



**A Vision for Forest Science
in the Twenty-First Century**



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in the Twenty-First Century

Center for International Forestry Research
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Preface

The need for greatly increased efforts in tropical forest research was recognised in the mid 1970s. The World Forestry Congress in Indonesia in 1978 resolved that more resources should be applied to forestry research. The sponsors of the Tropical Forestry Action Plan (The World Bank, UNDP and the World Resources Institute) identified the lack of research and information as major obstacles to forest development. The TFAP sponsors subsequently orchestrated two "Bellagio-style" meetings in the late 1980s to identify opportunities and build support for forest research. The establishment of CIFOR as part of the CGIAR network of international agriculture research centers has been the only significant response to these concerns.

The Bellagio meetings highlighted the fact that investments in agricultural research had resulted in major improvements in productivity. Investments in forest research are significantly less than those made in agricultural research (for equivalent product value), even valuing just the timber from forests. If the values of environmental services and non-wood products are also included, the figure could be as low as one-tenth of the investment in agricultural research.

Research on forests has not only suffered from a lack of resources. It has been fragmented and highly site-specific. It has never been organised in such a way as to yield a holistic vision of forests. The research effort is distributed in discipline-based or production-sector institutions. A surprisingly large number of forestry research institutions in the world still do not include social scientists amongst their staff.

The UNCED process and the various initiatives leading up to the Commission on Sustainable Development debate on forests scheduled for April 1995 have developed a strong consensus that far-reaching changes are needed in the ways in which the world's forests are used. A new perception ("paradigm") of forest management is rapidly gaining currency - that, in any particular locality, the forest and the people who depend upon it should be considered as a single ecosystem. This means that the ultimate success of management will have to be judged by the maintenance of the potential of the forest to provide a continuous but changing stream of goods and services. This will require forest policies that are socially acceptable, and policies that provide for steadily improving sustainable livelihoods.

These developments have enormous implications for forestry research. The "new forestry" depends upon a more comprehensive view of the nature of the forest ecosystem, but there is still a critical lack of research on approaches that combine biological, physical, economic and social variables. Even if the ecosystem can be brought under optimal management, how can decisions be

made about the inevitable trade-offs among objectives and special interest groups? How can sensible decisions be made about the long-term management of forests against a background of changing societies and economies? All these problems require an unprecedented effort and a new vision of the importance of forestry research.

To address these problems CIFOR and the Government of Indonesia convened a dialogue involving scientists from a variety of disciplines and backgrounds and key persons from the post-Rio processes, NGOs, indigenous people's groups, industry, government and development agencies. The dialogue brought together 60 thoughtful, committed individuals in an environment that was politically neutral and conducive to intense reflection and interaction. Participants were invited in their personal capacity and not as representatives of governments or organisations.

The boat on which the dialogue took place provided efficient access to sites that demonstrate critical issues of tropical forest conservation and management. Participants visited industrial logging areas, lands degraded by fire and shifting agriculture and an area protected for biological diversity.

The primary objective was to review the results of the various international forest initiatives and to determine their implications for future research and information needs.



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Introduction

Forest science has reached a critical cross-roads. There have been major improvements in forestry practices, despite some historical flaws in its structure. However, with rapidly changing expectations of forests, a new direction of research is needed. The focus of forestry research is currently too narrow. It is time for a major re-evaluation of forest science needs for the 21st century. Without diminishing the value of the existing areas of research we need to expand the agenda and refocus priorities.

In December 1994, the Center for International Forestry Research (CIFOR) and the Government of Indonesia hosted a policy dialogue on *Science, Forests and Sustainability*. Sixty people participated, drawn from science, government and non-governmental organisations. The participants engaged in broad discussions on critical research issues relating to the United Nations Commission on Sustainable Development (UNCSD) debate about the conservation and management of all types of forests. The deliberations generated many ideas for major changes in the content and organisation of forest science. It was agreed that forest science requires a radical change in direction and expansion of effort to be relevant to the needs of today and the 21st century.

There are major weaknesses in the policies, methods and mechanisms adopted to support and develop the multiple ecological, economic, social and cultural roles of trees, forests and forest lands.

Agenda 21; Para 11.1

The participants in the Dialogue reached agreement on a statement *Forest Research: A Way Forward to Sustainable Development* (Annex 1). This identified some key areas for future long-term research which are reflected in Box 1. However, the richness and diversity of the discussions could not be captured in this brief statement. CIFOR staff, aided by a small number of dialogue participants, have therefore attempted a more comprehensive review of the issues. This publication is the result of our work. Our intent is to indicate how forest science's agenda could be modified in broad terms in response to present needs of all sections of society – local, national and international. It attempts to reflect the questioning spirit of the Dialogue and is based on the ideas generated by the discussions. The areas where views most varied have been identified in Box 2. As shown at this meeting, involving eminent participants, there sometimes remain large differences in the way forest science is viewed. The differences can result in less than effective communication of opinions and viewpoints. Thus, fora such as the Bali Dialogue are necessary to promote a common understanding of forest science.

Box 1

Long-term Research Priorities for Forest Science

1. Integrated socio-economic and biophysical studies at a network of landscape-scale sites, to understand the relationship of human development to forests.
2. Examination of trends of supply and demand for forest goods and services, and their relationship to forest area and health; the development of strategies to optimise the balance between them, in pursuit of sustainable development.
3. Research into methods for assessing patterns of change in the extent, condition and use of all types of trees and forest ecosystems, and analysis of the causes of these changes.
4. Studies on the role of political and institutional arrangements in attaining sustainable development.

CIFOR believes this meeting represents a significant moment in the history of forest research, and is publishing this document as a contribution to what we hope will be a continuing debate on this critical subject. As such we hope that it will assist those who practise science as well as those who determine science policy and provide resources.

Box 2

Issues which need Further Discussion

1. **An intergovernmental panel to review the status of forest science related to sustainability**
Some participants at the Bali Dialogue felt a need for an international body to review the directions of forest science as they relate to the achievement of sustainability. This effort could parallel some of the functions of the "Intergovernmental Panel on Climate Change" where international cooperation was able to identify areas for immediate action. A concern was expressed by some discussants that any scientific process might pre-empt or over-ride any national political initiatives being put into place. A further consideration is that any such body may strengthen one or more large international organisations at the expense of more regionally based bodies. In addition the management of research activities can be at issue between various levels of institution.
2. **Monitoring of forests**
The question of whether international monitoring of forest change is necessary and/or desirable needs to be resolved. If such activities are agreed to, then methods and criteria acceptable to all countries will need to be developed. One body of thought believes that international scientists should be free to assess the global condition of forests, while another view sees monitoring as a national responsibility. While a central, standardised measure would be useful, a worldwide collection of national monitoring systems may be more feasible. The threat posed by global monitoring to national sovereignty is a further area of discussion.
3. **Government, participatory research and the role of NGOs**
There is considerable debate about the capability or even legitimacy of various actors in the forest research community. Some believe that government and scientific organisations have a pre-eminent role in implementing a research agenda. Others counter that forest communities must be given a voice in how science serves them, through participatory research methods and through the assistance of non-governmental organisations. It is the extent to which local communities have the tools to effectively carry out or direct such research that is a key issue. Recognition of the value of input from local people in the form of knowledge and skills is not in doubt.

Chapter 1: Critical Issues for Forestry

Forests play a unique role in meeting human needs at local, national and global levels. Finding a balance between the productive and protective functions of forests is essential if individual countries, and the world as a whole, are to derive maximum benefits from this valuable resource. However, forests in many parts of the world are being eroded in both area and quality because of pressures

The vital role of all types of forests in maintaining the ecological processes and balance at the local, national, regional and global levels . . . should be recognized.

*Statement of Principles on Forests,
Para 4*

from population growth and economic development. If these trends continue, there will be twice as many people in the world by the middle of next century, relying on a much smaller area of forest. This will have major impacts on biodiversity, global climate and life-support systems in general, and could severely constrain human development. There is consensus on the need to halt and even reverse these negative trends (UNCED 1992), through nationally based strategies and policies to increase agricultural and forestry productivity, halt forest degradation and deforestation, enhance forest benefits, increase efficiency and provide incentives for the conservation, management and sustainable development of forests.

Realising these goals will depend on decisions made by national and local governments, as well as commercial and non-governmental organisations, communities and individuals. These decisions, and their associated actions, will be influenced by subjective opinion, legislation, and economic and social circumstances. They will require

negotiation and compromise. Another crucial influence will be the information available to the decision makers, and their perception of the likely consequences of their actions. Reliable information, robust decision-making frameworks and effective planning and management techniques are all things that scientific research can provide. As the world approaches the 21st century, it is opportune to assess the capacity of forest science to meet present and future information needs and, if necessary, to redefine its research agenda.

The Global Dimension

The biophysical environment

Concern about the state of the environment has been growing since the 1960s and became a political priority in the 1980s. Then governments were forced to acknowledge major changes to the global environment and accept that only rapid, concerted action could remedy the situation. Pathfinding international agreements were reached in the 1980s to reduce the production of chlorofluorocarbon compounds that deplete the planet's ozone layer, to introduce greater transparency and to promote sustainability in the international tropical timber trade and to promote concerted international effort to improve tropical forest management. These were followed by the two conventions on climate change and biodiversity signed at the UN Conference on Environment and Development in Rio de Janeiro in 1992, and by a Desertification Convention in 1994.

Forests play a major role in the global environment. Deforestation is a key component of global land-use change and degradation. Forests account for a substantial proportion of the terrestrial carbon store, and

so can influence that part of the greenhouse effect caused by the transfer of carbon into the atmosphere as carbon dioxide. Clearing and burning tropical forests are the second main source of carbon dioxide after fossil fuel combustion. One way to slow down climate change is to reduce the rate of carbon dioxide emissions by improving conservation and energy efficiency and by controlling deforestation. Another is to absorb some of the surplus carbon dioxide in the atmosphere by increasing the world's forest area.

Tropical moist forests contain at least half of all the species on earth. As forest areas shrink, so does the number of species, reducing biodiversity, with adverse environmental consequences. Ecosystem stability can be threatened and the potential for the use of plant genetic resources to develop new products reduced.

The new science being developed to understand global environmental change, and its control, places emphasis on forests as a key element of the world's vegetation. Much of the current research in this field is being undertaken outside forestry research institutes. This highlights the need to develop new alliances between formerly discrete disciplines and institutions.

The social dimension

The effects of deforestation are experienced at not just the global level, but also within national boundaries. Among the grave consequences of shrinking forests are degradation of land and water resources, decline of food production capability and decreasing availability of wood for fuel, shelter and manufacture of goods.

Box 3

Some Achievements of Forestry Research

It must be acknowledged that forest scientists have made significant accomplishments over the last hundred years, but these have been primarily restricted to improving forest management techniques and timber utilisation technology.

1. **Forest management systems**, based on research into appropriate forms of silviculture for various forest types, have led to the development of harvesting schedules which are now accepted by government and the general public as sustainable and environmentally benign.
2. Improved yields in timber and pulpwood plantations have been achieved as a result of **forest genetics** and **tree breeding** research. Returns to investments on research have been many-fold.
3. **Control of forest pests, diseases and weeds** by biological means has reduced timber losses without endangering the environment. Techniques have been developed to replace expensive and hazardous chemical controls.
4. Comprehensive **computer simulation models** of world trade in forest products allow policy makers to test the likely impacts on future world wood demand and supply of major changes in forest policies.
5. **Techniques to utilise previously non-commercial timbers**, such as old rubber wood, have been developed leading to new industries supplying both local and export markets.

