DEFORESTATION: POLICIES TOWARD A MORE SUSTAINABLE TROPICAL TIMBER INDUSTRY

by

JENNIFER LYNN GRIFFITH

B.S. in Engineering - Environmental, University of Vermont
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Signature of Author _____
Technology and Policy Program
May 10, 1993

Certified by _____
Fred Moavenzadeh
Professor of Civil and Environmental Engineering
Thesis Supervisor

Accepted by _____
Richard de Neufville
Chairman, Technology and Policy Program

Accepted by _____
Eduardo Kausel
Chairman, Departmental Committee on Graduate Studies

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ABSTRACT

Deforestation stands at the heart of the global environmental debate and serves as an example of the complex issues involved. Tropical moist forests are almost exclusively located in developing countries, raising all the issues of the North v South, rich v poor debate. In addition, the tropical moist forests maintain tremendous quantities of biological diversity and are the target of efforts of species and ecosystem protection. The burning of the forest contributes significant quantities of carbon to the atmosphere adding to the debate on the greenhouse effect and global warming. Finally, tropical wood products are traded internationally highlighting the links between trade and the environment. It is within the context of all these issues that the subject of deforestation is discussed and the question of what are the most appropriate policies to implement is addressed in this thesis.

The direct causes of deforestation are outlined: population growth and poverty, market failures and international trade. The thesis then focuses in on the deforestation caused by the international trade of wood products and examines the various options available to both the exporting and importing countries. For exporting countries, these options include: altering or eliminating various subsidies, improving the terms of logging concessions, raising the forest fees to capture the economic rent as well as incorporate the environmental and social costs, establishment of extractive reserves and nature parks, improvement of technology and the strengthening of institutions. For the importing countries options include: import tariffs, quotas, restrictions and bans, labeling of wood products, reducing demand and financing efforts in exporting countries.

After examination of the issues, it is concluded that there is no quick and easy solution to this complex problem. However, there are several options that appear promising, such as: raising forest fees and improving forest management for exporting countries, and elimination of protective tariffs, development of a credible labeling scheme, technology transfer, and debt-forgiveness for importing countries. To be the most effective, coordinated action between importing and exporting nations is required. In several cases, if one acts without the other, the effect on the forest may be to increase deforestation. The most important factor is whether there is the political will to alter the status quo.

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The global discussion of environmental issues first attracted widespread attention in 1972 with the United Nations Conference on the Human Environment held in Stockholm, Sweden. When the ten year anniversary of this summit passed, little action had been taken to improve the human environment; in fact, in many places it had gotten much worse. The World Commission on Environment and Development was created by the United Nations in 1983 to formulate "a global agenda for change." The publication of their book, Our Common Future, in 1987, was a watershed event in the global environmental arena and the term "sustainable development" was coined. The idea that economic development was necessary, but must be pursued in a manner that is sustainable over the long-term, attracted attention around the globe. Sustainability was equated with the wise use of the environment such that its capacity to support the future needs of the population was not undermined. Global environmental issues and economic development issues were raised to the forefront in 1992 with the United Nations Conference on Environment and Development (UNCED) held in Rio de Janeiro, Brazil.

Our Common Future placed the degradation of the environment throughout the developing world in a context larger than mere population expansion or national government policies.

> Over the past few decades, life-threatening environmental concerns have surfaced in the developing world. Countrysides are coming under pressure from increasing numbers of farmers and the landless. Cities are filling with people, cars, and factories. Yet at the same time these developing countries must operate in a world in which the resources gap between most developing and industrial nations is widening, in which the industrial world dominates in the rule-making of some key international bodies, and in which the industrial world has already used much of the planet's ecological capital. This inequality is the planet's main 'environmental' problem; it is also its main 'development' problem (World Commission on Environment and Development).

The governments of many industrialized nations are not willing to accept this statement, instead pointing the finger of blame at the developing nations themselves; looking merely at population data and technical and economic backwardness. Industrialized countries

enjoy a high standard of living, based upon the consumption of large quantities of resources per capita, and many are not interested in altering their behavior in any fundamental way. For example, look at the debate on global warming that centers on the burning of fossil fuels. The United States, the largest consumer, would have no part in the global climate change treaty brought forth at UNCED that would have set limits on the release on carbon dioxide to the atmosphere.

The industrialized nations, most geographically located in the north, and therefore referred to as "the North", want to import raw materials from the rest of the world to support their high standard of living. This trade pattern was established during the period when many developing nations, most located south of the industrialized nations, and therefore referred to as "the South", were colonies of the North, but it continues to this day. For example, more than 98% of the total export of Bolivia, Ethiopia, Ghana, and Nigeria are primary products, compared with 24% of U.S. exports and only 2% of Japan's (French, 1993). Nations relying on the export of raw materials would like to improve the standard of living of their citizens, however there is scarce capital to allow them to do so. Raw materials are almost always commodity goods that compete on price. Therefore, there is little profit to be made for investment in economic development, especially since the world price of most commodity items has decreased in real terms over the past two decades. In their attempts to industrialize, many nations of the South borrowed heavily from the North during the 1970's. Many of these projects did not accomplish their objectives; however in order to service the debt, increasing pressure is placed on the environment as it is their main resource from which to draw.

The South, therefore, often blames the North for global environmental issues and its economic plight, wanting the North to decrease its consumption and to alter the terms of trade so it is more equitable. In the context of environmental issues, the North is demanding that the South decrease their exploitation of their natural resources. However, the South counters that the North grew rich by exploiting their resources, as well as those of the South, so why shouldn't they be able to do the same? They see the environmental debate as an attempt by the North to keep the South poor for their continued economic exploitation. The following quote sums up the plight of the South today:

> Most of these countries face enormous economic pressures, both international and domestic, to overexploit their environmental resource base... Their roots extend also to a global economic system that takes more out of a poor continent than it puts in. Debts that they cannot pay force... nations relying on commodity sales to overuse their fragile soils... Trade barriers in the wealthy nations... make it hard... to sell their goods for reasonable returns... Aid from donor nations has not only been inadequate in scale, but too often has reflected the priorities of the nations giving the aid, rather than the needs of the recipients... natural resources are now being used not for development but to meet financial obligations to creditors abroad. It requires relatively poor countries simultaneously to accept growing poverty while exporting growing amounts of scarce resources (World Commission on Environment and Development).

There has been an increasing awareness of the inter-linkage between environmental problems in the developing world and the trade policies and consumption of resources in the industrialized world. Unfortunately, many industrialized nations have a vested interest in maintaining the status quo. Therefore, they are concentrating their efforts on such popular global environmental issues as ozone depletion, biodiversity loss, and global warming, rather than the fundamental underlying causes of these problems. However, when one delves into these issues, it is impossible to ignore the linkage between what is happening at the local level in a developing country and the larger global context that the industrialized world dominates.

Deforestation stands at the heart of the global environmental debate and serves as an example of the complex issues involved. Tropical moist forests are almost exclusively located in developing countries, raising all the issues of the North v South, rich v poor debate. In addition, the tropical moist forests are the home of tremendous quantities of biological diversity and is the target of efforts of species and ecosystem protection. The burning of the forest contributes significant quantities of carbon to the atmosphere adding to the debate on the greenhouse effect and global warming. Finally, tropical wood products are traded internationally which raises the issues of trade and the environment. It is within the context of all these issues that the subject of deforestation is discussed and the question of what are the most appropriate policies to implement is addressed in this thesis.

1.0 INTRODUCTION

It was estimated by the Food and Agriculture Organization of the United Nations (FAO) in their 1990 assessment of forest resources that the world lost 15.4 million hectares of tropical forests each year from 1980 to 1990. This is a 35% increase above the 11.4 million hectares per year rate estimated in their 1980 forest assessment. During the 1980's, there was increasing attention paid by the international environmental movement to the rapidly increasing rates of deforestation occurring in tropical moist forests around the world. Response by international community at the government level has been largely centered on The Tropical Forest Action Plan (TFAP) developed jointly by the FAO, the United Nations Development Programme (UNDP), the World Bank and the World Resources Institute (WRI) in 1985 and the International Tropical Timber Organization (ITTO) founded by the United Nations in 1987 based upon the International Tropical Timber Agreement (ITTA) of 1983. In addition, numerous non-governmental organizations throughout the world have become involved in the issues ranging from the Rainforest Action Network and the Rainforest Alliance to Friends of the Earth, the World Wildlife Federation (WWF) and the World Conservation Union (IUCN).

Large areas of tropical moist forests are disturbed for three primary reasons: to provide agricultural land, to supply the timber market and to provide fuel. There is substantial disagreement over the relative contributions of each, however there is no doubt that the largest is the conversion to agricultural land (which includes pasture in this report unless stated separately). The World Bank estimates that roughly 60% is due to agricultural conversion, 20% from timber logging and 20% more gradually by spreading urbanization, the gathering of fuelwood and the construction of roads and dams (World Bank, 1991a). Others cite 64% for agriculture, 18% for logging, 10% for fuelwood and 8% for cattle ranching (Low). Finally, those in the tropical timber business site figures as low as 14% for logging (Tropical Forest Foundation).

Most deforestation of tropical moist forests is caused by conversion to agricultural land. However, the conversion to agricultural land has its roots in the distribution of land, wealth and power in and among nations. Those are difficult issues to deal with and governments

tend to lack the political will to substantially alter the status quo. Therefore, many groups throughout the industrialized world are focusing in on the more tangible cause of deforestation, logging. It is also something that, as importers, industrialized countries have the power to impact directly. Some environmental organizations have even called for importing nations to ban the import of logs and wood products that were harvested from tropical moist forests.

This thesis focuses on the deforestation caused to provide timber for trade in the market, and more specifically, trade in the world market. National and international actions to make the forest products industry a more sustainable sector and alleviate deforestation problems are presented and evaluated. Finally, the purpose of this thesis is to recommend the most effective policies to be implemented at the national and international levels that would reduce pressure on the tropical forests.

The thesis begins with a description of the various types of forests, the reasons that tropical moist forests are important, and the locations of significant deforestation. Chapter Two outlines the various causes of deforestation and then focuses in on the international trade in tropical timber. Chapter Three presents the policy options available to timber exporting countries and evaluates their potential effectiveness. Chapter Four examines the various policy options available to timber importing countries. Finally, Chapter Five draws conclusions and makes recommendations of the most promising policies to alleviate the deforestation caused by the international trade of wood products.

1.1 Types of Forests

Forests cover approximately 3.6 billion hectares, or 28% of the total land area in the world (World Bank, 1991a). It is estimated that in pre-agricultural times, the forested area was 5 billion hectares (WRI, 1990). In addition, today there are approximately 1.7 billion hectares of other wooded area, forest fallows and shrublands, bringing the total to 5.3 billion hectares of forests and woodlands. Forests and woodlands are generally classified into one of three categories; tropical dry, tropical moist, and temperate. The distribution of these forest types by continent and their total hectares are illustrated on Figure 1.1.

Forests are also classified as open or closed, which refers to the forest canopy. Open forests are those in which tree crowns cover at least 10% of the land and grasslands are continuous. Open forests cover approximately 700 million hectares. Closed forests are those with at least 20% covered by tree crowns and discontinuous grass cover. Closed forests cover 2.9 billion hectares. The distribution of forest between open and closed over the continents is illustrated on Figure 1.2.

Forests can also be classified as coniferous or non-coniferous (broadleaf). This refers to the predominant tree type in the forest. Coniferous trees, generally known as softwoods, are typically fast growing, taking 20 to 30 years to reach marketable size. Examples of conifers are pine, fir and spruce. Approximately 35% of forest worldwide are coniferous. The majority of forests therefore are non-coniferous. Non-coniferous trees are generally known as hardwoods and are typically slow growing, taking 60 years or more to reach good size. Examples of non-coniferous trees are oak, maple, and the dipterocarps of Asia.

1.1.1 Tropical Dry

There are approximately 1.6 billion hectares of tropical dry forests and they are largely characterized as open and non-coniferous with the vegetation consisting mainly of forest fallows and shrublands (World Bank, 1991a). Approximately 75% are located in Africa. The primary use of tropical dry forests are for grazing of livestock and gathering of fuelwood by local populations. Loss of tropical dry forests results in conversion to grasslands or more extremely, desertification.

1.1.2 Tropical Moist

Tropical moist forests are perhaps better known today as the "rainforest". Tropical moist forests are closed canopy forests that receive over 100 millimeters of rain each month for two out of three years with mean temperature of at least 24 C (Low). This temperature and precipitation allows a tremendous growth of vegetation that contains and supports over half of the world's biological diversity. Almost two-thirds of the 1.5 billion hectares of tropical moist forests are located in Latin America, with the other one-third split between

western Africa and eastern Asia (World Bank, 1991a). The locations of tropical moist forests are shown on Figure 1.3. Brazil, Indonesia, and Zaire together contain almost 50% of all remaining rainforests.

Approximately 900 million hectares of the tropical moist forests are considered to be primary forests (virgin), 300 million hectares are secondary forests (disturbed) impacted by human activities such as logging and the remaining 300 million hectares are forest fallow woodlands (World Bank, 1992a). Tropical moist forests are predominately non-coniferous. The soils under the forest tend to be of poor quality and inhibit the ability of the forest to regenerate to its former level of diversity after it is disturbed.

1.1.3 Temperate

The majority of the 2.2 billion hectares of temperate forests and woodlands are located in North America and Europe, including the former Soviet Union. The remaining one-tenth of temperate forests are located in China, southern portions of Latin America and non-european mediterranean areas (World Bank, 1991a). 1.6 billion hectares of temperate forests are considered closed forests. Over 85% of the world's coniferous forests are located in temperate forests (World Bank, 1991a).

Temperate forests have been heavily exploited by man over history and currently supply 85% of the world's non-fuel wood demand (World Bank, 1991a). Due to their basic nature and also the high level of historical interference, temperate forests do not contain biological diversity at levels comparable with the tropical moist forests. The soils under temperate forests are such that, if they are not washed away through erosion, regeneration is possible.

1.2 Forest Provisions

Forests provide numerous services to both human activity and the local and global ecosystems. The international community has been concerned primarily with the issues of biological diversity and the forests' role in the global ecosystem. At a more local level,

the forest serves numerous roles, including sustaining human populations, maintaining the local ecosystem, and the production of wood and non-wood products. These services are discussed in the following sections.

1.2.1 Biological Diversity

Forests, particularly tropical moist forests, contain a tremendous number and variety of plant and animal species in their ecosystems. It is estimated that at least half of the world's species live in the tropical moist forests that cover only 7% of the earth's land area.

Biological diversity is typically discussed at three levels: genetic, species and ecosystem. Genetic diversity considers the variety of genetic material available in the individuals of a species. Genetic diversity ensures that there will be "survival of the fittest" and adaption to changes in the surroundings (provided the changes are not too rapid). Species diversity refers to the total number of different species of living organisms. Species diversity provides the "robustness" to adapt to changes in the ecosystem. Finally, ecosystem diversity refers to different types of ecosystems in terms of habitat, interdependence of living organisms within the community, and function of the ecosystem within the larger global context. Ecosystem diversity is what makes the earth function and therefore provides for the survival of humans.

It is difficult to put an economic value on biodiversity or to predict the consequences of the extinction of a species or the alteration or elimination of an ecosystem. Once a species is extinct, it cannot be revived. This irreversibility has been a powerful element in the arguments over the values of biodiversity and of the forests that contain it. Any adaptions that species might have made or caused in another species will not occur and that whole evolution path is eliminated. The undiscovered benefits of that species to humans may have been enormous, but will never be discovered. The link that species may have been in the ecosystem web may not be able to be replaced and the ecosystem is altered. The loss of biodiversity can have far-reaching effects and impact the survival of humans on this planet.

In many cases, deforestation does not directly eliminate the plant and animal species, rather it rapidly alters the habitat in ways that cause the extinction of the species. Twelve "hot-spot" tropical forests throughout the world have been identified and are shown on Figure 1.4 (McNeely et al). Of the 12 areas, two are in the industrialized world; Hawaii in the United States and Queensland in Australia, and the remaining ten are in the developing world; Colombia, Ecuador, Peru, Brazil, Madagascar, Malaysia, Philippines, New Caledonia and the eastern Himalayan region. The ten developing region forests covered only 3.5% of the remaining tropical forest area in 1988 but contained at least 27% of the world's higher level plant species, and over 13% of the world's plants are found only in these forests (McNeely, et al). In these 10 biological diversity hotspots, the total forested area has been reduced from an estimated original extent of 220 million hectares to approximately 29 million hectares by 1988, a loss of over 85% (McNeely et al).

1.2.2 Global Ecosystem

Deforestation is the second largest contributor of greenhouse gases to the atmosphere, behind combustion of fossil fuels. Fossil fuels account for approximately 4.9 to 5.9 billion tons of carbon per year and deforestation approximately 0.6 to 2.6 billion tons per year (Doos) The burning of forests for conversion to agriculture rapidly releases large quantities of carbon dioxide from the estimated 125 tons of carbon per hectare stored in the vegetation (World Bank, 1991a). Logging also results in the release of greenhouse gases. After the marketable trees are removed, the ground vegetation and the damaged trees dry out and decay releasing methane, another greenhouse gas. 25-50% of the trees in a logged area are killed indirectly during the harvesting of the few commercial trees present (Whitmore and Sayer).

It is also believed that extensive areas of tropical moist forests influence global weather patterns. Therefore, there is concern that the removal of large areas of tropical forest cover may ultimately alter global weather patterns. When the forest cover is removed, soil moisture and therefore the ability to absorb heat are reduced. More solar heat is reflected back into space which, over large enough areas, can lead to changes in the global circulation patterns.

1.2.3 Sustain Human Populations

Forests provide the habitat and way of life for numerous communities throughout the world. It is estimated that approximately 500 million peoples live in or near forests and directly depend upon them for their lives (World Bank, 1991a). Forests provide food, fuel, building material and medicines for the direct consumption of the local population. The forest also provides perfumes, dyes, material for handcrafts and foodstuffs for trade.

Many indigenous communities have managed the forest for agricultural production without damaging the ecosystem by using small, widely spaced cleared plots and long fallow periods or even a thinning of the forest with crops interspersed with the trees. The ability of these communities to sustain themselves is diminished as their immediate habitat is destroyed and areas of forest to relocate into are reduced.

In many governments, ownership of the land is tied to "improving" the land (e.g. conversion to agriculture). Indigenous peoples do not have legal title to their land and there is little they can do to stop the destruction of their culture and the natural resources they depend upon. This has lead to sometimes violent confrontations, particularly in Brazil, Indonesia and Malaysia (Gradwohl and Greenberg).

1.2.4 Local Ecosystem

On the local level, forests provide important hydrologic and watershed protection functions. Forests hold the water close to the earth's surface and slowly release it to the groundwater, the surface waters, and the air through transpiration. Forests are a vital link in the hydrologic cycle that determines the regional climate. Interfering with the cycle by removing trees can significantly reduce area rainfalls. It is estimated that up to 50% of the rainfall in the Amazon region is due to the moisture released through vegetation transpiration. In Indonesia, it was determined that the temperature range in the forest was between 23 and 26 C, however after logging temperatures of 40 C were common (Hurst).

Removal of trees and vegetative cover not only disrupts the nutrient cycle but also leads to increased soil erosion by wind and water. Wind and water erosion physically remove

the thin layer of nutrient rich topsoil, thereby rendering the land infertile. Wind and water erosion are estimated to have caused 28% and 56% of world soil degradation, respectively (WRI, 1992). It is further estimated that approximately 30% of the world's areas of degraded soils, or 579 million hectares, is directly caused by deforestation for agricultural and urban use conversion, and commercial logging. When looked at on a regional basis, soil degradation caused by deforestation is estimated at 38% in Europe, 4% in North America, 14% in Africa, 22% in Central America, 12% in Oceania (Australia, New Zealand and the South Pacific Islands), 40% in Asia and 41% in South America (WRI, 1992).

The other major causes of soil degradation are: overgrazing, 35% of world problem (with 49% in Africa and 80% in Oceania), improper agricultural activities, 28% of world problem (with 57% in North America), over-exploitation for fuelwood, 7% of world soil degraded area (with 13% in Africa), and finally, industrial pollution accounts for approximately 1% of the worldwide situation (and 9% of the European problem).

In addition to removing productive soils making agricultural production difficult, water erosion also causes the sedimentation of water supply reservoirs and irrigation projects. In a study of irrigation projects in Indonesia, it was determined that not properly safeguarding the watershed areas could cause a 30-40% reduction in the efficiency of the irrigation system (McNeely et al). In India, is was estimated that the clearing of the forests in the 1960's and 70's has caused $36 billion in damages from soil loss, nutrient loss, flooding and sedimentation of reservoirs. The expected life of the Hirakud reservoir was reduced from 110 to 35 years due to the deforestation in its watershed. On a better note, the World Bank has funded the establishment of the Dumoga Bone National Park in Indonesia to protect the watershed of a large hydroelectric dam downstream and ensure that project's success.

Deforestation also reduces the capacity of the soil to hold water thereby increasing surface water run-off (and erosion) which in turn increases the frequency and severity of floods. In Kenya, studies have shown that when trees were removed from a valley to establish a tea plantation (trees were left on the steep slopes and along the river), there was a fourfold increase in the peak flow levels during storms (OTA, 1984). In the reverse,

when the steep hillsides were reforested in Chandigah India, the peak storm flow was reduced by 73% and the total storm flow was reduced by 28% (OTA, 1984).

1.2.5 Production of Wood

Worldwide, nearly 3.4 billion cubic meters of wood are consumed each year (World Bank, 1991a). Of this approximately 50% is used in developing countries for fuel and building material. The other 50% is used in the industrialized countries for commercial uses such as, construction, paper-making, and furniture.

I. Fuel

Wood is the fourth largest source of fuel in the world, surpassed only by oil, coal and natural gas. Over 3 billion of the world's population utilize wood as their main source of household energy. Worldwide, approximately 80% of wood production in developing countries is for use as fuel. Gathering of fuelwood is a main source of deforestation in the tropical dry forests of Africa where 80% of that collected is used for domestic purposes, heating and cooking.

As trees become more scarce or access to them is restricted, those gathering fuelwood for the household, typically women, have to spend a greater portion of their time to obtain the same quantity of wood. This decreases time available for other required productive activities and leisure. Therefore, households see the need for additional workers and have more children fueling the viscous cycles of population growth, poverty and degradation of the environment.

II. Commercial

Approximately 80% of commercial wood is produced in industrialized countries from temperate forests where harvesting and replanting are managed. Virtually all of the 15% of commercial hardwoods coming from tropical moist forests is harvested in an unsustainable manner. In a tropical forest, it can take 150 years for a large tree species to grow to maturity and up to 400 years for a cleared area to develop a forest comparable

to the one destroyed (Hurst). With such long regeneration periods, there is little incentive for a logging company to slow their extraction rates or to replant after harvesting even if they were to own the forest.

1.2.7 Production of Non-Wood Products

Forests also provide numerous non-wood products used directly by indigenous peoples and cultivated for both domestic and international markets. For example, in Ghana and Cameroon, approximately three-quarters of all meat consumed is wild "bush meat".

International trade exists in items such as, spices, gum, nuts, latex, rattan, house plants, medicinal ingredients, and extracted oils. In 1980, approximately 25% of prescription drugs in the United States, worth $8 billion, were derived from tropical plants (OTA, 1992). World trade in essential oils and spices is worth over $1 billion (OTA, 1984). In addition, the United States relies on cross-breeding with wild species to maintain disease and insect resistance in agricultural crops. A wild melon from India was used to give California's melon crop resistance to powdery mildew (OTA, 1984) and peanut resistance to leafspot was found in the Amazon region (Gradwohl and Greenberg).

1.2.8 Value of the Forest

The previous sections describe the roles of the forest, but how is their existence valued? Forests can be valued both economically and ethically. The economic values revolve around "use" values; the market value of forest products (productive use) and the estimated market value of products that are not traded in the marketplace (consumptive use). In addition, attempts are made to assess the indirect economic values of the forest ecosystem functions, such as flood prevention (non-consumptive use).

On the ethical basis, forests can be valued for their "option" value and their "existence" value. The option value involves knowing that the option exists in the future to visit the forest, to study the ecosystem of the forest, to find and develop the medicine that may cure cancer (if one exists in the forest). Existence value is finding value or comfort in simply knowing that the forest exists in the world. The ethical argument also includes the

assertion that all living organisms/ecosystems have a right to exist and humans have no right to destroy organisms/ecosystems in pursuit of human gains. Coupled with this is the belief that the extinction of each species lessens the fullness of life for everyone.

There is much conflict between nations and even between individuals within nations on how to value the forest. Some see the only value of the forest as economic. If more money can be made in the market by maintaining the forest, then keep it; otherwise, cut it down. Option and existence values regarding the tropical forests are higher and more prevalent among the industrialized countries and the wealthy within them. Option value is hard to appreciate when your family is starving and your time horizon extends only to the next day or week or season, and existence value can be inconceivable. Nations with masses of hungry landless citizens may only consider the economic values of production uses when making decisions. No effort is spent trying to assess the consumptive and non-consumptive economic values and the concepts of option and existence values are totally ignored. In fact, poor countries often resent the insistence of industrialized countries that there are these option and existence values, and see them only as a means to keep them poor. After all, industrialized countries got wealthy by using their natural resources without regard to option and existence values.

1.3 History and Current Scope of Deforestation

Deforestation has historically been largely confined to the temperate forests of Europe and North America, however since the second world war, deforestation of the tropical forests has increased dramatically. Currently, deforestation outside the tropical areas is relatively low, and temperate forests in North America and Western Europe may have actually increased by approximately 5% during the 1980's (FAO, 1993b). However, temperate deforestation may become a problem in the former communist countries of Europe in their search for sources of foreign currency and throughout the temperate forests due to increased acidification of soils due to industrial pollution.

Currently, tropical deforestation is approximately 15.4 million hectares per year, compared to an estimate of 11.5 million hectares made by the FAO in the early 1980's.

Deforestation in FAO terms, applies to changes in the use of the forest such that less than 10% is now covered by the tree crown, such as after conversion to agriculture. Degradation refers to changes in the tree cover such that there is more than 10% covered by the tree crown, but the original function(s) of the forest are impaired. Degradation, such as that associated with selective logging, is not included in the deforestation estimates provided by the FAO. Each year, approximately 5 million hectares are degraded by logging (Whitmore and Sayer). However, it should be noted that constructing roads into an area to log it, opens up the area to settlement and the conversion to agriculture. Therefore, logging may not be a direct cause of deforestation, however it often precedes and facilitates it.

Figure 1.5 shows the relative deforestation/afforestation rates in each major land area differentiated by the type of forests lost and gained. Table 1.1 shows the tropical moist forest resources by country with the average annual deforested area. It should be noted that there is considerable uncertainty regarding the available data on deforestation. Most of the data was estimated several years ago. Unfortunately, the 1990 FAO tropical forest assessment data are not yet available on a detailed country by country basis, only the summary information has been published to date (FAO, 1993b&c).

1.3.1 Africa

Africa had 528 million hectares of tropical forest in 1990, covering 24% of the land area (FAO, 1993c). Africa's tropical forest loss from 1981 to 1990 was 0.7% of total tropical forests per year, or 4.1 million hectares each year (FAO, 1993a). West Africa, holder of significant areas of tropical moist forest, had the highest regional deforestation rate in Africa at 1.0% per year. The two african regions of Central and Southern Africa had their deforestation rates increase in the 1980's by over 50% from 1970's levels (WRI, 1992).

The two nations with the highest deforestation rates during the 1980's, in terms of percent of remaining forest, were the West African nations of Nigeria and Cote d'Ivoire. Nigeria's forests have become so depleted that the country is now a net importer of wood (Gradwohl and Greenberg).

1.3.2 Asia

Asia and the Pacific islands had 311 million hectares of tropical forest in 1990, 35% of land area (FAO, 1993c). On a continental basis, Asia has the highest tropical deforestation rate in the world at 1.2% per year during the 1980's, or 3.9 million hectares lost per year (FAO, 1993a). The regions of continental Southeast Asia were deforested at 1.6% and the islands of Southeast Asia at 1.2%, representing over 50% increase over the 1970's rate (WRI, 1992).

In the Philippines, 57% of the land was forested in the 1940's. By 1990 that was reduced to only 22%. Most of this occurred during the 1960's and 1970's when up to 300,000 hectares were cut each year, largely to supply the export market. By the 1980's deforestation was so widespread that the rate was reduced to approximately 100,000 hectares/year. Thailand was once over 50% covered by tropical moist forests; now forests cover less than 25% of the land. In 1961, Thailand had over 273 million hectare of forest, by 1985 only 115 million hectares remained (Hurst). Thailand was once a major exporter of wood, particularly teak, however they now have to import wood to supply their furniture production and housing needs.

