

# **AN ANALYSIS OF THE IMPACT BY THE ENVIRONMENTAL PRICING TO SUSTAINABILITY OF GLOBAL FORESTS BY GLOBAL TRADE MODEL OF FOREST PRODUCTS**

Mihoko Shimamoto  
Associate Professor  
Faculty of Social Sciences  
Hosei University  
Aihara-cho 4342, Machida-shi, Tokyo 194-0298, JAPAN  
e-mail: mihokos@mt.tama.hosei.ac.jp

**ABSTRACT:** I analyzed the impact to the production, consumption, export, and import of forest products in the world by comparative dynamics using modified IIASA Global Trade Model. I also clarified whether the system of environmental pricing will be effective to diminish the degradation of the growing stock especially of tropical forests.

The results are mainly as follows. The production of nonconifer sawlog of tropical forests will decrease almost within 10%. In temperate and boreal zone the effect will be very small. As for the growing stock of tropical regions, in the Base Case the annual decreasing rate of growing stock were 0.16% in Latin America, 0.08% in Africa, 0.48% in Southeast Asia. Considering the damage of surrounding stumpages during harvesting and road construction, each rate were 1.32%, 0.67%, 2.29%. When we carried out the environmental pricing under the very moderate assumption of deforestation, we would be able to sustain the forest stock quantity in Africa and Latin America. But under the assumption of forest degradation counting damage of surrounding stumpages during harvesting and road construction, the annual decreasing rate became 0.97%, 0.48%, 1.98% in each area. Therefore the deforestation would not be stopped by only environmental pricing in all tropical regions.

**KEY WORDS:** Global Trade Model, Forest Products, Tropical Forest, Environmental Pricing, Sustainability, Reforestation Costs

## **1. INTRODUCTION**

When a new orientation or more concrete policies about tropical deforestation and sustainability of global forest are proceeded by some international organization or national governments, policy assessment would facilitate better understanding of the various stakeholders and the third parties. In early 1990's the policy to buy and sell only the tropical forest products harvested from sustainable forests has been focused. This movement has promoted the recent development of forest certification systems. When the certification systems would be realized, eventually not only the forest products from man made forests but also ones from natural forests should be dealt with prices including the reforestation costs. We can call them environmental prices.

In this paper what kind of impact would occur to the production, consumption, export, and import of forest products in each regions in the world by the environmental pricing policy will be analyzed by comparative dynamics using modified IIASA Global Trade Model of forest products. What extent the system of environmental pricing will have effect to diminish the degradation of the growing stock of especially tropical forests will be also considered.

## **2. IIASA GLOBAL TRADE MODEL(GTM) AND THE POINTS OF IMPROVEMENT**

IIASA GTM is the first spatial equilibrium model which analyzed the global trade perspectives of forest products in the long term. It divided the world into following 18 regions: Western Canada Eastern Canada Western US Eastern US Brazil Chile Rest of Latin America Finland Sweden

Western Europe Eastern Europe USSR Africa China Japan Southeast Asia Australia New Zealand Rest of the World. It consider 16 kinds of forest products and regard one period as 5 years to simulate from 1980 to 2030. The various assumptions and the results of the simulation of this model could be referred to M.Kallio, D.P.Dykstra, C.S.Binkley et.al.(1987) in detail.

In this analysis the simulation was implemented by reconstructing IIASA GTM by modifying mainly next 4 points.

1)The calibration of the parameters of demand and supply functions was implemented using the actual data of production and consumption of forest products and exchange rates in 1980, 1985, 1990.

2)About the former socialistic regions IIASA GTM assumed that the fixed supply amount of log were given by social plan in each period. In this simulation the same kind of market system were introduced referring to the parameter of the other regions.

3)In this model the log supply functions are set to shift by the amount of the growing stock of forest in each region. The original IIASA's macro growth functions of growing stock in temperate and boreal regions are modified by the data of forest resource assessment by ECE/FAO in 1980 and 1990. As for the tropical regions, though the first simulation was run using the same parameters as original IIASA GTM, the results were not realistic. Therefore the annual growth rate of nonconifer natural forests in tropical regions were set zero(i.e. steady state if there is no harvesting), and the growth rates were set positive in only the man-made forests in the regions.

4)As the result of the simulation using the original parameters of IIASA GTM, the amount of the trade flow were drastically smaller than real one because the transportation costs were too expensive. Therefore the various cases changing the transportation costs without changing the proportion of the costs of each trade route for the same forest product were tried, and selected the nearest cases comparing with the real trade flow of the base year.

