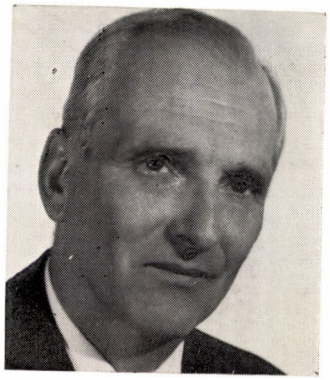
WORLD CONSUMPTION OF WOOD

trends and prognoses

by András Madas

Akadémiai Kiadó, Budapest



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Today, one quarter of the Earth's surface is covered by forests, the least polluted part of nature. Being the only reproduceable raw material, wood is especially important on account of the limited availability of other, unreproduceable raw materials.

Dr. Madas, Chairman of the Timber Committee of the European Economic Commission, presents an overall review of the world's forests, and forecasts their possible development up to the year 2000. He relies upon the results of theoretical analyses, various plans, FAO—ECE publications, and works by renowned forestry economists. He concludes that a harmonious combination of the various functions of forests may lead to their optimum utilization.

It appears from his forecasts that by the year 2000 the *total* forest area of the world will have to be exploited. (Today only forty per cent is utilized!) Highly interesting are the chapters dealing with the resources in Siberia and Canada for the foreign trade of the near future and with the vast reserves of South America and South-Eastern Asia, which will enter into consideration presumably in the later decades, i. e. in the years of the general economic expansion of these regions.

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by

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FOREWORD

Wood as a raw material is one of the most vital natural resources of man, comparable only to ores, oil and coal but, unlike these, it is renewable.

Its very long production cycle that may sometimes extend over a century, as well as the diversified role of forests in economic and social life, induced progressive-thinking forestrymen more than a hundred years ago to urge the application of various forms of long-term planning and legal regulation of forestry activities in order to limit the owners' individual decisions in the interest of the community and the protection of forests. Indeed, forestry is the very field where forecasting, central regulation and planning of economic processes were first applied.

In the economically advanced countries of our time, long-term forecasts and hypotheses regarding the future of forestry are also elaborated on a national scale, the more so in recent years. They aim partly to ensure the supply of wood in the required quantities and qualities for the rapidly growing future generations so as to meet the expectable demand and partly to make accessible the beneficial effects of forests on soil, water, air and on human environment as a whole, including the rich opportunities they are offering for recreation and relaxation to an increasing number of people.

I learned to love the forest as a child, from my grandfather who was for half a century the chief forester of the town of Sopron in Western Hungary. It is mainly the result of his work that the forests of this town now fortunately combine efficient wood production with protective and environmental benefits. His successors (with my father among them) have continued to develop the Sopron forests in the same spirit, in order both to increase wood production and to offer new opportunities for recreation and tourism.

After World War I Sopron became Hungary's centre for training forestry engineers and it still fulfils this role. I also spent my university years in this town where, partly by observing the methods and results of my ancestors' work in practice, partly owing to the theoretical education provided by excellent professors, I was able to obtain most of the practical and theoretical foundation I could rely upon during my life's work.

I happened to assume a leading economic position at a relatively young age. In 1949 I was made responsible for agricultural and forestry planning in the National Planning Office of my country. In the course of my work I also had the honour of taking part in the work of several international agencies. Then, in 1972, I became a deputy minister in the Ministry of Food and Agriculture, where part of my work

consists in maintaining international relations. Experience gained in the practice of planning, in the analysis of European and world problems related to forestry and the wood industry, and particularly in my work of about twenty years spent on behalf of the Timber Committee of the ECE, encouraged me to sum up what I have to say in this field. This is what I tried to do in the present book, and I hope that some of my readers will find incentives in the ideas expounded and will help in promoting their implementation.

The author

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CHAPTER 1

FUNCTIONS OF THE FOREST

1.1. THE THREEFOLD FUNCTION OF PRODUCTION, PROTECTION AND RECREATION

In 1960, the leading forestry experts of the world convened in Seattle, Wash., USA, at the Fifth World Forestry Congress. The main theme of this Congress was "The Multiple Use of Forests". In several respects this meeting represented a turning point in the formation of views and conceptions relating to forestry. Formerly, the way of thinking of forest experts was characterized by a good deal of conservativism. Only the rapid evolution following World War II has made it increasingly clear both to experts and to politicians that the forest and timber economy is an organic part of the national economy as well as of world economy as a whole, and that it has to meet several requirements of mankind to an ever increasing extent. The Sixth World Forestry Congress was held in 1966 in Madrid, and FAO suggested as its central topic "The Role of Forestry in the Changing World Economy". This proposition, and even more the discussions which took place about it, emphasized the fact that the general world trends of economic, political and social evolution have irrevocably burst the framework of traditional, mostly static conceptions on forestry which was primarily concerned with the conservation of growing stocks, and that a new, more dynamic and flexible approach was needed which could fit organically into the rapidly developing, continuously changing world economy, first of all through the productive function of forestry.

The central theme of the Seventh World Forestry Congress held in 1972 in Buenos Aires was "Forests and Socio-Economic Development". As stated in its Declaration, this Congress examined many facets of contemporary challenges: how to accelerate economic and social progress and maintaining or enhancing the quality of the environment at the same time, having recognized that the aspiration to raise living standards often finds expression in forms that threaten the environment.

The Congress believed that the Plan of Action formulated by the United Nations Conference on Human Environment in Stockholm in 1972 would influence forestry development throughout the world in the years to come. It stressed that "whatever the political objectives, whatever the form of economic organization, whatever the present patterns of forest land tenure, governments are responsible for planning the continuous flow of the productive, protective and social goods and services from the forests, ensuring that the physical output and the environmental benefits of the forests are available for the general welfare of their peoples now and for all time".

The Congress did not share the view of the futurologists who had become prophets of doom. It was fully confident that the need of the world for an ever increasing flow of goods and services from the forest can be ensured through the rational management and valorization of existing forests and through the creation

of new man-made forests. The Congress was also confident "that the governments and people of the world were capable of achieving this task, simultaneously with the task of ensuring not only maintenance but enhancement of environmental quality". Members of the Congress unanimously pledged their unstinted contribution to these targets.

This Declaration shows clearly the extent to which the direct relations between man and forests and, besides their productive function, their protective and recreational functions are coming to the fore. The gradual change in approach consists in the increasing attention paid to the "indirect" effects and benefits of forests, irrespective of their economic usefulness. This is due partly to the growth in world population much accelerated during the post-war demographic explosion, partly to the improvement in living conditions. Both tend to emphasize the want for recreation and people's desire to get away, if only for short holidays, from their noisy environment where both air and water are unprecedentedly polluted by the rapid growth of industry.

Although in all developed countries the necessity of protecting natural environment and of recreational facilities has been more or less intensively discussed, it is only quite recently that the whole complexity of problems has won the simultaneous attention of national and international organizations, politicians, sociologists, futurologists, economists, planners, forestrymen, builders, transport and hydrologic experts, and journalists.

The role of forests in the protection of human environment is vital, for in our days they represent the most untouched, least polluted part of nature. Thus, forestry experts must participate adequately in the ever-increasing efforts aimed at the protection and rehabilitation of human environment. These growing requirements provide an opportunity for them to show what they can do in putting the forests at the service of society, hoping that society in turn will provide the moral and financial support needed by forestry for accomplishing these functions.

But in order to succeed, we must carefully assess what forestry is able to offer and at what costs; and we must also allocate the available resources wisely. Otherwise all we can expect is the continuation of futile debates without any hope of satisfying the needs of society. If, however, clear accounts were made, no doubt all individuals, production units and national economies would be prepared to bear the costs proportionally.

Efforts aimed at formulating the relevant theoretical principles and measuring the indirect effects of forests in terms of money have only been started recently, both in Hungary and abroad. The sylvicultural faculties of the universities are just starting to create chairs dealing with the relations between forestry and environment and to encourage the work of the few full-time experts. Therefore, the number of papers, data collections, models etc. utilizable in national planning or operative control of forestry is relatively small yet. Every contribution is welcome that may help to clear up notions and definitions, to measure the indirect effects of forests, to fit this set of phenomena into the theory of economic growth, and to establish clear-cut conceptions regarding the future role of forests.

An approach, still frequently occurring, distinguishes between the "direct" and the "indirect" benefits of forestry; sometimes the indirect ones are called its "welfare effects". This distinction seems to be no longer satisfactory; we ought to de-

fine more elaborately and with greater exactness the various effects of forestry, as well as the social requirements it has to meet.

Moreover, our analysis must be comprehensive, including all economic branches that are in some way or other connected with forestry and forest products. In the past, the forestry, the wood-processing industries and the branches trading in wood products formulated their development conceptions and plans independently, or observed some loose interdependence only. When, however, economic development approaches the stage where the "intensive" type of growth begins, the activities of these branches become increasingly intertwined. Long-term planners are confronted with a host of questions that can be examined and decided upon only by a more sophisticated approach, assessing the situation and prospects of all branches concerned: e.g., what quantities of timber, in what qualities and at what prices will be needed; what kind of technological change may be expected in the various processing industries; how the processing of the types of wood still insufficiently used will develop; what the prospects of export will be, how the competition between wood and the substituting materials will evolve, etc. It will, therefore, become necessary for the practice of planning to introduce a new and broader notion of "forest and timber economy" that should include (1) *forestry,* i.e. the production, felling and removal of wood, as well as all other physical and immaterial benefits deriving from forests, (2) the *primary processing of wood* including the sawmilling, the panel-producing and the pulp and paper industries, (3) the *secondary processing* industries, making furniture, building accessories, packing materials, matches and other products, and finally (4) the *domestic and external trade* dealing with wood and wood products. Thus the notion of forest and timber economy includes several economic branches and industries that were formerly dealt with under separate headings in the traditional system of statistical accounting. In this case, it is the *product* that is common to all activities and unites them into what is often called a "block" in the terminology of this new system of analysis. Only in this way does it become possible to consider all relevant activities, starting from production and ending with final use, as links of a single vertical chain. All this makes it necessary to elaborate the questions of methodology more exactly and distinctly.

Requirements arising against forests and forest products may be divided into three groups according to the three principal functions of forests, namely, production, protection and recreation.

1.1.1. PHYSICAL PRODUCTS OF FOREST AND TIMBER ECONOMY

To the sphere of physical production belong, in addition to production proper, all activities which serve to forward the products to the final user or facilitate final use. Under modern circumstances it is becoming increasingly difficult to separate "production" from "services"; their methodological distinction is far from uniform. Also in the forest and timber economy, it is hardly possible to separate the two kinds of activities unequivocally. However, it would be desirable to reach an international agreement on some kind of grouping in order to establish a uniform statistical approach as soon as possible. This would help governments in reviewing their requirements and resources in comparison with those of other countries, and to take their decisions accordingly.

In the following, we shall include in the sphere of production the activities of
- wood production,
- contribution to the water supply,
- hunting,
- pasture and other complementary uses.

This means that all activities which, by the use of human labour and material means, contribute to the output of some marketable products belong under this heading. The first and most important of all these is wood production.

First, forests themselves should be grouped from an economic point of view, by carefully considering both practically and theoretically the circumstances in each country. It should be done according to the conditions of an economically efficient wood production (if they are present or might be created), or to some other primary aim, like soil protection, water economy, recreation etc. (if these are preferred). The methods of managing forests of different destination may vary to a considerable extent, and so may the origin of the financial resources of management.

Water economy is meant here in its whole complexity, including also the management of forests covering watersheds which may significantly influence the amount of water supplied by the rivers.

Hunting, pasture and other complementary uses of forests also belong to the sphere of production. Someone may doubt whether hunting should be classed here. In our opinion, it meets all the criteria mentioned above, since there is an ever increasing interest in hunting as a sport, now accessible to wide strata of the population, moreover, some people are ready to pay for hunting opportunities, so that gamekeeping forestry can be made a lucrative enterprise. Furthermore, a certain equilibrium has to be maintained between gamekeeping and other uses of the forests, so that none of them should expand to the detriment of others. At present, in most places where conditions are suitable, the maximum of the aggregate net income from wood production and hunting is being strived after.

All costs emerging in the sphere of production should be covered from the income resulting from the sale of products.

1.1.2. ROLE OF FORESTS IN PROTECTING HUMAN ENVIRONMENT

The protective functions of forests are the following:
- protection of wildlife,
- protection against damage caused by water,
- protection against wind erosion,
- protection against water and air pollution,
- protection against noise,
- production of oxygen.

Protection of wildlife is a highly important function for in our days forests represent the last and still more or less untouched refuge of the original ecosystem that existed before the advent of man. It aims to protect or rehabilitate plant and animal species which man has brought near the edge of extinction, to conserve greater units of natural environment (national parks), of historical relics, etc. in the interest of science and general education. The other functions help to protect people, human dwellings, public or industrial establishments and arable land

against damage caused by water, wind, pollution of air and water, and noise. It is characteristic of all these functions that

a. they increasingly influence the living conditions of human beings;

b. they influence – directly or indirectly – some production processes, though such effects cannot be measured numerically;

c. investments serving such purposes (e.g. planting of tree groups, protective belts and forests) start to exert their effects many years after their implementation, so that there is a considerable time lag between the occurrence of costs and benefits;

d. investment and maintenance costs cannot be charged to an unequivocally definable group of "users";

e. protection against environmental damage becomes increasingly a part of government policies serving the improvement of living conditions.

In all advanced countries, living standard policies now place less emphasis on maintaining the former growth rates of material consumption than on ensuring an adequate environment, pure water and air, and silence.

The functions of forests in this field are characterized by the following common features:

a. none of them creates new values, but all meet some vital needs of society and its members;

b. since they serve direct or indirect long-term interests of the community, their planning must not depend upon short-term considerations or partial interests of individuals or enterprises;

c. their realization takes place, in general, as a result of decisions taken by the government or some competent local authority;

d. regarding the forests themselves as well as all relating auxiliary equipment, all operations and technologies must be strictly subordinated to the objective of protection.

It follows from these features that the protective functions of forests have to be classed into the sphere of "services".

The part of national wealth serving the protective functions of forests should be considered as belonging to the category of "infrastructure". According to Csernok, Ehrlich and Szilágyi [7], infrastructure means a distinct part of national wealth that does not serve directly either the production or the use of material goods but is necessary for ensuring the smooth flow of the processes of production, distribution and consumption on the prevailing level of economic development and technology. In this sense, infrastructure is part of the nation's accumulated stock of physical capital goods. To this, the available amount of "human capital" is added, which must be proportional to the amount of physical capital. The infrastructural stocks of physical and human capital are combined in what we may call services.

In the terminology of political economy "services" mean social activities that, though not producing material goods in a direct way, meet some more or less important needs of the society and its members. The nature of services may be physical or non-physical. To the first group belong some activities performed in industry or agriculture, which, though having the character of services, are closely connected with the production of physical goods, as they are aimed at making these goods more suitable for final use.

Accordingly, the protective function of forestry may be classified as belonging to the group of *physical services.*

As a rule, these functions of forestry serve the interests of large communities rather than those of individual persons or enterprises. Forests planted for protection begin to exert their effects only gradually, and it is very difficult to express such effects in terms of money. It is even more difficult to allocate and charge their investment and maintenance costs on the various categories of beneficiaries. It is clear, however, that their importance for society as a whole is increasing. Accordingly, their investment, maintenance and operation costs have to be considered as social costs and be covered, as a rule, either by the state or some local authority, depending on the extent and importance of the function in question. When such forests are operated by an enterprise, social costs may be covered by state or local subsidy.

1.1.3. ROLE OF FORESTS IN RECREATION

The third function of forests consists in meeting some part of the rapidly growing demand for recreation. Particularly since the late 1960's, this demand has grown to such an extent that in many advanced countries as well as in some international organizations it is believed to have almost the same importance as the production of wood.

The recreational functions of forests may be distinguished as follows:

a. forests, groves, parklands, riversides, lakes etc. situated in the vicinity of urban districts serving the crowd of *weekend visitors* arriving by public transport or private motor car; they have to meet recreational demands at different levels according to the pocketbooks and dispositions of the various visitors;

b. larger recreational areas (e.g., mountains, lakes, reaches of streams or rivers etc.) situated at a greater distance from urban concentrations, which, owing to natural beauty or bathing, have touristic and sporting opportunities suitable for spending longer holidays in summer or winter (in favourable cases all the year); these have to meet the diversified requirements of holidaygoers;

c. regions, forests, mountains etc. provided with foot paths, rest-houses, hostels etc. serving the purposes of walking tourism;

d. regions provided with roads, lanes, motels, inns, campings etc. serving the purposes of motoring.

At the early stages of economic development, demand for recreation arose mostly on the part of walking tourists whose needs had no significant impact on the economic management of forests; at least they did not try to change, by the pressure of public opinion, its methods aimed at profitability. (In some cases, e.g., the stoppage of quarrying in certain beauty spots threatening to disfigure the scenery was attained after many years of social protest, but these cases were outside the sphere of forestry.) At this stage, the need for revealing the recreational functions of forestry theoretically and for drawing the conclusions implied was not yet felt.

In our days, however, the steady rise in living standards enables people to start every summer a veritable mass migration by motor car, railway, bus, ship and aeroplane. This not only means increasing requirements for roads, public transport and catering, but an increasing burden on forestry as well, and makes it necessary to clear up the recreational functions of the latter unequivocally.

This function is evidently a *service*, aimed at meeting, to the greatest possible extent, the recreational demand of the masses which increases both quantitatively and qualitatively in proportion with the rising living standards. In order to meet this demand, forestry must face extra costs and/or renounce part of its incomes. The difference can be charged directly or indirectly to those who enjoy the benefits of recreation. Therefore, the following may be said as regards the recreational functions of forestry:

a. in advanced countries recreation is an important element of improving living conditions, and the rapidly growing demand for recreation facilities should be met, to a certain extent, also by the forests which serve mainly for the purposes of either production or protection;

b. in forests located in the vicinity of urban districts and particularly suitable for recreation, this should be considered as the *primary* function, with production as a secondary purpose;

c. the utilization of forests for recreational purposes has to be regulated partly by national and partly by local legislation, in order to prevent individual interests of an enterprise or of private owners from hindering this kind of utilization of forests which would seem particularly important for recreation;

d. extra costs or income losses connected with such utilization should be carefully assessed, and charged directly or indirectly to the users;

e. one way of indirect charging would be that the state, in the framework of its social policy, would grant the forest managements a tax reduction (or a subsidy) to cover the extra costs or losses caused by the recreational function; direct charging may take various forms like tolls and fees on the use of forest roads, parking places, camping sites, fire-laying places, etc.

It is important to distinguish and define the three main functions of forests, both for choosing the technologies to be applied and for finding the coverage of the costs. In reality, however, these functions will but rarely occur separately, in pure form; in most cases they are combined and appear with varying weights. The question of proportions is often decisive. In forestry, the effects of a mistake once committed may last for decades. Thus, when establishing the long-term strategic objectives of forest management, one has to start from the requirement of optimizing the multiple utilization in the long run. The demand for a long-run optimum does not mean neglecting the present needs, it rather means that we must not meet the present needs at the cost of the coming generations, by making irreparable mistakes.

1.2. PLANNING IN THE FOREST AND TIMBER ECONOMY

The national-economic and social importance of the various functions of forests, the very long cycle of wood production (up to a hundred years), and the high capital-intensity of the processing industries make it necessary for the socialist countries having centrally planned economies to plan the activities of the forest and timber economy as a whole, in consideration of the interdependence and mutual effects among its branches; but the necessity of long-term prognoses is being increasingly felt also in the "free-market economies". This recognition induced the leaders of the FAO to organize, in the spring of 1971, a seminar for the

English-speaking forestry experts of the African and Central American countries, dealing with the planning problems of the forest and timber economy. On the grounds of a lecture held by the present author on this occasion, the main problems of planning the sector of the forest and timber economy in socialist countries may be briefly summed up in the following (see Madas [48, 49]).

1.2.1. PLANNING IN THE SOCIALIST COUNTRIES

In the socialist countries, the overwhelming part of the means of production is in social ownership and is managed by state-owned enterprises or cooperatives. In this way, a comprehensive planning of the whole process of social and economic development is made possible and also necessary. In implementing the fundamental development objectives established by the central leadership, one of the most important instruments is economy-wide planning, dealing with all significant factors and processes of social and economic development, like the improvement of living conditions, the availability of natural resources, means of production and manpower, the development of production, the use of output for accumulation, domestic consumption and exports, the import needs, the price and credit policy, etc.

The general directives of the central plans are determined by the highest party and state organs. They contain the main objectives of economic, social and cultural development, including the country's relations with the rest of the world. The plans themselves are then elaborated by the central planning organs.

The implementation of central plans may take place either through centrally issued obligatory instructions, or through a system of economic regulators acting indirectly on the economic units. As a rule, a combination of the two methods is applied. In some socialist countries the implementation of the national economic plan is based mainly on centrally issued direct and obligatory instructions; others believe that an extensive application of adequately differentiated economic regulators acting indirectly is more expedient.

The combination of direct instructions and economic regulators provides the framework within which economic units can perform their activities. People employed in these units are made interested in implementing the plan of their unit by various incentives, affecting their personal and collective incomes. Some of these incentives are valid for all enterprises, others for certain economic sectors only.

In the process of planning, the top leadership establishes the main objectives and the central planners assess to what extent the existing productive capacities will have to be increased during the plan period. Thus, the targets of economic policy are confronted with the resources available for their implementation. To this end, various alternatives are analyzed, until some near-optimum solution is found, which is then embodied into the national plan.

Thus the three main elements of planning on any level are (1) the establishing of objectives, (2) the accounting of limiting factors and (3) the choice of the best alternative.

According to the period covered, it is customary to distinguish (1) prognoses covering, as a rule, more than 15 years, (2) long-term plans (10–20 years), (3) medium-term plans (4–7 years) and (4) short-term plans (1–2 years).

Prognoses forecast social, technical and economic trends expectable in the plan period. They represent an important part of the planning process and of central economic management in general. They usually precede the establishing of the plans proper, and sometimes only prognoses are made for the more distant future. The methods of prognosis may be different, e.g.,

- various estimates,
- logical models relying on the methods of historical analogies,
- trend calculations with extrapolation of time series,
- trend calculations based on the level of development attained,
- mathematical models,
- determination of the final situation with the aid of normatives.

Long-term plans deal essentially with the strategy of developing the social and economic structure of the country. Their main purpose is to establish the most important economic proportions to be created by the end of the plan period. Here the elements of development conceptions are dominating. In a long-term plan the freedom of decision is much greater than in the medium or short-term ones, since the shorter the period, the less possibility is available for changing the historically determined factors (e.g. productive capacities) which may limit the future development measures and alternatives. As the principal task of long-term plans is to establish the most important proportions, tendencies and interrelationships, smaller details can and must be neglected here. For the organizations controlling economic units themselves, the long-term plan contains guiding principles rather than obligatory prescriptions to be followed with numerical accuracy.

Medium-term plans apply the strategy of long-term plans to a given period of development, determining the rate of growth of the national economy as well as its branches. Essentially, they are called upon to ensure intersectoral and interregional coordination; they determine the ways and means of attaining each plan target and provide for the necessary supply of labour, materials and equipment. Medium-term plans are legally enacted; they are binding for the central government agencies. For individual economic units, they establish partly concrete plan targets and partly principles of economic behaviour to be followed during the plan period, thus providing a fixed framework within which each unit may build up its individual plan for production and for technological improvement, may conclude contracts for selling its products or purchasing what it needs, etc.

Short-term plans cover a shorter period (usually one year) of the current medium-term plan. Here the production targets, growth rates etc. prescribed by the medium-term plan for the year in question may be modified according to the extent the medium-term plan has been implemented in the preceding year or years, and also according to such changes in circumstances as were not foreseen when the medium-term plan was established. As a result of its flexible adaptation to achievements and external factors, short-term plans create an adequate framework for channelling everyday economic activity and central measures in harmony with the medium-term plan.

At the beginning of socialist development, the main emphasis was laid on the short-term (annual) plans, with a successively increasing role of the medium-term ones. At present, beside the medium-term plans, an increasing emphasis is laid on the long-term approach. The growing importance of forecasting future tendencies and of establishing development strategies for the more distant future may be ex-

plained by the increasing amount of capital required for economic growth, as well as by the increasing length of time needed for projecting and implementing large-scale investments called upon to improve the economic structure.

Any national economic plan has to be "consistent" in the sense that the various plan objectives and targets must be compatible with, and complementary to, each other, and that the various resources available for growth must be sufficient for, and fully utilized in, the process of its implementation. The consistency of the plan is ensured mainly by the *system of national economic balances* in which all the important resources (e.g., labour, materials, equipment, etc.) and the ways of their utilization are numerically established. The set of national economic balances connects the plan indicators expressed in physical units with those expressed in terms of money. It gives a comprehensive picture of economic growth, follows the flows of products from their output to their ultimate consumption, the supply and employment of manpower, the growth of national wealth, etc. The system of national balances usually consists of three main parts:

- the balance of social product,
- the balance of national income,
- the aggregate balance of manpower.

Planners working in the individual *branches of the national economy* have to draw up detailed plans according to the particular features and requirements of each branch, and to fit these plans into the national economic plan.

In *plans regarding the forest and timber economy* there are three particular features to be considered: strong dependence on natural factors, the very long cycle of production and the increasing importance of the protective and recreational functions of forests. Planning must establish plan targets and find the means of their implementation in such a way that forestry might be able to fulfil all its productive, protective and recreational functions.

Forestry planning is based essentially on the *forest inventories* and on the *management plans which the forestry enterprises are obliged to draw up.* Inventories must contain the forest area, the quantity of its growing stock, the structure of the latter by species and age, and its net annual growth. The accuracy of forest inventories may vary, and its different degrees are required for the various purposes. The drawing-up of management plans starts from the inventories. Such plans are established, as a rule, for ten-year periods, but they also supply some data for estimating the possibilities of wood production in the following twenty years.

Regarding the importance and the role of management plans, there are various views. According to one of these, the establishing of these plans is exclusively the task of the forestry organizations, since only they know how to manage their forests in order to ensure a sustained yield in the long run; the central planning agencies of the state have to accept these management plans and to start from them when determining their forestry policy.

Unlike most capitalist countries, where large forests are privately owned, and not much possibility is left to the state for regulating forestry activities in the interest of society, under socialism almost all forests are in social ownership. Here the central planning authorities are able to issue directives and guidelines for the planning of individual forestry units. As a matter of fact, decisions regarding the extent of wood production do not depend exclusively (not even primarily) on technological and profitability considerations. This is a problem to be solved on

the national level. Besides technological, biological and profitability aspects, decisions must also take into consideration the requirements of the industrial and foreign-trade policies. According to the role and future objectives of forestry set by the central plan, the relative significance of the various factors determining the desirable volume of wood production may differ widely, hence also the production targets can and must vary. Therefore, under socialist conditions, it is possible and necessary for the central planning authorities to issue directives to the units of forestry management as regards the drawing-up of their plans. These directives must express the objectives of the central economic policy in respect of forestry, both for the immediate and the more distant future. These objectives may vary by countries, but the following are likely to occur everywhere:

a. In view of the continuous growth of population and economic activities, in particular of the fact that per capita consumption of timber tends to grow parallel with the level of economic development, forestry must ensure a sustained growth of wood production in the long run, in order to meet increasing demand in terms of quantity and quality, and in accordance with the long-term economic policy of the state.

b. Forests must fulfil their protective and recreational functions continuously, also in the more distant future.

c. In order to meet these requirements, a dynamic approach is needed for the drawing-up of management plans. Both theoretical considerations and practical experience have shown that the traditional system of production policy that was aimed at ensuring a stationary wood production for any length of time cannot fulfil these requirements. Modern forestry is no longer a "stationary" branch; like all others, it must develop and grow.

d. The management plans of forestry must be drawn up in accordance with the planned development of the forest and timber economy as a whole, taking into consideration, e.g., the planned increase of the (relatively capital-intensive) wood-processing capacities and the rather long time needed for putting them into operation, as well as the desired development of foreign trade, in particular, the progressing economic integration of the European socialist countries.

As an example of management plans based on central decision, let us mention that, in 1958, the Hungarian government approved a large-scale project of poplar plantation in order to expand the basis of future pulp production. In 1965, this project was extended over the state-owned and the cooperative agricultural farms, to which long-term credits were granted for the purpose of planting and raising poplar forests. The management plans concerning these forests (counting with a felling at the age of fifteen years) were closely linked with the plans relating to the development of the pulp and paper industry.

Regarding such growing stocks where the rotation of felling is slow (e.g. oak, beech), the age at which the various species will be cut down may vary between certain limits, according to the long-run strategic objectives. (One of the limitations is of a biological nature: trees must reach the age when they begin to produce such quantity and quality of seed as is suitable for reproduction.) Thus, there are certain alternatives open for economic policy; and according to the decision made in this respect, the structure of wood production by species, the technologies of felling, removal and new plantation must be planned adequately.

Therefore, in the first phase of forestry planning, the forest inventories and management plans should inform the central planning authorities on the forest situation and on the feasible strategies; in the second phase, however, they should be modified according to central directives which inform the managing units on the objectives of the central economic policy.

The long-, medium- and short-term plans of the forest and timber economy, elaborated with a view to the centrally determined long-term strategies, are then fitted into the national economic plans according to the general principles of planning (e.g. checking for consistency, balances, etc.).

1.2.2. EFFORTS AT FORECASTING AND PLANNING FOREST MANAGEMENT IN THE CAPITALIST ECONOMIES

In capitalism the existence of the private ownership of the means of production prevents central planning on a national economic scale. In some countries, indeed, protests were made even against such activities of international agencies as the drawing-up of the "Indicative World Plan" (IWP), only because this set of sheer forecasts bore the word "plan" in its name.

As regards forestry, we have seen that as early as a century ago progressive-minded experts concerned about the future of forestry urged legislative regulation of its activities. The practice of individual capitalist countries varies widely in this respect. In the United States the dominating opinion considers the restriction or regulation of felling as incompatible with the principles of free economy, whereas, e.g. in Switzerland clearfelling has been forbidden by law for more than sixty years. The regulating role of the state, however, is increasing everywhere. Thus, in most European capitalist countries the owners of forests are obliged by law to work out management plans. However, the expectation that management strategies elaborated by experts thinking in long perspectives will prove stronger than the short-term interests of private owners has not yet come true.

The varying extent of the influence that may be exerted by the governments on the management of forests is shown by Table 1.

Anyhow, the increasing importance of the protective and recreational functions of the forests does everywhere enhance the claim for a social control of their management.

It is partly due to this claim that an increasing number of prognoses regarding the forest and timber economy of individual countries and the world as a whole have been elaborated. Thus, e.g., in the USA a forecast for the year 2000 regarding the expectable extent and pattern of timber consumption and the future trends of supply was published in *Timber Trends in the United States,* Forest Service, U.S. Department of Agriculture, Washington, D.C., February 1965 (it will be cited in the following as "TTUS" [63].

Particularly important are the prognoses systematically worked out by UN organizations, namely, the FAO and the ECE. The FAO began with studies relating to the expectable supply and consumption of wood in the world's main regions, then built up a world prognosis on the grounds of these data published in *Wood: World Trends and Prospects,* Food and Agriculture Organization of the United Nations, Rome, 1967 (mentioned in the following as "WWTP") [14].

Table 1

Public ownership and systematic management of forests (1963)

Countries	Total forest million hectares	In public ownership		Under management plans	
		million hectares	per cent	million hectares	per cent
Soviet Union and Eastern Europe	937.5	935.9	99.8	322.0	34.4
Canada	443.2	418.3	94.4	418.3	94.4
USA	205.9	57.4	27.9	84.4	41.0
Brazil	352.0	150.0	42.6	202.0	57.4
Others	1,435.6	1,126.7	78.5	150.4	14.5
Total of area covered	3,374.2	2,688.3	80.0	1,177.1	34.8
Rest of the world	855.0	–	–	–	–
World total	4,229.2	–	–	–	–

Source: [14].

The following three publications, prepared jointly by FAO and ECE, have a theoretically fundamental value: *European Timber Trends and Prospects,* UN – FAO, New York, 1953 (cited as "ETTS I") [22]; *European Timber Trends and Prospects, A New Appraisal 1950–1975,* UN–FAO, New York, 1964 (cited as "ETTS II") [22]; and *European Timber Trends and Prospects, A New Appraisal 1950–1975,* An Interim Review, UN–FAO, New York, 1969 (cited as "ETTS II/IR") [24].

