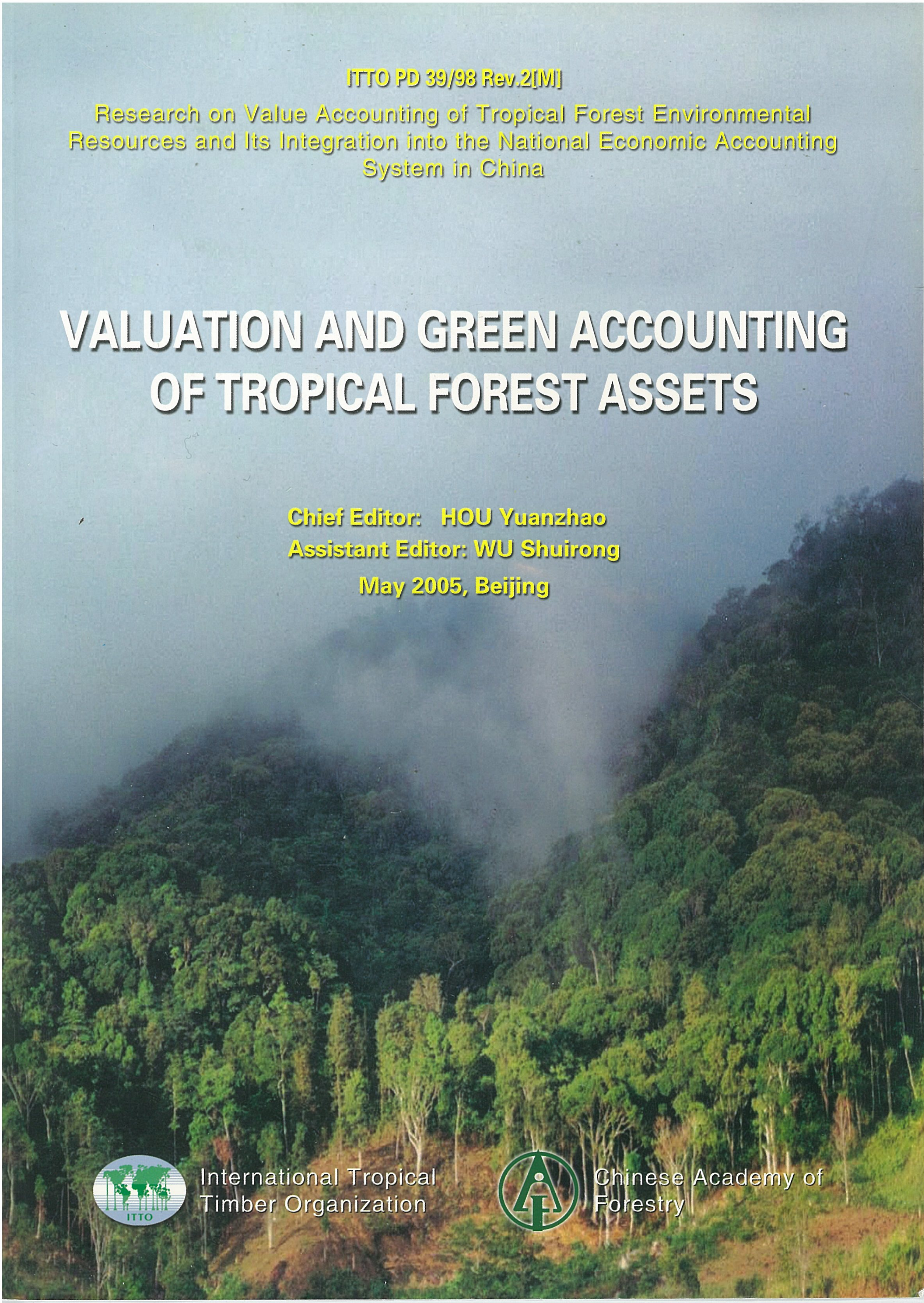

ITTO PD 39/98 Rev.2[M]

Research on Value Accounting of Tropical Forest Environmental Resources and Its Integration into the National Economic Accounting System in China

VALUATION AND GREEN ACCOUNTING OF TROPICAL FOREST ASSETS

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International Tropical Timber Organization

Chinese Academy of Forestry

PREFACE

This book contains the main achievements of ITTO Project PD 39/98 Rev.2 (M) undertaken by the Chinese Academy of Forestry in collaboration with other national institutions including the general report on theory and methods of valuation and green GDP accounting for tropical forest assets, the case study report on valuation of tropical forests of Hainan Island, the case study report on green GDP accounting of tropical forests of Hainan Island, the special report on green policies for tropical forests. In addition, it also includes a part of papers for the International Workshop on Environmental Economics of Tropical Forest and Green Policy organized by this project in March 2004 at Beijing.

The research is based on the following understandings: (i) the socioeconomic background of the societies in the tropics, where the tropical forests are located, is different from that of temperate developed areas; (ii) natural factors play a greater role in the formation of tropical forest assets; (iii) the stock of multiple ecosystem functions of tropical forest is far more than that of temperate forest and, most important, the livelihood issues are of central concern for most tropical developing countries. With this in view the detailed objectives of tropical forest accounting have been identified as follows:

(i) To help the society appreciate the true value of the sustainably managed forests through an economic valuation of all the goods and services provided by the tropical forests;

(ii) To provide a basis for the innovation of sustainable forestry development especially for improvement of institution and policy system for sustainable forest development;

(iii) To provide a scientific basis for decision-making by governments such as the formulation of policy of payment for forest ecological services;

(iv) To provide technical basis for the development of tropical forest ecological service market;

(v) To prepare for implementing the green GDP accounting at national level.

This research has two major objectives and involves two sequential steps: the first objective is to promote the establishment of the true value of forests in the society and the second one is to create the conditions for realizing the whole range of economic values of the tropical forests. And the first step is to make an economic valuation of all the goods and services provided by the tropical forests and the second its integration with the National Economic Account System.

Recent advancements in the knowledge in this field, as reflected in *Integrated Environmental and Economic Accounting* (SEEA, 2003) of UN, *The European Framework for Integrated Environmental and Economic Accounting for Forests* (IEEAF) of Eurostat and *Manual for Environmental and Economic Accounts for Forestry: a tool for cross-sectoral policy analysis* of FAO, were utilized in this research work and it caused repeated revision of the research reports.

While there has been considerable advance in the valuation technology of ecosystem services in recent years it is still inadequate in meeting the requirements for national economic accounting. This report seeks to fulfill this major need through

(i) A comprehensive and systematic classification for tropical forest assets, industries, products and ecosystem services, especially the classification of forest ecosystem services and establishment of an integrated value system for tropical forests;

(ii) Classification of the accounting objects into six categories and thirty-two items in accordance with the degree to which these services have been integrated in the markets;

(iii) A systematic review of the valuation methods based on the natural attributes of accounting objects;

(iv) Presentation of several options of accounting framework suitable for developing countries, and a pilot accounting case of green GDP accounting for tropical forests of Hainan Island of China.

This project has caused significant impacts that it would not be farfetched to call it a milestone in the development of forest and environmental economics in China. The project reports in Chinese version have been referred widely across the country. The case study on valuation and green GDP accounting of forest resources of Hainan Island is perhaps the most advanced report in this field so far giving the development of the concept, the process and the outcome and should prove to be a useful guide for similar works elsewhere. The project achievements have promoted the development of theory and practice of forest resource accounting in China, and have begun to make decisive impacts on the relevant policymaking at national and local levels. The two international workshops have also created considerable international interest in promoting work of valuation and green GDP accounting of forest resources. Perhaps most importantly, the project has trained a number of young professionals who should prove to be the backbone in the promotion of natural resource accounting in China and we would be happy to share their expertise with the countries around the world.

While the research has reached important achievements and significant impacts there are many flaws in it and some technical issues that need to be dealt with such as the selection of discount rate. In addition, the translation from chinese into foreign languages also caused some flaws. We appreciate any comments and suggestions and are most willing to develop exchanges in this field.

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Acknowledgement

Major members of project team and their contributions to the General Report:

Mr. Cao Keyu (National Bureau of Statistics), *Scenario of Integrated Environmental and Economic Accounting for Forests in Hainan Province (Pilot)*

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Dr. Li Zhongkui (Institute of Forestry Policy and Information, Chinese Academy of Forestry), *Valuation of Tropical Forest Resources in Hainan Province*

Dr. Wu Shuirong (Institute of Forestry Policy and Information, Chinese Academy of Forestry), Translating the important international documents into Chinese such as *The European Framework for Integrated Environmental and Economic Accounting for Forests - IEEAF (2002 Edition)* published by the Eurostat, and *Manual for Eenvironmental and Economic Accounts for Forestry: a Tool for Cross-sectoral Policy Analysis (2004)* published by FAO.

Dr. Gao Minxue (College of Statistics, Renmin University of China), Translating the important international documents into Chinese such as *Integrated Environmental and Economic Accounting (2003)* completed by UN/EC/IMF/OECD/WB.

Dr. Wen Zuomin (College of Economics and Management, Nanjing Forestry University), *Proposals on Environmental Policy Framework of Tropical Forest in China*

Dr. Jiang Wenlai (Chinese Academy of Agriculture Science), *Valuation of Watershed Service from Forest*

Dr. Jin Yanping (College of Economics and Management, Beijing Forestry University), *Valuation of Soil Protection Service from Forest*

Dr. Liu Can (Chinese Forestry Economics and Development Research Center, State Forestry Adminstration), *Valuation of Carbon Sequestration and Oxygen Generation from Forest*

Dr. Huang Yi (College of Environmental Science, Peking Universty), *Valuation of Environment Purification from Forest*

Dr. Zhang Tao (Institute of Forestry Policy and Information, Chinese Academy of Forestry), *Evaluation of Protection Value from Forests in Hainan Province*

Dr. Hu Mingxing (College of Economics and Management, Beijing Forestry University), *Valuation of Forest Recreational Functions*

Mr. Chen Yong (Institute of Forestry Policy and Information, Chinese Academy of Forestry), *Social Benefits Accounting of Forestry Resource*

Ms. Li Yumin (Institute of Forestry Policy and Information, Chinese Academy of Forestry), Editing the project reports for publishing

Mr. Jing Qianping (Institute of Forestry Policy and Information, Chinese Academy of Forestry), Editing the project reports for publishing

This general report is formulated on the basis of the special research reports by the above members and the three important international literatures.

CONTENT

Valuation and Green Accounting of Tropical Forest Assets

Hou Yuanzhao

Introduction

The research work on the tropical forest accounting undertaken by the Chinese Academy of Forestry in collaboration with other national and international insititutions has two major objectives and involves two sequential steps: the first objective is to promote the establishment of the true value of forests in the society and the second one is to create the conditions for realizing the whole range of economic values of the tropical forests. And the first step is to make an economic valuation of all the goods and services provided by the tropical forests and the second its integration with the National Economic Account System.

While the work undertaken in this direction in the developed countries was of great use in the conceptualization of this project, the systems developed there could not be used directly since the socioeconomic background of the societies in the tropics, where the tropical forests are located, is different from that of temperate developed areas. Also natural factors play a greater role in the formation of tropical forest assets; the stock of multiple ecosystem functions of tropical forest is far more than that of temperate forest and, most important, the livelihood issues are of central concern for most tropical developing countries. With this in view the detailed objectives of tropical forest accounting have been identified as follows:

i. To help the society appreciate the true value of the sustainably managed forests through an economic valuation of all the goods and services provided by the tropical forests;
ii. To provide a scientific basis for decision-making by governments such as the formulation of policy of payment for forest ecological services;
iii. To provide technical basis for the development of tropical forest ecological service market;
iv. To prepare for implementing the green GDP accounting at national level.

While there has been considerable advance in the valuation technology of ecosystem services in recent years it is still inadequate in meeting the requirements for national economic accounting. This report seeks to fulfill this major need through

i. a comprehensive and systematic classification for tropical forest assets, industries, products and ecosystem services, especially the classification of forest ecosystem services and establishment of an integrated value system for tropical forests;
ii. classification of the accounting objects into six categories and thirty-two items in accordance with the degree to which these services have been integarated in the markets,

iii. a systematic review of the valuation methods based on the natural attributes of accounting objects;
iv. presentation of several options of accounting framework suitable for developing countries, and a pilot accounting case of green GDP accounting for tropical forests of Hainan Island of China.

1 Rationale of Tropical Forest Accounting

	Domestic production	Rest of the World	Final Consumption	Mannd Assets	Natural Assets: Cultivated Assets	Natural Assets: Non-Cultivated Assets	Natural Assets: Other Natural Assets
Opening Stock				KO_m	KO_n		
Supply	P	M					
Use	C_i	X	C	I_{mg}	I_{ng}		
Gross Domestic Product	GDP	X-M	C	I_{mg}	I_{ng}		
Consumption of Fixed Capital	CFC			-CFC	$-CFC_n$		
Net Domestic Product	NDP	X-M	C	I_m	I_n		
Environmental Cost	U_n					$-U_n$	
Adjusted Environmentally Domestic Product (EDP)	EDP	X-M	C	I_m	I_n	$-U_n$	
Compensation of Employees	L						
Taxes Less Subsidies on Production	T						
Depletion Adjusted Operating Surplus	$PR-U_n$						
Other Changes in Volume of Other Assets				VOL_m	VOL_n		
Increases and Decreases of Property				REV_m	REV_n		
Closing Stock				KI_m	KI_n		

Note: subscript n indicates natural assets; subscript m indicates manned assets; U_n indicates environmetal costs and also changes in assets caused by economic use.

National economic accounting has two basic contents, the accounting of economic flow and that of asset stock and its change. Table 1 describes the theoretic framework that integrates the resource and environmental factors into national economic accounting. The dark colors in table 1 indicate flow accounting, and the light color indicates the accounting of stock and its change. Each part is still based on traditional national accounting.

The center of flow accounting is the adjusted environmentally domestic product (EDP).

$$EDP = NDP - U_n$$

$$= GDP - CFC - U_n$$

Of which, NDP is Net Domestic Product; U_n is Environmental Cost; CFC is Consumption of Fixed Capital.

The accounting relation of natural asset stock and its change is as follows:

$$K1_n = KO_n + I_{ng} - CFC_n - U_n + VOL_n + REV_n$$

Of which, I_{ng} is accumulation of economic product (capital accumulation); CFC_n is Consumption of Fixed Capital; U_n is the change of natural asset; VOL_n is other changes in volume of other assets; REV_n is increases and decreases of property.

There overlap between flow and stock accounting in Table 1 reflects the relations between economic processes and resource and environment in the accounting period as follows:

i. capital formation, which is the increase in managed assets and the natural assets;
ii. consumption of fixed capital, which is the decrease in managed assets and the natural assets
iii. resource and environmental costs, which indicates the natural assets consumed in the economic processes.

The key step in integrated economic and environmental accounting is the valuation of the resource and the environment consumed or increased in the economic processes. The adjustment of traditional macroeconomic gross such as GDP is based on the valuation. The path of adjusting environmentally macroeconomic gross is to adjust GDP, sustainable revenue generation, consumption, savings and investment gross in turn. The central goal of macroeconomic gross adjustment is to adjust GDP.

2 Definition and Classification of Tropical Forest Assets

Tropical forest accounting involves expanding the scale of traditional economic assets and the classification of industries and products, the objective of which is to establish a uniform logical system. The systems evolved for this purpose so far are the Central Product Classification (CPC) and the International Standard Industrial Classification of Economic Actities (ISIC). Some international documents such as *Integrated Environmental and Economic Accounting* (SEEA-2003) by UN, *The European Framework for Integrated Environmental and Economic Accounting for Forests* (IEEAF) by Eurostat and *Manual for Environmental and Economic Accounts for Forestry: a Tool for Cross-sectoral Policy Analysis* by FAO have also harmonized the denifitional framework. The existing denifitions and classifications can also be applied to tropical forest accounting. However, it is necessary to make some adjustment considering the situation of a country when applying them.

This reseach classifies tropical forest land into 10 categories adding wetland and sand land with reference to ESA/SNA classification of non-financial assets and SEEA (CNFA) classification of non-financial tangible assets. It adds economic forest industry and flower industry to the ISIC's 4 levels and 17 categories. The CPC has 5 levels and 1811 categories, but there are two disadvantages in it: (i) the definition are too rigorious; (ii) ignores some products important for developing tropical countries. For example, the definitions of standing timber and its annual gross growth and etc are far different from that of National Forest Inventory. In addition, there is no category for bamboo in the classification of forestry and logging and important tropical non-wood forest products such as palm rattan, wildlife medicinal materials and forest fruits etc do not find place (See the section 3.2 of the general report for details).

There also exists some confusions with regard to the classification of forest ecosystem functions due to the differences among countries and regions, which has been reflected in the two international conference of this project ITTO PD39/98 Rev.(M) that took place in 2002 and 2004 at Beijing.

This research has helped bring forward the following classification of tropical forest ecosystem services (Box 1).

Box 1 Classification of Tropical Forest Ecosystem Services

Watershed protection

Rainfall increase

Water storation

Flow regulation (including flood regulation)

Water purification

Soil protection

Reduction of nutrient loss

Reduction of soil erosion

Increase in soil organic materials(forest soil incubation)

Sand fixation

Carbon sequenstration and oxygen generation

Carbon sequenstration

Oxygen gerneration

Environmental purification

Reduction of particulate mass in air(such as sand and dust etc)

Negative oxygen ion generation

Noise abatement

Absorption of harmful gas

Increase of air humidity (increase of amenities)

Biodiversity conservation

Diversity and quantity of wild flora

Diversity and quantity of wild fauna

Species of endangered flora

Species of endangered fauna

Protection functions

Protection of agricultural land

Desertification prevention

Protection of habitation, industrial estate and water supply etc.

Landscape and recreation

The social beneifts from forest are an important invisible asset. However, the study related to it is very brief. See the box 2 for the details of the classification of this item of research.

Box 2 Classification of the Social Benefits from Forest

Catastrophic prevention and abatement

Land slide, debris flow and flood protection etc

Scientific cultural and spiritual values

Scientific extension and education

Aboriginal cultural values

Religious values

Ethical and spiritual values

Employment increase

National defence

Improvement of investment environment

3 Valuation System of Tropical Forest Assets

The value of forests is associated with species composition and other components of forest ecosystem and ecosystem functions. The basis of valuing forests is to identify the carriers of these values and define their boundaries. This reseach has presented a valuation system of forests as table 2. This valuation system is classificated into 6 categories and 32 items, of which, the first, second, third and fifth categories are related to forest benefit accounting and the fourth and sixth categories are related to forest cost accounting. Of course, this system can still be further improved. More details can be seen in the full report.

Table 2 Valuation System of Tropical Forest Assets

1. market goods (assets and products)	11 physical and monetary quantity of forest land (including sand land)
	12 physical and monetary quantity of wetland
	13 physical and monetary quantity of standing timber (including bamboo)
	14 physical and monetary quantity of economic forests
	15 physical and monetary quantity of flower production and transaction
	16 physical and monetary quantity of timber industry
2. Quasi-market goods (products and services)	21 physical and monetary quantity of non timber forest products
	22 residuals in forestry industry
3. non-market goods (forest ecosystem services)	31 physical and monetary quantity of watershed protection
	32 physical and monetary quantity of soil protection
	33 physical and monetary quantity of carbon sequestration and oxygen generation
	34 physical and monetary quantity of environmental purification
	35 physical and monetary quantity of biodiversity conservation
	36 physical and monetary quantity of agricultural protection
	37 physical and monetary quantity of landscapes and recreation
4. cost accounting I (depletion, degradation and defensive)	41 depletion of forest resources
	42 degradation of forest resources
	43 forest environment defensive
5. invisible assets (forest social benefits)	51 physical and monetary quantity of catastrophe prevention and abatement services
	52 physical and monetary quantity of scientific cultural and spiritual functions
	53 physical and monetary quantity of employment increase
	54 physical and monetary quantity of national defence services
	55 physical and monetary quantity of improving investment environment
6. cost accounting II (public or private investment)	61 forestry administration budget of government
	62 forestry public service enterprise budget
	63 forest protection budget
	64 afforestation and forest management budget of government
	65 forestry program budget of government
	66 forest investment fund, greening fund and etc
	67 non-management international forestry assistance and donation
	68 research expenditure
	69 private investment in forest protection

4 Valuation Methods of Tropical Forest Assets

4.1 Summary of Valuation Methods

The value of market goods and services can be evaluated using market price methods. The quasi-market goods and services can be valued using the price signals of similar market. The non-market goods and services can be valued using stated preference methods. Please see table 3 for details.

Table 3 Valuation Methods of Forest Assets, Products and Services

Market Degree	Classification of forest asset, products and services	Valuation Methods
1. market goods (assets and products)	11 physical and monetary quantity of forest land (including sand land) 12 physical and monetary quantity of wetland 13 physical and monetary quantity of standing timber (including bamboo) 14 physical and monetary quantity of economic forests 15 physical and monetary quantity of flower production and transaction 16 physical and monetary quantity of timber industry	Market price method Production cost method Using the price signals of local market Using the price signals of similar products
2. Quasi-market goods (products and services)	21 physical and monetary quantities of non timber forest products 22 residuals in forestry industry	Using the price signals of local market Using the price signals of similar products Production cost method
3. non-market goods (forest ecosystem services)	31 physical and monetary quantity of watershed protection 32 physical and monetary quantity of soil protection 33 physical and monetary quantity of carbon sequestration and oxygen generation 34 physical and monetary quantity of environmental purification 35 physical and monetary quantity of biodiversity conservation 36 physical and monetary quantity of agricultural protection 37 physical and monetary quantity of landscapes and recreations	Using the payment for ecosystem services Production cost method Travel cost method Hedonic pricing method Contingent valuation method Carbon taxation Using the prices of emission trading Damage based method Cross-anaysis method
4. cost accounting I (depletion, degradation and defensive)	41 depletion of forest resources 42 degradation of forest resources 43 forest environment defensive	Market price method Production cost method Using the price signals of local market Using the price signals of similar products
5. invisible assets (forest social benefits)	51 physical and monetary quantity of catastrophe prevention and abatement services 52 physical and monetary quantity of scientific cultural and spiritual functions 53 physical and monetary quantity of employment increase 54 physical and monetary quantity of national defence services 55 physical and monetary quantity of improving investment environment	Market price method Production cost method Using the price signals of local market Using the price signals of similar products Contingent valuation method
6. cost accounting II (public or private investment)	61 forestry administration budget of government 62 forestry public service enterprise budget 63 forest protection budget 64 afforestation and forest management budget of government 65 forestry program budget of government 66 forest investment fund, greening fund and etc 67 non-management international forestry assistance and donation 68 research expenditure 69 private investment in forest protection	Actual statistics data

The above table describes briefly the forest assets, products and services and their valuation methods. More details related to all the methods including the relevant innovations of this research can be seen in the full report. It is noted that these valuation methods are developed in the context of developed countries, which can not be transfered or applied simply in developing countries. It is necessary to make some adjustment when applying them in tropical developing countries. For example, Chinese scholars have suggested the use of the development stage coefficient that is accociated with Engle Coefficient to adjust the valuation results in order to accord with the situation obtaining in China.

4.2 Case Study on Valuation of Tropical Forests of Hainan Island

A part of the above methods have been used to value the tropical forests of Hainan Island in this research. Most of forest assets, products and ecosystem services have been valued in this case study. But the cost accounting of forest depletion, degradation, defensive, forestry administration expenditure of government have not been done. In addition, there are some technical issues that need to be dealt with such as the selection of discount rate.

The Hainan case study has revealed the total value and its composition as follows:

The total value of forest resources of Hainan Island is 1886.66 billion yuan RMB (present value), of which, the value of forest land is 4.71 billion yuan RMB, standing timber 37.97 billion yuan RMB, non-timber forest products 73.04 billion yuan RMB, forest ecosystem services 1769.74 billion yuan RMB, part of the social benefits 1.20billion yuan RMB. The value of forest ecosystem services accounts for 93.80% of the total value, and is as 15.3 times the value of market goods and services. See figure 1.

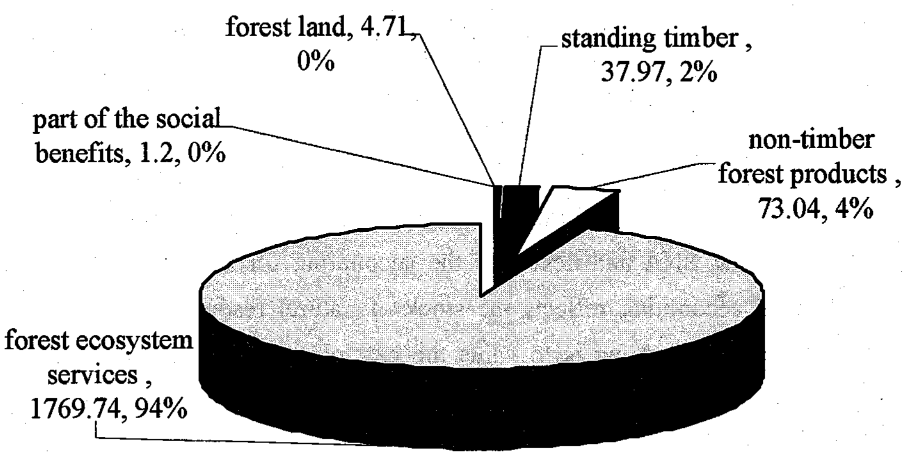


Figure 1 Total Value and its Composition of Forest Resources of Hainan Island

5 Green GDP Accounting Framework of Tropical Forest Assets

5.1 Three Options of Green GDP Accounting

Option I : satellite account of forest resource

That is to establish a satellite account of forest resource. The Framework of China's Integrated Environmental Resource and Economic Accounting (see figure 2) is developed on the basis of satellite account. This framework has been applied in the pilot case study on green GDP accounting of tropical forests of Hainan Island. Some results have been achieved that can be used to resolve problems.

Option II : system of integrated environmetal and economic accounting (SEEA)

SEEA is an ideal option of integrating entirely resource and environmental factors into national accounting system even though it is presently not fully evolved as it has many internal contradictions that need to be resolved. In short term it is difficult to apply SEEA in green GDP accounting in developing countries due to various limitations.

Option III : Improvement based on the European Framework for Integrated Environmental and Economic Accounting for Forests (IEEAF)

IEEAF by Eurostat focuses on the value accounting of market goods and services and part of quasi-market goods and services, not involving the non-market goods and services. This framework provides a good reference, but is not suitable for developing countries. It is needed to make some improvements so that it can be applied broadly.

5.2 Forest Satellite Account of China

The System of China's Integrated Environmental Resource and Economic Accounting (SEREA)[1] is a framework of resource and environmental accounting based on internal satellite account and external satellite account. The internal satellite account is simply a rearrangement of the existing SNA transactions. No new flows are added but those which are there may be presented and aggregated differently and in some case separated out from existing records by a process of "deconsolidation". The external satellite account, on the other hand, extends the scope of the system by including stocks, flows and transactions of resource and environment which are not covered by the existing SNA and describes the accounting for them in physical and monetary terms. The physical accounting reflects the stock of natural resource and environment and its change. The monetary accounting is to value the natural resource and environment in terms of economic asset and environmental asset and thus reveal the cross connection among economy, resource and environment.

This research has brought forward some concepts related to green economic flow of forest such as "green GDP of forest", "GeGDP of forest" and "EDP of forest"; and also some concepts related to green economic stock of forest such as "national wealth of forest". The indicators of green GDP

[1] In china, "environment" is defined in a narrow er sense, and the two concepts of resource and environment are often used synonymously.

and national wealth and their components compose the accounting framework and main accounting contents of China's SEREA.

The proposed tables for incorporating forest resources in green GDP accounting system include as follows:

- GDP adjusted by forest resource accounting
- economic use of forest assets
- expenditure of forest ecological construction
- forest asset stock
- opening and closing stock and net accomulation of forest asset
- opening and closing stock of forest environmental asset, other changes in volume
- forest ecosystem services in monetary terms

5.3 Improvement based on the IEEAF of Eurostat

The IEEAF consists of three parts:

(A) Simplified NationalAccounting Matrix (NAM), reflects flow accounts of forest assets. It includes the supply (output of domestic industries and imports) and uses (intermediate and final consumption, gross capital formation and exports) tables of the national accounts supply and use tables, and also presents income, capital and rest of the world accounts in a summarised way.

(B) Balance Sheets, reflect stock accounts of forest assets. It describes in monetary and physical terms the stocks of nonfinancial assets and changes in these stocks (forest balances in area and volume, changes in forest-related assets, changes in classification of assets and revaluation). Through quantitative (or qualitative) changes in assets (and corresponding changes in value, when monetary values are assessed), it permits to relate opening and closing stocks of forest related assets with the pressures exerted by economic activities and thus allow linking forests indicators with the system of national accounts.

(C) Flows of residuals, reflect flow accounts of forest assets. It describes in physical terms the flows of residuals by origin and destination, draws the balances of residuals, and thus establishes a link with the costs of the environmental protection activities.

The IEEAF has proposed twenty tables, covering the main aspects as follows:

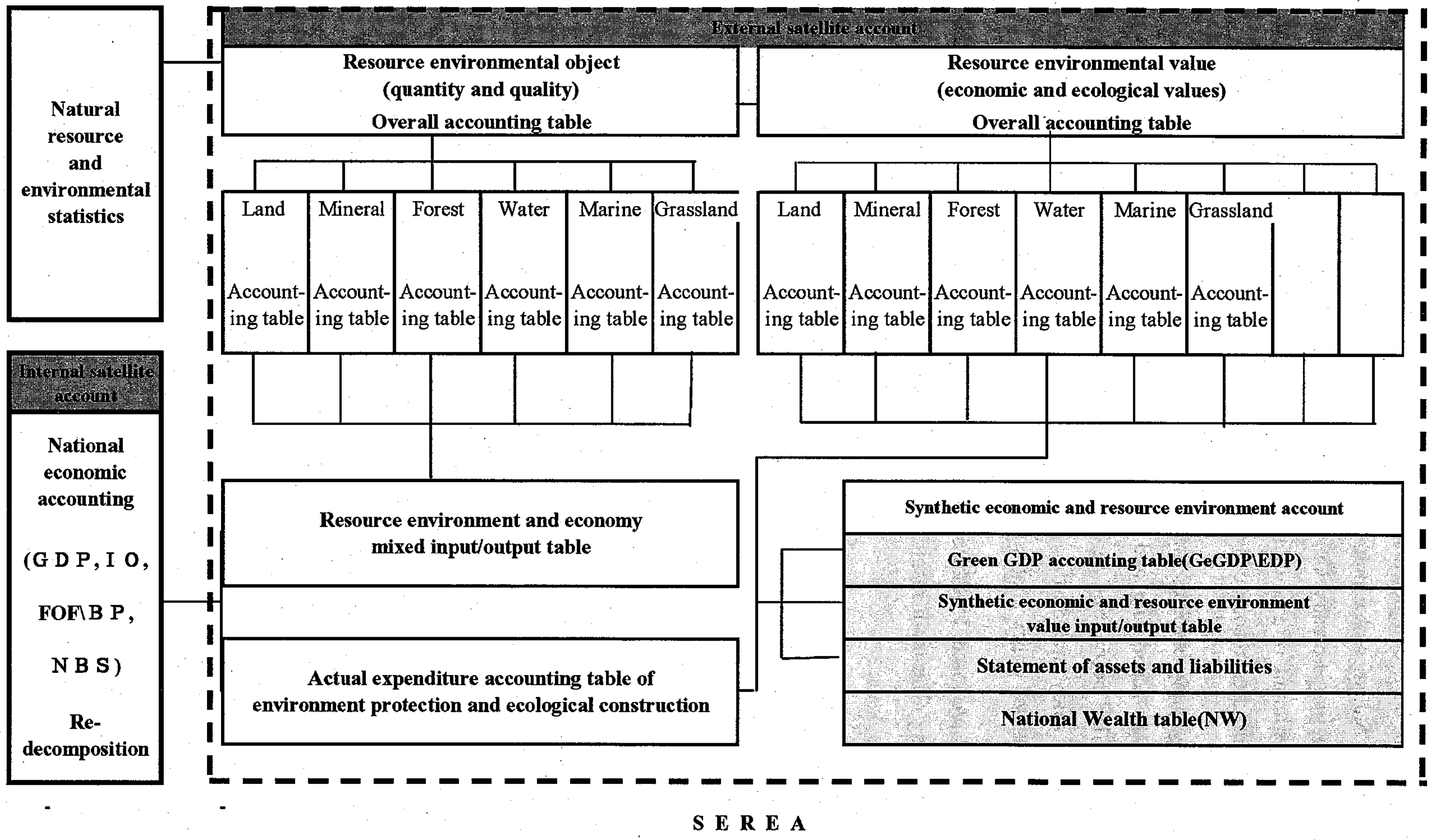
(i) Balance sheets for land and standing timber in physical and monetary terms;
(ii) Output related to wooded land, detailed accounts for forestry and logging and economic accounts for forestry and logging;
(iii) Supply and use tables in physical and monetary units;
(iv) Material balances;
(v) Tables describing origins and destinations of waste containing wood or paper, of black liquors and the corresponding wood contents.

The above framework and tables are useful for reference, but not suitable for developing countries.

This research has suggested the following improvements:

(i) Simplify and broaden the record standards of forest assets, industries and products;
(ii) adjust the classification of assets, industries and products according to the situation of a country;
(iii) add the account of non-market forest goods and services;
(iv) simplify the system of account.

Figure 2 System of China's Integrated Environmental Resource and Economic Accounting



6 Case Study on Green GDP Accounting of Tropical Forests of Hainan Island

This case study has been completed through cooperation with Chinese Academy of Forestry, National Bureau of Statistics of China, Statistics Bureau of Hainan Province, Forestry Bureau of Hainan Province, Beijing Forestry University and Renmin University of China. The pilot study takes 1995 as the beginning of accounting period and 2000 as the end, which is in accordance with the period of the fifth forest resource inventory.

The pilot accounting study involved the drafting of the accounting schemes, physical accounting, price study, monetary accounting and the integrated environmental and economic accounting (designing green GDP accounting table, balance sheet table and national wealth table). The conclusions of this study include the validation of accoungting data, assessment of accounting framework and a detailed policy analysis.

The case study has proposed 15 tables covering physical accounting, monetary accounting and integrated accounting. The main results of this case study are as follows (see the full report for details):

1) In terms of physical stock, at the end of accounting period the forestland assets account for 51.69% of forestland resources, the standing timber assets account for 34.41% of standing timber resources, reducing 2.37% and 15.92% respectively than that at the beginning of accounting period.

2) At the end of accounting period, GDP of Hainan province is 51.85 billion yuan RMB; the market output of cultivated forest assets is 1.86 billion yuan RMB; the depletion cost of forest assets is 1.93 billion yuan RMB; the degradation cost of forest assets is 4.80 billion yuan RMB; GeGDP of forests is 51.77 billion yuan RMB; EDP of forests is 46.98 billion yuan RMB; the depreciation of fixed assets is 8.35 billion yuan RMB. Thus it can be seen, that the market output of cultivated forest assets increase GDP of Hainan province at the rate of 3.59%, the depletion cost of forest assets reduce GDP of Hainan province at the rate of 3.73%, and then GeGDP of forests reduces GDP of Hainan province at the rate of 0.14%; the depreciation and degradation cost of forest assets reduce GDP of Hainan province at the rate of 25.36%, considering the market output of cultivated forest assets and depletion cost of forest assets EDP of forests reduces GDP of Hainan province at the rate of 25.50%; The sum of depletion and degradation cost of forest assets is 6.73 billion yuan RMB, accounting for 12.98% of GDP of Hainan province; considering the market output of cultivated forest assets the net cost of forests is 4.87 billion yuan RMB, accounting for 9.40% of GDP of Hainan province.

3) At the end of accounting period, the ratios of forest assets to net total assets adjusted environmentally through forest resources in Hainan province are as follows: for the cultivated forest assets calculated based on market prices, the ratio is 6.94%, reducing by 0.40% from the beginning of accounting period while for the non-cultivated forest assets the ratio is 2.30%,

reducing by 7.20% over the same period. And, for the cultivated forest assets calculated based on ecological prices, the ratio is 13.18%, reducing by 1.37% over the accounting period while for the non-cultivated forest assets it is 8.10%, reducing by 14.25% over the same period.

4) At the end of accounting period, the ratios of forest resources to national wealth adjusted environmentally through forest resources in Hainan province are 20.89% when calculated based on market prices and 44.68% calculated on ecological prices and reducing by 4.60% and 3.35% respectively over the accounting period.

7 Policy Analysis Framework and Green Forestry Policies

7.1 Policy Analysis Framework

Forest resource accounting provides comprehensive macro indicators that can facilitate appropriate policy responses.

(i) Sustainablity of forestry development and forest management

Sustainable management of forests requires that the resources are not reduced both in quantity and the quality. This can be judged through forest resource accounting from the trends in the changes of stocks of forest land, standing timber and forest ecological resources. Once the degree and the pace of decline is known policy responses could be fashioned for return to sustainable management. For example, the pilot study of Hainan province indicates that the total value of forests declined over the accounting period even when the area registered an increase. An appropriate policy response here could be shift of emphasis from forestry extension to intensive management practices designed to enhance stock in the existing area.

(ii) Recognition of the entire range of contributions of forests to development

This system of acounting would enable the society to recognize the entire range of contributions of forests to economy instead of merely the contributions from timber.

(iii) The real contributions of forests to concerned sectors

These accounts distinguish economic use of forests from the forest use for livelihood ; clearly demarcates the boundaries between the local beneficiaries, downstream beneficiaries and global beneficiaries, and also reveals systematically the interrelationships between communities and forests. For example, it enables the classification of the global value of a forestry project through carbon sequenstration distinct from the values that accrue to the local communities from the same project. This would make designing of policy nuances appropriate to the signals from the field situation and mid-course correction possible.

(iv) Payment for forest ecosystem services

The value accounting for forest ecosystem services such as carbon sequenstration, watershed protection and biodiversity conservation etc is helpful for the market creation and trading of forest ecosystem services. It also provides scientific proof for the governments to compensate the individual and community suppliers of forest ecosystem services, useful to the larger society, from public funds.

(v) Multiple use of forest resources

Forest resource has multiple functions. At present the total quantity demand and structure demand (economic demand and ecological demand) is more than supply. Under this resource scarcity scenario the optimal use of forest resources has become a global issue. The value accounting for forest resources potentially indicates the optimal options for forest management and end use.

(vi) The impacts of non-forestry policies on forest management and use

The main policies affecting forests include macroeconomic policies and public policies related to land resources. Forest accounts provides detailed data that can help get a measure of these interplays, which can be used to analyze the impacts of non-forestry polices.

(vii) The role of forestry in sustainable development

FAO has proposed a series of macroeconomic indicators that can be used for adjustments in forest accounting (table 4). The case study on green GDP accounting for tropical forests of Hainan province in this reseach has proposed more comprehensive macroeconomic indicators.

Table 4 Macroeconomic Indicators Including Forest Values

Conventional indicator from national accounts	Proposed adjustment from forest accounts	Revised indicator
GDP	non-market forest values	GDP including full value of forests
Depreciation capital stocks	Depletion of natural forests	Total depreciation including depletion of natural forests
NDP	Depletion or degradation of natural forests	NDP including loss of natural forests
National wealth	Capitalized value of natural forests	Total national wealth including natural forest assets

7.2 Green Forestry Policies

This research has presented a detail special report related to green forestry policies. The central points of which are summarized as follows:

(i) Policy objectives should aim at correcting the externalities, market failures and market limitations.

(ii) Policy principles should advance environmental concerns among the society and strengthen the 'polluter pays' principle to reduce the negative externalities.

(iii) Policy instruments should include traditional command and control and market-based instruments for reducing the costs of meeting the objectives described above.

(iv) Types of the policies

The economic instruments have been paid more and more attention in environmental and natural resource management to optimize measures for pollution control, nature protection, resource use, watershed management, global environmental management, production and consumption and so on. They are classificated into nine categories as follows:

- defining property, including ownership and use right and etc
- creating market, such as pollutant emmisions trading market, watershed service market, etc
- taxation, such as polluting taxation, resource taxation and etc
- charge scheme, such as user fee, compensation fee and etc
- graded penalties for acts that bring negative externalities into play
- fiscal instruments, such as loan of deducting interest, reducing or remitting tax and fee
- financial transfer
- Responsibility indemnity, such as legal indemnity, indemnity for damage of environmental resources and insurance indemnity and etc
- security and deposit scheme, such as security for ensuring environmental good behavior, security for residuals processing, deposit and stock and etc.

Valuation and Green Accounting of Tropical Forest Assets

Hou Yuanzhao

Introduction

The study is based on the following understandings:

1 Compared with temperate forests, tropical forests have a different socio-economic background, where natural factors play more important roles in the formation of forest assets.

2 Standing timber stocks in tropical forests include well-known commercial timbers and less well-known timbers. Well-known commercial timbers in tropical forests have higher values and smaller per hectare stocks than those in temperate forests; Less-well known timbers in tropical forests usually have larger stocks and lower values than those in temperate forests. Land use value in tropical forests is lower than that of temperate regions, due to socio-economic reasons. Tropical forests have more ecosystem service stocks than temperate forests, however, with lower values due to the lower prices (or lower WTP).

3 Citizens in developed countries are quite environment-conscious, while for developing countries, the priority still lies on livelihood. Therefore, we determined that the objectives of the rain forest accounting shall be as follows:

1) Through revealing the full value and the value structure of the forests, make the citizens and decision makers recognize the real value of the forests and help them to form a modern forest value that is consistent with sustainable development concept.

2) Establish a foundation for innovative study of forest sustainable development, especially for the institution and policy system for sustainable operation of forests.

3) Provide scientific evidence for compensation of forest ecosystem services to government and international community.

4) Provide technical foundation for developing the market of tropical forest ecosystem services.

5) Prepare for the country to adopt green GDP accounts.

Our priority purposes are the above four purposes, especially establishing a modern tropical forest value, instead of integrating forests into nation economic accounts. Therefore, the accounts should have a broad coverage, even though the methodology for valuation of ecosystem services is still not very mature, since it must be precise and accurate if it is for national accounts, but not necessarily so if it is for establishing the tropical forest value among people.

Although the whole world is undergoing the transition to sustainable development, it is still impossible to comprehensively integrate the economic value of natural resources and environment into national economic accounts in a fairly long period. We suggest that tropical forests GDP accounts should be adopted in 2 steps: the first step is to make comprehensive valuation of tropical forests; the second is to deal with the issue of integrating forests into national accounts.

In a word, we put forward two objectives and two steps for tropical forest accounts. These two steps are contradictory to the steps recommended by developed countries.

This report has four characteristics. The first characteristic is that we established an integral classification system for tropical forest assets, industries, products and ecosystem services, especially the classification for ecosystem services. The second characteristic is we developed an integral value system for tropical forests, in which the targets for accounting are classified into 6 categories and 32 items according to their natural attributes and the market development level. The third characteristic is that the valuation methods are systematically collected and sorted according to the natural attributes framework of the account components. The fourth characteristic is that four account frameworks that are suitable for developing countries are recommended, with a detailed introduction of a case study (Green GDP account for tropical forest assets in Hainan Province, China).

Suggestions are also made for the improvement concerning developing countries and tropical forests in the existing several important international environmental accounting documents.

Chapter 1 Basic Theories of Tropical Forest Accounting

This chapter briefly introduces the basic theories of tropical forest accounting, as our realization of what should we do and what results we want to get are based on our understanding of the theories.

1 Basic Theories[2]

National accounting is an accounting system tracing the economic activities of an economy and its sectors. With balance accounting as its principle, it develops a set of balance accounts or economic accounts, through the uniform definitions of the concepts, classifications, and accounting rules, and forms a tightly knitted data system, based on which various economic indicators are developed. What are first accounted are the marketed economic activities, which, with different natures, are expressed in uniform monetary terms. Therefore, national accounting is a monetary accounting system.

National accounts have two basic components. One is economic flow accounts, focused on GDP, which is a basic aggregate measure in flow accounts. From GDP, we can derive other indicators, such as net domestic product (NDP), national income, national disposable income, capital formation and savings, etc. The other component is account of asset stocks and changes in stocks.

One method in resources and environmental accounting is to construct a set of "satellite accounts" outside of the national accounting framework; the second method is to independently count the values of certain resources or environment, and use them to adjust the economic aggregates in conventional accounting; the third method is to comprehensively incorporate natural resources and environmental concerns into accounting system. System of Integrated Environmental and Economic Accounting (SEEA) of the United Nations uses the third method.

Figure 1 shows the framework of accounting system including resources and environmental factors.

[2] This part is mainly based on essays by Gao Minxue.

Figure1 Basic Framework of Integrated Environmental and Economic Accounting

	Domestic production	Rest of the World	Final Consumption	Mannd Assets	Natural Assets		
					Cultivated Assets	Non-Cultivated Assets	Other Natural Assets
Opening Stock				KO_m	KO_n		
Supply	P	M					
Use	C_i	X	C	I_{mg}	I_{ng}		
Gross Domestic Product	GDP	X-M	C	I_{mg}	I_{ng}		
Consumption of Fixed Capital	CFC			-CFC	$-CFC_n$		
Net Domestic Product	NDP	X-M	C	I_m	I_n		
Environmental Cost	U_n					$-U_n$	
Adjusted Environmentally Domestic Product (EDP)	EDP	X-M	C	I_m	I_n	$-U_n$	
Compensation of Employees	L						
Taxes Less Subsidies on Production	T						
Depletion Adjusted Operating Surplus	$PR-U_n$						
Other Changes in Volume of Other Assets				VOL_m	VOL_n		
Increases and Decreases of Property				REV_m	REV_n		
Closing Stock				KI_m	KI_n		

Note: subscript n indicates natural assets; subscript m indicates manned assets; U_n indicates environmetal costs and also changes in assets caused by economic use.

The shaded area of the figure represents flow accounts, while light part records stocks and changes in stocks, and both are based on traditional national accounts.

The core of the flow account is domestic product adjusted by environmental factors (EDP):

$$\begin{aligned} EDP &= NDP - U_n \\ &= GDP - CFC - U_n \end{aligned}$$

Where, NDP represents net domestic production, Un represents environmental costs and CFC represents consumption of fixed capital.

The equation of stock account is as follows:

$$K1_n = K0_n + I_{ng} - CFC_n - U_n + VOL_n + REV_n$$

Where, I_{ng} represents accumulation of economic products; CFC_n represents consumption of fixed capital; U_n represents changes of natural assets; VOL_n is other quantity changes; and REV_n represents holding gains and losses.

The overlapping of flow account and stock account in figure 1 reflects the connection between economic process and environment. The connections include: first, is the accumulation of economic products (capital formation) contribute to the increasing of not only man-made assets but also natural assets; second, the consumption of fixed assets include the consumption of both man-made assets and natural assets; third, resources and environmental costs not only represent natural assets consumed in economic process, but also reflect asset reduction. These accounts indicate that, on the one hand, economic process consumes resources and environment, reducing the stocks of them, on the other hand, stocks of resources and environment may be increases through products accumulation in economic processes, in which some natural assets are cultivated.

2 Components for accounting

1) Flow accounts describe the flow of various environmental elements in economic productions; Stock accounts describe the stocks of environmental elements under the influence of economic utilization and other factors.

2) Construct account framework with two parts, resources and environment (in the narrow sense), where, the resources accounts are focused on the accounting of natural assets and emphasize the consumption of natural assets in economic processes and the changes of the stocks; the environmental (in the narrow sense) accounts emphasize the utilization of environmental services in economic processes and the influence on environmental quality.

3) Integrated environmental economic accounting is an account system including not merely monetary accounts, but also physical accounts.

Combining the above three points, we have the following components of the accounts:

- Environmental and economic flow accounts in physical terms;
- Environmental and economic stock accounts in physical terms;
- Environmental and economic flow accounts in monetary terms;
- Environmental and economic stock accounts in monetary terms;

3 Valuation Methods

An important step in integrated environmental and economic accounts is to account the resources and environmental costs in economic processes by valuating the resources and environment consumed in economic processes, and to adjust the conventional gross economic indicators, such as GDP.

4 Adjustment of Aggregate Indicators

Adjusting macroeconomic aggregates means construct new indicators by integrating factors, such as consumption of resources, environmental degradation and defensive costs, etc. The ways to integrate macroeconomic aggregate indicators by integrating resources and environmental factors include:

1) ***Green GDP:*** Conventional GDP minus resources and environmental costs.

2) ***Sustainable income:*** The indicator of "Disposable Income" in traditional national accounts does not take the consumption of resources and environment into consideration. "Sustainable Income" is the value of "Disposable Income" minus the consumption of resources and environment.

3) ***Consumption:*** Some payments made in consumption only offset the negative influences on environmental changes and practically can't increase "welfare". We should deduct these payments, which are actually the payments related with environmental protection.

4) ***Total savings and investments:*** Traditional investments refer to the additional economic assets, which should minus the costs of the resources consumption and environmental degradation. Savings, as the source of investments, should be adjusted in the same way to reflect the "real" investment potential. Otherwise, some "environmental debts" are included in savings and investments. This will lead to the exhaustion of resources and environment.

Adjustments of GDP should be conducted systematically through incomes, consumptions, savings and investments; adjustment to income leads to the adjustment of GDP in the upper stream, and to the adjustments of consumption, savings and investments in the down stream. Thereby, we get the result of aggregates adjusted completely. The adjustment of each of the four indicators will lead to the adjustment of the whole aggregate system. However, since the source of the system is GDP, the focus of the adjustment should be GDP. The reason for adjustment is to truly realize the value of resources and environment and extend the scope of assets.

Chapter 2 Definition and Classification of Tropical Forest Assets

Forest accounts involve expanded conventional economic assets boundary, definition of natural assets, and classification of assets, industries, products and even government functions, all of which aims to construct a uniform logic system. International community has developed CPC for product classification and ISIC system for industrial classification. International accounting documents like "Integrated Environmental and Economic Accounting-2003" by United Nations and "The European Framework for Integrated Environmental, Economic Accounting for Forests-IEEAF" (2002) by Eurostat, and "Manual for Environmental and Economic Accounts for Forestry: a Tool for Cross-sectoral Policy Analysis" (March, 2004), etc., have also provided definitions of some concepts. These definitions and classification criterions can also be used in tropical forest accounting but need to be adjusted according to specific country situations.

1 Classification of Assets

The annex 2 of "IEEAF-2002" by Eurostat has provided the ESA/SNA classification standards for non-financial assets, and SEEA (CNFA) classification standards for tangible non-financial assets; while annex 1 of the same document provides several samples of "land cover and land cross-classification".

We referred to these classifications and added wetlands and sand lands to the categories in land asset classification. Furthermore, tropical woodlands are classified into 10 categories. Please refer to chapter 3 (2.1 marketed assets and products) for more detailed discription.

2 Classification of industries

"International Standard Industrial Classification of Economic Activities"(ISIC) comprises 4 levels and 17 categories. Considering the situation in China, we made the focus on economic wood industry and flower industry.

3 Classification of products

"Central Product Classification" (CPC), comprising 5 levels and 1811 categories, does suit China and need to be supplemented. Definitions concerning standing timbers in international documents are too strict. For example, the definition of ***standing timbers*** is "All alive or dead timbers with both height and diameter above 0 cm"; ***gross annual growth*** refers to "mean annual growth of all timbers with breast height and diameter above 0 cm"; ***net annual growth*** refers to "the result of average annual growth of all timbers with breast height and diameters not less than 0 cm minus their natural losses". There are major differences between these criterions and national forest inventory criterion. Our research is based on the current standard for national forestry statistics;

however, the possible price might be relatively rough accounting results.

"Bamboo timber" is added to categories under "cultivated forests and logging products"

"Palm rattan", "wild animal and plant medicinal materials", "trees and fruits (of non-specialized economic woods)", etc., are added to the categories under "non-timber products".

4 Classification of forest ecosystem services

IEEAF-2002 by Eurostat lists the schemes for classification of forest ecosystem functions, which, however, only suit application in Europe. Understandings of this issue are in confusion due to income differences, country and regional differences. It has also been the most confused issue on the two international workshops on tropical forest accounting, by ITTO PD 39/98 Rev. (M) project team, held in Beijing in 2002 and 2004 respectively.

This study proposes a classification system as follows:

Water head protection

Land protection and soil culturing

Reduce nutrient losses
Prevent soil erosion
Increase soil organic materials (forest soil culturing)
Sand-fixing

Carbon fixing and oxygen production

Carbon storage in forest organic materials
Oxygen production

Environment purification

Reduce air particles (sand, etc.)
Reduce negative oxygen ions
Reduce noises
Absorb harmful gases
Increase air moisture (improve amenity)

Biodiversity

Species and amounts of wild plants
Species and amounts of wild animals
Endangered plant species
Endangered animal species

Agriculture and settlement protection

Area of farm lands protected by protective forest and the benefits
Desertification prevention
Settlement, industrial zone and water supply protection benefits

Recreation and tourism

5 Classification of intangible forest assets (social benefits of forests)

It's a nearly blank area in domestic and international researches. Our classification is as follows:

Disaster proof and reduction benefits in physical terms and monetary terms
Scientific and cultural value in physical terms and monetary terms
Employment increase benefits in physical and monetary terms
National defense benefits in physical and monetary terms
Investment environment improvement benefits in physical and monetary terms

6 Flows and stocks in forest asset accounts

Flows and stocks are two important concepts in national accounting, while in forest accounting, their meanings are as follows:

Flows: measure area under a forestation, standing timber growth, cutting, growth, timber production and various forest ecosystem services, etc.

Stocks: measure existing wood land area, forested area, and timber stock, etc.

Relation between stock accounts and flow accounts: The changes between opening stocks and closing stocks equal the flows of forest assets during the accounting period. The difference between the opening stock and the closing stock equals the total of flows during the accounting period.

Stocks of forest ecosystem services: It represents the stock of environmental assets. Only the flow of tropical forest ecosystem services will be measured.

Chapter 3 Value Structure of Tropical Forest Assets

1 Forest asset value and value structure

Forest asset value can be expressed in two ways:

1) Total economic value TEV = Use value (UV) + Non use value (NUV)
= Direct use value (DUV) + Indirect use value (IUV) +
Option value (OV) + Existing Value (NUV) + ……

In this study, forest accounts will only measure use value due to measuring and pricing difficulties.

2) Total Monetary Value (TMV) = Option Value (OPV) +Economic Value (UEV)
+Environmental Value (EEV) ……

OR: Total Monetary Value (TMV) = Option Value (OPV) +User Economic Value (UEV)
+Environmental Economic Value (EEV)

2 Valuation System

We have described the value system of forest assets. These values are embodied in the types of forest systems, components or functions of forest ecosystem. The premise of estimating these values scientifically is to identify the carriers of the values and define the borders of the values, which is an innovative point of our study. We have designed "***Forest value Accounting System***". It comprises 6 categories, 32 items and still has room for improvement.

Table 1 Forestry valuation system

1 Market goods (assets and products)	11 Physical and monetary quantity of forest land (including sand land)
	12 Physical and monetary quantity of wetland
	13 Physical and monetary quantity of standing timber (including bamboo)
	14 Physical and monetary quantity of economic forests
	15 Physical and monetary quantity of flower production and transaction
	16 Physical and monetary quantity of timber industry
2 Quasi-market goods (products and services)	21 Physical and monetary quantity of non timber forest products
	22 Residuals in forestry industry
3 Non-market goods (forest ecosystem services)	31 Physical and monetary quantity of watershed protection
	32 Physical and monetary quantity of soil protection
	33 Physical and monetary quantity of carbon sequestration and oxygen generation
	34 Physical and monetary quantity of environmental purification
	35 Physical and monetary quantity of biodiversity conservation
	36 Physical and monetary quantity of agricultural protection
	37 Physical and monetary quantity of landscapes and recreation
4 Cost accounting I (depletion, degradation and defensive)	41 Depletion of forest resources
	42 Degradation of forest resources
	43 Forest environment defensive
5 Invisible assets (forest social benefits)	51 Physical and monetary quantity of catastrophe prevention and abatement services
	52 Physical and monetary quantity of scientific cultural and spiritual functions
	53 Physical and monetary quantity of employment increase
	54 Physical and monetary quantity of national defence services
	55 Physical and monetary quantity of improving investment environment
6 Cost accounting II (public or private investment)	61 Forestry administration budget of government
	62 Forestry public service enterprise budget
	63 Forest protection budget
	64 Afforestation and forest management budget of government
	65 Forestry program budget of government
	66 Forest investment fund, greening fund and etc
	67 Non-management international forestry assistance and donation
	68 Research expenditure
	69 Private investment in forest protection

2.1 Marketed Assets and Products

2.1.1 Wooded land

"Wooded land" refers to any land used for forests and trees, including existing forests, land occupied by trees, and forestable barren and sand land.

The value of wooded land is the current price paid by the new holder of use right for obtaining the use right of the land. It does not include the value of the trees and biologic assets. Tools like the existing land asset balance account and matrix for recording land classification changes during given period can be used in wooded land accounting. In China, land is not tradable, but land use right can be sold, therefore the price of use right is the price of the land.

Annual forestation area, agriculture and pasturage occupied land area after deforestation, industry and urbanization development occupied wooded land area, area of land returned from farming to forestry, and natural expansion area of forest, etc. are all the flows of wooded land. But activities like clear cutting that doesn't change area of wooded land are not counted as wooded land flows. Wooded land area updated from new forest inventory belongs to wooded land stock, the change of which is contributed to the accumulation during the accounting period.

Tropical wooded land can be classified into 10 categories:

Tropical virgin forest and natural forest
Tropical natural secondary forest
Tropical mangrove
Tropical forest protection zone and national park
Tropical bamboo grove
Tropical man-made forest
Tropical economic forest
Wooded land in agricultural zones (village forests, protective forest belt, highway planting belt, river bank planting belt)
Urban forest
Tropical barren and sand land

2.1.2 Wetland

Artificial wetland

Natural wetland (wetland forest is under forest category)

2.1.3 Standing Timber

Indicators that describe flows and stocks of standing timber include stock accumulations and growth of standing timbers, annual growth, felling volumes. Flows of standing timbers include felling volume and natural growth. The framework of flow accounts and stock accounts are based on forest balance account, sector/products balance account, and industry quality balance account.

Classification:

Cultivated standing timber:
Industrial wood forest
Operational natural forest
Artificial protective forest

Common artificial forest

Artificial firewood forest

Non-cultivated forest standing timber:

Primitive forest (coniferous forest, broad-leaved forest, mixed forest)

Natural forest (coniferous forest, broad-leaved forest, mixed forest)

Low-quality natural secondary forest

Shrub forest

Natural bamboo forest

2.1.4 Economic forest in physical and monetary terms

In China, fruit growing industry belong to forestry sector; Rubber industry is an independent sector, but belongs to forestry sector in statistics. Here only the areas and flows will be measured, and the products will be put under non-timber products category.

Cultivated economic forests are classified as follows:

Rubber

Tea and Kuding tea forest

Coconut

Mango

Areca nut

Litchi, longan

Coffee, coco

Medicinal plants

Others

Non-cultivated economic forest (Natural economic forest)

2.1.5 Flower growing and transaction in physical and monetary terms

Cultivated flowers (production, transaction volume…)

Wild flowers (Stock estimation, yield estimation, market transaction estimation)

2.1.6 Timber industry

Conventional national account has covered timber industry. Therefore, we've only to borrow it. The valuation of forestry will be more objective with the economic data, especially contribution of forest assets, integrated into the accounts.

Classification:

Timber converting industry;

Artificial board industry;

Pulp and paper making industry;

Floor and furniture production industry

Wood architecture

Article of utility and craft manufacturing industry that use woods and bamboos as raw materials

Fuel wood manufacturing industry

Forestry and timber production machinery industry

...

2.2 Quasi-market products and services

2.2.1 Non-wood forestry products in physical and monetary units

Use whole sale prices paid to the collectors in recording all harvested tropical forest non-wood products, whether they are for sale or for self-use, whether they are cultivated or natural.

Classification:

Forestry fuel (fuel wood, etc.)

Forestry materials for industrial uses (natural rubber, tannic acid, etc.)

Palm rattan

Bee honey

Wild plant medicines

Wild animal medicines

Games

Forage grass

Animals grazed in forests

Dry fruits (not necessarily the output of economic forests)

Berry (not necessarily the output of economic forests)

Other fruits (not necessarily the output of economic forests)

Wild forestry edible fungi

Peat, moss

Fur

Others

2.2.2 Forestry wastes

Forestry wastes include wastes from forests, wastes from timber production and waste gases discharged from forestry industries, etc. Waste flows don't include the residuals from forest felling, waste timbers or waste paper, among which, felling residuals enter into timber balances, instead of being recorded in the removed category, waste timbers and waste paper are recorded under product category and accounted in pollutants balance or "waste flow account".

2.3 Non-market forest ecosystem services

There is no existing international classification or domestic classification for this category. The classification of this study is as follows:

2.3.1 Water head protection

Rain water storage in underlayer of forests

Forest water storage

Runoff adjustment by forests (such as flood reduction)

Purification of water quality by forests

2.3.2 Land protection and soil conservation

Reduce soil erosion

Prevent silt accumulation

Preserve soil fertility

Nurture soil

Control sand

2.3.3 Carbon fixing and oxygen production

Forest carbon storage has formed a world market. Plants generate 1.2 tons of oxgen with every 1 ton of dry material. The marginal oxygen production function of forest vegetation is very important in high altitude regions and municipal areas (Table 2). Oxgen production function of the forest vegetations on highlands has been supporting all of the life forms there. In big cities and oxygen bar tourism regions, oxygen production function of the forests has also begun to enter market. More and more residents are seeking oxygen services of the forests, and medicine sectors have also begun to set sanitaria in forest areas.

Carbon storage (above land and below land)

Oxygen production

Table 2 Air pressure and partial pressure of oxygen

Altitude(m)	Air pressure (mmHg)	Partial pressure of oxygen (mmHg)	Kg/cm^2	°C
0	760	159	1	15.00
500	716	150	0.9424	11.75
1000	674	141	0.8870	8.50
2000	596	125	0.7845	2.00
3000	526	110	0.6918	- 4.50
4000	462	97	0.6083	-11.00
5000	405	85	0.5330	-17.50

2.3.4 Environmental purification

Mainly targeted at urban areas. Following functions are defined:

Absorb particles in air

Release negative oxygen ions

Reduce noises

Absorb harmful gases

Increase air moisture (improve amenity)

2.3.5 Biodiversity

Biodiversity includes species diversity, genetic diversity and habitat diversity. This concept is very abstract, and what we can now quantify and record up to date are as follows:

Species of wild plants
Species of wild animals
Species of endangered plants
Species of endangered animals

2.3.6 Agricultural and settlement protection

Here the values of protection (VP) of forests refer to the following 4 aspects (functions such as water source protection, soil conservation, carbon fixing and air purification are not included):

Protection value of field protection forests
Protection value of sand defense forests
Protection value of range protection forests
Protection value of seashore protection forests

2.3.7 Recreation and tourism

Area of scenic forests, visiting population, revenues (including scenic pastures on mountains)
Area of forest parks, visiting population, revenues
Area of common parks at suburb (parks at downtown regions excluded), visiting population, revenues
Hunting

2.4 Cost accounting 1: Depletion, degradation and defense

Like any other assets, forest ecosystems have ups and downs of assets both in quantity and quality. Here we record the reductions of forest assets and the necessary investments, treated as costs in the accounts, for preventing asset reductions, .

2.4.1 Depletion of forest resources

Depletion of forest resources refers to quantity reductions of forest resources due to various economic or non-economic factors. Felling is not included as it's normal production activities.

The following classes are to be accounted:

Depletion of wooded land (defined as permanent woodland converted to be used for other purposes due to economic reasons, not including clear cutting):

Wooded land be used for other purposes
Stone desertification, desertification
Land sedimentation

Forest depletion (defined as the quantity exceeding growth)

Forest depletion due to fire hazards;

Forest depletion due to diseases;

Forest depletion due to pests;

Forest depletion due to animal hazards (e.g., bitten by rats, sheep, deer, etc.);

Forest depletion due to other harmful life forms (e.g., tropical strangler plants);

Forest depletion due to meteorologic disasters (freezing injury, drought disaster, flood);

Forest depletion due to acid rain damage;

Forest depletion due to over felling

Over grazing damage;

Land rates degraded due to forest ecosystem degradation

2.4.2 Forest environment degradation

Forest environment degradation refers to quality declines of forest ecosystem due to inappropriate forest operation, felling, utilization and afforestation, or due to environmental pollutions (such as acid rains).

Environmental degradation affects plants growth and forest environmental services functions. Theoretically, asset accounts should reflect the value changes of the assets and treat them as natural assets consumption. Soil quality degradation, as a form of soil degradation, is described by the land areas at different quality levels. Value losses caused by soil degradation are counted in land value, and losses of ecosystem functions are included in ecosystem accounts. If a forest degraded to such a level that it doesn't meet the definition of forest assets, it will be put under the "other kinds of land" class.

Indicators to describe forest degradation situation are constructed, such as fallen leaves, soil erosion, soil hardening, accumulation of harmful materials, loss of organic materials, pest disasters, exotic species competition, forest zone water pollution, etc. A base year should be chosen in accounting.

Classification of forest environmental degradation:

Forest health condition, described by the color changes of leaves on trees and fallen leaves;

Biodiversity level, described by numbers of (endangered) species;

Plant losses as a result of abiotic or biological attacks;

Soil degradation (soil hardening, acidification, salinization, organic materials declining, etc.), described by productivity declining;

Distribution of wooded land.

2.4.3 Forest environmental defense

Forest environmental defense costs include preventive costs and restorative costs. Defensive costs measure the actual payments made for forest protection. This is different from degradation costs, which measure the virtual costs. Input-output table is the best instrument to measure the actual environmental preventive costs.

Environmental preventive investments are mostly public service investments made by government, although some private investments are also included. More details in 2.6.

2.5 Intangible assets (forest social benefits)

Disaster prevention and reduction function:

Reduce landslide and debris flow, and prevent floods, etc.

Scientific and cultural function:

Popular science education function;
Totem culture of aboriginal;
Religion value;
Ethic and sprite function.

Employment creation;

National defense;

Improve investment environment function.