Most forest-related problems are consequences of humanity's social and economic demands. The future of the world's forests is therefore not just dependent on appropriate management of the forests themselves, but also on the management of pressures which forests face from outside. To understand these pressures and learn how to deal with them, it is not enough just to know how forest ecosystems function. It is vital to understand social systems.

For this reason, forest science must incorporate a new social dimension. The underlying human causes of forest loss and degradation have been more systematically addressed since the 1980s, but remedies still tend to focus on treating symptoms rather than underlying causes. Foresters devise programs to improve forest protection or plant more trees – but understanding of the causes of deforestation in the wider context of overall land use is limited, and there is little capacity to study the underlying social, economic and political reasons for deforestation. In this area, also, a new direction in forest science is needed.

The Organisation and Funding of Forest Science

The forestry research agenda has been driven primarily by the technical needs of government forest services. Most countries lack the capacity to study the broader issues determining the extent and condition of forests, the supply and demand of forest products and the equitable distribution of the costs and benefits of forest use. Because forest science has been regarded as a service to forestry agencies, and is dependent on government funding, there has been little objective analysis of the effectiveness of forestry, or of the direct and indirect impacts of government policies on forest ecosystems.

This narrow focus has also been perpetuated by underfunding relative to other key sectors. It has been estimated that funding for research on tropical agriculture represents 10% of the total value of agricultural products, while research into tropical forestry accounts for less than 5% of the value of wood products. If the full value of forests is recognised in terms of all the other non-timber products and environmental services which they provide, then investments in research are but a tiny fraction of total product value.

Decision Making on Forests

There is, as yet, no body of forest science able to provide the kind of information and understanding needed to solve the problems faced by forest policy makers. Many decisions now being made at all levels – from local to global – are therefore based on incorrect or inadequate information. The impact of this information deficit on the sustainability of development is far-reaching. The failure of programs results from the inadequate attention to the broader dimension of forest problems.

Forest science will need to become less technique-oriented and more process-oriented in order to promote improved decision making on forest land use. If it is to build understanding of both human and biological issues it must therefore draw upon contributions from many scientific disciplines. To meet these new challenges forest science must broaden its horizons, and begin to encompass forest issues at local and global, as well as national, levels. It should address in a holistic and integrated way the social, economic, political and biophysical aspects of all forest uses, and must study the role of forests in society, rather than forest management alone.

This report suggests ways in which forest science can make this shift and move into the 21st century with confidence. The scope for new research includes boreal, temperate and tropical forests. The changes will revitalise forest science, giving it a higher profile and a reputation that will attract increased resources and well-qualified scientists. Thus the foresters of the future will be better trained, forest policy makers will be better informed, and both will have a more appropriate set of tools to enable them to hand on a healthy and productive forest estate to those who come after them.



Chapter 2: Forests, Society and Development

Research to improve forest management has been a mainstay of forest science, which has focused on the study of trees. People often have not been central to its deliberations. However, the last thirty years has seen major changes in society's environmental expectations. If forest science is to address the problems of today and the future, a new research agenda must embrace all the relationships between forests and society.

Integrated studies of these relationships at a network of long-term research sites (Box 4) were among the research priorities identified by the Bali Dialogue. These complex, local socio-economic and biophysical interactions must be seen in their global context, and in a dynamic, historical context of development. Thus international research to examine trends in forest areas, the supply and demand for forest goods and services, the global forces

Box 4

Forest Ecosystem Management

FEM aims to develop improved management methods that focus on the ecological relationships of a species within an ecosystem, rather than in isolation from its system determinants. Until now, the holistic nature of forest ecosystem dynamics, in particular the functional linkages between people and forests, has not received adequate recognition. FEM will use recently developed systems technology to generate testable, holistic models based on ecosystem dynamics that will focus on key interactive biophysical and socio-economic elements of forest performance.

The outcome will be a generalisable tool for generating improved, cost-efficient management options that can be applied via simple, decision-support systems by forest managers, planners and policy makers. FEM is a CGIAR global eco-regional initiative that seeks input from national research systems and other Centers. CIFOR's international perspective places it in a unique position to undertake this complex task. The challenge is to develop both appropriate modelling parameters and also to obtain data from representative tropical forest eco-regions. Although new data are to be acquired, FEM will, as far as possible, build on existing data and expertise in cooperation with in-country partners.

Initial key global sites have been identified in Africa, Indomalesia and Latin America.

Key elements of FEM are concerned with:

- Identification of management objectives and global partners
- Establishment of global benchmark sites
- Development of a generic method of data collection and analysis
- Survey of benchmark sites and establishment of a spatially-referenced databases
- Use of GIS to facilitate building of forest management models using biophysical and socio-economic data
- Field-testing of models
- Communication and transfer of results and technology

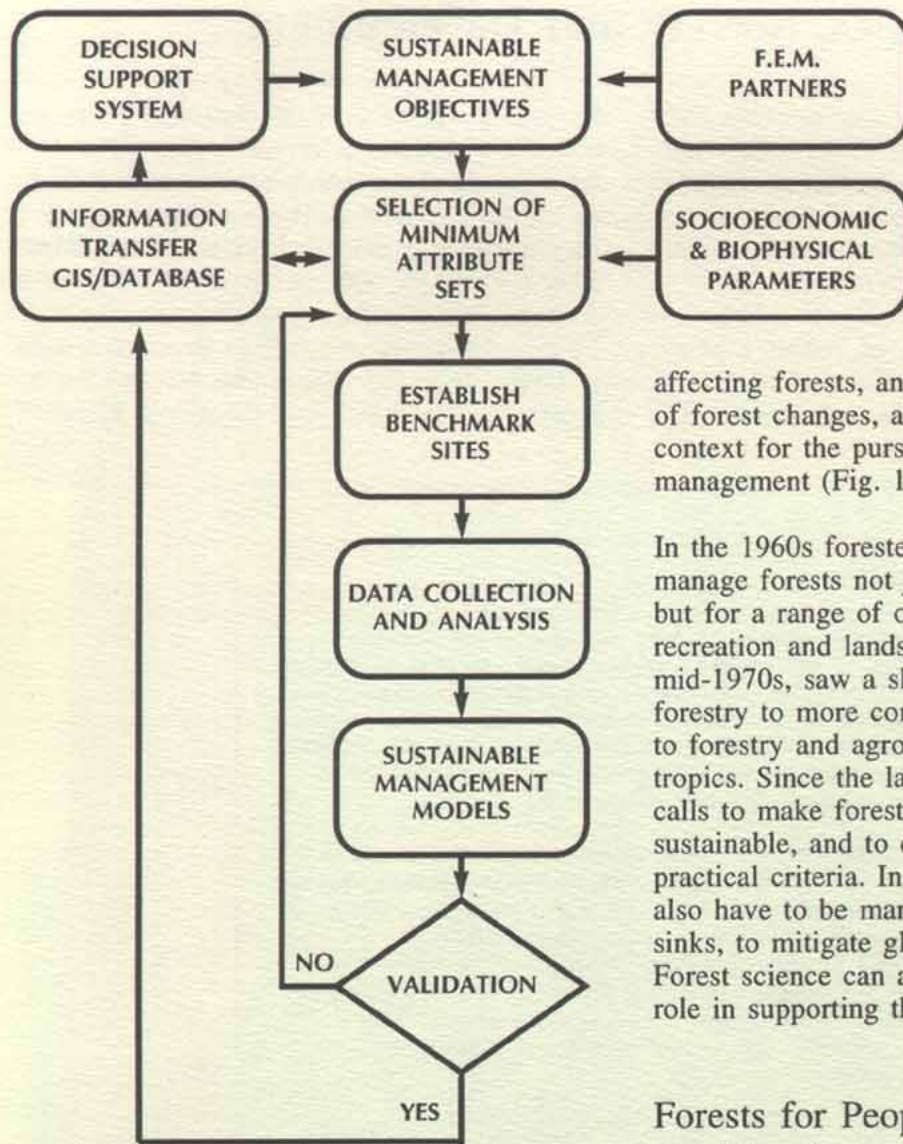


Figure 1: Flowchart of F.E.M. Activities

affecting forests, and the global consequences of forest changes, all provide a broader context for the pursuit of sustainable management (Fig. 1).

In the 1960s foresters had to learn how to manage forests not just for wood production, but for a range of other uses, such as recreation and landscape conservation. The mid-1970s, saw a shift from industrial forestry to more community-based approaches to forestry and agroforestry, especially in the tropics. Since the late 1980s there have been calls to make forest management more sustainable, and to define this in terms of practical criteria. In the future, forests may also have to be managed as carbon stores and sinks, to mitigate global climate change. Forest science can and must play a major role in supporting these new initiatives.

Forests for People – issues at the local level

An increased awareness of the importance of forests, due partly to advances in forest science, has changed perceptions of forests from being remote resources to being vital life-support systems for society, particularly for the people directly dependent on them. Forest managers are recognising the need to adapt management to meet new expectations related to access to forests; a more complete view of the role of forests (Box 5).

Box 5

The Role of Forests in Sustainable Development

The conservation, management and sustainable development of forests is critically dependent upon maintaining, and even enhancing, the potential of forest systems to deliver to this generation and future generations as many as possible of the benefits expected from the forests. Yet, all types of forests are now subject to unprecedented pressures which affect both their quantity and quality.

Forests occupy space. As the population of the world increases and social and economic development proceeds, there will be greater demands on this space for many different purposes – food production, living space, infrastructure. Forest potential will be lost if the claims of the forest for sufficient space to provide all its possible benefits are not fully and reasonably met in relation to claims for other uses.

In any particular locality, there are three elements which are vital to maintaining this potential. A key element is the forest ecosystem itself; but it is equally important to maintain the integrity of the surrounding network of social inter-relationships, especially those of the forest-dwelling people, and to ensure the continued effective functioning of the economic environment of the forest.

Potential will be lost if irreversible damage is caused to the capacity of any one of these three systems to deliver what society requires of them. The management of forests at the national level must therefore strive for an acceptable balance between: a yield of goods and services that is ecologically and economically sustainable; broad social satisfaction; and environmental quality.

Fundamental difficulties in trying to achieve this balance are the pace and unpredictability of change. Communications evolve – in numbers, skills and expectations. Markets change and fluctuate. Human values are not constant. The management of forests is a long-term enterprise. The social and economic conditions when a crop is harvested are seldom the same as when its seedlings first take root, nor are the priorities of people.

Forestry must therefore adopt a long-term perspective – as far as possible to anticipate future trends and to be flexible in adapting policies and management to changing circumstances.



During the 1970s the recognition of a need to gain local people's cooperation in protecting forests prompted a major shift in tropical forestry from "industrial forestry" to "forests for people". This became the theme of the Eighth World Forestry Congress in 1978, and led to a new concept of social forestry, where people other than foresters manage and protect forests and participate in afforestation. The concept integrates the needs of local people with those of distant markets in any management program. Community partic-

ipation can encompass: farm forestry – tree planting by farmers on individual farms; tree planting by foresters on communal land; and pure community forestry projects, where all of the planting is communally organised. In all these cases one major obstacle to adoption is uncertainty about the rights to the trees planted, caused by confused or contested land tenure. Another limitation is a lack of information about, and communication with, local people and their society.

Both foresters and conservationists now exhibit a greater awareness of the needs of local people, and try to work with them in afforestation and forest protection. In many forest areas in the past, local people have played a marginal role in management decisions and received limited access to the economic benefits of forest resources. The challenge is to devise and implement management models which give communities a genuine interest in better conservation or management of forest resources.

Another challenge is to improve forest management and conservation through recognition of local use of non-wood forest products like gums, latexes and medicines. This is an area where the Bali Dialogue saw the need for greater efforts to develop a more participatory research methodology to promote understanding of and to safeguard the

Appropriate indigenous capacity and local knowledge regarding the conservation and sustainable development of forests should . . . be recognized, respected, recorded, developed and, as appropriate, introduced in the implementation of programmes.

