The Global Forest Sector: An Analytical Perspective

Synopsis of an IIASA book edited by
Markku Kallio, Dennis P. Dykstra, and Clark S. Binkley
and published by John Wiley & Sons

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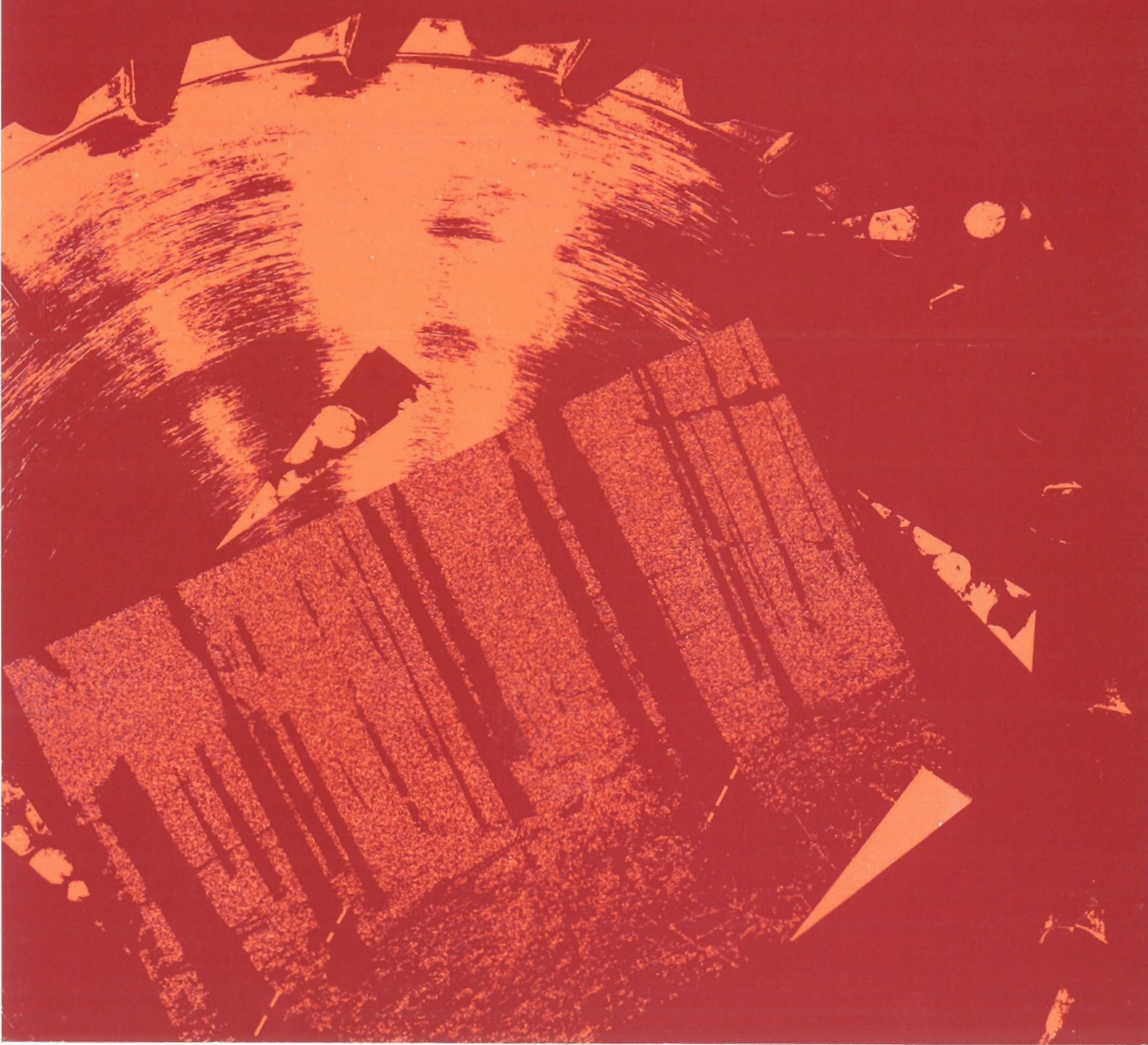

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INTRODUCTION

The world's forests, like its oceans and atmosphere, are global resources. Tree-covered landscapes blanket large parts of every major land mass except Antarctica and contribute to the well being of every individual on earth. Properly managed, they provide a myriad of products — from medicinal plants to cooking fuel to building materials to fine papers to special chemicals that serve as a base for plastics and other synthetic products. Reservoirs of enormous genetic diversity, forests comprise the habitats for a large share of the Earth's 10 million species of living things. Forests cleanse the air we breathe and the water we drink. It is not too much to say that the health of the forests underlies the health of mankind itself. Yet this global resource, and the multitude of products derived from it, have rarely been studied from a global perspective.