### **3. THE COMPARISON BETWEEN THE RESULTS OF THE BASE CASE IN THIS SIMULATION AND THE GENERAL LONG TERM OUTLOOK OF FOREST PRODUCTS**

Before and after IIASA GTM there are many future outlook of forest products in the long run for example by FAO, and they have some common prospects. The main purpose of this analysis is the comparative dynamics between the Base Case of modified IIASA GTM and the comparative case of pricing including reforestation costs from 2000. Therefore we had better confirm the consistency and different point of the Base Case and such a general long term outlook of forest products. Babier, Burgess, et.al.(1994) and Peter Blandon(1996) mentioned the following general consequences by aggregating the former forest products outlook.

1)The production of industrial round wood will increase 15-40% for next 15 years. The increment of production of nonconifer log will be higher ratio than conifer log.

The consumption share of the developing countries will increase compared with the developed countries.

2)The shift from production of almost unprocessed products like sawnwood to highly processed goods

like particle board and fiber board will occur.

4)The resource in tropical countries will decrease, but one in temperate countries will increase as much as it will be more than enough amount to stabilize the prices of forest products.

5)The demand increment will be filled up with man made forests. When unexpected increment of demand would happen, central Canada, northern Europe, and eastern Russia will supply their resources.

6)The shift of harvesting from old growth to man made forests will continue. Especially the production of pacific north west and tropical regions will shift into the production in southern and northeastern area of U.S. and the temperate regions in southern hemisphere.

7)Japan and western Europe will increase their self sufficiency rate. On the other hand some of developing countries will increase their import.

8)In tropical countries the production will shift from roundwood and sawnwood to farther processed products. Especially the tendency will clear in southeast Asia. Therefore it will be still the center of the tropical forest products, but the exporting countries of roundwood and sawnwood will shift a little to African and Latin American countries.

9)Form 1990 to 2000, the prices of nonconifer woods especially in southeast Asia will increase by 60 - 80 percent because of the resource depletion. The prices of nonconifer woods in temperate area will be more stable.

10) In the former USSR the amount of harvesting has decreased after the peak of 395 mil m3 in 1975. The roundwood production has declined from 354 mil m3 in 1988 to 175 mil m3 in 1993. The increment of total harvesting amount will not be expected due to the shortage of transportation facilities and workers and inefficient production process.

Referring to these points, the simulation results of this time were generally consistent with the general prospects as will be mentioned later, but there are some assumptions of this model which had distorted the simulation results from realistic ones.

(1)The calibration in 1980, 1985, and 1990 which reflected the trend of 1980's to the model improved the accuracy of the temperate regions, but fluctuate the results of the domestic demand of final products in tropical regions.

(2)There are many trade routes which are not set from developed regions to developing regions. Therefore sometimes the prices of the products in developing regions became too drastically high.

(3)IIASA's original model set the increment of the growing stock too small. The modified model followed this assumption, so there were some regions where the pulpwood prices got too high.

(4)The underestimate of the decreasing amount of growing stock and the increment rate of the prices of tropical wood happened because the amount of degradation of growing stock by harvesting log were regarded as only cutting amount without considering the damage of surrounding stumpages during harvesting and road construction. It will be supplemented by some sensitivity analyses as will be mentioned later.

The main results of the Base Case and the comparison with the general outlook will be as follows.

### **3.1 Production and consumption of forest products**

#### **3.1.1 Roundwood production**

The roundwood production will increase from 653.53 mil m<sup>3</sup> to 954.98 mil m<sup>3</sup> for conifer sawlog, from 379.63 mil m<sup>3</sup> to 689.08 mil m<sup>3</sup> for nonconifer sawlog, from 311.68 mil m<sup>3</sup> to 312.11 mil m<sup>3</sup> for conifer pulpwood, from 170.37 mil m<sup>3</sup> to 426.18 mil m<sup>3</sup> for nonconifer pulpwood, and the total will be from 1515.21 mil m<sup>3</sup> to 2382.35 mil m<sup>3</sup> from 1990 to 2030. The average increase rates per year during the period are 1.43% for total amount of roundwood, 1.15% for conifer sawlog, 2.04% for nonconifer sawlog, 0.14% for conifer pulpwood, and 3.74% for nonconifer pulpwood. These things are satisfying 1) of the general outlook..