Approximately 10% of tropical moist forests are in Indonesia. During the 1970's, Indonesia's forests were harvested at a rate of 300,000 hectares per year. This increased to approximately 600,000 hectares/year during the 1980's and is estimated to be over 1,000,000 hectares/year in 1991. Two states in Malaysia, Sarawak and Sabah on the island of Borneo, supply approximately two-thirds of the world's tropical hardwoods. From 1983 to 1990, an average of 220,000 hectares was logged each year on Sarawak, 2.3% of the forested area each year, to produce 11.8 million cubic meters of logs annually (Reinhardt). This was an approximately 180% increase above the 1977 level.

1.3.3 Europe and North America

Most commercial wood is produced and utilized in the economies of Europe and North America. Due to the comparatively long history of settlement and industrialization, the forests of these continents have been virtually fully exploited. Forests, other than those

set aside in parks or wilderness areas, are generally managed for the production of wood. This production is basically sustainable, however much of the land is clear-cut and replanted as a mono-culture. Mono-culture stresses the growth of one species and therefore does not present stimulating habitat for biological diversity. North America is a major exporter of raw logs, particularly to Japan and China. The export peaked in 1989 and in 1990 was 994 million cubic meters.

Even though the actual area under forest cover may have increased in recent time, that does not mean that the developed countries do not have any points of conflict regarding the issue of deforestation. For example, there are some areas of primary forest left in the United States and Canada, particularly in the states of Alaska, Oregon and Washington and the province of British Columbia. The controversy surrounding attempts to continue logging those areas is intense. In addition, for years environmental groups have opposed clear-cut harvesting methods, below-cost timber sales by the US government to private interests, and the subsidizing of the timber industry by building of access roads (often times the cost of road construction exceeded the revenue generated by the timber sale).

1.3.4 Latin America and the Caribbean

This region has the largest extent of forest cover with 918 million hectares in 1990, covering 56% of the land area (FAO, 1993b). This represents over 50% of world forested area with Brazil holding over one-quarter of world forests on its own. The amount of land deforested each year in Latin America is approximately 7.4 million hectares per year, or 0.8% of total forests (FAO, 1993c). This represents an approximately 50% rate increase over the 1970's. The Amazon region of Brazil accounts for approximately 2.2 million hectares of deforestation on its own each year. Central America and Mexico lose approximately 1.5% of tropical forests each year. Again, this is an approximately 50% increase over the rates in 1970's (WRI, 1992).

In 1970, Costa Rica was over 50% forested, however government policies combined with the North American demand for inexpensive beef created the incentive to clear forests for conversion to grazing land. From 1970 to 1980, over 700,000 hectares of forest was

cleared and during the 1980's, Costa Rica's deforestation rate was one of the highest in the world, only exceeded by the West African nations of Nigeria and Cote d'Ivoire.

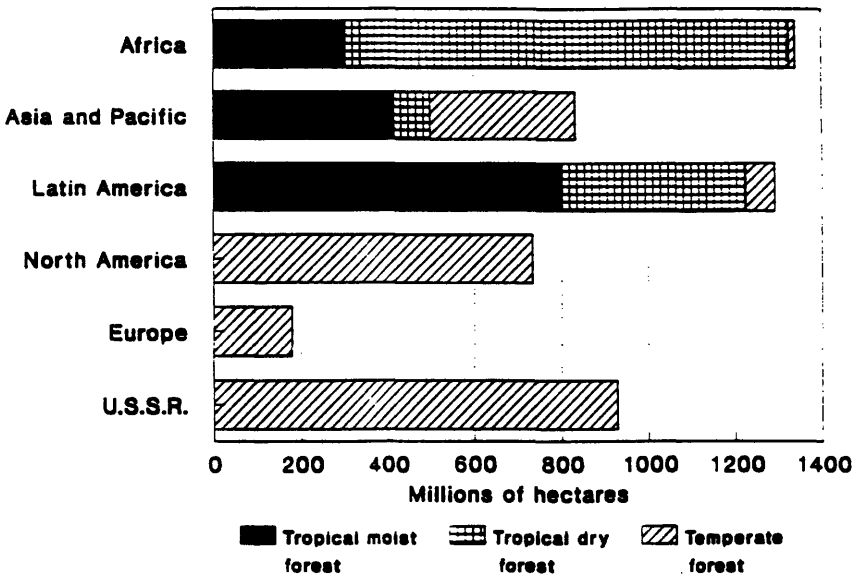


Figure 1.1 Distribution of Forest Types

Source: World Bank, 1991a

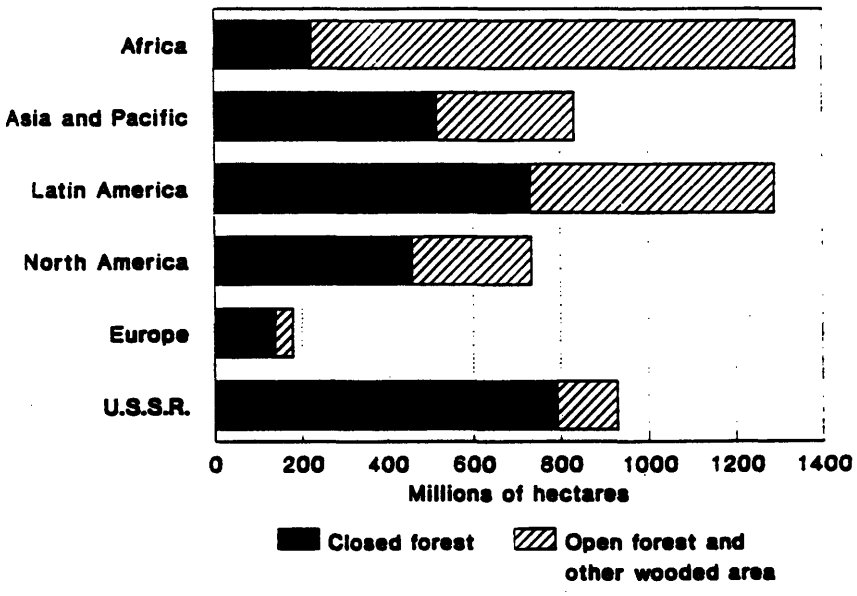


Figure 1.2 Distribution of Open and Closed Forests

Source: World Bank, 1991a

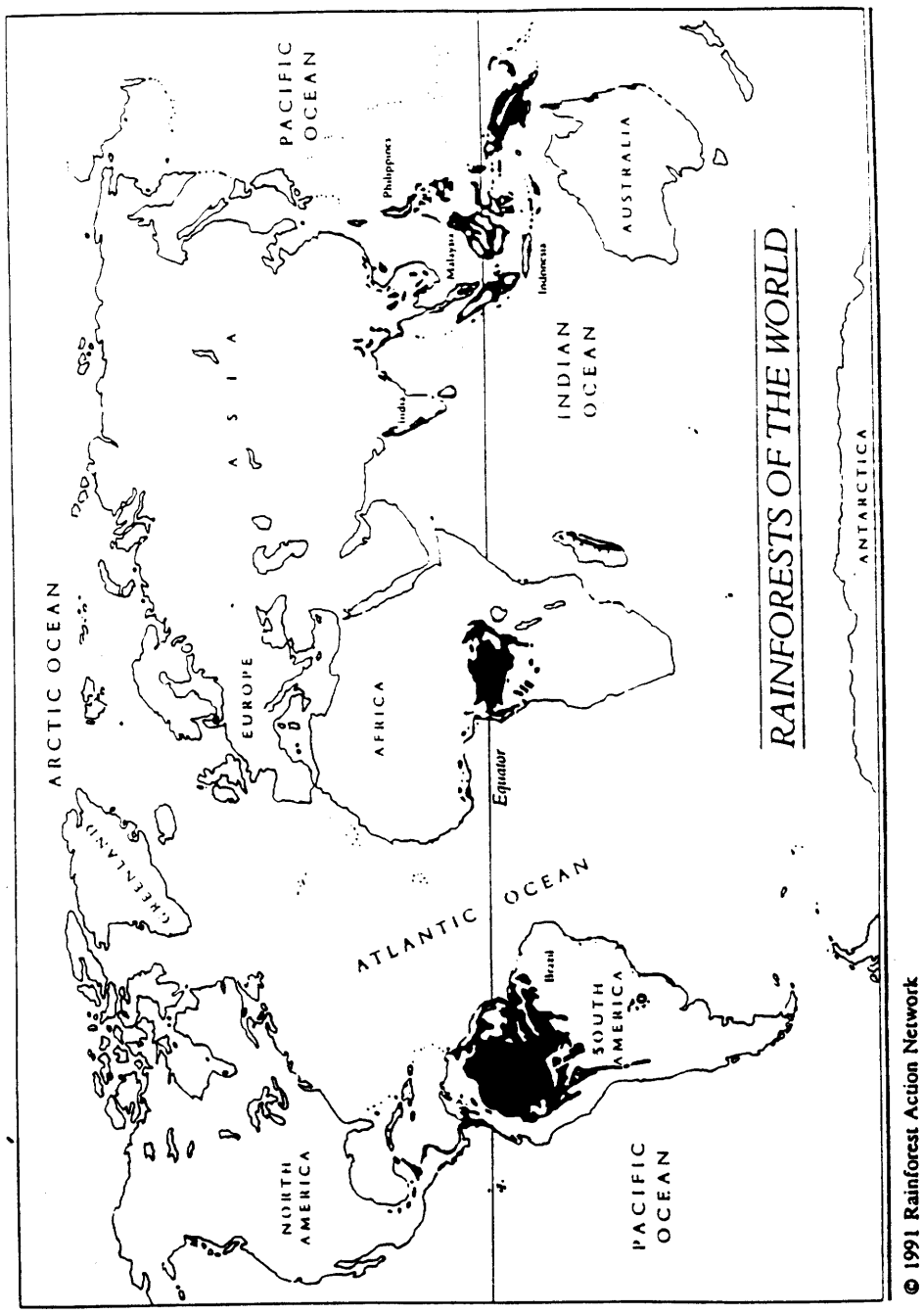


Figure 1.3 Locations of Tropical Moist Forests

Source: Rainforest Action Network

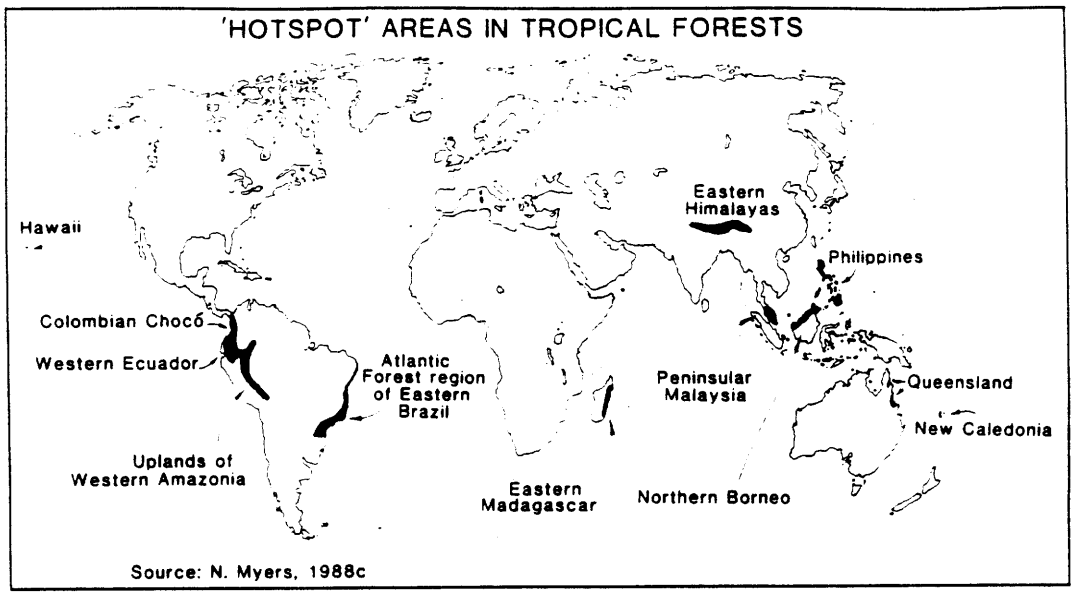
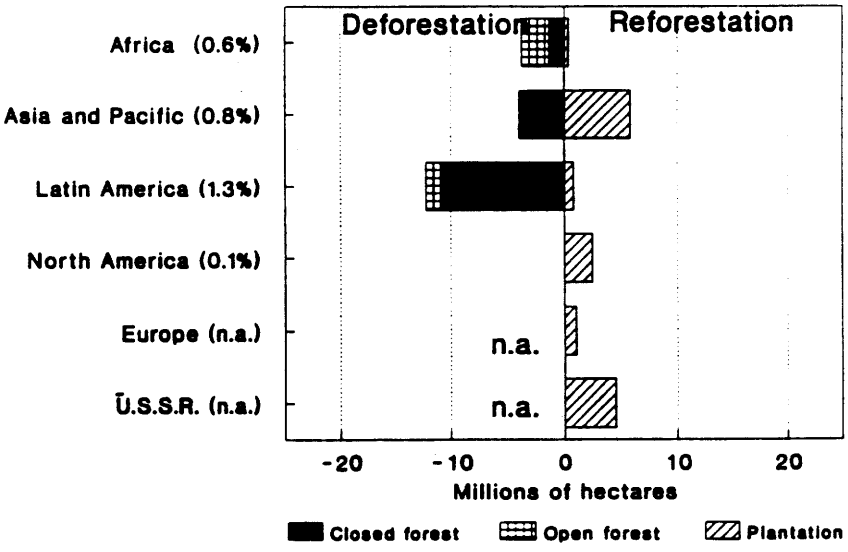


Figure 1.4 Biological Diversity Hotspots

Source: McNeely, et al



n.a. Not applicable.

Note: Numbers in parentheses as a percentage of total forest area.

Sources: World Resources Institute 1990; Food and Agriculture Organization 1985 and 1988.

Figure 1.5 Rates of Deforestation/Afforestation

Source: World Bank, 1991a

Country	Closed Forest in 1980 (000 ha)	Average Annual Deforestation in 1980s (000 ha)
AFRICA		
Angola	2,900	44
Benin	47	1
Cameroon	16,500	100
Central African Republic	3,590	5
Congo	21,340	22
Equatorial Guinea	1,295	3
Gabon	20,500	15
Ghana	1,718	22
Guinea	2,050	36
Guinea Bissau	660	17
Ivory Coast	4,458	250
Kenya	1,105	19
Liberia	2,000	46
Madagascar	10,300	150
Nigeria	5,950	350
Reunion	82	NA
Senegal	220	NA
Sierra Leone	740	6
Tanzania	1,440	10
Togo	304	2
Uganda	765	10
Zaire	105,750	400
TOTAL AFRICA	203,714	1,508
ASIA AND PACIFIC		
Australia	600	NA
Bangladesh	927	8
Brunei	323	5
Burma (Myanmar)	31,941	677
Fiji	811	2
Hawaii	445	NA
India	36,540	1,000
Indonesia	113,895	1,000
Kampuchea	7,548	25
Laos	8,410	100
Malaysia	20,966	310

Table 1.1 Total Closed Forest Area and Deforestation Rates for Tropic Countries

Source: Whitmore and Sayer

Country	Closed Forest in 1980 (000 ha)	Average Annual Deforestation in 1980s (000 ha)
New Caledonia	484	NA
Papua New Guinea	34,230	22
Philippines	9,510	143
Solomon Islands	2,423	1
Sri Lanka	1,659	58
Thailand	9,235	158
Vanuatu	236	4
Vietnam	8,770	200
TOTAL ASIA	288,953	3,713
LATIN AMERICA		
Belize	1,354	9
Bolivia	44,010	87
Brazil	357,480	2,666
Colombia	46,400	600
Costa Rica	1,638	124
Cuba	1,455	2
Dominican Republic	629	4
Ecuador	14,250	340
El Salvador	141	5
French Guiana	7,832	1
Guatemala	4,442	90
Guyana	18,475	2
Honduras	3,797	90
Jamaica	67	2
Mexico	46,250	700
Nicaragua	4,496	121
Panama	4,165	36
Peru	69,680	270
Puerto Rico	246	NA
Surinam	14,873	3
Trinidad and Tobago	208	1
Venezuela	31,870	125
TOTAL LATIN AMERICA	673,758	5,278
WORLD TOTAL	1,166,425	10,499

Table 1.1 continued Total Closed Forest Area and Deforestation Rates for Tropic Countries

Source: Whitmore and Sayer

2.0 CAUSES OF DEFORESTATION

"The only thing we can state with some confidence is that there are many factors behind tropical deforestation and that they are linked together as various causal chains and mechanisms (Doos)".

The International Institute of Applied Systems Analysis (IIASA) illustrates the causes of deforestation in the vicious cycle shown in Figure 2.1 (Doos). The World Bank (1991a) states that the principle causes of deforestation are: increasing population and the need for agricultural land, land ownership patterns that force landless persons into forest areas, commercial agriculture operations, and commercial logging (largely because it opens up previously inaccessible areas for cultivation and fuelwood harvesting). Along these lines, the World Bank, the United Nations Development Programme and the World Resources Institute stated in their 1985 Tropical Forests: A Call for Action that "it is the rural poor themselves who are the primary agents of destruction as they clear forests for agricultural land, fuelwood, and other necessities."

Many criticize this over-simplifying view saying "To blame colonizing peasants for uprooting tribal people and burning the rain forest is tantamount to blaming soldiers for causing war (Hurst)". Some developing countries and environmental groups identify the interconnected underlying causes of deforestation as: the debt crisis, the international terms of trade, ill-planned development projects and the distribution of land ownership (Hurst). The FAO states that "At the root of the problem is the weakness of the national economy in most tropical countries combined with the scarcity of capital to invest in development (FAO, 1993a)."

2.1 Population Growth and Poverty

"Poverty underlies all these causes. The destruction of forests is a symptom of the development path chosen by poor nations as they strive, by whatever means, to improve the living standards of their populations (Hurst)."

As the population grows, they require both food and fuel. This leads to increased pressures on the forests to be used for fuel and to be cleared for agriculture. In many countries, governments had programs meant to deal with the poverty and landlessness problem that purposely settled people in the primary forest. The largest of these are in Indonesia and Brazil. In Indonesia, a nation of over 13,000 islands, approximately 60% of the population lives on the Island of Java, only 7% of the land area. To relieve the pressure on Java, the government induced millions of people to move to the less populated islands, offering free cleared land, housing, seeds, fertilizer and infrastructure. These settlements were often established in the tropical forests, causing significant deforestation, estimated at over 48 million hectares (Gradwohl and Greenberg). The soils under the forest are of poor quality and are severely compacted during clearance. This infertility forces the migrants to clear new areas in an attempt to survive or move into the slums of the population centers. This massive movement of people and the destruction of the forest has encountered resistance from the indigenous peoples who have been severely repressed by the Indonesian military.

In Brazil, the ill-fated program, to be discussed further in Section 2.1.2, was established to avoid dealing with the underlying cause of poverty and landlessness, the concentration of ownership of the fertile lands among a small wealthy elite; 4.5% of landowners control over 80% of Brazil's productive agricultural lands.

2.1.1 Fuel

Fuel accounts for the largest use of wood production in the world. Even in the United States, over one-fifth of all timber production was used as fuelwood or charcoal, amounting to 116.3 million cubic meters of wood in 1989 (FAO, 1991). Most of this wood is the tree wastes consumed in pulp mills to fuel the production process. In tropical countries, fuelwood production accounts for a substantial percentage of all wood production. In Indonesia and Papua New Guinea, 46 and 62% of energy demand was met with wood in 1989, respectively, accounting for 136.1 and 5.5 million cubic meters of wood, respectively or 77 and 67% of total wood production, respectively (FAO, 1991). In Brazil, 40% of the fuel used in the steel industry is charcoal (OTA, 1984).

In the dry forests of Africa, production of fuelwood is a leading cause of deforestation. For example, in 1989, in the nations of Ethiopia and Tanzania, wood satisfied over 91 and 92% of energy demand, respectively, and accounted for 96 and 94% of all wood production, respectively, amounting to 37.9 and 31.1 million cubic meters of wood, respectively (FAO, 1991).

It is not the use of wood for fuel that has caused deforestation, per se, but rather the commercialization of the fuelwood collection. Obviously, industrial use of wood for fuel creates a concentrated demand for fuel that requires a logging operation to generate the supply. However, even household use can cause deforestation when the households are concentrated in towns and cities. In less populated areas, women and children gather small branches and basically leave the trees intact. However, as the demand increases, market oriented practices take over, and it becomes more efficient to cut the entire tree for larger scale fuelwood or charcoal production. The demand is often met by the poor gathering fuelwood from within an ever increasing radius. In the Sahel region of Africa, wood is transported over 100 kilometers to some population centers (OTA, 1984). If transportation costs become too great, the more fortunate in the population centers will switch to available substitute fuels, and the poor do without. The poor will also substitute dried animal dung for wood. This deprives the soils of nutrient replenishment, leads to declines in soil fertility and contributes to the perpetuation of hunger and poverty.

Throughout the world, wood is burned by the poor in open fires or in inefficient stoves that deliver only 5-15% of the heat energy to the food being cooked (OTA, 1984). Charcoal has approximately three times the energy content of wood. However, the conversion of wood to charcoal is a very inefficient process in most of the world. Traditional earthen pit or mound systems require 10 tons of air-dried wood to produce one ton of charcoal (OTA, 1984). There is great potential for increasing the efficiency of the charcoal conversion and the cooking processes thereby reducing the quantity of wood needed to perform the same work, substantially reducing the pressure on the forest.

Substituting dried wood for the typically moister wood can lower wood use as moist wood contains half the heat potential of dried wood. The efficiency of cook-stoves can be increased from 5-15% to 20-30% by providing better draft and more complete combustion

and by concentrating the heat produced to the surface being heated. Ceramic lining of stoves can act as insulation, reducing heat loss. In several projects, inexpensive stoves have substantially cut fuelwood demand. For example, in Guatemala, a $5 stove molded from mud and sand and fitted with a metal damper and pipe cut the fuelwood requirement by 50% (OTA, 1984).

Charcoal use is becoming more popular in urban areas. Because of the inefficiency of the conversion process, this trend increases demands on forests. It is estimated that a 50% gain in conversion efficiency can be obtained simply by using dried wood of relatively uniform size, packed tightly, covered with enough earth to prevent complete combustion, and the careful spacing of air vents (OTA, 1984). By inserting a metal liner between the wood and the earthen cover, dirt can be kept out of the wood, raising the efficiency by 20-30% in some kilns (OTA, 1984). Efficiency can also be substantially increased through the use of permanently placed brick, metal or concrete kilns or portable steel kilns. These later options are capital intensive, and thus widespread use will be doubtful without substantial government or international assistance. If the kilns are not mobile, the forest in the vicinity of the kiln will be exhausted over time unless the area is managed and replanting is undertaken.

Kerosine, electricity, and natural gas are traditional substitutions for wood in cooking and heating. There are also non-traditional substitutions such as solar, wind and small-scale hydropower. However, it is doubtful that users will substitute these more expensive options while there is still a supply of free wood available. Governments attempt to encourage the shift in demand by subsidizing the traditional substitute fuels to make them attractive. However, with the fiscal problems of most less developed countries, it is doubtful that these subsidies can or should continue.

Another approach to reducing the demand on natural forests is to plant trees expressly for the purpose of fuelwood production. In areas that are not supplying large concentrated population centers, trees can be planted along roadways and around the edges of fields. A community woodlot could be planted and maintained by larger settlements. Privately owned plantations of fast growing trees could be promoted for commercial charcoal production.

2.1.2 Agricultural Conversion

There are great pressures, from both population and also foreign currency needs, to clear the forest and establish agriculture and pasture. Shifting cultivation (or slash and burn agriculture) at the subsistence level has been practiced in tropical forests for centuries. Because populations were small, as was the size of their plots, and the fallow periods were long, this practice did little to disrupt the forest. During the 1970's and 1980's, as the established agricultural areas became mechanized, their ownership increasingly concentrated, and their production moved towards the export market, the majority of the population was landless. Large numbers of these peasants were then forced into the marginal areas, the tropical forests, and in the cases of Brazil and Indonesia, they are aided by government settlement plans. It is this increased concentration of population in the forest that has caused the destruction of the forest ecosystem.

In Brazil, most of the deforestation is due to conversion to agriculture and pasture. The areas to be settled are sometimes quickly commercially logged before the land clearing is done or settlers save aside valuable trees during clearing; however most of the trees are simply destroyed during the burning. It was estimated that $100 to $250 million worth of marketable trees were burned by the conversion to pasture alone (WRI, 1990). Through legislation in the mid-1960's, the government initiated a settlement plan aimed at gaining political control over the region. The government began extensive road-building and other infrastructure projects and created financial incentives for business to locate in the Amazon. Within a 47,000 square kilometer area (about the size of Switzerland) serviced by the first highway, the Belem-Brasilia Highway, the area of cleared land expanded from 300 square kilometers in 1972 to over 8,200 square kilometers in 1985 (Mahar). The population in the area of the highway also increased dramatically, from approximately 100,000 in the 1960's to over 2 million by the 1980's (Mahar).

In the state of Rhondonia, made accessible by the construction of highway BR-364, a settler could obtain title to a 100 hectare plot of forested land for a nominal price. Through another process, a settler could obtain title to an area three times the size of the area cleared, up to 270 hectares - providing substantial incentive to clear as much land as possible, regardless of need (Mahar). Some of these cleared lands have fertile soils;

however it is estimated that approximately 95% of the soils under the Amazon forest are not suitable for agriculture (Repetto). This fact, combined with human disease and sometimes violent resistance from the indigenous peoples of the region, meant heartbreak for many settlers and abandonment of their land after only two or three seasons. Because the official government distribution of land was unable to keep up with demand, squatter settlements became common. The percentage of cleared land in Rhondonia increased from 3% in 1980 to approximately 24% in 1988 (Mahar). The population increased from 111,000 in 1975 to over 1 million by 1986 (Wilson).

However, the shifting agriculture practiced by these peasants is not the only cause of deforestation in the Amazon. Businesses throughout Brazil were given up to a 50% tax credit for all their tax liabilities if the credit was invested in the Amazon. In addition, income from agriculture is minimally taxed. This lead to the establishment of large scale cattle ranching in the Amazon; by 1989, over 8.4 million hectares of forest was converted to cattle ranching (Mahar). This investment did little to provide employment in the region, other than in the initial clearing of the land, because cattle ranching typically employs only one person for every 300 hectares (Mahar). In addition, this corporate investment in large areas of land perpetuated the skewed distribution of land and wealth in Brazil. After increasing pressure from both within Brazil and internationally, these tax incentives have been abolished.

The environmental effects of cattle ranching are also devastating. Cattle ranching in the Amazon is only profitable with the tax credits (Mahar). Even then, the incentive for overgrazing is great, as it is cheaper to degrade a pasture and then clear a new one due to availability of land and the subsidized funding (Mahar). Pastures only remain viable for five or six years even when not overgrazed, due to the changes in the soil composition when the forest cover is removed. Incentives for cattle ranching and large scale export agriculture have destroyed millions of hectares of forest throughout Latin America, not just in Brazil. Governments have increased the profitability of agriculture or ranching by manipulating tax policy and farm prices. This negatively affects the value of forested land and increases incentives for conversion. For example, in the early 1980's the United States was importing 330 million pounds of beef from Central America (OTA, 1984). This was 25% of Central American production and 90% of their exports; however it amounted

to only 2% of US beef consumption (OTA, 1984). However, it should be noted that Brazil has a large domestic market for beef, and therefore beef from the Amazon is not exported (Low).

2.2 Market Failures

There are numerous market failures in the timber industry, particularly in developing countries and in the nature of tropical moist forests. The effect of these market failures is that the trees both standing in the forest and also during processing are under-valued. This leads to waste in the forest during harvesting and processing. This in turn leads to accelerated future logging. The market failures stem from: property rights, the divergence of social and private discount rates, the subsidy of the timber industry, and even the way national economic accounts are determined.

2.2.1 Property Rights

Ownership of forests varies from country to country and even region to region. Ownership of forest used for commercial purposes in North America and Europe is largely private (with the exception of the forest of the Northwest). The conifer forests of Central and South America also tend to be privately held. This reflects the more economically attractive growth rates of conifers that can induce private management of trees. The tropical hardwood forests of Central and South America are generally public property, owned by the government. In Asia, the governments own 80 to 90% of the forests (OTA, 1984). The main exception to this is Papua New Guinea, where clans and tribes have legal ownership of the forests (OTA, 1984). In Africa, a more complex system exists. Private ownership is rare, and members of the community have rights over use of the forest for extractive purposes (hunting, fuelwood, construction wood) and even locally regulated shifting cultivation and grazing. In some african nations, an individual retains the use rights to a tree planted on communal property; in other countries, that is not the case. In former British colonies, community ownership of forests is recognized at the national level, whereas in the former French colonies, local rights are not recognized and forests are considered property of the state (OTA, 1984).