In 1980, the International Institute for Applied Systems Analysis (IIASA) organized its Forest Sector Project (FSP) precisely to examine this global resource from a global perspective. This five-year project developed a computer-based model of the world's forest sector — forest resources, conversion processes, and international trade in forest products — and examined the global effects of national resource, industry, and trade policies. In addition to a small core team of scientists at IIASA, the FSP included a collaborative network of over 300 scientists, managers, and policymakers. Besides the model itself, one of the important products of that collaboration was a book entitled *The Global Forest Sector: An Analytical Perspective*. This report is a synopsis of that book.

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THE FOREST SECTOR PROJECT AT IIASA

In 1980, IIASA convened a meeting of forest scientists to consider launching a comprehensive, global study of the forest sector. The participants recommended strongly that IIASA initiate such a study, and that funding be sought to enable participation by scientists representing every forested region of the Earth, not just those of the IIASA member countries. This recommendation led to the establishment, in late 1980, of the IIASA Forest Sector Project under the leadership of Professor Risto Seppälä of the Finnish Forest Research Institute.

The initial plan of the Forest Sector Project involved separate but coordinated studies of:

(1) The ecological principles that govern forest ecosystems.
(2) The sociological impacts of man's activities on forests.
(3) The economic system that increasingly links the world's forests through international trade and by the global effects of environmental degradation.

Unfortunately, this ambitious plan itself fell victim to economic forces; the worldwide economic recession of the early 1980's, coupled with reduced contributions by certain of IIASA's member countries, necessitated a more modest approach. In 1982, the project's focus narrowed to consider but one of the original facets of the project: the economic system. In that same year, Professor Seppälä decided to return to Finland and was replaced as FSP Leader by Professor Markku Kallio of the Helsinki School of Economics. Together, Seppälä and Kallio traveled to virtually all of the world's forested regions, enlisting the help of scientists, managers, and policy makers willing to contribute to this ambitious, innovative project.

By mid-1983 a core team of scientists at IIASA began to develop the global forest sector model, which came to be known simply as the global trade model, or GTM. In addition to Professor Kallio, the team comprised Professor Åke Andersson, a regional economist from the University of Umeå in Sweden; Professor Dennis Dykstra, an American forest management scientist who had joined IIASA from the University of Dar es Salaam in Tanzania; Professor Valery Fedorov, a statistician from the All-Union Research Institute for Systems Studies in Moscow; Dr. Gábor Kornai, a trade economist from the Institute of Economic and Market Research in Budapest, Hungary; Miloslav Lenko, a computer programmer from the Research Institute of Socio-Economical Information and Automatic Control in Bratislava, Czechoslovakia; and administrative assistant Miyoko Yamada from Japan. Professor Clark Binkley, a forest economist from Yale University in the United States, later joined the FSP staff.

In addition to the core team, a collaborative network of approximately 300 forest scientists from all regions of the world provided detailed regional data not available from the standard international references, and assisted in developing model segments of particular relevance to specific geographic regions. Data collection and analysis were also facilitated by cooperation with the Food and Agriculture Organization of the United Nations, the UN Industrial Development Organization, the UN Economic Commissions for Europe and Africa, the International Union of Forestry Research Organizations, and several industrial associations. During the course of the project, many of the collaborators paid short-term visits to IIASA, forging relationships for a scientific network that remains active.

The work of the IIASA Forest Sector Project, though limited as compared to the original objectives formulated by the FSP team and collaborators, represents the most ambitious effort yet undertaken to study the world's forest sector. It seems likely that such an undertaking could only have succeeded at an institution such as IIASA, with its mixture of scientists from many countries and many different political systems, and its history of successful teamwork among individuals from East and West, North and South. By mid-1985, when the formal work of the Forest Sector Project was completed, FSP scientists and collaborators had published more than 100 research papers and articles in scientific journals describing research relating to the global forest sector model. We had produced a working computer model of the global forest sector. We had used the model to explore a range of alternative scenarios on issues of major relevance to those who are responsible for forest policy, forest industrial strategy, and trade policies in different regions of the world. The final product of this worldwide collaboration was the book described in this report.