2.6 Cost accounting 2: public investments

The function classification in SNA (1993) included the classification of function of government, the objective of which was to provide statistics to make regular or special analysis. It included 14 classes, such as public services, education transactions and services, agriculture, forestry, fishery, and game transactions and services, etc. These public payments will be put under appropriate classes in the accounts. For example, forest protection investments can be put under forest preventive costs. Those can't be merged into other classes should be recorded together, and be shared as costs by all cultivated and non-cultivated forest.

Public investments classification:

Government forestry administrative budget;
Public forestry institutions budget;
Forest protection budget;
Government afforestation budget and forest operation budget;
Government forestry projects budget;
Forest cultivation fund;
International non-business forestry supporting fund and donation;
Research fund;
Private investment on forestry for public welfare aims

Chapter 4 Tropical Forest Asset Valuation Techniques

1 Valuation of forest products and ecosystem services: overview

Forest products and services can be classifies into 3 categories: marketed products and services, which can be valued directly according to the market prices; near-market products and services, values of which are based on the market prices of closes substitutes; non-market products and services, which have no price to be based on. Different techniques are utilized to value the three types of products and services. See table 1.

Table 1 Approaches for Valuating Forest Assets, Products and Ecosystem Services

Market Degree	Classification of forest asset, products and services	Valuation Methods
1. market goods (assets and products)	11 physical and monetary quantity of forest land (including sand land) 12 physical and monetary quantity of wetland 13 physical and monetary quantity of standing timber (including bamboo) 14 physical and monetary quantity of economic forests 15 physical and monetary quantity of flower production and transaction 16 physical and monetary quantity of timber industry	Market price method Production cost method Using the price signals of local market Using the price signals of similar products
2. Quasi-market goods (products and services)	21 physical and monetary quantities of non timber forest products 22 residuals in forestry industry	Using the price signals of local market Using the price signals of similar products Production cost method
3. non-market goods (forest ecosystem services)	31 physical and monetary quantity of watershed protection 32 physical and monetary quantity of soil protection 33 physical and monetary quantity of carbon sequestration and oxygen generation 34 physical and monetary quantity of environmental purification 35 physical and monetary quantity of biodiversity conservation 36 physical and monetary quantity of agricultural protection 37 physical and monetary quantity of landscapes and recreations	Using the payment for ecosystem services Production cost method Travel cost method Hedonic pricing method Contingent valuation method Carbon taxation Using the prices of emission trading Damage based method Cross-anaysis method
4. cost accounting I (depletion, degradation and defensive)	41 depletion of forest resources 42 degradation of forest resources 43 forest environment defensive	Market price method Production cost method Using the price signals of local market Using the price signals of similar products

5. invisible assets (forest social benefits)	51 physical and monetary quantity of catastrophe prevention and abatement services 52 physical and monetary quantity of scientific cultural and spiritual functions 53 physical and monetary quantity of employment increase 54 physical and monetary quantity of national defence services 55 physical and monetary quantity of improving investment environment	Market price method Production cost method Using the price signals of local market Using the price signals of similar products Contingent valuation method
6. cost accounting II (public or private investment)	61 forestry administration budget of government 62 forestry public service enterprise budget 63 forest protection budget 64 afforestation and forest management budget of government 65 forestry program budget of government 66 forest investment fund, greening fund and etc 67 non-management international forestry assistance and donation 68 research expenditure 69 private investment in forest protection	Actual statistics data

The above table is only an overview of the approaches. More detailed introduction of each approach will be given in the following. What need to be pointed out is that all of the approaches are developed by developed countries and based on their economic, social and cultural conditions, and therefore incorrect conclusions might be reached, if the approaches are utilized in developing countries without adjustments. See, what can you expect from people who are still struggling for life or people who are illiterate in a contingent survey on their willingness to pay (WTP) for a tropical forest that is very far from them?

However, to develop a set of valuation approaches that are suitable for developing countries is not a piece of cake. Chinese scholars suggest using "development stage coefficient" to adjust the results from using the above approaches. And different coefficients are proposed by several scholars, including Engel coefficient by Li, Jinchang (1991), "market approximation coefficient" by Kuijian professor (2002), and "forest ecosystem function importance coefficient" by Hou, Yuanzhao(2002). The purpose of all of the efforts, which need further research, is to make the valuation result more scientific and credible.

2 Valuation Approaches: description

2.1 Valuation of marketed assets and products

The accounts of wooded land, forests and standing timbers must specify stocks and flows, the latter of which should include felling and natural growth.

2.1.1 Valuation of wooded land

The value of wooded land doesn't include the value of the vegetation on it but include the stocks of land improvement.

If no market price of land is available, discounted value of future benefits might be used. For wooded land, if they are sold or rented, the expected future benefits are the future flows of "net rental". If "net rental" is unknown, we might get the value of wooded land by deducting earnings of production capital from the net surplus of the production activities implemented on the land. If there are few cases of wooded land trading in an accounting period, the few trading prices might be concluded and used as the general price. Then use Lancaster method to find the characteristic "price", which is further used to classify all lands according to their characteristics and to calculate all of the values.

In china, scholars proposed ten plus techniques to measure wooded land price. The techniques have different scopes of application and each has its own strong points. The main techniques are listed in table 2.

Table 2 Wooded Land Valuation Approaches

Approaches	Scopes of Application	Strong Points	Weak points	Notes
Market Information Comparison Method	Any type of wooded land	Objectively reflect the market condition of wooded land; evaluation results are easy to be accepted.	Wooded land markets shall exist; applications are limited by factors like regional differences.	Pay attention to the selection of valuation parameters.
Cost Valuation Method	Applicable in valuation of wooded land with known purchasing price and specific use.	Fairly adequate consideration of wooded land degradation; contribute to maintaining wooded land assets.	Heavy workload.	Replacement costs shall be used.
Benefit Valuation Method	Any type of wooded land.	Fairly Close estimation of the capitalized price of wooded land; Easy to be accepted by both transaction parties.	Difficult to forecast future benefits; easy to be influenced by subjective judgment.	The wooded land shall have stable annual incomes (rent).
Middle Course Valuation Method	More used in economic forest.	Objectively reflect the wooded land market condition and capitalized price	Need adequate materials and normative standards.	A mature market shall exist as the premise.
Simplified Land Price Method	Applied in valuation of wooded land not in rotation period.	Very easy to use.	Small application scope.	Used as reference method for wooded land valuation in China.
Annuity Capitalization Method	Applied in economic forest.	Easy to calculate.	Stable annual incomes are required.	Average annual rent and rate of return shall be determined.
Other Approaches	Applied in valuation of bamboo forest and other kinds of wooded land.			

2.1.2 Valuation of wetlands

Wetland has the same value structure with that of wooded land. Its' valuation approaches also include direct market price method, substitute market method, conditional value method, production cost method and some market valuation methods that are based on evaluating actual influences (Dose-response method, production function method, etc.). A wetland ecological system that is made up of forests should be classified into category of forest.

2.1.3 Valuation of standing timbers

1) Cultivated standing timbers

Standing timber should be classified into mature standing timber and immature standing timber.

Mature standing timber: There are as many standing timber transaction ways, such as standing sale, felled sale and "road side delivery", as valuation methods.

Immature standing timber: "net present value method". The value of immature standing timber depends on the amount, price, and future payments during cultivated standing timber growing period and discount rate. Using this method requires to make many assumptions (like volume of mature timber, time to reach adult phase, appropriate discount rate, future price and payments, etc.), and should consider the benefits and costs (like thinning, etc.) of best management of forests.

2) Non-cultivated standing timber

The characteristics of non-cultivated standing timber include natural growth and no investment needed, therefore, the value of the timber is the present value of future incomes. Assumptions of future harvests and discount rate are needed for the calculation.

However, costs exist, as described in item 43 of table one of this chapter and items 61-69 in cost accounting2 in chapter 3. Theoretically, these costs should be divided by all standing timbers. As it's too complex, this study neglected these costs.

Box 1 Overview of standing timber valuation techniques

The general expression for the value of an asset, V, in the base year, 0, is simply the sum of the net economic benefits it yields in each year t, over the lifetime, T, of the asset, discounted to present value by the discount rate, r. where p is the unit rent (stumpage price) calculated as revenue minus the marginal cost of harvesting, and Q is the total harvest in a given period. SEEA identifies three alternative methods for valuation of standing timber:

Stumpage value method

The simplest of the three approaches, asset value of standing timber, V, is given as the product of total forest area in hectares, A, the stumpage price per cubic metre of timber, p, and the quantity of timber per hectare (cubic metres), Q:

$$V = ApQ$$

Consumption value method

This method expands the stumpage value method to account for the difference in value of trees of n different age or diameter classes, t. The stumpage value is calculated as:

$$S = \sum_{t=1}^{n} A_t P_t Q_t$$

Simplified net present value method

The total value of standing timber, V, is the sum of v_τ, the value per hectare of forestland of age class τ, weighted by A_τ, the total area in age-class τ, where T, is the actual cutting age, p t is the stumpage price, q_T, is the timber yield at actual cutting age. The value is discounted at a rate, r, by the time remaining until harvest, T-τ. (The following presentation abstracts from other important characteristics that affect forest value such as species, region, site quality, etc, for ease of reading.)

This expression for forest asset valuation may be further refined to reflect timber value, the value of the bare land, p L , and full rotation management costs, C_s.

Timber

The value of any timber asset is the discounted present value of the economic benefits it will generate in future years. Timber asset value is the discounted future stumpage price for mature timber after deducting costs of bringing the timber to maturity. The stumpage price is the price paid to the owner of the forest for standing timber, or in the absence of such markets the stumpage value can be estimated by deducting the costs of logging and transportation from the price received for raw wood. Costs include thinning (net of any income), other forest management costs and rent on forestland. To implement timber valuation, SEEA lists three alternative methods for calculating the value of standing timber):

Net present value approach may be implemented using the average stumpage value for all removals or by distinguishing stumpage values for different species.

Stumpage value approach, also known as the net price method, is a highly simplified version of the net present value approach. It multiplies physical stock with the average stumpage price of the timber removed. Where there is a market for standing trees, the stumpage values are directly observable. In the absence of such markets (or where market prices may be distorted), the stumpage value can be estimated. Under highly restrictive assumptions (that the discount rate equals the natural growth rate of the forest), this approach is the same as the net present value approach. This approach may be refined by applying the stumpage value for different species to the remaining stock of each species.

Consumption value approach is a variant of the stumpage value approach where stumpage value is distinguished not only by species but by age or diameter class as well. The distinction between the two is that the stumpage approach uses the structure of fellings for weighting stumpage prices, whereas the consumption approach uses the structure of the stock.

Source: Manual for Environmental and Economic Accounts for Forestry: a Tool for Cross-sectoral Policy

2.1.4 Valuation of economic forests

In valuation of economic forest assets, we divide them into two classes, namely economic forest products (such as natural rubber) and standing timber (such as standing timber of rubber plant), both of which are valuated based on market price.

2.1.5 Valuation of flower production and transactions

Based on market prices.

2.1.6 Valuation of timber industry

Based on market prices. Method in traditional national economic accounting can be used.

2.2 Valuation of near-market products and services

2.2.1 Valuation of non-timber products

Valuation of near-market products can be based on the market prices of similar products. Valuation of many non-market forest goods and services utilize the SNA near-market approach where possible; there are 3 major variations:

Price of identical or very similar product;

Price of replacement product (to value forest products at the cost of replacing them with close substitutes);

Production cost approach (in the case of many NFTP, the most significant production cost is labor).

Our study regard that non forest products are usually under-estimated. Aboriginal inhabitants' living demands are taken care of by market or government at very high price. In Hainan island of China, local residents are forbidden to collect traditional forest products subject to natural forest protection policy. The consequence is that aboriginal inhabitants return to poverty, and the government has to appropriate funds as subsidy.

2.2.2 Forest wastes

Recyclable forest waste mainly include felling residuals, wood processing residuals, waste paper, waste timber products, etc., which are valuated based on market purchasing price. Harmful wastes are calculated in damage costs.

2.3 Valuation of non-market ecological services

If there is no market price or near-market price, valuation of these non-market functions can only be achieved through simulating a market or a society and estimate the investments that it will make to create these functions.

Techniques to value non-market forest ecosystem services are very complex. Box 2 describes the 4 commonly used techniques.

Box 2. Non-market valuation techniques

Travel cost method measures the value of forest recreation services by estimating how much people are willing to pay to travel to that site. Information about travel costs and other socio-economic characteristics of users that affect demand (e.g. income, distance from site, etc.) is collected through site surveys and aggregated to estimate a demand curve, or several demand curves, for different zones around the site. Most costs associated with travel may be easily measured, although there remains controversy over whether to include the visitor's travel time as part of the cost.

Contingent valuation method (CVM) elicits the value individuals place on a hypothetical situation such as preservation of a forest or a species by asking them how much they would be willing to pay for it, or how much they would have to be compensated to do without it. This is particularly useful for eliciting the value of environmental goods and services for which there are no market prices, such as recreation and biodiversity.

Conjoint analysis is a survey technique developed by marketing experts to analyze consumer choice. It is similar to CVM, but the survey instrument differs. CVM poses the question 'How much are you willing to pay for a good?' or 'Would you be willing to pay $X for a good?' Conjoint analysis separates out the attributes of the good and asks individuals to rank the importance of each attribute. The survey presents a series of questions about different combinations of attributes. This approach can be particularly useful for forest ecosystem valuation because ecosystems provide multiple services; for example, a forest may provide recreation, wildlife habitat and hydrologic management.

Benefits transfer is a valuation method where environmental benefits measured for one site are applied to other sites. A meta-database of valuation studies, EVRI (Environmental Valuation Reference Inventory), has been compiled by Environment Canada and the US Environmental Protection Agency. It provides information from over 700 valuation studies, mainly from North America. Unless regional differences are factored in, the value estimate will not be accurate.

Source: FAO "Manual for Environmental and Economic Accounts for Forestry : a Tool for Cross-sectoral Policy Analysis"(March, 2004)

2.3.1 Water Source Protection

Valuation of water source protection utilizes cost benefit analysis, namely through estimating the losses that might be caused by these services. Another promising development for valuation of forest environmental services is Payment for Environment Services (PES). Costa Rica had some experiences in utilizing this method.

2.3.2 Land protection and soil conservation

In System of Economic and Environmental Accounts, land assets and soil assets are treated separately. Our study regard the two types of assets shall not be divided. Therefore, we make an integrated valuation and divided the value of soil protection function of forests into four classes: soil erosion reduction value, sediment accumulation prevention value, soil fertility preservation value, and soil cultivation value.

1) valuation of soil erosion reduction power of forest (land price differences)

$V = \alpha S\ (V_1 - V_2)$

V: soil erosion prevention or reduction value of forest
S: forest protection area;
V_1: value of unit land area before soil erosion
V_2: value of unit land area after soil erosion
α: soil protection factor of forest, namely the ratio of actual soil conservation area and forest protection area.
α value differs according to region, tree, forest density, etc. Generally, $\alpha \geq 1$. The value of V_1 and V_2 can be chosen according to land price per acre and abandoned land price stipulated by the government. This method has taken the value of soil fertility into account.

2) Valuation of sediment accumulation reduction power of forest (water and soil conservation method)

$\Delta W_s = \Sigma FI\ (M_{soi} - M_{oi})$

ΔW_s: sediment runoff reduction
F_I: effective action area of vegetation
M_{soi}: Sand transportation module of comparative region
M_{oi}: Annual sand transportation module of the wooded land

3) Soil fertility preservation value of forest

$P = (\Sigma(R_j/A_j) . C_j)\ W;$

P: Value of soil fertility conservation power of forest;
W: Amount of soil stabilized by forest;
R_j: Content of nutrient j in unit of sediment;
A_j: Content of nutrient j in standard chemical fertilizer;
C_j: Price of standard chemical fertilizer j.

3) Land conservation value of forest

$V = (V_1 - V_2)$
V: Soil conservation value of forest
V_1: Crop revenues after soil fertility is improved
V_2: Crop revenues under original soil fertility condition

2.3.3 Carbon fixation to produce oxygen

2.3.3.1 Foreign carbon storage

Methods to measure forest carbon storage:

Forest carbon storage above land mainly includes timbers, undergrowth plants and forest litter layer. Methods to evaluate them in physical terms include: Biomass Method, Stock Method, Forest Soil Carbon Measurement Method, Eddy Correlation of Eddy Covariance Method, Relaxed Eddy Accumulation, and Enclosures/Chamber Method, etc.

Methods to measure forest soil carbon storage

Forest soil carbon storage can be measured by multiplying land area with a coefficient. Leafed and leafless trees are not considered as different here; carbon storage of "forests available for timber production" and "those not available for timber production" are not differentiated; forested land area changes and carbon storage ability changes between juvenile phase, semi-mature phase and mature phase are considered. Forest soil carbon storage is regarded as a fixed value as long as the forest existen.

Valuation of forest carbon storage:

The monetary value of forest carbon storage can be calculated by multiplying the price of carbon per ton with fixed carbon storage. Methods to determine the price of carbon per ton include: market price of emission permits, emission taxes, and costs to prevent damage (costs to reduce carbon emission through some techniques or costs to increase carbon storage). German uses the market price of CO_2 (1-10 Euro per ton of CO_2 or 18 Euro per ton of carbon). Many studies relevant with climate changes use 10 USD per ton of carbon, which is also adopted by World Bank, to estimate the damage of carbon emission.

2.3.3.2 Oxygen production by forest

Oxygen content of forest is measured through photosynthesis equation:

$$CO_2(262g) + H_2O(108g) \rightarrow O_2(193g) + \underset{\text{Polysaccharides (162g)}}{\underset{\downarrow}{C_6H_{12}O_6\ (180g)}}$$

According to this equation, plants produce 1.2 g oxygen for 1 g of solid production (or 1.2 ton of oxygen for 1 g of solid).

Price of oxygen: use costs of oxygen production in industry as the price of oxygen, which is multiplied with the total amount of oxygen produced to get the total value of forest oxygen. In low altitude areas and areas with large scale of vegetation, the marginal value of vegetation oxygen production is relatively low and, therefore a low price might be appropriate. Suggest using oxygen production cost in industry for high altitude areas (e.g.2500m above) and skirts of bit cities, and using some point between 1/10 and 1 /2 of that cost for other areas.

2.3.4 Purifying the environment

Currently, techniques to valuate environmental damages mainly include: dose-response technique, changes in productivity approach, effect on production approach, cost of illness approach and human capital approach.

The basic formula of dose-response technique is as follows:

$$m_j = f(a_i, b_j, c_k)$$

where, m_j is the mortality or morbidity of a specific disease for age group j;

a_i is a group of environmental quality indicators relevant with the environmental quality for valuation;

b_j is the behavior parameter of age group j;

c_k is other environmental parameter.

In our study, we recommend the total value of environmental purification is as follows:

$$C = D \bullet \sum_{i=1}^{n} f_i \bullet W(W_{i1}, W_{i2})$$

Where, C is the total value of environmental purification power of the forest;

F_i is the value of environmental purification power i;

W_{i1} is the weight of purification power i in total value, indicating the significance of this power compared with others;

W_{i2} is the influence weight of other powers on purification power, indicating the mutual influence among the environmental purification powers.

W is the weight coefficient, also the function of W_{i1} and W_{i2}.

D is the parameter adjustment variable relevant with the total value.

Value weight can be determined by Analytical Hierarchy Method.

2.3.5 Biodiversity

The concept of biodiversity is immeasurable. Here we only record the species and amounts of the wild plants, species and amounts of wild animals, species of endangered plants and species of endangered animals. Different creatures have different implication and market features.

Table 4 Forest Creatures Biodiversity Valuation Techniques

Methods			Applicable Scope	Strong Points	Weak Points
Market evaluation methods		Actual market price method	Applicable in valuation of creature products that have market exchanges.	Easy to understand, easy calculation, accurate, and few disputes.	Good market operation mechanism needed.
		Present value of expected income	The same as the above.	Easy to understand, reliable, few disputes	Good market operation mechanism and appropriate discount rate.
		Net price method	Applicable in wild biologic community valuation.	Same as the above	Good market operation mechanism and materials concerning biotic resources development costs needed.
		Opportunity cost method	Applicable in evaluation of climate, ecology, species losses.	Same as the above	Good market operation mechanism and analysis of producer and consumer behavior needed.
		Travel cost	Applicable in evaluation of protection zones and national parks, etc.	The method is relatively mature.	Undervaluation of wild biologic protection zone.
	Preference statement approach	Bidding play method	Applicable in biological protection.	Be able to valuate resources without market values.	Actual effective demands from market and consumers are not observed.
		No cost selection method.	Applicable in valuating environmental products and services.	Be able to assess the value of environmental products or services.	WTP and WTA is different.
Integrated technical evaluation methods		Freeman basic model.	Applicable in valuation of environment and resources services.	The model is constructed on the base of the utility of environment and resources, and is fairly accurate.	Utility function of environment and resources needed.
		"Resources—Environment"	Applicable in valuating natural assets with stocks.	The model is constructed upon the basis of optimal control and can work out the "shadow price" of the resources.	Hard to understand, quite abstract, and require high maths knowledge.

2.3.6 Agricultural protection and prevention power

Protective powers of forests, including water source culturing, soil conservation, carbon storage and atmosphere purification, have specific valuation methods. Here, value of protection refers to the following 4 aspects:

VP_1: Protection value of farm field protection forests;

VP_2: Protection value of windbreak and sandbreak forests;

VP_3: Protection value of grazing land protection forests;

VP_4: Protection value of seacoast protection forests.

The total economic value of forests is: $VP=VP_1+VP_2+VP_3+VP_4$,

The present value of protection (PVp) is VP discounted by discount rate r.

1) Protection value of farm field protection forests

It equals the product of ecological benefit of crops under forest protection and the monetary value of unit crop:

VP1=EB×MV

Cao Xinsun (1983) developed the total economic value equation for farm field protection forest belts. The total annual income "m" of forest belt minus the total expenditure "n" of the forest in the same period is the value of protection of the forest belt("m" include the monetary value of the standing timbers.):

$$E = \frac{M}{N} = \frac{\int_0^t (k_1 \times \Delta_q + k_2 \times \Delta_v + A)dt}{\int_0^t [k_1 \times (q_0 + q_1) + p]dt}$$

Where, m: the total income of the forest belt in some year;

n: the total expenditure of the forest belt in the same year;

K_1: Monetary value of unit agricultural product;

q: crop yield increase in the year;

K_2: monetary value of unit timber;

Δ_v: timber production of the forest belt in the year;

q_0 : crop production loss for the area of the land occupied by the forest belt;

q_1: crop production loss for the area of the coerced land of forest belt;

P: operation and management costs of the forest belt in the year;

E: the total economic benefits of the forest belt from the beginning of forestation to the end of the calculated year.E<1, negative profit; E=1, Total income completely offsets the total expenditure; E > 1, positive profit。

The protection value of forest on large scale farm field is evaluated through remote sense method.

2) Protection value of windbreak and sandbreak forests

There are two valuation methods, one is to directly valuate the desertification land under protection, the other is production function method, .The formula of production function method is as follows:

$Y_i = K_i(A-C)$ $\qquad$ $Y = \sum_{i=1}^{n} Y_i$

Where, Y_i: the monetary value of desertification farm land reduction benefits per unit area of sandbreak forest in year i;

Y: monetary value of desertification farmland reduction benefits per unit area of sandbreak forest during the whole production period;

A: agricultural product price (yuan/jin[3]);

C: Production cost of agricultural product;

[3] Jin, Chinese unit for weight, equal to half of kilogramme.

K_i: benefit coefficient of desertification land reduction per unit area of sandbreak forest in year i.

3) Protection value of grazing land protection forests

Production function method is the major method. The equation (Zhou, Haiyan, et al, 1998) to valuate the disaster reduction benefits "ZA" and the net income "ZB" in one year from sheep raising on the pasture under protection is as follows:

$$ZB=(P_1-P_0)\times n$$

Where, ZB: the value of stock capacity increase due to protection forest;

P_1: net income in a year from sheep raising on a pasture with protection forest;

P_0: net income in a year from sheep raising on a pasture without protection forest;

R: years that the protection forest is in function;

4) Protection value of seacoast protection forests.

Han Xudong etc. adopted expert evaluation method to valuate the total ecological value of mangrove forest ecological system in China. The method is a Contingent Valuation method.

2.3.7 Forest tourism value in physical and monetary terms

Market price method is used here. Free forest tourism services are valuated in expenditure method, Contingent Valuation Method, Hedonic Price Method and Travel Cost Method, etc.

2.4 Cost accounting1: Depletion, degradation and defense

2.4.1 Costs of forest asset depletion

Cost of forest asset depletion is the value of natural resources consumption in economic production in a given period. Generally, the following methods are adopted:

1) Net price method

Asset depletion costs can be calculated in the following equation:

$$D=(P-C)R$$

Where, D is the asset depletion cost, P is the price of the resource, C is the marginal cost of resources exploitation, R is the volume of production of resources products.

2) Operation earning surplus calculation method

Asset depletion cost =total operation earning surplus-fixed capital consumption-productive capital reward

2.4.2 Forest environment degradation cost

Valuation of forest environment degradation cost, which utilizes a technique based on costs, describes deterioration of forest environmental quality in monetary terms.

SEEA-2003 provides two different conceptual methods: maintaining cost method and damage cost method

SEEA-2003 provides two different conceptual approaches to valuing degradation: the maintenance cost approach and the damage cost approach. Maintenance cost is based on the cost of actions that would have to be taken to prevent or remedy degradation; Damage cost is based on the value of the damages or loss of function due to degradation.

2.4.3 Forest environment prevention cost

Utilize actual expenditure statistics. Record the actual expenditures of the government, enterprises and households on forest protection in the counting period. Specifically, the expenditures include fire prevention cost, insect disease prevention cost and over felling prevention cost.

2.5 Valuation of intangible assets (social benefits of forests)

Valuation of social benefits of forests is still under development. The social benefit of forests is listed as an independent category in China, but no specific definition is given.

Presently, among the studies on evaluating employment opportunity generated by forests, methods that have won relatively wide recognition include input/output method and indicator method: evaluation of the scientific, cultural and historic value of forest mainly utilizes indicator assessment method and CVM etc. Generally, the changes of disaster damage before and after the forest come into existence is calculated in valuation of disaster prevention power (preventing landslide, debris flow etc) of forests. In the following, we take the example of debris flow and flood peak losses reduction power of forests to illustrate the calculation method. The equation is as follows:

$$V=\Sigma V_{i1}-\Sigma V_{i2}, \text{ dont } V_{i1}=\theta_1 f_1(Q) \text{ et } V_{i2}=\theta_2 f_2(Q)$$

Where, V: the value of reducing losses from debris flows and flood peaks;

V_{i1}: losses from debris flows and flood peaks without forest protection;

V_{i2}: losses from debris flows and flood peaks with forest protection.

Where, $V_{i1}=\theta_1$ f1(Q);

$V_{i2}=\theta_2$ f2(Q);

θ_1: annual occurrence of flood peaks of debris flow without forest protection;

θ_2: annual occurrence of flood peaks of debris flow with forest protection;

$f_1(Q)$: the function of flood peak of debris flow and the losses it generated without forest protection;

$f_2(Q)$: the function of flood peak of debris flow and the losses it generated with forest protection.

2.6 Cost Accounting 2: Public Investment

Government management is also a non-market service. Find the following annual data during accounting period:

Government budget for forestry administration

Forestry public institution budget

Forest protection budget

Government budget for forestation and forestry operation

Government budget for forestry projects

Forest cultivation funds, greening funds

Non-business international forestry supporting funds and donations

Research expenditures

2.7 Case Study: Value of Tropical Forest Assets in Hainan province

Our project team calculated the value of tropical forest assets in Hainan province. The calculation, which utilized various valuation techniques, covered forest assets, products and ecosystem services functions, but not for timber industry accounting, forest asset depletion, degradation and defense, and government public expenditures, etc. Although the calculation might have many technical problems, such as repeated calculation, and have big room for improvement, still, it has revealed the total value and the component of the value of tropical forest in Hainan province.

The result is : the total value of tropical forest resources in Hainan province is 1886,656 billion RMB(present value)

Where, wooded land value is 4.71 billion RMB;

Timber value is 37,968 billion RMB;

Non-wood forest products value is 73,041 billion RMB;

Forest ecosystem function value is 1769.736 billion RMB;

Forest social benefits (available part) value is 1.201 billion RMB.

Therefore, the ecological value of the forests accounted for 93.80% of the total value, and is 15.3 times of the value of marketed assets and products. Figure 1 provides the value structure.

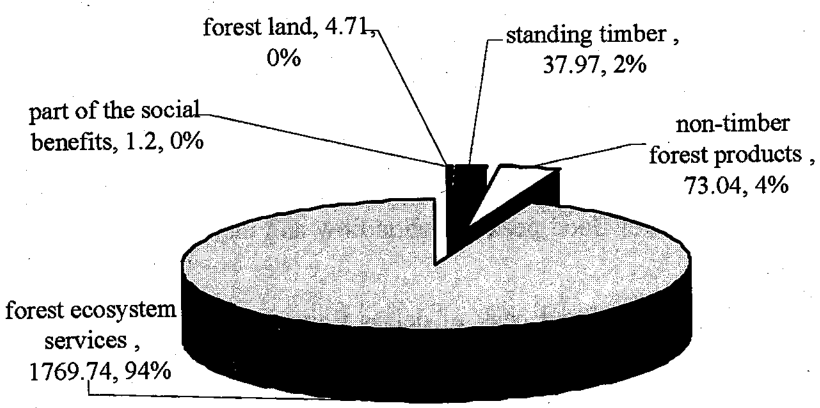


Figure 1 Total Value and its Composition of Forest Resources of Hainan Island

Chapter 5 Framework of Green GDP Accounting for Tropical Forest Assets

1 Overview

There are four accounting schemes, from the simplest to the most developed. The following will introduce the four schemes, among which the 2nd and the 4th schemes will be given brief introduction, as the two are between the simplest and the most developed.

Scheme 1 Evaluate the full value of the forests, and compare it with traditional aggregate index of GDP

Chapter 2, 3, and 4 of this report have given the definitions, classifications, recording standards, value system and valuation approaches. Calculations of the various values of the forests are based on these provisions, with the aim to assess the true value of the forest. It can link up with SNA on the whole, or valuation result of part of the assets, products or services may be picket out to adjust the nation accounts.

Scheme 2 Construct Forest Satellite Account

Construct forest satellite account for SNA to fully reveal the picture of the field and produce a set of adjustment indexes. Forest satellite account is actually a further standardized scheme of scheme 1.

In this study, we've developed a satellite account framework: "Basic Framework of 'System of Integrate Economic and Resources Environmental Accounting of China'", which includes 4 parts, namely Internal Satellite Account, External Satellite Account, GeGDP Accounting, and National Wealth Accounting. Based on the framework, we've valuated tropical forests in Hainan island and got results that can reveal some problems.

Scheme 3 SEEA Framework System

SEEA of the United Nations is an ideal scheme that fully integrates resources and environment into the national accounting system. However, developing countries are not ready to utilize the framework in a short period due to various factors.

Scheme 4 Improvement from European framework for forest accounts

EU Bureau of Statistics developed "The Framework for Integrated Environmental and Economic Accounting for Forests IEEAF (2002) ", which in essence is also a satellite account system. This framework adopted a conservative guideline, and put the emphasis on marketed forest assets and products, with a little mention of near-marketed forest products and services, and none on non-marketed forest products and services. This framework includes flow accounts, asset balance account and asset change account, residue flow account, with detailed accounting forms provided.

The framework is good for reference, but is not applicable in developing countries. We suggest improving it on the following four aspects: ①Simplify and relax the recording standards for forest assets, industries and products; ②Adjust the classification of assets, industries and products according to the specific nation; ③Add account of non-market forest products and services; ④Simplify the arrangement of the accounts.

Follows is the brief introduction of Chinese scheme and European scheme.

2 Framework for SEREA of China

2.1 Basic Structure of SEREA

The "System of Integrated Economic, Resources and Environmental Accounting" (Figure 1 in this chapter), is an accounting framework developed based on the accounting guidance books of UN, and modified according to Chinese circumstances. It includes:

1) Internal Satellite Account

This account is used to describe flow indicators and stock assets relevant with resources and environment in SNA, and account the exploitation and protection of resources and environment.

2) External Satellite Account

In External Satellite Account, corresponding accounting of resources and environment in physical and monetary terms is realized. Physical account records the stocks and changes of stocks of natural resources and environment; value accounts record both economic assets and ecological assets in monetary terms to valuate natural resources and environment and, therefore, reflect the connections between economy, resources and environment.

3) GeGDP accounting

Account the resources and environment from the angles of depletion, degradation and defense of resources and environment, with ecosystem functions also included, and adjust the macroeconomic flow indicators.

4) National wealth accounting

Stress the importance of manmade assets, natural assets and human capital in "national wealth", with the aim to highlight the function of resources and environmental stocks to sustainability.

2.2 Forest resources accounting and steps to integrate it into SNA

Overall steps: Basic theories of forest resources accounting and its integration>guiding line> accounting principle>basic framework>basic classification>indicator explanation > material collection > form construction and calculation > analysis and suggestion > others.

Step 1: Physical accounts of forest resources

Physical accounting of forest resources is the important foundation to construct integrated of forest resources and economic accounts. Detailed steps: defining accounting principle for physical accounts of forest resources>selection of valuation approaches>designing monetary accounting forms>analysis and suggestions>others

Step 2: Monetary Accounts of forest resources

Forest resources accounting in monetary terms mainly refers to the valuation of forest resources, including: economic valuation of forest assets, depletion, degradation and defense for forest resources, and valuation of intangible assets and management expenditures, etc. The steps are: Determining the valuation principle and guiding principle > valuation methods selection > designing value accounting forms > basic indicator explanation > price studies > form construction and calculation > analysis and suggestions > others

Step 3: Adjustment of aggregate indicators (integration into SNA)

Only by integrating the value of forest resources into system of national accounting, can the connections between forest resources and economy be reflected. The steps include:

1) flow accounts: GeGDPforest and EDPforest accounting. The talbe formers include: Green GDPforest account form and EDPforest account form and account form on economic uses of forest assets.

2) Asset stocks and changes accounting: one is asset and liability accounting, the other is stock change accounting. The account tables include: non-financial assets account table, forest assets account table, forest ecological asset accumulation account table, forest resources stock changes account table.

3) Integrated forest resources and economic accounting matrix

Step 4: Extended study of integrated forest resources and economic accounting

On the foundation of the above accountings, extended studies on the accounting of sustainable domestic income, true savings and effective investments, and national wealth should be undergone.

2.3 Green GDP accounting of forest

This project proposed green economic flow indicators such as Green GDP forest (GeGDP, EDP forest), and green economic stock indicators such as "National Wealth forest". The combination of the two indicators of Green GDP and National Wealth forms the basic framework and major accounting contents of "Integrated economic, resources and environmental accounting system" of China.

Green GDP measures the final production, minus the environmental and resources costs, by the permanent units in a country or a region in an accounting period. EDP is domestic production adjusted by environment and resources, namely, GDP minus resources and environmental costs (Un) and fixed asset consumption (CFC), that is EDP = GDP- CFC – Un.

$GeGDP_{forest}$ refers to the total value of the final forest products available for final use, with "forest asset stocks depletion costs" deducted. EDP_{forest} measures the total value of the products left in

$GeGDP_{forest}$ after deducting fixed assets depreciation, forest resources depletion and degradation costs from it.

National $Wealth_{forest}$ refers to the scale and structure of the opening or closing stocks of man-made forestry assets, natural forest assets and forestry human capital in a country or a region for a certain accounting period.

Account forms that integrate forest resources into GDP accounting include:

GDP account form integrated with forest resources;
Account Form of Economic Use of Forest Resources;
Forest Ecological Construction Expenditure Accounting Form

2.4 Asset and Liability Accounting

Asset and liability belong to stock accounting category, including the opening condition of the economic activities in the accounting period, described in the opening balance sheet, and the closing condition after the accounting period, described in the closing balance sheet. Therefore, asset and liability accounting is closely connected with the accounting of other flow indicators, and with all of them to make up a complete economic national accounting system.

2.5 Forest national wealth accounting

National wealth refers to the manmade assets, natural assets, and human capital owned by a country. Man-made assets are represented by NW_1. Natural assets and man-made assets, represented by NW_2, are the major components of national wealth. Together with human capital, which is the most creative element in national wealth, they make a complete national wealth. "Social capital " is still a category under studying and, therefore, is not included in current macro accounting practices.

The table forms include:

Account Form of Initial Stock of Forest Assets;
Account Form of Net Accumulation of Forest Assets;
Account Form of Forest Ecological Services;
Forest NW_1=net man-made assets + cultivated forest assets + human capital
Forest NW_2=Forest NW_1+non-cultivated forest assets (in physical/monetary terms)
Forest NW_3=Forest NW_1+forest ecosystem assets (ecological functions/ecological values)

3 Improvement from EU Framework

3.1 General Framework

"The European framework for integrated environmental and economic accounting for forests" (IEEAF) is consisted of 3 parts, namely (A) National Accounting Matrix, a flow account of forest assets, used to describe forestry transactions, (B) Balance Sheet, a stock account of forest assets; (C) Residue Account, a flow account of forest assets. Figure 2 describes the framework.

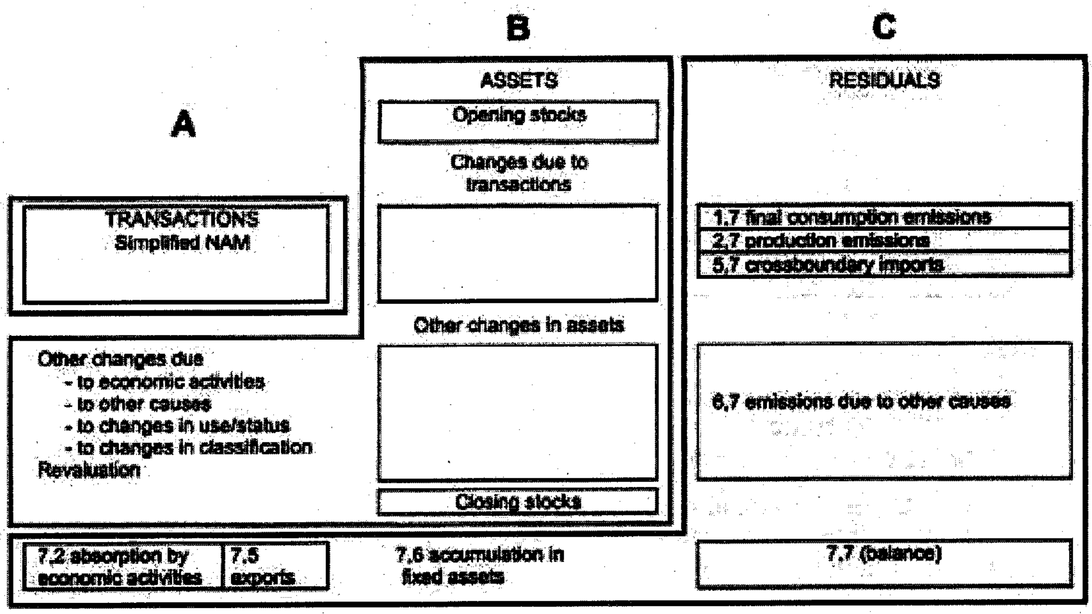


Figure 1 The European Framework for Integrated Environmental and Economic Accounting for Forests

(Source: Eurostat, 2002)

Part A. (Flow Account): brief introduction

Part A is the simplified National Accounting Matrix, including supply table and use table in national accounts (intermediate and final consumption, gross capital formation and exportation), used to describe records of incomes and capitals.

Part B. (Stock Account): brief introduction

The stocks and changes in stocks are described in physical terms and monetary terms, providing detailed description of the following aspects concerning forest assets (forest land, timbers, etc.):

Forest Balance Sheet (area of forest land, timber accumulation, etc.)
Changes of forest assets;
Changes of forest classification;
Changes due to revaluation.

This account connects the various changes of forest assets with economic activities and, thereby integrates forest accounting into national accounting system.

Part C. (Flow Account): brief introduction

This account constructs the balance sheet of forestry wastes according to where they come and where they go.

3.2 Implementation Account Tables

European IEEAF provides 20 account tables, listed in the following, involving the major aspects of accounting framework:

(1) Forest balance accounts for wooded land and standing timber

Table 1a. Balance account for area of wooded land

Table 1b. Balance account for forest land in monetary units

Table 2a. Balance account for standing timber accumulation

Table 2b. Balance account for standing timber in monetary units

Table 2c. Balance account for forest health

(2) Economic Account for Silviculture and logging

Table 3a Output related to wooded land by product and industry

Table 3b Output related to wooded land by market attributes and institutions

Table 3c Economic account for silvicuture and logging

(3) Supply and use tables in monetary and physical terms

Table 4a Physical supply and use table: use

Table 4b Physical supply and use table: supply

Table 4c physical supply and use table: summary

Table 5a Monetary supply and use table: use

Table 5b Monetary supply and use table: supply

Table 5c Monetary supply and use table: summary

(4) Material product balance table

Table 6a Physical material product balances: use table

Table 6b Material product balances: production table

(5) Balance table for residuals

Table 7a Starting points and ending points of wooded residuals

Table 7b Starting points and ending points of paper residuals

Table 7c Starting points and ending points of pulping liquor residuals

Table 8a Wood contents in residuals containing wood

Table 8b Wood contents in paper residuals

Table 8c Wood contents in black liquor

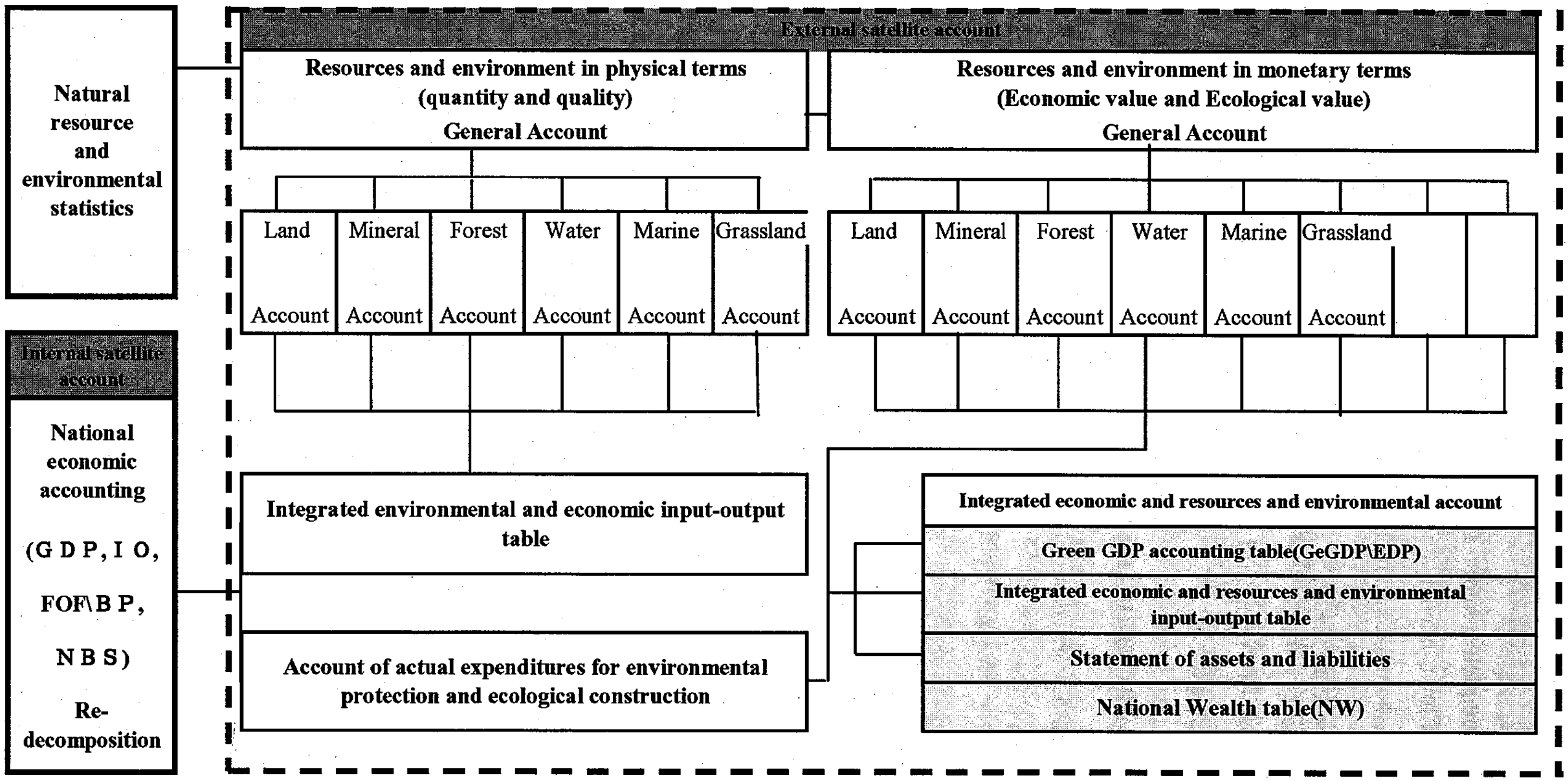
Table 8d Summary table of wood contents

These tables describe the accounting of marketed forest assets and products, and seldom mention even near-marketed products. They still have rooms for improvement at statistic standards, asset industries and product classifications. Tables for wood residuals are too complex to be used for developing countries.

However, with regard to accounts for wooded land and standing timbers, these tables can be used in developing countries after being modified for the needs of these countries.

This project wasn't able to use the European framework as we got the document rather late, and will maybe absorb the appropriate places in future case studies.

Figure 1 Framework of Integrated System of Economic and Resources and Environmental Accounting of China



S E R E A

Chapter 6 Green GDP Accounting for Tropical Forest Assets in Haiman Province, China

This study has been completed under the cooperation of Hainan Statistics Bureau, National Bureau of Statistics of China, Hainan Forestry Bureau, and forestry economic experts, and also with the support of the national government.

1 Framework and principles of the accounting

Implement the framework of "Integrated Economic, Resources and Environmental Accounting" (Described in Figure 1, Chapter 5).

2 Working plan of accounting in Hainan case

The study was planned to be carried out in 5 stages as follows:

Stage I: working out a scheme for integrated forest resource and economic accounting in Hainan Province.

Stage II: Physical accounting, which is the basis and premise of monetary accounting and of integration into national accounting. Tasks include: forest asset classification, basic indicator explanation, designing account table, deciding accounting principle, method and steps.

Stage III: One task is price study, including market price and structure, ecological price and structure, market price and ecological price coefficient and structure; the other task is monetary accounting, including market price of forest asset stocks, forest ecological stocks in monetary units, forest depletion costs and degradation costs, and monetary changes in forest resources.

Stage IV: Integrated resources and economic accounting period, major tasks include compiling Green GDP Accounts for Tropical Forests in Hainan Province, balance sheet and national wealth table.

Stage V: work conclusion period, major tasks include confirming data, evaluating accounting framework, drafting policy analysis views and recommendations.

3 Basic approaches to integrate forest assets into national economic accounts

3.1 Basic accounting principle

Accrual accounting, a basic principle of national economic accounting, is also the basic principle of forest asset accounting. It is applicable for increases and reductions due to economic activities, classifications and structures. The time when "right, responsibility" happens, transfers, or disappear shall be the time for recording.

3.2 Implementation methods and steps

Direst method: Use existing data of forest resource survey, forestry statistics and experiments on forest resource ecological effects and supplemented by necessary survey to obtain necessary data to meet the requirements of the integrated accounting.

Steps:

① Decide accounting scope (wooded land, timbers, water source protection, biodiversity, atmosphere purification, and forest recreation, etc.);

② Decide accounting principle (basic definitions, asset classifications and recording approaches, etc.);

③ Collect data, local visiting and consulting;

④ Analyze, adjust and summarize collected data in accordance with basic definitions and calibers;

⑤ compiling various accounting tables;

⑥ adjust macroeconomic indicators with forest asset factors;

⑦ Policy analysis, and reach conclusions;

⑧ Hold seminar to discuss and revise account tables.

3.3 Account table types

Account table types mainly include physical account table and monetary account table (including integrated account table). The tables are as follows:

1) Physical account table of forest resources in Hainan Province;

Physical changes account table for forest resources Table 1

Opening physical stock account table for forest resources Table 2-1

Closing physical stock account table for forest resources Table 2-2

2) Monetary account table for forest resources in Hainan;

Table of economic prices and ecological prices of forest resources Table 3

Table of price coefficient of forest resources Table 4

Account of forest resources value changes in monetary units(market price, ecological price) Table 5-1; Table 5-2

Table of market value of forest resource: table 6-1

Ecological value of forest resources: table 6-2

3) Integrated forest resources and economic account for Hainan Province

Green GDP account for forest: table 7

Balance sheet of forest (market price, ecological price): table 8-1,8-2

National wealth table for forest (market price, ecological price): table 9-1, table 9-2

4 Major accounting conclusions

① Physical stocks

In 1995, there were 1,734,840 hectares of wooded land(260,222,600mu), among which wooded land assets accounted for 35.85%; In 2000, there were 181,933 hectares (27,287,000 mu) of wooded land resources, among which wooded land assets accounted for 33.41%; There were 102,428,400 m^3 of standing timber resources, among which standing timber assets accounted for 17.46%

The percentages of wooded land assets and standing timber assets accounted reduced 2.44% and 19.18% respectively in 2000 from that of 1995.

② Physical changes in stocks

During the five years, wooded land resources increased 39.43%, declined 34.75%, with a net increase of 4.86%;

Among which, wooded land assets increased 94.12%, declined 96.39%, with a net reduction of 2.27%.

Standing timber resources increased 87.40%, declined 52.82%, with a net increase of 34.58%;

Among which standing timber assets increased 108.21%, declined 144.09%, with a net decline of 35.87%.

③ The closing physical stocks at the end of 2000 of wooded land and timber assets accounted for 51.69% and 34.41% of wooded land and timber resources respectively, and reduced for 2.37% and 15.92% respectively compared with the opening stocks.

The market value of the closing stocks of wooded land and timber assets accounted for 56.60% and 35.82% of wooded land and timber resources respectively, and reduced 2.74% and 23.33% respectively.

The ecological value of the closing stocks of wooded land and timber assets accounted for 58.84% and 31.67% of the wooded land and timber resources respectively, and reduced 2.10% and 22.21% respectively from the opening stockes.

④ In 2000, GDP of Hainan province was 51.848 billion yuan, cultivated forest assets output was 1.858 billion yuan, forest depletion costs (As most were forest asset stocks depletion costs, capital forest assets depletion costs were neglected) were 1.932 billion yuan, forest assets depletion costs were 4.798 billion yuan, GeGDPforest was 51.774 billion yuan, EDPforest was 4.6976 billion yuan, and fixed assets depreciation was 8.349 billion yuan.

Therefore, output of cultivated forest assets would create a GDP growth of 3.59% in Hainan Province, and forest asset depletion costs would make GDP to decline 3.73%, therefore, the integrated result is that GeGDPforest would make GDP decline 0.14%; Forest assets depletion and forest assets degradation costs would cause GDP to decline 25.36% and, with cultivated forest assets outputs and forest asset depletion costs integrated into it, EDPforest should deduct 25.50% from GDP growth; The total of forest depletion costs and degradation costs is 6.730 billion yuan, accounting for 12.98% of the GDP; considering the outputs of cultivated forest assets, the net costs of forest is 4.872 billion yuan, accounting for 9.40% of the provincial GDP.

⑤ At the end of 2000, the percentage that forest assets accounted for in Net Assets forest is as follows: If calculated at market prices, cultivated forest assets accounted for 6.94%, with 0.40% decline from opening stocks and non-cultivated forest assets accounted for 2.30%, with a decline of 7.20%.If calculated at ecological prices, cultivated forest assets accounted for 13.18%, with a increase of 1.37%, and non-cultivated forest assets,8.01%, with a decline of 14.25% from opening stocks.

⑥ At the end of 2000, the percentage of forest assets in National Wealth forest is: 20.89% in market value and 44.68% in ecological value, declined 4.60% and 3.35% respectively from opening stock.

Physical accounting of changes of forest environment resources in Hainan

Table 1

2000-1995

Unit: 100mu.100m^3 (1hectare=15mu)

Item	Changes of forest resources									Net changes of forest assets								Net changes of non asset forest resources	
	Increase in current period			Decrease in current period				Net increase of current period		Cultivation assets						Non cultivation			
	Natural		Economic	Disaster loss		Economic use				Subtotal		Fixed assets		In-process products		Forest land	Forest trees	Forest land	Forest trees
	Area	Volume	Area	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	33,891	662,738	67,384	47	269	86,366	398,590	**14,862**	**263,879**	10,808	104,579	6,765	56,000	4,043	48,579	-9,048	-133,822	13,102	293,122
1.1 Forested land and forest resources	31,427	651,112	62,443	40	261	77,669	390,176	16,161	260,675	10,789	103,774	6,746	56,000	4,043	47,774	-9,048	-133,822	14,421	290,724
1.1.1 Natural forest	21,106	532,454	48,165	17	196	64,463	375,563	4,791	156,695	0	0	0	0	0	0	-9,048	-133,822	13,839	290,517
(1) Stand	20,941	530,335	47,923	17	194	63,318	373,239	5,529	156,902	0	0	0	0	0	0	-8,892	-133,822	14,421	290,724
Timber forest	0	0	0	0	0	50,111	351,166	-50,111	-351,166	0	0	0	0	0	0	-12,381	-186,029	-37,730	-165,137
Protection forest	18,415	492,129	42,146	15	168	10,236	11,595	50,311	480,365	0	0	0	0	0	0	2,131	38,424	48,179	441,941
Fuelwood forest	166	687	376	0	0	62	14	481	673	0	0	0	0	0	0	122	245	359	428
Special use forest	2,360	37,519	5,400	2	26	2,909	10,464	4,849	27,030	0	0	0	0	0	0	1,236	13,538	3,613	13,492
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	157	0	-157	0	0	0	0	0	0	0	-157	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	165	2,118	242	0	1	988	2,324	-582	-207	0	0	0	0	0	0	0	0	-582	-207
1.1.2 Plantation	10,863	121,142	15,075	24	67	16,760	17,805	9,153	103,271	9,153	103,271	6,028	55,497	3,125	47,774	0	0	0	0
(1) Stand	5,796	120,777	7,913	10	66	6,782	16,937	6,917	103,774	6,917	103,774	3,105	56,000	3,812	47,774	0	0	0	0
Timber forest	4,065	63,324	5,665	8	39	6,154	15,888	3,568	47,397	3,568	47,397	0	0	3,568	47,397	0	0	0	0
Protection forest	856	38,949	1,259	2	22	6	1,011	2,106	37,916	2,106	37,916	2,106	37,916	0	0	0	0	0	0
Fuelwood forest	150	390	169	0	0	75	13	244	377	244	377	0	0	244	377	0	0	0	0
Special use forest	726	18,114	820	0	5	546	25	999	18,084	999	18,084	999	18,084	0	0	0	0	0	0
(2)Economic forest	4,448	0	6,544	13	0	7,339	0	3,641	0	3,641	0	3,641	0	0	0	0	0	0	0
(3) Bamboo forest	242	0	64	0	0	74	0	231	0	231	0	0	0	231	0	0	0	0	0
(4) Unestablished stands	354	0	520	1	0	1,790	0	-918	0	-918	0	0	0	-918	0	0	0	0	0
(5) Open forest area	23	365	34	0	0	775	868	-718	-503	-718	-503	-718	-503	0	0	0	0	0	0
1.2 Shrub land	2,110	0	3,105	6	0	8,571	0	-3,362	0	0	0	0	0	0	0	0	0	-3,362	0
1.3 Nurseries	9	0	13	0	0	3	0	19	0	19	0	19	0	0	0	0	0	0	0
1.4 Non-stocked forestland	344	0	1,823	1	0	122	0	2,044	0	0	0	0	0	0	0	0	0	2,044	0
1.5 4-side plantings	0	4,045	0	0	3	0	3,237	0	805	0	805	0	0	0	805	0	0	0	0
1.6 Scattered trees	0	7,581	0	0	5	0	5,178	0	2,398	0	0	0	0	0	0	0	0	0	2,398
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	12,645	0	0	0	0	12,645	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	0	0	867	0	0	13,512	0	-12,645	0	0	0	0	0	0	0	-10,116	0	-2,529	0

Table 2-1

Physical accounting of existing forest environment resources in Hainan

December 31, 1995 (90-94)

Unit: 100mu.100m^3(1 hectare=15mu)

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest	249,252	753,937	119,763	157,256	80,543	48,136	39,220	109,119	14,991	222,167	114,497	374,514
1.1 Forested land and forest	208,100	726,863	119,638	147,527	80,418	48,136	39,220	99,390	14,991	222,167	73,471	357,169
1.1.1 Natural forest	91,706	585,061	0	0	0	0	0	0	14,991	222,167	76,715	362,894
(1) Stand	88,306	579,336	0	0	0	0	0	0	14,835	222,167	73,471	357,169
Timber forest	50,111	351,166	0	0	0	0	0	0	12,381	186,029	37,730	165,137
Protection forest	32,440	157,726	0	0	0	0	0	0	1,129	11,966	31,311	145,759
Fuelwood forest	0	0	0	0	0	0	0	0	0	0	0	0
Special use forest	5,755	70,445	0	0	0	0	0	0	1,324	24,172	4,430	46,273
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	157	0	0	0	0	0	0	0	157	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	3,244	5,724	0	0	0	0	0	0	0	0	3,244	5,724
1.1.2 Plantation	127,368	148,981	127,368	148,981	81,510	49,591	45,858	99,390	0	0	0	0
(1) Stand	50,856	147,527	50,856	147,527	12,103	48,136	38,753	99,390	0	0	0	0
Timber forest	38,715	99,285	38,715	99,285	0	0	38,715	99,285	0	0	0	0
Protection forest	11,737	46,617	11,737	46,617	11,737	46,617	0	0	0	0	0	0
Fuelwood forest	38	105	38	105	0	0	38	105	0	0	0	0
Special use forest	366	1,520	366	1,520	366	1,520	0	0	0	0	0	0
(2)Economic forest	68,315	0	68,315	0	68,315	0	0	0	0	0	0	0
(3) Bamboo forest	467	0	467	0	0	0	467	0	0	0	0	0
(4) Unestablished stands	6,638	0	6,638	0	0	0	6,638	0	0	0	0	0
(5) Open forest area	1,092	1,454	1,092	1,454	1,092	1,454	0	0	0	0	0	0
1.2 Shrub land	37,502	0	0	0	0	0	0	0	0	0	37,502	0
1.3 Nurseries	125	0	125	0	125	0	0	0	0	0	0	0
1.4 Non-stocked forestland	3,524	0	0	0	0	0	0	0	0	0	3,524	0
1.5 4-side plantings	0	9,729	0	9,729	0	0	0	9,729	0	0	0	0
1.6 Scattered trees	0	17,345	0	0	0	0	0	0	0	0	0	17,345
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	248,389	0	0	0	0	0	0	0	198,712	0	49,678	0

Physical accounting of existing forest environment resources in Hainan

December 31, 2000 (93-98)

Table 2-2

Unit: 100mu.100m^3(1 hectare=15mu)

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest	264,114	1,017,816	130,571	261,835	87,309	104,137	43,262	157,698	5,943	88,345	127,599	667,636
1.1 Forested land and forest	224,261	987,538	130,426	251,300	87,164	104,137	43,262	147,164	5,943	88,345	87,892	647,893
1.1.1 Natural forest	96,497	741,755	0	0	0	0	0	0	5,943	88,345	90,554	653,410
(1) Stand	93,835	736,238	0	0	0	0	0	0	5,943	88,345	87,892	647,893
Timber forest	0	0	0	0	0	0	0	0	0	0	0	0
Protection forest	82,751	638,091	0	0	0	0	0	0	3,260	50,390	79,490	587,700
Fuelwood forest	481	673	0	0	0	0	0	0	122	245	359	428
Special use forest	10,603	97,475	0	0	0	0	0	0	2,561	37,710	8,043	59,765
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	0	0	0	0	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	2,662	5,517	0	0	0	0	0	0	0	0	2,662	5,517
1.1.2 Plantation	136,522	252,252	136,522	252,252	87,538	105,088	48,983	147,164	0	0	0	0
(1) Stand	57,773	251,300	57,773	251,300	15,208	104,137	42,564	147,164	0	0	0	0
Timber forest	42,283	146,682	42,283	146,682	0	0	42,283	146,682	0	0	0	0
Protection forest	13,843	84,533	13,843	84,533	13,843	84,533	0	0	0	0	0	0
Fuelwood forest	282	482	282	482	0	0	282	482	0	0	0	0
Special use forest	1,366	19,603	1,366	19,603	1,366	19,603	0	0	0	0	0	0
(2)Economic forest	71,955	0	71,955	0	71,955	0	0	0	0	0	0	0
(3) Bamboo forest	698	0	698	0	0	0	698	0	0	0	0	0
(4) Unestablished stands	5,721	0	5,721	0	0	0	5,721	0	0	0	0	0
(5) Open forest area	374	951	374	951	374	951	0	0	0	0	0	0
1.2 Shrub land	34,140	0	0	0	0	0	0	0	0	0	34,140	0
1.3 Nurseries	145	0	145	0	145	0	0	0	0	0	0	0
1.4 Non-stocked forestland	5,567	0	0	0	0	0	0	0	0	0	5,567	0
1.5 4-side plantings	0	10,534	0	10,534	0	0	0	10,534	0	0	0	0
1.6 Scattered trees	0	19,743	0	0	0	0	0	0	0	0	0	19,743
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	235,745	0	0	0	0	0	0	0	188,596	0	47,149	0

Prices of forestland and forest trees in Hainan Province

Table 3

Unit: RMB/mu, RMB/m^3(1 hectare=15mu)

	Market price			Ecological price		
	Forestland	Forest trees		Forestland	Forest trees	
	forfest/plantation	Natural forest	Plantation	forfest/plantation	Natural forest	Plantation
resources	159.37	271.50		183.76	815.02	
trees	182.84	271.50		203.85	823.94	
i) Forest stand	200.58/188.38	271.50	271.50	200.58/188.38	871.12	638.66
Timber forest	192.29	271.50	271.50	192.29	722.19	577.75
Young forest	192.29	124.89	124.89	192.29	332.21	265.77
Middle aged forest	192.29	186.44	232.22	192.29	495.94	494.16
Close to mature forest	192.29	304.08	304.08	192.29	808.85	647.08
Matured forest	192.29	412.68	412.68	192.29	1,097.73	878.18
Over matured forest	192.29	314.94	314.94	192.29	837.74	670.19
Protection forest	167.50	271.50	271.50	167.50	939.39	751.51
Young forest	167.50	124.89	124.89	167.50	432.12	345.70
Middle aged forest	167.50	263.85	220.62	167.50	912.94	610.67
Close to mature forest	167.50	304.08	304.08	167.50	1,052.12	841.69
Matured forest	167.50	412.68	412.68	167.50	1,427.87	1,142.30
Over matured forest	167.50	314.94	314.94	167.50	1,089.69	871.75
Fuelwood forest	40.80	268.42	268.42	40.80	569.05	455.24
Young forest	40.80	123.47	123.47	40.80	261.76	209.41
Middle aged forest	40.80	256.90	256.90	40.80	544.63	435.70
Close to mature forest	40.80	300.63	300.63	40.80	637.34	509.87
Matured forest	40.80	408.00	408.00	40.80	864.96	691.97
Over matured forest	40.80	311.37	311.37	40.80	660.10	528.08
Special use forest	459.23	271.50	271.50	459.23	1,460.67	1,168.54
Young forest	459.23	103.17	124.89	459.23	555.05	537.53
Middle aged forest	459.23	140.66	277.94	459.23	756.75	1,196.26
Close to mature forest	459.23	260.64	304.08	459.23	1,402.24	1,308.76
Matured forest	459.23	336.66	412.68	459.23	1,811.23	1,776.17
Over matured forest	459.23	266.07	314.94	459.23	1,431.46	1,355.50
ii) Economic forest	155.43	-	-	214.49	-	-
iii) Bamboo forest (100 stems)	220.00	-	-	761.20	-	-
iv) Unestablished stands	35.70	-	-	49.27	-	-
v) Open forest area	48.96	271.50	271.50	67.56	374.67	0.00
2) Shrub land	40.80	-		86.50	-	
3) Nurseries	155.43	-		214.49	-	
4) Non-stocked forestland	35.70	-		31.42	-	
5) 4-side plantings	-	271.50		-	575.58	
6) Scattered trees	-	271.50		-	575.58	
7) Statistical errors	192.29	336.66		511.49	895.52	
2. Die-back trees	-	271.50		-	722.19	
3. Non-forestry land	665.34	-		665.34	-	