ETTS I analyzed the situation shortly after the war. It contained estimates regarding the expected volume of European wood production and consumption up to 1960. It forecast a rapid growth in the consumption of industrial wood between 1953 and 1960 and urged dynamic policies of forestry development. The approach of this study was a completely novel one in its time; it set an example of prognostic analysis not only for the forest and timber economy but also for other branches of production.

ETTS II reviewed development between 1950 and 1960, drew conclusions from the differences between the earlier prognosis and actual data, and made esti-

mates for Europe up to 1975. Thus, together with the past period reviewed, the study covered a quarter of a century.

ETTS II/IR was published at a time when data were known for about half of the period covered by the former prognosis for 1960–1975. This "interim review" checked the forecasts made earlier for 1975. Also forecasts up to 1980 were added.

The joint efforts of European countries, including the socialist ones, made in the framework of the Timber Committee of ECE have succeeded in establishing a helpful methodology of forecasting, as well as a practice of accounting and planning. The continuity of this work was ensured in such a way that now at any point of time reliable prognoses are available for the next ten years. At present, work is in progress aimed at extending the period covered by the prognosis up to the year 2000, in order to offer a broader basis to the leaders of economic policy in all countries for planning the development of forestry and the wood-processing industries.

Other regional organizations of FAO and UN also perform important work in the field of forecasting wood supplies and consumption, in order to draw the attention of governments in time to the measures needed for ensuring the continuity of the increasingly important functions of the forests in the next two or three decades.

CHAPTER 2

PRINCIPAL MACRO-ECONOMIC INDICATORS OF THE PRODUCTION, TRADE AND CONSUMPTION OF WOOD

2.1. ROLE AND IMPORTANCE OF THE PRODUCTION AND CONSUMPTION OF WOOD

In man-made forests, wood production starts with the collecting of seeds, continues with planting and raising the growing stock until it becomes mature, after which the felling and logging of trees and, finally, the removal of assorted wood from the forest take place. In primeval forests, the process consists essentially of felling, logging and removal, but even here some previous operations belonging to the production process are necessary, e.g., the tracing out of cutting areas, the building of roads, settlements, repair shops, etc.

In the following, we shall deal only with the end products of the production process, i.e., with the various sorts of industrial wood and with firewood.

Table 2 shows the importance of timber according to the share of wood-processing industries in the industrial production of the world.

The woodworking and paper industries together grew between 1950 and 1960 somewhat slower than the industrial average, but their combined growth rate was higher than those of the food, textile, clothing and leather industries. The share of the wood and paper industry in total industrial production tended to fall slightly; in 1961 it was about one sixteenth in terms of value and one twelfth in terms of employment.

Within this general picture, the growth rates prevailing in the various branches of the wood-based industries differ greatly. Thus, the annual growth of the sawmilling industry was but 2.7 per cent between 1950 and 1960, whereas the output of plywood rose by more than 9 per cent annually, and that of fibreboard and particle board together rose more than threefold (of this, particle board more than fiftyfold) in ten years. The production of newsprint and other printing and writing paper rose between 1950 and 1960 by 5.3 per cent annually, that of industrial paper and paperboard by 5.9 per cent.

The output of the various kinds of wood-based products is in close correlation with world economic development.

1. Let us begin with the field where there is yet no significant substituting material for the wood-based product. *Paper* has remained up to now the only mass product used for writing and printing. True, microfilms are widely used, but they serve only for reproducing the material that has been previously printed on paper. Thus, from the point of view of sawing material, they offer only the advantage that books and periodicals can be printed in smaller editions. Also the magnetic bands used in computers are saving some paper. Finally, some recent experiments in Britain and Japan are aimed at creating paper from polymers (see below, p. 94). But in spite of all these, wood is, and will remain for a long time to come, indispensable for producing the vehicle of written or printed communication, from the simplest letter to the masterpieces of literature and science. At a time when every

Table 2

Structure and dynamics of world industrial production

Branches	Share of branches, in per cent of			Average annual rate of growth, per cent
	value added[a]		employment	
	1950	1961	1961	
Food, beverages and tobacco	13.1	10.7	13.6	4.8
Textiles, clothing and leather products	12.1	9.7	19.6	4.7
Wood and paper products	6.8	6.2	8.6	5.6
Coal and mineral oil	16.9	17.9	10.5	7.2
Other non-metallic minerals	4.7	5.1	6.0	7.9
Ore mining and smelting	10.4	9.5	6.2	5.9
Engineering	25.4	29.9	27.1	8.6
Electric energy and gas production	3.8	5.0	2.0	9.5
Others	6.7	6.0	6.4	–
Total	100.0	100.0	100.0	6.7

Source: [61].
[a]Based on 1958 US values.

year several hundred millions of people learn to read and write, the expectable rapid growth of paper consumption should warn us to save wood where we can, in order to ensure its supply for the use where, at least at present, it seems irreplaceable.

Paper and paperboard as well as the various kinds of sawnwood and wood-based boards as packaging materials have serious competitors (metal sheets and foils, glass, textile fabrics, synthetic materials, etc.), but they still supply about half of all the materials used for this purpose, in spite of the rapid advance of synthetics. The total demand for packaging materials increases continuously, owing partly to the growing tendency of supplying the retail trade with pre-packaged commodities.

It seems that, even in the decades to come, wood-based packaging materials will retain their decisive role. There is, however, a distinct tendency for the share of paper and paperboard to increase at the expense of sawnwood and wood-based boards. This is shown by Table 3. In the most advanced country, the USA, the total share of wood and paper did not change significantly between 1939 and 1958 (49.2 and 51.3 per cent) but, within this, the share of sawnwood and wood-based boards fell from almost one fourth to less than one twelfth. As a contrast, in Hungary, a moderately advanced country, the share of all wood-based packaging materials was 52.7 per cent in 1962, i.e., almost the same as in the USA in 1958, but

Table 3

Shares of the major packaging materials in the USA and in Hungary
(in per cent of the total value)

Country and year		Wood-based		Metals	Glass	Tex-tiles	Syn-thet-ics	Others
		sawn-wood and boards	paper and paper-board					
United States	1939	11.4	37.8	25.2	8.0	5.8	1.0	11.8
	1958	3.9	47.4	21.8	7.9	1.6	1.0	17.4
Hungary	1962	23.2	29.5	14.3	13.3	8.8	4.3	6.6

Source: [23].

within this, the share of sawnwood and wood-based boards was well over two fifths.

In many cases, it is economically more advantageous to use paper or paperboard for packaging but, in view of the very high capital-intensity of the pulp and paper industries, a certain level of economic development must be reached by a country before these could be sufficiently expanded, or before the countervalue of the rather expensive imports could be produced. According to recent experience, it seems that the wood-based packaging materials (above all paper and paperboard) will remain competitive and retain their combined share, owing to rapid technological improvement. For instance, if synthetic materials gain at the expense of paper and paperboard, the latter gain at the expense of glass due to the tendency favouring disposable packaging.

The paper types called "sanitary" are increasingly used in the advanced countries. Besides the traditional toilet paper, also the use of paper towels, handkerchiefs, diapers, hospital accessories etc. is spreading, owing to their availability in a nearly sterile state and because they can be discarded after use, thus eliminating their labour-extensive washing and ironing.

The products of the pulp industry have some role even in human clothing, partly by supplying dissolving pulp for the production of viscose rayon, and partly by the recent spread of light women's dresses made of special paper types.

2. From the experience of the past decades, many experts are inclined to conclude that *timber as a construction material* is gradually but irreversibly losing its importance. In reality, such a tendency cannot be stated unambiguously. There are countries – above all the USA and Canada – where the greater part of the newly-constructed dwelling units still consists of family houses. In the USA, from all newly-constructed dwelling units (without "mobile homes" and net "additions by conversions") the share of one-family and two-family houses in 1960 was exactly the same as the average of the 1920's, namely 79 per cent. According to esti-

mates [63] this share will fall to 65 per cent by 1980 and to 60 per cent by 2000, but the absolute number of the annually constructed one- and two-family units will increase by more than 50 per cent between 1960 and 2000. According to the same source, in this type of residential building the amount of sawnwood used per dwelling unit is about two and a half times greater than in the multi-dwelling houses (49.3 cu.m and 19.8 cu.m in 1962). Thus, although also the quantity of sawnwood used per dwelling unit tends to decrease, the total quantity needed for residential construction will grow by 40 per cent between 1960 and 2000. The same applies to the use of wood-based panels. The construction of "mobile homes", where the use of wood is relatively the greatest, is estimated to grow from about 100 million units to 200 million by 2000.

According to ETTS II [23], in Europe more than half of all sawnwood produced is used for construction, and the ratio tends to grow (from 48 per cent in 1950 and 52 in 1962 to an estimated 58 per cent in 1975). The role of wooden houses is particularly important in Northern Europe, but recently it has increased in England as well. Also the spreading of weekend houses contributes to the growing European demand for wood. In Hungary, for instance, the demand for prefabricated wooden houses has increased to such an extent that the wood industry is, for the time being, unable to meet it, since the development of contemporary large-scale manufacturing has started only recently.

A number of more or less recent innovations like the introduction of non-inflammable chemicals, fungicides, synthetic adhesives and paints, fibreboards, particle boards, bent and cemented beams, etc. have helped to restore the competitivity of timber as a construction material in many uses of which it was formerly believed to have lost its role for ever.

As regards the multi-storied residential buildings destined for a large number of families, the spreading of prefabricated elements has opened new fields for the use of wood. Light partitions are now made of fibreboard, and recently even room-sized outer walls have been constructed from timber, partly to animate the monotonous look of prefabricated buildings and partly to save labour and costs.

3. There are, however, *fields of application where wood consumption has been undoubtedly decreasing.* Such is, e.g., the use of pitprops. Coal as a source of energy is rapidly losing ground against oil, natural gas and nuclear energy, but even in coal mining, steel is increasingly substituted for timber. The situation is similar to the case of railway sleepers, although here the decrease in consumption is somewhat slower. We cannot expect any significant further expansion of the existing world network of railways, and in many countries sleepers made of pre-stressed concrete have been increasingly substituted for wooden ties, though opinions differ regarding the expediency of the change. Anyhow, the Hungarian railways have switched over to concrete sleepers, that is, only these are used when a stretch is completely renewed, and wooden sleepers serve only for individual replacement of old ones in case of small repairs. The use of wooden poles as line posts is rapidly decreasing, at a rate similar to that observed in the case of pitprops, partly because poles made of reinforced concrete or of steel are increasingly used, and partly because many communication lines are placed underground.

Thus, in the advanced countries the pattern of wood-based final products has been changing. The shares of printing and writing paper as well as of industrial paper (mainly paperboard for packaging) have been growing conspicuously; the

share of sawnwood and wood-based panels used in construction does not seem to show any change, whereas the use of wooden pitprops, railway sleepers and line posts has decreased fairly rapidly.

2.2. QUANTITY AND REGIONAL LOCATION OF WOOD PRODUCTION

Although the protective and "welfare" functions of forestry are continuously increasing, its main function invariably consists in satisfying the ever growing world demand for wood. As shown by Table 4, total world production nearly doubled between 1950 and 1968.

In terms of physical units (i.e. in cubic metres of roundwood) world production of wood amounted to about 2,100 million cu.m in 1968; of this, the share of fuelwood was 43.5 per cent (about 900 million cu.m), the rest was industrial wood. The utilization of timber is shown here in terms of final products, namely in cubic metres of sawnwood and in tons of wood-based panels, paper and paperboard (Table 5).

The development level of the various regions is well reflected by the proportions between fuelwood and industrial wood production. The share of fuelwood is about 43 per cent in world average, it amounts only to 6 per cent in North America and to 22–26 per cent in Europe, the Soviet Union and Oceania, whereas in Africa and Latin America it attains 87 and 84 per cent, respectively; even in Asia (Japan included) it is hardly less than two thirds.

Thus, about 80 per cent of all industrial wood produced in the world comes from the industrially advanced countries of the northern hemisphere (North

Table 4

World production of processed wood in terms of value

	Thousand million US dollars at 1961–1963 prices				1968 in per cent of 1950	Average annual growth rate, per cent
	1950	1960	1965	1968		
Sawnwood[a]	10.3	13.5	15.1	15.9	154	2.4
Panels[b]	1.0	2.7	4.4	5.4	540	9.8
Paper products[c]	8.7	12.2	16.2	19.0	218	4.4
Others[d]	3.9	5.5	5.3	5.2	133	1.6
Total	23.9	33.9	41.0	45.5	190	3.6

Source: [17].

[a] Including railway sleepers, and sawnwood for packaging.

[b] Veneer, plywood, fibreboard and particle board.

[c] Paper and paperboard.

[d] Roundwood used for pitprops, poles, fences, etc.

America, Europe and the Soviet Union), that is, from regions where only 28 per cent of the world's total population is living. In these parts of the world, the per capita annual production of industrial wood amounts to about 1 cu.m, whereas only one tenth of this is produced in the developing countries. The per capita consumption shows about the same difference in magnitude, reflecting the great (and still growing) gap between the advanced and the developing countries.

About two thirds of all industrial wood produced is sawn. The development level of the various regions is expressed also in the proportions of sawnwood production – that is, of the simplest processing – to the more complicated (mainly chemical) and more capital-intensive forms of processing, like the production of wood-based panels, paper and paperboard. Indeed, the sequence of fuelwood – roundwood – sawnwood – panels – pulp – paper means an increasing order of unit value, capital-intensity, advanced technology, as well as of increasing requirements towards qualified labour and infrastructure.

The growth rate of the main end product groups is different. Accordingly, their proportions expressed in terms of value have considerably changed, e.g., there was a great change between 1950 and 1968. Calculated at constant prices, the ratio of the "traditional" products (sawnwood and roundwood) to the "dynamic" ones (paper, paperboard and wood-based panels) was 59:41 in 1950 and 46:54 in 1968. In terms of quantity, i.e., on the basis of raw material used for turning out the products of these two groups, the ratio changed from 85:15 in 1950 to 70:30 in 1968. (In such calculations, the products are converted to "wood raw-material equivalent" or WRME, meaning the amount – in cubic metres – of decorticated roundwood needed for producing a cubic metre of sawnwood, a ton of paper, etc.)

Table 5

Production and use of wood by main regions in 1968

Regions	Production, million cu.m of roundwood			Use of industrial wood		
	total	fuel wood	industrial wood	sawnwood million cu.m	panels	paper products
					million tons	
Europe	309.7	68.9	240.8	75	10	34
Soviet Union	308.4	90.5	289.9	100	3	6
North America	444.9	27.2	417.7	114	14	53
Latin America	280.0	235.7	44.3	14	0.7	3
Africa	247.3	214.2	33.1	3	0.3	0.7
Asia	437.6	286.0	151.6	68	5	15
Oceania	26.1	6.9	19.2	5	0.4	1
Total	2,126.0	929.4	1,196.6	389	34	113

Source: [17].

Evidently, the proportion of the dynamic products is much greater in value than in terms of the raw material used, since the unit values of these products are higher. The annual growth rate of the production and consumption of paper and paperboard is three times the growth rate of sawnwood. This is the most important permanent tendency of the structural change. Mainly owing to the increasing demand for paper and paperboard, industrial wood as a raw material still holds its place and is likely to hold it in the decades to come in spite of the growing competition of other materials.

During the last fifty years, the proportions and directions of trade have been more or less stable; they have changed but slowly in size and tendency (see Table 6).

The statistics of international trade show the value of exports at f.o.b. (free on board) parity, whereas the value of imports is calculated at c.i.f. prices (including freight and insurance). Since the transport costs of wood are in relation to its value, the value of the aggregated import surpluses exceeds considerably that of the export surpluses.

The proportions shown by the table would change if we calculated in quantities. If the items of international trade were converted into quantities of raw material (cubic metres of "wood raw material equivalent") necessary to produce them, the wood balance of Africa would show an export surplus of 2 million cubic metres of WRME. Since, however, Africa exports mostly unprocessed wood of relatively low unit value and imports expensive final products, in terms of value its wood balance shows a small import surplus of $31 million. Also Latin America has a passive balance in terms of value. But both Africa and Latin America could, from their vast forest areas, cover all their needs and build up a large export surplus of wood and wood products if they developed adequate industries. On the other hand, Asia and Oceania are likely to remain passive regions also in the near future. As regards Europe, its import surplus would be very much greater in terms of quantity; its imports consist mainly of low-priced raw material whereas in the relatively high-priced category of pulp and paper it is nearly self-sufficient.

Table 6

Net exports (+) and net imports (−) of wood by regions in 1962
(millions of US dollars)

Regions	Unprocessed wood	Processed wood	Pulp and paper products	Total net balance
North America	+ 46.1	+ 21.7	+339.7	+ 407.5
Soviet Union	+110.0	+201.8	+ 1.9	+ 313.7
Europe	−345.1	−647.5	− 7.9	−1,000.5
Asia and Oceania	−182.0	+ 32.0	−298.7	− 448.7
Latin America	+ 7.3	+ 10.4	−397.4	− 379.7
Africa	+112.1	− 44.3	− 99.1	− 31.3

Source: [18].

CHAPTER 3

MAIN FACTORS INFLUENCING THE CONSUMPTION OF INDUSTRIAL WOOD

3.1. LEVEL OF ECONOMIC DEVELOPMENT

If we characterize the level of economic development by the per capita volume of GDP, the quantity of the consumption of industrial wood will seem to be correlated with it (see Figure 1).

Two conclusions may be drawn from this correlation:

1. Consumption of industrial wood seems to grow more or less parallel with per capita GDP. Roughly, a $100 increase in per capita GDP involves an increase of consumption by 0.1 cu.m per capita.

2. Dispersion around the regression line is considerable, indicating the necessity of a more detailed correlation analysis. The size of wood consumption conspicuously differs in the exporting and the importing countries which show comparable GDP-levels (e.g. Great Britain and Ireland *versus* Northern Europe).

When analyzing the consumption of various kinds of industrial wood, we find that the consumption of certain kinds grows more or less parallel with GDP, whereas in other cases it may grow faster or slower; the consumption may even decline with the growth of GDP.

3.2. THE AVAILABILITY OF WOOD

Most authors dealing with the factors influencing wood consumption name only three items: (1) the absolute or relative price level of wood, (2) the number of population and (3) per capita GDP; they neglect the availability of wood. However, it seems to be expedient to insert on the supply side a variable which indicates the relative ease with which wood can be obtained for use. In 1965 Prof. G. Robinson Gregory [33] constructed his "Wood Availability Index" (WAI) for this purpose. His formula was the following:

$$\text{WAI} = 142 \left[\left(\frac{\text{coniferous area}}{\text{population}} \right) 0.8 + \left(\frac{\text{hardwood area}}{\text{population}} \right) 0.2 \right].$$

The rationale of this was given by him as follows:

1. Where consumers have a reasonable freedom of choice (as in most countries of the northern hemisphere), about 80 per cent of all sawnwood is turned out from coniferous trees and 20 per cent from broadleaved ones; hence the weights 0.8 and 0.2 figuring in the index.

2. The area figures (in hectares) relate to "forests in use" rather than to total forest area, since it is the former which indicate the "accessibility" of the forests.

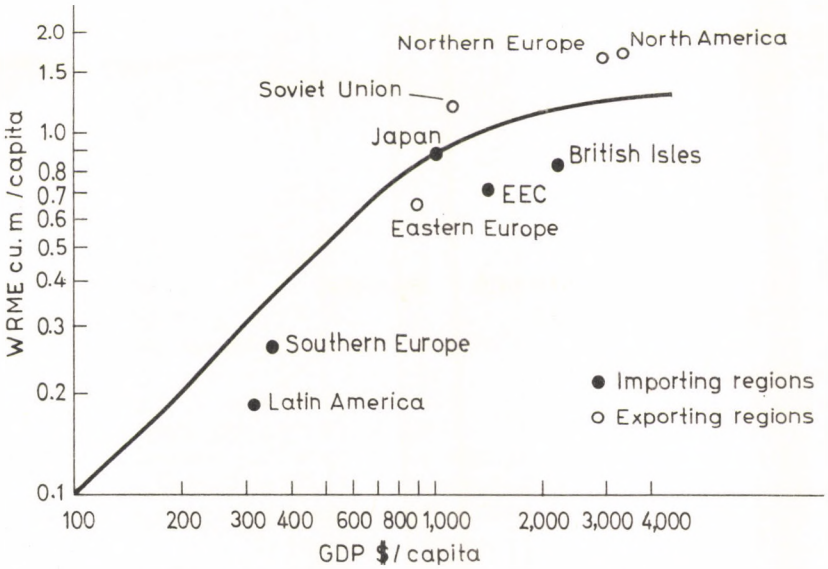

Figure 1. Per capita consumption of industrial wood as a function of per capita GDP (1970)[a]
Source: [18].
[a] GDP is expressed in US dollars of 1961–1963 purchasing power.

3. In order to express population pressure on the forest area (which is a significant factor in determining relative wood availability), per capita areas are also included in the formula.

4. The constant multiplier 142 serves for adjusting the value obtained from the formula in such a way that the index of the USA should correspond to the "real" situation of wood availability prevailing in that country. Namely, although the United States has abundant growing stocks of both softwood and hardwood, it cannot be said that the availability of wood in the USA is "100 per cent", i.e., that it reaches the maximum index score. According to experts, the index for the USA can be set at about 80. The multiplier 142 adjusts the value resulting from the formula for the USA to 80; and since the purpose of the index is to show the relative wood availability in the various countries *in comparison with the USA,* the same multiplier is used for all.

In the case of the USA, the per capita area (in hectares) of coniferous forests in use is 0.54, the per capita area of broadleaved forests is 0.66. Inserted in the formula, these data yield an index value of 80.

The author has calculated WAI's for many countries; some of his results are shown in Table 7.

Professor Gregory believes that two factors, i.e. per capita GDP and wood availability, are fairly sufficient for estimating wood consumption. He admits, however, that the WAI does not make allowance for the large differences in transportation costs, nor for the varying possibility of importing wood, which is a very significant factor for most European countries.

Table 7

"Wood Availability Indexes" by countries

Country	WAI	Country	WAI	Country	WAI
Canada	100	Portugal	20	Tunisia	5
Finland	100	Yugoslavia	18	Belgium	4
Sweden	91	Switzerland	15	Iraq	4
Norway	87	Argentina	15	Kenya	4
USA	80	Colombia	14	South African Republic	4
Australia	61	Greece	14	Ceylon	3
Honduras	48	Mexico	14	Denmark	3
Austria	43	Cambodia	13	India	3
Guatemala	40	France	13	Ecuador	2
Spain	35	South Korea	13	Egypt	2
Burma	32	German Federal Republic	11	Netherlands	2
Thailand	30	Ghana	10	Morocco	2
Turkey	28	Algeria	9	Pakistan	2
Brazil	26	Philippines	8	United Kingdom	2
Chile	25	Sudan	8	Nigeria	1
Tanganyika	23	Cuba	6	Rhodesia	1
Indonesia	21	Ireland	5	Uganda	1
Paraguay	20	Italy	5		

Source: [33].

Still, as one of the possible approaches, his method may prove helpful in drawing up estimates or long-term plans.

According to his calculations regarding 53 countries, a rather strong correlation can be shown between the per capita values of GDP and sawnwood consumption. For sawnwood consumption, he obtained the following equation:

$$C_s = \underset{}{-2.73} + \underset{(0.013)}{0.130Y} - \underset{(0.0000075)}{0.0000362Y^2} + \underset{(0.183)}{1.83WAI} - \underset{(7.66)}{31.7 \log WAI}$$

$$R^2 = 0.94,$$

where C_s = sawnwood consumption per capita in board feet,
Y = income (GDP) per capita,
WAI = wood availability index,
R^2 = coefficient of determination,
(...) = standard errors are shown in parantheses below the corresponding regression coefficients.

An interesting feature of this method consists in considering only the "forest area in use", when calculating the WAI. Thus, such countries as Nigeria, although potentially very rich in forests, show a very low WAI.

Evidently, if we compared the quantity of consumption with the total forest area, no significant correlation could be obtained. For instance, the per capita data of Zaire (Congo Kinshasa) are the following: forest area 10 hectares, GDP $56, consumption of industrial wood 0.03 cu.m, whereas the same data for Great Britain are: 0.03 hectare, $ 1,180, and 0.77 cu.m. Thus, with a per capita forest area 333 times less than that of Zaire, Great Britain consumes 26 times as much industrial wood. This, however, corresponds to the fact that the per capita GDP in Britain is 21 times as much as that in Zaire.

But it would be erroneous to conclude from this that only the per capita GDP has an effect on wood consumption, and per capita forest area has none.

First, we have learnt from Gregory that it is not the total forest area, only the part made accessible to exploitation which has an effect on consumption; and if we knew the ratio for Zaire, this would likely prove something similar to that in Nigeria, or an even lower value. The very fact that per capita GDP is 21 times less in Zaire than in Britain implies that the difference in the degree of industrialization must be at least as great and, thus, only a small fraction of the potential riches of the Congolese forests has been made accessible to exploitation.

Second, we also know that a large portion of British wood consumption is covered by imports, a factor independent of the area of domestic forests.

Third, turning back to Figure 1, we can see that whereas the data of the exporting regions (with the exception of Eastern Europe) are located *above the regression curve,* those of all importing regions are *on or below it.* In other words, in the exporting countries where wood supply is evidently more abundant, wood consumption is, as a rule, somewhat higher than it would be according to the GDP-level, whereas in the importing countries it tends to be relatively lower. In Figures 2 and 3 the wood consumption of the exporting and importing countries is shown separately, in this case for four years. (The four points connected with a line mean data for 1950, 1960, 1965 and 1970; in case of Latin America, there are only two points, meaning 1960 and 1965.)

By arranging the consumption data of exporting and importing regions in two separate rows, according to the levels of per capita GDP at which they are occurring, we obtain Table 8.

From this, it seems possible to draw two conclusions:

1. In both the exporting and the importing regions there is a distinct correlation between per capita data of GDP and wood consumption.

2. On comparable GDP levels, exporting countries consume about twice as much as the importers.

If we also add that the per capita forest area is usually *above* one hectare in the exporting and *below* one hectare in the importing countries, it becomes clear that, after all, a rise in the forest area significantly affects wood consumption.

According to our investigations, the relationships shown in Table 8 enable us to make, without any detailed calculation *a rough-and-ready estimate on the expectable consumption of industrial wood for any country* if we know its per capita GDP and also whether it is a net exporter or a net importer of wood.

If, however, one has to elaborate a long-term prognosis for a country, the following approach seems to be expedient:

a. estimate the development of future industrial wood consumption on the basis of the expectable per capita GDP levels, according to Table 8;

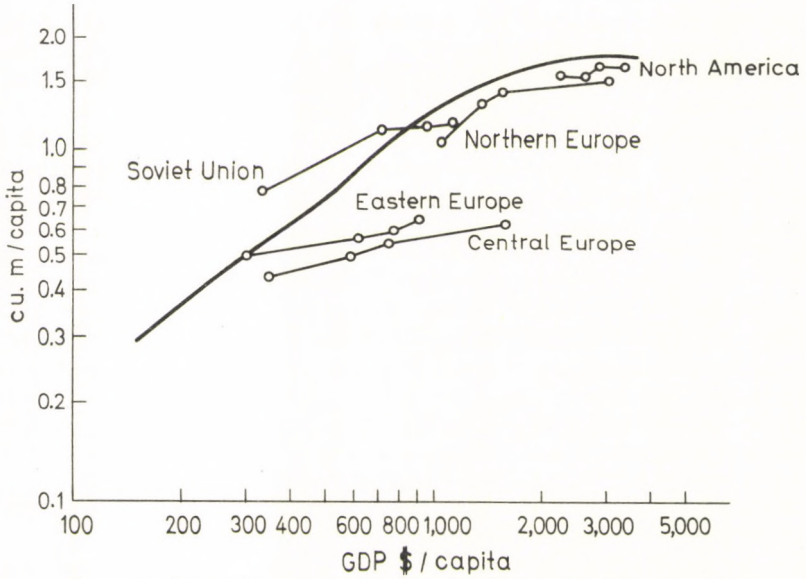

Figure 2. Per capita consumption of industrial wood as a function of per capita GDP in the exporting regions (1950–1970)[a]
Sources: [17, 18, 22, 23].
[a] Successive points mean, from left to right, the years 1950, 1960, 1965 and 1970. GDP = dollars of 1961–1963 purchasing power.

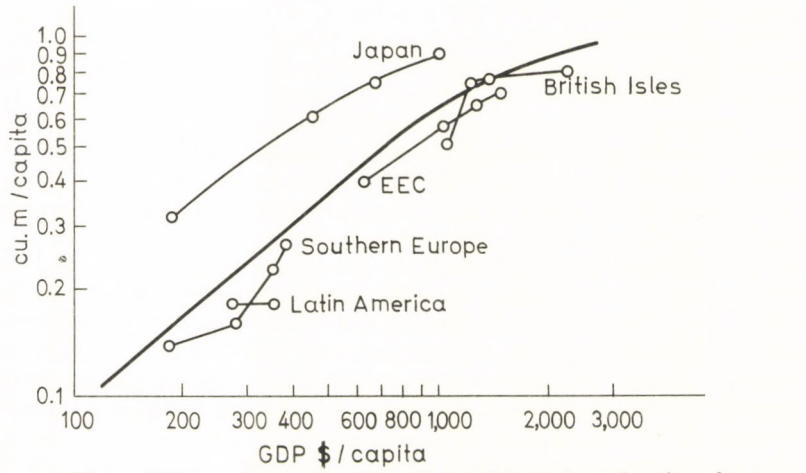

Figure 3. Per capita consumption of industrial wood as a function of per capita GDP in the importing regions (1950–1970)[a]
Sources: [17, 18, 22, 23].
[a] See Figure 2 (for Latin America, 1960 and 1975 only).

Table 8

Per capita consumption of industrial wood as a function of per capita GDP in the importing and the exporting countries

		Per capita GDP (US dollars of 1961–1963 purchasing power)								
		200	400	600	800	1,000	1,200	1,400	1,600	1,800
Per capita consumption of industrial wood, cu.m of WRME	Importers	0.17	0.30	0.44	0.55	0.65	0.72	0.79	0.83	0.86
	Exporters	0.38	0.63	0.86	1.08	1.25	1.30	1.50	1.58	1.63

Source: Calculations by the author.

b. calculate the WAI's according to Gregory's method and the regression functions described in his work cited, in order to obtain another set of estimates on the development of future consumption;

c. on the grounds of what is known about the particular conditions of the country in question, extrapolate a long-term trend of consumption;

d. by confronting the three sets of estimates, try to form an estimate that seems logically the most acceptable.

The functional relationship between wood consumption and GDP elaborated separately for net exporter and net importer regions may, in addition to serving as a numerical basis for prognoses, provide some ideas for studying the different behaviour of consumers in both exporting and importing regions.

There are a few countries where the per capita forest area is similar to that in the exporting countries, yet they are net importers of wood. Special analysis of the causes of such a situation is particularly important in the case of the USA, in view of the size and high development level of this country. The indicators of both the per capita forest area (more than 1.5 hectare for all forests, and 1.2 hectare for "forests in use" according to Gregory) and the per capita consumption (1.6 cu.m of industrial wood) would place the USA among the net exporters; yet, the USA is in our times a permanent net importer of industrial wood. This is explained by the fact that the Canadian industrial wood (mostly coniferous) shipped from Pacific ports to the southern and eastern parts of the United States can efficiently compete there with the wood produced in the western part of the United States. This situation is due, at least in part, to the possibility of Canadian exporters of choosing the cheapest transportation facilities offered by international competition, whereas according to the US prescriptions regarding "inter-state" (i.e.