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ORGANIZATION AND CONTENTS OF THE BOOK

The Global Forest Sector: An Analytical Perspective, the product of a team of three editors and 30 authors, encompasses in one volume:

- An integrated overview of the global forest sector.
- A state-of-the-art review of the analytical techniques useful in quantitative, economic analysis of forest sector problems.
- A detailed description of the IIASA global forest sector model, and
- The results of several simulations made with the model, which explore alternative views of future developments in the world's forest sector.

The book focuses on long-term global changes that might occur either as a result of policy decisions or as a consequence of such factors as air pollution, deforestation due to shifting agriculture and unrestrained exploitation, or major changes in the Earth's climate.

For the purposes of the book, we define the forest sector as comprising all activities relating to the production and use of wood in its many forms. Forest sector analysis therefore includes forest growth and harvest; the manufacture of pulp, paper, and solid wood products; the transportation and international trade of wood-based products; and the intermediate and final consumption of these products.

Because time and personnel were finite, we necessarily had to limit the scope of our work. As a consequence, we omitted from our definition of the forest sector the valuable nontimber outputs of forests — clear water, wildlife, pleasant landscapes for recreation, and so on. In addition, our treatment of fuelwood was not as complete as the magnitude of its

consumption worldwide would warrant. Rather, we focused on the forest sector's critical global linkages. Both nontimber outputs and fuelwood, while remaining essential features of forestry, influence such linkages only indirectly.

A large and diverse set of issues concerning demand, supply, and international trade drive structural change in the forest sector. These include the growth of population and the global economy, the development of new wood products and substitutes for wood products (such as electronic publication), the future supply of roundwood and alternative fiber sources, the development of new technologies in conversion processes and in forestry (such as the use of genetically improved tree stock), changes in pollution regulations, revised labor and investment policies that affect cost competitiveness, the imposition of new tariffs and nontariff barriers to trade, and changes in the political stability of important timber-producing or -consuming regions.

But it is not sufficient simply to understand the changes that originate within the forest sector itself. Forestry, the forest products industry, and consumers of forest products are inevitably affected by many decisions or changes that occur outside the sector. Examples include currency exchange rates, taxation, subsidies, monetary policy, and foreign policy. Thus, our efforts explicitly attended concerns, both internal and external to the forest sector, which might affect forest product prices, production, consumption, trade, profits, employment, and the state of the world's forests.

The forest sector is sufficiently complex that one factor cannot be analyzed in isolation from others. For instance, increased rates of forest plantation establishment in one part of the world will influence the profitability of harvesting more distant stands of virgin timber in another part of the world. Accounting for these linkages requires formal analytical models of the various forest sector components for each region of the world. An integrated forest sector model includes:

- A model of timber supply, including methods for linking forest growth to raw material costs and for projecting future forest growth while accounting for timber removals and changes in the forest land base.
- A model of the processing industries that describes how timber is converted into intermediate and final forest products and how key characteristics of the processing industry (such as capacity, processing costs, and technological efficiency) change over time.
- A model of product demand that relates consumption of forest products to factors within the forest sector, such as prices, and to factors outside the sector, such as levels of housing construction, population, and income per capita.

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- A model of trade among regions to account for the spatial aspects of timber supply, processing, and final consumption, including the effects of transportation costs, tariffs, and nontariff barriers to trade.

The organization of the book reflects the components of forest sector analysis listed above. The first four sections review the methods available for constructing formal analytical models of each component. No attempt is made to catalog or review the large number of national forest sector models built in recent years to assist central economic planning, policy analysis, or economic forecasting. Instead, the key components of such models are examined with the aim of improving the overall state of the art in forest sector modeling. The last two sections, roughly half of the book, comprise a final report on the IIASA Forest Sector Project, including a detailed description of the GTM and the results of the scenario analysis. The following discussion briefly describes each section of the book.

PART I. FOREST RESOURCES AND TIMBER SUPPLY

The five chapters in this section of the book address the existing state of the global forest resource, trends in both its use and its potential destruction by mankind, and techniques for building models of forest development that can provide assistance to decision makers. In addition to the chronic problem of tropical deforestation, chiefly attributed to rapidly rising populations in areas where shifting cultivation is practiced, we also consider changes in the chemical composition of the atmosphere that result primarily from the burning of fossil fuels. Our discussion centers on ways that these changes are ameliorated by forests and also ways in which they may influence the long-term development of forests. Part I concludes with two chapters that discuss large-scale models of forest dynamics and economic timber supply.

