Working Paper

AFRICAN FOREST SECTOR DATA

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December 1984
WP-84-106

International Institute for Applied Systems Analysis
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FOREWORD

The objective of the Forest Sector Project at IIASA is to study long-term development alternatives for the forest sector on a global basis. The emphasis in the Project is on issues of major relevance to industrial and governmental policy makers in different regions of the world who are responsible for forest policy, forest industrial strategy, and related trade policies.

The key elements of structural change in the forest industry are related to a variety of issues concerning demand, supply, and international trade in wood products. Such issues include the growth of the global economy and population, development of new wood products and of substitute for wood products, future supply of roundwood and alternative fiber sources, development of new technologies for forestry and industry, pollution regulations, cost competitiveness, tariffs and non-tariff trade barriers, etc. The aim of the Project is to analyze the consequence of future expectations and assumptions concerning such substantive issues.

The research program of the Project includes an aggregated analysis of long-term development of international trade in wood products, and thereby analysis of the development of wood resources, forest industrial production and demand in different world regions.

This paper represents the African data to be used in the preliminary analysis in the Project. It was assembled primarily during the author's visit to the joint Forest Industries Advisory Group (FIAG) of UNDP, UNIDO, FAO, and ECA in Addis Ababa, Ethiopia. The work was supported by the Finnish Forest Research Institute.

Markku Kallio
Leader
Forest Sector Project

ABSTRACT

This paper offers basic forest sector data for North Africa, Sub-Saharan Africa and South Africa. Documentation of the sources and comments on the validity of the data is provided. In the cases where the data have not been valid, the assumptions underlying the estimates are provided. The data are in most cases for twelve products for the year 1980. In the future projections, however, this level of aggregation was not available. The data on forest resources are given separately for natural forests and plantations.

CONTENTS

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1. INTRODUCTION

This work is part of IIASA's Forest Sector Project's Global Trade Model (GTM) (e.g., Dykstra and Kallio 1984). The aim of the work was to produce a data-set that would fulfill at least the minimum requirements of the GTM. The data was gathered from publications, mimeographies and drafts and by interviewing experts on African forest sector.

The work was done in co-operation between The Finnish Forest Research Institute, IIASA, and FIAG, which stands for UNDP/UNIDO/FAO/ECA jointly funded Forest Industries Advisory Group which is located in Addis Ababa, Ethiopia. The author expresses greatest gratitude to Project Manager, Michael J. Lyons of FIAG, and his staff whose assistance was of most importance.

2. REGIONAL AGGREGATION

African countries have, in this work, been aggregated into three subregions: North Africa, Sub-Saharan Africa, and South Africa. Countries belonging to these subregions are:

North Africa:	Algeria, Egypt, Libya, Morocco, Tunisia
Sub-Saharan Africa:	Angola, Benin, Botswana, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Congo, Djibouti, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Ivory Coast, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Niger, Nigeria, Reunion, Rwanda, Sao Tomé and Principe, Senegal, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, Togo, Uganda, Upper Volta, Zaire, Zambia, Zimbabwe
South Africa:	Republic of South Africa

There are slight variations to this aggregation according to different data sources. However, these variations are not significant in the context of forest sector data.

The main reasons for this aggregation are economical, physical and regional. North Africa has little forest resources but strongly growing economical possibilities. South Africa has forest resources (mainly plantations) and a strong and stable economy whereas the apparent consumption of Sub-Saharan Africa is too small to allow any further disaggregation according to the minimum of 100,000 units (m^3 or ton) used in the model.

3. DATA

The data are provided for the following products:

Coniferous logs
Non-coniferous logs
Pulpwood
Fuelwood
Coniferous sawnwood
Non-coniferous sawnwood
Panels
Pulp
Newsprint
Other printing and writing papers
Household and sanitary papers
Packaging paper and boards

Panels are in some cases disaggregated into veneer, plywood, particleboard, and fiberboard. In demand forecasts this level of disaggregation is not available.

3.1 Production, Trade and Apparent Consumption

The data have been produced mainly from the Yearbook of Forest Products 1971–1982 (FAO 1984a). Exceptions to this are marked with an asterisk (*). Data are for the year 1980 (Table 1).

TABLE 1. Production, trade, and apparent consumption (mill. m^3, mill. ton, \$/m^3, \$/ton) in 1980. Main source: FAO 1984a.

