a radical change in the attitudes toward deforestation by the national governments and by the individuals occurs.

A required change in attitudes could be caused by radically improving the observation and monitoring of tropical deforestation as well as by radically increasing investigations into the causes and consequences of tropical deforestation and by effectively transmitting the results (for further support, see Grainger 1990; von Fürstenberg 1990; Kengen 1990; Schmithüsen 1990). In this way a major part of likely future deforestation could be avoided or postponed, if the

national governments and the international organizations have enough political will and power. Unavoidable deforestation could also be effectively controlled in order to minimize its external disbenefits.

When future costs and benefits are uncertain and when current investment decisions are irrevocable (as in the case with expansion of the exploitation of tropical natural closed forests), current resource usage ought to be more "conservative" than when the decisions are not irrevocable, since a more "conservative" resource-exploitation policy enables the planner to maintain greater future flexibility (Dasgupta 1982, p. 200).

The provisional theory for tropical deforestation was created in a field in which previously no theory was found. It is interdisciplinary by nature and, as such, it can be regarded as provisional and flexible to future revisions. The theory has been shaped so that it is global and covers both the developing tropical and subtropical countries and the closed and open natural forests. Most of the propositions are inductive generalizations, with the intensity of different causal factors varying according to countries and major classes of forests. Pilot empirical analyses based on this theory have been encouraging (Palo & Mery 1986; Palo, Mery & Salmi 1987). More research is required to specify and develop the provisional theory as well as its empirical applications.

The last four paragraphs above are essentially quotations from an earlier report by the present author (Palo 1987, p. 80-81). The relevance of their message has become strengthened also through this paper and some other contributions and discussions of this seminar.

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According to the beliefs of the Amazonian Indians, plants and animals have spirits dwelling in them. Painting by Pablo Amaringo (Peru).

EPILOGUE:

EFFECTIVE REMEDIAL ACTIONS ON DEFORESTATION IN THE THIRD WORLD

Matti Palo, Ari Siiriäinen and Gerardo Mery

CONSIDERATIONS

The very survival and well-being of man on the Earth depends largely on the maintenance of forest ecosystems and the sustenance of the high variety of products, services and benefits they provide. This is especially true for the population of the Third World where deforestation affects extensive forest areas every year, and is progressing at an alarming rate. The socio-economic and environmental impacts of losses of these naturally renewable resources are not yet completely understood by scientists, nor fully appreciated by governments and the general public. The value of natural forests is underestimated, particularly in the Third World countries.

Deforestation is a widely spread and complex socio-economic problem in the Third World and especially in the tropics. Deforestation is caused by a most complex system of historical, political, demographic, economic, and natural factors. Excessive deforestation causes generally more social costs than benefits.

Along with the burning of fossil fuels for various energy purposes, the burning of tropical forest cover has been identified as one of the major sources of carbon-dioxide discharge into the atmosphere, and thus is a significant contributor to the green house phenomenon. Equally serious is the fact that we are loosing one important source of absorbing and retaining atmospheric CO_2. The forecasted subsequent changes in temperature, rainfall, and other aspects of climate are discernable globally. The accelerating extinction of species as a consequence of deforestation in the Third World is also a global concern. Deforestation-based erosion and siltation and its consequent flooding and drought are also often transnational in character.

The World Commission on Environment and Development (Brundtland Commission) asserted that environment and development are not separate challenges but are rather inextricably linked. This view is particularly appropriate in the joint analysis of deforestation and forest-based development as applied in the ongoing research project by The Finnish Forest Research Institute and the University of Helsinki.

Only a few countries in the Third World can be identified in which forest-based development can be observed on a scale that might have had net positive effects on the national development of the country. Instead, wide-scale deforestation initiates a form of antidevelopment process which is difficult to halt or decelerate. Effective measures to control unavoidable clearing of forests and to revert excessive deforestation in The Third World are badly needed.

A system causation model has been introduced in the ongoing research project. System causality - which relies on holistic and synthetic views where international, national and local system variables are assumed to produce joint causal effects - applies most appropriately to the scientific understanding of the accelerating deforestation process in the Third World.

Sound reasons exist for mobilizing effective international remedial strategies to halt, or at least decelerate, deforestation. **This generation may well be the last one to have this option.** A growing international awareness in the matter is ripening, but now it is the eleventh hour for effective international actions.

