AN INDONESIAN FORESTRY OPTIMIZATION MODEL FOR TIMBER SUPPLY ALTERNATIVE ANALYSIS

By

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ABSTRACT

AN INDONESIAN FORESTRY OPTIMIZATION MODEL
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Indonesian Forestry Optimization Model (INDO FOM) is an economic model for evaluating development alternatives for forest-based economies in Indonesia. It is a linear programming model designed to identify the most efficient pattern of supplying forest products to domestic and export markets, including optimal locations for logging, harvesting and industry; efficient transport links; and industry/port capacity requirements. The model has goal and separable programming features. Its formulation is based on a Forestry Sector Planning Model for Indonesia developed by Dr. Joseph Buongiorno.

The purposes of this study are: (1) to review and consider optimization models as methods for forest based economic planning, and (2) to exercise and to test the model to know its potential role and applications as well as its limitations. The INDO FOM was applied in the East Kalimantan forest-based economic region to a selected ten HPH- (Hak Pengusahaan Hutan, Forestry Licensed Concessionaire) industrial companies that meet the Indonesian Forestry Agreement criteria. There were nine sawmill, seven plywood and veneer mill, one chip-board and one pulp-paper operations; three ports; two local demand regions, six interinsular demand points and sixteen foreign demand points; and eight transportation links. Five development alternatives have been analyzed.

The results of the case study have assisted in giving general suggestions or guidelines to the East Kalimantan regional economic development planners, including (i) resource development, (ii) industry development, (iii) port development, (iv) market development and (v) transportation linked development.

INDO FOM has application to forestry in Indonesia: (1) as a training tool, (2) to provide quantitative information in identifying areas of research and development, and (3) as a computer-based economic planning tool. Aspects of INDO FOM that need to be revised in the future, in order to incorporate important related concerns are: (a) forest plantations, (b) port agglomeration economies, and (c) environmental goals.

KEY WORDS: Optimization model, timber supply, forest-based economy, regional development

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DEDICATION

To my wife, Isye, and our children,
Bogi, Rista and Rini

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CHAPTER I

NATIONAL GOALS AND STUDY PURPOSES AND INTRODUCTION TO FORESTRY IN INDONESIA

Statement of Goals and Purposes

The Indonesian Forest Sector National Policy laid down in the Third Five-Year National Development Plan (Repelita III, 1978/79-1983/84) expresses the following long-term timber-based economic goals:

- Effort will be made to change the distribution of earnings so that the discrepancies which exists between social strata and regions will be reduced.
- The timber-based economic development will be geared towards doubling per capita income between 1980 and 2000.
- Management of timber production and other natural resources will give high priority to the protection and improvement of the environment.

In order to maintain these national goals, Government, i.e., the Directorate General of Forestry, Indonesian Department of Agriculture has been preparing steps to develop strategic plans for national forests development. These plans may be varied from region to region within the country depending on variation in social and economic conditions.

One of the steps to develop strategic plans for national forests development is by improving planning methods and techniques in order to facilitate improved efficiency in the management of our national forests. This is particularly true of our timber-based economic development alternative strategies, as required by the Basic Provisions on Indonesian Forestry, Law No. 5, 1967 and Government Regulation, P.P. No. 33, 1970 which call for responsibility that includes planning the development and utilization of forest resources.

It seems unlikely that Indonesia could achieve its timber-based economic goals with its current methods of timber supply management and planning system. Furthermore, present conventional planning procedures cannot guarantee the basic policy of the Second and Third Five-Year National Development Plans, which call for increasing the market value of produce from Indonesia. Consequently, emphasis was placed on local processing and industry expansion as reflected by the joint decision of the Departments of Agriculture, Industry and the Trade and Co-operatives on timber supply for domestic needs dated May 1, 1979.[1] At the present time, 60 percent of the log out-put must be supplied to local log converting industries.

It is in this setting of compliance with the above mentioned national goals and the achievement of optimum timber supply alternatives that the use of optimization model as a planning technique has been evaluated and developed. The case study area is a forest-based economic region in the East Kalimantan Province of Indonesia. The solutions are quantitatively evaluated for their success in meeting objectives, constraints and other specified levels of performance. The potential role

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[1]The joint decision by the Minister of Agriculture, the Minister of Industry and the Minister of Trade and Cooperation (see footnote on p. 9), and which is based on a Presidential Instruction on Timber Supply of April 4, 1979, provides the basic rules for obligatory supply of roundwood to domestic industries and of processed timber to the domestic and export markets. The decision also divides the power of implementation and control between the three ministers.

of the model in Indonesia's forestry economic planning is based on the results of this experience.

Stated formally, the general purpose of this study is to indicate and to analyze timber supply alternatives in order to assist in the evaluation of development strategies of Indonesian Forestry planning, using economic distribution and efficiency criteria. However, other criteria can be introduced via constraints and/or weighted objectives. The general purpose may be defined in terms of specific purposes which are to:

(1) review and consider optimization models as methods for forest based economic planning, e.g., timber supply alternatives;

(2) exercise and to test the model on an East Kalimantan forest-based industries case study to know the potential role of the model.

Introduction to Indonesia

Indonesia consists of a broadly-spread archipelago with the major consumption centers separated from areas of industrial raw material supply by large expanses of water. The country is made up of 13,667 islands, of which 992 are inhabited. It stretches from 95°E to 141°E (about 5000 km along the equator) and between 6°N and 11°S (more than 2000 km). The main islands of Indonesia are Sumatra (lying almost parallel to West on Paninsular Malaysia across the straits of Malacca), Java, Kalimantan (part of the island Borneo and sharing common borders with East Malaysia), Sulawesi, and Irian Jaya (the western half of New Guinea). Figure 1 speaks for itself.

The highest mountain is the 4,900 meter Puncak Jaya in Irian Jaya. The climate is humid tropical with an average daily temperature

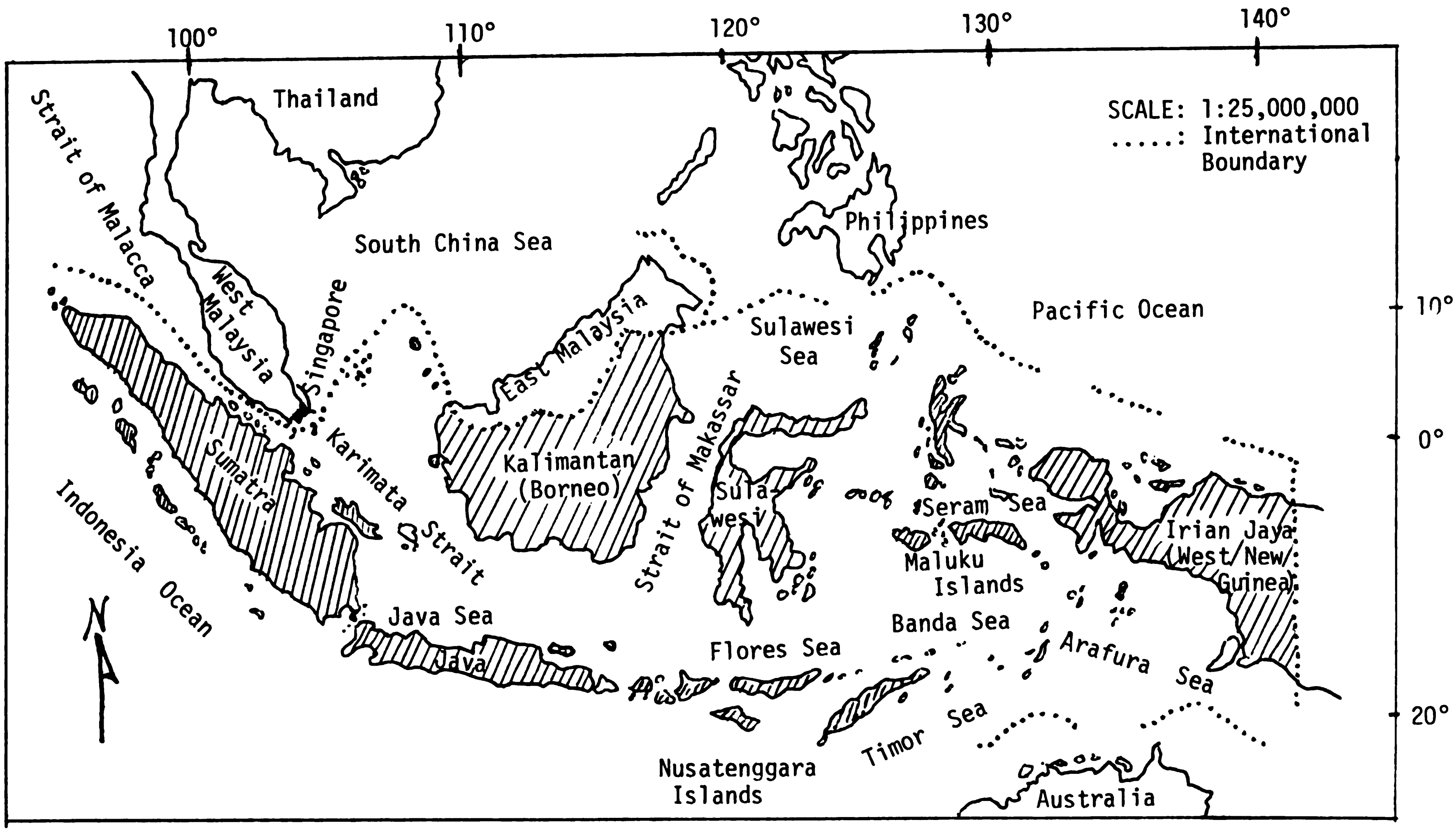


FIGURE 1. Map Showing the Country of Indonesia Consists of a Broadly-Spread Archipelago.

SOURCE: Directorate General of Forestry, 1979.

of 26°C in the lowlands and about 22°C in the highlands. Annual rainfall varies from island to island, with an average of 3,300 mm in Kalimantan and 2000 mm in the eastern part of Nusa Tenggara. Java averages 2000 mm in mountains. There are pronounced dry seasons (between April and October), and wet or rainy season (between November and March) particularly on Java and Nusa Tenggara islands. The natural vegetation is an evergreen mixed tropical rain forest abound with a wide variety of tropical mammals and birds.

The staples and spices add their share of resources and of beauty to the plantations and the countryside - rice, maize, tobacco, tea, palm oil, rubber, coffee, gambier, nutmeg, kapok, pepper, coconut and cloves. Petroleum, timber and timber-based products, rubber, palm oil, tin and other mining products comprise approximately 80 percent of the country's exports.

The 1980 census data show that the bulk of the 147.5 million population, 91.3 million or 61.9 percent live on Java, which constitutes only 7 percent of the land area. This concentration, which is constantly increasing due to an annual growth rate of 2.3 percent, makes Java the primary consumer of the country's production. On the other hand, the natural minerals and forest resources needed to provide for a large portion of this consumption, have been depleted in Java and need to be obtained from the outer islands.

The gross national product of Indonesia in 1980 was Rp 40660.7 billion (equal to US $65.06 billion with an exchange rate of 1 US $ = Rp 625), with a per capita income of Rp 275666 (equal to US $441) which ranked fifth among the Southeast Asian countries, following Singapore, Malaysia, The Philippines, and Thailand. Within Indonesia the provinces of Irian Jaya, Riau and East Kalimantan have the highest per capita income (approximately equal to US $3150, US $2750 and US $2295, respectively).

Light and heavy industries have been started and government policy encourages the rapid growth of industrialization in the country, particularly since Indonesia started with its First Five-Year National Development Plan in 1968/69. In the current Third Five-Year Plan, Repelita III (1978/79-1983/84), emphasis has been given on industry expansion.

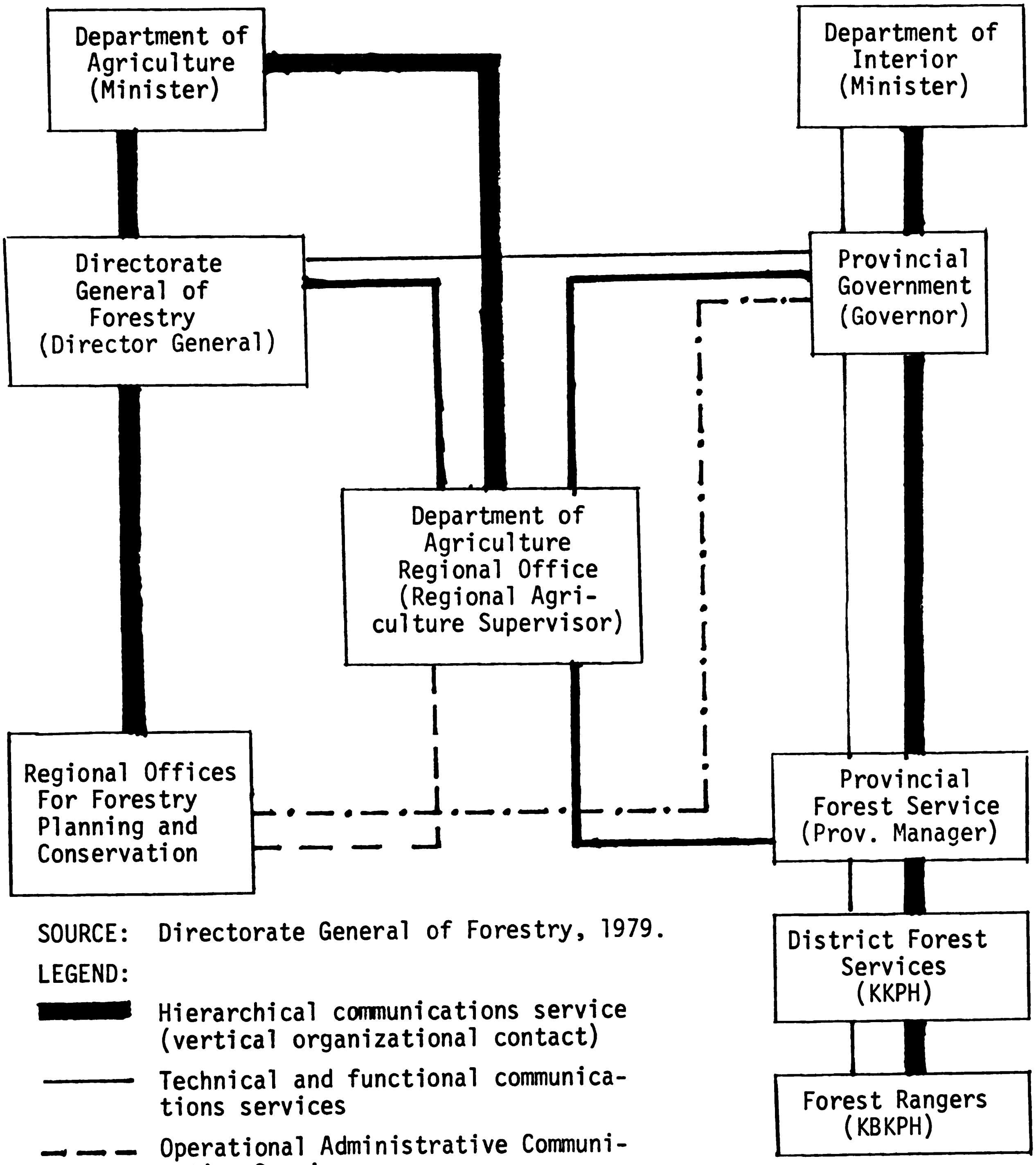
Forestry in Indonesia

Under the national constitution, the Undang-Undang Dasar (UUD) 1945, land and forest matters are prerogatives of the state. The administrative responsibility for all forests and forest lands in Indonesia rests with the Minister of Agriculture and is executed by the Director General of Forestry, as stated in Law No. 5, 1967 as the basic provisions made on forestry and its resources.

Under the recent structure of organization, the Directorate General has executive and administrative authority hierarchically only over central offices at the national level plus regional offices in planning and resource conservation services. National authority of the Director General over the provincial forest service extends only to providing technical advice, and information services, which goes through a co-ordinating body called the Department of Agriculture Regional Office. Most of the technical and professional staff in the provincial forest services are national government employees, but they serve the provinces as province personnel and are paid either by national government or provincial government. They are national government employees in that they are recruited by National Government, and may be transferred to any province in Indonesia. The lower echelon staff, from forest laborers to forest ranges, are province personnel.

The Organization of the Directorate General of Forestry (Department of Agriculture) and its managerial or structural links with the Department of Interior is shown in Figure 2. Coordination between province and national government on forest policies is achieved through the Department of Agriculture regional offices. The Department of Agriculture is headed by a Minister. The Head of the Directorate General of Forestry is Director General while each provincial forest service is headed by a Provincial Forest Manager (Kepala Dinas). The provincial forest services (Dinas Kehutanan Propinsi) are divided into various forest districts (KPH's) which are further divided into ranges (BKPH's). The Indonesian Forest Service had 21,319 professional and technical personnel as of April 1980, of whom 1,050 were working at the central office in Jakarta and Bogor, 928 at the regional offices for resource conservation and forestry planning, 451 at the forestry and forest products research institutes, 5,822 in the provincial forest services, 12,158 in the state forest corporation (Perhutani), and 760 in the logging and industry state corporation (Inhutani). Of these 21,319 government paid personnel, only 1,671 (6.4%) are college graduates. A major proportion (44.1%) are high school graduates (forestry and non-forestry) and elementary school graduates (41.3%); those without elementary education account for 8.2% (Directorate General of Forestry, 1979). Improvements are expected with more graduates coming from forestry colleges of the National universities as well as overseas universities.

FIGURE 2. Organization Structure of the Indonesia Forestry Administration.



SOURCE: Directorate General of Forestry, 1979.

LEGEND:

Hierarchical communications service (vertical organizational contact)

Technical and functional communications services

Operational Administrative Communication Service

Co-ordinative Communication Service function

Informative & Communicative Services Function

Logging in Indonesia

One of the present notable works on the logging industry of the forests of Indonesia has been by Victor Buenaflor as reported in Working Paper No. 10 of the FAO Project INS/78/054 (Buenaflor, 1981). The brief overview is the following.

Log production in Indonesia started to expand rapidly in the latter part of the 1960's. This expansion came as a result of increasing international demand for hardwood timber and was made possible by legislation encouraging foreign participation in the logging industry. The production rose from below 2 million cu.m per year in 1960-1965 to over 10 million in 1970 and approached 30 million cu.m during the 1970's. The expansion has been most rapid in Kalimantan, and there the province of East Kalimantan has accounted for the major share of this expansion. Log export as a proportion of total log production increased rapidly during the 1960's and has since 1970 stayed above 70 percent. However, this figure can be expected to be drastically reduced as a consequence of legislation introduced in 1979.[1]

The species composition of log out-turn has undergone some changes reflecting the trend in acceptance of species on the export market. The most significant changes are the rapid relative increase of Kapur and Keruing and a relative decline in Ramin. Meranti has remained fairly stable, around 6.65 percent of the total removal. In absolute terms, the production of logs from all species has increased during the 1970's,

[1]Joint Decision of the Minister of Agriculture, and the Minister of Trade and Co-operatives, No. 290/Kpts, UM/5/1979, No. 79/M/Sk/5/1979, No. 370/Kpb/V/79 on Timber Supply for Domestic Needs, plus Joint Decision of the Minister of Industry and the Minister of Agriculture No. 80/M/Sk/5/1979, No. 291/Kpts/Um/5/79 on Regulations on Roundwood/log allocation to domestic timber industries.

with the possible exception of Ramin, the volume out-put of which appears relatively stable. Figure 3 shows the Indonesian forest stand potential distributed by commercial species group and by province. East, Central and South Kalimantan rank the highest among the provincial figures in terms of natural forest commercial timber species.

The total area under confirmed logging licenses was, in May 1980, 44.8 million ha with an additional area of 7.6 million ha in the process of being licensed and a further area of 6.9 million being surveyed for possible exploitation.

The annual allowable cut in areas covered by confirmed licenses stood, in mid-1980, at 52 million cu.m. maximum with a potential increase from new licenses in various stages of establishment of 17 million cu.m. By the end of March 1980, approval has been granted for foreign investment into 80 forestry projects with a total expected investment of US $555 million. The approved domestic investment at the same point of time amounted to US $640 million. The largest foreign investment in forestry in Indonesia is from the Philippines followed by Hongkong and Malaysia. The ASEAN countries account for some 65 percent of foreign investment.

Wood-Based Industries in Indonesia

Primary forest industries in Indonesia, sawmills, plymills, and chip-board mills are listed in yearly references published by the Directorate of Production, Directorate General of Forestry excluding the mills of Forest State Corporation, the Perum Perhutani and

KEY TO FIGURE 3:

Identification of Species Group Number	Name	Identification of Province Code	Name
(1)	Commercial Exportable Dipterocarps[1]	A	Aceh
		B	North Sumatra
(2)	Commercial Exportable Non Dipterocarps[1]	C	West Sumatra
		D	Riau
		E	Jambi
(3)	Ramin[2]	F	South Sumatra
		G	Bengkulu
(4)	Agathis	H	Lampung
(5)	Sawokecik	I	West Java
(6)	Bali-Nusatenggara Commercials	J	Central Java
		K	D.I. Joyakarta
(7)	All commercials and "Lesser Known" species of Mixed Lowland Tropical Rain Forests	L	East Hava
		M	DKI Jakarta Java
		N	Bali
(8)	Teak	O	West Nusatenggara
		P	East Nusatenggara
(9)	Rimba (Non Pines, Non Teak In Java)	Q	East Timor
		R	West Kalimantan
(10)	Pines	S	Central Kalimantan
		T	South Kalimantan
		U	East Kalimantan
		V	North Sulawesi
		W	Central Sulawesi
		X	South Sulawesi
		Y	South East Sulawesi
		Z	Maluku
		ℓ	Irian Jaya

[1]Only from high density forests of diameter 50 cm and above; medium density and less density forests have much lower standing volumes. Standing trees per ha of a high densely, commercial and exportable Dipterocarps forests of diameter 50 cm and above is ranging from 7 to 18; in less dense and medium dense forests are much lower. Most of these figures are based on 1968-1975 HPH survey reports.

[2]Average Ramin forest stands volume figure; however, less dense, medium dense and high density Ramin forests in Kalimantan (West, Central, and South) consist, respectively, of 6.0 cu.m, 18.0 cu.m, and 36.50 cu.m per ha of diameter 50 cum up.

SOURCE: The Indonesian Timber Stand Reports, Tegakan Hutan Indonesia. Directorate of Forestry Planning, DGF, Bogor, 1976-1979; and The Forestry Master Plan 1975-2000, DGF, Jakarta, 1975.

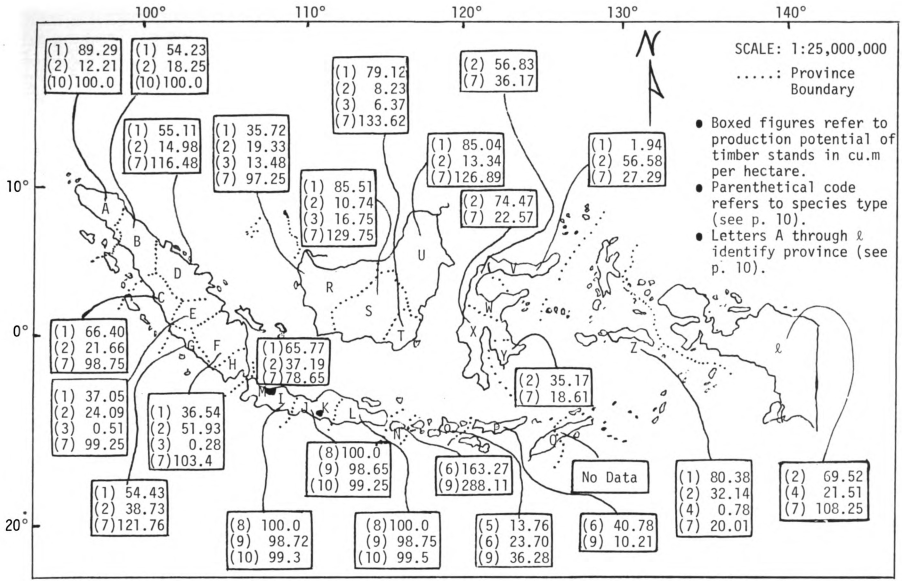


FIGURE 3. Forest Stand Potential in Indonesia, Distributed by Commercial Species and by Province.

non-HPH[1] industries in Java. The following brief overview has been based on the report of L. Waring as produced in Working Paper No. 11 of the FAO Project INS/78/054 (Waring, 1981).

In terms of the existing situation in Indonesia in general, most of the HPH industrial capacity works on a two-shift basis and non-HPH on a one shift basis. There are, respectively, 1,942 HPH and non-HPH saw mills with a total one-shift intake capacity in 1979 of 7.175 thousand cu.m, and 23 ply mills with 566 thousand cu.m. If the maximum production per day can be expanded to 2.25 shift production,[2] the intake capacity would be 17.5 million cu.m per year. The production of logs in 1979 was recorded as 27.07 million cu.m. The industry was, then, capable of converting to wood products nearly 30 percent of the yearly out-put of logs using a one-shift operation and 55 percent of the yearly out-put using three shifts per day.

Geographically, Kalimantan is one of the regions where forest-based industries are largely distributed in terms of number and capacity. In 1979, there were, respectively, 373 operating saw mills with a capacity of 4,355 thousand cu.m log intake per shift; 9 plywood mills (153 thousand cu.m log intake capacity); 30 saw mills under construction (773 thousand cu.m potential capacity) and 23 plywood mills

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[1]HPH = Hak Pengusahaan Hutan is forest exploitation rights or logging licenses which are granted by the Government (Minister of Agriculture) for large area to be logged over long periods, usually 20 years. Most of the pulp-paper industries in Java and Sumatra belong to the non-HPH or non-logging licensed industries.

[2]Total capacity of existing industry working on a three shift basis has been estimated using predominant pattern outside of North America, respectively, as: 0600 hrs.-1400 hrs. (morning shift, 100% productive capacity); 1400 hrs.-2200 hours (afternoon shift, 75% efficiency); and 2200 hrs.-0600 hrs. (night shift, 50% processing ability); so the maximum production per day then becomes (1x1.0) + (1x0.75) + (1x0.50) = 2.25 shift. See further Waring (1981), p. 3.

(572 thousand cu.m potential capacity) also under construction. The presently operating mills thus represent 60.70 percent of national saw mills capacity, and 39.05 percent of national plywood mills capacity.

The concessionaire (holder of a forestry HPH license) is obliged to build and operate log conversion facilities within a specified number of years at a specified capacity as stated by the Indonesian Department of Agriculture in the terms of the license. The aim is to secure an ample domestic supply of sawnwood and plywood and to affect a change of export from logs to processed products. In addition to existing mills, there is, therefore, a number of planned new mills, some of them already under construction, which will add to existing capacity. East Kalimantan will receive most of the new capacity of both saw mills and plywood mills followed by Central Kalimantan. Outside Borneo, the provinces Jambi and Riau will receive high additional capacity.

One of the problems in forest-based industries in Indonesia has been, to some extent, a lack of forward planning of the development of the industry. The "mushrooming" of industry in West Kalimantan can be taken as an example of this lack of planning, in as much as industry was allowed to proliferate without due regard for the quality of resource which was available. The demand for Ramin escalated and saw mills were built to rough saw and export the timber in volumes which caused rapid depletion of the resource. When controls were eventually applied, some 50 percent of the mills were forced to cease operation. The situation could have been markedly different if the growth had been anticipated.

Forest-Products Trade in Indonesia

The plywood production has, so far, largely been absorbed by the domestic (local and interinsular) markets. Sawnwood of Ramin attracts buyers from all over the world with Italy, Singapore and Malaysia the main importers. Teak is similarly sold throughout the world but with the concentration to Hongkong and Singapore where it is used in furniture, TV cabinets, etc.

The export of sawnwood has increased from a modest start in the early 1960's to reach 1.5 million cu.m in 1980. Ramin was the major species in sawnwood export contributing 71.0% to this trade in 1978/79, followed by Meranti (12.0%), Teak (3.0%), Keruing (2.0%), and others (12.0%). The other main importers in Asia besides Singapore and Hongkong for sawnwood products are Japan (13.0%), Muangthai (8.0%), Taiwan (6.0%), South Korea (2.0%), and Saudi Arabia (4.0%). In the European markets, Italy (75.0%), the U.K. (11.0%), the Netherlands (6.0%), West Germany (3.0%) and Denmark (2.0%) are the main importers for sawnwood. United States and Canada import mainly plywood. Some of the sawnwood goes to Australia. The U.K., Hongkong, Singapore, the Netherlands, Italy, Denmark and Japan are other main importers of plywood-veneer products from Indonesia.[1]

Geographically, in terms of domestic consumption, Java is the main market for sawnwood, plywood, chip-board, and pulp-paper products. The Java region consumes 65.0%, 70.0%, 72.0%, and 80.0%, respectively, of the domestic wood supply in Indonesia.

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[1]For detailed and more interesting figures on Forest Products Trade in Indonesia, see for example, Andang Trihadi, "Prospects of Timber Industry Products," The Forestry Journal; Majalah Kehutanan Indonesia 2 (VII), 1980, pp. 5-10, and pp. 19-24.

The forestry income in 1979 was US $2,841 million, where US $1,784 million or 53 percent of it came from foreign exchanges through timber exports. Trade balance between exports and imports is positive. Total imports of forest products in 1979 were only US $142 million. Paper and paper-board constitutes 72 percent of forest-products imports, wood pulp 27 percent, and plywood one percent (Central Bureau of Statistics, 1980).

In the last three years, some fundamental changes have occurred in international hardwood trade which may indicate the future pattern of the trade, at least for the next decade. Exports from West Africa have declined to a negligible quantity mainly because of earlier over-exploitation of the resources. Waring (1981) reported that countries in the Pacific fringe which have tropical hardwood forests have introduced increasingly severe restrictions on log exports resulting in a decline in wood manufacture in countries which rely on log imports for their industries. For the international market, there remains now two principal areas for the supply of processed tropical hardwoods: South East Asia and South America, and many countries in these supply regions have embarked on expansion programs for their timber industries.

Forest-Products Transportation in Indonesia

There are four basic modes of transportation used in forest products transportation in Indonesia, namely road (truck), river, railway, and sea. Transportation of logs from forest area to industry, port and local markets is mainly done by truck and river (rafting, floating, towing, barging). Transportation of processed products from industry location to port or shipping site and local demands is done either by truck or water, depending on location and port facilities. From port to importing (interinsular and foreign) demand points are done by shipping.

FAO Project INS/73/012 assigned G. Segerstrom to investigate port handling and shipping practices in Indonesia. The following brief overview has been based on his work as reported in Working Paper No. 3 (Segerström, 1978). Both inter-island and international shipping including port handling are administered by Government through the Directorate General of Sea Communications which forms part of the Department of Communications. However, in the case of port handling, some minor quays are privately owned by saw mills, logging enterprises, etc. Fleets used for timber transport are diverse. Most of the fleets are of the size 8000 Dead Weight Tonnage (DWT) or less (75.0%) followed by 8000-12,000 DWT (15.0%) and above 12,000 DWT (10.0%). For coastal and inter-island transport, sailships (perahu layar) below 2000 DWT are usually used. There are about 30,000 perahu layar in Indonesia, of which some 10,000 are used for transporting sawnwood, which can load from 75 to 300 cu.m per perahu layar. A small percentage are powered by diesel engines of 100-300 HP. Barges are increasingly being used for coastal and inter-island transport of timber, size varies between 200 and 1000 DWT. They are especially common in usage for the transport of timber from Kalimantan to Java and Singapore.

Loading rates differ from port to port, depending on ship size, general composition of cargo handled at the ports, equipment available and the degree of port congestion. Average loading rates are ranged between 800 cu.m per day for ship size of 5000 DWT to 1700 cu.m per day for 10,000 DWT. At some ports, it is much lower ranging between 360 cu.m per day (Palembang), and 1000 cu.m per day (Panjang).

Freight rates to importing countries like Japan, Korea and Taiwan are regulated by agreement between the Indonesian Ship Owners Association (INSA) and the countries concerned. These agreements (Liner Transport Agreement or LTA) form the basis of a virtual freight monopoly. Freight rates are also quoted by non-LTA shippers and these are, in general, considerably lower (25.0% to 31.0%) than those fixed by LTA. However, non-LTA shipping is not always regularly available or reliable.

Marketing Problems in Indonesia

Very little has been done to promote marketing activities for forest products from Indonesia to domestic as well as world markets. Marketing activities involve investigation of the unusual state of the markets, collecting market intelligence on a continuous basis, actively developing new markets or expanding old ones.

In the world market, exports have developed as a result of active buying by industries abroad and through establishment of logging and industry activities by expatriate firms catering to markets they have developed and earlier supplied from production elsewhere. Because of the way in which the export trade of the Indonesian timber industry has developed the firms, which are not partly or wholly owned by expatriates, do not have export marketing infrastructure or marketing experiences.

Waring (1981) reported that overseas potential buyers of Indonesian wood products often commented on the poor and varying quality of sawnwood and plywood produced in Indonesia. The fact that wood processing centres abroad can buy Indonesian lumber, re-process and re-export it at a profit indicates that much can be achieved by quality control. Most of the forest-based industries in Indonesia lack quality control and that production to exact dimensions is not always followed. However, there are Indonesian grading rules for sawnwood as well as for plywood, but the production is not geared to achieving specific uniform grades. Consequently, the overseas market has little trust in wood products from Indonesia.

Another marketing aspect which tends to affect prices of Indonesian timber-based products is reliability and regularity in shipment. The importers want to minimize their overhead costs by carrying as small an inventory as possible and are, therefore, dependent on prompt and frequent delivery of material. If the shipments are late, both importers and end-users face losses. The importers discontinue business with the unreliable suppliers and favor sources where the risk for financial losses are less or where this risk is compensated by lower prices.

In order to overcome the above mentioned shortcomings, the government should, through embassies abroad, channel market information to the industry and assist in establishing contact with overseas buyers. Improvement of port facilities for timber export is a matter of urgency. The forest-based industries need to design market organizations and start active marketing of their products in the world market. Large industries should probably do this on an individual basis but the smaller industries need to organize their marketing through cooperatives or branch organizations.

As far as quality control is concerned, the government should establish, in cooperation with the forest-based industries, manufacturing standards for various wood products. The government should also establish testing units which can provide unbiased checks of manufacturing standards and issue certificates of standard upon request. A HPH-industrial company needs to introduce, in all export oriented sawmills and in all plymills, quality control functions, independent from the production activities, and all plymills should have well-equipped testing sections.

CHAPTER II

OPTIMIZATION MODELS IN FORESTRY: A LITERATURE REVIEW AND CRITIQUE

Optimization models refer to a group of analytical techniques in mathematical programming involving maximization or minimization of some particular objective by placing specified restraints on resources allocated to alternative activities. In forestry, the most common form of optimization models have been linear programming (LP) and goal programming (GP), where the objective(s) and the constraints are expressed in the form of linear equations. This chapter provides a review of the LP and GP models and a critique on their uses and associated techniques.

Linear Programming Models

Linear Programming or linear optimizing can be defined as a geometric or algebraic procedure whereby one finds an optimum allocation of resources between two or more alternatives in light of certain goals and in light of given constraints or conditions. The emphasis here is on the notion of optimum allocation or optimum mix, that is, either maximization or minimization of a linear function subject to constraints in the form of linear inequalities (Nagel and Neef, 1976; Dorfman, 1951).