Table 9

Per capita consumption of industrial wood by kinds in exporting and importing regions

Region	Per capita		Per capita consumption of				
	GDP $	consumption of industrial wood cu.m of WRME	sawnwood		paper products		Other industrial wood cu.m of WRME
			cu.m	cu.m of WRME	tons	cu.m of WRME	
a) Northern Europe 1960	1,350	1.31	0.47	0.84	0.15	0.40	0.07
b) Great Britain and Ireland 1965	1,350	0.77	0.18	0.31	0.14	0.37	0.08
c) b in per cent of *a*	100.0	58.7	36.7	36.7	93.4	93.4	114.0

Source: [23].

domestic) shipments, domestic navigation companies must be preferred. Since trade between the USA and Canada is not yet limited by considerations relating to the balance of payments, US users are free to buy Canadian rather than US wood when it proves to be cheaper.

Thus, the United States' wood consumption is not affected by her being a net importer of wood; on the contrary, the fact that in some of her regions imported wood costs less than the domestic one tends to *increase* consumption. Accordingly, although the USA has a considerable import surplus, the size and trends of its wood consumption are similar to those prevailing in the exporting countries. Let us remark here that the USA was indeed a net exporter of wood until World War I, and her economic structure and wood consumption have been determined ever since by a relative abundance of wood, enhanced also by the possibilities of cheap Canadian imports. Even at present, however, there is no doubt that the USA would be able to meet all its needs by domestic production and even to produce a permanent export surplus if its economic interests warranted such a change.

It follows from all this that it would be quite misleading to draw mechanically the same conclusions in respect of each importer of wood.

Taken together, the USA and Canada, i.e. "North America", unequivocally constitute an exporting region.

It seems worthwhile to investigate the difference in the wood consumption of the exporting and the importing regions by product groups. For this comparison, let us choose the 1960 data of Northern Europe and the 1965 data of the British Isles (Great Britain and Ireland) because in both cases the per capita GDP had exactly the same size (see Table 9).

Thus, at identical GDP levels, the consumption of paper, paperboard and wood-based panels was almost the same in the exporting and importing regions, whereas from sawnwood the importing region consumed about two thirds less than the exporting one. Hence, the share of sawnwood in the total consumption of industrial wood was 64 per cent in Northern Europe but only 40 per cent in Britain and Ireland.

Similar proportions occur in the case of the other large-scale importer, the EEC region. The conclusion seems therefore justified that, whereas at comparable GDP levels the per capita consumption of sawnwood in the importing regions attains but 35–40 per cent of that consumed in the exporting countries, the consumption of paper products and wood-based panels is nearly similar in both cases, and tends to change parallel with the GDP-level.

The main reason for this evidently consists in the fact that whereas paper, paperboard and wood-based panels can hardly be replaced efficiently by other materials in their proper fields of use, sawnwood, under advanced conditions, can be very frequently replaced, e.g. in packaging partly by paper products, in construction by steel and reinforced concrete, etc. In many cases, it is economically more advantageous for a wood-importing country to increase its production of steel, cement, etc., than to increase its imports of sawnwood. Thus, in these countries the consumption of sawnwood tends to grow much slower than in the exporting ones.

3.3. THE LONG-TERM TENDENCIES OF WOOD PRICES

Experts dealing with long-term plans or prognoses frequently discuss the question whether wood prices have any effect on wood consumption and, when there is an effect, how could it be accounted for. First of all, it must be emphasized that long-term planners are not interested in temporary, short-term price changes which often have a speculative background, only in the long-lasting tendencies affecting the relative prices of product groups which are in one way or other interdependent.

Analysis of price tendencies is a complicated task. In this respect, it may prove helpful to review the methods and assumptions applied in the joint work of the Timber Committee of ECE and the European Forestry Commission of FAO.

Their first forecast made in 1953 regarding the 1950–1960 supply and consumption of wood in Europe [22] suggested two alternative hypotheses about the relative prices of wood and wood products, as compared with the prices of competing materials. The first hypothesis expected the relative prices of wood and wood products to return to the pre-Korean War level, the other assumed that they would remain on the high level attained during this war, meaning a rise of 25 per cent in their relative prices between 1950 and 1960.

Table 10

"Real prices" of wood and wood products (1953 = 100) in Finland (F) and in the United Kingdom (UK)

Product group and country		1950	1953	1955	1960
Coniferous sawnwood	F	88	100	106	104
	UK	102	100	102	95
Pulpwood	F	77	100	97	87
Wood pulp	F	114	100	115	121
Newsprint	F	102	100	107	117
	UK	95	100	101	104
Pitprops	F	79	100	100	96
	UK	106	100	100	89

Source: [23].

The second forecast (regarding 1960–1975) was published eleven years later [23]. In this it was admitted that the authors of the first publication "were somewhat naive in advancing assumptions concerning the *over-all* movement in relative prices, with the implication that these trends applied to all forest product categories and to all parts of Europe". Namely, actual data have shown that between 1950 and 1960 the relative prices of the various wood products changed at different rates, and also that the average index of relative prices of wood products changed differently in the various European countries.

Still, certain statements could be made that may prove helpful in long-term planning.

For instance, according to ETTS II [23], the European price indexes of coniferous sawnwood as a percentage of the general price index of all building materials did not seem to change substantially between 1950 and 1960, although in some countries (e.g. Austria, Finnland, Italy, the Netherlands) a rise and in some others (e.g. England) a fall seem to have occurred. By implication, this would mean that neither the relative price level of coniferous sawnwood changed very much compared to that of the "competing" materials.

Since it is very difficult to find price data relating to the commodities which may be considered as competing with the wood products, also another method was applied in ETTS II. This consisted in expressing the price index numbers of wood products in percentage of those indicating the general level of wholesale prices. The authors call the data obtained in this way "the *real* prices of wood products", as distinct from the "*relative*" prices already mentioned. From among the data thus obtained, Table 10 shows those relating to an exporting and an importing country (Finland and the United Kingdom).

From these and other, rather scattered data, the authors of ETTS II have drawn the following conclusions regarding the decade 1950–1960:

a. the general development of relative prices of wood and wood products did not justify the 1953 forecast of a considerable (20 per cent) rise as suggested in ETTS I [22];

b. the relative prices of coniferous sawnwood changed but little, while those of broadleaved sawnwood moved slightly upward;

c. the relative prices of plywood seemed to fall slightly, while those of fibreboard and particle board fell substantially (e.g. in the UK, on a 1956 basis, the relative price of fibreboard fell from 144 in 1950 to 91 in 1960);

d. pulpwood, wood pulp and paper generally maintained their relative price levels;

e. although many exceptions to these general trends were observed, the authors believed that, on balance, changes in the relative prices of wood and wood products between 1950 and 1960 were not substantial; therefore, in their new forecasts for Europe regarding 1960–1975 they did not believe it necessary to take the price factor into account.

Essentially similar conclusions were drawn in 1964 by the authors who elaborated the long-term prognosis for the demand and supply of wood in the USA [63]. According to these authors the price level of wood (i.e. the "real price" in the terminology of the ETTS II [23] was fairly stable from 1920 to World War II and, after peaks during World War II and the Korean War, by 1962 it went back to a level of about 15 per cent below the postwar peak. Long-term trends in the real prices of paper products were fairly stable. As regards wood-based panels, it was thought that their future real prices would approximate the average of 1955–1962. The authors of TTUS believed therefore that future price trends for wood and wood products between 1962 and 2000 "will not differ significantly from price trends for competing materials".

They added, however, that "substantial and continued improvements in productivity ... will be necessary to achieve stability of relative prices. Such technical progress will be difficult to achieve, however, in view of the limited research and development activities", and also because wood industry was more fragmented than those producing the major competing materials.

The assumption of the stability of "relative" and "real" wood prices may be acceptable in a forecast covering ten or fifteen years. But if the forecast has to cover a longer period, say, running to the end of this century, such an assumption seems to greatly simplify some essential problems. Let us investigate the development of "real" sawnwood prices over half a century in the USA, representing here the price tendencies of the exporting countries (we have seen earlier that, in spite of its import surplus, the USA behave rather like an exporting country), and in the UK, representing the importing countries (Tables 11 and 12).

It can be seen that the price level of sawnwood in relation to the general level of wholesale prices rose conspicuously in fifty years: 2.99 times in the USA (between 1900 and 1950), and 2.19 times in the UK (between 1901–1905 and 1951). The reason for the difference might have been, e.g., that technical progress in the industries other than wood processing was faster in America than in the UK, so that although the absolute price of sawnwood rose higher in the UK (10.5 times) than in the USA (8.53 times), its real price rose slower.

Table 11

The wholesale price and the "real price" of sawnwood in the USA
1926 = 100

Year	General index of wholesale prices	Wholesale price of sawnwood	"Real price" of sawnwood
1900	56.1	38.1	67.9
1910	70.4	48.4	68.8
1920	154.4	165.2	107.0
1926	100.0	100.0	100.0
1930	86.4	85.8	99.3
1940	78.6	102.9	130.9
1950	161.5	327.4	202.7
1952	174.8	344.4	197.0

Source: [62].

Table 12

The wholesale price and the "real price" of coniferous sawnwood in the United Kingdom

Period	General index of wholesale prices	Wholesale price of sawnwood	"Real price" of sawnwood
Average of 1901–1905	100	100	100
1951	480	1,050	219

Source: [60].

As regards the rise in relative prices, the following considerations have to be mentioned:

1. In the main field where sawnwood is used, i.e. construction, its two main competitors, namely cement and steel (and the pre-fabricated elements made from them) attained a very high rate of technological progress and became increasingly cheaper in relation to sawnwood. (This tendency was even more enhanced by the slow technical progress of the sawmilling industry.) As a result, the amount of sawnwood used, e.g. per dwelling unit, was gradually reduced. Although such data are not available for fifty years, the process is reflected in the de-

clining per capita rates of total consumption of industrial wood. This amounted in the USA to 3.27 cu.m in 1900 and to 1.85 cu.m in 1950.

2. Although the specific coefficients (per dwelling unit, per capita, etc.) of sawnwood consumption tended to decline, the rise in population and in living conditions, as well as economic growth in general, caused the absolute quantity of demand for sawnwood to grow steadily to such an extent that certain "rigidity factors" of the supply started to exert their effect. First of all, sawnwood production needs logs of a certain minimum size, which have to be obtained from trees of a certain minimum age. In the forests already in use the replacement of such trees takes a long time. And even where a remainder of primeval forests is still available for exploitation, they are located at a greater distance, so their exploitation involves higher transportation costs and new infrastuctural investments.

The relative prices of the products of the paper industry were fairly stable in the first half of our century both in the USA and in the UK. These products are "new", relative to sawnwood, and they are turned out with the aid of contemporary equipment and technology. As packaging materials, they successfully compete with sawnwood and many other products; and as a vehicle of written or printed communication, paper made from wood has not yet had any serious competitor. At the beginning of our century the share of the paper industry in the consumption of industrial wood was small, but it increased very fast.

In the price development following World War II, a turning point seems to have occurred about 1950. One could have thought that accelerated technological progress, the emergence and fast spreading of new synthetic materials, as well as the improvement in the technology of construction based on steel, reinforced concrete and pre-fabricated elements would increase the relative costliness of sawnwood, not to mention the rather slow technical progress in forestry and wood industry. Thus, it was rather a surprise that the rise in the relative price of sawnwood seemed to stop after 1950.

The reason for this may have been partly that sawnwood, after having been ousted from many fields of use, was pushed back exactly to those fields where it could compete most successfully and permanently, and partly that some technical progress took place at last also in forestry and wood processing. Forestry benefited from the increasing mechanization of cutting, logging, road building, removal and transportation; and in the primary wood-processing industries, part of their technical backwardness was made up for by the automation of certain complicated operations, as well as by improvements in glueing, eking out, drying, preservation, transportation, etc. of materials. As a consequence, the "relative" and the "real" price levels of sawnwood were relatively constant after 1950 [23].

The competitive situation of paper products did not change substantially, owing to a relatively fast technological progress; therefore their relative and real prices did not change much.

It was practically after World War II that two new groups of wood-based panel products, fibreboard and particle board, came into extensive use, owing to their excellent technical qualities. At the first time they were relatively expensive but, with demand and production increasing, economies of scale and new technical improvements caused their relative and real prices to decline significantly.

Thus, in the postwar period the price situation of the wood-based products seems to have stabilized in the sense that their relative and real prices did not change substantially and some of them even declined. Is it then justified to extrapolate this price situation for the last decades of our century? In my opinion, such a conclusion would be premature. Let us examine the following considerations:

a. In spite of stagnating and even, in some regions, declining per capita consumption of sawnwood, the total quantity of its demand is likely to rise in the long run, because the stagnation or decline in per capita consumption will be more than balanced by the growth of population (see above, Tables 4 and 5). At the same time, the per capita demand for paper, paperboard and wood-based panels tends to grow at least as fast as per capita GDP.

b. Regarding supply, the production of wood cannot be increased at will, and certainly not without a rise in costs, since the natural forests of the world still exploitable are located in regions where exploitation can be started only after substantial investments, that is, at higher costs. Even if certain infrastructural investments like roads, railways etc. are financed by the state budget, it is obvious that from the point of view of national economy as a whole, they increase the cost of wood production. As regards man-made forests, the production cycle extends over several decades so that no immediate rise in production is possible; moreover, production costs in such forests tend to rise continuously.

c. As regards the supply of Europe in particular, its net imports are increasing, which results in a rise of the average transportation distance and the average freight costs.

d. In the industries producing materials competing with wood (in particular the synthetic ones), technological progress is very rapid and tends to reduce prices.

In view of all this, it seems indicated to expect for the future (particularly for the last quarter of our century) a certain rise in the relative prices of wood and wood products.

3.4. THE GROWTH OF POPULATION

In the early stages of economic development the per capita consumption of industrial wood tends to rise more or less in proportion with per capita GDP. Later on, it tends to stabilize, and the absolute magnitude of demand is determined mainly by the growth of the population. The importance of this consideration is emphasized by the unprecedented rise in the world's population during the last two decades. To characterize this, it suffices to mention that while during the first fifteen centuries A.D., world population increased only by 200 million, its increase in the five years between 1955 and 1960 amounted to 350 million. According to competent estimates, the rate of increase is likely to accelerate in the coming decades (Table 13).

The postwar demographic explosion, owing mostly to the fall in infant mortality and general death rates resulting from the spread of hygiene in the developing world, has confuted many forecasts relating to the world's population development.

Let us mention as an example the excellent book entitled "World Timber" published in 1958 by Th. Streyffert [60], a renowned Swedish forester-economist. In his forecast relating to the demand and supply of wood about 2000, he used the forecasts made in 1953 by W.S. and E.S. Woytinski, and estimated a world popu-

Table 13

Estimated increase in world population (millions)

A.D.	1	150
	1500	350
	1700	600
	1800	900
	1900	1,600
	1955	2,700
	1960	3,000
	1965	3,350
	2000	6,000–6,500

Source: [44].

lation of 3,250 million for the year 2000. Seven years after his book was published, i.e. in 1965, world population already exceeded the number he predicted for 2000.

Streyffert did not suspect how right he was when he emphasized the "elements of uncertainty" involved in the forecasts relating to population; indeed, he was more right than he had ever imagined. An error of such magnitude has evidently made questionable his whole prognosis of wood consumption based on per capita ratios. Nevertheless, his book has remained significant as one of the first attempts at forecasting the development of wood consumption up to 2000, in spite of its elaboration at a time when little was known about the extent of the demographical explosion or the rate and nature of the economic reconstruction that took place in the early 1950's.

At present, the future increase of world population may be estimated with a somewhat greater degree of probability. It is true that even now every new publication contains a different prognosis for 2000, but it seems fairly certain that these forecasts do not contain errors comparable to that committed by Streyffert.

First, on the grounds of experience gathered in the past two decades, the effects of the postwar demographic explosion can more correctly be assessed. Secondly, the necessity of "family planning" (in a more plain language: birth control) is increasingly recognized in the developing world, in view of the inability of food production to keep pace with the increase of population. Thirdly, increasing per capita incomes (whenever and wherever they are attained) seem to act, at least above a certain income level, as a brake on the birth rate, partly because no rise in living conditions would be accessible to a family having too many children, and partly because, owing to the disruption of the traditional subsistence economy and to other changes, children have ceased to represent a source of family manpower and of additional family income.

Table 14

Estimated development of world population by regions
(millions)

Regions	1950	1965	1970	1975	1985[a]	2000[b]
Developed regions:						
Europe	415	480	501	522	564	670
Soviet Union	180	231	245	260	295	353
North America	166	214	229	247	274	345
Japan	84	99	103	108	117	135
Oceania	12	18	19	21	25	32
Total	857	1,042	1,097	1,158	1,276	1,535
Developing regions:						
Latin America	164	244	280	323	422	680
Africa	175	249	281	319	415	580
Asia (Japan excluded)	1,294	1,783	2,019	2,262	2,871	4,205
Total	1,633	2,276	2,580	2,904	3,708	5,465
World	2,502	3,355	3,700	4,087	4,984	7,000

Source: [10].
[a] Estimate based on FAO's "medium" rate of increase.
[b] Extrapolation made by the author.

All these considerations seem to lead to the conclusion that we are on the safe side when estimating the world population about 2000 at 7,000 million. In the following we shall start from this figure, although we do not exclude the possibility of an even steeper rise.

Also the estimates made by FAO seem to justify this prognosis (Table 14).

Any rise in population has a double effect on the demand and supply of wood. It increases the demand for wood (even if per capita consumption tends to decline), and reduces the forest area. In the early 1960's the average population density of the land areas of our planet amounted to 25 per square kilometre. This density will grow to about 50 about the year 2000, and to 100 in 2050 (this latter figure being near to the average density of present-day Europe). In view of this tendency, it seems certain that in the regions where forests abound at present, their relative area will have to decline in order to make place for settlements, industrial

Table 15

Consumption of sawnwood in the construction of new dwellings in Europe

Country groups	Consumption of sawnwood per dwelling unit			
	cu.m			1975 in per cent of 1950
	1965	1960	1975	
Northern countries	22.8	16.7	12.3	54.0
North-Western countries	8.4	6.8	6.0	71.0
Mediterranean countries	6.1	3.7	3.4	56.0
Eastern countries	9.7	6.0	3.8	49.1
Europe	9.1	6.4	5.0	45.0

Source: [23].

plants, roads, channels, airports, etc. Even in the regions where the relative area of forests at present is small, the same requirements will occur, although at a smaller scale. Thus, though here some possibilities of converting certain marginal agricultural areas into forests may exist, a substantial increase in the relative forest area is not likely in these regions. On the other hand, the present low alimentation level prevailing in most of the developing countries requires the conservation or even extension of their cultivated areas. Finally from the land area of our planet we have to exclude a considerable part on account of deserts, high mountains and areas of permanent frost where, according to our present knowledge, neither agriculture nor forestry is possible. All this gives some idea about the problems to be faced in the following decades.

3.5. TECHNOLOGICAL PROGRESS

An important factor influencing the consumption of industrial wood is the general progress of technology. It is, however, difficult to determine numerically its future effect on wood consumption. Essentially, it affects wood consumption in two ways: by creating new, technically better and cheaper competitors to wood products and by improving the technologies applied in turning out the wood products themselves.

As regards the competing materials, it has been already shown how steel and reinforced concrete have been substituted for sawnwood in construction. This process made considerable progress already in the first half of the century and, according to estimates, the per unit quantities of wood used in residential construction are going to be about halved again between 1950 and 1975 (Table 15).

In spite of the sharp fall in the consumption per dwelling unit, the total consumption of sawnwood in new housing rose in Europe from 13.1 million cu.m in 1950 to 17.3 million in 1960; the estimate for 1975 is 20.5 million cu.m.

As regards non-residential construction, ETTS II [23] stated that, since the use of sawnwood for this purpose has for a long time been restricted to the very fields where its continued use has seemed expedient, the future decline of demand per construction unit is likely to be slower than in housing. The total European consumption in this field amounted to 11 million cu.m in 1950, to 15.6 in 1960 and is estimated at 22.8 million cu.m for 1975.

Consumption of wood used for the making of pitprops, railway sleepers, utility poles, etc. has been, and is going to be, considerably affected by technological progress, namely by the increasing use of steel and reinforced concrete. According to ETTS II, the use of wood in Europe (roundwood plus sawnwood converted into terms of WRME) per thousand tons of coal mined fell from 30 cu.m in 1950 to 25 in 1960 and will amount to about 15 cu.m in 1975. The use of wood in other mines shows much the same tendency. Accordingly, in spite of an increasing mining activity, the total quantity used in European mining stagnated between 1950 and 1960 at the level of about 20 million cu.m, and is likely to fall to 12.5 million cu.m by 1975.

In 1948, 98.9 per cent of the new railway sleepers laid in Europe were made of wood. This ratio was only 83.5 per cent in 1959; in the late 1960's it fell to 72 per cent and is estimated to decline to 62.5 per cent about 1975.

The quantity of roundwood used for transmission poles in 1960 was estimated at 2.2 million cu.m; for 1975, a use amounting to 1.4 million cu.m is forecast.

The second effect of technological progress on the use of industrial wood is connected with the improvement of wood-processing technologies. For instance, improved techniques make it possible to turn out a greater quantity of final product from the same quantity of raw material, while others result in final products of a better quality, that is, a smaller quantity is sufficient for the same purpose. Both tendencies reduce the specific quantities of wood to be used for certain purposes but, since they also make wood-based products less expensive i.e. more competitive, thereby they tend to increase the demand for wood.

It frequently occurs that an improved wood product ousts a traditional one. Thus, as a packaging material, wood-based panels, paper and paperboard are being increasingly substituted for sawnwood. Obviously, such substitution does not reduce wood consumption as a whole; it means only that a more suitable and/or less expensive kind of wood product takes the place of the traditional one.

The advantages of substituting plywood or fibreboard for sawnwood are shown in Table 16.

It can be seen that one cubic metre of particle board (made of 1.86 cu.m of roundwood) can be substituted for 3.5 cu.m of sawnwood (made of 4.94 cu.m of roundwood), hence the quantity of raw material required for packaging a given quantity of goods can be reduced by more than 60 per cent. The quantity of wood needed for making a certain quantity of paperboard that can be substituted for sawnwood in certain fields is also considerably less than what would be used for producing an equivalent quantity of sawnwood.

Table 16

Specific use of wood in packaging

Packaging material	Quantity (cu.m) needed for packaging a given amount of commodity	Equivalent in round-wood, cu.m
Fibreboard	1.0	1.86
Plywood	1.0	2.00
Coniferous sawnwood	3.5	4.94

Source: Calculations by the author.

In such cases, technological progress evidently *reduces the specific demand for wood.* At the same time, however, as it tends to make the wood-based product relatively less expensive, it is likely to *increase* the total demand for it.

It is almost impossible to forecast the future rates of technological progress numerically, either for the most important production processes or for fields of utilization. All we can do is to follow up continuously the main tendencies and evaluate the new phenomena, to analyze interdependencies and to correct our conceptions from time to time, according to newly discovered tendencies that are likely to survive in the long run. The coming decades seem to bring as fast a technological progress in the wood-processing industries as in the industries producing competing materials, hence wood-based products will generally maintain their present level of competitiveness.

CHAPTER 4

FORECASTING THE WORLD CONSUMPTION OF INDUSTRIAL AND FUEL WOOD FOR THE YEAR 2000

4.1. METHODS OF FORECASTING AND THE PROBLEMS OF THEIR APPLICATION

Before dealing with the practical tasks of prognosis, it may prove helpful to review some basic statements regarding the theory of correlation. Relying on the classical textbook of M. Ezekiel and K. A. Fox [9] we could briefly review the theorems as follows.

The correlations obtained by plotting a dependent variable against an independent one may be expressed with the aid of various mathematical equations, each of which determines a curve of different shape. When seeking to express the exact nature of a correlation, we may proceed by using mathematical equations of increasing complexity, until we find one which describes our correlation satisfactorily. It may occur, however, that the "true" curve is too complicated for being determined by means of elementary algebraic expressions. In some cases, the logical background of the correlation is not yet sufficiently known, in others it may be based on very complicated physical, chemical or biological structures which cannot be satisfactorily expressed by any mathematical equation. Nevertheless, if we renounce to determine the "exact character" of a correlation and are satisfied with an equation expressing the changes in the dependent variable as a function of the known changes of an independent variable the type of the mathematical equation used is indifferent. The only important requirement is that our equation should reflect the correlation with a tolerable extent of accuracy.

As a matter of fact, there may be no need for any mathematical equation, since even a table or a graphically plotted series of points can express the coincidence of the values of the two variables. From a curve connecting those points, we can take readings for any situation even more accurately than required. If we are satisfied with this, we can save much work compared to that required for finding a mathematical equation that "fits" to all possible situations.

In such cases, a graphical curve can describe the correlation and it can serve to estimate the magnitudes of the dependent variable almost as well as detailed calculations based on a mathematical equation can. Namely, a mathematical formula can only provide an explanation for the real nature of a correlation when its general structure and the constants figuring in it have a *logical background*. If this is not the case (and in the natural and social sciences there are many correlations which can be measured but their causes are not fully known), the mathematical equation is not more reliable than a graphically plotted curve. And since the latter requires considerably less work, it is more extensively used for describing correlations.

When drawing such curves, however, we must not content ourselves by mechanically connecting the points corresponding to empirical data. Before drawing the curve, we should try to reveal, by a logical analysis of the correlation,

the principles limiting its shape. All information available must enter into this logical analysis.

It has to be emphasized that a curve obtained graphically does not enable us to estimate the magnitudes of the dependent variable *beyond the limits set for the actual observation* of the independent variable. Whether we are working with a "fitted" mathematical equation or not, a mechanical extrapolation must not be considered as one based on statistical facts. If we employ a logically justified mathematical formula, its extrapolation may yield a logically expectable result, but the rationale of such an extrapolation will be rather logical than statistical.

When elaborating prognoses regarding the consumption of industrial wood, we need not determine the exact nature of the mathematical correlation. What we want is only to determine, from the values of one variable, the values of another. For this, the graphical method is completely sufficient. Another advantage of the graphical method consists in that it clarifies the correlations also to those readers who are not familiar with mathematics.

Let us add finally that in the long-term analysis of wood consumption, many important data are lacking and must be estimated in much the same way as an archeologist reconstructs the original form of a vault from a few pieces of stone. It is also for this reason that we have chosen to apply the graphical method in our following prognoses.

For revealing long-term tendencies, two basic types of calculation are generally used. One of these starts from the actual level of economic development *(represented by per capita GDP)* and tries to forecast its future changes. After this, with the aid of various calculations, the probable correlation between GDP and the phenomenon to be forecast is established. This method is based on investigating the phenomenon *as a function of per capita GDP.*

The other method puts greater emphasis on investigating the past trends of the phenomenon, that is, it considers it as a mere *function of time*.

In practice, the two methods (in short, "GDP-based" and "time-based" trend calculations) are often combined for both elaborating and checking prognoses; and in any major long-term economic conception the elements of almost all possible forecasting methods are applied in some form or another.

Essentially, the two methods are closely related since, with the passing of time, the development level (i.e. the per capita GDP) of a country tends to rise, and its per capita consumption (e.g. of industrial wood) is likely to increase in some proportion with per capita GDP. Thus, even the first method boils down to applying a function of time. But it makes an important difference that whereas the first method starts from the correlation between wood consumption and a *single* factor (per capita GDP), the second correlates wood consumption theoretically with *all* factors influencing it. Therefore, a long-term forecast starting from "time-based" trend calculations may prove more reliable provided that the expected rate of economic growth is fairly steady. When, however, the rate of growth is expected to vary, the importance of the "GDP-based" trend calculations will be obviously increased. Let us investigate the particularities of both methods.

Here the essential task consists in establishing the level and structure of consumption belonging to a given level of per capita GDP with the possible greatest accuracy, in order to be able to forecast the dynamical and structural changes of consumption on the grounds of the expected future GDP-levels. An indispensable condition of this method is the availability of reliable data relating to the present and future number of population. This is equally important for establishing correct data for per capita GDP as well as for obtaining, with the aid of the forecast per capita consumption, the aggregate quantity of future consumption.

We have seen that the methods actually used by FAO, ECE and the US Department of Agriculture do not assume any change in the "relative" or "real" prices of wood products for 1975 or 2000 when forecasting the consumption of wood, because no significant changes were observed between World War II and the time when these forecasts were made. Neither the factor of technological progress is separately accounted for, because expectations relating to it are already expressed in the way of estimating the future levels of consumption of the various *kinds* of wood products, i. e. in the estimated future *production structure*.

Thus, an important part of the calculations based on this method is aimed at revealing correlations between per capita GDP and the use of industrial wood *in each of the major fields of consumption*. As a result of detailed investigations made by experts of the individual fields, a certain pattern of the expectable consumption of industrial wood may be obtained.

Obviously, extensive investigations are required for this method and a large set of *assumptions* has to be used for elaborating the forecasts. Practitioners of long-term planning know the dilemmas they have to face very well because theoreticians, owing to their zest for accuracy even in the details, tend to build up a labyrinth of alternative assumptions, which leads to a host of "variants". This, however, means that they leave it to the uninitiated practitioner to choose among the variants offered that one which pleases him best.

For instance, in ETTS I [22], four variants figured regarding the period 1950–1960, namely two for the rate of economic growth and two for the relative price level of wood products. Later on, the actual data relating to this period did not confirm *any* of these variants; actual consumption of wood products exceeded all of them. Drawing the lesson from this, later ETTS surveys tended to propose only a single forecast with some hints at the consequences of a lower or higher level.

All this, however, has not solved the problems, some of which may be put as follows:

a. how can the rate of economic growth of a particular country or of a major region be estimated;

b. how can the magnitudes of GDP in the same country at different points of time, or of the GDP's of different countries at the same point of time, be made comparable;

c. how can the elasticity of demand (with respect to income) of the individual wood products be assessed at various levels of per capita GDP, or at similar GDP levels prevailing in different countries or regions, or at various points of time?

First of all, it is necessary to find a method for comparing various GDP-levels.

Experience has shown that the difficulties of comparison are caused partly by the different methods applied by various countries for assessing GDP, and partly by the coefficients used for converting the values expressed in national currencies to a common currency, e. g. to US dollars. Price systems vary by countries, and official exchange rates fail to express the true proportions of purchasing power, not to mention that the same country may apply differential exchange rates for commodity trade, tourism, etc. Moreover, the currencies of the socialist countries are not directly convertible to dollars, and they are usually not quoted at Western exchanges.

For the purpose of the following calculations (the result of which will be shown in Table 17), the future levels of per capita GDP will be assumed according to FAO's forecasts published in 1967 (Agricultural Commodities – Projections for 1975 and 1985, an Indicative World Plan, i. e. "IWP" [10]). These calculations include *two* variants for 1975 and *four* for 1985. Readers of this book are fully in the right to demand from the author to take *his* choice from among these variants, since the complicated system of laws governing economic growth is difficult to penetrate even for those who deal with this field professionally. For our discussion, we shall choose the following variants from the ones figuring in IWP; we accept all data relating to 1962 and 1965; of the two variants established for 1975 we accept the lower one; and from among the four variants regarding 1985, we accept the one derived from multiplying the "lower" variant of GDP and the "higher" variant of population.

It seemed advisable to choose the higher population estimate for 1985 because during the past two decades the actual population figures proved invariably higher than the previous estimates. In the case of the 1985 GDP, however, the lower estimate was chosen, since FAO experts, though undoubtedly competent, seem to have been inclined towards a certain optimism. According to more recent experience, however, the higher variant of GDP was accepted for Japan.

The 1937 data have been obtained by the method of Jánossy [35] and Ehrlich [8]. Using a simple method, these authors established correlations between per capita GDP and a set of indicators expressed in physical terms (e.g. the per capita consumption of certain goods, the number of motor cars, telephones etc. per 1,000 inhabitants) which characterize the development levels and the living conditions in the various countries. By this, uncertainties arising from the application of official exchange rates can be circumvented, and per capita GDP's can be assessed even for countries for which no such data have been available, only the indicators expressed in physical terms are known. The method is also suitable for making comparable the GDP data of the socialist countries whose currencies are not directly convertible.