*Statement of Principles on Forests,
Para 12d*

knowledge, culture and livelihoods of local and indigenous groups. These are the people who are often displaced by the expansion of intensive agriculture and forestry.

Understanding the important people-forest interactions is crucial to rural development but is also a key to combating deforestation.

Priority areas for research should include:

- Case studies of the attitudes of local people to the forests, what causes them to support forest protection and afforestation, and how they are constrained by local land tenure rules and power structures.

- A survey of reasons why people choose to participate in social forestry projects, the forms which participation can take, including project design, and the mechanisms used for distributing benefits.
- Assessment of the existing species of plants in tropical forests and integration of local people in research to understand the traditional and potential uses of forest species.
- Development of, and training for, new systems to manage secondary and other degraded forests to meet local and national demands for wood and other goods and services. Despite low commercial value, local people, may utilise the areas and wish to improve management for the goods they need.
- A better understanding of problems that might limit the success of schemes to devolve forest management to local communities, such as conflicting demands for different forest products, which might also undermine sustainable forest management for timber production.

The Underlying Causes of Forest Change – issues at the national level

The underlying causes of change in the extent and condition of forests vary greatly from place to place. In general, industrial logging and atmospheric pollution affect the quality of the forest but may not lead directly to great change in extent. Change in demand for agricultural land is the primary determinant of change in forest area. The long-term contributions which forests can make to a national economy can be influenced more by outside pressures than by the activities of

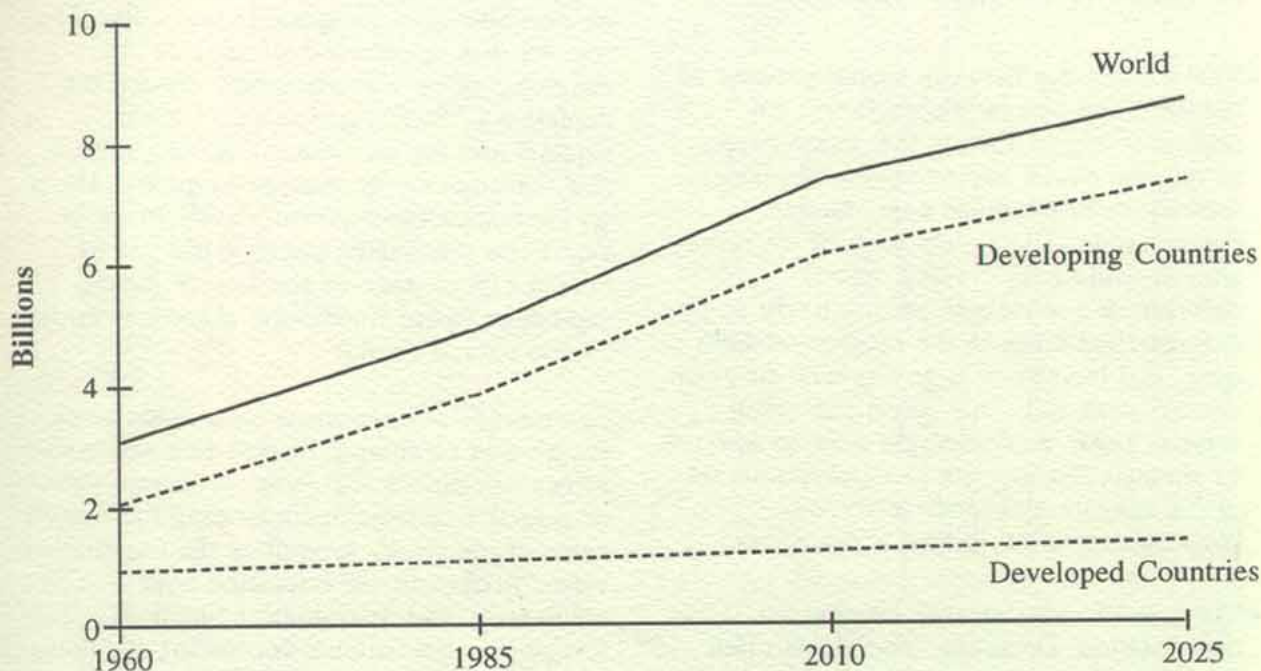
foresters. Tropical forests are especially vulnerable to human impact because the land they cover is often in demand for agriculture. Most deforestation in the tropics occurs because farmers place a higher value on the land beneath the forest, than on the wood it contains. If forest scientists wish to learn how to manage forest ecosystems they need to address the wider role of forests in society.

Among the main underlying forces changing forests are economic development and poverty. As an economy develops, pressures on resources increase but the wealth generated can pay for intensification of agriculture and forest areas may subsequently expand. One other important fundamental influence is population growth (Fig. 2). When poverty

prevails, agriculture is usually extensive and inefficient with the consequence that forest lands may be invaded. In addition, the fruits of economic growth are often not evenly distributed among a country's citizens, and considerable deforestation can occur if poverty and inequality force landless, unemployed people to migrate to forest areas to find land to feed themselves or to earn an income.

Scientists from different ecological zones should cooperate to better understand the dynamics of land-use change caused by the demand for land for agriculture and development. In the quest to achieve optimal forest use, science must place priority on research into the relationships between the forests and society. Research has shown

Figure 2: Global Population Distribution Trends 1960 to 2025



Source: Derived from data in CGIAR, Technical Advisory Committee (1990) "A possible expansion of the CGIAR". Paper AGR/TAC:IAR/90/24. TAC Secretariat, Rome: FAO.

recent afforestation trends in middle-income and industrialised countries are part of a wider continuum of land-use change associated with changes in agricultural practice. This situation needs to be further studied with particular emphasis on:

- The long-term inter-relationships between changes in forest area and quality, and population growth, economic development, and demand and supply of forest products, energy and food. Detailed national case studies of historical trends in forest land-use in particular countries could also illustrate the effects of government intervention, economic adjustment programs, international policies, technological change, industrialisation, etc. Generalisable processes identified by such studies could lead to models of land-use change and forest products consumption, planning techniques for governments, and realistic and achievable sustainable development indicators.
- The relationship between spatial patterns of deforestation and migration flows. An understanding of factors that cause people to migrate could lead to improved planning techniques to minimise unproductive deforestation. The results of such migration studies could help develop spatial deforestation models to predict likely deforestation areas in the short-to-medium term, and thereby help government focus on conservation and other forest protection efforts. These models might later be adapted to simulate the impacts of deforestation on global climate and biodiversity with particular attention to spatial variations.
- The role of unsustainable farming in deforestation. Declining crop yields often lead to an increased need for farmland and hence deforestation (Fig. 3). Solutions include matching land-use types more closely to site quality, and to concentrate

intensive farming on fertile lands. The social feasibility of concentration, and the possible limits to intensification, must also be studied.

- The underlying causes of forest degradation in temperate/boreal forests, e.g. by acid rain, and the involvement of the forestry community in its reduction.

Towards Sustainable Development

Sustainable development was placed on the international political agenda by the World Commission on Environment and Development in 1987 (Brundtland Report) as a strategy to make development less harmful to the environment. Since then, environmental economists have tried to convert it from an attractive, but poorly defined concept, into one that can be measured for each country on an internationally comparable basis. Recent research has represented sustainable development by a relationship between the depletion of forests and other "natural capital" and the increase in "human capital" that constitutes economic development. Based on alternative assumptions, development is said to be sustainable either if the rise in human capital matches the loss of natural capital, or (more rigorously) if there is no net loss in natural capital.

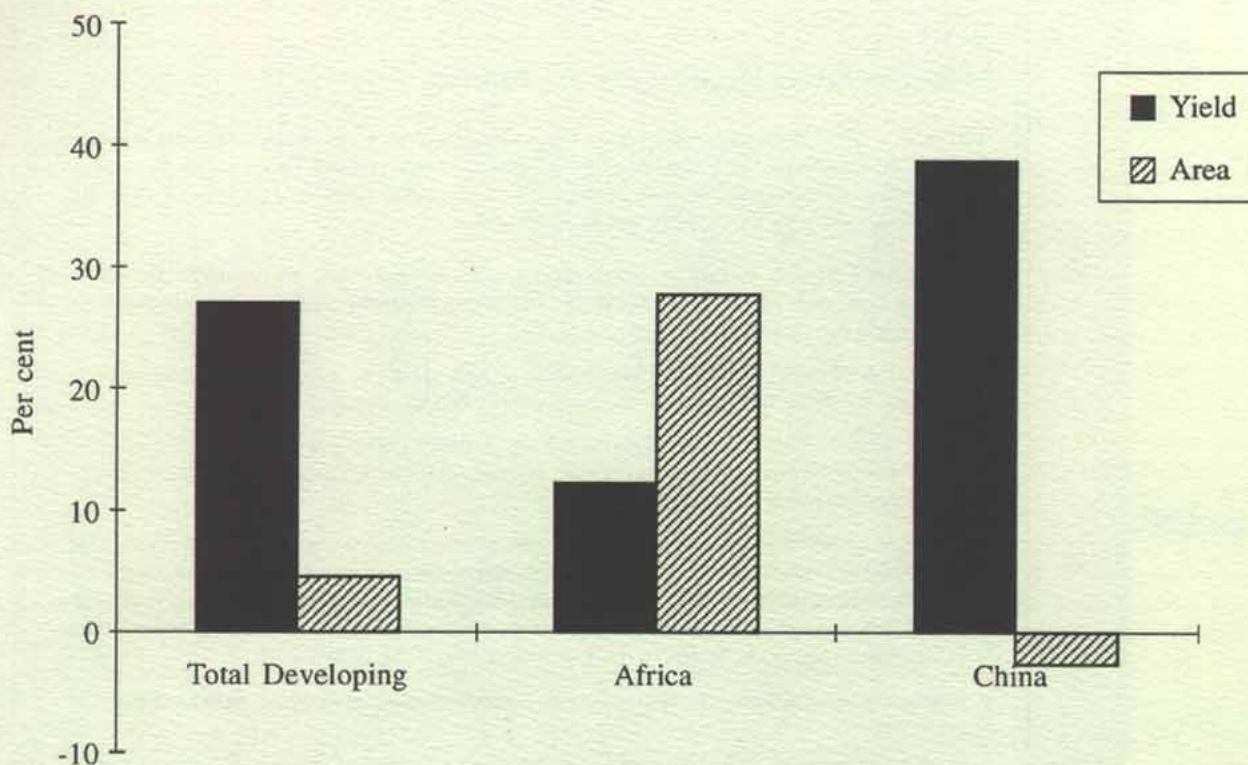
Environmental economists have made some progress in combining market and non-market values to estimate the "total economic value" of natural resources, incorporating the market value of the wood, as well as the non-market values (externalities) associated with biodiversity and hydrological functions. Comprehensive national accounting for human and natural capital is a potentially useful tool for estimating the sustainability of development. Whereas national economic accounting is geared to the estimation of the

Gross National Product, research on initial natural resource accounting is now under way in a number of countries. These early studies suffer from a restricted coverage of resource depletion, and from a limited theoretical framework used to assess depletion, but the scope is now being widened to include additional resource and environmental indicators.

With the shortcomings of research on natural resource accounting, it is a priority to continue study in this and associated fields. Forest science should:

- Compile and use data on the role of forests in national economies, at different stages of their economic development, to fully account for the forest components of sustainable development assessments.
- Devise ways to integrate the costs of forest management for all goods and services, including those without market values, and so optimise total forest outputs. Both supply of present needs and intergenerational equity issues need attention.