Price indices of forestland and forest trees in Hainan Province

Table 4

	Market price			Ecological price		
	Forestland	Forest trees		Forestland	Forest trees	
	forfest/plantation	Natural forest	Plantation	forfest/plantation	Natural forest	Plantation
resources	0.8288	1.0000		1.1530	3.0019	
trees	0.9508	1.0000		1.1149	3.0348	
i) Forest stand	1.0431/0.9797	1.0000	1.0000	1.0000/1.0000	3.2085	2.3523
Timber forest	1.0000	1.0000	1.0000	1.0000	2.6600	2.1280
Young forest	1.0000	0.4600	0.4600	1.0000	2.6600	2.1280
Middle aged forest	1.0000	0.6867	0.8553	1.0000	2.6600	2.1280
Close to mature forest	1.0000	1.1200	1.1200	1.0000	2.6600	2.1280
Matured forest	1.0000	1.5200	1.5200	1.0000	2.6600	2.1280
Over matured forest	1.0000	1.1600	1.1600	1.0000	2.6600	2.1280
Protection forest	1.0000	1.0000	1.0000	1.0000	3.4600	2.7680
Young forest	1.0000	0.4600	0.4600	1.0000	3.4600	2.7680
Middle aged forest	1.0000	0.9718	0.8126	1.0000	3.4600	2.7680
Close to mature forest	1.0000	1.1200	1.1200	1.0000	3.4600	2.7680
Matured forest	1.0000	1.5200	1.5200	1.0000	3.4600	2.7680
Over matured forest	1.0000	1.1600	1.1600	1.0000	3.4600	2.7680
Fuelwood forest	1.0000	1.0000	1.0000	1.0000	2.1200	1.6960
Young forest	1.0000	0.4600	0.4600	1.0000	2.1200	1.6960
Middle aged forest	1.0000	0.9571	0.9571	1.0000	2.1200	1.6960
Close to mature forest	1.0000	1.1200	1.1200	1.0000	2.1200	1.6960
Matured forest	1.0000	1.5200	1.5200	1.0000	2.1200	1.6960
Over matured forest	1.0000	1.1600	1.1600	1.0000	2.1200	1.6960
Special use forest	1.0000	1.0000	1.0000	1.0000	5.3800	4.3040
Young forest	1.0000	0.3800	0.4600	1.0000	5.3800	4.3040
Middle aged forest	1.0000	0.5181	1.0237	1.0000	5.3800	4.3040
Close to mature forest	1.0000	0.9600	1.1200	1.0000	5.3800	4.3040
Matured forest	1.0000	1.2400	1.5200	1.0000	5.3800	4.3040
Over matured forest	1.0000	0.9800	1.1600	1.0000	5.3800	4.3040
ii) Economic forest	0.8083	-	-	1.3800	-	-
iii) Bamboo forest (100 stems)	1.1441	-	-	3.4600	-	-
iv) Unestablished stands	0.1857	-	-	1.3800	-	-
v) Open forest area	0.2546	1.0000	1.0000	1.3800	1.3800	0.0000
2) Shrub land	0.2122	-		2.1200	-	
3) Nurseries	0.8083	-		1.3800	-	
4) Non-stocked forestland	0.1857	-		0.8800	-	
5) 4-side plantings	-	1.0000		-	2.1200	
6) Scattered trees	-	1.0000		-	2.1200	
7) Statistical errors	1.0000	1.2400		2.6599	2.6600	
2. Die-back trees	-	1.0000		-	2.6600	
3. Non-forestry land	3.4600	-		1.0000	-	

Accounting of market price changes of forest environment resources in Hainan

Table 5-1 Changes of market prices

2000-1995

Unit: 10,000RMB

Item	Changes of forest resources									Net changes of forest assets								Net changes of non asset forest resources	
	Increase in current period			Decrease in current period				Net increase of current period		Cultivation assets						Non cultivation assets			
	Natural		Economic	Disaster loss		Economic use				Subtotal		Fixed assets		In-process products		Forest land	Forest trees	Forest land	Forest trees
	Area	Volume	Area	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	62,837	1,817,321	124,633	76	737	156,734	1,070,883	**30,659**	**745,701**	21,275	281,460	13,806	152,040	7,468	129,420	-14,856	-491,791	24,241	956,032
1.1 Forested land and forest resources	61,839	1,785,757	122,695	74	716	153,189	1,048,038	31,271	737,004	21,244	279,273	13,776	152,040	7,468	127,233	-14,856	-491,791	24,883	949,521
1.1.1 Natural forest	41,829	1,463,817	95,666	34	540	127,720	1,006,109	9,742	457,168	0	0	0	0	0	0	-14,856	-491,791	24,598	948,959
(1) Stand	41,749	1,458,065	95,548	33	536	126,892	999,799	10,372	457,731	0	0	0	0	0	0	-14,511	-491,791	24,883	949,521
Timber forest	0	0	0	0	0	96,361	953,414	-96,361	-953,414	0	0	0	0	0	0	-23,808	-669,545	-72,553	-283,869
Protection forest	30,845	1,347,510	70,594	25	461	17,144	28,938	84,269	1,318,111	0	0	0	0	0	0	3,570	136,585	80,699	1,181,525
Fuelwood forest	68	1,844	153	0	0	25	38	196	1,805	0	0	0	0	0	0	50	904	146	902
Special use forest	10,836	108,711	24,801	9	75	13,361	17,408	22,268	91,229	0	0	0	0	0	0	5,677	40,266	16,591	50,963
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	345	0	-345	0	0	0	0	0	0	0	-345	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	81	5,751	119	0	4	484	6,310	-285	-563	0	0	0	0	0	0	0	0	-285	-563
1.1.2 Plantation	20,228	328,684	27,350	40	180	26,972	50,596	20,565	277,908	20,565	277,908	13,424	150,675	7,141	127,233	0	0	0	0
(1) Stand	12,645	327,692	16,835	20	179	14,383	48,239	15,078	279,273	15,078	279,273	8,117	152,040	6,960	127,233	0	0	0	0
Timber forest	7,817	171,695	10,893	15	104	11,834	45,369	6,861	126,222	6,861	126,222	0	0	6,861	126,222	0	0	0	0
Protection forest	1,433	105,748	2,109	4	61	11	2,744	3,527	102,943	3,527	102,943	3,527	102,943	0	0	0	0	0	0
Fuelwood forest	61	1,055	69	0	0	31	44	99	1,011	99	1,011	0	0	99	1,011	0	0	0	0
Special use forest	3,334	49,194	3,765	1	14	2,507	83	4,590	49,097	4,590	49,097	4,590	49,097	0	0	0	0	0	0
(2)Economic forest	6,914	0	10,172	20	0	11,407	0	5,659	0	5,659	0	5,659	0	0	0	0	0	0	0
(3) Bamboo forest	532	0	140	0	0	163	0	508	0	508	0	0	0	508	0	0	0	0	0
(4) Unestablished stands	126	0	186	0	0	639	0	-328	0	-328	0	0	0	-328	0	0	0	0	0
(5) Open forest area	11	992	17	0	1	380	2,356	-352	-1,366	-352	-1,366	-352	-1,366	0	0	0	0	0	0
1.2 Shrub land	861	0	1,267	2	0	3,497	0	-1,372	0	0	0	0	0	0	0	0	0	-1,372	0
1.3 Nurseries	14	0	20	0	0	4	0	30	0	30	0	30	0	0	0	0	0	0	0
1.4 Non-stocked forestland	123	0	651	0	0	44	0	730	0	0	0	0	0	0	0	0	0	730	0
1.5 4-side plantings	0	10,982	0	0	8	0	8,787	0	2,187	0	2,187	0	0	0	2,187	0	0	0	0
1.6 Scattered trees	0	20,582	0	0	14	0	14,057	0	6,510	0	0	0	0	0	0	0	0	0	6,510
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	0	0	5,772	0	0	89,901	0	-84,129	0	0	0	0	0	0	0	-67,303	0	-16,826	0

Accounting of ecological price changes of forest environment resources in Hainan

Table 5-2 Changes of ecological prices

2000-1995

Unit: 10,000RMB

Item	Changes of forest resources									Net changes of forest assets								Net changes of non asset forest resources	
	Increase in current period			Decrease in current period				Net increase of current period		Cultivation assets						Non cultivation assets			
	Natural		Economic	Disaster loss		Economic use				Subtotal		Fixed assets		In-process products		Forest land	Forest trees	Forest land	Forest trees
	Area	Volume	Area	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	67,727	6,189,672	130,190	87	2,495	166,232	2,882,944	**31,598**	**3,304,233**	24,686	771,211	15,968	496,261	8,718	274,951	-15,705	-1,089,861	22,617	3,622,882
1.1 Forested land and forest resources	65,774	6,122,758	126,904	82	2,449	158,774	2,834,514	33,822	3,285,795	24,644	766,576	15,926	496,261	8,718	270,315	-15,705	-1,089,861	24,883	3,609,081
1.1.1 Natural forest	41,860	5,259,098	95,711	34	2,003	128,752	2,738,651	8,785	2,518,443	0	0	0	0	0	0	-15,705	-1,089,861	24,490	3,608,304
(1) Stand	41,749	5,251,161	95,548	33	1,997	126,892	2,729,943	10,372	2,519,220	0	0	0	0	0	0	-14,511	-1,089,861	24,883	3,609,081
Timber forest	0	0	0	0	0	96,361	2,536,082	-96,361	-2,536,082	0	0	0	0	0	0	-23,808	-1,780,991	-72,553	-755,092
Protection forest	30,845	4,662,385	70,594	25	1,595	17,144	100,127	84,269	4,560,663	0	0	0	0	0	0	3,570	472,585	80,699	4,088,077
Fuelwood forest	68	3,909	153	0	1	25	81	196	3,827	0	0	0	0	0	0	50	1,916	146	1,911
Special use forest	10,836	584,867	24,801	9	401	13,361	93,653	22,268	490,812	0	0	0	0	0	0	5,677	216,629	16,591	274,183
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	1,193	0	-1,193	0	0	0	0	0	0	0	-1,193	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	111	7,937	164	0	5	668	8,708	-393	-776	0	0	0	0	0	0	0	0	-393	-776
1.1.2 Plantation	24,215	871,597	31,635	49	451	32,095	104,570	23,707	766,576	23,707	766,576	15,441	496,261	8,266	270,315	0	0	0	0
(1) Stand	12,645	871,597	16,835	20	451	14,383	104,570	15,078	766,576	15,078	766,576	8,117	496,261	6,960	270,315	0	0	0	0
Timber forest	7,817	365,368	10,893	15	222	11,834	96,545	6,861	268,600	6,861	268,600	0	0	6,861	268,600	0	0	0	0
Protection forest	1,433	292,710	2,109	4	168	11	7,595	3,527	284,947	3,527	284,947	3,527	284,947	0	0	0	0	0	0
Fuelwood forest	61	1,790	69	0	1	31	74	99	1,715	99	1,715	0	0	99	1,715	0	0	0	0
Special use forest	3,334	211,730	3,765	1	60	2,507	356	4,590	211,314	4,590	211,314	4,590	211,314	0	0	0	0	0	0
(2)Economic forest	9,541	0	14,037	28	0	15,741	0	7,809	0	7,809	0	7,809	0	0	0	0	0	0	0
(3) Bamboo forest	1,840	0	483	1	0	565	0	1,757	0	1,757	0	0	0	1,757	0	0	0	0	0
(4) Unestablished stands	174	0	256	1	0	882	0	-452	0	-452	0	0	0	-452	0	0	0	0	0
(5) Open forest area	16	0	23	0	0	524	0	-485	0	-485	0	-485	0	0	0	0	0	0	0
1.2 Shrub land	1,825	0	2,686	5	0	7,414	0	-2,908	0	0	0	0	0	0	0	0	0	-2,908	0
1.3 Nurseries	19	0	28	0	0	6	0	42	0	42	0	42	0	0	0	0	0	0	0
1.4 Non-stocked forestland	108	0	573	0	0	38	0	642	0	0	0	0	0	0	0	0	0	642	0
1.5 4-side plantings	0	23,281	0	0	16	0	18,629	0	4,636	0	4,636	0	0	0	4,636	0	0	0	0
1.6 Scattered trees	0	43,633	0	0	30	0	29,801	0	13,802	0	0	0	0	0	0	0	0	0	13,802
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	0	0	5,772	0	0	89,901	0	-84,129	0	0	0	0	0	0	0	-67,303	0	-16,826	0

Value accounting of existing forest environment resources in Hainan Province

Table 6-1-1 Market values of existing resources at the beginning of accounting period   December 31, 1995 (90-94)   Unit: 10,000RMB

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	397,236	2,046,936	203,208	426,946	127,719	130,690	75,490	296,256	32,126	783,763	161,902	836,227
1.1 Forested land and forest resources	380,482	1,973,430	203,013	400,532	127,524	130,690	75,490	269,841	32,126	783,763	145,343	789,135
1.1.1 Natural forest	179,057	1,588,440	0	0	0	0	0	0	32,126	783,763	146,931	804,677
(1) Stand	177,124	1,572,898	0	0	0	0	0	0	31,781	783,763	145,343	789,135
Timber forest	96,361	953,414	0	0	0	0	0	0	23,808	669,545	72,553	283,869
Protection forest	54,336	428,225	0	0	0	0	0	0	1,891	43,021	52,445	385,204
Fuelwood forest	0	0	0	0	0	0	0	0	0	0	0	0
Special use forest	26,427	191,259	0	0	0	0	0	0	6,082	71,197	20,345	120,062
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	345	0	0	0	0	0	0	0	345	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	1,588	15,542	0	0	0	0	0	0	0	0	1,588	15,542
1.1.2 Plantation	205,918	404,480	205,918	404,480	128,058	134,638	77,860	269,841	0	0	0	0
(1) Stand	95,802	400,532	95,802	400,532	21,341	130,690	74,462	269,841	0	0	0	0
Timber forest	74,446	269,559	74,446	269,559	0	0	74,446	269,559	0	0	0	0
Protection forest	19,659	126,565	19,659	126,565	19,659	126,565	0	0	0	0	0	0
Fuelwood forest	15	283	15	283	0	0	15	283	0	0	0	0
Special use forest	1,681	4,125	1,681	4,125	1,681	4,125	0	0	0	0	0	0
(2)Economic forest	106,183	0	106,183	0	106,183	0	0	0	0	0	0	0
(3) Bamboo forest	1,028	0	1,028	0	0	0	1,028	0	0	0	0	0
(4) Unestablished stands	2,370	0	2,370	0	0	0	2,370	0	0	0	0	0
(5) Open forest area	535	3,948	535	3,948	535	3,948	0	0	0	0	0	0
1.2 Shrub land	15,301	0	0	0	0	0	0	0	0	0	15,301	0
1.3 Nurseries	195	0	195	0	195	0	0	0	0	0	0	0
1.4 Non-stocked forestland	1,258	0	0	0	0	0	0	0	0	0	1,258	0
1.5 4-side plantings	0	26,414	0	26,414	0	0	0	26,414	0	0	0	0
1.6 Scattered trees	0	47,092	0	0	0	0	0	0	0	0	0	47,092
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	1,652,633	0	0	0	0	0	0	0	1,322,106	0	330,527	0

Value accounting of existing forest environment resources in Hainan Province

Table 6-1-2 Market values of existing resources at the end of accounting period — December 31, 2000 (93-98) — Unit: 10,000RMB

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	427,895	2,792,637	224,483	708,406	141,525	282,731	82,958	425,675	17,270	291,972	186,142	1,792,259
1.1 Forested land and forest resources	411,753	2,710,434	224,258	679,805	141,300	282,731	82,958	397,074	17,270	291,972	170,226	1,738,656
1.1.1 Natural forest	188,799	2,045,608	0	0	0	0	0	0	17,270	291,972	171,529	1,753,635
(1) Stand	187,496	2,030,629	0	0	0	0	0	0	17,270	291,972	170,226	1,738,656
Timber forest	0	0	0	0	0	0	0	0	0	0	0	0
Protection forest	138,605	1,746,335	0	0	0	0	0	0	5,461	179,606	133,144	1,566,729
Fuelwood forest	196	1,805	0	0	0	0	0	0	50	904	146	902
Special use forest	48,695	282,488	0	0	0	0	0	0	11,759	111,462	36,935	171,025
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	0	0	0	0	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	1,303	14,979	0	0	0	0	0	0	0	0	1,303	14,979
1.1.2 Plantation	226,483	682,387	226,483	682,387	141,483	285,313	85,000	397,074	0	0	0	0
(1) Stand	110,880	679,805	110,880	679,805	29,458	282,731	81,422	397,074	0	0	0	0
Timber forest	81,307	395,780	81,307	395,780	0	0	81,307	395,780	0	0	0	0
Protection forest	23,186	229,508	23,186	229,508	23,186	229,508	0	0	0	0	0	0
Fuelwood forest	115	1,294	115	1,294	0	0	115	1,294	0	0	0	0
Special use forest	6,271	53,223	6,271	53,223	6,271	53,223	0	0	0	0	0	0
(2)Economic forest	111,842	0	111,842	0	111,842	0	0	0	0	0	0	0
(3) Bamboo forest	1,536	0	1,536	0	0	0	1,536	0	0	0	0	0
(4) Unestablished stands	2,042	0	2,042	0	0	0	2,042	0	0	0	0	0
(5) Open forest area	183	2,582	183	2,582	183	2,582	0	0	0	0	0	0
1.2 Shrub land	13,929	0	0	0	0	0	0	0	0	0	13,929	0
1.3 Nurseries	225	0	225	0	225	0	0	0	0	0	0	0
1.4 Non-stocked forestland	1,988	0	0	0	0	0	0	0	0	0	1,988	0
1.5 4-side plantings	0	28,601	0	28,601	0	0	0	28,601	0	0	0	0
1.6 Scattered trees	0	53,603	0	0	0	0	0	0	0	0	0	53,603
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	1,568,503	0	0	0	0	0	0	0	1,254,803	0	313,701	0

Value accounting of existing forest environment resources in Hainan Province

Table 6-2-1 Ecological values of existing resources at the end of accounting period　　December 31, 1995 (90-94)　　Unit: 10,000RMB

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	458,022	6,144,735	246,159	998,186	168,140	368,088	78,019	630,098	32,975	2,312,882	178,888	2,833,666
1.1 Forested land and forest resources	424,208	5,988,901	245,890	942,188	167,871	368,088	78,019	574,100	32,975	2,312,882	145,343	2,733,830
1.1.1 Natural forest	180,509	5,068,160	0	0	0	0	0	0	32,975	2,312,882	147,534	2,755,278
(1) Stand	177,124	5,046,712	0	0	0	0	0	0	31,781	2,312,882	145,343	2,733,830
Timber forest	96,361	2,536,082	0	0	0	0	0	0	23,808	1,780,991	72,553	755,092
Protection forest	54,336	1,481,658	0	0	0	0	0	0	1,891	148,852	52,445	1,332,805
Fuelwood forest	0	0	0	0	0	0	0	0	0	0	0	0
Special use forest	26,427	1,028,972	0	0	0	0	0	0	6,082	383,040	20,345	645,933
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	1,193	0	0	0	0	0	0	0	1,193	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	2,192	21,448	0	0	0	0	0	0	0	0	2,192	21,448
1.1.2 Plantation	249,899	942,188	249,899	942,188	168,609	368,088	81,290	574,100	0	0	0	0
(1) Stand	95,802	942,188	95,802	942,188	21,341	368,088	74,462	574,100	0	0	0	0
Timber forest	74,446	573,621	74,446	573,621	0	0	74,446	573,621	0	0	0	0
Protection forest	19,659	350,332	19,659	350,332	19,659	350,332	0	0	0	0	0	0
Fuelwood forest	15	480	15	480	0	0	15	480	0	0	0	0
Special use forest	1,681	17,756	1,681	17,756	1,681	17,756	0	0	0	0	0	0
(2)Economic forest	146,531	0	146,531	0	146,531	0	0	0	0	0	0	0
(3) Bamboo forest	3,558	0	3,558	0	0	0	3,558	0	0	0	0	0
(4) Unestablished stands	3,270	0	3,270	0	0	0	3,270	0	0	0	0	0
(5) Open forest area	738	0	738	0	738	0	0	0	0	0	0	0
1.2 Shrub land	32,438	0	0	0	0	0	0	0	0	0	32,438	0
1.3 Nurseries	269	0	269	0	269	0	0	0	0	0	0	0
1.4 Non-stocked forestland	1,107	0	0	0	0	0	0	0	0	0	1,107	0
1.5 4-side plantings	0	55,998	0	55,998	0	0	0	55,998	0	0	0	0
1.6 Scattered trees	0	99,836	0	0	0	0	0	0	0	0	0	99,836
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	1,652,633	0	0	0	0	0	0	0	1,322,106	0	330,527	0

Value accounting of existing forest environment resources in Hainan Province

Table 6-2-2 Ecological values of existing resources at the end of accounting period December 31, 2000 (93-98) Unit: 10,000RMB

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	489,620	9,448,968	270,845	1,769,398	184,108	864,349	86,737	905,049	17,270	1,223,022	201,505	6,456,549
1.1 Forested land and forest resources	458,030	9,274,696	270,534	1,708,764	183,798	864,349	86,737	844,415	17,270	1,223,022	170,226	6,342,911
1.1.1 Natural forest	189,294	7,586,604	0	0	0	0	0	0	17,270	1,223,022	172,024	6,363,582
(1) Stand	187,496	7,565,932	0	0	0	0	0	0	17,270	1,223,022	170,226	6,342,911
Timber forest	0	0	0	0	0	0	0	0	0	0	0	0
Protection forest	138,605	6,042,320	0	0	0	0	0	0	5,461	621,438	133,144	5,420,883
Fuelwood forest	196	3,827	0	0	0	0	0	0	50	1,916	146	1,911
Special use forest	48,695	1,519,785	0	0	0	0	0	0	11,759	599,668	36,935	920,116
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	0	0	0	0	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	1,798	20,671	0	0	0	0	0	0	0	0	1,798	20,671
1.1.2 Plantation	273,606	1,708,764	273,606	1,708,764	184,050	864,349	89,555	844,415	0	0	0	0
(1) Stand	110,880	1,708,764	110,880	1,708,764	29,458	864,349	81,422	844,415	0	0	0	0
Timber forest	81,307	842,221	81,307	842,221	0	0	81,307	842,221	0	0	0	0
Protection forest	23,186	635,279	23,186	635,279	23,186	635,279	0	0	0	0	0	0
Fuelwood forest	115	2,194	115	2,194	0	0	115	2,194	0	0	0	0
Special use forest	6,271	229,070	6,271	229,070	6,271	229,070	0	0	0	0	0	0
(2)Economic forest	154,340	0	154,340	0	154,340	0	0	0	0	0	0	0
(3) Bamboo forest	5,315	0	5,315	0	0	0	5,315	0	0	0	0	0
(4) Unestablished stands	2,818	0	2,818	0	0	0	2,818	0	0	0	0	0
(5) Open forest area	253	0	253	0	253	0	0	0	0	0	0	0
1.2 Shrub land	29,530	0	0	0	0	0	0	0	0	0	29,530	0
1.3 Nurseries	311	0	311	0	311	0	0	0	0	0	0	0
1.4 Non-stocked forestland	1,749	0	0	0	0	0	0	0	0	0	1,749	0
1.5 4-side plantings	0	60,634	0	60,634	0	0	0	60,634	0	0	0	0
1.6 Scattered trees	0	113,638	0	0	0	0	0	0	0	0	0	113,638
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	1,568,503	0	0	0	0	0	0	0	1,254,803	0	313,701	0

Green GDP accounting for Hainan Province

Table 7-1: 1995 Unit: 100 million RMB

Production	Order	Cost	Uses	Order	Cost
1. Output of economic activities	1	843.14	9 Ultimate consumption	16	188.50
2. Intermediate input in economic activities	2	478.96	9.1 Residence consumption	17	153.09
3. GDP by production (or Income)	3	364.18	9.2 Government consumption	18	35.41
3.1 Remuneration of labors	4	217.27	10 Total cost of capital formation	19	219.21
3.2 Net production tax	5	36.02	11 Net exportation	20	0.00
3.2.1 Production tax	6	39.42	11.1 Exportation	21	125.60
3.2.2 Subsidy (-)	7	3.40	11.2 Importation (-)	22	125.60
3.3 Depreciation of fixed assets	8	57.48	12 GDP by expenditure	23	407.71
3.4 Operational balance	9	53.41	13.1 Net accumulation of forest assets at market value	24	-5.62
4 Market output of forest cultivation assets	10	12.64	13.2 Net accumulation of forest assets at ecological value	25	-10.19
5 Cost of forest assets exhustion	11	33.84	14 GeGDP by expenditure	26	402.09
6 Cost of forest assets degradation	12	84.07	15 EDP by expenditure	27	397.52
	13		16.1 Statistical error	28	43.53
7.GeGDP	14	342.98	16.2 Statistical error	29	59.11
8.EDP	15	258.91	16.3 Statistical error	30	138.61

Market output/GDP
0.0347
Cost of sonsumption/GDP
0.0929
Cost of degradation/GDP
0.2308
GeGDP/GDP
0.9418
EDP/GDP
0.7109
Net accumulation of market values/GDP
-0.0138
Net accumulation of ecological values/GDP
-0.0250
Cost of forests/GDP
0.3238

Green GDP accounting for Hainan Province

Table 7-2 1997 Unit: 100 million RMB

Production	Order	Cost	Uses	Order	Cost
1. Output of economic activities	1	952.7	9 Ultimate consumption	16	222.33
2. Intermediate input in economic activities	2	542.84	9.1 Residence consumption	17	176.82
3. GDP by production (or Income)	3	409.86	9.2 Government consumption	18	45.51
3.1 Remuneration of labors	4	244.53	10 Total cost of capital formation	19	187.92
3.2 Net production tax	5	40.54	11 Net exportation	20	-2.50
3.2.1 Production tax	6	44.51	11.1 Exportation	21	134.66
3.2.2 Subsidy (-)	7	3.97	11.2 Importation (-)	22	137.16
3.3 Depreciation of fixed assets	8	64.69	12 GDP by expenditure	23	407.75
3.4 Operational balance	9	60.10	13.1 Net accumulation of forest assets at market value	24	-3.41
4 Market output of forest cultivation assets	10	14.72	13.2 Net accumulation of forest assets at ecological value	25	-6.17
5 Cost of forest assets exhustion	11	20.49	14 GeGDP by expenditure	26	404.34
6 Cost of forest assets degradation	12	50.89	15 EDP by expenditure	27	401.58
	13		16.1 Statistical error	28	-2.11
7.GeGDP	14	404.09	16.2 Statistical error	29	0.25
8.EDP	15	353.20	16.3 Statistical error	30	48.38

Market output/GDP	0.0359
Cost of sonsumption/GDP	0.0500
Cost of degradation/GDP	0.1242
GeGDP/GDP	0.9859
EDP/GDP	0.8618
Net accumulation of market values/GDP	-0.0084
Net accumulation of ecological values/GDP	-0.0151
Cost of forests/GDP	0.1742

Green GDP accounting for Hainan Province

Table 7-3 2000 Unit: 100 million RMB

Production	Order	Cost	Uses	Order	Cost
1. Output of economic activities	1	1181.2	9 Ultimate consumption	16	284.51
2. Intermediate input in economic activities	2	662.76	9.1 Residence consumption	17	218.38
3. GDP by production (or Income)	3	518.48	9.2 Government consumption	18	66.13
3.1 Remuneration of labors	4	299.08	10 Total cost of capital formation	19	240.66
3.2 Net production tax	5	59.63	11 Net exportation	20	-7.44
3.2.1 Production tax	6	64.65	11.1 Exportation	21	215.62
3.2.2 Subsidy (-)	7	5.02	11.2 Importation (-)	22	223.06
3.3 Depreciation of fixed assets	8	83.49	12 GDP by expenditure	23	517.73
3.4 Operational balance	9	76.28	13.1 Net accumulation of forest assets at market value	24	-3.21
4 Market output of forest cultivation assets	10	18.58	13.2 Net accumulation of forest assets at ecological value	25	-5.81
5 Cost of forest assets exhustion	11	19.32	14 GeGDP by expenditure	26	514.52
6 Cost of forest assets degradation	12	47.98	15 EDP by expenditure	27	508.71
	13		16.1 Statistical error	28	-0.75
7.GeGDP	14	517.74	16.2 Statistical error	29	-3.22
8.EDP	15	469.76	16.3 Statistical error	30	38.95

Market output/GDP	0.0358
Cost of sonsumption/GDP	0.0373
Cost of degradation/GDP	0.0925
GeGDP/GDP	0.9986
EDP/GDP	0.9060
Net accumulation of market values/GDP	-0.0062
Net accumulation of ecological values/GDP	-0.0112
Cost of forests/GDP	0.1298

Balance sheet for forest resources in Hainan Province

Table 8-1-1 Value accounting at market prices for forest resources

December 31, 1995

Unit: 100 million RMB

	Code	Non financial enterprise				Fianancial enterprise				Government		Residence		Total within province				Outside of province		Total	
				State owned enterprise				State owned agency								State owned institution					
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1	472.14		185.99		9.74		6.25		102.92		204.72		789.51		295.16				789.51	
1) Produciton assets	2	430.50		144.36		9.74		6.25		78.46		189.22		707.92		229.07				707.92	
of which: cultivation assets	3	32.16		32.16		0.00		0.00		18.89		11.97		63.02		51.05				63.02	
forest land	4	10.37		10.37		0.00		0.00		6.09		3.86		20.32		16.46				20.32	
Forest trees	5	21.79		21.79		0.00		0.00		12.80		8.11		42.70		34.59				42.70	
i) Fixed assets	6	323.51		111.14		9.25		5.90		57.21		161.69		551.67		174.25				551.67	
of which: on-going programs	7	58.76		19.83		7.36		5.32		3.39		0.00		69.52		28.54				69.52	
Cultivation fixed assets	8	13.19		13.19		0.00		0.00		7.74		4.91		25.84		20.93				25.84	
Forest land	9	6.52		6.52		0.00		0.00		3.83		2.43		12.77		10.34				12.77	
Forest trees	10	6.67		6.67		0.00		0.00		3.92		2.48		13.07		10.59				13.07	
ii) Existing products	11	88.41		26.10		0.02		0.01		12.59		26.48		127.50		38.71				127.50	
of which: end products and commodity stocks	12	29.38		2.74		0.00		0.00		0.00		15.50		44.88		2.74				44.88	
In-process products of cultivation assets	13	18.97		18.97		0.00		0.00		11.14		7.06		37.18		30.12				37.18	
Forest land	14	3.85		3.85		0.00		0.00		2.26		1.43		7.55		6.12				7.55	
Forest trees	15	15.12		15.12		0.00		0.00		8.88		5.63		29.63		24.00				29.63	
iii) Other non financial assets	16	18.58		7.12		0.47		0.34		8.66		1.05		28.75		16.11				28.75	
of which: intangibles	17	13.80		2.10		0.01		0.01		0.00		0.00		13.81		2.11				13.81	
2) Non-production assets	18	41.63		41.63		0.00		0.00		24.45		15.50		81.59		66.09				81.59	
i) Forest assets	19	41.63		41.63		0.00		0.00		24.45		15.50		81.59		66.09				81.59	
Forest land	20	1.64		1.64		0.00		0.00		0.96		0.61		3.21		2.60				3.21	
Forest trees	21	40.00		40.00		0.00		0.00		23.49		14.89		78.38		63.48				78.38	
ii) Other assets (land,water,mines,sea)	22	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00				0.00	
2 Financial assets and debts	23	335.34	685.72	103.97	170.70	715.39	548.92	594.57	498.53	14.13	35.21	293.20	18.66	1358.06	1288.52	712.67	704.45	115.07	184.62	1473.13	1473.14
i) Domestic financial assets and debts	24	335.34	685.72	103.97	170.70	715.39	548.92	594.57	498.53	14.13	35.21	293.20	18.66	1358.06	1288.52	712.67	704.45	115.07	184.62	1473.13	1473.14
ii) Foreign financial assets and debts	36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Net value of assets	37	0.00	121.76	0.00	119.26	0.00	176.21	0.00	102.29	0.00	81.83	0.00	479.25	0.00	859.05	0.00	303.38	0.00	-69.55	0.00	789.50
4 Total assets, debts and net value of total assets	38	807.48	807.48	289.96	289.96	725.13	725.13	600.82	600.82	117.04	117.04	497.91	497.91	2147.57	2147.57	1007.83	1007.83	115.07	115.07	2262.64	2262.64

Balance sheet for forest resources in Hainan Province

Table 8-1-2 Value accounting at market prices for forest resources

December 31, 2000

Unit: 100 million RMB

	Code	Non financial enterprise				Fianancial enterprise				Government		Residence		Total within province				Outside of province		Total	
				State owned enterprise				State owned agency								State owned institution					
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1	1184.22		671.55		59.68		48.56		174.75		358.19		1776.83		894.86				1776.83	
1) Produciton assets	2	1168.78		656.11		59.68		48.56		166.07		351.38		1745.91		870.74				1745.91	
of which: cultivation assets	3	46.57		46.57		0.00		0.00		26.20		20.52		93.29		72.77				93.29	
forest land	4	11.21		11.21		0.00		0.00		6.30		4.94		22.45		17.51				22.45	
Forest trees	5	35.36		35.36		0.00		0.00		19.89		15.58		70.84		55.26				70.84	
i) Fixed assets	6	744.37		491.05		54.29		44.31		149.57		313.21		1261.44		684.93				1261.44	
of which: on-going programs	7	88.15		73.39		6.41		5.29		3.85		0.00		98.41		82.53				98.41	
Cultivation fixed assets	8	21.18		21.18		0.00		0.00		11.91		9.33		42.42		33.09				42.42	
Forest land	9	7.06		7.06		0.00		0.00		3.97		3.11		14.15		11.04				14.15	
Forest trees	10	14.11		14.11		0.00		0.00		7.94		6.22		28.27		22.05				28.27	
ii) Existing products	11	222.43		106.83		0.00		0.00		14.49		34.03		270.96		121.33				270.96	
of which: end products and commodity stocks	12	57.00		16.00		0.00		0.00		0.00		5.01		62.01		16.00				62.01	
In-process products of cultivation assets	13	25.39		25.39		0.00		0.00		14.28		11.19		50.87		39.68				50.87	
Forest land	14	4.14		4.14		0.00		0.00		2.33		1.83		8.30		6.47				8.30	
Forest trees	15	21.25		21.25		0.00		0.00		11.95		9.37		42.57		33.20				42.57	
iii) Other non financial assets	16	201.98		58.23		5.39		4.25		2.00		4.14		213.51		64.48				213.51	
of which: intangibles	17	67.99		44.45		1.79		0.00		0.00		0.00		69.78		44.45				69.78	
2) Non-production assets	18	15.44		15.44		0.00		0.00		8.68		6.80		30.92		24.12				30.92	
i) Forest assets	19	15.44		15.44		0.00		0.00		8.68		6.80		30.92		24.12				30.92	
Forest land	20	0.86		0.86		0.00		0.00		0.48		0.38		1.73		1.35				1.73	
Forest trees	21	14.58		14.58		0.00		0.00		8.20		6.42		29.20		22.77				29.20	
ii) Other assets (land,water,mines,sea)	22	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00				0.00	
2 Financial assets and debts	23	785.87	1319.31	399.75	630.60	706.65	1105.90	563.69	793.57	67.99	54.57	517.95	31.47	2078.46	2511.25	1031.43	1478.74	594.47	161.86	2672.93	2673.11
i) Domestic financial assets and debts	24	785.87	1319.31	399.75	630.60	706.65	1105.90	563.69	793.57	67.99	54.57	517.95	30.23	2078.46	2510.01	1031.43	1478.74	593.23	161.86	2671.69	2671.87
ii) Foreign financial assets and debts	36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	1.24	0.00	0.00	1.24	0.00	1.24	1.24
3 Net value of assets	37	0.00	650.78	0.00	440.70	0.00	-339.57	0.00	-181.32	0.00	188.17	0.00	844.67	0.00	1344.04	0.00	447.55	0.00	432.61	0.00	1776.65
4 Total assets, debts and net value of total assets	38	1970.09	1970.09	1071.30	1071.30	766.33	766.33	612.25	612.25	242.74	242.74	876.14	876.14	3855.29	3855.29	1926.29	1926.29	594.47	594.47	4449.76	4449.76

Balance sheet of green assets in Hainan Province

Table 8-2-1 Value accounting at ecological prices for forest resources — December 31, 1995 — Unit: 100 million RMB

	Code	Non financial enterprise		State owned enterprise		Fianancial enterprise		State owned agency		Government		Residence		Total within province		State owned institution		Outside of province		Total	
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1	571.64		285.49		9.74		6.25		161.35		241.76		984.49		453.09				984.49	
1) Produciton assets	2	451.93		165.78		9.74		6.25		91.05		197.19		749.90		263.08				466.52	
of which: cultivation assets	3	63.50		63.50		0.00		0.00		37.29		23.64		124.43		100.79				124.43	
forest land	4	12.56		12.56		0.00		0.00		7.38		4.68		24.61		19.93				24.61	
Forest trees	5	50.94		50.94		0.00		0.00		29.92		18.97		99.82		80.85				99.82	
i) Fixed assets	6	327.78		115.40		9.25		5.90		59.72		163.28		560.02		181.02				350.20	
of which: on-going programs	7	58.76		19.83		7.36		5.32		3.39		0.00		69.52		28.54				33.86	
Cultivation fixed assets	8	27.36		27.36		0.00		0.00		16.07		10.19		53.62		43.43				53.62	
Forest land	9	8.58		8.58		0.00		0.00		5.04		3.19		16.81		13.62				16.81	
Forest trees	10	18.78		18.78		0.00		0.00		11.03		6.99		36.81		29.82				36.81	
ii) Existing products	11	105.57		43.26		0.02		0.01		22.67		32.87		161.13		65.95				98.82	
of which: end products and commodity stocks	12	29.38		2.74		0.00		0.00		0.00		15.50		44.88		2.74				18.24	
In-process products of cultivation assets	13	36.13		36.13		0.00		0.00		21.22		13.45		70.81		57.36				70.81	
Forest land	14	3.98		3.98		0.00		0.00		2.34		1.48		7.80		6.32				7.80	
Forest trees	15	32.15		32.15		0.00		0.00		18.88		11.97		63.01		51.04				63.01	
iii) Other non financial assets	16	18.58		7.12		0.47		0.34		8.66		1.05		28.75		16.11				17.49	
of which: intangibles	17	13.80		2.09		0.01		0.01		0.00		0.00		13.81		2.10				2.11	
2) Non-production assets	18	119.71		119.71		0.00		0.00		70.31		44.57		234.59		190.01				234.59	
i) Forest assets	19	119.71		119.71		0.00		0.00		70.31		44.57		234.59		190.01				234.59	
Forest land	20	1.68		1.68		0.00		0.00		0.99		0.63		3.30		2.67				3.30	
Forest trees	21	118.03		118.03		0.00		0.00		69.32		43.94		231.29		187.34				231.29	
ii) Other assets (land,water,mines,sea)	22	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00				0.00	
2 Financial assets and debts	23	335.34	685.72	103.97	170.70	715.39	548.92	594.57	498.53	14.13	35.21	293.20	18.66	1358.06	1288.52	712.67	704.45	115.07	184.62	1715.50	1406.26
i) Domestic financial assets and debts	24	335.34	685.72	103.97	170.70	715.39	548.92	594.57	498.53	14.13	35.21	293.20	18.66	1358.06	1288.52	712.67	704.45	115.07	184.62	1715.50	1406.26
ii) Foreign financial assets and debts	36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Net value of assets	37	0.00	221.25	0.00	218.76	0.00	176.21	0.00	102.29	0.00	140.27	0.00	516.30	0.00	1054.03	0.00	461.31	0.00	-69.55	0.00	1010.34
4 Total assets, debts and net value of total assets	38	906.98	906.98	389.46	389.46	725.13	725.13	600.82	600.82	175.48	175.48	534.96	534.96	2342.55	2342.55	1165.76	1165.76	115.07	115.07	2416.61	2416.61

Balance sheet of green assets in Hainan Province

Table 8-2-2 Value accounting at ecological prices for forest resources

December 31, 2000

Unit: 100 million RMB

	Code	Non financial enterprise				Fianancial enterprise				Government		Residence		Total within province				Outside of province		Total	
				State owned enterprise				State owned agency								State owned institution					
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1	1285.97		773.30		59.68		48.56		231.98		403.03		1980.66		1053.84				1980.66	
1) Produciton assets	2	1224.05		711.38		59.68		48.56		197.16		375.74		1856.63		957.10				1381.40	
of which: cultivation assets	3	101.84		101.84		0.00		0.00		57.29		44.88		204.01		159.13				204.01	
forest land	4	13.52		13.52		0.00		0.00		7.60		5.96		27.08		21.12				27.08	
Forest trees	5	88.32		88.32		0.00		0.00		49.68		38.92		176.93		138.01				176.93	
i) Fixed assets	6	775.53		522.21		54.29		44.31		167.10		326.94		1323.86		733.62				1104.87	
of which: on-going programs	7	88.15		73.39		6.41		5.29		3.85		0.00		98.41		82.53				87.82	
Cultivation fixed assets	8	52.34		52.34		0.00		0.00		29.44		23.06		104.84		81.78				104.84	
Forest land	9	9.19		9.19		0.00		0.00		5.17		4.05		18.41		14.36				18.41	
Forest trees	10	43.15		43.15		0.00		0.00		24.27		19.01		86.43		67.42				86.43	
ii) Existing products	11	246.55		130.95		0.00		0.00		28.06		44.66		319.26		159.00				203.66	
of which: end products and commodity stocks	12	57.00		16.00		0.00		0.00		0.00		5.01		62.01		16.00				21.01	
In-process products of cultivation assets	13	49.51		49.51		0.00		0.00		27.85		21.82		99.17		77.35				99.17	
Forest land	14	4.33		4.33		0.00		0.00		2.43		1.91		8.67		6.76				8.67	
Forest trees	15	45.18		45.18		0.00		0.00		25.41		19.91		90.50		70.59				90.50	
iii) Other non financial assets	16	201.98		58.23		5.39		4.25		2.00		4.14		213.51		64.48				72.87	
of which: intangibles	17	67.99		44.45		1.79		0.00		0.00		0.00		69.78		44.45				44.45	
2) Non-production assets	18	61.92		61.92		0.00		0.00		34.83		27.29		124.03		96.74				124.03	
i) Forest assets	19	61.92		61.92		0.00		0.00		34.83		27.29		124.03		96.74				124.03	
Forest land	20	0.86		0.86		0.00		0.00		0.48		0.38		1.73		1.35				1.73	
Forest trees	21	61.05		61.05		0.00		0.00		34.34		26.91		122.30		95.40				122.30	
ii) Other assets (land,water,mines,sea)	22	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00				0.00	
2 Financial assets and debts	23	785.87	1319.31	399.75	630.60	706.65	1105.90	563.69	793.57	67.99	54.57	517.95	31.47	2078.46	2511.25	1031.43	1478.74	594.47	161.86	2707.54	2465.64
i) Domestic financial assets and debts	24	785.87	1319.31	399.75	630.60	706.65	1105.90	563.69	793.57	67.99	54.57	517.95	30.23	2078.46	2510.01	1031.43	1478.74	593.23	161.86	2706.30	2464.40
ii) Foreign financial assets and debts	36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	1.24	0.00	0.00	1.24	0.00	1.24	1.24
3 Net value of assets	37	0.00	752.53	0.00	542.45	0.00	-339.57	0.00	-181.32	0.00	245.40	0.00	889.51	0.00	1547.87	0.00	606.53	0.00	432.61	0.00	1747.33
4 Total assets, debts and net value of total assets	38	2071.84	2071.84	1173.05	1173.05	766.33	766.33	612.25	612.25	299.97	299.97	920.98	920.98	4059.12	4059.12	2085.27	2085.27	594.47	594.47	4212.97	4212.97

National wealth accounting for Hainan Province (market values)

Table 9-1-1

December 31, 1995

Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01	47.96	45.47	176.21	102.29	38.50	451.78	714.45	186.26	-69.55	644.90
1) Fixed assets	02	310.33	97.95	9.25	5.90	49.47	156.78	525.83	153.32	0.00	525.83
of which: on-going programs	03	58.76	19.83	7.36	5.32	3.39	0.00	69.51	28.54	0.00	69.51
2) Existing products	04	69.44	7.13	0.02	0.01	1.45	19.41	90.32	8.59	0.00	90.32
of which: end products and commodities	05	29.38	2.74	0.00	0.00	0.00	15.50	44.88	2.74	0.00	44.88
3) Other man-made assets	06	18.58	7.12	0.47	0.34	8.66	1.05	28.76	16.12	0.00	28.76
of which: intangibles	07	13.80	2.09	0.01	0.01	0.00	0.00	13.81	2.10	0.00	13.81
4) Net financial assets for overseas	08	-350.38	-66.73	166.47	96.04	-21.08	274.54	69.55	8.23	-69.55	-0.00
2 Natural resources	09	124.72	124.72	0.00	0.00	73.25	46.44	244.41	197.97	0.00	244.41
1) Resource assets	10	73.79	73.79	0.00	0.00	43.34	27.47	144.60	117.13	0.00	144.60
i) Forest resource assets	11	73.79	73.79	0.00	0.00	43.34	27.47	144.60	117.13	0.00	144.60
Forest land	12	12.01	12.01	0.00	0.00	7.05	4.47	23.53	19.06	0.00	23.53
Forest trees	13	61.78	61.78	0.00	0.00	36.28	23.00	121.07	98.07	0.00	121.07
ii) Other non-production assets	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Non assets natural resources	15	50.93	50.93	0.00	0.00	29.91	18.96	99.81	80.85	0.00	99.81
i) Forest environment assets	16	50.93	50.93	0.00	0.00	29.91	18.96	99.81	80.85	0.00	99.81
Forest land	17	8.26	8.26	0.00	0.00	4.85	3.08	16.19	13.11	0.00	16.19
Forest trees	18	42.67	42.67	0.00	0.00	25.06	15.89	83.62	67.73	0.00	83.62
ii) Other natural resources	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Human capital	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Total national wealth	25	**172.69**	**170.19**	**176.21**	**102.29**	**111.75**	**498.22**	**958.86**	**384.23**	**-69.55**	**889.31**

National wealth accounting for Hainan Province (market values)

Table 9-1-2

December 31, 2000

Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned Institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01	588.77	542.81	-339.57	-181.32	153.29	817.34	1219.83	514.78	432.61	1652.44
1) Fixed assets	02	723.19	469.87	54.29	44.31	137.66	303.88	1219.02	651.84	0.00	1219.02
of which: on-going programs	03	88.15	73.39	6.41	5.29	3.85	0.00	98.41	82.53	0.00	98.41
2) Existing products	04	197.04	81.44	0.00	0.00	0.21	22.84	220.09	81.65	0.00	220.09
of which: end products and commodities	05	57.00	16.00	0.00	0.00	0.00	5.01	62.01	16.00	0.00	62.01
3) Other man-made assets	06	201.98	58.23	5.39	4.25	2.00	4.14	213.51	64.48	0.00	213.51
of which: intangibles	07	67.99	44.45	1.79	0.00	0.00	0.00	69.78	44.45	0.00	69.78
4) Net financial assets for overseas	08	-533.44	-66.73	-399.25	-229.88	13.42	486.48	-432.79	-283.19	432.61	-0.18
2 Natural resources	09	160.77	160.77	0.00	0.00	90.43	70.85	322.06	251.21	0.00	322.06
1) Resource assets	10	62.01	62.01	0.00	0.00	34.88	27.33	124.22	96.89	0.00	124.22
i) Forest resource assets	11	62.01	62.01	0.00	0.00	34.88	27.33	124.22	96.89	0.00	124.22
Forest land	12	12.07	12.07	0.00	0.00	6.79	5.32	24.18	18.86	0.00	24.18
Forest trees	13	49.94	49.94	0.00	0.00	28.09	22.01	100.04	78.03	0.00	100.04
ii) Other non-production assets	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Non assets natural resources	15	98.76	98.76	0.00	0.00	55.55	43.52	197.84	154.32	0.00	197.84
i) Forest environment assets	16	98.76	98.76	0.00	0.00	55.55	43.52	197.84	154.32	0.00	197.84
Forest land	17	9.29	9.29	0.00	0.00	5.23	4.09	18.61	14.52	0.00	18.61
Forest trees	18	89.47	89.47	0.00	0.00	50.33	39.43	179.23	139.80	0.00	179.23
ii) Other natural resources	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Human capital	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Total national wealth	25	**749.54**	**703.58**	**-339.57**	**-181.32**	**243.72**	**888.19**	**1541.89**	**765.99**	**432.61**	**1974.50**

National wealth accounting for Hainan Province (ecological values)

Table 9-2-1

December 31, 1995

Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned Institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01	47.97	45.47	176.21	102.29	38.50	451.78	714.46	186.26	-69.55	644.91
1) Fixed assets	02	310.33	97.95	9.25	5.90	49.47	156.78	525.83	153.32	0.00	525.83
of which: on-going programs	03	58.76	19.83	7.36	5.32	3.39	0.00	69.51	28.54	0.00	69.51
2) Existing products	04	69.44	7.13	0.02	0.01	1.45	19.41	90.32	8.59	0.00	90.32
of which: end products and commodities	05	29.38	2.74	0.00	0.00	0.00	15.50	44.88	2.74	0.00	44.88
3) Other man-made assets	06	18.58	7.12	0.47	0.34	8.66	1.05	28.76	16.12	0.00	28.76
of which: intangibles	07	13.80	2.09	0.01	0.01	0.00	0.00	13.81	2.10	0.00	13.81
4) Net financial assets for overseas	08	-350.38	-66.73	166.47	96.04	-21.08	274.54	69.55	8.23	-69.55	0.00
2 Natural resources	09	336.95	336.95	0.00	0.00	197.89	125.46	660.29	534.83	0.00	660.29
1) Resource assets	10	183.21	183.21	0.00	0.00	107.60	68.22	359.03	290.81	0.00	359.03
i) Forest resource assets	11	183.21	183.21	0.00	0.00	107.60	68.22	359.03	290.81	0.00	359.03
Forest land	12	14.25	14.25	0.00	0.00	8.37	5.30	27.92	22.62	0.00	27.92
Forest trees	13	168.97	168.97	0.00	0.00	99.23	62.91	331.11	268.20	0.00	331.11
ii) Other non-production assets	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Non assets natural resources	15	153.73	153.73	0.00	0.00	90.29	57.24	301.26	244.02	0.00	301.26
i) Forest environment assets	16	153.73	153.73	0.00	0.00	90.29	57.24	301.26	244.02	0.00	301.26
Forest land	17	9.13	9.13	0.00	0.00	5.36	3.40	17.89	14.49	0.00	17.89
Forest trees	18	144.60	144.60	0.00	0.00	84.93	53.84	283.37	229.53	0.00	283.37
ii) Other natural resources	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Human capital	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Total national wealth	25	**384.92**	**382.42**	**176.21**	**102.29**	**236.39**	**577.24**	**1374.75**	**721.09**	**-69.55**	**1305.20**

National wealth accounting for Hainan Province (ecological values)

Table 9-2-2 December 31, 2000 Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned Institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01	588.77	542.81	-339.57	-181.32	153.29	817.34	1219.83	514.78	432.61	1652.44
1) Fixed assets	02	723.19	469.87	54.29	44.31	137.66	303.88	1219.02	651.84	0.00	1219.02
of which: on-going programs	03	88.15	73.39	6.41	5.29	3.85	0.00	98.41	82.53	0.00	98.41
2) Existing products	04	197.04	81.44	0.00	0.00	0.21	22.84	220.09	81.65	0.00	220.09
of which: end products and commodities	05	57.00	16.00	0.00	0.00	0.00	5.01	62.01	16.00	0.00	62.01
3) Other man-made assets	06	201.98	58.23	5.39	4.25	2.00	4.14	213.51	64.48	0.00	213.51
of which: intangibles	07	67.99	44.45	1.79	0.00	0.00	0.00	69.78	44.45	0.00	69.78
4) Net financial assets for overseas	08	-533.44	-66.73	-399.25	-229.88	13.42	486.48	-432.79	-283.19	432.61	-0.18
2 Natural resources	09	491.80	491.80	0.00	0.00	276.64	216.74	985.18	768.44	0.00	985.18
1) Resource assets	10	159.43	159.43	0.00	0.00	89.68	70.26	319.38	249.12	0.00	319.38
i) Forest resource assets	11	159.43	159.43	0.00	0.00	89.68	70.26	319.38	249.12	0.00	319.38
Forest land	12	10.05	10.05	0.00	0.00	5.66	4.43	20.14	15.71	0.00	20.14
Forest trees	13	149.38	149.38	0.00	0.00	84.03	65.83	299.24	233.41	0.00	299.24
ii) Other non-production assets	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Non assets natural resources	15	332.37	332.37	0.00	0.00	186.96	146.48	665.80	519.32	0.00	665.80
i) Forest environment assets	16	332.37	332.37	0.00	0.00	186.96	146.48	665.80	519.32	0.00	665.80
Forest land	17	10.06	10.06	0.00	0.00	5.66	4.43	20.15	15.72	0.00	20.15
Forest trees	18	322.31	322.31	0.00	0.00	181.30	142.04	645.65	503.61	0.00	645.65
ii) Other natural resources	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Human capital	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Total national wealth	25	**1080.57**	**1034.61**	**-339.57**	**-181.32**	**429.93**	**1034.08**	**2205.01**	**1283.22**	**432.61**	**2637.62**

Chapter 7 Policy Analysis Framework and Green Forestry Policy

Forest accounting, obviously provides indicators of forest assets stocks and its changes, flow indicators of forest products and services, and marketed value, near-marketed value and non-market ecosystem service values in value flows. It's a comprehensive indicator of forests, with high value for application.

1 Used for analysis of forestry development and forest operation sustainability

Forest accounts provide detailed data about forest assets and forestry production, indicating the developing trends of forest assets, and can be used to compare standards and indicator system of sustainable forestry development and sustainable operation. For example, weak sustainability of forestry development means non-declining of resources, while the accounting results judge it from the stock changing trends of wooded land resources, standing timber resources and ecosystem resources. In Hainan case, we found that the area of forests was enlarged at the end of the accounting period compared with that at the begging, but the total value of forests declined.

2 Used for analyzing the comprehensive contributions of forests on economy

Traditionally, the contribution of forestry to national economy is measured by the total economic value of timbers and, now has extended to near-market forest products and ecosystem services. Thanks to the influences of some case studies, China has become to realize the huge value of forests. Regular forest accounting will provide the society with information about ecological value of forest investment and, thereby helps to establish modern forest value.

3 Used for analyzing the true contribution of forests to relevant sectors

Many indicators show the service flows and value that forests provide for non-forestry sectors, proving the dependence of these sectors on forests.

Forest accounts differentiate economic use and livelihood use of forests, direst beneficiaries and indirect beneficiaries, and local benefits, "downstream" benefits (such as water power sector, city planning and fishery, etc.) and global benefits (like biodiversity and carbon storage).

Forest accounting system reveals the relationship between rural residents and forests, which can't be provided only through accounts of marketed product. These indicators act as a strong support for the decision making concerning anti-poverty.

Forest carbon storage and biodiversity protection also prove the social contributions and global contributions of forests.

4 Used for establishing forest ecological services market and analyzing ecological benefit compensation

Indicators about forest carbon storage, forest water source, forest biodiversity, and even oxygen generation help to establish forest ecosystem markets, or help to achieve ecosystem transactions. Generally, these indicators are the scientific foundation for public financial transfer on forest ecosystem services compensation. For example, in 2004, Beijing municipal government decided to provide 0.2 billion yuan on forest ecosystem benefits compensation every year, and this decision was made according to a report on forest accounting by ITTO forest accounting project team.

5 Used for the tradeoffs among competing uses of forests

Today, the total demand and structural demands (economic demands and ecological demands) of human Beijing for tropical forests have been expanding, and the diversified demands are bigger than supply. The tradeoffs among competing uses of tropical forests have become a universal issue, which needs the understanding about the total value and value structure of tropical forests, or the comprehensive measurement of the benefits and losses brought by use changes of forests. Forest accounts provide the data required.

Forest accounts can also be used in selective analysis of operation target of forests. For example, the biggest value of the tropical forests in Hainan Island is biodiversity preservation and water source protection. Forest accounts have proved that the most significant values of the forests in Beijing include water head conservation, atmosphere purification and biodiversity preservation.

6 Used for analyzing the impacts of non-forestry policies on forest uses

Policies that have impacts on forests mainly include macroeconomic policies and public policies, which can influence forests at last through economic system. Forest accounts provide detailed statistical tables that can be used to predict the impacts of these non-forestry policies, and to design economic development strategies taking all stakeholders into account.

7 Used for analyzing the sustainability of forestry

Chapter 1 has shown that adjustment to macroeconomic indicators from resources and environment accounts include: Green GDP, sustainable incomes, consumption adjustments, saving adjustments and investment adjustments, etc.

Table 1 is a indicator adjustment system recommended by FAO.

Table 1 Macroeconomic indicators including forest values

Conventional indicator from national accounts	Proposed adjustment from forest accounts	Revised indicator
GDP	Non-market value of forests	GDP including full value of forests
Depreciation capital stocks	Depletion of natural forests	Total depreciation including depletion of natural forests
NDP	Depletion or degradation of natural forests	NDP including loss of natural forests
National assets	Capitalized value of natural forests	Total national wealth including natural forest assets

8 Policy analysis conclusions

Forest accounts provide a comprehensive framework about forest uses. Table 2 lists the policy applications of forest accounts, Prominent among the policies are the institution of fees for environment services, identification of potential conflicts and designing of optimal forest uses. Forest accounts also assist in the building of economic alliances and cooperation across different sectors. Table 3 provides more detailed information.

Table 2 Policy Application of Forest Accounting

Indicator/measure	Use for policy analysis	Policies and actions
1.What is the total economic contribution of forests and what are the benefits from sustainable management		
Total value of forests including non-market forest goods and services.	More comprehensive, accurate value of forests' contribution to GDP.	Showing a higher value for forest contribution to GDP may increase the forestry sector's ability to request a larger share of national budget for forest management and investment.
Value of forest services to non-forestry sectors.	Measure of the economic importance of forest services to agriculture, electricity, fisheries, tourism, municipal water supply, etc.	Design economic instruments to promote sustainable forest use, for example: - institute conservation fee on water and hydroelectricity tariffs for downstream beneficiaries that can be used for forest management or to compensate local communities - institute tourism fees for biodiversity conservation for forest management/compensation of local communities - negotiate international payments for carbon storage services of forests. Build multi-sectoral stakeholder alliances on the basis of mutual benefits. Identify institutional weaknesses in forest management, e.g. where one sector benefits but does not pay, or does not have a say in forest management.
Value of forest goods and services used by local communities.	Share of forest goods in rural livelihoods provides measure of dependence on forests of local communities.	Useful for design and implementation of PRSPs.
2. What is the distribution of forest benefits among different groups in society		
Share of forest benefits accruing to commercial, artisanal and subsistence	Identify social benefits from preservation of local communities and	Identify potential conflicts, e.g. benefits to subsistence users/local communities are low because commercial/downstream users obtain benefits.

users of forests, or, Share accruing to local, downstream and global beneficiaries.	increased equity.	Design economic instruments so that beneficiaries pay for the benefits, compensating those who may sacrifice benefits. For example, property rights – some say over how a forest is managed – and fees for environmental services received. Optimize investment in forests and forest infrastructure that balances social objectives for equity and regional development as well as economic objectives of maximizing national income.
3. Is economic growth sustainable or is it based on the depletion of forests?		
Value of forest assets and the cost of deforestation and forest degradation.	Macroeconomic indicators of sustainability (such as NDP, national wealth, asset depletion).	Reassess forest management if deforestation is occurring.
4. What are the trade-offs among competing users of forests?		
Value of forest goods and services under alternative forest management options.	Measure economic linkages between forestry and other sectors of the economy, upstream and downstream. Identify the economic trade-offs among competing sectors.	Optimize forest use and investment in forests and forest infrastructure by taking into account total economic value of forests, market and non-market, including linkages to non-forestry sectors and impacts on all stakeholders, economy-wide. Identify winners and losers. Design appropriate economic instruments to achieve that strategy (fees, compensating payments, property rights, etc.).
5. What are the impacts of non-forestry policies on forest use?		
Analyze economic development scenarios that trace the full chain of causation from macroeconomic policy and/or non-forestry sector policies to their impact on forestry and land use.	Measures the winners and losers, pressures on forests and forest users from alternative development strategies. Identifies potential conflicts between development objectives of forestry and those of other sectors, e.g. commercial logging vs catchment protection (Ministry of Agriculture, Ministry of Energy, etc.). Identify conflicts among divisions of the same ministry (Ministry of Agriculture), e.g. pastoralists' use of forest vs downstream crop farmers.	Identify winners and losers. Identify optimal forest management strategy, based on addressing conflicts among ministries and within a single inistry. Design appropriate economic instruments to achieve that strategy (fees, compensating payments, property rights, etc.).

FAO: Manual for environmental and economic accounts for forestry: a tool for cross-sectoral policy analysis, March 2004

9 Green policies

Environmental economic policies ("Green" policies)

The slogans and wishes of sustainable development are to be materialized only if they are applied in policies and institutions. Policies with the aim to adjust the externalities of environmental resources and to efficiently allocate environmental policies are called environmental economic policies or "green policies", the building of which are generally based on the following aspects:

1) Target of the policies

Offset negative externalities, compensate positive externalities and solve market failure problem at this regard.

2) Principles of the policies

Fully use environmental capacity principle;

Polluters pay principle.

3) Instruments of the policies, including:

Utilize market (visible hand), e.g., jurisdictional interventions,etc.

Create market (invisible hand), e.g., build environmental services market, etc.

4) Types of policies

Economic means are the instruments to implement environmental policies and carriers to express policy embodiments. Up to date, economic instruments used in environmental economic policies in the world mainly include the following 9 types:

Property rights, e.g. ownership, use right;

Market creation, e.g. carbon storage market, water head protection market, emission trading market;

Taxes, e.g. pollution taxes. Resources taxes, compensation taxes and duty free, etc.

Fees, e.g. emission charges, users payment, resources(environment) compensating payments, etc.;

Fines, e.g. judicial fines, breach of contract damages, etc.

Financial instruments, e.g., discount loans, department funds, special funds, etc.

Liability compensations, legal liability compensations, environmental resources damage liability compensations,

Security and deposits, e.g. environmental behavior securities, waste treatment securities, deposits, stocks, etc.

The fields where these economic instruments are applicable include pollution control, natural protection, resource utilization, integrated environmental treatment of watersheds, international and global environmental problems, and production and consumption, etc.

Table3 Major indicators derived from accounts for output of forest goods and services

Purpose	Indicator
Economic contribution of forests relative to other sectors of the economy	Value of total forest goods and services as % of GDP Share of forest goods and services included in GDP, and omitted values as % of GDP Forest employment as % of total (national or regional) employment
Non-forestry sectors: economic contribution of forest services to non-forestry commercial sectors	% of land area providing forest services % of national energy provided by firewood % of tourists visiting forests % of employment in non-logging industries dependent on forest services Value of forest services as % of GDP Value of forest services as % of output and sectoral GDP of sector that benefits (e.g. agriculture. tourist, etc.)
Rural livelihoods: economic importance of forests to rural communities	% of rural energy needs met by firewood % of household nutritional requirements provided by forests % of animals grazed in forests Forest employment as % of rural employment Value of output by non-market and small-scale producers as % of GDP Value of output by non-market and small-scale producers as % of total forest value
Global benefits: economic importance of forest services to the global community	Carbon storage as % of national-global carbon emissions % of land devoted to biodiversity protection Value of carbon storage as % of total forest value and of GDP

FAO ： Manual for environmental and economic accounts for forestry: a tool for cross-sectoral policy analysis, March 2004

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Special Report: Case Study on Valuating Tropical Forest Resources of Hainan Island

ITTO PD 39/38 Rev.2 (M)

1 Introduction

As people realize the irreplaceable function of services from the forest ecological system more profoundly, the studies on accounting forest resource are regarded more and more. In recent years, noticeable progression has been made in the area.

Initially, the accounting frame for forest resource raised in Japan was divided as forest land, timber, water conservation, protection of wild propagations, public security of national land (land protection, prevention of snowslide and slopslide), environment purification, landscape and tour, etc. it is thought that the accounting systems in Korean and Taiwan are in agreement with that of Japan. Hou Yuanzhao valuated forest land, timber and 3 ecological effects from forest, i.e., water storage, soil conservation, carbon holding and oxygen production (1996).

The qualification of biodiversity was discussed on a session organized by Environment Committee of International League of Science. The book *Nature's Service: Societal Dependence on Natural Ecosystem* edited by Daily in 1997 introduced the concept, brief history, valuation of service, the serve function of various kinds of systems, of service function from ecosystem, and the special study on service function of ecosystem. Costanza et al partitioned and evaluated the function of the global ecosystem.

Ecological Economics (1998,25; 1999,29) collects the study results on ecosystem service function, many scholars (Bolund P. 1999; Bjorklund J. 1999; Holmund C. 1999; etc.) made studies on the function and its valuation in different points of view.

Of the study results in China, the accounting system is divided into 2 parts, one is to valuate organism produced from forest including timber, other products from forest, the biomass from photosynthesis in direct or indirect ways, another is to evaluate various types of environmental function from forest, such as water storage, soil conservation, carbon holding and oxygen production, tour in forest, biodiversity, and environment purification. In the similar principle and mean, the assets of Three-north shelter belt forest in Gansu province was calculated (Liu Cong, Liu Faming, 1997), the theory and method to evaluate service function and valuate the economics was studied (Ouyang Zhiyong, Wang Rusong, 1999). The service function of terrestrial system was evaluated; its eco-economy value was calculated preliminarily by Ouyang Zhiyong, Wang Xiaoke et al (1999). An approach to the theory and practice on ecological assets regionalization of China was made (Huang Xinwen, Cheng Baiming, 1999). The total value of ecosystem service function was calculated for 38 principal types of forests by Jiang Yanling and Zhou Guangsheng et al in 1999. The tour in forest was valuated by Xue Dayuan and Ba Haosheng (1999) for biodiversity of nature reserve in Changbai mountain. With a comprehensive accounting system the real and environmental resource of forest in Beijing was valuated (Zhou Bingbing, Li Zhongkui, et al, 2000). The index for the forest account raised by Leiming included land area for forestry, forest area, standing volume etc. In October, 2001, an international conference on value accounting of forest resource was convoked in Beijing.

2 Account of Forest Resource in Hainan Province

It is accounted that the total land area of Hainan province is 33,924 km^2.According to the statistics in 2000, the land area for forestry is 1,760,760 hm^2, being 51.90% of the total land area. In it the forested land area is 1,495,073 hm^2, shrub area is 227,600 hm^2, non-stocked land is 37,113 hm^2 and nursery for 967 hm^2.

Located in the middle and eastern parts of Hainan island are tropical moist forest, evergreen monsoon forest and hill rain forest, in the north is half-evergreen monsoon forest, in the west is monsoon forest of defoliation and tropical treeveld. There is little virgin forest; the others are fast-growing plantation of timber and various kinds of economy forests in tropical zone, including gum forest.

2.1 Value of forest land

In light with the method of sample in stratification, 4 counties were selected from 19 counties (cities) of the 3 types of topographic area including mountain, tableland in lower mountain and terraced plain, the local exchange prices of forest land in 1995 were collected, from which the mean price of forest land is obtained through comprehensive treatment and used to account the value of forest land in Hainan province.