Data regarding 1937, the last "normal" prewar year, had to be involved in order to assess the subsequent changes that occurred during World War II and the reconstruction period following it. This is highly important for avoiding e.g. the mistake of extrapolating, for the long run, the high growth rates observed during a relatively short reconstruction period, and drawing too optimistic conclusions therefrom. (Of course, a mistake in the opposite sense may also be committed e.g. by comparing the prewar level to some early postwar year when, with reconstruc-

Table 17

Estimated per capita GDP
(US dollars of 1961–1963 purchasing power)

Region or country	1937	1950	1957	1962	1965	1975	1985	2000
Northern Europe	753	1,020	1,250	1,450	1,570	2,000	2,660	4,000
EEC	610	606	860	1,123	1,241	1,637	2,090	3,200
Central Europe	315	345	500	660	730	1,000	1,310	2,120
Eastern Europe	277	300	487	696	794	1,102	1,553	2,600
Southern Europe	190	180	246	300	346	430	548	890
Great Britain and Ireland	950	1,038	1,160	1,290	1,350	1,570	2,050	2,840
EUROPE	495	520	720	900	980	1,280	1,700	2,500
Soviet Union	285	326	558	820	951	1,372	1,976	3,300
USA	1,550	2,280	2,500	2,684	2,912	3,477	4,026	5,600
Japan	220	183	333	521	662	1,372	2,606	5,600
WORLD	218	307	390	466	505	686	941	1,440

Source: [10].

tion still going on, the GDP was yet relatively low, and thus extrapolating a too low rate of growth into the more distant future. But, after all, careful consideration may help to avoid committing such mistakes.)

In the first step, we tried to establish the trends of per capita GDP for the period 1937–1985, when, by a graphical extrapolation of these, we obtained estimates for 2000. When comparing our figures with the estimates elaborated in 1967 for the year 2000 by Kahn and Wiener [37] and by FAO in its IWP also for the year 2000, it was found that ours were fairly close to those of the IWP [10].

All our GDP data are expressed in US dollars of a purchasing power corresponding to average US prices in 1961–1963. This has to be emphasized because the purchasing power of the US dollar has considerably declined since. Thus, when it is necessary to convert the equivalent of a magnitude figuring in our table into current dollars, for the purpose of a rough-and-ready estimate perhaps an annual 5 per cent price rise should be assumed; e. g., if we want to convert these figures into dollars of 1970 purchasing power, they should be increased by about 48 per cent.

Misleading comparisons may also occur because the dollar equivalents to GDP's of different countries were obtained by different methods (e.g. by converting national currencies to dollars at exchange rates in some cases, and on the basis of certain physical indicators in others). Any comparison of GDP levels must be preceded by corrections aimed at ensuring comparability. Otherwise, such com-

parisons will invariably cause confusion instead of contributing to the understanding of problems.

The numerical results of our calculations are shown by Table 17. The correlation between levels and growth rates of per capita GDP and the consumption of various wood products will be dealt with later, in the context of consumption forecasts.

4.1.2. "TIME-BASED" TREND CALCULATIONS

The economic development of individual countries or even of major regions takes place, as a rule, at surprisingly steady rates of growth, therefore "time-based" trend calculations can be successfully applied when elaborating long-term prognoses.

An important contribution to the theory of trends was made by the Hungarian economist F. Jánossy [36]. Some of his propositions relevant to our work may be recapitulated as follows:

1. When plotting a time series representing the GDP of a war-inflicted country (in this respect, there is not much difference between victorious and defeated) on a logarithmical scale, the recession caused by war and the subsequent process of reconstruction is likely to show the typical picture presented schematically in Figure 4.

In this figure, the straight line AF expresses the rate of undisturbed long-term growth, that may be considered as the trend line. The line BC represents the decline of output between the beginning and the end (or some time after the end) of the war. The section CE is the period of reconstruction, during which the prewar level is again reached at D. *At this point, however, the reconstruction period is not yet finished*. Relatively high growth rates, as a rule, continue to prevail until, at E, a level corresponding to the long-term trend is reached. After this, growth will slow down to the "normal" rate, that is, to the one which is determined by the general laws and conditions of the long-term economic development characteristic of the country in question. Subsequently, economic growth will again follow the long-term trend AF.

Thus, a reconstruction period does not end at D where the prewar level is reached, but only at E where a level corresponding to the long-term trend is again attained.

2. However, if we assume that after recession (caused by a war or an economic crisis) economic growth sooner or later attains the level corresponding to an undisturbed growth rate along the long-term trend, this means that any curve (e. g. of production or consumption) characterizing the long-term trend of economic development will connect the *peaks* of the actual data (in the form of an "enveloping curve"), rather than being a regression line obtained from the data available. Thus, the trend will show the rate of growth that would have occurred in the absence of any disturbing factor. In other words, the long-term trend forms a bridge over the temporary troughs caused by the disturbing factors, and shows the line of growth as if it had taken place in the absence of such factors.

3. The trend of economic development of any country can be determined with a tolerable degree of reliability as long as the most decisive factors influencing de-

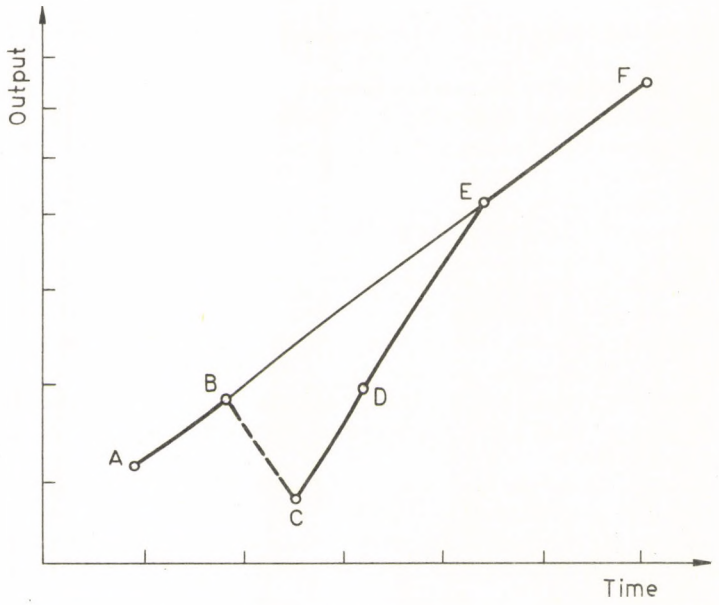

Figure 4. Typical scheme of the development of output during a postwar reconstruction period
AF = long-term trend of output
AB = prewar development
BC = wartime recession
CE = reconstruction period (prewar level reached again at *D*, the level of long-term trend attained at *E*)
EF = development of output after the reconstruction period
Source: [36].

velopment (including the conditions of production) remain unchanged. A change in any of the decisive factors is likely to cause a break in the trend line.

This theory can be fairly well applied to the elaboration of prognoses relating to wood consumption. Our investigations in this field have led to the conclusions expounded below.

A time trend obtained from the data of the base period is the result of *all* factors directly or indirectly influencing wood consumption, from demographical tendencies through technological progress to the relative forest area. Some of these factors and their effects can be measured, others cannot. It seems, however, that their *aggregate effect* tends to change but slowly, so that its extrapolation may yield perhaps as reliable a forecast as a detailed analysis of the measurable individual factors.

Adequate choice of the length, as well as of the starting and end points of the base period is very important. From what has been said above, it follows that only a trend line obtained by connecting the *peaks* may give reliable results. In both the Hungarian and the international literature we often find forecasts based on the

rapid economic growth during the postwar reconstruction period. Such an approach is evidently misleading. It induces us to forecast irrealistically high growth rates for the more distant future. One should never forget that when the steep rate of growth pertaining to the reconstruction period meets the level of long-term development, it necessarily slows down, fitting into the trend of the latter.

In international discussions relating to wood consumption, e.g. at the sessions of the Timber Committee of ECE, time and again opinions are heard saying that the consumption of industrial wood (in particular sawnwood) has taken up a new trend, and this is often attributed to the competition of substituting materials. In reality, the reason for a change in the rate of increase has been – as expounded by the present author at the Geneva session of the Timber Committee in 1968 – that the fast rise in the consumption of sawnwood observed during the postwar reconstruction period has given place to the slower rate of the long-term trend that includes the prewar period as well. Thus, there is no "new" trend; what happened was only that, after an exceptional interlude, the general trend came to its right again.

As has been mentioned above, it is also easy to make a mistake in the opposite sense: connecting some former peak with a later relatively low one, and thereby obtaining an irrealistically low rate of increase, which will then distort the forecasts toward unjustified pessimism. This was, indeed, the case with some forecasts made in the early 1950's. By comparing the high 1913 level with the trough of 1950, some experts came to the conclusion that no significant rise or fall in the European industrial wood consumption could be expected in the future, because the rise in 37 years (1913 to 1950) was only 22 per cent. For these experts the decade 1950–1960 brought a great surprise, namely a 35 per cent rise in ten years. Such surprises (more exactly, such gross mistakes) can be practically avoided, at least in the case of forecasts covering shorter periods, by a more careful study of the nature of trends.

Besides the essentially important choice of the starting and end points of the base period, the question of proportion also emerges, i.e. the proportion between the length of the base period and that to be covered by the prognosis. In the case of wood consumption, a safe forecast may only be expected when the base period is at least as long as the future period to be covered. This is particularly important when marked peaks occur in the base period, and in this case a projecting of the trend line obtained from connecting the peaks is logically justifiable.

When at least two or three well-marked peaks occur in the basic time series, the trend obtained from them may be used for forecasting the development of a future period, provided that it is not longer, or at least not much longer, than the base period. By any means one must avoid building up forecasts for decades on the data of just a few years: such forecasts will, as a rule, prove mistaken.

A special problem arises when forecasting the future consumption of those wood products the use of which began spreading only after the war, e.g. fibreboard and particle board. Mass consumption of these products started less than two decades ago. Such a short period is not a suitable base for forecasts covering the period 1970–2000, apart from the fact that part of it coincided with the postwar reconstruction period which *ipso facto* disqualifies it for being used as a base. Another contra-indication also arises because, shortly after the introduction of a new product, its consumption is likely to rise at an exceptionally high rate, since in

the first few years it conquers the fields where it is most competitive, whereas, later on, intrusion into the remaining fields becomes increasingly difficult. Thus, after some time, a state of dynamic equilibrium is likely to be reached, where the trend of consumption of the product in question adapts itself more or less to the general long-term rate of economic growth. ("More or less" means that its consumption may increase somewhat faster or slower, depending on its nature.) At present, both fibreboard and particle board seem to be somewhere around the end of the first period, characterized by a sharp rise in consumption. In their case, we cannot but form our opinion according to our best knowledge, both as regards the point of time when their consumption would take up a long-term trend of its own, and as to its rate of increase which is to be expected afterwards.

Finally, it has to be emphasized that a once-established long-term trend is not a fatal one, irrevocably determining the line and pace of development, nor is it a crystal ball telling the future to anybody looking into it, without effort, theoretical knowledge and practical experience.

Long-term trends offer only an auxiliary – although helpful – tool for forecasting future developments; a tool that can be used only in combination with thorough knowledge of the economic activities concerned and with practical experience checked through discussions with fellow experts.

From what has been said here it follows that the methods known at present are suited only for revealing some of the long-term tendencies and for making estimates accordingly, but they are not sufficient for elaborating long-term *plans,* that is, for decisions to be taken by the highest authorities of a country. They may serve, however, as a footing for the long-term conceptions of economic policy, including long-term investment plans.

In the following, we shall approach our objective in two ways.

First, we shall investigate the *total consumption of industrial wood* in the main regions. For some of them, adequate base-data are available. Forecasts built on such data imply, however, an uncertainty growing with the length of time to be covered by the forecast. Namely, we are able to forecast with tolerable reliability the *aggregate* effect of the factors influencing the *total* consumption of industrial wood, but it is not possible to forecast, within this, the *proportional changes* between the main types of wood product, e.g. between sawnwood and pulpwood. Therefore, our prognoses are to be checked by another method.

This second method consists in establishing *long-term trends for the consumption of the main kinds of industrial wood products* by regions. From this, we expect to obtain answers to such questions as that relating to the future proportions between e.g. the consumption of sawnwood and pulpwood in each of the main regions, also indicating the date when the steeply rising pulpwood consumption will equal, and begin to exceed, the quantity of sawnwood consumption which rises at a much slower rate.

This point, however, will mean *the start of a qualitative structural change* in the development of industrial consumption as a whole, because here an acceleration of its increase is likely to begin.

An answer to this question may be obtained by analyzing the trends of the various wood products separately. By confronting and weighing such data, it becomes possible to take a standpoint regarding the major problems of prognosis.

4.2. TENDENCIES OF INDUSTRIAL WOOD CONSUMPTION BY REGIONS

4.2.1. EUROPE

4.2.1.1. The official forecasts

Europe is the region for which the most reliable and detailed analyses, trend calculations and prognoses up to 1980 are available. For every one who deals with the theoretical and practical questions of wood consumption, it is advisable to study the documents elaborated jointly by FAO and ECE. In these, the development of consumption is analyzed separately for the various kinds of industrial wood, then factors of elasticity are established as a function of per capita GDP and, finally, the future tendencies for the major kinds of products are forecast on this ground. Table 18 sums up the data by final users in the major fields.

The forecasts for 1975 were elaborated on the grounds of studies made by the best experts as well as of data obtained from the governments concerned after detailed questionnaires had been sent to state organs and independent experts. Based on such careful studies and data collecting, prognoses are becoming increasingly reliable. Evidently, such facilities are not available to individual research workers. Therefore, simpler methods not requiring such apparatus have to be elaborated, based mainly on careful investigation and the application of time trends.

Table 18

Consumption of industrial wood in Europe by major end-uses

End-uses	Roundwood equivalents, million cu.m			As a percentage of total consumption		
	1950	1960	1975	1950	1960	1975
Construction	49	70	102	29	29	27
Packaging	26	45	96	15	18	26
Furniture	11	20	32	6	8	9
Mining	19	20	13	11	8	4
Railway sleepers	6	5	3	3	2	1
Printing and writing paper	12	23	51	7	9	14
Textiles	4	7	10	2	3	3
Other	47	56	58	27	23	16
Total	174	246	365	100	100	100

Source: [23].

Table 19

Per capita GNP and per capita consumption of industrial wood

	1950	1960	1975
1. GNP per capita (US $ at 1960 prices)	570	865	1,500
2. Per capita consumption of			
sawnwood (cu.m)	0.15	0.17	0.17
wood pulp (tons)	0.019	0.035	0.075
wood-based panels (cu.m)	0.007	0.019	0.050
total industrial wood (WRME/cu.m)	0.43	0.55	0.72
3. Ratio of 2 to 1, 1950 = 100			
sawnwood	100	75	43
wood pulp	100	121	150
wood-based panels	100	179	271
total industrial wood	100	84	64

Source: [23].

Note. Contrary to the calculations figuring elsewhere in the present study, this table compares European per capita wood consumption with per capita figures of the GNP rather than with those of the GDP; moreover, the figures are expressed here in dollars of 1960 purchasing power whereas our GDP data are expressed in dollars based on 1961–1963 prices. Since, however, after detailed calculations we found that the really relevant last four rows of the present table would change but slightly if they where recalculated on the basis of the GDP data, and the difference would not alter the conclusions, we deemed it useful to quote the table here.

Before expounding the method we are going to apply in the following, let us review the relationships between per capita GNP and wood consumption as stated in ETTS II [23] (Table 19).

According to these data, against an estimated 158 per cent increase of the per capita GNP (see our Note to Table 19), a 67 per cent rise in the per capita consumption of all industrial wood was forecast for the 25 years 1950–1975 (only 13 per cent for sawnwood but 296 per cent for wood pulp and more than 600 per cent for wood-based panels). This is quite understandable since, with rising per capita income, an increasing portion of it is spent on services, highly-processed industrial products, luxury goods and savings. The elasticity of demand with respect to income is much lower than average in the case of simple wood products like sawnwood whereas it is very high in the case of wood pulp (representing the demand for paper and paperboard) and of wood-based panels; but the elasticity of industrial wood in general is still less than average. Between 1950 and 1970 every 1 per cent increase of income was believed to induce only a 0.64 per cent rise in the per capita consumption of industrial wood. More exactly, the predicted proportions were 0.43 for sawnwood, 1.50 for wood pulp and 2.71 for panels. This also means, however, that an average value of 0.64 can only be arrived at if a definite *structure* of consumption is supposed.

From Table 19 we may draw the conclusions that (a) within the consumption of industrial wood the share of wood needed for making paper and panels is rapidly

Table 20

Proportion (in per cent) between the consumption of sawnwood and paper products (calculated from the WRME's)

	1913	1937	1960	1975
Sawnwood	84	73	66	50
Products of the paper industry	16	27	34	50

Source: [23].

increasing; and (b) the higher this proportion, the more the average elasticity of demand for industrial wood will be influenced by the high-elasticity goods, thus implying a relative acceleration of the growth in wood consumption as a whole.

Therefore, even if we accept the 1975 estimate of ETTS II [23], it is necessary to investigate developments expectable after 1975 more thoroughly. The proportion between the slow-growing consumption of sawnwood and the fast-growing one of pulpwood over more than 50 years is shown by Table 20.

Evidently, after 1975 the share of pulpwood will considerably exceed 50 per cent, so that the long-term trend of its consumption will dominate the general trend of industrial wood consumption. (As the growth in the consumption of wood-based panels is even faster, their influence will enhance the effect in question.)

ETTS II [23] did not yet take these new tendencies into consideration. It only stated that if the assumed tendencies continued to prevail, the aggregate consumption of industrial wood in Europe would reach 500 million cu.m by 2000.

The interim revision of estimates contained in ETTS II/IR [24] prolonged the forecast up to 1990 and included some estimates even for 2000. Accordingly, the two estimates (together with actual statistical data) are as shown by Table 21.

Table 21

Estimated aggregate consumption of industrial wood in Europe
(million cu.m of WRME)

	1913	1925/29	1935/38	1950	1960	1975	2000
Total:							
according to ETTS II [23]	138	153	173	178	247	378	500
according to ETTS II/IR [24]	138	153	173	178	247	378	680
of the latter:							
sawnwood and roundwood	96	150	108	103	138	175	190
other industrial wood	42	53	65	74	133	203	490

Sources: [23, 24].

The Interim Review also took into account the conclusions of the related discussions and the expectable results of recently observed tendencies. By raising the former estimate for 2000 by 36 per cent, it provided a more correct assessment relating to the consequences of the changing pattern of consumption. This fact exemplifies how prognoses change and may be made more accurate in the course of time, and how necessary it is *to continuously improve our conceptions of the future by utilizing recent information.* Only continuous work on the long-term prognoses is able to keep them up-to-date and ensure their practical applicability.

4.2.1.2. Trend-based calculations

As already mentioned, essentially the method based on the trends of time series is applied in the present study. With the aid of this method, the expectable consumption of industrial wood can be estimated as shown by Figure 5.

We have drawn the trend line of the aggregate consumption by connecting the peaks of 1913, 1927 (= average of 1925–1929), 1937 (= average of 1935–1938), 1966 (= average of 1965–1968), and 1968. The extrapolation of this line would give 520 million cu.m for 2000, that is, about the same as the estimate of ETTS II [23].

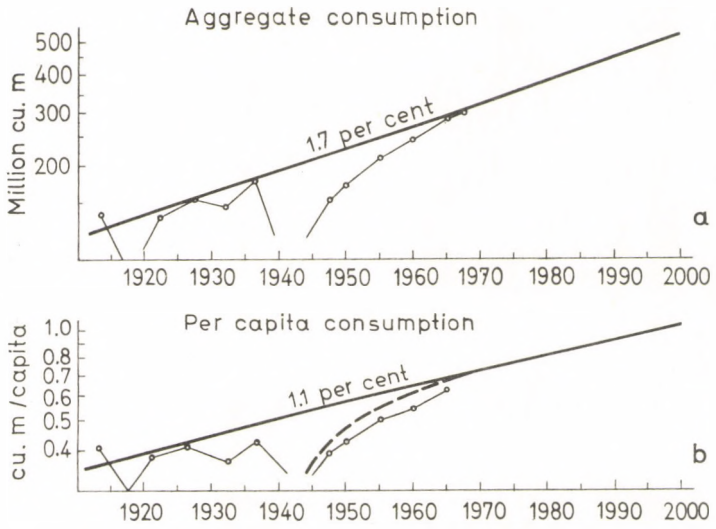

Figure 5. Consumption of industrial wood in Europe
Sources: Except otherwise stated, both here and in the following figures, calculations are made by the author, based on [14, 17, 22, 23].

Doubts may arise, however, whether the point called "1966" (meaning the average of 1965–1968) may be really regarded both as a peak and as the point where the faster growth rate of the postwar reconstruction period returns to the long-term trend. This cannot be affirmed unequivocally. Indeed, it seems as if the faster growth of the postwar years were continued, although at a somewhat slower rate.

Since the 24-year period 1913–1937 is not sufficiently long to serve as a basis for a prognosis extending over 50–60 years, and since the 1965–1968 figure cannot be unequivocally considered as one lying on the long-term trend line, it is necessary to apply further methods of checking. What we have obtained up to now indicates that a modification in the long-term trend line may occur, namely, the rise in consumption might accelerate.

In order to reveal the expectable tendencies more reliably, two methods could be applied.

The European trend of per capita consumption of industrial wood. The lower line in Figure 5 indicates that in the 52-year period 1913–1965 the average annual growth rate of per capita consumption was 1.1 per cent. Postwar growth, taken separately, was very much faster, and even here one cannot affirm unequivocally that it was exactly in the late 1960's when the long-term rate of 1.1 per cent set in again. So much is certain, however, that the long-term trend of per capita consumption is less steeper than that of the *aggregate* consumption (which shows an annual rise of 1.7 per cent), and that, by this fact alone, its extrapolation into the future seems to be more justified. Hence, we might consider the level of consumption indicated by this trend line as the lowest limit. By extrapolating this trend, we obtain a per capita consumption of 0.71 cu.m for 1975 and 0.92 cu.m for 2000. When multiplying these by the estimated population, the aggregate consumption would be 386 million cu.m for 1975 and 617 million for 2000. Both figures are lower than those estimated in ETTS II/IR [24] (see Table 22), but even so they indicate an acceleration in the growth rate of consumption during the second half of the century.

Correlation between per capita GDP and consumption of industrial wood in Europe. Here, several calculation possibilities are conceivable. Since, however, the present study strives to achieve its objective mainly by revealing the general tendencies of consumption, rather than to build up the whole consumption from its parts, we start from investigating the correlation between per capita GDP and per capita wood consumption *as a whole.* Europe is, and will increasingly be, an importing region; for this we can find the relevant ratios in the upper line of Table 8 (see p. 39). Further, Table 17 (p. 56) shows that the European average of per capita GDP will attain $1,280 in 1975. According to Table 8, a per capita wood consumption of about 0.74 cu.m would correspond to such a GDP level, and this would amount to an aggregate consumption of 386 million cu.m in 1975. Similarly, we obtain 0.95 cu.m and 636 million cu.m (see Table 22) for 2000 when per capita GDP is assumed to reach $2,500.

Thus, the results of our two calculations deviate by less than ten per cent from the estimates of ETTS II/IR [24].

Let us sum up what can be stated on the grounds of these calculations.

1. By simply extrapolating the trends of aggregate industrial wood consumption in Europe we obtained a magnitude of *500–520 million cu.m* for 2000 (Figure 5). Various considerations, however, have indicated that a simple extrapolation of the trend line observed in the first half of the century is misleading, since in the second half a somewhat faster increase is likely to take place.

2. On the grounds of the forecasts made by FAO and ECE in 1964 [23] and their revision in 1969 [24], as well as of various researches and discussions, it was believed that consumption of industrial wood in Europe was going to attain 680 million cu.m by 2000.

Table 22

Comparison of data and prognoses relating to per capita and aggregate consumption of all industrial wood in Europe

	1950	1960	1965	1970	1975	1985	2000
1. Aggregate consumption (mill. cu.m of WRME) according to [24]	*178*	*247*	*291*	*329*	*378*	*490*	*680*
2a. Per capita consumption (cu.m of WRME) according to our time-based trend	0.43	0.55	0.62	0.67	0.71	0.79	0.92
2b. Aggregate consumption (mill. cu.m of WRME) according to (2a)	*177*	*247*	*293*	*332*	*368*	*448*	*617*
3a. Per capita consumption (cu.m of WRME) according to our GDP-based trend	0.38	0.56	0.64	0.71	0.74	0.84	0.95
3b. Aggregate consumption (mill. cu.m of WRME) according to (3a)	*154*	*260*	*306*	*366*	*386*	*475*	*636*
4. (2b) as a percentage of (1)	100	100	101	101	97	92	91
5. (3b) as a percentage of (1)	86	105	105	111	102	97	94

Sources: (1): [24].
(2a): Figure 5.
(2b): Row (2a) times population (Table 14).
(3a): Tables 8 and 17.
(3b): Row (3a) times population (Table 14).

3. The two approaches figuring in this study resulted in forecasts amounting to 617 and 636 million cu.m, respectively.

4. Thus, the European consumption of industrial wood in 2000 will be somewhere between 620 and 680 million cu.m, probably nearer to the upper than to the lower limit. All this is, however, but a very rough approximation of the magnitude to be expected. Namely, the small but continuous change in the pattern of consumption (essentially, pulpwood *versus* sawnwood) is likely to continue at a higher rate and thereby to accelerate the growth rate of industrial wood consumption as a whole. This circumstance will be taken into account when investigating the principal kinds of industrial wood in details.

4.2.2. NORTH AMERICA

This region is highly important for the consumption of industrial wood because it is at present the economically most advanced one, so conclusions drawn from the tendencies prevailing there may be helpful in forecasting future development of other, less advanced regions. Also it is the greatest consumer of industrial wood, and the extent of changes in its consumption significantly influences world consumption as a whole. Finally, it is for the USA, the leading unit of this region, that the most detailed calculations or forecasts up to 2000 are now available, and the study of the methods applied there in this respect may be helpful to anybody engaged in long-term forecasting.

4.2.2.1. The USA

Regarding industrial wood consumption in the USA, the Forest Service of the US Department of Agriculture elaborated an extensive study in 1965 [63].

Here, after establishing the basic assumptions for 2000 as regards population (estimated at 325 million), gross national product ($ 1,920 billion at 1961 prices, or $ 5,910 per capita), and the available manpower etc., the authors of the study, similarly to the method used by FAO and ECE, proceed on to forecast consumption by main kinds of industrial wood, obtaining the total consumption from summing up the parts. The calculations relating to the elasticity of demand with respect to income as well as the long-term trends calculated from long base periods are used extensively. According to the final result, US consumption of industrial wood is believed to attain 586 million cu.m in 2000.

Generally speaking, it would be difficult to challenge the final conclusions and statements of the study as regards magnitudes, since its methodology as a whole may be considered as correct. Besides, this was not the first attempt in this field. The authors could rely upon ample experience gathered from elaborating earlier prognoses, the latest of which was published in 1958. Nevertheless, we cannot rest satisfied by taking over the final result without any further investigation. First, since our aim is to elaborate a forecast for the whole world with the aid of a *uniform method,* the calculations required by our method have to be performed also for the USA. Second, *some* of the statements included in TTUS can be disputed, e.g. the statement that "relative" and "real" wood prices will remain stable in the decades to come, close to the level of the 1950's. True, there is a hint that they may rise again towards the end of the century, but nothing indicates whether, and to what extent, the possibility of such change was taken into consideration when elaborating the forecasts.

For instance, it seems quite justified to assume that the growing distances between felling places and consumption centres, as well as the expectable deterioration in the production pattern by sizes and qualities are likely to cause a rise in relative wood prices, perhaps already about the middle of the period covered.

Another questionable statement of the study assumes that wood as an industrial raw material will practically maintain its present share in relation to total raw material consumption, namely about 20–22 per cent. Our Table 2 shows that even in the short period between 1950 and 1960 this share slightly declined: whereas the output of world industry as a whole rose by an annual 6.7 per cent,

that of the wood and paper industries increased by 5.6 per cent only. Moreover, past experience and future prospects make it probable that technological progress in some other branches of industry (above all, chemistry and metallurgy) will continue to go on much faster than in the wood-processing industries, and under such circumstances their output and (perhaps to a lesser extent) also their consumption of raw material will grow faster. Thus the assumption that wood as a raw material is going to retain its present share in the next three or four decades can hardly be agreed with.

The final numerical results of TTUS are shown by Table 23; the years figuring here were selected from a continuous time series so as to show the main peaks occurring between 1920 and 2000.

Let us now present the results of our own calculations made in the two ways suggested earlier (for detailed explanation see section "Europe").

When plotting the actual data of aggregate industrial wood consumption from 1910 to 1968 (Figure 6a), we find that they can hardly be fitted to any trend of the first degree. At best, only the data of three years would lie on such a continuous trend line. This trend would imply the very moderate annual rise of 0.8 per cent. However, the broken line connecting the *peaks* might be easily divided into two parts. Aggregate consumption seems to have *stagnated* during the first part (i.e. until 1944) around the level of 270 cu.m, and to have *risen* by about 1.2 per cent annually in the second.

According to our second method of approach (Figure 6b), per capita wood consumption was plotted according to its correlation with per capita GDP. (Here, of course, the second row of Table 8 relating to exporting regions was used, according to what has been said previously of the USA, see p. 40.) It can clearly be seen that per capita consumption (which was very high at the beginning) fell sharply during the first subperiod. This is compatible with our previous assumption according to which aggregate consumption stagnated, in spite of the population increase. In the second subperiod, however, per capita consumption seems to have been practically constant. This, again, is compatible with our assumption that at this time aggregate wood consumption rose more or less parallel with the population.

Table 23

Estimated consumption of industrial wood in the USA (1920–2000)
(million cu.m of WRME)

	1920	1923	1942	1956	1962	1970	1980	2000
Sawnwood	156	178	188	178	168	177	194	237
Veneer logs	3	5	7	18	28	42	52	75
Pulpwood	16	22	50	85	94	112	153	261
Other industrial wood	52	50	28	16	13	13	13	13
Total industrial wood	227	225	273	297	303	344	413	586

Source: [63].

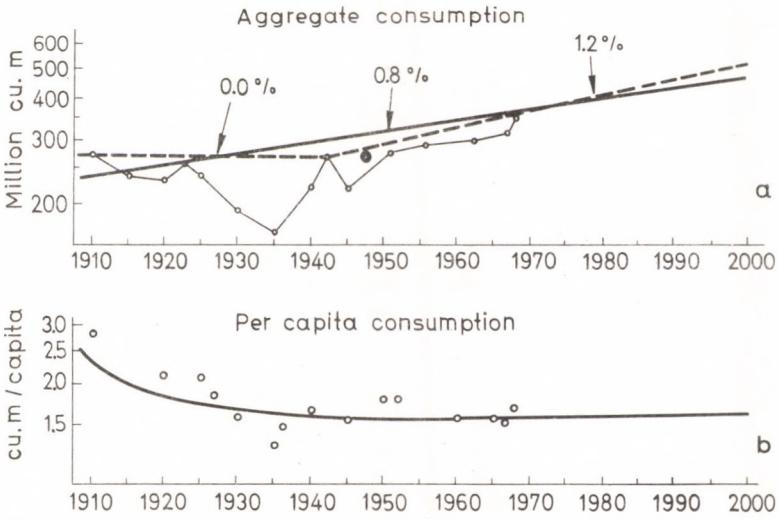

Figure 6. Consumption of industrial wood in the USA
Sources: [60, 63].

Whereas the straight trend line indicates an aggregate consumption of 450 million cu.m for 2000, that is, an irrealistically low level, our broken trend line shows about 515 million cu.m. Finally, if we start from per capita consumption and assume it to retain its present level (about 1.6 cu.m) or to rise slightly, say to 1.7 cu.m before the end of the century, we obtain an aggregate consumption of 550–560 million cu.m, i.e. somewhat less than what TTUS forecast [63].

Thus, again, our two forecasts (515 and 550–560 million cu.m) differ but moderately from the 580 million forecast by the authors of the study cited (see Table 24).

Table 24

Comparison of data and prognoses regarding aggregate US consumption of industrial wood
(million cu.m of WRME)

	1956	1962	1970	1980	1990	2000
1. According to [63]	297	303	344	413	510	586
2. According to our time trend	297	303	360	410	470	515
3. According to our elasticity trend	272	300	335	391	465	553
4. (2) as a percentage of (1)	100	100	105	99	92	88
5. (3) as a percentage of (1)	85	99	97	95	91	94

Summing up, we may state that no straight trend line can be drawn for the base period 1910–1968, because first a marked fall in per capita consumption and a stagnation of aggregate consumption prevailed, whereas later, from 1950 to 1968, with per capita consumption stagnating, aggregate consumption rose at a rate of about 1.2 per cent annually. This second subperiod is, however, too short to serve as a projection basis for the next three decades. At any rate, against the TTUS forecast for 2000, namely 586 million cu.m, our results show 515 and 550–560 million, respectively. From this we might conclude that in 2000 the consumption of industrial wood in the USA will be somewhere between 550 and 590 million cu.m.