Figure 3: Change in Areas and Yields for Cereals 1979-81 to 1989-91



Source: Per Pinstrup-Andersen, "World Food Trends and how they may be Modified". A paper prepared for the CGIAR International Centers Week, Washington, D.C., 25-29 October 1993.

Towards Sustainable Forest Management – the global issues

Since the 1980s, the international forestry community has attempted to ensure forests are managed to sustain **all** their productive potential. Their efforts led to the signing in 1983 of the first International Tropical Timber Agreement (ITTA 83), by which developing and developed countries agreed to work together toward this end. While progress has been made, the area of sustainably managed forest is still quite low. The main constraints may be organisational, not technical, and related to shortfalls in implementation, monitoring and regulation of forest

management systems, not necessarily the systems themselves.

The first International Tropical Timber Agreement took an open-ended approach to improving sustainability. However, the second Agreement (ITTA 94), finalised in 1994, included a target of the year 2000 for all tropical hardwood exports to come from sustainably managed forests. The published set of criteria for determining sustainable management places emphasis on management inside the forest. Little attention has been paid to the influence of social, economic and political factors outside the forest, and how these could delay the attainment of

Box 6

Modelling Future Wood Supply and Demand

Wood is a major raw material in virtually every country in the world and may become increasingly important if renewable hydrocarbon sources replace fossil fuels. In developed countries wood is used mainly for construction, furniture or paper, while in developing countries its primary use is fuelwood.

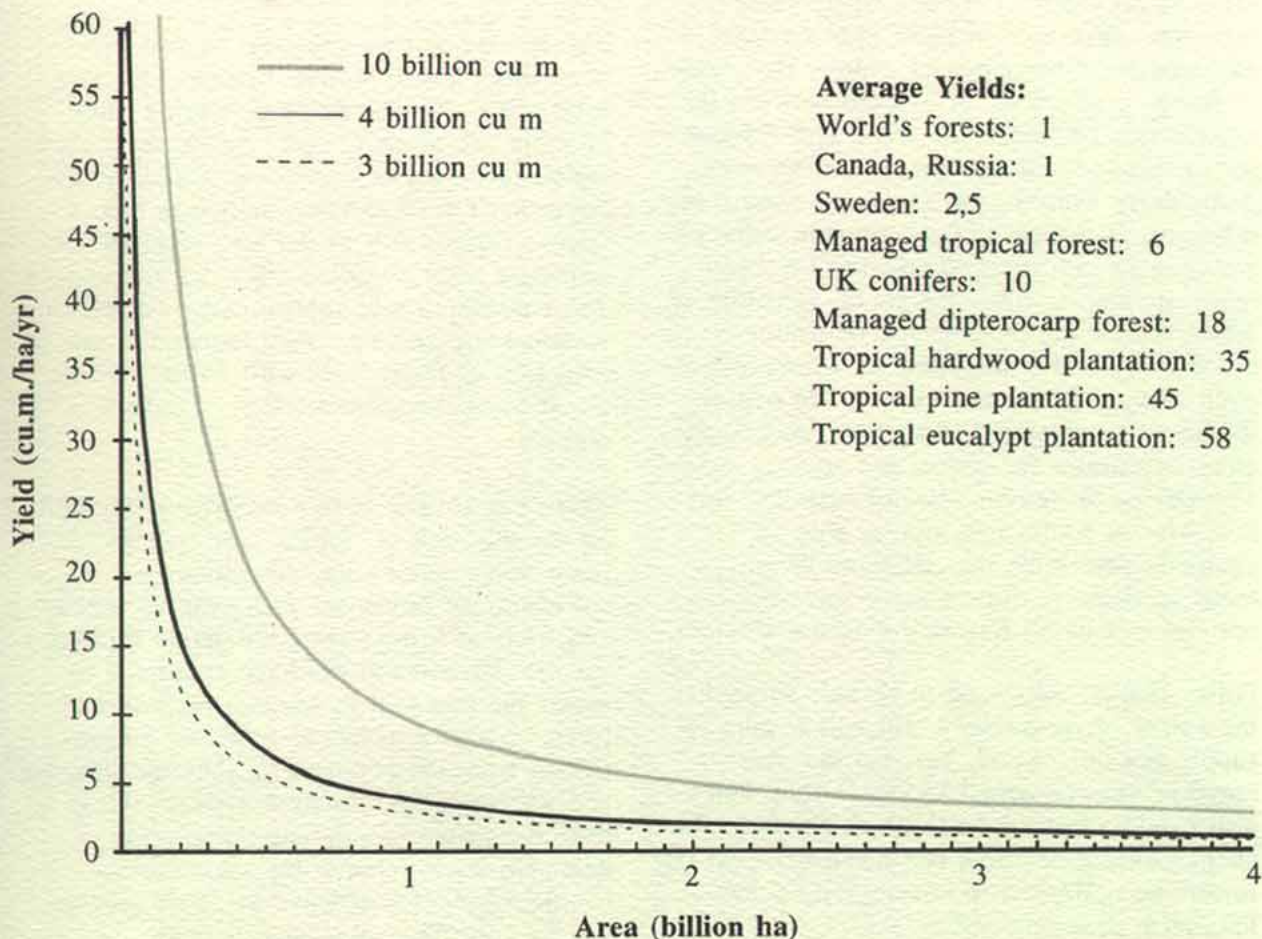
Mathematical models to project wood supply, demand and trade are valuable aids to planning. Research needs to focus on the following priorities as key inputs to the models used for prediction:

- Extension of existing global trade models to provide more accurate information on possible future trends in world forest products supply, demand and trade.
- Study of historical trends in forest products demand and supply and global trade flows to verify prediction by economic models, and the influence of trade barriers and other government interventions.
- Assessment of the influence of past technological changes on demand for wood and the possible impact of future changes. Incorporation of these data into economic models. Recognition of the need for long-term planning to incorporate technical and social changes including management for environmental services such as watersheds, landscapes, recreation facilities, carbon stores and plant gene banks.
- Studies of the influence of deforestation and forest management on wood supply potential.
- Simulation of the possible impacts of both trade liberalisation and “environmental trade barriers” on timber trade flows. Policies on the import of timber only from sustainably managed forests, the establishment of the new World Trade Organization, and the closure of the Uruguay Round will have major influences on trade patterns.

sustainability on a national scale. Research is needed in this area, to explore the validity of the expectations of policy makers and determine the time scale for achievement of sustainability. Priorities should include:

- Studies of the range of environmental impacts of forest management. It remains to effectively quantify the economic costs of all impacts for inclusion in comprehensive analyses and natural resource accounts.

Figure 4: Impact of Productivity Increases on Area required to Produce the World's Timber Supply



Source: Paper presented by D. Poore to *Science, Forests and Sustainability – A Policy Dialogue*. CIFOR and the Government of Indonesia, December 1994.

This graph illustrates the area that would be required to produce specified quantities of timber for each level of productivity. The average annual timber productivity of natural forests, worldwide, is currently 1m³/ha/yr, thus 4 billion ha presently yield 4 billion m³ of logs. At the other extreme, only 1 million ha of tropical plantations could generate the same timber harvest. By increasing the productivity of forest management, the area required to produce the same timber yield can be significantly reduced.

- Studies of the full range of social impacts of forest management so that the sustainability of key societal values can be assessed.

The Demand and Supply of Environmental Services

Wood is only one of the many goods and services provided by forests. Sustainable economic development must also maintain environmental services and address the needs of future generations. A balance between the exploitation of forests for wood and the need for them to provide environmental services, particularly hydrological functions, should be achieved. Historically, the economic value of wood as an industrial commodity has been relatively stable, while the social valuation of watersheds, wildlife, amenity, recreation, biodiversity and landscapes, for example, has risen sharply. There is little basis to expect this trend to reverse. While there are potential close substitutes for timber and paper, alternatives to “environmental amenity” are few. Market forces may not be able to equitably determine the costs and benefits of these services to allow a more socially optimal mix of all forests goods and services.

Policy makers will need to be able to predict the extent of forest the world will require to supply not only wood, but also the wide range of environmental services. They will also need to know how these demands might change over time. How can the overall use of forests be optimised to ensure sustainable long-term development?

Energy and Climate Change Mitigation

Half the wood harvested in the world is still burnt as fuel, and in developing countries as much as 80% is used for this purpose. Fuelwood is again becoming an important

source of energy for some developed countries who are faced with the need to cut back on fossil fuel combustion to reduce carbon dioxide emissions to combat the greenhouse effect. The possibility of greatly expanded use of plant biomass for fuel, fibre and chemical feedstock could vastly increase pressures on natural forest lands in the 21st century.

The 1990s has seen growing interest in controlling global climate change. One key approach is to conserve and develop more efficient use of fossil fuels on an international scale. Forest sector initiatives could involve the protection of existing forests as carbon stores or expansion of the area of forests to sequester surplus carbon from the atmosphere. The consumption of fuelwood grown on sustainable plantations may reduce the rate of depletion of fossil fuels with no net rise in the atmospheric concentration of carbon dioxide.

There has already been considerable research on the selection of tropical tree species for fuelwood, high-density, short-rotation cultivation of numerous fast-growing species, and trials of fast-growing temperate fuelwood species. Various models have attempted to assess the potential to expand the world's forest area as a means to sequester surplus carbon from the atmosphere. Satellite imagery and geographic information systems (GIS) have been used to estimate the area of degraded lands suitable for afforestation. Continued studies of ways in which forests can be used for energy and their role in global climate are needed. This area of research is still quite new and a body of information to benefit policy makers could be developed from initiatives which include:

- Studies to improve our knowledge of fuelwood harvesting and consumption patterns.

- Development of improved models for simulating scenarios on the impact on forests of different strategies to mitigate global climate change, including increased use of biomass to replace fossil hydrocarbons. In theory, there is sufficient degraded land to establish forest plantations which could significantly reduce the annual increase in atmospheric carbon dioxide content. What is less certain is the actual availability of this land, given social, economic and political constraints, and the rate at which new plantations might actually be established within these constraints.



Chapter 3: Forest Policy and its Implementation

Sustainable forest management will not be achieved simply by improving management methods or making forests and forestry more relevant to local people. Sustainability also depends crucially upon effective governance – used here to refer to the combination of management and policy interventions at all levels from central government through local

Governments at the appropriate level . . . should, where necessary, enhance institutional capability . . . supporting sustainable development and environmental conservation in all sectors.

Agenda 21; Para 11.3

administration to communities and households. Forest policy analysis, which studies how forest policy is actually formulated and implemented within a society, has received little scientific attention in the past. Expanding work in this field was another priority area identified by the Bali Dialogue.

Forest policy has often been a matter of deciding on long-term goals without full consideration of the complexity of outside forces influencing forest lands. Because forestry occupies a large area of land with a variety of potential uses, it can be a highly political activity, and priorities for land allocation can be greatly influenced by powerful interest groups in government, commerce and other sectors.

The success of any future international cooperative action to improve the sustainability of forest management will depend on implementation being equitable to

all countries and within countries. A critical element will be a common framework within which to compare national forest practices and their implementation. This framework must be based on a sound body of information. A new research initiative is urgently needed in this area to provide policy makers with the appropriate tools for such appraisal and comparison.

Forests and National Governments

Where a large proportion of forest land is under public ownership, governments, through their forestry departments, largely determine how forests are managed, how funding is allocated, and which individuals or groups benefit from forest exploitation. Other branches of government may bias the allocation of land by providing incentives to promote the expansion of competing land uses at the expense of forest conservation or establishment. When receipts from forestry are substantial, governments may be tempted to over-exploit without thought for future needs. The need to meet long-term timber demands may result in government intervention to establish plantations and/or conserve forests.