#### **3.1.2 Share of Tropical Timber Production**

The share of tropical roundwood (Brazil, the rest of LA, Africa, and southeast Asia) is decreasing from 57.3% in 1990 to 45.9% in 2030 for nonconifer sawlog. For nonconifer pulpwood the share don't change, and for conifer pulpwood one is decreasing from 5.9% to 3.0% during the period. The production amount of pulpwood would largely change by the fast growing species of planting. But nonconifer sawlog production would be expected to shift from tropical area to temperate area. It is suit for 5) and 6) of the general outlook.

#### **3.1.3 Conifer Sawlog Production Region**

The production amount of conifer sawlog in America changes from 68.87 mil m<sup>3</sup> to 75.36 mil m<sup>3</sup> in Western Canada, from 40.54 mil m<sup>3</sup> to 44.06 mil m<sup>3</sup> in Eastern Canada, from 75.82 mil m<sup>3</sup> to 88.26 mil m<sup>3</sup> in Western U.S., and from 63.85 mil m<sup>3</sup> to 126.61 mil m<sup>3</sup> in Eastern U.S. from 1990 to 2030. The average increase rate is 0.24%, 0.22%, 0.41%, and 2.46% in each region. Though the rate in Western and Eastern Canada and Western U.S. is much smaller than 1.15% the average of the whole regions, in eastern U.S. the drastic increment will be expected than other regions. In Australia and New Zealand the average increase rate is 2.55%, and in Chile the one is 2.39%. These things are consistent with 6).

#### **3.1.4 Roundwood Production in the former USSR**

Though the roundwood production in USSR is expected to largely increase (average increase rate per year is 1.39%), and the export to Japan and China will be also very much increase, it is largely different from the general prospects 10). It is because of the lack of the assumption of the shortage of infrastructure.

#### **3.1.5 Final Products Production**

Comparing with the lower processed goods and highly processed goods, the production of the latter is drastically increasing than the former for the total amount in the whole regions. Especially plywood is 5.40%, construction panel is 5.40%, household and sanitary paper is 2.92%, packaging paper and paper board is 2.53% increasing per year. These are high ratio less than 2% of sawnwood. It is suit with 2) of the general outlook.

But in the tropical regions the increase rate is rather low for the paper and paper board, and on the

contrary the demand of sawnwood largely increases. It is not consistent with 8). It is because of the reason (1) and (3). If we changed the assumption according to the tropical resource assessment in 1990, the production of paper and paper board would much increase.

### **3.1.6. Other Points about Production and Consumption of Final Goods**

The final products production in China, especially plywood will expected to drastically increase, and according to this tendency the production of nonconifer sawlog will also increase. It is the reflection of the calibration by the data in 1980s'. The same kind of thing appears for packaging paper and paper board and construction panel in the rest of the world. On the other hand the increase rate is rather low for the demand of newsprint in the world because of the same reason.

## **3.2 Prices of Forest Products**

### **3.2.1 Trend in Temperate Zone**

The prices of forest products in temperate zone especially in Europe and North America will be stable both for the raw material and final goods from 1990 to 2030, because the growing stock of the regions is expected to increase gradually, and the demand will moderately increase.

### **3.2.2 Trend in Tropical Zone.**

On the other hand in the tropical regions prices of some goods show the drastic increment. For nonconifer sawlog the average increment rates of prices are 4.61% in Brazil , 2.03% in Africa, and 5.82% in Southeast Asia because of the depletion of tropical forest growing stock. The most typical region is southeast Asia. This supports the general expectation that position of southeast Asia will decline as exporting countries( 8) of the general outlook). If we consider about the assumption (4), the price rise will be more drastic. For pulpwood in tropical region prices trends show the drastic up or down because of the mixed effects of the assumption (1), (2), and (3).

The sawnwood price trend is following to sawlog's one. So if the stock depletion were more intensive, it would be also more drastic. The trend of the prices of board and paper products are linked with the pulpwood price trend and the setting of demand parameters.

## **3.3 Trade**

### **3.3.1 Export**

The total amount of export is increasing for almost products. The most remarkable point is decline of the trade of nonconifer sawlog. It is largely due to the decrease of export amount from tropical zone especially from southeast Asia. In this area the amount is expected to decrease from 30.86 mil m3 in 1990 to 27.28 mil m3 in 2030. If the assumption (4) was considered, the price rise would be more drastic, so the export decline would be more dramatic. Nonconifer sawnwood will have same trend, especially in southeast Asia, the export will decrease from 10.91 mil m3 in 1990 to 3.96 mil m3 in 2030.