4.2.2.2. Canada

In Canada, per capita consumption of industrial wood is very similar to that of the USA as regards its size, pattern and dynamics. The population of this country being only about one tenth of that of the USA, it does not seem worthwhile to perform a separate calculation. Instead, we assume that the Canadian consumption shows, and will show, about the same proportion. It is to be noted that Canada's importance for the future of the world's forest and timber economy lies not in its consumption but in its exports which are, as we shall see, with their volume and quality one of the decisive factors in world trade.

Accordingly, the total consumption of North America may be forecast as 600–650 cu.m for the year 2000.

4.2.3. THE SOVIET UNION

It is more difficult to forecast the situation in the Soviet Union than in the case of either Europe or North America. In this respect, international estimates regarding the consumption of industrial wood contain, as a rule, only the statistical data and perhaps some plan figures published in the Soviet Union. As regards forecasts for 2000, it is known that they are under elaboration in the Soviet Union, so nothing has been published so far.

Difficulties start to arise already in connection with the choice of the base period. World War I, the revolution and the war against the interventionists drained the resources of this country to the utmost limit. Its economic activity in the late 1910's and early 1920's declined incomparably steeper than anywhere else. Afterwards, however, the building of socialism introduced faster growth rates than had prevailed in Czarist Russia, and radically transformed the economic structure. Clearly, all this changed also the trends and patterns of wood consumption. World War II brought about another very heavy recession, but after a relatively short reconstruction period fast progress started again and, in an unbelievably short time, the country became the world's second industrial power.

The turbulent events in the first half of the century and the fast transformation of economic structure make it impossible to construct a long-term trend line that could safely be prolonged into the future.

Another difficulty is that so far only a small number of published studies has dealt with the tendencies, development hypotheses and prognoses regarding this country's industrial wood consumption. In our opinion, the work of P.V. Vasilyev [64] is the most valuable among the available sources. Being a world-renowned forester-economist, he sums up here the results of his researches in analysing the

problems (and possible solutions) of the Soviet forest and timber economy. Though briefly, he also deals with forecasting wood consumption, offering an important starting point for our estimates concerning the year 2000. We shall follow his train of thoughts in our examinations below.

The long-term programme of the Soviet Communist Party has provided for a sixfold rise of industrial production between 1960 and 1980. In the early 1960's the output of industrial wood was about 450 million cu.m. Thus, even if the specific consumption of wood in construction, mining and other branches were reduced to less than half, the required amount of industrial wood would attain at least 1 billion cu.m in 1980. This would exceed even the capacity of Soviet forestry. Although it has the world's biggest forest area, the annual net increment of growing stocks is only about 850 million cu.m at present. Besides, also the manpower required would be immense. While representing in terms of value only 7 per cent of all industrial production in the Soviet Union, forestry and the exploitation of wood employ 14 per cent of all industrial manpower.

In view of these facts, the future of the Soviet forest and timber economy will increasingly depend on making wood use much more efficient,

a. by organizing the complex use of wood produced, ensuring maximum utilization of residues, including both the slashings produced in the cutting-place and the residues of industrial processing (shavings, sawdust, etc.);

b. by replacing natural wood by panels, paperboard, pressed elements etc. that can be produced from poor-quality wood or residues, as well as by materials other than wood;

c. by increasing the durability and lengthening the life-span of wood products, and by recycling, etc.

Even if all this were assumed, about 500–550 million cu.m of newly-produced wood would be needed by 1980. This corresponds to harvesting about 4 million hectares of forest area annually. This is a very high requirement in view of the fact that in the poorly or moderately afforested parts of the Soviet Union, forests ripe for cutting have been strongly over-exploited already since the beginning of World War II, and the amount of wood that can be produced here does not satisfy even the requirements of agriculture and the local industries. (In the Soviet terminology "local industry" means smaller state-owned enterprises operating under the supervision of the local authorities, as well as industrial cooperatives.) A considerable part of such needs has to be met either by continued over-exploiting of the local forests or by transporting wood from somewhere else, at distances ranging from 2,000 to 4,000 kilometres. The average railway transporting distance of wood rose from 415 kilometres in 1913 to 1,019 in 1940, and to 1,500 in the early 1960's. Nowhere in the world is wood, or any other material, transported by rail over such average distances.

Siberia and the far-eastern parts of the Soviet Union have forest reserves amounting to about 300 million hectares but their economic utilization is problematic owing to long transport distances, the need for massive infrastructural and productive investment, and also to the relatively poor growing stock of these forests (in terms of industrial wood, it ranges from 20 to 50 cu.m/ha, against the European average of 75 cu.m/ha). In order to find a solution, it is necessary to investigate the consumption pattern and tendencies of industrial wood, since the measures aimed at developing forestry must depend on the trends and patterns of consumption.

Table 25

Quantity of wood products turned out from 100 cu.m of roundwood by countries (1960)

Countries	Total production of industrial wood, million cu.m	Products turned out from 100 cu.m of wood				
		sawnwood	veneers	paper	paperboard	fibreboard
		cu.m		tons		
USA	311.1	26.3	2.52	5.2	4.2	0.53
Canada	96.7	19.0	1.0	7.2	1.0	0.2
Sweden	46.0	18.8	0.13	3.9	0.7	1.32
Finland	42.3	19.6	0.98	3.4	1.2	0.45
German Federal Republic	25.3	31.0	2.64	10.8	3.5	0.66
German Democratic Republic	7.7	38.6	0.52	7.2	3.5	0.61
Czechoslovakia	12.6	31.5	1.45	3.6	1.3	0.3
Japan	65.0	41.2	1.97	4.4	2.7	0.11

Source: [64].

Vasilyev analyses the proportions between the use of fuelwood and industrial wood as well as of the various kinds of the latter.

He shows the structural changes in consumption on the example of the USA where the total production of wood was fairly constant through our century. But while the output of fuelwood became almost meaningless and that of sawnwood remained practically unchanged, the production of paper and paperboard rose from less than 2 million tons at the beginning of the century to 6 million in 1929 and to 31 million in 1961, and the output of fibreboard rose from 970 tons in 1946 to 1.6 million tons in 1960.

Similar tendencies prevail also in most other countries where forestry and wood processing are in an advanced state. The situation is somewhat different in the countries liberated only recently from colonialism. Here, the mechanical wood processing industries are growing rapidly, that is, the phases of development known from the economic history of the advanced countries are being repeated here at a faster rate. For instance, between 1946 and 1960 the output of sawnwood rose from 0.5 to 1.3 million cu.m in India, and from 0.12 million to 1.6 million cu.m in Indonesia.

Table 26

Amounts of wood products and raw material needed for packaging a given sort and quantity of commodity

Packaging material	Quantity of final product needed	Roundwood equivalent needed cu.m
Sawnwood	4.5 cu.m	8.0
Fibreboard	1 ton	2.8
Paperboard	0.5 ton	1.8

Source: [64].

In order to compare the structure of wood processing in various countries, Vasilyev proposes a set of indicators which show the quantities of various products turned out from 100 cu.m of wood (see Table 25).

Postwar development is everywhere characterized by efforts aimed at more efficient processing of wood, better utilization of refuses and at greater economic efficiency of investments.

Analyzing the problems of a more efficient, complex utilization of wood, Vasilyev emphasizes first of all that, within the wood consumption of the Soviet Union, the share of fuelwood declined from 54 per cent in 1913 to 33 per cent in 1950 and to 24 per cent in 1965. Moreover, there are important possibilities of improving the ways of using wood, above all in construction, mining and agriculture. He attributes particular importance to the chemical processes protecting wood. Further, he lays stress on the replacing of wood-based materials by others. Nevertheless, he believes that all these devices will not suffice to bridge the gap between future supply and demand. According to him, the main task consists in improving the structure and technology of the processing industries and ensuring a fuller utilization of the raw material. The savings attainable by the use of up-to-date products are shown by him on the example of packaging (Table 26).

Taking the amount of roundwood needed for sawnwood packaging for 100, only 35 per cent of this is necessary for fibreboard packaging, and only 23 per cent for paperboard packaging.

In the Soviet Union, however, the output of up-to-date wood products is below that of the advanced capitalist countries (Table 27).

Per capita output of sawnwood is now somewhat higher in the Soviet Union than in the USA, but that of paper and paperboard is only one tenth of the US level.

As regards the utilization of wood as a raw material (i.e. the ratio of the quantity of the end product to that of the raw material), it is now better in the Soviet Union than in the USA in respect of sawnwood; but the quantity of paper and paperboard produced from 100 cu.m of roundwood is much less in the Soviet Union.

Table 27

Output per 1,000 inhabitants in the Soviet Union and in the USA

Year	Sawnwood, cu.m		Paper and paperboard, tons	
	USSR	USA	USSR	USA
1913	85	860	1.7	57.6
1940	183	558	5.0	111.4
1960	500	442	15.2	160.0
1969	480	403	22.5	225.0

Sources: [18,64].

Attention and efforts in the Soviet Union are now being concentrated on the fast development of the production of paper, paperboard and wood-based panels, while timber production as a whole and the output of sawnwood are rising at a much slower rate. It is hoped that this structural change will result in significant savings in raw material, so that about 1980, the industrial demand for wood will not exceed the level of about 500–550 million cu.m annually. Out of this, 180–200 million cu.m (including residues) will be required for the production of paper and paperboard.

Forecasts regarding Soviet wood consumption about the end of the century have not been published so far either by the Soviet government or by international agencies; however, research has been carried out in this field by competent Soviet authorities, institutes and economists.

Summing up his opinion, Vasilyev believes that the structural change in both production and consumption will accelerate in the future. The total output of paper, paperboard and wood-based panels may attain the quantity of 40 million tons about 1980, and 80 million tons in 2000. For producing the latter, about 200 million cu.m of roundwood will be needed. Assuming that other requirements will amount to about 400 million cu.m, this author estimates the aggregate consumption of industrial wood in 2000 at 600–620 million cu.m.

Vasilyev's prognoses serve as a suitable starting-point for our calculations, although he arrived at his conclusions with methods differing from what we have applied to Europe and North America. He did not assume e.g. correlations between the consumption of industrial wood and GDP, and he mentions even the trends obtainable from time series only incidentally. Essentially, he starts from the possibilities of wood *production* and confronts these with the expected demand and with the tendencies of technological progress. His prognosis is hallmarked both by his great experience and his detailed calculations.

Nevertheless, let us apply now our own method in order to ensure uniformity in our world prognosis. Figure 7 shows aggregate and per capita consumption of industrial wood in the Soviet Union as derived from statistical data and from the correlation between per capita consumption and GDP.

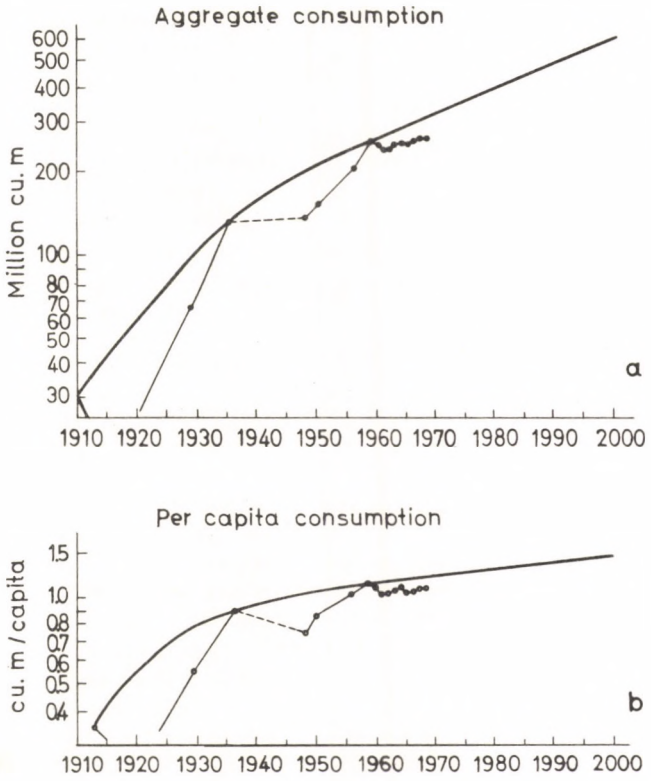

Figure 7. Consumption of industrial wood in the Soviet Union
Sources: as for Figure 5 and [64].

Aggregate Soviet consumption shows a very steep increase essentially until about the beginning of World War II (7 per cent annually). In the postwar period, a much slower rise (1.8 per cent annually) can be noticed if we connect the points for 1935 and 1950. The latter rate is comparable with the long-term growth rates prevailing in a number of economically advanced countries. It is not at all unusual that a relatively short period of very fast development is followed by a much slower long-run rise. Many advanced countries showed the same type of development. It is more difficult to explain the data relating to the years 1959–1968 which seem to remain *below* the extrapolated trend, and it is highly improbable that the stagnation observed in the 1960's will continue in the coming decades. In any case, we have to find answers to the following questions:

a. what was the cause of this temporary stagnation of production and consumption;

b. how long is it likely to last;

c. what circumstances will make production and consumption rise and gradually approach the long-term trend line again?

However difficult it would seem for an outsider, we must try to find acceptable answers.

In the late 1950's and the early 1960's, after a long development, two long-term processes seem to have reached the point where they – independently of each other but synchronously and in the same direction – began to affect the consumption of industrial wood in the Soviet Union. The first of these factors was the transition from the "extensive" to the "intensive" path of economic growth; the second consisted in the transfer of the bulk of wood production from the European parts of the Union (where consumption exceeded production) to the Siberian forests.

The main features of the *transition from extensive to intensive economic growth* are the following:

a. the easily mobilizable major manpower reserves of the economy become practically exhausted;

b. the share of agriculture in total employment falls below 30 per cent and continues to decrease;

c. the bulk of manpower released from agriculture, however, flows not into industry, but into the service branches which acquire increased importance;

d. industrial employment is hardly rising, the progress of industry is essentially ensured by improving labour productivity and relies only to a smaller extent on the dwindling manpower reserves still available among the urban population;

e. whereas under the conditions of extensive growth there was almost a general shortage in the necessaries of life, that is, almost anything produced seemed to be "necessary" for the society, and quality or costs had but a marginal importance: now requirements for a determined structure of supply and for determined qualities produced at limited costs begin to dominate, with all their impacts on investments, the utilization of manpower on raw materials, etc.;

f. accordingly, the predominance of the producers' interests is gradually giving way to the influence of the purchasers; in the countries applying national economic planning, planners have to count not only with the quantitative growth of demand but with its structural changes and with the buyers' qualitative requirements as well;

g. all these changes start, as a rule, about the time when per capita GDP reaches the level of $500.

According to all data available, this turning-point was reached in the Soviet Union about 1960. It was then that the share of agricultural employment fell below 30 per cent, that an accelerated development of servicing activities started, and that the more easily accessible reserves of manpower began to become exhausted. At the same time, at least in the most dynamic branches of the Soviet economy, efforts at improving labour productivity and product quality as well as at reducing production costs also became dominating. Finally, it was just about that time that Soviet GDP exceeded $500 per capita.

In the forest and timber economy the change involved, first of all, a hard limitation of manpower supply. We have seen that forestry and wood-cutting employ 14 per cent of all workers active in Soviet industry; and probably there is no other group of the Soviet working population that works under more adverse conditions. Hence comes the necessity for planners to improve the productivity of a more or less stagnating manpower by mechanizing the labour-intensive processes

and operations of wood production and by saving wood as a raw material to the maximum extent possible. The latter requirement involves a structural change in wood processing and in the use of the different wood products, e.g. the substitution of paperboard for sawnwood in packaging, the increased use of wood-based panels in construction and furniture-making, etc. From the data published one may conclude that the industries producing wood pulp, paper, paperboard and wood-based panels are being rapidly developed, implying a radical change in the structure of the wood-processing industry as well. Fundamentally improving the efficiency of production, this change clearly requires huge investments and will take some time to materialize.

Thus, we may assume that the temporary stagnation in the consumption of industrial wood is, at least in part, connected with the transition from the extensive path of economic growth to the intensive one (including some vast investments serving this purpose, which are already under implementation) and with a significant change in the pattern of production and consumption. Under such circumstances the consumption of industrial wood is not likely to develop either structurally or dynamically at the same rate as it did under the conditions of extensive economic growth.

It has been mentioned above that, in addition to this general factor, a more specific one also acted during the 1960's towards limiting the production and the consumption of wood, causing a change in the regional pattern of exploitation.

Forests are very unevenly distributed over the territory of the Soviet Union. Where most of the population is living, i.e. in the central and southern areas of the European part of the country, the share of forests in the total area is relatively low. The north-western parts of the European territory of the Soviet Union and the Ural, as well as Siberia and the far-eastern areas are rich in forests but very thinly populated. In Czarist Russia the production of wood – a considerable part of which was exported – came from the European parts. During the inter-war period, the demand for wood was vastly increased by industrialization and collectivization; even this had to be satisfied mostly by exploiting the forests already in use. Even after World War II, when unprecedented devastations had to be made up for, the required wood was taken essentially from the same source. This forced rate of exploitation led finally, about the mid-1950's, to a situation when wood production could not be increased any more without a serious over-exploitation of the forests already in use. As a result, wood production had to be transferred gradually to the regions rich in forests, and was restricted in the "deficitous" regions.

This, however, required huge investments since owing to the vast distances, hard climate and the scantiness of settlements, infrastructural investments of an unprecedented magnitude became necessary in Siberia. In order to visualize the proportions, let us remember that in Siberia, a region extending over 6,000 kilometres from the Ural to the Pacific, only one fifth of the population of the Soviet Union is living while about 50–66 per cent of its water power, mineral deposits and forests are located there.

The re-grouping of Soviet wood production that took place in the 1950's is shown by Table 28.

Wood production in the well-afforested zones rose by about 40 per cent in ten years, while it stagnated in the poorly afforested ones. In spite of this, the latter

Table 28

Exploitation of forests in the Soviet Union

	Population, million	Total area	Forests	Growing stock of wood million cu.m	Exploitation million cu. m	
		million hectares			1950	1960
Zones poor in forests[a]	173	732	64	5,000	107	105
in per cent of total	80	33	9	7	40	29
Zones rich in forests[b]	43	1,496	623	70,000	159	264
in per cent of total	20	67	91	93	60	71
Total	216	2,228	687	75,000	266	369

[a]The western, central and southern zones of the European area of the Soviet Union, the southern Ural, the Trans-Caspian and south-eastern Asian zones.

[b]The northern zones of the European part of the Soviet Union and of the Ural; western and eastern Siberia and the Far East.

Source: [64].

zones still supplied 29 per cent of the wood production, although they represented only 7 per cent of all growing stock. The re-allocation of wood production has of course continued and this has slowed down the increase in consumption, simply by making wood relatively more expensive. Further, this has also involved a structural change within the wood-processing industries. Without this, the re-grouping of wood production would be impracticable, since voluminous and low-priced wood products could not be transported by rail over distances of 3,000–5,000 kilometres. It is inconceivable e.g. that the Ukraine, previously self-sufficient in wood, will be supplied in the future with sawnwood coming from the Far East. Over such distances, only paper, paperboard or high-priced wood panels can be transported with an acceptable efficiency.

This answer to our first question implies that the "stagnation" observed in the 1960's should be considered a transitory stage of constant production that resulted from a radical change in the sources and patterns of supply.

As regards the second and third questions, asking how long this period of transitory stability is likely to last and what factors may be expected to bring about a new increase in production and consumption, we have to consider the following.

First, aggregate consumption of industrial wood in the Soviet Union shows a moderate rise after a recession between 1958 and 1961. Further, some large

Table 29

Estimates of the consumption of industrial wood in the Soviet Union
(million cu.m of WRME)

	1913	1936	1959	1968	1980	2000
According to Vasilyev	30	130	260	–	–	600–620
According to our time-based trend	30	130	260	265	400	560
According to our GDP-based trend	30	130	260	265	400	530

Sources: [64] and calculations of the author.

investment projects started recently will be put into operation in the 1970's. Large-scale plants in Siberia will begin to produce paper, paperboard and wood-based panels, while important infrastructural investments will improve the economic and technical conditions for the production and processing of wood. Thus, one is induced to believe that in the 1980's an acceleration of wood consumption may take place, sooner or later fitting into the long-term trend suggested by us, and afterwards it will continue to develop like this. The Soviet five-year plan for 1971–1975 seems to justify this expectation, by providing for a significant rise in the production and processing of wood.

The forecasts made by Vasilyev and those obtained by our two methods are compared in Table 29.

As a final conclusion, we believe that Soviet consumption of industrial wood in 2000 may be entered with 560–600 million cu.m into our world prognosis. This would mean a per capita consumption of 1.6. or 1.7. cu.m, that is, exactly what we have forecast for the USA. It would be, indeed, hardly acceptable to forecast, for 2000, a Soviet per capita consumption of industrial wood exceeding the present (and even 2000) level of the USA, since

a. the share of family houses in total residential construction, and therefore also of wood as a building material is, and is likely to remain, lower in the Soviet Union than in the USA;

b. already the present US consumption of paper and paperboard is uneconomical and wasteful, owing mostly to excessive advertising;

c. natural and economic endowments, e.g., the average distance between the forest and the final consumer, are much more favourable in the USA than in the Soviet Union, hence in the latter country the incentives for saving wood or for replacing it with other materials are stronger than in the USA.

All this, however, is only an opinion based on present-day data and tendencies; hence, it is subject to future modification.

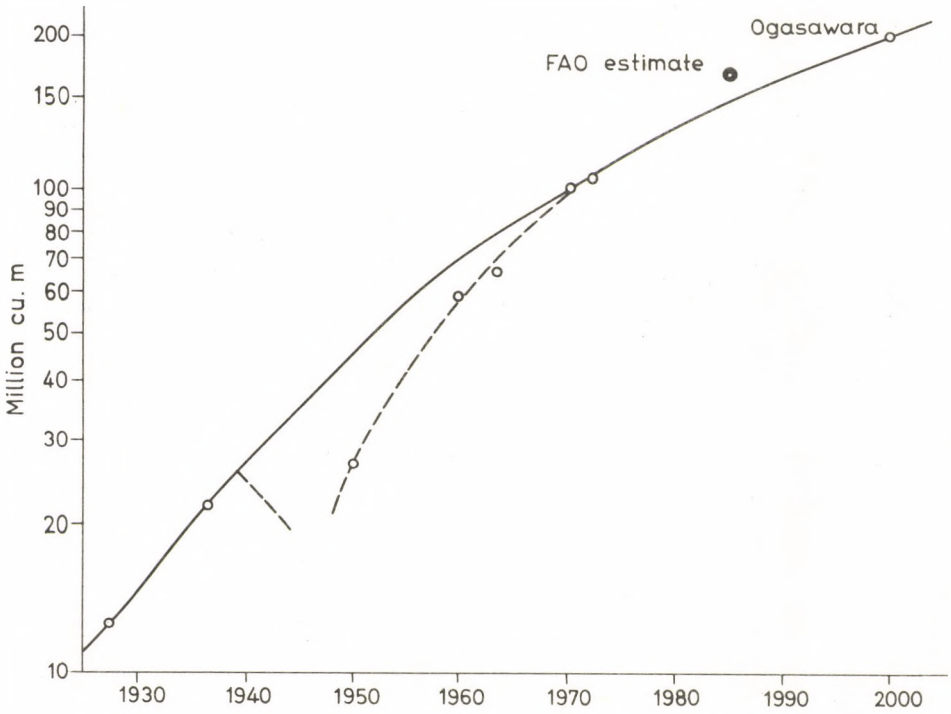

Figure 8. Aggregate consumption of industrial wood in Japan

4.2.4. OTHER REGIONS

4.2.4.1. Japan

From among the other regions, Japan has to be dealt with separately. Until very recently, this country's consumption of industrial wood was unimportant on world scale. The country's unprecedented rate of economic growth in the postwar period, however, resulted in a steep rise also in this field; at present, Japan is an important purchaser of Canadian and Soviet wood. Japan exports machines for the cutting, removal and processing of wood to the Soviet Union mainly against shipments of Soviet timber.

The trend of the aggregate consumption of industrial wood in Japan is shown by Figure 8. It significantly exceeds the average shown by the importing countries. This may result partly from the extremely high rate of her economic growth, and partly from special causes. Without attempting here to provide an explanation for the general rate of economic growth, we may find one of the specific causes of the rapid increase in *wood consumption* in the particularities of Japanese residential construction. In this country, the age-old and still living tradition of wooden buildings is due to the permanent danger of earthquakes.

Table 30

Number and size of dwelling houses in Japan (1970)

Size of houses (number of flats)	Number of houses		
	total	wooden	per cent
1	20,000,000	19,000,000	95
2–4	275,000	250,000	91
5–19	332,000	291,000	88
20–39	33,000	12,000	36
40 and more	7,000	1,000	14
Total	20,647,000	19,554,000	95

Source: [1].

According to Japanese statistical data relating to 1970, from among the 24 million dwelling units of the country, 22 million, i.e. 91.5 per cent, were built of wood. The number of residential buildings amounted to 20.6 million. Of these, 19.6 million, or 95 per cent, were built of wood (see Table 30).

Amidst the rapid economic growth of Japan, also residential construction is expanding. Out of the 24 million dwellings that existed in 1970, 12 million were built after 1955. Thus, only in the last fifteen years, at least 10 million houses must have been built from wood.

Thus, in spite of its rapid technological progress, the danger of frequent earthquakes still forces Japan to employ, essentially, the traditional wood construction. The country is poor in forests in relation to its high population density. According to Ogasawara [53], domestic wood production in 1960 amounted to about 48 million cu.m, covering 88 per cent of the contemporary consumption. It seems to have slightly increased later as well. An estimate approved of by a 1966 Cabinet Meeting – cited by the same author – stated that it was 51 million cu.m in the average of 1962–1964, equalling 77 per cent of the total inland consumption. As regards the future, however, this official estimate made in 1966 was too optimistic in forecasting home production, whereas it strongly underestimated total consumption (see Table 31). The latter was then believed to attain only 100 million cu.m in 1975 and 146 million in 2005, while domestic production was hoped to equal 70 and 82 per cent of these quantities, respectively. In a few years, however, it turned out that the 100 million cu.m level was reached already in 1970, and only 46 per cent (rather than 70) of it could be covered by domestic supplies (see Figure 9, taken from the paper cited). When trying to prolongate the two short-time trends shown in Figure 9, even if we assume a very strong deceleration in the growth of domestic demand, it can hardly be estimated at less than 180–200 million cu.m for the year 2000, and inland production is not likely to cover much more than one third of this.

Table 31

An official forecast on the demand and supply of wood in Japan
(million cu.m)

	1962–1964 average	1975	1985	1995	2005
Demand for wood:					
construction	24.9	38.0	–	–	–
packaging	7.1	8.0	–	–	–
public utilities	4.3	6.6	–	–	–
furniture	7.0	9.1	–	–	–
pulp	17.2	33.3	–	–	–
others	4.3	3.4	–	–	–
export	1.7	1.7	–	–	–
Total demand	66.5	100.1	120.0	136.0	146.0
Domestic supply	51.0	70.6	90.0	112.0	127.0
Imports	15.5	29.4	30.0	24.0	19.0
Imports as a percentage of demand	23.3	29.4	25.0	17.7	13.1

Source: [53].

Table 32

Estimates on the per capita consumption of industrial wood in the developed and the developing regions of the world
(cu.m)

	1950	1960	1975	2000
Developed regions	0.80	0.92	1.04	1.38
Developing regions	0.07	0.08	0.11	0.16
World	0.32	0.34	0.38	0.47

Sources: [10, 22, 23] and estimates by the author.

All this seems to justify our estimate expressed in Figure 8, on the grounds of which we believe that the Japanese consumption of industrial wood in 2000 will not be much less than 200 million cu.m.

Such high levels of consumption and imports can only materialize if wood production around Japan – i.e. near the shores of the Pacific or in areas connected with them through cheap river transport – develops rapidly. Forest areas in Siberia, Indonesia, the Philippines and other developing Asian countries, but to

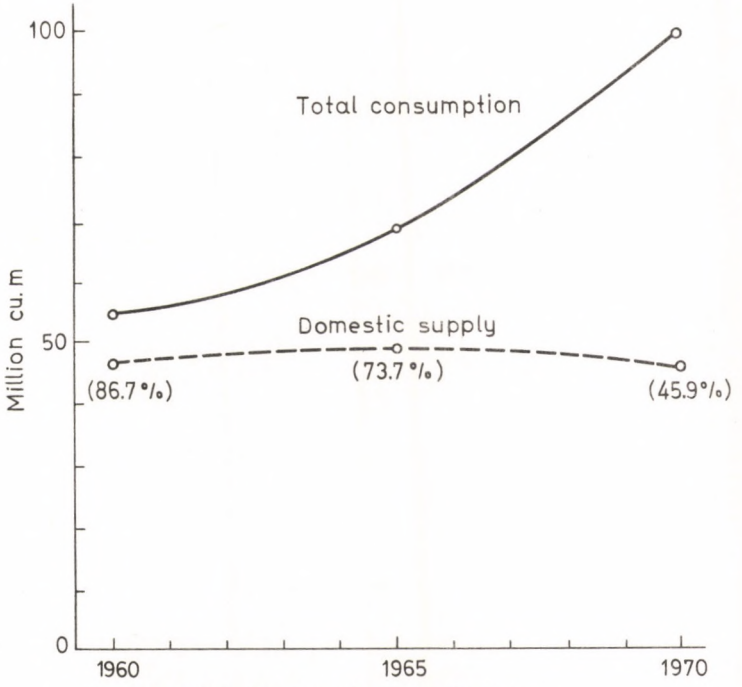

Figure 9. Demand and supply of wood in Japan
Source: [53].

some extent also those lying on the western shores of Canada and the USA, are the prospective suppliers, since the great distances are balanced by the relative cheapness of water transport. Relying on its expanding exports of up-to-date industrial products and on its wealth of capital, Japan is able to help to mobilize the wood reserves of Siberia and South-East Asia.

4.2.4.2. The rest of the world

The regions not mentioned yet mainly belong to the developing countries; the few advanced countries like Australia, New Zealand, South Africa, etc. do not influence the world consumption of industrial wood significantly, due to their relatively small population. Therefore, we think they need no separate treatment here.

The trend of consumption in these parts of the world (see Figure 10) was drawn on the grounds of the scanty statistical data and of FAO's estimates for 1975. If we accept the latter, the trend obtained forecasts a consumption of about 700–750 million cu.m for 2000. In other words, per capita consumption in the developing world is likely to double between 1950 and 2000, but the present wide gap between the levels of advanced and developing regions will practically remain (Table 32).

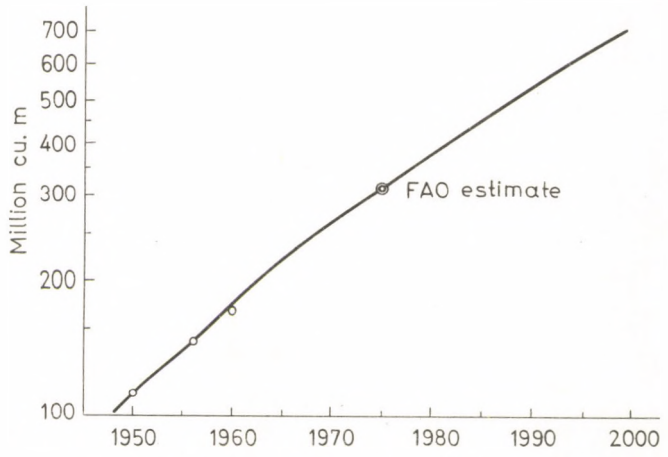

Figure 10. Aggregate consumption of industrial wood in the rest of the world

Admittedly, it is difficult to believe that in three decades from now on the per capita consumption of industrial wood in the developing world will still not exceed 0.16 cu.m; but since per capita GDP is estimated to rise during the same period by about 100 per cent in these areas, and since it cannot be assumed that the long-term rate of increase in per capita wood consumption will exceed that in per capita GDP, we are bound to accept this estimate.