A government's forest policy affects both public and private forest activities. Policies are formulated in response to pressures from a range of different interest groups, or "stakeholders". Only some of these are involved in forestry, others are concerned with agriculture, conservation, protection of indigenous rights, hunting, recreation, etc., and may overwhelm stated policy on forests. In some countries, policy is entirely codified in legislation, which aims to achieve the policy's long-term goals. Other countries may

not have a written forest policy. Even if policy is specified in legislation, this may differ from actual practices, reflected by activities inside the forests.

The success of forest management is affected by various factors related to the process of policy formulation and the nature of government. Even if government policy requires the equitable inclusion of all stakeholders, implementation may be undermined by lack of political will, weak administrative structures, or lack of sound policy linkages to other economic sectors. If no defined forest policy exists, then the more powerful among the stakeholders may impose their will on others with possible adverse consequences for the forests.

Resource policy analysis is well-established, although it has mainly focused on the pressures acting on policy makers in the policy formulation stage. Few researchers are involved in analytical studies of forest policy, where the majority have been descriptive. The roles of government and society in policy formulation and implementation require urgent study. To facilitate understanding it is particularly important to identify common processes, if they exist, in the following priority areas:

- Studies in a wide range of countries of actual forest policies, the formulation process, pressures from interest groups within and outside government, the degree of transparency to the general public and how far the latter are involved in the policy process.
- The national pressures on policy makers and how these are related to the distribution of power among interest groups. Is there a role for international agreements in modifying the balance?

- Cross-sectoral influences on policy formulation for forests in a wider context of national land use. Consultation between government departments responsible for different land uses could lead to an integrated approach to land use.
- Evaluation of policies in other sectors which affect forests, e.g. policies on agriculture, energy, population, economic development, trade, environment, etc. The impact of macro-economic intervention policies, for structural adjustment or economic reform, is of particular interest. Identification of conflicts between the aims of different policies, and determination of whether governments are aware of the impacts of these policies on forests. How is the economic environment for forestry affected by incentives in other sectors?
- The implementation of policies and constraints to implementation. What implications do these have for cooperative international initiatives?
- Identification and evaluation of existing mechanisms to assess the results of implementation and other policy impacts. If such mechanisms do not exist, or function poorly, the entire policy process is severely weakened. Non-governmental organisations can play an effective role in this evaluation and modification process.
- Studies of major contemporary policy shifts, such as the decision to reduce governmental control over forests and devolve management to local communities, and their impacts on the forest. The institutional and other factors which will influence the success of policy changes should be identified.

The results of these studies can lay a foundation for the expansion of forest policy analysis, by the development of improved tools and procedures for policy makers and by clarifying the purposes and objectives of participation in policy formulation, implementation and impact monitoring. Other benefits will be new techniques for cross-sectoral and multi-level planning, and a greater understanding of the interaction of policies from different sectors.

International Agreements

While national governments attempt to take account of global concerns in their policy making, there is conflict between the valuation of national assets on local and global bases. Any international cooperation involving environmental management will need to use an equitable and widely acceptable basis for evaluation.

The UN Conference on Environment and Development (UNCED) in Rio de Janeiro in 1992, identified a major issue as the existence of significant variation in the values that different nations and sectors of society attribute to forests. A broad Statement of Forest Principles was agreed at UNCED and forests were mentioned in various chapters of Agenda 21 – the compendium of UNCED recommendations. These, together with forest-related activities to implement the conventions on climate change and biodiversity, will ensure that forestry continues to occupy a place on the international environmental agenda.

In the two years since UNCED there have been significant moves toward a consensus on forest management. A meeting in Bandung, Indonesia, the Bandung Initiative on Global Partnerships, recognised the key role of global cooperation in advancing the forest

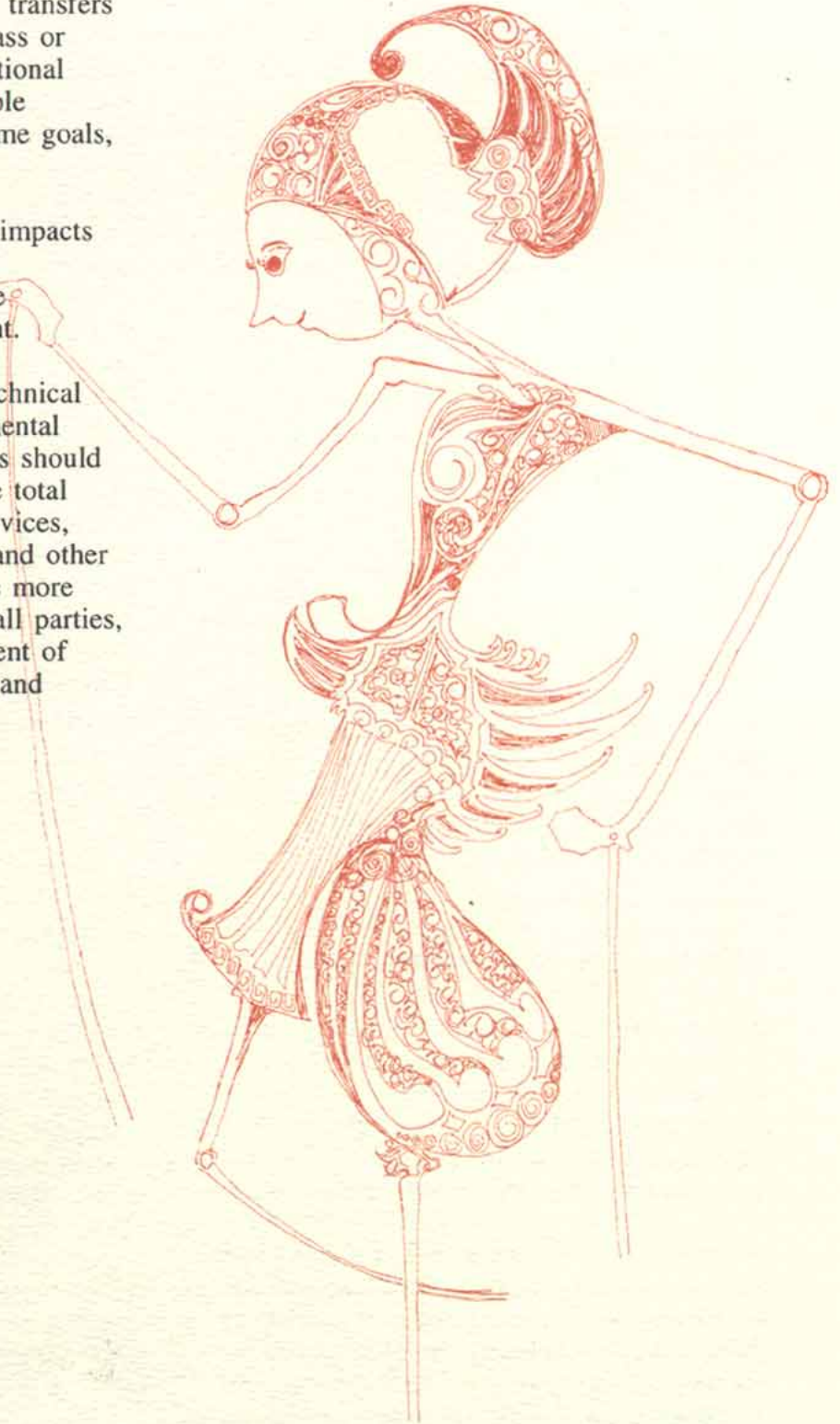
agenda. A conference of European forest ministers in Helsinki in June 1993 launched a project to define criteria and indicators for sustainable forest management in European forests, and the CSCE Seminar of Forestry Experts, in Montreal, Canada in September 1993, initiated a similar project for non-European temperate and boreal forests.

The Forest Forum for Developing Countries, held in New Delhi in 1993, developed a common understanding of the special challenges faced by developing countries in this field. During 1994, an Intergovernmental Working Group on Forests, led by Malaysia and Canada, reached a consensus on several key policy issues and identified research priorities for gaining a better understanding of the role of forest management, trade and conservation in sustainable development, and on criteria and indicators for sustainable forest management. It also discussed how to organise and fund improved forest management.

To continue these moves towards cooperation on conservation of the world's forests, research priorities include:

- Documentation and analysis of the processes leading to the formulation of international environmental agreements. What issues, external to forestry, are introduced as trade-offs in negotiations?
- Research into the extent that energy conservation and efficiency in developed countries might reduce carbon emissions. If developed countries are able to reduce their emissions, then there is less pressure on developing countries to balance the carbon emission problem alone. Strong energy conservation measures in developed countries may increase the acceptability of international forest agreements.

- Comparative assessment of the value of international financial transfers, technical assistance projects and technology transfers for the conservation of high-biomass or biodiversity forests for the international collective good. What other possible interventions could achieve the same goals, e.g. modifying trade policies?
- Assessment and evaluation of the impacts of trade agreements and non-tariff trade/environmental barriers on the sustainability of forest management.
- Development of theoretical and technical bases for comprehensive environmental trade policies. Future trade policies should be designed to take account of the total economic value (all goods and services, traded and non-traded) of forests and other natural resources. These should be more equitable and more acceptable to all parties, and may depend on the development of comprehensive valuation methods and national accounting systems.



Chapter 4: Monitoring Global Forest Resources

Initial Assessment

The efficient management of forested lands must rely on an adequate knowledge of the resource. Baseline inventories should be geared to the specific scale and purpose of forest use. While resource surveys traditionally focus on commercial output such as extractable volume of trees, this is clearly inappropriate for the wider use of forest products that include the conservation and management of biodiversity. Although there is a demonstrable move towards resource inventories geared to multiple-use strategies, fundamental questions remain about the nature of resource indicators and uniform methods of sample design and data analysis. In the majority of cases, methods differ widely between countries, resulting in problems for comparative assessment at global scale and for monitoring change in forest ecosystems. Clearly these are pressing questions that must be considered in developing new operational concepts for forest science.

The Role of Monitoring

Because of the dynamic relationships between forest ecosystems and people, any management strategy must have the capacity to assess and evaluate changes in the resource base that are caused by human or natural environmental agents. So that useful bases for comparison can be developed, monitoring requires *a priori*, access to a cost-efficient method of assessing the initial resource base. A challenge for forest science is to identify appropriate indicators to facilitate inventory. The role of local, national and international resources in this appraisal process needs to be

clearly defined to maximise cooperation and minimise the potential for misunderstanding and conflict. With such a consensus, appropriate indicators and cost-efficient survey techniques, coordinated monitoring of the forest resource can provide a major contribution to both understanding forest dynamics and to the development of models that can be used to predict the outcome of specific resource uses. This is central to effective resource management and policy making, and was identified as an important research priority area by the Bali Dialogue.

Scientific monitoring should be distinguished from other, operational types. Satellites and other forms of remote sensing can be used by national forest managers to monitor fire hazards, deforestation hot-spots and the activities of logging concessionaires. They are also used to obtain data to update national timber inventory maps used in forest planning.

Monitoring Forest Areas and Rates of Change

Forest distribution maps produced from satellite imagery can be used to estimate forest areas and changes over time. Linking these changes to socio-economic and other variables can help to identify the underlying causes of deforestation and permit simulations of possible future trends in forest areas. These data are analysed to help understand the processes involved in forest change and build explanatory theories and predictive models. Often they need access to huge global datasets, and data must be accurate, relevant and current.

The 1972 UN Conference on the Human Environment in Stockholm called for a continuous global monitoring system for the

The provision of timely, reliable and accurate information on forests and forest ecosystems is essential for public understanding and informed decision-making and should be ensured.