International and national policies and politics in the fields of development, environment and forestry have been transformed during the recent years. Environmental considerations have increasingly been launched into development and forest policies. Several international programmes and organizations have been established - as the International Tropical Timber Organization (ITTO) and the Topical Forestry Action Plan (TFPA) - most of which develop their activities in the forest sector or, in the best cases, in combined forest and agricultural sectors. Accordingly, from the system causality point of view, it is most doubtful that the remedial strategies emanated from these organizations and programmes would match the intersectoral problems of deforestation, and effectively contribute to halt or decelerate deforestation in the tropical or subtropical regions.

RECOMMENDATIONS

1. The ongoing research project has considerably benefited from the correspondence, exchange of scientific papers, manuscripts, references, and from discussions, visits, and various meetings. This seminar has significantly strengthened the existing information network. It is important to maintain and develop further this network, and to promote a continuous discussion and exchanges of findings of the interested researchers. The XIX IUFRO World Congress, August 1990, to be held in Montreal, Canada, provides a good opportunity for such an encounter.

2. The International Organization of Forest Research Institutes (IUFRO) should establish a **new interdisciplinary working group to intensify and co-ordinate interactive investigations into deforestation and development in the Third World.**

3. Common undervaluation of natural forests both in monetary and psychological terms should come to the end. A change in the attitudes of newsmedia and the general public could foster a radical change of the political will of the governments. Governments, national and international development agencies, recognizing the socio-economic and environmental importance of forest ecosystems, **should provide increasing resources for research, development and application of appropriate, sustainable systems of forest resource management**. The primary challenge lies with the Third World governments. However, international organizations and the industrialized world also have key roles to play to apply effective remedial means.

4. In recognizing the system causality and accelerating nature of deforestation in the Third World, its bleak global and national consequences and the inadequencies of the present initiatives and international bodies, **the immediate establishment of a new body (e.g. International Deforestation Commission) is proposed to combat deforestation in the Third World**. Such an International Deforestation Commission should be created by international agreement as a narrow and specific agency committed to its mission. The Commission should be independent at the decision-making level and should have adequate funding. Monitoring and sanction systems (positive and negative) would have to be part of its regular activities. The international remedial strategy proposed above, if appropriately implemented, would halt or decelerate deforestation, according to our system causation model.

ANNEX 1

PROGRAM OF THE INTERNATIONAL SEMINAR[1]

Wednesday, April 26

9:00 Welcome to the Finnish Forest Research Institute (FFRI) headquarters: Dr. Jari Parviainen, Director of Research

10:00 Sight-seeing of Helsinki city. The bus will arrive at the at the Helsinki Airport at 12:00

14:20 Flight Helsinki - Ivalo (AY 454)

16:45 Arrival and registration at Riekonkieppi Hotel, Saariselkä

18:30 Reception and welcome dinner at Kaunispää

21:30 Sauna

Thursday, April 27

8:00 Breakfast

9:00 **Opening of the Seminar**: Professor Matti Palo
Agenda

10:00 Coffee break

10:30 **Assessment and scenarios of deforestation**
Moderator: Professor Matti Palo
Key speaker: Associate Professor Risto Päivinen
Invited papers: Dr. Assefa Kuru, Professor Simo Poso, Professor Ari Siiriäinen
Discussion

13:00 Excursion to a fell forest - open air lunch

16:00 **Deforestation or Development: Regional and National reviews**
Moderator: Professor Ole Hofstad
Key speaker: Dr. Peter von Fürstenberg
Invited papers: Mr. Homero Altamirano, Mr. Antti Erkkilä, Mr. Darrell Sequeira

Coffee break

Discussion

20:30 Dinner

21:30 Excursion and musical evening, Laanila Forest Museum

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[1] *International Seminar on Deforestation or Development in the Third World - Saariselkä, Finland - April 26 - 29, 1989.*

Friday, April 28

7:30 Breakfast

8:30 **Deforestation or Development: Regional and National reviews (continuation)**
Moderator: Professor Ari Siiriäinen
Key speaker: Dr. Alan Grainger
Invited papers: Professor Ole Hofstad, Mr. Li Liyun
Dr. Marcio Nahuz, Ms. Francisca Nasol-Dayrit, Mr. Bo Olsson