### **3.3.2 Import**

One of the characteristic thing is decline of the import amount of conifer sawlog in Japan. It is because the domestic price is kept cheap from 2000 to 2020, so it supports 7). On the other hand in China the import of conifer sawlog and plywood will swiftly increase. As for plywood because the trend of fast

growing of demand of plywood in China in 1980s' was assumed to be followed, the price of it in China drastically rose, as the result the export from various countries in the world increased.

#### **4. OUTLOOK OF EXPLOITABLE FOREST AREA AND GROWING STOCK**

##### **4.1 Exploitable Forest Area.**

In the Base Case of this simulation harvesting will never decrease the exploitable forest area. in temperate zone by an assumption. For tropical zone the average decrease rates of exploitable forest area are 0.824% in the rest of LA, 0.977% in Africa, 1.09% in southeast Asia. According to the FAO Tropical Resource Assessment in 1990 the average decrease rates of whole forest area are 0.8% in LA, 0.7% in Africa, 1.2% in Asia-Pacific region. So these results are similar to the data of FAO.

##### **4.2 Growing Stock.**

Conifer stock in the world will grow from 85.3122 bil m<sup>3</sup> in 1990 to 111.498 bil m<sup>3</sup> in 2030, and the average growth rate is 0.77%/year.

Nonconifer stock in the world will grow from 143.53 bil m<sup>3</sup> in 1990 to 168.073 bil in 2030, and the average increase rate per year is 0.44%. This is caused by the increase of stock in temperate zone and depletion of stock in tropical region. In tropical zone the stock depletion amounts are from 32.37433 bil m<sup>3</sup> to 30.3434 bil m<sup>3</sup> in the rest of LA, from 38.49055 bil m<sup>3</sup> to 37.29618 bil m<sup>3</sup> in Africa, from 26.86479 bil m<sup>3</sup> to 21.742 bil m<sup>3</sup> in southeast Asia from 1990 to 2030. The average rate of each region are 0.16%, 0.08%, and 0.48%. The numbers are much smaller than the rates of decrease of forest area because the assumption that depletion amount include only the harvested amount of wood without considering the damage of surrounding stumpages during harvesting and road construction.

When the harvesting are implemented in natural forests in tropical area, many neighbor woods are usually injured. According to Kumazaki(1993), from the research in lowland dipterocarpaceae forests in East Kalimantan State in Indonesia, "At the time of harvesting roads for tractors are constructed.....About 30 % of the woodland the stumpage are injured from their roots or the land have become the nearly naked." "The trees whose canopies are injured are more than 3/4 and the ones which are difficult to grow anymore amount to about 10% of whole stumpage".

Therefore decrease of the growing stock which include injured trees and stumpages lost by the road construction were calculated for each period.(Merely suppressing them from the growing stock of the simulation result for each period.) About southeast Asia growing stock per 1 ha was assumed 300m<sup>3</sup>, so the amount lost by road construction was assumed 90m<sup>3</sup>, and during harvesting and transportation one tenth of the rest, that is 21 m<sup>3</sup> was assumed to be injured. About the rest of LA and Africa the same amount was used for the destruction by road construction, and about injury of the trees, the amounts are assumed to be proportion with the density of harvesting, so 8.9 m<sup>3</sup>, 8.6 m<sup>3</sup> were used to the calculation. By this calculation the growing stock in 2030 are 14.67891 bil m<sup>3</sup> in the rest of LA, 27.02448 bil m<sup>3</sup> in Africa, 2.09391 bil m<sup>3</sup>, the average decreasing rates are 1.32%, 0.67%, 2.29% in each region.

## **5. IMPACT OF ENVIRONMENTAL PRICING TO FOREST PRODUCTS MARKET**

Environmental Prices in this paper means the prices including the reforestation costs, and reforestation after harvesting is assumed to be done by this fund stocked by selling forest products by the environmental prices. What will be analyzed is the effects to the regional demand and supply, trade flow, prices, forest stock depletion in the case of dealing with forest products by this environmental prices.

### **5.1 Reforestation Costs and the Assumption about Reforestation**

The reforestation costs in each region are as table 1. But in some regions harvesting are done mainly in man made forests and the forest products prices have already included the reforestation costs. So only in the Western Canada, Western U.S., Brazil, rest of LA, the former USSR, Africa and southeast Asia, supply functions are set including reforestation costs in the environmental pricing case.