Over-exploitation tends to occur on lands that have the weakest property rights. Typically these are open-access areas owned by the public (government). For common property, the individual has no incentive to conserve or manage the land for the future. The individual will not see the benefits of prudent actions, but rather they accrue to others who use the resource more aggressively. If forest management controls are not developed and enforced this can lead to over-exploitation, especially by those who can pay the government to ignore it. In addition, there are the problems created by associating the clearance of land with "improvement" and making it a prerequisite for gaining ownership of the land, as in Brazil. The land in a forested state is therefore valued at zero.

2.2.2 Discount Rates

In forestry, private discount rates are high and resource growth rates are low. This leads to the "mining" of the resource and an enhanced possibility for complete exhaustion of the resource. In fact, extinction may be the economically efficient outcome for high discount rate, low growth resources such as tropical forests (McNeely, et al). Present benefits are more valued than those of the future. In addition, the high discount rate and slow growth rate discourage investments in conservation or regeneration of the resource. "The apparent returns per unit area of forest are commonly too low to secure the necessary level of investment for sustainable management, or even to retain the land against pressures for alternative land use (FAO, 1993a)."

The entire issue of sustainable development and inter-generational equity is invoked here. Is the logging of tropical moist forests sustainable? Can it be? The answers to these questions depend on which criteria sustainability is judged by. One can be concerned with maintaining the ecological processes, maintaining the biological diversity, satisfying the needs of the local population, sustaining the production of non-wood products or finally, sustaining the production of commercial timber. It is clear that sustainable wood production is not synonymous with sustainable forestry. "During the 1980's, notions such as 'ecologically sustainable development', biodiversity conservation', 'inter-generational equity' and 'global conservation obligations'... (have resulted in) a paradigm shift in forest policy from sustainable wood production to 'ecologically sustainable forestry which involves the development of management systems that facilitate integrated and multiple

resource use whilst conserving the resource stock' (Costantini and Gilmour)". Therefore, one needs to look at the forest as an ecosystem and employ an integrated and inter-disciplinary approach including socioeconomics and ecology to determine forest management. However today, "Logging is most often controlled by entrepreneurs, to whom short-term profits are of prime importance, rather than by foresters, whose duty is to the long-term maintenance of the resource (Whitmore and Sayer)."

I. Characteristics of the Tropical Moist Forest

Most of the nutrients that support the tremendous plant-life in the forest are located in the vegetation itself. When leaves and trees fall to the ground a very complex system of insects, fungi, birds and other plants quickly act to recycle the nutrients. Over time, the heat and heavy rainfall in tropical forest areas have leached the nutrients from the soil so that only the top few inches have any nutrients at all. Clearing and burning the forest releases most nutrients which are then washed out during the heavy tropical rains. Tropical moist forests are highly dynamic with patches of decline and growth always present. The trees are usually pollinated by insects and their seeds are often dispersed by animals.

Trees in the tropical moist forest can be classified as pioneer and climax. The seeds of pioneer species can remain dormant for long periods and germinate in direct sunlight or elevated temperature. Therefore, pioneer species rely on the development of relatively large gaps in the canopy created by the death of a climax tree. Climax species are slower growing and develop in the shade of pioneer species. Once the shorter-lived pioneer falls, the climax species will grow to fill its small gap. The seeds of climax species are recalcitrant, meaning that they germinate upon release. Therefore, before a gap is opened in the forest canopy, there will be a seed bank of pioneer species and a seedling bank of climax species on the forest floor. Each specific species, whether pioneer or climax has its own, often narrow, range of tolerable light and humidity levels.

Climax species have difficulty recolonizing an area of significant disturbance because they cannot tolerate the light and their seeds cannot remain dormant until pioneer species provide the shade. The regeneration of a disturbed area to its former level of complexity

and diversity can take 400 years (Hurst), depending upon the initial conditions and the size of the disturbance. Most of today's commercially valuable species are climax species.

II. Logging in the Tropical Moist Forest

Intensive timber harvesting did not occur until after World War II with the introduction of capital-intensive methods of road construction and capital-intensive equipment such as the one-man chain saw and mechanical hauling vehicles (Whitmore and Sayer). These capital-intensive processes required high-extraction rates to cover costs. Prior to the 1950's, forests were harvested using axes, handsaws and animal power. This did less damage to the forest and limited extraction rates and the areas penetrated. Only timber near rivers could be extensively exploited.

Only 15 to 20 species of tropical woods have significant commercial value in the world market. In contrast to temperate forest, tropical moist forests are very heterogenous, with only 3 to 5 marketable trees per hectare in the Brazilian Amazon (Whitmore and Sayer). In Africa this can reach as low as 1 tree per hectare. In Asia, the marketable trees are found at a greater density providing an average of 14 per hectare.

There are basically two extraction systems: polycyclic and monocyclic, although neither one is widely followed. In theory forestry departments support one system, however in reality, commercial logging mostly done "log and leave", with little regard to the regeneration of the area (FAO, 1993a). In a monocyclic system, such as the Malaysian Uniform System (MUS), all good size trees are harvested at one time and then the area undergoes a long regeneration period (70 years under the MUS). However, harvesting so much volume, typically 50 cubic meters per hectare (up to 110 in Sabah), opens large gaps in the canopy and severely limits the forest's ability for regeneration. In some Southeast Asian locations, harvests of up to 72 trees per hectare have been found, creating almost total damage to the forest (Whitmore and Sayer).

Under a polycyclic management system, only the largest trees are initially harvested. The smaller trees are left to continue growing and another cut of just the largest trees is made

20-30 years later. Because growth rates are slow, the timber yields of only 8-13 cubic meters per hectare have not been satisfactory. The success of polycyclic forest management depends on whether the forest is adequately stocked with young trees before harvesting begins and that they are not damaged during harvesting.

The impact of logging is dependent upon the number of trees extracted and the residual damage done. Regeneration following logging is dependent upon the quantity of surviving seedlings, the presence of pollinating and dispersal agents (insects and animals), and the maintenance of soil fertility (Whitmore and Sayer). In some cases, a second cut has been made after 30-70 years without obvious changes in the forest character other than the increased concentration of commercial species (Whitmore and Sayer).

2.2.3 Subsidy of the Timber Industry

Because the true value of forests is not easily quantified, they are treated by governments as a free commodity that they can generate revenue from by selling logging concessions. Timber concessionaires do not have to pay for the local or global ecosystem effects of their harvesting practices (e.g. extinction of species, depletion of soils, flooding, sedimentation of irrigation systems) and therefore do not consider them in their decisions.

Economic rent is the market value of the trees less the cost of harvesting, transporting and processing the tree. In theory, after allowing a reasonable profit to the logging company, the government should capture the economic rent as the fee to buy the trees from the public. Tropical hardwood log rents are high, an average of over $50 per cubic yard (Repetto). For a country like Malaysia, that exports over 20 million cubic yards of logs a year, this amounts to over $1 billion a year. With this level of potential profits, there is considerable rent-seeking behavior (bribery) and political favoritism.

Governments throughout the developing world collect far less in forest revenues than required to sustain adequate forestry departments to coordinate and oversee the current system, never mind efforts to promote sustainable forestry management. For example, in Cameroon, the total of all forest revenues collected from all forest fees in 1987 was only

2-4% of the price of the export logs, and in Ghana, the revenues collected were less than 0.5% of the price of the logs delivered to processing plants (Grut et al).

The non-collection of possible rents is effectively a subsidy of the timber industry. The timber company is essentially taking the trees for free. The low cost of the trees to the user encourages waste and discourages conservation. Also, when the government does not effectively appropriate the rents, the high profits attract companies to engage in harvesting and fosters over-cutting. The subsidies take numerous forms: low collected fees due to weak forest institutions as well as inflation effects, under-measurement, under-invoicing and illegal logging; government construction of logging roads; promotion of the processing industry through preferential credit, export bans, quotas and differential tax structures. The various forms of subsidies are discussed further in Chapter 3.

2.2.4 System of National Accounts

The System of National Accounts (SNA) was developed by the United Nations as a measure of a country's macroeconomic performance. The SNA was developed based upon the economic statistics and theories of the 1930's. At that time, environmental pollution and resource depletion were of little concern, and therefore their effects are eliminated from the calculations. The method used to calculate the gross national product (GNP) and its variants, the gross domestic product (GDP) and net national product (NNP), are widely used by governments and industry to assess the health of an economy and as a basis for financial and policy decisions. However, it does not provide any information on the actual welfare of the environment and the people living in the nation. The SNA provides inadequate and distorted information that leads to misguided decisions that can undermine a nation's long term viability.

This is because the GNP, GDP and NNP do not include the depletion of natural resources or pollution of the environment as negative factors or the increase in natural resource stock as a formation of capital. In fact, improvement of land by clearing for agriculture or pasture or establishing industrial timber plantations are included as an increase in capital, even if the land is not suitable for sustained agriculture or grazing as in the case of the Amazon region of Brazil. On the other-hand, activities to sustain the functioning of an

ecosystem, such as planting trees for watershed protection, is not included as capital formation because the result is not traded in the marketplace.

In many developing countries, their natural resources are their "most important economic asset (WRI, 1991)", and many economies are based upon resource exploitation. Significant depletion of natural capital is an indication that the economy is based on activities that cannot be sustained over time. Depletion of a resource means a deterioration of the both quantity and quality of the resource and therefore a loss of its capacity to generate income in the future. Because the accounts do not include depletion of natural capital, they "create the illusion of income development, when in fact national wealth is being destroyed. Economic disaster masquerades as progress (WRI, 1991)."

In the case of forests, the economic value of a forest's standing timber (stumpage value) equals the market value of the wood less the costs of harvesting and transporting the wood to market. The depreciation (or appreciation) of forest capital, in purely market terms, would be the difference in stumpage value over the time period. The capital value of the forest will not decline if harvesting rates do not exceed growth rates. Ideally, only the annual growth should be harvested (WRI, 1991). However, in practice this is rarely the case, as discussed in Section 2.2.2.

When harvested quantities exceed the quantity added by natural growth, the forest's potential for future production is decreased. The portion of the harvest that exceeds the growth in that area is not included in the SNA as the reduction in capital that it is. Currently, the larger the harvest, the higher the income generated from logging. The same is true with the conversion to agriculture/pasture lands, the decrease in the forest asset is not considered, only the increase in agricultural assets: the larger the cleared area, the larger the increase in capital. If the land is suitable for agriculture, then the cutting of the forest should result in a real net capital gain (although lower than the gain now registered by not subtracting the loss of forest capital). However, if the land is not suitable for agriculture, as most land under tropical moist forests is not, then a net loss in capital should result from conversion. It is estimated that the economic costs of unsustainable forest depletion are 2-4% of GNP for resource dependent economies. At that level, it basically offsets the GNP growth achieved by most countries (Ahmad et al).

The concept of income, as stated by Sir John Hicks in 1947, is the maximum value that can be consumed during a time period and still be as well off at the end as one was in the beginning. The SNA needs to be altered so "that governments know the maximum amount that can be consumed by a nation without causing its eventual impoverishment. It is important, therefore, that national income be measured correctly to indicate sustainable income (Ahmad et al)."

2.3 Relationship Between International Trade and Deforestation

"Forest depletion has already significantly affected the economy of some developing countries, constraining their capacity to generate foreign exchange via exports of forest products -- e.g., Philippines, Nigeria and Cote d'Ivoire... if the pace of deforestation of the mid-1980's is maintained in the 1990's, the number of net exporters of forest products among developing countries will fall from 33 to less than 10 by the end of the century (WRI, 1985)."

Although only 14-20% of global deforestation is directly attributed to commercial logging, "... there is no doubt that its environmental impact may be significant (Low)." This conclusion was based upon the accumulated evidence that commercial logging: precedes permanent conversion of the forest to agriculture, affects "the delicate balance of these ecosystems", and "is accused of nurturing conditions that may contribute to ecological disaster." The permanent conversion of the forest to agriculture can also be for international trade purposes. For example, in 1989 Indonesia advertised that 20% of its forests would be converted to plantations for the production of teak, rubber, rice, coffee, and other agricultural crops (WRI, 1990). The "ecological disaster" that is often given as an example of the consequences of commercial logging is the enormous fire in the East Kalimantan region of Indonesia that burned over 3.6 million hectares in 1982-83. It is widely accepted that the fire was able to spread over such a large area because of the dried vegetation and other forest damage left after the remote area was extensively logged. The total value of the unharvested timber that burned is estimated at $5 billion.

The commercial logging of primary tropical forests affects approximately 5 million hectares each year: 723,000 hectares in Africa, 1.86 million hectares in Asia, and 2.29 million hectares in Latin America (FAO, 1993c). These rates have increased dramatically since the 1960's. In the period 1961 to 1965, the area of primary forest harvested each year was 394,000 hectares in Africa, 510,000 in Asia and 1.25 million in Latin America (FAO, 1993c). Although the area affected by logging is largest in Latin America, the quantity of wood extracted is much less. This is due to the more sparsely concentrated marketable species in Latin American tropical moist forests. The average harvest intensity, in cubic meters per hectare, varies from 33 in Asia, to 13 in Africa, to 8 in Latin America (FAO, 1993c).

2.3.1 Dependence of Developing Countries

"The market economy cannot wait for the trees to grow and, as a result, producing countries, desperate for cash, must somehow ensure they can meet any future peaks in demand if they are to retain their markets (Hurst)."

Many tropical countries consume most of the trees cut within their own economies for fuel and building materials. However, there are countries where most of the wood production is for export commodity production and international trade is a significant factor in their deforestation. For example, Malaysia exported approximately 70% of all wood production in 1989: 40% as logs, 20% as sawnwood and 10% as wood based panels (FAO, 1991). The other 30% was consumed in Malaysia, 15% for fuel (providing 10% of the nations total energy demand) and 15% for construction. In Indonesia, a major world wood products exporter, 46% of energy demand is met by wood, accounting for over 75% of roundwood production. However, over 75% of the remaining 25% was exported in 1989, primarily as plywood. In the Congo, over one-third of all wood production was exported in 1989, mainly as logs.

The trade in tropical timber is worth approximately $6-8 billion a year. Exports from some countries may not be great enough, in terms of quantity, to rank in the published FAO statistics; however the export of tropical hardwoods is a significant source of foreign currency for many developing nations. The great pressures placed upon developing

nations to obtain foreign currency, primarily due to their substantial foreign debt, may lead to ever increasing tropical deforestation. Table 2.1 shows the developing countries that derive a significant portion of their export earnings from forest products (greater than 5% or at least one of the top five export products).

The timber industry can also be a large employer in a country. In the African nations of Gabon, Cameroon and Nigeria, the forest sector employs 28%, 7% and 4% of the work-force (World Bank, 1991a). In Ghana and Indonesia, 70,000 persons were employed in the forest sector in 1982, a large portion of the population in Ghana and a small percentage in Indonesia (Repetto). In Malaysia, over 150,000 persons are employed in the wood products sector (World Bank, 1991a). The timber industry may provide a substantial portion of government revenue. For example, in 1990, forestry related fees, based upon harvested volume, accounted for 40-45% of the total revenues of the Sarawak state government (Reinhardt) and 70% of total government revenues in Sabah (World Bank, 1991a).

2.3.2 Demand in Industrialized Countries

The demand for tropical hardwood products in industrialized countries has dramatically increased since the 1960's; however the demand peaked in 1987, and has since declined due to the worldwide economic downturn. In 1961 the exports from developing economies were 16.7 million cubic meters, by 1970 this increased to 44.6 million cubic meters, and by 1980 demand was 60.0 million cubic meters, representing a 360% increase from 1961 (Repetto). In 1989 total exports were slightly more, at 60.1 million cubic meters (FAO, 1991). The types of export and the origin locations have changed over the years. In 1961 approximately 75% of export volume from developing countries were in the form of logs, with less than 10% as plywood and veneers (FAO, 1991). By 1989, logs represented less than 60% of wood volume, and over 20% was as plywood and veneers. In 1961, 33% of logs and wood products came from African nations, 53% from Asia and 13% from Latin America (Repetto). In 1989, the percentage originating in Africa was reduced to less than 11%, Latin America's percentage increased slightly to approximately 14% and Asia's share increased to almost 75%. Asian wood dominates the market for several reasons: it tends to be light colored and therefore, preferred by customers; the

trees occur at a higher density in the forest, allowing economical harvesting; and they are closer to the dominant world buyer, Japan. However, many analysts believe that the darker colored woods of Latin America could become more important on the world market as the supply in Asia declines and as the infrastructure in the region improves.

In industrialized countries, demand is for high quality woods of just a few well-known species. For example, in Indonesia there are approximately 4,000 tree species; however only four account for 75% of export products: Meranti, Ramin, Keruing and Agathis (Hurst). In order to provide this species-concentrated output from the heterogenous tropical forest, large areas must be logged. This increases the disturbed area and also the area accessible for settlement. In addition, because the other types of trees are not valued, excessive damage is done to them during the harvest of the valuable trees, and there is under-utilization of the forest resource within the disturbed area.

2.3.3 Terms of Trade

The terms of trade also contribute to greater areas being affected by logging than is necessary. If a log can be processed before it is exported, its value is increased (and due to size reductions, the wood can be transported more efficiently). Therefore, processing would allow the same profits to be made and the same number of people to be employed using less logs. However, many industrialized nations have significant wood processing industries (such as Japan, France and Italy) and want wood imported as logs. Therefore, they have tariff structures to penalize the import of processed wood and encourage the import of raw logs. Examples of these tariff rates in the 1985 are presented in Table 2.2. Several countries have instituted log export bans to simulate value-added industry, Indonesia and peninsular Malaysia for example. However, the Sabah and Sarawak regions of Malaysia and the nation of Papua New Guinea export primarily raw logs.

Tariff-induced protection causes a high demand for raw logs and does not allow wood producing countries to gain the income and employment from value-added processing. Protectionism in industrialized countries helps prevent less developed nations from using their natural resources as a basis for industrialization and therefore, helps to keep them in a resource exploitation dependent system (Low). For example, it is noted that Japan,

the largest importer of wood products, has extensive domestic forest cover and very strict forest management practices for its own forests. Japan has a 60 year harvesting cycle on softwoods and has reduced the area open to cutting by over 50% since the 1960's (Hurst). It is alleged that "Japan has a very clear strategy to exhaust the South-East Asian forests before turning to its own sizeable resources of timber" (Hurst).

2.4 International Trade in Forest Products

Coniferous trees are relatively fast growing and are produced in temperate forests or plantations in tropical countries. With the exception of Chile, the main exporters of coniferous wood products are North American and European nations. As stated previously, temperate forests in North America and Europe are actually expanding in size. Although the local effects of clear-cutting may be devastating, temperate forests are on soils capable of supporting regeneration, and replanting is typically undertaken. Therefore, there is little concern that the trade in coniferous woods is causing deforestation in North America and Europe. There is, however, concern that the current situation in Chile, the former Soviet Union, and the other formerly communist countries in Europe, with their enormous need for foreign currency, may produce great pressures to quickly log their forests and to not spend the resources to replant the area.

Non-coniferous woods are produced in both temperate forests and in tropical moist forests. Due to the long regeneration times, it is difficult for any extraction of hardwoods to be sustainable, particularly when large quantities are involved. Soil conditions combined with the high market value of hardwood means that the possibility of regeneration is much greater in temperate forests. However, it can be concluded that the international trade of hardwoods contributes to the deforestation occurring in tropical countries.

The production of wood can be broken into seven basic categories: fuelwood and charcoal, logs, pulpwood and particles, sawnwood, wood-based panels, wood pulp and paper and paperboard. The FAO international trade statistics divide logs and sawnwood into coniferous and non-coniferous, and wood-based panels into plywood, veneer sheets,

particleboard and fiberboard. The standard industrial category codes published by the United Nations Conference on Trade and Development (UNCTAD) categorize wood products more generally into the same basic categories, but using different terminology. Coniferous and non-coniferous logs are together in "other wood rough, squared", coniferous and non-coniferous sawnwood are together "wood shaped, sleepers", veneer sheets, plywood, particle board and fiberboard are together in "veneers, plywood, etc", and finally pulpwood and chips and particles are together in "pulpwood, chips".

This thesis focuses on the internationally traded forest products produced from tropical hardwoods. Therefore, the categories of coniferous logs and sawnwood, chips and particles, particleboard, fiberboard and pulp wood will not be examined in this report. Coniferous logs and sawnwood are eliminated because they are not primarily produced from tropical forests. The trades in chips and particles, particleboard, fiberboard and pulp wood are dominated by industrialized countries. Only 5% of all wood pulp produced worldwide is from tropical woods. Developing countries produced only 4.04 million cubic meters of particleboard where industrialized countries produced 48.37 million cubic meters in 1990 (FAO, 1992). The situation with fiberboard was also similar: developing countries produced only 2.61 million cubic meters and industrialized countries 15.35 million cubic meters in 1990 (FAO, 1992). The main developing country producers in both particleboard and fiberboard were China, who imports significant quantities of logs, and Brazil, whose forest product industry is based upon the softwoods grown in the southern portion of the country. Therefore, very little tropical hardwood residues are becoming processed wood products, and it is virtually not traded in the international market.

This domination by industrialized countries in processed wood products is due to a combination of two factors. First, particleboard, fiberboard and wood pulp are primarily made from softwoods due to the longer tree fibers that produce better product characteristics. Second, chips and particles, and the products made from them, particleboard, fiberboard and wood pulp, are typically secondary products recovered from processing or are produced from trees that are harvested but are not suitable for the market. For reasons that are discussed in Section 2.2 and Chapter 3, in most developing countries the cost of the input tree is so low that the recovery of processing wastes is not considered. In industrialized countries, the cost of the input trees are higher and

therefore, recovery and trade of the wood wastes and their products is a developed industry. For example, it is estimated that Swedish sawmills use 98% of a tree, whereas Malaysian mills utilize only 40%.

Overall, excluding fuelwood use, approximately 50% of all tropical industrial wood production enters international trade, and approximately 15% of all wood traded in the world originates from the primary forests of tropical countries. The following sections outline the trade in tropical timber in the form of logs, sawnwood, and plywood and veneer. It should be noted that FAO, the main compiler and distributor of worldwide forest product data, has an approximately two year lag on data publication. Therefore, the data available was for 1990, and the 1991 data will be published later in 1993. The trade in tropical woods is approximated from the export data from developing countries that contain tropical moist forests.

2.4.1 Logs

According to the UNCTAD, the world trade in logs, both coniferous and non-coniferous in 1989 was estimated to be at $6.63 billion, of which developing countries capture $2.73 billion. The largest exporter of logs from the developing countries, in terms of dollar value, was Malaysia which accounts for $1.67 billion, over 25% of world value, on its own. The remainder of the top ten exporters from developing countries in 1989 were: Gabon ($204 million), the Cote d'Ivoire ($139 million), Papua New Guinea ($107), Cameroon ($92), Liberia ($86), Congo ($82), Ghana ($72), Chile ($50), and Myanmar ($47).

World trade in non-coniferous logs was estimated to be 31.93 million cubic meters in 1990, with developing economies exporting 26.73 million cubic meters. The trade in tropical logs is illustrated in Figure 2.2 (FAO, 1992). The largest exporter by far is Malaysia which exported 20.36 million cubic meters of hardwood logs in 1990, almost two-thirds of total world trade in non-coniferous logs. The destinations of these logs were primarily: 10.44 million cubic meters to Japan, 3.69 million cubic meters to China, 3.49 million cubic meters to the Republic of Korea, and 1.3 million cubic meters to India.

Tropical countries following Malaysia were: Papua New Guinea at 1.35 million cubic meters (0.92 to Japan and 0.37 to the Republic of Korea); Gabon at 0.85 million cubic meters (0.48 to France and 0.11 to Portugal); Myanmar at 0.70 million cubic meters (0.65 to Thailand); Liberia at 0.70 million cubic meters (0.22 to France and 0.17 to Portugal); Cote d'Ivoire at 0.55 (0.09 each to Italy and Spain and 0.07 each to France and Portugal); Cameroon at 0.46 (0.11 to France, 0.1 to Spain, and 0.07 to Italy) and the Congo at 0.35 million cubic meters (0.1 to Portugal and 0.08 to Spain). It should be noted that Papua New Guinea substantially increased its export of logs between 1989 and 1990, from 0.91 million cubic meters to 1.35 million cubic meters.

Japan was also the largest importer, by far, of tropical logs, importing 11.44 million cubic meters in 1990, or 35% of total world trade in non-coniferous logs. Almost 90% of Japan's imported logs came from the largest exporter, Malaysia. China was the world's second largest importer at 3.7 million cubic meters, followed by the Republic of Korea at 3.49 million cubic meters, Thailand at 1.42, India at 1.3, and France at 0.94.

2.4.2 Sawnwood

The primary processing of logs is into sawnwood, or lumber. Lumber is then used in building construction, furniture production and the manufacture of other construction related items such as doors and window frames. The production of 1 cubic meter of sawnwood requires approximately 2.4 cubic meters of log (Kallio et al). The conversion also produces 0.7 cubic meters of chips, and 0.7 of sawdust and bark (Kallio et al). WRI uses a conversion of 1.8 cubic meters of log for every 1 cubic meter of sawnwood (Repetto). In 1990, on the international market, the average price of 1 cubic meter of tropical sawnwood was almost three times the average price of 1 cubic meter of raw log, $230-293 a cubic meter compared to $78-137 per cubic meter of log (FAO, 1992). Many nations consume most, if not all, of the sawnwood they produce within their own economies for construction and furniture. However, Malaysia, the world's major exporter of non-coniferous sawnwood, exported over 60% of it's production in 1989 (FAO, 1991).

The world trade in sawnwood, both coniferous and non-coniferous, in 1989 was estimated to be at $16.83 billion, of which developing countries accounted for only $3.39 (UNCTAD).

The largest exporters of sawnwood from the developing countries in 1989, in terms of dollar value, were Malaysia which accounted for $913 million and Indonesia at $730 million. The remainder of the top ten exporters from developing countries were: Singapore ($301 million), Yugoslavia ($228 million), the Ivory Coast ($203), the Philippines ($195), Brazil ($177), Chile ($114), Republic of Korea ($65), Ghana ($65), and Taiwan ($63).

Worldwide trade in non-coniferous sawnwood was estimated by the FAO to be 14.48 million cubic meters in 1990, with developing countries exporting 9.06 million cubic meters. The trade in tropical sawnwood is illustrated in Figure 2.3 (FAO, 1992). Once again world trade was dominated by one country, Malaysia which exported 5.28 million cubic meters, over one-third of worldwide trade. The major destinations of Malaysia's hardwood lumber were Thailand (1.2 million cubic meters), Singapore (1.0 million cubic meters), Japan (0.53 million cubic meters), the Netherlands (0.48 million cubic meters) and the Republic of Korea (0.45 million cubic meters).

The next largest exporters were: Singapore (1.0 million cubic meters at small quantities to numerous countries); 0.61 million cubic meters from Indonesia (0.39 to Japan and 0.09 to Italy); 0.53 million cubic meters from Brazil (also small quantities to numerous, mainly developed countries); 0.46 from Cote d'Ivoire (0.16 to Italy, 0.09 to France) and 0.08 from the Philippines (down from 0.44 the previous year). It should also be noted that Indonesia significantly decreased its exports of sawnwood between 1989 and 1990, from 2.71 million cubic meters to 0.61 million cubic meters.

Tropical sawnwood is imported by many countries. The countries that imported more than 1.0 million cubic meters in 1990 were: Thailand (1.2 million cubic meters), Japan (1.01 million cubic meters), and Singapore (1.01). Other significant importing countries are: the Netherlands (0.62 cubic meters), China (0.49), the Republic of Korea (0.49), and Italy (0.37).

2.4.3 Plywood and Veneer Sheets

The production of plywood and veneer sheets are considered advanced, higher value-added processing. To produce 1 cubic meter of plywood, approximately 3.7 cubic meters of log are consumed (Kallio et al). The processing generates 1.8 cubic meters of chips, and 0.9 cubic meters of bark and sawdust (Kallio et al). The WRI states that the conversion of log to plywood only requires 2.3 cubic meters of wood to produce on cubic meter of plywood (Repetto). In 1990, on the world market, plywood was worth 2.9 to 4.2 times that of a raw log, $330-398 per cubic meter compared to $78-137 per cubic meter of log (FAO, 1992). The major producers of veneer sheets and plywood are clearly manufacturing for export. Indonesia, the dominant world trader of plywood, exported over 91% of its production in 1989. Malaysia exported over 75% of its production.