Coffee break

Discussion

13:00 Lunch and excursion to Urho Kekkonen National Park

16:00 **The role of deforestation in development**
Moderator: Mrs. Francisca Nasol-Dayrit
Key speaker: Dr. Sebastiao Kengen
Invited papers: Mr. Lars-Eric Birkegård, Ms. Gina Green
Dr. Luis Luna, Dr. Juan Novara, Mr. Jyrki Salmi, Mr. Mikael Ståhl

Coffee break

Discussion

20:30 Dinner

Sauna

Saturday, April 29

7:00 Breakfast

8:00 **Challenges in financing deforestation research in developing countries**
Moderator: Professor Simo Poso
Key speaker: Professor Reidar Persson

Coffee break

Discussion

11:30 Lunch

13:00 Departure from Riekonkieppi Hotel to Ivalo Airport

14:20 Flight Ivalo - Helsinki (AY 453)

16:25 Arrival at Helsinki Airport

17:15 Farewell snack at the Department of Forest Economics of The Finnish Forest Research Institute

ANNEX 2

LIST OF PARTICIPANTS IN THE INTERNATIONAL SEMINAR [1]

Mr. **Homero Altamirano**
CEFOR (Centro para el Desarrollo Forestal)
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Ph. D. **Gina C. Green**
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Jamaica (from U.S.A.)

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[1] *International Seminar on Deforestation or Development in the Third World Saariselkä, Finland - April 26 - 29, 1989*

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Mr. **Gerardo Mery**
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Finland (from Chile)

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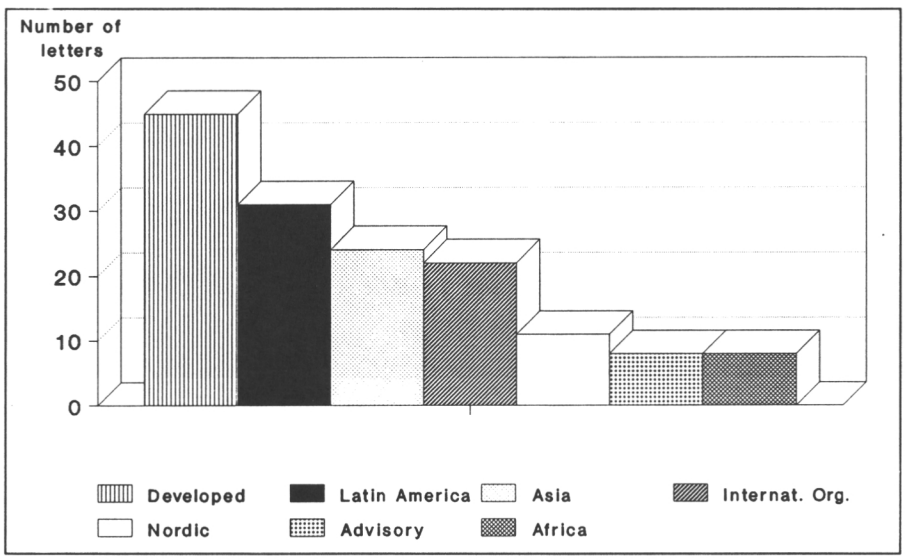
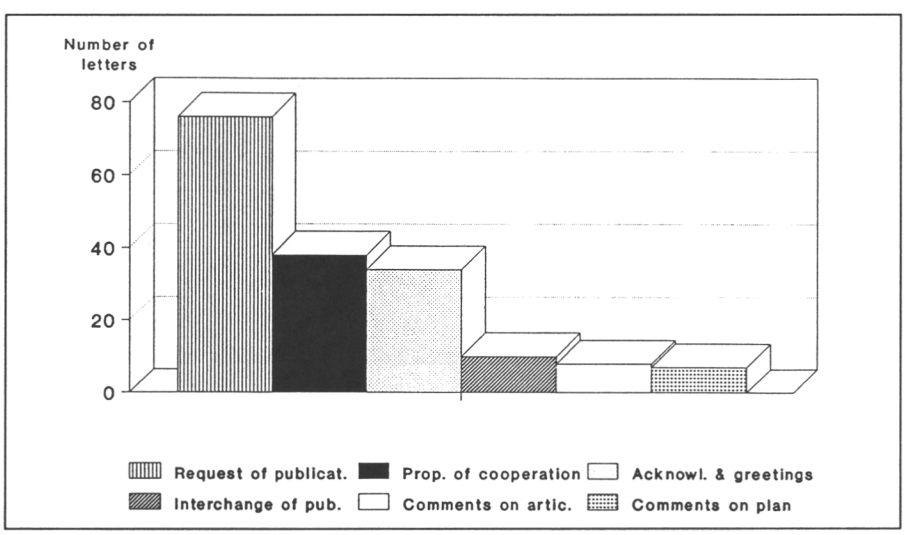
ANNEX 3