Formally, the general form of the LP model in algebraic terms is:

Optimize (maximize or minimize)

$$Z = \sum_{j=1}^{n} c_j x_j \qquad \text{for } j = 1, 2, \ldots, n \tag{1}$$

subject to

$$\sum_{j=1}^{n} a_{ij} x_j \leq \text{ or } \geq b_i \qquad \text{for } i = 1, 2, \ldots, m \tag{2}$$

and

$$x_j \geq 0 \tag{3}$$

where c_j's are optimization criterion weights or parameters (e.g., cost), of decision variables x_j's; a_{ij}'s are technological constraint coefficients of activities in question; b_i's are resource constraint levels for particular activity, and Z is the scalar value of the objective function or criterion variable. To put the LP problem in a form suitable for mathematical analysis, there exist three common elements: (1) an objective function; (2) functional constraints; and (3) non-negativity constraints. It is important to note the linearity, proportionality, additivity, divisibility and deterministic assumptions that this model implies as the following (Wu and Coppins, 1981; Hillier and Lieberman, 1980; and Dorfman, 1951):

- Linearity -- This assumption demands that the ratios between any two inputs and between any input and the output are fixed and hence, independent of level of production. If the objective function, $c_j x_j$, is not linear, we cannot use the LP technique as such.

- Proportionality -- This assumption means that if decision variable, x_j, were (say) doubled, so would its contribution to the objective function, $c_j x_j$, and to each constraint, $a_{ij} x_j$, be doubled. The implications are that there can be no increasing or decreasing returns to scale and also no setup costs in a LP model.

- Additivity means that optimization criterion weights (e.g., costs) are the sum of the individual costs and that total impact on the ith constraint is the sum of the individual impacts of the decision variables, x_j's.

- Divisibility -- This means that the decision variables, x_j's, can be divided into any fractional level desired, i.e., noninteger values of the decision variables are permitted.

- Deterministic -- The deterministic or certainty assumption is that all the parameters of the LP model (the c_j, a_{ij} and b_i values) are known constants. In real problems, this assumption is seldom satisfied precisely. LP models usually are formulated in order to select some future course of action. Therefore, the parameters used would be based on a prediction of future conditions which inevitably introduces some degree of uncertainty.

One specific formulation of a LP model is known as a transportation model, it focuses on minimization of total transportation costs of any commodity from supply points to demand points. According to Black and Hlubik (1980), linear programming can be subdivided into seven parts, respectively, (i) mathematical background, primarily the theory of linear equalities; (ii) solution methods (e.g., simplex method); (iii) development of computer systems to handle LP; (iv) system management procedures including matrix generators, report writers and data base management; (v) data gathering, conversion, and transcription; (vi) modeling real world problems; and (vii) interpretation and presentation of results in management decision making. My primary focus is formulation and modeling of real-world problems. The concept of LP is developed with a focus upon forest-based economic modeling.

Literature Review

According to Chappelle (1977), linear programming methods have been developed relatively recently. George Dantzig, the American mathematician of the U.S. Air Force Operations Research Group, is generally credited with development and first application of linear programming techniques. Numerous problems of a linear programming type were formulated prior to the release of Dantzig's work, like Von Neumann and Leontief's pioneering solution techniques for large sets of simultaneous linear equations in the 1930's (Hadley, 1962), but a systematic method of solutions had not been presented up to that time. Dantzig presented the simplex method for solving linear programming problems along with the initial mathematical statement of the general linear programming model in 1947 (Gass, 1958). The first applications, and the basic reason for the development of LP, was for solving problems in military planning (e.g., World War II) and other aspects of operations research. Such applications as optimization of the transportation of war materials were of first consideration. Since that time, the models and solution method have been refined, modified and widely applied to problems in many areas.

One of the first applications of linear programming oriented to the timber-based industry was concerned with the optimization of plywood production and distribution at the level of the individual plant (Bethel and Harrell, 1957), and a hypothetical analysis of site preparation for pine plantations (Yoho and Row, 1958). A mill seeking a least-cost supply of pulpwood from its woodlands was the first instance of stand-cut scheduling application (Theiler, 1959). Coutu and Ellertsen (1960) used linear programming as an aid in farm forestry planning. Applications which were oriented to larger aggregates of decision-making units came later. An early application with a regional orientation was concerned with optimizing inter-regional flows of hardwood and softwood lumber (Holland and Judge, 1963). Nautiyal and Pearse (1967) combined much of the early LP work in forest regulation with the work in economic analyses of timber-stand financial maturity (e.g., Gaffney, 1960; Kidd, Thompson, and Hoepner, 1966). They formally stated the forest stand's regulation problem as an LP optimization model and used it to show the economic implications of rotation length and the length of the conversion period.

LP applications and studies continue to be reported in the literature. In the United States, Martin and Sendak (1973) reported 105 applications of LP to forestry and the forest products industry in general during years 1955 through 1970. Field (1976) lists 174 references for the years 1955-1975. One of the well known LP models in private forestry sector has been the MAX-MILLION which was developed at the University of Georgia (Ware and Clutter, 1971). The model was designed to accommodate problems of industrial ownership -- continuous wood supply to the mill, and open market for wood, federal income tax accounting, and economic efficiency. MAX-MILLION's counterpart in the public sector is Timber RAM (Resources Allocation Method) developed by Navon and others at the Pacific Southwest Forest and Range Experiment Station of the U.S. Forest Service (Navon, 1971).

In wood-based industries specifically, (i.e., processing and transportation of manufactured products to market or final demand) applications in the United States have been increasing according to Martin and Sendak's and Field's reports, very rapidly since 1955. For example, Bruce (1969) applied the linear programming model to analysis of interregional competition of lumber in eleven western states of the United States. Holley (1971) used it to study the flow of softwood lumber and plywood. Holley, Haynes and Kaiser (1975) applied LP model for interregional timber supply alternatives. Pearse and Sydneysmith (1966) developed a LP model to analyze the pattern of alternative allocation of logs and intermediate products among a utilization complex producing sawntimber and lumber, veneer and plywood, chip-board, pulpwood, and hog fuel to obtain the highest economic value from the timber output.

Linear programming model applications were also being used in other parts of the world. For example, the Development Research Center of the International Bank for Reconstruction and Development (IBRD) of the World Bank has developed a successful LP model for forest sector analysis (Bergendorf, 1974a). This model was applied to a forest industry planning problem in Turkey (Bergendorf, 1974b) and later tested by FAO in a special study of Malaysia (FAO, 1976). Because of the model's successful performances in Malaysia and Turkey, it was selected for use in an analysis of pulp and paper industry development strategies in the ASEAN region (Svanqvist, 1980; Staab, 1981).

In Indonesian forestry and forest industry, a planning exercise was begun in 1976. The Food and Agriculture Organization (FAO), in cooperation with the Indonesian government, developed a linear programming model to identify the most efficient pattern of supplying wood products to domestic markets and of exporting these products to Singapore and Japan (FAO, 1978; Buongiorno, 1978). The model can be modified to solve location-allocation problems or to assist, in general, timber sector planning (Buongiorno, 1979 and 1980).

Critique

Linear programming models for timber management alternative analysis such as MAX-MILLION and Timber RAM may be more powerful planning tools than either formulas or area-volume checks that are not optimizing techniques, since they permit the exploration of a wide spectrum of alternative silvicultural practices and harvest control policies, given certain assumptions and criteria (Hannes, Irving and Navon, 1971). However, from a realistic viewpoint, critics such as Chappelle, Mang and Miley (1976) contend that the optimal solution generated is not likely to be a forest management optimum, because values of non-timber uses of the forest do not enter the various objective functions permitted. In terms of economic and social consideration, Timber RAM accepts only biological and production economic objective functions. It ignores completely regional economics, political and social goals which certainly should apply in the case of public timber management agencies, and perhaps as well to many of the corporations that manage timber as part of an integrated wood products complex. Timber RAM fails to recognize the spatial and transportation dimension in an integral way.

It seems appropriate to counter the reality argument by keeping the model relatively small and confined to those variables which can be most accurately modeled. Post optimal procedures may then be used to test the sensitivity of solutions to parametric changes. The relatively small allocation model may be linked with sub-system models to provide input or to treat specific problems of the actual allocation. By linking models to solve specific parts of the forest-based economic problem, some of the difficulties encountered by very large LP models may be avoided. For example, an econometric model is linked to an industry or forest production function specified as a linear program by assuming the minimization of the cost of meeting annual demand. Colletti (1978) developed such a model for the paper and paperboard industry in order to overcome some of these shortcomings.

Another criticism of LP models which schedule future events is that they fail to consider the chance that those events may not occur. Omission of the uncertainty problem is embodied in linear programming's deterministic assumption. Sensitivity analysis may provide some insights into the consequences of varying assumptions about the future. In this area the use of N-stage linear programming model which takes account of the different stages of nature involving stochastic events, can be more appropriate. The model in which chance-constrained programming can be incorporated to take account of risk and uncertainty inherent in certain parameters has been suggested by Wagner (1975) and Thompson and Haynes (1971). Because this iterative technique requires many solutions to the same problem, it is likely to be cost prohibitive for other than small models.

Most of the other criticisms of linear programming are due to its linearity assumption. A special type of LP model which can accommodate certain non-linear constraints is separable programming. This technique separates non-linear constraints or objective function into linear segments which may be represented by piece-wise linear approximation. It then considers them sequentially through modifications in the simplex algorithms, if the constraints are entered as sequential linear segments in the matrix and appropriate changes are made in the objective function. Separable programming may give a local optimum but mixed integer programming may give the global optimum. This approach has been suggested by Hrubes and Navon (1976) to handle downward-sloping demand curves in timber production, and Buongiorno (1980) to handle economies of scale of the port capacity expansion costs when the level of production or demand rises.

More drastic departures from the linearity assumptions require different solution techniques. Among those available are quadratic programming, which can use the simplex algorithm with minor modifications to solve problems with quadratic objective functions and linear constraints, or vice-versa. Other non-linear methods can handle problems with particular specifications. While there are well developed algorithms to solve such problems, they have not achieved the standardization and widespread availability that linear programming enjoys, simply because of the complexity of the solution techniques and their limited applicability to certain problem forms. The expanse of the solution generally makes non-linear programming suitable only to small problems and unique situations. For large scale and repetitive problems it is usually advisable to sacrifice non-linearity for easier problem formulation and computational efficiency (Moskowitz and Wright, 1979; Wu and Coppins, 1981).

Another optimization technique, dynamic programming, can provide an excellent model of the problem conditions. However, it has disadvantages similar to the non-linear programming approaches mentioned above. Furthermore, there are no standard solution algorithms. Each problem requires that a unique solution program be written for it by an experienced system analyst. Solution times are comparatively long and problems with many time periods become uneconomical to formulate, let alone solve. Small dynamic programs may, however, be combined with linear programming to reduce the LP matrix and shorten the solution time.

Non-optimization techniques such as simulation and gaming models have also been proposed for forestry planning models, for example, for calculating allowable cut using area and volume check method (Chappelle, 1966), for area regulation only (Chappelle and Sassaman, 1968) and for processing inventory records into a management guide (Myers, 1970 and 1974). Gaming models such as SNAFOR can simulate nearly all the multiple use aspects of a national forest system, including regional and inter-regional systems (Countryman, 1973). Gaming models allow input from the human decision-maker, feeding decisions as inputs and watching effects or consequences of the decisions on the outputs. Simulation and gaming models force the planner to look at a forest-based economy as a complete system, because it allows feedback. In general, such techniques seems to offer all the disadvantages of dynamic programming with none of the advantages. They require the same difficult and problem formulation, but offer no procedure for optimization nor do they guarantee feasibility, although hybrid models exist which utilize mathematical programming techniques for optimization. On the other hand, by using sensitivity or post-optimal analysis, most optimization models can function as simulation and gaming models. In general, special simulation models are not recommended where such an analytical approach is available and cost-effective (Hillier and Lieberman, 1980).

A final criticism of linear programming and the other models discussed above is that they provide for the optimization of only one objective at a time. Different optimal solutions based on different criteria are generally available from the same formulation. If the conflicting objectives can be expressed in a common unit of measure, then a combined objective or criterion might be used for simultaneous optimization, however, it is beyond the capabilities of the LP techniques discussed in this section.

Goal Programming Models

Goal programming (GP), in its simplest form, is a special case or a modification of conventional Linear Programming (LP) aimed at minimizing the departures from specified goals or targets, subject to the usual constraints on resources, operations, etc. It differs from that more familiar technique primarily in perspective. The technique was developed by Charnes and Cooper (1961) and was first applied by Field (1973) to a woodlot for timber production including hunting and camping. A primal (as opposed to dual) linear programming model focuses on the problem of determining an optimal allocation of scarce resources given a set of objectives. Goal programming, in a similar format, seeks a plan that comes as close as possible to attaining specified goals. Both procedures deal with constrained optimization. Both are limited by the assumptions that model variables are infinitely divisible and connected only by linear relations. Goal programming requires, further, the explicit specification of quantitative goals and any preference structure that may be associated with these objectives. It is this orientation that provides the technique with the flexibility necessary to circumvent two major weaknesses of LP.

A first shortcoming deals with the existence of an optimal solution. A GP model may incorporate two classes of objectives in the same problem: (i) an overall, single-dimensional, optimization criterion such as profit maximization or cost minimization; (ii) a set of secondary requirements imposed by the decision-maker (distinct from absolute physical or economic constraints) such as the attainment of certain minimal production levels. Ordinary LP procedures yield an optimal solution to a quantitative allocation problem only if a feasible solution exists. Feasibility is assured if the requirement specified by the analyst and the constraints imposed by the problem environment are all mutually consistent. In contrast, the objectives specified in a GP format are approached as closely as possible but need not all be met completely. This flexibility allows the specification of a problem in terms of multiple conflicting goals and the allocation of resources according to subjective priorities.

Given the existence of a feasible solution to an ordinary LP problem, a second shortcoming is the requirement of a single-dimensional optimization criterion. Whatever the measure associated with the objective specified by this criterion, the outcomes of the several activities included in the solution plan must be expressed in common units. The requirement has two particularly serious effects. First, analysts eager to apply LP to problems involving incommensurable values are tempted to search for indirect measures of relatively intangible results in terms of those more easily valued. Thus, for example, vacation expenditures are used as a surrogate gauge of outdoor recreation benefits, and a wilderness preserve is valued in terms of timber harvests forgone. Secondly even with a clearly valid relationship between the optimization criterion standard and a particular activity does exist, that relation may be very difficult to specify. GP allows not only the simultaneous consideration of resource allocations to activities whose outcomes cannot be valued in like terms but it also permits the analyst to specify directly activities whose levels can be associated with a common measure. For example, the consequences of a shortage of pulpwood at a mill can be expressed in cubic meters rather than requiring the difficult estimate of the overall dollar impact of such a shortage on the firm's operating costs and sales revenues.

The mathematical expression of the goal programming model generally has the structured form:

$$\text{Minimize } \not{z} = \sum_{j=1}^{n} (w_j^- d_j^- + w_j^+ d_j^+) \quad \text{objective function} \qquad (4)$$

subject to

$$\sum_{i=1}^{m} a_{ij} x_i + d_j^- - d_j^+ = b_j; \; j = 1, 2, \ldots, m \quad \text{goals} \qquad (5)$$

$$\sum_{i=1}^{m} g_{ki} x_i \leq \text{ or } \geq b_k; \quad k = 1, 2, \ldots, p \quad \text{functional constraints} \qquad (6)$$

and

$$x_i, \; d_j^-, \; d_j^+ \geq 0$$

$$d_j^- \cdot d_j^+ = 0 \quad \text{non-negativity constraints} \qquad (7)$$

where $d_j^{-,+}$'s are the number of deviation units short (-) or in excess (+) of the goal (b_j); $w_j^{-,+}$'s are the weights or priority factors given to a unit deviation short (-) or in excess (+) of the goal (b_j); a_{ij}'s are technical coefficients relating goals to the decision variables; x_i's are decision variables or activity variables now called subgoals; b_j's are minimum desirable goals; g_{ki}'s are constraint coefficients; b_k's are constraint levels or limiting amount of resource k available.

This model states the optimization problem as one of minimizing the aggregate sum of individual positive and negative deviations from specified goals. The d_j^+ and d_j^- variables are, in fact, the same as the slack and surplus variables of the conventional LP model. The distinguishing feature of the GP formulation is that it incorporates one or more of goal requirements directly into the objective function via the deviational variables and focuses the optimization procedure on these deviations by placing no value on structural variables x_i. Thus we value not activity levels but the deviations from goals that are caused by those solution values.

In general, the model is subject to the same linearity that applies to the usual LP model. Furthermore, the simplex algorithm guarantees condition (7). The nature of the functional, (4), and the specification of goals given rise to the majority of the variations in goal programming. Note that the coefficients of a_{ij}'s and g_{ki}'s must be explicitly stated. This means that while trade-offs between objectives need not be quantified, interactions among resources must be given. For example, a hectare (ha) of land allocated to intensive pine production may be able to support less wild monkey than a hectare allocated to dipterocarps production.

Literature Review

Goal programming is not a new technique. The basic elements of the method were introduced by Charnes, Cooper, and Ferguson (1955) as simply an extension of linear programming. Charnes and Cooper (1961) apparently coined the term "goal programming". In the subsequent decade, the authors of the term have contributed much of the sparse, but rapidly growing, literature on the topic.

Ijiri (1965) provided a more rigorous conceptualization, detailed variations in the functional weights, and introduced the idea of cardinal and ordinal weights on the several goals. Cardinal weights are simply coefficients on the variables in the objective function and the standard LP algorithms that can be used to solve these problems. If all weights are equal, then the achievement of one goal is generally assumed to be no more important than another. Unequal weights imply a differential preference in simultaneous goal achievement.

If the preference among goals is so strong that maximum effort at achieving one particular goal is desired before attempting to achieve another, than one of the several pre-emptive or ordinally-weighted methods may be used. Ijiri suggested that the weights on higher order goals be made large enough to minimize their nonachievement. Field (1973) presented an algorithm for establishing "priority factor" weights which insures that they be no larger than is necessary to force the desired results. However, if there are many priority levels, the size of the priority coefficients may become impossibly large. Such an approach to goal ordering permits the achievement of lower order goals even if higher order goals cannot be met, and it can be solved using standard LP algorithms. Stepwise optimization of individual goals could produce the same result. Lee (1972) has developed a modified simplex algorithm which treats all goals sequentially without the use of cardinal weights to imply priority. While this approach is pre-emptive, it does permit differential weights to be used within priority levels. However, Lee's published program contains some computational errors, and it is restricted to small problems (Field, 1978). Bartlett, Bottoms and

Pope (1976) have corrected and improved Lee's algorithm but their expanded version is still too small for problems with more than 1000 activities.

In spite of its recent arrival, goal programming has already seen use in many areas. Since Field's (1973) introductory example, there have been numerous applications in natural resources, particularly in the area of land use planning. Straightforward uses of goal programming in this area have been reported by Bell (1975), Dress (1975), Bottoms and Bartlett (1975), Schuler, Webster and Meadows (1977), Dane, Meador and White (1977), and Steuer and Schuler (1978). In other countries, like West Germany, the GP is named a "psychometric method", and called "Nutzwertanalyse" as reported by Henne (1978). Its popularity has been enhanced for Forest Service planning by the availability of Bartlett et al's program for general use, and by a general technical report on goal programming for land use planning (Bell, 1976). Turner (1974) reports that a study project based on the RCS allocation package may also be modified to incorporate a GP structure.

The natural resources literature also contains some interesting variations of goal programming. Porterfield (1976) evaluated tree improvement programs by using a separable programming procedure to solve a goal formulation. Neely, North and Fortson (1976) report the use of an integer GP model to allocate entire and indivisible projects which may statisfy the multiple objective of water resources planning. Meadows and Schuler (1976) have suggested a GP framework with quadratic loss functions to account for decreasing marginal utility.

There are also reports of GP variations similar to those for linear programming. Ruefli (1971) described a generalized goal decomposition model while Contini (1968) used a goal interval programming model to allocate Coast Guard activities to prevent the pollution of the marine environment. Here they described each goal as a range of values so that the decision maker could examine trade-offs within as well as among effectiveness measures. They indicate that the results would be enhanced through an interactive approach. Indeed, almost all GP applications must involve interaction between the model (analyst) and the decision maker, due to the subjective specification of the trade-off relationships. It is highly unlikely that an "acceptable" preferred solution will surface during the first running of the model. Dyer (1972) has developed an algorithm which precisely monitors the interaction between the decision maker and the model and selects the preferred solution in a finite number of steps. However, this procedure comes close to the class of vector optimization techniques which simply generate non-inferior solutions for consideration by the decision maker. Such an approach which drops the formulation altogether is being considered by Steuer and Schuler (1978) for national forest planning. Goal programming is a useful tool for the manager-analyst; however, Dyer, Hof, Kelly, Crim and Alward (1979) recommend that it only be used with a thorough understanding of the algorithm and its economic implications, and with extensive sensitivity analysis on each problem. Recent studies made in timber management planning of National Forest indicate that goal programming can be used complementary with linear programming to produce operationally feasible solutions as reported by Field (1978) and Field, Dress, and Fortson (1980) because it provides improved sensitivity testing and strategy selection in timber harvest scheduling.

Transportation and marketing literature is growing rapidly with examples using a GP approach to special cases of transportation method, since it uses only one objective criterion -- minimization of transportation cost. The basic assumption of the transportation method which is based on LP model is that management is concerned primarily with cost minimization. However, this assumption is not always valid. As demonstrated by Lee and Moore (1974), Lee and Nicely (1974), and discussed in more detail by Lee (1976), in an example of transportation schedule contracts, concurrence with union contracts, the provision of stable employment levels in various plants and transportation fleets, balancing of the work among plants, and minimization of transportation hazards may also be important to management. Thus, the transportation problem includes not only the determination of optimal transportation patterns, but also the analysis of production-scheduling problems, transshipment problems, and assignment problems. If one accepts the premise that the transportation problem may involve multiple, possibly conflicting objectives, then the GP approach is an appropriate technique to use. For Indonesian application of the transportation method in the multiple objective problem, goal programming has been used in a timber-based economic problem to design the optimal pattern of timber supply alternatives, port capacity and locations, shipping patterns, and other alternatives, as indicated by Buongiorno (1978, 1979, and 1980), and FAO (1978) for broad, long-term National Forest Sector analysis.

Critique

The most obvious advantage of the GP model is that it permits the simultaneous consideration of multiple but incommensurable objectives.

It is one of the most computationally efficient techniques of vector optimization compared to conventional linear programming, the transportation method, and to those vector optimization methods which use a single utility criterion. Bottoms and Bartlett (1975) and Lee (1976) found goal programming more akin to the actual thinking process of a manager than linear programming. The GP formulation also posses a less obvious computational advantage, even for problems with a single objective. The possibility of an infeasible solution is effectively eliminated because the sizes of the variables in the function (the goal deviations) are virtually unconstrained. From another viewpoint, this may not be an advantage after all. Generally, infeasibilities are the result of incorrect problem formulation or inattention to binding constraints. These problems may be ignored by the GP model but they are not eliminated. An analyst viewing the feasible GP solution may be unaware of such hidden deficiencies and accept the invalid results.

The most frequently cited disadvantage of goal programming is the difficulty in setting the goals, priorities and weights. This drawback cannot be considered unique to goal programming for it will occur in any attempt to objectively consider multiple goals. The same may be said for resource interactions where they enter the problem. Bell (1975 and 1976) has reviewed the goal-setting aspect of this problem in detail and has suggested some ways to obtain the necessary coefficients. Regardless of the method, the goals, priorities, weights and interaction used must generally be considered assumptions. Specifically, they would be subject to sensitivity testing. The inherent disadvantage that goal programming possesses in this area is related to the property of "universal feasibility". Almost any specification of goals and weights will apparently yield a candidate for the preferred solution. Cohon and Marks (1975) plainly illustrate that goal programming could produce an inferior solution which would generally be unacceptable as a preferred solution. Careful setting of the goals can eliminate this possibility but may then lead to implicit and undesired assumptions about weights on each goal. Each problem situation calls for complete recognition of the assumptions and their implications and requires explicit steps for testing their sensitivity. This approach is illustrated in Field, Dress and Fortson (1980) on their test case study in Oconee National Forest in Georgia, where the possibility of an inferior solution was ignored. Rustagi (1976) and McMinn (1977) also used the same approach, in their applications of goal programming to forest management planning and regulation problems. Dyer et al (1979) fully recognized the implications of goal programming in forest resource allocation problems and pointed out that goal programming, generally because of its demand for ranking objectives, does not generate theoretically desirable solutions, i.e., welfare economic (Pareto-efficient) solutions to the public resource allocation problem. Goal programming is then analyzed as a "satisficing" alogorithm and as a production feasibility test, indicating that GP will not generate income distribution solutions since variously weighted (preemptive) GP solutions are inferior to cardinally weighted GP solutions, inaccurately reflecting the real world situation. Therefore, Field et al (1980) dismissed the use of preemptive GP and recommend the exclusive application of cardinally weighted GP for considering the trade-offs among multiple criteria or objectives.

Generally, these refinements to the standard GP model as presented in equations (4) to (7) are for special cases and small, well defined problem situations. Their formulation and solution typically requires an experienced analyst and special algorithms. For the purpose of this study and any evisioned application of its results, goal programming in its cardinally weighted linear form, which may be solved using standard LP algorithms, is preferable. This permits easy and efficient solution, transformation from linear to goal models and the use of the full range of post optimal procedures available with standard computing packages.

Indonesian Forestry Optimization Model (INDO FOM) was developed and has, indeed, a goal programming feature. However, because mathematically, it does not differ from linear programming, I prefer to keep the linear programming appellation as found in Buongiorno's papers (Buongiorno, 1978 and 1980). Some people prefer to keep the term goal programming for the cases in which there are multiple objectives, that are ordinally weighted (in fact, INDO FOM has cardinally weighted formulation).

CHAPTER III
THE INDONESIAN FORESTRY OPTIMIZATION MODEL (INDO FOM)

Model Purpose

The Indonesian Forestry Optimization Model (INDO FOM) is an economic model for evaluating development alternatives for the forest-based economies in Indonesia. It is a linear programming model to identify the most efficient pattern of supplying logs and processed wood products to domestic (local and interinsular) and export markets. However, the model may be used also for non-timber forest products resource allocation. This model is designed to identify the optimal locations for logging or harvesting and industry, the most efficient supply routes, and the port capacity requirements for domestic supply and export. The model can be modified to solve location-allocation problems in Indonesia (e.g., finding the optimal port capacity and handling sites for logs and processed wood products transshipments) or to assist in general forest-based economic planning alternatives analysis. The model has goal programming and separable programming features. It was designed and implemented based on a Forestry Sector Planning Model for Indonesia developed by Dr. J. Buongiorno of the University of Wisconsin, under a consultancy contract with the F.A.O. Project INS/78/054, and in cooperation with Directorate General of Forestry of the Government of Indoensia (Buongiorno, 1980). In spite of its promise, there are many critical limitations in INDO FOM as in most of the optimization models in forestry. The INDO FOM limitations will be discussed in

Chapter IV. It can, however, facilitate analyzing the alternatives with respect to cost and other quantifiable criteria so that forestry decision makers can be guided by the promise and limitations of INDO FOM to a given criteria.

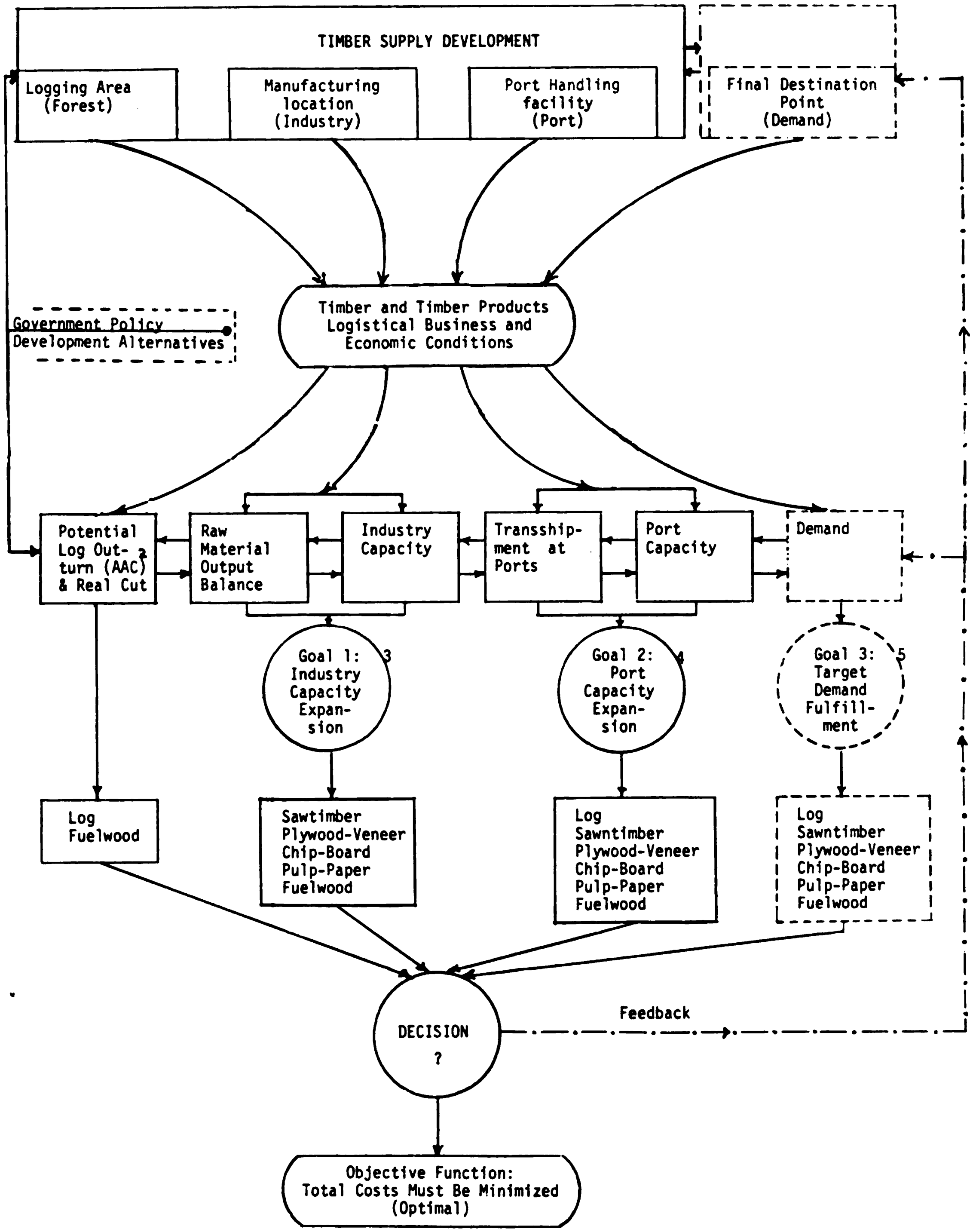
Conceptualization of the Model

Figure 4 shows a diagrammatic representation of the basic concept of the INDO FOM in this study. The three components of the timber supply development system which have direct impact on timber and timber products are considered. They are the logging area (forest), the manufacturing or milling point (industry), and the port handling facility (port). The final destination point (demand) is considered as an exogenous component to the timber supply development system which gives impacts on the system. These constitute the basic manipulative tools that a timber manager (government agency, private business agency, concession holder, etc.) can use to affect the development of a timber and timber products business management.

The impacts of these manipulative tools depend on the nature and characteristics of timber and timber products logistical business (i.e., transportation, warehousing, inventory, communication and material movement) and economic conditions. They are monitored by sub-components of timber supply development system, viz., potential log out-turn, industry capacity and raw material output balance, transsshipment at port and port capacity, and final destination or demand sub-component, respectively.

The potential log out-turn sub-component estimates log and fuel-wood outputs, the industry capacity and raw material output balance

FIGURE 4. The Basic Concept of INDO FOM in this study.[1]



SOURCE: Benjamin D. Nasendi, developed from formulations in INDO FOM and from Forestry Sector Planning for Indonesia.

[1]For logic of flows and its explanation, see pages 39 to 42.

[2]AAC = Annual Allowable Cut

[3, 4, 5]These are the goals of the analytical formulations of INDO FOM.

sub-components estimate sawntimber, plywood and veneer, chip and board pulp and paper and fuelwood outputs that may be processed. The port capacity and transshipment sub-components estimate log, sawntimber, plywood and veneer, chip and board, pulp and paper and fuelwood outputs that may be transshipped, and the demand sub-component estimates consumption trend and growth of log, sawntimber, plywood and veneer, chip and board, pulp and paper and fuelwood outputs that may be demanded by foreign countries (export) and other cities and provinces within Indonesia (domestic, i.e, local and interisland or interinsular).

Based on results of these six sub-components the manager makes economic or management decisions on an appropriate timber supply system to meet his objectives, for example: total cost must be minimized in order to meet an efficient requirements. Costs include transport costs, costs of industrial and port capacity expansion, cost of not meeting domestic and foreign demand for logs, sawnwood, plywood and veneer, chip and board, pulp and paper, and fuelwood. If logging, manufacturing, and handling costs differ according to location, these differential costs must be reflected by the corresponding transport costs.

The decision to minimize costs now becomes a criterion function or an objective function. The sub-components of the system now become the system's constraints. The outputs of the sub-components now become endogenous variables or output variables. The manager now makes economic or management decisions based on optimal conditions, i.e., minimum total costs. There are three goals to be fulfilled; respectively, industry capacity expansion, port capacity expansion, and demand target goals. Feedback on the objective function and optimal conditions can be monitored by altering different alternatives on constraining input of the six sub-components.

Given development alternatives or government policy levels (exogenous variables) imposed on the sub-components of the system, i.e., annual allowable cuts and log out-turns, export level or targets, domestic processing requirements or targets, etc., the model is designed to answer the following question: What is the geographic pattern of timber production, industrial processing, port transshipment and transportation which minimizes total costs? Costs include transportation, investments in new industries and port facilities, as well as penalties for not meeting domestic demand and export targets. Penalty costs reflect also harvesting and processing costs.

This model may be used to analyze the economic development effects of many variable aspects of a given alternative or strategy, such as changing domestic or foreign demand targets, modification of allowable cut levels, requiring that all or part of exports be in processed form, modification of port handling capacity at specific locations, and other attendant circumstances.

Model Structure

A forest based economic development region may be represented by a grid of points corresponding to geographic locations of forest, industries, ports, and demand (market area). However, identifications of forest product type, source point of a product, destination point, and location or region where these points are located are accounted for differently and formulated specifically.

The timber can be transported to importing foreign countries (export), and importing interisland cities and local demand areas for domestic consumption. At each forest area, timber and/or fuelwood may be harvested, within specific limits imposed by the productive potential of the forest and by policy.