The world trade in veneer sheets, plywood, etc in 1989 was estimated to be at $8.23 billion, of which developing countries account for $4.1. There is no distinction in the data between those products produced from hardwoods and those produced from softwoods. The largest exporter of veneer sheets, plywood, etc from the developing countries in 1989, in terms of dollar value, is Indonesia which accounts for $2.33 billion, 25% of world value, on its own. The remainder of the top ten exporters from developing countries were: Malaysia ($376 million), Taiwan ($332 million), Singapore ($287), Brazil ($195), the Philippines ($102), Chile ($82), Yugoslavia ($61), the Ivory Coast ($57), and Gabon ($33).

I. Plywood

Plywoods can be high quality wall coverings made by bonding together veneer sheets over a thin solid core, with the grain of alternating sheets at right angles. Or plywood can be low quality, such as disposable concrete forms made with layers of low quality strips.

World trade in plywood is significant at 16.25 million cubic meters in 1990, with developing countries accounting for 11.84 million cubic meters. The trade of tropical plywood is illustrated on Figure 2.4. Indonesia exported over 50% of all the plywood traded, 8.43 million cubic meters. One-third of that, 2.80 million cubic meters, was sent to Japan. China also received significant quantities of plywood from Indonesia, 1.50 million cubic

meters. The other major destinations were the Republic of Korea (1.05 million cubic meters), the United States (0.99), Singapore (0.64) and Hong Kong (0.48).

Behind Indonesia is Malaysia, which exported 1.02 million cubic meters of plywood in 1990. Their exports went primarily to Singapore (0.35 million cubic meters), Hong Kong (0.78) and the Netherlands (0.69). Brazil was the only other tropical exporter with only 0.36 million cubic meters with 0.12 to the United States (however, much of Brazil's forest industry is based on softwoods grown in the south, so this may not even be hardwood).

The major importers of tropical plywood in 1990 were: Japan (2.82 million cubic meters), China (2.08), the United States (1.20), the Republic of Korea (1.06), Singapore (1.0) and Hong Kong (0.69).

II. Veneer Sheets

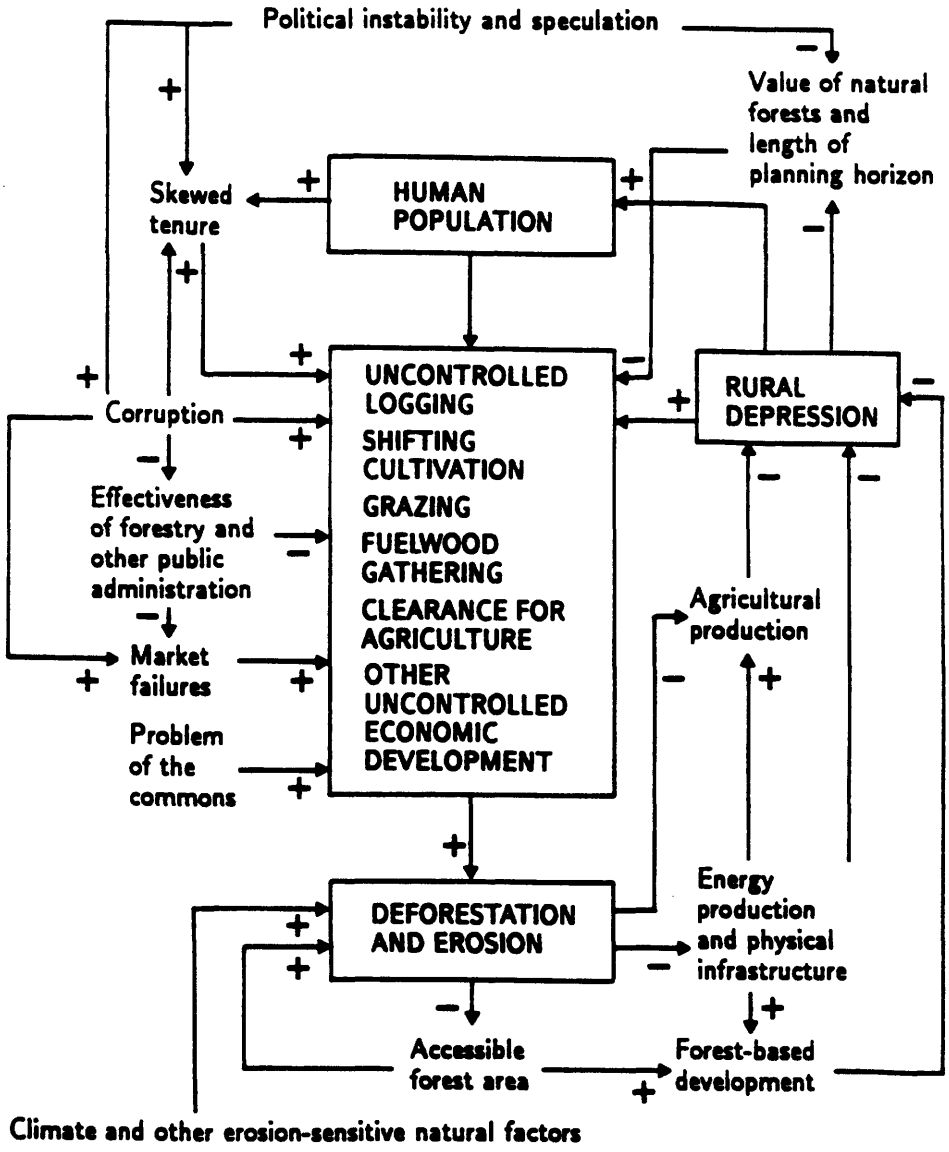
Veneers are used to laminate an attractive outer surface on a cheaper underlying material. They are used for furniture and construction accessories such as cabinets, doors and decorative moldings. Veneers are thin sheets of high quality wood of a uniform thickness that are rotary cut.

World trade in veneer sheets is relatively small, only 2.06 million cubic meters in 1990, with only 0.73 from developing countries. Malaysia was the largest tropical exporter at 0.33 million cubic meters, all exported to Japan. Following Malaysia was Cote d'Ivoire at 0.08 (0.05 to Germany), Indonesia at 0.06 (0.02 to China and 0.01 to Japan) and Brazil with 0.06 (0.04 to the United States and 0.02 to Germany).

The largest importer of tropical veneer sheets was Japan at 0.38 million cubic meters. Other large importers were Germany (0.06 million cubic meters) and the United States (0.05).

2.4.4 Summary

The largest exporters of tropical hardwood logs, sawnwood and plywoods, in terms of quantity, are summarized on Table 2.3. The demand for imported hardwoods that is primarily met by the tropical countries of Southeast Asia is largely from Japan and the now forest resource poor countries of Asia; China, the Republic of Korea, Taiwan, Thailand and India. The demand for imported hardwoods in Europe is met primarily by the tropical countries of Africa; largely Gabon and Liberia with some from Cote d'Ivoire, Cameroon and the Congo. There is also some trade between suppliers in Asia and the market in Europe; almost 10% of Malaysia's export of non-coniferous sawnwood goes to the Netherlands.



The vicious circle of population pressure, deforestation, and rural depression in the tropics. (Source: Palo and Salmi, 1987.)

Figure 2.1 Causes of Deforestation

Source: Doos

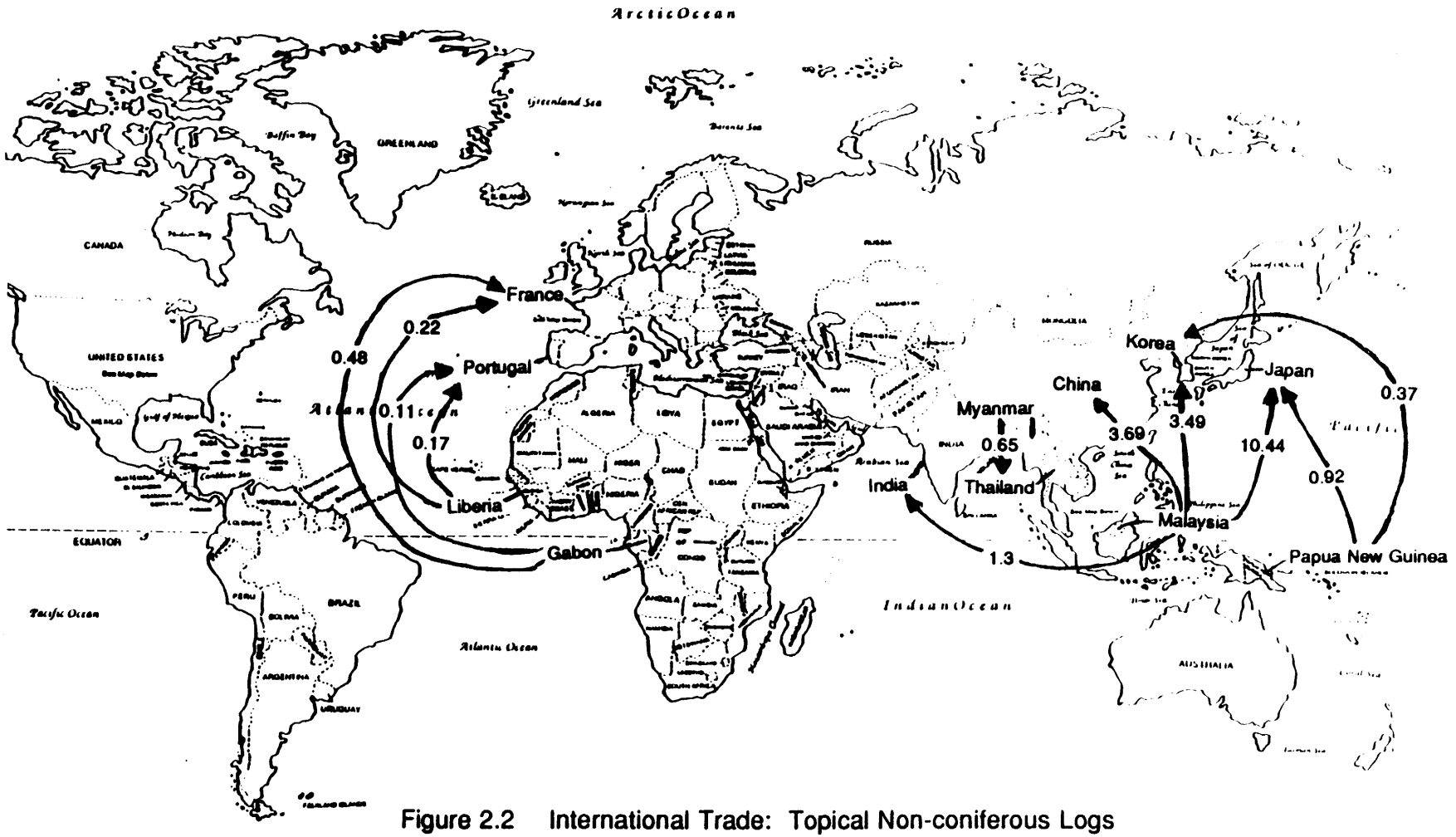


Figure 2.2 International Trade: Topical Non-coniferous Logs

Source: FAO, 1992

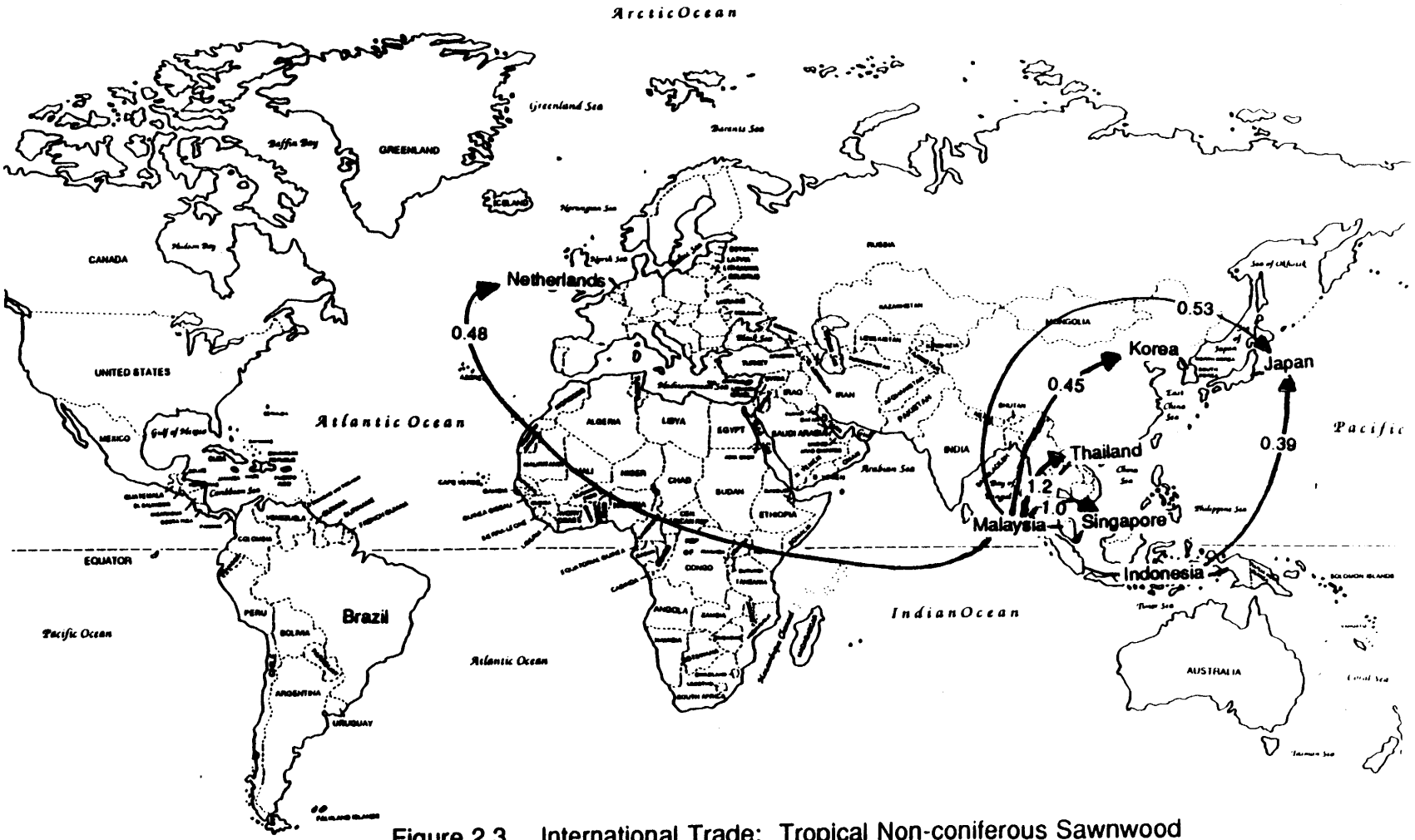


Figure 2.3 International Trade: Tropical Non-coniferous Sawnwood

Source: FAO, 1992

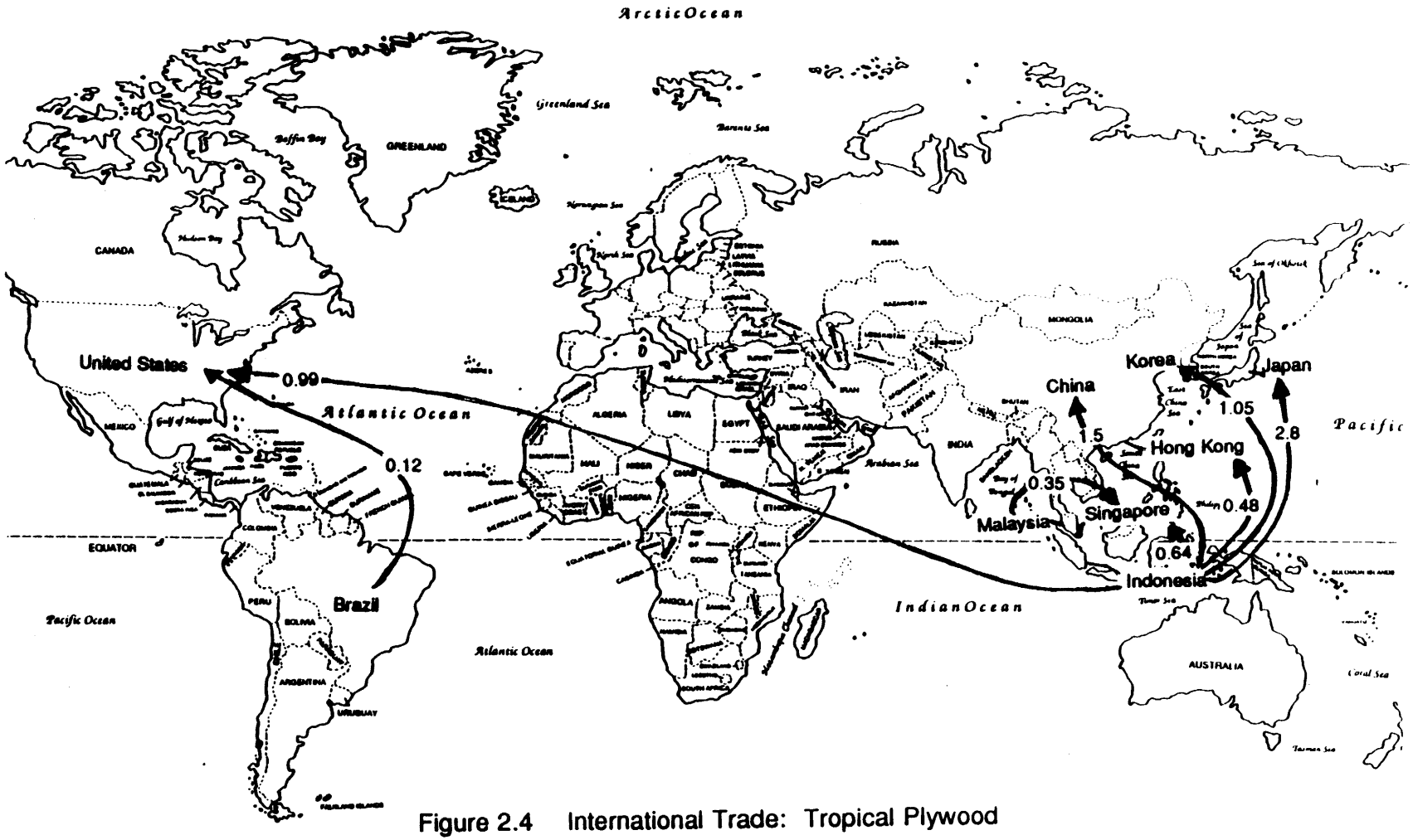


Figure 2.4 International Trade: Tropical Plywood

Source: FAO, 1992

Country	Product	Percent of Total Export $ 1989	Rank in Country's Exports
Cameroon	Logs	8.34	4
	Sawnwood	2.47	7
	Veneers/Plywood	1.63	10
		12.44 %	
Central African Republic	Logs	7.95	3
	Sawnwood	4.28	5
		12.23 %	
Congo	Logs	10.02	2
	Veneers/Plywood	2.59	4
	Chips	1.78	5
		14.39 %	
Fiji	Logs	1.11	11
	Sawnwood	1.21	9
	Veneers/Plywood	1.67	5
	Chips	1.09	12
		5.08 %	
Gabon	Logs	0.13	15
	Sawnwood	0.21	13
	Veneers/Plywood	2.52	5
		2.86 %	
Liberia	Logs	17.37 %	3
Indonesia	Sawnwood	3.54	6
	Veneers/Plywood	11.29	3
		14.83 %	
Ivory Coast	Logs	5.05	5
	Sawnwood	7.38	4
	Veneer/Plywood	2.06	11
		14.49 %	

Table 2.1 Developing Countries that Depend on the Timber Trade

Source: UNCTAD

Country	Product	Percent of Total Export $ 1989	Rank of Exporter
Malaysia	Logs	7.23	5
	Sawnwood	3.95	6
	Veneers/Plywood	1.63	12
		12.81 %	
Myanmar	Logs	26.4	1
	Sawnwood	10.06	2
		36.46 %	
Papua New Guinea	Logs	7.46	3
	Chips	0.5	12
		7.96 %	
Philippines	Sawnwood	2.64	11
	Veneers/Plywood	2.76	16
	Furniture	1.38	9
		6.78 %	
Soloman Islands	Logs	30.96	1
	Sawnwood	1.82	9
		32.78 %	

Table 2.1 continued Developing Countries that Depend on the Timber Trade

Source: UNCTAD

CCCN Tariff no.	General Product Description	Tariff Rate (percent) Australia	EEC	Japan	United States
44.03	Wood in rough	0	0	0	0
44.05	Wood simply sawn	5	0, 4.1	0, 7, 10	0
44.09	Wood chips	0	0	0	0
44.13	Wood planed, grooved, etc.	0 to15	0, 4.1	10	0, 4.4
44.14	Veneer	5	6.1	15	0
44.15	Plywood	30 to 40	10.4	15, 20	4.1 to 20
	Laminated Lumber	15	11.1	20	1.9¢/lb+3.4%
44.19 to 44.28	Manufacture of wood products	15	2.6 to 9.1	2.5 to 7.2	0 to 8
44.01 to 44.03	Furniture	30	5.6, 6.3	4.8	4.7 to 9.3
47.01	Wood pulp	0	0	0	0
48.01 to 48.15	Newsprint	7	5.4	3.9	0
	other paper and paperboard	6 to 14	4.1 to 12.8	5 to 12	0 to 3.3

Table 2.2 Protective Tariffs Rates in Industrialized Countries
Source: Repetto and Gillis

Wood Type	Exporting Country	Quantity (million m3)	Importing Country	Quantity (million m3)
Logs	Malaysia	20.36	Japan	11.44
	Papau New Guinea	1.35	China	3.70
	Gabon	0.85	Republic of Korea	3.49
	Myanmar	0.70	Thailand	1.42
	Liberia	0.70	India	1.30
	Cots d' Ivoire	0.55	France	0.94
	Cameroon	0.46		
	Congo	0.35		
Sawnwood	Malaysia	5.28	Thailand	1.20
	Indonesia	0.61	Japan	1.01
	Brazil	0.53	Singapore	1.00
	Cots d' Ivoire	0.46	Netherlands	0.62
	Philippines	0.08	China	0.49
			Republic of Korea	0.47
			Italy	0.37
Plywood	Indonesia	8.43	Japan	2.82
	Malaysia	1.02	China	2.08
	Brazil	0.36	United States	1.20
			Republic of Korea	1.06
			Singapore	1.00
			Hong Kong	0.69

Table 2.3 Top Exporters and Importers of Tropical Non-Coniferous Logs, Sawnwood and Plywood, 1990

Source: FAO, 1992

3.0 EXPORTING COUNTRY POLICIES TO IMPACT DEFORESTATION CAUSED BY INTERNATIONAL TRADE OF WOOD PRODUCTS

Most groups, from the World Resources Institute to the United Nations believe that one of the most important components, or perhaps the most important component, of slowing tropical deforestation, is for the countries exporting tropical timber to alter their own internal policies and practices. There are numerous aspects, not all applicable to every country, that could be changed to make forestry less destructive. Most involve changes to make the price of the wood include all the costs involved with cutting the trees: market, environmental and social.

3.1 Subsidies

Governments in tropical forest rich countries see their forests as an asset to utilize as a basis for their nation's economic development. Therefore, the timber industry and the wood processing industry enjoy subsidies of several types, some planned and some inadvertent. However, subsidies prop up inefficient processes that would not be profitable without them. Therefore, production is higher and waste is greater in a subsidized industry than in one without subsidies, particularly when there is little government regulation.

3.1.1 Low Fees

It is suggested that countries should raise the fees they charge for the privilege of cutting the forest. Increasing the fees would increase the cost of harvesting the trees, thus encouraging conservation and less waste during both harvesting and processing. The different methods of setting the fees and of assessing the fees are discussed in Section 3.3.

There are several practical and political problems with the general suggestion of raising fees. One, there may be a reluctancy on the part of the government to impose higher

fees. If a nation imposes higher fees, it will raise the cost of production in that nation, resulting in a reduction in the quantity of logs harvested. Therefore, the quantity of wood sold in the international market will be reduced as will the export earnings. A nation imposing the higher fees may be better off in the long-run as it will conserve its forest resources, however it may suffer in the short-run from the decreased export earnings. Unfortunately, with the current debt obligations and the chronic state of poverty, most nations cannot enjoy the luxury of looking past the short-term. A way to maintain the needed trade and foreign currency income would be to raise the world price of tropical woods after the production costs are increased. The quantities would be lower but the price received would be higher. This would require a coordinated international action.

There are several reasons why fees and their collection rates are so low. These are presented below, as are possible improvements.

I. Inflation Impacts

Often the forest fees were set many years ago and have not been adjusted for inflation. Therefore, in real terms the fees have actually dropped over time. For instance, if inflation is only 5% per year (a very rare case in the less developed world where inflation can be 5% per month), after 12 years, the real value of the fee would be only 55% of the original (Grut et al). To overcome this, the fee must be increased by a substantial amount, almost 100% in the above case, just to bring the fees up to the original fee in real terms. An even greater increase in the fee would be required to bring it to a level that captures the economic rent and an even greater increase to internalize the environmental and social costs.

Politically, raising the fee by this large percentage is often not feasible, as there is substantial opposition to any large change. The timber industry has gained more profits as the real value of the fees has declined, making the industry more powerful and influential. Forest concession fees are typically set by the legislature and require legislative approval for changes. Forest fees are often seen as a low priority item and involve considerable political dealings that reduce the incentive for change, and thus, changes in fees are often put off until "next year."

If fees could be raised, they could be either indexed to inflation, set in terms of a stable foreign currency or fixed as a percentage of the log or processed product sale price (ad valorem). It should be noted that even stable foreign currencies experience inflation that, over time, can undermine the fee. From 1980 to 1989, US inflation averaged 4.4%, which would have reduced the real value of a fee set in terms of US dollars, by almost one-third (Grut et al). With ad valorem fees, the market price upon which they are based would automatically include inflation. However, a government body would have to monitor market prices and regularly update the corresponding fees in order for this system to work. This has been a problem in several countries where the posted price against which the ad valorem fee is calculated is often 50% below the actual market price (Grut et al).

II. Collection Rates

In Ghana, the collected fees were only one-sixth of those that should have been assessed even at the currently very low real rates; in the Congo only one-fifth was collected; and in the Philippines less than one-tenth (Grut et al). When forest fees are not collected by the government, the logging company takes the logs, and damages the forest, for free - a huge subsidy of the industry.

Without collection of fees, there is no possibility of using the fees as incentives to induce more sustainable logging practices. The need to strengthen forestry institutions so they can assess and collect fees will be discussed in Section 3.8. There are several other options to increase collection rates.

(A) Measurement

Most existing fee systems are based upon the measurement of the logs or the processed products. Because the amount of the fee is based upon quantity, there is a strong incentive for the logging company to minimize the amount of wood measured. Measurement is done by the forestry department themselves or by the logging company and then checked by the government. In West and Central African nations, if the forestry department performs the measurements, due to lack of government vehicles, the forestry official is typically transported, housed and fed by the logging company while in the field

(Grut et al). Therefore, the official is under substantial pressure to not record the full cut, to increase the amount of defects recorded, or to the classify the trees as a lower value species. If the company measures its own harvest and then has it verified by the government, due to under-staffing and possible corruption, the official is not likely to actually measure the wood and will typically accept the company figures.

The system of wood measurement could be improved in order to ensure a higher correlation between the quantity harvested and the quantity reported. One possible improvement would be for the level of pay of the government inspector to be tied to the quantity of wood measured or to a percentage of the fee collected by the government. There would be a strong incentive to record all the wood possible and also create less susceptibility to bribery. The company would have an interest in making sure that the inspector did not over-record. However, the company would also be less likely to support the forestry official in the field. Therefore, it would be necessary for the forestry department to equip the inspectors with their own provisions. Another possibility would be to hire an independent third-party to perform the audits (Grut et al) and have their pay based upon wood measurements. This method would be more expensive than having the government perform the audits and would provide little additional benefit.

Grut et al also suggest that the forestry department align themselves with the individuals hired by the logging company to cut or haul the logs. These contractors are paid by the amount of wood delivered and therefore have a strong incentive to ensure that the correct quantity of wood is recorded. However, the logging company can exert substantial power over their employees, as there is typically an oversupply of labor in developing countries. Therefore, there may be a reluctance on the part of the hired workers to report the correct figures to the government. In addition, even if company power was weak, the contractors would still remain open to bribery.

(B) Under-invoicing

Under-invoicing appears to be common practice in the forest product exporting industry throughout the developing world (Hurst and Grut et al). The value (either quantity or quality) of the wood invoiced by the exporting company is less than the actual price paid

by the importing company. The importing company deposits the difference between the invoiced price and the actual price in a foreign bank account owned by the exporting company. This process is also known as transfer pricing when the exporting and importing companies are related. Under-invoicing is an effective, but illegal, way to accumulate foreign exchange reserves or to export profits to an affiliated company in a different country.