North Africa	Production	Imports	Exports	Consumption	Imp.price	Exp.price
Logs (C)	0.1	0.1	0.0	0.2	105(*)	–
Logs (NC)	0.1	0.3	0.0	0.4	130	–
Pulpwood	0.2	0.0	0.0	0.2	20(*)	20(*)
Fuelwood	7.2	0.0	0.0	7.2	–	–
Sawnwood (C)	0.0	1.9	0.0	1.9	193	–
Sawnwood (NC)	0.1	0.2	0.0	0.3	238	–
Panels	0.2	0.3	0.0	0.5	356	–
Pulp	0.1	0.1	0.1	0.1	478	449
Newsprint	0.0	0.1	0.0	0.1	445	–
Other Prtg+Wrtg	0.1	0.1	0.0	0.2	759	–
Household+Sanit.	0.0	0.0	0.0	0.0	1909	–
Packaging	0.1	0.2	0.0	0.3	555	–
Sub-Sahara Africa	**Production**	**Imports**	**Exports**	**Consumption**	**Imp.price**	**Exp.price**
Logs (C)	1.3	0.0	0.0	1.3	124(*)	–
Logs (NC)	19.5	0.1	6.1	13.5	135	126
Pulpwood	1.8	0.0	0.1	1.9	–	30(*)
Fuelwood	367.6	0.0	0.0	367.6	–	–
Sawnwood (C)	0.5	0.1	0.1	0.5	225	138
Sawnwood (NC)	5.3	0.1	0.7	4.7	181	203
Panels	0.7	0.2	0.2	0.7	451	384
Pulp	0.6	0.0	0.2	0.4	458	276
Newsprint	0.0	0.1	0.0	0.1	555	–
Other Prtg+Wrtg	0.0	0.1	0.0	0.1	1072	544
Household+Sanit.	0.0	0.0	0.0	0.0	1245	–
Packaging	0.0	0.1	0.0	0.1	815	–
South Africa	**Production**	**Imports**	**Exports**	**Consumption**	**Imp.price**	**Exp.price**
Logs (C)	2.7	0.0	0.0	2.7	163	84
Logs (NC)	0.4	0.1	0.0	0.5	248	91
Pulpwood	3.8	0.0	0.0	3.8	20(*)	20(*)
Fuelwood	7.0	0.0	0.2	6.8	–	19
Sawnwood (C)	1.6	0.0	0.1	1.5	267	115
Sawnwood (NC)	0.2	0.3	0.0	0.5	264	151
Panels	0.3	0.0	0.1	0.2	544	234
Pulp	1.0	0.2	0.4	0.8	355	330
Newsprint	0.2	0.0	0.1	0.1	–	247
Other Prtg+Wrtg	0.2	0.1	0.0	0.3	786	577
Household+Sanit.	0.1	0.0	10.0	0.1	1828	801
Packaging	0.6	0.1	0.0	0.7	627	400

(*) IIASA estimate.

Production and trade figures for volume have simply been added according to the regional aggregation used for each product. Apparent consumption has then been calculated from these figures using the following formula

$$AC = PROD + IMP - EXP$$

where

AC =apparent consumption

PROD =production

IMP =imports

EXP =exports

Import and export prices have been calculated by adding up the value of import or export respectively for each product in the three subregions. This value has then been divided by added volume for each product in the three subregions, thus the prices are weighted averages of the prices in each subregion where volume of trade has been used as weight.

If there is no import or export price there have been no imports or exports. However, the figures for the volume of imports on exports may equal zero although there is a price for the product. This means that there have been imports or exports but the volume is less than 0.1 million m^3 or million tons.

3.2 Demand Forecasts

FAO's Programme in Outlook Studies for Supply and Demand of Forest Products has produced several forecasts for forest sector. Those available have been used here.

None of the forecasts are in the product aggregation level used in the GTM. The most usual product aggregates used are sawnwood (sometimes sleepers are included), panels (wood-based panels) and paper & paperboards (Tables 2 & 3).

The differences in the values for 1980 between the forecasts and the figures in Tables 1 & 2 are due to differences in the data-base used.

A detailed description of the methodology and assumptions on which the figures in Tables 2 and 3 are based, has been prepared by Rytkönen (1984). A similar description of the calculation procedure has been prepared by Viitanen (1984).

The high GDP forecast has been criticized heavily as being too optimistic, especially for Sub-Saharan Africa. In North Africa the high GDP forecast can be used as a very optimistic, but still possible development of economy.

TABLE 2. Demand forecasts for sawnwood & sleepers, wood-based panels and paper & paperboard. Volume (mill. m^3, mill. ton) and index (1980 = 100). Low GDP forecast.