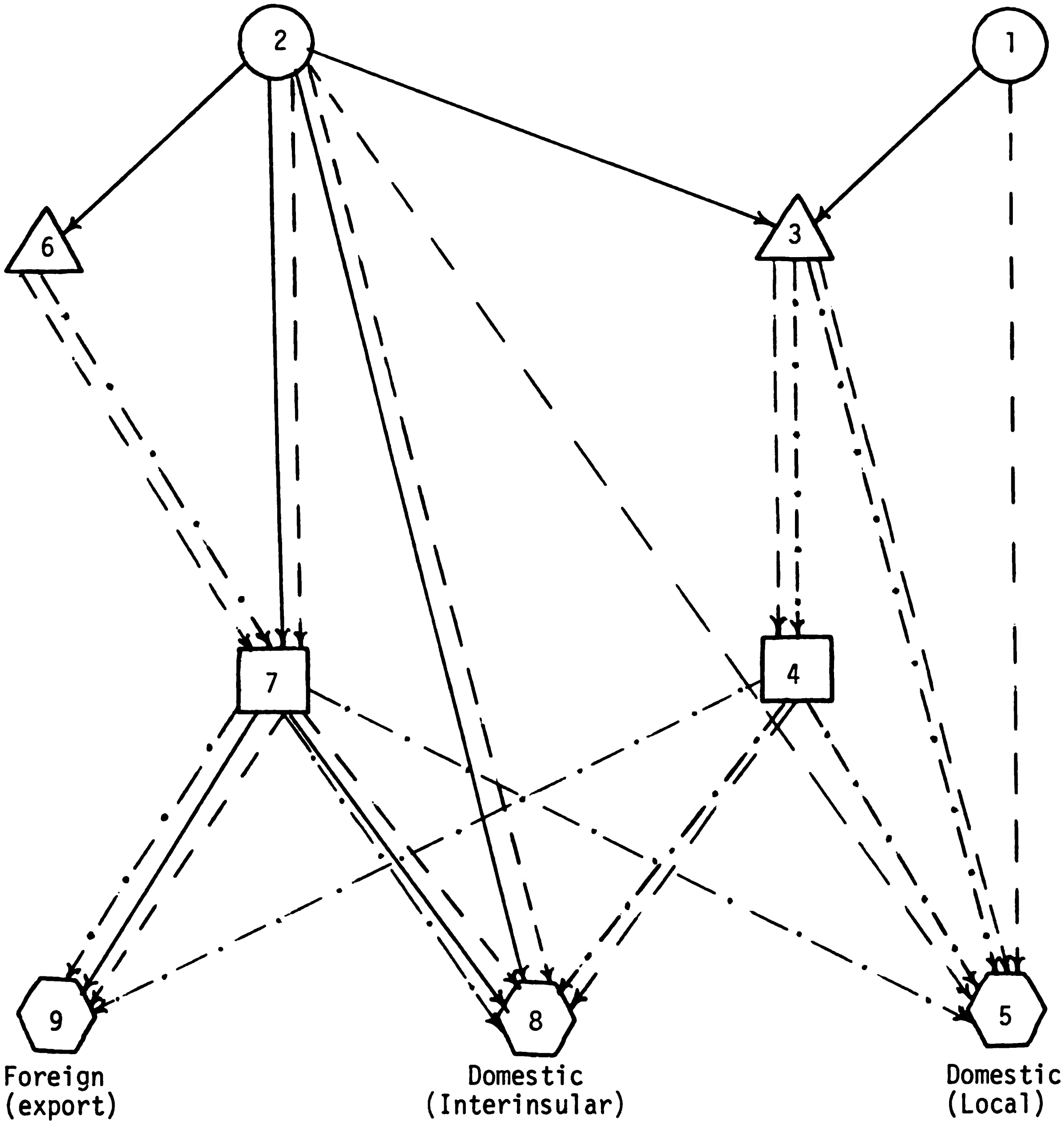
Figure 5 summarizes some possible shipment activities of timber supply alternatives of this model. Logs harvested at a location may be transported either to an industry or to a port or to a final destination point. If transported to a port, logs can be shipped to another port within Indonesia or to an export point. Transshipment through a port towards another final destination may also occur. Fuelwood is treated in the same manner as logs, except that it is transported directly from its source to a consumption point or to a port. Mill residues may either be wasted, or cut into fuelwood and transported to a consumption area either by land or water.

If necessary, port capacity at a particular point may be expanded. Due to economies of scale, the unit cost of capacity expansion is a declining function of the size of the expansion. Each industry point has an existing capacity to manufacture sawnwood, plywood and veneers, and other mechanical woodbased products. This capacity may be used at different levels defined by the number of operating shifts. Mills can be expanded beyond full capacity utilization but only at the cost of additional investment. Investment costs in industry are directly proportional to capacity expansion, and may provide economies of scale for a larger net return. Investment cost and number of shifts may vary from industry to industry and from location to location.

Model Formulation

The model is formulated as a linear programming problem. Non-linear cost of port capacity expansion are approximated by piecewise

FIGURE 5. An Example of A Transport Pattern of INDO FOM (Based on A Forestry Sector Planning Model for Indonesia: Buongiorno, 1980).



LEGEND:

○ : Forest (logging point)
△ : Industry (milling or processing point)
□ : Port (loading/transshipment point)
⬡ : Demand (wood center: intermediate or final destination point)

________ : Logs
_ . _ . _ : Industry processed product (sawnwood, ply-veneer, chipboard, pulp-paper, etc.)
_ _ _ _ _ : Residue-fuelwood

linear functions (separable programming). Because of the variables used to measure deviations from various planning objectives, the model also has some features of goal programming. This formulation insures that there always will be a numerical solution to the problem. The objective function is linear in all variables and measures total costs which should be minimized. The various constraints are also linear and represent resource limitations, industry capacity expansion, raw material product balance in manufacturing, transshipment at ports, port capacity expansion, and final demand targets.

The model is static in the sense that no intertemporal optimization is attempted. All variables used by the model are defined in Table 1.

Log and Fuelwood Output Constraints

At any given time and location, the volume of logs or fuelwood moving out of a supply point to a destination point cannot exceed the maximum allowable volume out-put or allowable cut in that location. The maximum allowable volume is dictated by government policy and although a lesser volume may be cut, the maximum imposed by policy may not be exceeded even though it is not the maximum possible cut. The government also specifies the proportions of the annual cut that go to domestic use and to export markets.

$$\sum_{i}\sum_{j}\sum_{k}\sum_{l}(\alpha_{ijkl})L_{ijkl} \leq XL_{kjl} \tag{8}$$

$$\sum_{i}\sum_{j}\sum_{k}\sum_{l}(\beta_{ijkl})F_{ijkl} \leq XF_{ijl} \tag{9}$$

TABLE 1. Definition of Variables Used in INDO FOM (in order of appearance).

NAME	DEFINITION
i, j, k, l	Integers, i=1, 2,...,n; j = 1, 2, ..., p; k=1, 2, ..., w; l=1, 2, ..., z; identifying respectively, forest product type, source point (can be forest, industry or port), destination point (can be industry, port, demand), and location or region (where forest, industry, ports and demand points are located).
α_{ijkl}	Input-output coefficient of portion of logs type i imposed by policy from source j to be transported to destination point k at location l.
L_{ijkl}	Volume of logs type i transported from source j to destination point k at location l (1000 cu. m/year).
XL_{ijk}	Maximum possible log out-turn (or annual allowable cut) of logs type i at source (forest area) j at location l (1000 cu. m/year).
β_{ijkl}	Input-output coefficient of portion of fuelwood residue type i which can be possibly allocated from source j to be transported to destination point k at location l.
F_{ijkl}	Volume of fuelwood residue type i transported from source j to destination point k at location l (1000 cu. m/year).
XF_{ijl}	Maximum possible fuelwood residue type i output to be manufactured further or for direct consumption available at source (forest area) j at location l (1000 cu. m/year).
L_{lkji}	Incoming volume of logs type i from source j received by destination point k at location l (1000 cu. m/year). Destination point can be industry mill, port, or demand.
RP_{ijl}	Recovery input-output coefficient of industry processed product (volume of log required per volume of industry processed product) type i made at industry mill type j at location l.
I_{ijkl}	Volume of industry processed product type i produced by industry mill type j and transported to destination k at location l.

TABLE 1 (cont'd.).

NAME	DEFINITION
F_{lkji}	Incoming volume of fuelwood residue type i from source j received by destination point k at location l (1000 cu. m/year). Destination point can be industry mill, port, or demand.
RF_{ijl}	Recovery input-output coefficient of fuelwood (volume of residues produced per unit of industry processed product) type i manufactured at industry mill type j at location l.
S_{ijl}	Number of shifts per day operation used to produce product type i at industry mill type j at location l.
XI^{+}_{jil}	Capacity expansion of industry mill type j which produced product type i at location l, (1000 cu. m/year at s shift/day), where s = 1.0, 1.75, and 2.25, respectively.
XI^{-}_{jil}	Unused capacity of industry mill type i which produced product type i at location l (unit is measured same as for XI^{+}_{jil}).
XI_{jil}	Maximum (existing or target) capacity of industry mill type j which produced product type i at location l (1000 cu. m/year at s shift/day operation), where s = 1.0, 1.75 and 2.25, respectively.
CEP_{mjli}	Capacity expansion of port j, at location l for transshipment of forest product type i, m^{th} module[1] (1000 cu. m/year).
XP^{+}_{mjli}	Fraction of module m of port j capacity built for transshipment forest product type i in order to expand to CEP_{mjli}, at location l.
XP^{-}_{jil}	Unused capacity of port j for transshipment of forest product type i at location l (1000 cu. m/year).
XP_{jil}	Maximum (existing or target) capacity of port j for transshipment of forest product type i at location l.

[1]Module refers to per day operation per shift per port facility (see Table A9 of Appendix A page 138).

TABLE 1 (cont'd.).

NAME	DEFINITION
DL^{-}_{ijk}, DI^{-}_{ijk}, DF^{-}_{ijk}	Deviation from existing (or target) demand for logs processed products and fuelwood, respectively of type i's at destination k's, from source j (1000 cu. m/year).
DL_{ijk}, DI_{ijk}, DF_{ijk}	Existing (or target) demand for logs, industry processed products and fuelwood, respectively of type i's, at destination k, from source j (1000 cu. m/year).
A_{ijkl}	Transport cost of logs type i transported from source j to destination point k at location l (Rp/cu. m).
B_{ijkl}	Transport cost of industry processed product type i transported from source j to destination point k at location l (Rp/cu. m).
C_{ijkl}	Transport cost of fuelwood product type i transported from source j to destination point k at location l (Rp/cu. m).
D_{jil}	Cost of capacity expansion (new establishment) of industry mill type j to produce product type i at location l (Rp/cu. m).
G_{mjli}	Cost of module m building (expansion) of port j at location l for transshipment of forest product type i (Rp/cu. m).
a_{ijk}, b_{ijk}, c_{ijk}	Cost of not meeting demand (penalty cost) respectively for logs, industry processed product, and fuelwood type i's, at destination k from source j (Rp/cu. m).

Raw Material Output Balance Constraints

At each location where a specific type of industry mill is located which is receiving logs from supply point, only a specific fraction of log input may be recovered in manufacturing any type of industry processed product. The volume of residues generated as fuelwood is directly proportional to the final products. Only part of the residues may be used as fuelwood, the rest being wasted.[1]

$$\sum_{l}\sum_{k}\sum_{j}\sum_{i} L_{lkji} - (RP_{ijl}) \sum_{i}\sum_{j}\sum_{k}\sum_{l} I_{ijkl} = 0 \qquad (10)$$

$$\sum_{l}\sum_{k}\sum_{j}\sum_{i} F_{lkji} - (RF_{ijl}) \sum_{i}\sum_{j}\sum_{k}\sum_{l} I_{ijkl} \leq 0 \qquad (11)$$

Industry Capacity Goal Constraints

The volume of industry-processed product of any type manufactured at each industry mill at a specific location must equal each industry mill capacity, plus or minus any capacity expansion of under-utilization. One of the objectives will be to minimize the cost of capacity expansion.

$$\sum_{i}\sum_{j}\sum_{k}\sum_{l} (S_{ijk}/RP_{ijl}) I_{ijkl} - XI^{+}_{jil} + XI^{-}_{jkl} = XI_{jil} \qquad (12)$$

GOAL: Minimize positive deviation, XI^{+}_{ijl}.

Transshipment at Port Constraints

At each port, the volume of incoming logs, industry processed products and fuelwood, respectively, of any type must balance the volume of outgoing products. There is one transshipment constraint for each type of product at each port and at each location.

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[1] See footnote 2 in Table A6 of Appendix A.

$$\sum\sum\sum\sum_{lkjk} L_{lkji} - \sum\sum\sum\sum_{ijkl} L_{ijkl} = 0 \qquad (13)$$

$$\sum\sum\sum\sum_{lkji} I_{lkji} - \sum\sum\sum\sum_{ijkl} I_{ijkl} = 0 \qquad (14)$$

$$\sum\sum\sum\sum_{lkji} F_{ijkl} - \sum\sum\sum\sum_{ijkl} F_{ijkl} = 0 \qquad (15)$$

Port Capacity Goal Constraints

The total volume of material shipped into, or out of a port, must equal the handling capacity of that port, plus or minus any capacity expansion or under-utilization. Capacity expansion may occur in three units of "modules" whose size and cost are specified by the user. These may vary depending on port location. Part of the objective will be to minimize the cost of port capacity expansion.[1]

$$\sum\sum\sum\sum_{ijkl} L_{ijkl} + \sum\sum\sum\sum_{ijkl} I_{ijkl} + \sum\sum\sum\sum_{ijkl} F_{ijkl} -$$

$$\sum_{m=1}^{3}\sum\sum\sum\sum_{jli} CEP_{mjli} \cdot XP^{+}_{mjli} + XP^{-}_{jil} = XP_{jil} \qquad (16)$$

GOAL: Minimize positive deviation, XP^{+}_{mjli}.

Product Demand Goal Constraints

These constraints refer to domestic (local and interinsular) or foreign demand for logs, industry-processed products, and fuelwood, respectively, of any type. The constraints specify that demand for

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[1]Port capacity expansion ($CEP.XP^{+}$) is a separable programming function, approximated by using a piece-wise linear function (for details see Buongiorno, 1980, op. cit., pp. 10-12).

these products at each geographic point must be closely approximate. In order to meet the demand goal, the negative deviation should be minimized.

$$\sum_{l}\sum_{k}\sum_{j}\sum_{i} L_{lkji} + DL^{-}_{ijk} = DL_{ijk} \quad (17)$$

$$\sum_{l}\sum_{k}\sum_{j}\sum_{i} I_{lkji} + DI^{-}_{ijk} = DI_{ijk} \quad (18)$$

$$\sum_{l}\sum_{k}\sum_{j}\sum_{i} F_{lkji} + DF^{-}_{ijk} = DF_{ijk} \quad (19)$$

GOAL: Minimize DL^{-}_{ijk}, DI^{-}_{ijk} and DF^{-}_{ijk}.

Objective Function

Total costs must be minimized. Costs include transport costs, costs of industrial and port capacity expansion, cost of not meeting domestic and foreign demand for logs, industry processed products, and fuelwood. If logging, manufacturing, and handling costs differ according to location, these differential costs must be reflected by the corresponding transport costs. Penalties or costs of not meeting target demand for forest products reflect also logging, manufacturing, handling and transport costs. The objective function takes the following form (where A, B, C, D and G, and a, b, and c, respectively, refer to a unit cost of respective activity defined as in Table 1):

Minimize

$$COST = \sum_{i}\sum_{j}\sum_{k}\sum_{l} A_{ijkl} L_{ijkl}$$

$$+ \sum_{i}\sum_{j}\sum_{k}\sum_{l} B_{ijkl} I_{ijkl} + \sum_{i}\sum_{j}\sum_{k}\sum_{l} C_{ijkl} F_{ijkl}$$

(Transportation Costs)

$$+ \sum_{j}\sum_{i}\sum_{l} D_{jil} XI^{+}_{jil}$$

(Industry Capacity Expansion Costs)

$$+ \sum_{mj}^{3}\sum\sum\sum G_{mjli} XP^{+}_{mjli}$$

(Port Capacity Expansion Costs)

$$+ \sum_{ijk}\sum\sum(a_{ijk} DL^{-}_{ijk} + b_{ijk} DI^{-}_{ijk} + c_{ijk} DF^{-}_{ijk}) \quad \text{(Costs of not meeting demand targets)} \qquad (20)$$

Numerical Analysis and Computation

Numerical analysis of INDO FOM may best be generated by a computer program due to its large size. The current Indonesian Forest Sector Planning Model of Bunogiorno[1] was designed and developed via two computer programs for the execution on the Sperry UNIVAC 1100 Series Computer System installed at the Department of Finance in Jakarta. The FORTRAN program generates a linear programming matrix from an initial data set supplied by the user. This matrix is stored on a permanent file to be used as part of the input to FMPS (Functional Mathematical Programming System) program of the Sperry Rand Corporation[2] in analyzing alternative development strategies for the Indonesian forestry sector.

INDO FOM has been modified for execution on the Michigan State University Computer System using its CDC 6500 and CDC Cyber 170/750 under the Scope/Hustler Operating System. However, this model can be executed on other computer systems by employing the MPS (Mathematical Programming System) of the system chosen. All data are supplied on the formated input file containing a runstream of the APEX-III MPS. The execution with APEX-III MPS is employed with LP, REDUCED and PARAMETRIC

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[1] For the details, see Buongiorno (1980), op. cit., pp. 11-21.

[2] Sperry Rand Corporation, Sperry Univac 1100 Series Functional Mathematical Programming System, Programmer Reference. (Glue Bell: Sperry Univac, P.O. Box 500, PA 19422, 1977).

options. Basically, APEX-III is an optimization system of the Control Data Corporation for Cyber 700 Computer Systems Models 72, 73, 74, 76, Cyber 170 Computer Systems, 6000 Series Computer Systems, and 7600 Computer Systems.[1] Its main function is to optimize MPS formatted linear models to either maximize gains or minimize losses. APEX-III REDUCED option includes the capability of performing a presolution analysis of the linear programming matrix, eliminating null rows and columns, row and column singletons and redundant rows. APEX-III PARAMETRIC option provides the capability of parameterizing the objective function and right-hand side. After the LP model is generated, the system produces an answer that is both feasible (an answer that satisfies all of the constraints that comprise the LP model) and optimal. Alternatives and sensitivity (post optimal) analysis may be performed on the answer according to the wants of a user by modifying basic matrix (parameters of the objective function, right-hand-side values, and input-output coefficients of the functional constraints) in various ways to reflect alternative strategies. Demand levels of exports and domestic consumption and industry capacity constraints, may thus be changed and the resulting effects on the solution observed.

Required Data and Assumptions

The data required for INDO FOM may be based on primary and secondary data surveys. Secondary data may be obtained from various

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[1]For the details, see Control Data Corporation, Control Data Cyber 70 Computer Systems Models 72, 73, 74, 76 Cyber 170 Computer Systems 6000 Series Computer Systems 7600 Computer Systems, APEX-III Reference Manual Version 1.1 (Minneapolis: Control Data Corporation, HXC02 2, P.O. Box 0, Minnesota 55440, 1977).

publications and represent real life data as obtained from specific situations. Primary data may be collected by a survey through field checks and interviews. In general, data inputs which are required for INDO FOM can be divided into five groups: resource data, industry data, port data, market data and transportation costs data. Secondary data sources for these data groups are for example, Central Bureau of Statistics, Directorate General of Forestry, Department of Industry, Department of Trade and Commerce, Directorate General of Water and Land Communication, Directorate General of Sea Communication, Forest Products Research Institute, the Indonesian Timber Society, F.A.O. of the United Nations, and the Company Headquarters. Primary data survey is particularly important because most of the data required for INDO FOM are many times not available in secondary data sources. Primary data sources are, for example, data recorded from field checking and interviewing at company headquarters, industry location, distribution and transportation centers, forest products terminals, port authorities, local government forest managers, and local agencies (government and private or communities).

Resource data required by INDO FOM are respectively log out-turn (annual allowable cut) and logging residue (fuelwood output) potentials for each forest point. To apply for non-timber analysis, INDO FOM also required non-timber out-turn potentials. Industry data required in terms of mill intake capacity (existing or target) recovery rates in processing, input-output coefficient of the mill recovery per operating shift for each type of product processed, and industry capacity expansion (new establishment) cost. Port data are, respectively, existing or target capacity of port and port capacity expansion (new establishment) cost. Market data are, respectively, estimated demand potentials and market prices for forest products. Transportation costs data are all aspects of transport concerned with procurement and distribution of forest products from any supply point (geographic area: forest, industry, port, province, region, etc.) to a demand point distributed per grid point or geographic area. Penalty costs (costs of not meeting demand) are imported prices (F.O.B. or C.I.F. for export demand, and domestic market prices for local and interinsular demands). The substitutes for domestic production used in INDO FOM are imports from foreign or other region for logs and industry processed products, and kerosene in the case of fuelwood. In addition, for non-timber types of forest products (i.e., resin, rattan, etc.), substitution requires non-timber material imports (i.e., plastic).

There are two main assumptions that have been incorporated in the INDO FOM: (i) log removal from each grid point representing a management unit (concession area of a company, localities, province, or region) may reach but not exceed potential out-turn or annual allowable cut, and (ii) logging, industry establishment, port establishment, distribution centers, and market area, land, water, and sea transport will develop in a manner which will ensure minimum cost of supplying domestic (local and interinsular) and export market demands, including opportunity cost of not fully meeting the desired demands.

For the purpose of future policy analysis (long-range planning), INDO FOM requires projected data of resource potentials, and demand or market data to be entered into the model, including also industry data, port data, and transportation costs data.

Policy statements of Government may be used to investigate alternative analysis, that is, analysis of general impacts of the changes in the constraining decision variables of the model to the output. Examples of alternative analysis are illustrated in the Alternative Analysis section of Chapter V.

CHAPTER IV

POTENTIAL ROLE AND APPLICATION OF INDO FOM TO FORESTRY IN INDONESIA

There are three major potential roles and applications of INDO FOM to forestry in Indonesia: (1) as a training tool in natural resource economics, (2) to provide quantitative information in identifying areas of research and development, and (3) as a computer-based economic planning tool to aid the forestry planning process in a manner which, as far as possible, makes efficient use of its resources. INDO FOM, in order to fulfill its potential roles and applications as noted above, demands a realistic and reliable data collecting effort especially in the areas of resource potential, cost of industry and port establishments, market, and transportation.

Due to the lack of numerous constraining decision variables and the nature of assumptions currently being incorporated in the formulation of INDO FOM, in some cases, it may be unrealistic to apply this version to real situations. Complete validation of the model and review and further development of the constraining decision variables and its assumptions will be necessary if INDO FOM is to play a role in Indonesian Forestry. The potential role of INDO FOM is limited only by resources given to its development.

INDO FOM as a Training Tool

INDO FOM is a model about economic or managerial decision making and how to make better decisions. It serves as a tool for determining optimal decisions and patterns of resource allocation among competing demands according to a predetermined objective in Indonesian Forestry. The "what if" type of questions of a forest manager, dealing with forestry and forest products business in an economic environment for which he is responsible for can be developed and solved by the help of the INDO FOM. Here INDO FOM can be used to a great advantage by forestry business managers and students as a pre-service or in-service training tool in such areas as forest resource economics, regional economics, resource development, and marketing and transportation administration.

Identifying Areas of Research and Development

INDO FOM is also an operations research technique dealing with strategic problems of the forest-based economic aspects. Since it is a formal approach, it involves a symbolic or mathematical model. A model is not reality but an abstraction of it which employs a set of mathematical symbols and functions to represent decision variables and their relationships. It describes the behavior of the economic or management goals of the Indonesian Forestry systems. It is a very useful tool to facilitate identification of areas for research and development in forestry and forest products business management.

The results of INDO FOM give certain guides to the continuation of the study and research in five main areas of forest based-economic systems, respectively, forest resource and its potentials, industry and its mill sites and facilities, port and its economic aspects, market and its potentials, and transportation and its economic or business and logistical administrations. Product trade, supply patterns for domestic and foreign, geographic location of economic activities, and shipping patterns are some of the headings to be identified, explored and studied. Questions as to where or which industries or ports should immediately be expanded to the levels where they can convert the total potential of forest resource and its products are examples which can be identified by INDO FOM.

Development patterns in the forestry sector of an economy (regional as well as national) may be compared with plans for development in other sectors of the economy, inorder to achieve a harmony with the development in supporting and dependent sectors by identifying development priorities. One of the questions like which location (industry, port, forest area, region, province, etc.) should be investigated by the help of INDO FOM as a planning facility.

A Computer Based Economic Planning Model

INDO FOM is a computer based economic planning model to assist in the exercises and the evaluation of development strategies (alternatives) for the Indonesian forest-based economic activities. It means that a computer facility is required in order to use the model due to its large size of the problem. The model may be revised to answer specific questions of the Indonesian forest-based economic problems. The linear programming matrix of INDO FOM has an option to be generated by a FORTRAN program as listed, for example, in a separable programming version of the Indonesian Forestry Sector Planning Model (Boungiorno, 1980), or in an integer programming version of the model (Boungiorno, 1979), or in its goal programming version (Buongiorno, 1978), respectively. However, it will depend on software and hardware facilities available to be employed by INDO FOM. For example, the APEX-III OUT OF CORE SYSTEM 1 linear programming system where INDO FOM was generated, provides a streamlined and flexible approach for solving LP problems. Use of disk, extended core storage or large core memory allows APEX-III to solve LP problems which are too large to solve in core.

Critique and Limitations of INDO FOM

It is necessary to emphasize here that INDO FOM is only as good as the assumptions used and the data provided. A computer output is not a gospel truth as far as economic and management decisions are concerned. The output is only as good as the input used. The model is designed to be as realistic as the real world assumptions incorporated in it.

There are many aspects of INDO FOM that may need to be revised or reformulated. Logging cost and industrial processing cost can be reformulated as separate functional constraints instead of imposing it into transportation and penalty costs. Areas such as forest plantations, agglomeration effects of a port and environmental constraints may be incorporated in future INDO FOM reformulation. The following are short comments on the above mentioned areas.

Forest Planations

INDO FOM assumes a fixed maximum allowable cut (or maximum log and fuelwood output) of trees available in each development planning alternative. The concept of maximum allowable cut is a traditional one relating to the attempt to sustain a fixed amount of forest areas and volume intact. A more relevant approach should be one in which planting activities (i.e., not replanting per se) are included in the decision variables. Expansion as well as acceptable construction (plantation) of forests should be as important decision variables as other transport considerations. They are especially relevant decisions in the long-range forest-based eocnomic planning. Hybrid models like simulation-optimization model can be of use for this problem.

Port Agglomeration Effect

INDO FOM considers the choice of port location on the basis of minimum costs of transportation as well as minimum cost of capacity expansion of additional investment (loading, handling, transshipment, etc.) concerned with forest products. This may be an area where the model may seriously fail to take account of economic development reality of port operation. Economic location of ports as well as investments, even for forest-based products, does not depend on cost consideration of one or few loading/unloading or transshipment items alone. Agglomeration effects concerning the transport costs and additional as well as new investment costs of a number of loading and unloading (or export and import) items will determine the economic facilities and best location of port. It is in this area which forest products are only part of the whole picture and consideration may be made to ascertain the relative importance of forest product transshipments before location/capacity expansion decision variables are included in the model. One or more constraints for port location and its capacity expansion goal may be added in order to explain agglomeration effects of the ports.

Environmental Goal

As far as national goals are concerned, INDO FOM neglects the environmental aspects of the third national timber-based economic goal as expressed in the Statement of Goals and Purposes section of Chapter I. INDO FOM may be best to achieve the first and second national timber-based economic goals. Environmental constraints may be as important as economic constraints and should be included in a model like INDO FOM. Being a public model, failure to include such variables as soil loss because of the timber cutting activities, transport improvement and other relative external costs in order to satisfy the economic-ecologic goal may give the model a weak foundation as far as social and political aspects are concerned. A simulation-optimization model, or gaming-optimization model may be explored to solve these real world problems in future developments of INDO FOM.

CHAPTER V

AN EXAMPLE OF AN APPLICATION OF INDO FOM TO EAST KALIMANTAN

Introduction to East Kalimantan

East Kalimantan is one of the 27 provinces of Indonesia, and is considered Indonesia's largest timber-producing province. It is located within latitudes 4°12' north and 2°18' south and east longitudes 108°5' and 118°7'.

The average monthly rainfall recorded in this area was 220 mm, with its average temperature of 26.6°C and the average humidity of 82 percent.

The 1980 census data show that 1.2 million people (only 0.83 percent of the total Indonesian population) live on an area of 202,440 sq. km., which constitutes 10.55 percent of Indonesia's land area. This averages to 6 people per sq. km. (Central Bureau of Statistics, 1981).

The gross domestic product of East Kalimantan in 1980 was Rp 1721.6 billion (equal to US $2.75 billion with an exchange rate of 1 US $ = Rp 625), with a per capita income of Rp 1434667 (equal to US $2295) which was ranked number three in the country after Irian Jaya and Riau. Forestry and agriculture together shared 10 percent of total East Kalimantan GDP. Oil and mining also shared a major portion, 73 percent.

In terms of forest-based economic development, East Kalimantan is ranked nationally as one of the highest priority geographical areas in accordance with its ability to initiate and sustain development of forest-based industries, including its potential supply of timber products to foreign countries and domestic (local and interinsular) regions. This implies that in order of urgency, forestry sector development in Indonesia may be concentrated in this particular area.

Forestry in East Kalimantan

Under the recent structure of the Forestry organization, the East Kalimantan Provincial Forest Service has 7 Divisions (Bagian) in the capital of the province, Samarinda. There are 10 District Forest Services (KPH's), 41 Forest Rangers (BKPH's) and 129 Forest Sub-rangers (RPH's). The East Kalimantan Forest Service has a total of 997 professional, technical and non-technical or administrative personnel as of October, 1980. The 32 percent or 323 personnel out of the total were paid on the national and the provincial governments salary system (pegawai negeri), the remainder were paid on a daily basis (pekerja harian) which is normally lower. Of the 323 employees on salary, 24 percent were college graduates, 63 percent were high school graduated, and the rest were primary school and without elementary education laborers (East Kalimantan Provincial Forest Service, 1981; Regional III Forestry Planning Bureau, 1981). Improvements have been achieved through career promotion training and education programs at the provincial and the national levels. A great proportion of college graduates is expected in the future years.

The Forests and Their Potentials

Forest land in East Kalimantan is administered by the Government (Provincial Forest Service) as required by Law No. 5, 1967 as mentioned earlier. Forests and associated resources are utilized by private and state (Inhutani I) companies under a 20-year period of HPH-license from the Minister of Agriculture or a 2-year HPHH-license from the province Governor.

The following are some of the most notable works concerned with natural forest classification and potentials in Indonesia including East Kalimantan: Burt (1938), Steenis (1957), Verkuijl (1952), Richards (1952), Whitmore (1975), Directorate of Forestry Planning (1976), and Buenaflor (1981). The following brief overview has been based on the reports.

There are five types of natural forests in Indonesia, respectively, (1) mangrove forest; (2) fresh water swamp forest; (3) lowland tropical rain forest; (4) hill tropical rain forest; and (5) moss forest. The bulk of commercial forests of East Kalimantan and on which the timber-based industry relies for its raw material supply are respectively, lowland tropical rain forest, and hill tropical rain forest.

Lowland Tropical Rain Forest

The lowland tropical rain forest in East Kalimantan is generally dominated by the Meranti group (*Shorea spp.*) which comprises approximately 70 percent of the commercial timber stands. A mixture of timber species including Keruing (*Dipterocarpus spp.*), Mersawa (*Anisoptera spp.*), Kempas (*Koompassia malaccensis*), Kapur

(_Dryobalanops_ _spp_.). _Hopea_ _sp_., _Vatica_ _sp_., _Cotylebium_ _sp_., _Parashorea_ _sp_. and a few others make up the remaining 30 percent of the currently commercial growing stock.

The general topography of the lowland forest is mostly flat to slightly undulating but with occasional areas of steeper terrain with average slope ranging from 10-30 percent. Elevation of the forest area is usually between 50 and 250 meters above mean sea level and up to 500 meters altitudes.

The average size of logs in lowland forest is smaller than that of logs coming from hill forests. Trees average 70 cm in diameter and two and a half log lengths, or 12.5 meters (one log is about 5 meters). The lowland tropical rain forest in East Kalimantan is estimated to have an area of 8695 thousand ha or about 41 percent out of 21084.6 thousand ha total East Kalimantan Forest area. However, since 15622.7 thousand ha of East Kalimantan's forests have been designated as accessible and productive forest areas, 55 percent of it consisted of lowland forest timber stands with an average potential volume of commercial species of 63.61 cu.m per ha (with a range of 52-82 cu.m average volume per ha).

Hill Tropical Rain Forest

The hill tropical rain forest areas of high commercial potential in East Kalimantan are dominated by Dipterocarps (Meranti mixed with other dipterocarps) of very good stand quality and an average commercial volume of 80-120 cu.m per ha. Areas adjacent to the lowland rain forest contain commercial timber stock of Meranti-mix with a density of commercial volume of 60-90 cu.m per ha. The timber stands of hill forests are usually very good compared with the lowland forests. The average clearable height and dbh (diameter breast high) of the dominant commercial tree species are large, with stems producing 3-4 logs of 5-7 meters having diameters of 70-90 cm. Most of the big straight bole trees are free of defects, and hence the volume recovery for each felled tree is very high.

The hill tropical rain forest in East Kalimantan occur along the slope of the mountains at elevations ranging from 500 to 1500 above sea level and have generally undulating to steep topography, averaging 20-30 percent slope. Total area of hill forest is estimated about 3339.0 thousand ha or 21 percent out of the total designated East Kalimantan productive and accessible forest areas.

Logging Operations and Timber Production

Basically, there are two types of logging operations which have been used in East Kalimantan, respectively, lowland and hill forest logging operations.

All logging operations in the lowland forest areas use machines for moving logs from the stump to a navigable river or a road that can be used by fast-moving hauling equipment. The most common method used for off-road transport in lowland tropical rain forests is skidding. This operation is of three different types according to the type of the equipment and expertise provided by the HPH-logging company. These three ways of skidding in East Kalimantan are (Buenaflor, 1981):

- Crawler tractors (Caterpillar D6 and D7) combined with self-loading winch lorries (known in Indonesia and Malaysia as "San Tai Wong", King of the Forest).
- Crawler tractors (D6 and D7) combined with wheel-loaders and conventional logging trucks.
- Crawler tractors combined with wheel skidders, wheel loaders, and conventional logging trucks.

There are four methods of logging operations used in the hill tropical rain forests of East Kalimantan by the big HPH-logging companies according to Buenaflor's report:

- Crawler tractor skidding.
- Crawler/tractor/wheeled skidder combination.
- Cable or highlead yarding in combination with skylining.
- Crawler tractor/track skidder combination.

Crawler tractor skidding is the most popular method and is widely used in East Kalimantan hilly forest. On the other hand, cable/highlead yarding is not extensively used in logging operations.

The entire province of East Kalimantan is criss-crossed by several big rivers ideal for logging operation. Some of the big rivers and their tributaries are, respectively, the Mahakam River, the Kayan River, the Berau River, the Sengata River, and the Bengalon River. The presence of these rivers offer two major advantages to the forest concessionaires: accessibility and low transportation cost.