Grut et al point out several negative consequences of this practice. First is the loss of revenue to the government. Another is that this practice provides an unfair advantage to foreign affiliated companies and discriminates against domestic industry. Finally, the practice under-values the timber and therefore encourages wasteful harvesting and processing.

Unfortunately, there does not appear to be an easy solution to the problem. It is difficult for the government to keep such a tight control over exports so as to measure the quantity of every shipment and inspect its quality. An option may be to base the forest use fees upon a system that does not require measurements. This will be discussed further in Section 3.3.

(C) Illegal Logging

Illegal logging to supply the capacity of the domestic and international log processing industries is common and represents a loss of revenue to the government. Illegal logging is often increased in response to the imposition of high export fees or other export restrictions. Illegal logging is allowed to flourish due to the lack of government oversight and control, reflecting the weakness of forestry institutions in the developing world.

For example, in Thailand, despite a 1989 ban in all logging of government forests, illegal logging was estimated at 143,000 cubic meters in 1990. In the late 1970's published statistics showed that Thai sawmills were producing 6.5 million cubic meters of lumber from an annual legal production of 2.5 million cubic meters (Hurst). The government stopped publishing the statistics by the 1980's. In the early 1980's in the northern parts of Thailand, highly organized timber poachers were hijacking trains to transport illegal

timber to sawmills outside Bangkok (Hurst). Now, the volume of timber poaching has diminished and most transport of illegal logs is by truck. The wood processing industry is still a major component of the Thai economy, and there is little restriction on the export of processed product, therefore, wood from illegally harvested logs is still traded. The Thai logging ban has also increased pressures on the forests of Myanmar and Laos to supply logs to the processing facilities.

3.1.2 Road Building

Road-building by the government also creates a subsidy for the forest industry. In some cases roads are financed by the government for the purpose of providing access to the forest for logging. The road construction costs are not passed onto the logger in the concession agreements. Road-building also creates access to a previously inaccessible area for illegal logging and agricultural conversion, subsidizing these environmentally undesirable practices as well. Most forestry departments cannot monitor the newly accessible areas to prevent these illegal activities. Approximately 13 kilometers of roads and skidder tracks are constructed during the logging of a 100 hectare area (Hurst). One company in the East Kalimantan region of Indonesia opens up approximately 75 km of roads each year (Hurst). These are hauling roads not the skidder tracks through the forest.

In other cases, as in the Brazilian Amazon, road-building by the government is an direct attempt to increase access to the area along the road for settlement. When a road is built into an area, it makes previously unmarketable land more desirable. A land market is created and conversion of land beside the road begins.

To reduce this subsidy, governments could build as few logging roads as is possible to manage the forest. This will require better planning and control in the forestry departments. It has been suggested that governments no longer build the road into the forest from the main roads (Grut et al). If the private sector does not consider it worth their while to build the tracks then the wood is not valuable enough to extract and would remain intact.

3.1.3 Log Processing Industry

Developing countries see the subsidy of wood processing industry as a vital element of their economic plans. By increasing value-added industry, more employment is created and more of the wood-based industry profits are captured domestically, rather than exported to another country with the raw logs. The increased value-added product brings in more money from the international market, improving the country's trade balance. Therefore, the domestic processing of logs should be encouraged. However, a large subsidy of processing without other controls will not alleviate the pressure on forests, and may in fact increase deforestation. The cost of the input timber also needs to be increased in order to decrease waste of the logs and increase employment. If the input becomes more expensive, labor would be substituted to increase the rate of recovery.

Subsidies make getting into processing economically attractive and, without tight government restriction of the number and capacity of log processing operations, encourage the start up of many, many processors. These processors need a timber supply and therefore, increase pressures for exploitation of the forest. Companies that waste the timber input can remain profitable when they would otherwise not be. This waste places further unnecessary pressure on the forests to supply more wood than is truly needed. In tropical countries 50-60% of the raw log is not converted into the desired product during sawmilling, whereas in industrial countries only 40% is unconverted (Grut et al).

In 1990, the average export value of tropical logs ranged from $78 per cubic meter for logs from Asia to $137 from Africa (FAO, 1992). The average export value of tropical sawnwood ranged from $230 per cubic meter from Asia to $293 from Latin America. Tropical plywoods had an average export value of $330 per cubic meter from Asia to $398 from Africa. The value-added is not as great as it might appear due to the reduction in volume during processing discussed in Section 2.4. Therefore, one cubic meter of sawnwood requires more than one cubic meter of log.

In addition to the setting of low and often uncollected forest fees, the wood processing industry is currently subsidized in four other ways: log export bans, log export quotas, differential export taxes, and financial incentives.

I. Export Bans

Many nations, particularly in Southeast Asia, have instituted a ban on the export of raw logs. In the Philippines and Thailand, this was done to slow rampant deforestation and ensure that domestic wood needs were met (although devaluing the trees had the opposite effect, creating stronger incentives for land conversion and an increase in deforestation). In Indonesia and peninsular Malaysia, the ban was designed as a specific instrument to promote the downstream processing of wood; to spur the development of value-added industry. In the 1970's Indonesia had links with international companies to export raw logs. Now, with the export ban in place since 1985, plywood is the major wood based export and only 16% is through joint ventures with multi-national firms.

A log export ban can have the positive effect of promoting value-added industry. However, the ban lowers the value of the logs in the domestic market since there is not an export market for them, and therefore waste throughout the system is encouraged. An export ban on logs also increases the incentive for timber smuggling to supply still hungary foreign markets. In the Philippines, in 1980 after the log export restrictions became tighter, the government officially registered an export of 0.5 million cubic meters of logs to Japan, whereas Japan reported the import of 1.1 million cubic meters of logs from the Philippines (Repetto).

II. Export Quotas

Export quotas on raw logs are also used to encourage domestic processing industry. The log export quota for a company is typically set by requiring that a certain percentage of the company's harvested logs are processed domestically. Therefore, this mandates that processing plants are developed in the country, however no incentive is given as to the efficiency of these plants. Many companies only have processing facilities in order to continue to export logs. Therefore, they harvest more than they desire, export the

valuable logs and process the low quality logs without regard to efficiency. This leads to the use of old, secondhand, inefficient equipment and waste of the forest resource (Grut et al).

Export quotas could be effective if they were unlinked from production capacity and auctioned to the highest bidder. These maximum export quantity based quotas would protect the domestic processing industry by ensuring domestic log supply. In addition, the price of the domestic logs that could not be exported would be below the world price, providing the subsidy to the processors. Export quotas are valuable to their holders as they lower the supply for export, possibly raising the selling price on the world market. This would be especially true if exported nations implemented a coordinated quota system. However, this price increase does not originate from an increase in costs, and therefore increases the incentives for rent-seeking (corruption).

III. Differential Export Tax Structure

The processing industry is also subsidized by the placing of high export taxes on raw logs with the export taxes falling as the amount of processing increases. Unfortunately, the differential is often too great to be worth it; the tax lost is greater than the value-added. Repetto and Gillis, give many examples of government tax incentives given the processing industry. For instance, in the Sabah region of Malaysia in 1979, for a log valued at $100 per cubic meter, the royalty for export of the raw log was $51.56. The royalty on the export of sawnwood was only $7.00 per cubic meter. Therefore, the government forgo $44.56 for each cubic meter of log processed. The value-added by processing into sawnwood is only $25. Therefore, by processing the wood, the company saved a royalty worth 178% of the value added. This assured that sawmills remained profitable even when 1.78 times less efficient than processors in the importing country.

Although differential export taxes are a subsidy, Repetto and Gillis note that "Higher export taxes on logs than on lumber and plywood are superior in all respects to bans or quotas on log exports." This is due mainly to the fact that, with taxes, the government collects revenues that aren't generated with bans and quotas. Also, with an export tax, logs could still be exported and in a number not limited by a quota. If the processing industry is too

wasteful, it may be more economical for the firm to export the unprocessed log. Therefore, a graduated export tax would have a greater possibility to create an incentive for the processors to become more efficient, than a ban or quota would.

IV. Financial Incentives

Governments give preferential credit and tax holidays to wood processors. In Ghana, long-term loans at zero or negative real interest rates were given to sawmills and plywood mills (Repetto). Also in Ghana, a 50% rebate on income taxes was given to processors who exported over 25% of their production (Repetto). In Malaysia, low-cost subsidized credit is available for exporters of processed wood products such as lumber and plywood, but not for logs. Once again, because they are not linked to efficiency of the processing, these credit terms amount to a subsidy of the industry that encourages waste.

3.2 Logging Concession Terms

The planning that goes into determining logging concessions is often minimal. The rights to exploit an area are often given away for free or for a minimal fee. Therefore, the size and time-frame of the concessions and the rents obtained from them can be sub-optimal.

3.2.1 Size

Often, due to the low price of forest fees, many logging companies will hold concessions much larger than they intend to log. In one way this is positive, keeping areas unlogged for longer periods, however it also creates two negative effects. One, if the concession is held by a processing facility, as is often the case, the rights to a large area provides a large input supply which lowers the value of the trees to the company and increases waste in harvesting and processing. Additionally, because the company does not need all the forest, it has little incentive to control encroachments onto it by settlers, who typically clear the land permanently. On the other-hand, concessions that are too small foster over-cutting within the concession area and illegal logging in nearby areas in order to extract enough wood to be profitable.

Logging concessions need to be large enough to be economically viable to harvest and to minimize pressures for over-cutting. However, they need to be small enough to allow enough companies to be able to compete for them. An export oriented company needs a concession of approximately 100,000 hectares for a 15 year period to support an efficient logging and sawmilling operation (Whitmore and Sayer).

3.2.2 Time Frame

Most governments grant concessions on a 5 to 20 year use basis. However, it typically takes at least 60 to 70 years for a tropical hardwood tree to grow to a desirable size. The loggers rights to an area are for a time period much less than that required for regeneration. Therefore, the logger has no incentive to practice less damaging logging methods to ensure that the area is viable for regeneration and has no incentive to replant the area after extraction. The logger will not see the benefits of these actions and therefore, will not spend the money to ensure the sustainability of the forest. In addition, the short time frame of the concessions does not create the incentive for the logging company to prevent the conversion to agricultural uses that often follows the extraction of logs. There are two possible modifications that could be made: renewable terms and privatization.

I. Renewable Concessions

Forestry institutions are chronically understaffed so the government cannot monitor logging sufficiently to enforce replanting requirements, ensure the minimizing of erosion and compaction, or prevent the influx of settlers who completely destroy the forest to begin agriculture. To encourage the logger to undertake these activities, the length of the concession could be increased. However, if logging concession terms are increased to the cutting cycle, as often suggested, the government may not have any recourse against a company that pursues destructive harvesting actions. It may be efficient for the time frame of logging concessions to be increased, however a requirement for periodic (every 5 years) confirmation and renewal based upon environmental performance would be beneficial. The review and confirmation system would have to be stable and not subject to political influence. If the logging company perceives that their rights may be taken

away due to political favoritism, no matter what their environmental record, then the incentive for positive behavior is eroded.

If the logging company thought that they would capture the benefit of regeneration of the forest and knew that their continued access to the forest was based upon their performance, then they would have incentives to utilize more forest friendly harvesting techniques and prevent settlement of their concessioned lands. A variation of the confirmation and renewal approach would be to grant interim or trial concessions that would be renewed or made permanent upon successful demonstration of adherence to environmental measures. Demonstration implies that it would be up to the company to show the government that they are worthy, in order to receive approval for continued operation. This is opposed to the requirement in confirmation and renewal concessions that the government inspect the area on its own with no help from the concessionaire.

II. Privatization

Private ownership of forests is common in the temperate forests of Europe and North America. Although it often leads to clear-cutting and then replanting with the most economical species, private ownership tends to produce well-managed sustainable forests in the temperate regions. However, in tropical moist forests, forest dynamics are more complex and the regeneration rate of the tropical hardwoods is so slow that unregulated privatization would probably not lead to sustained forest management. Because the growth rates are so slow, the economically rational private firm will remove all the trees as soon as possible. They can obtain a higher return on the money generated by the sale of the timber when it is invested in another activity than to invest in the forest and wait for the trees to continue to grow at such a slow rate. "The ecological economy is clearly less adaptable than the market economy, as is unmistakably demonstrated by comparing the time scales of market fluctuations and forests' ecological recovery rates (Hurst)." The previously forested area could then be more profitably broken up, sold and converted to other uses, or replanted with a plantation cash crop such as bananas or oil palm.

In order to prevent this conversion from occurring and keep the land forested, government regulation with strict enforcement procedures would be necessary. Minimum diameters

for harvesting trees would be required as well as specifications for regeneration. The right to revoke the land title if the forest was not sustained would also be required to create the incentive to keep the land forested. However, the possibility of losing the land may actually create the incentive to over-exploit the forest, particularly when environmental considerations are not naturally economical. Finally, the social costs of removing the trees, such as the loss of watershed benefits off the property, would not be considered by a private actor. Therefore, the government would have to regulate to make the landowner account for these effects. All of this government involvement in planning and enforcement is in direct conflict with the purpose of privatizing the forest; inducing sustainable management of the forest without needing government resources. In addition, the regulation of the use of private property is not enthusiastically accepted in industrialized nations and would be very difficult in developing countries where forestry institutions are so weak.

3.2.3 Allocation Method

Because the use fees are so low and the economic rents so high, substantial sums of money are made in side-payments to officials to influence the granting of concessions. Also, the government can use the granting of the underpriced concession as political favors, rewarding their influential supporters. For example, in the Sabah and Sarawak regions of Malaysia, it is widespread knowledge that timber concessions are political. In Sarawak, the concessions are granted by the Chief Forester or the Chief Minister, cost nothing to obtain and can be revoked at the will of one of the granting individuals (Hurst). During the election of 1987, lists of timber concession holders were published and showed that millions of hectares were controlled by the leading politicians, their families and their friends (Hurst). In Sarawak, the concession holder subcontracts out the actual logging operation, therefore, they own no equipment and hire no employees, all they add is a layer of fat to the economics of the operation (Hurst). In Malaysia, Indonesia and the Philippines, the awardees of timber concessions are closely related to the military (Repetto). This reduces the power of the forestry officials to develop or enforce forestry practice and greatly increases their reluctance to do so.

Another allocation suggestion is that concessions should be awarded by competitive bidding. Awarding concessions through bidding would allow the government to capture most of the economic rents, rather than having them accrue to the logging company or corrupt government officials. To be effective, the bidding process would require that the government and the bidders have sufficient information on the characteristics of the parcel and that there are several companies bidding on each concession. These levels of information and competition may be difficult to achieve.

It is argued that the raising of fees and the competitive bidding for concessions would limit the money available for side-payments and therefore, make the whole system more just. However, as explained here and in Section 3.1.1, there is little political incentive to alter the existing system.

3.3 Basis of Forest Fees

There are many methods that can be used to assess forest fees. The ones most widely used, volume-based and export taxes, have some serious drawbacks, as discussed below. The main benefit of raising fees is that the cost of harvesting the logs will be increased. Because more is paid to obtain the log, harvesters and processors will have a greater incentive to reduce waste. The price increase would accrue to the government, hopefully allowing them to strengthen their forestry institutions. This increased cost will lower profits and therefore there is less incentive to engage in logging. This will decrease harvesting levels, reducing pressure on the forest. On the negative side, increasing the cost of harvesting will also lead to lower employment and decreased export earnings, unless combined with increased value-added processing before export. Increasing the cost of legal logging also increases the incentives for illegal logging or for under-measurement and misclassification discussed in Section 3.1.1.

3.3.1 Stumpage Fee

Forest fees are often based upon the volume of wood extracted from the forest. This is known as the stumpage fee and in theory should equal the economic rent. There are a

couple of ways that the volume could be determined: per tree or volume based, with differentiation by species, size and/or accessibility.

I. Per Tree

The fee would be one assessed per-tree removed from the forest. If the fee could be based upon the number of trees felled, instead of the number that are transported, there would be an incentive to reduce the damage to unwanted trees as there would be a cost involved with the felling every tree. Additionally, a per-tree fee would reduce waste by encouraging full utilization of every tree that was cut. The per-tree fee could be varied depending upon species and diameter, or set as a flat fee, regardless of tree size. These are discussed Paragraph III.

The major drawback to the per-tree fee system is that substantial human resources are required. For the system to work, personnel must be aware of the areas being logged and then must count the actual number of stumps in those areas. However, this effort is not greater than that ideally required to assess fees based upon the volume of timber removed and to monitor logged areas for excessive environmental damage. Reliance on the human factor increases the possibility of corruption, particularly if forestry worker pay is low.

II. Volume Based

A volume-based fee requires the measurement of the log. There are several possible errors involved with log measurement as discussed in Section 3.1.1. In addition, it becomes logistically difficult to measure each log. If an inspector could be at every roadside loading point, he may as well count the stumps and collect fees on a per-tree basis. Therefore, what is typically done is to measure at centralized locations in the log transportation routes from the forest. In practice, this central location is often the export port. Administratively, the export location is the easiest to control. That aspect is very important in less developed countries. However, assessing fees at the export location does not account for or discourage any of the waste that occurs in the forest or in the transport or processing of the logs prior to export.

III. Differentiation by Species, Size and/or Accessibility

In an effort to influence the composition and management of the forest, the stumpage fee could be varied with one or all of: species, diameter and accessibility to market. This would also allow the forestry department to assess fees based upon the economic value of the trees, thereby capturing a larger portion of the rent (Grut et al).

A flat fee per stump provides the incentive to over-harvest valuable species as more money can be earned from them. It also makes the value of lower desired species zero since the cost to transport them to market may be more than the fee. When the value of a tree is zero, there is no incentive to prevent unnecessary damage to the trees and general environment during the felling of the valuable species. To avoid this, the fee could be differentiated by species class such that more valuable species would cost more to harvest than lower valued trees. Fuller utilization of the disturbed area is encouraged and damage to residual trees is minimized. In Sarawak, species specific fees are imposed and only half as much damage is done to the residual forest (Repetto). However, Grut et al point out that differentiation by species will encourage misclassification of trees towards lower valued species to avoid the higher fees. Where the forestry institutions are weak, there would be little to stop this. They also point out that most fees are assessed roadside or at centralized transportation points. By the time that logs reach those points, it is difficult to distinguish between species, particularly if they have been debarked or are dirty and wet. The misclassifications will provide incorrect data to the forest department and possibly be the basis for improper forest management decisions.

In order for the forest to have a chance to regenerate, the smaller trees need to be undisturbed. Often, minimum legal diameters are set, however they are not enforced and are therefore ignored. To provide the incentive to leave the smaller trees, the volume-based fee could be biased against smaller diameter logs, making them uneconomical to harvest and transport to market. Grut et al and Repetto, believe that the same objective can be reached by a high flat-fee without consideration of diameter (volume). A flat-fee would not make the large mature trees unattractive, as a high volume-based fee would. With a flat-fee, the more expensive it is to remove a tree, the more favorable larger

diameters become; the more wood obtained for the same fee. At a high fee, a small diameter tree would not provide enough wood to make it worth extracting. The removal of the largest trees will provide an opening in the tree canopy, allowing young trees to regenerate the forest and become a future timber harvest (Repetto and Gillis).

Finally, accessibility to transportation and the sale/processing point, are a consideration in the value of timber from a certain area. The less accessible, the more expensive it is to remove the trees from those areas. This leads to overvaluation of trees in more accessible areas and therefore higher pressures for over-exploitation. If fees are varied, with higher rates for more accessible areas, these areas will potentially be less damaged. However, the lower fees associated with less accessible areas will lead to greater penetration into previously undisturbed areas. As stated previously, it is not typically the logging itself that causes deforestation, but the accessibility provided by logging roads that leads settlers into an area and the subsequent conversion of the forest to agriculture. If a differential fee based on accessibility was considered, distant areas that are environmentally sensitive should be excluded from logging. Determining these areas would require somewhat detailed knowledge of the outlying areas, something lacking in developing countries, even in their accessible areas.

3.3.2 Standing Volume

A standing volume fee would be based upon the number, size and species of marketable trees in a specific area. The main advantage to this method is that measurement of the harvest would not be necessary, and therefore the associated problems are avoided. However, standing volume fees imply that the area would have to be inventoried in detail by the government forest agency in order to determine the fee. It is unlikely that this type of effort could be undertaken in a developing country without substantial improvements in the forestry departments. Also, in a tropical moist forest the vegetation is dense and the tree composition heterogenous. Therefore, performing an inventory would be very difficult, particularly because the area is not typically accessible before the logging roads are built.

Even if the inventory effort could be implemented, government oversight of the logging operation would still be required to assure that environmental measures are implemented and that the logging is confined to the concession area. A standing volume fee would create a large incentive for the company to harvest every possible tree, whereas under another fee system, that incentive may not exist. The forestry institution would need the capability to assess and collect heavy fines if minimum diameters are not adhered to or if regeneration is not occurring.

3.3.3 Area Based

An area based fee is similar to a standing volume fee, except that the detailed forest inventory is not performed. The fee assessed considers the area of the concession, its proximity to transportation, and the main commercial tree species. Again the need to measure the harvested logs is eliminated, but the incentive to over-exploit the area is still present, since all of the trees have been paid for. Therefore, there would still need to be significant government involvement to monitor the logging operation.

3.3.4 Processed Product Fee

A fee based upon the amount of product produced by a processor is perhaps easier to administer than going into the field to monitor the logs removed, however it also has problems. The fee does not discriminate against products produced inefficiently with lots of waste. Therefore, it is actually a penalty against efficient processors, a subsidy of inefficient ones and discourages innovation to improve utilization. To help correct this, if measurements are to be made at the processing facility, they should at least be made on the timber inputs rather than the facility output (Grut et al).

Measurement inaccuracies in either the input or the output can also occur. As discussed under Section 3.1.1, there is strong incentive for the company to under-measure its production or report the utilization of a lower value species. Due to the under-staffing of forestry departments, it is unlikely that they can perform the actual measurements to verify those provided by the company. Even if they could, there is also the possibility of bribery.

3.3.5 Export Tax

If an export tax is implemented, it would reduce the incentive for logging for the export market. However, an export tax would do little to affect domestic consumption, since the domestic price would not include the social costs. In addition, the export tax could act as a subsidy of the domestic processing industry with the ramifications discussed in Section 3.1.3. There are some benefits to an export tax though; the primary one being that on an administrative level, it is much easier to collect an export tax than a production tax due to the smaller number of players involved. This benefit should not be underestimated in a developing country.

3.4 Incorporate Environmental and Social Costs

The methods discussed in the previous three sections were all in the context of capturing the economic rent associating with timber harvesting. However, as discussed in Chapter 1, the forest provides services other than just the production of marketable wood products. Many groups believe that one way to impact environmentally damaging processes is to regulate them such that the environmental use and social disruption costs are no longer external to the market economics. By including all the costs, the price of the product will be raised, the demand reduced and the quantity produced will be what is really appropriate. In addition, the environmental and social impacts would be compensated for when they are internalized.

This internalization of externalities is very difficult due to the very fact that they are not traded on the market - there is no monetary cost established. Determining the social and environmental costs requires approximations and extrapolations based upon what can be measured. This requires a consensus among policy-makers as to how to cost the externalities and allocate the costs within the industry.

There have been several general suggestions for methods to incorporate environmental costs in forest fees, however none go as far as to determine the appropriate price. These methods are discussed below and include: a reforestation deposit, a production tax and a minimum forest fee.

3.4.1 Reforestation Deposit

A possible solution would be to require the awardee of the concession to pay the government a refundable fee in the beginning of the term. The fee would then be returned to the logging company at the end of the concession if the area was in a forested and productive state. The fee charged would have to be substantial in order to create the incentive for the logging company to want to get it back. In addition, if the government does not pay interest on the reforestation deposit over and above the rate of inflation then the value in real terms over the period of the concession becomes insignificant. In Indonesia, logging concession holders pay a "deposit" of $4 per cubic meter of timber that is returned when the logged area is reforested. However, most companies in Indonesia forfeit this deposit because it is more costly to replant the area than to write the up-front expense off as a loss (Repetto).

Another form of the reforestation deposit could be that companies would pay a large up front fee and then the government would take over the replanting effort. This is the method in sectors of some industrialized countries, such as the Province of British Columbia in Canada and the Bureau of Land Management forests in the United States (Grut et al). The requirement of payment up front would bias the system towards large companies with up front resources. In order to make the system more equitable, it may be possible to delay payments until after the forest began generating revenue for the company.

3.4.2 Production Tax

The World Bank argues that the most effective policy to be implemented is for the national government to impose a production tax based upon the societal costs of logging. This basically amounts to raising the fee over and above that which captures the economic rent in order to account for the environmental and social costs of disruption of the forest. The tax will lower the profits available to the seller therefore reducing the supply to where the social costs of production are accounted for. This assumes that there is an international price that the wood sells at and therefore represents the maximum price. The size of the appropriate tax depends upon whether the social costs are domestic (watershed and local

climate problems, loss of alternative incomes, ...) or include the international effects too (carbon dioxide emissions and loss of biodiversity). Determining these costs is difficult and requires substantial future study at the national and international levels.

3.4.3 Minimum Forest Fee

A minimum forest use concession fee could be assessed to ensure that the downstream consequences of logging, such as watershed effects and loss of non-forest products, are accounted for in the economics of logging an area. In addition, minimum fees can ensure that the administrative costs of forest management are accounted for, including replanting schemes. A minimum concession fee will raise the cost to harvest the forest, however, the incentive for over-exploitation of the area would be increased since the whole area was paid for. This problem could be minimized by the strict enforcement of environmental standards or by combining the minimum fee with another fee based on volume or number of trees extracted. The combination would ensure that waste was reduced and only the most marketable sizes and types of trees are removed, thereby increasing the opportunity of regeneration. The main problem is that the indirect effects of logging are not easily quantified.

3.5 Extractive Reserves

The main benefit of extraction of non-wood products is that the forest is not substantially altered and therefore continues to provide all of the services discussed in Chapter 1. The extraction of non-wood products provides an income from those activities that extends into the future indefinitely (as long as there is a market for the product). In logging, the income in a particular forest area is only produced for a short period of time and then not again for the long period of regeneration or, if the area is severely degraded, the income potential is lost forever. When the value of non-wood products is considered, the value of the intact forest is increased, and incentives to log the area are diminished.

Extractive reserves are large forested areas set aside, protected from logging, agricultural conversion and other development, to allow for the development and continued economic

use of the forest for the extraction of the non-wood items. By setting aside areas as extractive reserves and therefore eliminating the possibility of logging those areas, the value of the forest that can be logged is increased. This reduction in supply may raise timber prices and lower production in the long-term, reducing the waste that is occurring in the tropical forests.

There are have been two examples of extractive reserves in the media recently. One is the extractive reserves established in the Brazilian Amazon in order to allow the continued collection of rubber from the forest. The rubber tappers in the State of Acre, under their leader Chico Mendes (who was assassinated in December 1988), pressured the government to stop the destruction of the forests they had lived in for generations. Rubber tapping relies on the continued health of the rubber tree and therefore the continued health of the forest. Rather than retreat even further into the dwindling forest or leave the forest to join the masses of settlers in unsustainable agricultural pursuits, the rubber tappers challenged the wisdom of the government's policies. In 1988 four extractive reserves totaling over 3 million hectares were established in the states of Acre, Amazonas and Rhondonia and the territory of Amapa. The government retains ownership of the forest, but the cooperatives have secure rights to manage and utilize it. The rubber tappers and indigenous peoples are also marketing hearts of palm and Brazil nuts and other products from the reserves. Each year Brazil exports over 100 million pounds of Brazil nuts worth over $50 million; however much of the profits accrue to the middlemen, not the forest dwellers (Earth Care Annual).

The other example of a type of extractive reserve is the agreement between the government of Costa Rica and Merck Pharmaceutical Corporation. Costa Rica will receive $1 million to protect an area of tropical forest in exchange for granting Merck exclusive rights to investigate the plant resources within the protected area. Profits from products eventually developed by Merck will be shared with Costa Rica. This profit revenue will be targeted by Costa Rica to their national conservation program. This type of agreement has been hailed by free-market believers as a prototype for private interests to finance preservation of the forest.

In Indonesia, the export of rattan, resin, essential oils, kapok and chinchona bark (quinine) was worth $134 million in 1986 (World Bank, 1991a). The Sudan and Madagascar each earn $60 million from the exports of gum and vanilla beans, respectively. In Guatemala, the decorative green, xate, is collected from the forest and shipped to market in North America and Europe, earning $4-6 million each year (Earth Care Annual). Extractive activities could also capture more of the value of their products and provide more employment if the processing facilities could be located in the remote forest areas rather than in the larger cities or in the importing countries. For example, approximately one quarter of the Brazil nuts collected in the Amazon rot during their three week long transport to the processing facility in Belem (Earth Care Annual).