PART II. FOREST INDUSTRY

The second section of the book deals with the conversion of wood raw materials into intermediate and final products. We evaluate the potential of various production models for accurately representing the forest industry and the ability of those models to capture future trends in wood processing. We consider specifically the potential of integrated production facilities to reduce conversion wastes and improve energy use. In addition, we consider the current state of the processing industry and technological developments that are likely to influence its direction in the decades to come.

PART III. DEMAND FOR FOREST PRODUCTS

Estimation of global demand for forest products has long been a difficult and unrewarding task because of apparent discrepancies in reporting standards among trading partners. Recent advances in both the theory and practice of demand estimation are discussed in this section of the book. In addition to chapters dealing generally with demand estimation, product substitution, and technological change, we present separate estimates of demand functions for solid wood products and for chemical products (paper and paperboard). Because it accounts for more than half of all wood consumed annually on a global basis, we also discuss current and future trends in the household demand for fuelwood.

PART IV. INTERNATIONAL TRADE

Trade is one of the primary linkages that binds national forest sectors into a global entity. Only recently have the data and analytical techniques become available to permit a comprehensive analysis of these linkages. This section of the book opens with a chapter on barriers to trade in forest products, including both tariff and nontariff barriers, and demonstrates how these barriers are evolving over time. We then consider methods for modeling interregional trade and contrast these spatial models with nonspatial ones. Because much of the international trade in forest products travels on the seas, we discuss ocean shipping in particular and shipping costs in general. This section concludes with an historical analysis of international trade in forest products undertaken by the Forest Sector Project with the assistance of the UN Food and Agriculture Organization.

PART V. METHODOLOGY FOR GLOBAL FOREST SECTOR ANALYSIS

The final sections of the book, Parts V and VI, are concerned specifically with the IIASA global forest sector model. The model organizes the world into 18 regions that cover the globe, and recognizes 16 intermediate and final forest products (although the model has intentionally been designed to permit redefinition of both regions and products). Each region is described by a regional component model that includes timber supply, industrial production of forest products, and the demand for all final products. The regional components are connected by bilateral trade linkages, which take into account transportation costs, tariff and nontariff barriers to trade, and trade "inertia" due to logistical, marketing, or trade policy considerations.

The global perspective of the IIASA forest sector model requires that trade flows must balance — a constraint that has not been imposed on the national forest sector models used in many countries today. The IIASA model also imposes two other important consistency requirements: material flows must balance, and prices must stay in line with costs. While the structure of the model is very simple, its power comes from its global perspective and rigorous observance of trade flow balances, material flow balances, and price–cost consistencies.

Part V begins with an overview of the global forest sector model and its theoretical underpinnings. Subsequent chapters describe in detail the approaches used to model timber supply, the forest processing industry, and the demand for forest products. Separate chapters discuss the treatment of trade barriers and inertia, and the transportation cost model. Because the global forest sector model is an economic model based on an assumption of supply–demand equilibrium, an additional chapter discusses centrally planned economies and the way we ensure that our models of production, consumption, and trade relating to those regions conform to historical patterns.

PART VI. SCENARIO ANALYSIS

In any modeling project, the primary interest of potential users centers on the utility of the model for analyzing pertinent policy issues. The book specifically addresses this question through a detailed analysis of alternative future scenarios for the world's forest sector. To define the scenarios, we drew on the expertise of scientists, managers, and policy makers who are active in the forest sector. The scenarios provide interesting and perhaps useful conjectures as to how long-term trends in the forest sector might be influenced by policy decisions, by developments within or outside the forest sector, or even by chance occurrences during the coming decades. The scenario analysis also tests the sensitivity of the model to a variety of assumptions. Part VI, the concluding section of the book, discusses the important results for each scenario.

The IIASA global forest sector model was designed as a policy analysis tool, not as a forecasting model. The objective of forecasting is to predict accurately the development of key factors, such as prices or production levels. In contrast, a policy analysis model attempts to show how these variables are likely to change in response to alternative decisions made by governments (such as changes in tariff levels, in tax rates, in subsidies, or in currency exchange rates) or by industry (such as investments in productive capacity, in forest plantations, and in forestry infrastructure). To emphasize that results from the global forest sector model are not to be taken as forecasts, the results of our scenario analysis are presented in relation to the results of a base scenario. The base scenario itself is not a forecast, but rather the outcome of a moderate set

of assumptions about future developments within and outside of the forest sector.