INTERNATIONAL RESPONSE TO THE RESEARCH PROJECT ON DEFORESTATION AND DEVELOPMENT IN THE THIRD WORLD [1]



Number of letters received by the project by location.



Number of letters received by the project by contents.

[1] *Note: The total number of letters received by the project during 1986-89 is 149.*

ANNEX 4

FURTHER ACTIVITIES EXECUTED IN 1986-89 BY THE RESEARCHERS OF THE PROJECT ON DEFORESTATION AND DEVELOPMENT IN THE THIRD WORLD

SEMINARS

- May 1986: A discussion seminar on the draft research plan of the project at the University of Helsinki. Twenty two finnish participants attended at this seminar.

- April 1989: An international seminar on Deforestation or Development in the Third World ? at Saariselkä, Finland. Twenty six participants who came from fourteen different countries, attended at the seminar.

SCIENTIFIC EXCHANGE

- **Foreign participation by the project staff:**

  - Mery, G. and Salmi, J. material gathering visit to the FAO Forestry Department, Rome, 1986.

  - Palo, M. XVIII IUFRO World Congress. Ljubljana, Yugoslavia, 1986.

  - Palo, M. VIII World Congress of the International Economic Association. New Delhi, 1986.

  - Palo, M. and Mery, G. Biennial Meeting of the Scandinavian Society of Forest Economics. Establishment of a Working Group on Developing Countries. Haikko, Finland, 1987.

  - Mery, G. Visit to Chile. Establishment of counterpart groups and gathering of information. Santiago, Concepción, Valdivia, 1987/1988.

  - Palo, M. Visits to development agencies and research institutions of Sweden, Norway and Denmark. Stockholm, Oslo and Copenhagen, 1988.

  - Mery, G. VIII Nordic Research Conference on Latin America. Stockholm, 1988.

- Siiriäinen, A. Research expedition to Sahelian countries. 1988.

- Palo, M. Biennial Meeting of the Scandinavian Society of Forest Economics. Visby, Sweden, 1989.

- Palo, M. Consulting the Tropical Forest Research Assessment Project of FAO, invited by its Forestry Department, Rome, Italy, 1989.

- Palo, M. Visit to ETH-Zentrum. Zürich, Switzerland, 1989.

- Palo, M. Visit to Oxford Forestry Institute. University of Oxford, Oxford, United Kingdom, 1989.

- Palo, M. Visits to The International Institute of Environment and Development (IIED) and London Environmental Economics Centre (LEEC). London, United Kingdom, 1989.

- Palo, M. International Conference and Workshop on Global Natural Resource Monitoring and Assessment: Preparing for the 21st Century. Venice, 1989.

- Siiriäinen, A. Research expedition to Peru. Lima and Peruvian Amazon, 1989.

- **Foreign scientists visiting the project**

  - Mr. Bengt Kriström, The Swedish University of Agricultural Sciences, Umeå, Sweden 1986 and 1987.

  - Professor P.O. Johansson, The Swedish University of Agricultural Sciences, Umeå, Sweden, 1987.

  - Mr. Luis Astorga, CEDFOR - Santiago, Chile, 1987, 1988 and 1989.

  - Dr. K. D. Singh, FAO, TRopical Forest Resources Assessment Project, Rome, Italy, 1987 and 1989.

  - Dr. José Pablo Arellano, CIEPLAN - Santiago, Chile, 1988.

  - Dr. Kari Keipi and Dr. José Rentes, Inter American Development Bank, Washington D.C., U.S.A., 1989.

  - Senior Lecturer, Dr. Neil Byron, Australian National University, Department of Forestry, Director of the Centre of Forestry and Rural Development, Canberra, Australia, 1989.

- Mr. Jon Tellum, Hedmark Distrikshogskole (Forestry College), Norway, 1989.