Another non-timber product showing potential in recent years is the tagua nut. In earlier days, most buttons in the world were made from tagua nuts imported from rainforest countries. These natural buttons were replaced by plastic buttons. With the new environmental consciousness in industrialized countries, renewed markets for tagua nuts have developed. Another market for non-timber rainforest products is in the cosmetics industry. In Europe and North America, The Body Shop has developed into large retailer of natural products, several produced with fruits and oils from tropical rainforests.

In a study of an area of Peruvian tropical forest, it was found that for a 1 hectare area, harvesting rubber and fruits had a 20 year net present value of $6,440, whereas the conversion of land ideally suited for pasture to cattle ranching would be worth approximately $2,960 and the one time harvesting of timber would produce $1,000 (Whitmore and Sayer). Unfortunately, many rural poor cannot look 20 years into the future and would prefer the immediate $1,000 from the timber harvest and take their chances on making the $2,960 from cattle ranching. Therefore, there needs to be strong community control over the area to ensure the long-term viability of the community and the forest.

There is another danger in extractive reserves. As the demand for products grows, there will be the tendency for over-exploitation. The extraction of large quantities may destroy the delicate ecological balance. For example, although ruining the long-term viability, it has become more economical in the short-run to cut the whole tree down to extract the

hearts of palm (Earth Care Annual). Careful planning and oversight of extractive activities needs to be in place to prevent opportunistic behavior of individuals in a publicly owned resource and to avoid the extraction of products that cannot be harvested sustainably.

3.6 Nature Reserves/Parks

Nature reserves/parks can be established in critical areas in terms of watershed capabilities, uniqueness of habitat, abundance of animal and plant species, scenic beauty or other criteria deemed important. As with extractive reserves, the establishment of conservation areas reduces the supply of trees available to the logging companies, effecting the long-term dynamics and possibly fostering better care of logged areas.

The FAO Forest Resources Assessment 1990 identified that substantial areas of tropical forests are theoretically under management for conservation or protection. In Africa, 10% of the land area is under partial or total protection, with 3.3% of land area under total protection (74.6 million hectares). In Asia and the Pacific, 10.9% is protected, 5.3% totally (47.1 million hectares). 21.4% of Latin America is theoretically protected with 3.8% totally (61.9 million hectares). However, the assessment noted that "Throughout the tropics there tends to be inadequate legislation and ineffective application of the legal measures that do exist... Consequently, there is a strong tendency towards 'paper parks' whose existence is largely theoretical and is not reflected by substantive and durable conservation reserves on the ground (FAO, 1993c)." In addition, the forestry department designates and oversees a substantial quantity these protected areas (18% of all protected areas in Africa, 44% in Asia and 36% in Latin America). Therefore, these "protected" areas are not protected from logging, but rather are designated as protected to ensure that logging can occur there in the future.

By establishing and maintaining nature reserves/parks, countries can promote eco-tourism and generate a source of foreign currency income to replace or supplement the currency realized from the timber trade. Costa Rica has been particularly active in this movement. Costa Rica now has over 55 national and private wildlife reserves that cover almost 20% of the nation's land area (OTA, 1992). Of the $55 billion generated from tourism in developing countries in 1988, it was estimated that between $2 and $12 billion was

generated by nature-oriented tourism (OTA, 1992). In fact, it is estimated that some parks in Thailand bring in 3 to 10 times more income than the costs of park maintenance (OTA, 1992).

The main drawback to eco-tourism is that often the profits generated from publicly owned reserves are not accrued to the government to be used to manage and expand the reserve. Usually the money is earned by the private interests near the reserve, such as stores and hotels. Fortunately, as the profits grow, so does the political clout of these private interests that rely on the maintenance of the forest not its destruction. One possible method of government income generation could be to grant concessions to the recreational facilities and the tour companies that operate in the reserve and then use the funds collected to maintain the protected area. Preservation projects also need the support and involvement of the local population in their development and maintenance. Prior to the reserve's protection, the local population used the land to support all or part of their livelihood. If the local inhabitants do not have a stake in the success of the reservation, their actions can undermine the preservation efforts.

Creation of nature reserves and eco-tourism generates not only direct employment in remote areas to run the reserve but also indirect employment to support the new industry, such as food production and craft markets. In addition eco-tourism brings in sanitation improvements demanded by western tourists. Preservation of the forest also means that incomes from the reserve have the potential to be generated year after year, rather than the one time profits gained from logging. However, local economies should not rely totally on the tourist industry, as the number of visitors can fluctuate with the economy both domestically and abroad. In times of low demand, incomes would be low and the incentives for destroying the forest may be increased.

Eco-tourism has benefits other than direct income generation. The more people are brought in contact with the tropical forests and the people who live there, the more educated they become to the benefits of ensuring the preservation of the forest and the cultures that depend upon them. By making somewhat vague notions of tropical forests more real, consciousness is raised and the likelihood of individuals taking action to

preserve the forests is increased. The importance of this aspect will increase as more and more wealthy urban citizens travel to their own forests for vacation.

3.7 Improve Technology

Most methods that can be used to minimize damage to the forest and improve recovery of the processing industry are simple, requiring only planning and education. The process of forest regeneration is much more complicated and little knowledge has been gained thus far.

3.7.1 Tree Growth

The ITTO has stated that "it is not yet possible to demonstrate conclusively that any natural tropical forest andy where has been successfully managed for the sustainable production of timber" (OTA, 1992). Some tropical forestry researchers recommend that all logging of primary forests be replaced by the development of tropical hardwood plantations (Johnson and Cabarle). Agenda 21 and the Forest Principles from UNCED also advocate development of plantations, rehabilitation of degraded areas and management of secondary growth forests as vital to reduce demands on primary forest.

In order for governments and the forestry industry to spend the money to develop the most appropriate technologies for tropical hardwood plantations, secondary growth management or rehabilitation of degraded areas, the cost of harvesting the undisturbed primary forest will have to increase. The need to save the primary forest and invest in alternatives has to be perceived by all those involved, from the local community, the government and the forestry industry. WRI also warns that "Degraded forest lands, secondary forests and areas targeted for plantation development are frequently called home by many people. If they are not seen as part of the solution in the development of these alternatives, they may very well be a decisive factor in their failure (Johnson and Cabarle)."

I. Plantations

By 1990, in 90 tropical countries, 43.9 million hectares of tree plantations had been established: 73% in Asia and the Pacific, 20% in Latin America and only 7% in Africa (FAO, 1993c). Almost two-thirds of the total plantation area is to provide non-industrial timber (e.g. fuelwood, agro-forestry and watershed projects): 53% of African plantations, 72% of Asian/Pacific and 41% of Latin American. India had the largest plantation area at 18.9 million hectares; followed by Indonesia with 8.8 million and Brazil with 7.0 million. Industrial plantation forests are developed to provide large quantities wood with uniform characteristics for a specific application such as wood pulping or lumber. Therefore, they are developed as mono-cultures of fast-growing species. There is substantial debate as to whether the tree plantations, which are basically cultivating one species of tree to the exclusion of others, are actually a healthy method of production from an ecosystem point of view. Mono-cultures reduce the complexity and lack the "robustness" of a natural system, providing little habitat for wide varieties of species and little use to the surrounding population. They are also particularly susceptible to insect infestation and disease.

Most tropical hardwoods are not fast-growing and require specific environmental conditions in order to flourish. Tropical hardwood species have developed in response to the "complex ecological and environmental relationships (of the natural forest) that cannot be replicated in large open environments with a very simplified ecological structure, so they're left open to insect infestations, deprived of vital soil microbial relationships, and inadequate moisture supplies (Johnson and Cabarle)." With a few exceptions such as teak, laurel and some dipterocarps, tropical hardwoods are not well suited to plantation-style production. For those species where plantation-style growth is feasible, wood yields can be about 10 times that from natural forests (OTA, 1992). However, rates of plantation development are much lower than deforestation rates: 1 to 29 in Africa, 1 to 10.5 in tropical America and 1 to 4.5 in Asia (OTA, 1984).

In West Africa, India and Southeast Asia, teak is the main industrial plantation tree, while in Central and South America and East Africa, pines and cypress are planted (OTA, 1984). Eucalyptus is also planted in India and Brazil for pulp production. Approximately 14 million hectares of land, primarily in Asia, is plantation for non-timber production: 7.2

million hectares is rubber plantation, 4.2 million is coconut, and 2.7 million is oil palm (FAO, 1993c). The FAO speculates that these non-timber plantations could become important sources of fuelwood and of industrial wood with improving technology (FAO, 1993c).

II. Secondary Growth Management

The World Resources Institute advocates the management of secondary growth forests as "a more promising alternative" to exploitation of the primary forest than are plantations (Johnson and Cabarle). Secondary forests account for 36% of productive closed tropical forests according to the FAO and the area of secondary growth forests annually increases at over 50% of the primary forest area lost (Johnson and Cabarle). Because the forest has been logged before, it is more accessible than primary forests.

The logging of secondary growth forests has increased over time, reflecting the capability of forests to regenerate commercial species. Also, as highly valuable species become over-exploited, their price increases due to the lower supply. Therefore, other species become more important and the forest is re-logged to obtain them. In the period 1971 to 1975, 506,000 hectares of secondary forest were harvested each year: 166,000 in Africa, 221,000 in Asia, and 119,000 in Latin America (FAO, 1993c). Currently, over 1 million hectares of secondary growth forests are harvested each year: 248,000 hectares in Africa, 453,000 hectares in Asia and 320,000 hectares in Latin America (FAO, 1993c). Although this appears substantial, it should be remembered that the logging of primary forests affects almost five times as much area each year.

As discussed in Section 2.2.2, there is an optimum canopy gap size for particular species. Larger gaps correlate with the growth of less-desirable pioneer tree species, shrubs and vines. A possible method of secondary forest management would be to harvest to provide optimum gap for encouraging the smaller sized commercial species to grow (and protect them during log harvesting). Location specific studies would need to be performed in many areas to determine how to harvest to obtain these appropriate gap sizes. Regrowth can be rapid; however the species concentration and relative proportions within the forest is altered to favor the commercial trees.

Regeneration of logged areas could be facilitated if there were unlogged primary forest areas preserved within the logging concession. These areas would provide the sources of the colonizing tree species and the pollinating and dispersal agents (insects and birds/animals). In Sabah, maintenance of 5% of the area preserved populations of most bird species, although 20% would be a more optimal area to ensure genetic diversity and regeneration capabilities (Whitmore and Sayer).

Secondary forests contain species more adapted to their environment and are better at providing soil, water and biological diversity functions and are less susceptible to insects and fungi than plantations (Johnson and Cabarle). Finally, secondary growth forests tend to evolve naturally and therefore involve less financial investment and risk than plantations. Even if the forest is damaged during extraction such that commercial species regeneration is not possible, secondary forests can perform virtually the same watershed functions as a primary forest and can be a valuable source of firewood and local construction materials.

The ITTO advocates the establishment of permanent forest estates in each country as a way to decrease primary forest destruction. These areas would remain permanently forested and be managed to provide wood-based resources indefinitely. However, it should be noted that several countries have established permanent forest estates and have failed to protect and manage them to ensure this permanence. In the Philippines and in Thailand, 56% and 40% of their total land areas, respectively, are legally classified as forest estate, however the total forested area of each country is now less than 20% (Johnson and Cabarle).

III. Regeneration of Degraded Areas

Some areas may be suitable for rehabilitation such as more than 54 million hectares of previously logged land in Asia and 10 million hectares of abandoned pasture land in the Amazon Basin in Brazil (Johnson and Cabarle). Sometimes regeneration will occur naturally, as long as interferences from resettlement attempts are prevented. In other cases, more direct manipulation is required such as creating less eroding drainage patterns and actively planting and caring for seedlings.

3.7.2 Harvesting, Transporting and Handling Techniques

In tropical moist forests, only a small portion of the vegetation is of high enough economic value to be worth cutting and transporting. Clear-cutting of tropical moist forests for timber is rare, however, there is considerable unnecessary damage done when the valued species are selectively extracted. This is due to the low perceived value of the forest and the lack of training received by the loggers and the tractor skid drivers. The result is often disruption of the ecosystem such that regeneration is not possible.

The damage to the forest occurs during three activities: harvesting, transport and handling. Even when the market valued species are selectively cut, the undesired species are damaged, typically 50% of the remaining forest (OTA, 1984). For every tree removed, a second tree is completely killed and a third tree sustains damage from which it can recover (Whitmore). In addition, the soils of the area are compacted by the heavy equipment used. This compaction severely inhibits the capability of the forest to regenerate. The seed bank is within the top 0.1 to 0.3 meters of the surface soils and after compaction, few seedlings can survive to regenerate the forest (Whitmore). Infiltration is also reduced and erosion due to run-off is increased. Most accessible areas have already been logged or converted to agriculture, therefore, most logging is now on sloped areas creating even greater erosion problems.

I. Clear-cutting

One possible method to slow the overall rate of deforestation would be to encourage clear-cutting and the use of more tree species in the market (OTA, 1984). In this way, smaller areas would be needed to provide the same quantity of wood, therefore, lessening the need for roads and confining damage to smaller areas. However, clear-cutting could increase soil erosion and nutrient loss and would cause more severe habitat loss that fewer species could adapt to. Also, the forest is heterogenous and the trees with market-value are not found in uniform stands. Therefore, for clear-cutting to be viable, it would have to be combined with creating markets for lesser-known species and with the development of uses for woods of little value (such as particleboard).

II. Harvesting in Narrow Bands

A refinement of the clear-cutting method, would be to harvest all the marketable trees from narrow bands through the forest. When the strips are kept narrow, less than 100 meters, it allows the maintenance of forest habitat for animals and the proximity of plant species for natural regeneration (OTA, 1984). The main negative aspect of this method is the lessened economic attractiveness due to the increased complexity of implementation. In addition, access to a large area would be granted, and without proper oversight, there would be little incentive to maintain the strips.

III. Transport of Logs

Logs are removed from the forest using tractors. The economics of using this capital-intensive equipment requires that large areas are quickly logged. Heavy equipment causes severe compaction of the vegetation and soils over the whole path the tractor follows. The damage is typically widespread and somewhat uniform. Roads are typically cut 20-30 meters wide to ensure that they dry out after the heavy rainfalls. Therefore they can occupy 6-20% of forest. In addition, the skidder tracks are approximately 4 m wide. In an intensive logging effort, 27 km of road and tracks can be built per 100 hectares logged, rendering 30-40% of forest bare of vegetation (Whitmore and Sayer).

Better planning of hauling roads and tractor paths can reduce damage and improve performance. In Sarawak, Malaysia, better planning improved timber movement by 36%, lowered overall costs by 19%, reduced open cuts in the forest from 40% to 17%, and improved commercial seedling survival from 40 to 60 stems per hectare (Whitmore). Instead of tractors, overhead cables can be used to transport logs through the forest. There is severe damage along the cable paths but very little in between the cables. Therefore, more viable seedlings remain following extraction (Whitmore).

Tractors using treads, as opposed to tires, cause extensive compaction of soils and damage to vegetation. The Rainforest Alliance states that "harvesting machinery must haul logs with the front end and any blade lifted off the ground to minimize soil disturbance. Excessive spillage of fuel and other fluids are to be avoided (Johnson and

Cabarle)." The ideal solution would be to go back to log hauling with animals. Animals require pathways that are much narrower, their tracks are less destructive to the soils than tractors and they are less polluting. In Thailand, it is generally recognized that logging was not as destructive as in other areas due to their reliance on elephants for log transport.

IV. Directional Felling

Simply planning and controlling the direction the falling tree will take can be used to minimize damage.

V. Improved Handling and Storage of Logs

There is significant loss of harvested wood due to molds, insect infestation, splitting and other damage due to improper drying and damage simply from negligent handling in general. In Malaysia, where Japanese trading houses buy 50% of exports and have very high quality standards, the buyers purchase upon inspection. Therefore, millions of cubic meters of "unacceptable" logs are transported to common areas where they are left to rot (Hurst, 1990). According the OTA, large quantities of logs rot at the roadside in countries such as Myanmar, India and Bangladesh where the roads are impassable during the rainy season (OTA, 1984).

VI. Use of More Species and Smaller Sizes

The export orientation of selective logging practice increases the desirability for large quantities of uniform size, single species logs. Studies have shown that over 200 tree species with diameters greater than 10 cm exist in one hectare of Southeast Asian forest and 138 species were identified in 0.64 hectare in Cameroon (Sayer and Whitmore). In the Amazon region of Brazil, only 5 or 6 of the hundreds of tree species are removed and found in the marketplace. In Cote d'Ivoire, where commercial logging has a longer history, the number of species harvested is still only 25. The OTA and others allege that the absence of uniformly applied quality standards and grading system, and prices that do not reflect the quality of the logs, leads the importing country to demand a higher quality

product than the ultimate end-use requires (OTA, 1984). This eliminates from the market species that may adequately serve the user. It also increases pressure on the exporter to provide the most desirable species thereby increasing the forest area that needs to be exploited. In Australia and Great Britain, systems have been developed to group species by applicability for end-use and to provide the user with references to the more well known species for comparison (OTA, 1984).

The use of smaller sized and/or lesser known trees would also allow greater utilization of areas that are damaged during selective logging. The smaller, or less uniform, trees could be sold for end-uses that could be less exacting, such as charcoal production, pulpwood, and chips that are made into pressed wood panels (OTA, 1984). The wood from the center of the tree is typically very soft from the tree sap and highly perishable. It is typically cut from the tree and discarded. In smaller trees, the proportion of the tree that is sapwood is greater, therefore the percentage of waste per tree used may increase. Finally, smaller trees provide the best hope of growing into larger trees and regenerating the forest. Therefore, minimum diameter standards need to be set and enforced to ensure that regeneration may occur.

VII. Use of Preservatives

Generally, tropical woods are highly valued because of their hardness, durability and natural resistance to insect infestation. However, there are tropical woods with satisfactory properties that are susceptible to insects or fungi (OTA, 1984). If wood preservative methods could be used soon after harvest, more wood species could be marketed and less waste would occur. However, the existing preservative methods, creosote impregnation and pressure treatment with heavy metal compounds (copper-chromium-arsenic), involve the use of hazardous materials which can pollute the land and waters if their use and waste disposal are not tightly controlled. The topical woods are also not readily permeable and existing penetration techniques are not successfully applied. In addition, the use of chemicals adds a significant expense to the process, reducing the potential for practical application. Research is required to develop a better understanding of the interactions between the various woods and preservative solutions.

In addition, there is potential application of biotechnology to wood preservation, however research is necessary (Kallio et al).

If non-hazardous inexpensive methods for wood preservation could be developed for the woods used at the local level in tropical areas for housing construction, it could extend the lifespan of a typical house from five to ten years. This would significantly reduce the domestic demand for wood and the amount of time spent by a family to rebuild their home.

3.7.3 Processing Techniques

Sawmills in tropical countries are designed to cut large logs. If, in an effort to better utilize the disturbed area, smaller or less uniform logs are input, complications are introduced to the processing and output would be decreased. However, in an effort to reduce waste, it would be advisable to introduce smaller saws and planing machines. They would allow better utilization of smaller trees and enable the conversion of imperfect material into smaller units suitable for uses such as furniture and flooring. A method that increases the labor input and decreases waste is the most appropriate in developing countries. Therefore, hand-cutting and hand-sawing may be the best "technology" (especially since they do not use fossil fuels, and therefore are not costly to obtain and they do not pollute).

On the large scale, it is estimated that if Indonesian sawmills and plywood manufacturers were utilizing the equipment on "... the world technological frontier...", that current levels of production could be maintained with a savings of 3.3 million cubic meters of logs per year. This translates into a harvesting reduction of approximately 10% (Low).

Another way to reduce waste is to process the logs in closer proximity to their harvesting location. There are portable sawmills that could be transported into the forest. However, they are difficult to move due to their weight, cause significant damage to the forest during moving and would make access to previously undesirable areas more profitable (OTA, 1984). Another modification would be to process the logs right at the stump. By eliminating the need to move the large logs through the forest, environmental damage could be reduced, particularly if the lumber is transported to the roadway manually (OTA,

1984). These in-the-forest processing methods would also have the added benefit of increasing labor requirements.

Finally, to more fully utilize each tree that is harvested, markets for waste products need to be developed. As discussed in Chapter 2, the conversion of a log into lumber or plywood creates significant quantities of chips and sawdust. In industrialized countries where the input log is more expensive, these chips and sawdust are used to make particleboard, fiberboard and wood pulp. Currently, there is little international market for the raw chips and sawdust due to their low value and the relatively high transportation costs. However, domestic markets could be developed to process these wastes and then international trade does exist in the products (particleboard, fiberboard and wood pulp). These domestic markets will not develop until the cost of harvesting the tree is raised to the point where using the wastes is economical.

3.8 Strengthen Institutions

The success of virtually all of the economic and technical methods to improve the sustainability of the tropical timber industry discussed above depends on a strong forestry department. The forestry department needs to collect accurate baseline data regarding the characteristics of the existing forest resources of the country and the economics of the forest sector. This data would then be used to develop a forest use plan and the best policies to assure that price of the wood reflects the true cost of the logging impacts and that the government collects as large a portion of the economic rents possible. Finally, and most importantly, the government needs to be able to supervise forestry projects, enforce their policies and collect their fees. In order to move towards this ideal situation, forest institutions need to be strengthened in many ways.

3.8.1 Increase Skills

The persons who work in the forestry department need to receive adequate training in the components of forest management. Currently, throughout the developing world, there is a severe shortage of technically trained personnel. Improved management of the forest

requires that the individuals involved understand and often quantify the possible multiple benefits and uses of the forest. The more knowledgeable the regulators, they more likely they are to recognize harmful policies and practices.

Training programs, at both vocational and university levels, need to be developed, supported and made available. In order to attract and keep trained individuals, and minimize graft, the forest management institutions will also need to provide employees with adequate salaries. "Salaries are commonly so low that people must work at other jobs just to survive. Salaries are then viewed as retainers rather than as payment for performance (Grut et al)." The government will also have to place greater importance on the forest institution in order to increase the prestige of the profession.

3.8.2 Improve Planning

National governments need to develop comprehensive forest preservation and management plans. In their 1990 assessment of world forest resources, the FAO discovered that "there is a wide variation among regions with respect to completeness and quality of data... the data is about ten years old, on average... countries have not used appropriate techniques... (and) only a few countries have reliable estimates of actual plantations, harvest and utilization although such estimates are essential for nations forestry planning and policy making (FAO, 1993c)". The forest institution needs to undertake an inventory of existing resources as a first step towards true management of the forest resource and its use. The sustainable yield of the forest also needs to be determined in order to determine allowable harvesting rates and frequencies.

"The problem of ensuring an adequate industrial wood supply for international trade is more tractable than the problems associated with fuelwood supply, impacts of deforestation on soil and water resources, or maintenance of biological diversity (OTA, 1984)." However, these considerations greatly effect the success of any forest management plan in meeting the needs of the citizens who depend upon it. Therefore, the forest institution needs to widen its approach to forest management to include these environmental and social aspects. These efforts will require increased financial resources and significant levels of training of forestry officials. It will also require change in the focus

of forest management that will not occur without a change in the attitude of political leaders.

Through the Topical Forestry Action Plan, 86 governments are participating the development of national forest management plans. The plans are supposed to be comprehensive, including elements such as reorganization of the forest institution, data gathering, development of forest use policies, as well as a coordination with other national and international institutions. There have been significant problems with the political commitment and funding necessary to implement the plans.

3.8.3 Increase Monitoring and Enforcement

Virtually all of the economically related improvements suggested in Sections 3.1 through 3.4 are dependent upon increased monitoring of the harvesting and enforcement of restrictions by the forestry institution. As discussed in Section 3.1.1, no matter how high fees are set, if they are not collected, then the subsidy of the industry continues and so does the waste it inspires. Even the fees that do not involve the measurement of harvested trees, such as area-based fees, require the enforcement of harvesting restrictions in the forest. Policies such as log export restrictions increase the incentive for illegal logging. To deter this, monitoring of the forest for illegal logging and prosecution of those found engaging in illegal activities needs to occur.

Even without altering the current forestry policies, significant improvements in the forest sector could be made if just by enforcing the existing policies. As mentioned in Section 3.2.3, there is often corruption at the highest levels of the government associated with commercial logging. As a consequence, there is reluctance to improve monitoring and enforcement both at the policy-making level and at the ground level.

3.8.4 Improve Equipment

The forest institutions are chronically short of funds and therefore lack equipment. They often do not have the vehicles that would allow travel into the forest to inspect the logging

concessions. Without adequate equipment, monitoring of logging concessions and enforcement of policies is at best difficult.

3.8.5 Increase Cooperation

Virtually all government policies have a possible impact on forests; from dam and road construction to agriculture programs to resettlement plans. To ensure that the plans of other agencies do not undermine the forestry plan, there needs to be cooperation between the various government agencies.

Increased cooperation could also yield substantial quantities of data that could be used to develop resource use plans. Data is gathered by agencies, ministries, scientific institutes and universities, businesses and international organizations. Most of the data is used by the group that gathered it and little is disseminated to the other groups. For example, in Thailand, over 80 different groups produce environmentally relevant data, however the methods used are often in incompatible formats and nomenclatures (Ahmad et al). Harmonization of competing data gathering systems and institutions could integrate knowledge and reduce the amount of redundant work undertaken.

3.8.6 Improve Education of Public

Almost all agencies, governmental and non-governmental, stress that without the involvement of the public in forest management, improvements in deforestation cannot be made. Management of the forest for fuelwood production needs the cooperation of the users. This also applies to the timber industry, as it is typically the locals who actually cut the trees and transport them through the forest. The viability of nature reserves and extractive reserves also depends upon the education and support of the local population.

4.0 IMPORTING COUNTRY POLICIES TO IMPACT DEFORESTATION CAUSED BY INTERNATIONAL TRADE OF WOOD PRODUCTS

In recent years, environmental and government groups in numerous OECD countries have called for restrictions or even bans on the import of tropical hardwoods. In fact, Holland has proposed a ban on tropical timber to take effect in 1995. The World Bank argues that free trade does not cause the environmental degradation and that trade restrictions are not the way to deal with environmental problems (Low). The Bank advocates open trade policies combined with a labeling program and education in the consuming countries as the most appropriate measures. Other organizations, such as UNCED in their publication Agenda 21, stress technical advances and improvements in planning and management through the strengthening of forestry institutions.

As stated in Chapter 1, only 14-20% of global tropical deforestation is caused by the production of wood products, and even less than that by the international trade. The remainder is basically caused by population pressures and government policies that encourage or force agricultural conversion of forests. Therefore, changes in the international tropical hardwood trade would have only a comparably small effect on the total problem. However, the commercial forestry sector is a significant contributor to deforestation in several countries. In addition, it is a relatively easy sector to concentrate efforts on and obtain a result. The causes of the other 80-84% of deforestation are much harder to fully understand and correct. Since environmental groups, and the population in general, in many importing countries are concerned with the loss of rainforests, there is great pressure to do something. That something will most likely involve the trade of wood products, as it is a more tangible subject to deal with. There are several different policies that are considered by the international community and are discussed below.

4.1 Import Tariffs

There are two different issues regarding import tariffs. The first involves altering the existing tariff structure and the other involves the establishment of a new multi-national coordinated tariff system.

4.1.1 Eliminate Protective Tariffs

Virtually all organizations, from the World Resources Institute to the World Bank advocate the elimination of the escalating protective tariffs imposed by importing nations. Most industrialized nations, particularly Japan and the European Community protect their own forests and wood processing industries by imposing low tariffs on raw logs and increasingly higher tariffs increased processing of the incoming products (e.g. the higher tariffs on plywood than on sawnwood). The removal of these tariffs would give exporting countries the incentive to engage in value-added processing. As discussed in Chapter 3, processing can maintain employment with less input (lowering pressure on the forest) and help the trade balance of the exporting country. An even stronger incentive would be to reverse the tariff structure with the highest tariffs on raw logs and the lowest tariffs on processed woods.

4.1.2 Funding of Sustainable Forestry Through Raising Tariffs

The second import tariff policy is to use import tariffs to achieve a desired environmental result. An import tariff raises the selling price of the product in the importing country market. If import tariffs on logs were raised, the higher price may lower demand for the tropical wood products in the importing country. The importing country government normally collects the tariff and the exporting country obtains none of this price increase. The lower demand will reduce the incentive to produce wood for the export market. This will lower the income generated by the trade of tropical woods. Or, in an attempt to keep the same quantity demand, the export price of logs would be lowered. In either case, the income of the export country is lowered, and therefore the value of the forest to them is lowered. As a consequence, the incentive to convert the forest to other uses is increased.