2.1.1 Price determination for forest land

(1) Of economic forest

The economic forest is composed of oil forest, special type of economic forest, fruit trees and other economic forests, of which special type of economic forest occupies dominant position in the economic forest. The area of gum forest is 399,720.2 hm^2, being amounted to 87.8% of the total economic forest, its accumulation is 22,327,312 m^3. Accordingly, the price determination of economy forest is dependent on that of gum forest, 23,314.8 Yuan/hm^2. The price of forest land is 10% of the economic forest; it is 2331.48 Yuan/hm^2.

(2) Of other forests

With the method of current market price the forest land prices are determined of the province as is shown in Table 1. That of bamboo is 3300 Yuan/hm^2, of open forest land is 1181.025 Yuan/hm^2.

Table 1 Integrated prices of the forest land

Type	L. of timber F.	L. of protect. F.	L. of special.	L. of firewood F. wild	Wild land
Adjust. Coeffic.	1.00	1.00	1.00	1.00	0.875
Integrated prices(Yuan/hm^2)	2884.42	2512.46	6888.50	612.0	535.5

Type	L. of bam.	L. of nursery	Shrub land	L. of younger trees	Non-stocked land
Adjust. Coeffic.	1.00	1.00	1.00	0.875	0.875
Integrated prices(Yuan/hm^2)	3300	2331.48	612.0	535.5	535.5

2.1.2 Calculation of forest land value

(1) Value of stock

Based on the prices and statistic data of forest land area, the value of forest land stock is accounted to 127.79×10^8 Yuan.

(2) Value of flow

In accordance to the 4th and 5th national accounting data of forest resource, the land area for forestry was reduced for 26,300 hm^2, the annual reduction is 5300 hm^2, and the net loss from it is 0.78×10^8 Yuan.

(3) Of the forested land the value of economic forest land is the most, 119.12×10^8 Yuan; the second is bamboo land, 7.13×10^8 Yuan. Of the others, the value of shrub land is the higher, 1.26×10^8 Yuan.

2.2 Value of forest stock and timber

Forest on Hainan Province could be classified into timber forest, special-use forest, protection forest, fuel forest, bamboo forest, sparse forest, and irregular stocking.

2.2.1 Determination of stocking price

Using back-calculation of market price method and cost method with samples taken in layers, 4 of 19 counties (cities) in 3 types of topography including hill, table land in lower mountain and terraced plain in Hainan province were selected. Based on the local trade price of timber in 1995, the average price of stocks was obtained through comprehensive treatment, including the price of natural broadleaf forest for 522 Yuan/m^3, 174~290 Yuan/m^3 for horsetail beefwood and soft broadleaf forest. The price determination of economy forest is mainly from gum forest. According to the stock price, area and stocking volume of forests the comprehensive price of stock is calculated as is shown in Table 2 and Table 3.

Table 2 Stock price of dominant tree species of Hainan province in 2000

Dominant tree species	Fir	Conifer	Eucalypt	Natua.Broad	Soft broad.	Horsetail beefwood
Stock price (Yuan/m^3)	280	350	273	522	174~290	232

Table 3 Comprehensive price of stock of forests

Types	Timber f.	Protect. f.	Special f.	Fuel f.	Econ. f.	Bamboo f.	Sparse f.	Irreg.sto.
Per m^3	271.50	271.50	271.50	68.42			271.50	271.5
Per hm^2	28844.16	25124.61	68884.98	6120	23314.8	33000	11810.25	

2.2.2 Stock value

Based on the statistics of forest resource in 2000 the substances of the counties/cities are accounted as is shown in Table 4.

Table 4 Land area for forestry and stock volume in Hainan province

Counties/ cities	Total		Timber F.		Protection F.		Special F.		Fuel F.		Economy F.	
	Area (10^2 hm^2)	Volume (10^4 m^3)	Area (10^2 hm^2)	Volume (10^4 m^3)	Area (10^2 hm^2)	Volume (10^4 m^3)	Area (10^2 hm^2)	Volume (10^4 m^3)	Area (10^2 hm^2)	Volume (10^4 m^3)	Area (10^2 hm^2)	Volume (10^4 m^3)
Tongshi	659.81	838.98	105.76	131.5	508.98	616.1	45.07	91.37			47.63	27.56
Baisha	848.66	733.25	392.15	282.84	417.5	375.65	38.97	74.76	0.03		252.55	162.04
Baoting	337.77	286.59	289.5	256.96	48.22	29.5	0.06	0.12			245.02	162.87
Ledong	940.28	1200.93	619.47	920.62	244.75	187.09	76.06	193.22			219.57	120.89
Qunzhong	1241.8	974.68	885.7	630.1	242.99	101.25	112.58	243.15	0.52	0.18	365.61	238.47
Ding'an	130.23	72.1	95.81	41.89	32.97	29.68	0.08		1.37	0.54	134.04	53.54
Lingao	201.3	93.61	169.65	82.82	31.42	10.69	0.2	0.09	0.03	0.01	102.43	40.03
Wanning	682.02	283.39	187.87	109.8	467.69	169.73	26.45	3.85			411.61	211.73
Zhanzhou	425.44	212.39	288.38	117.52	136.71	94.66	0.26	0.16	0.08	0.05	563.03	315.14
Linshui	355.09	401.24	289.99	326.75	30.49	5.53	34.6	68.96			72.33	42.97
Changjiang	394.01	477.72	318.63	450.17	73.76	23.33	1.61	4.21			59.93	34.35
Haikou	28.01	8.34	19.7	6.76	8.31	1.58						
Sanya	537.97	338.93	476.2	320.87	39.08	10.31	22.69	7.75			197.27	95.81
Qunshan	271.64	147.16	204.95	98.63	66.66	48.52	0.04	0.01			188.22	82.31
Wenchang	542.84	225.02	346.97	119.6	195.45	105.3	0.43	0.13			137.71	103.23
Qunhai	320.56	145.52	229.33	88.54	55.64	34.63	35.59	22.35			393.15	206.63
Dungchang	254.02	123.68	195.27	78.12	52.86	42.66	5.51	2.69	0.39	0.22	257.83	150.25
Dengmai	407.23	168.32	296.9	106.39	106.71	59.8	3.58	2.11	0.04	0.02	274.99	151.03
Dongfang	698.76	536.79	509.49	434.62	184.93	97.43	4.28	4.71	0.06	0.03	74.29	33.88

The Value of forest stock is calculated from the stock prices and the statistics of forest substance determined, as is shown in Table 5.

Table 5 Stock value of Hainan province in 2000

Forest types	Stock price (Yuan/m^3)	Stock volume (10^4m^3)	Value (10^8Yuan)
Timber F.	271.5	4504.50	122.30
Protection F.	271.5	2043.42	55.48
Special-use F.	271.5	719.65	19.54
Fuel F.	268.42	1.05	0.03
Economy F.			93.19
Total			290.54

The total value of forest stock of Hainan province is over 290.54×10^8 Yuan.

2.2.3 Value of timber production

Based on annual net production, use rate of lumbered wood, averaged local market price of timber and core wood, production cost of timber and other parameters it is seen that about 10% of the stock volume of forest could be used as fuel wood for daily use of the inhabitant. The averaged production value of core wood is 26 Yuan/hm^2 per year, the annual production value of tropical timber and core wood is averaged as 542 Yuan/hm^2, the total value from the production of Hainan province is 81,032.96×10^4 Yuan.

2.3 Value from non-woody forest products and fruits output

2.3.1 Value from non-woody forest products

The value from non-woody forest products of tropical forest is produced from the resources of medicine use plants, textile plants, palm and rattan plants, flower, oil plants, wildlife, characters of wild relatives of both crop and poultry. Due to the limit of data only the value of wildlife, medicine plants, flowers, palm and rattan plants is accounted.

According to the estimation from limited data the annual production values from palm and rattan, wild flowers and greening plants, wild medicine plants are 22, 6 and 6 Yuan/hm^2 respectively, which is amounted to 34 Yuan/hm^2. That of Hainan province is 5083.25×10^4 Yuan.

Additionally, on the quality resource of wild relatives of crop and poultry, its benefit or value cannot be evaluated, for instance, the hybridized paddy from wild paddy through breeding way, distributed in the half-defoliation monsoon forest of tropical zone, has created invaluable benefit of economy.

2.3.2 Value from fruit production

It is calculated from the statistics of the data accounted from 1998 to 2000 (http://www.statictic.hainan.gov.cn/yearbook) that the annual production value of fruit is 66.22×10^8 Yuan, as is shown in Table 6.

Table 6 Annual production value of fruit

Forest products	Production (t/year)	Price (Yuan/kg)	Value (10^4 Yuan)
Rubber(t)	426301	13.20	562717.32
Coconut(10^4)	17457	2.318	4032.567
Pepper(t)	16304	40.0	65216
Coffee(t)	425	11.55	490.875
Areca(t)	31785	5.50	17481.75
Cashew(t)	1362	90.20	12285.24
Total			662223.752

2.4 Value of forest to store water

2.4.1 Principle and method

(1) Model of water equilibrium.

The shadow engineering method (replacing engineering method) is used to account the value of forest to store water. Suppose there is an engineering that could store water, the value of the engineering can be calculated, and then the construction cost or the fabrication cost of the engineering could substitute the value of the forest to store water.

In the case of the study Jianfengling was selected as the experimental area. The model of water equilibrium is used to calculate the value of forest to store water, i.e., the amount of water stored by forest is the difference between rainfall and evapotranspiration and other consumption in the forest area, the value is the difference multiplied with water price.

(2) Fuzzy mathematics model to study the value of forest to store water

Fuzzy mathematics model to study the value of forest to store water is a systematic approach to examine the forest of water storage in the compound system of society, economy and environment, the value system of forest to store water is complex and fuzzy, its treatment could be made by fuzzy mathematics. The model is written as

$$V = (A \circ R) \cdot S$$

Where V is the value of forest to store water; A is weighting value of the factors affecting water storage of forest; R is the integrated evaluation matrix composed of the single evaluation matrix of the factor affecting the water storage; S is the price vector of water resource,

$$S = (P, P_1, P_2, P_3, 0),$$

P is the upper limit endurable of the local price of water resource, P_1、P_2、P_3 are the given values when P is vectorized.

2.4.2 Price of forest to store water

There are many kinds of replacement methods to determine the price of the forest to store water. In the paper, the cost for unit volume in the construction of reservoirs in the period from 1988 to

1996 is taken as the price of forest to store water; the cost in average of years is 0.86 Yuan/m^3, which would be used to calculate the water storage value.

2.4.3 Value of forest to store water

It is measured that the annual input of rainfall to the tropical forest system in mountain is 2911.0 mm, 7.06% of which enters the forest land in the shape of trunk runoff, penetration rain in the forest is 78.88% of the total, 14.06% of it is lost of interception by the leaf canopy; the output in the form of runoff from the system is 1540.6 mm, being 52.92% of the total. The other output of water from the system is evapotranspiration, about 1370.6 mm, being 47.08% of the total. It is calculated from the figures that the runoff coefficient is 0.5292.

The averaged rainfall of many years is 2265 mm; the forest area in 2000 is 77333 hm^2 in Jianfengling area. The cost of unit volume of reservoir is 0.86 Yuan/m^3. Thus, the value of forest to store water is 7971.7×10^4 Yuan in the area. It is reckoned from the area that the value of Hainan province is over 154.1164×10^8 Yuan.

2.5 Value of forest to conserve soil

2.5.1 Value of forest to reduce lose of land resource

The basic method is to calculate the area of land protected by forest according to reduced soil loss and thickness of local soil, then the value of forest to reduce lose of land resource is obtained with land price (rent price).

It is observed that the averaged amount of soil loss reduced by forest is 6.3076 t/hm^2, which could be converted into 0.00079 hm^2. In 2000, the total area of forest is 1,495,073.33 hm^2, the reduced soil loss amount by forest is converted into land area for 1,181.11hm^2. Using the averaged price from 3 prices (826775, 503092 and 333274), it is known that the total value of forest to reduce the loss of land resource is 554,380 Yuan.

2.5.2 Value of forest to reduce loss of soil fertility

It was known in 1996 that the area of vegetation including forest and tropical crops was 1,907,468.97 hm^2, the value of the vegetation to reduce the loss of N、P、K could be accounted as much as 1,907,468.01 Yuan (Table 7), the value of vegetation to reduce the loss of soil fertility is 19.83 Yuan/hm^2. According to the figures, the value of forest in Hainan province is $2,964.7304\times10^4$ Yuan.

Table 7 Value of forest to reduce the loss of soil fertility

Types of vegetation	Area (hm^2)	N (Yuan/year)	P (Yuan/year)	K (Yuan/year)
Mangrove	1801	1177.37	17.77	98.12
Prote.F.	63466	63900.72	858.44	6218.65
Timber F.	8137	62748.95	501.39	5164.64
Trop.crop and econ. F.	551087	5364568.5	47908.77	496030.41
Bushwood	627983	10331811	83864.59	911957.25
Trop.conif.F.	6792	121606.2	1202.51	9338.22
Trop.mons. F.	501705.01	2170772	153843.14	1799603
Ravine rainF.	3832	244147.5	1751.2	14514.35
Mount.rainF.	99734	10141957	64656.52	517943.44
Hill evergreen laurisilvae	36484	4086307.25	26298.44	184475.98
Coppice F.on hilltop	6447	861753.38	5540.2	34332.94
Total	1907468.01	33450749.87	386442.97	3979677

2.5.3 Value of forest to reduce detention and siltation of sediment

It is examined that the sediment proportion of detention, siltation and entering sea is 33%, 24% and 37% respectively. In reference to the proportion, the value of forest in Hainan to reduce detention and siltation of sediment could be calculated.

It is known that the soil loss reduced by forest is amounted to 9,430,324.54 t in Hainan province.

(1) Value of forest to reduce detention of sediment

The reduced amount of sediment detention by forest is 3,112,007.10 t, the cost to cleanup 1 t of sediment is 10 Yuan, the value of forest to reduce detention of sediment in Hainan province is 31,120,071Yuan.

(2) Value of forest to reduce siltation of sediment

In Hainan province, the forest could reduce siltation of sediment for 2,263,277.89 t, if the cost to pull out sediment is taken as 10 Yuan/t, the value of forest to reduce siltation of sediment is 22,632,779 Yuan.

In total, the value of forest to reduce detention and siltation of sediment is accounted to 53,752,850 Yuan or $5{,}375.29\times10^4$ Yuan.

2.5.4 Value of forest to cultivate soil

There are large amount of withered matter in tropical forest, as is shown in Table 8.

Table 8 Annual return of N、P、K in the withered matter of forest

Forest area	N	P	K
$1km^2$	8.65 kg	3.77 kg	9.88 kg
14950.73 km^2	129.33t	56.37t	147.72t

The basic method is to convert the returned amount of N, P, and K into the related fertilizers, the value of the returned N, P, and K is calculated according to prices of the fertilizers.

It is investigated from market in March, 2003, that the retail prices of ammonium bicarbonate, common calcium superphosphate, and potassium sulfate are 434.02 Yuan/t, 374.58 Yuan/t and 1920 Yuan/t respectively.

The value of forest to cultivate soil is accounted with the converted amount of fertilizers from returned N, P, K and price of the fertilizers. It is known from account that the value of Hainan province is 103.53×10^4 Yuan.

2.5.5 Total value of forest to conserve soil in Hainan province

The total value of forest to conserve soil is shown in Table 9.

Table 9 Sum of the value of forest to conserve soil

Function	Value (Yuan)
Reduce loss of land resource	554,380
Reduce loss of soil fertility	29,647,304
Reduce detention and siltation of sediment	53,752,850
Soil cultivation	10,35,300
Total	84,989,834

2.6 Value of forest to fix carbon and produce oxygen

2.6.1 Value of stocked carbon by forest

The value is calculated in steps as follows:

(1) With reference to sample data and model to calculate biomass of standing stock, the biomass and net growth of the forest community are computed;

(2) In virtue of the measured results of withered matter its reserves and annual output are accounted;

(3) The content of organic carbon in sample, components, and withered matter in different extent of decomposition are tested;

(4) The carbon bank in the vegetation and withered layers are counted;

(5) The samples are taken every 10cm in the 100cm thick soil layer separately, the carbon bank is measured.

(6) The content of organic carbon is analyzed; the model between carbon content and depth of soil is established.

The measured results of carbon bank in virgin forest of tropical hill rain forest are shown in Table 10.

Table 10 Evaluation of carbon equilibrium in virgin forest of tropical hill rain forest

item	Dry matter1)	CO_2converted	Carbon converted
Net increment of biomass	6.9213	13.9947	3.8167
Production of withered matter	9.3800	17.5956	4.7988
Respiration consumption of the community 2)	22.9341	42.6899	11.6427
Total	39.2354	74.2802	20.2582
Respiration in withered layer3)		3.2684	0.8914
Respiration of soil3)		26.9559	7.3516
Total		72.9142	19.8857
Balance		1.3660	0.3725

1) The unit for dry matter, amount of CO_2 and carbonic t/hm^2 per year;
2) The temperature for measurement of respiration is 24 5℃;
3) The amount of dry matter and respiration of soil are calculated with tested data in months of 2 years, the regression equation between fitting respiration rate and ground temperature.

In the whole system it is seen that the carbon is accounted to 342 t/hm^2, being converted to 1253.77 t/hm^2 of CO_2.

Among which, Standing stock of the forest community could be converted into 850~870 t/hm^2 of CO_2; Current stock of withered matter could be converted into 10.9267 t/hm^2 of CO_2; Carbon amount in soil could be converted into 383.1874 t/hm^2 of CO_2.

The stock of carbon holding in forest of Hainan province is 1,495,073×1253.77=1874477675 (t) =18.75×10^8. The value of it is 4612.5×10^8 Yuan taking the cost to harness CO_2 as 30 Dollars/t (246Yuan/t).

2.6.2 Annual value of forest to hold CO2

It is found that the ecosystem releases CO_2 due to the respiration of the community when CO_2 is held in the processes of photosynthesis of the forest community, that the balanced holding amount by the ecosystem of tropical rainforest in mountain of CO_2 is 1.366 t/hm^2 per year, as is shown in Table 10.

In another study of the same area, it is seen that the annual net holding amount of CO_2 is 7.213 t/hm^2 in the ecosystem of natural rehabilitation in tropical hill rainforest aged of 30 years, it is 5.3 times of the virgin forest.

It is averaged as 4.23 t/hm^2. The annual holding amount of CO_2 is over 6,324,158.79 t in Hainan province, its value is 15.557×10^8 Yuan.

2.6.3 Value of forest to produce O2

It is observed that the forest could release O_2 for 1408 kg when it produces 1 t of dry matter, the annual net production of dry matter by the virgin forest in Hainan is 6.9213 t/hm^2. The average price of O_2 for production in Industry is 0.12 Yuan/kg.

It is known from the total reserves and annual holding of CO_2 that the living time of the forest is 296.5 years.

In the period the annual production of O_2 is 1,408×6.9213×1,495,073=145.6977 ×10^8 (kg), its value is $145.6977 \times 10^8 \times 0.12 = 17.4837 \times 10^8$ (Yuan);

O_2 produced in the past time is $296.5 \times 145.6977 \times 10^8 = 43{,}196.74 \times 10^8$ (kg), its value is $17.4837 \times 296.5 = 5{,}183.924 \times 10^8$ (Yuan)

2.7 Value of forest to protect farmland

It is counted that the shelter forest in Hainan province is 643,960 hm^2, which could be divided into 3 types, the 1st is coast protection forest mainly composed of horsetail beefwood or mangrove; the 2nd is shelter forest for farmland composed of "eucalypt—horsetail beefwood" or "eucalypt –Taiwan acacia"; the 3rd is forest for soil and water conservation.

2.7.1 Value from production increase

The area of farmland in Hainan province is 400,000 hm^2. It is observed that the area in production increase is 71.7% of the area protected by the whole net of shelter forest, area of production decrease because of obligation effect from the belt of forest is 8.6% (19.7% in normal yield area) of the total. The decreasing rate is 13% in average of the area obliged. The statistics data shows that the local prices of rice and peanut are 1.2 Yuan/kg and 2 Yuan/kg respectively.

It is calculated with the figures that the annual value of the shelter forest to improve micro-climate and increase yield is $27{,}259.2 \times 10^4$ or $56{,}790 \times 10^4$ Yuan. In the study the lower value of $27{,}259.2 \times 10^4$ is taken.

2.7.2 Value of forest to proof wind and mitigate disaster

The 10000 km long coast protection forest could reduce the loss from typhoon for $9 \times 10^8 \sim 12 \times 10^8$ Yuan each year. It could be reckoned in proportion that the 1500 km long coast protection forest in Hainan province could reduce the loss from typhoon for $1.35 \times 10^8 \sim 1.80 \times 10^8$ Yuan each year, the lower value of 1.35×10^8 Yuan is taken.

Sum of the values is 4.08×10^8 Yuan.

2.8 Value of forest to provide tour

It is analyzed with the method of capitalized returns.

2.8.1 Method

The method takes tour resource of forest as an assets able to produce benefit, and the discounted value from maximum annual benefit of forest tour as the value of forest tour.

2.8.2 Calculation of forest tour value in Hainan province

Some parameters are required:

(1) ***Maximum annual capacity of tourists in forests***: It is the environmental capacity of the tour areas in forests, i.e., the maximum capacitive of tourist number in tour area of forests under the precondition of no damage to the forest eco-environment.

The environment capacities of ecological tour area in Wuzhishan mountain and national forest park in Jianfengling of Hainan province are 1200 people per day and 140×10^5 people each year. If the tour days in a year are 365, the averaged annual environmental capacity for tour area of Wuzhishan mountain, Eastern forest park in Mihouling and the national forest park in Jianfengling is 45.87 people/hm^2. The maximum annual capacitive of tourists in Hainan province is 69×10^6 in term of the criterion of environment capacity.

(2) ***Averaged benefit of tourist in forest:*** The averaged net rate of income from the prosecution of major forest parks in 2000 was 16.2%, the net income from each person-time is averaged as 18.15 Yuan based on the management data of forest parks in the forestry system of the period from 1999~2001.

(3) ***Social discount rate:*** in combination with the general value scope of social discount rate, study sample of accounting forest resource and the practical rate of production of the forestry capital, the adaptable rate of the discount is 3%~7% in the case, the mean value is 5%.

(4) ***Coefficient for development phase:*** It was raised by Mr. Li Jinchang, used to measure the willingness to pay. In 2000 the Engel coefficient was 0.51; the coefficient for development phase is calculated as 0.26.

In accordance to the parameters raised above, the annual value of forest tour and the assets value of the forest tour are accounted as is shown in Table 11.

Table 11 Value of forest tour resource in Hainan province ($\times10^8$ Yuan)

Types of the forest tour	Forest park	Tropical forest	Total forest
Annual value of forest tour	0.33	1.42	3.26
Total value of forest tour assets	6.60	28.31	65.10

2.9 Value of forest to protect biodiversity

2.9.1 CVM method

Taking the current state of forest resource in Jianfengling as example, the method of bid game in the CVM was use to investigate and valuate the protection of forest biodiversity. The inquiry table was designed (Table 12) and is used to make inquiry by questionnaire for the tourists in national forest park in Jianfengling. The value to protect the forest biodiversity could reflect the value of the biodiversity.

The inquiry content of the table includes cognition, consumption and expenditure to the forest biodiversity from the participators in ecosystem tour of forest, the basic information of the person inquired such as earnings of his/her family, educated extent, age, gender, duty and the configuration of the families, etc. the inquiry was conducted in February and March, 2003. In the investigation 38 questionnaires were sent out, and 27 were then returned, the returning rate is 71.05%.

Table 12 Questionnaire to valuate protection benefit of forest biodiversity

(1) How much would you like to pay each year for the protection of forest biodiversity ? ①0—10 ②10—20 ③30—40 ④40—50 ⑤50 以上
(2) At least how mush should the country invest would the forest biodiversity be protected well ? ①0—100 ②100—200 ③200—300 ④300—400 ⑤400—500 ⑥500 以上

From the investigation results it is seen that most of the tourists select the payment of 40~50 Yuan and over 50 Yuan, being 70.37% of the total.

For the country investment the selection over 5 million Yuan is the dominant, being 55.56% of the total.

It is thought that the there are higher willingness to pay and aspiration to invest or the protection of forest biodiversity in Jianfengling.

In average, the willingness to pay of the tourist is 42.22 Yuan per year for the sustaining of forest biodiversity in Jianfengling; the maximum capacity of tourist is 1.40 million in a year, the amount paid by the tourists would be 59.108 million Yuan. The minimum investment from the country would be 4.4074 million Yuan. The average value is the minimum value to protect forest biodiversity of Jianfengling, 3175.77×10^4 Yuan, being equivalent to 710.99 Yuan/hm^2 per year.

2.9.2 Opportunity cost method.

The opportunity cost is the discharged inhering benefit for the protection of forest biodiversity. It was investigated that the total loss in net income of timber, diversification in forest area, tour income, income from forest management, export of timber and lingnosol for the protection of forest biodiversity is 679.92 Yuan/m^3 in 1998, which is the opportunity cost.

From it the value of forest biodiversity in tropical forest area is 29,625.07 Yuan/hm^2.

The values of forest biodiversity, calculated by both CVM and opportunity cost method, are 710.99 Yuan/hm^2 and 29,625.07 Yuan/hm^2 each year respectively. Based on these, the value of Hainan province is accounted as much as 10.63×10^8 or 442.92×10^8 Yuan.

2.10 Value of forest to purify environment

Jianfengling area was taken as example.

2.10.1 Value of forest to absorb sulfur dioxide (SO2)

It includes 3 parts, one is the value from the mitigation of heath endanger to human body, the second is that from mitigation of eroding construction material, and the other is decreasing the loss of agricultural p-production.

In Jianfengling the total value of forest to absorb SO_2 is mainly shown in the benefit of mitigating endanger from SO_2.

It was measured that the forest in Jianfengling could reduce concentration of SO_2 for 25% of the area, as a consequence, the related hazard including COPD (chronic obstructed plumo disease), PED (pulmonary emphysema disease) and CCVD (centra—cerebrovascular disease) is alleviated, YPLL（Years of Potential Life Lost）become less.

From the data of days in hospital and the local income of the residents, it is accounted that the value of forest to absorb SO_2 in Jianfengling is 1059.5×10^4 Yuan.

2.10.2 Value of forest to absorb hydrogen fluoride (HF-1), chloride (CL-1) and radioactive material

(1) The forest in Jianfengling is regarded to be broadleaved trees, there capability to absorb HF^{-1} is 4.65 kg/hm^2 each year. The price of HF^{-1} absorption is 0.16 Yuan/kg that is the mean value from the blowdown charge standard of atmospheric pollution material. According to this, the value of forest to absorb HF^{-1} in Jianfengling is 3.51×10^4 Yuan.

(2) The capability of the forest to absorb CL^{-1} and radioactive material is supposed to be the same as it to absorb HF^{-1} with same values, then, the total value of forest to absorb the 3 kinds of contamination is 10.53×10^4 Yuan.

2.10.3 Value of forest to absorb and hold smoke dust

This function is valuated with the method of substitution expenditure; the value is calculated with the cost to minify dust.

The capability of broadleaved forest is 10.2 t/hm^2, the cost to minify dust is 170 Yuan/t, the value of forest to absorb and hold smoke dust in a year is amounted to $8,189.16\times10^4$ Yuan.

2.10.4 Value of forest to sterilize

Given the proportion coefficient of sterilization value to the ecological value is 15% that of substantial value to total value of forest is 10% according to the timber value of the tropical forest in Jianfengling, value of forest to sterilize is amounted to $9,671.55\times10^4$ Yuan.

2.10.5 Value of forest to reduce noise

The proportion coefficient of the value to reduce noise to the forest ecological value is taken as 10%, the value of forest to reduce noise in tropical forest in Jianfengling is over 6447.70×10^4 Yuan.

In total, the value of forest to purify environment and reduce noise is $34,264.2\times10^4$ Yuan. Herefrom, the value in Hainan province is 108.4709×10^8 Yuan.

2.11 Value of social benefit from forest

2.11.1 Value of forest to increase occupation

By virtue of the study from the World Bank the increment coefficient of forest to provide occupation directly is 2.2~4.2. The direct provision of occupation in Jianfengling was 2,400; the direct and indirect provision of occupation from the forest was 5,280~10,000 in 2000. The income per capita in the forest area is 2922 Yuan, the value of forest to provide occupation is amounted to $3,000\times10^4$ Yuan.

2.11.2 Value of forest to prevent and mitigate disasters

The benefit of forest to prevent and mitigate disaster includes these of forest to reduce the disasters from sand blown by wind and flood or drought. On the basis of valuation to the disasters of the area, the annual loss from the disasters is about 200×10^4~300×10^4 Yuan, the primary estimation of forest to reduce the loss is 250×10^4 Yuan in Jianfengling. Therewith, the value of forest to prevent and mitigate disasters in Hainan province is $7,914.3\times10^4$ Yuan.

2.11.3 Value of forest to develop science and culture

In Hainan province there are large area of tropical original forest, valuable animal resource, landscape resource, which provides conditions for scientific study, exploration, and education.

3 Conclusions

The value of forest resource in Hainan province includes these from forest land, standing stock and timber, non-wood products of forest and fruits, environment resource and social benefit. Considering the relative stability of the ecological and economy environment, it could be thought that the annual output values are constant roughly. The forest in Hainan province ought to exist forever, the time length of years would be infinite. Along the lines of convention, the discount rate is taken as 10%. From it the values calculated in the front are discounted, and the present values are obtained as is listed in Table 13.

Table 13 Accounting of forest resource in Hainan province

Terms	Annual output (Yuan)	Present value ($\times 10^8$ Yuan)
I. Forest land		127.79
II. Standing stock and timber		379.68
1.Standing stock		290.54
2.Timber	81032.96×10^4	89.14
III. Non-wood products of forest and fruits		730.41
1.Non-wood products from forest	5083.25×10^4	5.59
2.Fruits	66.22×10^8	728.42
IV. Environment resource		17701.10
1.Water storage	154.1164×10^8	1695.28
2.Soil conservation	8498.98×10^4	9.35
1) Reduction of land resource	55.438×10^4	
2) Reduction of soil fertility	2964.7304×10^4	
3) Reduction of sediment siltation and detention	5375.2850×10^4	
4) Cultivation of soil	103.53×10^4	
3.Carbon holding		4783.63
1) Stock		4612.5
2) Annual holding	15.557×10^8	171.13
4.Oxygen production		5376.24
1) Stock		5183.92
2) Annual production	17.4837×10^8	192.32
5.Protection	4.08×10^8	44.88
1) Increase of yield	2.73×10^8	
2) Windproof and disaster reduction	1.35×10^8	
6.Forest tour	3.26×10^8	35.86
7.Protection of forest biodiversity	442.92×10^8	4872.12
8.Purification of environment	80.3410×10^8	883.75
1) Absorption of SO_2	33540.80×10^4	
2) Absorption of HF^-、CL^- and radioactive material	333.35×10^4	
3) Absorption and detaining of smoke and dust	259245.88×10^4	
4) Sterilization	306174.19×10^4	
5) Reduction of noise	204116.13×10^4	
V. Social benefit		12.01
1.Increment of occupation	3000×10^4	3.3
2.Prevention and mitigation of disasters	7914.3×10^4	8.71
3.Science and culture	---	
Total		18950.99

The total value of forest resources in Hainan is 18,950.99×10^8 Yuan, 17,701.10×10^8 Yuan of it is the value of environment resource of the forest, being 93.40% of the total. According to the value number, the environment components of the forests could be listed as oxygen production, protection of biodiversity, carbon holding, water storage, environment purification, shelter forest, forest tour, and soil conservation. The part quantified of the social benefit is 12×10^8 Yuan. The great value in science and culture of forest is awaiting more study.

The ratio of substantial value to that of environment in Hainan province is 1: 15.3, this shows the importance of forest environment value and the characters in composition, and suggests the value orientation and priority.

Value composition of forest resource in Hainan province

Total value is 18866.56×10^8 Yuan (in present value), in it the values of

Forest land:	127.79×10^8 Yuan
Standing stock and timber:	379.68×10^8 Yuan
Non-wood products of forest and fruits:	730.41×10^8 Yuan
Environment resource:	$17{,}701.10\times10^8$ Yuan
Part quantified of the social benefit:	12.01×10^8 Yuan

It is known that the value of environment resource is 93.40% of the total value of forest resource, 15.3 times of the substantial value.

Special Report: Framework of Green GDP Accounting for (Tropical) Forests of China and Case Study in Hainan Island

ITTO PD 39/38 Rev.2 (M)

1 A brief introduction of natural resource accounting in China's National Accounting System (2002)

China's national accounting system (2002) is consisted of the table of basic accounting, national accounts and auxiliary tables. The table of basic accounting is consisted of GDP table, input-output table, assets flows table, balance of international payments and balance sheet; national accounts is consisted of total economy account, domestic department accounts and foreign department accounts; and auxiliary tables includes accounting table of natural resources stocks, accounting table of population resource and manpower capital stocks. Basic accounting table and national accounts are the central contents of this system; it gives a comprehensive description to the operational process of national economy through a number of forms. Auxiliary tables are the supplements for basic accounting table or national accounts; it gives description to natural resources and manpower capital concerned in the operational process of national economy.

Part one: An Overview

Part two: Table of Basic Accounting
- GDP table
- Input-output table
- Capital flows table
- Balance of international payments
- Balance sheet

Part three: National Accounts

Part four: Auxiliary Tables
- Annex: Basic Form of China's National Economic Accounting System
- Annex: Explanation on Main Indexes

The relationships among basic accounting tables and between basic accounting tables and auxiliary tables are shown in Figure 1.

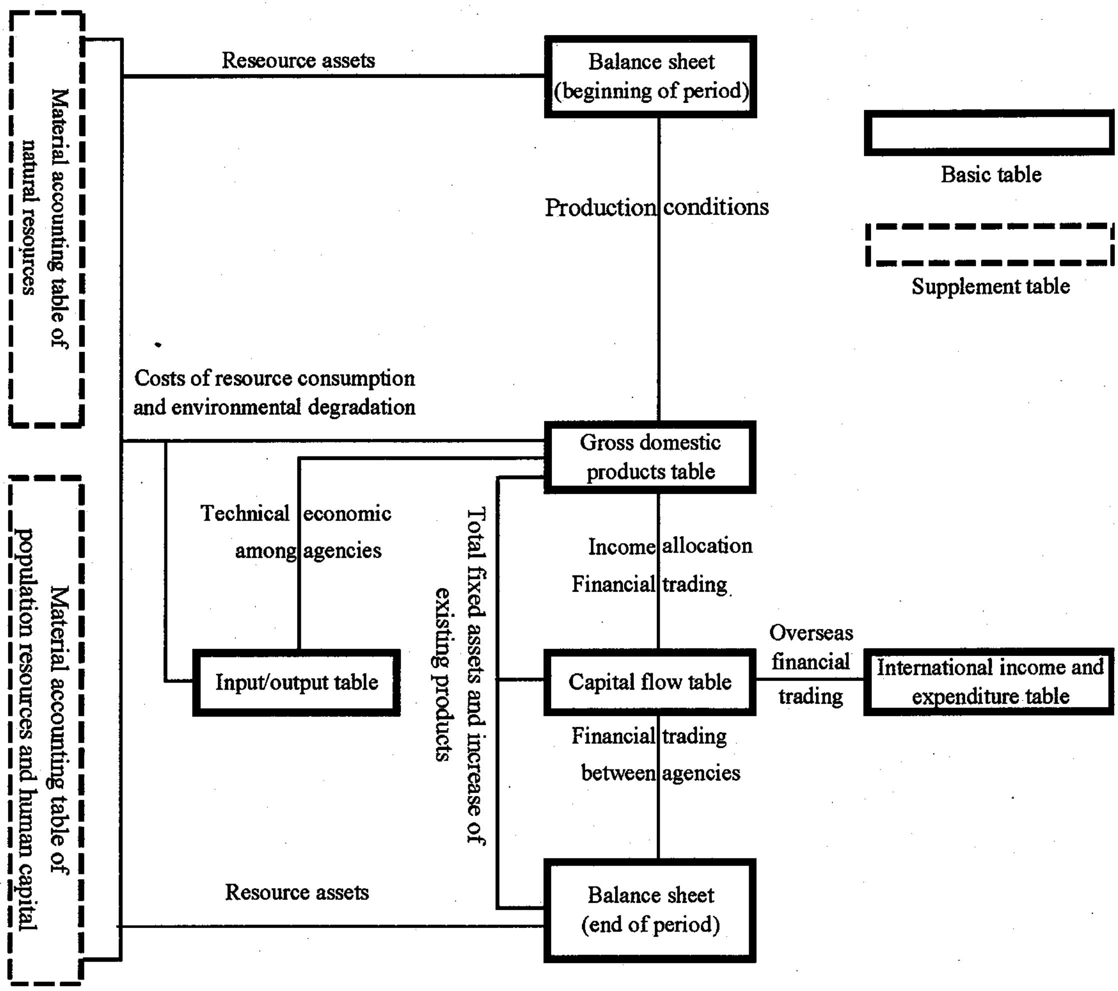

Figure 1 Relations among basic accounting tables and other supplement accounting tables

1.1 Objectives and goal of accounting

The objectives of accounting for natural resource physical flows are natural resources within the country's economic territory such as land, forest, mineral and water resources. The characteristic of natural resource is with the natural formation as the center and supplemented by human labor including resource assets that belongs to economic assets and non-asset natural resource that does not belong to economic assets.

The goal of practicing natural resource physical accounting is to reflect the relationship between resource elements and economic increase through the stocks of resource asset and its variation; to reflect the relationship between resource elements and the sustained development of the economy through the stocks of natural resources and its variation; and to provide a basis for the understanding and analysis of the relationship between natural resources and economic activity, hence to provide a foundation for the development of an integrated economic and resource environmental accounting.

1.2 Basic principle of accounting

1.2.1 Recording time

Resources amount recording time: using data to record at the time of table compliance land, minerals and forest physical flows at the beginning and the end of the period; and using accumulated data of this year and last year to record this period and last period physical flows of water resources.

Resource stocks variation recording time: the variations of land, minerals and forest resources within the accounting period and the variations of water resources between two accounting periods can be divided into variations by transactions and variations by non-transaction. In the former variations, the time of ownership change is the time of recording. In the latter variations, there are increase variations and decrease ones: in the former variations, discovery time is the recording time for minerals resource, and survey time is the recording time for other natural resources on the supposition that the increase is well-distributed and continuous; and in the latter variations including sudden decrease and well-distributed and continuous decrease, the time of amount decrease or the time of quality decrease or the time of survey is the time for recording.

1.2.2 Accounting unit

According to different properties of various resources, the natural resource physical flows accounting is selecting appropriate physical flows unit as accounting unit. For instance, 10,000 hectare or 10,000 mu[4] for land resources, 100 hectare or 100 m^3 for forest resources, 100,000,000 m^3, 100,000,000 ton, 10,000 ton, ton or kg for minerals resources, and 100,000,000 m^3 for water resources.

1.2.3 Regional principle

Natural resource is the sum of natural environment elements in a certain sphere of region and in a certain amount of quality and quantity; it has a strong time certainty. Hence, on the basis of reflecting the general conditions of natural resources, the reflection of the quality and quantity of natural resources in various regions is also an important aspect for physical flows accounting. Thus, it is necessary to use administrative zoning as the basis to delimit regional scope of natural resource accounting where the increase, decrease and regulative changes of natural resource stocks are assessed.

1.3 Basic accounting method

Natural resources physical flows accounting is to combine comprehensively the natural resource of land, forest, minerals and water resources into the index of resource assets and realizes the conversion from natural resource classified statistics to an integrated accounting through physical flow accounting and reflects comprehensively and systematically the relationship between the overall natural resource elements and national economic activity.

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[4] 1 hectare=15mu

The basic method of natural resource physical flows accounting is as follows:

First of all, we should determine accounting period of natural resource physical flows. According to survey patterns and features of various natural resources, the accounting period of land and minerals resources is determined as one year, the beginning and the end of the year are the times of the beginning and the end of the period of stocks accounting, and calendar year as flows accounting period; the accounting period of forest resources is determined as five years, the beginning of the first year is the time of the beginning of the stocks accounting period, the end of the fifth year is the time of the end of the stocks accounting period, and the total of five calendar years is the flows accounting period; the accounting period of water resources is one year, there is no period beginning and period end, using water resources conditions of accounting year and last year as time stocks of period beginning and period end, and the variations of water resources in accounting year and last year is called flows variations.

In the second place, we should compile period beginning and period end physical flows table of natural resources. In accordance with the balance relationship of: Period end stocks – Period beginning stocks = Increase of this period – Decrease of this period ± Variations of this period, we use net variation as total control number to compile natural resource physical flows variations.

Factors that caused increase or decrease of this period include natural factors, economic factors and factor of classification and structure changes. The natural growth and death, pests, diseases and forest fires of forest resources and rainfalls of water resources are natural factors. Reclamation of land resources, degradation of land assets due to improper farming, exploration and extracting of minerals resources, planting, tending and harvesting of forest resources, construction of water conservancy projects and facilities for water resources, pollution control of water assets and introduction and raising of water for socio-economic usage are economic factors. And the changes of ownership of resources caused by the adjustment of administrative zoning and the changes of resource structure caused by mutual diversion between resource assets and non-asset natural resources are factors of classification and structure changes.

Factors caused the changes in accounting period are the advance of science and technology, cost changes and the change of accounting method. Science and technology advance refers to the increase of those natural resources that transformed from unknown and unused to known and used due to science and technology advance; cost change factor refers to those natural resources that transformed from not being utilized due to high cost to being utilized due to economic development and cost lowering; and the factor of accounting method changes refers to the changes of accounting data caused by the change of accounting method due to the improvement of accounting theory and methodology.

1.4 Basic accounting framework and form structure

1.4.1 Basic framework

Natural resources physical flows accounting reflects mainly physical stocks at the times of the beginning and the end of accounting period and the changes during accounting period of natural resources, especially resources assets. Resource assets has close linkage with the operation of national economy, most of the resource products consumed by production and consumption activities has the property of resource assets, thus, resource assets is the priority of natural resource physical flows accounting.

The table of natural resource physical flows accounting is a basic framework table, based on the requirements of the accounting and the common features of natural resources, it concentrates different accountings into one table. As the accounting for minerals resources uses different measuring units and the inner structures of land, forest and water resources has its peculiar natural features, so under the basic framework different accounting tables should be compiled.

The accounting tables include land, forest, minerals and water resources physical flows accounting tables and land, forest, minerals and water resources stocks changes tables.

1.4.2 Form structure

The main column of the accounting table includes period beginning stocks, increase in this period, decrease in this period, changes and period end stocks. Supplement columns include land resources, forest resources, mineral resources and water resources, and each resource includes resource assets and non-asset natural resource. Since forest resource has its peculiar ecological effects, the non-asset forest resources are also called forest environmental assets. The distinction of resource assets and non-asset natural resource is the basic distinction between natural resource physical flows accounting and the country's current natural resource assessment, and is also the foundation for an integrated economic and resource accounting.

Natural resource physical flows accounting table is divided into five parts: part one (line 1) reflects physical flows of natural resources in the beginning of accounting period. Part two (line 2-6) reflects the increase of natural resource flows due to the changes of nature, economy, classification and structure. Part three (line 7-11) reflects the decrease of natural resource amounts due to the aforementioned changes. Part four (line 12-15) reflects the changes of natural resources during accounting period due to science and technology advance or the changes of accounting method. And part five (line 17) reflects physical flows of natural resources at the end of accounting period.

In order to prevent imbalance caused by sources and other reasons, statistical error item is set up in line 16.

Natural Resource Physical Flows Accounting

1 hectare=15mu

Item	Serial No.	Land resource（10,000 mu）					Forest resource（100ha,100m³）				Mineral resource（100,000,000m³）				Water resource（100,000,000m³）			
		Land assets				Non-assets land resource	Forest assets			Non-assets forest resource	Mineral assets		Non-asset mineral res.		Water resource			Non-assets water resource
		Land for Agri.use		Land occu.by archi	Others		Cul. assets	Non-cul. assets			Coal	Petro	Coal	Petro	Initial use amount		Repeatly used amount	
			Farm-land					Man-assets forest	Natural forest						Sur-face	Under ground		
1.Initial stocks	1	947065.0	192364.0	45705.0	21274.0	411975.0	4882889.0	2710081.7	36005371.3	66515987.0	4132.7	14.3	5929.8	10.6	4520.0	1074.6	18.7	22601.1
2.Increase in this period	2	2357.6	548.6	524.9	86.4	544.3	2388852.7	2144877.6	7661248.4	10910354.6	42.1	0.5	29.4	1.3	25.6	9.3	2.1	1060.0
Natural increase	3	-	-	-	-	-	2383104.7	2139716.6	7642813.9	10884102.1	-	-	-	-	23.7	0.0	0.0	1059.6
Eco. discovery	4	2183.0	508.0	486.0	80.0	504.0	2144.8	1925.7	6878.5	9795.7	41.4	0.5	29.0	1.3	0.0	8.6	2.0	0.0
Class. and structure changes	5	131.0	30.5	29.2	4.8	30.2	2859.7	2567.7	9171.4	13060.9	0.2	0.0	0.1	0.0	1.1	0.5	0.1	0.3
Other ele.	6	43.7	10.2	9.7	1.6	10.1	743.5	667.6	2384.6	3395.8	0.5	0.0	0.3	0.0	0.8	0.2	0.0	0.1
3. Decrease in this period	7	2496.4	1492.7	204.8	93.7	729.3	929839.1	898470.8	8055573.7	7354016.1	20.0	1.6	0.4	0.0	100.8	15.0	4.7	1475.0
Natural decrease	8	-	-	-	-	-	129296.7	124995.1	1124955.5	1025539.5	-	-	-	-	98.3	0.0	0.0	1474.5
Economic use	9	2313.0	1450.0	164.0	87.0	687.0	794251.0	767826.8	6910441.2	6299742.6	19.3	1.6	0.0	0.0	0.0	14.1	4.6	0.0
Classifi. & structure changes	10	131.0	30.5	29.2	4.8	30.2	2859.7	2567.7	9171.4	13060.9	0.2	0.0	0.1	0.0	1.1	0.5	0.1	0.3
Other ele.	11	52.4	12.2	11.7	1.9	12.1	3431.7	3081.2	11005.7	15673.1	0.5	0.0	0.3	0.0	1.4	0.4	0.0	0.2
4.Regulative changes	12	8.7	2.0	1.9	0.3	2.0	457.1	487.9	1656.4	2610.0	-21.6	-0.1	-61.5	0.0	0.6	0.2	0.0	0.1
Technologi. improvement	13	4.4	1.0	1.0	0.2	1.0	365.7	390.3	1325.1	2088.0	-21.3	0.0	-46.4	0.0	0.0	0.0	0.0	0.0
Improving estimating method	14	3.5	0.8	0.8	0.1	0.8	-36.6	-39.0	-132.5	-208.8	0.0	-0.1	-10.2	0.0	0.6	0.2	0.0	0.1
Other ele.	15	0.9	0.2	0.2	0.0	0.2	128.0	136.6	463.8	730.8	0.0	0.0	-6.7	0.0	0.0	0.0	0.0	0.0
5. Sta. error	16	0.0	2.0	0.0	-2.0	-2.0	86.2	0.1	86.2	-128.4	0.3	0.0	1.8	0.0	13.5	0.1	0.0	0.0
6. End stocks	17	946935.0	191424.0	46027.0	21265.0	411790.0	6342446.0	3956976.5	35612788.5	70074807.0	4133.5	13.1	5899.1	11.9	4458.9	1069.2	16.1	22186.2

1.5 Explanation of the main indexes

Land resource: refers to inner lands, connected surface waters and tidal zones that are naturally formed in the country's territory and can be exploited and used to raise people's livelihood and existing capacity and possess certain scarcity. Land resource does not include lands covered by seawater during lower tides, these parts is called sea resource. Based on its correlation with the economy, land resources are divided into land assets and non-asset land resources.

Land asset: refers to land resource that its ownership has been defined, and the owners could effectively control them and the assets could produce anticipated economic benefits at present and in the foreseeable future. Land assets belong to economic asset scope including land for agricultural use, lands occupied by houses and other architecture and other land assets.

Land for agricultural use: refers to lands used directly for agricultural production, including farmland, orchards, forest land, pasture and other agricultural lands.

Farmland: refers to lands planted with agricultural crops, including cultivated land, newly reclaimed land, fallow land, rotationally fallow land, rotated land for grass and crop, land with crops as the center and scattered with trees, and tidal zones that can be harvested at least once. The farmland also includes gully, road and ridge with width less than 1.0m in the south and more than 2.0m in the north.

Land occupied by house and other architecture: refers to architecture used for socio-economic activity, including land used for architecture and transportation facilities in urban and rural areas.

Other land assets: are mainly water areas that can be used for breeding, it refers to the areas of natural or manual fresh water regions that can be used for the breeding of aquatic plants, including breeding in rivers, lakes, ponds and reservoirs.

Non-asset land resource: refers to the resources that do not have the conditions – "the ownership has been defined and the owner could control or deal with and could produce economic benefits at present and in the foreseeable future" at the same time; it does not belong to the scope of economic assets, it includes land and water that has not been used, such as desert, waste grassland, saline-alkali land, wetland, glacier and permanent snow.

Forest resource: refers to woody plants and related lands that was naturally formed in the country's territory and can be exploited and used under certain economic and technical conditions to raise people's livelihood and existing capacity and possess certain scarcity, including forest trees, wild plants and animals within forest areas and forest land. Based on its correlation with the economy, forest resources can be divided into forest assets and non-asset forest resources.

Forest assets: refers to forest resources that its ownership has been defined, its owners could effectively control and could produce at present and in the foreseeable future anticipated economic benefits. Forest assets belongs to the scope of economic assets, it includes cultivated assets and non-cultivated assets. It should be explained that forest assets has not only economic value, but also the function of ecological protection.

Cultivated assets: refers to forest assets that produce only once or repeatedly products, its natural growth or regeneration is under institution's direct control and management, including man-made forests, nursery land and "four-around" trees. Of which plantations with inventory nature, such as timber forests and fuel wood forests, is called plantations with fixed asset nature, such as protection forests, special-purpose forests and cash crop trees; they are called cultivated fix assets.

Non-cultivated assets: refers to forest assets that produce only once or repeatedly products, but its natural growth or regeneration is not under institution's direct control or management, such as natural forests and partial shrubs.

Non-asset forest resource: refers to forest resources that do not have the conditions – ownership has been defined and the owner could effectively control or deal with and could produce economic benefits at present and in the foreseeable future; it does not belong to the scope of economic asset, including forest land, forest trees and wild plants and animals. Non-asset forest resources has the ecological functions of soil and water conservation, oxygen providing and carbon fixing, air purifying, water source conservation and bio-diversity protection, it has huge positive effects to natural environment and has important impacts on the raising of human's welfare level, so it is also called forest environmental assets.

Mineral resource: in earth crust or on the surface within the country's economic territory and was naturally formed by geological force, it could be exploited and utilized under certain economic and technological conditions to raise people's livelihood and existing capacity and has a scarcity nature. They are natural aggregates in the forms of solid, fluid and gas calculated or estimated on geological basis and knowledge.

Mineral assets: refers to those that the ownership has been defined, the owners could effectively control them and could produce at present and in the foreseeable future economic benefits. Mineral assets belongs to the scope of economic asset and is a part of proven mineral resources, it could meet the index requirements, including grade, quality, thickness and exploiting technology, needed for mining and production, and they are mineral assets before the deduction of design and mining losses.

Non-asset mineral resources: refers to those that do not satisfy the aforementioned conditions at the same time. It does not belong to the scope of economic assets; it is the sum of partial proven mineral resources and potential mineral resources.

Water resource: refers to those that was formed naturally within the country's economic territory and could be exploited and utilized under certain economic and technological conditions to raise people's livelihood and exiting capacity and has at the same time the feature of scarcity, they are the sum of surface and underground fresh water formed by rainfall and melted glacier, commonly called the sum of water resources; it is composed by surface water resources amount plus underground water resources amount and minus the amount calculated repeatedly due to mutual transfer. Since the sum of water resources contains natural water that cannot be used such as water with super high content of certain element that harmful to health and seriously polluted water (water quality above V inferior grade); therefore, the amount of water resources that can be used equals to the sum of water resources deducts the amount of natural water that cannot be used and the amount of water with quality above V inferior grade. Based on the correlation with the economy, water resources can be divided into water assets and non-asset water resources.

Water assets: refers to those that the ownership has been defined, and at the same time the owner could effectively control them and could produce at present anticipated economic benefits. Water assets belong to the scope of economic asset. It includes the amount of surface water that could be supplied, the amount of aggregated rain water, recycled treated waste water and the amount of underground water that could be supplied.

Amount of water initially used: refers to the water, including surface water and underground water, that used by socio-economic activities in the first time.

Amount of water reused: refers to the amount of water used by socio-economic activities in the second and more than second time.

Non-asset water resource: refers to the water resources that meets the aforementioned two conditions not at the same time, it does not belong to the scope of economic assets, including ecological water resources and other surface and underground water resources that have not been used or could not be used.

The basic balance relationship among indexes is:

Stocks at period end = Stocks at period beginning + Increase at this period – Decrease at this period ± Changes

Natural resources = Resource assets + Non-asset natural resources

1.6 Method of compiling accounting table

Since natural resources have their own unique features, when we carry out calculation to each natural resource, we must first clarify calculating indexes in accordance with the requirements of general accounting framework and existing data foundation, then clarify the logic relationships among various indexes in accordance with accounting requirements and resource feature; finally compile the stocks accounting table of each natural resource.

1.6.1 Basic steps

The basic method to compile natural resources stocks accounting table at present is direct method. Namely to fully utilize the existing materials of resource inventory, prospecting and others owned by relevant resources competent department to compile the accounting table. The steps are:

1.6.1.1 Fully collect survey materials of existing stock conditions and changes of land, mineral, forest and water resources through survey, checking, prospecting, assessment and monitoring owned by the Ministry of Land and Resources, the State Forestry Administration and the Ministry of Water Resources and visiting and consulting with relevant persons.

1.6.1.2 Reclassify and calculate the basic data of natural resources on the basis of the definition and the scope of "economic assets" and the research and analysis of the basic data collected, all data that tally with the definition of economic assets will be put into resource assets, while others into non-asset natural resources.

1.6.1.3 Based on resource stocks structure and changed data and according to resource assets, non-asset natural resources and its inner structure, we preliminarily compile period beginning and period end stocks table and stocks variations table during accounting period of four kinds of natural resource physical flows. The main sum data in the tables is based on the relevant resource sum data owned by competent departments.

1.6.1.4 Put the data in the compiled stocks tables and variation tables of land, forest, mineral and water resources into natural resource stocks accounting table.

1.6.1.5 Review and prove the preliminarily estimated data and hearing the opinions of competent departments and relevant experts.

1.6.1.6 Revise and complete preliminarily assessing work of the accounting table.

1.6.2 Data sources

1.6.2.1 Land resources: Survey year land resource stocks, changes of land resource utilization and other relevant materials from Land Register Management Department, Land Utilization Department and Land Arrangement Department of the Ministry of Land and Resources.

1.6.2.2 Forest resources: National forest inventory, forestry yearbook, materials of yearly tree planting and afforestation, closing the hillside for forest growing and damages by calamities from Planning and Fund Management Department, Forestry Administration and Resource Management Department and Afforestation Department of the State Forestry Administration.

1.6.2.3 Minerals resources: National mineral stock table, national mineral stocks bulletin, yearly statistics of national mineral resources exploitation and utilization from Minerals Deposit Department, Planning Department and Exploitation and Utilization Department of the Ministry of Land and Resources.

1.6.2.4 Water resources: the sum of national water resources, yearly utilization and changes (by Water Resources Research Institute of the Academy of Water Resources) from Water Resources Management Department, Economic Regulation Department and Planning Department of the Ministry of Water Resources.

2 Introduction of China's Forest Resources and the Trial Scenario of Integrated Accounting

2.1 The purpose of accounting

2.1.1 Provide basic data for the establishment of China's forest resources and integrated accounting system, for the country and governments at various levels to carry out a sustained development strategy of forest resources, for the research and formulation of an optimal deployment of forest resources and for the putting forward of policy measures to promote a good circle of forest resources.

2.1.2 It is beneficial to the promotion of changes of reproduction mode and utilization pattern of the country's forest resources for further enhancement of forest asset utilization efficiency and a gradual transition of forestry production mode that taking the utilization of forest ecological function as the center and the utilization of timber as the supplement.

2.1.3 It is beneficial to the establishment of a value compensation mechanism for forest resource utilization and to the building and management of a legal system, and to the promotion of a gradual improvement of a forest resource taxation policy.

2.1.4 It is beneficial to the establishment of a green industry, to the promotion of forest resource management in an asset way, and to the promotion to further improvement of a terrestrial ecological environment.

2.2 Accounting principle

Considering fully domestic and foreign theories, methodologies and experiences of forest resource accounting; using fully existing materials of forest survey and sampling investigation; theory and methodology research combined with application research; and protruding the accounting feature that forest resources is correlated with the economy.

2.3 Scope, unit and objectives

Accounting scope includes forest resources of the country's all standing institutions. Provinces, autonomous regions, municipalities and cities specifically designated in the state plan are basic accounting units; accounting objectives include all forest assets and non-asset forest resources within the administrative regions. Of which forest assets refers to forest resources that their ownerships has been clarified and institutions have effectively exploited, held and dealed with, including cultivated and non-cultivated assets; and forests that does not tally with the definition of economic asset are non-asset forest resources (including wild plants and animals).

2.4 Accounting year and form

Survey period (five years) is used as accounting period, including the beginning of accounting period, the end of accounting period and accounting period.

There are two categories of accounting form: forest resource accounting table (including variations and stocks) and integrated forest resource and economic accounting table (including table of green GDP forest, balance sheet forest and table of national wealth forest).

Variation table reflects the changes of forest resources and their inner structure during the accounting period (within 5 years); stocks table reflects the sum of forest resources and their structure at the beginning and end of accounting period. Forest table of green GDP reflects the output of forest cultivated assets, the structures of reduction cost of forest resource assets and ecological degradation cost of forest resources and their relationships with GDP, forest table of balance sheet reflects the asset, debt and net value of including forest assets, while forest table of state wealth reflects economic and natural wealth including artificial assets and forest resource.

3 Scenario of Integrated Forest Resource and Economic Accounting in Hainan Province (Trial implementation)

The implementation of a sustained development strategy is basically a process of "wealth" creation, accumulation and management, thus, the transfer of people's attention from the flows standard of economic activity to an organic combination with the stocks standard of the wealth seems more and more important.

The core of Hainan development strategy is to realize a sustained development, to realize a unity of economic, social and environmental benefits, and to realize a unity of immediate benefits and long-term ones.

Hainan is situated in tropical zone with abundant forest resources and excellent natural environment. Therefore, ensuring a sustained utilization and ecological safety, fully playing the role of ecological benefit potential of tropical forest resources and promoting a sustained development of the provincial socioeconomy is one of the key factors that ensuring regional even national economic safety, and at the same time is also an important fundamental capacity building.

3.1 Accounting goal

3.1.1 Provide scientific, systematic and comprehensive basic data for Hainan government to promote provincial development strategy, for the research and formulation of policies of optimal deployment of forest resources, the establishment of a forest ecological industry and the improvement gradually of its structure.

3.1.2 Beneficial to the fully excavation of environmental effects of provincial tropical forests, the playing of the role of geo-potential, the study on the quantified relationships among forest resource protection, forest ecological development and regional economic development, and the promotion of the province to play a demonstration role in the aspect of the country's forest resource and ecological building.

3.1.3 Promote the transfer of reproduction and utilization modes of provincial forest environmental resource, further enhance utilization rate of forest trees and promote the transfer to a production mode that taking the use of forest ecological effects as center and the use of timber as supplement; and ensuring a sustained utilization of forest environmental resource.

3.1.4 Beneficial to the establishment of an economic use of forest resources and a mechanism that could compensate the value of natural environmental effects, to the development and management of a legal system, and to the promotion of a gradual improvement of the policy of tropical forest resources and natural environmental taxation.

3.1.5 Beneficial to the establishment of a green industry, the promotion of restructuring toward an ecological type economy, and the promotion of modern enterprise system reform and the management of taking forest resource as asset and natural environment as capital.

3.1.6 Lay a technological foundation for the nation and other regions to establish an integrated economic and environmental accounting system.

3.2 Principle of accounting work and accounting research plan

3.2.1 Principle of accounting work

Integrated accounting of Hainan forest resources and economy is a quite new work, requires more efforts for exploration and research. The difficulties and problems encountered at present are diversified data source, different contents and classification of index, weak accounting basis, difficult to estimate economic value and ecological price, complicated technology and broad coordination. Thus, the work should follow the principle of fully prepared, unified deployment, coordination, implementation step by step and gradual improvement.

3.2.2 Procedure

On the basis of its property and logic relations, the accounting work consists of four phases:

Forest resource physical flows accounting – research into economic and ecological prices of forest resources – forest resource values accounting – forest resource integrated into national economic accounting.

3.2.2.1 Forest resource physical flows accounting is an important basis and precondition for the establishment of its value and the linkage with national economic accounting. Hainan forestry department has accumulated quite rich data concerning physical flows statistics of forest resources, tropical forest ecological effects, survey data and experimental data that has laid the foundation for implementing forest resource stocks accounting.

Accounting contents: forest resources classification, forest assets classification, explanation of basic index, accounting forms, table compiling principle, methodologies and steps.

3.2.2.2 Tropical forest resource price research is the key for establishing its value accounting and integrated accounting, including mainly research into economic price of forest resource assets and ecological price of forest resource.

Accounting contents: market price and structure, ecological price and structure, coefficient and structure of market price and ecological price.

3.2.2.3 Forest resource value accounting is the bridge of realizing an integrated forest resource and economic accounting. Only the output value of forest cultivated assets, deducted value of forest assets and degraded value of forest resource be reflected objectively and correctly, can the impacts of economic activity flows to forest resources be reflected objectively; only through the economic value of forest asset stocks and the ecological effects value of tropical forest resource, can the essential characteristics of Hainan tropical forest environmental asset and its real contributions to the region's socioeconomic development be really controlled, the organic linkage between tropical forest resource and the economy be correctly reflected, the forest ecological industry policy beneficial to the implementation of a sustained development be completely and objectively reflected, the economic policy be organically linked with forest policy, and the measuring index and fundamental information for boosting socioeconomic welfare level be provided.

Accounting contents: forest asset market value stocks, tropical forest environmental resource ecological value stocks, forest consumption cost and tropical forest environmental degradation cost and variation of forest resource value.

3.2.2.4 Incorporating forest resource into national economic accounting is the goal of establishing an integrated forest resource and economic accounting. Only incorporating the economic value of forest assets into national accounting, can the effective increase of national economy and the potential support of forest resource assets to economic development be reflected? Only comparing ecological effects of tropical forest environment with national accounting, can the real contributions of tropical forest resource to natural environment and the organic linkage of mutual reliance and constraint among forest resource, forest environmental resource and economic development be objectively and completely reflected?

Accounting contents: Green GDP accounting that considering forest cost, asset and debt accounting that considering forest assets and national wealth accounting that considering forest resource.

The final goal of an integrated tropical forest resource and economic accounting in Hainan Province is to, through the display of integrated data; evaluate sustainable degree of Hainan Province after considering forest resource element. Establishing gradually a compensatory mechanism for an economic use of forest resource and the ecological use of forest environment, establishing gradually an integrated decision-making mechanism for local government and improving and enhancing coordinative effects of economic, forest environment and forest resource policies are the essence of undertaking this accounting research.

3.2.3 Duration and working plan

Accounting duration was one year: September of 2002 – September of 2003.

Phase one: working out a trial plan of integrated forest resource and economic accounting in Hainan (Sept. – middle Oct.). Main works include: determining accounting sphere and organization form, staff preparation, sector coordination, background materials study, formulating implementation plan, procedure and steps discussion, revision and improvement.

Phase two: forest resource stocks accounting (middle Oct. 2002 to the end of Dec. 2002). Main works include: investigation, collection and processing of forest resource stocks data, designing stocks accounting table and undertaking accounting work.

Phase three: forest resource value accounting (Jan. – April, 2003). Main works include: researching into, coordinating, estimating and working out forest resource economic price and tropical ecology price, discussing relevant theory, assessment approaches, economic and ecological price levels; estimating total market value and structure of forest resource asset and total ecological value and structure of tropical forest environmental resource, designing forest resource value accounting table and undertaking accounting work.

Phase four: integrated tropical forest resource and economic accounting (May, 2003). Main works include: studying and estimating the impacts of forest resource and tropical forest environment on and its relationship with Hainan economic development, and formulating Hainan Green GDP forest Accounting Table, Balance Sheet forest and National Wealth Table forest that has taken account of tropical forest resource.

Phase five: summing up and material writing (June – Sept., 2003). The main task include: convene a seminar to revise and confirm accounting data, review accounting framework and accounting mode, and formulate preliminarily analyzed points of view and measure recommendations; and write report on integrated forest resource and economic accounting in Hainan. In addition, to review the basic conditions for accounting work the accounting plan and the experience on organizing and implementing.

3.3 Objective and scope

The objective of the integrated accounting work is the woody plant resource that could be exploited and utilized to enhance people's welfare and existing capacity and at the same time has certain scarcity. And the accounting scope includes forest land, forest trees and forest environmental resources (such as biodiversity, water source conservation, soil conservation, oxygen supplying and carbon fixing, tourism and rest, air purifying, wind resistant and sand fixing).

3.4 Organizing form and working mode

3.4.1 ***Participating organs:*** Accounting Division of Hainan Statistics Bureau, Hainan Forestry Department, National Economic Accounting Department of the State Statistics Bureau.

3.4.2 ***Organizing form:*** The Chinese Academy of Forestry acting as the head and undertaking organizing and coordinating, Accounting Division of provincial bureau implementing accounting, data support by Forestry Department, consulting and guidance by experts from Accounting Department and forestry universities, the aforementioned sides formulate working plan and objectives, and Accounting Division responsible for organizing.

3.4.3 ***Working mode:*** periodical meeting system is adopted. Important works and technological problems are discussed and solved at the meeting.

3.5 Type of form and table compiling methods

3.5.1 Type of form related to the accounting research is mainly in kind type accounting table, value type accounting table (including integrated accounting table).