Logging operations and timber production in East Kalimantan have been growing fast since the First National Development Plan (Repelita I) was started in 1968. At present, in the Third National Development Plan period as of March 1981, there have been 102

HPH-companies recorded as operating in East Kalimantan on a total accessible and productive forest areas of 11268.75 thousand ha. Since the Repelita I up to 1978, yearly logs production have been increased up to 10.1 million cu.m. As a consequence of legislation introduced in 1979 (as mentioned earlier), the production figures dropped down to 7.8 million cu.m. in 1980, because most of the HPH-companies did not have their own timber-based industries to process their own logs. However, as a positive effect of the legislation, there have been fast developments occurring in the forest-based industries sector in East Kalimantan by HPH-companies. These companies, by and large, have been forced to expand their investments in the processing industries in order to increase value-added to the East Kalimantan Regional Economy as well as Indonesian National Economy as required respectively by Law No. 5, 1967 (Forestry Basic Provisions), Laws No. 1, 1967 and No. 11, 1970 (both concerning Foreign Capital Investments) and Laws No. 6, 1968 and No. 12, 1970 (both concerning Domestic Capital investments). Regardless of national policies favorable to forest-based industries, forward planning of the development of these industries expansions should be viewed in line with the domestic as well as the international market absorptions of the industry-processed products. However, expected changes in future patterns of international hardwood trade, as well as domestic demand in the next decade will demonstrate the success of the expansion policies.

Out of the total logs volume produced in East Kalimantan, 25% are classified as F (first grade) or veneer logs, 70% are as S (second grade) or either veneer logs or sawlogs, and 5% are T/L (Third/local grades) or sawlogs and chip-boards logs.

Total manpower in the East Kalimantan HPH-companies as of 1979 was 17,946 including 17,093 Indonesians (95%) and 853 foreigners (5%) in the form of foreign expertise. This number decreased by April 1980 to only 5,953 (including 94% Indonesians and 6% foreigners) because of the declining production of the exports in the forms of logs. However, manpower trade-offs and transfers have been made from logging activities into manufacturing (industrial) activities (East Kalimantan Provincial Forest Service, 1981).

Minimum Annual Allowable Cut (AAC) of timber applying a cutting cycle of 35 years, in East Kalimantan is estimated to be 7.84[1] million cu.m. per year from 10,404.8 thousand ha of permanent accessible and productive forests. The maximum AAC is 13.91[2] million cu.m per year from 15,622.7 thousand ha of total accessible and productive forest (including 5,217.9 thousand ha of non-permanent productive forest which is allocated as conversion forests[3] for other uses). Most of the timber cutting systems in East Kalimantan natural rain forests is logged according to the Indonesian Selective Logging System.[4]

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[1]Estimate based on real 1975-78 area and volume cuts which was 58.3 cu.m/ha of diameter 50 cm and above, as: AAC = 70% x 10404.8 thousand ha x 53.8 cu.m/ha x 0.70 x 1.35 = 7.84 million cu.m per year, where 70% is the proportion of productive assumed areas of the 10404.8 thousand ha of accessible and productive forests area, 53.8 is the real area-volume cut per ha per year of 1975-78, 0.70 is the logging recovery factor, and 35 is a normal cutting cycle in years, assuming sustained yield at 1.0 cu.m/ha/year over accessible and permanent productive forests.

[2]Estimation was based on 63.61 cu.m/ha of potential out-turn per year of timber stands of diameter 50 cm and above.

[3]Conversion forests are defined as forest areas which have, by law, convertible functions into different uses, such as estate plantations, agriculture, resettlement, industries, etc., if they are required in the long-run to do so.

[4]For detailed explanations about the Indonesian Selective Logging System, see Buenaflor (1981), op. cit., pp. 85-89.

Wood-based Industries

Out of 102 HPH-companies in East Kalimantan, only 35 companies (34%) had their own wood-based industries, at the production stage. These included 30 sawmills, 4 plywood and veneer mills, and 1 chip-board mill industry (East Kalimantan Provincial Forest Service, 1981) as of March 1981. However, in the period of 1979-81, there has been much progress in the expansion of the wood-based industries in East Kalimantan. The official East Kalimantan Provincial Forest Service figures show that there has been a growth of about 40 percent of new industry establishments, including 24 sawmills and 17 plywood and veneer mills. Some of them are in the application and recommendation stages, and some of them are in the construction stage. In the final period of Third National Development Plan (Repelita III, 1978/79-1983/84) it is expected that there will be 54 sawmills, 21 plywood and veneer mills, several chip-board mills, and at least 1 pulp and paper mill, which will be operating at full capacity.

The capacities of existing sawmills, plywood mills and chip mills in East Kalimantan as of March 1981, respectively were, 862 thousand cu.m/year, 263 thousand cu.m/year and 252 thousand m. ton/year, mostly working with 50 to 80 percent intake capacity at 1 to 1.75 shifts of operation per day. The new established industries are expected to be producing 1080 thousand cu.m/year (sawnwood), 850 thousand cu.m/year (plywood-veneer), 500 thousand cu.m/year (chip-board), and 330 thousand m. ton/year (pulp-paper/bleach craft) in 1983/85. The industry-processing recovery rates were 35-55%, and 45-65% respectively for sawmills and plywood mills. The existing industries are expected to be expanded to the full capacity at 2.25 operating shift per day. The total amount of investments which have been invested in the wood-based industries in East Kalimantan as of March, 1981 for sawmills and plywood-veneer mills for example, are respectively, Rp26.1 billion (equal to US $417 million), and Rp 16.1 billion (US $258 million). The "mushrooming" growth of wood-based industries in East Kalimantan should be based on good planning because of the quantity and quality of timber potential and other resources available including port, marketing and transportation facilities now and its expectations particularly in the future.

Forest Products Marketing

The export of logs had increased from only 7 thousand cu.m in 1966 to a peak of 7.4 million cu.m in 1973. Since then, East Kalimantan exported a yearly average of 6.59 million cu.m until 1978. The year 1979/80 was a "recession" period for the timber producers and exporters of East Kalimantan since 1979 legislation restricted log export to 40 percent and reserved 60 percent of total production for domestic production of wood products. The export of logs went down to 3.8 million cu.m in 1980 and to 2.7 million cu.m in 1981. Sawntimber exports in 1980 was 79.9 thousand cu.m (increased by 67 percent from 1979). Plywood and veneer exports went up to 74.3 thousand cu.m (an increase of 62 percent from 1979), chip-board, to 113.4 m. tons.

Meranti was the major commercial species in timber exports (76%), followed by Kapur (11%), Keruing (4%), Agathis (1.7%), and others (7.3%). There have been 35 commercial species marketed to foreign and domestic demand points. Out of the total exports, sawlogs grades (T/L) has been 12%, plywood and veneer grades (F/S) were 88%. Japan was the main importer of logs (64%), followed by Korea (16%), Taiwan (13%), Hongkong (6%), Singapore (0.30%), Europe and others (0.7%). Industrial-processed products from East Kalimantan went to 12 different importing countries, mainly Singapore, Japan, Taiwan, and Kongkong, some European countries like the Netherlands and France, the U.S.A. and others. These products also went to 15 different importing cities and regions in the domestic (local and interinsular trades), mainly to Surabaya/East Java (48%), followed by Ujung Pandang (22%), Jakarta (16%), and the other regions including Parepare, Palu, Banjarmasin, Semarang, etc., shared 14 percent of 82 thousand cu.m total domestic trade in 1978.

According to the APKINDO[1] projections, the future markets for sawnwood, plywood and veneer products absorptions are expected to be the U.S.A. and Canada (50%), Europe (19%), and others (including Saudi Arabia/Middle East) will be sharing 31 percent. Domestic markets for industrial-processed products will be concentrated in Java, followed by Sulawesi and other eastern Indonesian regions (Annonymous, 1981).

The forestry income in 1972-77 was 19% out of the total East Kalimantan gross domestic product, number three after restaurants and hotels, and the oil and mining sectors which have accounted for the majority of the GDP since the 1960's. In 1980, the forestry income dropped to number four (8%) after petroleum/mining, trade and restaurants/hotels, out of the total GDP as mentioned in the earlier part of this chapter. In terms of trade balance of forest-based products, East Kalimantan is a net exporter. Import-export and shipping balance of total dray cargo including forest-based products and other products. In 1977, for example, there were 91 thousand m. ton of imports, and 6861 thousand m. ton of exports (Segerstrom, 1978).

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[1]APKINDO = Assosiasi Produsen Kayu Lapis Indonesia (Association of Indonesian Plywood and Veneer Wood Producers).

The future market policy will be based on the diversification approach, including (1) product diversification (more varieties of types of products of the industrial products based on the international quality standards); (2) species diversification (more varieties in promoting and selling of a "lesser-known" commercial timber while expanding the well-known marketable species); and (3) market diversification (more varieties in demand points, domestic as well as foreign demand for timber-based products). It will also depend on marketing efficiency, better logistical management, and efficient business administration.

Forest Products Transportation

The East Kalimantan HPH-companies own 19.2 thousand km of road system, including 8.8 thousand km main roads, 10.1 thousand km branch roads, 208 km corridors, and 92 km of railroads, in order to transport logs and other forest products from forest point to industry as well as port and local demand points by using truck transports (East Kalimantan Provincial Forest Service, 1981). Forest concessionaires also use the water transport system by using the navigable rivers in East Kalimantan (Figure 6). The Forest Service statistics, as of the year 1981, show that there were 6560 logging and transportation facilities with regard to forest products procurement and distribution activities: 902 road construction units (14%), 4417 hauling and loading units (67%), 412 rafting units (6%), 582 transportation units such as truck and boat (9%), and 247 other transportation facilities (4%). Most of these facilities have not been fully utilized, since logging and timber-based industries slowed down after the well-known 1979 timber-based economics government

KEY TO FIGURE 6:

Identification of River

Code	River Name
A	Sembakung
B	Sesayap
C_1	Bahau
C	Kayan
D	Kelai/Derau
E	Telen
F	Belayan
G_1	Bah
G	Mahakam

Identification of City/Town/Village and Port

Number	Name
1	Samarinda
2	Balikpapan
3	Tenggarong
4	Tarakan
5	Nunukan
6	Sangkulirang
7	Tanjungredeb
8	Tanjungselar
9	Sebuku
10	Malinau
11	Sesayap
12	Muarapangean
13	Napaku
14	Longnawan
15	Sepasu
16	Bontang
17	Muaramawai
18	Muaraancalung
19	Laham
20	Danompanai
21	Longiran
22	Muarantunan
23	Sebakung
24	Tanahgrogot

LEGEND:

: Capital City of the Province

: Commercial city/Timber-based Industry Point

: Town/Village

: River (Navigable)

: Road (Truck)

: Port (Loading or Transshipment Point)

SOURCE: Atlas Ganaco and Atlas PT Starnico, and East Kalimantan Provincial Forest Service, 1981.

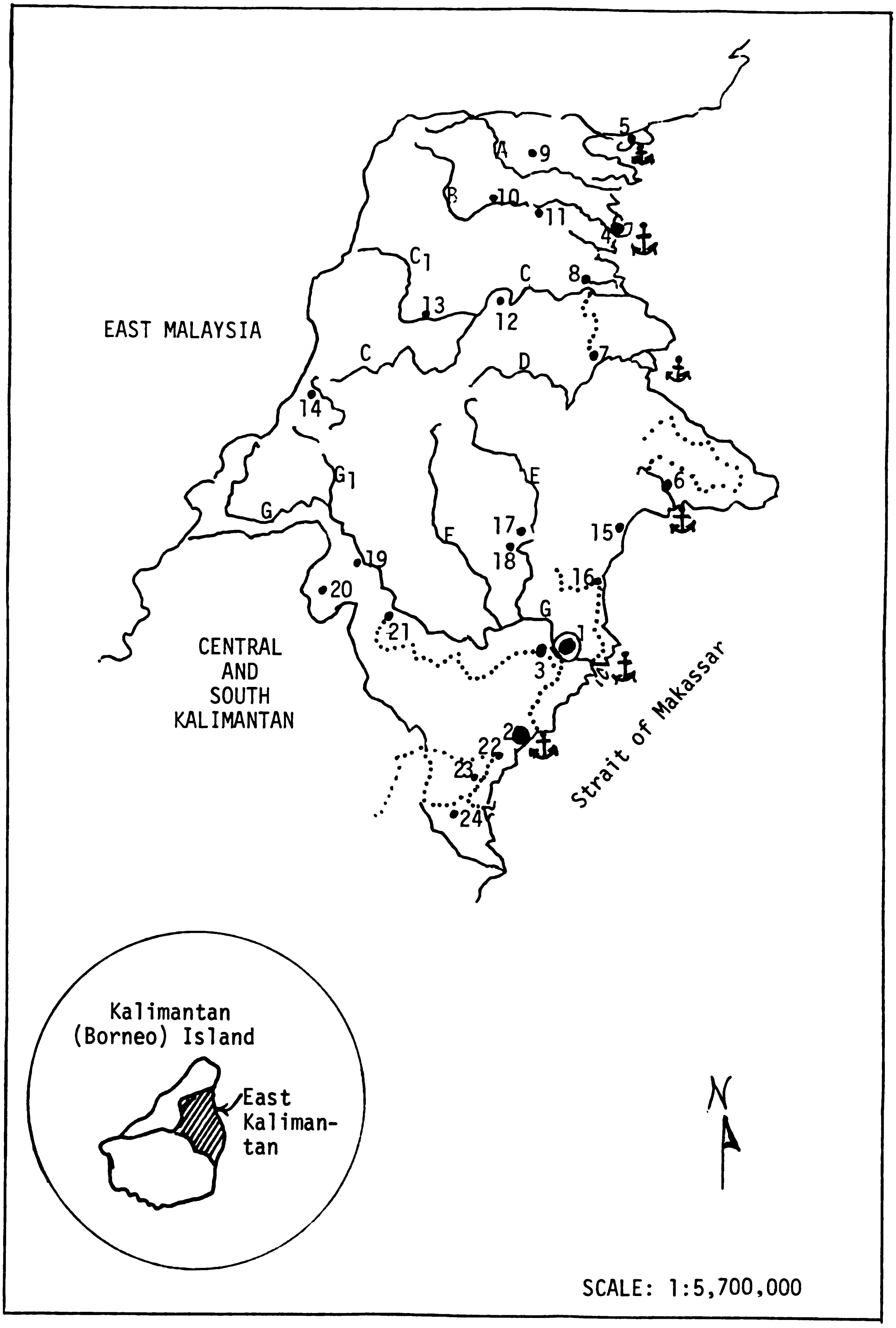

FIGURE 6. Map Showing Navigable Rivers, Road and Port and City, Town and Village in East Kalimantan.

policy had been passed. However, this recession would not be expected in the long-run.

The interinsular and international transportation of timber-based products from East Kalimantan are carried by shipping facilities which are constrained the same as for the global forest products transportation network in Indonesia as mentioned in Chapter I. There are a number of ideal shipping points strategically located in this province, and these provide considerable advantages in relation to the cost of handling and shipping. Among the ideal shipping points are respectively, Samarinda, Balikpapan, Tarakan, Nunukan, and Sangkulirang. These ports are classified as Class B (medium cost category) ports by the Directorate General of Sea Communication in terms of assigning a set of standard costs which becomes a component of the interinsular freight rates, including sea component cost, harbor component, cargo category factor, stevedoring, etc. (Segerstrom, 1978). International shippings are conducted by LTA (Liner Transport Agreement).[1]

Import and export shipping to foreign countries and from East Kalimantan has been done by employing two shipping systems (Annonymous, 1981):

- Direct transportation to final destination at port point of importing country by using liner shipping system (LTA or non-LTA).

- Indirect transportation to final destination of importing country by using log/bulk carrier system with the allowance of transshipment at, (1) Singapore for European demand destination, and (2) Koahshiung (Taiwan) for U.S.A. and Canada demand points.

[1]Refer to Page 18; further details, see Segerstrom (1978) pp. 13-15.

Shipping freights with transshipment at Singapore and Taiwan are cheaper than that of direct transportation system. For example, plywood-veneer products transport costs only US $85 per revenue ton (for East Kalimantan - West Coast of the U.S.A.), but it is $110 if a direct transportation system is employed. Further research and planning of these systems are necessary in order to achieve an efficient forest products shipping pattern for East Kalimantan.

The Data for the Case Study

Secondary data were based on the different secondary data sources as mentioned earlier. Primary data were based on the author's field check program in July-September, 1981 to South Kalimantan, East Kalimantan and East Java. The HPH-industrial companies were selected randomly, based on the criterion that an HPH-industrial company must have its own logging operation and industrial-processing mill to produce different types of timber-based products to be transported to different destination (demand) points through a competitive market system as required by the Forestry Agreement.[1] This criterion has automatically eliminated most of the 102 HPH-industrial companies in East Kalimantan which, in fact, did not fit into it. There were only 20 HPH-industrial companies who meet this purposive random sample selection criterion. Further sample selection in order to record resource data, industry data, port data, market data and transportation cost data, respectively, was based on the 20 potential HPH-industrial

[1] Forestry Agreement is an agreement between the Government, i.e., Department of Agriculture and a concession holder, i.e., HPH-industrial company -- An official document for both parties to facilitate the planning and control functions of the Government and the utilizing and investment functions of a concession holder in a manner which would optimize the use of forest-based resources in such a way to satisfy the societal (national) goals.

companies in East Kalimantan.

Ten out of the 20 HPH-industrial companies were selected to study an example of an application of INDO FOM to East Kalimantan. Those companies are respectively, (1) Georgia Pacific Indonesia/Kalimanis, (2) Sumber Mas I, (3) Inhutani I, (4) Meranti Sakti Indah, (5) Kayan River Indonesia, (6) International Timber Corporation Indonesia (ITCI), (7) Balikpapan Forest Industries (BFI), (8) Inne Dong Hwa, (9) Chipdeco, and (10) Inhutani-Savoda Joint Ventures. Figure 7 is a map showing port points and forest points for each company included in this study.

Most of the data were based on the scalar estimates of the figures as have been reported respectively in the FAO Project's INS/73/012 and INS/78/054 working papers Numbers 1 to 11, the FAO field trip missions reports to East Kalimantan, the HPH-Company Headquarters annual reports, the East Kalimantan Provincial Forest Service annual reports, and others. Some data were based on the author's interviewing records with the company HQ's. All but the Inhutani-Savoda Joint Ventures data were estimated figures derived from the Inhutani I headquarters annual reports.

Detailed definitions about the data and its sources for the case study in East Kalimantan can be seen in Appendix A (Table A3 to A17). These are grouped in 5 data groups, respectively, resource data, industry data, port data, market data, and transportation cost data, all of the input data required for an example of an application of INDO FOM to East Kalimantan. The output data are as listed in Appendix B (Tables B18 to B47). There are 10 logging (forest) points and 10 industry points of 5 different mills located at different locations producing different

KEY TO FIGURE 7:

Identification of Forest Point Number	Concessionaire Name	Identification of Industry and Port Points Dot	Name
1	Georgia Pacific Indonesia/Kalimanis	▲	5 HPH-industrial companies mills located in Samarinda/Kutai geographical areas
2	Sumber Mas I		
3	Inhutani I	●	3 HPH-industrial companies mills located in Balikpapan geographical area
4	Meranti Sakti Indah		
5	Kayan River Indonesia		
6	International Timber Corp. Indonesia (ITCI)	■	1 HPH-industrial company's mill located in Tarakan geographical area
7	Balikpapan Forest Industries (BFI)	*	1 HPH-industrial company's mill located in Nunukan geographical area
8	Inne Dong Hwa		
9	Chipdeco/Karna Kencana	⚓	Port (or transshipment point) located in Balikpapan, Samarinda and Tarakan/Nunukan geographical points
10	Inhutani-Savoda Joint Venture		

SOURCE: Adapted from East Kalimantan Provincial Forest Service Concession Maps and Report, Samarinda, 1981.

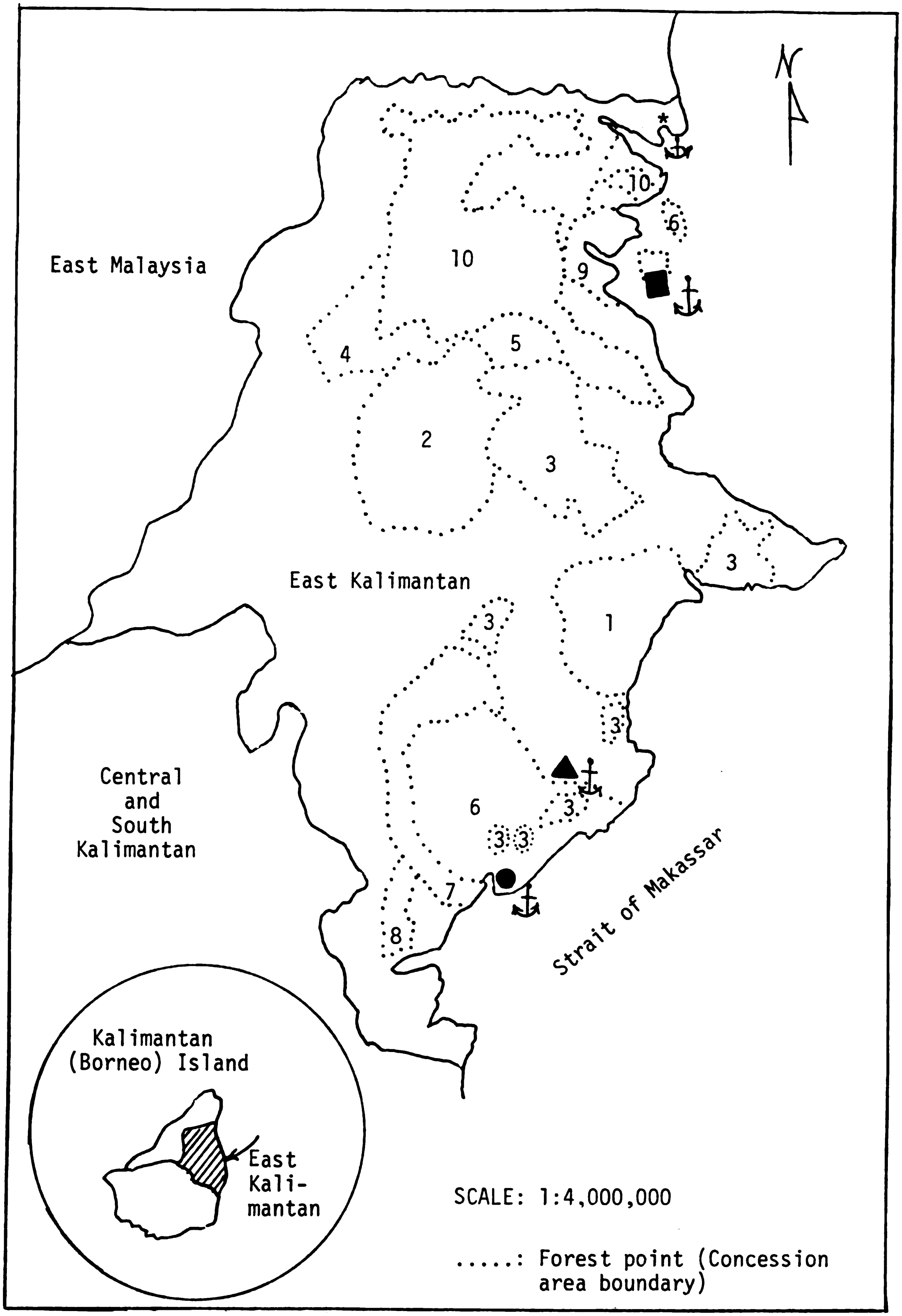

FIGURE 7. A Map Showing Forest Points (HPH-Company Concession Areas) and Location of Industry Points and Ports of the Case Study in East Kalimantan.

types of timber-based products, i.e., sawnwood, plywood and veneer-wood, chip and board, pulp and paper, and fuelwood. Three ports (Samarinda, Balikpapan and Tarakan/Nunukan) were selected to be studied. Twenty-four demand points were incorporated in this case study. There were 2 local demand points (Samarinda and Balikpapan), 6 interinsular demand points (Surabaya/East Java, Semarang/Central Java, DKI-JAKARTA Raya, South Sulawesi, Central Sulawesi, Cirebon/West Java), and 16 foreign or export demand points (Singapore, Japan, Hongkong, South Korea, Taiwan, the U.S.A., Thailand, Malaysia, Saudi Arabia/Middle East, the U.K., the Netherlands, West Germany, Italy, Denmark, Australia, and Canada). Figure 8 shows interinsular and international shipping networks of this case study.

The size of the LP matrix of INDO FOM for this particular case study in East Kalimantan was 205 rows and 483 columns.

Alternative Analysis

Five alternative strategies were studied using the INDO FOM in the case study analysis of the East Kalimantan forest-based economic development. Description of the alternatives analyzed in this study, together with their definitions, are described by Table 2. All other input data regardless of the alternative considered, together with their definitions, are as reported in Tables A3 to A17 of Appendix A. The alternatives which are processed in this case study analysis were designed to determine and illustrate the general impact of changes in the constraining decision variables of the model rather than trying to find a politically acceptable development strategy. Therefore, the alternatives represent extremes within theoretically possible limits for

KEY TO FIGURE 8:

Identification of Port and Demand Points

PORT POINT:

21 = Samarinda
22 = Balikpapan
23 = Tarakan/Nunukan

DEMAND POINT:

24 = Surabaya/East Java
25 = Singapore
26 = Japan
27 = Hongkong
28 = South Korea
29 = Taiwan
30 = Semarang/Central Java
31 = DKI-Jakarta Raya
32 = South Sulawesi
33 = Central Sulawesi
34 = Samarinda
35 = Balikpapan
36 = U.S.A.
37 = Thailand
38 = Malaysia
39 = Saudi Arabia/Middle East
40 = U.K
41 = Netherlands
42 = West Germany
43 = Italy
44 = Denmark
45 = Australia
46 = Cirebon/West Java
47 = Canada

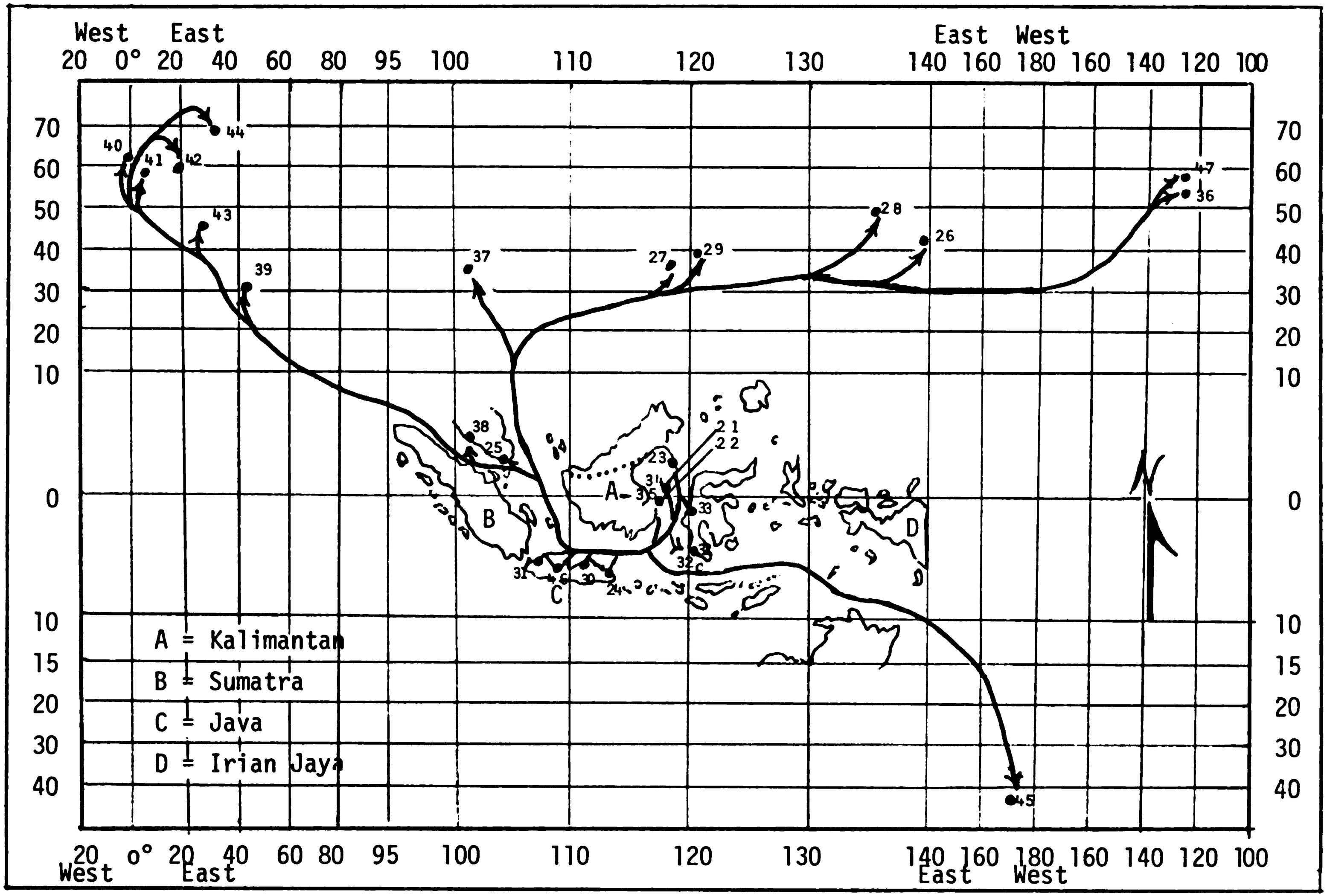

FIGURE 8. Transportation Network (From Port to Importing Demand Point) Analyzed in this Case Study and Geographical Distribution of Demand Points (Global Orientation for East Kalimantan.

TABLE 2. Description of Alternatives Analyzed in the Case Study of an Example of an Application of INDO FOM to EAST KALIMANTAN.

Alternative Number	Resource Supply[1]			Industry Capacity[3]		Port Capacity[4]			Market Situation	Objective Function[6]
	Total Logs Out-turn	Logs for Export	Logs for Domestic Processing	Intake Capacity	Number Of Shifts	Logs Transship-Ment	Processed Products Transship.	Fuel-Wood Transship.	Product[5] Demand	Transport-ation Cost
1	50% of AAC[2]	40%	60%	20-50%	1.0	SC	SC	SC	No change	No change
2	70% of AAC	40%	60%	25-75%	1.75	No change	Increase 40%	Increase 40%	Increase 2.5%	No change
3	90% of AAC	40%	60%	60-95%	1.75	No change	Increase 50%	Increase 50%	Increase 20%	No change
4	Maximum (100% of AAC)	40%	60%	80-100%	2.25	No change	Increase 55%	Increase 65%	Decrease 10%	Increase 25%
5	AAC drops 20%	40%	60%	Target Capacity (100%)	2.25	No change	Increase 100%	Increase 100%	Increase 50%	Increase 25%

[1]Logs for Export and Domestic Processing is 40:60% or 40% out of the total logs out-turn cut every year is for direct exports to foreign importing countries in log form; 60% out of it is required to be processed in the domestic timber-based industries as of the legislation introduced in 1979 (as mentioned in Chapter I).

[2]Most of the HPH-industrial companies actual cuts have been averaging 50% of their AAC (Annual Allowable Cut) as of 1978/81. The AAC can be increased until its maximum (100%) as has been allowed by the Directorate General of Forestry, assuming no declining in productive and accessible forest areas. AAC may be decreased as much as 20% down if productive and accessible forest areas were declining at a rate of 10% per year.

[3]Intake capacities of most industrial mills have been averaging within the range of 20-50% or 25-75% of their existing (design or target) capacities as per letter of decision of the Department of Industry by employing 1.0 to 1.75 shift per day operation as of the year 1978/81. These capacities can be increased or expanded until its peak (100%) by employing 2.25 shift per day operation.

[4]SC is the capacity of a port according to the Directorate General of Sea Communication and the Companies Headquarters as of the year 1978/81. Increase in the capacity or expansion including new establishments can be made at a range from 60% to 100% increases in a port capacity (handling, loading, new facilities, etc.). No capacity expansion is assumed for logs transshipment since logs are having a declining function because of the 1979 legislation.

TABLE 2. (cont'd.).

[5] Alternative changes (increase or decrease) in product demand has been made iteratively for the convenience of the analysis (it may not be a true change).

[6] Transportation cost is a major portion of the total costs structure of the Objective Function of the INDO FOM, and has been assumed (iteratively) it may increase, for example, up to 25% -- it may not be a true change but rather one for the purpose of the post optimal or sensitivity analysis of the INDO FOM in this case study.

convenience in post optimal or sensitivity analysis.

The five alternative strategies assume the same development of domestic processing and export of logs at a composition of 60%:40% out of the total log output of AAC. Each alternative differs in its composition of resource supply percentage of total AAC of commercial species), industry capacity (intake capacity development and number of shift employed per day of operation), port capacity for processed products and fuelwood transshipments (no development of port capacity for logs transshipment) market situation (product demand development), and the change in the transportation costs of the objective function. Shipment to interinsular and foreign demand points was assumed to be a direct transportation system (no transshipments) to final destination at the port points of an importing region or a country using perahus (sailing ships) and liner shipping systems (interinsular) or LTA and non-LTA systems (international). No transshipment at Singapore and Koashiung have been assumed. Transshipment is allowed at all East Kalimantan ports of this case study (Samarinda, Balikpapan and Tarakan/ Nunukan). Costs of capacity expansions of industry and port have been assumed stable.

The output data of each alternative strategy analyzed in this study are as reported in Table B18 to B47 of Appendix B.

Main Results of the Case Study

For the purpose of presentation, the consequences of each one of the five alternatives defined earlier, the main results of the case study have been grouped into 5 following areas, (1) resource surplus, (2) industrial capacity development, (3) port capacity development,

(4) market analysis and (5) transportation patterns. The principal features of each alternative are summarized and briefly discussed in the following sections. The tabular form of the main results are presented in Tables B18 to B47 of Appendix B.

Resource Surplus

Table B18 in the Appendix B indicates what surplus of resources in terms of log out-turn of annual allowable cut (AAC) and logging residuces of fuelwood output are likely to develop in each HPH-industry concession area under the various alternatives. There are large surpluses of wood usable for fuel or saw logging residue under any of the five alternatives considered. The largest surpluses occur in the International Timber Corporation Indonesia (ITCI) and the Balikpapan Industries (BFI) concession areas. They could easily fill the deficits or shortages of fuelwood demands in local, interinsular and foreign demand points (regions) but the analysis in the Market Analysis section indicates that it would be uneconomical to do so.

Given the planned AAC, there are no surpluses of logs that would remain in each HPH-industry concession area but the ITCI with only 72.18 thousand cu.m per year of saw logs under alternative strategy 4. This surplus would be sufficient to supply the deficit demand points (local, interinsular or foreign) or to supply its own plywood-veneer mills deficit but under the assumed cost structure this solution would be uneconomical.

Industrial Capacity Development

Table B19 gives a description of the rates of capacity expansion or stagnation which would be necessary to each HPH-industry of the case study in East Kalimantan, in order to meet the domestic (local and interinsular) and foreign (export) demands described previously (Table A10 of Appendix A and its alternative growth strategies as described by Table 2).

The results suggest industrial capacity stagnation in all HPH-industries observed in the case study, except for the ITCI under alternative strategy 1, which would be slightly expanded by some 11,980 cu.m and 5,450 cu.m per year, respectively, for its sawmill and plywood-veneer mill.