In an effort to compensate the exporting countries for this lost income and to promote long-term sustainable forestry, importing countries could collect the import tariffs and place them into a fund to benefit forestry management programs in exporting nations. This policy may produce the desired environmental result if the fund can offset the negative environmental effects created from lowering the value of the in-situ trees, and make some improvements beyond merely off-setting the effects of the tariffs. This would have to be

an international action, with all importing countries implementing the same tariff structure and assessing it on all imported tropical woods. Otherwise, exporters will simply develop markets in industrialized countries that do not have high tariffs.

Determining the tariff structure that would bring about the desired environmental effect would be difficult. Also, it is doubtful, especially in the free-trade climate in many of the major importing countries, that all importing nations would agree to a common system of determining and overseeing the tariff system.

Another consideration is the General Agreement on Tariffs and Trade (GATT). The GATT is administered by the United Nations and is the comprehensive agreement under which international trade is monitored and disputes are resolved. The main goal of the GATT is the eventual removal of all trade barriers between all nations. By joining the GATT, which virtually all nations have, a country commits itself to applying its trade restrictions in a nondiscriminatory manner (e.g. applied uniformly to all nations) and to negotiating to reduce its trade restrictions (Low). Any action taken by a country in relation to international trade has to be "fair" and the least trade distorting option possible. Therefore, under the GATT, if a participating nation wants to raise the tariffs on one product it imports from a particular country, it needs to compensate by reducing the tariff on another product it imports from the same country by an amount equivalent to the raise. If industrialized countries want to raise the import tariffs on raw logs, the tariffs on another imported product would have to be reduced. The raised tariff would have to be applied equally to all nations that it imports the product from. So increasing the tariffs on tropical woods is not as simple as it may at first appear.

In recent years, there has been substantial controversy over the GATT in regard to the environmental issues, and efforts are underway to modify the GATT to allow for environmental sanctions, at least at the multi-national treaty level. Some nations, particularly those that are not yet industrialized, see environmentally-based requirements as a non-tariff barrier to trade and an interference with their sovereignty. Or taken the other way, industrialized nations see the lack of environmental regulation as unfair trade advantage. Environmental groups see the GATT as undermining all efforts to "save the planet" since unilateral, and even multi-lateral, efforts to restrict the import of products

produced in ways that severely harm the environment are not legal under the GATT. Until these issues of environmental regulation and trade sanctions are decided within the framework of the GATT, the existing system prevails.

4.2 Import Quotas

Some organizations and governments have called for importing nations to develop annual quotas for tropical hardwood logs and products. These quotas would then be negotiated with exporting nations with preference given to those nations practicing the most environmentally sound forest management. This type of policy has both positive and negative aspects. Positively, it creates an incentive for nations to develop sustainable forestry programs due to the potential foreign currency gains if they do and losses if they don't. Quotas also restrict supply in the importing country causing price increases. With a quota the increase accrues to the exporter not the importer (as a tariff does). Increased sale price theoretically increases the value of the standing forest which theoretically increases the incentive to preserve the forest. The quantity quotas should quell the natural tendency to increase production in response to the higher price.

The negatives of import quotas are several. In order to truly be effective in controlling deforestation for the wood products trade, all importing nations would have to participate. Otherwise, the incentive to develop and implement sound forestry practices is undermined. There would still be a market for the products of unsound management and some nations may not want to undertake the large task of altering the status quo in regard to their forestry system. As with the tariffs, it is doubtful that all importing nations would agree to a system of determining and overseeing the quota system.

In addition, there is the major question as to how would the quotas be set? What institution would set and implement the system? What would be viewed as "sustainable", environmentally-sound forestry practice? How would the quotas be broken down and allocated? Can importing nations determine the appropriate level of import quotas that will cause the appropriate environmental effect in the exporting nations? Assuming that this is possible, import quotas may be seen by many exporting countries as an attempt

of industrialized nations to control their domestic policies. There is the added concern regarding the impartiality of the allocations; could the quotas be used to punish a nation(s) for policies/actions unrelated to forestry?

Finally, their is the whole question of the GATT. In the much-publicized 1991 US-Mexico tuna dolphin case, the GATT ruled that the process used to produce a product cannot be used as a basis for restrictions, only the quality of the product itself can be controlled by the importing nation. Clearly, wood is wood, whether it is cut in a sustainable or unsustainable manner. Therefore, it is doubtful that, under the GATT, import quotas with favorably given to nations producing wood in an "approved" manner would be allowed. If the favorably was removed, the GATT may not overturn the policy, however the effectiveness of the policy to reduce environmentally destructive logging would be significantly reduced. The incentive to adopt environmentally sound practices would not exist other than the portion created by the quota-induced increased prices and the theoretically increased value of the forest.

4.3 Labeling of Imported Wood Products

Surveys indicate that consumers would differentiate between products produced in countries with adequate forest management programs and those without when making a wood products purchase (WRI, 1992). A credible labeling system would require a standardized labeling program implemented by an impartial and technically competent international institution. The Economist Magazine believes that a voluntary labeling program "is almost certainly GATT-legal", however a mandatory labeling program would have GATT implications and perhaps would not stand a challenge (11-24-92, 1-30-93 and 2-27-93). "GATT is uncomfortable with Austria's new scheme for labelling tropical timber, partly because it is mandatory and partly because temperate timber is excluded" (The Economist, 2-27-93).

The World Bank believes that consumer education is the most appropriate action for the international community and that a credible and impartial labeling program could be consistent with the GATT (Low). The Economist also advocates "Clearer rules on eco-labeling...", applied to both domestic and imported products, as "... a modest concession for GATT's members to make to environmentalists (2-27-93)". Finally, the World Resources Institute, in light of the GATT's ruling in the US-Mexico tuna dolphin dispute, believes that "in this context, certification programs and labelling may do more than bans or boycotts to encourage producers to adopt sustainable timber management practices." (Johnson and Cabarle).

In recent years, several tropical timber certification programs have been initiated. The Rainforest Alliance has its "Smart Wood" certification, the Scientific Certification System has the "Green Cross", and the Institute of Sustainable Forestry has the "Pacific Certified Ecological Forest Product" (Johnson and Cabarle). All these certification programs have their own definitions of what is sustainable forestry and their own methods for providing certification and only a small portion of timber imports are participating in any certification scheme (Johnson and Cabarle). In order for a certification scheme to be successful, a uniform system needs to be agreed to and implemented throughout both importing and exporting nations. The World Resources Institute believes that "... representatives from both producing and consuming constituencies must be equally represented within the certifying institution. Further, the evaluation criteria must reflect consensus, the monitoring apparatus must be controlled by independent entities, and monitoring results must be readily and freely available to all concerned parties (Johnson and Cabarle)."

4.4 Import Restrictions

Import restrictions go further than quotas or labeling as they would eliminate imports of tropical hardwoods that are produced from unsustainable forestry practices. This policy would require adherence to strict forest management practices in order to export to nations that impose the restrictions.

The positives and negatives of this policy are similar to the import quotas discussed in Section 4.2, however the GATT implications are even more severe. It is doubtful that restrictions based solely upon production methods would be acceptable under the GATT. Once again, all importing nations would have to agree to restrict imports for the policy to succeed. One nation's restriction would have little effect, as the market for unsustainably harvested wood products would still be large. A unilateral action would encourage the development of other markets for the lower priced unsoundly produced products. Finally, the definition of what environmentally sound forest management is needs to be developed, detailed and agreed to by all the parties, both importers and exporters.

4.5 Import Bans

Import bans can come in three forms, a ban of all products of a specific species, a ban of all tropical hardwood products, regardless of species or production method, or a ban of raw logs.

4.5.1 Species-Specific Ban

In March 1992, one tropical hardwood species, Brazilian rosewood, was determined to be dangerously close to extinction and was placed on the Appendix A list of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), thereby making all trade illegal (Johnson and Cabarle). A total of 113 nations participate in CITES and therefore trade is severely restricted; although illegal trade can remain a problem, as it is with the horns of the black rhino, another endangered species listed on Appendix A of CITES. Three more tropical tree species, afrormosia, Central American mahogany, and lignum vitae, were included in Appendix B, allowing monitored trade. Because the ban applies to the wood species, it is theoretically applied to every nation, both importing and exporting, without the possibility of discrimination, and therefore may be acceptable under GATT. In the words of the Economist Magazine, CITES "gets away with banning trade in a number of rare woods. That is partly because it is a multilateral agreement, and partly because it refers to individual species (1-30-93)."

Inclusion on the CITES list only protects an endangered species and it's particular habitat, and would not have a significant effect on the more widespread environmental effects caused by the logging of tropical timber in general. In addition, it is not easy to distinguish all tropical hardwood species from each other. Also, since government oversight is not strict and side-payments are rampant, there is the considerable possibility for misclassification of the banned wood to one that is not considered endangered and therefore trade would continue.

4.5.2 Ban on All Tropical Hardwood Products

In an attempt to effect general deforestation, some organizations have advocated a ban in the trade of all tropical timber regardless of nation of origin or species. Removing the international market for wood products would make the value of a standing tree almost zero to most persons. There would be little incentive to maintain forests and agricultural conversion would increase. In addition, as the ban would only apply to tropical hardwoods, it could be argued under GATT that it discriminates unfairly against tropical countries and provides unfair advantage to temperate hardwood producers. In order to gain acceptance under the GATT, bans in the trade of all hardwoods may be required. This is clearly not a possibility, since the use of wood products cannot be eliminated and softwoods cannot be totally substituted.

Acceptability under the GATT also assumes that all nations participate in the ban. An import ban would not likely be acceptable if it was applied by one or a few nations or was applied to only one or a few exporting nations. Assuming that agreement to impose a ban on tropical timber imports could be obtained from all nations, and is not overturned by the GATT, a severe disruption of several economies would occur. As described in Section 2.3, the international sale of tropical hardwood products is a large component of the economies of several nations and a substantial source of foreign currency. The elimination of the entire industry would be very destructive to the economies of whole nations and the people who depend upon wood products for a living. It is also a source of material by several importing nations, particularly Japan, China and the Republic of Korea. Elimination of all tropical hardwoods would disturb the wood dependent components of those economies and would put pressures on temperate hardwood forests

to fill the gap. This could have negative environmental consequences for the temperate forest of North America and Europe, particularly those in the formerly communist nations that are in need of foreign currency.

4.5.3 Ban on Tropical Hardwood Logs

A ban on log imports would have similar pros and cons to the ban on all tropical wood products, except that it would leave open the market for processed wood. This would encourage value-added processing in the exporting country. Simply requiring the processing of wood before export does not mean that it will be done efficiently. By removing the export market for the whole tree, the value of the tree is reduced. The input to the process is less valued, leading to the waste during harvesting and conversion, perhaps even increasing deforestation as was the case after Indonesia imposed its log export ban. Significant, and perhaps increased, waste of the tree resource would still occur unless the cost of the input tree is also raised.

4.6 Reduce Demand

Tropical hardwoods are used by importing nations for several applications: concrete construction forms, furniture, boat decks, and housing components such as flooring, ceiling and wall coverings, doors, decorative moldings, and window frames. For example, in 1991 Indonesia's breakdown of wood processing for export was: 70% plywood (concrete forms and decorative wall coverings) and 30% lumber. The lumber was used to produce the following export products: 20% decorative woods, 16% dowels, 15% flooring and wall covering, 14% component sets (furniture), and the other 35% to housing components such as doors, windows and laminated frames. Other than raising the price, there are two primary ways to reduce the demand for tropical hardwoods, reduce unnecessary uses and substitute other materials.

4.6.1 Reduce Unnecessary Uses

Significant quantities of tropical woods are used once and then discarded; such as the approximately 25 billion pairs of disposable chopsticks used annually and $2 billion worth of non-reusable concrete forms used in the construction industry annually (WRI, 1992). Demand for these one-time use products could be reduced by substituting readily available reusable products.

Chopsticks are typically supplied by Taiwan and consumed in restaurants all over the world. Chopsticks could be made from plastic so they can be washed and reused. Non-reusable concrete forms are made from plywood in Indonesia and Malaysia and are used primarily by the Japanese construction industry. The forms can be made from a more durable material, such as sawnwood, so that they can be removed and reused. Both of these replacements may require increased initial financial investment and additional labor inputs by the user, however the demand for low value tropical forest products will be lowered. In addition, waste disposal requirements in the consuming nation would be reduced.

4.6.2 Substitute Materials

Perhaps the most obvious substitute for tropical hardwoods are temperate hardwoods. However, in some applications the insect/disease resistant characteristics of tropical woods are necessary and therefore temperate woods cannot be completely substituted. Also, tropical woods are known for their extraordinary beauty and therefore, in decorative applications, other woods may not substitute. However, does one really "need" tropical woods or wood at all?

Substitutes for wood are generally plastics, metal and concrete. Concrete and structural steel have been substituted for wood for decades now in the construction industry, primarily in large projects. In wood scarce areas such as the southwest United States and in the high humidity of many tropical areas, individual homes are constructed from concrete. However, in many areas wood is still the primary building material and there is potential for wider use of non-wood products in the home construction market.

Aluminum siding can replace wooden shingles on the outside of homes and steel girders can replace the wooden beams in walls. Currently, the aluminum siding and steel girders are more expensive than wood, however, as the price of wood increases due to the increased restrictions places on harvesting, these substitutions are likely to become common (The Economist, 3-13-93).

Wood flooring is also produced from tropical hardwoods and can be replaced by ceramic tile, carpeting or softwood. The use of wooden window frames is now being replaced with vinyl. More and more furniture, cabinet, and door construction is using particleboard or fiberboard covered with hardwood veneer rather than the solid wood. Cabinets and doors are also constructed of coated metal. Wood wall and ceiling coverings can be substituted with plaster finishing. Finally, the use of decorative hardwood moldings can be eliminated or made from metal or softwoods.

Plastics are certainly durable and can be engineered for substantial strength. There are many possibilities for expanded application in the outdoor furniture industry. The City of Chicago successfully combined a plastics recycling effort with a project to refurbish 360 neighborhood parks (Morse). The Park District collects 30,000 to 45,000 pounds of plastic per week and it is converted into items such as, park benches, picnic tables, wheelchair ramps, and basketball backstops. Because the City supplied the input raw material, the items only cost approximately 50% more than wood products. However, it is believed that the products will be able to withstand the weather conditions and vandalism better than wood products, and therefore save money in the long run due to less replacement. The program also provides a market for the plastics collected through consumer recycling and lowers the need for waste disposal.

4.7 Role of the International Community in National Efforts

The primary role of the international community in national efforts is to provide funding for the most feasible projects discussed in Chapter 3. The Global Environment Facility (GEF) was created by the World Bank and the United Nations to transfer funds from industrialized countries to developing countries to implement the CFC use requirements

of the Montreal Protocol. The GEF mandate has been expanded to finance other types of globally beneficial projects. The protection of biodiversity, particularly the preservation of tropical forests, is one of the areas eligible for funding.

4.7.1 Strengthen Institutions

In addition to the numerous non-governmental organizations, there are several international government institutions that are involved in addressing the deforestation issue. These include the United Nations Environment Programme (UNEP), the UNDP, the FAO, the ITTO, and the various development banks, including the World Bank. The ITTO consists of 50 members, representing both importing and exporting nations, whose purpose is to develop criteria for sustainable forestry and to ensure that all tropical timber is produced from sustainably managed forests by the year 2000. The ITTO has been largely ineffective, admitting that less than 1% of tropical timber is sustainably managed today (only 4.4 million hectares out of a total of 828 million, WRI 1990). However, the are currently negotiations to re-authorize the ITTA, including strengthening and reforming the ITTO so it can accomplish it's goals.

Currently, there is also much discussion of revising the Tropical Forestry Action Plan. Currently, 86 countries are part of the TFAP that was designed to promote forest conservation and management plan and to strengthen international cooperation. Critiques charge that the TFAP places too great an emphasis on timber production, and not enough on community participation and non-timber values of the forest. "In the absence of any challenge to the political status quo that governs most forest areas, the Plan can be regarded as contributing to maintaining the present situation (Hurst)". Again, the program has been largely ineffective due to lack of funding, particularly in the national governments to implement the national forestry action plans developed under the TFAP. The national plans exist on paper, but not in practice, less than 1% of the value of project proposals based upon the forestry plans have been funded. The TFAP has succeeded in drawing more attention to the complexities and problems of forest management, particularly within the national governments. The TFAP's have also stimulated a significant increase in the level of investment in tropical forestry in a short period of time, from $500 million in 1985 to $1.35 billion in 1990 (WRI, 1992).

Agenda 21, one of the documents produced by UNCED, devotes an entire chapter to the issue of deforestation. In addition, UNCED produced a statement of Forest Principles. Agenda 21 and the Forest Principles are believed by some to be a very important documents, as they will be used by developing countries as a basis to design programs to obtain international funding. In Chapter 11 of Agenda 21, "Combating Deforestation", four action areas are outlined: sustain multiple roles and functions of the forest, enhance protection and sustainable management of forests and improve degraded areas, promote efficient use of forests, and establish and strengthen planning and assessment capabilities. Of the estimated annual expenditure of $32 billion necessary to implement the proposals, Agenda 21 advocates that $6.22 billion (approximately 20%) be provided by the international community on "grant or confessional terms". This is a 460% increase over the level of funding provided by the international community in 1990.

Much of this international money would be to aid in technical research and training and for the strengthening of both national and international institutions. The most critical role for international efforts is in research, data gathering and dissemination, the development and implementation of standardized methods of forest characterization, valuation of forest resources and finally, determination of the criteria for sustainable forest management. The international community also needs to increase resources provided to governments for development of forest management skills and practices and to enforce their regulations and revenue plans. "Projects which assist forestry departments to improve collection rate and/or increase the stumpage rates normally give a very high financial rate of return (Grut et al)."

4.7.2 Technology Transfer

One of the largest obstacles to sustainable management of the forest is the lack of data with which to make plans and decisions. The most valuable technology transfer would be in physical data gathering and analysis techniques such as remote sensing and geographic information system (GIS) modeling. Other useful technology would be in economic data collection and analysis methods, as well as methods to value the non-market benefits of the forest. The FAO in their 1990 assessment of world forest resources gathered statistical data of forest resource, population and socioeconomic data at the sub-

national level and also geographic data including vegetation types, eco-floristic zones (climate and indigenous flora) and political boundaries. All this information and remote sensing data is integrated into GIS and a computer database called FORIS (FAO, 1993c). This database and GIS modeling offer powerful planning information, however planners need to have access to both computers and the programs and also be trained in their use.

Technology transfer also involves the harvesting methods and equipment that causes less overall damage to the forest and processing equipment that create less waste as described in Section 3.7. This would also include training on less damaging methods of harvesting and less wasteful processing. The transfer of technologies that develop products from the chip and particle wastes is also important. Currently, approximately half of the input log is wasted during the conversion to lumber and two-thirds during the conversion to plywood (Kallio et al). Assistance in the development of tropical moist forest management technology, such as appropriate rates of extraction and rotation schedules for sustainable harvesting, plantation development, and regeneration of degraded areas is also required.

4.7.3 Debt-for-Nature Swaps

Developing countries have over $800 billion of external debt. "Debt-for-nature exchanges are a new and politically appealing form of development assistance (OTA, 1992)." The World Resources Institute projects that debt-for-environmental project swaps will become increasingly larger and more important as the international environmental movement gains momentum (WRI, 1992). The United States Office of Technology Assessment (OTA) agrees, however it recognizes that "it is unlikely they will retire a significant portion of developing countries' debts. For the 13 countries involved in debt swaps between 1987 and 1990, under one-twentieth of 1 percent of countries' external debts was retired (OTA, 1992)." Never-the-less, the United States government has encouraged the facilitation of debt-for-nature swaps by broadening their applicability from commercial debt to public debt and by providing U.S. banks with incentives to participate (OTA, 1992).

Generally, debt-for-nature swaps involve a large international non-governmental organization (NGO) purchasing some of the debt owed by the government of a less

developed country to a commercial bank. Because repayment of the debt by the debtor country is considered unlikely by the creditor, the debt can be purchased by the NGO at a substantial discount. In turn for purchasing the debt, the donor NGO negotiates that the face value of the debt is made available by the central bank of the government in local currency that will be used for environmental purposes, typically under the control of a local NGO. The debt is not gone, it is just transferred into local currency terms. This can create financial problems within the debtor country. By increasing the money supply, the inflation rate can be increased. This effect can be dampened by the issuance of government bonds to finance the project. However, the issuance of bonds can increase interest rates.

To date, the projects funded consist mainly of creating and\or enlarging national parks or preserves. If population pressures exist in the area under consideration, it will be very difficult to eliminate them and degradation will continue. Protection projects have the greatest chance of success if they are located in relatively unpopulated areas and have the support of the local communities as one of the project components.

Another problem is that the debt-for-nature swap agreements are not enforceable. Once the money is transferred, the project success depends entirely upon the debtor government voluntarily implementing the terms negotiated. Governments typically have conflicting interests and shifting priorities. Protection of large areas requires the commitment of the debtor government and the enactment of compatible government policies. These might be difficult to obtain, much less sustain, in a country faced with the more pressing concerns of poverty, hunger or political unrest. Therefore, committing substantial resources to environmental protection, something they and their constituents may view as an unessential low priority program, can have adverse political consequences.

Many governments and citizens of less developed countries are reluctant to enter into any agreement in which "northern" money and influence are involved. Regardless of the good intentions of the donor NGO, this influence is seen as interference and a threat to sovereignty by some. If the debtor government and the local population do not support the project, it will have little chance of achieving sustained environmental protection.

Debt-for-nature swaps may be an effective way for international groups to participate in the establishment and maintenance of the extractive reserves and nature reserves/parks discussed in Chapter 3.

4.7.4 Alter Development Assistance

Prior to the 1980's, most development assistance in the forestry sector was for industrial use plantation development, logging projects and the development of wood processing industries. Since then, most of the forestry projects sponsored by the World Bank have been for reforestation projects. These projects have goals such as, watershed protection, fuelwood production and the development of plantations for commercial logging. The Bank now states that "the Bank Group will not under any circumstances finance commercial logging in primary tropical moist forests." (World Bank, 1991a). To go further, any new development projects, whether forest related or not, should be sited in already disrupted forests, rather than in virgin forest areas.

Many previously funded dam, road and plantation projects have been proven to produce more harm that good to the forest, the local population and their economy. The World Bank helped to finance the transmigration effort in Indonesia and BR-364, the highway into the Brazilian Amazon, discussed in Section 2.1 as major causes of deforestation in those countries. The World Bank also financed the construction of a dam on the Tocantins River that has flooded over 215,000 acres of the Brazilian Amazon. These negative results and mounting public pressure have caused the World Bank to recently place increased importance on assessing and minimizing the environmental impact of all proposed projects. The effect on forests and biodiversity should now be prominent considerations. The Bank will require "rigorous environmental assessment" of all projects that may impact primary forests as well as consideration of the social issues involved (World Bank, 1991a). The Bank promises to place funding priority on projects that protect the forest and also that generate income from non-wood forest products.

The World Bank is also requiring institutional reforms in their loan conditions. Although many recipient countries resent this interference in national sovereignty, the forestry sector is so poorly managed and often overrun with corruption in most countries, that the loan

requirements may be the only incentive strong enough to stimulate change. In the 1991 Forest Sector Policy Paper, the World Bank states that "government commitment to sustainable and conservation-oriented forestry" is required to obtain forest related loans. By requiring land use planning, research and training of personnel, and enforceability of policy, forest projects may move towards sustainability. The changes in the World Bank policy are relatively recent and how these ideas are put into practice on a large scale remains to be documented.

4.7.5 Alter Calculation of National Accounts

Many environmental groups, industrialized countries and even the World Bank are calling for changes in the method used to calculate GNP that would add in a negative impact for environmental pollution and depletion of natural resources. The joint UNEP-World Bank 1989 symposium recognized "the urgent need to recognize the shortcomings of the current measures of income and to work toward a more sustainable concept and measurements (Ahmad et al)". The ongoing SNA revision discussions were undertaken by the United Nations to simplify and clarify the existing system and were not intended to formulate and incorporate radical changes to the method (Ahmad et al). There is strong resistance to changing the current method, as the results of the change are uncertain. Although new theories of how to calculate a more relevant GDP, have been proposed, there has been no agreement on one method. The debate is only just beginning and a consensus among environmentalists and traditional economists is far from imminent.

There are several ideologies regarding the best approach to resource accounting. Some advocate physical accounting of resources in order to influence public policy but have no concern with connecting the physical account to the SNA. Others believe that unless the environment is quantified in monetary terms and included in the SNA there will be no real change. In both methods, physical inventory of natural resources is required, therefore, the collection of even more data than presently gathered will be required. Even now, in developing nations, the data gathered to produce GDP is often generalized and is not considered accurate. Adding in a factor for resource depletion would require that all natural resources be inventoried and quantified. This is a daunting task in any nation, and may be virtually impossible in a developing country. Several industrial nations, including

Canada, the United States, Norway, Japan and France, have undertaken efforts to develop physical accounts of their natural resources and monitor their use. However, all of these methods are in development and serve different political purposes.

Ideally, all of the benefits and costs to the environment would be included in the accounts, not just the marketplace values of potential resource based products. The forest is not only a source of wood, but is also a key factor in water management, a regulator of the climate, a source of biodiversity, a supplier of products for the local population, a source of income from tourism and a buffer for carbon dioxide and heat (Ahmad et al). However, assessing the value of the multiple benefits of the in-situ resources and the costs of removing them is very difficult to measure, as many of them are not traded in the market. "Aside from the difficulty of reaching a consensus as to how the environment or natural capital is to be treated conceptually, the greatest difficulty lies in actually estimating the level of environmental services and damages (Ahmad et al)."

Virtually all parties agree that the reduction of natural capital should be treated in the same manner as reductions in man-made capital. The SNA classifies the clearing of land for agriculture as a formation of capital and ignores the loss of forest resource capital. In addition, in timber production, only the economic gains from logging are included in income: the more logging the better. However, when the extraction rate exceeds the growth rate, the capital stock is eroded. The national account does not include this capital consumption, this loss of future production capacity.

In natural-resource based economies, as most tropical forest nations are, the impact of adding in the depreciation of natural capital can be significant. The World Resources Institute found that, in the twenty years from 1970 to 1989, Costa Rica depleted their natural resources by an amount valued at a whole year of their GDP (WRI, 1991). If this 5% per year reduction was added into Costa Rica's GDP calculation the economic growth experienced from 1970 to 1989 would have been reduced from an average of 4.6% to only 2.6-3.1% (WRI, 1991).

4.7.6 Payments for Not Cutting the Forest

Less developed countries have argued that if industrialized countries are so concerned about biodiversity loss and carbon dioxide release they should compensate tropical nations to not remove their forests. These actions could easily be bilateral agreements, avoiding the often lengthy process of achieving consensus among nations. The source of payments would not necessarily have to be the government. There is potential for private initiatives, however the scope of these efforts may not reach the scale achievable if multiple governments are involved.

In the case of biodiversity loss, payments could be made to compensate logging companies for not utilizing a controversial concession. This practice may lead to corruption as companies acquire concessions and then threaten to log them just to receive payments. It also brings up the question as to why is the government granting logging concessions in biologically significant areas? It may be more effective to help the forest institution to develop and implement its forest use plans so that critical areas are not open to logging. Another type of biodiversity payment, less associated with the timber industry, would be to help the government to establish and maintain nature reserves in important areas.

The issue of payment for the prevention of carbon dioxide release is more complicated, particularly as it relates to the timber industry. An intact mature tropical forest is a state of equilibrium with regard to carbon. When the forest is burned, massive quantities of carbon are quickly released. Even if the forested area is allowed to grow back, a large net release of carbon is realized due to the relatively slow regrowth rate compared with the rapid release rate. The burning of the forest and its conversion to agriculture is not a result of the actions of the forest industry, however logging often precedes agricultural conversion. Therefore, it may be in the interests of industrialized countries to finance efforts to prevent disruption of the forest by logging.

In a mature forest, the carbon utilized in photosynthesis for biomass growth is approximately balanced by carbon released by decaying vegetation. However, growing forests sequester more carbon than they release. As a consequence, the International

Panel in Climatic Change has recommended that strategies to impact climate change include "sustainable forest management and afforestation" (Doos). Exactly what constitutes "sustainable forest management" is a current topic of much debate and study. However, it is clear that when an area is reforested, the growing trees are absorbing carbon dioxide. Therefore, a forest can be considered as having absorbed the quantity of carbon dioxide from the atmosphere necessary for the forest to reach maturity. After that point, sequestration is over and equilibrium is established.

If trees are harvested before the forest reaches maturity and the forest is replanted then the cycle can continue. This implies that harvested trees are utilized so that very little of the original tree returns carbon dioxide to the atmosphere through decay or burning. For example, if a tree is harvested to produce lumber for construction or furniture-making and the chips and sawdust produced during processing is collected and made into particleboard, then near full utilization of the tree is assumed. Only the bark and a small amount of waste are left to decay or are burned for fuel. However, it must be recognized that carbon containing fuels are burned to power the saws that cut the trees, the vehicles that transport the trees, the machinery of the sawmills and the particleboard production process, as well as the vehicles used to transport the lumber within the producing nation. Even more carbon dioxide is released when fuel is used to transport those wood products around the globe. However, it is assumed that the commercial logging and processing will occur and that these fuels will be burned.