In temperate and boreal zone harvesting are assumed to be clear cutting of small area. In Canada and U.S. generally natural regeneration is possible thanks to the mild climate and flatter inclination, and plantation is done usually in order to grow up commercial species. Therefore the parameters of growing stock function are assumed not to change between the case of natural regeneration and plantation. Nevertheless when the forests are reforested( in the case of environmental pricing), the supply functions of roundwood are including reforestation costs, so they may have some effect to the market such as to undermine the production of roundwood and to increase growing stock.

In tropical regions, in the Base Case harvesting was assumed to decrease the growing stock, and further more half of the harvested land will be assumed to be deforested eventually. In the environmental pricing case, enrichment planting are assumed to be implemented after sawlog harvesting, and fast growing species plantation are assumed to be implemented after pulpwood harvesting. Though there are data of reforestation costs about fast growing species plantation in Brazil , the rest of LA, Africa, and southeast Asia, there are data about enrichment planting only in southeast Asia. So the data of southeast Asia are also used in the Brazil , the rest of LA and Africa. Net annual increment value are also available only about southeast Asia for enrichment planting, so by using the proportion of the net annual increment of fast growing species plantation for each region and by the data of the net annual increment of southeast Asia, 1.2m<sup>3</sup>/ha/year, the value of the rest of LA and Africa was assumed 2 m<sup>3</sup>/ha/year. About fast growing species plantation net annual increment are assumed 12 m<sup>3</sup>/ha/year in the rest of LA, 16 m<sup>3</sup>/ha/year in Africa, 12.5 m<sup>3</sup>/ha/year by the data of each region. The species of planting after harvesting conifer sawlog are conifer species, and after nonconifer sawlog nonconifer ones are assumed to be planted. For post-pulpwood the value of proportion between conifer and nonconifer plantation actually done are endorsed from the data of FAO forest resource assessment in 1990. In the case of environmental pricing, reforestation after the harvesting is assumed to be sure to be done, therefore exploitable forest area doesn't decrease by roundwood production.

### **5.2 Results of Comparative Dynamics**

Under the assumptions above, the following results about the comparative dynamics between the Base Case and the Environmental Pricing Case which would be held from 2000 were appeared.

**Table1. Reforestation Costs(1993-94)**

	1	2	3	4	5	6	7
	Western Canada	Eastern Canada	Western U.S.	Eastern U.S.	Brazil	Chile	Rest of Latin America (c)
us\$/m3	<b>10.14</b>	<b>6.74</b>	<b>4.65</b>	<b>2.80</b>	<b>2.33</b>	<b>0.93</b>	<b>3.50</b>
Species, Rotation Period			National Forest 300m3/ha	National Forest 300m3/ha	Ave. of Eucalyp-tus, Pain 300m3/ha	Pain 400m3/ha	300m3/ha
	7	8	9	10	11	12	13
	Rest of Latin America (NC)	Finland	Sweden	Western Europe	USSR	Eastern Europe	Africa
us\$/m3	<b>4.37</b>	<b>8.35</b>	<b>6.37</b>	<b>5.51</b>	<b>0.42</b>	<b>0.13</b>	<b>6.83</b>
Species Rotation Period	300m3/ha Eucalyp-tus	300m3/ha	300m3/ha	U.K. Rotation 37years 250m3/ha	Ave. of Russia Rep. 200m3/ha	National Forest	South Africa 480m3/ha Rotation 30 years
	14	15	16	16	17	18	
	China	Japan	Southeast Asia(EP)	Southeast Asia(FG)	AustreliaNZ	Rest of the World	
us\$/m3	<b>2.59</b>	<b>73.27</b>	<b>13.31</b>	<b>3.66</b>	<b>4.14</b>	<b>5.50</b>	
Species Rotation Period	Chinese Fir Rotation 25years 128m3/ha	Ave. of Cedar 304.5m3/ha	Ave. of Peninsula and Sarawak 35m3/ha, 32m3/ha	Ave. of Peninsula Saba Sarawak 250m3/ha	N Z 600m3/ha	Isreal 237.1m3/ha	

notes)

FG...Fast Growing

EP...Enrichment Planting

C...conifer

NC...Nonconifer



### **5.2.1 Production of Temperate and Boreal Zone**

Nevertheless the shift of the log supply function by adding the reforestation costs, there was little difference of production amount and prices between two cases. It is due to the linearization of nonlinear supply and demand curves.