Sawnwood & sleepers	1980	1985	1990	1995	2000
North Africa	2.2	2.6	3.2	3.9	4.7
	100	115	142	173	210
Sub-Saharan Africa	5.4	5.6	6.6	7.9	9.5
	100	103	122	146	176
South Africa	2.1	1.9	2.0	2.1	2.2
	100	92	95	100	105
Wood-based panels					
North Africa	0.5	0.6	0.7	0.9	1.1
	100	116	145	181	225
Sub-Saharan Africa	0.7	0.7	0.9	1.1	1.3
	100	106	133	160	196
South Africa	0.3	0.3	0.3	0.3	0.4
	100	107	112	119	127
Paper & paperboard					
North Africa	0.7	0.8	0.9	1.0	1.1
	100	120	133	148	164
Sub-Saharan Africa	0.6	0.6	0.7	0.8	1.0
	100	116	131	150	172
South Africa	1.1	1.1	1.2	1.3	1.4
	100	104	109	118	127

TABLE 3. Demand forecasts for sawnwood & sleepers, wood-based panels and paper & paperboard. Volume (mill. m^3, mill. ton) and index (1980 = 100). High GDP forecast.

Sawnwood & sleepers	1980	1985	1990	1995	2000
North Africa	2.2	2.6	3.4	4.4	5.7
	100	115	152	195	254
Sub-Saharan Africa	5.4	5.6	7.1	9.0	11.7
	100	103	130	166	215
South Africa	2.1	1.9	2.0	2.2	2.3
	100	92	96	102	109
Wood-based panels					
North Africa	0.5	0.6	0.8	1.0	1.4
	100	116	159	212	288
Sub-Saharan Africa	0.7	0.7	1.0	1.3	1.7
	100	106	143	187	248
South Africa	0.3	0.3	0.3	0.3	0.4
	100	107	113	122	132
Paper & paperboard					
North Africa	0.7	0.8	0.9	1.1	1.2
	100	120	138	159	184
Sub-Saharan Africa	0.6	0.6	0.8	0.9	1.1
	100	116	138	166	201
South Africa	1.1	1.1	1.2	1.3	1.5
	100	104	111	122	133

In another set of projections, low GDP growth forecasts have been used (FAO 1984b). The projections are only for sawnwood and wood-based panels (Table 4). The data on which these projections are based, is basically the same that has been used to produce the forecasts presented in Table 2. The differences are mainly caused by different methodology used to estimate income elasticities, but also by use of lower starting values for the projections.

3.3 Costs of Production and Capacities of Processes

Costs of production figures are mainly unofficial estimates provided by FIAG (Tables 5 and 6). Some examples have also been used for checking the relevance of the estimates (Doffiné-Consult G.m.b.H 1977, Bison-Werke Bähre & Greten G.m.b.H & Co KG 1976, Defibrator Fiberboard AB 1976).

TABLE 4. Projected consumption of sawnwood & sleepers and wood-based panels. Volume (mill. m^3) and index (1981 = 100).

Sawnwood & sleepers	1981	1985	1990	1995	2000
North Africa	3.2	3.7	4.5	5.4	6.6
	100	116	141	171	209
Sub-Saharan Africa	5.8	5.8	6.9	8.3	10.1
	100	101	120	144	175
South Africa	2.1	2.2	2.5	2.8	3.2
	100	105	115	131	150
Wood-based panels					
North Africa	0.6	0.7	0.9	1.1	1.3
	100	124	160	199	240
Sub-Saharan Africa	0.6	0.7	0.9	1.1	1.3
	100	110	141	175	210
South Africa	0.3	0.4	0.5	0.6	0.8
	100	120	155	210	274

TABLE 5. Average wood costs delivered at mill in Sub-Saharan Africa ($/$m^3$l).

	Natural forests	Plantations
Coniferous logs	60	50
Non-coniferous logs	100	50
Pulpwood	15	15

TABLE 6. Production costs (%, $/$m^3$).

	Raw material	Labor	Energy	Capital costs	Others	Total
Sawnwood	40%	25%	5%	10%	20%	80.0
Veneer sheets	40%	10%	30%	20%	0%	200.0
Plywood	25%	5%	25%	15%	30%	240.0
Particle board	10%	5%	25%	30%	30%	150.0
Fiberboard	10%	10%	30%	25%	25%	(*)200.0

(*) $/ton

Although the figures are provided in a quite disaggregated level, it is strongly recommended to use them at the aggregated level labeled "total costs." This is due to the fact that the figures are usually based on only a few cases which have been considered by FIAG to represent the whole subregion.

In the case of labor costs the data have been gathered from Annual Labor Statistics (ILO 1980), which includes information on only a few African countries. Some of these figures have been corrected accordingly to criticism received from FIAG.

There is no commercial chip production in Sub-Saharan Africa, hence there is no price for chips.