Scenario assumptions can always be criticized because they are just that — assumptions. The scenario analyses are intended to demonstrate how the model works and to illustrate its analytic capabilities, rather than to provide a fully comprehensive description of possible future developments in the forest sector.

In addition to the base run, the scenarios described in Part VI of the book are:

- *Low-growth and high-growth scenarios* to examine variations in the average worldwide rate of economic growth over the next five decades.
- *Weak US dollar and strong US dollar scenarios* to explore the sensitivity of the model to changes in currency exchange rates and also to provide an interesting projection of the possible effects of different exchange rate developments on the future of the forest sector.
- *A trade liberalization scenario* to measure the effects of greatly reduced tariffs and nontariff barriers to trade worldwide on the long-term development of the forest sector.
- *A USSR timber exploitation scenario* assuming that within the next two decades the volume of annual timber removals in the Soviet Union will increase by approximately two thirds beyond present levels. The world's largest coniferous forest resides in the Soviet Union, and current removals are far below the sustainable harvest levels. Aside from its inherent interest, this scenario tests the effects of a major change in timber supply on the global forest sector.
- *An "acid rain" scenario* to examine the economic impacts of sustained forest decline owing to atmospheric pollution in Eastern and Western Europe.
- *A "greenhouse effect" scenario* to assess the possible economic consequences of climatic warming due to a doubling of atmospheric carbon dioxide by the year 2030.

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CONCLUSIONS

The IIASA Forest Sector Project developed a global forest sector model as a policy analysis tool for use in many countries. In demonstrating the utility of the model for this purpose, some interesting results have emerged from the scenario analyses described in Part VI of the book. For example, when many regions are interlinked by trade, the impacts of changes in one (or a few) of those regions tend to be dampened by adjustments in other regions and by changes in trade flows. Therefore, national forest sector models that ignore import and export demand (and most do) will tend to overstate the sensitivity of economic responses to policy interventions.

The outcomes of the scenario runs seem especially sensitive to several factors. These include the assumed levels of growth in population and income (especially in developing countries), the rates of currency exchange, technological developments in the forest industry and in industries that produce substitutes for forest products, the supply of economically available timber (which might change significantly due to large-scale plantation investments in the tropics or as a result of increased harvesting in the Siberian and Far Eastern regions of the Soviet Union), and the growth of forest-product consumption in such large or rapidly growing countries as the People's Republic of China (where a quarter of the world's population resides) and Brazil.

None of these conclusions is particularly surprising. However, the global forest sector model provides a means for evaluating such impacts quantitatively and for assessing their economic effects both locally and globally. By imposing important consistency checks on policy analysis, it permits a more rigorous analysis and perhaps more realistic conclusions concerning the effects of policy interventions.

Wide dissemination and application measure the utility of a new idea. By this standard, the IIASA global forest sector model has achieved a measure of success. It has been adopted by many of the countries of both Eastern and Western Europe, the Soviet Union, the United States, Canada, and Australia. It was recently used by the Timber Committee of the UN Economic Commission for Europe to investigate more fully the potential economic impacts of forest decline in Europe caused by extended atmospheric pollution. A working group has been formed in the International Union of Forestry Research Organizations for the purpose of continuing the dialogue among forest scientists that centers around the use of this model.

For a period of slightly more than four years, global-scale forest sector analysis united the efforts of some 300 forest scientists worldwide. In a relatively short time, the fundamental ideas of spatial equilibrium economics have become widespread within the discipline of forestry and are continuing to receive attention from forest scientists in many countries. Through the analytical methods it developed and the international network of scientific collaboration it engendered, this modest effort by IIASA is likely to have far-reaching effects in the decades to come.

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PURCHASING THE BOOK

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RELATED PUBLICATIONS

Forest Sector Models, edited by Risto Seppälä, Clark Row, and Anne Morgan, 1983, A B Academic Publishers, Berkhamsted, UK (ISBN 0-907360-08-4).

Systems Analysis in Forestry and Forest Industries, edited by Markku Kallio, Åke E. Andersson, Risto Seppälä, and Anne Morgan, Volume 21 in TIMS Studies in Management Science Series, 1986, North-Holland, Amsterdam (ISBN 0-444-87648-0).

International Trade in Forest Products, edited by András Nagy, in preparation, A B Academic Publishers, Berkhamsted, UK.

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