### **5.2.2 Production and Trade Flow of Tropical Zone**

The differences of production of nonconifer log between two cases are as follows. The amount of nonconifer sawlog decrease within 10% in all regions in the case of environmental pricing. On the other hand there are little impact about nonconifer pulpwood. It is because the reforestation costs of pulpwood are cheaper than the case of sawlog. The prices of nonconifer sawlog are also increasing around US\$10. But since 2020 in Africa and Southeast Asia sawlog production amount overcome the ones in the Base Case. Because the increment of growing stock by reforestation in these regions will mitigate the strain of the log markets. Farther more as mentioned in the explanation of the Base Case, the amount of decrease of growing stock by harvesting didn't include the injured trees and stumpages lost by the road construction. If they were considered, the decrease of the production in the Base Case would have appeared more drastically, therefore the tendency of mitigation of the market would have occurred more dramatically.

As for the trade flow there were little decrease of the case of environmental pricing comparing with the Base Case in this simulation. It is also due to the calculation of decrease of growing stock only by harvesting value of overbark. The prices of sawlog didn't rise drastically by the depletion of growing stock, so it didn't overcome the domestic prices of sawlog in importing countries. If the impact of the injured trees were considered, the importing value would have decrease by the price rising.

### **5.2.3 The Impact to the Market of Processed Goods**

The impact of the environmental pricing were weakened but succeeded to the market of sawlog, veneer and plywood. But in the market of paper and paperboard the impact of the policy hardly appeared. It is because the materials of them are pulpwood, and the pulpwood market hardly suffered the impact of the policy.

### **5.2.4 Exploitable Forest Area and Growing Stock**

In temperate and boreal zone the exploitable forest areas are assumed to unchange with the Base Case. The growing stock in these regions also go to the same trajectory as the Base Case because the harvesting values were not different from the Base Case.

On the other hand the impact were drastic in tropical regions. In the Base Case the average deforestation rate of the exploitable forest areas from 1990 to 2030 were 0.824% in the rest of LA, 0.977% in Africa, 1.09% in Southeast Asia. But the exploitable forest areas will not change from 1990 to 2030 in the Environmental Pricing Case because of the assumption that all the area will be reforested after harvesting.

The growing stock of nonconifer forests *increase* by 0.22%/year in the rest of LA, 0.12%/year in Africa, decrease by 0.1%/year in Southeast Asia in the Environmental Pricing Case, though in the Base Case the

average decreasing rate of each region were 0.16%, 0.08%, and 0.48%. It means that if the environmental pricing are realized, sustainability of the tropical forests in two regions will be accomplished.

But according to the forest resource assessment of 1990 by FAO all of the planting forests will not be able to mature in tropical zone, the survival rate is around 70%. Using this survival rate the sensitivity analysis were done. It shows that in the Environmental Pricing Case the growing stock decrease 0.07% in the rest of LA, 0.04% in Africa, 0.41% in Southeast Asia annually.

These results are under the assumption that the depletion of the growing stock are counted only by harvesting value of overbark without the injured trees and the impact by road construction. Sensitivity analysis were implemented considering these factors. In the Base Case the growing stock are drastically changed from 32.37433 bil m<sup>3</sup> to 14.67891 bil m<sup>3</sup> in the rest of LA, from 38.49055 bil m<sup>3</sup> to 27.02448 bil m<sup>3</sup> in Africa, from 26.86479 bil m<sup>3</sup> to 2.09391 bil m<sup>3</sup> in southeast Asia from 1990 to 2030, and the annual decreasing rate are 1.32%, 0.67%, 2.29% in each regions. Introducing the environmental pricing scenario, the growing stock in 2030 are 19.21005 bil m<sup>3</sup>, 29.77097 bil m<sup>3</sup>, 5.09676 bil m<sup>3</sup> in each region, and the annual decreasing rate become 0.97%, 0.48%, 1.98%. Moreover in the case that the survival rate of man made forests is assumed 70%, the annual decreasing rate become 1.24%, 0.63%, and 2.21% in each regions even in the Environmental Pricing Case.

From all these results we can say that even if the reforestation costs are included in the prices of forest products by some policies like eco-labelling, as far as the assumption are not very moderate, the growing stock in tropical forests will continue to decrease. Therefore in order not to deplete the forest stock anymore, not only the environmental pricing but another also the policies like controlling the demand side(ex. constraint of consumption amount) or the extension of the sanctuary would be necessary.

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