The stagnation of industrial capacity development in the observed HPH-industries indicate the current absorption of industrial-processed products from East Kalimantan in the market (domestic as well as export) are still low. Marketing expansion policies is necessary in order to meet the industrial capacity development of HPH-industries regardless of alternative strategies considered.

Port Capacity Development

Table B20 gives data on port capacity development at 3 ports analyzed in the case study (Samarinda, Balikpapan, and Tarakan/Nunukan) under each one of five alternatives. These volumes are the sum of shipments of all logs, all processed products and residue-fuelwood in and out of each port.

The results suggest port capacity stagnation in all ports analyzed in this case study, except for the Tarakan/Nunukan port under alternative

5, which would be slightly expanded that is, by building 1.9% of the first module relative to the initital capacity, in terms of number of shifts and port facilities (handling, transshipment, etc.) to handle incoming and outgoing volumes of forest products.

Market Analysis

Market analysis includes respectively, supply alternatives to meet domestic demand (local and interinsular supply shortages) and foreign demand (export supply shortage) as represented by Tables B21, B22, and B23, respectively. The following is its brief analysis.

Local Supply Shortage

Samarinda and Balikpapan have been chosen as two main local demand regions which consume high rate of forest products. These regions are also ranked as the most developed part of the East Kalimantan Province. From table B21 it appears that considering transport costs only, at a substitute price of Rp 300 per cu.m in Balikpapan and Rp 350 per cu.m in Samarinda, it is economical to supply 100 percent of the total residue-fuelwood requirement of Samarinda under five different alternative strategies. However, it would be economical to supply only 40 percent in Balikpapan, which is viable only under alternatives 2 and 3. Import of pulp and paper products are not viable under alternatives 3, 4, and 5 at the assumed C.I.F. price of RP 63,500 per m. ton and Rp 64,000 per m. ton, respectively for Balikpapan and Samarinda. Other industrial-processed products (sawnwood, plywood, and chip-board) supply would fall short of requirements in Samarinda and Balikpapan regions regardless of the five alternatives considered under assumed different market prices.

This deficit can be met by importing from other regions in East Kalimantan/Kalimantan, Indonesia or even from foreign countries, but under the current assumed transport costs, substitute market prices, and other costs incorporated in the model, this solution might be uneconomical.

Interinsular Supply Shortage

Table B22 gives interinsular supply shortages for forest products from East Kalimantan under different alternative strategies at six main domestic demand regions. Surabaya/East Java is considered in this case study as the only region which imports logs (saw logs and veneer logs) from East Kalimantan, e.g., Sumber Mas I to its sawmill and plymill located in Gresik, Surabaya.

Under each alternative considered the saw log supply would fulfill the requirements in Surabaya under the recent demand structure. Veneer logs supply would be fulfilled only under alternatives 4 and 5, but would fall short of requirements under alternatives 1, 2, and 3, meaning that Surabaya/East Java should buy from other sources or regions with average imported domestic market prices (penalty costs) in order to meet its requirements.

As shown by Table B22, the largest shortages for industrial-processed products (sawnwood, plywood, chip-board, and pulp-paper) would occur in Surabaya/East Java and DKI-Jakarta Raya, followed by Semarang/Central Java, Cirebon/West Java, South Sulawesi and Central Sulawesi. Given the assumed import price (penalty cost, C.I.F.) of Rp 89,750 to Rp 95,000 per cu.m for sawnwood, plywood, veneer, and chip-board products, and Rp 60,000 to Rp 64,000 per m. ton for pulp-paper products as shown by Table 11, it would be economical for these regions to import industrial processed products either from other HPH-industries in East Kalimantan or from other regions in Indonesia or from foreign countries.

Under alternatives 1, 2, and 3, interinsular residue-fuelwood supply would fall short of requirements in Surabaya/East Java, Semarang/Central Java, DKI-Jakarta Raya, Central Sulawesi and Cirebon/West Java. The largest shortages would occur in Semarang/Central Java, Surabaya/East Java and Cirebon/West Java. With a substitute price of Rp 4,500 to Rp 5,500 per cu.m of fuelwood, which roughly corresponds to Rp 70 litre of kerosene, it is not financially viable to ship most of the fuelwood supply to meet the requirements, particularly under alternatives 4 and 5 when the transportation costs structure would be increased by 25 percent.

Foreign Supply Shortage

The demand for all forest products, except saw logs, for foreign (export) countries' demand points are not always met under various alternative strategies as presented by Table B23. Veneer log demand would be met only under alternative 4, that is, by assuming 100 percent AAC and a 25 percent increase in transportation costs along with a decrease in demand of 10 percent per year. The largest shortages would occur in Japan respectively for plywood-veneer logs (under alternatives 1, 2, and 3) chip-board logs, pulp-paper logs, plywood-veneer products, and residue-fuelwood, followed by Singapore, South Korea, and Hongkong. Taiwan would fall short of requirements of plywood-veneer logs (under alternatives 1, 2, and 3) and residue-fuelwood (under alternatives 4 and 5) but the U.S.A. in sawnwood and plywood-veneer products (under all five alternatives), Thailand in sawnwood and pulp-paper products, followed by Malaysia (in pulp-paper products), the Netherlands and Italy (in sawnwood and plywood-veneer), West Germany (in sawnwood products), and Denmark (in plywood-veneer products). Saudi Arabia/Middle East would fall short of plywood-veneer products under alternatives 1, 4, and 5 but sawnwood under alternative 5.

Under alternative strategy 5, the U.K. and Canada would fall short of requirements in plywood-veneer products, but Australia in sawnwood products.

Since the case study was concerned only with 10 HPH-industry companies in East Kalimantan, it does not mean that the shortages of supply at the above export demand points can not always be met by the East Kalimantan forest-based industries under the assumed economic conditions which, in fact, has more than 10 HPH-industries as has been mentioned in the earlier sections of this chapter.

Transportation Patterns

Tables B24 to B47 summarize the optimal transportation patterns in terms of the forest products volumes transported and/or shipped on the various transportation links. These transportation links are: (1) forest to local industry, (2) forest to local port, (3) forest to local and interinsular demand points, (4) local industry to local port, (5) local industry to local demand point, (6) port to local demand point, (7) port to interinsular demand point, and (8) port to foreign demand point. The following is a brief discussion of each link.

Forest to Local Industry

Given the transportation costs and their possible changes, and the policy that 60 percent of all logs harvested would be allocated for domestic processing, and total log out-turn (AAC) would be increased until its peak (100 percent of planned cut) and then dropped to 80 percent and under different industrial capacity assumptions, Table B24 presents data on optimal volumes of logs (saw logs, plywood-veneer logs, chip-board logs, and pulp-paper logs) which should be transported from logging point (forest) to industry point (mill location) under different alternatives considered.

The results show pulp-paper logs are uneconomical to be transported from logging point to local pulp-paper industry under current costs structures plus other above-mentioned criteria by the Inhutani-Savoda Joint Venture company. However, further development of this transportation link would depend on the mode of transport used. It may be unrealistic since, in this case study, the water (rafting) and land (trucking) transportation modes have been assumed by averaging their costs data, although rafting and barging modes have lower costs structure than the trucking transportation mode.

The largest procurements would occur under alternative 4 for all logs at all HPH-industrial companies but the ITCI, the Chipdeco/Karyasa Kencana and Inhutani-Savoda Joint Venture would have their highest supply from forest to local industry under alternative strategy 3. The ITCI company would have a non-optimal transport link under alternative 5 for plywood-veneer logs, and a very low volume of only 6,740 cu.m per year of plywood-veneer logs would be transported to mill site under alternative 4.

Forest to Local Port

Table B25 shows data on optimal volumes of logs and residue-fuelwood which would be transported from forest areas or logging points to local ports for further transshipment to different final destination or importing demand points of forest products under different alternative strategies. This transportation link has been incorporated with the policy of 40 percent export portion for all logs as has been mentioned in the earlier sections and chapters which becomes part of other alternative strategies considered in the model.

All HPH-industrial companies but the Sumber Mas I and the Inhutani-Savoda Joint Venture would have optimal transport links for plywood-veneer logs transportation under alternative 5 and the ITCI's under alternatives 4 and 5. Based on the study data, it appears that all companies have been transporting their saw logs and residue-fuelwood from forests to ports or shipping sites under conditions that are not cost effective, regardless of the alternative considered. The pulp-paper logs transports of the Inhutani-Savoda Joint Venture is efficient only under alternatives 2 and 5.

Further observation would be required to take a look at different transportation modes used for this particular transport link by differentiating water and land transports in order to achieve a realistic transport cost structure.

Forest to Local and Interinsular Demand

Tables B26 to B30 supply data regarding optimal transportation patterns of forest products (saw logs, plywood-veneer logs and residue fuelwood) directly from logging areas to local and interinsular demand points under different alternative strategies assuming perahu (sail ships), rafting, and barges or industrial carrier transport modes at an aggregate level for domestic supply.

All companies would be involved in inefficient transport business of this particular link under alternatives 4 and 5 if transport costs increased by 25 percent relative to current costs structures. Inefficiency also occurs under alternatives 1, 2, and 3 for the transport of saw logs and plywood-veneer logs from East Kalimantan to Surabaya/East Java which was assumed to be the only region receiving logs. Residue-fuelwood products from logging areas can be shipped optimally under alternatives 1 to 3 to Surabaya, and Semarang/Central Java, which can be allocated from Sumber Mas I, Inhutani I and Meranti Sakti Indonesia HPH-company forest areas, and for Balikpapan under alternative 3 from Inne Dong Hwa logging points. The Kayan River Indonesia, the ITCI and the Inhutani-Savoda Joint Venture could not economically transport residue-fuelwood products to DKI-Jakarta demand region, regardless of the alternatives considered.

Local Industry to Local Port

Table B31 shows optimal transportation patterns of industrial processed wood products (sawnwood, plywood and veneer, chip-board and pulp-paper products) and industrial residue-fuelwood products from local industry to local port in East Kalimantan under five different alternative strategies considered.

The results indicate industrial residue-fuelwood products can not be efficiently transported under the current costs structure from all HPH-industry saw mill locations to three different port or shipping sites (Samarinda, Balikpapan and Tarakan/Nunukan), regardless of the alternatives considered, except from the ITCI saw mill industry location to its shipping sites in Balikpapan port point under alternatives 1, 2, and 3. The ITCI company becomes inefficient in the procurement of its plywood-veneer products to shipping sites under alternative 5 when transport costs increased by 25 percent. Pulp-paper products movements along this transport link by the Inhutani-Savoda Joint Venture company's pulp-paper mill to its shipping sites in Tarakan/Nunukan port location would be uneconomical under the current assumed cost structures.

Local Industry to Local Demand

Tables B32 to B36 indicate optimal transportation patterns of industrial-processed products (sawnwood, plywood and veneer) and industrial residue-fuelwood products from local industry to local demand points (Samarinda and Balikpapan) under five different alternative strategies.

The results show non-optimal transport activities along this particular link to transport sawnwood and plywood-veneer products from all saw mill and plywood-veneer mill industrial locations observed in this case study. As far as residue-fuelwood transport activities are concerned, the Inhutani I has a strong capability to achieve this transport link efficiently to supply Samarinda demand region under five different alternatives assumed. The Inne Dong Hwa company would be efficient only under alternative 2 to transport 6,150 cu.m of residue-fuelwood products per year to Balikpapan demand region.

Port to Local Demand

Table B37 explains optimal shipping patterns of chip-board and pulp-paper products from Tarakan/Nunukan port to Samarinda and Balikpapan demand points under five different alternative strategies considered, in order to meet assumed local target demands.

There would be non-optimal transport activities along this link for chip-board products to Samarinda and Balikpapan under each of five different alternatives, by assuming perahus and domestic liner-shipping systems, i.e., INSA, and industrial carrier. Pulp and paper products are economically viable only under alternatives 2, 4, and 5. These products would be inefficient to be transported under alternatives 1 and 2. This is because the demands are very low to be met by the current transport costs structure assumed in the case study.

Port to Interinsular Demand

Tables B38 to B42 give data on optimal shipping patterns of forest products from local ports in East Kalimantan. Samarinda, Balikpapan, and Tarakan/Nunukan to 6 interinsular demand points (Surabaya/East Java, Semarang/Central Java, DKI-Jakarta Raya, South Sulawesi, Central Sulawesi, and Cirebon/West Java) under five different alternative strategies considered.

Under the current shipping costs structure (assuming perahu, industrial carrier, barges, and INSA Liner Systems) saw logs would be economically viable to be transported only from Balkipapan port to Surabaya/East Java demand point in the amount of 72-120 thousand cu.m per year under five different alternative strategies, but not efficient to be transported from Samarinda and Tarakan/Nunukan ports. Plywood-veneer logs would be met only by Tarakan/Nunukan port points to be transported to Surabaya/East Java region under alternatives 4 and 5 in the amount of some 90 thousand and 150 thousand cu.m per year, respectively, when the demand goes up to 10 and 50 percent, respectively, relative to the initial demand level regardless of the increase in transport costs by 25 percent relative to the current costs structure. Sawnwood products would be economical to be transported to Semarang/ Central Java in the amount of 10 to 15 thousand cu.m per year from Samarinda port location under each of five different alternative strategies. Pulp and paper products are economically viable to be transported from Tarakan/Nunukan port sites to Surabaya/East Java, Semarang/ West Java, DKI-Jakarta, and Cirebon/West Java, respectively in the amount of 5,200 m. ton, 9,000 m. ton, 18,000 m. ton and 10,800 m. ton per year in order to meet the assumed demands, under alternatives 4 and 5 when the growth rates of demand are higher than that of the interinsular transport costs. Residue-fuelwood products are economical to be transported from Balikpapan and Tarakan/Nunukan ports only to DKI-Jakarta, Central Sulawesi, and Cirebon/West Java under alternatives 1, 2, and 3, respectively, in the amount of 4,800-5,760 cu.m, 1,200-1,400 cu.m, and 9,600-11,520 cu.m per year. For other products and from Samarinda ports, the current transport costs structure resulted in non-efficient shipping activities.

Port to Foreign Demand

Tables B43 to B47 show data on optimal shipping patterns of forest products from local ports (Samarinda, Balikpapan and Tarakan/Nunukan) to foreign or export demand countries under five different alternative strategies assumed.

Under each of the five different alternatives, saw logs would be efficient to ship only from port Balikpapan, respectively, to Singapore (in the amount of 11,700-19,500 cu.m per year), Japan (90,000-150,000 cu.m per year, Hongkong (9,000-15,000 cu.m per year), South Korea (65,000-127,500 cu.m per year), Taiwan (81,000-135,000 cu.m per year) the U.K. (4,500-7,500 cu.m per year), the Netherlands (3,600-6,000 cu.m per year), West Germany (2,700-4,500 cu.m per year), Italy (10,800-18,000 cu.m per year), and Australia (2,700-4,500 cu.m per year). Plywood-veneer logs show an efficient shipment under the current cost structure from port Tarakan/Nunukan to Singapore (by some 23,400-39,000 cu.m per year) and Japan (135,000-225,000 cu.m per year).

The industrial-processed products like sawnwood would be financially viable to ship from Balikpapan port as well as Samarinda and Tarakan/Nunukan. For example, to Hongkong from Balikpapan and Samarinda ports, to Saudi Arabia/Middle East from Balikpapan, respectively, in the amount of 4,000-7,500 cu.m per year (alternatives 1-5), 24,640-58,250 cu.m per year (alternatives 1-4), and 5,400-7,200 cu.m per year. Plywood and veneer products would be efficient to ship from Samarinda port to Taiwan under alternatives 1-5 (in the amount of 22,500-37,500 cu.m per year). It is also worth economically to ship it from Samarinda to Hongkong under alternatives 1 and 2, respectively in the amount of 37,800 cu.m and 61,900 cu.m per year; Samarinda to the U.K. under all alternatives but the largest volume would be under alternative 3 by some 26,600 cu.m per year when its demand increased by 20 percent assuming no increases in shipping (transportation) costs. Canada would receive plywood-veneer products in the amount of 28,600-34,940 cu.m per year under alternatives 1-4, but this transport link would become inefficient under alternative 5. Plywood-veneer products transport activities from Samarinda and Balikpapan to the west coast of the U.S.A. and some other European demand points show an inefficient pattern under each of the alternatives considered. This is true, since most of the shipments to the U.S.A. destination from East Kalimantan are transshipped through Koahshiung (Taiwan), and European demands through Singapore. For further detailed information regarding other forest products shipments activities along this particular transport link see Tables B43 to B47 in Appendix B.

Guidelines to East Kalimantan Regional Economic Development

The exploratory analysis of the case study in East Kalimantan of the INDO FOM provides, in spite of its very preliminary and theoretical nature, offers certain guides to the continuation of the study as well as some important suggestions have been developed.

The INDO FOM applications to East Kalimantan forest-based economic development to guide timber supply alternative analysis should be advanced further by incorporating all possible units of HPH-industrial company development and business activities in order to facilitate best planning efforts, control functions and policy guidance of the government and maximum utilization and best investment possibilities of a concession holder in a manner which would optimize the use of forest-based resources as required by the society, i.e., Forestry Agreement.

The results of this case study have assisted in giving general suggestions or guidelines to East Kalimantan regional economic development including (1) resource development, (2) industry development, (3) port development, (4) market development and (5) transportation link development, stated briefly as the following.

Resource Development

The potential maximum sustained yield log out-turn, specified on exportable and domestic market species, as well as commercial and "lesser known" species, should be investigated for all HPH-industrial companies in East Kalimantan by intensive marketing research and extensive marketing diversification policy both by government and private agencies under the continuing support from HPH-industrial companies.

Industrial Development

Current capacity expansion policy of the government as required by the well-known 1979 timber supply legislation should be viewed carefully before implemented, particularly since most of the HPH-company industries observed in this case study showed a total stagnation of capacity development under assumed criteria. However, this does not necessarily mean capacity development would not be advanced, because the real demands of local, interinsular and export importing regions and countries are, in fact, beyond those analyzed in this case study. The point is that "mushrooming" industrial development would be best viewed under variable economic and financial criteria planning requirements, as well as environmental goals criteria in order to achieve regional and national economic goals, including transport facilities and links, port facilities and capacities.

Port Development

The cost of goods handling, storage and handling facilities, goods-handling limitations and expansion plans and possibilities should be investigated for all ports in East Kalimantan, particularly at three main ports, respectively, Samarinda, Balikpapan and Tarakan. However, Balikpapan may be considered the largest port which would be given the first expansion priority.

The increase in forest products handling in the ports should be viewed in the context of the increase in trade in general. Logs and industrial processed products as well as residue-fuelwood products are relatively low value products, bulky to handle and requiring comparatively large storage areas. These characteristics will give forest products a low priority rating in shipping and the handling capacity of the major ports in East Kalimantan may pose a problem which need special attention.

It has to be pointed out, when considering the implications on port capacity development in INDO FOM which have been derived, that forest product shipments alone has been optimized, disregarding all other goods movements or agglomeration effects. Further studies should be carried out in the context of port development for total shipping, including the possibilities of carrying return freight which would have great impact on the shipping economy, particularly forest-based economy in East Kalimantan.

Market Development

In the case of high internal requirement the full domestic supply (60 percent out of total logs out-turn) together with export (40 percent of it) as have been required by the 1979 legislation, would approach the limits of the resource potential in East Kalimantan. When this happens and under the price and cost assumptions used in the case study analysis, export would be favoured before domestic requirements. The short supply on the domestic as well as foreign markets would need further studies and analysis by incorporating complete East Kalimantan forest-based industrial units as mentioned earlier.

Transportation Link Development

In order to minimize cost of local, interinsular and foreign supplies of forest products the transportation links studied in this case study would be necessary to be viewed, researched and developed further in order to achieve optimal transportation patterns of the East Kalimantan forest-based economy as well as its general regional economy. However, all transportation rates used in the analysis should be scrutinized. Efforts should be made to obtain real cost of transport for each type of transportation mode used in forest-products movements along different transport links rather than averaged, recommended or quoted cost and prices in order to achieve real and reliable policy recommendation to the regional economy development alternatives. For example, a special study should be made into dry cargo movements in local, interinsular and export shipping and the trend in volume shipped along specific links or routes.

CHAPTER VI

SUMMARY AND CONCLUSIONS

Indonesia has important tropical forestry resources to meet domestic as well as world demands for forest products, but the management of forests and development of timber-based economic activities is uncertain. Efforts to meet the national long-term timber-based economic goals call for responsible efforts that include planning, development and utilization of forest resources in such a way as to make optimal use of all the resources available. Basic policy of the Second and Third Five-Year National Development Plans call for the increase of the market value of produce from Indonesia. Emphasis was placed on local processing and industry expansion as reflected by the Timber Supply Legislation of 1979. An optimization model as a planning technique, was developed, evaluated, and implemented under the name INDO FOM (Indonesian Forestry Optimization Model). The area selected in which to exercise and apply the model was East Kalimantan, which is one of the major forest-based industrial provinces in Indonesia. The INDO FOM formulation is based on a Forestry Sector Planning Model for Indonesia developed by Dr. J. Buongiorno in 1980. The input-output coefficients of the LP matrix were modified for this study. Other modification includes industry capacity goal and log and fuelwood output constraints I-O coefficients. Identifications of forest product type, source qrid point of a product, destination point, and location or region where those points are located, are considered and formulated specifically.

Structure of INDO FOM

INDO FOM is an economic model for evaluating development alternatives of forest-based economies in Indonesia. As a linear programming model, it was designed to identify the most efficient pattern of supplying forest products, including logs, industrial-processed products and residue-fuelwood to meet domestic (local and interinsular) and foreign (export) markets. The objective function is to minimize total costs of transport, costs of industrial and port capacity expansion, and the penalty costs of not meeting local, interinsular and export demand for forest products. Demand in this case is an exogenous variable. There are three goals incorporated in INDO FOM to be fulfilled: industrial capacity development, port capacity development, and market development.

Further developments of INDO FOM may incorporate other goals, including environmental goal, forest plantation goal, port agglomeration goal, and other related forestry economic development goals.

Potential Role of INDO FOM

There are three major potential roles and applications of INDO FOM to forestry in Indonesia: (1) as a training tool, for example, in forest resource economics, regional economics, resource development, and marketing and transportation administration; (2) as a source of quantitative information in identifying areas of research and development; and (3) as a computer-based economic planning tool to aid the forestry planning process in a manner which, as far as possible, makes efficient use of production and forest resources.

The major roles and applications mentioned demands a huge data collecting effort which is realistic and reliable. It should include resource data, industry data, port data, market data, and transportation costs data.

Review and further development of the constraining decision variables and model assumptions would be necessary if INDO FOM is to play a role in Indonesian Forestry.

Limitations of INDO FOM

The current formulation of INDO FOM neglected areas such as, forest plantations, port agglomeration, and environmental consideration. In order to overcome these weaknesses, forest planting activities could be incorporated in the further development of INDO FOM, hybrid models like simulation-optimization can be applied. One or more constraints for port location and their capacity development objectives may be added to accomodate the agglomeration effects of the ports. Environmental goals may be explored by a simulation-optimization or gaming-optimization model in the future.

Alternatives Analyzed

Five development alternatives considered in the case study are:

- Alternative 1 -- Total log out-turn would be 50% of planned AAC (Annual Allowable Cut). Logs for export would be limited to 40% of production; 60% of the total would be processed locally. Industry capacity, operating at one shift per day, would be 20-50% of target allowable capacity. No change is visualized in port capacity for transshipment of logs, processed products and fuelwood. No change is visualized in product demand or transportation costs.

- Alternative 2 -- Total log out-turn would be 70% of planned AAC. The proportions of logs for export and local processing would remain as in Alternative 1. Industry capacity, operating at 1.75 production shifts per day, would be 25-75% of target allowable capacity. Port capacity for transshipment of logs remains unchanged, but capacity for processed products and fuelwood would be increased 40%. Demand for forest products would be increased 2.5% relative to the initial demand structure. No change is visualized in transportation costs.

- Alternative 3 -- Total log out-turn would be 90% of planned AAC. The proportions of logs for export and local processing would remain as in Alternative 1. Industry capacity, operating at 1.75 shifts per day, would be 60-95% of target allowable capacity. Port capacity for processed products and fuelwood transshipment would be increased to 50% of target capacity. Demand for forest products would be increased 20%. Transportation cost structure would remain unchanged.

- Alternative 4 -- Log out-turn would equal 100% of planned AAC. The proportions of logs for export and domestic processing would remain as in Alternative 1. Industry capacity, operating at 2.25 shifts per day, would be 80-100% of target capacity. Port capacity for processed products and fuelwood transshipment would be increased to 65% of target capacity. Demand for forest products would be decreased 10% relative to the initial demand. Transportation costs would be increased 25% relative to the initial cost structure.

- Alternative 5 -- AAC lowered 20% from that of Alternative 4. The proportion of logs for export and domestic processing would remain as in Alternative 1. Industry capacity, operating at 2.25 shifts per day would reach 100% of target capacity. Port capacity for processed products and fuelwood transshipment would be increased to 100% of target capacity. Demand for forest products would be increased 50%. Transportation costs would remain as in Alternative 4.

Additional alternatives need to be considered which will expand the range of contraction of industrial and port capacities in future studies.

The alternatives may be considered to be representing extremes within theoretically possible limits -- lowest and highest domestic and export requirements, zero initial port and industry versus total existing port and industry, one shift operation compared to 2.25 shift, etc.

Regional Economic Development

In order to exercise planning ability and to recognize use and potential roles as well as limitations of INDO FOM to a user, I applied INDO FOM to East Kalimantan Forestry Economic region as a case study by observing ten HPH-industrial companies actively involved in utilization of forest-based resources. Each of the following -- Georgia Pacific Indonesia/Kalimanis, Sumber Mas I, Inhutani I, Meranti Sakti Indah, Kayan River Indonesia, all located in Samarinda -- operate one sawmill and one plywood and veneer mill. The International Timber Corporation Indonesia (ITCI), the Balikpapan Forest Industries (BFI), and the Inne Dong Hwa operate individual saw mills. Additionally, ITCI operates a plywood and veneer mill. The Chipdeco/Karyasa Kencana Company and Inhutani-Savoda Joint Venture are located in Tarakan/Nunukan region. The former operates a chip-board mill, and the latter has a pulp and paper mill under construction. Three ports were considered in the analysis; two local demand regions, six interinsular demand points, and 16 foreign demand points. Eight transportation links (patterns) are incorporated in the analysis.

The case study indicates the following results, in the area of regional economic development--resource development, industrial development, port development, market development, and transportation link or route development.

Resource Development

It was assumed that each of the 10 companies considered would be able to allocate their forest resources in such a way as to meet the domestic (local and interinsular) and foreign (export) demands for forest and forest-based products from East Kalimantan.

The analysis indicates, there are large surpluses of wood usable for fuel or sawlogging residue under any of the five production alternatives considered. The largest surpluses occur in the ITCI and the BFI concession areas. Given the planned Annual Allowable Cut (AAC), log surpluses occurred only in the ITCI, in the amount of only 72.18 thousand cu.m per year of sawlogs under alternative strategy 4. These surpluses would be sufficient to supply the deficit demand points (local, interinsular or foreign) but under the assumed cost structure these solutions would be uneconomical. In terms of economic viabilities, the alternatives 1 to 4 may be considered as worthwhile since they could force total logging cost reduction by some Rp 17,000 to Rp 38,000 per additional 1000 cu.m per year relative to the current cost structure assumptions.

The potential maximum sustained yield log output, specified on exportable and domestic market species, as well as commercial and "lesser known" species, should be investigated for all HPH-industrial companies in East Kalimantan by an intensive marketing research and extensive marketing diversification policy both by government and private agencies under the continuing supports from HPH-industrial companies.

Industrial Development

Under the current industrial capacity development assumptions and cost structures analyzed in the study, all of the mills should not consider expanding capacity with the exception of ITCI under alternative strategy 1.

The indication that 9 mills should only maintain or construct industrial capacity indicates that the current absorption of industrial-processed products from East Kalimantan in the market (domestic as well as foreign) is still low. The current policy of government in urging expansion of capacity should be reviewed carefully before it is implemented. Of the five alternative strategies considered, the alternative strategy 1 is most preferable for industrial development since it provides for a slight contraction of industrial capacity.

Port Development

The three ports analyzed are: Samarinda, Balikpapan and Tarakan/Nunukan, under five different alternative criteria. Out of the three ports, the Tarakan/Nunukan port should be slightly expanded under alternative strategy 5. The expansion would be 1.9 percent of additional capacity relative to the initial assumed capacity. That expansion would be in terms of number of port production shift and port handling facilities, in order to handle wood products transshipments, if the demand would rise 50 percent.

However, regardless of all five alternative criteria assumed, Balikpapan may be considered the largest port which would be given the first expansion priority as a handling and transshipment point for East Kalimantan. The increase of forest products handling at ports should be viewed in the context of the increase of trade in general in order to take account of all other goods movements of agglomeration effects of a port economy.

Further studies of total shipping should be carried out in the context of port development, including the possibilities of carrying return freight which would give great impact on the shipping economy of East Kalimantan.

Market Development

Market development includes the analysis of supply alternatives to meet domestic demand (local and interinsular supply shortages) and foreign demand (export supply shortages).

Local Supply Shortage

Two main local demand points (region) analyzed are: Samarinda and Balikpapan. It would be economical to supply all of the total residue-fuelwood requirements of Samarinda under five different alternatives considered. However, it would be economical to supply only 40 percent in Balikpapan, which is viable only under alternatives 2 and 3. Import of pulp and paper products is not viable under alternatives 3, 4, and 5 at the assumed C.I.F. prices. Other industrial process products (sawnwood, plywood-veneer, and chip-board) supply would fall short of requirements regardless of the five alternatives considered.

Interinsular Supply Shortage

The six main interinsular demand points which have been assumed and incorporated in the analysis are: Surabaya/East Java, Semarang/Central

Java, DKI-Jakarta Raya, South Sulawesi, Central Sulawesi, and Cirebon/ West Java. Surabaya/East Java was the only region which imports logs from East Kalimantan.

Under each alternative considered, the sawlog supply would fulfill requirements in Surabaya under the assumed demand structure. Plywood-veneer log supply would be fulfilled only under alternatives 4 and 5, but would fall short of requirements under alternatives 1, 2, and 3.

The largest shortages for industrial-processed products would occur in Surabaya/East Java and DKI-Jakarta Raya, followed by the other demand regions. Given the assumed import prices (penalty cost, C.I.F.) ranging from Rp 60,000 to Rp 95,000 per unit of industrial-processed products mentioned, it would be economical for these regions to import those products either from other HPH-industries in East Kalimantan or from other regions in Indonesia or from foreign countries, regardless of alternative considered.

The largest shortages for residue-fuelwood would occur in Semarang/ Central Java, Surabaya/East Java and Cirebon/West Java. It is not financially viable to ship most of the fuelwood supply to meet the interinsular requirements particularly under alternatives 4 and 5, when the transportation costs would increase at 25 percent relative to the initial assumed costs structure.

Foreign Supply Shortage

Sixteen foreign or export demand points assumed and analyzed in the study are: Singapore, Japan, Hongkong, South Korea, Taiwan, the U.S.A., Thailand, Malaysia, Saudi Arabia/Middle East, the U.K., the Netherlands, West Germany, Italy, Denmark, Australia and Canada.

The demand for all forest products from East Kalimantan, except sawlogs, for foreign countries' demand points are not always met under various alternative strategies assumed in the study. Plywood-veneer log demand would be met only under alternative 4. The largest shortages for plywood-veneer logs would occur in Japan and Taiwan, particularly under alternatives 1, 2, and 3.

Sawnwood and plywood-veneer products would fall short of requirements mostly in the assumed demand points of the U.S.A., the Netherlands, Italy, West Germany, Saudi Arabia/Middle East, the U.K., and Canada.

The limits of the resouce potential of the observed HPH-companies concession areas in East Kalimantan would be approached if a high internal requirement of full domestic supply (60 percent out of total logs output) together with export (40 percent of it) would be applied as the consequence of the 1979 legislation regardless of the alternative criteria assumed. When this happens and under the price and cost assumptions used in the analysis, export would be favored before domestic requirements, since it has higher comparative advantages in terms of foreign exchange and market absorption opportunities. The short supply on domestic as well as foreign markets would need further studies by incorporating complete East Kalimantan forest-based HPH and non-HPH industrial units.

Transportation Link Development

Transportation link development deals with the development of the optimal transportation patterns, which would minimize transportation costs of forest products transported and/or shipped on the various transportation routes. The study analyzed 8 transportation links.

Forest to Local Industry

The largest procurement for this route would occur under alternative 4 for all logs at all HPH-industrial companies observed, but ITCI, Chipdeco/Karyasa Kencana and the Inhutani-Savoda Joint Venture would have their highest supply from forest to their local mills under alternative 3. In this link, the 60 percent of domestic supply of logs has been assumed, as required by the 1979 timber supply legislation.

Forest to Local Port

This transportation link incorporates the 40 percent of domestic log supplies as required by law. The Sumber Mas I and the Inhutani-Savoda Joint Venture would have financially viable transport for this link of their plywood-veneer log transportation under alternative 5 and ITCI would have it under alternatives 4 and 5.

Forest to Local and Interinsular Demand

All companies observed would be involved in uneconomical transport for this particular link under alternatives 4 and 5, that is, if transportation costs would increase by 25 percent relative to the current cost structures. Inefficiency would also occur under alternatives 1, 2, and 3 for the transportation of sawlogs and plywood-veneer logs from East Kalimantan to Surabaya/East Java which was assumed to be the only region which would receive logs.

Local Industry to Local Port

This link involves transportation of industrial-processed products and industrial residue-fuelwood products. Under the current assumed cost structure, ITCI would be the most economically viable company in the transportation of its products to local ports or shipping sites in Balikpapan under alternative criteria 1, 2, and 3, but not under alternatives 4 and 5.

Local Industry to Local Demand

Under each alternative strategy considered, it would be uneconomical to transport sawnwood and plywood-veneer products from all mill locations along this particular route. However, the Inne Dong Hwa company could economically transport 6,150 cu.m of residue-fuelwood products per year to the Balikpapan demand region under alternative 2.

Port to Local Demand

It would not be financially viable to transport chip-board products with sail ships or domestic liners to Samarinda and Balikpapan demand points under five different alternative criteria. Pulp and paper products could be shipped economically only under alternatives 3, 4, and 5, that is, when the demands are high.

Port to Interinsular Demand

Under current shipping cost structure (assuming perahu, industrial carrier, barges, and the INSA Liner Systems), sawlogs could be transported economically from Balikpapan port to Surabaya/East Java. It would be uneconomical to ship directly from forest point to demand point in Surabaya/East Java as was mentioned before. This transportation route would also be economical for shipping plywood-veneer logs from Tarakan/Nunukan port to Surabaya/East Java. Other possible shipments which would meet minimum costs requirements are: sawnwood products from Samarinda port to Semarang/Central Java under each of five alternative assumptions; pulp-paper products from Tarakan/Nunukan port to Surabaya/East Java, Semarang/Central Java, DKI-Jakarta Raya, and Cirebon/West Java. The latter shipments would be possible under alternatives 4 and 5 when the growth rates of demands are higher than that of the interinsular transportation cost increases.