1) Hainan forest resource in kind type accounting form:

Forest resource stocks variation accounting table: table 1

Stocks accounting table on forest resource at period beginning: table 2-1

Stocks accounting table on forest resource at period end: table 2-2

2) Hainan forest resource value type accounting form:

Forest resource economic price and ecological price table: table 3

Forest resource price coefficient table: table 4

Forest resource value (market price, ecological price) variation accounting table: table 5-1, table 5-2

Forest resource market value accounting table: table 6-1

Forest resource ecological value accounting table: table 6-2

3) Hainan integrated forest resource and economic accounting form:

Green GDP forest accounting table: table 7

Balance sheet forest (market price, ecological price): table 8-1, 8-2

National wealth table forest (market price, ecological price): table 9-1, table 9-2

3.5.2 The scale of compiling should be enlarged in accordance with gradual improvement of the work. It should begin with the most basic classification, and finally undertake more detailed structural accounting. The scale of form should be determined in accordance with accounting basis and other objective conditions.

3.5.3 Direct method is used as the main compiling approach. Direct method refers to the use of existing data of forest resource survey, forestry statistics and experiments on forest resource ecological effects and supplemented by necessary survey in a bit to obtain comprehensive, systematic and objective data to meet the requirements of the integrated accounting.

3.6 Data quality control

Persons relevant to this research go to related departments to collect materials should analyze its technological and economic meaning and statistical calibre in accordance with the country's national economic accounting system, basic theory and principle of SEEA 2003 and in conjunction with Hainan tropical forest resource features. If the data is not tally with accounting demands, they should made consultations and revise them, or to estimate them through scientific approaches.

Accounting personnel should carefully deal with the data during the phase of data processing and collating, they could randomly check the data if necessary. They should estimate the general structure number by using Hainan forest resource stocks data from the State Forestry Administration and the stocks or structure data from provincial forestry department as reference in a bit to satisfy the demands of Hainan integrated forest resource and economic accounting.

3.7 Analysis and application of accounting data

The goal of undertaking this accounting is for analysis and application. Therefore, after preliminary completion of tropical forest resource stock accounting, value accounting and integrated accounting, relevant persons from Statistics Bureau, Chinese Academy of Forestry, especially related departments of Hainan Province should undertake analysis work in a bit to provide services for leaders at various levels of provincial government to work out policies on ecological economy, forest resource management and carry out macro-regulation of socioeconomic sustainable development.

3.8 Work result and new ideas

Through integrated accounting research, we will provide the following results: report on the framework of China's integrated economic and forest resource environmental accounting system, the basic approach to incorporate forest resource into national economic accounting system, and report on the case study of integrated forest resource and economic accounting in Hainan. The reports include accounting framework, accounting plan, accounting tables and a brief analysis. It is estimated to have 40,000 words and about 20 tables.

The research work has the following new ideas:

3.8.1 Organic unity of "environment in broad sense (including natural resource)" recognized internationally and "environment in narrow sense (natural resource not included)" adopted extensively in China. The western developed countries pay more emphasis on the accounting of natural environment and environment covers natural resource in so far as the environmental accounting field is concerned. This is determined by their economic development level and social development phase and their interest demands in the international political economy. According to China's current socioeconomic development features and demands and the constraints to economic development rendered by natural resource and environment, and according to China's current operational mechanism of macro-management system, we should deal with "natural resource" and "natural environment" in a parallel way, from accounting view point, we should consider them as the same important elements, and the adopting of the concept of "environment in narrow sense" is considered more suitable. Thus, it not only tally with the country's macro-management system and management policy, but also beneficial for international comparison and exchange. Therefore, on the basis of reflecting resource features of forest resource in kind nature and economic effectiveness, the research protrudes essentially the environmental features of non-in kind nature and ecological effectiveness.

3.8.2 The division of forest resource into resource assets and non-asset forest resource (forest environmental assets) and the division of forest effects into economic use value and tropical ecology use value is also the new idea of this research.

According to SEEA's recent display, natural environmental assets is divided into cultivated assets, non-cultivated assets and environmental assets, of which cultivated assets and non-cultivated assets belong to economic assets scope of SNA; at the same time, the environmental assets is further divided into natural resources, natural environment and memorandum item – intangible environmental assets. We hold that the addition of "assets" after each classified attribute is easily to confuse the boundary of assets and difficult to grasp the essence of assets. Therefore, the protruding of forest resource asset element on the basis of adopting the concept of "environment in narrow sense" could manifest the direct organic linkage between forest resource and economic growth. Tropical forest environment manifests mainly ecological utilization effects, the potential support of forest biological resource to the economy and the holdness of natural environment. In so doing, this classification could not only carry out the accounting of "forest resource", protruding the feature of tropical forest environmental resource, but also reach an organic unity and integrated accounting of "forest asset and forest environmental resource" with the "economy" through forest resource assets as the point of penetration.

3.8.3 The organic unity between economic value of forest resource assets and the ecological value of tropical forest environmental resource provides a new visual angle for reflecting more objectively the precious forest wealth endowed by the nature and its important role played in human's existence and developing process. Forest resource assets has economic value, the adoptation of current market price principle that is in unison with the national accounting for assessment will be more easily compared. Tropical forest environmental resource has abundant ecological value, the adoptation of the assessment principle of market value in combination with marginal opportunity cost for assessment will be more objective and comprehensive.

3.8.4 The undertaking of accounting directly by governmental statistical department is also a new idea and advantage, as it is more beneficial for the transfer of research result to policy effects, for the establishment of an accounting system integrated forest resources with economy, and for the implementation and improvement of policies on Hainan's sustainable development and on the management of forest resource and forest environment.

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Annex I: Tables for National Integrated Forest Resources and Economic Accounting

Annex I: National forest resource and economic accounting table

Accounting of changes in forest resources

Table 1-1

Unit: 100mu.100m^3(1 hectare=15mu)

Item	Changes in forest resources									Net change of forest assests								Non-assets forest resources net change	
	Increase			Decrease				Net increase		Cultivation assets						Non-cultivation assests			
	Natural		Economic	Disasters		Economic uses				Subtotal		Fixed assets		In-process products		Land	Trees	Land	Trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1.Forestry land and forest resources																			
1.1 Forested land and forest resources																			
1.1.1 Natural forest																			
(1) Stand																			
Timber forest																			
Protection forest																			
Fuelwood forest																			
Special use forest																			
(2)Economic forest																			
(3) Bamboo forest																			
(4) Unestablished stands																			
(5) Open forest area																			
1.1.2 Plantation																			
(1) Stand																			
Timber forest																			
Protection forest																			
Fuelwood forest																			
Special use forest																			
(2)Economic forest																			
(3) Bamboo forest																			
(4) Unestablished stands																			
(5) Open forest area																			
1.2 Shrub land																			
1.3 Nurseries																			
1.4 Non-stocked forestland																			
1.5 4-side plantings																			
1.6 Scattered trees																			
1.7 Statistical errors																			
2. Die-back trees																			
3. Non-forestry land																			

Annex I: National integrated forest resources and economic accounting table

Accounting of existing forest resources

Table 1-2

Unit: 100mu.100m^3(1 hectare=15mu)

Item	Totalforest resoruces		Forest assests								Non-assets forest resources	
			Cultivation assets						Non-cultivation assests			
	Land	Trees	Subtotal		Fixed assets		In-process products		land	Trees	land	Trees
	1	2	3	4	5	6	7	8	9	10	11	12
1.Forestry land and forest resources												
1.1 Forested land and forest resources												
1.1.1 Natural forest												
(1) Stand												
Timber forest												
Protection forest												
Fuelwood forest												
Special use forest												
(2)Economic forest												
(3) Bamboo forest												
(4) Unestablished stands												
(5) Open forest area												
1.1.2 Plantation												
(1) Stand												
Timber forest												
Protection forest												
Fuelwood forest												
Special use forest												
(2)Economic forest												
(3) Bamboo forest												
(4) Unestablished stands												
(5) Open forest area												
1.2 Shrub land												
1.3 Nurseries												
1.4 Non-stocked forestland												
1.5 4-side plantings												
1.6 Scattered trees												
1.7 Statistical errors												
2. Die-back trees												
3. Non-forestry land												

Green GDP forest accounting

Table 1-3

Unit: 100 million RMB

Production	**Order**	**Cost**	**Use**	**Order**	**Cost**
1. Output of economic activities	1		9 Ultimate consumption	16	
2. Intermediate input in economic activities	2		9.1 Residence consumption	17	
3. GDP by production (or Income)	3		9.2 Government consumption	18	
3.1 Remuneration of labors	4		10 Total cost of capital formation	19	
3.2 Net production tax	5		11 Net exportation	20	
3.2.1 Production tax	6		11.1 Exportation	21	
3.2.2 Subsidy (-)	7		11.2 Importation (-)	22	
3.3 Depreciation of fixed assets	8		12 GDP by expenditure	23	
3.4 Operational balance	9		13.1 Net accumulation of forest assets at market value	24	
4 Market output of forest cultivation assets	10		13.2 Net accumulation of forest assets at ecological value	25	
5 Cost of forest assets exhustion	11		14 GeGDP by expenditure	26	
6 Cost of forest assets degradation	12		15 EDP by expenditure	27	
	13		16.1 Statistical error	28	
7.GeGDP	14		16.2 Statistical error	29	
8..EDP	15		16.3 Statistical error	30	

Balance sheet for forest

Table 1-4

Unit: 100 million RMB

	Code	Non financial enterprise				Fianancial enterprise				Government		Residence		Total within province				Outside of province		Total	
				State owned				State owned								State owned					
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1																				
1) Produciton assets	2																				
of which: cultivation assets	3																				
forest land	4																				
Forest trees	5																				
i) Fixed assets	6																				
of which: on-going programs	7																				
Cultivation fixed assets	8																				
Forest land	9																				
Forest trées	10																				
ii) Existing products	11																				
of which: end products and commodity stocks	12																				
In-process products of cultivation assets	13																				
Forest land	14																				
Forest trees	15																				
iii) Other non financial assets	16																				
of which: intangibles	17																				
2) Non-production assets	18																				
i) Forest assets	19																				
Forest land	20																				
Forest trees	21																				
ii) Other assets (land,water,mines,sea)	22																				
2 Financial assets and debts	23																				
i) Domestic financial assets and debts	24																				
ii) Foreign financial assets and debts	36																				
3 Net value of assets	37																				

National wealth: forest accounting

Table 1-5

Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned Institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01										
1) Fixed assets	02										
of which: on-going programs	03										
2) Existing products	04										
of which: end products and commodities	05										
3) Other man-made assets	06										
of which: intangibles	07										
4) Net financial assets for overseas	08										
2 Natural resources	09										
1) Resource assets	10										
i) Forest resource assets	11										
Forest land	12										
Forest trees	13										
ii) Other non-production assets	14										
2) Non assets natural resources	15										
i) Forest environment assets	16										
Forest land	17										
Forest trees	18										
ii) Other natural resources	19										
3 Human capital	20										
4 Total national wealth	25										

Annex II: Tables for Integrated Forest Resource and Economic Accounting of Hainan Island

Material accounting of changes of forest environment resources in Hainan

Table 1

2000-1995

Unit: 100mu.100m^3 (1hectare=15mu)

Item	Changes of forest resources									Net changes of forest assets								Net changes of non asset forest resources	
	Increase in current period			Decrease in current period				Net increase of current period		Cultivation assets						Non cultivation assets			
	Natural		Economic	Disaster loss		Economic use				Subtotal		Fixed assets		In-process products		Forest land	Forest trees	Forest land	Forest trees
	Area	Volume	Area	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	33,891	662,738	67,384	47	269	86,366	398,590	**14,862**	**263,879**	10,808	104,579	6,765	56,000	4,043	48,579	-9,048	-133,822	13,102	293,122
1.1 Forested land and forest resources	31,427	651,112	62,443	40	261	77,669	390,176	16,161	260,675	10,789	103,774	6,746	56,000	4,043	47,774	-9,048	-133,822	14,421	290,724
1.1.1 Natural forest	21,106	532,454	48,165	17	196	64,463	375,563	4,791	156,695	0	0	0	0	0	0	-9,048	-133,822	13,839	290,517
(1) Stand	20,941	530,335	47,923	17	194	63,318	373,239	5,529	156,902	0	0	0	0	0	0	-8,892	-133,822	14,421	290,724
Timber forest	0	0	0	0	0	50,111	351,166	-50,111	-351,166	0	0	0	0	0	0	-12,381	-186,029	-37,730	-165,137
Protection forest	18,415	492,129	42,146	15	168	10,236	11,595	50,311	480,365	0	0	0	0	0	0	2,131	38,424	48,179	441,941
Fuelwood forest	166	687	376	0	0	62	14	481	673	0	0	0	0	0	0	122	245	359	428
Special use forest	2,360	37,519	5,400	2	26	2,909	10,464	4,849	27,030	0	0	0	0	0	0	1,236	13,538	3,613	13,492
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	157	0	-157	0	0	0	0	0	0	0	-157	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	165	2,118	242	0	1	988	2,324	-582	-207	0	0	0	0	0	0	0	0	-582	-207
1.1.2 Plantation	10,863	121,142	15,075	24	67	16,760	17,805	9,153	103,271	9,153	103,271	6,028	55,497	3,125	47,774	0	0	0	0
(1) Stand	5,796	120,777	7,913	10	66	6,782	16,937	6,917	103,774	6,917	103,774	3,105	56,000	3,812	47,774	0	0	0	0
Timber forest	4,065	63,324	5,665	8	39	6,154	15,888	3,568	47,397	3,568	47,397	0	0	3,568	47,397	0	0	0	0
Protection forest	856	38,949	1,259	2	22	6	1,011	2,106	37,916	2,106	37,916	2,106	37,916	0	0	0	0	0	0
Fuelwood forest	150	390	169	0	0	75	13	244	377	244	377	0	0	244	377	0	0	0	0
Special use forest	726	18,114	820	0	5	546	25	999	18,084	999	18,084	999	18,084	0	0	0	0	0	0
(2)Economic forest	4,448	0	6,544	13	0	7,339	0	3,641	0	3,641	0	3,641	0	0	0	0	0	0	0
(3) Bamboo forest	242	0	64	0	0	74	0	231	0	231	0	0	0	231	0	0	0	0	0
(4) Unestablished stands	354	0	520	1	0	1,790	0	-918	0	-918	0	0	0	-918	0	0	0	0	0
(5) Open forest area	23	365	34	0	0	775	868	-718	-503	-718	-503	-718	-503	0	0	0	0	0	0
1.2 Shrub land	2,110	0	3,105	6	0	8,571	0	-3,362	0	0	0	0	0	0	0	0	0	-3,362	0
1.3 Nurseries	9	0	13	0	0	3	0	19	0	19	0	19	0	0	0	0	0	0	0
1.4 Non-stocked forestland	344	0	1,823	1	0	122	0	2,044	0	0	0	0	0	0	0	0	0	2,044	0
1.5 4-side plantings	0	4,045	0	0	3	0	3,237	0	805	0	805	0	0	0	805	0	0	0	0
1.6 Scattered trees	0	7,581	0	0	5	0	5,178	0	2,398	0	0	0	0	0	0	0	0	0	2,398
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	12,645	0	0	0	0	12,645	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	0	0	867	0	0	13,512	0	-12,645	0	0	0	0	0	0	0	-10,116	0	-2,529	0

Material accounting of existing forest environment resources in Hainan

Table 2-1

December 31, 1995 (90-94)

Unit: 100mu.100m³(1 hectare=15mu)

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest	249,252	753,937	119,763	157,256	80,543	48,136	39,220	109,119	14,991	222,167	114,497	374,514
1.1 Forested land and forest	208,100	726,863	119,638	147,527	80,418	48,136	39,220	99,390	14,991	222,167	73,471	357,169
1.1.1 Natural forest	91,706	585,061	0	0	0	0	0	0	14,991	222,167	76,715	362,894
(1) Stand	88,306	579,336	0	0	0	0	0	0	14,835	222,167	73,471	357,169
Timber forest	50,111	351,166	0	0	0	0	0	0	12,381	186,029	37,730	165,137
Protection forest	32,440	157,726	0	0	0	0	0	0	1,129	11,966	31,311	145,759
Fuelwood forest	0	0	0	0	0	0	0	0	0	0	0	0
Special use forest	5,755	70,445	0	0	0	0	0	0	1,324	24,172	4,430	46,273
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	157	0	0	0	0	0	0	0	157	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	3,244	5,724	0	0	0	0	0	0	0	0	3,244	5,724
1.1.2 Plantation	127,368	148,981	127,368	148,981	81,510	49,591	45,858	99,390	0	0	0	0
(1) Stand	50,856	147,527	50,856	147,527	12,103	48,136	38,753	99,390	0	0	0	0
Timber forest	38,715	99,285	38,715	99,285	0	0	38,715	99,285	0	0	0	0
Protection forest	11,737	46,617	11,737	46,617	11,737	46,617	0	0	0	0	0	0
Fuelwood forest	38	105	38	105	0	0	38	105	0	0	0	0
Special use forest	366	1,520	366	1,520	366	1,520	0	0	0	0	0	0
(2)Economic forest	68,315	0	68,315	0	68,315	0	0	0	0	0	0	0
(3) Bamboo forest	467	0	467	0	0	0	467	0	0	0	0	0
(4) Unestablished stands	6,638	0	6,638	0	0	0	6,638	0	0	0	0	0
(5) Open forest area	1,092	1,454	1,092	1,454	1,092	1,454	0	0	0	0	0	0
1.2 Shrub land	37,502	0	0	0	0	0	0	0	0	0	37,502	0
1.3 Nurseries	125	0	125	0	125	0	0	0	0	0	0	0
1.4 Non-stocked forestland	3,524	0	0	0	0	0	0	0	0	0	3,524	0
1.5 4-side plantings	0	9,729	0	9,729	0	0	0	9,729	0	0	0	0
1.6 Scattered trees	0	17,345	0	0	0	0	0	0	0	0	0	17,345
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	248,389	0	0	0	0	0	0	0	198,712	0	49,678	0

Material accounting of existing forest environment resources in Hainan

Table 2-2

December 31, 2000 (93-98)

Unit: 100mu.100m^3(1 hectare=15mu)

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest	264,114	1,017,816	130,571	261,835	87,309	104,137	43,262	157,698	5,943	88,345	127,599	667,636
1.1 Forested land and forest	224,261	987,538	130,426	251,300	87,164	104,137	43,262	147,164	5,943	88,345	87,892	647,893
1.1.1 Natural forest	96,497	741,755	0	0	0	0	0	0	5,943	88,345	90,554	653,410
(1) Stand	93,835	736,238	0	0	0	0	0	0	5,943	88,345	87,892	647,893
Timber forest	0	0	0	0	0	0	0	0	0	0	0	0
Protection forest	82,751	638,091	0	0	0	0	0	0	3,260	50,390	79,490	587,700
Fuelwood forest	481	673	0	0	0	0	0	0	122	245	359	428
Special use forest	10,603	97,475	0	0	0	0	0	0	2,561	37,710	8,043	59,765
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	0	0	0	0	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	2,662	5,517	0	0	0	0	0	0	0	0	2,662	5,517
1.1.2 Plantation	136,522	252,252	136,522	252,252	87,538	105,088	48,983	147,164	0	0	0	0
(1) Stand	57,773	251,300	57,773	251,300	15,208	104,137	42,564	147,164	0	0	0	0
Timber forest	42,283	146,682	42,283	146,682	0	0	42,283	146,682	0	0	0	0
Protection forest	13,843	84,533	13,843	84,533	13,843	84,533	0	0	0	0	0	0
Fuelwood forest	282	482	282	482	0	0	282	482	0	0	0	0
Special use forest	1,366	19,603	1,366	19,603	1,366	19,603	0	0	0	0	0	0
(2)Economic forest	71,955	0	71,955	0	71,955	0	0	0	0	0	0	0
(3) Bamboo forest	698	0	698	0	0	0	698	0	0	0	0	0
(4) Unestablished stands	5,721	0	5,721	0	0	0	5,721	0	0	0	0	0
(5) Open forest area	374	951	374	951	374	951	0	0	0	0	0	0
1.2 Shrub land	34,140	0	0	0	0	0	0	0	0	0	34,140	0
1.3 Nurseries	145	0	145	0	145	0	0	0	0	0	0	0
1.4 Non-stocked forestland	5,567	0	0	0	0	0	0	0	0	0	5,567	0
1.5 4-side plantings	0	10,534	0	10,534	0	0	0	10,534	0	0	0	0
1.6 Scattered trees	0	19,743	0	0	0	0	0	0	0	0	0	19,743
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	235,745	0	0	0	0	0	0	0	188,596	0	47,149	0

Prices of forestland and forest trees in Hainan Province

Table 3

Unit: RMB/mu, RMB/m^3(1 hectare=15mu)

	Market price			Ecological price		
	Forestland	Forest trees		Forestland	Forest trees	
	forfest/plantation	Natural forest	Plantation	forfest/plantation	Natural forest	Plantation
resources	159.37	271.50		183.76	815.02	
trees	182.84	271.50		203.85	823.94	
i) Forest stand	200.58/188.38	271.50	271.50	200.58/188.38	871.12	638.66
Timber forest	192.29	271.50	271.50	192.29	722.19	577.75
Young forest	192.29	124.89	124.89	192.29	332.21	265.77
Middle aged forest	192.29	186.44	232.22	192.29	495.94	494.16
Close to mature forest	192.29	304.08	304.08	192.29	808.85	647.08
Matured forest	192.29	412.68	412.68	192.29	1,097.73	878.18
Over matured forest	192.29	314.94	314.94	192.29	837.74	670.19
Protection forest	167.50	271.50	271.50	167.50	939.39	751.51
Young forest	167.50	124.89	124.89	167.50	432.12	345.70
Middle aged forest	167.50	263.85	220.62	167.50	912.94	610.67
Close to mature forest	167.50	304.08	304.08	167.50	1,052.12	841.69
Matured forest	167.50	412.68	412.68	167.50	1,427.87	1,142.30
Over matured forest	167.50	314.94	314.94	167.50	1,089.69	871.75
Fuelwood forest	40.80	268.42	268.42	40.80	569.05	455.24
Young forest	40.80	123.47	123.47	40.80	261.76	209.41
Middle aged forest	40.80	256.90	256.90	40.80	544.63	435.70
Close to mature forest	40.80	300.63	300.63	40.80	637.34	509.87
Matured forest	40.80	408.00	408.00	40.80	864.96	691.97
Over matured forest	40.80	311.37	311.37	40.80	660.10	528.08
Special use forest	459.23	271.50	271.50	459.23	1,460.67	1,168.54
Young forest	459.23	103.17	124.89	459.23	555.05	537.53
Middle aged forest	459.23	140.66	277.94	459.23	756.75	1,196.26
Close to mature forest	459.23	260.64	304.08	459.23	1,402.24	1,308.76
Matured forest	459.23	336.66	412.68	459.23	1,811.23	1,776.17
Over matured forest	459.23	266.07	314.94	459.23	1,431.46	1,355.50
ii) Economic forest	155.43	-	-	214.49	-	-
iii) Bamboo forest (100 stems)	220.00	-	-	761.20	-	-
iv) Unestablished stands	35.70	-	-	49.27	-	-
v) Open forest area	48.96	271.50	271.50	67.56	374.67	0.00
2) Shrub land	40.80	-		86.50	-	
3) Nurseries	155.43	-		214.49	-	
4) Non-stocked forestland	35.70	-		31.42	-	
5) 4-side plantings	-	271.50		-	575.58	
6) Scattered trees	-	271.50		-	575.58	
7) Statistical errors	192.29	336.66		511.49	895.52	
2. Die-back trees	-	271.50		-	722.19	
3. Non-forestry land	665.34	-		665.34	-	

Price indices of forestland and forest trees in Hainan Province

Table 4

	Market price			Ecological price		
	Forestland	Forest trees		Forestland	Forest trees	
	forfest/plantation	Natural forest	Plantation	forfest/plantation	Natural forest	Plantation
resources	0.8288	1.0000		1.1530	3.0019	
trees	0.9508	1.0000		1.1149	3.0348	
i) Forest stand	1.0431/0.9797	1.0000	1.0000	1.0000/1.0000	3.2085	2.3523
Timber forest	1.0000	1.0000	1.0000	1.0000	2.6600	2.1280
Young forest	1.0000	0.4600	0.4600	1.0000	2.6600	2.1280
Middle aged forest	1.0000	0.6867	0.8553	1.0000	2.6600	2.1280
Close to mature forest	1.0000	1.1200	1.1200	1.0000	2.6600	2.1280
Matured forest	1.0000	1.5200	1.5200	1.0000	2.6600	2.1280
Over matured forest	1.0000	1.1600	1.1600	1.0000	2.6600	2.1280
Protection forest	1.0000	1.0000	1.0000	1.0000	3.4600	2.7680
Young forest	1.0000	0.4600	0.4600	1.0000	3.4600	2.7680
Middle aged forest	1.0000	0.9718	0.8126	1.0000	3.4600	2.7680
Close to mature forest	1.0000	1.1200	1.1200	1.0000	3.4600	2.7680
Matured forest	1.0000	1.5200	1.5200	1.0000	3.4600	2.7680
Over matured forest	1.0000	1.1600	1.1600	1.0000	3.4600	2.7680
Fuelwood forest	1.0000	1.0000	1.0000	1.0000	2.1200	1.6960
Young forest	1.0000	0.4600	0.4600	1.0000	2.1200	1.6960
Middle aged forest	1.0000	0.9571	0.9571	1.0000	2.1200	1.6960
Close to mature forest	1.0000	1.1200	1.1200	1.0000	2.1200	1.6960
Matured forest	1.0000	1.5200	1.5200	1.0000	2.1200	1.6960
Over matured forest	1.0000	1.1600	1.1600	1.0000	2.1200	1.6960
Special use forest	1.0000	1.0000	1.0000	1.0000	5.3800	4.3040
Young forest	1.0000	0.3800	0.4600	1.0000	5.3800	4.3040
Middle aged forest	1.0000	0.5181	1.0237	1.0000	5.3800	4.3040
Close to mature forest	1.0000	0.9600	1.1200	1.0000	5.3800	4.3040
Matured forest	1.0000	1.2400	1.5200	1.0000	5.3800	4.3040
Over matured forest	1.0000	0.9800	1.1600	1.0000	5.3800	4.3040
ii) Economic forest	0.8083	-	-	1.3800	-	-
iii) Bamboo forest (100 stems)	1.1441	-	-	3.4600	-	-
iv) Unestablished stands	0.1857	-	-	1.3800	-	-
v) Open forest area	0.2546	1.0000	1.0000	1.3800	1.3800	0.0000
2) Shrub land	0.2122	-		2.1200	-	
3) Nurseries	0.8083	-		1.3800	-	
4) Non-stocked forestland	0.1857	-		0.8800	-	
5) 4-side plantings	-	1.0000		-	2.1200	
6) Scattered trees	-	1.0000		-	2.1200	
7) Statistical errors	1.0000	1.2400		2.6599	2.6600	
2. Die-back trees	-	1.0000		-	2.6600	
3. Non-forestry land	3.4600	-		1.0000	-	

Accounting of market price changes of forest environment resources in Hainan

Table 5-1 Changes of market prices

2000-1995

Unit: 10,000RMB

Item	Changes of forest resources									Net changes of forest assets								Net changes of non asset forest resources	
	Increase in current period			Decrease in current period				Net increase of current period		Cultivation assets						Non cultivation assets			
	Natural		Economic	Disaster loss		Economic use				Subtotal		Fixed assets		In-process products		Forest land	Forest trees	Forest land	Forest trees
	Area	Volume	Area	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	62,837	1,817,321	124,633	76	737	156,734	1,070,883	**30,659**	**745,701**	21,275	281,460	13,806	152,040	7,468	129,420	-14,856	-491,791	24,241	956,032
1.1 Forested land and forest resources	61,839	1,785,757	122,695	74	716	153,189	1,048,038	31,271	737,004	21,244	279,273	13,776	152,040	7,468	127,233	-14,856	-491,791	24,883	949,521
1.1.1 Natural forest	41,829	1,463,817	95,666	34	540	127,720	1,006,109	9,742	457,168	0	0	0	0	0	0	-14,856	-491,791	24,598	948,959
(1) Stand	41,749	1,458,065	95,548	33	536	126,892	999,799	10,372	457,731	0	0	0	0	0	0	-14,511	-491,791	24,883	949,521
Timber forest	0	0	0	0	0	96,361	953,414	-96,361	-953,414	0	0	0	0	0	0	-23,808	-669,545	-72,553	-283,869
Protection forest	30,845	1,347,510	70,594	25	461	17,144	28,938	84,269	1,318,111	0	0	0	0	0	0	3,570	136,585	80,699	1,181,525
Fuelwood forest	68	1,844	153	0	0	25	38	196	1,805	0	0	0	0	0	0	50	904	146	902
Special use forest	10,836	108,711	24,801	9	75	13,361	17,408	22,268	91,229	0	0	0	0	0	0	5,677	40,266	16,591	50,963
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	345	0	-345	0	0	0	0	0	0	0	-345	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	81	5,751	119	0	4	484	6,310	-285	-563	0	0	0	0	0	0	0	0	-285	-563
1.1.2 Plantation	20,228	328,684	27,350	40	180	26,972	50,596	20,565	277,908	20,565	277,908	13,424	150,675	7,141	127,233	0	0	0	0
(1) Stand	12,645	327,692	16,835	20	179	14,383	48,239	15,078	279,273	15,078	279,273	8,117	152,040	6,960	127,233	0	0	0	0
Timber forest	7,817	171,695	10,893	15	104	11,834	45,369	6,861	126,222	6,861	126,222	0	0	6,861	126,222	0	0	0	0
Protection forest	1,433	105,748	2,109	4	61	11	2,744	3,527	102,943	3,527	102,943	3,527	102,943	0	0	0	0	0	0
Fuelwood forest	61	1,055	69	0	0	31	44	99	1,011	99	1,011	0	0	99	1,011	0	0	0	0
Special use forest	3,334	49,194	3,765	1	14	2,507	83	4,590	49,097	4,590	49,097	4,590	49,097	0	0	0	0	0	0
(2)Economic forest	6,914	0	10,172	20	0	11,407	0	5,659	0	5,659	0	5,659	0	0	0	0	0	0	0
(3) Bamboo forest	532	0	140	0	0	163	0	508	0	508	0	0	0	508	0	0	0	0	0
(4) Unestablished stands	126	0	186	0	0	639	0	-328	0	-328	0	0	0	-328	0	0	0	0	0
(5) Open forest area	11	992	17	0	1	380	2,356	-352	-1,366	-352	-1,366	-352	-1,366	0	0	0	0	0	0
1.2 Shrub land	861	0	1,267	2	0	3,497	0	-1,372	0	0	0	0	0	0	0	0	0	-1,372	0
1.3 Nurseries	14	0	20	0	0	4	0	30	0	30	0	30	0	0	0	0	0	0	0
1.4 Non-stocked forestland	123	0	651	0	0	44	0	730	0	0	0	0	0	0	0	0	0	730	0
1.5 4-side plantings	0	10,982	0	0	8	0	8,787	0	2,187	0	2,187	0	0	0	2,187	0	0	0	0
1.6 Scattered trees	0	20,582	0	0	14	0	14,057	0	6,510	0	0	0	0	0	0	0	0	0	6,510
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	0	0	5,772	0	0	89,901	0	-84,129	0	0	0	0	0	0	0	-67,303	0	-16,826	0

Accounting of ecological price changes of forest environment resources in Hainan

Table 5-2 Changes of ecological prices

2000-1995

Unit: 10,000RMB

Item	Changes of forest resources									Net changes of forest assets								Net changes of non asset forest resources	
	Increase in current period			Decrease in current period				Net increase of current period		Cultivation assets						Non cultivation assets			
	Natural		Economic	Disaster loss		Economic use				Subtotal		Fixed assets		In-process products		Forest land	Forest trees	Forest land	Forest trees
	Area	Volume	Area	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	67,727	6,189,672	130,190	87	2,495	166,232	2,882,944	**31,598**	**3,304,233**	24,686	771,211	15,968	496,261	8,718	274,951	-15,705	-1,089,861	22,617	3,622,882
1.1 Forested land and forest resources	65,774	6,122,758	126,904	82	2,449	158,774	2,834,514	33,822	3,285,795	24,644	766,576	15,926	496,261	8,718	270,315	-15,705	-1,089,861	24,883	3,609,081
1.1.1 Natural forest	41,860	5,259,098	95,711	34	2,003	128,752	2,738,651	8,785	2,518,443	0	0	0	0	0	0	-15,705	-1,089,861	24,490	3,608,304
(1) Stand	41,749	5,251,161	95,548	33	1,997	126,892	2,729,943	10,372	2,519,220	0	0	0	0	0	0	-14,511	-1,089,861	24,883	3,609,081
Timber forest	0	0	0	0	0	96,361	2,536,082	-96,361	-2,536,082	0	0	0	0	0	0	-23,808	-1,780,991	-72,553	-755,092
Protection forest	30,845	4,662,385	70,594	25	1,595	17,144	100,127	84,269	4,560,663	0	0	0	0	0	0	3,570	472,585	80,699	4,088,077
Fuelwood forest	68	3,909	153	0	1	25	81	196	3,827	0	0	0	0	0	0	50	1,916	146	1,911
Special use forest	10,836	584,867	24,801	9	401	13,361	93,653	22,268	490,812	0	0	0	0	0	0	5,677	216,629	16,591	274,183
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	1,193	0	-1,193	0	0	0	0	0	0	0	-1,193	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	111	7,937	164	0	5	668	8,708	-393	-776	0	0	0	0	0	0	0	0	-393	-776
1.1.2 Plantation	24,215	871,597	31,635	49	451	32,095	104,570	23,707	766,576	23,707	766,576	15,441	496,261	8,266	270,315	0	0	0	0
(1) Stand	12,645	871,597	16,835	20	451	14,383	104,570	15,078	766,576	15,078	766,576	8,117	496,261	6,960	270,315	0	0	0	0
Timber forest	7,817	365,368	10,893	15	222	11,834	96,545	6,861	268,600	6,861	268,600	0	0	6,861	268,600	0	0	0	0
Protection forest	1,433	292,710	2,109	4	168	11	7,595	3,527	284,947	3,527	284,947	3,527	284,947	0	0	0	0	0	0
Fuelwood forest	61	1,790	69	0	1	31	74	99	1,715	99	1,715	0	0	99	1,715	0	0	0	0
Special use forest	3,334	211,730	3,765	1	60	2,507	356	4,590	211,314	4,590	211,314	4,590	211,314	0	0	0	0	0	0
(2)Economic forest	9,541	0	14,037	28	0	15,741	0	7,809	0	7,809	0	7,809	0	0	0	0	0	0	0
(3) Bamboo forest	1,840	0	483	1	0	565	0	1,757	0	1,757	0	0	0	1,757	0	0	0	0	0
(4) Unestablished stands	174	0	256	1	0	882	0	-452	0	-452	0	0	0	-452	0	0	0	0	0
(5) Open forest area	16	0	23	0	0	524	0	-485	0	-485	0	-485	0	0	0	0	0	0	0
1.2 Shrub land	1,825	0	2,686	5	0	7,414	0	-2,908	0	0	0	0	0	0	0	0	0	-2,908	0
1.3 Nurseries	19	0	28	0	0	6	0	42	0	42	0	42	0	0	0	0	0	0	0
1.4 Non-stocked forestland	108	0	573	0	0	38	0	642	0	0	0	0	0	0	0	0	0	642	0
1.5 4-side plantings	0	23,281	0	0	16	0	18,629	0	4,636	0	4,636	0	0	0	4,636	0	0	0	0
1.6 Scattered trees	0	43,633	0	0	30	0	29,801	0	13,802	0	0	0	0	0	0	0	0	0	13,802
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	0	0	5,772	0	0	89,901	0	-84,129	0	0	0	0	0	0	0	-67,303	0	-16,826	0

Value accounting of existing forest environment resources in Hainan Province

Table 6-1-1 Market values of existing resources at the beginning of accounting period — December 31, 1995 (90-94) — Unit: 10,000RMB

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	397,236	2,046,936	203,208	426,946	127,719	130,690	75,490	296,256	32,126	783,763	161,902	836,227
1.1 Forested land and forest resources	380,482	1,973,430	203,013	400,532	127,524	130,690	75,490	269,841	32,126	783,763	145,343	789,135
1.1.1 Natural forest	179,057	1,588,440	0	0	0	0	0	0	32,126	783,763	146,931	804,677
(1) Stand	177,124	1,572,898	0	0	0	0	0	0	31,781	783,763	145,343	789,135
Timber forest	96,361	953,414	0	0	0	0	0	0	23,808	669,545	72,553	283,869
Protection forest	54,336	428,225	0	0	0	0	0	0	1,891	43,021	52,445	385,204
Fuelwood forest	0	0	0	0	0	0	0	0	0	0	0	0
Special use forest	26,427	191,259	0	0	0	0	0	0	6,082	71,197	20,345	120,062
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	345	0	0	0	0	0	0	0	345	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	1,588	15,542	0	0	0	0	0	0	0	0	1,588	15,542
1.1.2 Plantation	205,918	404,480	205,918	404,480	128,058	134,638	77,860	269,841	0	0	0	0
(1) Stand	95,802	400,532	95,802	400,532	21,341	130,690	74,462	269,841	0	0	0	0
Timber forest	74,446	269,559	74,446	269,559	0	0	74,446	269,559	0	0	0	0
Protection forest	19,659	126,565	19,659	126,565	19,659	126,565	0	0	0	0	0	0
Fuelwood forest	15	283	15	283	0	0	15	283	0	0	0	0
Special use forest	1,681	4,125	1,681	4,125	1,681	4,125	0	0	0	0	0	0
(2)Economic forest	106,183	0	106,183	0	106,183	0	0	0	0	0	0	0
(3) Bamboo forest	1,028	0	1,028	0	0	0	1,028	0	0	0	0	0
(4) Unestablished stands	2,370	0	2,370	0	0	0	2,370	0	0	0	0	0
(5) Open forest area	535	3,948	535	3,948	535	3,948	0	0	0	0	0	0
1.2 Shrub land	15,301	0	0	0	0	0	0	0	0	0	15,301	0
1.3 Nurseries	195	0	195	0	195	0	0	0	0	0	0	0
1.4 Non-stocked forestland	1,258	0	0	0	0	0	0	0	0	0	1,258	0
1.5 4-side plantings	0	26,414	0	26,414	0	0	0	26,414	0	0	0	0
1.6 Scattered trees	0	47,092	0	0	0	0	0	0	0	0	0	47,092
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	1,652,633	0	0	0	0	0	0	0	1,322,106	0	330,527	0

Value accounting of existing forest environment resources in Hainan Province

Table 6-1-2 Market values of existing resources at the end of accounting period December 31, 2000 (93-98) Unit: 10,000RMB

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	427,895	2,792,637	224,483	708,406	141,525	282,731	82,958	425,675	17,270	291,972	186,142	1,792,259
1.1 Forested land and forest resources	411,753	2,710,434	224,258	679,805	141,300	282,731	82,958	397,074	17,270	291,972	170,226	1,738,656
1.1.1 Natural forest	188,799	2,045,608	0	0	0	0	0	0	17,270	291,972	171,529	1,753,635
(1) Stand	187,496	2,030,629	0	0	0	0	0	0	17,270	291,972	170,226	1,738,656
Timber forest	0	0	0	0	0	0	0	0	0	0	0	0
Protection forest	138,605	1,746,335	0	0	0	0	0	0	5,461	179,606	133,144	1,566,729
Fuelwood forest	196	1,805	0	0	0	0	0	0	50	904	146	902
Special use forest	48,695	282,488	0	0	0	0	0	0	11,759	111,462	36,935	171,025
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	0	0	0	0	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	1,303	14,979	0	0	0	0	0	0	0	0	1,303	14,979
1.1.2 Plantation	226,483	682,387	226,483	682,387	141,483	285,313	85,000	397,074	0	0	0	0
(1) Stand	110,880	679,805	110,880	679,805	29,458	282,731	81,422	397,074	0	0	0	0
Timber forest	81,307	395,780	81,307	395,780	0	0	81,307	395,780	0	0	0	0
Protection forest	23,186	229,508	23,186	229,508	23,186	229,508	0	0	0	0	0	0
Fuelwood forest	115	1,294	115	1,294	0	0	115	1,294	0	0	0	0
Special use forest	6,271	53,223	6,271	53,223	6,271	53,223	0	0	0	0	0	0
(2)Economic forest	111,842	0	111,842	0	111,842	0	0	0	0	0	0	0
(3) Bamboo forest	1,536	0	1,536	0	0	0	1,536	0	0	0	0	0
(4) Unestablished stands	2,042	0	2,042	0	0	0	2,042	0	0	0	0	0
(5) Open forest area	183	2,582	183	2,582	183	2,582	0	0	0	0	0	0
1.2 Shrub land	13,929	0	0	0	0	0	0	0	0	0	13,929	0
1.3 Nurseries	225	0	225	0	225	0	0	0	0	0	0	0
1.4 Non-stocked forestland	1,988	0	0	0	0	0	0	0	0	0	1,988	0
1.5 4-side plantings	0	28,601	0	28,601	0	0	0	28,601	0	0	0	0
1.6 Scattered trees	0	53,603	0	0	0	0	0	0	0	0	0	53,603
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	1,568,503	0	0	0	0	0	0	0	1,254,803	0	313,701	0

Value accounting of existing forest environment resources in Hainan Province

Table 6-2-1 Ecological values of existing resources at the end of accounting period — December 31, 1995 (90-94) — Unit: 10,000RMB

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	458,022	6,144,735	246,159	998,186	168,140	368,088	78,019	630,098	32,975	2,312,882	178,888	2,833,666
1.1 Forested land and forest resources	424,208	5,988,901	245,890	942,188	167,871	368,088	78,019	574,100	32,975	2,312,882	145,343	2,733,830
1.1.1 Natural forest	180,509	5,068,160	0	0	0	0	0	0	32,975	2,312,882	145,343	2,733,830
(1) Stand	177,124	5,046,712	0	0	0	0	0	0	32,975	2,312,882	147,534	2,755,278
Timber forest	96,361	2,536,082	0	0	0	0	0	0	31,781	2,312,882	145,343	2,733,830
Protection forest	54,336	1,481,658	0	0	0	0	0	0	23,808	1,780,991	72,553	755,092
Fuelwood forest	0	0	0	0	0	0	0	0	1,891	148,852	52,445	1,332,805
Special use forest	26,427	1,028,972	0	0	0	0	0	0	0	0	0	0
(2)Economic forest	0	0	0	0	0	0	0	0	6,082	383,040	20,345	645,933
(3) Bamboo forest	1,193	0	0	0	0	0	0	0	0	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	1,193	0	0	0
(5) Open forest area	2,192	21,448	0	0	0	0	0	0	0	0	0	0
1.1.2 Plantation	249,899	942,188	249,899	942,188	168,609	368,088	81,290	574,100	0	0	2,192	21,448
(1) Stand	95,802	942,188	95,802	942,188	21,341	368,088	74,462	574,100	0	0	0	0
Timber forest	74,446	573,621	74,446	573,621	0	0	74,446	573,621	0	0	0	0
Protection forest	19,659	350,332	19,659	350,332	19,659	350,332	0	0	0	0	0	0
Fuelwood forest	15	480	15	480	0	0	15	480	0	0	0	0
Special use forest	1,681	17,756	1,681	17,756	1,681	17,756	0	0	0	0	0	0
(2)Economic forest	146,531	0	146,531	0	146,531	0	0	0	0	0	0	0
(3) Bamboo forest	3,558	0	3,558	0	0	0	3,558	0	0	0	0	0
(4) Unestablished stands	3,270	0	3,270	0	0	0	3,270	0	0	0	0	0
(5) Open forest area	738	0	738	0	738	0	0	0	0	0	0	0
1.2 Shrub land	32,438	0	0	0	0	0	0	0	0	0	32,438	0
1.3 Nurseries	269	0	269	0	269	0	0	0	0	0	0	0
1.4 Non-stocked forestland	1,107	0	0	0	0	0	0	0	0	0	1,107	0
1.5 4-side plantings	0	55,998	0	55,998	0	0	0	55,998	0	0	0	0
1.6 Scattered trees	0	99,836	0	0	0	0	0	0	0	0	0	99,836
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	1,652,633	0	0	0	0	0	0	0	1,322,106	0	330,527	0

Value accounting of existing forest environment resources in Hainan Province

Table 6-2-2 Ecological values of existing resources at the end of accounting period December 31, 2000 (93-98) Unit: 10,000RMB

Item	Total forest resources		Forest assets								Non asset forest resources	
			Cultivation assets						Non cultivation			
	Forestland	Forest trees	Subtotal		Fixed assets		In-process products		Forestland	Forest trees	Forestland	Forest trees
	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume	Area	Volume
1.Forestry land and forest resources	489,620	9,448,968	270,845	1,769,398	184,108	864,349	86,737	905,049	17,270	1,223,022	201,505	6,456,549
1.1 Forested land and forest resources	458,030	9,274,696	270,534	1,708,764	183,798	864,349	86,737	844,415	17,270	1,223,022	170,226	6,342,911
1.1.1 Natural forest	189,294	7,586,604	0	0	0	0	0	0	17,270	1,223,022	172,024	6,363,582
(1) Stand	187,496	7,565,932	0	0	0	0	0	0	17,270	1,223,022	170,226	6,342,911
Timber forest	0	0	0	0	0	0	0	0	0	0	0	0
Protection forest	138,605	6,042,320	0	0	0	0	0	0	5,461	621,438	133,144	5,420,883
Fuelwood forest	196	3,827	0	0	0	0	0	0	50	1,916	146	1,911
Special use forest	48,695	1,519,785	0	0	0	0	0	0	11,759	599,668	36,935	920,116
(2)Economic forest	0	0	0	0	0	0	0	0	0	0	0	0
(3) Bamboo forest	0	0	0	0	0	0	0	0	0	0	0	0
(4) Unestablished stands	0	0	0	0	0	0	0	0	0	0	0	0
(5) Open forest area	1,798	20,671	0	0	0	0	0	0	0	0	1,798	20,671
1.1.2 Plantation	273,606	1,708,764	273,606	1,708,764	184,050	864,349	89,555	844,415	0	0	0	0
(1) Stand	110,880	1,708,764	110,880	1,708,764	29,458	864,349	81,422	844,415	0	0	0	0
Timber forest	81,307	842,221	81,307	842,221	0	0	81,307	842,221	0	0	0	0
Protection forest	23,186	635,279	23,186	635,279	23,186	635,279	0	0	0	0	0	0
Fuelwood forest	115	2,194	115	2,194	0	0	115	2,194	0	0	0	0
Special use forest	6,271	229,070	6,271	229,070	6,271	229,070	0	0	0	0	0	0
(2)Economic forest	154,340	0	154,340	0	154,340	0	0	0	0	0	0	0
(3) Bamboo forest	5,315	0	5,315	0	0	0	5,315	0	0	0	0	0
(4) Unestablished stands	2,818	0	2,818	0	0	0	2,818	0	0	0	0	0
(5) Open forest area	253	0	253	0	253	0	0	0	0	0	0	0
1.2 Shrub land	29,530	0	0	0	0	0	0	0	0	0	29,530	0
1.3 Nurseries	311	0	311	0	311	0	0	0	0	0	0	0
1.4 Non-stocked forestland	1,749	0	0	0	0	0	0	0	0	0	1,749	0
1.5 4-side plantings	0	60,634	0	60,634	0	0	0	60,634	0	0	0	0
1.6 Scattered trees	0	113,638	0	0	0	0	0	0	0	0	0	113,638
1.7 Statistical errors	0	0	0	0	0	0	0	0	0	0	0	0
2. Die-back trees	0	0	0	0	0	0	0	0	0	0	0	0
3. Non-forestry land	1,568,503	0	0	0	0	0	0	0	1,254,803	0	313,701	0

Green GDP accounting for Hainan Province

Table 7-1: 1995 Unit: 100 million RMB

Production	Order	Cost	Uses	Order	Cost
1. Output of economic activities	1	843.14	9 Ultimate consumption	16	188.50
2. Intermediate input in economic activities	2	478.96	9.1 Residence consumption	17	153.09
3. GDP by production (or Income)	3	364.18	9.2 Government consumption	18	35.41
3.1 Remuneration of labors	4	217.27	10 Total cost of capital formation	19	219.21
3.2 Net production tax	5	36.02	11 Net exportation	20	0.00
3.2.1 Production tax	6	39.42	11.1 Exportation	21	125.60
3.2.2 Subsidy (-)	7	3.40	11.2 Importation (-)	22	125.60
3.3 Depreciation of fixed assets	8	57.48	12 GDP by expenditure	23	407.71
3.4 Operational balance	9	53.41	13.1 Net accumulation of forest assets at market value	24	-5.62
4 Market output of forest cultivation assets	10	12.64	13.2 Net accumulation of forest assets at ecological value	25	-10.19
5 Cost of forest assets exhustion	11	33.84	14 GeGDP by expenditure	26	402.09
6 Cost of forest assets degradation	12	84.07	15 EDP by expenditure	27	397.52
	13		16.1 Statistical error	28	43.53
7.GeGDP	14	342.98	16.2 Statistical error	29	59.11
8.EDP	15	258.91	16.3 Statistical error	30	138.61

Market output/GDP
0.0347
Cost of sonsumption/GDP
0.0929
Cost of degradation/GDP
0.2308
GeGDP/GDP
0.9418
EDP/GDP
0.7109
Net accumulation of market values/GDP
-0.0138
Net accumulation of ecological values/GDP
-0.0250
Cost of forests/GDP
0.3238

Green GDP accounting for Hainan Province

Table 7-2 1997 Unit: 100 million RMB

Production	Order	Cost	Uses	Order	Cost
1. Output of economic activities	1	952.7	9 Ultimate consumption	16	222.33
2. Intermediate input in economic activities	2	542.84	9.1 Residence consumption	17	176.82
3. GDP by production (or Income)	3	409.86	9.2 Government consumption	18	45.51
3.1 Remuneration of labors	4	244.53	10 Total cost of capital formation	19	187.92
3.2 Net production tax	5	40.54	11 Net exportation	20	-2.50
3.2.1 Production tax	6	44.51	11.1 Exportation	21	134.66
3.2.2 Subsidy (-)	7	3.97	11.2 Importation (-)	22	137.16
3.3 Depreciation of fixed assets	8	64.69	12 GDP by expenditure	23	407.75
3.4 Operational balance	9	60.10	13.1 Net accumulation of forest assets at market value	24	-3.41
4 Market output of forest cultivation assets	10	14.72	13.2 Net accumulation of forest assets at ecological value	25	-6.17
5 Cost of forest assets exhustion	11	20.49	14 GeGDP by expenditure	26	404.34
6 Cost of forest assets degradation	12	50.89	15 EDP by expenditure	27	401.58
	13		16.1 Statistical error	28	-2.11
7.GeGDP	14	404.09	16.2 Statistical error	29	0.25
8.EDP	15	353.20	16.3 Statistical error	30	48.38

Market output/GDP
0.0359
Cost of sonsumption/GDP
0.0500
Cost of degradation/GDP
0.1242
GeGDP/GDP
0.9859
EDP/GDP
0.8618
Net accumulation of market values/GDP
-0.0084
Net accumulation of ecological values/GDP
-0.0151
Cost of forests/GDP
0.1742

Green GDP accounting for Hainan Province

Table 7-3 2000 Unit: 100 million RMB

Production	Order	Cost	Uses	Order	Cost
1. Output of economic activities	1	1181.2	9 Ultimate consumption	16	284.51
2. Intermediate input in economic activities	2	662.76	9.1 Residence consumption	17	218.38
3. GDP by production (or Income)	3	518.48	9.2 Government consumption	18	66.13
3.1 Remuneration of labors	4	299.08	10 Total cost of capital formation	19	240.66
3.2 Net production tax	5	59.63	11 Net exportation	20	-7.44
3.2.1 Production tax	6	64.65	11.1 Exportation	21	215.62
3.2.2 Subsidy (-)	7	5.02	11.2 Importation (-)	22	223.06
3.3 Depreciation of fixed assets	8	83.49	12 GDP by expenditure	23	517.73
3.4 Operational balance	9	76.28	13.1 Net accumulation of forest assets at market value	24	-3.21
4 Market output of forest cultivation assets	10	18.58	13.2 Net accumulation of forest assets at ecological value	25	-5.81
5 Cost of forest assets exhustion	11	19.32	14 GeGDP by expenditure	26	514.52
6 Cost of forest assets degradation	12	47.98	15 EDP by expenditure	27	508.71
	13		16.1 Statistical error	28	-0.75
7.GeGDP	14	517.74	16.2 Statistical error	29	-3.22
8.EDP	15	469.76	16.3 Statistical error	30	38.95

Market output/GDP
0.0358
Cost of sonsumption/GDP
0.0373
Cost of degradation/GDP
0.0925
GeGDP/GDP
0.9986
EDP/GDP
0.9060
Net accumulation of market values/GDP
-0.0062
Net accumulation of ecological values/GDP
-0.0112
Cost of forests/GDP
0.1298

Balance sheet for forest resources in Hainan Province

December 31, 1995

Table 8-1-1 Value accounting at market prices for forest resources

Unit: 100 million RMB

	Code	Non financial enterprise				Fianancial enterprise				Government		Residence		Total within province				Outside of province		Total	
				State owned enterprise				State owned agency								State owned institution					
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1	472.14		185.99		9.74		6.25		102.92		204.72		789.51		295.16				789.51	
1) Produciton assets	2	430.50		144.36		9.74		6.25		78.46		189.22		707.92		229.07				707.92	
of which: cultivation assets	3	32.16		32.16		0.00		0.00		18.89		11.97		63.02		51.05				63.02	
forest land	4	10.37		10.37		0.00		0.00		6.09		3.86		20.32		16.46				20.32	
Forest trees	5	21.79		21.79		0.00		0.00		12.80		8.11		42.70		34.59				42.70	
i) Fixed assets	6	323.51		111.14		9.25		5.90		57.21		161.69		551.67		174.25				551.67	
of which: on-going programs	7	58.76		19.83		7.36		5.32		3.39		0.00		69.52		28.54				69.52	
Cultivation fixed assets	8	13.19		13.19		0.00		0.00		7.74		4.91		25.84		20.93				25.84	
Forest land	9	6.52		6.52		0.00		0.00		3.83		2.43		12.77		10.34				12.77	
Forest trees	10	6.67		6.67		0.00		0.00		3.92		2.48		13.07		10.59				13.07	
ii) Existing products	11	88.41		26.10		0.02		0.01		12.59		26.48		127.50		38.71				127.50	
of which: end products and commodity stocks	12	29.38		2.74		0.00		0.00		0.00		15.50		44.88		2.74				44.88	
In-process products of cultivation assets	13	18.97		18.97		0.00		0.00		11.14		7.06		37.18		30.12				37.18	
Forest land	14	3.85		3.85		0.00		0.00		2.26		1.43		7.55		6.12				7.55	
Forest trees	15	15.12		15.12		0.00		0.00		8.88		5.63		29.63		24.00				29.63	
iii) Other non financial assets	16	18.58		7.12		0.47		0.34		8.66		1.05		28.75		16.11				28.75	
of which: intangibles	17	13.80		2.10		0.01		0.01		0.00		0.00		13.81		2.11				13.81	
2) Non-production assets	18	41.63		41.63		0.00		0.00		24.45		15.50		81.59		66.09				81.59	
i) Forest assets	19	41.63		41.63		0.00		0.00		24.45		15.50		81.59		66.09				81.59	
Forest land	20	1.64		1.64		0.00		0.00		0.96		0.61		3.21		2.60				3.21	
Forest trees	21	40.00		40.00		0.00		0.00		23.49		14.89		78.38		63.48				78.38	
ii) Other assets (land,water,mines,sea)	22	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00				0.00	
2 Financial assets and debts	23	335.34	685.72	103.97	170.70	715.39	548.92	594.57	498.53	14.13	35.21	293.20	18.66	1358.06	1288.52	712.67	704.45	115.07	184.62	1473.13	1473.14
i) Domestic financial assets and debts	24	335.34	685.72	103.97	170.70	715.39	548.92	594.57	498.53	14.13	35.21	293.20	18.66	1358.06	1288.52	712.67	704.45	115.07	184.62	1473.13	1473.14
ii) Foreign financial assets and debts	36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Net value of assets	37	0.00	121.76	0.00	119.26	0.00	176.21	0.00	102.29	0.00	81.83	0.00	479.25	0.00	859.05	0.00	303.38	0.00	-69.55	0.00	789.50
4 Total assets, debts and net value of total assets	38	807.48	807.48	289.96	289.96	725.13	725.13	600.82	600.82	117.04	117.04	497.91	497.91	2147.57	2147.57	1007.83	1007.83	115.07	115.07	2262.64	2262.64

Balance sheet for forest resources in Hainan Province

Table 8-1-2 Value accounting at market prices for forest resources

December 31, 2000

Unit: 100 million RMB

	Code	Non financial enterprise		State owned enterprise		Fianancial enterprise		State owned agency		Government		Residence		Total within province		State owned institution		Outside of province		Total	
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1	1184.22		671.55		59.68		48.56		174.75		358.19		1776.83		894.86				1776.83	
1) Produciton assets	2	1168.78		656.11		59.68		48.56		166.07		351.38		1745.91		870.74				1745.91	
of which: cultivation assets	3	46.57		46.57		0.00		0.00		26.20		20.52		93.29		72.77				93.29	
forest land	4	11.21		11.21		0.00		0.00		6.30		4.94		22.45		17.51				22.45	
Forest trees	5	35.36		35.36		0.00		0.00		19.89		15.58		70.84		55.26				70.84	
i) Fixed assets	6	744.37		491.05		54.29		44.31		149.57		313.21		1261.44		684.93				1261.44	
of which: on-going programs	7	88.15		73.39		6.41		5.29		3.85		0.00		98.41		82.53				98.41	
Cultivation fixed assets	8	21.18		21.18		0.00		0.00		11.91		9.33		42.42		33.09				42.42	
Forest land	9	7.06		7.06		0.00		0.00		3.97		3.11		14.15		11.04				14.15	
Forest trees	10	14.11		14.11		0.00		0.00		7.94		6.22		28.27		22.05				28.27	
ii) Existing products	11	222.43		106.83		0.00		0.00		14.49		34.03		270.96		121.33				270.96	
of which: end products and commodity stocks	12	57.00		16.00		0.00		0.00		0.00		5.01		62.01		16.00				62.01	
In-process products of cultivation assets	13	25.39		25.39		0.00		0.00		14.28		11.19		50.87		39.68				50.87	
Forest land	14	4.14		4.14		0.00		0.00		2.33		1.83		8.30		6.47				8.30	
Forest trees	15	21.25		21.25		0.00		0.00		11.95		9.37		42.57		33.20				42.57	
iii) Other non financial assets	16	201.98		58.23		5.39		4.25		2.00		4.14		213.51		64.48				213.51	
of which: intangibles	17	67.99		44.45		1.79		0.00		0.00		0.00		69.78		44.45				69.78	
2) Non-production assets	18	15.44		15.44		0.00		0.00		8.68		6.80		30.92		24.12				30.92	
i) Forest assets	19	15.44		15.44		0.00		0.00		8.68		6.80		30.92		24.12				30.92	
Forest land	20	0.86		0.86		0.00		0.00		0.48		0.38		1.73		1.35				1.73	
Forest trees	21	14.58		14.58		0.00		0.00		8.20		6.42		29.20		22.77				29.20	
ii) Other assets (land,water,mines,sea)	22	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00				0.00	
2 Financial assets and debts	23	785.87	1319.31	399.75	630.60	706.65	1105.90	563.69	793.57	67.99	54.57	517.95	31.47	2078.46	2511.25	1031.43	1478.74	594.47	161.86	2672.93	2673.11
i) Domestic financial assets and debts	24	785.87	1319.31	399.75	630.60	706.65	1105.90	563.69	793.57	67.99	54.57	517.95	30.23	2078.46	2510.01	1031.43	1478.74	593.23	161.86	2671.69	2671.87
ii) Foreign financial assets and debts	36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	1.24	0.00	0.00	1.24	0.00	1.24	1.24
3 Net value of assets	37	0.00	650.78	0.00	440.70	0.00	-339.57	0.00	-181.32	0.00	188.17	0.00	844.67	0.00	1344.04	0.00	447.55	0.00	432.61	0.00	1776.65
4 Total assets, debts and net value of total assets	38	1970.09	1970.09	1071.30	1071.30	766.33	766.33	612.25	612.25	242.74	242.74	876.14	876.14	3855.29	3855.29	1926.29	1926.29	594.47	594.47	4449.76	4449.76

Balance sheet of green assets in Hainan Province

Table 8-2-1 Value accounting at ecological prices for forest resources

December 31, 1995

Unit: 100 million RMB

	Code	Non financial enterprise				Fianancial enterprise				Government		Residence		Total within province				Outside of province		Total	
				State owned enterprise				State owned agency								State owned institution					
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1	571.64		285.49		9.74		6.25		161.35		241.76		984.49		453.09				984.49	
1) Produciton assets	2	451.93		165.78		9.74		6.25		91.05		197.19		749.90		263.08				466.52	
of which: cultivation assets	3	63.50		63.50		0.00		0.00		37.29		23.64		124.43		100.79				124.43	
forest land	4	12.56		12.56		0.00		0.00		7.38		4.68		24.61		19.93				24.61	
Forest trees	5	50.94		50.94		0.00		0.00		29.92		18.97		99.82		80.85				99.82	
i) Fixed assets	6	327.78		115.40		9.25		5.90		59.72		163.28		560.02		181.02				350.20	
of which: on-going programs	7	58.76		19.83		7.36		5.32		3.39		0.00		69.52		28.54				33.86	
Cultivation fixed assets	8	27.36		27.36		0.00		0.00		16.07		10.19		53.62		43.43				53.62	
Forest land	9	8.58		8.58		0.00		0.00		5.04		3.19		16.81		13.62				16.81	
Forest trees	10	18.78		18.78		0.00		0.00		11.03		6.99		36.81		29.82				36.81	
ii) Existing products	11	105.57		43.26		0.02		0.01		22.67		32.87		161.13		65.95				98.82	
of which: end products and commodity stocks	12	29.38		2.74		0.00		0.00		0.00		15.50		44.88		2.74				18.24	
In-process products of cultivation assets	13	36.13		36.13		0.00		0.00		21.22		13.45		70.81		57.36				70.81	
Forest land	14	3.98		3.98		0.00		0.00		2.34		1.48		7.80		6.32				7.80	
Forest trees	15	32.15		32.15		0.00		0.00		18.88		11.97		63.01		51.04				63.01	
iii) Other non financial assets	16	18.58		7.12		0.47		0.34		8.66		1.05		28.75		16.11				17.49	
of which: intangibles	17	13.80		2.09		0.01		0.01		0.00		0.00		13.81		2.10				2.11	
2) Non-production assets	18	119.71		119.71		0.00		0.00		70.31		44.57		234.59		190.01				234.59	
i) Forest assets	19	119.71		119.71		0.00		0.00		70.31		44.57		234.59		190.01				234.59	
Forest land	20	1.68		1.68		0.00		0.00		0.99		0.63		3.30		2.67				3.30	
Forest trees	21	118.03		118.03		0.00		0.00		69.32		43.94		231.29		187.34				231.29	
ii) Other assets (land,water,mines,sea)	22	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00				0.00	
2 Financial assets and debts	23	335.34	685.72	103.97	170.70	715.39	548.92	594.57	498.53	14.13	35.21	293.20	18.66	1358.06	1288.52	712.67	704.45	115.07	184.62	1715.50	1406.26
i) Domestic financial assets and debts	24	335.34	685.72	103.97	170.70	715.39	548.92	594.57	498.53	14.13	35.21	293.20	18.66	1358.06	1288.52	712.67	704.45	115.07	184.62	1715.50	1406.26
ii) Foreign financial assets and debts	36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Net value of assets	37	0.00	221.25	0.00	218.76	0.00	176.21	0.00	102.29	0.00	140.27	0.00	516.30	0.00	1054.03	0.00	461.31	0.00	-69.55	0.00	1010.34
4 Total assets, debts and net value of total assets	38	906.98	906.98	389.46	389.46	725.13	725.13	600.82	600.82	175.48	175.48	534.96	534.96	2342.55	2342.55	1165.76	1165.76	115.07	115.07	2416.61	2416.61