4.2.5. WORLD CONSUMPTION OF INDUSTRIAL WOOD

Summing up our estimates for 2000, world consumption of industrial wood shows a quantity of about 2.8 billion cu.m (see later in Table 38), which is double the present consumption and means an annual 2.5 per cent increase for the coming decades (Figure 11).

4.3. CONSUMPTION OF INDUSTRIAL WOOD BY PRODUCT GROUPS

Besides total consumption in the various regions, also its pattern by product groups and the tendencies changing this pattern have to be taken into consideration. We have already seen that in respect of some regions it is not advisable to extrapolate the past tendencies of total consumption of industrial wood, for it is likely that the future growth of consumption will slow down in some regions and accelerate in others, owing mostly to changes in its pattern, i.e. the proportion between sawnwood, on the one hand, and paper products and wood-based panels, on the other. Such changes may also have taken place in the past, but they were not significant as they are at present and will be in the future. As the part of industrial wood consumption (in terms of WRME) used by the paper and panel indus-

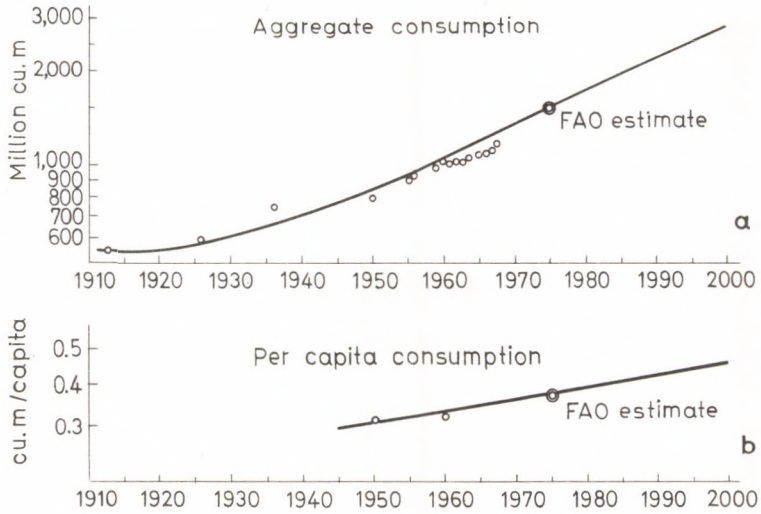

Figure 11. World consumption of industrial wood

tries is growing much faster than the part used for manufacturing sawnwood, it is the faster growth rate of the paper and panel industries that will determine to an ever increasing extent the growth rate of industrial wood consumption as a whole.

By investigating the trends of consumption in the various groups of products, we want to know essentially whether a superposition of their different trends would not result in other (most probably higher) forecasts for 2000 than what we have obtained so far with the aid of trends relating to total consumption.

4.3.1. SAWNWOOD

4.3.1.1. Time trends of the aggregate consumption

On the grounds of actual data, the trend of aggregate world consumption of sawnwood can be drawn as shown in Figure 12.

This trend seems to be fairly well determined by the peaks of 1913, 1927, 1937 and 1955, as well as by the time series 1955–1968. It can be seen that the reconstruction period following World War II came to an end about 1960 and that, subsequently, the development of consumption more or less followed the proposed trend.

The base period 1913–1968 is sufficiently long for allowing the extrapolation of this trend over the next three decades.

It is interesting to know also the separate shares of coniferous and broadleaved wood in the total consumption of sawnwood (Table 33).

The consumption of broadleaved sawnwood is gaining importance in Europe and in Asia, and even in world consumption as a whole. This tendency is likely to continue, at least at the rate observed between 1959 and 1968, owing to the increasing exploitation of broadleaved forests in Latin America and Africa.

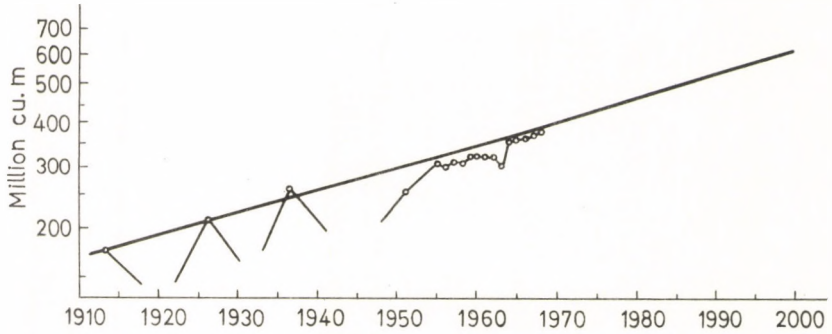

Figure 12. World's sawnwood consumption

According to our trend line, world consumption of all sawnwood is likely to attain about 600 million cu.m in 2000. Previously we have mentioned some factors influencing this consumption. Let us add here that its distribution over the world is highly uneven. Ninety per cent of all sawnwood is used in North America, Europe, the Soviet Union and Japan, although only about 30 per cent of the world's population live in these regions. In addition to the relatively high development level, other factors are also responsible for the large per capita wood consumption in these parts of the world. First of all, let us note that all these regions are located in or near the zone of coniferous forests in the northern hemisphere; nearly 80 per cent of the world's total output of sawnwood is made of softwood, as it is far more suitable for producing sawnwood than broadleaved trees are, which dominate in most of the developing world. The second factor is climate, on which the various requirements for human shelter depend, and the third one is the in-

Table 33

Share of broadleaved sawnwood in the total consumption of sawnwood
(per cent)

Regions	1959	1968
Europe	19	23
Soviet Union	15	15
North America	16	15
Asia and Oceania	32	37
Latin America	62	59
Africa	63	68
World	20	23

Source: [17].

Table 34

Consumption of sawnwood by end-uses and regions about 1960
(per cent)

End-uses	USA	Europe	Asia and Oceania	Latin America
Construction	65	52	60	57
Furniture	7	14	4	10
Packaging	12	9	18	12
Mining	1	4	1	–
Railway construction	2	4	4	8
Other	13	17	13	13

Source: [14].

come level. For example, we have seen that in the United States about 20 cu.m of sawnwood are used for each new dwelling unit, since here this is the principal material used for frameworks, roof and floor supports, and is often used for sheathing the walls, for flooring, for doors and windows and their frames, shelving, joinery, finishings and fittings, as well as for formwork and scaffolding. In northwestern Europe, only 6.7 cu.m of sawnwood are used for an average dwelling unit, partly because dwellings are smaller, and partly because here sawnwood is practically never used for the construction or sheathing of walls, moreover, its use for floor and roof support structures is also less frequent. In southern Europe the average use of sawnwood per dwelling unit is about 3.7 cu.m, being almost completely restricted to joinery, finishing and fittings (and also the dwellings are smaller). Finally, in South-Asia, where dwellings are even smaller and there is less need for protection against cold, the average is 1 cu.m (in rural districts only 0.2 cu.m) per dwelling, used exclusively for joinery.

Whereas, however, the per capita use of sawnwood is already stagnating or even declining in the developed countries, it tends to increase in the developing world. This tendency is enhanced by technological progress, that is, by the improved possibility of manufacturing sawnwood from the broadleaved species dominating in these regions. Thus, the present large gap existing between the per capita consumption of the developed and the developing regions is likely to diminish, if at a very slow pace.

As regards the pattern of sawnwood use, the main uses show more or less similar proportions all over the world (Table 34).

Thus, though per capita consumption of sawnwood differs widely by regions, the greater or smaller quantities are divided up among the various uses in a much similar fashion.

(It is to be remarked here that the uses designed as "mining", "railways" and "other" – mainly agriculture – relate only to the use of *sawnwood;* however,

industrial wood in the form of roundwood – being dealt with later – is also consumed in these fields.)

When forecasting future tendencies of sawnwood consumption, a set of factors tending to restrict or increase it has to be considered.

The most important among the restrictive factors are the following:

a. some of the economic activities using sawnwood tend to stagnate or decline, e.g. railway construction and certain branches of mining;

b. in some fields the pattern of activities tends to change towards those requiring smaller specific use of wood, e.g. in housing, the share of family houses is decreasing;

c. sawnwood tends to be used more economically in certain fields as a result of technological progress, so its specific use is reduced (e.g. in construction);

d. sawnwood is replaced partly by wood-based materials (e.g. paperboard in packaging, wood-based panels in many fields), and partly by other than wood (steel, reinforced concrete, synthetic materials, etc). In the latter case, also the growth in the total use of industrial wood is slowed down;

e. in the first half of our century, rising "relative" or "real" prices of sawnwood also tended to reduce its consumption.

Some of the factors that may increase the consumption of sawnwood are the following:

a. the growth of population tends to balance out, to a smaller or greater extent, the stagnation or decline of per capita consumption in the advanced regions, and to enhance the effect of a rising per capita consumption in the developing ones;

b. in comparing the first half of our century (when economic growth was not at all a phenomenon characteristic of all the countries), later faster or slower rates of economic growth occurred almost everywhere, causing an increase in sawnwood consumption as well;

c. substitution of other materials for sawnwood has already taken place in most fields of use where sawnwood has proved to be less competitive and thus, in the remaining fields of its application, sawnwood has increasingly been able to compete and retain its share; as a consequence, aggregate consumption in such fields – after stagnating for a time – is likely to grow parallel with population;

d. technological progress has improved the usability of sawnwood by introducing the techniques of bending, glueing, patching, impregnation, etc.;

e. improved living conditions tend to increase the demand for weekend and summer houses, which may be built most advantageously from wood;

f. the techniques of transporting, storing and marketing sawnwood have improved much and become less expensive, e.g. materials shaped into accurate sizes are shipped in uniform packages;

g. after 1950, the rise in the "relative" and "real" prices of sawnwood stopped; since then its producers have acquired improved methods of marketing, with the result that sawnwood has regained some of its former competitiveness.

Evidently, the final outcome of the influences restricting or increasing consumption will differ by regions and periods. However, we believe that during the three decades to come, the increasing factors will predominate, hence our consumption prognosis for 2000 seems to be justified.

Let us now investigate the trends of sawnwood consumption in the main regions.

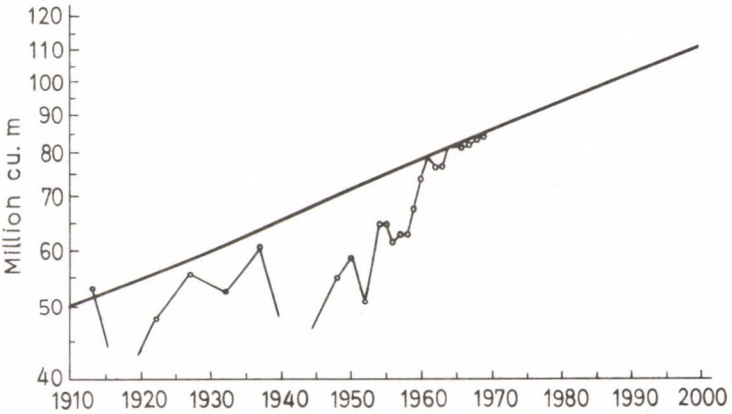

Figure 13. Europe's sawnwood consumption
Sources: As for Figure 5 and [21].

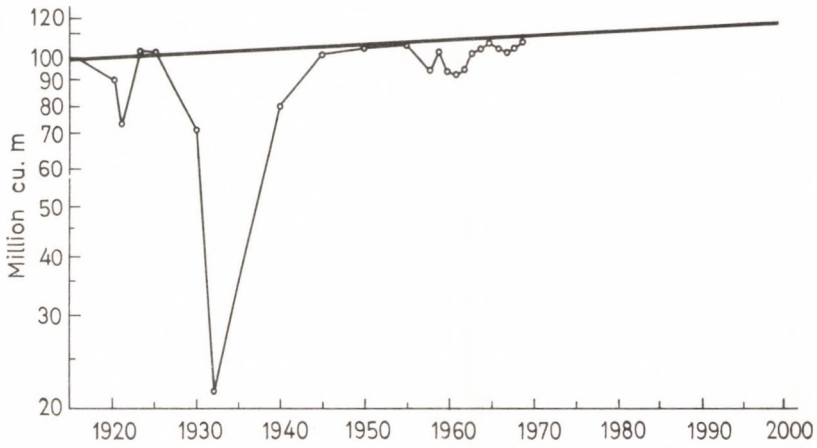

Figure 14. North America's sawnwood consumption
Source: [63].

In *Europe* (Figure 13) the peaks of 1913, 1927, 1937 and the sequence of the years 1961–1969 seem to determine the trend line unequivocally. In the 1960's consumption practically followed this line. It shows an annual increase of about 0.8 per cent, and its extrapolation results in 110 million cu.m about 2000.

In *North America* (Figure 14) the trend line can be read with similar reliability. Consumption almost stagnates here, its annual increase is but 0.1 per cent, reaching an expected level of 110 million cu.m in 2000.

The picture of consumption in the *Soviet Union* (Figure 15) is more problematic. Its annual growth between 1913 and 1939 was extremely rapid. After this, however, a sharp fallback came and consumption reached its 1939 level only in

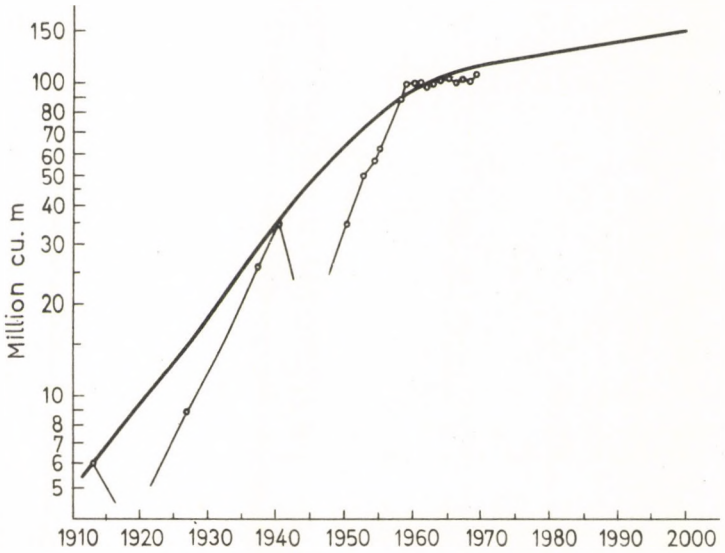

Figure 15. The Soviet Union's sawnwood consumption
Sources: as for Figure 14 and [64].

1950. From this point to 1959 there was a very steep rise, followed by stagnation in the 1960's. The probable cause of all this has been dealt with previously. Thus, our forecast can be based only on the short period between 1959 and 1969. Nevertheless, our forecast seems acceptable partly because, according to several considerations, the new tendency of consumption is likely to continue, and partly because the new growth rate (about 1 per cent annually) is still higher than in other regions of a comparable development level (0.8 per cent in Europe and 0.1 per cent in North America). According to this rate, Soviet consumption of sawnwood is likely to attain about 150 million cu.m in 2000.

In the sawnwood consumption of *Asia and Oceania,* Japan is the most decisive factor. Figure 16 shows the consumption of Japan also in the form of a separate curve. In this case, the base period is again too short and hence, the future trend is uncertain. What we may take for sure is that Japan's consumption will not continue to rise at the excessively high rate of the years 1955 to 1967; however, its slowing down may be balanced by acceleration in some other countries of Asia and Oceania. It is even possible that in some Asian countries which are rich in forests Japanese investments will enhance production, which may start to increase not only their exports but their domestic consumption as well. Our proposed trend would mean an annual 3 per cent rise in the next decades, resulting in a consumption of 250 million cu.m in 2000 for the region as a whole. In other words, by the end of the century this region may become the world's greatest consumer of sawnwood. This will involve important changes in the directions of world trade. Such changes are likely to materialize even if the regional magnitudes of consumption as forecast by us do not prove exactly correct.

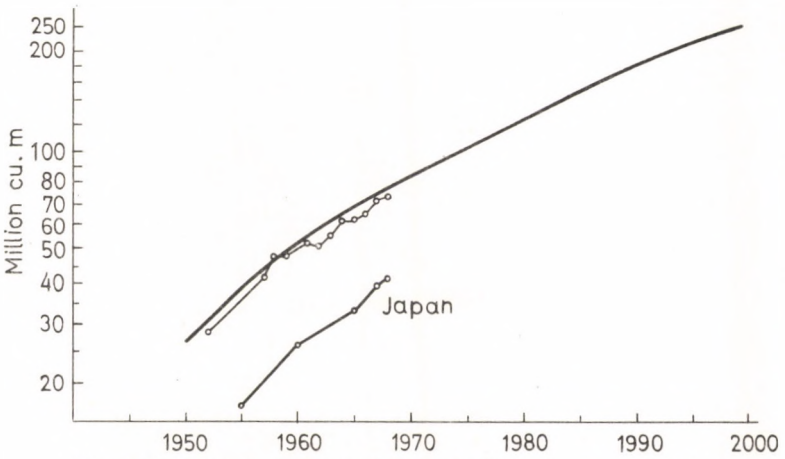

Figure 16. Sawnwood consumption of Asia (including Japan) and Oceania

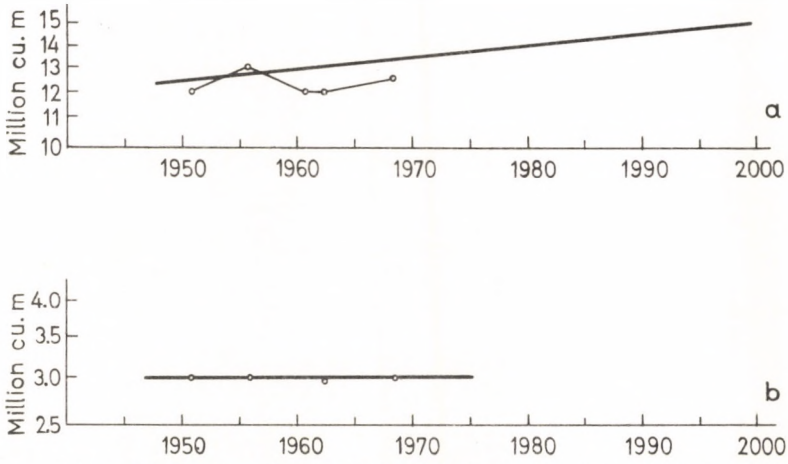

Figure 17. Sawnwood consumption of (a) Latin America and (b) Africa

The consumption of *Latin-America and Africa* (Figure 17) shows the picture of a very slow rise and of stagnation, respectively. Admittedly, it is very difficult to believe that in Latin America the increment of sawnwood consumption during the next three decades will not be more than 2 or 2.5 million cu.m, or that Africa's total consumption will remain on the excessively low level of 3 million cu.m; but anyway this is the conclusion we obtain from the actual data. Incidentally, from the point of view of world consumption as a whole, it would not involve any significant change even if we assumed that the present small consumption in these two regions would double until 2000.

By summing up the regional figures obtained above, *world consumption* in sawnwood may be forecast for the year 2000 at 640 million cu.m, against the 600

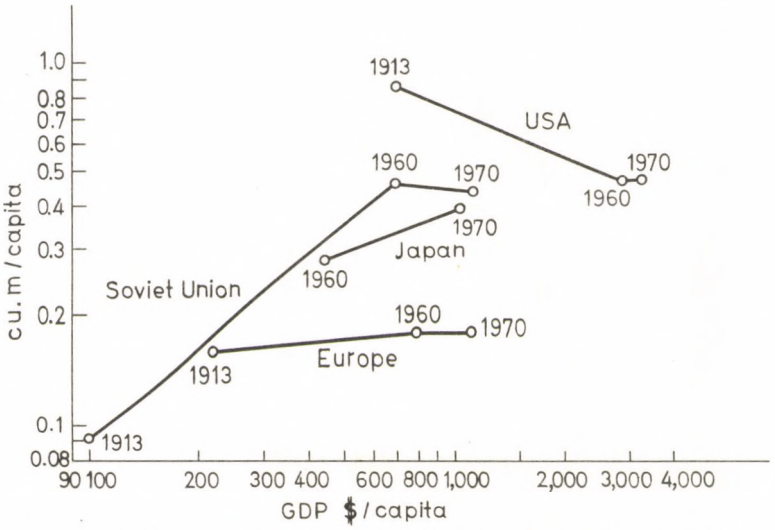

Figure 18. Per capita sawnwood consumption as a function of per capita GDP, by regions

million we have obtained by extrapolating the development of the world total. This small difference is due mainly to the higher estimates regarding the consumption of Asia and Oceania. On the grounds of past experience, according to which all previous forecasts elaborated by international agencies have invariably tended to underestimate future consumption, it seems advisable to accept the higher figure, i.e. 640 million cu.m.

4.3.1.2. Calculation based on the correlation of per capita GDP and sawnwood consumption

In Figure 18, per capita consumption of sawnwood is plotted against the per capita levels of GDP.

It is not possible to establish a worldwide correlation between the per capita values of GDP and sawnwood consumption. In the USA a sharp decline, in the Soviet Union a steep rise in per capita sawnwood consumption occurred in the first half of the century, but in both countries a period of very slow rise followed, and per capita consumption seems to have practically stabilized about 0.5 and 0.4 cu.m, respectively. In Europe, per capita consumption has fluctuated about 0.18 cu.m for more than half a century and this level is not likely to change in the future. Thus, in these three regions, the magnitude of the per capita consumption of sawnwood seems to have been independent of the rise in per capita GDP. It increased only in Japan where its growth rate exceeded that of per capita GDP. (In view of the small volumes, the data of Latin America and Africa are not shown in the diagram. Consumption in Latin America rose parallel with per capita GDP between 1960 and 1965, but lagged behind it between 1965 and 1970; per

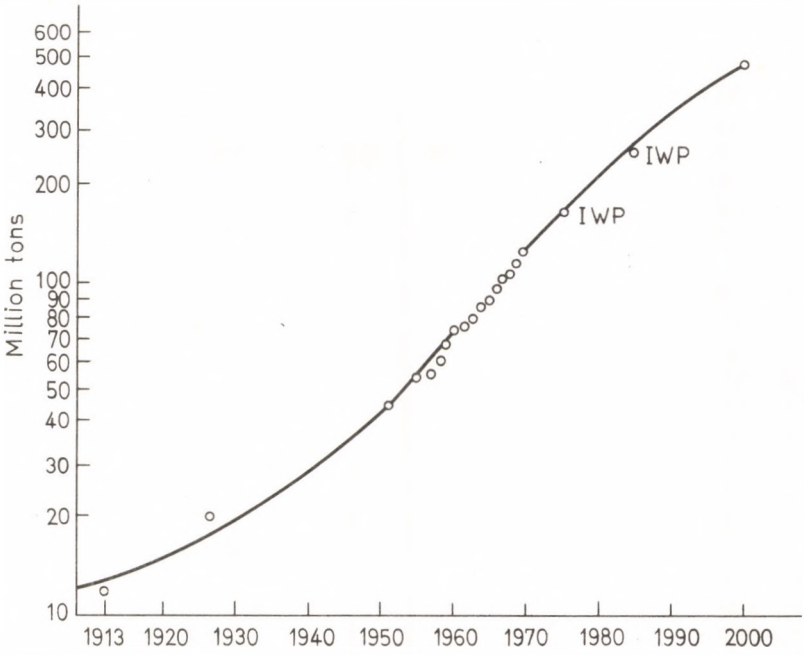

Figure 19. World's consumption of paper and paperboard
Sources: As for other figures and [60].

capita consumption of sawnwood in Africa rose at a slightly higher rate than GDP between 1960 and 1965; there are no data for 1970.)

Generally speaking, one may state that, with the notable exception of Japan, the per capita consumption of sawnwood is becoming more or less constant in the main regions, that is, aggregate consumption tends to rise parallel with the increase of population.

According to this assumption, aggregate world consumption of sawnwood may be estimated at 600 million cu.m. Thus, the calculation based on the correlation between GDP and sawnwood consumption does not introduce any new elements into our estimates. It seems, therefore, advisable to retain our forecast of 640 million cu.m for 2000.

4.3.2. PRODUCTS OF THE PAPER INDUSTRY

A correct estimate of the future consumption of paper and paperboard is decisive, since it seems clear that, towards the end of this century, pulpwood will have the biggest share in the world consumption of industrial wood.

4.3.2.1. Calculations based on world trends of aggregate consumption

Figure 19 shows the actual data of world's aggregate consumption of paper and paperboard from 1913 to 1968, as well as the forecasts made by FAO for 1975 and 1985.

The points representing these data may be connected by a quasi-logistic curve showing an annual increase of 5.7 per cent in its steepest section, and one of 4.1 per cent between 1975 and 2000.

Forecasts relating to future development will have to be made separately, according to the two principal uses: writing and printing paper on the one hand, and paper and board for packaging and the rest of industrial uses, on the other.

As regards writing and printing paper, wood-based products have had no significant competitor as yet. Recently, a British-invented synthetic paper called "Finoplast" has been announced and, according to some other information, synthetic paper might cover part of Japan's paper consumption in the near future. At any rate, the introduction of a synthetic product is not likely to influence the consumption of writing and printing paper, only the demand for pulpwood; we should know more about the serviceability and production costs of synthetic products to be able to judge on its expectable rate of spreading in the next three decades. All we know is that e.g. synthetic fibres have not affected very seriously the demand for cotton and wool in the thirty years of their existence.

The increasing demand for paper and paperboard as packaging material is due to several factors. First, with the increase of population and the rising standards of living, the quantity of consumer goods to be packaged is also rising. Secondly, a rapidly increasing part of the goods is distributed by the retail trade in small, closed packages, partly for hygienic and technical reasons but mainly because the package has become an important vehicle of trade-marking and advertising, and also because the rapidly spreading supermarket system can sell most goods only in a pre-packaged form. Thirdly, an increasing demand for discardable packaging gives preference in certain fields to paper against glass and metal. Fourthly, paperboard has been improved to the extent that it may now be substituted for sawnwood in some fields of packaging. Finally, new inventions combining paper with synthetic materials or metal foils have resulted in more resistant, attractive and cheap wrappings, and are likely to increase the demand for paper products. In view of all this, it seems that in the decades to come the paper industry will be able to adapt itself to the current requirements in the field of packaging and to maintain its competitiveness, so that the demand will continue to rise at its present high rate.

The consumption of paper products also has to be analyzed by main regions. Whereas the world trend could be described as a straight line, the trends of the various regions show either an acceleration or a slow-down. Figure 20 shows the expectable trend for Europe.

The trend for *Europe* may be determined on the grounds of data for 1913, 1930 and 1961 to 1968. It shows a slight acceleration. For the next three decades we have obtained an average annual growth rate of 4.8 per cent, resulting in an aggregate consumption of 150 million tons (225 kg per capita) in 2000. This level is much higher than what the USA consumed when its per capita GDP was as high as Europe's is expected to be in 2000. In Figure 20, we have also plotted FAO's forecast for 1975 which amounts to 51 million tons, but left it out of consideration. If our trend line included this estimate, it would run up to 200–220 million tons (or 300 kg per capita) by 2000. According to our present knowledge, this would seem unlikely as a European average. Such level of per capita consumption seems to be attainable only for a small number of very advanced countries. Therefore, this forecast of FAO should be viewed with reservation.

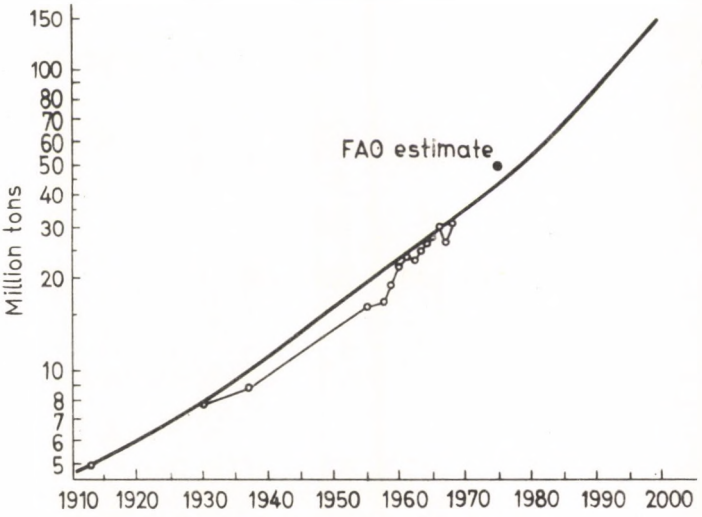

Figure 20. Europe's consumption of paper and paperboard

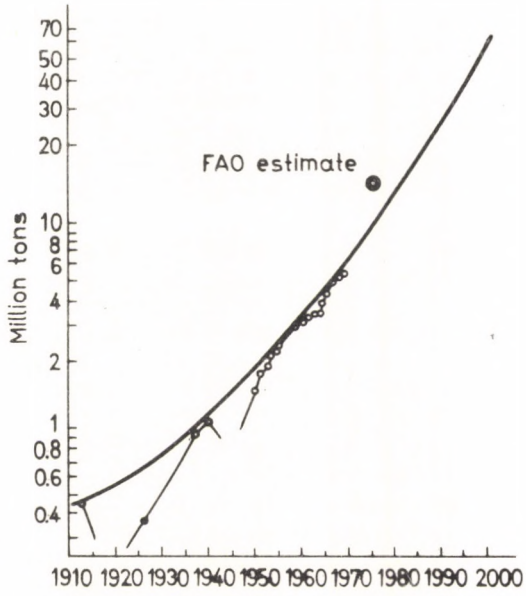

Figure 21. The Soviet Union's consumption of paper and paperboard
Sources: As for other figures and [60].

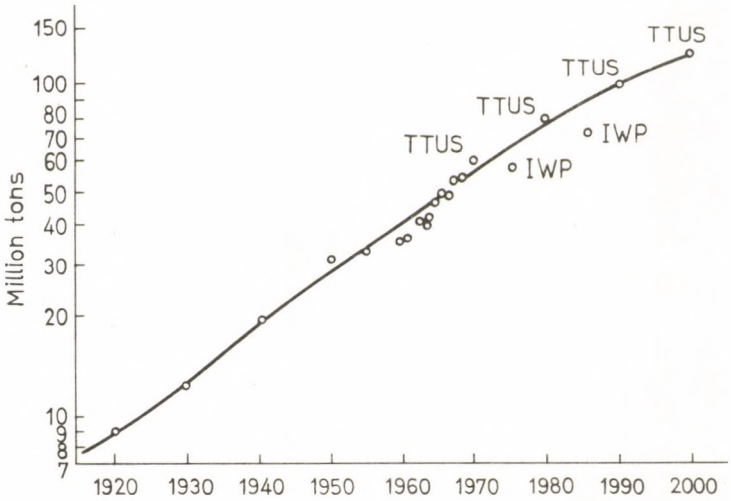

Figure 22. North America's consumption of paper and paperboard
Sources: [10, 63].

The consumption of the *Soviet Union* (Figure 21) shows a very steep and accelerating rise. The question is open, however, whether one should not forecast an even steeper one. FAO's forecast for 1975 is 10 million tons, or a per capita consumption of 58 kg, against our trend line which shows but 37 kg. On the grounds of our present knowledge, our estimate seems to be more realistic. Our proposed trend indicates an aggregate consumption of 66 million tons (186 kg per capita) for 2000 which seems compatible with the expected GDP level and the consumption structure of the country.

The trend proposed for *North America*'s consumption (Figure 22) has been drawn in accordance with the forecasts of TTUS and IWP. It follows a quasi-logistic curve. In the next two decades when the rise in consumption is expected to slow down slightly, it will be about 2.6 per cent annually, ending at 126 million tons in 2000.

Consumption in *Asia and Oceania* (Figure 23) rose very steeply between 1950 and 1960; afterwards, a rather even rise of about 5.4 per cent per annum can be noticed, which is expected to result in an aggregate consumption of 110 million tons by 2000. As in the case of sawnwood, the consumption of Japan is now decisive in this region, although before the end of the century several other countries will also increase their per capita consumption significantly and this, in view of their vast population, may considerably affect the aggregate consumption of the region.