Port to Foreign Demand

Under each of the five different alternative strategies considered, sawlogs would meet cost minimization criteria only from port Balikpapan to Singapore, Japan, Hongkong, South Korea, Taiwan, the U.K., the Netherlands, West Germany, Italy and Australia, respectively. Plywood-veneer logs shipments show the same opportunity under current cost structure assumptions from Tarakan/Nunukan port to Singapore and Japan.

Industrial processed products, including sawnwood and plywood-veneer products, could be shipped economically from Balikpapan port as well as Samarinda and Tarakan/Nunukan ports to Hongkong, Saudi Arabia/ Middle East and other importing foreign countries analyzed in the study, regardless of alternative considered. Except for the U.S.A. and some European importing countries, transport activities along this particular link show an inefficient pattern. This is because most of the shipments to the U.S.A. destination from East Kalimantan are transshipped through Koahshiung (Taiwan), and to the European demand points through Singapore, which are, in fact, economical.

In order to minimize costs of local, interinsular and foreign supplies of the East Kalimantan forest-based products, the transportation links analyzed in this study need to be researched and developed further in order to achieve optimal transportation patterns of the East Kalimantan regional economy. Efforts should be made to obtain real cost of transport for each type of transportation mode used in forest-based products movements along different transportation links rather than averaged, recommended or quoted costs or prices.

As has been demonstrated in this case study, the INDO FOM, as a computer-based planning model applied to regional economic development of East Kalimantan Forestry, offers the best approach because of its ability to analyze massive amounts of information in a fast, reliable way. It will also expedite the process of bringing the forest-based economy of East Kalimantan as well as Indonesia in general under improved planning systems, including timber resource supply management and its development, industrial development, port and market developments, and transportation economic development in an integrated way.

Conclusions

The future role of INDO FOM and its effectiveness depends on the amount of investment that the Directorate General of Forestry of the Government of Indonesia is willing to put into its development. However, INDO FOM, at this stage, has been designed with major attention to answer limited timber supply development alternatives, but it has the basic structure and format to develop into an operational model to guide forestry decision makers.

A user of INDO FOM would be assumed to have little previous knowledge of mathematical programming and computing, although some familiarity with these two disciplines would be necessary to modify the model in a major way in order to fulfill the refinements as suggested above, and previously noted in Chapter IV.

There were two purposes of the study mentioned in Chapter I. Chapters II, III and IV have met the first purpose and Chapter V has fulfilled the second specific purpose. In combination all the chapters have met the general purpose of this study in such a way as to design a plan to meet the long-term national forest-based economic goals of Indonesia. However, further investigation by future forestry economists will be necessary to achieve fruitfull development plan for optimal use of Indonesia's forest resources.

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APPENDICES

APPENDIX A

INPUT DATA FOR AN EXAMPLE OF AN APPLICATION OF THE INDONESIAN FORESTRY OPTIMIZATION MODEL (INDO FOM) TO EAST KALIMANTAN

RESOURCE DATA

TABLE A3. Log Out-turn (Annual Allowable Cut) and Logging Residue (Fuelwood Output) Potentials for Each Forest Point (in thousand cu.m Per Year as of the Year 1978/81),[1] East Kalimantan.

		Saw Logs		Saw Logging Residues		Plywood-Veneer Logs		Plywood-Veneer Logging Residues		Chip-Board Logs	
Forest Point[2]	Concessionaire Name	Actual Cut	Max. AAC	Min. Output	Max. Output	Actual Cut	Max. AAC	Min. Output	Max. Output	Actual Cut	Max. AAC
1	Georgia Pacific Indonesia/ Kalimanis	53	100	21	40	211	400	84	160	--	--
2	Sumber Mas I	35	40	14	16	79	92	32	36	--	--
3	Inhutani I	34	38	14	15	9	57	4	23	--	--
4	Meranti Sakti Indah	18	24	7	10	72	84	29	30	--	--
5	Kayan River Indonesia	27	48	11	19	63	112	25	45	--	--
6	International Timber Corp. Indonesia (ITCI)	341	450	136	180	85	450	34	180	--	--
7	Balikpapan Forest Industries (BFI)	114	500	45	200	--	--	--	--	--	--
8	Inne Dong Hwa	43	260	17	104	--	--	--	--	--	--
9	Chipdeco[5]	--	--	--	--	--	--	--	--	55	126
10	Inhutani-Savoda Joint Ventures[3]	--	92	--	37	--	110	--	44	--	--

TABLE A3 (cont'd.).

Forest Point[2]	Concessionaire Name	Chip-Board Logging Residues		Pulpwood Logs		Pulpwood Logging Residues		Total Logs		Total Residues[4]	
		Min. Output	Max. Output	Min. Outturn	Max. Outturn	Min. Output	Max. Output	Actual Cut	Max. AAC	Min. Output	Max. Output
1	Georgia Pacific Indonesia/ Kalimanis	--	--	--	--	--	--	264	500	105	200
2	Sumber Mas I	--	--	--	--	--	--	114	132	46	52
3	Inhutani I	--	--	--	--	--	--	43	95	18	38
4	Meranti Sakti Indah	--	--	--	--	--	--	90	108	36	43
5	Kayan River Indonesia	--	--	--	--	--	--	90	160	36	64
6	International Timber Corp. Indonesia (ITCI)	--	--	--	--	--	--	426	900	170	360
7	Balikpapan Forest Industries (BFI)	--	--	--	--	--	--	114	500	45	200
8	Inne Dong Hwa	--	--	--	--	--	--	43	260	17	104
9	Chipdeco[5]	22	50	--	--	--	--	55	126	22	50
10	Inhutani-Savoda Joint Ventures[3]	--	--	--	166	--	66	--	368	--	147

[1]Actual cut or real production and maximum Annual Allowable Cut (AAC) figures for forest points 1 to 9 were based on the following documents, respectively (in Indonesian Language): East Kalimantan Provincial Forest Service Annual Report of the Year 1980/1981, prepared for National Forestry Workshop 1981 (Samarinda: East Kalimantan Provincial Forest Service, March, 1981), and East Kalimantan Provincial Forestry Long-Range Planning 1981-2000, Draft I (Banjarbaru: Regional III Forestry Planning Bureau, Report No. 03/RKPD/BPK III, (cont'd.).

TABLE A3 footnotes (cont'd.).

January, 1981). Figures for forest point 10 (Inhutani-Savoda Joint Ventures) were based on The Annual Report 1980 of the Inhutani I, Inc. (Jakarta: Board of Directors, May, 1981).

[2]Forest point means forest area under the concession of the respective concessionaire name.

[3]Inhutani-Savoda Joint Ventures would be starting its production in 1982 with logging activities for export and domestic demands.

[4]Residues outturn as fuelwood energy sources were estimated as 40 percent from the log outturn, e.g., 0.40 x Actual Cut (or min. outturn) = 0.40 x 264000 = 105000 cu.m, the same estimates were assumed for max. AAC (or max. log outturn).

[5]Actually, Chipdeco is owned by PT Karyasa Kencana, and deals specifically with chip and board products industry.

INDUSTRY DATA

TABLE A4. Industry Capacity (in thousand cu.m Intake Capacity Per Year) for Each Industry Point as of the Year 1978/1981,[1] East Kalimantan.

Industry Point[2]	Company Name	Saw Mill		Plywood Wood Veneer Mill		Chip-Board Mill		Pulp-Paper Mill		Total Industry	
		Actual Cap.[3]	Max. Cap.	Actual Cap.	Max. Cap.	Actual Cap.	Max. Cap.	Actual Cap.	Max. Cap.	Actual Cap.	Max. Cap.
11	Georgia Pacific Indonesia/ Kalimanis	20	100	90	160	--	--	--	--	110	260
12	Sumber Mas I	20	80	80	180	--	--	--	--	100	260
13	Inhutani I	48	175	30	90	--	--	--	--	78	265
14	Meranti Sakti Indah	40	100	90	150	--	--	--	--	130	250
15	Kayan River Indonesia	30	40	40	100	--	--	--	--	70	140
16	International Timber Corp. Indonesia (ITCI)	100	280	20	200	--	--	--	--	120	480
17	Balikpapan Forest Industries (BFI)	56	240	--	--	--	--	--	--	56	240
18	Inne Dong Hwa	26	120	--	--	--	--	--	--	26	120
19	Chipdeco[5]	--	--	--	--	130	190	--	--	130	190
20	Inhutani-Savoda Joint Venture[4]	--	124	--	162	--	--	--	300	--	586

[1]Sources for industry points 11 to 20 respectively are same as for actual cut and maximum AAC in Table A3 (Log out-turn and logging residue potentials). (cont'd.)

TABLE A4 footnotes (cont'd.).

[2] Industry Point means industry location under the ownership of the respective company name.

[3] Actual capacity is an average capacity where a mill has been operating (cu.m per year per shift as of the year 1978/81), and maximum capacity is a design capacity of a mill under industry operating license from the Government.

[4] Inhutani-Savoda Joint Venture would be starting its respective mills as follows: year 1983 (saw mill), 1984 (plywood-veneer mill), 1985 (pulp-paper mill).

[5] Chipdeco is under the ownership of the PT Karyasa Kencana.

Table A5. Average Recovery Rates in Processing at Industry Points as of the Year 1978/81,[1] East Kalimantan.

Logs Intake: / Product Output	Sawmill		Plywood-veneer Mill		Chip-Board Mill		Pulp-Paper Mill	
	Sawn Wood	Fuelwood Residues	Plywood-veneer	Fuelwood-Residues	Chip-Board	Fuelwood-Residues	Pulp-Paper	Fuelwood-Residues
Sawlogs	0.45[2]	0.40[2]	--	--	--	--	--	--
Plywood Veneer Logs	--	--	0.50	0.40	--	--	--	--
Chip-Board Logs	--	--	--	--	0.65	0.15	--	--
Pulp-Paper Logs	--	--	--	--	--	--	0.75	0.10
Input-Output Coefficient:								
1 Shift	2.22[3]	0.80[4]	2.0	0.72	1.54	0.22	1.33	0.13
1.75 Shift	3.89	1.4	3.5	1.26	2.69	.38	2.33	.22
2.25 Shift	5.0	1.8	4.5	1.62	3.46	.49	3.0	.28

[1]Sources for sawmill and plywood-veneer mill industries, as well as for chip-board mill and pulp-paper mill industries average recovery rates were respectively: same as for Table A3, An Indicative Analysis of Timber Supply Alternatives in Indonesia. (Bogor: Forestry and Forest Products Development Project of the F.A.O., FO:INS/73/012, Working Paper 1, Nov., 1978), L. Waring, Primary Wood Based Industries (Bogor: F.A.O. of the United Nations in cooperation with Directorate General of Forestry of the Government of Indonesia, FO: INS/78/054, Working Paper No. 11, Feb., 1981), Prospects for the Development of Pulp and Paper Industries-ASEAN, Volume 2 - A Description of Technical Inputs (Rome: U.N.D.P. and F.A.O. of the United Nations, FO: DP/INT/74/026, FO: DP/RAS/75/018, Technical Report 1, Vol. 2, 1979).

[2]Recovery rate for sawnwood (for example) is 0.45 mean that from 1 cu.m sawlogs intake to be processed in sawmilling industry, only 0.45 cu.m or 45% of the sawlogs volume is recovered. It is assumed that the rest of it can be allocated as fuelwood-residue potential, where in this case, the volume of the sawmill residue is 0.40 or 40% of the sawlog volume. The rest is wasted. (cont'd.)

Table A5 Footnotes (cont'd.).

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[3]The input-output coefficient for sawmill recovery (SAWR), for example, under 1 shift operations (SL) at the average recovery rate of 0.45 for sawnwood (RRSAW) is SAWR = SL/RRSAW = 1/0.45 = 2.22.

[4]It was assumed that 0.90 unit or 90% of sawmill industry residues (for example) can be recovered (SIR) as fuelwood manufacturing potential (see further Table A6) with a recovery rate of fuelwood-residue (RRFR) of 0.40. The input-output coefficient for fuelwood-residues manufacturing (FSAWR) under the condition of 1 shift labor production (SL) for saw log at 0.45 sawmilling recovery (RRSAW) is FSAWR = SIR x RRFR x SL/RRSAW = 0.90 x 0.40 x 1/0.45 = 0.08.

TABLE A6. Fuelwood Potential From Residues,[1] East Kalimantan.

Logging Residues	Fuelwood Manufacturing Potential	Input-Output Coefficient
Saw Logging	0.85[2]	1.18[3]
Plywood-Veneer Logging	.85	1.18
Chip-Board Logging	.85	1.18
Pulp-Paper Logging	.85	1.18
Industry Residues		
Sawmill	0.90	--
Plywood-Veneer Mill	.90	--
Chip-Board Mill	.95	--
Pulp-Paper Mill	.95	--

[1]Data based on the author's field check as of August 1981, and on assumptions made in J. Buongiorno, A Timber Supply Model for Indonesia, Model Description and Users Manual (Bogor: Forestry and Forest Products Development Project of the F.A.O. of the United Nations, FO: INS/73/012, Working Paper 2, Dec., 1978).

[2]For example, it was assumed that when the unit of fuelwood is cut from saw logging residues (FSC), 0.15 unit or 15% of raw material is lost or wasted, so residue potential left for fuelwood is only 0.85 unit or 85% (FM).

[3]The input-output coefficient for fuelwood-residue manufacturing potential which can be transported (IOFM) from saw logging residues area, for example, is IOFM = FSC/FM = 1/0.85 = 1.18.

TABLE A7. Industrial Capacity Expansion (new establishment) Cost[1] (in Rp per unit output per day operation as of the Year 1978/1981),[2] East Kalimantan.[3]

Industry Point	Company Name	Saw Mill		Plywood-Veneer Mill	Chip-Board Mill	Pulp-Paper Mill
		1.75 Shift	2.25 Shift	2.25 Shift	2.25 Shift	2.25 Shift
11	Georgia Pacific Indonesia/ Kalimanis	4500	--	2500	--	--
12	Sumber Mas I	--	2454	2550	--	--
13	Inhutani I	--	2575	2475	--	--
14	Meranti Sakti Indah	4500	--	2325	--	--
15	Kayan River Indonesia	--	2750	2350	--	--
16	International Timber Corp. Indonesia (ITCI)	--	2500	2365	--	--
17	Balikpapan Forest Industries (BFI)	4550	--	--	--	--
18	Inne Dong Hwa	4650	--	--	--	--
19	Chipdeco	--	--	--	2600	--
20	Inhutani-Savoda Joint Venture	4750	--	2600	--	2850

[1]Sources, see respective sources as in Tables A3 and A5.

[2]Actual time of shifts vary in different companies in East Kalimantan, but the predominant pattern is:
0630 hrs-1600 hrs: Morning shift (the production per shift can be nominated as 100 percent).
1600 hrs-2300 hrs: Afternoon shift (declines in productivity, usually shows an efficiency of 75 percent as compared to morning shift.
2300 hrs-0630 hrs: Night shift (a processing ability can be rated as 50 percent).
The maximum production per day then becomes respectively, 1.0 of morning shift, 1.75 of morning + afternoon shifts, and 2.25 of morning + afternoon + night shifts. In explanation, the industries in East Kalimantan (cont'd.)

Table A7 Footnotes (cont'd.).

are labor intensive and a greater degree of fatigue is often felt and shown by workers in the hours of darkness as opposed to daylight. Declining productivity in the afteroon can be caused by a degree of fatigue of workers, heat in the factory (non-air conditioned working environment) etc. See further, L. Waring (1981), _op_, _cit_., pp. 3-10.

[3]Based on the information from the Indonesian Timber Society (M.P.I.), average expansion costs respectively: 1.75 shift per day operation is Rp 4520 per cu.m output, and 2.25 shift per day operation Rp 2355 per cu.m output.

PORT DATA

TABLE A8. Existing Capacity of Port (transshipment point), in thousand cu.m of forest products transshipment as of the Year 1978/81,[1] East Kalimantan.

Port Point[2]	Port Name	Logs Transshipment[3]		Processed Products Transshipment		Residues-Fuelwood Transshipment	
		Per day Loading	Capacity Per Year[4]	Per day Loading	Capacity Per Year	Per day Loading	Capacity Per Year
21	Samarinda	0.950	1425	0.750	1125	0.100	150
22	Balikpapan	1.006	906	.830	750	.175	105
23	Tarakan/Nunukan	.635	382	.680	400	.083	50

[1] Source: G. Segerstrom, Shipping in Indonesia (Bogor: Forestry and Forest Products Development Project of F.A.O. of the United Nations, FO: INS/73/012, Working Paper 3, Dec., 1978). See also the respective sources as in Tables A3 and A5.

[2] Port Point Samarinda per day transshipment rate for logs transshipment (for example) was calculated as the average loading rate per day of 9 other loading/checking points located in Samarinda geographical area along the Mahakan River and Samarinda Bay. The same explanation is applied also for Balikpapan and Tarakan/Nunukan port points.

[3] Log transshipment including all logs (saw logs, ply-veneer logs, chip-board logs, and pulp-paper logs). Processed products transshipment including all processed products (sawnwood, plywood-veneer, chip-board, and pulp-paper). Residue-fuelwood transshipment in this study has been assumed only saw logging and saw milling industry residues.

[4] Log transshipment capacity per year was calculated as per day loading-unloading capacity x 300 effective transshipment days x number of companies using a port point facility, for example, 0.950 x 300 x 5 = 1425 thousand cu.m for logs transshipment at Port Samarinda per year.

TABLE A9. Port Capacity Expansion (New Establishment) Cost, (in Rp per cu.m of Forest Products, Transshipment of Per Day,[1] East Kalimantan.

Port Point	Port Name	Logs Transshipment			Processed Products Transshipment			Residue-Fuelwood Transshipment		
		1 Shift[2]	1.75 Shift	2.25 Shift	1 Shift	1.75 Shift	2.25 Shift	1 Shift	1.75 Shift	2.25 Shift
21	Samarinda	857 (157)[3]	300 (500)	200 (750)	2283 (125)	2144 (300)	1638 (700)	520 (25)	300 (50)	267 (75)
22	Balikpapan	1604 (106)	567 (300)	340 (500)	3875 (200)	3437 (400)	1167 (150)	1000 (15)	667 (30)	500 (60)
23	Tarakan/ Nunukan	1707 (82)	1400 (100)	700 (2667)	3500 (200)	3000 (50)	2667 (150)	950 (20)	812 (16)	714 (14)

[1]Source: Based on the author's field check information as of August 1981. See also G. Segerstrom (1978), _op. cit._, and other respective sources as in Tables A3, A5 and A8.

[2]Per day operation per shift per port facility in this model is called "a module", so there are respectively, Module 1 (loading-unloading capacity under the condition of 1 shift per day per port facility), Module 2 (loading-unloading capacity under the condition of 1.75 shift per day per port facility), Module 3 (loading-unloading capacity under the condition of 2.25 shift per day per port facility).

[3]Figures in parentheses are values in thousands of cu.m of port capacity for the respective Modules 1, 2, and 3.

MARKET DATA

TABLE A10. Estimated Demand Potential Per Year as of the Year 1978/81, Distributed by Demand Point (in thousand m. Ton for Pulp-Paper, and Thousand cu.m for Other Products),[1] East Kalimantan.

Demand Point	Name	Saw Logs	Plywood Veneer Logs	Chip Board Logs	Pulp-Paper Logs	Sawn Wood	Plywood-Veneer	Chip-Board	Pulp-Paper[2]	Residue Fuelwood
24	Surabaya/East Java	80.0	100.0	--	--	85.0	60.0	10.0	15.0	9.0
25	Singapore	13.0	26.0	8.0	5.0	50.0	70.0	5.0	10.0	2.4
26	Japan	100.0	150.0	80.0	80.0	25.0	51.0	10.0	10.0	2.4
27	Hongkong	10.0	20.0	--	--	5.0	100.0	10.0	--	1.2
28	South Korea	85.0	90.0	--	--	2.0	3.0	--	--	--
29	Taiwan	90.0	85.0	--	--	10.0	25.0	--	--	2.13
30	Semarang/Central Java	--	--	--	--	65.0	45.0	5.0	10.0	9.6
31	DKI-Jakarta Raya	--	--	--	--	70.0	65.0	10.0	20.0	4.8
32	South Sulawesi	--	--	--	--	20.0	15.0	--	--	3.6
33	Central Sulawesi	--	--	--	--	18.0	13.0	--	--	1.2
34	Samarinda	--	--	--	--	16.0	6.0	2.0	3.0	4.8
35	Balikpapan	--	--	--	--	17.0	7.0	2.0	3.0	6.0
36	U.S.A.	--	--	--	--	4.0	60.0	--	--	--
37	Thailand	--	--	--	--	12.0	--	--	10.0	--
38	Malaysia	--	--	--	--	30.0	--	--	18.0	--
39	Saudi Arabia/M. East	--	--	--	--	6.0	12.0	--	--	--
40	U.K.	5.0	--	--	--	12.0	36.0	--	--	--
41	Netherlands	4.0	--	--	--	7.0	18.0	--	--	--
42	West Germany	3.0	--	--	--	3.0	--	--	--	--
43	Italy	12.0	--	--	--	36.0	6.0	--	--	--
44	Denmark	--	5.0	--	--	--	8.0	--	--	--
45	Australia	3.0	--	--	--	2.0	--	--	--	--
46	Cirebon/West Java	--	--	--	--	18.0	18.0	10.0	12.0	9.6
47	Canada	--	--	--	--	--	36.0	--	--	--

(cont'd.)

TABLE A10 Footnotes (cont'd.)

[1] Source: Based on the author's field check information as of August 1981. Estimation based on the 1978/81 figures for local demand, interinsular demand, and export demand respectively. Logs export demands were specified based on grade or quality class, respectively P/F (Ply-veneer logs), S, T and L (Saw logs, Chip-Board logs, and Pulp-Paper logs) as of Directorate of Forestry Marketing grade and quality specification standard. All demand data are referred to the historical demand point marketing in past 4 years (1978-81) based on export figures, and domestic (interinsular, local) marketing figures. It was not based on population distribution and differences in consumption between rural and urban population since the study was involved only with several companies of East Kalimantan Region for the convenience of testing the model as a sample case. Some data were based on sources in Tables A3, A5 and A8.

[2] Some data for Chip-Board and Pulp-Paper demands were based on N. Svanqvist, Pulp and Paper in the ASEAN Region - An Analysis of Development Potential up to the Year 2000 (Uppsala, Sweden: The Swedish University of Agricultural Sciences, College of Forestry, Studia Forestalia Suecica Nr. 153, 1980).

TABLE A11. Average Market Prices for Logs, Processed Products and Fuelwood on Local, Interinsular, and International Market, as Distributed by Demand Point[1] (in Rp per m. Ton for Pulp-Paper, and Rp per cu.m for Other Products) as of the Year 1978/81,[2] East Kalimantan.

Demand Point	Name	Saw Logs	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper Logs	Sawn Wood	Plywood-Veneer	Chip-Board	Pulp-Paper	Residue-Fuelwood
24	Surabaya/East Java	30000	35000	--	--	90000	92500	93000	60000	4500
25	Singapore	75000	78000	76000	77000	164062	139045	140000	165000	6750
26	Japan	80000	81250	78000	79000	165050	126925	170000	180000	6400
27	Hongkong	79000	81000	--	--	168750	180151	168000	--	--
28	South Korea	78000	79000	--	--	165000	90000	--	--	--
29	Taiwan	78125	80000	--	--	164000	205881	--	--	8500
30	Semarang/Central Java	--	--	--	--	92000	95000	92000	62000	4500
31	DKI-Jakarta Raya	--	--	--	--	91500	92000	90750	63000	5500
32	South Sulawesi	--	--	--	--	45000	89750	--	--	3500
33	Central Sulawesi	--	--	--	--	35000	88550	--	--	2500
34	Samarinda	--	--	--	--	20000	40000	48000	64000	350
35	Balikpapan	--	--	--	--	22000	42000	45000	63500	300
36	U.S.A.	--	--	--	--	166500	119465	--	--	--
37	Thailand	--	--	--	--	159675	--	--	190253	--
38	Malaysia	--	--	--	--	175000	--	--	192178	--
39	Saudi Arabia/M. East	--	--	--	--	181559	195752	--	--	--
40	U.K.	79800	--	--	--	215750	238935	--	--	--
41	Netherlands	82000	--	--	--	185750	193467	--	--	--
42	West Germany	82100	--	--	--	187500	--	--	--	--
43	Italy	79800	--	--	--	185750	190250	--	--	--
44	Denmark	--	85950	--	--	--	195250	--	--	--
45	Australia	75750	--	--	--	175650	--	--	--	--
46	Cirebon/West Java	--	--	--	--	91000	95250	89750	65500	4750
47	Canada	--	--	--	--	--	238567	--	--	--

(cont'd.)

Table A11 Footnotes (cont'd.).

[1]Source: See sources in Tables A3, A5, and A8. Some market data (F.O.B. or C.I.F.) were based on Indonesian Forestry Statistics, 1979 (Bogor/Jakarta: Directorate General of Forestry, March 1981); Statistical Yearbook of Indonesia, 1979 (Jakarta: Indonesia Central Bureau of Statistics, December, 1980). Logs specification were based on marketing grade and quality class standard (P/F, S. T. L), respectively, for Ply-Veneer Logs, Saw Logs, Chip-Board Logs, Pulp-Paper Logs.

[2]F.O.B. and C.I.F. prices were transformed from US Dollar values into Indonesian Rupiah based on the exchange rate of 1 US $ = Rp 625 for the convenience of calculation in the model.

TRANSPORTATION COST DATA

TABLE A12. Average Transport Costs of Forest Products from Forest to Local Industry (in Rp per cu.m as of the Year 1978/1981),[1] East Kalimantan.

From Forest Point	Consessionaire Name	TO: Industry Point (11,12,...,20) Saw Logs	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper[2] Logs
1	Georgia Pacific Indonesia/ Kalimanis	1535.0	1535.0	--	--
2	Sumber Mas I	1650.0	1650.0	--	--
3	Inhutani I	1550.0	1550.0	--	--
4	Meranti Sakti Indonesia	1475.0	1475.0	--	--
5	Kayan River Indonesia	1500.0	1500.0	--	--
6	International Timber Corp. Indonesia (ITCI)	1600.0	1600.0	--	--
7	Balikpapan Forest Industry (BFI)	1550.0	--	--	--
8	Inne Dong Hwa	1450.0	--	--	--
9	Chipdeco	--	--	1250.0	--
10	Inhutani-Savoda Joint Venture	1150.0	1150.0	--	1150.0

[1]Source: V. Buenaflor, Logging and Transportation (Bogor: F.A.O. of the United Nations in Cooperation with Directorate General of Forestry of the Government of Indonesia, FO: INS/78/054, Working Paper No. 10, March, 1981). Differences in figures were made for convenience in testing the model. Some data were based on Study Tours to Several Logging Companies in East, South and Central Kalimantan (Bogor: Forestry and Forest Products Development Project of the F.A.O. of the United Nations, FO: INS/78/054, Field Mission Report Logging/1, October, 1979). All costs are average costs for water and land (truck) transports.

[2]Estimated figures.

TABLE A13. Average Transport Costs of Forest Products from Forest to Local Port[1] (in Rp per cu.m as of the Year 1978/1981), East Kalimantan

From: Forest Point	Name	TO: Port Point (21,22,23)				
		Saw Logs	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper Logs[2]	Residue-Fuelwood
1	Georgia Pacific Indonesia/ Kalimanis	1635.0	1635.0	--	--	1800.0
2	Sumber Mas I	1750.0	1750.0	--	--	1850.0
3	Inhutani I	1650.0	1750.0	--	--	1700.0
4	Meranti Sakti Indonesia	1575.0	1575.0	--	--	1675.0
5	Kayan River Indonesia	1600.0	1600.0	--	--	1650.0
6	International Timber Corp. Indonesia (ITCI)	1750.0	1750.0	--	--	1800.0
7	Balikpapan Forest Industry (BFI)	1675.0	--	--	--	1300.0
8	Inne Dong Hwa	1575.0	--	--	--	1350.0
9	Chipdeco	--	--	1380.0	--	--
10	Inhutani-Savoda Joint Venture	1250.0	1250.0	--	1300.0	1250.0

[1]Source: See sources in Tables A3, A5, A8 and A12.

[2]Estimated figures.

TABLE A14. Average Transportation Costs of Forest Products from Forest Point to Demand Point (in Rp per cu.m as of the Year 1978/81),[1] East Kalimantan.

From: Forest Point	Name	Product Type	To: Demand Point Surabaya/East Java (24)	Central Java (30)	DKI-Jakarta (31)	Samarinda (34)	Balikpapan (35)
1	Georgia Pacific Indonesia/ Kalimanis	• Residue Fuelwood	4500.0	--	--	--	--
2	Sumber Mas I	• Saw Logs	7500.0	--	--	--	--
		• Plywood Veneer Logs	7500.0	--	--	--	--
		• Residue-Fuelwood	4250.0	--	--	--	--
3	Inhutani I	• Residue-Fuelwood	--	4500.0	--	--	--
4	Meranti Sakti Indonesia	• Saw Logs	7000.0	--	--	--	--
		• Plywood Veneer Logs	7200.0	--	--	--	--
		• Residue-Fuelwood	4200.0	4350.0	--	--	--
5	Kayan River Indonesia	• Residue-Fuelwood	--	--	5250.0	--	--
6	International Timber Corp. Indonesia (ITCI)	• Residue-Fuelwood	--	--	5000.0	--	350.0
7	Balikpapan Forest Industry (BFI)	• Residue-Fuelwood	--	--	--	--	450.0
8	Inne Dong Hwa	• Residue-Fuelwood	--	--	--	--	300.0

TABLE A14 (cont'd.).

From: Forest Point	Name	Product Type	To: Demand Point Surabaya/East Java (24)	Central Java (30)	DKI-Jakarta (31)	Samarinda (34)	Balikpapan (35)
9	Chipdeco	--	--	--	--	--	--
10	Inhutani-Savoda Joint Venture	● Residue-Fuelwood	--	--	5000.0	--	--

[1]Source: See sources in Tables A3, A5, A8, and A12. All figures are average figures of sail ships (perahus) and barges (industrial carriers) and cargo (liner) shipping costs.

TABLE A15. Average Transportation Costs of Forest Products from Industry Point to Port Point (in Rp per m. Ton for Pulp-Paper, and Rp per cu.m for Other Products as of the Year 1978/81),[1] East Kalimantan.

From: Industry Point	Name	TO: Port Point (21,22,23)[2]				
		Sawnwood	Plywood-Veneer	Chip-Board	Pulp-Paper[3]	Residue-Fuelwood
11	Georgia Pacific Indonesia/ Kalimanis	300.0	300.0	--	--	200.0
12	Sumber Mas I	250.0	250.0	--	--	250.0
13	Inhutani I	250.0	300.0	--	--	350.0
14	Meranti Sakti Indonesia	300.0	300.0	--	--	350.0
15	Kayan River Indonesia	275.0	275.0	--	--	300.0
16	International Timber Corp. Indonesia (ITCI)	200.0	200.0	--	--	175.0
17	Balikpapan Forest Industry (BFI)	265.0	--	--	--	275.0
18	Inne Dong Hwa	255.0	--	--	--	375.0
19	Chipdeco	--	--	345.0	--	--
20	Inhutani-Savoda Joint Venture	285.0	275.0	--	305.0	245.0

[1]Source: See sources Tables A3, A5, A8, and A12. Some of the data are based on the author's field check figures of August, 1981.

[2]Port points are respectively Samarinda (21), Balikpapan (22), Tarakan/Nunukan (23). See Tables A8 and A9.

[3]Estimated figures.

TABLE A16. Average Transportation Costs of Forest Products from Industry Point to Demand Point (in Rp per m. Ton for Pulp-Paper, and Rp per cu.m for Other Products as of the Year 1978/1981),[1] East Kalimantan.

From: Industry Point	Name	Product Type	To: Demand Point Samarinda (34)	Balikpapan (35)
11	Georgia Pacific Indonesia/ Kalimanis	• Sawnwood	500.0	--
		• Plywood-Veneer	450.0	--
		• Residue-Fuelwood	200.0	--
12	Sumber Mas I	• Sawnwood	550.0	--
		• Plywood-Veneer	455.0	--
		• Residue-Fuelwood	200.0	--
13	Inhutani I	• Sawnwood	300.0	--
		• Plywood-Veneer	250.0	--
		• Residue-Fuelwood	100.0	--
14	Meranti Sakti Indonesia	• Sawnwood	350.0	--
		• Plywood-Veneer	250.0	--
		• Residue-Fuelwood	150.0	--
15	Kayan River Indonesia	• Sawnwood	400.0	--
		• Plywood-Veneer	300.0	--
		• Residue-Fuelwood	200.0	--
16	International Timber Corp. Indonesia (ITCI)	• Sawnwood	--	600.0
		• Plywood-Veneer	--	650.0
		• Residue-Fuelwood	--	350.0
17	Balikpapan Forest Industry (BFI)	• Sawnwood	--	650.0
		• Residue-Fuelwood	--	350.0
18	Inne Dong Hwa	• Sawnwood	--	625.0
		• Residue-Fuelwood	--	300.0
19	Chipdeco	----	--	--
20	Inhutani-Savoda Joint Venture	----	--	--

[1]Source: See sources Tables A3, A5, A8, and A12. Some data are based on the author's field check as of August 1981, assuming truck and water transportation.

TABLE A17. Average Transportation (Shipping) Costs of Forest Products from Port Point to Demand Point (in Rp Per m. Ton for Pulp-Paper and Rp Per cu.m for Other Products as of the Year 1978/81,[1] East Kalimantan.

From: Port Point	Name	Product Type	To: Demand Point Surabaya/ East Java (24)	Singapore (25)	Japan (26)
21	Samarinda	• Saw Logs	8000.0	9500.0	19000.0
		• Ply-Veneer Logs	8250.0	9500.0	23750.0
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	6500.0	8600.0	8450.0
		• Plywood-Veneer	6000.0	8500.0	8300.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	4500.0	---	---
		• Residue-Fuelwood (Industry)	4500.0	6750.0	6400.0
22	Balikpapan	• Saw Logs	8000.0	9500.0	19000.0
		• Ply-Veneer Logs	8150.0	9500.0	19600.0
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	6250.0	8500.0	8350.0
		• Plywood-Veneer	6000.0	8450.0	8200.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	4250.0	---	---
		• Residue-Fuelwood (Industry)	4750.0	6500.0	6350.0
23	Tarakan/ Nunukan	• Saw Logs	8900.0	9800.0	19500.0
		• Ply-Veneer Logs	8550.0	9800.0	19500.0
		• Chip-Board Logs	---	9800.0	19500.0
		• Pulp-Paper Logs	---	9800.0	19500.0
		• Sawnwood	6850.0	8700.0	8750.0
		• Plywood-Veneer	6600.0	8650.0	8600.0
		• Chip-Board	6500.0	8550.0	8400.0
		• Pulp-Paper	6000.0	8400.0	8200.0
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---

TABLE A17 (cont'd.).