Balance sheet of green assets in Hainan Province

December 31, 2000

Table 8-2-2 Value accounting at ecological prices for forest resources

Unit: 100 million RMB

	Code	Non financial enterprise		State owned enterprise		Fianancial enterprise		State owned agency		Government		Residence		Total within province		State owned institution		Outside of province		Total	
		Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source	Use	Source
A	B	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1 Non financial assets	1	1285.97		773.30		59.68		48.56		231.98		403.03		1980.66		1053.84				1980.66	
1) Produciton assets	2	1224.05		711.38		59.68		48.56		197.16		375.74		1856.63		957.10				1381.40	
of which: cultivation assets	3	101.84		101.84		0.00		0.00		57.29		44.88		204.01		159.13				204.01	
forest land	4	13.52		13.52		0.00		0.00		7.60		5.96		27.08		21.12				27.08	
Forest trees	5	88.32		88.32		0.00		0.00		49.68		38.92		176.93		138.01				176.93	
i) Fixed assets	6	775.53		522.21		54.29		44.31		167.10		326.94		1323.86		733.62				1104.87	
of which: on-going programs	7	88.15		73.39		6.41		5.29		3.85		0.00		98.41		82.53				87.82	
Cultivation fixed assets	8	52.34		52.34		0.00		0.00		29.44		23.06		104.84		81.78				104.84	
Forest land	9	9.19		9.19		0.00		0.00		5.17		4.05		18.41		14.36				18.41	
Forest trees	10	43.15		43.15		0.00		0.00		24.27		19.01		86.43		67.42				86.43	
ii) Existing products	11	246.55		130.95		0.00		0.00		28.06		44.66		319.26		159.00				203.66	
of which: end products and commodity stocks	12	57.00		16.00		0.00		0.00		0.00		5.01		62.01		16.00				21.01	
In-process products of cultivation assets	13	49.51		49.51		0.00		0.00		27.85		21.82		99.17		77.35				99.17	
Forest land	14	4.33		4.33		0.00		0.00		2.43		1.91		8.67		6.76				8.67	
Forest trees	15	45.18		45.18		0.00		0.00		25.41		19.91		90.50		70.59				90.50	
iii) Other non financial assets	16	201.98		58.23		5.39		4.25		2.00		4.14		213.51		64.48				72.87	
of which: intangibles	17	67.99		44.45		1.79		0.00		0.00		0.00		69.78		44.45				44.45	
2) Non-production assets	18	61.92		61.92		0.00		0.00		34.83		27.29		124.03		96.74				124.03	
i) Forest assets	19	61.92		61.92		0.00		0.00		34.83		27.29		124.03		96.74				124.03	
Forest land	20	0.86		0.86		0.00		0.00		0.48		0.38		1.73		1.35				1.73	
Forest trees	21	61.05		61.05		0.00		0.00		34.34		26.91		122.30		95.40				122.30	
ii) Other assets (land,water,mines,sea)	22	0.00		0.00		0.00		0.00		0.00		0.00		0.00		0.00				0.00	
2 Financial assets and debts	23	785.87	1319.31	399.75	630.60	706.65	1105.90	563.69	793.57	67.99	54.57	517.95	31.47	2078.46	2511.25	1031.43	1478.74	594.47	161.86	2707.54	2465.64
i) Domestic financial assets and debts	24	785.87	1319.31	399.75	630.60	706.65	1105.90	563.69	793.57	67.99	54.57	517.95	30.23	2078.46	2510.01	1031.43	1478.74	593.23	161.86	2706.30	2464.40
ii) Foreign financial assets and debts	36	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.24	0.00	1.24	0.00	0.00	1.24	0.00	1.24	1.24
3 Net value of assets	37	0.00	752.53	0.00	542.45	0.00	-339.57	0.00	-181.32	0.00	245.40	0.00	889.51	0.00	1547.87	0.00	606.53	0.00	432.61	0.00	1747.33
4 Total assets, debts and net value of total assets	38	2071.84	2071.84	1173.05	1173.05	766.33	766.33	612.25	612.25	299.97	299.97	920.98	920.98	4059.12	4059.12	2085.27	2085.27	594.47	594.47	4212.97	4212.97

National wealth accounting for Hainan Province (market values)

Table 9-1-1

December 31, 1995

Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01	47.96	45.47	176.21	102.29	38.50	451.78	714.45	186.26	-69.55	644.90
1) Fixed assets	02	310.33	97.95	9.25	5.90	49.47	156.78	525.83	153.32	0.00	525.83
of which: on-going programs	03	58.76	19.83	7.36	5.32	3.39	0.00	69.51	28.54	0.00	69.51
2) Existing products	04	69.44	7.13	0.02	0.01	1.45	19.41	90.32	8.59	0.00	90.32
of which: end products and commodities	05	29.38	2.74	0.00	0.00	0.00	15.50	44.88	2.74	0.00	44.88
3) Other man-made assets	06	18.58	7.12	0.47	0.34	8.66	1.05	28.76	16.12	0.00	28.76
of which: intangibles	07	13.80	2.09	0.01	0.01	0.00	0.00	13.81	2.10	0.00	13.81
4) Net financial assets for overseas	08	-350.38	-66.73	166.47	96.04	-21.08	274.54	69.55	8.23	-69.55	-0.00
2 Natural resources	09	124.72	124.72	0.00	0.00	73.25	46.44	244.41	197.97	0.00	244.41
1) Resource assets	10	73.79	73.79	0.00	0.00	43.34	27.47	144.60	117.13	0.00	144.60
i) Forest resource assets	11	73.79	73.79	0.00	0.00	43.34	27.47	144.60	117.13	0.00	144.60
Forest land	12	12.01	12.01	0.00	0.00	7.05	4.47	23.53	19.06	0.00	23.53
Forest trees	13	61.78	61.78	0.00	0.00	36.28	23.00	121.07	98.07	0.00	121.07
ii) Other non-production assets	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Non assets natural resources	15	50.93	50.93	0.00	0.00	29.91	18.96	99.81	80.85	0.00	99.81
i) Forest environment assets	16	50.93	50.93	0.00	0.00	29.91	18.96	99.81	80.85	0.00	99.81
Forest land	17	8.26	8.26	0.00	0.00	4.85	3.08	16.19	13.11	0.00	16.19
Forest trees	18	42.67	42.67	0.00	0.00	25.06	15.89	83.62	67.73	0.00	83.62
ii) Other natural resources	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Human capital	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Total national wealth	25	**172.69**	**170.19**	**176.21**	**102.29**	**111.75**	**498.22**	**958.86**	**384.23**	**-69.55**	**889.31**

National wealth accounting for Hainan Province (market values)

Table 9-1-2

December 31, 2000

Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned Institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01	588.77	542.81	-339.57	-181.32	153.29	817.34	1219.83	514.78	432.61	1652.44
1) Fixed assets	02	723.19	469.87	54.29	44.31	137.66	303.88	1219.02	651.84	0.00	1219.02
of which: on-going programs	03	88.15	73.39	6.41	5.29	3.85	0.00	98.41	82.53	0.00	98.41
2) Existing products	04	197.04	81.44	0.00	0.00	0.21	22.84	220.09	81.65	0.00	220.09
of which: end products and commodities	05	57.00	16.00	0.00	0.00	0.00	5.01	62.01	16.00	0.00	62.01
3) Other man-made assets	06	201.98	58.23	5.39	4.25	2.00	4.14	213.51	64.48	0.00	213.51
of which: intangibles	07	67.99	44.45	1.79	0.00	0.00	0.00	69.78	44.45	0.00	69.78
4) Net financial assets for overseas	08	-533.44	-66.73	-399.25	-229.88	13.42	486.48	-432.79	-283.19	432.61	-0.18
2 Natural resources	09	160.77	160.77	0.00	0.00	90.43	70.85	322.06	251.21	0.00	322.06
1) Resource assets	10	62.01	62.01	0.00	0.00	34.88	27.33	124.22	96.89	0.00	124.22
i) Forest resource assets	11	62.01	62.01	0.00	0.00	34.88	27.33	124.22	96.89	0.00	124.22
Forest land	12	12.07	12.07	0.00	0.00	6.79	5.32	24.18	18.86	0.00	24.18
Forest trees	13	49.94	49.94	0.00	0.00	28.09	22.01	100.04	78.03	0.00	100.04
ii) Other non-production assets	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Non assets natural resources	15	98.76	98.76	0.00	0.00	55.55	43.52	197.84	154.32	0.00	197.84
i) Forest environment assets	16	98.76	98.76	0.00	0.00	55.55	43.52	197.84	154.32	0.00	197.84
Forest land	17	9.29	9.29	0.00	0.00	5.23	4.09	18.61	14.52	0.00	18.61
Forest trees	18	89.47	89.47	0.00	0.00	50.33	39.43	179.23	139.80	0.00	179.23
ii) Other natural resources	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Human capital	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Total national wealth	25	**749.54**	**703.58**	**-339.57**	**-181.32**	**243.72**	**888.19**	**1541.89**	**765.99**	**432.61**	**1974.50**

National wealth accounting for Hainan Province (ecological values)

Table 9-2-1

December 31, 1995

Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned Institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01	47.97	45.47	176.21	102.29	38.50	451.78	714.46	186.26	-69.55	644.91
1) Fixed assets	02	310.33	97.95	9.25	5.90	49.47	156.78	525.83	153.32	0.00	525.83
of which: on-going programs	03	58.76	19.83	7.36	5.32	3.39	0.00	69.51	28.54	0.00	69.51
2) Existing products	04	69.44	7.13	0.02	0.01	1.45	19.41	90.32	8.59	0.00	90.32
of which: end products and commodities	05	29.38	2.74	0.00	0.00	0.00	15.50	44.88	2.74	0.00	44.88
3) Other man-made assets	06	18.58	7.12	0.47	0.34	8.66	1.05	28.76	16.12	0.00	28.76
of which: intangibles	07	13.80	2.09	0.01	0.01	0.00	0.00	13.81	2.10	0.00	13.81
4) Net financial assets for overseas	08	-350.38	-66.73	166.47	96.04	-21.08	274.54	69.55	8.23	-69.55	0.00
2 Natural resources	09	336.95	336.95	0.00	0.00	197.89	125.46	660.29	534.83	0.00	660.29
1) Resource assets	10	183.21	183.21	0.00	0.00	107.60	68.22	359.03	290.81	0.00	359.03
i) Forest resource assets	11	183.21	183.21	0.00	0.00	107.60	68.22	359.03	290.81	0.00	359.03
Forest land	12	14.25	14.25	0.00	0.00	8.37	5.30	27.92	22.62	0.00	27.92
Forest trees	13	168.97	168.97	0.00	0.00	99.23	62.91	331.11	268.20	0.00	331.11
ii) Other non-production assets	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Non assets natural resources	15	153.73	153.73	0.00	0.00	90.29	57.24	301.26	244.02	0.00	301.26
i) Forest environment assets	16	153.73	153.73	0.00	0.00	90.29	57.24	301.26	244.02	0.00	301.26
Forest land	17	9.13	9.13	0.00	0.00	5.36	3.40	17.89	14.49	0.00	17.89
Forest trees	18	144.60	144.60	0.00	0.00	84.93	53.84	283.37	229.53	0.00	283.37
ii) Other natural resources	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Human capital	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Total national wealth	25	**384.92**	**382.42**	**176.21**	**102.29**	**236.39**	**577.24**	**1374.75**	**721.09**	**-69.55**	**1305.20**

National wealth accounting for Hainan Province (ecological values)

Table 9-2-2 December 31, 2000 Unit: 100 million RMB

	Code	Non financial enterprise		Fianancial enterprise		Government	Residence	Total within province		Overseas	Total
			State owned enterprise		State owned agency				State owned Institution		
A	B	1	2	3	4	5	6	7	8	9	10
1 Man-made assets	01	588.77	542.81	-339.57	-181.32	153.29	817.34	1219.83	514.78	432.61	1652.44
1) Fixed assets	02	723.19	469.87	54.29	44.31	137.66	303.88	1219.02	651.84	0.00	1219.02
of which: on-going programs	03	88.15	73.39	6.41	5.29	3.85	0.00	98.41	82.53	0.00	98.41
2) Existing products	04	197.04	81.44	0.00	0.00	0.21	22.84	220.09	81.65	0.00	220.09
of which: end products and commodities	05	57.00	16.00	0.00	0.00	0.00	5.01	62.01	16.00	0.00	62.01
3) Other man-made assets	06	201.98	58.23	5.39	4.25	2.00	4.14	213.51	64.48	0.00	213.51
of which: intangibles	07	67.99	44.45	1.79	0.00	0.00	0.00	69.78	44.45	0.00	69.78
4) Net financial assets for overseas	08	-533.44	-66.73	-399.25	-229.88	13.42	486.48	-432.79	-283.19	432.61	-0.18
2 Natural resources	09	491.80	491.80	0.00	0.00	276.64	216.74	985.18	768.44	0.00	985.18
1) Resource assets	10	159.43	159.43	0.00	0.00	89.68	70.26	319.38	249.12	0.00	319.38
i) Forest resource assets	11	159.43	159.43	0.00	0.00	89.68	70.26	319.38	249.12	0.00	319.38
Forest land	12	10.05	10.05	0.00	0.00	5.66	4.43	20.14	15.71	0.00	20.14
Forest trees	13	149.38	149.38	0.00	0.00	84.03	65.83	299.24	233.41	0.00	299.24
ii) Other non-production assets	14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2) Non assets natural resources	15	332.37	332.37	0.00	0.00	186.96	146.48	665.80	519.32	0.00	665.80
i) Forest environment assets	16	332.37	332.37	0.00	0.00	186.96	146.48	665.80	519.32	0.00	665.80
Forest land	17	10.06	10.06	0.00	0.00	5.66	4.43	20.15	15.72	0.00	20.15
Forest trees	18	322.31	322.31	0.00	0.00	181.30	142.04	645.65	503.61	0.00	645.65
ii) Other natural resources	19	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
3 Human capital	20	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
4 Total national wealth	25	**1080.57**	**1034.61**	**-339.57**	**-181.32**	**429.93**	**1034.08**	**2205.01**	**1283.22**	**432.61**	**2637.62**

Annex III: Explanation of the Indexes of the Integrated Forest Resources and Economic Accounting

1 Explanation of supplementary column index

1.1 ***Forest resources:*** refers to woody plant resources that is naturally formed within the country's sovereign scope, under certain economic and technological conditions, it could be exploited and utilized to raise people's standard of living and existing capacity and at the same time has certain scarcity. It includes forest land, forest trees and wild plants and animals in forest area. According to its correlation with the economy, forest resources are divided into forest assets and non-asset forest resources.

1.2 ***Forest assets:*** refers to forest resources that its ownership has been defined, at the same time the owner could effectively control it and could produce at present and in the foreseeable future anticipated economic benefits. Forest resource assets belong to the scope of economic assets. It includes forest land asset and forest tree asset (including bamboo forests), of which forest tree asset also includes cultivated asset and non-cultivated asset.

1.3 ***Cultivated assets:*** refers to the forest assets that produce products only once or repeatedly, but its natural growth or regeneration is not under direct control and management by institutions, it includes man-made forests, nursery and "four-around" plantations. Of which man-made forests with the property of stocks, such as timber forests and fuel wood forests, is called product of cultivated asset under manufacturing, while man-made forests with the property of fixed asset, such as protection forests, forest for special purposes and cash tree crops is called cultivated fixed assets.

1.4 ***Non-cultivated assets:*** refers to those forest resource assets, its products produced only once or repeatedly, but its natural growth or regeneration is not under institution's direst control and management, such as partial natural forests.

1.5 ***Non-asset forest resource:*** refers to partial forest resources that do not have the property of forest asset. It includes non-economic asset forest land, forest trees and wild plants and animals. Since forest resources has the ecological effects of soil and water conservation, oxygen providing and carbon fixing, air purifying and biodiversity, a number of forest resources do not belong to the scope of economic assets, but they have a huge positive effect to natural environment, and have important impacts on the raising of human's standard of living, thus they are called forest environmental assets. It includes non-asset forest land, forest trees and wild plants and animals within the forests.

1.6 ***Increase in this period:*** refers to the increase of the sum and structure elements of forest resource in the accounting period due to the impacts of economic and non-economic factors.

1.7 ***Natural increase:*** refers to the increase of forest land area and forest stocks of forest resources by natural growth rules; such as the increase of natural forest area and the natural growth of forest and other trees.

1.8 ***Economic increase:*** refers to the increase of man-made forest land and other forest land by economic activities such as afforestation.

1.9 ***Increase by classification and structure transfer:*** refers to numerical increase of the forest resource structure due to the changes of classification, institutional structure and forest resource structure.

1.10 ***Decrease of this period:*** refers to the decrease of the sum and structure elements of forest resources in accounting period due to the impacts of economic and non-economic factors.

1.11 ***Disaster damage:*** refers to the decrease of forest land or forest stocks by non-economic factors such as forest fire, pests and diseases.

1.12 ***Economic use:*** refers to the decrease of forest land or forest stocks by economic activities such as harvesting.

1.13 ***Decrease by classification and structural transfer:*** refers to numerical decrease of forest resource structure due to the changes of institution's classification, institutional structure and forest resource structure.

1.14 ***Net increase of this period:*** refers to the net increase of the sum and structural elements due to the impacts of economic and non-economic factors.

1.15 ***Regulative changes:*** refers to the variation of account that should be regulated due to the changes of technological and economic conditions, accounting approaches or data sources

2 Explanation of main column index

2.1 ***Forestry land area:*** refers to the area of land used for developing forestry; it includes the areas of arbor forest land and bamboo forest land with density over 0.2, open forest land with density over 0.1~0.19, shrub land with density over 0.3 and cash tree crops, nusery land, afforestation land with premature forest, cut-over land, burned land and lands that planned for planting by people's governments of county and above.

2.2 ***Area of forest land (forest area):*** refers to the area of forest land with arbor species, density over 0.2 (including 0.2), or of forest belts with crown width over 10m. It includes the areas of coniferous forest, broad-leaved forest, mixed forest and bamboo forest both natural and artificial, areas of shrubs and open forests not included.

2.3 ***Forest resource stocks:*** refers to stocks of standing trees of all species with above set diameter in a certain scope of forest land, including forest stocks, open forest stocks, stocks of scattered trees and the sum of "four-around" plantation stocks.

2.4 ***Natural forest:*** refers to those naturally grown forests with density over 0.2 (including 0.2).

Owning to the fact that the country's forest resources has been long-term interfered by human factors, the term of natural forest used nowadays is referring to forest naturally formed, including naturally sourced forests by hillside closing, artificial replanting and thinning.

2.5 *Man-made forest:* refers to those forests formed (3~5 years after planting or 5~7 years after air seeding) by seeding, planting or cuttage with survived number equal to or larger than 80% of designed figure, or with density over 0.2.

2.6 *Timber forest:* refers to the forests with the production of timber as the main goal.

2.7 Protection forest: refers to forests with the aims of water source conservation, soil and water conservation, wind resistance and sand fixing, protection of farmland and pasture and protection of embankment and road. Including farmland shelterbelts and all forest belts with density over 0.2 and crown width over 10m.

2.8 *Fuel wood forest:* refer to forest with the production of fuel wood as the main goal.

2.9 *Forest for special purposes:* refers to forests for war preparedness, environmental protection and scientific experiments. Including national defense forest, experimental forest, plus tree forest, environmental protection forest (air purifying and sound reduction for urban area, hospital and sanatorium), scenery forest, scenic spots and historical sites, memorial forest and forest in nature reserve.

2.10 *Cash tree crops:* refers to forest trees with the production of fruits, edible oil, drink, spices, industrial raw materials and medicinal herbs as their main goal.

2.11 *Bamboo forest:* refers to forest (both natural and artificial) that produce moso bamboo and other large diameter bamboo, small bamboo groves with diameter of breast height under 2cm not included.

2.12 *Open forest land:* refers to the area of arbor tree forest land with density 0.10~1.19. Cash tree crops and bamboo forest not included.

2.13 *Shrub land:* refers to the area of forest land of shrub species or shrub-type arbor species due to poor habitat and small bamboo groves with diameter of breast height under 2cm and the density over 0.3.

2.14 *Afforestation land with trees not grown up into forest:* refers to newly planted forest land (less than 3~5 years after planting or less than 5~7 years after air seeding), the number of survival trees equals or larger than 80% of designed number, it has not closed but is hopeful to be grown into forest.

2.15 *Nursery land:* refers to fixed land for seedling breeding.

2.16 *Land without forest:* refers to land that used to develop forestry , it does not qualified as forest land at present, nor to be open forest land, shrub land or afforestation land with trees not grown up into forest. It includes:

Waste hillside and waste land suitable for forest: land for forestry use including forested land, open forest land, shrub land and afforestation land with trees not grown up into forest that do not up to the abovementioned standards. Such as open land in forest, shrub land and other lands planned to be used to develop forestry.

Cut-over land: after cutting, the retained trees do not up to the standard of open forest and has not regenerated in 5 years.

Burned land: after burning, the retained trees do not up to the standard of open forest and has not regenerated in 5 years.

Desert land suitable for forest: refers to fixed and semi-fixed sand dunes and sandy wasteland.

Land prepared for planting: refers to land that site preparation has been made.

2.17 ***"Four-around" plantations:*** refer to trees around the village and on the side of road, water and house with density over 0.2.

2.18 ***Scattered trees:*** refer to high and big trees scattered in bamboos, cash tree crops and in the land without forest and in young forest.

2.19 ***Withered trees:*** refer to the stocks of trees that have been died but still could be used as fuel wood or raw material for fiber products.

2.20 ***Land not for forest use:*** refers to land that not belongs to forestry; it includes lands for agriculture, animal husbandry and water area.

Special Report: Proposals on Environmental Policy Framework of Tropic Forest in China

ITTO PD 39/38 Rev.2 (M)

1 Introduction

The area of tropic zone covers 1/3 of the whole land area of the world, where the tropic forest occupies over 40% of the forest area in the world. Tropic forest is the largest treasury of animal, plant and microorganism gene resources of the world. Experts calculate that there are 5~30 million species on earth, among these 50~90% of species exist in the tropic rain forest. The tropic forest is one of the most multifunctional and multi-value of the ecosystem. The tropic forest ecosystem is very exquisite and frail, which means once it is destroyed, it will be hardly resumed. Tropic forest is the important underpinning of keeping the ecological balance of biosphere. Destruction of tropic forest will not only decrease the variety of biology, but also lead to the loss of water and erosion of soil, and climate warming-up. The environmental policy research of tropic forest, which is the most complex, refined, and frail of forest, will insure the sustainable management of the forest ecosystem.

The tropic zone of China locates at the edge of north Asia, which is from east longitude 123° nearby south Jingpu of Taiwan Province, to east longitude 86° nearby Yadong, Nielamu of Tibet; It extends to north latitude 21°~24°. The land area of Chinese tropic zone is about 0.308 million km^2, which is almost 3.2% of the whole country's area. It possesses 25% of the total number of the domestic species, and 25.8% of the whole ecosystem types in China.

There are three parts of Chinese tropic forest: one is eastern transitional tropic season rain forest section, which includes southeast of Fujian Province, south of Guangdong and Guangxi Provinces, and middle south of Taiwan Province; The second is western transitional tropic season rain forest section, which includes south of Yunnan Province, and river valley of south Tibet; And the third is southern tropic season rain forest section, which includes Hainan Island and Nanhai Islands. At present, Chinese tropic forest only distribute in Hannan Island, south of Yunnan (mainly in Xishuangbanna), and a few in southeast of Tibet river valley. Chinese tropic forest locates at the furthest north of tropic zone, which is precious natural legacy. Two existent natural tropic forests in Hannan and south Yunnan locate at the transitional section of dry and wet tropic climate alternately. Their quantity of heat and moisture as well as their habitation are all at the edge of tropic rain forest. If the use of forest resources were not irrational, vegetation would be in converse succession soon, and then diversity of biology would decrease sharply. Species resources of Chinese tropic forest are only inferior to Brazil and Malaysia. And the tropic forest not only has key function of keeping the local natural ecological balance and accelerating local economics development, but also has profound effects on keeping species resources. It deserves the protection value of the whole world.

Chinese tropic forest was havocked during the past several decades because of the historical reasons and unsuited national forest policies, such as changing forest lands into farming lands in large scale, predatorily cutting, and nature disasters. The great decrease of natural tropic forest has led to the depravation of the local environment, and natural disasters occurred frequently. The several decades' forest economical mechanism of our country still remains with free exploitation, pay attention to take from forest rather than invest, as a result the development of forest cannot sustain. With the reform, some policies of controlling forest cutting and compensating forest resources were being adopted. However, the policies still cannot reflect the value of these natural forest resources. We have admitted the value of growing stock, but it is not enough. We are far from admitting the whole value of forest, including the value of environmental resources. In recent years, although we have some degree of amelioration, but basic mechanism is still not rectified, so that we should change the actual forest environmental policies.

2 Theory base of forest environment policy

Forest environment policy is based on the principle of forest sustainable development, which abstracts from concrete forest environment policy, and guides the establishment of general forest environment policy. As a new theory system, sustainable development stratagem gradually comes into consummate. Its meaning and character also cause abroad attention and discussion throughout the world.

2.1 Basic idea of sustainable development stratagem

Sustainable development is an integrated conception relate to economy, society, culture, technique and environment. It is a stratagem establishing on environment and natural resources concerning the long development of human beings, and emphasizing on the ability of carrying capacity of environment, as well as sustainable using of resources. Its basic ideas mainly include three aspects:

2.1.1 Encourage economic increase

It emphasizes the necessity of economy increase, in order to enhance welfare level, national strength and social wealth. However sustainable development concerns not only the quantity, but also the quality. The increase of resource quantity is limited, so that we should depend on the development of science and technique to improve the benefit and quality in economic activity, and adopt scientific increase way are sustainable. We need scan over again the way of using energy sources and raw materials, change the traditional model of "high investment, high consume, high pollution" into clean production and moderate consumption, thus we can reduce the environment pressure, which came from economic activity. Environment degradation derived from economic activity, so that solving the problem also depends on economic development.

2.1.2 Sustained using of resources and favorable environment

The development of economy and society cannot be beyond the carrying capacity of resources and environment. Sustainable development is based on natural resources and harmonizes with environment. To realize the sustainable development, we must make the exhausted speed of natural resources slower than the rebirth speed, and change the immoderate development mode, solve the environmental problem radically. If we can consider the environmental factors in the economy decision, the sustainable aim will be attained. But if we deal with it unsuitable, the cost of degradation will be very great, even counteract the fruit of economy increase.

2.1.3 Goal of comprehensive progress of the society

Development is not only an economic problem, which means sustainable development cannot be realized by simply pursuing the production value. The phases and aims of development can be different in different countries, but the essence of development should include advance the living quality and the health level of human beings. It means that economic development is the base, nature protection is the condition, and society progress is the aim. As long as we can harmonize with economy, resources and environment in each phase, the society can be sustainable development. It is obvious that the common aim of human being is the persistent, stable, healthy development of nature- economy-society system.

2.2 Externality

Externality means the external effects that generate beyond the subject of economic activities, which the effects are not reflected by price system, so externality can bring out social cost that does not include in private cost. Externality can be classified into positive and negative. From the theory, the ultimate reason of externality is the lack of explicit property right. Ronald Coase pointed out that if the property right is owned by private person, who can bargain for a competitive price, then there is no problem of externality and resources can be effectively allocation. Because it is difficult to delimitate property right, environmental pollution is caused. For instance, air is not exclusive, so its property right cannot be delimitated. Government should interfere to change social cost into private cost. It is called as internalization.

2.3 The sustainable conditions of forest management

Forest resource becomes a production factor that means it will be used up, and loses the value of environment. Therefore, we can propose one of the sustainable conditions of Available Amount of Forest Resource as:

$$\mathrm{AAFR} > 0 \tag{1}$$

Based on the principle of sustainable development, cost includes not only productive cost, but also environmental cost, such as using amount of resource, the price of ecological degradation and damaging human health, pollution control and administrative fees. Thus, it can be expressed:

$$\mathrm{NBEE} = \mathrm{GP} - \mathrm{PC} - \mathrm{EC} \tag{2}$$

In (2), NBEE means Net Benefit of Economy and Environment; GP means Gross Production; PC means Productive Cost; EC means Environmental Cost. Economic activity can be accepted only when NBEE>0. In the view of this, the second condition should be:

$$\text{NBEE} > 0 \tag{3}$$

To sum up, an environmental resource could enter its economic system only when it meets conditions of (1) and (3). At the same time, it means that there is a "taboo" of using forest environmental resources, which can be divided by absolutely and comparatively.

Absolutely forbidden condition is AAFR≤0. For example, natural protection areas and ecological fragile zones are situated up stream, where the quantity of forest resources is lower than or not as high as their ecological threshold. Thus, available amount of forest resource could be less than or equal to zero, that means that any economic activity should be absolutely prohibited. Otherwise, it will lead a disaster to this resource or its ecosystem.

Comparatively forbidden condition is AAFR>0 and NBEE≤0. It means, although available amount of forest resource is above zero, the net benefit of economy environment is less than or equal to zero, so it is prohibited too. We call it "comparatively", because as long as the technique and management are improved, and other economic activities cause the net benefit of economy environment above zero, this environmental resource could enter economic system. Entering by force under the comparative condition will lead resources destroy and ecosystem retrogression, and make environment resources become an absolutely forbidden situation. The cutting and utilizing of some wild woods belong to the situation of comparative. Hereby, AAFR>0 and NBEE≤0 accord with the feeble sustainable condition of forest management.

Under the condition of not considering environmental values, the phenomena of violating absolutely and comparatively forbidden largely exist. In other words, nowadays' condition of resource and environment is the result of still following the traditional conception of natural resources. Nowadays, there are not only violation of absoluteness, but also even more violation of comparativeness in economy of all the countries. This means the value judge of marketing mechanism is GP–PC>0, and EC is excluded. As a result, although NBEE probably lower or further lower zero after EC introduced, but the choice came from the market also according to the result of GP-PC. If the market mechanism could not improve and admit the environment price, then its infection to environmental situation will be negative. Therefore, condition of NBEE=GP–PC–EC>0 accords with strong sustainable of forest management.

China not only hold large base of population, but also is great in population increase every year. A person must consume some economic and environmental resources daily, so the factor of population should be considered when we think about sustainable problem on economy and environment. Thus, the formula can be established:

$$
\begin{aligned}
R &= (R_1 - R_0)/R_0 \\
&= \Delta R/R_0 \geq 0
\end{aligned} \tag{4}
$$

Or

$$
\begin{aligned}
R &= \frac{R_1}{R_0} - 1 \\
&= \frac{(GP_1 - PC_1 - EC_1)/P_1}{(GP_0 - PC_0 - EC_0)/P_0} - 1 \geq 0
\end{aligned} \tag{5}
$$

In (5), R is the integrated sustainable developmental index, R_1 is the current per capita net benefit of environment and economy, R_0 is the former per capita net benefit of environment and economy, GP_1 is the current gross production value, PC_1 is the current production cost, EC_1 is the current environmental cost, P_1 is the current population, GP_0 is the former gross production value, PC_0 is the former production cost, EC_0 is the former environmental cost, P_0 is the former population. From (5), condition of $R \geq 0$ accords with the integrated sustainable development of population, resource and environment.

According to these conditions, commonweal forest and multifunction forest, especially those upriver forest on the great river, are all belong to absolute and comparative forbidden. But to create an admittance condition, people can make the forest felling cycle long enough, like one or two hundred years. If do so, it can be met with admittance condition of (1), (3). Moreover, the long cycle of moderate cutting is permitted by the rule of "environmental capability", and it is low cost and high net benefit. To build artificial industrial forest, we should produce timber intensively in the area as small as possible. It is a tactic choice of entering economical system because of the low cost and high benefit. On the other hand, we should control the increase of population, especially those fragile zones. The main frame of forest environmental policy has been given from condition (5). We should account the external value of EC first, because accounting of tropic forest ecological value is the precondition of carrying out policy of tropic forest environment. Then, we should depend on the all possible strength of government and market to change the external value of environment cost into internal cost. By doing so, the actual power of encouragement and control of building and protecting environment can be formed. At the same time, we should pay attention to the economic development of tropic forest zone, improve the value of (GP–PC), and control the population or carry out the policy of ecological emigration in ecological fragile zones. As a result, P_1 can be reduced.

3 Comparing analysis of the environmental policy

For scores of years, the mankind has begun to ponder over its developmental style comprehensively because of the sharply increasing of population, the destroying of ecosystem, the deteriorating of environment and the obstructions of economic development. Since 1970s, a series of law documents of international environment have been formed in the world, such as United Nations Declaration on the Human Environment, Nairobi Declaration and Rio Declaration on

Environment and Development. At the same time, many international environmental protection conventions produced, such as United Nations Framework Convention on Climate Change, Vienna Conservation for the Protection of Ozone Layer, Montreal Protocol on Substances that Deplete the Ozone Layer, Convention on Long-range Trans-boundary Air Pollution, United Nations Framework Convention on Climate Change, International Convention for Bird Preservation, International Convention for the Protection of Plants, Convention on International Trade in Endangered Species of Wild Fauna and Flora, Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Convention on the Conservation of Migratory Species of Wild Animals and United Nations Convention on Biologic Diversity.

Environment law system of each country also been influenced by international environment documents in different degree. Compared with other section law, its formation is late, but development is quick. Each country regards written laws as principle environment law. At present, the United States, Britain, Germany and Japan are representation in this field.

Our country already established Environmental Protection Law as a fundamental law. In China, issue amount of environment and nature resources laws is not less than the developed country. Besides the environment protection basic law, government branch and each local government have established a series of environmental and natural resource laws.

3.1 Different and similar viewpoint of the environment right

Right is the core of the law relationship. Traditional environmental law is derived from pollution prevention laws, which main content is to restrict human special action. Along with the gradually serious environment pollution, especially after Second War the idea of human rights is developed in the western, international community concentrates on making use of the technique means to solve pollution, and on the other hand works hard to seek environmental theories and laws. Accompanying with this kind of situation, the concept of environment right has been established. The discussion and research on rights started from 1960s, and developed in 1970s, and become one of the most important contents of human rights presently.

As for the concept of the environment right, the basic viewpoint of Chinese scholars is consistent. They think environment right is a basic right related to possessing the feat health and living environment, as well as reasonable using natural resources. Yet in the process of establishing environmental law, appraise of environment right is always in a disorder situation. Some scholars think that is an environmental administration right of government, others think that is a trade right of pollution, but most of the scholars believe that the environment right is a basic human right, which core is a right of human subsistence.

Environment right should include the environmental administrative right of government and the basic human right of environment. Establishing environment right is the request of solving environmental problem, which is consistent of all around the world. However, the question is how to harmonize the relation between the environmental administrative right of government and the basic human right of environment. The environmental infringement will result in the clash of the benefits of every group. If ceasing economic activities of pollution enterprises the economic development of society will be damaged; if not, public hygiene could not be protected, which will cause the social unrest and be harmful to social economic development in the end. Furthermore, environment destruction and resources overusing will not only infect the present interests, but also the future interests. Because of the reasons of history and national situation, environment right of our country always gives priority to government, so that we should change the situation and make a balance between the environmental administrative right of government and the basic human right of environment.

As a national law system, people should have more widespread rights, which include the environment right. We should fix the position of civil environment right on the constitutional foundation, and put it together with property right in civil law. Particularly we can learn from the overseas' experiences of legislation and justice, endue citizens a request right based on property right. According to the principle of return duty, we could adopt duty-inferred rule and no fault rule, as well as improve its legal pitch.

3.2 Environmental lawmaking lagging

In China, many environmental laws established in the 1980's, did not meet the requirement of sustainable development. Along with the development of modern environmental idea, the majority nations alleged to protect human health, and keep a sustainable development of economy and society. Most countries are favorable to ecological benefits in their national legislation, as well as change their protection aim from the present age to offspring and ensure the environmental safety. But our country still stays around the traditional purpose of environmental protection. Moreover, we lack of a synthesis law to adjust environment and natural resources. Meanwhile, it is an objective request that environmental law joins with nature resources law.

3.3 Insufficient protection efficiency of nature resources law

Modern environmental law primarily has two main missions: One is protecting human health and keeping environment from pollution; the other is protecting the ecosystem and making use of nature resources in a reasonable way. Therefore, the protection of the ecosystem and nature resources should be enhanced in fundamental law, but there are little contents of the protection of ecosystem and nature resources in which. For some reasons of environmental legislation, each branch of government used to emphasize their own environmental problems, so the whole effect was not obvious in protecting environment and natural resources.

3.4 Favorable to protective function of government administration

Our country is favorable to protective function of government administration, and the function is enhanced continuously. The participation of public in protecting environment and natural resources is weak according to environmental laws. The reasons can be attributed as follows:

The first problem is lawmaking mechanism. Legislation attaches importance to administrative right of government and law duty of administrative objects, while public right and social benefits are ignored.

The second is that Legislation emphasizes the decrease of pollution rather than protection of environment and natural resources. Because lack of the regulations about public's participation in environmental and resources protection. As a result, enforcing law was insufficient finally.

The third is man-made reason. In China, the protective department of environmental resources is divided, such as land administrative bureau, forestry administrative bureau, ocean administrative bureau, water conservancy ministry...etc. Each government department excessively emphasizes their own administration and attaches importance to economic benefits rather than environmental benefits.

3.5 Judicial deviation

In china, the law usually puts into practice by executive rules, which were made by administration organizations. According to the law, civil cases of environment are accepted by count only after the treating of environmental administration, especially the pollution cases. As a result, environmental justice becomes a supplement of environmental administration.

The civil law and relevant other laws are not perfect in duty returning, duty free and relief of environmental infringement. On the other hand, our criminal law about environment and nature resources is lack of efficient quantity standards and justice explanations, which will impact the exact punishment. Furthermore, the criminal laws pay more attention to the harmful outburst affairs and behavioral person than the harmful process of damaging environment. Thus, we should further research the policies of environment and natural resources.

4 General questions of tropic forest policy system design

The aim of the sustainable development of forestry should be expressed as some forms. Policy is one of important forms. Policy is an integrated system, but isolated and scattered system. Only when its inner logic is grasped, an integrated and effective policy system can be established.

4.1 The target of policy

The target of policy is to internalize the external benefits of tropical forest, to compensate the external benefits, and to implement sustainable development in tropical forest.

4.2 The principle of policy

4.2.1 Effectiveness

Effectiveness is a successful degree, which the policy can meet the environmental target. That means whether the environmental policy can prompt environmental construction and prevent environment from destruction. For instance, the policy which allows the charges of disposing pollutants lower than the cost of harnessing them and subsidy which cannot compensate the cost of forest management can be all attributed to inefficient policy.

4.2.2 Efficiency

Efficiency means to achieve the policy target at the lowest cost as possible as we can. The cost of environmental policy may be represented by decreasing of sale profit of some forest products and income of local finance, losing of employment opportunities and increasing of administrative cost. For example, both trade of pollution right and drainage charging is effective, but both of the implement costs are not the same. Cost of the former is apparently lower than the latter. Therefore, the former is more efficient than the latter.

4.2.3 Justice

Forest environmental policy must be based upon the matching of right and obligation, as well as consider justice between intra-generational and intergenerational. Justice in one generation must be judged according to the allocation decided by the market. If the allocation decided by the market is already justified, environmental policy should not interfere with it as possible as it can. If not, for example, when there is external environmental problem due to market failure, the reallocation function of policy must be exerted to rectify the allocation structure, until it matches our demand of justice. As for the intergenerational justice problem, we should ensure that every generation in the future has the same right using resources. At least the recoverability of the natural resources should not be destroyed.

4.2.4 Elasticity

Elasticity means adjustability can be established, which can adapt the change of economy, technology, politics and environment. For instance, the target of ecological compensation is to change the people's interest structure of economy or ecology in forest regions, while the structure changes with the change of timber price, silvicultural cost, felling cost and inflation rate. Otherwise, tropical forest regions in China extend for thousands kilometers and cover seven provinces where different provinces have different situations. The implement of environmental policy is a process to reify the policy targets, which requires that we should take different steps according different situations and local conditions respectively.

4.3 The implement condition

In order to ensure the environmental policy can be implemented successfully, such conditions must be considered before establishing policy:

4.3.1 The acceptance of policy

The implement of forest environment policy will influence the interests of some departments, regions and groups. The groups whose interests have been influenced will adopt some countermeasure. When the counter power is strong enough to influence the process of political decision, the policy may be amended or even be abandoned. Therefore, when we consider whether forest environmental policy can be implemented successfully, it is necessary to evaluate its political and social acceptance. Since 1999, china government has already completely banned the commercial cutting of natural tropical forests, but the problem of sustainable management of the tropical forests is not resolved entirely, because the most distinct problem is that the goals of government, local enterprise and individual are disaccord in protecting natural tropical forests.

(1) The target of center government

Center government is firm and positive in protecting natural tropical forests, and has taken environmental construction as one of the basic national policies. The target of government is to protect natural tropical forests as ecological resource, and to lower protection cost as less as possible on the premise that the ecological security is satisfied. The main steps include forbidding commercial cutting of natural tropical forests, preserving biologic diversification, and improving ecological habitation in order to protect and restore the natural tropical forest.

(2) The target of local government

Economic developing level, especially the state of financial income, is the main achievement standard for local government, which can lead some local governments mistreating with the relation of economic development and environmental construction, as well as the relation of present benefits and future benefits. Thus they either develop local economy at the cost of depleting forest resource and devastating environment, or ignore the cultivation and protection of tropical forests.`

(3) The target of forest plantations

The target of enterprise is to increase its profit and competitive capability. A few forest plantations in tropical forests regions were in such a dilemma of economic distress and resource scarceness. Some of them do not make profit from self-reformation, but regard the fund using in cultivation and protection of tropical forests from government as a chance for them to avoid or reduce the market competitive risk. For this misunderstanding, some of them will only protect tropical forests as ecological resource, and ignore the exploitation of biologic diversity in tropical forests on the premise of sustainable management. The main problem of forest plantations is to release themselves from economic distress. Therefore, if there are no other coordinated policies, the economic problem of plantations will also influence the implement of the policy to cultivate and protect tropical forests.

(4) The target of forest farmers

Forest farmers attached the most important problem to their survival. They try to make food by using agricultural land and forest resources, and their target can be simplified as their expectation to increase income. To protect tropical forests involves returning some farming land to forest and preserving some lands which belong to farmers as reserved land for environmental protection, all these will cut off farmers' economic chain to make living on tropical forests. If the farmers have not been compensated appropriately, their life conditions will be worse than before. For instance, there are the largest groups of wild Asian elephants in Xishuanbanna of Yunnan province. The elephants destroyed many local crops, but the local government had not compensated the farmers appropriately. If we cannot harmonize with the relation of protecting tropical forests and increasing living standard of local farmer, the conflict between these targets cannot be avoided.

The result may lead the sustainable development of tropical forests to failure.

4.3.2 Corresponding legislative guarantee

Environmental policies will gain the validity and authority, only if there is a premise of corresponding legislative guarantee. Therefore, when establishing environmental policies, we must seek the support of legislative system firstly. If some environmental policies are in the discord with present legislation, unless the related part of law is amended, the policy cannot be carried out. There already had been precedents abroad. For example, in some countries the constitution allows only one tax can be imposed upon one trade. Therefore, under this constitutional system, to impose environmental tax upon any producing or consuming activity that has been imposed is illegal and cannot be implemented. On the other hand, even if the environmental policy being drawing up is not in discord with present legislation, it also must be legalized and be endowed with policy validity. This legislation guarantee not only affirms the validity of the policy, but also authorizes the department to wok out implement details and management rules of the policies.

4.3.3 The harmonization of policies

Environmental policies will finally participate in national economy and exert macro-adjustment functions. Officials of some departments and local governments worry about those environmental policies, such as the ban of natural forest cutting and environmental tax will decrease local finance income and reduce market competitive capability of local products. Therefore, when we establish some of the environmental policies, coordinated policies should be settle down. For instance, when carrying out the policy of forestry classified management which classified forests into commonweal forests and commercial forests, we should settle down the compensatory policies to subsidize ecological benefits of commonweal forests.

4.3.4 Coordinated regulations and institutions

Essential regulations and institutions are necessary to implement environmental policies successfully. For instance, if implementing ecological taxation, it is necessary to form detailed rules and charge criteria, as well as to set up supervising institutions to check the collection of tax and the use of revenue.

4.3.5 The feasibility of management

The feasibility of management can influence not only the choices of the environmental policies, but also their implement. For example, in 1992 Holland government combined five kinds of environmental tax into a single, because the tax had so many sorts and was difficult to manage. In our country, a drainage license system is being carried out. Due to hardly handle the technique, the system holds back its popularization in many regions.

4.3.6 Corresponding data

Necessary data is still the important condition to establish and implement the environmental policies. If adjusting environment management on an optimized level, a manager must establish an information system of environment.

5 Policy of forest environmental accounting

To internalize the external benefit of forest, the external benefit should be measured firstly, which is necessary for compensating ecological value of forest. From the 1980s, with the further knowing of environmental problem caused by economic development, people connect environment with development, and look for a long sustainable economic increase and social development. All these have become the common understanding of the international community.

Nowadays' system of national accounting is available as measuring economic activities in short term, but invalid in long term. In current accounting system there are two defects: ignorance of the short of natural resources, which can endanger the capability of sustainable production; ignorance of the decrease of environmental quality, which can jeopardize human health and welfare. These defects also cause false increase of GDP and mislead the effective allocation of resources. Hence, establishing the accounting system of forest environment will benefit environmental construction and restrict ecological destruction.

Forest environmental accounting means that forest environmental material and service are endowed with currency value, which includes both of physical accounting and value accounting. Physical accounting is the base, while value accounting is the key. Value accounting includes tangible resources and intangible ecological value. All the problems of pollution, resource exhaust and ecological breakage should be reflected in the system of national accounting by value. Establishment of forest environmental accounting policy can measure the true value of forest resources and environment, and change current accounting system that only taking exploited cost of resources as the price of resources. As a result, resource price should include exploited cost, breakage cost and the future user cost.

Thus we can give currency value to forest environment and compare forest environmental value with other social commodity by a uniform ruler. It is convenient for government to measure the environment prices and benefits of social economic activities. Meanwhile it will be a foundation of carrying out compensation policies of forest environment. On the other hand, although Chinese financial power is not strong enough, but there are still more than ten billions invested into environmental construction every year. With the arousal of ecological recognition, manmade capital will shift to natural capital in large scale. The accounting of forest ecological benefit is useful for people to check up the efficiency of investment of forest environmental construction from manmade capital.

The research aims of forest environmental accounting include: ①The flux and stock which relate to ecology should be separately shown in the SNA; ②Physical resources account and currency environmental account should connect with the balance sheet; ③The loss and benefit of environment should be evaluated; ④The upholding of physical fortune should be given a special account; ⑤The traditional indexes of output and income should be adjusted with environmental value. All of them will be showed in SEEA. The improvement of SNA can reflect the cost of natural resources consumption and the cost of environmental depravation, and also reflect fees of environment preventing and resources compensating. The accounting system will get 4 indexes: first is GDP; second is NDP_1 (traditional NDP) ,which from traditional GDP minus fixed capital; The third is NDP_2 (NDP_1 minus environmental consumption or plus the new benefit of environment); fourth is NDP_3 (NDP_2 minus fees of environmental protection and defending). This is "green" GDP meaning.

6 Gross control policy

At present, the most important measure in China to insure sustainable using of forest resources is gross control. That means strictly control the cutting quantity of forest according to the rule of its consumption lower than its production. Chinese Forestry Administration Bureau has established the cutting quota, which approved by the State Council, as well as the quota is adjusted five years once. The concrete policies include limited cutting policy, planned cutting policy, as well as warranted cutting, transport and management policy, etc.

Under the condition of lacking of forest resources supply, the design intention of this policy is to satisfy the need of forest ecology with reduction of timber supplies. But the cost is great, because the biggest disadvantage is that it confused the difference of management aim on environment and business. Thus most commercial forest could not realize the optimized allocation by market rules, and its development badly obstructed.

7 Area control policy

Now, China has adopted a strategy of forest-classified management. According to the purpose of forest management, we divide forest into commonweal forest and commercial forest, and carry out the policy of classified management. We manage part of forest to meet pure economic aim, and the other to meet pure ecological aim.

Classified management is actually a regulation and control of forest area. Comparing with gross control policy, there are some differences in area control policy as follows: firstly, it can interdict the possibility of substituting ecological use with economic use, and insure sustainable development of human beings. Secondly, it is convenient to identify the management aim of commonweal and commercial forests, because the former is to improve the environmental quality, and the latter is the profit. These lead difference in species allocation, foster way and cutting intensity. Thirdly, ways of regulation and control are also different, because the former attach most importance to government control, and the latter attach to market regulation. Therefore, while strengthening commonweal forest management, gross control of commercial forest cutting limited should be softened, as well as commercial forest can be distributed effectively by the rule of ultimate profit.

8 Property policies of environmental resources

Property policy of tropic forest is the core of environmental resource reproduction and a big problem, which most farmers pay much attention to. Most destruction of tropic woods and forestlands are connected with forest property. Because of historical and practical reasons, our forest property changes frequently, which leads realistic and potential dispute. Because the property is not distinct, forest plantations and farmers lack of enthusiasm to product and manage forest.

Therefore, establishment of the property policy should emphasize the stabilization of forest property, and keep the legal rights and interests of owners. Only if the properties are definite, their rights and obligations can be protected and supervised by laws. When forest plantations and farmers can count on forest to increase its value, they will sufficiently exploit kinds of available benefits of forest in positive and creative way. The stability of property will directly affect the credibility of government policy and the sustainable development of forest environmental resources.

9 The internalizing policy of government

9.1 Subsidy of forest ecological benefit

Currently, Chinese government has pushed the subsidy system of forest ecological benefit in commonweal forest, and the funds directly come from public finance budget. It is an important government behavior of internalizing policy. For lack of forest environmental accounting, compensating standard is not reasonable, the compensation standard is RMB 75~150 per hm^2 per year. The standard is too low and could not compensate the management cost of commonweal forest, which will transmit the huge task of building environment to forest farmers, and actually request these poor people who have not solved the problem of dressing warmly and eating their fill bear the important task. Motive lack of material benefit will lead unsustainable development of economy and ecology in tropical forest. Therefore, establishing a reasonable compensation standard and compensation mechanism are urgent affairs in building tropical forest ecosystem.

We must considerate the compensation bases of ecological benefits. There are three bases of compensation in theory. The first is based on amending economic externality, which means the fittest compensation standard of forest ecological benefit is equal to the marginal benefit of each unit on the premise of most suitable resources allocation. According to this, government might return funds to ecological construction units with compensation, and change economic externality to internal economic motive of them, which entirely accords with the fair principles. However, according to the principle, the compensation standard seems to be too high. Japan forest service calculated seven kinds of ecological benefits in 1978 and the evaluation value was 91 billion dollars. In 1999, the forest resources and environment value of Beijing was estimated by Beijing Forestry Bureau and Chinese forestry Academy, which value is RMB 231,337,000,000. We cannot burden so high compensation under this standard. The second is that average management cost could be taken as compensation standard and the compensation per hm^2 per year should not lower than this standard annually. The standard maybe feasible under planned economy, but it is too low under market economy. The third is that a reasonable compensation standard should be in the middle of above standards, and under the steady economic condition of forest ecosystem. The conditions are as follows:

Forest ecological compensation > average management cost+ average timber sale profits

The compensation rate should be appropriately adjusted according to management cost and timber sale profits, as well as the state of economic development in different regions. If the standard was too low, the excessive cutting mechanism of forest will still exist. When economic lever is invalid, the administrative lever and even law lever will be introduced, which increases government cost in large degree. Moreover, we should consider not only the area of ecology, but also the quality of ecology, because ecological benefit lies on the ecological quality in large degree and not simply equals to forest area. Furthermore, the more ecological quality is, the higher ecological compensation is, which can guide forest plantations to pay more attention in ecological quality, but quantity.

9.2 Appropriation of forest stress projects

A huge sum of funds to establish ecosystem in tropical forest come from government appropriation for forest stress projects, such as natural forest protection project, returning farming land to forest land project, wild animal and plant protection project, as well as natural protected area project. Appropriation for these national stress forest projects shares 90% of funds of building ecosystem in China. Since the projects are in large scale, vast terrain and long period, government directly led them in programming, design, investment and organization. Chinese government still undertook the long-term and low interest loan of USD 300 million from the World Bank, which was all invested in forest projects. Appropriation for forest stress projects plays a crucial role in protection Chinese tropic forest. But there are two big problems which do not be resolved about the projects. The first is lack of ecological benefit audits fore-and-aft project construction. Independent audit organization rather than forest administrative department should carry out the audits. Since there is a lack of audit, we cannot give convictive data of ecological benefit. It will lead a fluctuation of the confidence of government in vast amount investment. The second is appropriation of projects has limit time. When these projects end, Chinese tropical forest will again face a lack of enough funds and cannot keep its sustainable development. Thus, we should take a precautionary step to build a long and stable environmental financing policy in China as early as possible.

9.3 Establishment of forest ecological taxation

Government must intervene in the construction of forest ecosystem in order to protect the environment and restrain the destroying of forest ecosystem. By virtue of tax, we should levy forest ecological tax on units, which take advantages of forest ecological benefit. By doing so, funds can be effectively returned to ecological construction units and the external economic effects of forest can be changed into internal motive of the construction units. We should also levy the tax on units, which consume and destroy the forest ecological resources and cause a result of uneconomic externality in order to stop unfriendly behavior of destroying ecosystem.

Forest ecological tax includes many virtues such as mandatory, normative and efficient. However, forest ecological tax has its limitations just like other things. Since tax belongs to the law category, National People's Congress must strictly review its establishment so that the process is rather slow. Next, determination of tax rate should be based on technological standards of forest ecological benefits, while forest ecological technological standards, like ISO, have not been formed at present in China. Furthermore, government usually cannot adopt the principle of funds earmarked for the special purpose. However, it is possible that forest ecological tax partly becomes a tax category of earmarking a fund for its specified purpose. At present there is a tax of maintenance and construction of city which has the feature of earmarking a fund for its specified purpose in China. In overseas countries, funds come from environment tax firstly ensure expenses used in environment administration and construction, and then compensate financial deficit or use to arrange unemployment. Certainly, there is a possibility that forest ecological tax firstly breaks through in some tax items, because the urging demands of sustainable development will accelerate the possibility in great degree.

Comparing government budget of compensating forest ecological benefit with forest ecological tax, it is available that ecological appropriation is taken from government budget because ecological benefits possess the character of public consumption. Presently, the subsidy of forest ecological benefit can be attributed to the compensation of government budget. This method can make up forest ecological benefit, and correct its positive externality, which is more feasible than forest ecological tax. However, the most defect of the subsidy is that the destructive behaviors cannot be punished and the negative externality cannot be corrected. Besides, the method cannot get hold of enough and stable compensation of ecological benefits. With the improvement of domestic ecological consciousness, environmental demand will increase quickly, which will lead a big gap of ecological appropriation. Forest ecological tax can amend not only positive externality but also negative externality, and can also ensure the funds of ecological construction in a top priority. Therefore, establishment of forest ecologic taxation will create a long and stable environmental financing mechanism in China.

9.4 The loan of deducting interest

From 1985, Chinese government has successively provided several loans of deducting interest, such as forestry projects loan of deducting interest, forest industry diversified economic loan of deducting interest, as well as controlling sand loan of deducting interest. The sum of the three loads was 3 billion RMB with a length of maturity of 1~7 years, and center and local government paid the deducting interest respectively. The long-term forestry loan of deducting interest should be insisted and expanded in reasonable degree.

9.5 Reducing or remitting tax and fee

In order to encourage the exploitation of barren mountains and develop forestry, the policy of reducing or remitting forestry tax and fee is established in China. For example, forestry income which is obtained in exploited wasteland and enlarged forestland will exempt agro-special product tax of 1~3 years when the income is got; forestry income which emigration farmers obtain in exploited wasteland will exempt agro-special product tax of 3~5 years when the income is got. Moreover, according to the appeal of reforming country taxes and fees, China will gradually cancel the agriculture special product tax of log and bamboo, and abolish kinds of irrationality fees, which were collected from forest farmers and operator. The imposition, management and using of silvicultural funds should be reformed. The collected silvicultural funds should all be returned to forest operator gradually. The funds gap of local forestry administration will be solved by public finance.

9.6 Remittal of turning over profits

During the period of forest upbringing, the state-owned forest plantations need not to turn over their profits, called as keeping woods with woods, which can be actually attributed to a hidden compensation of internalizing policy of government.

10 The market behaviors of internalizing policies

Since inefficiency caused by externality relates to the absence of corresponding resource markets, so government should create environmental market in some corresponding fields, such as property trade market, license trade market and market of public calling for bids on ecological projects.

10.1 Property trade

Coase (1960) thinks that when all sides can bargain without cost and the property is delimitated, the final result is efficient. In many cases property trade can internalize externality, no matter how property is allocated initially. To illustrate the situation, we suppose that there are a hydropower station and a forest plantation upstream. The hydropower station and the plantation have their own explicit properties. If the forest plantation takes a clear cutting to get the lowest operating cost in large area, it might lead an erosion of soil, which will produce silt to damage the ability of generating electricity of the hydropower station. Namely the forest plantation externalizes its private cost. When without losses of water and erosion of soil, the hydropower station can gain additional 70 million every year, so it is willing to pay less than 70 million to the forest plantation. The forest plantation also wants to cooperate with the hydropower station for it can get compensation of more than 10 million which is increase cost of ecological cutting. We assume that the forest plantation and the hydropower station bargain with each other, and reach a sharing agreement of the additional 70 million profits. It means that the forest plantation gets 35 million as compensation for its ecological cutting each year, of which 10 million compensate the additional cost of selective cutting and the other 25 million is net increase of profit. The hydropower station gets 35 million as its additional profit. The result is that both of them increase their benefits. The situation is illustrated at table 1.

Table 1 Profit distribution fore-and-after the trade of property

Item	Before cooperation	After cooperation
	Loss of water and erosion of soil	Without loss of water and erosion of soil
Profit of forest plantation (CNY)	40,000,000	30,000,000
Profit of water and electricity station (CNY)	200,000,000	270,000,000
Total profit (CNY)	240,000,000	300,000,000

From table 1 we can find that efficient property rights trade is of the same efficiency. Thus within the Coase's markets, it is unnecessary for the government to interfere all the things.

But if Coase theorem holds, certain assumptions must be satisfied. The first is bargaining fee (trade costs) must be very low or zero. The second is the property rights must be distinct, no matter what the original allocation is. The third is external effects in a small area. In fact it is very difficult to meet these conditions. The reasons are as follows: initially, due to the selfish behaviors, one part of the negotiation will not hurry to reach an agreement but lay some barriers to get the largest profit; furthermore, any external effects, especially the effects of ecological system relate to a lot of units, even including other countries; finally, the title delimitation is clear in theory but dim in practice. Therefore, Coase theorem is not efficient in every field.

10.2 License Transaction system

License transaction system offers a way for government to improve its efficiency. The main idea of the system is that environmental management organization initially allots environmental quota or the highest level of pollution. Once it is decided, the quota of license can be traded according to some rules. The system include tradable plan of draining waste, tradable license, credit card system, as well as the buy out or buy in of license to gain a more favorable average price. For the pollution licenses can be traded in the market, as a result, the pollution licenses more likely be collected by the enterprises with high efficiency in environment harness, so that environmental goal can be achieved at the lowest social costs. The mechanism of license transaction system can be illustrated as Figure 1.

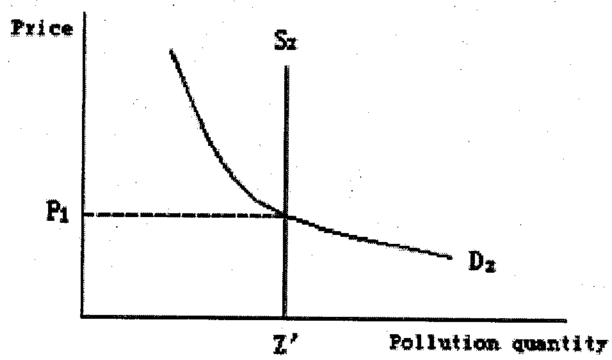

Figure 1 Market of pollution right

In Figure 1, horizon axis denotes permitted pollution quantity; and vertical axis denotes the price of license transaction. Z' is the quantity of pollution permitted by government. A vertical line crossed point Z' represents the supply quantity of pollution. The demand curve of pollution right declines down, P_1 is the balance price per unit. If factory A is allocated with six units of greenhouse gas decreasing, factory A's cost for dealing with per unit pollution is ¥4.5; factory B is allocated with four units of that, and factory B's cost for dealing with per unit pollution is ¥2.5. If there is no license transfer, the total cost of controlling pollution is ¥37. If the balance prince of the pollution right per unit is ¥4, factory A sales four units to factory B and will get ¥2 of profit, and factory B gets ¥6 of profit. As a result, the total cost of dealing with greenhouse gas is ¥29, so the license transaction is effective. License transaction system is available to the trade of carbon pollution license, water loss and soil erosion license, and woodcutting license. By doing so, the harness and operation costs can lower at the limit of certain environmental standards.

It is a governmental behavior to issue licenses, which is the legislating of permitting environmental administrative. It is an important method for environmental administration to protect environment. The implement of the system will put all kinds of harmful activities to environment into the control of government rules. In order to carry out effective administrative supervision and management, the system can assign qualification and specific requirements to the license holders according to the need of situations. Thus, the system is broadly adopted in environmental protection and is regarded as a backbone of pollution control.

10.3 Market of public bids for ecological projects

The system of public inviting and entering bids for ecological projects should include not only construction right but also management right in national and local ecological projects, as well as commonweal forest. Ecological construction units should openly compete with each other to gain the right of construction and management by virtue of their strength of technology and economy. In China, most of the ecological projects are taken in commonweal forests, which primarily meet the environment need. Far from commonweal forest, commercial forest which is oriented by market maximizes profit as its only purpose and self-determination. Thus, we must line the commonweal forest out from commercial forest. The property of commonweal forest must belong to government organizations of ecological administration, not forest plantations. If the property of commonweal forest is attributed to someone forest plantations, the plantations will become the only owner of construction and management, not one of the public and competitive bidder in whole social extension. This will lead no competition and low efficiency so that ecological resources cannot be distributed optimally. The purpose of nationalization of commonweal forest property is to break the rigidity of ownership allocation by virtue of government strength and distribute management right optimally by virtue of market strength, as a result carrying out internalizing policy at a low cost.

11 Conclusions

Area of tropic forest occupies over 40% of the whole world. The tropic forest structure is most complex, in which there are high biology diversity and the most multifunctional and multi-value ecosystem. Tropic forest is the important underpinning of keeping the balance of biosphere, which has become one of the hotspots of international researches about its infection to the world. There are a few tropic forest resources in China, which are mainly limited to Hainan, Yunnan area, but they delegate the special transitional style of world tropic forest and sub-tropic forest. Tropic forest occupies 25% of the total number of the national species, and 25.8% of all kinds of ecosystem of our country. With the increase of social economy and the decrease of tropic forest area, biologic species died out in a great deal, environment deteriorated and nature disaster pricked up, which have strictly affected the living environment and social economic development of human beings. Therefore, it is necessary to do some policy researches on Chinese tropic forest, which is also part of the world tropic forest sustainable activity plan. The basic conclusions are as follows:

(1) Sustainable development of tropic forest needs harmonize social economy with natural environment

Sustainable development is a synthetic conception of economy, society, culture, technology and natural environment. It is a stratagem concerning the long development of human beings and possessing a foothold of environment and nature resources. It specially emphasizes on importance and necessity of environmental carrying capacity and resource forever utilization to development process. Its basic ideas include three aspects: sustainable development encourages economics increase; resources forever utilization and favorable environment as a sign of sustainable development; and completed social progress as an aim of sustainable development.

(2) Foundation of environmental property system

Foundation of environmental property can supply a basic right to enjoy nice environment and to use sustainable resources. Environmental property is a new type of basic human rights, and the core is survival right. It is the outcome of harmonizing human with environment in environmental crisis era, which includes national environmental administration right and basic human right of environment. Because of the reasons of history and national situation, environmental right of our country always gives priority to government, so that we should change the situation and make balance between the environmental administrative right of government and the basic human right of environment, as well as put it together with property right in civil law, in order to improve its legal pitch.

(3) Establishment of forest environmental accounting policy

Establishment of forest environmental accounting will accelerate the sustainable development of tropic forest environment. The main aim is to supply a broad concept and accounting system for an environmental and economic database to analyze and evaluate forest environment states. The database is the precondition of making wise and reasonable policies and decisions. It will get 4 indexes: ①GDP; ②NDP_1 (traditional NDP), namely traditional GDP minus fixed capital; ③NDP_2 (NDP_1 minus environmental consumption or plus the new benefit of environment); ④NDP_3 (NDP_2 minus fees of environmental protection and defending). This is "green" GDP meaning. In order to realize the goal, we should research on accepted measure techniques of physical and value magnitude of forest ecological benefits as soon as possible, as well as financial accounting system of forest ecological benefits based on micro-level.

(4) Government intervention to internalize externality

In the last several decades, our tropic forest was seriously destroyed, which mainly displayed in over cutting and changing most natural tropic forest into single manmade forest. The most precious biologic diversity of tropic forest was badly destroyed, which leads more than 200 species died out, some of them vanished. Thus, government should efficiently intervene in the sustainable development of tropical forest, such as subsidy, appropriation, forest ecological taxation, the loan of deducting interest, as well as reducing or remitting tax and fee. By virtue of the intervention, we can effectively return funds to ecological construction units and change the external economic effect of forest construction into internal motive of the units. However, the reasonable compensation standard should be set up on the stable economic condition of forest ecosystem, which must higher than forest management cost and timber sale profit. Of course, the exact standard still needs adjust according to different areas and economic conditions. Generally speaking, dealing cost of the west forest is higher, and timber sale profit is higher in the east.

(5) Establishment of environmental market to internalize externality

Externality of environment will lead market failure, which forms the logical base of government intervention. However, it will not repulse part of environmental resources into the market allocation efficiently. Therefore, establishment of environmental market should be brought into government macro policies, such as property trade, license transaction system and market of public inviting and entering bids for ecological projects.

In views of these, it is a vast task to design tropic forest environmental policies, which need plentiful researches and analyses to ensure efficient and fair. The establishment of tropic forest environment policies based on internalizing externality would be available to approach economic and ecological sustainable development, which will realize the whole sustainable development of human beings.

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Evolving Directions in Environmental and Ecological Economics

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Evolving Directions in Environmental and Ecological Economics

1 Introduction

In a paper delivered to the 2001 International Conference on Forest Accounting, I surveyed recent developments in environmental economics, examined major current areas of research activity, and attempted to identify important areas where future research effort might usefully be directed. This paper re-visits those themes from a perspective in which more than two years have passed.

As with my earlier paper, the exposition is brief and non technical, and only on a few occasions provides specific references to the associated journal literature. I do, however, provide a selected bibliography of recent research papers and other scholarly output in the fields discussed in this talk. While this bibliography is far from being comprehensive, I would argue that it provides a useful lead into an examination of the recent developments to which I refer in this paper.

2 Recent themes in environmental and ecological economics

During the last decade, a large number of countries have moved further towards a position in which environmental protection has taken a prominent place in policy making. The organising principle has been the search for sustainability, and with designing policy so that behaviour is consistent with that constraint.

However, official surveys of the state of the environment have consistently reported that environmental degradation continues to worsen rather than improve in almost all relevant dimensions. For example, the 2000 edition of the United Nations Environment Programme (UNEP) Global Environmental Outlook concludes that current and expected future states of the environment are worrying (or much worse) in each of the following areas: global climate change; biodiversity decline; air pollution; water quality deterioration and quantity pressures; disruption to the nitrogen cycle; chemical risks; the state of global fisheries.

This is not the place to investigate why environmental quality has continued to deteriorate, not least because I am sure that most of the audience here will have a good idea of the reasons for that. Rather, my interest lies in what current environmental economics research reveals are the responses to this dilemma among our colleagues. There appears to be three main forms of response. In no particular order these could be described as:

(1) Using standard neo-classical economic theory to design operational policy instruments that are attractive to policy makers in terms of cost-efficiency, which work well under conditions of limited information, and which are politically feasible given the configuration of interests at local, state, national and regional levels.