*Statement of Principles on Forests,
Para 2c*

tropical forests. Subsequently, the governing bodies of FAO and UNEP mandated these organisations to undertake periodic assessment of forest areas and deforestation rates. Although these assessments have proven to be of major importance for policy makers, the data are less useful for scientific analysis because of uneven quality and the incompatibility of inter-national definitions. More recently, several NGOs or national institutions, with advanced capacity in processing remotely sensed imagery, have compiled maps of some major forest regions. As yet none of these efforts has the resources to take advantage of the technologies now available to produce credible detailed, internationally comparable information.

To advance the process of surveying the world's forests, priorities should include:

- Establishment of better links and mechanisms for data standardisation and sharing between the numerous national, regional and global initiatives to assess and monitor forest extent and condition. These must be designed to facilitate the aggregation of data sets from different sources, the comparison of data from different countries and the determination of trends at national, regional and global levels.

- Development of new data-handling and processing techniques to provide cost-effective and time-efficient operational monitoring systems.
- Effective interpretation and dissemination of forest resource data for use by policy makers and managers at all levels of administration, research and participation.

Monitoring Forest Quality

Deforestation is only one of the forest changes which occurs as a result of human impact. Another is degradation, which reduces the quality of forest rather than its area. Degraded forest is deficient in one or more physical attributes, such as biomass, biodiversity or productivity. Because human settlement and forest exploitation are so widespread, modified forests probably account for the majority of all forest cover, yet our understanding of them is limited. Activities which variously alter the quality of forests include selective logging, shifting cultivation and development actions leading to air and water pollution.

Spatial models to simulate these changes in area, biomass and biodiversity could be very useful for policy formulation. Various forest attributes, such as biomass and species density can be linked to forest area maps using computer-based geographic information system (GIS) techniques.

Considerable research has taken place in the 1990s, primarily under the auspices of the Intergovernmental Panel on Climate Change (IPCC Reports), to map the distribution of biomass in forests as a measure of the depletion of carbon stores in tropical forests and the potential to replenish them to mitigate global climate change. The mapping of biodiversity distributions has so far been

Box 7

Biodiversity Assessment and Forest Science

The developing global interest in biological diversity, and the emerging awareness that tropical forests are some of the richest reservoirs of such diversity, have created a new role for forest science in developing management options that ensure the maintenance of biodiversity.

Questions remain about definitions of ecologically sustainable development and the functional relationships between forest productivity and biodiversity. CIFOR is concerned with developing a generic approach to Rapid Biodiversity Assessment using cost-efficient methods of survey based on indicator groups. The aim will be to use these methods as a means of forecasting the likely environmental impact of specific land uses on biodiversity.

Key research elements will be:

- The identification of key taxonomic and functional groups of plants and animals that can be assumed to represent biodiversity within the region under study.
- The establishment of baseline study areas within the Forest Ecosystem Management benchmark sites to help calibrate and refine key biological and physical environmental indicators.
- Predictive models of plant and animal distribution using GIS technology.
- Testing and refinement of models.

Outputs will include:

- A manual of cost-efficient procedures for biodiversity assessment in tropical forests. With software to assist with data coding and exploratory pattern analysis of key groups.
- A set of user-friendly computer algorithms to assist in survey design and assessment of representativeness of biodiversity for conservation purposes.

confined to the production of species distribution maps for vertebrates and some plants. The spatial distribution of the majority of species in other taxa remains poorly known.

Priorities for monitoring forest quality include:

- Continued mapping of the biomass of forests to improve estimates of their environmental values and changes over time, e.g. erosion control, carbon stores.
- Improvement of methods for assessing the condition of forests using remote sensing techniques. This is important in understanding biodiversity status and carbon sequestration.

- Studies of the spatio-temporal dynamics of degraded forests. The results from localised research can form the basis for new management techniques, and can also be used as a basis for global models.

- Development of more accurate, quantifiable methods of measuring and mapping biodiversity, to improve conservation planning. More accurate maps will help improve future siting, assist planners in determining priority conservation areas, and provide an essential database for future national and international activities to conserve biodiversity.

- Studies of the effects of human activities on biodiversity. The size of reserves should be determined to take account of the minimum critical populations of important species to ensure survival at the same time as recognising the presence of local people and their daily requirements.
- Improvement of baseline biodiversity inventories, by expanding plant collections, designing effective rapid biodiversity assessment techniques, and developing ways to integrate field assessments with remote sensing data from satellites, aerial photography, etc.
- Production of maps showing the distribution of commercial timber reserves, in order to improve prediction of the world forest products trade and projections of potential timber supplies.

Compliance with International Conventions

Extension of the initial framework conventions on climate change and biodiversity will require evaluation of the progress of all signatory countries. An international compensation scheme or subsidies to maintain large areas of forest as carbon stores or biodiversity reserves would require some monitoring for effective implementation and sustainability achievement. This form of monitoring, however, makes judgements on national activities, relative to given criteria, in contrast to the scientific monitoring described above which is largely judgement-free. Internationally acceptable and cooperative forms of monitoring will be necessary for acceptance of research and policy recommendations. Sustainability criteria for forest management, for agreement by all countries, are currently being developed.

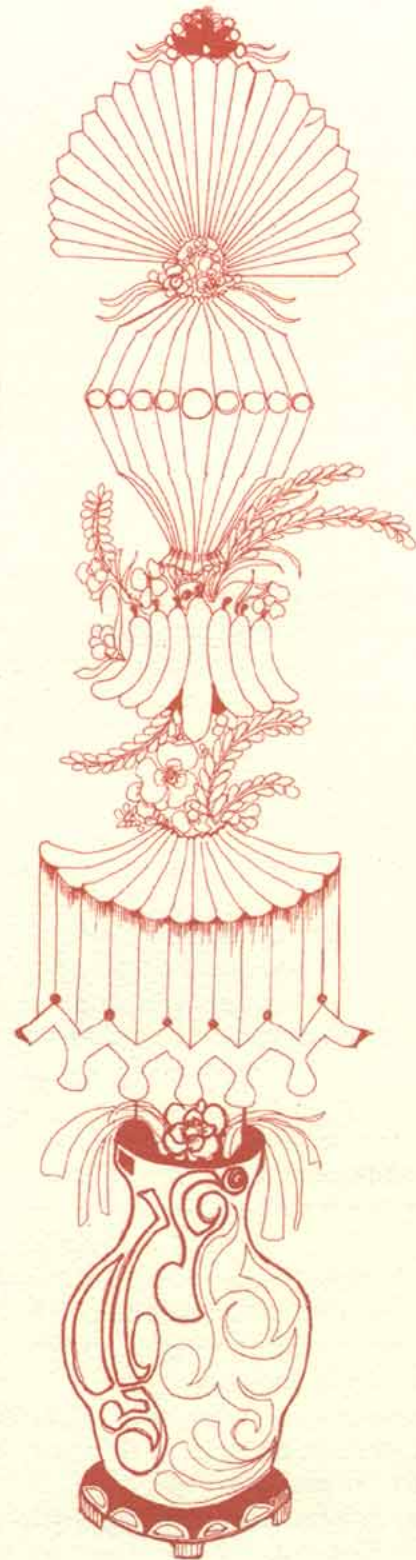
Research priorities to aid monitoring of international obligations include:

- Conversion of agreed criteria for sustainable forest management (ITTO 1993) into measurable indicators. The criteria and indicators must be cost-effective, and provide the basis for policies on sustainable forest management and the tools for its evaluation. They should be evolved to reflect each society's changing needs and expectations of forest ecosystems and their management. While there should be a common core of global indicators, some may need to be region-specific to allow for the immense variation that exists.
- Development of valuation methods for carbon stores. It has been suggested that countries with large areas of high biomass forest should be compensated for the cost of conservation to mitigate global climate change. As a prerequisite to any such scheme, the monetary values of forests as carbon stores would need to be estimated and assessment methods developed.
- Development of valuation methods for biodiversity. The present biodiversity convention allows for the transfer of funds from developed to developing countries to subsidise conservation, but the level of compensation is not based on any monetary valuation of biodiversity content. A more rational approach to biodiversity valuation is needed to take account of the real costs of conservation, i.e. the value of foregone activities.
- Development of techniques to map the distributions of forests, biomass, biodiversity and their associated economic values.

From Assessment to Modelling (and back)

As scientific assessment techniques become more sophisticated, they will make possible much more powerful models of world trade in forest products, for example. However, the big advance could be the production of spatial models of sustainable development. These models would require research to:

- Devise improved techniques to follow progress towards sustainable development using comprehensive natural resource accounting systems which balance economic development with the depletion of natural resources.
- Extend these models to assess forest condition by identifying characteristics of degraded forests and their resilience to human intervention, acid deposition and other pollution impacts, and global climate change.
- Generate models to be used to advise policy makers on the forest area required to supply not only wood, but also the wide range of other environmental services, the overall use of forests to optimise sustainable long-term development, and the desirable distribution of this forest in relation to demands for all these goods and services.



Chapter 5: New Directions for Forest Science

This report has argued that forest science needs to make a conceptual shift if it is to contribute its full potential to today's needs and those of the 21st century. Progress in the main priority areas of integrated socio-biophysical studies, management planning, forest policy and monitoring will also require major changes in the organisation of research. If the new forest science is to study the wider role of "forests in society" it will have to take a more interdisciplinary approach and use the findings and methods of many disciplines, including economics, geography, political science and sociology. There will have to be a greater emphasis on research which identifies underlying causes, rather than applied research limited only to forest management and timber production. International collaboration is necessary to develop globally generalisable and acceptable research conclusions which, in turn, can support local and national development goals.

A New Interdisciplinary Approach to Research

Forestry research has been poorly linked to research on social, economic and biological issues relating to forests. This must change if we are to achieve a holistic understanding of the role of forests in society. The types of problems facing forest science can only be adequately understood and addressed by adopting an interdisciplinary approach which combines methodologies from the social and biological sciences. In a truly interdisciplinary study, the languages, techniques and theories from a number of disciplines will be used in a combination that can address the problem most effectively.

New interdisciplinary methodologies need to be developed. Preferably these should combine the best of the existing theories of different disciplines with new theories as appropriate. It is possible that the theoretical base of existing theories may be insufficient to address the social aspects of a particular problem. In these cases new theories and models will be needed. Systems science is one methodology which provides a powerful set of tools for interdisciplinary work and it may provide the crucial first step. Geographic information system (GIS) techniques also allow the physical and socio-economic attributes of forests to be interfaced easily in digital form.

Institutions and funding agencies must allocate resources for interdisciplinary training, so that personnel can develop the skills necessary to undertake such research. The time constraints placed on formal study programs may need to be relaxed to recognise the important role of a broad training. The professional and academic environments should not discriminate against those skilled in interdisciplinary research.

The research institutions that produce the new holistic, strategic understanding of forests may not be the traditional Forest Research Institutes which are often part of the structure of national forest services. They may very likely be located in research institutions with a mandate beyond the conventional forestry goals of maximising management for timber production. Forest science needs to recognise the role of fundamental research which identifies underlying causes and inter-relationships and leads to the development of theories and methodologies to work in new areas. Such research is appropriate because there is still much to discover about the role

of forests in society, and so many processes and relationships to identify.

Funding Research on Forests

Current funding allocation procedures can be biased against interdisciplinary research, both because of the structure of reviewing committees and the fact that their membership is often dominated by researchers with backgrounds in traditional, highly focussed disciplinary research. A new appreciation of the need for, and value of, interdisciplinary research should bring expanded funding opportunities. Funding agencies must be convinced of the value of funding research in the areas proposed here. This report is a first step in publicising the need for a new research agenda, and hopefully it will provide a basis for discussion between forest scientists and the administrators of funding agencies. The proposed priority activities are both implementable and of prime concern.