- Dr. Robert Pringle, WIDER (The World Institute of Development Economics), Helsinki (United Kingdom), 1989.

- Assistant Professor, Dr. David H. Newman, The University of Georgia, School of Forest Resources. Athens, Georgia, U.S.A., 1989.

INVITED LECTURES AND FELLOWSHIPS

- Palo, M. and Mery, G. The Society of Forestry in Finland, Helsinki, 1986.

- Mery, G. University of Chile, Santiago, 1987.

- Palo, M. Internordic Course of Forestry in Developing Countries. Copenhagen, 1987, and Helsinki, 1989.

- Mery, G. The Society of Forestry in Chile, Santiago, 1988.

- Palo, M. International Course in Forestry. University of Helsinki, 1988 and 1989.

- Palo, M. University of Joensuu, Finland, 1988 and 1989.

- Palo, M. Developing country course, Forestry Training Programme, Kotka, Finland, 1989.

- Palo, M. Oxford Forestry Institute, University of Oxford, United Kingdom, 1989.

- Palo, M. invited as Associated Fellow by London Environmental Economics Centre, London, United Kingdom, 1989.

INTERNATIONAL REVIEWS

- International Society of Tropical Foresters 1988. Finns analyze Third World problems. (A review of Metsäntutkimuslaitoksen tiedonantoja 272). ISTF News. Vol. 9 (2):11.

- Ecoforum 1988. Latin American Net Importer of Forest Products. (A review of Metsäntutkimuslaitoksen tiedonantoja 272). Vol. 13:6. Nairobi.

- World Forest Resources Management Vol. 4(1). 1989. (A review of Metsäntutkimuslaitoksen tiedonantoja 272).

NOTES

NOTES

SCANDINAVIAN SOCIETY OF FOREST ECONOMICS

History and publications

The Scandinavian Society of Forest Economics was established in 1958 as a result of a proposal by the late Norwegian professor Frits Jorgensen, under the name of Nordic Forest Economics Seminar. Today the Society has about 80 active members - teachers and researchers in Denmark, Finland, Norway and Sweden. The objectives of the Society are according to the bylaws of 1982 stated as follows:

- to further co-operation between forest economists in the Nordic countries;
- to further the planning and execution of joint Nordic research projects within the field of forest economics;
- to further co-operation of joint Nordic measures within post graduate education and training.

In order to fulfill these objectives the Society organizes biennial meeting and working group symposiums. The currently active working groups are: *Forest Products Markets, Economic Planning, Multiple Use of Forests* and *Developing Countries Group,* but these groups change over time. The Society has no personnel nor a budget of its own. Its meetings and seminars are supported by Nordic research foundations.

Between 1979-1981 the Society executed its first joint research project on "Forestry and Regional Development" under the Forest Policy Analysis Working group, financed by Samarbetsnämden för Nordisk Skogsforskning (SNS).

Recent publications of the Society include:

Tervo, M. & Selby, J.A. (editors) 1984. Symposium on Forest Products and Roundwood Markets. Hanasaari, Finland 14.-16.11.1983. Metsäntutkimuslaitoksen Tiedonantoja 141/ Scandinavian Forest Economics 27. Helsinki. 202 p.

Saastamoinen, O. & Hultman, S-G. & Koch, N.E. & Mattsson, L. (editors) 1984. Multiple-Use Forestry in the Scandinavian countries. Comm. Inst. For. Fenn. 120. Helsinki. 141 p.

Hänninen, R. & Selby, J.A. (editors) 1987. Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics, Porvoo, Finland, May 1987. Scandinavian Forest Economics 29, 284p.

Mattsson, L. & Sodal, D.P. (editors) 1989. Multiple Use Forestry - Economics and Policy. Scandinavian Forest Economics 30, 184p.

Lohmander, P. (editor). 1989. Proceedings of the Biennial Meeting of the Scandinavian Society of Forest Economics, Visby, Sweden, May -June 1989. Scandinavian Forest Economics 31.

SCANDINAVIAN SOCIETY OF FOREST ECONOMICS, 1989 - 91

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SCANDINAVIAN FOREST ECONOMICS

No. 32, 1990



DEFORESTATION OR DEVELOPMENT IN THE THIRD WORLD?

VOLUME III

Matti Palo & Gerardo Mery (editors)

Helsinki