(2) Questioning the usefulness of neo-classical economic theory as a policy design framework, and positing alternative paradigms for developing sustainable policy initiatives.

(3) Adopting an institutional economics perspective, which pays careful attention to property rights structures and principal-agent relationships, and which recognises that new institutional structures and relationships are evolving or will have to evolve - in a world in which environmental problems are international or global but sovereignty largely resides at the nation-state level.

The first two of these responses are, loosely speaking, those found in the environmental economics and the ecological economics literatures, respectively. While this distinction is far from being a new one, it continues to be substantial. The third response is more eclectic, finding support from within both of the above-mentioned sub-disciplines, being driven heavily by the agenda and activities of international organisations (particularly those under the United Nations organisation framework), and by the growth in interest in the so-called New Institutional Economics.

In what follows, I shall attempt to substantiate these remarks by an inspection of the recent journal and monograph literature in the (broadly defined) fields of environmental and ecological economics. My earlier paper argued that several recurring themes had dominated debate. As my paper will show, many of those continue to be found in the literature. Those which I shall focus on today are:

Economic incentive based instruments
Non-market valuation theory and practice
Sustainability
Biodiversity decline
International and global environmental problems
The New Institutional Economics
Modelling approaches, including complex systems and evolutionary economics
Forestry & Timber

2.1 Economic incentive based instruments

My earlier paper remarked on the fact that environmental regulation in most countries had, until the 1990's, predominantly taken the form of a patchwork of direct controls, collectively known as "command-and-control" instruments. One of the most important recent developments within the OECD economies has been the design of incentive-based approaches to pollution control, centred largely around emissions charges and taxes, and marketable permit systems. Initially the use of incentive-based instruments was largely concerned with reducing emissions of non-uniformly mixing air pollutants in and around heavily populated urban areas. An additional impetus was provided by a variety of international agreements that sought to reduce emissions of the precursors of acid rain, and of ozone-depleting substances.

These efforts met with considerable success, partly because gains from action within countries, and from collaboration across national boundaries, were realised relatively quickly and were substantial in size. Because substantial abatement could be achieved by focussing on a relatively small number of large point sources, and substitution possibilities were readily available, abatement costs were also relatively low. And finally, where action required cross-country cooperation, the number of parties to negotiations were relatively small, were affected similarly in terms of abatement costs and benefits, and those countries were culturally homogeneous (see the references to Barrett and Sandler in the Bibliography for more on these matters).

Progress has been far less impressive, though, with regard to some other global and international problems, particularly with respect to CO_2 emissions abatement and the conservation of biological diversity. This seems to be associated with the qualitatively different nature of these forms of environmental problem. We return to this matter in sections 2.4 and 2.6 below.

Two types of pollution problem have proved to be stubbornly resistant to the use of incentive-based instruments. One of these is mobile source pollution, and the congestion problems associated with road transport. With car ownership growth rates continuing to be high, it is not surprising that transport policy is so high on the policy agenda of many countries. The second category I have in mind is non-point source pollution. Environmental economists are well aware of the difficulties in designing practicable incentive-based regulatory schemes for non-point source pollution.

But recent concerns with water body quality, and excessive rates of abstraction of water, have re-invigorated our interest in non-point source pollution, along with sewage disposal being the principal cause of water quality degradation. In Europe, the Water Framework Directive has recently required that all degraded water bodies must, except where costs are demonstratively excessive, be brought to good ecological status within a relatively short period of time. Many environmental economists will find employment as consultants in undertaking the benefit-cost analyses that will be needed to identify where costs are excessive! In many developing countries, water quality and quantity are now serious impediments to economic and social development, while the construction of big dams to provide (among other things) controlled flows of water is subject to major controversy.

2.2 Non-market valuation theory and practice

The successful design and implementation of environmental policy requires that policy makers have available some reasonable estimates of the values of costs and benefits of alternative choices. Not surprisingly, the economic literature on valuation continues to grow rapidly, and is perhaps the single most frequently published topic area in environmental economics. Discussion of contingent valuation methodology remains a major research area, being one of the few approaches which holds out the prospect of being able to elicit measures of 'total economic value' (including non-use values).

Much research output is about refining established techniques. But an increasingly large amount, perhaps not surprisingly in a relatively 'mature' field, is devoted to broadening its scope or challenging its methodological basis. So, for example, we find much being written now about multiple valuation of landscape, water body and eco-system attributes. And considerable concern remains about two supposed characteristics of much valuation theory: its preference-based approach to valuation, and its deterministic methodology (that can handle risk appropriately, but is much less suited to dealing with fundamental uncertainty). Many of the readings cited below explore these critiques and the defences put up against them. An extensive critique of conventional environmental economics valuation techniques can also be found in my textbook (Perman et al, *Natural Resource and Environmental Economics*), which I know several of you have seen in its Chinese translation!

At a more mundane level, the issue of transferability of valuations from one context to others is attracting considerable interest, as concerns grow about the cost of valuation studies.

2.3 Sustainability

One rather controversial component of the 'sustainability debate' relates to the question of whether there exists an Environmental Kuznets Curve (EKC), and so whether environmental pressures lessen as economies become richer. This question has generated a huge amount of research activity. Key recent questions about the EKC have included the role of individual preferences in determining income-environmental pressure relationships, the determinants of CO_2 emissions (and whether CO_2 exhibits an EKC relationship), the role of population pressures, and how to model EKC relationships in open economies. It has to be said that this research area has arrived at little in the way of useful results, not least because much of it has been investigating non-structural, reduced-form relationships. This author suggests that a line should now be drawn under this literature, and than further research be limited to structural modelling only.

One of the most cited conceptual distinctions in environmental economic theory is that between 'weak' and 'strong' sustainability. In essence, this concerns the question of whether a non-declining aggregate capital stock – with capital broadly defined – is a necessary (and possibly sufficient) condition for sustainability, or whether it is also required that the aggregate natural capital stock be maintained intact.

Conventional environmental economics models of sustainability have, although not exclusively, built in the condition of weak sustainability. In contrast, ecological economics modelling places maintenance of the natural capital stock at the centre.

This raise the question of exactly what is meant by natural capital, what kinds and extent of substitution are possible within it, and whether some elements (or systems) of natural capital can be regarded as critical. A recent issue of Ecological Economics (44(2~3), March 2003) was largely devoted to the theme of identifying critical natural capital, and contains several papers which together constitute an excellent survey of research in this area.

2.4 Biodiversity decline

Biodiversity decline is, for many commentators, the most worrying of all global environmental problems. But it is one of the least tractable because biodiversity is, at least partially, a global public good, and enforceable property rights in biological material itself scarcely exist. At least, they do not exist where it most matters. This is one area where the so-called 'New Institutional Economics' is having its greatest impact, focussing as it does on institutional arrangements, transactional difficulties, and their underlying cultural and social basis. The environmental economist would do well to watch carefully emerging work in this area.

2.5 International and global environmental problems

At the time of the Kyoto Protocol accord, there was considerable optimism about the progress of international collaboration about reducing greenhouse gas emissions. This optimism has waned since, not least because the USA has refused to ratify the Protocol and because several signatories look set to fail to reach their Kyoto commitments. Reasons why one might expect these outcomes are well-described by Barrett and Sandler (see references below). However, an interesting spin-off of the Protocol is the start of emerging markets in tradable carbon permits. The progress of initial experiments in this area is something that environmental economists should watch with interest.

2.6 The New Institutional Economics

According to Furubotn and Richter (2000) "the central message of the New Institutional Economics is that institutions matter for economic importance". We might add to this by saying that they also matter for environmental performance. These observations are not new in themselves; what is true, though, is the extent to which ideas dating back to the work of Coase and Williamson, among others, have been re-invigorated, and with great success in re-thinking problems of environmental policy. Much of the important work in this field is due to Elinor Ostrom. Interesting applications concern fisheries and property rights regimes, causes of tropical deforestation, mineral extraction processes, and – more generally – most facets of the economics of nature. Much of the literature in this field, some examples of which are detailed below, is not to be found in the conventional environmental and ecological economics journals.

2.7 Modelling approaches

The majority environmental-economic modelling effort continues to use one or more of a set of relatively conventional optimising or simulation frameworks, such as natural resource augmented economics growth models, environmentally-augmented input-output models, and computable general equilibrium (CGE) models. Among this group, CGE models have become widely used for analysis of change climate and the effectiveness and distributional consequences of policy instruments such as emissions taxes. Where particular energy or environmental systems need to be modelled in some details, these models are sometimes linked to disaggregated energy sector engineering models or to GIS models.

Conventional modelling approaches are based on more-or-less restricted forms of neo-classical economic structure. A significant part of the recent research literature takes as its starting point a critique of the neo-classical modelling foundation itself, and explores alternative methodological foundations.

One interesting approach, borrowed from the operational research literature, makes use of fuzzy logic to analyse sustainability. Starting from a database which contains a large set of environmental, economic and social performance indicators, fuzzy logic techniques are used to construct composite indices of sustainability. Then perturbations to the primary indicators are examined to assess the sensitivity of the composite sustainability measures. Andriantiatsaholiniaina et al (2003) is a good example of this approach.

A second alternative modelling approach that is attracting attention is agent-based modelling and simulation. Here I repeat some comments made in my earlier survey paper. Agent-based modelling has been particularly exciting when combined with careful ecological modelling. In this literature, emphasis is on ecosystems rather than individual populations, using linked models of complex social systems and non-linear ecological dynamics. Behaviour is complex, adaptive and evolutionary.

These models enable the researcher to explore multiple equilibria, stable and unstable steady states, fast and slow variables, and concern with variances rather than means. A good insight into this new field can be found in recent issues of the online journal Conservation Ecology. One striking example is the 1999 paper by Carpenter, Brock and Hanson titled "Ecological and Social Dynamics in Simple Models of Ecosystem Management" in Conservation Ecology 3(2). This can be downloaded and read at the URL http://www.consecol.org/Journal/vol3/iss2/art4/.

Yet another emerging modelling approach is that which makes use of evolutionary theory. In a good, recent exposition of this thinking Rammel et al (2003) argue that models and policy making based on the neo-classical paradigm

"Are founded on artificial planning-market systems that resemble closed mechanical systems that do not change over time, they are especially inappropriate to deal with the dynamics of structural and adaptive changes in economic systems. ...This calls for alternative approaches that might be better in coping with complex systems (Funtovicz and Ravetz, 1994)."

Rammel and van den Bergh are particularly scathing of the use of efficiency-based policy instruments, arguing that these search for at best transient optima, but pay a heavy price for doing so in terms of reducing diversity, increasing risks and throwing away the basis for adaptability in complex, changing and highly uncertain systems. It has to be said that the literature in this area is at present suggestive of possibilities rather than fully worked out. But it is pregnant with possibilities for radically new insights, and casts doubt on the whole raft of policy advice and valuation techniques that emerge from standard economics methodology.

2.8 Forestry & Timber

In this paper, I make just a few, extremely brief references to developments in the field of forestry economics. Much of the work here has involved a continuation and elaboration of an existing agenda. Notable here are the multiple uses of forests and other woodlands, and in particular the use of forests as ways of mitigating global climate change (either as sources of wood fuel to replace fossil energy sources, or as carbon sinks to fix atmospheric carbon dioxide stocks; although note that these two uses pull in different directions when selecting optimal rotation lengths of managed forests).

Forestry research is also now paying more careful attention to the various stakeholder values, and to market mechanisms for internalising values of the ecological and environmental services of forests.

Perhaps most exciting – and also indicative of the increasing integration of ecology with environmental economics that has been a central thrust of this paper – is an attempt to give a proper treatment to the role of space in forestry modelling, and so to move away from the artificial model of a forest as simply an aggregate of stands whose spatial location and distribution is arbitrary and insignificant. Without proper attention being given to space, we are unable to properly capture the notion of forests as complex ecosystems.

A collection of important recent papers and monographs

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Forest Resource Valuation and Accounting in Malaysia: Present Status and Future Directions

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1 Introduction

Forest is an important source for timber and non-timber forest products (NTFPs) and usually forms the dominant natural ecosystem in tropical countries.The forest provides valuable timber species, a main source of food to local people, provides a wide variety of materials used in medicine, provides a source of eco-tourism and recreation opportunities, and helps maintain favorable environmental conditions. The benefits of forest resources are derived not only by the local people but also global community. This had provided greater impacts in terms forest revenue to the state governments, generate employment opportunities, improve standard of living, and provide other services to the local and global community.

In the past, however, the forest has been viewed mainly as a source of timber, which can be converted to other wood products to meet the demand from overseas and domestic market. Among the major wood products are sawn timber, plywood, mouldings, furniture, laminated board, medium density fibre board, and so forth. The main motive for wood production activity is to generate forest revenue to the state governments and increase foreign exchange earnings needed for the economic development of a country. The other equally important components of the forest resources such as water, wildlife, rattan, medicinal plants and so forth, however, have not attracted much attention, not until very recently. This is indeed an unfortunate situation knowing the fact that forests, in particular tropical forests, are very rich in flora and fauna. Malaysia's tropical forests, for example, inhabit about 15,000 species of flowering plants, of which only about 2,600 species are tree species. The forest is also the home to about 300 species of mammals, 700 species of birds, 300 species of reptiles, 165 species of amphibians, 300 species of freshwater fish and millions of invertebrates.

Besides the above mentioned resources, other resources that come from the forests include latexes, steroids, edible oils, bamboo, spices, pesticides, and dyestuffs while some of the consumer goods made from forest products are coffee, lubricants and glue for postage stamps, golf balls, chewing gums, toothpaste, shampoo, mascara and lipstick. The market in these industrial products is worth billions of dollars per year.

Forests also yield many different types of fruits, cereals, and nuts and half of the world's main crops were originally discovered in the tropical forests. Amongst the more widely used are tea, coffee, sugar, bananas, oranges, rice, maize and cocoa. About twelve crops provide 90 percent of the world's food and half a dozen of them are descended from tropical forest plants, including rice and maize. In addition, more than 1,600 known tropical forest plants have potential as vegetable crops.

The flora and fauna of tropical forests hold an astonishing cornucopia of medicines for traditional and industrial uses. Up to a quarter of the prescribed drugs used in the United States are derived from tropical rainforest plants. Nearly three-quarters of the 3000 plants identified by the US National Cancer Institute as having anti-cancer properties comes from the rainforest. Quinine derived from the cinchona tree is used to treat malaria. Rainforest plants also offer much promise of new treatments, particularly as cures for cancer and AIDS.

The fact that forests help reduces soil erosion, siltation and flood hazard is well acknowledged. Now, a greater attention is given to the role of forests in environmental protection, particularly in regulating the earth's temperature. The clearing and burning of forests, in particular tropical forests are believed to have made a significant contribution to recent warming of the earth's atmosphere through the so-called 'greenhouse effect'. Through the process of burning of forests, carbon dioxide and methane are released into the atmosphere and these gases trap long-wave radiation thereby generating heat which is reflected into the space above the earth. It has been estimated that deforestation injects between 5 and 10 billion tones of carbon dioxide into the atmosphere each year, between 3 and 6 million tones of it coming from the tropical forests. Deforestation contributes to more than half of the global warming.

A more recent phenomenon is that forest is viewed as potential income generating from eco-tourism and knowledge-based economy activities. Development of forest for eco-tourism purposes has been viewed as one of the key sectors in national economy. Increasing information and communication technology (ICT) has enabled the development of various knowledge-based outputs using forest as a source of inspiration, activities, projects, and programmes. By combining technical and scientific knowledge of forest ecosystem, one can produce tremendous outputs for the benefits of society not only in respective countries but to other countries as well. For instance, promotion of eco-tourism activities in the tropical countries may attract foreign visitors and hence increase significant impacts to the local economy.

Even though much have been said and reported about the importance of forest resources, the full potential of the biologically diverse tropical forests has never been fully quantified from the economic perspective. It is relatively simple to determine the economic value of market goods such as logs but not the economic value of other non-market goods and services such as recreation, wildlife conservation, medicinal plants, carbon sequestration, or other ecological and environmental functions. As such, their real potential as income generators has not been fully explored or realized by the government.

Malaysia has a luxuriant and extensive forest resource base but with current rapid rate of economic development, its resources has dwindled. The forested area in Malaysia has declined from 23.4 million ha in 1970 to 20.0 million ha in 2000. This has an implication on the issue of sustainability of the forest resources in the country. It may be that to develop, the extraction of forest is necessary. But the crux of the problem is whether enough of the returns specifically have been ploughed back into the rehabilitation of the resource, and in general reinvested into the economy to support growth. A forest resource account would particularly be able to provide information on the depletion of the resource base, and if this information is integrated into the national income accounts, it would provide information on the impact of this resource depletion onto the whole economy.

The objective of this paper is to present the current status of forest resource valuation and accounting studies in Malaysia and their results as well as suggested future directions.

2 Forest Resources in Malaysia

Malaysia is rich in natural biological diversity and resources and is well endowed with valuable goods and services. The natural environment of the country comprises many diverse ecosystems, which houses numerous timber species and NTFPs such as flowering plants, ferns, fungi, mammals, birds, and environmental resources such as water. Many of the NTFPs have provided useful and important products to the local people and the country. Among the important NTFPs are rattan, bamboo, medicinal plants, resins, honey, essential oils, protected areas, water and so forth. These resources have contributed significantly in terms of state revenue collection, employment exchange earnings, and employment opportunities to the local people. The majority of NTFPs related industries are rural-based, which are confined to handicraft production. Such industries have played a prominent role in providing employment opportunities to the rural people and this helps to increase rural income. Table 1 lists some of forest goods and services that are provided by a forest ecosystem. These forest resources are either traded at the local, national and global levels (for example timber, rattan, medicinal plants, etc) or they are consumed on-site (recreation, eco-tourism, research, etc).

Table 1 List of Forest Resources by Major Categories

Forest Goods	Forest Services
Timber	Microclimate regulation
Rattan	Carbon sequestration
Bamboo	Recreation
Medicinal plants	Soil protection
Fruits	Watershed protection
Nuts	Asthetic/amenity
Vegetables	Wildlife habitat
Fibre/Thatch	Human habitat
Ornamental	Security
Latex/Resin	Landscape
Dyes/Tannins	Genetic conservation areas
Feed plants (fodder)	Land physical structure
Occult magic	Pollination
Fuelwood/poles	Nutrient cycling
Essential oils	Air pollution control
Vegetable oils	Noise pollution control
Honey	Seed dispersal
Climbers	Shoreline stabilization
Water	Sediment retention
Wildlife	Water transport
Minerals	Cultural heritage
Genetic resources	Natural museum
Forest seedlings	Arboretum
Seeds	Games/hunting
Palms	Research
	Education
	Training

Forest resource may interchangeably be used as 'forest produce' as defined in the National Forestry Act 1984 (NFA 1984) which distinguished between major forest produce and minor forest produce. Major forest produce comprises the followings (Second Schedule, Part A of NFA 1984):

(a) Round Timber
(b) Poles
(c) Fuelwood
(d) Charcoal
(e) All types of rattan

Minor forest produce as prescribed in the NFA comprises all other forest produces not included as major forest produce. The NFA also does not specify whether environmental services and ecological functions (such as carbon sink, biodiversity, water, habitat protection, etc) belong to forest produce. This is important from the economic point of view, since the sustainability of other key resources as mentioned above are essential for the survival and continued economic growth and development. The legal aspects of forest resources or forest produce need to be clearly specified in view of current interest in environmental services and ecological functions of forest ecosystem.

Malaysia still contains a relatively large area of forests. The total area of natural forest in Malaysia in 2000 was approximately 20 million hectares or 62 percent of the total land area. Of this forested land, Malaysia has designated 14.5 million ha or 44 percent of the total land area as Permanent Reserved Forest (PRF). These forested lands permanently reserved under legislation to be managed sustainably for protection, production, amenity, research and education purposes. Protection forest is reserved for its many ecological and environmental services such as the maintenance of climate conditions, water resources, soil fertility, biological diversity conservation, flood mitigation, and ameliorating soil erosion and river siltation. Production forest is reserved for timber production and other non-timber forest products such as rattan and bamboo. Amenity forest is normally reserved for recreation and other purposes such as ecotourism. The research and education forest is reserved for research and educational purposes such as growth and yield studies, impact studies, environmental education, and so on.

The forests provide many valuable timber species which are used in the manufacture of sawntimber, plywood, veneer, mouldings, furniture and furniture components and other wood-based panel products. Forest harvesting is currently primary activity in the production forest of Malaysia. About 105,801 hectares of forest were opened for logging in Peninsular Malaysia in 2002, which comprised 31,962 hectares from the PRF, 43,872 hectares stateland forest and 29,967 hectares alienated land. For the last 10 years, the area opened for logging had decreased by about 44% in line with the department's efforts in sustainable forest management and strict adherence to annual coupe. Among the major species harvested from the production forest include Shorea spp., Diptrocarpus spp., Kompassia spp., Dyrobalanops spp. and others. These species are valuable timber, which are processed into sawntimber, veneer, plywood, and so on.

3 The Importance of Forest Resources to Malaysian Economy and Local People

As a renewable resource, the forest has always plays a significant role to the socio-economic development of the country. The forest sector is an important sector for foreign exchange earnings, state revenue collection, employment opportunities, resource-based industrialization, environmental protection, ecotourism, water supply and so forth.

Timber Products

Over the last three decades, Malaysia has experienced increased demand for wood products and other environmental services. Log production has increased steadily by an average of 8 percent per year during the 1970~1990 periods. However, its growth has decreased beginning early 1990 due to strict adherence to annual coupe by the state governments, in line with the department's efforts in sustainable forest management.

Log production is used by the local industry for the manufacture of sawnwood, plywood, veneer, mouldings, furniture and furniture components and other higher value added panel products. Recent developments in the wood-based industry have been focused into downstream activities such manufacture of furniture and timber mouldings for export market. The wood-based industries is one of the largest industries in Malaysia, contributing about 6.2 percent of the total manufacturing output, 7.7 percent of the total manufacturing value-added, 11.3 percent of the total manufacturing employment and 3.4 percent of the total manufactured export.

Trade in timber products is also significant with total trade amounting to RM15.3 billion in 2002 or 4.3 percent of the total exports (Table 2). The trend will continue in the future as a result of increased demand for wood and timber products from the overseas market.

Table 2 Total Exports of Major Timber Products, Malaysia 1997-2002

Year	Total WoodProducts Exports (RM million)	Total Exports (RM million)	Percentage share of wood products
1997	14,700	221,408	6.6%
1998	14,200	286,756	5.0%
1999	17,100	321,181	5.3%
2000	17,700	373,300	4.7%
2001	14,300	334,000	4.3%
2002	15,300	354,500	4.3%

Source: Forestry Department Peninsular Malaysia (2002)

Non Timber Forest Products (NTFPs)

Rattan and bamboo are two most important NTFPs in Malaysia. The resource is next to timber in economic importance and has been put to many uses ranging from handicraft items to some parts of housing components in Malaysia (Abd. Latif, 1998). There were quite an abundant supply of raw rattan can be found in Peninsular Malaysia. The total gross value collected is about RM 5 million per month and the value could be increased to more than 21~25 times if the manufacturers concentrate on downstream processing (furniture or semi-processed products such as ropes and binds) which are traditionally imported from Singapore, Hong Kong, Indonesia and Taiwan (Abd. Latif, 1989b; Abd. Latif & Aminuddin, 1996).

According to the statistics, the percentage of revenue collected from the NTFPs out of the total forest revenue collection, in terms of royalty, is still low. The contribution of NTFPs revenue to the total forest revenue from 1992 to 2002 was less than 5 percent (Table 3). However, the absolute value of NTFP's collection revenue showed that the utilization of NTFPs increased over the 1992-2002 period as compared to revenue from logs which showed a decreasing trend over the same period.

Table 3 Revenue collection from NTFPs in Peninsular Malaysia ('0000 RM)

Year	Royalty		Premium	Cess	Others	Total	% of NTFPs revenue from the total revenue collection
	Logs	NTFPs					
1992	124117	3656	151842	30821	25545	335981	1.09
1993	98527	5720	180611	26290	40703	351851	1.62
1994	99689	4961	232036	26037	27768	390491	1.27
1995	93362	5678	214302	22959	37845	374146	1.52
1996	94432	9107	162319	23360	70202	359420	2.53
1997	113341	9940	158964	45407	24735	352387	2.82
1998	81387	8998	141083	35328	15004	281800	3.19
1999	65347	9542	137551	40030	15793	268263	3.56
2000	66339	11712	153977	36341	24883	293252	4.00
2001	52428	13013	137828	32276	29517	265062	4.90
2002	55487	13966	154495	33227	19898	277073	5.04

Notes: [1] Total revenue collection included premium, royalty, cess on sawlogs and others
[2] Revenue from cess and premium included revenue from cess and premium of NTFPs
Sources: Forestry Department Peninsular Malaysia (1992~2002)

The trend of exporting more value-added finished products rather than traditional practice of exporting the raw and semi-processed products (since the ban on the export of raw rattan and the imposition of high import duty for the semi-processed products in 1989) had generated and increased the foreign exchange earnings and the employment opportunities in the rural-urban sectors.

In a study on Petai (*Parkia speciosa*) (Woon et al., 1995), the trade of the fruit could range between RM 336,000 to RM 900,000 per annum depending on the locality and the magnitude of the trade is large in the domestic markets (Abd. Razak & Abd. Latif, 1998).

Trade of NTFPs

Presently, at least 150 NTFPs are significant in terms of international trade. Including honey, gum, resins, rattan, cork, forest nuts, mushrooms, essential oils and plant or animal parts for pharmaceutical products (Vantomme, 1998). The Federation of Malaysian Manufacturers projected that revenue from the export of rattan furniture would reach RM150 million by the end of the 1990s (Abd. Razak & Abd. Latif, 1998).

In Malaysia, the proper statistics on the production of NTFPs is still lacking as it was not properly formulated at the initial stage. The same situation also occurs in the development of NTFPs resources. Most of the information with regards to the development of NTFPs only confined to rattan and bamboo. Rattan and bamboo are two of the main NTFPs that have been given attention due to their economic potential. De Beer and Dermott (1989) reported that rattan furniture had provided about 0.06% and 0.96% of total forest export for Malaysia in 1980 and 1991, respectively. This reflects that the economic contribution of NTFPs based on the market values is still lower than of timber. Statistics on the export of medicinal plants in Malaysia was estimated amounting to about RM55 million (Ng and Mohd Azmi, 1997) and RM43 million (Anon, 1998) in

1996 and 1997, respectively.

According to the statistics, Malaysia was exporting more rattan than importing it from the year 1980 to 1984. However, in 1986 to 1989, the trend had been changed where the industries had used more imported rattan than the local rattan available. From the year 1990 to 1996, the export value of rattan had always exceeding the import.

In 1993, the export value of semi-products and rattan furniture increased gradually and amounted to RM 90.4 million. The highest export value increased to RM111 million in 1994. As a result of global economic recession, the amount of export decreased during the late 1995-1998 period. Japan, United Kingdom, United States of America and Singapore are the most popular market for Malaysian rattan furniture. The total export value to these countries in 1998 was estimated at RM55 million or 64 percent of the total rattan furniture export. Other important importing countries include Australia and some European countries.

The situation is different to bamboo. The data from 1991 to 1996 showed that the import value of bamboo always exceeded the export value and this could describe that the bamboo in Malaysia are not fully utilized (FDPM, 1980 – 1996).

In Malaysia, there were no accurate data or information could describe the use of raw materials from the wild by traditional medicinal industries. Therefore, it is difficult to recognize and estimate how much raw materials (medicinal plants) had been collected and utilised as well as which part of the plants is mostly needed by industries. However, a study by Ng and Mohd Azmi (1997) shows that the trade of medicinal plants (raw materials and plant products) for the ten-year period in Malaysia is quite significant. It is also found that our imports are always exceeding our exports since 1986. This shows that most of the raw materials used in the industries has sourced from outside countries such as China, India and Indonesia (mostly imported by Chinese and Indian traditional medicine industries).

4 Forest Valuations

The Need to Estimate Value of Forest Resources

The government normally involves making decisions on how to allocate public spending to manage forest ecosystems, which includes forest rehabilitation, protection and conservation. In order to justify the decisions made, the total values of benefits and costs need to be determined. However, the values of forest goods and services are difficult to estimate because most of them are not traded in the marketplace. It is important to note also that the tradeoffs among competing forest land use options can be made if all the benefits and costs are taken into account. The need for economic valuation of forest resources can be summarized as follows:

- To justify and decide how to allocate public spending on forest and environmental conservation
- To incorporate public willingness to pay (society value) and encourage public participation in forestry and environmental conservation project

- To determine and compare the benefits of different alternatives or competing projects, particularly projects involve forestry and environmental resources
- To prioritise forestry and environmental development project at the local and national level
- To ensure that forest and environmental conservation or development project is maximized for each money spent in this effort
- To determine the opportunity cost of utilizing forest and environmental resources for other uses

Economic valuation of forest and environmental resources can be applied in many situations depending on the nature of the problem being investigated. The followings are some of the examples of application of forestry and environmental valuation:

- Cost Benefit Analysis
- Feasibility studies of public forestry and environmental projects
- Ranking of projects and setting forestry and environmental conservation priorities

Examples are:

- Timber harvesting activities
- Dam construction project
- Sustainable forest management project
- Wetland conservation project
- Ecotourism project
- Rural forestry development project
- Community forestry project
- Wildlife conservation project
- Sustainable use on non-timber forest products
- Rural water supply project from watershed forest
- Mangrove and coastal resource management project

- Taxation of forest and environmental resources

  - Optimal forest resource tax
  - Optimal environmental tax
  - Optimal pollution tax

- Damage assessment and compensation

  - Visual disamenity
  - Loss of potential economic timber crop in the harvest
  - Relocation cost due to dam construction
  - Loss of species extinction
  - Forest and environmental degradation

- Green Gross Domestic Product or Natural Resource Accounting

- Depletion allowance of forest resources
- Degradation of stateland forest resources
- Soil erosion and sedimentation

- Pricing policies

  - Entrance fees for recreational sites
  - Royalty for timber and non-timber forest products
  - Entrance fees for national and state parks

- Benefit assessment

  - Performance of firms in forest resource extraction
  - Benefits of forest and environment to local community

- Policy guidelines

  - Economic instruments in forest and environmental conservation and regulation
  - Incentives on forest and environmental conservation and regulation

Valuation Studies of Forest Resources

There have been significant efforts to estimate economic values of forest resources in Malaysia in the last two decades. However, the focus of the previous studies has been mainly on certain forest resources, particularly timber and the forest ecosystem that attract the attention of researchers have been widely studied in the dipterocarp forest. Little studies have been done to quantify the economic value of NTFPs in Malaysia due to some difficulty in data collection and availability of market information. Nevertheless, some efforts have been made to impute the economic values of some of NTFPs by universities, research institutions, and government agencies and under different forest ecosystems. The following section highlights the valuation studies of forest and environmental resources in Malaysia.

Timber

The results of these studies are presented in Tables 4 to 6 for various forest ecosystems, geographical regions, and compartments. Most of studies used residual value technique, a practical and common method to compute the value of timber resources. The method estimate the stumpage value by the deducting the cost of timber harvesting and profit margin from the market price (quoted at log yard). As can be seen in Table 4, the total stumpage value for the dipterocarp forest ranges from RM4,200 to RM42,000 per hectare. The mean stumpage value per hectare is estimated at RM15,629. The total stumpage value for wetlands (mangroves and peat swamps) is lower than that of the Hill Dipterocarp Forest. The values vary from RM187 per ha to RM9,086 per ha (Table 5). The total stumpage value for plantations of fast growing timber species was estimated at RM3,378 per ha. In the peat swamp forest, the estimated stumpage value per hectare ranging from RM1,722 to RM15,765 (Table 6). The variation in stumpage values results from differences in forest productivity and composition of growing stock in terms of species, species groups, diameter size, logging costs, log prices, and year of assessment.

The use of market evidence approach in estimating stumpage value has also been carried out. Those studies were conducted by Nur Hajar (1998, 1999) and Azmi (2001). The study by Nur Hajar (1998) was conducted in the state of Kedah. Data on tender price (i.e. the successful tender price-maximum bid price) were gathered directly from tender document submitted by the concessionaires to the Kedah State Forestry Department. This document records the accepted tender price for each compartment by the department. The results of successful tender price were calculated to estimate the average tender price for the period between 1978 and 1996. The results show that for the period from 1978 to 1990, the average tender price was RM1,717 per hectare the value increased to RM13,626 during the 1991 to 1996 period (Table 7).

A similar study was also conducted by Nur Hajar (1999) in three logging compartments Pahang and found that the average tender price was estimated at RM8,622 per hectare. A study by Azmi (2001) on tender price in the stateland forest in Pahang was also conducted and the results of the average tender prices for the period 1996 to 1999 by district are shown in Table 7. As shown in the table, the average tender price in the district of Bentong shows the highest (RM12,538 per ha) and the lowest average tender price is in the Temerloh District (RM2,939 per ha). The average tender price for all districts was estimated at RM6, 514 per hectare.

Table 4 Estimated total stumpage value from previous studies in Malaysia for Dipterocarp Forest (RM/ha) (trees 30 cm and above)

State	Forest Reserve/compartment	Year of assessment	Stumpage value (RM/ha)	Source
Pahang	Lesong FR C86/87	1989/90	14,351	Awang Noor et al. (1992)
	Lesong FR C88/89	1989/90	25,235	"
	Bencah FR C15	1989	11,200	"
	Bencah FR C16	1989/90	9,128	"
	Berkelah FR C43	1999	5012	Nur Hajar (1999)
	Berkelah FR C31	1999	9485	"
	Berkelah FR C50	1999	12106	"
	Tekai Tembeling FR C76	2000	7,078	Awang Noor & Mohd. Shahwahid (2000)
	Tekai Tembeling (Special Permit)	2000	8,495	"
	Tekai Tembeling FR C77	2000	13,992	"
	Ibam FR D1	2000	27,144	"
	Ibam (Special Permit)	2000	25,344	"
	Lesong FR	2000	42,532	"
	Ibam (Special Permit)	2000	24,850	"
	Ibam (Special Permit)	2000	11,988	"
	Lesong FR Block G	2000	13,886	"
	Lesong FR Block H	2000	15,823	"
	Ibam FR Block C	2000	12,494	"
	Lesong FR Block C	2000	11,027	"
	Average 27 compartments	2003	24,161	Awang Noor & Mohd. Shahwahid (2003)
Kelantan	Balah FR Block 91	1996	23,632	Che Roslan (1996)
	Balah FR Block 93	1996	28,267	"
	Balah FR Block 95	1996	26,271	"
	Berangkat FR C13	1989/90	5,883	Awang Noor et al. (1992)
	Berangkat FR C14	1989/90	7,166	"

State	Forest Reserve/compartment	Year of assessment	Stumpage value (RM/ha)	Source
Terengganu	Jengai FR C86	1988/89	17,172	Awang Noor et al. (1992)
	Jengai FR C87	1988/89	14,385	"
	Average 25 compartments	2003	24,503	Awang Noor & Mohd. Shahwahid (2003)
Kedah	Ulu Muda FR C26	1994	27,332	Awang Noor & Mohd. Shahwahid (1995)
	Ulu Muda FR C27	1994	26,710	"
	Ulu Muda FR C29	1994	24,023	"
Johor	Lenggor FR C221	1994	15,155	Dominic (1995)
	Lenggor FR C225	1994	23,038	"
	Lenggor FR C226	1994	14,740	"
Negeri Sembilan	Angsi FR	1995	8,674	Awang Noor & Mohd. Shahwahid (1996)
	Serting FR (C18)	1995	13,031	
	Serting FR (C49)	1995	9,691	"
	Johol FR	1995	9,233	"
	Pasoh FR (C71)	1995	6,137	"
	Pasoh FR (C72)	1995	4,218	"
Selangor	All Forest Reserves – 10-20 years after logging (Based on NF3)	1995	9,532	Awang Noor & Mohd. Shahwahid (1997)
	All Forest Reserves – 21-30 years after logging ((Based on NF3)	1995	9,715	"
	All Forest Reserves - > 31 years after logging (Based on NF3)	1995	10,775	"
	Air Hitam FR C1		5,279	Norashikin (1998)
	Air Hitam FR C2		9,521	Norashikin (1998)
	Air Hitam FR C12		30,318	Norashikin (1998)
	Air Hitam FR C13		25,260	Dominic (1995)
	Air Hitam FR C14		17,169	Johnny (1997)
	Air Hitam FR C15		14,500	Johnny (1997)
	1 ha plot		26,362	Pius (1995)
Sabah	Tagaroh FR	1995	9,924	Christopher (1995)
	Ulu Bengkoka FR	1995	13,947	"
	Lingkabau FR	1995	10,738	"
	Deramakor FR (C 40) – Block 1 (all trees 45 cm and above)	2003	6,760	Paul (2003)
	Deramakor FR (C 40) – Block 2 (all trees 45 cm and above)	2003	5,226	Paul (2003)
	All forests (total stumpage; 1980 price)	1966-85	17.72 billon	Vincent (1990)
	All forests (total stumpage)	1983	304.8 million	Repetto & Gillis (1988)
Sarawak	All forests (total stumpage; 1980 price)	1966-85	7.29 billion	Vincent (1990)

Table 5 Estimated total stumpage value from previous studies in Peninsular Malaysia for Mangrove Forest (RM/ha)

State	Forest Reserve	Year of assessment	Stumpage value (RM/ha)	Source
Perak	Matang Mangrove FR	1994	7,996 (25 years old)	Abd. Hadi (1994)
			9,086 (30 years old)	"
Perak	Matang Mangrove FR (Charcoal production – allocated area)	1999	2,449	Awang Noor et al. 1999
	Matang Mangrove FR (Charcoal production – tendedred area)		2,535	"
	Matang Mangrove FR (Excellent Forest)		3,053	"
	Matang Mangrove FR (Good Forest)		2,549	"
	Matang Mangrove FR (Poor Forest)		1,843	"
Johor	Sungai Pulai Mangrove FR			Mackinna (1995)
	- (19 years old)	1995	187	
	- (23 years old)		237	"

Table 6 Estimated total stumpage value from previous studies in Peninsular Malaysia for Peatswamp and Plantation Forests (RM/ha)

State	Forest Reserve/ compartment	Year of assessment	Stumpage value (RM/ha)	Source
Peatswamp Forest				
Selangor	Raja Musa FR (average)	1990	2,149	Kumari (1995a)
	Sg. Karang FR (C190)	1999	1,722	Awang Noor and Mohd. Shahwahid (1999)
	Sg. Karang FR (C190)	1999	2,946	Awang Noor and Mohd. Shahwahid (1999)
	Raja Musa and Sg. Karang FR (average)			Anon (1998)
	- Low disturbance	1998	10,510	"
	- Intact regenerated	1998	15,765	"
Plantation Forest				
Pahang	Kemasul FR	1995	3,378	Hii (1995)

Table 7 Average Stumpage Value Using Market Evidence Method (Tender Price RM/ha)

State	Forest Reserve/District	Average Tender Price (RM/ha)	Source
Kedah	Average 1978-1990	1,717	Nur Hajar (1998)
	Average 1991-1996	13,626	"
Pahang	Berkelah FR (C 50)	11,366	Nur Hajar (1999)
	Berkelah FR (C 43)	4,488	"
	Berkelah FR (C 31)	10,012	"
	Kuantan	10,983	Azmi (2001)
	Bentong	12,538	"
	Raub/C.H	7,095	"
	Jerantut	3,758	"
	Lipis	4,384	"
	Rompin	3,902	"
	Temerloh	2,939	"

Note: Study by Azmi (2001) was based on stateland forest.

Rattan

The economic value of rattan using the residual value technique was carried out by Awang Noor and Mohd. Shahwahid (1997) (Table 8). The study was carried out in Negeri Sembilan to compute the value of rattan stocks by different rattan species and forest types. The study used data from the Third National Forest Inventory III to determine the number of rattan clump by species and type of forests. A special inventory to identify the number of potential sticks of rattan given its diameter was also conducted. A market survey was also conducted to collect information on price, costs, and profit margin. The average stock value per hectare depends on species and forest status. As shown in the table, the average stock values per hectare for a particular species range from RM0.94 to RM32.52. The negative stock values indicates that most of the rattan stocks are either immature, which show higher cost than benefits. The total economic value per hectare is estimated at RM942.52 per hectare.

A more recent study conducted in Compartment 51, Jengai Forest Reserve, Terengganu under ITTO/FRIM project indicates that the total value of rattan was RM49.54 per hectare, which is low compared to the rattan value in Negeri Sembilan (Awang Noor et al. 2000). This is due to the fact that only 30.7% of the rattan stocks is matured and can be marketed while others are still immature sticks. The value will increase to RM 1,321.29 per hectare if all standing stock of rattan were included in the analysis.

Table 8 Value of rattan stocks in the Forest Reserves of Negeri Sembilan

No.	Rattan species	Forest type	Number of clumps per ha	Number of matured clumps	Number of sticks	Value of rattan stock(RM/ha)
1.	Manau	Virgin	18.00	15.48	61.91	12.95
		Logged	2.50	1.69	4.50	0.94
2.	Mantang	Virgin	23.50	20.21	102.33	32.52
		Logged	12.63	8.53	18.13	5.76
3.	Semambu	Virgin	0.00	0.00	0.00	0.00
		Logged	2.00	1.35	11.71	6.32
4.	Dahan	Virgin	17.00	14.62	267.67	n.a.
		Logged	6.00	8.88	351.32	n.a.
5.	Rattan G	Virgin	25.00	21.50	222.83	-6.49
		Logged	5.00	3.38	8.45	-0.25
6.	Rattan H	Virgin	120.00	103.18	n.a.	n.a.
		Logged	n.a.	n.a.	n.a.	n.a.
	Total		235.63	235.63	471.26	942.52

Source: Awang Noor and Mohd. Shahwahid (1997)

Bamboo

Awang Noor and Mohd. Shahwahid (1997) used the residual value approach in estimating the economic value bamboo stocks in Negeri Sembilan. Various data were collected to compute the value of rattan stocks including the number of clumps per hectare by different rattan species and forest types, potential number of marketable sticks per clump of bamboo species, ex-mill prices of processed bamboo sticks, costs of collecting of raw rattans, transportation cost, processing cost, and a fair profit margin for the bamboo processing industry firm. The estimated total economic values of bamboo were RM23,175 and RM155,099 for virgin and logged over forests, respectively.

A study was also conducted in Compartment 51, Jengai Forest Reserve and Terengganu under

ITTO/FRIM project (Awang Noor et al. 2000). From the study, the estimated economic value of bamboo sticks was RM471.39 per hectare.

Wild Fruits

Of many wild fruits available in the forest, the focus of the previous studies has been mainly on *Parkia speciosa* (petai). Petai is an important NTFPs in Peninsular Malaysia because its seeds and pods are widely consumed both by rural and urban people. Petai is an excellent appetizer as well as has some medicinal value. Woon et al. (1995) have conducted an extensive study on the economic value of petai. A market price approach was used to derive the economic value of petai. The benefit derived from petai is the value accrued when it is traded in the local market. The economic values of petai production under the three management options were estimated by using the Net Present Value (NPV) approach. The results indicate that the petai and durian management option or combination provided the highest NPV per ha (RM42, 461) and IRR of 22.4 percent. Petai production and banana combination ranked second in value (NPV RM2, 401 per ha, IRR 3.25%) followed by petai and timber production option (NPV RM1, 179 per ha). This shows that inclusion of economic value of petai in analysing land use option will favour fruit tress than timber production. In another study, Awang Noor and Mohd Basri (2001), reported that the NPVs for fruit trees (petai and durian) ranked highest compared to other species in tree planting in the degraded forest areas in Korbu Forest Reserve, Perak.

A study by Woon and Poh (1998) estimated that the net value of petai (net of harvesting cost) under primary forest conditions in Pasoh Forest Reserve is RM22.04 per hectare (Table 9). Using a discount rate of 7 percent, they calculated that the net present value that could be derived from pod production in perpetuity is RM314.86 per hectare. Woon (2001) reported that the total potential value of petai in various forest types in Peninsular Malaysia was RM47.3 million or RM12.97 per hectare (Table 10). This is the estimated stock value of petai, not the actual resource of petai.

Economic values of other wild fruits have also been estimated by many researchers. The estimated economic value of NTFPs in a 50-ha Pasoh Forest Reserve was RM44, 591 or about RM892 per ha (Anon., 1994) (Table 11). In another study in Pasoh Forest Reserve, LaFrankie (1994) estimated that the economic values of *Aquilaria malaccensis* (gaharu) and *Cinnamomum mollissimum* (cinnamomum bark) were RM19 per ha and RM4.50 per ha, respectively. The annualized value of fruit trees was estimated at RM812.50 per ha per year (or RM11, 607.50 per ha per year in perpetuity at 7% discount rate). The economic value of wild durian was estimated by Vincent et al. (1993) and the value was RM170 million based on 4 percent discount rate. At 10 percent discount rate the value was estimated at RM79.5 million (Table 11).

In ITTO Project, Awang Noor et al. (2000) reported that there are two main species of fruit trees being utilized by communities living near the study site of Compartment 51, Jengai Forest Reserve, Terengganu. The study found that the economic value of petai (*P. speciosa*) and keranji (*D. indum*) per hectare was estimated at RM77.20 and RM373.26, respectively.

Table 9 Value of Petai in Pasoh Forest Reserve, Negeri Sembilan (50-ha plot)

Diameter class (cm)	No of trees	Productivity per tree	Petai value (RM)
< 10	449	-	-
10 – 19.9	37	-	-
20 – 29.9	12	50	96
30 – 39.9	16	100	256
40 – 49.9	9	500	720
50 – 59.9	8	500	640
60 – 69.9	1	500	80
> 70	0	-	-
Total	532	1,650	1,792
Average per ha			22.04

Source: Woon and Poh (1998)

Table 10 Estimated Potential Annual Value of Petai in all states in Peninsular Malaysia (tress of 30 cm and above)

Forest type	Petai value (RM)
Very good	638,620
Good	1,686,944
Average	8,177,416
Poor	1,651,590
Hill	0
Logged over forest:	
Logged in 1991-92	0
Logged in 1986-90	0
Logged in 1981-85	0
Logged in 1971-80	14,459,155
Logged in 1961-70	9,353,549
Logged before 1960	6,922,848
Shifting cultivation area	4,389,400
Total	47,279,582
Average per ha	12.97

Source: Woon (2001)

Table 11 Economic Values of Wild Fruits in Peninsular Malaysia

Location	Products	Scientific name	Total value (RM)	Year of Assessment	Source
Pasoh Forest Reserve, N. Sembilan (50 ha plot)	Fruits and nuts	*Artocarpus integer*	3,375	1990	Anon (1995)
	Fruits and nuts	*Baccaurea griffithi*	150		
	Fruits and nuts	*Baccaurea ramiflora*	167		
	Fruits and nuts	*Bouea oppositifolia*	3,533		
	Young Leaves	*Champeria manillana*	1,121		
	Roots	*Eurycoma longifolia*	4,475		
	Fruits	*Garcinia atroviridis*	240		
	Young Leaves	*Garcinia atroviridis*	72		
	Fruits and nuts	*Lansium domesticum*	24,505		
	Fruits and nuts	*Mangifera indica*	883		
	Fruits and nuts	*Parkia specioca*	6,450		
	Fruits and nuts	*Phyllantus emblica*	62		
Total			45,033		
Peninsular Malaysia	Wild durian - (4% discount rate) - (10% discount rate)		 RM170 million RM79,483,752	1989	Vincent et al. (1993)

Medicinal Plants

Traditional medicine is important to all ethnic groups in Malaysia. The forest provides valuable medicinal plants and the estimates show that the forest supports more than 200 potential important medicinal plants (Sabariah, 1989 cited by Kumari 1995b). However, it is difficult and almost impossible to estimate the economic value of all medicinal plants as a source of medicinal products. Even though tropical forest has yielded several important drugs which are vital in the treatment of related diseases, the economic value derived from these plants have to be assessed in terms of its potential earnings, costs of prospecting, research and development, and cultural practices. A study conducted by Kumari (1995b), however, provides some insight information about the value of medicinal plants from Malaysian forests. Using a variety of assumptions, such as low, medium and high level of earnings from plant drugs, and at the 10, 50 and 100 percent appropriation rates, and different types of forest area (protected area and production forest, effective protected area), the annual medicinal plants values per hectare were estimated. The results indicate that the economic value of medicinal plants depends on the combination of assumptions made. For instance, at a 50% appropriation rate, and calculated on the basis of the effective protected area for Peninsular Malaysia, the annual medicinal plant value per hectare was estimated to range from US7~117 per hectare per year from the low to the high earnings from drugs. Detailed estimates are provided in Table 12.

The most popular medicinal plants in Malaysia are *Eurycoma longifolia* (Tongkat ali) and the estimated economic value have been reported by Mohd. Azmi (2003). The total economic value per hectare was calculated by multiplying the dry weight by the price. To estimate the dry weight of *Eurycoma* spp., personal interviews with medicinal plant collectors and manufacturers in various states in Peninsular Malaysia were carried out. The studies were conducted in three forest areas in Kedah, namely Gunung Jerai Forest Reserve, Gunung Raya Forest Reserve and Bukit Perak Forest

Reserve. The residual value technique was used in the analysis and the results are presented in Table 13. The table shows that the economic value of *Eurycoma longifolia* is substantial ranging from RM49 to RM1,497 per hectare. The proportion of economic value of Tongkat ali to the total medicinal plants was about 1 to 60 percent. The total economic value of medicinal plants was estimated at between RM1,984 and RM10,033 per hectare and the average value is RM4,832. It can be concluded that the economic value is site specific, and the variation in its economic value depends on many factors including the forest type, soil condition, habitat, species composition of forest resources, and micro climate.

In ITTO project (2001), Awang Noor et al. (2000) reported that the estimated stock value of medicinal plants is RM40.21 per hectare. The results of the study are presented in Table 14. The economic value in this area is low compared to the ones obtained by Mohd. Azmi (2003) because of factors mentioned above.

Table 12 Estimates Economic Value of Medicinal Plants (US$ Per Hectare per Year)

Scenario	Drug value		
	Low (US$390 million)	Medium (US$1000 million)	High (US$7,000 million)
100% appropriation rate:			
protected area (711,472 ha)	38.73	99.30	695.11
protected area+production forest (5.34 mill ha)	5.16	13.23	92.61
effective protected area (2.1 mill ha)	13.12	33.64	235.50
50% appropriation rate:			
protected area (711,472 ha)	19.36	49.65	347.55
protected area+production forest (5.34 mill ha)	2.58	6.62	46.31
effective protected area (2.1 mill ha)	6.58	16.82	117.75
10% appropriation rate:			
protected area (711,472 ha)	3.87	9.93	69.51
protected area+production forest (5.34 mill ha)	0.52	1.32	9.26
effective protected area (2.1 mill ha)	1.31	3.36	23.55

Source: Kumari (1995)

Table 13 Economic Value of Medicinal Plants and *Eurycoma longifolia* (Tongkat ali) in Three Forest Reserves, Kedah, Peninsular Malaysia

Forest Reserve	Location	Total Value of Medicinal Plants (RM/ha)	Total Value of Tongkat ali (RM/ha)	% of Tongkat ali to total values
Gunung Jerai				
Compartment 22	Lowland	1,984	517	26.1
Compartment 2	Top ridge	2,451	1,457	59.5
Gunung Raya				
Compartment 7	Lowland	3,279	195	5.9
Compartment 9	Top ridge	4,330	127	2.9
Bukit Perak				
Compartment 48	Lowland	6,921	49	0.7
Compartment 50	Top ridge	10,033	162	1.6
Average all compartments		4,832	418	8.6

Source: Mohd. Azmi (2003)

Table 14 Economic Value of Medicinal Plants in Jengai Forest Reserve, Terengganu (Compartment 51 and Adjacent Areas)

Species	Local Name	Total value of medicinal plants (RM/ha)
Goniothalamus sp	Gajah Tarik	0.97
Eugenia dyerina	Haji Samad	0.97
Labisia pothoina	Kacip Fatimah	3.00
Melastoma malabathricum	Keduduk Rimba	0.22
Artaboltrys sp	Rancang Besi	0.20
Polyalthia hypoleuca	Lara Api	0.27
Maesa ramentacea	Melada Bukit	0.20
Coscinium blumeanum	Mengkunyit	0.80
Diospyros buxifolia	Meribut	0.61
N/A	Pecah Kelambu	4.11
Brucea sumatrana	Pedu Beruang Sayap	1.12
N/A	Kelawar	0.25
N/A	Selayar Hitam	2.33
N/A	Siong Beruang	0.67
Cinnamomum iners	Teja Lawang	1.02
Eurycoma longifolia	Tongkat Ali	0.23
Total		40.22

Note: This is estimated using residual value technique based on the resource inventory and market survey. The dry weight of each medicinal plant is estimated to be 50% from the green weight since the medicinal plants basically being exposed to the sun about 3 to 7 days before process it into powder.

Forest Recreation Areas (FRAs)

Forest recreation areas (FRAs) in Malaysia are one element of a forestry strategy directed towards the sustainable use of the forest reserves in Malaysia. The economic value of recreation benefits can be estimated from the consumer surpluses of visitors to the recreational forest. Consumer surplus is basically the net social benefits that visitors to a recreational site obtain in excess to the expenditures committed when making the trip to and recreating at the site. A comprehensive study covering many of FRAs in Malaysia was carried out by (Willis, et al., 1998). The recreational values of the FRAs in Peninsular Malaysia were estimated using contingent valuation method (CVM) and individual travel cost method (ITCM). The results of the study are presented in Table 15 for the contingent valuation method. From Table 15, the results show that the sample mode and median WTP per visit is RM1 for most sites, indicating that the distribution has a normal distribution than usually found in the CVM studies. Removing illegitimate bid bids increases sample mean WTP from RM1.22 to RM1.46 per visit. On average, it can be said that the expressed willingness to pay was RM1.46 per adult visitor. The study also concludes that values for children, being approximately half those of adults. The results from the individual travel cost method were used to construct the validity of the CVM results. The ITCMs estimate consumer surplus of between RM0.67 and RM3.74 for three FRAs for the marginal visit. Studies comparing CVM and travel cost revealed preference (RP) estimates (such as TCM) have generally found that CVM estimates are smaller, but not grossly smaller than their counterparts. The overall CVM/ITCM ratio was estimated at 0.67.

The study also estimated aggregate benefits of FRAs based on annual visit numbers to the FRAs.

Capitalizing the benefits at 5% discount rate, the total economic value of FRAs was estimated at RM53.06 million for the 20 FRAs in Peninsular Malaysia. The study also showed that the benefits exceed costs by a factor of 2.0 (BCA=2.0).

Other studies on the economic value of recreational benefits are presented in Table 16. The method used in most studies was the travel cost method (TCM). It should be pointed out that the values estimated from these studies are site specific and are not transferable to other sites as each site has its own unique characteristics. Further, the development of recreational facilities or availability of substitutes within the travelling zones of visitors in the future would alter the consumer surplus.

Table 15 Consumer Surplus Values per Visit for Selected Forest Recreation Areas in Peninsular Malaysia

No.	FRA	Mean WTP Simple	Mean WTP Trimmed	Mean WTP Modified
1	G. Arong, Johor	Data error on survey	Data error on survey	Data error on survey
2	GPulai, Johor	1.97	1.63	2.15
3	Gua Cerita, Kedah	0.61	0.52	1.32
4	Sg. Teroi, Kedah	1.57	0.88	2.71
5	Jeram Linang, Kelantan	1.05	0.99	1.05
6	Ayer Keroh, Melaka	0.88	0.84	1.13
7	Gallah, N. Sembilan	1.97	1.86	2.29
8	Ulu Bendol, N. Sembilan	1.18	0.90	1.33
9	Kenong, Pahang	4.38	4.38	4.85
10	Lentang, Pahang	0.75	0.69	0.98
11	Sg. Pandan, Pahang	1.02	1.02	1.24
12	Kuala Woh, Perak	1.01	0.99	1.22
13	Bukit Larut, Perak	1.51	1.32	1.62
14	Bukit Kubu, Perak	0.72	0.63	1.27
15	Telok Bahang, Penang	1.16	1.07	1.41
16	Sg. Chongkak, Selangor	1.19	1.17	1.33
17	Kanching, Selangor	1.17	1.00	1.42
18	Sg. Tua, Selangor	1.52	1.35	1.79
19	Sekayu, Terengganu	0.98	0.96	0.98
20	Lata Tembakah, Terengganu	0.88	0.71	1.05
	Average for all areas	1.22	1.03	1.46

N = 5606 for mean WTP per adult
N = 5046 for trimmed mean WTP per adult
N = 4677 for adjusted mean WTP per adult
Source: Willis et al. (1998)

Table 16 Summary of Economic Value of Other Forest Recreation Areas in Malaysia

State	Forest Reserve	Value	Non-monetary indicator	Year of assessment	Source
Selangor	Kanching FR	RM300, 000/year (consumer surplus)	No. of visitors 77,126/year	1982	Abas (1982)
	Semenyih Dam	RM0.50-2.50/visit		1990	Ahmad, Wan Sabri & Rashid (1990)
	Air Hitam FR	RM1.23 per visit		1998	Mohd. Shahwahid et al. (1998)
Negeri Sembilan	Ulu Bendul FR	RM61,005/year (consumer surplus)	No. of visitors 35,996	1995	Mohd. Khidir (1995)
	Ulu Bendul FR	RM0.58 to RM2.26 per visit		1997	Awang Noor and Mohd Shahwahid (1997)
Kuala Lumpur	Lake Garden (Urban Park)	RM36/per capita per year		1993	Nik Mustapha (1993)

Protected areas

Protected areas include nature reserves, recreation forests, national and state parks, and wildlife sanctuary. In addition to providing recreation opportunities and habitat for wildlife, these areas are important in conserving biodiversity as well as maintaining ecological stability. The economic values of protected areas accrued through fulfilling the various functions mentioned have not been thoroughly understood. However, a number of studies have attempted to address this question. The results are presented in Table 17.

One of the important studies was carried out in the Kuala Selangor Nature Park (KSNP). This Park is a highly modified mangrove forest of approximately 320 ha, situated 65 km from Kuala Lumpur. The park was established in 1987 and is being managed by the Malayan Nature Society (MNS) following an agreement with the State Government of Selangor. Currently, the park is gazetted as a town/public park under the Local Government Act 1976. The KSNP was established to promote conservation of the mangrove and mudflats in the site and re-establishment of indigenous plant species. There is considerable public interest on the park, which is a well-known site for observing mangroves, water birds and other wildlife such as silvered leaf monkeys. Of global interest, is the site's importance for migratory birds. Kuala Selangor is a link in the migratory chain through South East Asia for waders. There is a potential for introducing a milky stork population into the KSNP, which is being bred at Zoo Negara with sponsorship from the Malaysian Wildlife Conservation Foundation. The milky stork is a CITES I bird. The captive management programme has been successful at Zoo Negara and by September 1995, there are 48 milky storks and about five chicks at the aviary.

The economic value of on-site recreational benefits of KSNP was estimated by Jamal (1997) using the travel cost method (TCM) and contingent valuation method (CVM). Consumer's surplus per user per trip was found to range between RM62.00 to RM120.00. This estimate yields a gross economic value in the range of RM1.1 million to RM1.68 million annually. Other estimates indicate that the economic value range from RM15 to RM126 per visitor per year.

The economic values of protected areas are significant a shown in Table 17. The values were mainly derived from the ecotourism potential and the role of products to local communities.

Table 17 Summary of Economic Value of Protected Areas in Malaysia

State	Protected Area	Value	Non-monetary indicator	Year of assessment	Source
Pahang	Tasik Bera	US$15-2714/ household Mean:US$84/household		1990	Anon (1995)
Selangor	Kuala Selangor Nature Park	WTP RM62-120 per visitor per trip (CVM)		1995	Jamal (1997) (1995)
	Kuala Selangor Nature Park	CS RM126 per visitor per visit (TCM) WTP RM15 per visitor (CVM)		2001	Rusmani (2001)
	Kuala Selangor Nature Park	US476,252(1987-2000)		1995	Mohd. Shahwahid (1995)
Terengganu	Rantau Abang Turtle onservation Area	RM3.65 mill.(1984-95)		1995	Mohd. Shahwahid (1995)
Pahang	National Parks	RM6,530,044 (Total visitor expenditure in the park, including transportation cost)	No. of visitors 18,000/year	1994	Ahmad Shuib (1994)
		RM120 – RM280 per visitor per year	57,000 (1998)	2000	Norlida and Jamal (2000)
Johor	Mangrove Protection (Benut Mangrove Forest)	RM1/household per month or RM151,000 per year (12,650 households)		1999	Bann (1999)
Sarawak	Bako National Park	RM990,436/year (consumer surplus)	No. of visitors 32,880	1982	Chung (1982)
Sarawak	Niah National Park	RM851,761/year (consumer surplus)		1982	Chung (1982)
Sarawak	Lambir National Park	RM1,011,611/year (consumer surplus)		1982	Chung (1982)

Wildlife

A limited study has been carried out that try to estimate the economic values of wildlife species. Stuebing et al. (1993) and Caldecott and Nyaoi (1984) conducted studies on the economics of wildlife hunting in Sabah and Sarawak, respectively. The values obtained were expressed either as per animal, per kilogram of meat or the total value of meat per year. The value of milky stork was estimated to be RM246,000 per bird and RM10 per bird for spotted dove. The economic value of long-tailed macaque was estimated at RM1,650 per animal. The value of sambar deer meat to the economy of Sabah was estimated to be RM530, 400 per year. While in Sarawak, the total value of the meat of barking deer and wild pig were estimated at RM24,852,555 and RM3,335,332 per year, respectively. Wildlife products such as swiftlet nest bring in RM6.75 million in government revenue for Sarawak. In Sabah an average of RM6.0 million per year in government revenue was obtained from swiftlet nests. The values of other wildlife products such as sambar deer antler, tail and male reproductive organ, crocodile hide and meat, turtle shell and sun bear gall bladder are also estimated. In Peninsular

Malaysia, the value of elephant was estimated at RM186, 000 per animal at 4% discount rate and RM244, 000 per animal at 10% discount rate (Vincent et al. 1993).

Carbon Benefits

Vincent et al. (1993) estimated the economic value of carbon storage and wild durian. The value of carbon storage was RM500 million in 1989, a reduction of RM300 million from 1971. Roslan (1995) also conducted a study on the role of forest to carbon sequestration based on three management systems, viz. protective management system, production forestry system, and plantation forestry system under various assumptions such as different interest rates (0%, 1%, 3%), different business activities (usual business and improved situation), timber quality situation (quality timber and fast growing species). These assumptions were used for different forest management systems. Different interest rates, however, were presence in all management systems. The main conclusion was that the forests provide significant impacts in carbon sequestration with some of the situations examined showed positive NPVs.

Watershed Protection

Functions of forest for watershed protection include soil conservation, flood and storm protection, water supply and water quality regulation. The effects of timber harvesting can be significant if its practices are not fully regulated and controlled especially in water catchment area. The economic effects of timber harvesting practices of watershed protection functions are still limited. Comprehensive estimates have still to be researched in water catchment areas because the concern now is on long term water supply for the urban and urban dwellers. There have been two studies so far which have focused on the links between sustainable timber harvest and sedimentation of dams.

A study conducted by Mohd. Shahwahid et al. (1999) aimed at determining the economic value of the benefits and costs and analysis of the trade-off between managing forest land for timber production and water supply. The results of the analysis are presented in Table 18. Under the total protection option, the NPV at 10 percent discount rate was estimated at RM10.4 million compared to RM26.6 million under the reduced impact logging (RIL). In the study, the RIL is preferred to total protection in terms on net benefits generation. This is because sediment yields from timber harvesting activities that incur external costs are not large enough to outweigh the net benefits derived from HEP generation.

In another study by Mohd. Rusli (2002) on the impacts of timber harvesting in watershed area in MUDA/Pedu water catchment area, Kedah found that the net present value of timber harvesting options reveals positive values compared to that of the total protection. The results are presented in Table 19. However, it should be noted that the study only considered the values of timber and water treated plants. The dredging cost was not taken into account because the calculation showed that it was not significant under the three forest management options when it was evaluated over a 60-year period. In this case, the loss in storage capacity of the dams (Pedu and MUDA dams) was minimal. If the benefits and costs of other forest and environmental resources were included, the results would have been different.

Table 18 Present Value of Net Benefits from Watershed Protection under Different Forest Landuse Options in Hulu Langat Water Catchment Area, Selangor

Good/Service	Total protection	Reduced Impact Logging
Timber	-	16,692,434
Treated Water	7,694,319	7,694,319
Hydroelectric power	2,736,918	2,211,635
Total Net Benefits (PV at 10% discount rate)	10,431,237	26,598,388

Note: The Hulu Langat catchment comprises four catchment areas (Langat dam and catchment area 3,823 ha, Lolo catchment area 473 ha, Pangson catchment 265 ha, Lupok catchment 455 ha).
Source: Mohd Shahwahid et al. (1999)

Table 19 Present Value of Net Benefits from Watershed Protection under Different Forest Landuse Options in Ulu Muda Forest Reserve Area, Kedah

Good/Service	Total protection	Conventional Logging	Reduced Impact Logging
Timber	-	119,406,465	87,966,199
Treated Water	128,841,265	121,354,969	125,876,881
Total Net Benefits (PV at 10% discount rate)	128,841,265	249,761,434	213,843,080

Note: The total catchment area is 118,600 ha, of which 98,539 ha are MUDA catchment area and 20,134 ha are Pedu catchment.
Source: Mohd. Rusli (2002)

Total Economic Value (TEV)

Another important concept of valuation is the total economic value (TEV), which is useful to highlight the full extent of benefits and costs that can be provided by forest ecosystem. The valuation of forest goods and services using the TEV framework was conducted by Kumari (1995a), DANCED Project (1998) and Jamal et al. (1998). The results of these studies are presented in Tables 20 to 22.

Kumari study was carried out in North Selangor Peat Swamp Forest, Selangor under a range of management options and a base case situation. The analysis sought to illustrate what such TEV would mean in the context of the forest management of the site. The results of various forest goods and services per hectare of the base case and three management options are presented in Table 20. The results indicate that even when local benefits alone are considered it is financially profitable to shift from unsustainable to sustainable options (Table 20). The results also show that the carbon value is significant and contribute much of the total value of the forest ecosystem.