From: Port Point	Name	Product Type	To: Demand Point Hongkong (27)	Korea (28)	Taiwan (29)
21	Samarinda	• Saw Logs	12500.0	17500.0	15625.0
		• Ply-Veneer Logs	12500.0	17500.0	15625.0
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	10250.0	15500.0	13000.0
		• Plywood-Veneer	9150.0	13000.0	12000.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	8500.0
22	Balikpapan	• Saw Logs	12500.0	17250.0	15600.0
		• Ply-Veneer Logs	12500.0	17250.0	15500.0
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	10000.0	15000.0	12950.0
		• Plywood-Veneer	8750.0	12500.0	12000.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	8000.0
23	Tarakan/ Nunukan	• Saw Logs	---	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	12750.0	15750.0	13500.0
		• Ply-wood-Veneer	9500.0	13500.0	12500.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---

TABLE A17 (cont'd.).

From: Port Point	Name	Product Type	To: Demand Point Semarang/ Central Java (30)	DKI-Jakarta Raya (31)	South Sulawesi (32)
21	Samarinda	• Saw Logs	---	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	6550.0	8500.0	4950.0
		• Plywood-Veneer	6050.0	7750.0	4500.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	4550.0	5000.0	---
		• Residue-Fuelwood (Industry)	4550.0	5500.0	3500.0
22	Balikpapan	• Saw Logs	---	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	7000.0	8000.0	4850.0
		• Plywood-Veneer	6500.0	7500.0	4000.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	4500.0	4750.0	---
		• Residue-Fuelwood (Industry)	4350.0	5000.0	3750.0
23	Tarakan/ Nunukan	• Saw Logs	---	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	6850.0	8950.0	5000.0
		• Plywood-Veneer	6500.0	7850.0	4550.0
		• Chip-Board	6250.0	7000.0	4500.0
		• Pulp-Paper	6150.0	6500.0	4250.0
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---

TABLE A17 (cont'd.).

From: Port Point	Name	Product Type	To: Demand Point Central Sulawesi (33)	Samarinda (34)	Balik-papan (35)
21	Samarinda	● Saw Logs	---	---	---
		● Ply-Veneer Logs	---	---	---
		● Chip-Board Logs	---	---	---
		● Pulp-Paper Logs	---	---	---
		● Sawnwood	4000.0	---	---
		● Plywood-Veneer	3000.0	---	---
		● Chip-Board	---	---	---
		● Pulp-Paper	---	---	---
		● Residue-Fuelwood (Logging)	---	---	---
		● Residue-Fuelwood (Industry)	3500.0	---	---
22	Balikpapan	● Saw Logs	---	---	---
		● Ply-Veneer Logs	---	---	---
		● Chip-Board Logs	---	---	---
		● Pulp-Paper Logs	---	---	---
		● Sawnwood	3750.0	---	---
		● Plywood-Veneer	2750.0	---	---
		● Chip-Board	---	---	---
		● Pulp-Paper	---	---	---
		● Residue-Fuelwood (Logging)	---	---	---
		● Residue-Fuelwood (Industry)	2000.0	---	---
23	Tarakan/ Nunukan	● Saw Logs	---	---	---
		● Ply-Veneer Logs	---	---	---
		● Chip-Board Logs	---	---	---
		● Pulp-Paper Logs	---	---	---
		● Sawnwood	4250.0	---	---
		● Plywood-Veneer	3250.0	---	---
		● Chip-Board	3000.0	1500.0	1750.0
		● Pulp-Paper	2750.0	1000.0	1250.0
		● Residue-Fuelwood (Logging)	---	---	---
		● Residue-Fuelwood (Industry)	---	---	---

TABLE A17 (cont'd.).

From: Port Point	Name	Product Type	To: Demand Point U.S.A. (36)	Thailand (37)	Malaysia (38)
21	Samarinda	• Saw Logs	---	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	65312.0	11500.0	9750.0
		• Plywood-Veneer	43125.0	---	---
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---
22	Balikpapan	• Saw Logs	---	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	65400.0	11400.0	9650.0
		• Plywood-Veneer	44000.0	---	---
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---
23	Tarakan/ Nunukan	• Saw Logs	---	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	---	11600.0	10000.0
		• Plywood-Veneer	---	---	---
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---

TABLE A17 (cont'd.).

From: Port Point	Name	Product Type	To: Demand Point Saudi Arabia/ M. East (39)	U.K. (40)	Netherlands (41)
21	Samarinda	• Saw Logs	---	42500.0	42500.0
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	28500.0	40625.0	40500.0
		• Plywood-Veneer	24000.0	35750.0	35600.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---
22	Balikpapan	• Saw Logs	---	42000.0	42000.0
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	28000.0	40500.0	40250.0
		• Plywood-Veneer	23500.0	35500.0	35450.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---
23	Tarakan/ Nunukan	• Saw Logs	---	42250.0	42100.0
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	28750.0	40750.0	40750.0
		• Plywood-Veneer	24100.0	35950.0	35800.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---

TABLE A17 (cont'd.).

From: Port Point	Name	Product Type	To: Demand Point West Germany (42)	Italy (43)	Denmark (44)
21	Samarinda	• Saw Logs	42450.0	35200.0	---
		• Ply-Veneer Logs	---	---	43275.0
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	40600.0	33450.0	---
		• Plywood-Veneer	---	30400.0	40750.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---
22	Balikpapan	• Saw Logs	42000.0	35000.0	---
		• Ply-Veneer Logs	---	---	43500.0
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	40300.0	33000.0	---
		• Plywood-Veneer	---	---	30000.0
		• Chip-Board	40250.0	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---
23	Tarakan/ Nunukan	• Saw Logs	42000.0	35150.0	---
		• Ply-Veneer Logs	---	---	43500.0
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	40900.0	33850.0	---
		• Plywood-Veneer	---	30500.0	40900.0
		• Chip-Board	---	---	---
		• Pulp-Board	---	---	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---

TABLE A17(cont'd.).

From: Port Point	Name	Product Type	To: Demand Point Australia (45)	Cirebon/ West Java (46)	Canada (47)
21	Samarinda	• Saw Logs	25000.0	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	18500.0	6500.0	---
		• Plywood-Veneer	---	6000.0	45000.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	4500.0	---
		• Residue-Fuelwood (Industry)	---	4500.0	---
22	Balikpapan	• Saw Logs	22500.0	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	18000.0	6250.0	---
		• Plywood-Veneer	---	5750.0	43750.0
		• Chip-Board	---	---	---
		• Pulp-Paper	---	---	---
		• Residue-Fuelwood (Logging)	---	4350.0	---
		• Residue-Fuelwood (Industry)	---	4350.0	---
23	Tarakan/ Nunukan	• Saw Logs	22550.0	---	---
		• Ply-Veneer Logs	---	---	---
		• Chip-Board Logs	---	---	---
		• Pulp-Paper Logs	---	---	---
		• Sawnwood	18850.0	6570.0	---
		• Plywood-Veneer	---	6750.0	45250.0
		• Chip-Board	---	6000.0	---
		• Pulp-Paper	---	5550.0	---
		• Residue-Fuelwood (Logging)	---	---	---
		• Residue-Fuelwood (Industry)	---	---	---

SOURCE: See sources in Tables A3, A5, A8 and A12. Some data are based on the author's field check information as of August 1981, assuming all water transportation (perahu, liner, barge, etc.).

APPENDIX B

OUTPUT DATA (OPTIMAL RESULTS) FOR AN APPLICATION OF THE INDONESIAN FORESTRY OPTIMIZATION MODEL (INDO FOM) TO EAST KALIMANTAN

RESOURCE SURPLUS

TABLE A18. HPH-industry log (AAC) and logging residue (fuelwood) out-turn surplus (unused amount) under five different alternative strategies distributed by forest point (in thousand cu.m per year of forest products), East Kalimantan.

Forest Point	Concessionaire Name	Alternative Strategy[1]	Saw Logs	Plywood Logs	Chip-Board Logs[3]	Pulp-Paper Logs	Sawlogging residue (fuelwood)	Total Logs	Total Residue
1	Georgia Pacific Indonesia/ Kalimanis	1	--[2]	--			21.0	--	21.0
		2	--	--			29.0	--	29.0
		3	--	--			37.0	--	37.0
		4	--	--			40.0	--	40.0
		5	--	--			32.0	--	32.0
2	Sumber Mas I	1	--	--			3.38	--	3.38
		2	--	--			4.11	--	4.11
		3	--	--			3.26	--	3.26
		4	--	--			16.0	--	16.0
		5	--	--			13.0	--	13.0
3	Inhutani I	1	--	--			9.67	--	9.67
		2	--	--			14.39	--	14.39
		3	--	--			10.41	--	10.41
		4	--	--			15.0	--	15.0
		5	--	--			15.0	--	15.0
4	Meranti Sakti Indah	1	--	--			--	--	--
		2	--	--			--	--	--
		3	--	--			--	--	--
		4	--	--			17.0	--	17.0
		5	--	--			7.0	--	7.0
5	Kayan River Indonesia	1	--	--			11.0	--	11.0
		2	--	--			13.0	--	13.0
		3	--	--			17.0	--	17.0
		4	--	--			19.0	--	19.0
		5	--	--			15.0	--	15.0

TABLE A18 (cont'd.).

Forest Point	Concessionaire Name	Alternative Strategy	Saw Logs	Plywood Logs	Chip-Board Logs	Pulp-Paper Logs	Sawlogging residue (fuelwood)	Total Logs	Total Residue
6	International Timber Corp. Indonesia (ITCI)	1	--	--			136.0	--	136.0
		2	--	--			126.0	--	126.0
		3	--	--			130.0	--	130.0
		4	72.18	--			180.0	72.18	180.0
		5	--	--			144.0	--	144.0
7	Balikpapan Forest Industries (BFI)	1	--				45.0	--	45.0
		2	--				85.0	--	85.0
		3	--				130.0	--	130.0
		4	--				200.0	--	200.0
		5	--				160.0	--	160.0
8	Inne Dong Hwa	1	--				17.0	--	17.0
		2	--				40.0	--	40.0
		3	--				61.50	--	61.50
		4	--				104.0	--	104.0
		5	--				83.0	--	83.0
9	Chipdeco	1			--		--	--	--
		2			--		--	--	--
		3			--		--	--	--
		4			--		--	--	--
		5			--		--	--	--
10	Inhutani-Savoda Joint Ventures	1	--	--		--	44.0	--	44.0
		2	--	--		--	44.0	--	44.0
		3	--	--		--	58.0	--	58.0
		4	--	--		--	37.0	--	37.0
		5	--	--		--	29.0	--	99.0

[1]Alternative Strategies (1 to 5) are referred to Table 2 of Chapter 5.

[2]The dash (--) means no unused or surplus amount available.

[3]The blank means no data (activity is not included in the analysis/study).

INDUSTRY CAPACITY DEVELOPMENT

TABLE B19. Optimal Industry Capacity Development: Expansion (+) or contraction (-) required under five different alternative strategies, relative to initial capacity for each industry (in thousand m. ton of pulp-paper products and thousand cu.m other industrial-processed products, per year), East Kalimantan.

Industry Point	Company Name	Alternative Strategy	Sawn-wood	Plywood-Veneer	Chip-Board[3]	Pulp-paper
11	Georgia Pacific Indonesia/ Kalimanis	1	- 5.70[1]	- 26.83		
		2	- 33.68	- 91.91		
		3	- 51.93	-104.11		
		4	- 74.73	-136.58		
		5	- 95.78	-141.26		
12	Sumber Mas I	1	- 10.56	- 56.35		
		2	- 36.75	- 91.52		
		3	- 56.58	-131.13		
		4	- 77.89	-174.61		
		5	- 78.30	-177.57		
13	Inhutani I	1	- 38.83	- 27.3		
		2	- 64.14	- 42.64		
		3	- 98.40	- 62.81		
		4	-148.0	- 87.01		
		5	-173.0	- 87.78		
14	Meranti Sakti Indah	1	- 35.14	- 68.44		
		2	- 58.25	-102.20		
		3	- 78.16	-121.81		
		4	- 97.73	-146.19		
		5				
15	Kayan River Indonesia	1	- 22.72	- 21.14		
		2	- 37.10	- 52.49		
		3	- 36.31	- 70.44		
		4	- 37.47	- 93.44		
		5	- 37.95	- 94.79		

TABLE B19 (cont'd.).

Industry Point	Company Name	Alternative Strategy	Sawn-wood	Plywood-Veneer	Chip-Board	Pulp-paper
16	International Timber Corp. Indonesia (ITCI)	1	+ 11.98[2]	+ 5.45		
		2	- 72.27	- 19.52		
		3	- 71.48	- 48.31		
		4	-180.09	-119.34		
		5	-281.03	-200.0		
17	Balikpapan Forest Industries (BFI)	1	- 25.25			
		2	- 57.22			
		3	- 62.48			
		4	- 89.65			
		5	-218.92			
18	Inne Dong Hwa	1	- 14.40			
		2	- 37.23			
		3	- 50.65			
		4	- 76.30			
		5	-109.04			
19	Chipdeco	1			-108.61	
		2			-140.48	
		3			-155.41	
		4			-181.78	
		5			-182.31	
20	Inhutani-Savoda Joint Ventures	1	- 41.03	- 76.41		-100.0
		2	- 54.26	-113.32		-150.0
		3	- 71.28	-132.54		-175.0
		4	-119.15	-155.56		-200.0
		5	-120.15	-156.85		-300.0

[1]The minus (-) sign indicates contraction (or stagnation, reduction) of the industry (mill) capacity development relative to initial capacity under a given alternative strategy.

[2]The plus (+) sign indicates expansion required for that particular industry (mill) relative to initial capacity under a given alternative.

[3]The blank space means no activity included for this study.

PORT CAPACITY DEVELOPMENT

TABLE B20. Optimal Port Capacity Development: Expansion (+) or contraction (-) required under five different alternative strategies, relative to initial capacity for each port (in thousand m. ton of pulp-paper products and thousand cu.m other industrial-processed products, per year), East Kalimantan.

Port Point	Port Name	Alternative Strategy	Logs transshipment	Processed Products Transshipment	Residues-Fuelwood Transshipment
21	Samarinda	1	-1425.0[1]	- 950.01	- 150.0
		2	-1425.0	-1094.91	- 200.0
		3	-1425.0	-1346.97	- 350.0
		4	-1425.0	-1871.98	- 475.0
		5	-1412.0	-2901.02	- 750.0
22	Balikpapan	1	- 350.0	- 746.22	- 74.87
		2	- 495.98	-1367.09	- 104.12
		3	- 426.0	-1817.40	- 128.84
		4	- 370.50	-2362.24	- 231.0
		5	- 162.0	-3884.07	- 585.0
23	Tarakan/Nunukan	1	- 382.0	- 372.75	- 50.0
		2	- 382.0	- 942.19	- 70.0
		3	- 382.0	-1303.48	- 120.0
		4	- 126.4	-1889.25	- 160.0
		5	+ 1.9% built[2] (Module 1)	-1909.27	- 160.0

[1]Minus sign (-) means port capacity contraction (reduction) required relative to intial capacity.

[2]Need to be built 1.9% in addition to the current available capacity of port for first module (1.0 shift per port facility) for log transshipment. Plus sign (+) indicates expansion of capacity development required relative to intial capacity under given alternative strategy.

MARKET ANALYSIS

DOMESTIC DEMAND
- Local Supply Shortage
- Interinsular Supply Shortage

FOREIGN DEMAND
- Export Supply Shortage

TABLE B21. Domestic: Local supply shortages for forest products under five different alternative strategies, distributed by demand point (in thousand m. ton of pulp-paper products and thousand cu.m for other products, per year), East Kalimantan.[1]

Demand Point	Name	Alternative Strategy	Saw Logs	Plywwod Veneer Logs	Chip-Board Logs	Pulp-Paper Logs	Sawn-wood	Ply-wood Veneer	Chip-Board	Pulp-Paper	Residue-Fuelwood
34	Samarinda	1					16.00	6.00	2.00	3.00	--
		2					16.40	6.15	2.05	3.08	--
		3					19.20	7.20	2.05	--	--
		4					14.40	5.40	1.80	--	--
		5					24.00	9.00	3.00	--	--
35	Balikpapan	1					17.00	7.00	2.00	3.00	6.00
		2					17.43	7.18	2.05	3.08	--
		3					20.40	8.40	2.40	--	--
		4					15.30	6.30	1.80	--	5.40
		5					25.50	10.50	3.00	--	9.00
	● Total local supply shortages	1					33.00	13.00	4.00	6.00	6.00
		2					33.83	13.33	4.10	6.16	--
		3					39.60	15.60	4.45	--	--
		4					29.70	11.70	3.60	--	5.40
		5					49.50	19.50	6.00	--	9.00

[1]Prices are exogenous to the model, evaluation was based on cost structure incorporated in the model.

[2]Blank space means no activity included in the study.

[3]The dash (--) means no shortages occured under assumed cost structure.

TABLE B22. Domestic: Interinsular supply shortages for forest products from East Kalimantan distributed by demand point (in thousand m. ton of pulp-paper products and thousand cu.m of other products, per year).[1]

Demand Point	Name	Alternative Strategy	Saw Logs[2]	Plywood Veneer Logs	Chip-Board Logs[3]	Pulp-Paper Logs	Sawnwood	Plywood Veneer	Chip-Board	Pulp-Paper	Residue-Fuelwood
24	Surabaya/	1	--	100.00			85.00	60.00	10.00	15.00	--
	East Java	2	--	102.50			87.13	61.50	10.25	15.38	--
		3	--	120.00			102.00	72.00	12.00	18.00	--
		4	--	--			76.00	54.00	9.00	8.30	8.10
		5	--	--			127.50	90.00	15.00	22.50	13.50
30	Semarang/	1					65.00	45.00	5.00	10.00	--
	Central Java	2					66.63	46.13	5.13	10.25	--
		3					78.00	54.00	6.00	12.00	--
		4					58.50	40.50	4.00	--	8.64
		5					97.50	67.50	7.50	15.00	14.40
31	DKI-Jakarta	1					70.00	65.00	10.00	20.00	--
	Raya	2					71.75	66.63	10.25	20.50	--
		3					84.00	78.00	12.00	24.00	--
		4					63.00	58.50	9.00	--	4.32
		5					105.00	97.50	15.00	30.00	6.00
32	South	1					20.00	15.00			3.60
	Sulawesi	2					20.50	15.38			3.69
		3					24.00	18.00			4.32
		4					18.00	13.50			3.24
		5					30.00	22.50			5.40
33	Central	1					18.00	13.00			--
	Sulawesi	2					18.45	13.32			--
		3					21.60	15.60			--
		4					16.20	11.70			1.08
		5					27.00	19.50			1.80

TABLE B22 (cont'd.).

Demand Point	Name	Alternative Strategy	Saw Logs	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper Logs	Sawnwood	Plywood Veneer	Chip-Board	Pulp-Paper	Residue-Fuelwood
46	Cirebon/ West Java	1					18.00	18.00	10.00	12.00	--
		2					18.45	18.45	10.25	12.30	--
		3					21.60	21.60	12.00	13.60	--
		4					16.20	16.20	9.00	--	8.60
		5					27.00	27.00	15.00	4.20	14.40
	● Total Inter-Insular supply shortages:	1	--	100.00			276.00	216.00	35.00	57.00	3.60
		2	--	102.50			282.91	221.41	35.88	58.43	3.69
		3	--	120.00			331.20	259.20	39.00	67.60	4.32
		4	--	--			299.40	194.40	31.00	8.30	33.98
		5	--	--			414.00	324.00	52.50	71.70	55.50

[1] Prices are exogenous to the model, evaluation based on cost structure incorporated in the model.

[2] The dash (--) means no shortages occured under assumed cost structure.

[3] Blank space means no activity included in the analysis.

TABLE B 23. Foreign: Export supply shortages for forest products from East Kalimantan under five different alternative strategies, distributed by demand point (in thousand m. ton of pulp-paper products and thousand cu.m for other products, per year).[1]

Demand Point	Name	Alternative Strategy	Saw Logs[2]	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper Logs	Sawnwood	Plywood Veneer	Chip-Board	Pulp-Paper[3]	Residue Fuelwood
25	Singapore	1	--	26.00	8.00	5.00	--	70.00	3.61	10.00	--
		2	--	26.65	8.20	5.13	--	71.75	5.13	10.25	--
		3	--	31.20	9.60	6.00	--	84.00	4.40	--	--
		4	--	--	--	4.00	--	63.00	3.31	--	2.16
		5	--	--	12.00	7.50	48.54	105.00	7.50	--	3.60
26	Japan	1	--	150.00	80.00	80.00	--	51.00	--	10.00	2.40
		2	--	153.75	82.00	82.00	--	52.28		1.45	2.46
		3	--	180.00	96.00	96.00	--	61.20	--	--	2.88
		4	--	--	72.00	72.00	--	45.90	--	--	2.16
		5	--	--	120.00	120.00	--	76.50	--	--	3.60
27	Hongkong	1	--	20.00			--	38.02	--		1.20
		2	--	20.50			--	64.70	3.80		1.23
		3	--	24.00			--	61.75	--		1.44
		4	--	--			--	65.36	--		1.08
		5	--	--			--	150.00	12.52		1.80
28	South Korea	1	--	90.00			--	3.50			
		2	--	92.25			2.05	3.59			
		3	--	108.00			2.40	4.20			
		4	--	--			--	3.15			
		5	--	135.00			3.00	5.25			
29	Taiwan	1	--	85.00			--	--			--
		2	--	87.13			--	--			--
		3	--	102.00			--	--			--
		4	--	--			--	--			1.92
		5	--	--			--	--			3.19

[1]Prices are exogenous to the model, evaluation based on cost structure incorporated in the model.

[2]The dash (--) means no export supply shortages occured under assumed cost structure.

[3]Blank space means no activity included in this study (analysis).

TABLE B23 (cont'd.).

Demand Point	Name	Alternative Strategy	Saw Logs	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper Logs	Sawnwood	Plywood Veneer	Chip-Board	Pulp-Paper	Residue Fuelwood
36	U.S.A.	1					4.00	60.00			
		2					4.10	61.50			
		3					4.80	72.00			
		4					3.60	54.00			
		5					6.00	90.00			
37	Thailand	1					7.66			10.0	
		2					12.30			10.25	
		3					14.40			12.00	
		4					18.00			9.00	
		5					--			15.00	
38	Malaysia	1					--			18.00	
		2					--			18.45	
		3					--			21.60	
		4					--			16.20	
		5					--			27.00	
39	Saudi Arabia/ Middle East	1					--	12.00			
		2					--	--			
		3					--	--			
		4					--	10.00			
		5					9.00	18.00			
40	U.K.	1	--				--	--			
		2	--				--	--			
		3	--				--	--			
		4	--				--	--			
		5	--				--	5.61			
41	Netherlands	1	--				7.00	18.00			
		2	--				7.18	18.45			
		3	--				8.40	21.60			
		4	--				--	16.20			
		5	--				10.50	27.00			

TABLE B23 (cont'd.).

Demand Point	Name	Alternative Strategy	Saw Logs	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper Logs	Sawn-wood	Ply-wood Veneer	Chip-Board	Pulp-Paper	Residue Fuelwood
42	West Germany	1	--				3.00				
		2	--				3.08				
		3	--				3.60				
		4	--				--				
		5	--				4.50				
43	Italy	1	--				--	6.00			
		2	--				34.63	6.15			
		3	--				25.71	7.20			
		4	--				--	5.40			
		5	--				54.00	9.00			
44	Denmark	1		--				8.00			
		2		--				8.20			
		3		--				9.60			
		4		--				7.20			
		5		--				12.00			
45	Australia	1	--				--				
		2	--				--				
		3	--				--				
		4	--				--				
		5	--				3.00				
47	Canada	1						--			
		2						--			
		3						--			
		4						--			
		5						54.0			
	● Total Foreign (Export) Supply Shortages:	1	--	371.00	88.00	85.00	21.66	266.52	3.61	48.00	3.60
		2	--	380.28	90.20	87.13	63.34	286.62	8.93	40.40	3.69
		3	--	445.20	105.60	102.00	55.71	321.55	4.40	33.60	4.32
		4	--	--	72.00	76.00	3.60	270.21	3.31	25.20	7.32
		5	--	135.00	132.00	127.50	156.36	552.36	20.02	42.00	12.19

TRANSPORTATION PATTERN

From Forest to Local Industry
From Forest to Local Port
From Forest to Local and Interinsular Demand Points
From Local Industry to Local Port
From Local Industry to Local Demand Point
From Port to Local Demand Point
From Port to Intersular Demand Point
From Port to Foreign Demand Point

TABLE B24. Optimal transportation patterns of forest products from forest to local industry under five different alternative strategies (in thousand cu.m per year), East Kalimantan.[1]

FROM: Forest Point	Concessionaire Name	Alternative Strategy	TO: Industry Point (11, 12, ..., 20) Saw Logs	Plywood Veneer Logs	Chip-board Logs[2]	Pulp-Paper Logs	All Logs
1	Georgia Pacific Indonesia/ Kalimanis	1	31.74	126.35			158.09
		2	43.11	172.46			215.57
		3	55.09	220.36			275.45
		4	59.88	239.52			299.40
		5	47.90	191.62			239.52
2	Sumber Mas I	1	20.96	47.31			68.27
		2	22.16	52.09			74.25
		3	23.35	54.49			77.84
		4	23.95	55.09			79.04
		5	19.16	24.85			44.01
3	Inhutani I	1	20.36	5.39			25.75
		2	26.35	25.75			52.10
		3	24.55	25.15			49.70
		4	22.75	30.54			53.29
		5	22.75	22.75			45.50
4	Meranti Sakti Indonesia	1	10.78	43.11			53.89
		2	11.98	47.90			59.88
		3	12.57	50.30			62.87
		4	25.75	38.92			64.67
		5	10.78	41.32			52.10
5	Kayan River Indonesia	1	16.17	37.72			53.89
		2	19.76	46.11			65.87
		3	25.15	58.68			83.83
		4	28.74	67.06			95.80
		5	23.35	53.29			76.64

TABLE B24 (cont'd.).

FROM: Forest Point	Concessionaire Name	Alternative Strategy	TO: Industry Point (11, 12, ..., 20) Saw Logs	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper Logs	All Logs
6	International Timber Corp. Indonesia (ITCI)	1	204.19	50.90			255.09
		2	189.22	125.75			314.97
		3	194.61	194.61			389.22
		4	226.24	6.74			232.98
		5	215.57	--			215.57
7	Balikpapan Forest Industry (BFI)	1	68.26				68.26
		2	128.14				128.14
		3	194.61				164.61
		4	299.40				299.40
		5	239.52				239.52
8	Inne Dong Hwa	1	25.75				25.75
		2	59.88				59.88
		3	104.79				104.79
		4	155.69				155.69
		5	124.55				124.55
9	Chipdeco/Karyasa Kencana	1			32.93		32.93
		2			44.91		44.91
		3			68.86		68.86
		4			64.67		64.67
		5			60.48		60.48
10	Inhutani-Savoda Joint Venture	1	6.59	7.19		--	13.78
		2	66.48	53.29		--	119.77
		3	86.83	58.08		--	144.91
		4	55.09	65.86		--	120.95
		5	43.71	52.69		--	96.40
●	Total optimal transportation (supply) from Forest to local industry	1	404.80	317.97	32.93	--	755.70
		2	567.08	523.35	44.91	--	1135.34
		3	721.55	661.67	68.86	--	1452.08
		4	897.49	503.73	64.67	--	1465.89
		5	747.29	386.52	60.48	--	1194.29

TABLE B24 (cont'd).

[1]The figures in the table indicate the best amount (optimal, economically viable) of forest product (thousand cu.m/year) transported from forest to local industry under assumed transportation cost structure.

[2]Blank space means no activity included in the analysis.

[3]The dashes (--) indicate transport activity in question is not viable economically/financially under assumed cost structure, and under given alternative strategy.

TABLE B25. Optimal transportation patterns of forest products from forest to local port under five different alternative strategies (in thousand cu.m per year), East Kalimantan.[1]

FROM: Forest Point	Name	Alternative Strategy	TO: Port Point (21, 22, 23) Saw Logs[2]	Plywood Veneer Logs	Chip-Board Logs[3]	Pulp-Paper Logs	Residue-Fuelwood	All Logs
1	Georgia Pacific Indonesia/ Kalimanis	1	--	--			--	--
		2	--	--			--	--
		3	--	--			--	--
		4	--	--			--	--
		5	--	--			--	--
2	Sumber Mas I	1	--	--			--	--
		2	--	--			--	--
		3	--	--			--	--
		4	--	--			--	--
		5	--	13.00			--	13.00
3	Inhutani I	1	--	--			--	--
		2	--	--			--	--
		3	--	--			--	--
		4	--	--			--	--
		5	--	--			--	--
4	Meranti Sakti Indonesia	1	--	--			--	--
		2	--	--			--	--
		3	--	--			--	--
		4	--	--			--	--
		5	--	--			--	--
5	Kayan River Indonesia	1	--	--			--	--
		2	--	--			--	--
		3	--	--			--	--
		4	--	--			--	--
		5	--	--			--	--

[1]The explanation, same as footnote 1 of Table B24.

[2]See footnote 3 of Table B24.

[3]See footnote 2 of Table B24.

TABLE B25 (cont'd.).

FROM: Forest Point	Name	TO: Port Point (21, 22, 23) Alternative Strategy	Saw Logs	Plywood Veneer Logs	Chip-Board Logs	Pulp-Paper Logs	Residue-Fuelwood	All Logs
6	International	1	--	--			--	--
	Timber Corp.	2	--	--			--	--
	Indonesia (ITCI)	3	--	--			--	--
		4	--	175.50			--	175.50
		5	--	144.00			--	144.00
7	Balikpapan Forest	1	--				--	--
	Industry (BFI)	2	--				--	--
		3	--				--	--
		4	--				--	--
		5	--				--	--
8	Inne Dong Hwa	1	--				--	--
		2	--				--	--
		3	--				--	--
		4	--				--	--
		5	--				--	--
9	Chipdeco/Karyasa	1			--			--
	Kencana	2			--			--
		3			--			--
		4			7.20			7.20
		5			--			--
10	Inhutania-Savoda	1	--	--		--	--	--
	Joint Venture	2	--	--		8.80	--	8.80
		3	--	--		32.00	--	32.00
		4	--	--		66.40	--	66.40
		5	--	414.00		52.80	--	466.80
	● Total optimal trans-		--	--	--	--	--	--
	portation (supply)		--	--	--	8.80	--	8.80
	from forest to local		--	--	--	32.00	--	32.00
	port		--	175.50	7.20	66.40	--	241.90
			--	517.00	--	52.80	--	623.80

TABLE B26. Optimal transportation patterns of forest products directly from forest point in East Kalimantan to local and interinsular demand points under Alternative Strategy No. 1 (in thousand cu.m per year) for domestic supply.

FROM: Forest Point	Name	Product Type	TO: Demand Points — Interinsular: Surabaya/ East Java (24)	Interinsular: Central Java (30)	Interinsular: DKI-Jakarta (31)	Local: Samarinda (34)	Local: Balikpapan (35)	Total Supply: Inter-insular	Total Supply: Local
1	Georgia Pacific Indonesia/ Kalimanis	● Residue-Fuelwood	--					--	
2	Sumber Mas I	● Saw Logs	--					--	
		● Plywood Veneer Logs	--					--	
		● Residue-fuelwood	9.00					9.0	
3	Inhutani I	● Residue-fuelwood		3.67				3.67	
4	Meranti Sakti Indonesia	● Saw Logs	--					--	
		● Plywood Veneer Logs	--					--	
		● Residue-fuelwood	--	5.93				5.93	
5	Kayan River Indonesia	● Residue-fuelwood			--			--	
6	International Timber Corp. Indonesia (ITCI)	● Residue fuelwood			--		--	--	--
7	Balikpapan Forest Industry (BFI)	● Residue fuelwood					--		--
8	Inne Dong Hwa	● Residue fuelwood					--		--
9	Chipdeco/Karyasa Kencana	------							
10	Inhutani-Savoda Joint Venture	● Residue fuelwood			--			--	

[1] Explanation about figures in the table, blank spaces and the dashes (--), see footnotes 1, 2 and 3 of Table B24. Also for Tables B27 to B30.

TABLE B27. Optimal transportation patterns of forest products directly from forest point in East Kalimantan to local and interinsular demand points under Alternative Strategy No. 2 (in thousand cu.m per year) for domestic supply.[1]

FROM: Forest Point	Name	Product Type	TO: Demand Points — Interinsular: Surabaya/ East Java (24)	Interinsular: Central Java (30)	Interinsular: DKI Jakarta (31)	Local: Samarinda (34)	Local: Balikpapan (35)	Total Supply: Inter-insular	Total Supply: Local
1	Georgia Pacific Indonesia/ Kaliminis	• Residue-fuelwood	--					--	
2	Sumber Mas I	• Saw Logs	--					--	
		• Plywood Veneer Logs	--					--	
		• Residue-fuelwood	9.23					9.23	
3	Inhutani I	• Residue-fuelwood		3.06				3.06	
4	Meranti Sakti Indonesia	• Saw Logs	--					--	
		• Plywood Veneer Logs	--					--	
		• Residue-fuelwood	--	6.78				6.78	
5	Kayan River Indonesia	• Residue-fuelwood			--			--	
6	International Timber Corp. Indonesia (ITCI)	• Residue-fuelwood			--		--	--	--
7	Balikpapan Forest Industry (BFI)	• Residue-fuelwood					--		--
8	Inne Dong Hwa	• Residue-fuelwood					--		--
9	Chipdeco/Karyasa Kencana	------							
10	Inhutani-Savoda Joint Venture	• Residue-fuelwood			--			--	

TABLE B28. Optimal transportation patterns of forest products directly from forest point in East Kalimantan to local and interinsular demand points under Alternative Strategy No. 3 (in thousand cu.m per year) for domestic supply.

FROM: Forest Point	Name	Product Type	TO: Demand Points — Interinsular: Surabaya/ East Java (24)	Interinsular: Central Java (30)	Interinsular: DKI Jakarta (31)	Local: Samarinda (34)	Local: Balikpapan (35)	Total Supply: Inter-insular	Total Supply: Local
1	Georgia Pacific Indonesia/ Kaliminis	● Residue-fuelwood	--					--	
2	Sumber Mas I	● Saw Logs	--					--	
		● Plywood Veneer Logs	--					--	
		● Residue-fuelwood	10.80					10.80	
3	Inhutani I	● Residue-fuelwood		4.74				4.74	
4	Meranti Sakti Indonesia	● Saw Logs	--					--	
		● Plywood Veneer Logs	--					--	
		● Residue-fuelwood	--	6.78				6.78	
5	Kayan River	● Residue-fuelwood			--			--	
6	International Timber Corp. Indonesia (ITCI)	● Residue-fuelwood			--		--	--	--
7	Balikpapan Forest Industry (BFI)	● Residue-fuelwood					--		--
8	Inne Dong Hwa	● Residue-fuelwood					7.20		7.20
9	Chipdeco/Karyasa Kencana	------							
10	Inhutani-Savoda Joint Venture	● Residue-fuelwood			--			--	

TABLE B29. Optimal transportation patterns of forest products directly from forest point in East Kalimantan to local and interinsular demand points under Alternative Strategy No. 4 (in thousand cu.m per year) for domestic supply.