Final product capacities and costs are mainly estimates received from FIAG. The use of the concept of capacity was strongly criticized by both FIAG and UNIDO. The main reason for the criticism was that, especially in Sub-Saharan Africa, the given capacity is seldom achieved. This is because the capacity figures are given for a new mill using ideal raw material. The mills are often old and the quality of the raw material in use is far from ideal.

However, the capacity was estimated roughly to be two times the amount of production on average. The future development of capacities can accordingly be estimated by multiplying demand forecasts by two. The use of the demand forecast as a production forecast is based on the assumption that in Sub-Saharan Africa production must, in general, follow the demand because those countries cannot afford to import forest products, at least not in significant amounts and not over a long period of time.

Energy supply and costs for Sub-Saharan Africa are provided by FIAG (Table 7). These are again estimates, but reliable ones. The most important thing is the heavy increase of wood and wood residues as a source of energy by decreasing the use of oil. As oil is usually imported' and wood and wood residues are not (in the case of residues not even paid for), it is probable that the energy costs of the wood industries will decrease by the year 2000.

Unit prices of these energy types were in 1980

- Electric power 0.07 US$/Kwh
- Heavy fuel oil 200 US$/ton

As stated earlier, wood residues are usually not bought from outside the mill and therefore do not have a price.

Labor costs are derived from the Yearbook of Labor Statistics (ILO 1980) (Table 8). Information was available only for few African countries in all manufacturing industries and the case was still worse with forest industries. The figures for forest industries in Sub-Saharan Africa are not entirely reliable, according to FIAG. South African figures are from the *Official Yearbook of the Republic of South Africa* (South Africa 1984).

As the figures were for years 1975 and earlier, the 1980 figure has been calculated by taking the average annual growth during years 1971–1975 and using that in predicting for the period 1976–1980.

TABLE 7. Energy mix for mechanical wood industry in Sub-Saharan Africa (%).

	1980	1990	2000
Electric power	15	20	25
Fuels total	85	80	75
Oil	80	70	35
Wood & wood residues	5	10	40
Total	100	100	100

TABLE 8. Labor costs ($/working hour).

	All manufacturing industries		Forest industries	
	1975	1980	1975	1980
North Africa	0.5	0.7	1.1	1.5
Sub-Saharan Africa	0.4	0.6	0.3(*)	0.4(*)
South Africa	–	2.1	–	1.2

(*) estimate by FIAG.

3.4 Conversion Factors

The conversion factors have been taken from the report "Development of Tropical Forests and Forest Industries in Africa" (Thege 1984). The figures are for Cameroon, but they have been considered by FIAG to represent an average for whole Sub-Saharan Africa (Table 9).

One should pay attention to the facts that there are no chips used in forest industries in Sub-Saharan Africa and that almost all of the residues are used as fuelwood.

3.5 Forest Resources

3.5.1 Natural forests

The data for natural forests in Sub-Saharan Africa are for productive closed forests (Table 10). The data is given separately for broadleaved and coniferous species. The data for year 1980 and the forecast to year 1985 have been adopted from *Forest Resources of Tropical Africa* (FAO 1982).

The forecasts beyond year 1985 have been calculated for both species separately using the following formula:

$$V_{t+1} = (A_t - D)(G + S)$$

TABLE 9. Matrix of conversion factors (m^3).

Processes / Products	NI Plantation (C)	NI Plantation (NC)	I Plantation (C)	I Plantation (NC)	Natural forest (C)	Natural forest(NC)	Logs to pulpwood	Logs to fuelwood	Pulp to fuelwood	Sawnwood (C)	Sawnwood (NC)	Panels	Veneer	Plywood	Particleboard	Fiberboard
Logs (C)			+1		+1		−1	−1		2.00		−				
Logs (NC)				+1		+1	−1	−1			2.22	−	1.90	2.30		
Pulpwood (C)	+		+		+		+1		−1			−				
Pulpwood (NC)		+		+		+	+1		−1			−			2.00	2.00
Fuelwood	+	+	+	+	+	+		+1	+1	+	+	+	+	+		
Sawnwood (C)										+1						
Sawnwood (NC)											+1					
Panels												+1				
Veneer													+1			
Plywood														+1		
Particleboard															+1	
Fiberboard																+1

* NI – Non-industrial, I – industrial.

TABLE 10. Development of natural forests in tropical Africa.