The World Bank in its 1991 Forest Sector Policy Paper, states that in relation to the global warming debate, "opportunities exist for trades between developed countries and owners of Amazonian and other forest resources." If the cost to the world economy is $3-13 per ton of carbon released and a tropical forest contains an equilibrium quantity of 125 tons of carbon per hectare, every hectare not burned may be worth from $375 to $1,625 (World Bank, 1991a). Although this is more than the market value of land, it is less than the market value of the hardwoods that could be extracted from the forest, if valuable species were on the plot. A single log of meranti, a species exported from Malaysia, can be worth several months income for the average Malaysian family (Reinhardt).

As with debt-for-nature swaps, these payments for biodiversity preservation and carbon storage are likely to impact only relatively small areas and do not address the root causes of most of the deforestation. Their impact globally will be minimal unless the levels of financial commitment are large and the programs are linked with efforts to address the other factors. Also, in the case of carbon dioxide, the method of determining and making payments would be very complex due to the social, economic, political, land ownership and national sovereignty factors involved.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The causes of deforestation are many, varied and interconnected. Likewise the proposed methods to prevent the disappearance of primary tropical forests are many, varied and interconnected. There is no quick and easy solution. As discussed in the Forward, at the root of this environmental problem are the patterns of political and economic power that keep the rich nations rich and the poor nations poor. Despite the reluctance to enter into fundamental change, there are many things that should be done to alleviate the pressure on the primary forest.

The most important factor is whether there is enough political will in the countries that are exploiting the forest to change the status quo. As discussed in Chapters 2 and 3, there is a lot of money being made at the expense of tropical forests and the political, military and corporate beneficiaries wield considerable power within their particular nation. Perhaps the most effective role of the international community is to expose corruption and use financial influence to put an end to it or at least to not support it anymore. It is very important that nations remain sovereign and industrialized countries do not attempt to dictate how forests are to be managed. However, industrialized countries do have the money to fund efforts they deem appropriate, to gather and disseminate data, and to harmonize and coordinate efforts on a global basis.

5.1 Exporting Nation Actions

Repetto sums up the causes of tropical forest destruction as: the benefits from intact natural resources have been consistently under-valued and the benefits from forest conversion have been consistently over-valued. In addition, governments have drawn on forests to solve fiscal, economic, and social problems, and therefore, planners have encouraged settlement and exploitation of the forest without adequate data on the economic potential and the environmental limitations (Repetto). The two most important efforts that should be undertaken in tropical forest nations with regard to the timber industry are to correct market distortions and to improve forest management.

5.1.1 Correct Market Distortions

The low value placed upon the standing forest does not create incentives to protect the forest from encroachments, to control logging practices or to initiate forest management planning. The low value of the forest are a result of government policies that essentially allow timber companies to essentially take the logs for free. Because the timber fees do not even cover the purely market economics of the situation, they surely do not include environmental damage costs. As detailed in Chapter 3, the low cost of obtaining timber causes waste in log harvesting and processing. This leads to logging of higher volumes than necessary for the production level.

Timber fees are low either because they are set that way or because they are not collected. If governments would raise the timber fees to capture more of the economic rents, then the pressures on the forest would decrease and environmental damage would be lessened.

I. Raise Timber Harvest Fees

When the price of timber is increased it has far-reaching effects. As the cost of harvesting the standing timber is increased, the cost of production is increased. Assuming the world price sets a price ceiling, this reduces the profit to be made and the incentives to cut the forest are decreased. Therefore, pressures on the forest are reduced. In addition, the reduced supply may raise the domestic price, increasing the input cost for processing and therefore reducing waste. However, the reduction in supply will lower the export earnings brought into that country. As discussed in Section 3.1.1, in the long-run, that nation will be better off because it will have maintained its resource base; however in the short-term, which is how most poor nations have to look, they will be worse off.

Therefore, what is needed in conjunction with the raise in harvesting fees is a raise in the world price of timber. The increased price to importing countries will lower the demand for imported woods, counteracting the desire to increase production. A raise in the world price should come about only through a coordinated action where the harvesting fees (and therefore the costs of production) in all exporting countries are raised to a comparable

level. A world price increase should not be supported unless the costs of production in all nations are increased. Otherwise, the "free-rider" problem is invoked where a nation not increasing fees would benefit from the price increase without reform. In fact raising the price without raising the costs would actually stimulate production, increasing deforestation. Therefore, methods of raising the world price without raising the costs of production should be avoided. For example, a system of export quotas, as in OPEC, would allow excessive profits to accrue to those that were able to harvest and export, without raising their costs (other than in rent-seeking to obtain the quota). Waste during harvesting and processing would continue.

If a raise in world price cannot be negotiated, raising the cost of harvesting trees should be performed by a single nation. As stated before, in the long-run the country would be better off, and in the short-run rent-seeking would be reduced since the profit margin would be lower. Perhaps a way to induce this fee increase would be to compensate the country for its loss in export earnings through increased aid or debt-forgiveness, as discussed further in Section 5.2.8.

In order to reduce corruption, the concession granting mechanism should be reformed. A minimum concession price should be set to at least cover forest department costs, and awarded by competitive bidding. This concession fee could be assessed lump sum, or, to attract smaller players for more competitive bidding, could be collected on a yearly basis. The concessions should also be for the management of the forest, not just the harvest of the timber. In this way, the harvester would be responsible for the continued functioning of the forest after harvesting. To make this more attractive, the time-frame of the concessions should be increased to 50 or 70 years, with the requirement of periodic renewal based upon environmental performance. If environmental standards are not upheld, the forestry department needs the capability to collect heavy fines from the harvester.

Besides making the rights to utilize the forest more expensive, there needs to be an additional cost related to the market value of the timber in order to realize all the benefits of a price increase. The most efficient fee would be the standing volume fee. The fee should be based upon the value of marketable timber in the stand not the quantity

harvested and be part of the competitive bidding, since they could not be auctioned separately. A standing volume fee would increase the administrative burden as areas to be concessioned would have to be evaluated to determine the timber quantity and quality. This would be difficult in the densely vegetated tropical forest particularly when there are no roads into an area to provide access for the evaluation. However, the investment by governments in more detailed forest exploration and inventory is likely to have an immediate pay-off in improved revenue capture (Repetto) and in providing data for improved forest management planning. These benefits to improved long-term forest management would be enormous and would justify the expense of the reconnaissance efforts.

Standing volume fees would stimulate greater utilization of the areas being harvested since they are paid for. However, monitoring and enforcement efforts would have to be made by the government to ensure that over-exploitation of species and excessive environmental damage are not occurring. Minimum harvestable diameters should be set and enforced, as well as the requirement to leave a certain percentage of the concession area (5 to 20%) untouched to serve as a repository of diversity. Periodic inspections, at least yearly, of harvested areas would be required, as well as the capability to apply and collect heavy fines upon finding conditions of severe degradation discussed above.

II. Subsidies

The government should not provide tax breaks or discounted credit to timber harvesting or processing companies as they only secure the viability of inefficient operations. The government should also stop the construction of logging roads into the forest. If the harvesting company does not believe that the logs are valuable enough to build the road in to take them out, then the trees should remain inaccessible until they are valuable enough.

Governments should encourage the development of value-added wood processing industry. It is important the nations extract as much value from their natural resources as possible. In this way, a greater number of people can be employed using less raw resource. The country will also gain more foreign currency with the utilization of their

resources, helping their trade balance. However, the waste and inefficiency of the current processing industry should be substantially reduced.

To encourage processing while reducing waste, it is recommended that a differential export tax structure be established that essentially discourages the export of raw logs combined with substantial increases in the cost of the input logs by raising the cost of harvesting, as discussed in the previous sub-section. If the input cost is not raised, then the processing industry will remain inefficient and wasteful and should not be supported. Raising the cost of the input will also spur the development of uses for the sawdust and chips generated so they are no longer unrecovered resources.

Differential export taxes are preferential to log export quotas and bans because they generate revenue for the government while providing essentially the same effect. However, it should be noted that there is a finite difference in the market price between logs and the processed product. The differential tax structure should not be one that gives excessive benefits to those who process logs, or else devaluing of the log occurs and waste is not prevented. The economics of the situation should not be such that the social costs outweigh the benefits. In other-words, the government tax revenue foregone (determined by the differential tax structure) by the exporting processed product rather than the quantity of log required to make the product should not exceed the value-added by the processing.

The investment in capital to provide the value-added processing, that is efficient, can be substantial. When the high profits of today are removed, investors will require some stability in order to risk engaging in processing. This stability will come mainly in assuring adequate supply of input. This is another way that the subsidy of processing ties together with concession reform. Companies need to know that they will have a long-term supply of logs. The systems of today where concession rights can be revoked at political will, will not support investment in efficient processing. The system of assessing fees and fines also needs to be stable and transparent, so that fear of excessive increases and political favoritism are minimized.

There are a couple of dangers in promoting value-added processing that need to be examined and accounted for. One of the reasons that industrialized countries like to import logs is that they can control the quality of the processed product. Therefore, the quality control standards of the processing and shipment need to be tight and enforced to assure a market for the product. This behavior may be induced by the efficiency improvements caused by raising the cost of input. Secondly, if the supply of processed product on the world market is substantially increased, the price will drop, undermining the purpose of processing. Therefore, the trade of raw logs needs to be minimized so that suppliers who satisfy the demand for tropical woods will have to buy the processed products. When the raw logs could not be easily purchased, those importers that desired products made from tropical woods would need to work with an exporting nation to develop the desired product. This could also improve quality. One way to bring about a reduction in the supply of logs is to combine the introduction of a differential export tax advocated above with the removal of protective tariffs in importing nations as discussed in Section 5.2.1. By removing the artificially high demand for logs and by reducing the effective price of the processed product in the importing country, the market for the processed products will increase.

5.1.2 Improve Forest Management

The success of any method to reduce deforestation is dependent upon vast improvements in forest management, particularly in use planning and control, and the collection of fees from timber harvesting. The forest management institution needs to develop an understanding of all the functions of the forest, not just the timber production potential. This will require coordination with other government planning agencies and the transfer of knowledge from around the globe. The ecological, social, economic and cultural impacts of any proposed forest impacting project need to be evaluated.

Detailed baseline data on timber values, the forest's ecological and biological systems and the current human interaction with the forest need to be established. Then governments need to evaluate the primary forest areas to determine which areas are the most ecologically sensitive, such as important watershed areas or areas containing endangered species. These areas should then be designated as nature reserves/parks. Nature

reserves should also have a mixed use buffer zone established around it to provide the local population with access to the forest resources while protecting the core area from encroachment.

Areas with significant indigenous populations, or others, should be established as extractive reserves managed by the residents. It has been suggested that extractive reserves be established around or even in the logging concessions. The population lives in the forest and has an interest in maintaining the forest's functions; therefore, they may be the best overseer's of the logging companies procedures. However, there could be violent confrontations between these two interests if rights and laws were not clear as well as performance standards. The government should also actively support the viability of extractive reserves by promoting value-added processing of the extracted products before they are transported.

In the cases of both nature and extractive reserves, the forest institutions will have to be strengthened to protect them from exploitation by timber interests and from encroachment by settlers. If studies of the underlying soils indicate that areas can sustain agriculture, plans to convert them could be included (unless they are in other sensitive areas). If conversion to agriculture is to take place, the timber resource should be extracted before it occurs.

Removing significant areas of primary forest from ever being logged will make the areas that can be logged even more valuable. It will also increase the value of secondary growth forests and foster investment in raising their productive capacity. These remaining areas of primary and secondary forest should be established as public forest and managed for the sustainable production of timber. However, it must be emphasized again that the forest institutions need to be strong and the commitment of the government as a whole to forest management and the maintenance of nature and extractive reserves needs to remain high. Otherwise, in the future when the only areas of forest containing marketable timber are those set aside in conservation or extractive reserves, the government may succumb to pressures from the logging industry to open up those areas and undermine all the previous planning efforts.

The forest management institution should also expend considerable effort in planning the location and development of logging concessions. These plans can be made a stipulation of the logging concession or the government may want to actually build them and then charge the cost to the concession. The minimization of road building is essential. Road-building in itself it causes significant damage to the forest and better planning before the areas are opened up can minimize damage done during harvesting. The connection between the building of logging roads and the subsequent settlement of the area because of its newfound accessibility needs to be acknowledged and planned for. Perhaps increasing the value of the forest will cause the logging companies to prevent encroachment onto their concessions; however this cannot be counted on.

Forest management techniques appropriate to the tropical forest need to be developed. Appropriate harvest quantities and cycles should be developed and enforced to ensure regeneration of market species and ecosystem functions. The use of animal labor should be encouraged as it is less damaging to the forest and less polluting. Directional felling and other simple methods for reducing residual damage should also be encouraged. These methods could be developed as stipulations within the concession contract and monitored in the field by forestry officials, or they may be indirectly induced by increasing the cost of harvesting and by increasing the term of concessions so that reinvestment is more attractive.

Forest institutions need to develop what specific items need to be monitored in order to assess ecosystem health and the success of sustainable forest management. Standards for the assessment of data including what indicates unacceptable impacts will also need to be developed. Perhaps the best place for these standards to be developed is at the international level in order to harmonize the efforts of individual countries. The institution will also need information in order to respond to timber management problems such as insect and disease infestation or the breakdown of the ecological system. Finally, the forest management plans need to be somewhat flexible so it can be improved to take advantage of the improved data gathering efforts. If the established timber cutting volumes or harvest cycles are proven unsustainable, then they should be modified, same with extractive reserve management.

5.1.3 Political Stability

The successful implementation of any of these recommended policies depends upon establishing the political will to alter the status quo. "However this presupposes not only the willingness to subordinate short-term financial gain to long-term ecological objectives but also a degree of understanding of forest consumption and dynamics (FAO, 1993a)." As discussed previously, substantial quantities of money are being made off the trade in tropical timber: politicians, military leaders and wealthy businessmen. The people who are benefiting from the current system are precisely the same persons who must design and implement the changes. This seems rather unlikely without substantial outside pressure.

Provided that changes are made, the new system will only be effective if their is long-term political stability in the country. As long as there are doubts about the permanence of the government, who will grant these more restrictive and more costly long-term concessions to the forest, the prudent businessman will try to extract as much money now as possible, since future conditions are uncertain. There will always be doubts about the permanence of the government when the majority of the population is poor and landless, when there is repression and not democracy. Even with a strong non-democratic government who has been and appears likely to remain in control, the policies of the government are subject to change with the political or military will. Again, making business decisions look short-term since the future is uncertain.

Finally, it should be recognized that the "rural landless... have no option but to invade the remaining tropical forest in an endeavor to scratch a living from soils that are both unfamiliar and fragile... So long as the highly skewed distribution of land, wealth and power that characterizes most tropical forested countries endures, the battle to save the tropical forest will inevitably be a losing one (Kallio et al)." How to effectively deal with these more nebulous and politically sensitive issues without resorting to revolution has confounded man through the centuries and suggesting policies in relation to these root causes of deforestation is way beyond the feasible scope of this report. However, if the skewed distribution of land and wealth is not addressed, any economic or planning improvements made will be undermined over the long-term.

5.2 Importing Country Policies

Despite the fact that most policy implementation needs to occur on the exporting country end, there are several things that importing countries should do to help the deforestation effort. Some environmental groups would advocate the end of the importation of tropical woods as the moral duty of industrialized nations. However, this would have a devastating effect. Not only would a major source of foreign exchange be lost to many nations, as described in Section 2.3.1, but the loss of the export market would reduce the value of the standing trees, increasing waste in the domestic timber industry, increasing illegal logging and increasing the conversion to other uses. Therefore, economic barriers to the import of tropical woods such as bans or quotas are not recommended. The following subsections outline the most promising actions for importing nations to initiate.

5.2.1 Elimination of Protective Tariffs

The policy with the largest potential impact would be to eliminate the tariffs that protect the processing industries in importing nations. Developing countries have a cost advantage in the production of processed wood due to the lower wage and the lower general overhead costs. They should be able to develop an efficient wood processing industry that keeps as much added value in the originating country. In this manner, fewer logs would be needed to employ the same number of people and generate the same overall revenues. On a global level, lumber and plywood are much smaller and compact, therefore requiring less energy to transport around the world.

It should be stressed that importing nations do not want to support the inefficient processing occurring today. If the only action to occur is that protective tariffs were eliminated, then harvesting and processing waste would probably continue or even increase. Therefore, exporting countries will have to raise the timber input costs as discussed in Section 5.1.1, prior to or in conjunction with the elimination of protective tariffs. Elimination of protective tariffs is a key to the success of policies in exporting nations towards stimulating efficient value-added processing, as discussed in Section 5.1.1. If protective tariffs are not eliminated in industrialized countries, then the incentive to move from trading in logs to trading in sawnwood or plywood is severely reduced. And

if logs are still traded, then the market for processed products will be smaller than what is possible. It seems that the ITTO, a UN organization developed to monitor and coordinate the trade of tropical woods, would be the ideal forum to coordinate these three inter-related issues: raising of forest fees, supporting the value-added processing in exporting countries and elimination of protective tariffs.

In order to have a positive effect on tropical forests, the elimination of protective tariffs must be done by those industrialized nations that import the largest quantity of raw logs: Japan, the Republic of Korea and Italy. However, this may be politically difficult to implement because those nations have large wood processing industries that rely on tropical logs and therefore have vested interests with a lot of money at stake. However, if nations are really serious and truly want to "save the rainforest", they should generate enough world pressure to dismantle these protective tariffs. However, it remains to be seen whether when the realization is made that jobs in industrialized countries will be lost, people remain committed and can convince their governments to act.

5.2.2 Credible Labeling Scheme

In an effort to stimulate the development and adoption of sustainable forest management in the tropical forests, it is recommended that both importing and exporting nations work together to develop a credible forest products labelling scheme. A labeling of the country of origin of the log (not where the processed product was made) and the evaluation of the forest from which it came (or at least the overall situation of that country) would allow interested consumers in industrialized countries to discriminate against products produced by methods or governments they did not want to support. This would reduce the market for tropical hardwood products that were harvested unsustainably. This would give governments that want foreign exchange the incentive to move towards less damaging harvesting and less wasteful processing.

In order for product labeling to have the greatest effect on tropical forests, only one labeling method should be used worldwide. This will require that all groups get together and come to a global consensus as to what constitutes sustainable forest management and how it is to be measured. The forest management research that is necessary to

determine this would be incredibly valuable to all tropical forest nations. The monitoring effort needed to make the system work would also help forest management as it would provide coherent and coordinated data gathering, assessment and dissemination. The ITTO is already a UN established group of producing and consuming nations with the goal of ensuring that all traded timber is produced from sustainably managed forests. Therefore, it makes sense that this worldwide labeling effort be developed and implemented under that body with the help of all the other stake-holders in the tropical forest issue. All interested parties should join together to support the viability of the forest and the economies of the nations that hold them and reduce the uncoordinated efforts of various groups that are currently involved.

In order to get the support of tropical nations and the GATT, the labeling scheme should apply to all timber produced from all forests throughout the world. Tropical nations resent the hypocritical stance of industrialized nations such as the United States, that allow and in fact subsidize the destruction of their own primary forests. How can industrialized nations expect poor developing countries to do something that they are not willing to do themselves?

It should be noted that the impact of product labeling may have less effect than import restrictions based upon production method. There will always be those consumers that are concerned only with price and do not care about "the rainforest". Therefore, there will still be a market for unsustainably produced timber products, although it should be substantially reduced. Action through consumer education and individual purchasing power should also be acceptable under the GATT, whereas the perhaps more effective import restrictions based on production method would not. There are mounting pressures to modify the GATT to allow these environmentally based, process dependent restrictions on at-least the level of a multi-lateral treaty; however no agreements have been reached.

5.2.3 Use of New Species

Industrialized countries should promote the use of a wider range of tropical wood species. This would have several results. One would be to reduce the pressure on the highly prized species that are already over-exploited and leads to the continuing need to expand

the area of harvesting at a rapid rate. Another benefit would be to increase the value of the forest as a whole by making previously undervalued trees a potential source of foreign currency. In this way, unnecessary destruction of the forest during harvesting should be reduced along with waste in the domestic processing industry. In addition, smaller areas would need to be harvested to extract the same value of timber. This will then reduce the construction of roads which are the main conduit of settlers into the forest. If species that typically grow up in the secondary forest could be more widely marketed, the value of secondary forests would increase, perhaps stimulating investment in them and reducing pressure on the primary forest.

5.2.4 Promote Markets for Extracted Products

An integral part of importing country efforts advocated in Section 5.1, is the recognition of the economic value of the non-wood related products of the standing forest and the establishment of extractive reserves. If the management of the extractive reserve does not obtain adequate economic rents from the forest, the incentives for unsustainable behavior are increased and for prevention of illegal uses are reduced. Therefore, the success of these reserves depends on there being a market for the products extracted. Groups within industrialized countries should promote the development of useful and desirable products using inputs from tropical forests rainforest and then market them using public education to increase their purchase. Efforts should be made to avoid the import of raw material and encourage development of value-added processing in the exporting nation. Governments should ensure that the rainforest derived inputs are imported without tariffs.

Industrialized nations should also support efforts to investigate the genetic resources of forest for the development of medicines and the improvement of agricultural crops. The efforts could be government or privately sponsored, but they should involve some sort of payment to the extractive reserve, preferably in the form of voluntary profit-sharing as in the Merck - Costa Rica agreement. Otherwise this brings up the whole global debate regarding the issue of genetic property rights; who owns the species and when does that ownership begin? With the owner of the property it was extracted from? With the company that develops the market product from the genetic material in the plant? Or

somewhere inbetween? These questions were major issues at UNCED and resolution does not appear to be in the near future.

5.2.5 Reduce One-Time Uses

The reduction of the one-time use of tropical timber products, such as plywood for disposable concrete forms, could have a significant impact on forests. Two billion dollars worth of disposable plywood forms is approximately half of the value of the plywood exported by developing countries. As a principle, one-time use of any product and followed by disposal should not be encouraged anywhere. Groups could use public awareness and political pressure to alter the practices of companies that engage in these wasteful uses of forest products. One-time uses will also be discouraged with a rise in the price of tropical hardwood products advocated in Section 5.1. This may be the more effective mechanism in a nation like Japan, where public action is not as tolerated by the society to the level it is in Europe and North America.

5.2.6 Alteration of the SNA

The information generated by the SNA is widely used as a basis for economic planning and project evaluation. The existing SNA generates biased data that leads to faulty decision making, both domestically and internationally. Unless the SNA is altered, the economists who use the SNA data and advise the policy makers will continue to advocate policies that lead to the unsustainable exploitation of natural resources. In developing countries, as well as many industrialized nations, the advice of economists is highly regarded, and the attention given to environmental concerns is minimal and often disregarded by policy makers as anti-market and anti-development.

Alteration of the SNA to include resource depletion as a reduction of national wealth should be a long-term goal. This effort will take much debate to come to a consensus of the method to be used. After the method is chosen by the UN, the data necessary to determine the resource depletion needs to be compiled. These are substantial efforts that cannot happen overnight, but that is not a valid excuse for inaction. Governments need to commit themselves now to the idea that the SNA needs to be fundamentally altered.

In the shorter term, pilot projects in developing countries should be sponsored by governments. This would include training of the local statisticians, scientists and economists that are involved with national accounts as to the importance of environmental considerations and the methods to include them. These sponsored efforts could provide testing grounds for the various methods proposed in the hopes of determining the one method that is most appropriate for inclusion in the SNA.

The effort to establish baseline physical inventories should also be undertaken immediately. Much of this information is available through numerous uncoordinated sources and efforts should be made to gather and compile it. The international community should place emphasis on harmonizing future individual data generating efforts so they can serve a dual purpose with little or no extra effort.

5.2.7 Technology Transfer

Industrialized nations should promote the transfer of technology to increase the efficiency of the forest industry. The largest impact is likely to be in establishing the production of products made from wood wastes such as particleboard and fiberboard. Currently so much of the log is unrecovered from the sawmilling and plywood manufacturing processes. By providing a market use for this waste, the value of the input tree that creates the waste is increased, stimulating efficiency throughout the system. If the development of value-added processing is to be advocated, it needs to be efficient processing.

The major drawback to the production of particleboard and fiberboard is that they involve the use of hazardous chemicals such as urea formaldehyde. Therefore, the technologies to safely use and dispose of them need to be transferred too (and the will to implement them). If it is not assured that the processes will be run to safely protect the workers and the environment, then the development of these industries is not recommended. However the sawmill and plywood waste chips and sawdust should still be collected, but then introduced into international trade unprocessed. The production of plywood also involves the use of adhesives consisting of hazardous chemicals. Efforts should be undertaken to ensure that safety related technology is transferred to that industry too.

Another area of technology transfer is in the processing of logs into lumber and plywoods. Tropical hardwoods are often of irregular size and shape and have other problems such as hollow or brittle centers. Therefore, there is a need to introduce smaller scale and simpler sawmilling that can better adapt to these irregularities and reduce the quantity of waste. Waste can also be reduced if sawmilling could be done in the forest, thereby indicating the need for the introduction of the portable sawmill. These smaller scale processing methods will inevitably be more labor intensive and therefore have the added bonus of providing employment. It is imperative that the technology be easy to operate and maintain so it can be successful within the existing labor skills base and technical support system.

Another technology transfer that could substantially reduce pressures on forests, particularly dry tropical forests would be to greatly increase the efficiency of the uses of wood-based fuels. Some of these methods were discussed in Section 2.1.1. Effort should be put into the development of alternative energy sources, particularly solar, to foster energy independence and the minimization of pollution.

5.2.8 Debt Forgiveness and Foreign Aid

One of the major reasons that over-exploitation of the forest occurs is to obtain the foreign currency needed to pay foreign debt, either through the direct sale of tropical woods or indirectly by clearing the forest for export-oriented agriculture, or even more indirectly by developing export oriented agriculture on the fertile lands, forcing the poor into the forest. In fact, some of the foreign debt incurred was to finance development projects that have actually been responsible for destroying the forest. Therefore, if industrialized countries are serious about halting the destruction of the rainforest, then they should relieve the debt burden that ultimately drives the over-exploitation. Agreements in which exporting nations would lower their levels of harvest or protect areas from exploitation in return for the elimination of some of their debt or a lowering of the interest rate should be negotiated. "Without reasonable [external capital in-] flows, the prospect for any improvements in living standards is bleak. As a result, the poor will be forced to overuse the environment to ensure their own survival. Long-term development thus becomes much harder... Net resource flows to developing countries have fallen in real terms; in

aggregate, there is now actually an outflow (World Commission on Environment and Development)."

As stressed in Section 5.1, the biggest improvements in tropical forest management will come through better planning of forest uses. These efforts will require the generation of substantial quantities of data that will need to be analyzed and synthesized into a coherent conservation and use plan. The international community can aid in these efforts by directly funding the forest management institutions in individual countries and/or through funding more indirect efforts such as development of a credible labeling program or reformulation of the SNA. These actions, although large in scope, are definable and can be implemented within a finite period of time. There is no reason to delay getting started any longer.

The international community should also fund research into developing solutions to the underlying causes of deforestation: terms of trade, inequitable distribution of land and wealth, foreign debt service. The causes to these problems often lie within industrialized countries; through the global terms of trade and perhaps the financial support of a corrupt regime. Therefore, the ability to at least begin to solve these problems also lies within industrialized countries. However, political will to fundamentally alter the global economic and political systems does not appear to exist. "The challenge ahead is for us to transcend the self-interests of our respective nation-states so as to embrace a broader self-interest - the survival of the human species in a threatened world (World Commission on Environment and Development)."

NOTES

1 hectare = 2.47 acres

100 hectares = 1 square kilometer = 0.375 square miles

1 square mile = 267 hectares

1 million hectares = 3,745 square miles

CITES	Convention on International Trade in Endangered Species
FAO	Food and Agriculture Organization of the United Nations
GATT	General Agreement on Tariffs and Trade
ITTA	International Tropical Timber Agreement
ITTO	International Tropical Timber Organization
IUCN	World Conservation Union
NGO	Non-governmental Organization
OECD	Organization for Economic Cooperation and Development
OTA	Office of Technology Assessment, Congress of the United States
SNA	System of National Accounts
TFAP	Tropical Forest Action Plan
UNCED	United Nations Conference on Environment and Development
UNCTAD	United Nations Conference on Trade and Development
UNDP	United Nations Development Programme
UNEP	United Nations Environmental Programme
WRI	World Resources Institute
WWF	World Wildlife Fund

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