Forest scientists should recognise the need to diversify their funding sources. Government forestry departments will not immediately be able to reallocate funding to new research directions. However, other funding agencies may be able to provide resources for a new strategic agenda. Greater diversity of funding will also lead to a more independent forest science which can at once criticise and guide. If forest management in some countries is devolved to local communities and in others is increasingly in the hands of private companies, this may also affect the funding and organisation of research. Commercial and other non-governmental organisations may concentrate funding on applied research. If this happens, then government-funded research may concentrate more on issues related to management for public goods.

International Collaboration and Coordination

A new research agenda will not be achieved by concentrating all funding within any single institution. The strategy most likely to succeed will be to encourage existing research groups and institutions to collaborate at both the national and international levels. However, present research structures are not adequate, especially for forest policy analysis and global-scale research. Existing forestry research has commitments to present agendas. Those willing and able to work in the new research areas are still relatively few in number.

Some new structures are therefore necessary. The Bali Dialogue felt that an international framework for research collaboration would provide a support mechanism for the limited numbers of scientists from each country, promote comparative and widely applicable analysis, allow a division of labour, act as a meeting ground for scientists from different disciplines and ensure the critical mass of effort needed to make important breakthroughs. It could also facilitate research in practical ways, by acquiring the large global datasets used by researchers in individual countries, providing a vehicle for allocating funds, and even providing a bulletin board to promote rapid electronic communication.

This does not mean that research has to be centrally directed. This would be both difficult and undesirable, given its exploratory nature, but coordinated effort can achieve advances. Even if a coordinating group merely lists the key research questions and acts as a clearing house to bring researchers together to address these, it will serve a useful function. Large-scale international forest research collaboration has been successful in the areas of modelling world

trade in forest products (Kallio et al. 1987) and identifying causes and impacts of global climate change and possible strategies to mitigate it (IPCC).

Participants at the Bali Dialogue debated whether a similar mechanism might help to achieve the proposed renewal and redefinition in forest science. Any such body should have international status to attract and disburse funds to support joint research. The actual work plan for a new international network could be modelled on the research agenda presented here. Papers could be commissioned to review the state of the art in particular areas, and synthesised to produce a comprehensive report which also identifies gaps to be filled by further research. Research understanding could be advanced by specially commissioned short-term collaborative projects combined with long-term research initiatives in selected areas.

The research program would cover countries in all eco-regions. The governments of interested developed countries could collaborate to fund research, carried out by their own scientists, as well as counterpart scientists from developing countries. Research carried out through and by local people could provide access and insights not available to the outsider. The Bali Dialogue saw partnerships between developed and developing countries, and between different developing countries, as critical to the advancement of the initiative. Whatever structure might finally be established to achieve these functions, the existing capacities and networks of IUFRO, FAO and CIFOR must be fully exploited to achieve maximum impact and efficiency.

Other Changes in Research Organisation

There will need to be wider changes in the organisation of forest research. The international research program will undoubtedly be complemented by projects undertaken by individual researchers. Some of them will be in national forest research institutes and others in universities. Staff of the leading international forestry institutes will probably have a prominent role. Some research centres may establish specialist units focussing on particular aspects of the new research agenda. If a new direction is to take hold in forest science generally, it is important that forest research institutes and university forestry departments appoint social scientists to their staffs.

Already, much research in the new priority areas takes place outside conventional forest research centres, in other university departments, private non-profit research institutes, and NGOs. As the influence of NGOs increases, which is probable if forest management becomes more decentralised, they may require more research support (perhaps from government research institutes), and are likely to undertake more research themselves. The research activities of commercial forestry organisations are also likely to expand, especially in countries where governments devolve management of forests to the private sector.

Putting Research Results Into Practice

The results obtained from the research proposed here will lead to major advances in our understanding of the role of forests in society, and improved techniques for forest planning and management for an era of more

sustainable development. If the results are to be put into practice, they need to be communicated effectively to forest policy makers and managers. The Bali Dialogue regarded this as a vital element and emphasised the need to improve communication of research findings in the identified priority areas. The users of the information will vary from university level researchers to local forest dwellers and managers. At each level of dissemination, a different and innovative communication facility may be needed. Where personnel are scarce to "spread the word" substantial resources will need to be directed towards training.

Modern information technology is an effective communication tool. This report has shown the potential for improving access to forest resource information by various kinds of assessment activities, and using computer models to give policy makers and forest managers more sophisticated decision-support tools. A partnership between policy makers and researchers should be seen as a potential source for improvement in the techniques to deal with the issues presented by the need to pursue sustainable forest management. Researchers will need to recognise that government is not their only client. They will also have to service the different needs of private companies and small communities and ensure that research results are communicated effectively to every type of client.

Conclusions

This report reflects the general feeling of the Bali Dialogue in calling for radical changes in the nature of forest science and the way it is undertaken. The need for change is urgent. Several leading forest scientists participated in the Dialogue, and so the need for change is clearly recognised by the research community.

One activity common to all scientists is asking questions. There is a need for scientists with more time to ask questions and learn about the role of forests in society; this is at the heart of the many real-world

The objectives of forest science must be to optimise the extent of forest not to maximise it.

Director General, CIFOR

problems facing not just foresters and forest policy makers, but the society at large. If this is not done, the techniques needed to solve current problems will never be developed. If forest scientists widen their field of view and look at problems in a cross-sectoral way, they will start to ask the right questions. If they adopt an analytical, rather than a descriptive approach, they will make many new discoveries. The new policy environment in which forest science now has to operate reflects a growing concern about environmental change, locally and globally, and the need to control this through more sustainable development. The heart of the problem is to achieve a balance between the needs of all people; to recognise that changes in forest health have multiple impacts on both local and global environments. Forests are a key part of the interface between humanity and the environment. They can no longer be studied as though they were divorced from society and as if forest activities were only of local concern. In the real world, forests play a fundamental role in society and can have impacts on all scales. As more forest scientists (and others) appreciate this, the world will realise the true importance of forests and their central role in sustainable development.



Annexes

Annex 1:

Forest Research: A Way Forward to Sustainable Development

In preparation for the UN Commission on Sustainable Development's review of forest issues at its third session in April 1995, there has been a series of mutually supporting national and international initiatives.

This Policy Dialogue on Science, Forests and Sustainable Development has been hosted by the Government of Indonesia and CIFOR in order to identify and consider the key research needs for the support of sustainable forest management to meet human needs now and in the future.

International Initiatives to Promote Management, Conservation and Sustainable Development of Forests

Since UNCED '92 there have been several initiatives to raise awareness, help develop consensus and to advance towards improving the management, conservation and sustainable development of all types of forest. These initiatives have provided a mutually supporting framework for international action.

- The Bandung Initiative: The Global Forest Conference, held in Bandung, Indonesia, in February 1993, recognised the key role to be played by global partnerships in advancing the forest agenda.
- The Helsinki Process: The Forest Ministers' Conference in Helsinki in 1993 adopted resolutions on sustainable forest management and biological diversity of forests in Europe and launched work on "Criteria and Indicators for Sustainable Management for European Forests".
- The Delhi Declaration: The Forest Forum for Developing Countries met in Delhi in 1993 to develop partnerships and a common understanding of the particular challenges faced by developing countries.
- The Montreal Process: The Conference on Security and Cooperation in Europe convened a Seminar of (Forestry) Experts in Montreal to initiate work on criteria and indicators for the sustainable management of non-European, temperate and boreal forests.
- The Indo-British Workshop held in Delhi in July 1994, agreed on a format for national reports on forests to be submitted to the CSD review.
- The IWGF: The Intergovernmental Working Group on Forests, led by Malaysia and Canada, has achieved a consensus on approaches and options to address several important policy issues, at meetings in April and October 1994.
- The FAO Working Group: FAO is the UN-appointed task manager for forest-related issues and preparation of documentation for the CSD review of forests in April 1995. FAO has participated in all the forest initiatives and intends to host a meeting of Ministers responsible for forests in Rome in March 1995. The results of all the above initiatives will be available for consideration at the FAO meeting and the CSD review.

The Challenge

- Forests play a unique role in meeting human needs at local, national and international levels. They protect local and global environments, and so are essential for sustainable development.
- At the United Nations Conference on Environment and Development held in Rio de Janeiro, in June 1992, world governments agreed to conserve, manage and sustainably develop their forest resources. The UNCSD in April 1995 will review progress towards implementation of the Forest Principles and relevant Chapters in Agenda 21.
- Rapid social, economic and technical changes increase global inter-dependence and uncertainty. Demographic pressure and other human impacts, including patterns of consumption, exert growing demands on the forests. As a result, some forests are being eroded in both quality and area. Smaller areas of forest will need to deliver ever more goods and services, to meet the demands of twice as many people by the middle of the 21st century.
- Without immediate action, this erosion of forest resources, and the environments they protect, will increase. Loss of biodiversity will become more rapid and life support systems will be further damaged. Benefits will be lost or reduced and sustainable development adversely affected.
- It is also the role of forest management to sustain and enhance the potential of forests to provide goods and services to as wide a range of people as possible on an equitable basis.
- There is a consensus on the need to halt and reverse these negative trends. Nationally based strategies and policies must increase productivity, halt forest degradation and deforestation, enhance forest benefits, increase efficiency and provide incentives for the conservation, management and sustainable development of forests.
- However achievement of these objectives will be the product of hundreds of decisions and actions taken at many levels. Individuals, communities, local authorities, private sector interests and non-governmental organisations, as well as government and inter-governmental bodies have a role to play. There will be negotiations and compromises. These decisions and actions will be strongly influenced by: public opinion, legislation, economic and social circumstances; the quality of information available about options, opportunities and approaches; and an understanding of the likely consequences of actions taken, now and in the future.
- The current state of forest science is not adequate to provide reliable and comprehensive information needed for timely decision making. Decisions being made at all levels may be based on incorrect or inadequate information. The effect of such decisions could impair the pursuit of sustainable development. Thus there is an urgent need for forest research to provide the relevant information to guide decisions taken on forest issues at all levels. This must be available in an accessible form and a timely and cost-effective way.

Therefore the Challenge for forest research is to:

Provide the knowledge and information to assist decision making that will sustain and enhance the benefits of forests to all people, including future generations.

In accepting this Challenge, the Dialogue concluded that forest research must broaden its horizons and adopt a more holistic approach. It must attempt to address all forest functions, values and potentials, in order to achieve effective management, conservation and sustainable development in all types of forests and for as many stakeholders as possible.

Research priorities identified by the IWGF (Malaysia-Canada Initiative)

- management, conservation, and sustainable development, and enhancement of all types of forests to meet human needs
- criteria and indicators for sustainable forest management
- trade and management issues
- approaches to mobilising financial resources and environmentally sound technologies
- institutional linkages
- participation and transparency in forest management, and
- cross-sectoral linkages and integration.

Action – The Way Forward

The complexity of issues in the management, conservation and sustainable development of forests requires better research tools, diverse sources of information and flexibility in how problems are identified and solved. Further research is needed to provide a firm scientific basis for sustainable forest management and for discussion of environmental issues with global impacts.

The Dialogue identified an urgent need to improve research tools and understanding, and a longer-term need for improved research methodology.

It identified the following urgent research priorities.