	Productive closed broadleaved		Productive coniferous	
	Area (mill. ha)	Volume (mill. m^3)	Area (mill. ha)	Volume (mill. m^3)
1980	161.7	38723	0.6	66
1985	155.5	37378	0.6	64
1990	149.2	35872	0.5	61
1995	143.0	34365	0.5	58
2000	136.7	32859	0.5	55

where

t = time, years
V = volume, mill. m^3
A = area, 1000 ha
D = deforestation rate, 1000 ha/year
G = growth rate, m^3/ha/year
S = standing volume/area, m^3/ha

Variables D, G and S are time invariant. This is important to note especially in the case of annual deforestation rate if the forest resources of a country approach zero. Also, growth rate and standing volume/area vary according to the stage of the forest.

The problem of the latter two variables can be treated by using a weighted average of all the observations for standing volume/area and for growth rate. The main driving force behind deforestation rate is the need for new agricultural land which, in turn, is closely linked with population growth and intensity of agriculture. As no major changes in either of these two are likely to occur during 20th century, I have used the estimated deforestation rate of years 1981–1985. (We can assume that the increased intensity of agricultural activities is cancelled by the exponential population growth).

An average growth rate of 1 m^3/ha/year has been used. This is at the same time considered as "the volume theoretically available every year" (FAO 1982) in order not to overuse the forest resources. Standing volumes 239.4 and 112.8 m^3/ha and deforestation rates 1253 and 5 thousand of ha/year have been used for broadleaved and coniferous forests respectively.

The estimated (low) demand for wood in Sub-Saharan Africa in year 2000 is 746 mill.m^3 (Viitanen 1984) whereas the supply, according to annual growth would be only 136.7 mill.m^3. Although much of the fuelwood comes from other sources, there will still be a shortage of raw material. The shortage of fuelwood will mainly concentrate on the Sahal region and East Africa. The shortage of industrial wood will be worst in West African countries which are Africa's main log and sawnwood exporters (Nigeria, Ivory-Coast, Ghana and Liberia).

North Africa does not have any significant natural forest resources. The existing resources are concentrated on Morocco and Algeria and they are mainly montane forests.

In South Africa, heavy exploitation in the past has virtually exhausted supplies of marketable timber from natural forests.

3.5.2 Plantations

The data for plantations are provided separately for industrial and non-industrial plantations (Table 11). Industrial plantations are further separated into hardwood and softwood classes. The data source for Sub-Saharan Africa is *Forest Resources of Tropical Africa* (FAO 1982) and for South Africa the *Official Yearbook of the Republic of South Africa* (South Africa 1984).

TABLE 11. Existing plantations in year 1980 (1000 ha).

	Industrial plantations		Non-industrial plantations
	Hardwood	Softwood	
Sub-Saharan Africa	456	541	784
South Africa	505	590	na.

Three different scenarios are given for the industrial plantations in Sub-Saharan Africa in the year 2000 (Table 12). The first scenario is based on the average planting rate calculated from existing data (scenario 1). In scenario 2, the annually planted amount is assumed to be equal to the annually deforested area. The deforested area is allocated to industrial and non-industrial plantations according to their shares in year 1980. As industrial plantations produce approximately 10 and non-industrial ones 5 times as much as natural forests the allocated areas have been divided respectively by these figures. Therefore the plantations would produce as much wood as the deforestated area did. In the third scenario the plantations are assumed to fulfill the projected demand.

Average productivity of 10 m^3/ha/year has been used for industrial and 5 m^3/ha/year for non-industrial plantations.

In South Africa the area of industrial plantations has been assumed to remain in the level of 1980. This is based on the facts that first, South Africa will have enough plantations to fulfill the demand and second, the existing plantations would fulfill the projected demand of year 2000.

It is suggested to use the first two scenarios in GTM.

TABLE 12. Projections for plantations in Sub-Saharan Africa to year 2000 (1000 ha).

	Industrial plantations		Non-industrial plantations	
	1980	2000	1980	2000
Sub-Saharan Africa				
Scenario 1	997	1359	784	1069
Scenario 2	997	1409	784	2214
Scenario 3	997	2767	784	143616(*)

(*) fuelwood supply would be totally fulfilled with output from plantations.

4. CONCLUSIONS

The forecasts promise a quite strongly growing economy and thus high demand for forest products in North Africa. As the region's forest resources are extremely small, this implies either increased imports of end products or imports of roundwood combined with investments in forest industries.

In Sub-Saharan Africa, especially in West Africa, there will be a shortage of roundwood. Due to this shortage the exports from the region will decrease sharply by the year 2000. As no sudden shifts are projected to take place in the region's economy, the demand for forest products will also remain at a low level.

The demand and supply of forest products are and are projected to remain in balance in South Africa. All roundwood is taken from plantations and used inside the region.

Africa's share of production and consumption and impact on international trade in forest products will globally remain small.

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