In the case of *Latin America and Africa* (Figures 24 and 25) the quantity of wood required by the consumption of paper products is (in terms of WRME) already higher than that required for sawnwood; but even this quantity is irrelevant on a world scale. It is conceivable that the consumption forecast for 2000 on the grounds of our proposed trends (20 million tons for Latin America and 9 million

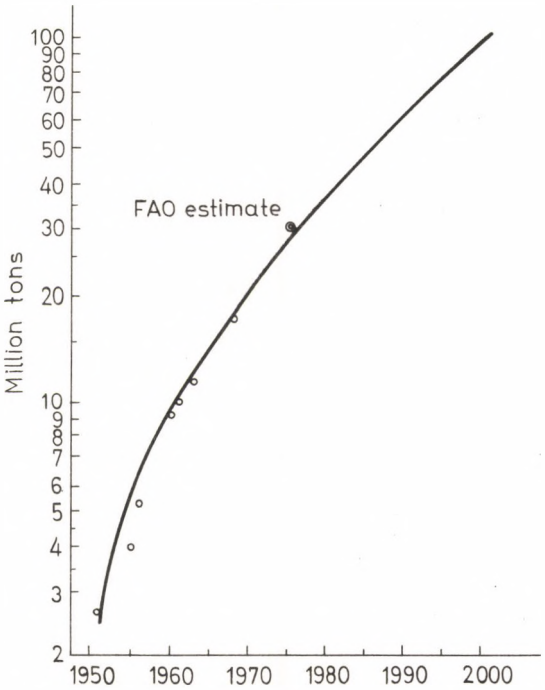

Figure 23. Asia's (including Japan) and Oceania's consumption of paper and paperboard

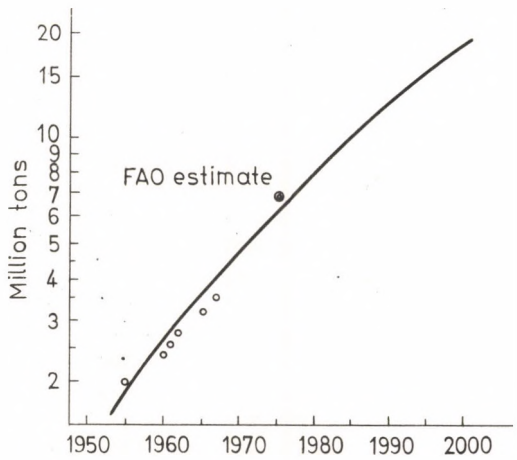

Figure 24. Latin America's consumption of paper and paperboard

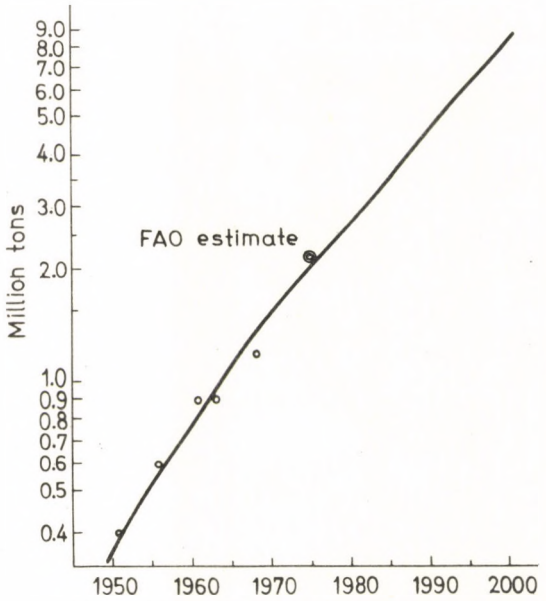

Figure 25. Africa's consumption of paper and paperboard

for Africa) may become somewhat higher in reality; but this difference would not modify the total of world consumption significantly.

Summing up the forecasts made for the main regions, we obtain a world consumption of 465 million tons for 2000, which is fairly compatible with the quantity of 470 million tons obtained from the trend of world consumption as a whole.

4.3.2.2. Calculations based on the correlation between per capita GDP and consumption

According to comprehensive studies elaborated by FAO, the elasticity of demand for paper products with respect to income differs in the various income brackets. When per capita GDP is about $ 100, the coefficient is between 2.5 and 3.0; at income levels of $ 200–400 it varies between 1.5 and 2.5. The coefficient declines to about 1.0 with incomes of $ 500–1,000, and to below 1.0 in the USA.

Also the elasticity of the two main product groups tends to vary. At the lowest income levels, the elasticity coefficient of writing and printing paper is higher than that of packaging paper and paperboard; about an income level of $ 1,000 the elasticity of packaging paper tends to become higher than that of writing and printing paper.

Table 35 shows the structure of world consumption.

When plotting the regional per capita consumption of paper in 1955, 1960 and 1965 against per capita GDP (Figure 26), we obtain a straight line along which the data of North America, Europe, Latin America and the world as a whole are located; the two notable exceptions are Japan and the Soviet Union, located above and below this line, respectively. From the main trend and the expected world av-

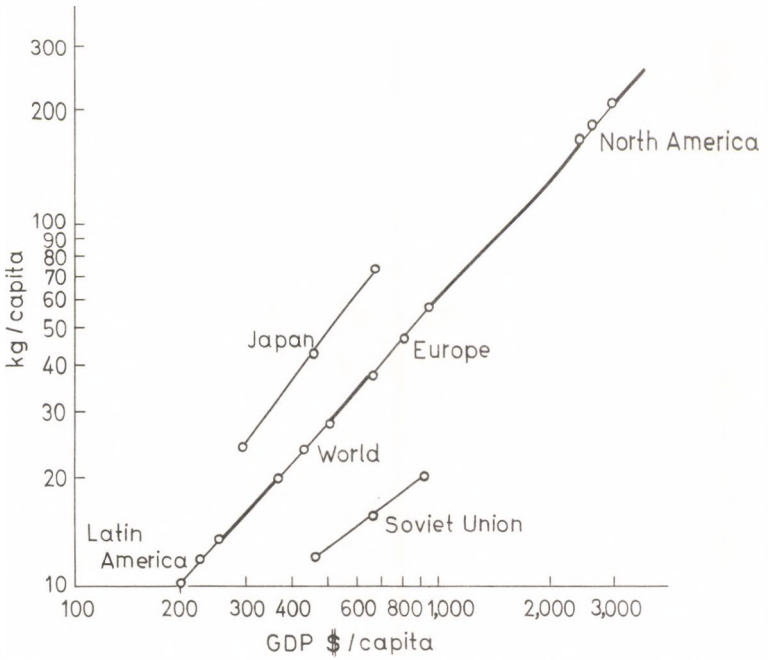

Figure 26. Per capita consumption of paper and paperboard as a function of per capita GDP (1955, 1960 and 1965)

erage of per capita GDP in 2000, as well as from the world population expected by 2000, one may obtain an aggregate world consumption of about 640 million tons for that year. This is considerably higher than the 470 million tons obtained by the method of time trends. Since both methods may claim some credit from one point of view or another, we must admit that at present there exists a rather wide belt of equally probable estimates.

Table 35

World consumption of paper and paperboard

	1951		1968	
	million tons	per cent	million tons	per cent
Newsprint	9	21	19	17
Other printing and writing paper	8	18	23	21
Packaging paper and paperboard	27	61	70	62
Total	44	100	112	100

Sources: [14, 18].

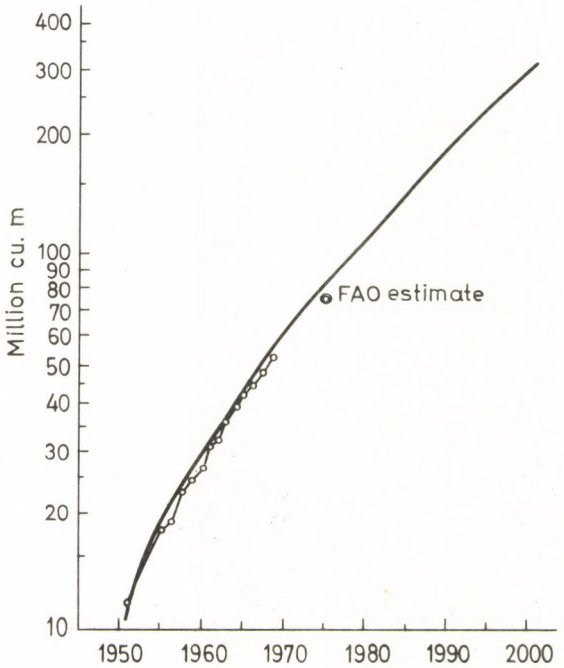

Figure 27. World consumption of wood-based panels

4.3.3. WOOD-BASED PANELS

Though veneer and plywood are "long-introduced classical products", the development of consumption in this group as a whole became more significant only after about 1950, when two entirely new kinds of products belonging here, viz. fibreboard and particle board, started to be used on a mass scale. This is why our time series begins with 1950.

On the grounds of the base period and FAO's estimate for 1975, the trend of consumption (Figure 27) may be drawn fairly unequivocally. It seems that it will continue to develop at a fast but slightly decelerating rate. In the next three decades, the average annual rate of growth will be about 5.3 per cent, and an aggregate consumption of about 300 million cu.m may be expected for 2000.

It is interesting to note that against the expectations and in spite of the rapid increase of fibreboard and particle board between 1951 and 1968, classical plywood could almost retain its share (Table 36). This is due partly to the fact that at the beginning the shares of the new products were very small, but partly also to the special suitability of plywood in many fields.

In contrast to sawnwood, the aggregate consumption of wood-based panels has been and will be rising at a rate much exceeding general economic growth. In a great part they are substituted for sawnwood, due to their relatively lower prices and excellent technical properties, e.g. constant size and quality, greater strength,

Table 36

World consumption of wood-based panels

	1951		1968	
	million cu.m	per cent	million cu.m	per cent
Plywood	7	58	28	52
Fibreboard	4.5	38	12	22
Particle board	0.5	4	14	26
Total	12	100	54	100

Source: [17].

larger choice in width and length, a well-finished surface and consequently, smaller amount of labour required for their fitting, mounting and finishing. These properties make them excellently suitable for producing prefabricated construction elements with the aid of mechanized processes. In furniture-making, their attractive finish makes it possible to dispense with veneers. Moreover, even from thin, low-quality coniferous or broadleaved logs unsuitable for making sawnwood, it is possible to produce panels that may replace sawnwood or veneer made of high-aged, expensive logs. Panels can be produced at low cost in large, up-to-date, labour-saving or even automated plants. Their advantages become most conspicuous where manpower is scarce and expensive, even if an adequate supply of materials for making sawnwood is available.

It is still a matter under discussion how this very fast rise of consumption is likely to slow down in the decades to come. It may be true that there are technological and economic limits to substituting panels for sawnwood; as regards fibreboard and particle board, the past two decades represented a period of very rapid *initial* expansion, after which the increase in consumption is likely to be smoothed along a slower long-term trend. But it is also true that no deceleration has occurred so far, and new inventions keep emerging (e.g. in the field of the chemical treatment of panels), enhancing the use of panels in still other fields. Thus, some experts believe, contrary to our trend shown by Figure 27, that the present rate of growth will continue in the next 2–3 decades; moreover, there are opinions that it will even accelerate.

After all this, we still believe that the differences between the annual rates we have forecast for the growth of consumption in the three main product groups (1.3 per cent for sawnwood, 4.3 per cent for paper products and 5.3 per cent for wood-based panels) express fairly correctly what we are now able to foresee. Of course, new inventions may open up new possibilities for substitution at any time, but this can be predicted neither by our method based on past development, nor by any other.

4.3.4. OTHER INDUSTRIAL WOOD

To this group belongs industrial wood used in the form of roundwood. The most important fields are mining (pitprops), communication (transmission poles), construction (scaffolding and formwork supports) and agriculture (cheap buildings, fences, etc.). Our proposed trend drawn on the basis of actual consumption data and FAO's estimate for 1975 shows a decline from 190 to 170 million cu.m between 1970 and 2000 (Figure 28).

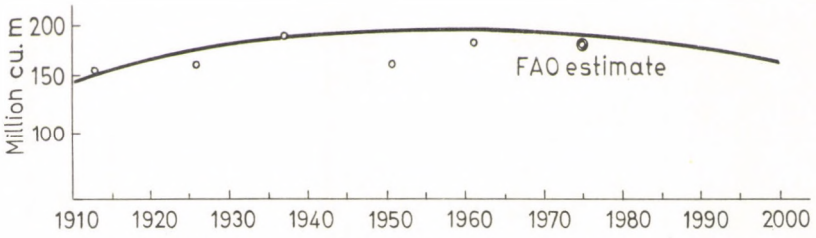

Figure 28. World consumption of other industrial wood

When summing up our estimates made for the main kinds of industrial wood (taking everywhere the highest of the alternatives) we obtain that the total world consumption of industrial wood may amount to 3.2–3.8 billion cu.m about 2000. This figure exceeds by 20–30 per cent the one obtained by calculating trends for the total consumption of the main regions (2.7–2.9 billion cu.m). Since, however, all previous forecasts that can be checked by now have invariably proved to underestimate future consumption, it is the higher estimate that seems to be nearer to reality in our case as well.

4.4. THE CONSUMPTION OF FUELWOOD

Statistical data on the consumption of fuelwood are even less reliable than those relating to industrial wood; they indicate only orders of magnitude. Thus, e.g., in the average of 1960–1962, the statistically recorded world consumption was but 878 million cu.m, while FAO estimated in WWTP [14] that the total consumption amounted to 1,088 million cu.m.

In the early 1960's slightly more than half of the world's wood consumption consisted of fuelwood (1,088 million cu.m in the average of 1960–1962, as against 1,043 million cu.m of industrial wood, according to WWTP). As the per capita consumption of fuelwood is about inversely proportional to the level of economic development (world average 0.36 cu.m; Europe and North America 0.23, Latin America 0.89, Africa 0.67 cu.m), its share in world consumption tends to decline. This, however, is a slow process. Consumption in the advanced countries has been decreasing for a long time, but in most developing countries, where

Table 37

Estimated world consumption of fuelwood
(million cu.m)

Regions	1950/1952	1960/1962	1975	1975 as a percentage of 1950/1952
Europe	118	108	74	63
Soviet Union	108	101	80	74
North America	67	46	34	51
Latin America	174	192	220	127
Africa	148	183	246	158
Asia and Oceania	251	458	545	217
World	866	1,088	1,199	138

Source: [14].

the greater part of wood consumption still consists of fuelwood, aggregate fuelwood consumption is still likely to rise despite stagnating or decreasing per capita rates, owing to the fast population increase (see Table 37).

World total may still rise until about 1980, but afterwards it will start to decline. Accordingly, we propose an estimate of 1.0–1.2 million cu.m for 2000.

CHAPTER 5

EXPECTATIONS FROM FORESTRY AND THE POSSIBILITIES OF ACHIEVING THEM BY THE YEAR 2000

The main objective of the present study has been to provide a prognosis of wood consumption for 2000. In the following, however, we shall attempt to give a short review of *all* requirements in connection with the multi-purpose use of forests. Namely, the various functions of forestry are intertwined, and the tasks relating to products other than wood or to the protective and recreational functions may as well affect the supply and consumption of wood.

5.1. REQUIREMENTS RELATING TO THE PRODUCTIVE FUNCTIONS

5.1.1. THE EXPECTED DEMAND FOR WOOD ABOUT 2000

Table 38 sums up our prognoses of the expected wood consumption on the basis of our calculations expounded above.

According to past experience, actual consumption always tended either to exceed what had been forecast, or to justify the higher alternative. Therefore, let us accept as a basis of the following calculation *the aggregate of the higher forecasts.* Thus, we obtain a total consumption of wood amounting to about 5 billion cu.m in 2000.

Of course what is shown by Table 38 is not an exact figure, only a starting point for further calculations concerning the requirements against the productive functions of forestry from the side of wood consumption. Even if the demand for 5 billion cu.m did not occur exactly in 2000 but one or two decades later, it is obvious that such demand will arise, so forestry must be prepared to meet it.

Our investigation has clearly shown that the change in the *pattern* of consumption tends sooner or later to change its *growth rate*, too. This will become most conspicuous in the course of the next three decades when, within the total consumption of industrial wood, the share of the so-called "up-to-date" or "dynamic" products (paper, paperboard and wood-based panels) will equal or exceed the share of "traditional" or "stagnating" products (sawnwood, and wood used in the form of roundwood). Towards 1980 both product groups will require about similar quantities of roundwood (850 million cu.m for each), but subsequently, the rates of their increase will differ markedly: an annual 5.5 per cent in the case of the "dynamic" products, against 1.5 per cent for the "traditional" ones.

In view of these tendencies one may assume that, from the 1980's onwards, the rate of increase in the aggregate consumption of industrial wood will tend to accelerate. Of course, we cannot foresee how new inventions might enhance the re-

Table 38

Estimated world consumption of wood for the year 2000
(million cu.m of WRME)

	Estimated consumption in 2000
1. Industrial wood	
a. According to the trends in the main regions:	
Europe	600 – 680
North America	600 – 650
Soviet Union	560 – 600
Japan	180 – 200
Other regions	700 – 750
World	2,660–2,880
b. World consumption according to the trends of the main products:	
Sawnwood (600–640 million cu.m)	1,000 – 1,100
Paper and paperboard (465–640 million tons)	1,400 – 1,900
Wood-based panels (300 million cu.m)	600
Other industrial wood	170
Total	3,170 – 3,770
2. Fuelwood, world total	1,000 – 1,200
1/b + 2 Total wood consumption	4,170 – 4,970

Source: Author's calculations.

placing of wood by other materials, nor is it possible to tell how an increasing demand for wood will affect wood prices in the long run. All we can say is that it seems advisable for the forest and timber economy to prepare for the higher variant of the consumption volume.

5.1.2. OTHER PRODUCTIVE FUNCTIONS OF THE FORESTS

Grazing has long ceased to be a productive function of forestry in the advanced countries as this practice is not compatible with the up-to-date methods of either animal husbandry or forest management. In the developing world, however, forest grazing has survived, and is frequently connected with the shifting cultivation of forests (slash-and-burn method), so it is a frequent cause of their devastation. Its elimination is desirable but will become possible only after a certain level of economic development has been reached. As regards the future, one may expect a slow elimination of its harmful effects.

Hunting tends to gain importance. In our days, its joys and trophies are in most countries accessible to anyone who is prepared to pay some fixed fee; accordingly,

it has become a source of forestry income. Of course, intensive wood production and intensive protection (or even raising) of game are hardly compatible, but in many countries there exist now wide forest areas where gamekeeping combined with a moderate production of wood ensures higher profitability than what a high level of wood production alone could yield. Nevertheless, it is not likely that hunting will ever affect the world's wood production to a significant extent.

In the complicated complex of *water supply*, forests have a very important role. For instance, riverheads and watersheds must be covered by forests. This means, on the one hand, that these areas have to be reserved for the purposes of forestry but also, on the other, that wood production in these areas is limited. The interests of water supply are hardly likely to influence wood production to a tangible extent. But the activities of forestry and, in some cases, their international coordination, may well contribute to stabilizing the water output of the streams and to making them more suitable for continuous use.

5.2. REQUIREMENTS FOR PROTECTION AND RECREATION

Many were the factors under whose effects man became increasingly conscious of the environmental and recreational role of the forest. Increase in population and its concentration in urban districts, air polluted by industry and motoring, noise, the city dwellers' lack of physical exercise and the threat of diseases deriving from all these – combined with increasing income, more free time and the longing for silent and beautiful surroundings – have started an exodus of masses from the cities, seeking recreation for at least some days or weeks. Thus it has become a requirement of the society as a whole that also the forests should take their share in satisfying this demand for recreation. In view of the relative scarcity of forests in Europe, it is particularly important to assess the impact of these functions on forestry.

Whereas at present, or in the near future, the *protective* functions of the forests do not seem to influence wood production significantly, sharp debates are going on concerning their *recreational* use. How could the demand for recreation be numerically assessed, what part of it has to be satisfied by the forests, how could the costs involved be estimated, and who is going to pay for it? These are the questions which are of increasing concern for the owners and managers of forests, the authorities and the research institutions dealing with the future of forests. The literature of the problem is continuously growing; essentially two different opinions could be distinguished in it.

One of them starts from the fact that "recreational pressure" on forests is so heavy and will increase in the future to such an extent that their production function is doomed to become secondary. Around each urban settlement one may draw a circle within which the recreational function is already primary, with production interests falling into the background. Now with the growth of urban population, greater leisure, higher income, an ever increasing number of motor cars, etc. the radii of these circles tend to lengthen, until some time the circles will cover all or most of the forest area; as a result, the recreational (and protective) function will dominate almost everywhere. Therefore, in the economically advanced regions, first of all in Europe, wood production will surely stagnate or even decline.

And since the consumption of industrial wood is likely to increase, Europe will increasingly rely on the forest reserves of Canada, Siberia and the tropical regions. According to this opinion, about the end of this century when average per capita income in Europe will double the present level, the protective and recreational functions of forests will become absolutely decisive, pushing the interests of production into the background. Namely, wood and wood products can be bought – if at a higher price – from overseas, but *clean air, pure water, silence* and beautiful scenery *cannot be imported*, whatever price Europeans would offer for them. This means that one must not expect any significant increase in European wood production during the decades to come. The adherents of this opinion also emphasize that a considerable part of European forests belongs to small owners and is therefore unsuitable for large-scale mechanization, hence, wood production here is too expensive, unable to compete with the cheap wood and wood products coming from overseas. Moreover, general scarcity of labour makes it hardly conceivable that European forestry could be developed in a way enabling it to simultaneously satisfy the demands of protection, recreation and wood production. Finally, the income of forestry to be earned by its recreational functions may become large enough to push the income of wood production into the background.

The adherents of the opposite opinion also admit that the "recreational pressure" on forests is growing, but they emphasize that this pressure is very uneven. Not to mention the forest area of a whole country, even the forests surrounding any given urban concentration are unevenly visited by tourists. This uneven pressure is a highly characteristic feature of the recreational function of the forests. Its various causes are partly objective, such as distance from the town, accessibility by mass communication and motor car, catering and camping facilities, fresh air, well-conducted hiking paths, etc., and partly subjective, like the aesthetical values of the landscape and the forest itself (e. g. mixed forests are more attractive), and even the whims of fashion or the effects of advertising. As a result, there are forest areas where the annual number of visitors per hectare is one thousand or more, while others are hardly visited at all. However, visitors can be influenced to a certain extent, and can thus be concentrated to spots where appropriate investments in roads, catering, etc., aimed at meeting their needs have been made. It seems therefore probable that the demand of Europeans for recreation can be met by making available only part of the total forest area for this purpose.

The most important argument underlying this opinion is, however, that Europe's possibilities for importing wood or wood products from elsewhere are rather limited. In 1961 the net imports of Europe from Canada, the Soviet Union and the tropical regions amounted, converted to WRME, to slightly more than 20 million cu.m. FAO estimated the 1975 deficit of Europe at 79 million cu.m. But it is one thing to import a volume of this magnitude, and another to ensure net imports at an annual 200–300 million cu.m about 2000 – because this amount would be needed if *all* European forests were then used primarily for protection and recreation. The non-European countries would not be able to supply such a mass of wood without over-exploiting their own growing stocks; and such an over-exploitation could only be induced by excessively high prices. Under such circumstances, however, it would be more advisable for Europe to increase its own wood production, by introducing a rational management of its forests, permitting them to perform all their functions of production, protection and recreation at an optimum level.

If, however, this reorganization of European forestry comes later by one or two decades, labour will migrate from it to other branches, and about the end of the century any attempt at organizing forestry in a way to ensure the combined optimum of productive, protective and recreational functions will be frustrated by the lack of manpower. Therefore, it is highly urgent to formulate a sound All-European forest policy, to take coordinated measures for introducing contemporary technologies and for ensuring the present and future performance of the recreational function – before it will be too late. At present, it seems still possible to ensure the simultaneous performance of all three functions and the optimum use of the European forests for a long time to come, provided that adequate foresight in planning and steadiness in implementing will prevail.

According to the adherents of this opinion, only 30 to 20 per cent of the whole forest area should be reserved exclusively for recreational purposes, and the remaining 80–70 per cent could serve all the three functions simultaneously. Within this, the role of wood production will vary according to the local importance of the other two functions, but it may be realistically hoped that European wood production as a whole will continue to increase at a steady rate.

At the European Regional Conference of FAO held in Budapest (September, 1970), lively discussions took place in the Forestry Section between the adherents of these two opinions. Ever since, discussions have continued both within the international agencies and in the various countries.

The present author subscribes to this second opinion. He believes that everywhere in Europe an optimum of the three functions should be striven for. In this case, the rising demand for recreation will not hinder the constant increase in wood production. Of course, all this has to be very carefully planned and very consequently implemented; if spontaneous processes are allowed to take place, they may soon become dominating and will almost certainly lead the European forest and timber economy into a blind alley.

In Hungary, a uniform conception has been formulated in this respect: our forests have to perform all three functions. Accordingly, their protective and recreational performance will have to be increased significantly in the coming decades, without neglecting the equally important task of developing wood production. This seems possible in view of the increase in our forest area that has been going on for more than a quarter of a century and is intended to be continued. The public ownership of almost all forests and the existence of central planning, both characteristic of a socialist system, facilitate the implementation of long-term plans, their coordination with the rest of the national economy as well as their financing.

5.3. THE SUPPLY OF OXYGEN

Until most recently, little attention was paid to the role of the forest as a supplier of oxygen, for this element was abundantly available to man for the purposes of burning food in his own body and of burning wood, coal, oil and gas in his home, or in power plants and factories. In our days, however, population increase and the rapid development of industrial and transport activities have reached such an extent that it seems advisable to pay more attention to this question. Researches

in this respect are still in their infancy all over the world, so reliable data and conclusions are not yet available. Let us, however, recall what we may know about the oxygen production of the forest.

About one fifth of the air we are breathing in consists of oxygen, the rest is mainly nitrogen, except small quantities of carbon dioxide, water vapour, a few other gases and an increasing amount of various pollutants. The chlorophyll contained in the leaves of green plants, when exposed to light and in the presence of water, disintegrates carbon dioxide, produces carbohydrates like starch and sugar, and releases part of the oxygen inhaled. This process, which is called assimilation or photosynthesis, is only possible in the presence of light, water and chlorophyll. This function is performed only by the green plants (but even these must, in the absence of light, inhale oxygen and exhale carbon dioxide). They provide nutrients for all other life on our planet. Plants without chlorophyll, as well as all animals, are unable to assimilate carbon dioxide and must feed themselves, ultimately, on organic matter produced by the green plants. Until recent times, man was more interested in the assimilation products built into the plant organisms than in the amount of oxygen released by them into the atmosphere.

Let us start with the demand for oxygen. According to Krebs [43], human beings use up about 6 per cent of the oxygen content of the air inhaled, and they exhale the rest into the atmosphere, mixed with nitrogen, carbon dioxide, water vapour, etc. A grown-up man consumes about one third of a ton of oxygen a year. Thus, in 1970 the human population of our planet consumed about 1.2 billion tons of oxygen, and is expected to consume some 2.3 billion tons in 2000. If there were no other demand for oxygen, the problem could be easily disregarded. But, according to the same author, the experts in energetics expect that in 1980 the burning of fuels for technical purposes will use up 23 billion tons of oxygen, releasing, at the same time, about 30 billion tons of carbon dioxide into the atmosphere. It is also interesting to remark that according to Cserkuti a jet-plane, while crossing the Atlantic in eight hours, consumes about as much oxygen as 25,000 hectares of forest are producing during the same time. (Let us add that the picture is even more dismal: namely, forests can produce oxygen only in sunlight, whereas jet-planes consume oxygen at any time.)

When trying to forecast the world trend of fuel consumption for the year 2000, we obtain the following figures regarding the demand for oxygen (in billion tons):

	1970	2000
direct consumption by human beings	1	2
technical consumption	14–18	45–50
total consumption	15–19	47–52

Thus, the total demand for oxygen created exclusively by man is likely to rise about threefold in three decades.

As regards the sources and amounts of the world's oxygen supply, the estimates published so far differ widely. First of all, there is a traditional theory saying that the only source of oxygen for our planet is the emission of green plants. However, on the grounds of some more recent observations, e.g. the photographs taken of the Earth by Apollo 16, some experts suggest that the Earth's "geocorona ex-

tends to 100,000 miles. Breakdown of water vapour from the oceans sends hydrogen drifting far above the surface... the separation of water vapour into its two elements rather than the photosynthesis in plants, may be the major source of Earth's oxygen" [51]. In the following, however, we shall deal only with the biological sources of oxygen production, in order to estimate the share of forests in this respect.

The most reliable method of estimating the oxygen output of green plants would be to start from the amount of organic matter produced by them; but this quantity is hardly accessible to estimates.

Biological oxygen output is generally classified into three groups: the output of forests, of cultivated plants (and pastures) and, finally, of the green plants living in the oceans.

Brünig [5] estimates the annual amount of dry matter produced (above the surface) by world's *forests* at 42 billion tons. This would result in an oxygen production of 55 billion tons. According to him, the oxygen produced by the green sea plants is considerably larger, amounting to 144 billion tons.

Baumgartner [2] estimates the annual oxygen production of forests at 54 billion tons, that of cultivated plants and pastures at 40 billion tons.

According to Morgan [50] the net increment of one ton of wood involves the exhaustion of 1.07 tons of oxygen. If we assume that the annual net growth of the world's forests amounts to 4 billion cu.m, we obtain a forest-generated oxygen production of 4.3 billion tons.

According to Komisarov [41] the terrestrial and aquatic green plants of our planet produce 460 billion tons of oxygen annually.

According to Belov [3] the forests of the Soviet Union produce 3 billion tons of oxygen annually. Since the forests of this country represent about one fifth of the world total, this would mean that the world's forests produce 15 billion tons of oxygen a year.

If from these contradictory estimates we accept three things: (1) the minimum oxygen output of the forests (4.3 billion tons), (2) the maximum output of all green plants (460 billion tons), and (3) the proportion between the three categories (agricultural oxygen equals 0.75 times forest oxygen, and oxygen produced by aquatic plants equals three times the sum of the first two), we obtain the figures shown by Table 39.

The total amount of oxygen contained in the terrestrial atmosphere is estimated at $1{,}233 \times 10^{12}$ tons. For the time being, this seems an inexhaustible reserve, even if we assume that some oxygen escapes into the interplanetary space. Nevertheless, we should remember that the estimated oxygen consumption of mankind was already in 1970 between one half and two thirds of our minimum estimate of the oxygen produced by the green plants, and that by 2000 it is likely to *exceed* the minimum estimate by 50 to 75 per cent.

Indeed, the most advanced industrial countries of our time seem to approach, one by one, the state when they consume more oxygen than they produce. According to Cole [6] the oxygen consumed in the USA already exceeds by 50 per cent the amount produced by the green plants of the country. Life can continue there, in spite of growing industrial activity, only because the movements of the atmosphere bring in some oxygen. Krebs [43] believes that even Switzerland consumes now more oxygen than she produces in her local forests and agriculture, al-

Table 39

Estimated annual oxygen production of green plants
(billion tons)

Category	Minimum	Medium	Maximum
Forests	4.3	35	66
Agriculture	3.2	26	49
Oceans	22.5	184	345
Total	30.0	245	460

Source: Calculations made by the author, based on the various sources mentioned in the text.

though "fresh air" still figures among the factors attracting millions of tourists to this country.

Future-conscious experts are already beginning to suggest to maintain large forest areas in order to ensure the world's oxygen supply. Among these, the Amazon Basin deserves some attention. When the Brazilian government elaborated a long-term agricultural and industrial development program for this region, some critics objected exactly because it would affect the oxygen production of this largest continuous forest area of the world, by damaging the growing stock of these forests as well as their soil. Thus, *demand for the oxygen-producing function of forests has emerged on a world scale*. This is a problem that cannot be decided on by any individual country. Clearly, it emerges as an international task.

There are several alternatives for maintaining the oxygen equilibrium, but they all require large-scale measures.

Industrial oxygen consumption may, for example, be first slowed down in its growth, then stabilized and perhaps reduced. This would involve, for instance, an increasing share of hydro-electric, solar and nuclear power plants in total energy production, as well as the substitution of motor cars with internal-combustion engines by those which consume less oxygen (at least for smaller distances and for certain purposes). All these require, however, several decades of transition.