FROM: Forest Point	Name	Product Type	TO: Demand Points — Interinsular: Surabaya/ East Java (24)	Interinsular: Central Java (30)	Interinsular: DKI Jakarta (31)	Local: Samarinda (34)	Local: Balikpapan (35)	Total Supply: Inter-insular	Total Supply: Local
1	Georgia Pacific Indonesia/ Kalimanis	• Residue-fuelwood	--					--	
2	Sumber Mas I	• Saw Logs	--					--	
		• Plywood Veneer Logs	--					--	
		• Residue-fuelwood	--					--	
3	Inhutani I	• Residue-fuelwood		--				--	
4	Meranti Sakti Indonesia	• Saw Logs	--					--	
		• Plywood Veneer Logs	--					--	
		• Residue-fuelwood	--	--				--	
5	Kayan River	• Residue-fuelwood			--			--	
6	International Timber Corp. Indonesia (ITCI)	• Residue-fuelwood			--		--		--
7	Balikpapan Forest Industry (BFI)	• Residue-fuelwood					--		--
8	Inne Dong Hwa	• Residue-fuelwood					--		--
9	Chipdeco/Karyasa Kencana	------							
10	Inhutani-Savoda Joint Venture	• Residue-fuelwood			--			--	

TABLE B30. Optimal transportation patterns of forest products directly from forest point in East Kalimantan to local and interinsular demand points under Alternative Strategy No. 5 (in thousand cu.m per year) for domestic supply.

FROM: Forest Point	Name	Product Type	TO: Demand Points — Interinsular: Surabaya/ East Java (24)	Interinsular: Central Java (30)	Interinsular: DKI Jakarta (31)	Local: Samarinda (34)	Local: Balikpapan (35)	Total Supply: Inter-insular	Total Supply: Local
1	Georgia Pacific Indonesia/ Kalimanis	● Residue-fuelwood	--					--	
2	Inhutani I	● Saw Logs	--					--	
		● Plywood Veneer Logs	--					--	
		● Residue-fuelwood	--					--	
3	Inhutani I	● Residue-fuelwood		--				--	
4	Meranti Sakti Indonesia	● Saw Logs	--					--	
		● Plywood Veneer Logs	--					--	
		● Residue-fuelwood	--	--				--	
5	Kayan River	● Residue-fuelwood			--			--	
6	International Timber Corp. Indonesia (ITCI)	● Residue-fuelwood			--		--	--	--
7	Balikpapan Forest Industry (BFI)	● Residue-fuelwood					--		--
8	Inne Dong Hwa	● Residue-fuelwood					--		--
9	Chipdeco/Karyasa Kencana	------							
10	Inhutani-Savoda Joint Venture	● Residue-fuelwood			--			--	

TABLE B31. Optimal transportation patterns of forest products from local industry to local port under five different alternative strategies (in thousand m. ton of pulp-paper products and thousand cu.m of other products, per year), East Kalimantan.[1]

FROM: Industry Point	Name	Alternative Strategy	TO: Port Point (21, 22, 23) Sawnwood	Plywood-Veneer	Chip-Board	Pulp-Paper	Residue-Fuelwood
11	Georgia Pacific	1	14.29	63.17			--
	Indonesia/	2	11.08	49.27			--
	Kalimanis	3	14.16	62.96			--
		4	11.98	53.23			--
		5	9.58	42.58			--
12	Sumber Mas I	1	9.44	23.65			--
		2	5.69	14.88			--
		3	6.00	15.58			--
		4	4.79	12.24			--
		5	3.83	5.52			--
13	Inhutani I	1	9.17	2.69			--
		2	6.77	7.36			--
		3	6.31	7.18			--
		4	4.55	6.79			--
		5	4.55	5.06			--
14	Meranti Sakti	1	4.85	21.56			--
	Indonesia	2	3.08	13.69			--
		3	3.23	14.37			--
		4	5.15	8.65			--
		5	2.15	9.18			--
15	Kayan River	1	7.28	18.86			--
	Indonesia	2	5.08	13.17			--
		3	6.46	16.77			--
		4	5.75	14.90			--
		5	4.67	11.84			--

[1]The explanation about figures in the table, the blank spaces, and the dashes (--), see footnotes 1, 2, and 3 of Table B24.

TABLE B31 (cont'd.)

FROM: Industry Point	Name	Alternative Strategy	TO: Port Point (21, 22, 23) Sawnwood	Plywood-Veneer	Chip-Board	Pulp-Paper	Residue-Fuelwood
16	International Timber Corp. Indonesia (ITCI)	1	91.98	25.45			20.13
		2	48.64	35.93			20.63
		3	50.03	55.60			24.16
		4	58.25	1.50			--
		5	43.11	--			--
17	Balikpapan Forest Industry (BFI)	1	30.75				--
		2	32.94				--
		3	50.03				--
		4	59.88				--
		5	47.90				--
18	Inne Dong Hwa	1	11.50				--
		2	15.39				--
		3	26.94				--
		4	31.14				--
		5	24.91				--
19	Chipdeco	1			21.38		
		2			16.69		
		3			25.60		
		4			18.69		
		5			17.48		
20	Inhutani-Savoda Joint Venture	1	2.97	3.59		--	--
		2	17.09	15.23		--	--
		3	22.32	16.59		--	--
		4	11.02	14.64		--	--
		5	8.74	11.71		--	--
	● Total optimal transport (supply) from industry to local port	1	182.33	158.97	21.38	--	20.13
		2	145.76	149.53	16.69	--	20.63
		3	185.48	189.04	25.60	--	24.16
		4	179.51	166.05	18.69	--	--
		5	149.44	85.89	17.48	--	--

TABLE B32. Optimal transportation patterns of forest product from local industry to local demand under Alternative Strategy No. 1 (in thousand m. ton of chip-board and pulp-paper products and thousand cu.m of other products, per year), East Kalimantan.[1]

FROM: Industry Point	Name	Product Type	TO: Local Demand Point Samarinda (34)	Balikpapan (35)
11	Georgia Pacific Indonesia/Kalimanis	• Sawnwood	--	
		• Plywood-Veneer	--	
		• Residue-Fuelwood	--	
12	Sumber Mas I	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
13	Inhutani I	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	4.80	
14	Meranti Sakti Indonesia	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
15	Kayan River Indonesia	• Sawnwood	--	
		• Plywood-Veneer	--	
		• Residue-Fuelwood	--	--
16	International Timber Corp. Indonesia (ITCI)	• Sawnwood		--
		• Plywood-veneer		--
		• Residue-Fuelwood		--
17	Balikpapan Forest Industry	• Sawnwood		--
		• Residue-Fuelwood		--
18	Inne Dong Hwa	• Sawnwood		--
		• Residue-Fuelwood		--
19	Chipdeco	------		
20	Inhutani-Savoda Joint Venture	------		

[1]The explanations about figures in the table, the blank spaces, and the dashes (--), see footnotes 1, 2, and 3 or Table B24. Also for Tables B33 to B36.

TABLE B33. Optimal transportation patterns of forest products from local industry to local demand under Alternative Strategy No. 2 (in thousand m. ton of chip-board and pulp-paper products and thousand cu.m of other products, per year), East Kalimantan.

FROM: Industry Point	Name	Product Type	TO: Local Demand Point Samarinda (34)	Balikpapan (35)
11	Georgia Pacific Indonesia/Kalimanis	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood		
12	Sumber Mas I	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
13	Inhutani I	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	4.92	
14	Meranti Sakti Indonesia	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
15	Kayan River Indonesia	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
16	International Timber Corp. Indonesia (ITCI)	• Sawnwood		--
		• Plywood-veneer		--
		• Residue-Fuelwood		--
17	Balikpapan Forest Industry	• Sawnwood		--
		• Residue-Fuelwood		--
18	Inne Dong Hwa	• Sawnwood		--
		• Residue-Fuelwood		6.15
19	Chipdeco	------		
20	Inhutani-Savoda Joint Venture	------		

TABLE B34. Optimal transportation patterns of forest products from local industry to local demand under Alternative Strategy No. 3 (in thousand m. ton of chip-board and pulp-paper products and thousand cu.m of other products, per year), East Kalimantan.

FROM: Industry Point	Name	Product Type	TO: Local Demand Point Samarinda (34)	Balikpapan (35)
11	Georgia Pacific Indonesia/Kalimanis	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
12	Sumber Mas I	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
13	Inhutani I	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	5.76	
14	Meranti Sakti Indonesia	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
15	Kayan River Indonesia	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
16	International Timber Corp. Indonesia (ITCI)	• Sawnwood		--
		• Plywood-veneer		--
		• Residue-Fuelwood		--
17	Balikpapan Forest Industry	• Sawnwood		--
		• Residue-Fuelwood		--
18	Inne Dong Hwa	• Sawnwood		--
		• Residue-Fuelwood		--
19	Chipdeco	------		
20	Inhutani-Savoda Joint Venture	------		

TABLE B35. Optimal transportation patterns of forest products from local industry to local demand under Alternative Strategy No. 4 (in thousand m. ton of chip-board and pulp-paper products and thousand cu.m of other products, per year), East Kalimantan.

FROM: Industry Point	Name	Product Type	TO: Local Demand Point Samarinda (34)	Balikpapan (35)
11	Georgia Pacific Indonesia/Kalimanis	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
12	Sumber Mas I	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
13	Inhutani I	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	4.32	
14	Meranti Sakti Indonesia	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
15	Kayan River Indonesia	• Sawnwood	--	
		• Plywood-veneer	--	
		• Residue-Fuelwood	--	
16	International Timber Corp. Indonesia (ITCI)	• Sawnwood		--
		• Plywood-veneer		--
		• Residue-Fuelwood		--
17	Balikpapan Forest Industry	• Sawnwood		--
		• Residue-Fuelwood		--
18	Inne Dong Hwa	• Sawnwood		--
		• Residue-Fuelwood		--
19	Chipdeco	------		
20	Inhutani-Savoda Joint Venture	------		

TABLE B36. Optimal transportation patterns of forest products from local industry to local demand under Alternative Strategy No. 5 (in thousand m. ton of chip-board and pulp-paper products and thousand cu.m of other products, per year), East Kalimantan.

FROM: Industry Point	Name	Product Type	TO: Local Demand Point Samarinda (34)	Balikpapan (35)
11	Georgia Pacific Indonesia/Kalimanis	● Sawnwood	--	
		● Plywood-veneer	--	
		● Residue-Fuelwood	--	
12	Sumber Mas I	● Sawnwood	--	
		● Plywood-veneer	--	
		● Residue-Fuelwood	--	
13	Inhutani I	● Sawnwood	--	
		● Plywood-veneer	--	
		● Residue-Fuelwood	7.20	
14	Meranti Sakti Indonesia	● Sawnwood	--	
		● Plywood-veneer	--	
		● Residue-Fuelwood	--	
15	Kayan River Indonesia	● Sawnwood	--	
		● Plywood-veneer	--	
		● Residue-Fuelwood	--	
16	International Timber Corp. Indonesia (ITCI)	● Sawnwood		--
		● Plywood-veneer		--
		● Residue-Fuelwood		--
17	Balikpapan Forest Industry	● Sawnwood		--
		● Residue-Fuelwood		--
18	Inne Dong Hwa	● Sawnwood		--
		● Residue-Fuelwood		--
19	Chipdeco	------		
20	Inhutani-Savoda Joint Venture	------		

TABLE B37. Optimal transportation (shipping) patterns of chip-board and pulp-paper products: From Tarakan/Nunukan port to Samarinda and Balikpapan demand points under different alternative strategies (in thousand cu.m of chip-board and thousand m. ton of pulp-paper products, per year).[1]

Alternative Strategy	TO: Samarinda (34)		TO: Balikpapan (35)	
	Chip-Board	Pulp-Paper	Chip-Board	Pulp-Paper
1	-	-	-	-
2	-	-	-	-
3	-	3.60	-	3.60
4	-	2.70	-	2.70
5	-	4.50	-	4.50

[1]The explanations about figures in the table, the blank spaces, and the dashes (--), see footnotes 1, 2 and 3 of Table B24.

TABLE B38. Optimal transportation (shipping) patterns of forest products from East Kalimantan: From local port to interinsular (domestic) demand point under Alternative Strategy No. 1 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).[1]

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point Surabaya/East Java (24)	Semarang/Central Java (30)	DKI-Jakarta Raya (31)
21	Samarinda	• Saw Logs	--		
		• Ply-Veneer Logs[1]	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	10.00	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)	--	--	--
		• Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	• Saw Logs	80.00		
		• Ply-Veneer Logs[1]	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)	--	--	4.80
		• Residue-Fuelwood (Industry)	--	--	--
23	Tarakan/ Nunukan	• Saw Logs	--		
		• Ply-Veneer Logs[1]	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board	--	--	--
		• Pulp-Paper	--	--	--
		• Residue-Fuelwood (Logging)			
		• Residue-Fuelwood (Industry)			

[1]"Ply-Veneer Logs" refers to plywood and veneer logs. Same meaning applies to the following Tables (Tables B38 to B47).

TABLE B38.(cont'd.).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point South Sulawesi (32)	Central Sulawesi (33)	Cirebon/West Java (46)
21	Samarinda	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)			--
		• Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)			9.60
		• Residue-Fuelwood (Industry)	--	.20	--
23	Tarakan Nunukan	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			--
		• Pulp-Paper			--
		• Residue-Fuelwood (Logging)			
		• Residue-Fuelwood (Industry)			

[1]The explanation about figures in the table, the blank spaces, and the dashes (--), see footnotes 1, 2, and 3 of Table B24. Also for Tables B-39 to B-42.

TABLE B39. Optimal transportation (shipping) patterns of forest products from East Kalimantan: from local port to interinsular (domestic) demand point under Alternative Strategy No. 2 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point Surabaya/East Java (24)	Semarang/Central Java (30)	DKI-Jakarta Raya (31)
21	Samarinda	• Saw Logs	--		
		• Ply-Veneer Logs	--		
		• Chip-Board Logs			
		• Pulp-paper Logs			
		• Sawnwood	--	10.25	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-paper			
		• Residue-Fuelwood (Logging)	--	--	--
		• Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	• Saw Logs	82.00		
		• Ply-Veneer Logs	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)	--	--	4.92
		• Residue-Fuelwood (Industry)	--	--	--
23	Tarakan/ Nunukan	• Saw Logs	--		
		• Ply-Veneer Logs	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board	--	--	--
		• Pulp-paper	--	--	--
		• Residue-Fuelwood (Logging)			
		• Residue-Fuelwood (Industry)			

TABLE B39 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point South Sulawesi (32)	Central Sulawesi (33)	Cirebon/West Java (46)
21	Samarinda	● Saw Logs			
		● Ply-Veneer Logs			
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	--	--
		● Plywood-Veneer	--	--	--
		● Chip-Board			
		● Pulp-Paper			
		● Residue-Fuelwood (Logging)			--
		● Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	● Saw Logs			
		● Ply-Veneer Logs			
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	--	--
		● Plywood-Veneer	--	--	--
		● Chip-Board			
		● Pulp-Paper			
		● Residue-Fuelwood (Logging)			9.84
		● Residue-Fuelwood (Industry)	--	1.23	--
23	Tarakan Nunukan	● Saw Logs			
		● Ply-Veneer Logs			
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	--	--
		● Plywood-Veneer	--	--	--
		● Chip-Board			--
		● Pulp-Paper			0.80
		● Residue-Fuelwood (Logging)			
		● Residue-Fuelwood (Industry)			

TABLE B40. Optimal transportation (shipping) patterns of forest products from East Kalimantan: From local port to interinsular (domestic) demand point under Alternative Strategy No. 3 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point Surabaya/East Java (24)	Semarang/Central Java (30)	DKI-Jakarta Raya (31)
21	Samarinda	• Saw Logs	--		
		• Ply-Veneer Logs	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	12.00	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)	--	--	--
		• Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	• Saw Logs	96.00		
		• Ply-Veneer Logs	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)	--	--	5.76
		• Residue-Fuelwood (Industry)	--	--	--
23	Tarakan/ Nunukan	• Saw Logs	--		
		• Ply-Veneer Logs	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board	--	--	--
		• Pulp-Paper	--	--	--
		• Residue-Fuelwood (Logging)			
		• Residue-Fuelwood (Industry)			

TABLE B40 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point South Sulawesi (32)	Central Sulawesi (33)	Cirebon/West Java (46)
21	Samarinda	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)			--
		• Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)			--
		• Residue-Fuelwood (Industry)	--	1.44	11.52
23	Tarakan Nunukan	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			--
		• Pulp-Paper			--
		• Residue-Fuelwood (Logging)			
		• Residue-Fuelwood (Industry)			

TABLE B41. Optimal transportation (shipping) patterns of forest products from East Kalimantan: From local port to interinsular (domestic) demand point under Alternative Strategy No. 4 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point Surabaya/East Java (24)	Semarang/Central Java (30)	DKI-Jakarta Raya (31)
21	Samarinda	• Saw Logs	--		
		• Ply-Veneer Logs	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	9.00	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)	--	--	--
		• Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	• Saw Logs	72.00		
		• Ply-Veneer Logs	--		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)	--	--	--
		• Residue-Fuelwood (Industry)	--	--	--
23	Tarakan/ Nunukan	• Saw Logs	--		
		• Ply-Veneer Logs	90.00		
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board	--	--	--
		• Pulp-Paper	5.20	9.00	18.00
		• Residue-Fuelwood (Logging)			
		• Residue-Fuelwood (Industry)			

TABLE B41 (cont'd).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point South Sulawesi (32)	Central Sulawesi (33)	Cirebon/West Java (46)
21	Samarinda	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)			--
		• Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			
		• Pulp-Paper			
		• Residue-Fuelwood (Logging)			--
		• Residue-Fuelwood (Industry)	--	--	--
23	Tarakan Nunukan	• Saw Logs			
		• Ply-Veneer Logs			
		• Chip-Board Logs			
		• Pulp-Paper Logs			
		• Sawnwood	--	--	--
		• Plywood-Veneer	--	--	--
		• Chip-Board			--
		• Pulp-Paper			10.80
		• Residue-Fuelwood (Logging)			
		• Residue-Fuelwood (Industry)			

TABLE B42. Optimal Transportation (shipping) patterns of forest products from East Kalimantan: From local port to interinsular (domestic) demand point under Alternative Strategy No. 5 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point Surabaya/East Java (24)	Semarang/Central Java (30)	DKI-Jakarta Raya (31)
21	Samarinda	● Saw Logs	--		
		● Ply-Veneer Logs	--		
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	15.00	--
		● Plywood-Veneer	--	--	--
		● Chip-Board			
		● Pulp-Paper			
		● Residue-Fuelwood (Logging)	--	--	--
		● Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	● Saw Logs	120.00		
		● Ply-Veneer Logs	--		
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	--	--
		● Plywood-Veneer	--	--	--
		● Chip-Board			
		● Pulp-Paper			
		● Residue-Fuelwood (Logging)	--	--	--
		● Residue-Fuelwood (Industry	--	--	--
23	Tarakan/ Nunukan	● Saw Logs	--		
		● Ply-Veneer Logs	150.00		
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	--	--
		● Plywood-Veneer	--	--	--
		● Chip-Board	--	--	--
		● Pulp-Paper	--	--	--
		● Residue-Fuelwood (Logging)			
		● Residue-Fuelwood (Industry)			

TABLE B42 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Interinsular Demand Point South Sulawesi (32)	Central Sulawesi (33)	Cirebon/West Java (46)
21	Samarinda	● Saw Logs			
		● Ply-Veneer Logs			
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	--	--
		● Plywood-Veneer	--	--	--
		● Chip-Board			
		● Pulp-Paper			
		● Residue-Fuelwood (Logging)			--
		● Residue-Fuelwood (Industry)	--	--	--
22	Balikpapan	● Saw Logs			
		● Ply-Veneer Logs			
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	--	--
		● Plywood-Veneer	--	--	--
		● Chip-Board			
		● Pulp-Paper			
		● Residue-Fuelwood (Logging)			--
		● Residue-Fuelwood (Industry)	--	--	--
23	Tarakan/ Nunukan	● Saw Logs			
		● Ply-Veneer Logs			
		● Chip-Board Logs			
		● Pulp-Paper Logs			
		● Sawnwood	--	--	--
		● Plywood-Veneer	--	--	--
		● Chip-Board			--
		● Pulp-Paper			13.80
		● Residue-Fuelwood (Logging)			
		● Residue-Fuelwood (Industry)			

TABLE B43. Optimal transportation (shipping) patterns of forest products from East Kalimantan: From local port to foreign (export) demand point under Alternative Strategy No. 1 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).[1]

FROM: Port Point	Name		TO: Foreign Demand Point Singapore (25)	Japan (26)	HongKong (27)	S. Korea (28)	Taiwan (29)	U.S.A. (30)	Thailand (37)
21	Samarinda	• Saw Logs	--	--	--	--	--		
		• Ply-Veneer Logs	--	--	--	--	--		
		• Chip-Board Logs							
		• Pulp-Paper Logs							
		• Sawnwood	10.04	25.00	--	--	--	--	--
		• Plywood-Veneer	--	--	61.98	--	25.0	--	
		• Chip-Board							
		• Pulp-Paper							
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)	--	--			--		
22	Balikpapan	• Saw Logs	13.00	100.00	10.00	85.00	90.00		
		• Ply-Veneer Logs	--	--	--	--	--		
		• Chip-Board Logs							
		• Pulp-Paper Logs							
		• Sawnwood	39.00	--	5.00	2.00	--	--	1.37
		• Plywood-Veneer	--	--	--	--	--	--	
		• Chip-Board							
		• Pulp-Paper							
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)	2.40	--			2.13		
23	Tarakan/ Nunukan	• Saw Logs	--	--					
		• Ply-Veneer Logs	--	--					
		• Chip-Board Logs	--	--					
		• Pulp-Paper Logs	--	--					
		• Sawnwood	--	--	--	--	--		2.98
		• Plywood-Veneer	--	--	--	--	--		
		• Chip-Board	1.38	10.00	10.00				
		• Pulp-Paper	--	--					
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)							

[1]The explanations about figures in the table, the blank spaces, and the dashes (--), are footnotes 1, 2 and 3 of Table B24. Also for Tables B44 to B47.

TABLE B43 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Malaysia (38)	Saudi Arabia/ Middle East (39)	U.K. (40)	Netherlands (41)
21	Samarinda	• Saw Logs			--	--
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	--	--	--	--
		• Plywood-Veneer			6.96	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
22	Balikpapan	• Saw Logs			5.00	4.00
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	30.00	6.00	12.00	--
		• Plywood-Veneer		--	25.45	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
23	Tarakan/ Nunukan	• Saw Logs			--	--
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	--	--	--	--
		• Plywood-Veneer		--	3.59	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				

TABLE B43(cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point West Germany (42)	Italy (43)	Denmark (44)	Australia (45)	Canada (47)
21	Samarinda	• Saw Logs	--	--		--	
		• Ply-Veneer Logs			--		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer		--	--		36.00
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					
22	Balikpapan	• Saw Logs	3.00	12.00		3.00	
		• Ply-Veneer Logs			5.00		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	36.00		2.00	
		• Plywood-Veneer		--	--		--
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					
23	Tarakan/ Nunukan	• Saw Logs	--		--		
		• Ply-Veneer Logs			--		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer		--	--		--
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					

TABLE B44. Optimal transportation (shipping) patterns of forest products from East Kalimantan: From local port to foreign (export) demand point under Alternative Strategy No. 2 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Singapore (25)	Japan (26)	HongKong (27)	S. Korea (28)	Taiwan (29)	U.S.A. (36)	Thailand (37)
21	Samarinda	• Saw Logs	--	--	--	--	--		
		• Ply-Veneer Logs	--	--	--	--	--		
		• Chip-Board Logs							
		• Pulp-Paper Logs							
		• Sawnwood	--	--	--	--	--	--	--
		• Plywood-Veneer	--	--	37.80	--	25.63	--	
		• Chip-Board							
		• Pulp-Paper							
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)	--	--			--		
22	Balikpapan	• Saw Logs	13.32	102.50	10.25	87.13	92.25		
		• Ply-Veneer Logs	--	--	--	--	--		
		• Chip-Board Logs							
		• Pulp-Paper Logs							
		• Sawnwood	34.16	25.63	5.13	--	--	--	--
		• Plywood-Veneer	--	--	--	--	--	--	
		• Chip-Board							
		• Pulp-Paper							
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)	2.46	--			2.18		
23	Tarakan/ Nunukan	• Saw Logs	--	--					
		• Ply-Veneer Logs	--	--					
		• Chip-Board Logs	--	--					
		• Pulp-Paper Logs	--	--					
		• Sawnwood	17.09	--	--	--	--		--
		• Plywood-Veneer	--	--	--	--	--		
		• Chip-Board	--	10.25	6.44				
		• Pulp-Paper	--	8.80					
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)							

TABLE B44 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Malaysia (38)	Saudi Arabia/ Middle East (39)	U.K. (40)	Netherlands (41)
21	Samarinda	• Saw Logs			--	--
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	21.46	--	--	--
		• Plywood-Veneer			--	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
22	Balikpapan	• Saw Logs			5.13	4.10
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	9.29	6.15	12.30	--
		• Plywood-Veneer		12.30	21.67	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
23	Tarakan/ Nunukan	• Saw Logs			--	--
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	--	--	--	--
		• Plywood-Veneer	--	--	15.23	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				

TABLE B44 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point West Germany (42)	Italy (43)	Denmark (44)	Australia (45)	Canada (47)
21	Samarinda	• Saw Logs	--	--		--	
		• Ply-Veneer Logs			--		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer		--	--		34.94
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					
22	Balikpapan	• Saw Logs	3.08	12.30		3.08	
		• Ply-Veneer Logs			5.13		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	2.26			
		• Plywood-Veneer		--	--	2.05	1.95
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					
23	Tarakan/ Nunukan	• Saw Logs	--	--		--	
		• Ply-Veneer Logs			--		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer	--	--	--		--
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					

TABLE B45. Optimal transportation (shipping) patterns of forest products from East Kalimantan: From local port to foreign (export) demand point under Alternative Strategy No. 3 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Singapore (25)	Japan (26)	HongKong (27)	S. Korea (28)	Taiwan (29)	U.S.A. (36)	Thailand (37)
21	Samarinda	● Saw Logs	--	--	--	--	--		
		● Ply-Veneer Logs	--	--	--	--	--		
		● Chip-Board Logs							
		● Pulp-Paper Logs							
		● Sawnwood	--	--	58.25	--	--	--	--
		● Plywood-Veneer	--	--	--	--	30.0	--	
		● Chip-Board							
		● Pulp-Paper							
		● Residue-Fuelwood (Logging)							
		● Residue-Fuelwood (Industry)	--	--		--			
22	Balikpapan	● Saw Logs	15.60	120.00	12.00	102.00	108.00		
		● Ply-Veneer Logs	--	--	--	--	--		
		● Chip-Board Logs							
		● Pulp-Paper Logs							
		● Sawnwood	37.68	30.00	6.00	--	--	--	--
		● Plywood-Veneer	--	--	--	--	--	--	
		● Chip-Board							
		● Pulp-Paper							
		● Residue-Fuelwood (Logging)							
		● Residue-Fuelwood (Industry	2.88	--			2.56		
23	Tarakan/ Nunukan	● Saw Logs	--	--					
		● Ply-Veneer Logs	--	--					
		● Chip-Board Logs	--	--					
		● Pulp-Paper Logs	--	--					
		● Sawnwood	22.32	--	--	--	--		--
		● Plywood-Veneer	--	--	--	--	--		
		● Chip-Board	1.60	12.00	12.00				
		● Pulp-Paper	12.00	12.00					
		● Residue-Fuelwood (Logging)							
		● Residue-Fuelwood (Industry)							

TABLE B45 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Malaysia (38)	Saudi Arabia/ Middle East (39)	U.K. (40)	Netherlands (41)
21	Samarinda	• Saw Logs			--	--
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	24.17	--	--	--
		• Plywood-Veneer			--	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
22	Balikpapan	• Saw Logs			6.00	4.80
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	11.82	7.20	14.00	--
		• Plywood-Veneer		14.40	26.60	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
23	Tarakan/ Nunukan	• Saw Logs			--	--
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	--	--	--	--
		• Plywood-Veneer		--	16.59	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				

TABLE B45(cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point West Germany (42)	Italy (43)	Denmark (44)	Australia (45)	Canada (47)
21	Samarinda	● Saw Logs	--	--		--	
		● Ply-Veneer Logs			--		
		● Chip-Board Logs					
		● Pulp-Paper Logs					
		● Sawnwood	--	--		--	
		● Plywood-Veneer		--	--		28.60
		● Chip-Board					
		● Pulp-Paper					
		● Residue-Fuelwood (Logging)					
		● Residue-Fuelwood (Industry)					
22	Balikpapan	● Saw Logs	3.60	14.40		3.60	
		● Ply-Veneer Logs			6.00		
		● Chip-Board Logs					
		● Pulp-Paper Logs					
		● Sawnwood	--	17.49		2.40	
		● Plywood-Veneer		--	--		14.60
		● Chip-Board					
		● Pulp-Paper					
		● Residue-Fuelwood (Logging)					
		● Residue-Fuelwood (Industry)					
23	Tarakan/ Nunukan	● Saw Logs	--	--		--	
		● Ply-Veneer Logs			--		
		● Chip-Board Logs					
		● Pulp-Paper Logs					
		● Sawnwood	--	--		--	
		● Plywood-Veneer		--	--		--
		● Chip-Board					
		● Pulp-Paper					
		● Residue-Fuelwood (Logging)					
		● Residue-Fuelwood (Industry)					

TABLE B46. Optimal transportation (shipping) patterns of forest products from East Kalimantan: From local port to foreign (export) demand point under Alternative Strategy No. 4 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Singapore (25)	Japan (26)	HongKong (27)	S. Korea (28)	Taiwan (29)	U.S.A. (36)	Thailand (37)
21	Samarinda	• Saw Logs	--	--	--	--	--		
		• Ply-Veneer Logs	--	--	--	--	--		
		• Chip-Board Logs							
		• Pulp-Paper Logs							
		• Sawnwood	--	--	24.64	--	--	--	--
		• Plywood-Veneer	--	--	--	--	22.50	--	
		• Chip-Board							
		• Pulp-Paper							
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)	--	--			--		
22	Balikpapan	• Saw Logs	11.70	90.00	9.00	76.50	81.00		
		• Ply-Veneer Logs	--	--	18.00	81.00	76.50		
		• Chip-Board Logs							
		• Pulp-Paper Logs							
		• Sawnwood	44.78	22.50	4.00	1.80	--	--	--
		• Plywood-Veneer	--	--	--	--	--	--	
		• Chip-Board							
		• Pulp-Paper							
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)	--	--			--		
23	Tarakan/ Nunukan	• Saw Logs	--	--					
		• Ply-Veneer Logs	23.40	135.00					
		• Chip-Board Logs	7.20	--					
		• Pulp-Paper Logs	--	--					
		• Sawnwood	0.22	--	--	--	--		10.80
		• Plywood-Veneer	--	--	--	--	--		
		• Chip-Board	0.69	9.00	9.00				
		• Pulp-Paper	9.00	9.00					
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)							

TABLE B46(cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Malaysia (38)	Saudi Arabia/ Middle East (39)	U.K. (40)	Netherlands (41)
21	Samarinda	• Saw Logs			--	
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	--	23.21	--	--
		• Plywood-Veneer			16.26	
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
22	Balikpapan	• Saw Logs			4.50	
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	--	3.78	5.40	10.80
		• Plywood-Veneer			--	1.50
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
23	Tarakan/ Nunukan	• Saw Logs			--	
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	10.80	--	--	--
		• Plywood-Veneer			--	14.64
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				

TABLE B46 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point West Germany (42)	Italy (43)	Denmark (44)	Australia (45)	Canada (47)
21	Samarinda	• Saw Logs	--	--		--	
		• Ply-Veneer Logs			--		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer		--	--		32.40
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					
22	Balikpapan	• Saw Logs	2.70	10.80		2.70	
		• Ply-Veneer Logs			4.50		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	2.70	32.40		1.80	
		• Plywood-Veneer		--	--		--
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					
23	Tarakan/ Nunukan	• Saw Logs	--	--		--	
		• Ply-Veneer Logs			--		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer	--	--	--		--
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					

TABLE B47. Optimal transportation (shipping) patterns of forest products from East Kalimantan: From local port to foreign (export) demand point under Alternative Strategy No. 5 (in thousand m. ton pulp-paper products, and thousand cu.m of other products, per year).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Singapore (25)	Japan (26)	HongKong (27)	S. Korea (28)	Taiwan (29)	U.S.A. (36)	Thailand (37)
21	Samarinda	• Saw Logs			--	--			
		• Ply-Veneer Logs	--	--	13.00	--	--		
		• Chip-Board Logs	--	--			--		
		• Pulp-Paper Logs							
		• Sawnwood	--	--	--	--	--	--	--
		• Plywood-Veneer	--	--	--	--	37.50	--	
		• Chip-Board							
		• Pulp-Paper							
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)	--	--		--			
22	Balikpapan	• Saw Logs	19.50	150.00	15.00	127.50	135.00		
		• Ply-Veneer Logs	--	--	17.00	--	127.00		
		• Chip-Board Logs							
		• Pulp-Paper Logs							
		• Sawnwood	17.72	37.50	7.50	--	--	--	--
		• Plywood-Veneer	--	--	--	--	--	--	
		• Chip-Board							
		• Pulp-Paper							
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)	--	--			--		
23	Tarakan/ Nunukan	• Saw Logs	--	--					
		• Ply-Veneer Logs	39.00	225.00					
		• Chip-Board Logs	--	--					
		• Pulp-Paper Logs	--	--					
		• Sawnwood	8.74	--	--	--	--		--
		• Plywood-Veneer	--	--	--	--	--		
		• Chip-Board	--	15.00	2.48				
		• Pulp-Paper	15.00	15.00					
		• Residue-Fuelwood (Logging)							
		• Residue-Fuelwood (Industry)							

TABLE B47(cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point Malaysia (38)	Saudi Arabia/ Middle East (39)	U.K. (40)	Netherlands (41)
21	Samarinda	• Saw Logs			--	--
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	9.79	--	--	--
		• Plywood-Veneer			36.68	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
22	Balikpapan	• Saw Logs			7.50	6.00
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	35.21	--	18.00	--
		• Plywood-Veneer		--	--	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				
23	Tarakan/ Nunukan	• Saw Logs			--	--
		• Ply-Veneer Logs				
		• Chip-Board Logs				
		• Pulp-Paper Logs				
		• Sawnwood	--	--	--	--
		• Plywood-Veneer		--	11.71	--
		• Chip-Board				
		• Pulp-Paper				
		• Residue-Fuelwood (Logging)				
		• Residue-Fuelwood (Industry)				

TABLE B47 (cont'd.).

FROM: Port Point	Name	Product Type	TO: Foreign Demand Point West Germany (42)	Italy (43)	Denmark (44)	Australia (45)	Canada (47)
21	Samarinda	• Saw Logs	--	--		--	
		• Ply-Veneer Logs			--		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer		--	--		--
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					
22	Balikpapan	• Saw Logs	4.50	18.00	--	4.50	
		• Ply-Veneer Logs			7.50		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer		--	--		--
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					
23	Tarakan/ Nunukan	• Saw Logs	--	--		--	
		• Ply-Veneer Logs			--		
		• Chip-Board Logs					
		• Pulp-Paper Logs					
		• Sawnwood	--	--		--	
		• Plywood-Veneer		--	--		--
		• Chip-Board					
		• Pulp-Paper					
		• Residue-Fuelwood (Logging)					
		• Residue-Fuelwood (Industry)					