- *Criteria and indicators*
Criteria and indicators for the assessment and prediction of impacts of management, conservation and sustainable development in all types of forests are urgently needed. The scientific basis for these, and their ease of use, should be improved and tested in large-scale demonstration sites.
- *Linkage to global environment*
The increasing number of environmental conventions and agreements on climate change, biodiversity, desertification, etc. requires a better understanding of the linkages between trees and forest ecosystems (at national and global levels) and the general health of the environment, including the impact of human activities.
- *Assessment systems*
Periodic measurement and assessment of the state of forests is needed, at local and national levels, including their biodiversity and other environmental services and values. Exchange of information through cooperation at national and international levels should be enhanced. This will require the creation of standardised techniques and methodologies and appropriate means to share the information gathered. Predictive models would greatly facilitate assessment and future action.
- *Forest valuation*
Reliable methodologies and appropriate mechanisms need to be further developed, to assess the contribution of forests to sustainable national development. These should include ecological, environmental, economic, social and cultural aspects. They should take into

account the services provided and all values of forests, including the effects of other sectors such as agriculture, energy, mining and urbanisation.

The costs of management, conservation and sustainable development of all types of forests should be fully reflected in market mechanisms. All impacts of forest industries on the provision of other forest goods and services should be incorporated in forest valuation and land-use planning.

- *Community participation*

Traditional knowledge and management of trees and forest ecosystems by local communities, who may play an important role in the maintenance of healthy forests, should be documented. Local communities and other forest managers and stakeholders should be included in forest research as appropriate. Means to better achieve this must be developed.

- *Forest Conservation*

There is a need for more research on, and a better understanding of, the impact of forest management on biological diversity. Conservation values of forests are of prime importance, and should be a subject of future research.

The Dialogue identified the following as necessary elements of research methodologies to provide a more comprehensive approach to the understanding of the basic science of trees and forest ecosystems, deforestation, and degradation, in their social and economic contexts.

- *Integrated socio-economic and biophysical studies, at a network of landscape-scale sites, to understand the relationship of human development to forests.*

This should include consideration of: inter-sectoral interactions; the causes of deforestation and degradation; the impact of all stakeholders, and ways of ensuring their participation; and the role of forests in the socio-economic development process.

- *Periodic assessment of all types of trees and forest ecosystems, and of forest management, at national levels; and exchange of information at national and international levels.*

This would include: methodological development of criteria and indicators for assessment systems; implementation of these systems; information exchange; and international cooperation networks.

- *Examination of trends of supply and demand in forest goods and services and their relationship to forest area and health; the development of strategies to optimise the balance between them, in pursuit of sustainable development.*

This should include consideration of: causes, patterns, and rates of change; patterns of production and consumption; improvement of productivity; international trade; natural resource accounting; efficient use and conservation of forest resources and products; inter-generational allocation of natural resources endowment; incentives; technological gaps; fiscal measures, and compensation mechanisms and subsidies. In the context of a rapidly changing world, these analyses must explicitly consider uncertainty as to future conditions.

- *Studies on the contribution of political and institutional arrangements in support of sustainable development.*

This should include consideration of: management issues; participation and devolution; governance and decision making; conflict resolution; international trade; policy and institutional design; cross-sectoral linkages; land tenure and ownership; community forest management and traditional knowledge of forests; and legal and customary rights.

Guiding Principles for the Conduct of Forest Research

The research agenda described above is forward-looking, and represents a marked shift from the present orientation of forest research. A widespread transformation in attitudes will be needed to establish a new research culture. It will require changes in the management of science, maintenance of organisational and financial stability, improvement in the status of scientists and other incentives, and revised patterns of assistance for research in developing countries. Implementing the new research agenda will require major revisions in the way research is conducted.

- *Scales*
Research should be conducted at the global, national, regional (eco-regional or political regions) and local levels; in recognition of the differing scope of the emerging issues.
- *Cross-sectoral*
The research outputs should be comprehensive and consider forest-related problems within a cross-sectoral and inter-disciplinary context.
- *Problem-oriented*
The research should focus on problem identification, solution and prevention. Research on developing new methodologies appropriate for each type of problem, at each scale, may be required.
- *Stakeholders*
Involvement of all the appropriate stakeholders in the design and conduct of research, at each level, can achieve both better research results and their more effective implementation. Thus, wherever possible, formulation of research should be guided by the priorities identified by local people and others who depend on forests for their livelihoods.
- *Networking and Participation*
Networking and linkages between institutions, researchers and clients is essential. Existing networks must be strengthened, and new ones developed as necessary. At the local level, NGOs, local government agencies, extension workers, forest managers, industry, local people and researchers should network and communicate, ensuring that there is close collaboration between researchers and the users of the research outputs including collective decisions on the research agenda and priorities.
- *Exchange and Use of Information*
Coordination mechanisms will be necessary to ensure networking at the international level. New assessment methodologies are required for the provision of transparent, comprehensive and timely national databases, as well as for international comparisons of databases. Spatial predictive models can be developed as aids to decision making.

There is a need to seize opportunities presented by modern communications technologies (e.g. Internet) to improve accessibility to, and diffusion of, forest-related information through both informal and formal networks.

Access to existing sources of forest-related information should be facilitated. Inventories of databases, including libraries, will enable more efficient use of existing knowledge.

The issue of intellectual property rights needs to be resolved in a way that is equitable to all parties concerned, including traditional users of forests, national governments and the international community at large.



- *Partnerships*

South-South research cooperation between countries should be encouraged and facilitated by new and existing mechanisms. In this way affordable and appropriate technologies can be directly transferred, between scientists and between nations.

There is a need to promote joint working arrangements between scientists from developed and developing countries, in institutions located in developing countries.

The private sector should be encouraged to conduct in-house research and to support external research, whenever possible.

- *Capacity building*

Training in research for scientists from developing countries should involve up-to-date concepts, methods and techniques; as well as, where appropriate, research administration (e.g. through internship programs).

New educational approaches are needed to promote true inter-disciplinary understanding and research, and for inter-disciplinary programs of post-graduate study.

Strengthening of local institutions will also frequently require suitable research facilities. Support for NGOs will enable them to facilitate local participation in research.

- *Dissemination of research results*

A "user-friendly" means of communicating forest research results to decision makers needs to be promoted. Efforts should be strengthened to make information available in national languages and accessible media.

- *Coordination of Research*

Improved collaboration and coordination of research activities by funding agencies would considerably enhance research effectiveness and efficient use of resources.

- *Funding*

New forest research activities can be supported by refocusing existing research, and by innovative reallocation of existing funding, as well as a net increase in research expenditures.

In the context of the above guiding principles, urgent attention is required:

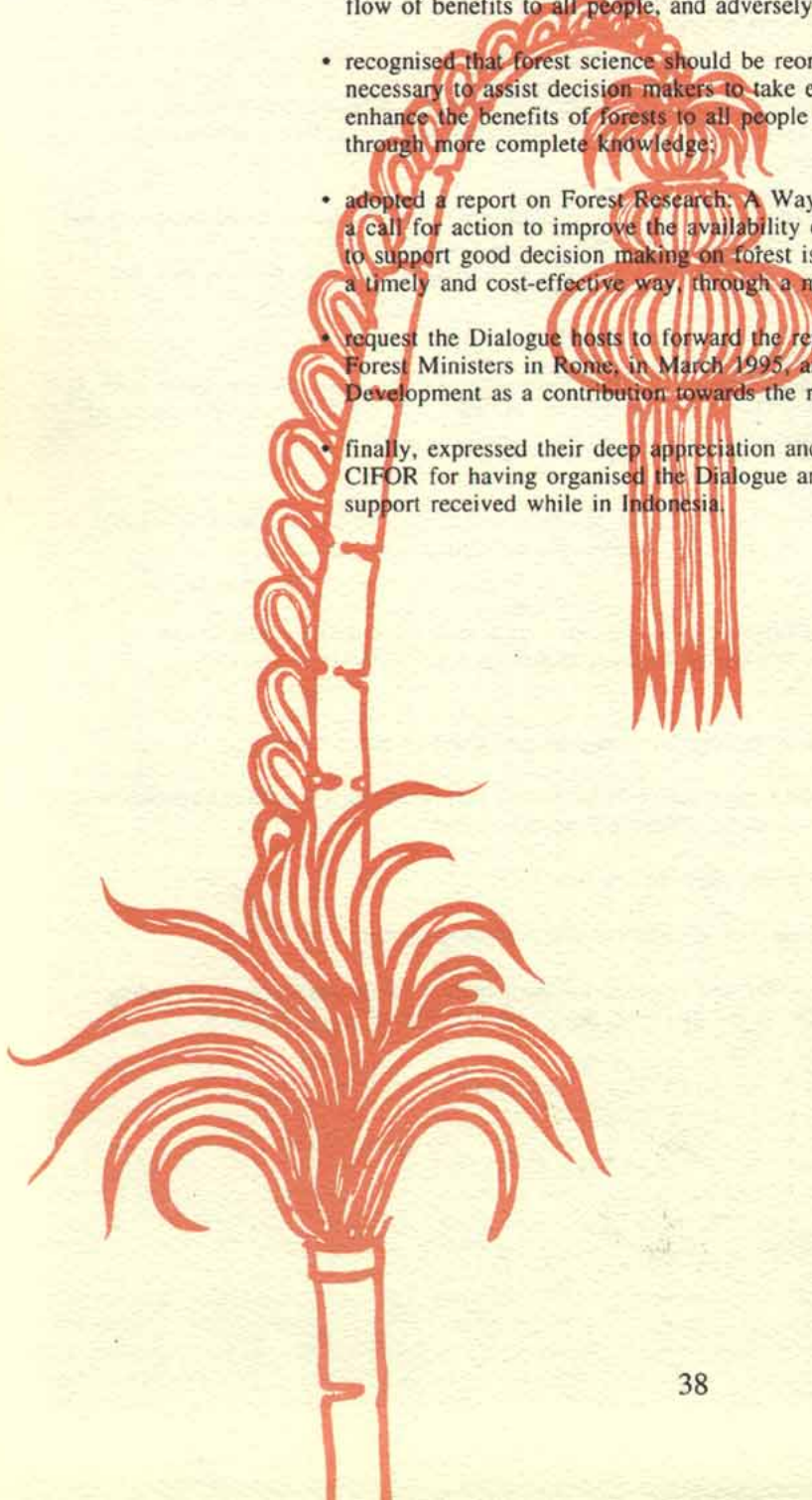
- to develop and strengthen the research capacities of nations through a political commitment at the national and international levels to support research;
- to develop true global partnerships in research;
- to make concerted efforts to share and transfer technologies; and
- to encourage where possible and relevant, the participation of all stakeholders, including communities and NGOs, in the planning, design and conduct of forest research.



Resolution: Policy Dialogue on Science, Forests, and Sustainability at Bali, Indonesia

The participants at the Policy Dialogue on Science, Forests, and Sustainability meeting in Bali, Indonesia, from 10-15 December, 1994

- expressed their concern at the state of forest resources and the environments they protect, and the loss of biodiversity which could further damage life-support systems, reduce the flow of benefits to all people, and adversely affect sustainable development;
- recognised that forest science should be reoriented to provide more complete information necessary to assist decision makers to take effective decisions and actions to sustain and enhance the benefits of forests to all people and conserve the forests for future generations through more complete knowledge;
- adopted a report on Forest Research: A Way Forward to Sustainable Development, which is a call for action to improve the availability of information and scientific knowledge needed to support good decision making on forest issues at all levels, in an accessible form, and in a timely and cost-effective way, through a more comprehensive approach to forest research;
- request the Dialogue hosts to forward the report to FAO for consideration at the meeting of Forest Ministers in Rome, in March 1995, and to the Commission on Sustainable Development as a contribution towards the review of forests in 1995; and
- finally, expressed their deep appreciation and thanks to the Government of Indonesia and CIFOR for having organised the Dialogue and for their warm and generous hospitality and support received while in Indonesia.



Annex 2:

Participants in the Dialogue

NAME	NATIONALITY	NAME	NATIONALITY
ABDULLAH, Othman Dr.	Malaysian	MONIAGA, Sandra	Indonesian
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Annex 3:

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