The other alternative consists in increasing the amount of oxygen supplied by the green plants.

The oxygen production of the most important category, i.e. aquatic plants, does not seem to be significantly influenced in the decades to come.

The oxygen production due to agricultural activity is likely to rise parallel with the demand for vegetables as human food, animal fodder and agriculturally-produced raw materials, that is, roughly at the rate at which population increases. We know, however, that human consumption of oxygen rises much faster than population itself because of industrial consumption.

Thus, with an aquatic oxygen production that cannot be influenced, and an agricultural oxygen production that can rise only about proportionally with the population increase, an additional supply of oxygen above this may be expected

only from the *forests*. It seems that the time has come when mankind must also take into account the necessity and possibility of oxygen when deciding on questions of land use.

To sum up: under the present circumstances, the restrictions of wood production deriving from the protective and recreational functions of forests can be realistically assessed by saying that their importance is rapidly growing and, about the end of this century, they may affect about one fifth of the total forest area in the advanced countries. (In other words, wood production may remain unrestricted in 80 per cent of the forest area and may be subject to some restriction in the rest.) As regards, however, the *world's total forest area* altogether, the necessary restriction of wood production due to these factors is not likely to amount to more than the margin of error of the estimates on the net annual increment of the growing stocks. It may be hoped that, in the course of time, more accurate forest inventories and better information on the extent and requirements of the protective and recreational functions will enable us to make more realistic estimates. At present, it seems satisfactory to compare the estimated utilizable annual growing stock of world forests with our forecasts regarding consumption.

5.4. WORLD'S FORESTS AND THEIR ESTIMATED GROWING STOCKS

Soil, climate, historical events and human activities have developed diverse types of forest. FAO has classified them according to six principal types [14]. This classification is satisfactory for an economic assessment, since it reflects the most important features of quality and enables us to estimate actual and potential yields in the various parts of the world within certain margins of error. The main features of these types are the following.

5.4.1. COOL CONIFEROUS FORESTS

They occur only in the Northern Hemisphere, forming a broad belt of "taiga" around the globe. The number of species in this area is small, most of the trees are uniformly sized, the wood material is longfibered. In spite of heavy exploitation in the southern parts, the virgin forest has been preserved over large areas, due to the sparsity of population and to the lack of transport facilities.

5.4.2. MIXED FORESTS IN THE TEMPERATE ZONE

They occur almost exclusively in the middle latitudes of the Northern Hemisphere. The number of species is considerably higher than in the taiga. There is a large number of subtypes, from predominantly coniferous forests to almost purely broadleaved ones. The proportion of softwood is very important, since many broadleaved species growing here exhibit poor quality and form. These forests are generally located in densely populated regions and have been subject to human intervention for a long time. Considerable forest areas have been cleared and used for agriculture. The need for fuelwood has resulted in the conversion of

many forest areas into coppice forest. Structure and quality of wood have changed and are still changing as a result of intensive forest management. Most of the beech, oak, birch and – from among the more valuable species – walnut used throughout the world comes from these forests. There exist here considerable areas of coniferous forests, mainly in the Soviet Union and at the Pacific coast of North America.

5.4.3. MOIST FORESTS IN THE WARM TEMPERATE ZONE

These forests occur in the warm temperate zones of both hemispheres. Although they contain a large number of hardwood species, they are most heavily exploited (in the easily accessible areas) for their softwoods. Virgin forests are being replaced to an increasing extent by plantation with native or exotic softwood species. These forests occur in the coast belt of southern Australia, in New Zealand, in the relatively narrow mountainous belt running roughly parallel with the north-western coast of South America, in south-eastern USA, in south-eastern China, etc. The better known hardwoods include oaks and (in Australia) eucalyptuses.

5.4.4. EQUATORIAL RAIN FORESTS

They occur everywhere in the tropical regions where rainfall is abundant, and are predominantly broadleaved. A hundred or even more species can be found within a few hectares, with a very wide variety of size, form and quality, which fact causes difficulties in industrial processing. So far, human exploitation has only penetrated into the fringes of tropical rain forests. Nevertheless, it is here where most of the high-quality and large-size hardwood used in the world is coming from. This type of forest has been steadily decreasing, due to clearings for permanent agriculture; in many areas, forests are farmed under shifting cultivation (slash-and-burn method) with the result that they are transformed into secondary forests, unable to produce quality wood any more. The commercially well-known species of this forest type include mahogany, okoumé, limba, etc. The most important rain forest areas are in Latin-America (mainly in the Amazon Basin), as well as in West Central Africa, in South-West Asia and Indonesia.

5.4.5. TROPICAL MOIST, DECIDUOUS FORESTS

They occur in the tropical regions where the climate is moist but rains are interrupted by a relatively long dry season. Depending on the length of the dry season, there are subtypes ranging from quasi-rain forests to almost savannah-like formations. Considerable areas of these forests have been cleared and used for permanent agriculture. Another part has become heavily degraded by shifting cultivation and grazing. The forests of this type contain some commercially well-known species like teak only in Asia.

5.4.6. DRY FORESTS

Such forests occur everywhere where dry seasons are long and severe, but particularly in the tropical regions. In general, the trees are short, badly formed, comprising a large number of species; the volume of growing stock per hectare is

small. This type has spread in historical times through the activity of man – through grazing and forest destruction – particularly in the Mediterranean region. In Africa, dry forests have been advancing for centuries at the expense of rain forests, due largely to fire, grazing and shifting cultivation. Little or no commercial timber is produced by these forests, but they provide important quantities of poles and fuelwood for local use.

The principal types enumerated here do not include some locally important types as, e.g., bamboo and mangrove forests since, on a world scale, they have no role of consequence in wood production.

*

In order to highlight the economic significance of the various forest types, the following remarks seem to be necessary.

In Europe, the Soviet Union, North America and Japan, i.e. in the regions where most wood is consumed, the forests are predominantly *coniferous*. Across the northern latitudes of all these regions runs a wide belt of coniferous-forested land. The proximity of these large reserves of softwood has obviously been of primary importance in shaping the pattern and character of the use of wood and of the wood-processing industries in the densely populated and economically advanced regions located immediately south to this coniferous forest belt. Moreover, here even the more densely populated regions were relatively well afforested. In Northern Europe, the United States and Japan, at least one fourth of the total area is covered by forests, and within these mixed forests the proportion of softwood is considerable. Moreover, these forests have the advantage of containing a relatively small number of species and of producing wood fairly uniform in character, properties and log sizes. They are therefore relatively easy to harvest, transport, handle and process. Also the temperate broadleaved forests contain relatively few species in any single area, and this enhances their commercial usefulness.

The larger part of the temperate mixed forests is now in use, and it is provided with transportation facilities. The still remaining virgin forests of the Northern Hemisphere are located mainly in the northern and eastern parts of the Soviet Union and at the Pacific coast of North America, these two regions representing the world's largest reserves of softwood.

Most tropical forests consist of *broadleaved species*. Most of their growing stock is concentrated in the rain forests which contain the world's largest reserves of broadleaved woods. They have been very scantily used so far, because the sparse population and the low level of economic development of their surroundings.

Tropical rain forests contain – as it has been said earlier – a great variety of species within every small area: Extremely hard, heavy and slow-growing broadleaved species are mixed with very soft, light and quick-growing ones. This extreme diversity has been an important factor hindering the utilization of these forests.

Little is known about tropical rain forests, exactly because only a small part of them is under regular management. They amount perhaps to some 850 million hectares, with about 120–130 billion cu.m (gross volume) of growing stock, i.e. roughly the same amount as can be found on the much larger area of the northern

temperate forests. But only a small fraction of this quantity is industrially utilizable and even less of it is saleable. For instance, the growing stock per hectare of the West African rain forests may amount to 300 cu.m, but only 80 cu.m of this has commercial log sizes, and even from this only 20 cu.m belongs to the species now acceptable in international trade.

The area of the tropical moist, deciduous forests is small, their importance is limited.

Apart from these two types, most of the other forests in the tropics and subtropics are "dry". For instance, only one fourth of all African forests are rain forests (mainly located in Central West Africa), and most of the rest is poor-quality, sparse dry forest. Also the forests of wide areas in Latin America as well as in South Asia are of the savannah type.

5.4.7. MAN-MADE FORESTS

Forests planted by man form already an important part of the world's productive forest resource. Their contribution to wood production is proportionately much larger than their share in the total of forest area, since their net annual growth considerably exceeds that of the natural forests, as a result of rational planting and management.

New forests are generally planted for two reasons: (1) to regenerate overexploited areas by natural or artificial means in order to ensure continuous exploitation on a sustained basis, and (2) to increase the forest area by planting unforested lands in order to fulfil the three main functions of wood production, environment protection and recreation.

As regards the survival of forests, traditional forest regeneration has had a long-standing technique.

In Central Europe, Hungary included, the systematic regeneration of forests was initiated in the 18th century, usually near the mines in order to ensure continuous pitprop supply. Today, the systematic regeneration of overexploited areas is prescribed in some form wherever systematic sylviculture is being carried out.

In the last decades there has been major progress in planting unforested lands in the economically developed countries. Partly, this has been due to the fact that up-to-date and intensive agriculture has gradually abandoned the areas unsuitable for its purposes (first of all the declivities). These areas must be afforested, or else, erosion may cause irreparable damage in a few decades. These soils, which were actually covered by forests at some earlier date, are generally of a better quality than the average forest lands. These new forests serve partly for wood production and partly for the purposes of environment protection (e.g. soil amelioration).

Increasing the forest area is also aimed at doubling wood production under intensive conditions, competing at the same time with some branches of agricultural production as regards profitability.

As a matter of fact, such afforestations and the raising of such forests are more closely related to agricultural production than to traditional sylviculture (e.g. the intensive planting of poplars).

Among the developing countries China has planted by far the most new forests. So far, no exact data have been available, but according to some reports, the territories afforested in China during the last 25 years may be somewhere about 50 million hectares. However, we have no information about the survival rate of these new forests.

In both the developing and the developed countries, the intensive methods of planting and of sylviculture have become equally characteristic of the regeneration of existing forests and the planting of unforested lands.

The major means of intensive afforestation and sylviculture which help to achieve substantial annual increment are as follows:

- the use of improved, highly productive and controlled species for the planting of unforested lands,
- drainage of marsh-lands,
- irrigation of dry areas,
- intensified use of chemical fertilizers,
- application of up-to-date methods in soil protection, etc.

In a proper soil, eucalyptus, for instance, is able to achieve an annual increment of 20–30 cu.m/ha in Latin America, and only 15–25 cu.m/ha in tropical Africa.

During the VIIth World Forestry Congress, we took part in a study tour where we saw a forest of *Pinus elliotti,* not far from Rosario (Argentina), which yielded an average increment of 20 cu.m/ha at the age of 15 years, yet it would be cut to be replaced by eucalyptus which may achieve there an increment of 30–40 cu.m/ha.

In the last 25 years, some 100,000 ha of unforested land have been planted with poplars in Hungary. Their annual increment has been more than double the country's average increment.

As regards Italy, for example, these fast-growing poplars cover only 6 per cent of the country's total forest area, yet they supply 40 per cent of her industrial wood production. Intensive afforestation with such fast-growing species are carried out in other parts of the world as well: in Japan, New Zealand, South Africa and in some countries of Latin America, such as Chile and Argentina. Mainly poplars, eucalyptus and different coniferae are used in these areas, though important afforestations are also carried out with teak tree in Indonesia and Burma.

Intensive afforestation, however, has not only advantages, but it has its limits too. Large forests consisting of a single species are particularly sensitive to various biotic and other damage. Therefore, it is better to restrict such afforestations to areas where all the conditions are given, ranging from soil analysis to up-to-date plant protection.

5.5. WORLD FORESTRY STATISTICS

The scanty information available does not suffice for building up reliable trends and prognoses regarding the principal regions. FAO has therefore decided to collect periodically, in cooperation with the ECE, the most important data on all forests of the world. At present, practically all countries having forests systematically report data from which a "world forest inventory" can be elaborated periodically. So far, the reliability of the data reported by the various countries has been different, but it seems that the coverage and the accuracy of the successive reports

Table 40

Forest areas by main regions about 1963

Regions	Total land area	Forest area		
		total	in per cent of land area	per capita hectares
	million hectares			
North America	1,875	710	38	3.8
Central America	272	71	26	1.4
South America	1,760	830	47	7.3
Africa	2,970	700	24	3.4
Europe	471	138	29	0.34
Soviet Union	2,144	738	34	4.1
Asia	2,700	500	19	0.32
Oceania	842	92	11	6.5
World	13,034	3,799	29	1.4

Source: [16].

have been steadily improving, and so the initial ambiguities of methodology can be cleared up to an increasing extent. Part of the data are based on systematically assessed forest inventories and management plans built upon representative sampling; the rest are estimates regarding forest areas for which no management plans have been elaborated. It seems that the last World Forest Inventory – published in 1963 – can already give some orientation as to the forest areas and the growing stocks of the world (Table 40).

According to this estimate, about 29 per cent of the planet's land surface was covered by forests in 1963, and the per capita world average of forest area was 1.4 hectares. There was, however, a wide dispersion in both respects: by main regions the share of forests in total land surface varied between 11 and 47 per cent, the per capita forest area between 0.3 and 7.3 hectares.

Two thirds of the total forest area consist of broadleaved or (to a smaller extent) mixed forests. But if we take the Northern Hemisphere separately, about two thirds of the forest area located there are covered by coniferous species.

From the point of view of forecasting, the data regarding the growing stock (Table 41) are particularly important. In this respect, however, there are great differences in coverage. As regards the coniferous forests, which are mostly located in the economically advanced regions, the coverage is almost complete, whereas for the vast broadleaved forests of the developing regions only rough estimates are available, which are likely to be corrected upwards in some respects. For instance, the data regarding Africa and, in particular, Asia are incomplete, probably showing less than the actual values. At the same time, the high relative

Table 41

Growing stocks in world's forests about 1963
(with bark)

Regions	Growing stocks		
	total billion cu.m	cu.m per hectare	
		coniferous	broadleaved
North America	60	105	90
Central America	2	70	85
South America	110	140	190
Africa	30	55	45
Europe	12	95	80
Soviet Union	79	120	75
Asia	35	85	90
Oceania	5	94	58
World	333	–	–

Source: [16].

share of South America shown by the table is due to recently revised estimates on the vast Brazilian forests.

As regards the annual net increment of the growing stock, the data relating to the greater part of the world are incomplete, since the assessing of this figure is rather complicated and costly, requiring local survey and sampling. The advanced countries perform such work continuously, as a result of their systematic forest management, and they are able to report annual growth data with increasing accuracy. It would be, however, quite misleading to extrapolate the coefficients obtained from such data to forests not subject to systematical management, viz. to those located in other parts of the world. Thus, it would be premature to estimate the annual net increase for whole regions or the world as a whole.

Table 42 shows the data of net annual growth for some advanced regions in the Northern Hemisphere; about 40 per cent of the world's total forest area is located in these regions.

Here one may count with a net annual growth of 1.8–2.0 cu.m per hectare. But these figures are not wholly accurate. As regards the other 60 per cent of the world's forest area, no reliable data on annual growth are available. In respect of this 60 per cent, it seems fairly probable that both the per-hectare growing stocks and their annual growth are smaller than in the temperate forests of the Northern Hemisphere. We do not seem to commit a great mistake by assuming the annual growth in this 60 per cent of the forest area to be about as much as that produced by the more intensively managed 40 per cent.

On these grounds, we would obtain a total annual growth of about 3.5–4.0 billion cu.m for the world as a whole. It seems that a rather long time will be needed

Table 42

Estimated annual net growth in the forests of the northern temperate zone

Regions	Average annual net growth	
	total million cu.m	cu.m per hectare
Europe	344	2.3
Soviet Union	874	1.2
USA	461	2.2
Canada	211	1.2

Sources: [4, 16, 22, 59, 63].

for obtaining a more reliable estimate, since the coverage and accuracy of forest inventories depend, among other things, on the general level of economic development. It is probable that with more accurate data in the future, a somewhat higher world total of annual increment will be arrived at.

5.6. FACTORS INFLUENCING THE AMOUNT OF WOOD PRODUCTION

When assessing these factors, it is advisable to clear up such general tendencies as are likely to prevail more or less in all regions.

Part of these acts in the direction of *increasing wood production.* The most important ones seem to be the following:

1. Successive forest inventories of individual countries and of whole regions almost invariably prove that assessments and estimates performed by more up-to-date and more reliable methods show *larger* growing stocks and annual increments than those formerly applied. Since the statistical coverage of forests is still widening, and the methods are technically improved, one may expect a tendency of the future national and world inventories to indicate larger growing stocks and annual increments than are known at present.

2. With the progress of economic growth, both the governments and the public opinion tend to become increasingly aware of the importance of forests, and to give rise to increasingly effective legislative, administrative and economic measures serving to protect them and improve their condition. At the same time, also the quality of forest management tends to improve, resulting in higher rates of annual growth and exploitation.

3. At present, the bulk of the world's wood production still comes from "virgin" forests. Indeed, Europe is the only large region where a kind of continuous rotation of forest exploitation and renewal has generally set in, and where one can

speak of a systematic forest management. In the planted stocks replacing the exploited virgin forests, the pattern by tree species is more favourable, and annual growth is larger than in the original forest. In the replanted areas, the proportion of the fast-growing species (coniferous trees and poplars) has increased, soil meliorations are performed before their planting, and even the application of fertilizers has begun in some countries. Economic development involves, among other things, the intensification of agriculture in general and of animal husbandry in particular, and this leads to the gradual elimination of forest grazing, one of the greatest damages done to sylviculture. There is a definite tendency of the ratio of man-made forests as well as of forests under intensive management to increase. All this results in higher rates of annual growth and exploitation, and in an improved quality of the wood produced. It seems, therefore, very probable that when – obviously some time after 2000 – all forests of the world will be managed systematically and intensively, their annual growth will be considerably higher than what we have estimated above for 2000 on the grounds of the present situation.

4. Also an absolute expansion of the forest area may be justifiably expected in the next decades to come, at least in the advanced countries with relatively low forest areas. In many of these countries domestic agricultural production develops at such a rate that it approaches full saturation of the home market in several respects. At the same time, sooner or later it will become necessary for these countries to reduce the sacrifices born by taxpayers and consumers in order to subsidize home agriculture, and to increase their imports of cheaper food from the developing world. Such imports will become necessary also because the highly-profitable industrial exports flowing from the advanced countries to the developing ones can be paid for mostly in the form of food or raw materials. All this raises the problem for the advanced countries how to utilize considerable marginal areas now cultivated by agriculture. As these areas cannot lie fallow if the danger of water and wind erosion is to be averted, and since there will be a growing demand for wood, their afforestation is likely to offer the most reasonable solution. Not only in the advanced countries but in some other areas poor in forests as well (first of all in China), considerable afforestation is already being planned and partly implemented. Reports on forest areas actually planted in the People's Republic of China during the 1950's range from 30 to 60 million hectares, and the afforestation of even larger areas is planned.

5. The planting of improved strains of tree species is an important factor in increasing production. The effect is likely to become even more dramatic in forestry than in agriculture. According to some authors, only improved tree strains will be planted in Europe about 2000 [38].

6. Continuous technological progress also tends to increase wood production, by making it possible to industrially utilize such tree species and such small-sized logs as were formerly unsuited for industrial purposes. Most important in this respect is the increasing utilization of thin logs of many broadleaved tree species for manufacturing wood pulp and wood-based panel products.

The most important factors tending to *restrict wood production* are the following:

1. In the economically advanced regions – as has been mentioned before – the welfare (recreational) functions of forests are rapidly gaining importance, with

the double effect that cutting in the so-called park forests is possible only when and where it does not impair their "primary" function, and that the limited possibilities of exploitation necessarily hinder profitable forest management, whereas the question whether, and how, the community should compensate forestry for this loss of profits has not yet been unequivocally cleared.

2. In many parts of the developing world, shifting (slash-and-burn) cultivation and forest grazing are still important factors of deterioration. The first is still widely applied in large parts of tropical Africa and Asia, consisting in the burning of forests in order to use the cleared area for cultivation for a few years. The forest soil – initially enriched by the mineral salts contained in the ashes – tends to get exhausted in a short time; moreover, it is subject to water and wind erosion. Therefore, cultivation is abandoned after some years and the area is left for natural reafforestation, but the new forests are usually of poorer quality. In addition, with increasing population density, a kind of rotation sets in in most regions, and the periods between successive burnings are shortened to the extent that in the meantime the forest can never regain its original state. The second feature of backward agriculture, i.e., the grazing of forest fallows and virgin forests, is also causing serious damage. Thus, in many developing countries one has still to reckon – at least for the next few decades to come – with some reduction of the forest area and with a deterioration of what remains.

3. As a result of the rapid increase in population, considerable forest areas are cleared in order to make place for human settlements, industrial plants, roads, railways, airports, etc.

Nevertheless, if one tries to draw the balance of the favourable and the adverse effects, *it seems probable that about 2000 the forests of the world will be able to meet the demand for wood at that time.*

It is also probable that, at least until about 1980, part of the additional demand will be met by the growth of production in the already used – or more easily accessible – forests of the Northern Hemisphere, whereas the opening up of the vast potential reserves available in South-East Asia, Africa and Latin America will need some more time. By the end of our century, technological progress seems to enable the yet unutilized reserves of the southern regions to increase their share in world supply.

The difficulties standing in the way of this development are, however, so great that one cannot conceive an "automatic" solution to emerge as a result of a mere continuation of the present trends. In our days, it is becoming increasingly obvious that a long-term forest policy has to be elaborated and consequently implemented not only by the individual countries concerned but also for each main region; furthermore, these regional conceptions will have to be integrated into a *world strategy of the forest and timber economy* based on the analysis of all relevant factors.

5.7. WORLD TRADE IN WOOD AND WOOD PRODUCTS

Let us analyze now the expected trends separately for the importing and exporting regions.

In Europe, the demand for industrial wood and wood products is likely to rise in the coming decades in proportion with economic growth. Since the European forests are already unable to meet the regional demands and will be even less able in the future, European net imports of wood and wood products are likely to rise. But with the increase of European imports, also the production costs in the supplying regions must rise, as large investments will be needed for the production and transport of the additional quantities. In other words, this will result in a rise in the import price of wood and wood products. At the same time there are still possibilities for increasing wood production in Europe – at least in its northern and eastern parts. In view of various circumstances (e.g., the great difference between the wages, say, in Canada and East-Europe, the advantages of the large, state-owned management units in the East-European socialist countries ensuring the application of technological improvements, the gradual maturing of planted forests consisting of fast-growing species and the favourable effect of many other factors), one may expect that European wood will remain able to compete with the products imported from Canada or from any other part of the world, provided that the necessary conditions are created.

As regards the welfare (recreational) functions of forests, they will obviously gain momentum in Europe. It may be hoped, however, that a reasonable compromise will be arrived at between the productive and recreational functions.

Some part of European wood production is at present handicapped by the smallness of management units. Clearly, small forests cannot be competitive, and their integration into diverse forms of cooperatives is already in progress. Beside this "horizontal" integration, a "vertical" integration is also taking place, through the intertwining of large forestry units and large wood-processing plants. The latter ones tend to acquire forests of their own, partly in order to ensure a constant supply of raw material, partly to cheapen it by introducing contemporary, mechanized methods of harvesting and transport, and finally because thus they can also use the refuses found at the cutting-places. At the same time, the larger forest domains tend to build wood-processing plants of their own in order to combine the higher profits of the processing industries with the low profits or even losses of forestry proper. In both cases, full verticality permits the choice of optimum plant sizes and the introduction of modern technology. Let us note that even among the wood-processing industries there are great differences in profits. According to [52], in the case of the largest Swedish firms, profits as a percentage of the production value are as shown in Table 43.

Vertical integration is also desirable because the sawmilling industry is the largest producer of refuses (sawdust, shavings, etc.), and these can be used by the pulp and panel industries.

International cooperation and integration is developing in the future too in order to ensure a more efficient utilization of raw materials of different qualities and sizes. All these tendencies increase step by step the competitiveness of European wood.

Nevertheless, Europe will remain the greatest import market for wood. If the assumption were true that the wood production of the European forestry is not going to increase significantly in the future (owing partly to rising production costs

Table 43

Profits of the largest Swedish enterprises as a percentage of their production value

Year	Industrial average	Paper industry	Sawmilling industry
1960	29.3	28.4	13.6
1968	26.1	40.5	15.5

Source: [52].

and partly to the welfare function), this would mean that the wood imports of Europe would have to rise from the 50 million cu.m expected for 1980 to about 300 million cu.m by 2000. European imports of such magnitude would exhaust not only the entire export potential of Canada, but also the whole growing stock of the tropical regions that seems to be accessible about 2000, and even the Soviet Union would have to contribute by significantly extending its Siberian production.

All this is, however, conceivable only by assuming a very steep rise in wood prices. But such a price rise would favour the extension of European wood production on the one hand, and reduce the consumption of industrial wood to the benefit of the competing materials, on the other. Thus, on the grounds of present information, we rather discard this variant. It is much more probable that, in continuation of the present tendencies, European forestry will be rationalized step by step and will be able to meet a large part of additional demand. Even in this case, we may realistically reckon with a considerable increase of European wood imports which may attain the level of 100 or even 150 million cu.m about 2000.

The main potential source of these imports is Canada. Although this country will have to increase its exports also towards the USA and Japan, it is likely to become the largest supplier of Europe. The other main source will be the Soviet Union. But as Soviet exports are likely to rise at a relatively slow rate – and part of them will be directed to Japan –, it is probable that the share of this country in meeting European demand will decrease. The third potential source of European wood imports is Africa; its share is likely to rise considerably.

These three sources seem to be able to satisfy Europe's demand about 2000, provided that also the European production of industrial wood rises adequately.

Japan will most probably become the second greatest wood import market of the world; by 2000 its wood imports may more or less equal those of Europe. Japan will also have to rely on three main sources: the far-eastern parts of the Soviet Union, the western parts of Canada (British Columbia), and South-East Asia. This, however, involves considerable sylvicultural and infrastructural investments in the Soviet Union, as well as in the Asian countries concerned. In all probability, an economic cooperation will develop between Japan and its wood suppliers, in continuation of the present tendencies. According to published data, for the

five-year period beginning with 1968 Japan promised to deliver the Soviet Union machines, lorries, tractors and cranes in the value of $ 163 million, against 8 million cu.m of construction wood. It is known that in the region of Khabarovsk 18–20 million cu.m of wood is annually produced with fully mechanized processes. The Amur region is very rich in forests, its wood can be directly floated down to the sea port. The distance between the Amur outlet and the Japanese ports is relatively small, and so this export can be realized entirely by way of cheap water transport.

The third greatest potential import market is *China.* The import demand of this vast territory with a population already exceeding 740 million will present itself sooner or later, depending on the time it will reach the level of economic development where the consumption of industrial wood and wood products (first of all paper and paperpoard) must inevitably increase. When China's demand appears in the world market – probably somewhat before 2000 –, a growing pressure will be felt on the potential export sources, mainly on the far-eastern parts of the Soviet-Union, Canada and South-East Asia. This may also affect strongly the wood supply of Europe and Japan.

5.7.2. EXPORTING REGIONS

The world's greatest utilizable growing stocks are located in the Siberian parts of the *Soviet Union.* In the northern regions, many problems arise due to hard climate, short vegetation period and the short season of water transport. In the south, mainly in the Amur Valley, forest exploitation develops at fast rates, and this region takes an increasing share in world trade.

Some scientists have thought of the possibility (of course, only if assuming lasting world peace and extensive international cooperation) of closing down the Bering Strait by a dam and pumping, with the aid of a huge power plant, the relatively warm water of the Pacific into the Arctic Ocean. The depth of water in the Bering Strait being about 200 feet, even the present Soviet technology of dam construction would be able to close it down. In this case the climate of Northern Siberia would become milder and the Arctic Ocean and (with the creation of storage lakes which might give rise to a set of power plants) the huge rivers flowing into it would become navigable throughout the year.

The realization of such a plan is, however, not conceivable before the year 2000. It would surely transform the forests of Northern Siberia into an important and growing source of the world's wood supply. But since we want to count only with possibilities utilizable before 2000, we may be sure of only two main tendencies. First, the growing stocks of the Amur forests will gradually join the flow of world trade, in the form of logs, pulpwood and processed products. Second, based on the cheap energy produced by the hydro-electric plants of the rivers Angara and Yenisey, large plants turning out wood pulp and paper are being built already, and some others are planned. Pulp and paper will be produced there under very favourable conditions (cheap wood obtained from virgin forests, and cheap hydro-electric energy) so they will be able to bear even the high costs of railway transport. This situation will last as long as wood is obtained from virgin forests where the relatively small annual growth (due to the short vegetation period) does not affect the calculation of prime costs. Beyond doubt, however, this factor

will have considerable importance in case of the replanted forests, raising a serious problem to be solved in the coming century.

One may also assume that the improvement of nuclear-powered ice-boats will open up a possibility for transporting, across the Arctic Ocean, the whole quantity of wood that can be floated down the rivers during the short summer season.

The rivers Ob and Yenisey are running towards the north; they are frozen during nine months of the year. It is possible only in the three summer months to float the logs to the northern estuaries from where they are shipped through the Arctic Ocean to the European ports. During this short season the cost of transportation is very low, not exceeding 8 roubles per ton, whereas the cost of railway transport from the same sites to the western frontier of the Soviet Union amounts to 70–80 roubles per ton.

Canada is at present, and will remain during the two or three decades to come, the world's largest potential supplier of wood. Within the country, it is the virgin forests located near the Pacific shore (mainly in British Columbia) that offer the greatest possibilities for increasing wood production. At present, Canada produces about 100 million cu.m of industrial wood annually. According to some calculations, an additional amount of 25–30 million cu.m could be produced profitably if prices went up by about 10 per cent. It is also believed that if the period of rotation were shortened down to the length of time required for attaining pulpwood sizes, and all Canadian forests were involved in production, the total annual output of industrial wood might reach 300–320 million cu.m.

The forests located near the Pacific coast of Canada are excellently exploited. Part of the wood produced reaches the sea ports by cheap water transport, the rest is converted in the vicinity of the forests into woodpulp or paper, and is transported in this form to the ports by rail or lorries. The competitiveness of Canadian wood in the southern and eastern parts of the USA and in the European ports rests partly on the large size of logs, partly on the mechanization of harvesting and transportation, and partly on the cheap water transport. However, as the virgin forests located at an ever growing distance from the sea ports have to be exploited and, at the same time, the relatively thin-logged and more expensive stocks of man-made forests are becoming mature, Canadian wood and wood products will lose some of their competitive power. This time, however, is far away.

When looking at a map of the world's forests, the huge green area of the *Amazon Basin* inevitably grasps our phantasy and makes us think that this is the largest and almost inexhaustible resource of the world's wood supply. Those, however, who know this area better are of a rather pessimistic opinion. These forests contain an immense variability of species; a hundred or more kinds and sizes are to be found within a few hectares. This makes industrial utilization very difficult. Another difficulty is the lack of manpower, as this huge area is practically uninhabited. Finally, also the climatic and health conditions are unfavourable. Most probably, this area can only be included into world trade to a significant extent when the basic infrastructural facilities will be available (roads and railroads built with human settlements along them) and when after clearing the virgin forests, they will be replanted with adequate, homogeneous and industrially utilizable growing stocks. Thus, it is only the man-made forests in this area, that is, well after 2000, from which we may expect a significant contribution to world supply.

The great potential wood resources near the Equator are thus likely to be joined to world trade in the following order: 1. South-East Asia, 2. Africa, 3. Latin America.

The first full clearing of the world's virgin forests will end only some time in the next century, but in the meantime, the share of man-made forests will increase step by step, first of all in Europe, in the USA and in the Soviet Union. These artificial plantations will constitute the firm basis for development in the more distant future.

*

At present, a uniform world market of wood and wood products is in the making. Neither the developed nor the developing countries can withdraw themselves from the ever increasing mutual effects acting on it. Even if the demand for wood may be nearly satisfied up to about 2000, development will not stop at that time, as both population and its needs will continue to grow. To lay the foundation on a world scale for permitting the satisfaction of these growing needs is the task of a farsighted, internationally coordinated policy to be followed in the coming decades.

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