A similar study of the DANCED project was also conducted in the same area the results are presented in Table 21. The results show that the total economic value of the North Selangor Peat Swamp Forest RM1.1 billion at 8 percent discount rate. The total global value (RM682 million) is greater than the estimated private value (RM321 million) and the social value (RM113.4 million).

The TEVs of mangrove forest are presented in Table 22. The results indicate that mangrove forest is significant in providing other environmental services as shown by recreation, ecotourism and conservation values. Ignoring these values in other land use options will result in unsustainable forest management and the costs involved will be borne by the public.

Table 20 Total Economic Value (TEV) in the North Selangor Peat Swamp Forest (Present value 1980 price, 8% discount rate)

Good/Service	Base Case (RM/ha)	% of TEV	Change from Base Case Option to Sustainable Option (RM/ha)		
			B1	B2	B3
Timber	2,149	21.3	-696	-399	-873
Agro-hydrological	319	3.1	0	411	680
Endangered species	454	4.4	35	20	44
Carbon stock	7,080	69.2	969	1,597	1,597
Rattan	22	0.2	88	172	192
Bamboo	98	1.0	0	-20	-20
Recreation	57	0.6	0	0	0
Domestic water	30	0.3	0	0	0
Fish	20	0.3	0	0	0
TEV	10,238	100.0	396	1,782	1,620

Notes: 1.Base case option – represents the current unsustainable harvest where the harvest rate is high and the logging method environmentally destructive.
2. Management options B1, B2 and B3 all represent sustainable harvest options.

Table 21 Total Economic Value (TEV) of some Forest Goods and Services in the North Selangor Peat Swamp Forest (Net Present Value at 8% discount rate)

No.	Good/Service	NPV at 8% (RM million)	Note
1	Timber	321.21	26,649 ha are commercial forests
2	Hydrological	109.56	Irrigation water accounted for 99% of the total hydrological value
3	Carbon: Above ground Below Ground	 583.33 99.03	A value of RM14 per Ct was used
4	Ecotourism	1.78	WTP of RM1.42 per person used
5	Fish	2.08	Based on fishing in Sg, Tengi and main canal.
6	Asam kelubi	0.023	Based on socio-economic survey by Lim et al. (1998)
7	Total social values	113.437	Items 1+2+2+4+5+6
8	Total global values	682.36	Item 3
9	Total private values	321.21	Item 1
Grand Total		1,117.01	

Source: Anon (1998)

Table 22 Total Economic Value (TEV) of some Forest Goods and Services in Matang Mangrove Forest, Perak (Figures in 1998)

No.	Good/Service	Economic value	Note
1	Timber	RM2,448/ha RM2,535/ha RM3,053/ha RM2,549/ha RM1,843/ha	Stumpage value based on charcoal production – allocated area Stumpage value based on charcoal production – tendered area Stumpage value based on charcoal production – excellent forest Stumpage value based on charcoal production – good forest Stumpage value based on charcoal production – poor forest
2	Ecotourism – bird watching	RM38-70 per trip	Consumer surplus using individual travel cost method (TCM) using semi-log regression model
3	Ecotourism – sport fishing	RM15.69 – 18.93 per trip	Consumer surplus using individual TCM using semi-log regression model
4	Conservation value (non-use value)	RM10-17 per household	Mean WTP using logit model from 571 respondents
5	Conservation value (non-use value)	RM8.84 per household RM18.28 per household	Mean WTP using choice model from 571 respondents This value is an equivalent surplus (ES) (WTP to avoid a degradation in resource use) Compensating surplus (CS) (WTP to obtain an improvement in resource use)
6	Fish	RM452.60 per vessel/month RM583.64 per vessel/month RM8,621,138 per year	Resource rent for open sea fishing Resource rent for river fishing Total resource rent from fishing

Source: Jamal et al. (1998)

Local Community's Dependence on NTFPs

In most cases, the use of NTFPs to the local community either for their own consumption or for sales can provide useful information on implicit value of NTFPs. However, such studies are still lacking even though research opportunities in this area are potentially high. Mohd Shahwahid (1992) attempted to impute the benefits generated from the utilisation of forest produce in the Tasek Bera ecosystem in Pahang by the *Orang Asli* (indigenous people) community. A sample of 43 families or 23% of the total population were interviewed using a structured questionnaire. The main aim of the interview was to solicit the respondents' consumption patterns of forest produce in the forest ecosystem. Respondents were requested to specify the quantity of each plant produce collected from the forest during a period of a week or a month, the number of times collected during the course of a year and where possible their market values. The study found that the mean imputed economic value per household was RM2,105. About 35% of the families surveyed obtained economic values of less than RM3,772.5 per annum while only 5% obtained more than RM6,605 per annum. The collection of various rattan species from the genus *Calamus* and *Korthalsia* contributed the most to the total economic value, which was about 68% of the mean household economic value. This was followed by the collection of resins from *Dipterocarpus kerii* (11%), mats and baskets made from *Pandanus* sp. and other species (10%), fragrant wood from *Grewia antidesmaefolia* and *Aquilaria malaccensis* and the rest from plant parts collected for building materials, food and medicinal herbs.

Another study on the role of timber and non-timber forest products to the *Orang Asli* community in Air Hitam, Puchong, Selangor was conducted reported by Rusli et al. (1998). The main objectives of the study were to estimate the quantity of timber and non-timber forest produce collected by the *Orang Asli* as well as the revenue that could have been generated by collecting these produce. Using a structured questionnaire, interviews were held with each of the household heads of two *Orang Asli* communities residing at Sungai Rasau Luar and Sungai Rasau Dalam in November and December, 1996. Data on price estimates of the various products were obtained by surveying market outlets in the vicinity as well as in the city of Kuala Lumpur. The household heads were also asked about the prices of some of the produce in cases where these are not obtainable from the markets.

The results show that, in terms of species collected, the *Orang Asli* communities are more dependent on the forest reserve for food and fruits than for other purposes like housing construction, handicraft-making and medicine. While all the 24 animal species mentioned by the *Orang Asli* were hunted for their meat, 48% (10 species) of the plant species are for fruits. Birds and small mammals comprise 75% of the animal species collected. The revenue that could have been generated and/or saved by collecting the timber and non-timber produce amounted to nearly RM110,000 for the year 1996. The revenue generated by plant species was about seven times more than that of animal species. The greatest source of revenue came from housing construction followed by handicraft making and fruits. These values could have been bigger before. The *Orang Asli* commented that they are less dependent on the forest now than before. According to them, the forest now provides lesser number of useable species of plants and animals than before. Also, the *Orang Asli* are now economically better off than before and they can depend more on markets than the forest for their daily necessities.

5 Forest Accounting

At the national level, net domestic product (NDP) is gross domestic product after deducting off allowance for manmade capital. At the sectoral level, the increase in the aggregate value added from forestry and wood-based industries is often seen as a major contributor to NDP. Considering that forestry is a renewable natural resource, it is assumed that such a contribution can be sustained. Yet, no indicator is being measured to determine its actual status. For this reason, NDP is often criticized for only taking into account depletion of man-made capital while ignoring depletion of natural resources. In view of this, resource economists suggest an alternative measure of national income, namely the adjusted net domestic product (ANDP). ANDP is calculated as in NDP but with further subtraction for depletion in natural resources. This alternative measure can indicate whether a country is reinvesting enough of its economic output to offset both the depreciation of man-made capital and the depletion of natural resources.

ANDP is also useful in revealing whether the growth of a country is derived from utilising the returns of its wealth, i.e. living off the dividends or whether it is growing by using up its wealth. The former is sustainable in that its forest stock (wealth) remains intact (Figure 1). On the other hand, the latter is not sustainable since its forest stock is depleted (Figure 2). The country grows at a high rate while it has the natural resources to extract. Once the natural resource is exhausted, the economy stops growing. Thus the ANDP concept can alert policy makers as to the kinds of economic development that the sector is involved in.

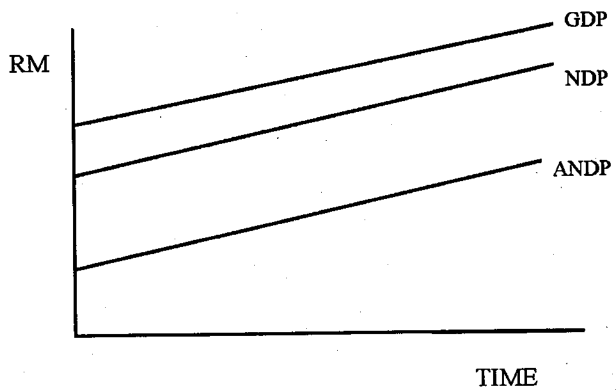

Figure 1 Economic Growth with Less Dependent on Natural Resources

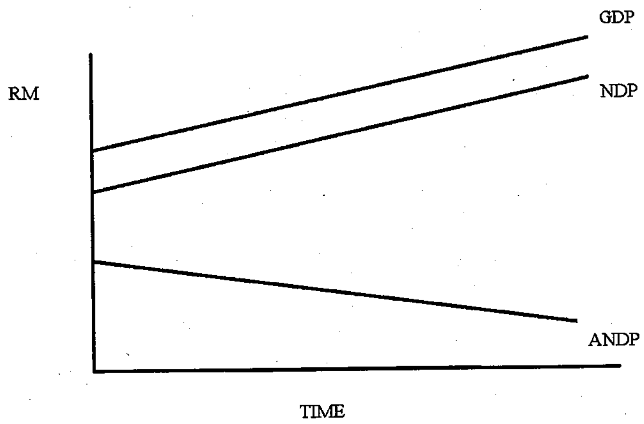

Figure 2 Economic Growth with Greater Dependent on Natural Resources

There is relative lack of familiarity amongst development economists throughout the world with the economic concepts and methods of accounting for natural resources. This stems from a period when natural resources seemed to be virtually unlimited, and could therefore be ignored without introducing obvious distortions into economic projections. The more recent recognition that natural resources are indeed limited requires changes in economics methodology. Natural resource economics as a sub discipline of economics dates back only to the 1930s. Many of the advances in the field have occurred only within the last decade (Davison & Vincent, 1997).

The Economic Planning Unit (1993), conducted a study carried out by WWF Malaysia in

1991-1992 and reviewed by Davison & Vincent (1997) which used a modification of the Repetto method and applied this to oil and gas, tin, timber, value-added processing of timber, carbon storage, some aspects of biological diversity, and soil erosion. This study used data up to 1969, and was subsequently updated to 1993.

The method used was a modification of that developed by Repetto et al. (1989), the net price method.

- For each resource, data were compiled showing changes in the physical stocks over time (usually over the period 1971-1989).

  For these resource accounts, the accounting convention is simply:

  Closing stock=Opening stock + Positive flows – Negative flows

  = Opening stock + Net change

- An annual depletion allowance was then calculated by multiplying the change in the physical stock of the resource over a given year, times a measure of the economic value of one unit of the resource .

  Net change x economic value per unit = Depletion allowance

- This economic value is known as the "user cost". It was calculated by using the net price for the resource, which equals the price the extracted resource minus the unit costs of production.

- The depletion allowance was then deducted from the Net Domestic Product (NDP) for Malaysia (or sometimes for a particular region of the country).

  NDP – Depletion allowance = Adjusted NDP

The chief modifications from the Repetto method were which specifically concerned timber was:

- The net prices were smoothed to remove short-run market fluctuations;
- Total remaining stock of a given resource were not revalued at the end of each calendar year (this was considered unrealistic, since it was not possible to sell off all of a resource at the year's end, and is unnecessary to the calculation of NRA);
- Depletion allowances were deducted from NDP, not GDP, (this modification was also used by Repetto et al. (1991).

Study Results

Physical trends: timber

In the case of timber and other renewable resources such as fisheries, change in stock is complicated by the possibility of biological growth, and can potentially be positive. Other than downturns during the economic recessions, the national trend in timber harvest through the period was strongly upward (Figure 3). This resulted in doubling of harvest between 1971 and 1989. This rise was associated with an increase in log prices (real terms), which rose sufficiently to offset the rising costs of access as logging moved to more interior regions of the country.

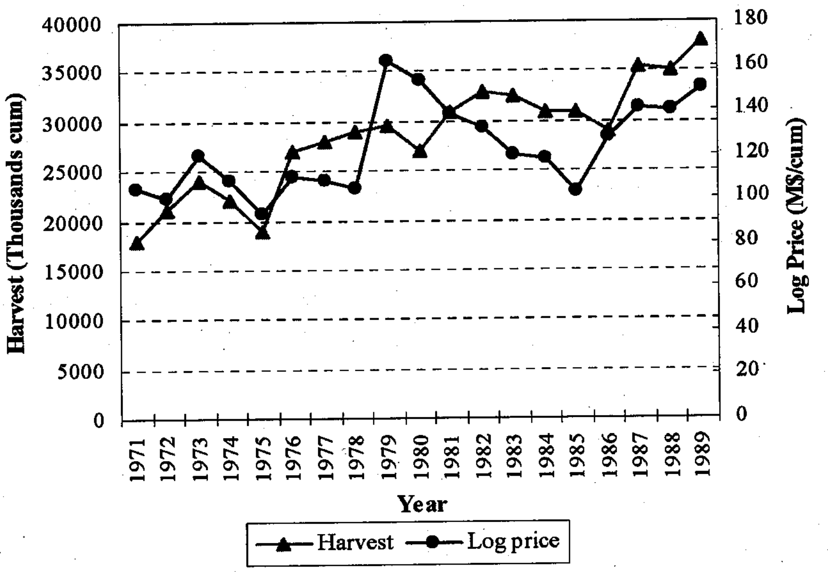

Figure 3 Total Timber Harvest and Log Prices Malaysia

The net harvest (Figure 4) is the commercial harvest of timber, minus the amount of replacement growth. If the harvest is approaching a sustained yield level, then the net harvest should be getting closer and closer to zero. Instead the net harvest tripled from 1971 to 1989. Harvests, primarily from previously unlogged forest, continued to outstrip the growth occurring in the logged-over forest.

Moreover, there were additional reductions in stock owing to deforestation and degradation (e.g. illegal logging damage). In fact these other reductions were two to three times larger than the net harvests. On the positive side, after increasing during the 1970s (due to deforestation for land development), the rate of timber depletion steadied and may have started to decrease during the 1980s. However, the country continued to lose more timber to these processes than to recorded commercial timber harvests (Figure 4).

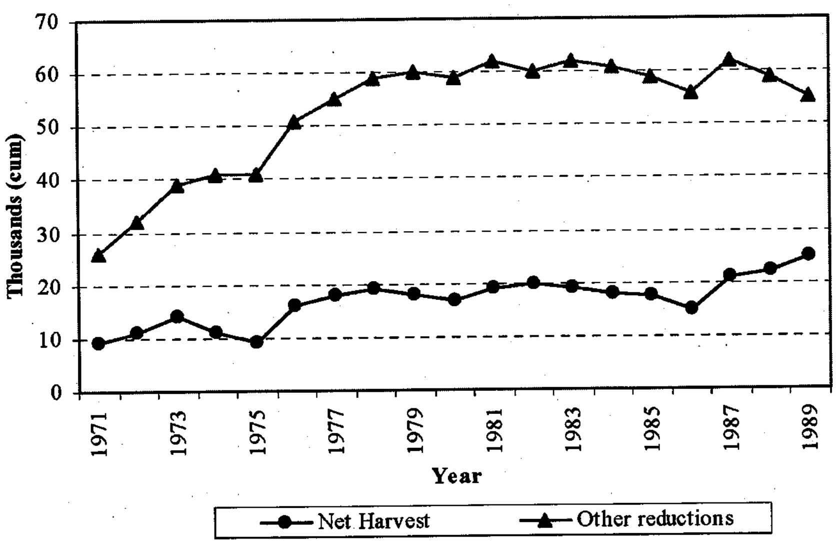

Figure 4 Depletion of Timber Stock Malaysia

The effect of net harvests and other causes of reduction has been a continuing decline in timber stocks. By 1989 timber stocks had been reduced to half of the 1971 level (Figure 5). The country's forests not only contained less timber than they did in 1971, but also stored less carbon (which could contribute to global warming), and contained less biological diversity.

During the period 1971 to 1989, the area of forest declined by about a quarter (Figure 6). This was less rapid than the decline in stocks, indicating that not all of the forests that have been harvested were converted to other land uses. The decrease in areas of unlogged forests has been faster, both relatively and absolutely, than the decrease in forest overall. Because the unlogged forest is the more important for protection of biological diversity, this trend suggests that the country's resources have been eroded.

Even this simplistic analysis therefore shows the complexity of issues relating to renewable resource such as timber, in comparison with a non-renewable resource such as oil.

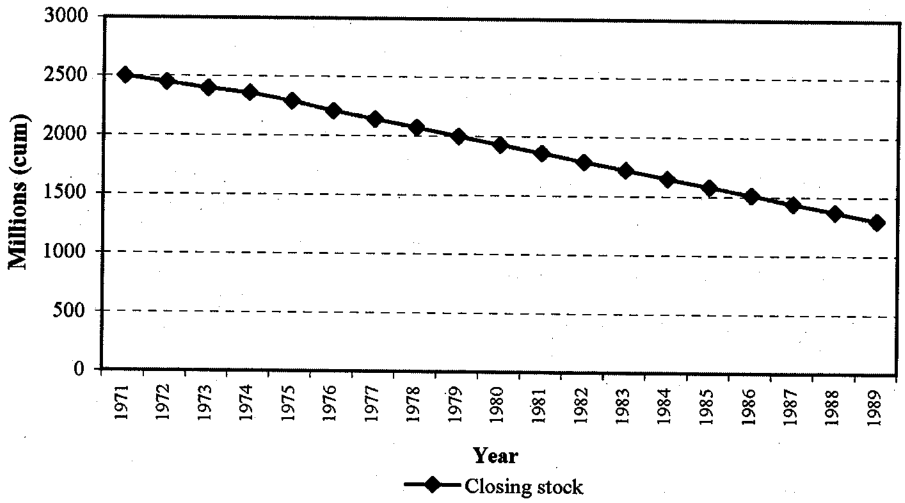

Figure 5 Total Closing of Timber Stock Malaysia

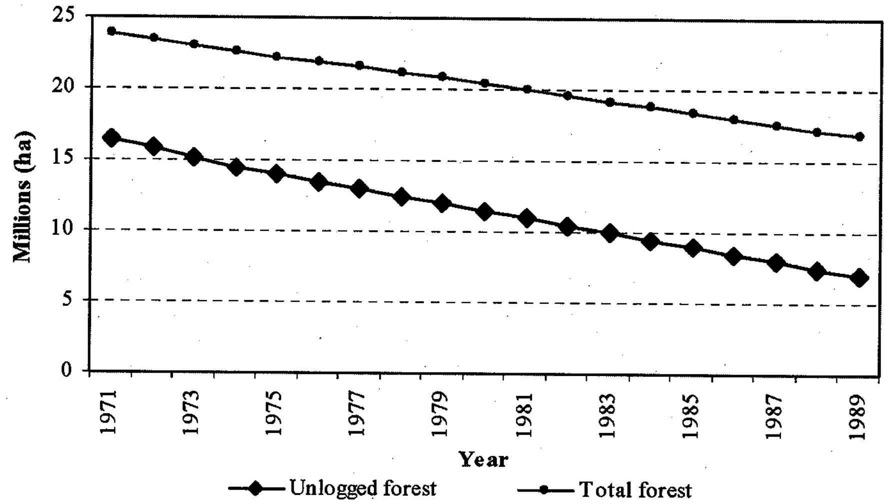

Figure 6 Closing Forested Areas Malaysia

Mohd Shahwahid (1996) conducted a study to describe a method of deriving the natural resource account for forestry, in order to account for changes in the physical stock, as well as changes in the value of the forestry resource specifically for timber. The approach used was based on the principle that in order to obtain a forest resource account, necessitates the generation of a physical timber account, prices to value the stock of timber and its depletion, and the eventual value account. The stock of timber and its changes during the accounting period will be recorded in physical units. The accounting principle is that the opening stock plus all growth or addition (such as natural growth and reforestation) minus all extraction or harvesting, natural degradation (such as fire, insects and infestation) and deforestation (conversion to other land uses), equal closing stocks. The value accounts impute monetary value on changes in the physical accounts.

The physical account requires the computation of both forest area and timber volume accounts. The physical accounts calculate the net change in timber stocks. Areas and timber volumes are recorded separately for primary or virgin forests (that have never been logged before) and for secondary forests (that have been logged before). The report described the accounting identities for primary and secondary forest areas as well as the accounting identity of the primary forest stock and secondary forest stock.

The concept of economic rent is essential for natural resource valuation since it places monetary value on changes in physical assets. Economic rent is the return to any production input over the minimum cost required to retain it in its present use. In forest resource production, economic rent can be estimated by the stumpage value which is the market value of the standing timber prior to any value added by processing.

Physical forest accounts

The physical forest accounts of the Peninsular Malaysia natural forest resource is given in Table 23 below:

Table 23 Physical Account of Natural Forest in Peninsular Malaysia at 31 December 1981 (Thousand Cubic Metres)

Opening stock(1/1/72)		**1,193,794**
ADD:		
Growth	117,615	
Less: offset accumulated Growth	(52,920)	
Net growth	64,695	
Reforestation	2,509	
Total stock		**1,260,998**
Less:		
Harvest	(94,565)	
Deforestation	(40,663)	
Degradation	(121,043)	
Due to misstatement	(44,223)	
Total depletion		**(300,494)**
Closing stock(31/12/81)		**960,504**

Source: Mohd. Shahwahid (1996)

The estimated stumpage prices were used to convert the physical account in Table 23 to the monetary accounts. The stumpage price for natural forest was based on RM 54.79 per cubic metre while for plantation stumpage is based on RM 22.00 per cubic metre. The results are presented in Table 24.

Table 24 Monetary Forest Accounts of Natural Forest Resources in Peninsular Malaysia as at 31.12.1981 (Million RM)

Opening stock(1/1/72)		**65,408**
Add:		
Growth	6,444	
Less: offset accumulated growth	(2,899)	
Net growth	3,545	
Reforestation	115	
Total stock		**69,068**
Less:		
Harvest	(5,181)	
Deforestation	(2,228)	
Degradation	(6,632)	
Due to misstatement	(2,423)	
Total depletion		**(16,464)**
Closing stock(31/12/81)		**52,604**

Source: Mohd. Shahwahid (1996)

The above forest resource accounts clearly indicate that Peninsular Malaysia's natural forest resources has in fact suffered depletion in stumpage by 300.5 million cubic metres valued at RM16.5 billion in 1981. This decline in stumpage volume and value is caused by logging, deforestation and degradation in excess of natural growth and reforestation. In principle, sustained yield management requires that on average, annual rates of depletion be equal to the rehabilitation capacity of the forest resource (Lockman, 1969). Implications of the net depletions, especially if there are insufficient efforts to correct them, would jeopardize logging yields in the next cutting cycle.

The study captures only the commercial timber loss resulting from forest resource depletion. It is an understatement of the true loss to the society, because it excludes the value of environmental services, non-market forest products and non-commercial timber species. Restricting adjustment to commercial timber, however, will maintain the consistency of the SNA, a system which is designed to reflect only market transactions and market proxies.

Ahmad Mustain (2000) found out that the present system of national accounts (SNA), the concept of capital maintenance applies to physical capital only. Limited account is given to the contribution of natural resource and environment to economic activities.

The study applies the user cost method in estimating the resource depletion in forestry. The user cost is considered to be better method in estimation of resource depletion as it unlike the net price method which takes into account the future benefits foregone or gained. For the national economy, using both the methods, the study found out that the trend of per capita real ANDP and AGDP increased almost three times over the last 25 years, indicating welfare increase. The theory and experience of El Serafy (1989, 1991) and (Vincent, 1997) are incorporated in the user cost approach for computing the depletion of forest of Malaysia. The net price method applied by Repetto et al. (1989 and 1991) was also used.

The present study focuses in more detail the depreciation accounts for the natural forest resources, rubber resources and forest plantation of Peninsular Malaysia. The results showed that during the study period (1972-96) it was observed that natural forest declined about 30% from 8.2 million ha in 1972 to 5.7 million ha in 1996. The closing stock accounts of its timber stock showed a declining trend by 33% from 547.2 million m^3 in 1972 to 368.3 million m^3 in 1996. In terms of rubberwood declined over time from 234.1 million m^3 in 1980 to 188.0 million m^3 in 1996 due to the declining rubber holdings area for other development purposes. Conversely, the timber stock for plantation forest increased during the study period due to an expansion of compensatory plantation area and increasing growth of newly plantation forest.

Natural Forest Accounts: User Cost and Net Price Method

The trend of user cost under the scenario of 1% price and cost increase at 6% discount rate showed that the user cost was negative all the way for the last 25 years, signifying the appreciation of resource value. The limitation of the net price method is by ignoring the future benefits foregone or obtained. Thus the net price method provides an improper indicator of resource depletion.

6 Future Directions

Most of the studies that have been done in Malaysia are in the areas of forest resource valuation and only very limited studies in forest resource accounting. These studies are important as baseline information for future undertakings in forest resource valuation and accounting. In the future, greater efforts should be directed towards the valuation of indirect benefits particularly on NTFPs, such as watershed protection, soil erosion, biological diversity, climate change which are difficult to assign monetary values but nevertheless must be accounted for in any forest policy decision making with a view to securing sustainable development.

Due to underpricing and under valuation of the forest resources of Malaysia, the economic benefits of forest and environmental services have been largely undervalued and ignored in economic developments and the Forestry Department cannot ascertain whether enough reinvestment in the sector. Forest valuation and accounting are important and in line with the department's efforts in ensuring sustainable forest management. Sustainable forest management takes on a new dimension now and is defined as the management of forest goods and services on a sustainable basis for optimum utilization in line. with environmental requirements. From the definition it is clear that sustainable management of forest resources had changed from management of forest for timber production only into management of the forest for timber as well as non-timber forest products and services. In view of this, the Forestry Department of Peninsular Malaysia will be conducting a joint project with Universiti Putra Malaysia on "Economic Valuation of Forest Goods and Services in Peninsular Malaysia". The study will be conducted to cover all forest types throughout Peninsular Malaysia. This is important so that the study will cover various time and ecosystems unlike the past studies which are site-specific and limited in scope. Selection of forest goods and services to be included in the project will be based on its importance to the national and local economy. The study will be conducted within a timeframe of three years with an estimated budget of about RM 200,000.00 per year. The results from the study will serve as baseline information for future works in forest accounting.

The System of Environmental and Economic Account (SEEA) proposed by the United Nations (2000) should be used as guidelines in any future undertakings in forest resource valuation and accounting. Based on the United Nations guidelines, institutional frameworks should be strengthened including capacity building, pilot works, database compilation and human resource developments.

Pilot compilation

A national programme of environmental accounting could be initiated by a pilot project. The pilot study could start with the development of the accounting framework based on the structure of SEEA. The pilot project should take into account data availability and the study should be designed for long term analysis. The pilot project should be supported by national staff who are familiar with the concepts and methods of integrated accounting, assist in setting up of coordination mechanisms of data collection and guides future development.

It is suggested that the pilot compilation be carried out as an interdisciplinary research programme in which the statistical office or the institution responsible for the compilation of national accounts and/or a particular research institute play(s) key roles. In the case of Malaysia, the agency responsible is the Economic Planning Unit in the Prime Minister's department. Two years are usually required in a developing country, to conduct a national pilot study of integrated accounting. Depending on the scope, coverage and data availability, the project costs ranged between US$ 100,000.00 and US$ 200,000.00.

Capacity building

There is no question about the need for harmonization and standardization of indicator and accounting methodologies. The current proliferation of different concepts, methods and classification, frequently developed outside any organizing framework or system, has generated non-comparable information and confusion in countries attempting to implement these methodologies.

Internationally adopted standards, such as those developed under the aegis of the United Nations Statistical Commission, would facilitate international comparison and a coordinated approach to capacity building. This is important in order to arrive at international adoption which is still lacking in environmental accounting nor in development of indicators of sustainable development.

Benchmark compilation and data collection

Benchmark compilation would be similar to pilot compilations in scope and coverage, but would be carried out, not at the beginning, but in the course of the long-term programme, possibly every 5 or 10 years. Their purpose would be to develop and update the economic-environmental database time series and detailed structural analyses. Benchmark compilation would thus make use of extensive data sets that accumulated over time and would incorporate the results of special, more detailed environmental accounting studies.

Human resource requirements: training, workshops and distribution of work

Training seminars, workshops and on-the-job instructions are needed to familiarize staff with the concepts and methods of environmental accounting, not only within the lead agency but also in the cooperating data-producing institutions. Staffs have different background and therefore training should be tailored in areas of data processing, accounting concepts and methods and basic environmental science.

7 Conclusions

Economic valuation and accounting of forest resources is an important task towards providing information on the benefits and costs of alternative forest land use options and adjustment to the system of national account (SNA). Previous studies have shown that the economic values derived from forest goods and services have been substantial and contributed significantly in national economic development. However, there have been very limited studies on the impacts of these values in alternative forest landuse options, particularly the values of NTFPs. Studies on forest resource accounting have also been carried out but the focus has been mainly on timber resources, with limited emphasize on non-timber forest products. Future efforts therefore should be strengthened to estimate economic values of various forest goods and services, particularly the economic values of environmental services. These values can then be incorporated in the System of Environmental and Economic Account (SEEA) as proposed by the United Nations. Combining the forest valuation and accounting, future work is therefore should be strengthening an institutional framework which may include pilot compilation, capacity building, benchmark compilation and data collection, and human resource requirements.

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Review of the Development Environmental Services Market in Indonesia

S. Suyanto and Beria Leimona

1 Background[1]

Environmental service market is defined as a creation of incentive system that provides the link between providers and beneficiaries of environmental services (Landdell-Mills and Porras, 2002). In Asia, the environmental service market has not yet developed well, as manifested communities that provide environmental services to outside beneficiaries, but without sharing in the benefits from such services. The services include clean and abundant water supplies from watersheds, biodiversity protection, and stocks of carbon that may alleviate global warming. Rewarding the poor providers would enhance their livelihoods, reduce poverty, and contribute to securing these environmental services.

There is a new paradigm on the environmental policy to recognize and to reward for the environmental services. A popular example is forest policy reform in Costa-Rica that occurred in 1996, by recognizing the environmental services. This policy introduced a new concept that is a payment for environmental services, based on the principle that the provider of the services will receive payment to compensate them for the benefits provides to the Costa Rican society (de Camino et al, 2002). A strategy of this policy is to increase income from forest production activities to make them competitive with alternative land uses. The National Forestry Financing Fund, a main agency that administrated the fund for environmental payments, has been established. A major source of fund comes from the national sources (fuel tax) and from international agencies. This policy has been successfully implemented.

In Asia, a small village of Sukhomajri in the northern India has provided a model of the development of watershed services payment in which the village's inhabitants shared the costs and benefits of environmental restoration to ensure that everyone gained from the process (Kerr 2002). There was an initiative to share water rights among all residents, including the landless. It can be seen as a type of environmental service payment, or in fact, as an agreement to share the benefits that would accrue from providing the service. The outcome of this mechanism was a major transformation in the village, with spectacular success in regenerating vegetation on the hillsides, increasing agricultural production and raising incomes throughout the villages.

China also has progress in establishing the rule and framework for setting up the mechanisms for environmental services payment. Forest Law 1998 introduced the forest ecological benefit compensation funds as a responsible institution that channeled the money from beneficiaries to providers. The implementation on the ground, however, is still limited. (Wenming et al, 2002).

In Indonesia initial work on development environmental services market has begun. For example,

[1] This paper is a summary from the RUPES project report (Suyanto et.al, 2004).

the International Centre for Research in Agroforestry (ICRAF) is building a consortium among the international and national research centres, government and non-government organizations and other interested parties to conduct action research for rewarding the upland poor in Asia for environmental services they provide (RUPES). This programme is funded by a grant from the International Fund for Agricultural Development (IFAD). The overall goal of the project is enhanced livelihood and resource security for poor upland communities in Asia. Improved livelihoods in this context refer to: improved food security, income and welfare of poor households and communities in upland areas; improved nutritional status; greater access to and control over the use of resources. The project objective (purpose) is proven institutional mechanisms for recognizing and rewarding poor farmers for the environmental services they provide. Appropriate methods for transfer payments to upland communities will be tested and monitored through action research.

2 Objectives and Method of the Research

The objective of this study is to review the development environmental services market in Indonesia. The assessment will follow a framework of environmental services typology that develops by Noordwijk et al (2003) (Figure 1). The focus of our assessment will be on lower half of Figure 1 that is a development of environmental services market. Thus, the focus of the assessment is to identify seller of ES, buyer of ES, payment/reward of ES, mechanisms, intermediaries, transaction cost, supporters and obstructers. We also add a stage of development ES market to the assessment.

By documenting the development of environmental services market, it will help concerned stakeholders to understand the stage of development of the markets of environmental services in Indonesia, and to identify possible gaps in our knowledge in recognizing the potential markets of environmental services and developing transfers mechanisms to the providers.

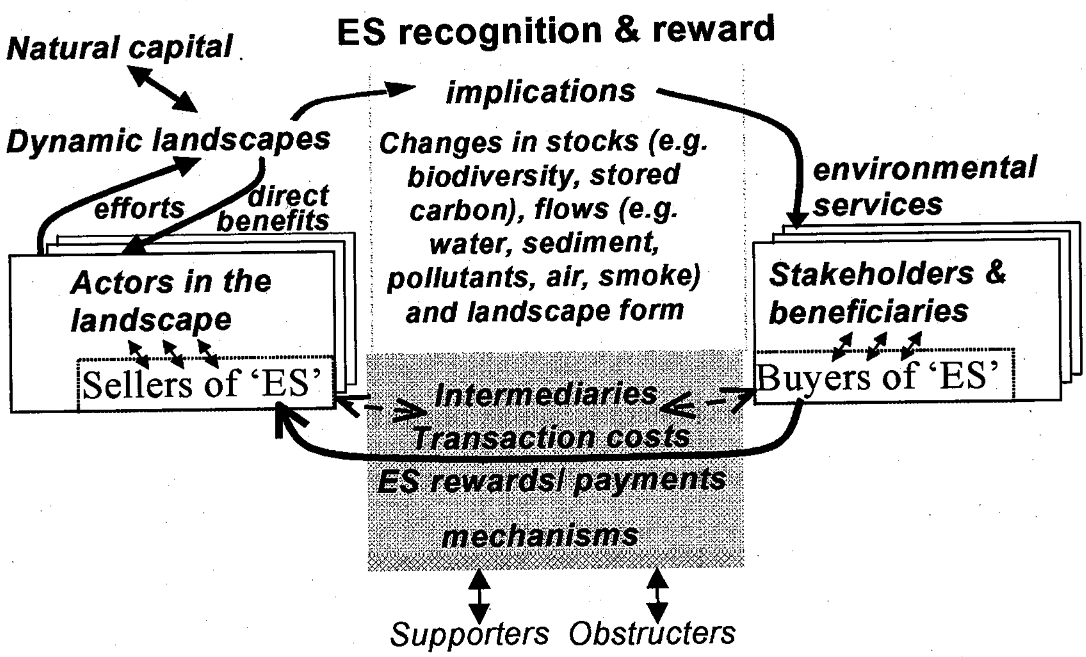

Figure 1 Environmental Service Recognition and Reward

Source: Meine et al, 2003.

We also use the following terms that created by Noordwijk et al (2003):

Sellers of environmental services (ES providers): any actor or collection of actors who modify the landscape and through this modification provides environmental services to potential buyers of these services.

Buyers of environmental services: Any stakeholder who recognizes environmental services are being provided, and who can be morally, legally or rationally motivated to pay for these services.

ES reward/payment: Compensation for service, merit or effort, and/or incentive for maintaining or enhancing environmental service functions, received by the sellers or paid by the buyers of the environmental service(s). Compensation may be made in terms of direct payments, financial incentives, or in kind. Rewards and payments in kind may include the provision of infrastructure, market preference, planting materials, health and educational services, skills training, technical assistance or other material benefits. In addition to indirect and direct monetary payments rewards can take the form of land tenure security.

We also define the type of rewards[1] as follows:

Land lease/land concession defined as allocation of land use rights in a defined area to the lesser who commits to maintain and/or to produce certain environmental service(s).

Best management practice contract defined as contract between landowners and those who wish to produce certain environmental service function(s), whereby the landowner is paid to manage their land in ways that achieve the desired contract objective.

Eco-certification/eco-labelling defined as environmental service friendly products that attract a price premium, the price difference reflects consumers' willingness to pay for environmental service function(s).

Carbon credit defined as contract between landowners and those who wish to reduce emission or increase the rate of carbon sequestration though a set of regulations either in Kyoto Protocol or non-Kyoto Protocol.

Entrance permit defined as fee for capturing beneficiaries' willingness to pay for scenic beauty.

Ecotourism service defined as a broader benefit that includes value-added features in recreation activities.

Ecotourism concession defined as a concession to deliver ecotourism services, mostly the concessionary is private company.

Mechanism: Any mechanism or institution by which rewards/payments are made available to intended beneficiaries. Development of a reward/payment mechanism involves identifying who

[1] The term 'reward' in this report refers to 'commodity used in emerging market of environmental service' in Landell-Mills and Porras (2002). 'Commodity' is defined as tangible product bought and sold in an environmental service market transaction.

receives the reward or payment, for what reason, when it is made, in what form, who delivers it and the source of the reward. Some examples of mechanisms can include direct payments to communities who use funds for local development, payments to individuals, land tenure conditional upon maintenance of services, forms of ecolabelling for premium prices.

Intermediaries: Institutions or persons who can link the buyers, or potential buyers, to the actors in the landscape and broker agreements for the continuation (or increase) in the supply of environmental services, in return for specific forms of rewards/payments.

Transaction (intermediation) costs: The costs involved in establishing and maintaining a transaction between buyers and sellers, these costs will generally include the costs for negotiating agreements, monitoring of the landscape consequences, enforcing contracts and the necessary institutional mechanisms.

Supporters: Institutions or individuals – for example government agencies, NGO's, or donors – who provide an enabling environment and/or legal basis for reward mechanisms and support the function of intermediaries. The RUPES project is itself a 'supporter', facilitating the emergence (we hope) of honest brokers and intermediaries.

Obstructers: Institutions or individuals – for example government agencies, NGO's, or donors – who discourage the development of enabling environment and/or legal basis for reward mechanisms and hinder the functions of intermediaries.

Bundling of services: Any land use pattern can be said to 'produce' different types of environmental services that may be relevant to different groups of external stakeholders. 'Bundling' involves mechanisms that provide rewards to sellers that are based on payments made by a single buyer interested in multiple services, or by different groups of buyers for separate services.

3 Overview of Developing Markets for ES in Indonesia

Major sources of literatures for this study come from published and unpublished documents, internet searches and limited interviews, undertaken between July and November 2003. Thus the authors realize a limitation scope of this study.

In total, 84 case studies have been covered from all over Indonesia. Attachment table 1 show a summary list of studies related to environmental services market in Indonesia. Although some of these studies relate to a bundle of services, but we classify the studies into a single service (major important service): biodiversity conservation, watershed protection, carbon sequestration and landscape/seascape beauty. We collected 84 studies related on development market for ES that consist to 40% studies on biodiversity, 21% studies on watershed, 18% studies on carbon sequestration and 21% studies on landscape/seascape beauty.

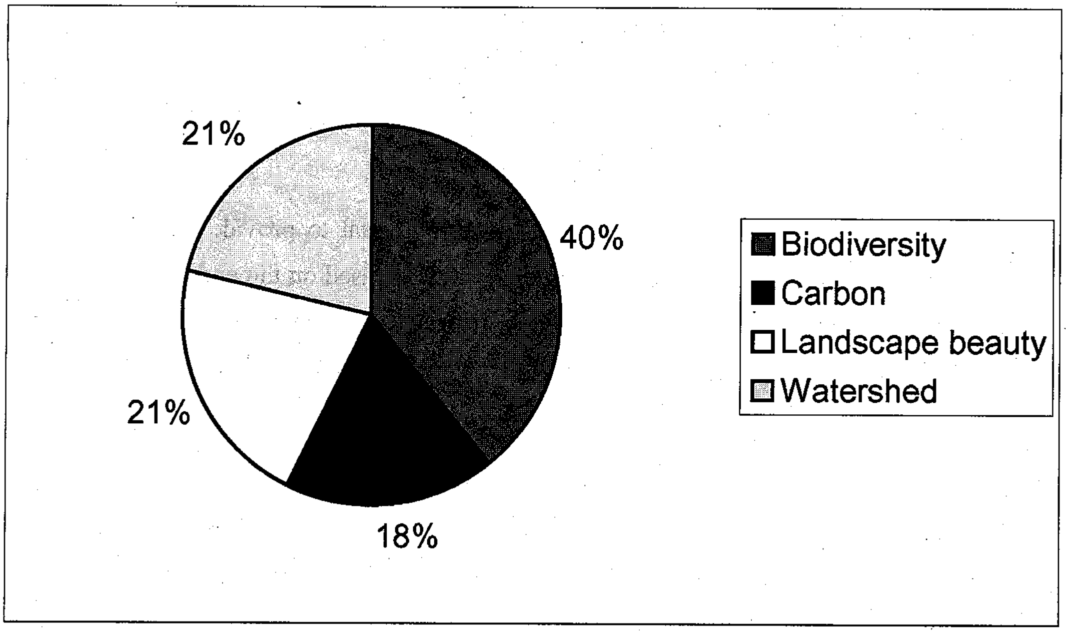

Figure 2 Percentage of Cases Study by Environmental Service Type

The first lesson from our review is that the development of environmental services in Indonesia is still in its early stage (Table 1). It is very few cases study that ES market has been implemented. Similarly, the studies that proposed the ES market are also rare. However, there are many initiative/ emerging projects and researches related to the development of market of environmental services.

Table 1 Stage of Development for Environmental Services Market

Environmental Service type	Total number of case studies	ES market developed		ES market potential be developed
		On going	Proposed	
Biodiversity Conservation	33	1	2	30
Watershed protection	18	2	3	13
Carbon sequestration	15	1	2	12
Landscape/Seascape beauty	18	5	1	12
Total	84	9	8	67

3.1 Biodiversity

There is only one case study on ES market for biodiversity. The project called "community based-medicine plantation conservation at Meru Betiri National Park" reported by Kaswito (1999) (See Box1) that lead by Latin (NGO) and Bogor Agriculture University (IPB). The community obtains the land lease to manage the buffer zone, but they are required to plant local medicine trees.

Two proposed study on development ES market for biodiversity are in progress. The first study called "rewarding rubber tappers for the environmental services provided by agroforests in the Bungo district in Batang Hari catchment, Jambi" led by ICRAF, IRD, Warsi, Gita Buana (Joshi

2003). This project tries to explore kinds of rewards that are either 'area based' or 'market based' is relevant for a considerable part of the rural poor in Indonesia. Exploration of market-based environmental services instruments can have considerable spin-off where the focus is on a test case of reducing transaction costs for individual applicants.

The second proposed study is "local asset of Barugae potential to provide global communities with sustainable environmental services" (Alam et al, 2003). Based on the need of maintaining the biodiversity functions and increasing land productivity, a specific community forest management (known as HKM pola Sul-Sel) is designed to be implemented on the site, giving attention to the development of multipurpose trees focused on candlenut agroforestry.

To promote and open markets in global level, the recent trend is to construct charismatic or flagship species. A study from Swanson and Kontoleon (2000) showed that there was internally consistent willingness to pay existed for the purchase of property rights of the habitat required for the conservation of flagship species. The strategy also has shifted to principles that recognize the concerns and needs of people, who compete with the conservation activities for resources. For example, the World Wildlife Fund with its flagship species programs pays attention to improve people's livelihoods as part of its strategies to conserve global biodiversity.

Box 1 Community based - medicine plantation conservation at Meru Betiri National Park

Application Year: 1993 – present

Project Description:

Meru Betiri National Park is an important asset, especially for the local community. Handayani (2002) stated that the total economic value of Meru Betiri National Park is about US$ 300 million and it tangible value (40% from the total value) contributes 31.67% yearly to the income of two sub-districts (Pesanggaran and Tempurejo). It is also well known as an important source of local medicinal plants. The research from Lembaga Alam Tropika Nusantara (LATIN) and Bogor Agricultural University (IPB) resulted that there are 331 species of medicinal plants in this area.

Groups of local community intensively source these medicinal plants from the forest and sell in wholesale to increase their daily income. Combined with other problems such as illegal logging and land encroachment, this activity can give more negative pressure on the sustainability of the national park. In anticipating this issue, LATIN and IPB in collaboration with Balai Taman Nasional Meru Betiri are conducting a pilot project on critical land rehabilitation in the buffer zone of Meru Betiri National Park using medicinal plant agroforestry.

In the beginning of the project, it was planned to cover 600-ha critical land involving 2400 households. Currently, it has rehabilitated 2500 ha critical land involving 104 farmer groups in 4 villages; facilitated intensively by Local Community Organizer from LATIN, KAIL (local NGO) and management staff of Meru Betiri National Park. This pilot project will be scalled-up until all the critical land in the buffer zone area (about 4730 ha) rehabilitated.

Location: Buffer zone of Meru Betiri National Park.

Buyer: Management of National Park, Perum Perhutani (State owned enterprise on timber plantation)

Seller: Community

Intermediaries: At district level, Coordination Forum of Meru Betiri National Park Management (Forum Koordinasi Pengelolaan Kawasan Penyangga Taman Nasional Meru Betiri) based on SK Bupati Jember no. 34 tahun 1997. At sub-district level, Coordination Forum of Buffer Zone Community based on SK Camat no.3 tahun 1998, in each sub-district.

Supporters: Consortium of LATIN and IPB, KAIL (Local NGO)

Mechanism:

Land use rights in buffer zone of national park are rewarded to the community. During the first four years, they grow recommended agricultural plants and fruit trees (and also medicinal plants, if they intend to). From the fourth to the eight-year, they do enrichment planting with high-value medicinal plant existed in the national park area. Starting from the eight-year and over, the community will grow shade resistance medicinal plant and be able to harvest fruits, bamboo, rattan and also the medicinal plants. The community gets continuous incentives from each growing stages as additional incomes.

The medicinal plant agroforestry impacts on other positive activity such as home industry processing the medicinal plants into herbal medicine. These home industries are supported by the housewife organization on planting herbal medicine at home gardens (TOGA).

Jember Local Government supports these activities through supplying seedlings and the equipment for herbal medicine processing. The Local Government Health Service assists them in analyzing the quality of the products and promoting the usefulness of herbal medicine to the paramedic. It is expected that the paramedics can include these herbal medicines into their prescriptions.

3.2 Carbon

In Indonesia, the market for carbon sequestration is stimulated by international efforts to control green house gas emissions (GHG) started by the adoption and signing of the Kyoto Protocol in 1998. The Kyoto Protocol is a legal instrument designed for implementing Climate Change Convention to stabilize the GHG concentration in order not to disturb the climate system on earth (Murdiyarso 2003). As a developing country, Indonesia can technically participate through one of three mechanisms of Kyoto Protocol, namely Clean Development Mechanisms (CDM). The other two mechanisms, Joint Implementation (JI) and Emission Trading (ET), are workable only for the developed countries.

Indonesian government shows their enthusiasm in joining the Kyoto Protocol. In collaboration with some international and national institutions, they explored possible national strategies for GHG reduction in all sectors including to prepare Designated National Authority (DNA) as the primary requirement within the National Strategy Study (NSS, see Box). The DNA will design the activities that related to project development and capacity building and to increase public awareness.

Box 2 National Strategy Studies

The Kyoto mechanisms, in particular the CDM, could become an interesting instrument for developing countries which may possess large potentials for generating green house gasses (GHG) emission reductions. The instruments, that create emission reductions through investment projects, might not only lead to a modernization of the existing capital stock for energy production and consumption but may also generate a financial surplus for the hosting country in the form of additional financial flows. Indonesia is interested to benefit from the CDM.

Within the framework of promoting market based instruments for GHG reductions, the World Bank in close co-operation with partner organizations like the GTZ assists developing countries to explore the opportunities and benefits they may have when participating in the CDM. The assistance provided to Indonesia by the GTZ within the National Strategy Studies involves the initiation and commissioning of a study that explore possible national strategies for GHG reduction in all sectors.

The study has pursued this objective from an Indonesian perspective and through a well balanced and integrated dual set of tasks: First, the study has analyzed general elements that will impact a future market for GHG emission reductions; second, the study has, within the general context of its objectives, address a small number of carefully selected particular issues that are of special interest to the partner country. In particular, the study has addressed issues like Indonesia's negotiating position on the CDM, the CDM in Indonesia, international demand and markets for certified emissions reductions, benefits for Indonesia as CDM host country, institutions and policies required in Indonesia to stimulate, support and regulates CDM projects, and a realistic and representative portfolio of possible and replicable CDM projects.

Source: http://www.gtz.de/climate/deutsch/projekte/laender/indonesia2.html

The on going of ES for carbon sequestration is "climate change, forest and peatland in Indonesia" where the community will be given a 'loan' equal with the number of trees that they have planted with the contract of 5 years with the Wetland (See Box 3). A proposed study that develop carbon credit is "Development of Reward Mechanisms for Environmental Services Provided by Upland Poor at Singkarak Watershed" (Boer et al, 2003), a pilot project of National Strategy Studies.

Some researches and studies also have been conducted to support Indonesia's readiness in participating in the carbon markets. Indonesian Ministry of Forestry in collaboration with Japan International Cooperation Agency (JICA) established new techniques and methodologies related to the carbon fixing plantation forestry while the other studies focused on how to provide practical and feasible design of carbon projects in establishing markets for GHG especially for participating in the CDM projects.

Box 3 Climate Change, Forest and Peatland in Indonesia (CCFPI)

Application Year: 2002 – 2005

Project Description:

The project is designed to promote the sustainable management of peatland in Indonesia in order to increase its forest functions as carbon sequester and storage, and also to improve the local community welfare.

The project is an action research program that also attempts to increase the awareness of community and decision makers of the link between climate change and peatland conditions. At the end, it will recommend the revision of Indonesian National Strategic on Wetland to ensure the inclusion of peatland in climate change issues of wetlands. There are some activities that related to this project:

Conducting some pilot projects on community-based peatland management in specific sites in Sumatra and Kalimantan, restoration of drained peatland in Kalimantan site and granting some small funding for other activities that are not covered under the pilot project initiatives.

Strategic research and data gathering on peatland, carbon and climate change such as: carbon storage measurement, analysis on the distribution and the status of peatland in Indonesia, canal blocking technique for reforestation of drained peatland, etc.

Information sharing and dissemination.

Location: villages surrounding the Berbak National Park (Jambi Province), future Sembilang National Park (South Sumatra Province) and the community peatland area of Sungai Puning, Buntok (Central Kalimantan Province).

Seller: Community

Buyer: Canada International Development Agency

Intermediaries: Local NGO, Wetland International-Indonesia Program

Supporters:

Mechanism:

Community-based peatland management in specific sites in Sumatra and Kalimantan:

A five-year loan contract is the form of reward. The amount of the loan is equivalent to the quantity of planted trees on agreed areas, compacted in the buffer zone of National Parks. The value of each tree is varied depending on its type (from Rp. 5000 to Rp 10000). It is the average of the seedling price and the maintenance cost until the third year of planting.

The loan will be used to increase the welfare of communities, such as an additional for their financial capital or for improving the quality of their livelihoods. It cannot be used to buy seedling that will be planted in the conservation areas. These seedlings must be gained from their own efforts.

The quality of the trees determines the amount of money that has to be returned. The Wetland International-Indonesia Program has a set of criteria and indicator for quantifying the quality of the trees and its money conversion. The principle is the better the quality, the lesser the return. If the community has reached a certain agreed percentage of planting success, for example 80%, the return will be zero and they do not have to pay their loan. On the other hand, if they cannot maintain their trees and the quality is lower than expected, then they have to return the loan. The accompanied facilitators as the partners of community, who give technical assistance in implementing the project and measure the amount of returns.

Restoration of drained peat land in Kalimantan site (Canal Blocking):

Located at Sungai Puning, Central Kalimantan, this activity is aimed to block the canals that previously function as traffic lane of illegal logs. These canals cause unstable decrease of water table especially in dry season and make the area susceptible to fire.

The community can earn some additional income as daily labors. After the program finished, the community can obtain the loan based on the quantity of trees that will be planted and maintained surrounding the blocked canal. The contract and mechanisms is similar to the previous program.

Small grant funding:

The small grant funding is given to the communities who have not involved in the pilot projects yet. They can propose loans with similar requirements and values to the ones of the pilot projects.

3.3 Watershed

On the watershed function, there are two cases study of on going ES market. The first case is the annual fee for water that paid by PT Inalum (PT Indonesia Asahan Alumunium) to North Sumatra district government for conserving the Lake Toba (Hutabarat, 2002; Kompas Cyber Media, 2002). The second on going ES market is land lease of state land to local community for providing watershed function. This project is called Negotiation Support System (NSS) that lead by ICRAF in collaboration with local NGO Watala and local government of Lampung (van Noordwijk et al, 2003) (See Box 4). There are three proposed studies on development of ES market for watershed function. First is the project called "development markets for watershed protection services in Segara River Basin, Lombok" (Munawir et al, 2003). A negotiation between the state-owned water supply enterprise and a rafting company raised a decision to pay the communities around the Bantek village (See box 5).

Second proposed study is "Exploring and developing reward mechanisms for upland farmers for watershed functions in Sumberjaya". Among the types of watershed commodities, water flow, water quality and sediment control are the most potential to be traded at the Sumberjaya site and payment by water users for watershed protections is an option rewards.

The third case is "Poverty alleviation for upland poor communities through developing mechanism for rewarding them for the watershed protection services for sustainable use of water in Province of Banten, Indonesia". The strong and legal intermediary is now in the process of establishing an alternative financial institution that will collect all the 'rewards' from the existing buyer and channel them to the providers of the environmental services.

Box 4. Multi level dialog of Negotiating Support System for Integrated Natural Resource Management

Application Year: 2000 – up to now

Project Description:

One of the lessons learned from this Negotiating Support System process is in Sumberjaya, Lampung located in upper Way Besay watershed. In this area, there are four state forest zones as part of its upper watershed ecosystem. Population pressure to the state forestlands is high caused by forest status disputes, poverty and lack of rural economic infrastructures, market driven of coffee commodity, and man-agriculture land ratio. Forest conversion is blamed as a source of erosion and sedimentation to Way Besay and affecting the hydropower plant downstream. There is also distrust of the people to the government caused by previous governmental repressive policies used to evict people from the forest. Some people returned to the forest form where they were evicted, some others became landless and getting poorer.

In 2000, ICRAF and local NGO Watala collaboratively began developing a mutual trust between local people and government as a basic social capital to create space for dialog, negotiation and collective actions. The Hutan Kemasyarakatan (HKm), in English 'Social Forestry' program – a program promoted by the government – was used as policy entry point for reconstructing mutual trust based land tenure conflict resolution.

Location: Sumberjaya, Lampung Province

Buyer: Forestry Department

Seller: Community

Intermediaries: ICRAF, WATALA (local NGO)

Supporters: Ford Foundation, DFID

Mechanism:

The most current policy on Community Forestry (HKm) from the Indonesian Forestry Service is Surat Keputusan No. 31/Kppts-II/2000 about permit in gaining the HKm Initial License. This policy obligates forming community groups among the communities who are willing to gain the HKm License. This process follows by making the group rules and working plans. Furthermore, these community groups will determine management area though participatory mapping. After completing all these requirement, the community group will make a proposal and propose it to the Forestry Service.

In operating the HKm, some constraints caused by inconsistency of policy and limited resources appear. Legal location of HKm proposed by district/province has not been approved by the national level of Forestry Department. In addition to that, the Forestry Department admit that currently they only have very limited human and financial resources in developing the HKm. From the community perspectives, there is still limited socialization about the HKm policy and the process in applying the license is considered too long and tedious. Supports from external parties such as research centers or NGOs are still needed. In term of monitoring and evaluation process of HKm, no participative process operates. ICRAF and its partners are working on how to develop the mechanism of participative monitoring and evaluation process of this HKm including its criteria and indicators.

Some initiatives in supporting the development of HKm have been done by both the government (the Forestry Service) and the communities. The government starts to do some socialization of this HKm and provides supports by supplying the multi purpose tree species (MPTS) seedlings. The communities respond these efforts by actively joining in forest rehabilitation under HKm either using the seedling from the Forestry Service or initiatively obtaining seedlings in groups.

Up to now, there are 12 HKm groups (about 1035 farmers as members) facilitated by ICRAF and Watala. Three groups of them had have HKm Initial License valid for 5 years issued by Bupati Lampung Barat and become the first HKm groups licensed by Bupati in Indonesia under Ministry of Forestry Decree No. 31/Kpts-II/2001.

Box 5. Action-learning to develop and test upstream-downstream transactions for watershed protection services: a diagnostic report from Segara River Basin, Indonesia

Application Year: 2001 - 2005

Project Description:

The overall goal of this project is to promote maintenance of water services that support local livelihoods. It is aimed to increase understanding of the potential role of market-based approaches in promoting the provision of watershed services for improving livelihoods in Indonesia, especially in Segara River Basin, Lombok.

Despite its early stage and lack of accurate hydrological information, the mechanisms for linking downstream water users to upstream land managers in the Segara Watershed exist. A financial arrangement for land and forest management in the upstream area of Segara River Basin has emerged. It responds the environmental degradation in the upstream area that is perceived causing decline of dry season water flows, decrease of water quality and unexpected flooding. A negotiation between the state-owned water supply enterprise (PDAM) and a rafting company (the Lombok Inter-Rafting Company) raised a decision to pay the communities around the Bantek village.

Location: The Rinjani National Park, in the Segara River Basin of Lombok

Potential Buyer: six Water Users' Associations (921 hectare), PDAM drinking water company, Lombok InterRafting Company, and local communities.

Potential Seller: Communities in upper watershed through community organizations, such as Majlis Kerama Adat or Desa (traditional institutions), Kelompok Masyarakat Peduli Lingkungan (community group for the environment), Tim Pengelola Kawasan Hutan Ex. HPH (forest management team for the ex-logging area),Banjar Pengelola Hutan Mejet (Mejet forest management institution).

Intermediaries: KONSEPSI, YLKMP

Supporters: LP3ES, IIED, Government of Indonesia, International Development Agency (AusAID) and WWF.

Mechanism:

Several financial arrangements for water and related environmental services have emerged independently in the Segara Basin. Table 2 shows the existing water service payments in Segara Basin. A number of payment schemes to finance irrigation infrastructure (Sawinih, Irrigation Service Fees, and operational fee) contributed by farmers with irrigated land have been already managed by the six associations of irrigation water users, but still nothing is transferred upstream communities.

Table 2 the Existing Water Service Payments in Segara Basin

Name of payment	Details / Amount paid	Used for	Contributed to	Contributed by
Sawinih	Sawinih: Rp 7,500 per 0,5 ha paid once a year at the second rice crop	Operational budget of Water Users' Association (WUA) and infrastructure improvement	Pelopor WUA, Gondang Village, Gangga Sub-District	Farmers with irrigated land
Sawinih, Irrigation Service Fee (ISF) and Operational fee	ISF: Rp 15,000/ha/year Sawinih: Rp 5,000 /cropping season Operational fee for head of tertiary irrigation block: Rp 5,000/ha	Rehabilitation of irrigation system Sawinih is for WUA operation Operational fee is collected when water is scarce	Sumber Rejeki WUA	Farmers with irrigated land
Contribution to village development	Bentek and Jenggala Villages: Rp 600,000 per village/year	Meeting of Majlis Kerama Adat (customary council)	Majlis Kerama Adat	Lombok Inter Rafting Company
Social fund	Ad hoc payments depending on existing social activities	Tree-planting and other social or environmental activities	Upstream community groups	Lombok Inter Rafting Company
Contribution to village development	Rp 2,000,000 (2001), Rp 5,000,000 (2002).	Salary of Lang-lang Jagad (forest guards) and local work on reviving and codifying traditional rules on environmental protection	Upstream community groups	Drinking water company (PDAM)
Land tax	Variable annual cost – PDAM has contracted to pay for 30 years	Payment of land tax on behalf of individual land-owners affected by route of water pipes	Local government	Drinking water company (PDAM)
Ngaji-Lawat	Voluntary payments to cover costs of buffalo sacrifice, other food etc	Celebration of Berangkak religious ceremony, which links forest protection to lessons of the ngaji (Holy Qur'an)	Upstream community groups	Downstream residents
Sedekah Gumi Paer	Voluntary payments to cover costs of food etc	Annual religious / Environmental ceremony at Bebekeq Grave	Organizers of ceremony	Other Bentek residents

Source: Munawir et al (2003)

3.4 Landscape/Seascape Beauty

Five on going ES markets for landscape beauty with types of reward are entrance permit, ecotourism service and ecotourism concession are described. The first one is "Komodo National Park Collaborative Management Initiative". The overall strategy seeks to make Komodo National Park a self-sustaining entity with its management costs being covered by tourism revenue. The project includes substantive positive incentives and will enforce negative incentives to encourage local communities to switch from the current destructive fishing practices to sustainable livelihoods based on the rational use of park resources (See box 6).

Secondly, Consortium of Ecotourism Development conducted a project called "Community based ecotourism Package in Gunung Halimun National Park". A share of revenue from ecotourism was collected and is channeled back to local communities through community development and conservation funds.

Third is "community based ecotourism development and conservation in Togean Island". The concerned consortium established long-term development of ecotourism in Togean. The program includes local community managed attraction, product marketing and promotion, capacity building of stakeholders and policy reform. The consortium has the role of facilitating community and policy makers, and building capacity of stakeholders on management and sustainable ecotourism development, while government takes role in making policies.

Fourth is "Sustainable Community Based Ecotourism in Tiga Gili". Tiga Gili is three cluster islands (Gili Trawangan, Gili Meno and Gili Air) that located in North Lombok. This site is one famous tourism area at Nusa Tenggara Barat Province and rich of diverse of biodiversity include mangrove forest, fish and coral reefs. The objectives of this project are: (1). Empowering local organization; (2) Establish management of tourism that emphasized on ecological, sustainability and fairness basis; and (3) Establish policy on management of tourism that emphasized on ecosystem basis and involving local communities through partnership system.

Last literature is a government regulation PP no. 34/2002 about "Tourism Licences/ Concessions in Protected Area". The government issues licenses of the environmental services concession for up to 10 years and up to 1000 ha areas. The mechanism of the service are entrance fee and user fees e.g. for facilities in the park.

Box 6 Komodo National Park Collaborative Management Initiative

Application Year: The process has been started since 1995

Project Description: The goals for Komodo National Park are to protect its biodiversity (particularly the Komodo dragon) and the breeding stocks of commercial fishes for replenishment of surrounding fishing grounds. The main challenge is to reduce both threats to the terrestrial and coastal marine resources and while avoiding conflicts between stakeholders. A comprehensive 25 year management plan completed in 2000 provides the basis for adaptive management to regulate all uses in the park and address threats while maximizing benefits for local communities in a sustainable way.

The objective of the Komodo National Park Collaborative Management Initiative (KCMI) is to ensure effective long-term management of Komodo National Park (KNP), by:

Improving the effectiveness of park management through the adoption of a collaborative management approach, involving all key stakeholder groups, including the Park authority (PHKA), local government, a joint venture between an international NGO (The Nature

Conservancy) and a local tourism company (Jaytasha Putrindo Utama), and with additional input from local communities, government agencies and private sector organizations;

Supporting the conservation of the marine and terrestrial resources of KNP, using an adaptive management approach to identify and respond to the changing threats facing these resources;

Establishing structures and guidelines to promote environmentally sensitive tourism development in the region and developing a strategy for the appropriate use of tourism revenue generated by KNP, to ensure long-term financial security for the park and sustainable benefits for the local communities; and

Introducing a system of appropriate incentives to encourage conservation-enhancing livelihoods and stimulate the development of a local economy based on the sustainable use of the resources in and around the park.

A key element of the 25-year park management plan is the development of self-financing mechanisms for the park through the establishment of an Eco-tourism Concession with the goal of protecting the park's bio-diversity and generating revenues required for the park in a way that is environmentally sound, socially responsible and economically viable. By the end of the seven-year grant period, it is expected that the park will be self-financing.

Innovations brought in by this project include: the testing of new park management and financing models; the partnership of an international NGO with a local tourism operator to form a Joint Venture and their using of a collaborative management approach with strong links to local community and private sector stakeholders; and the adoption of an adaptive management approach. The joint venture is established as a for-profit company whose revenues will be re-invested in the park

Location: Komodo National Park, East Nusa Tenggara

Buyer: Tourist, both local and foreign

Seller: Management of Komodo National Park

Intermediaries: a Joint Venture company (JV) "Putri Naga Komodo" between The Nature Conservancy (TNC) and a local tourism company (Jaytasha Putrindo Utama), as well as local communities, government agencies, and private sector organizations as a concession holder

Supporters: Government of Indonesia representing by Park Authority (PHKA) and Local Government

Mechanism: At present, basic funding for the Park is provided through the Government of Indonesia. These funds, however, are insufficient to meet all the management needs for the Park. Revenues from the Park are not fed back to Park management resulting in limited incentive to increase infrastructure needed to attract a greater number of eco-tourists. If park revenue were funnelled back into the Park, tourists would supply much needed revenue to the area. Komodo National Park has been selected by the Ministry of Finance as a pilot site to test new Park financing mechanisms and privatization of tourism management.

The Komodo National Park management will conduct an assessment of options for restructuring tourist gate fees and reforming the gate fee distribution system within PHKA, so that a significant portion of these fees can be channelled directly to Park management support. Following this assessment, the Park will work with partners to implement the gate fee reform as a way to fund future conservation activities in the Park.

The most likely form of financial management system may be a Concession for Tourism Management. The Tourism Concession will be responsible for financial management, investments in Park infrastructure and marketing. It will require an initial outside infusion of funds (possibly from the Global Environmental Fund) to make the necessary Park improvements to justify later increases in user fees. After several years, the Park should be financially self-sustaining. The Tourism Concession will collect user fees and distribute the funds to the Park management.

If successful, the concession could lay the foundation for expanding management activities to include additional aspects of Park management such as enforcement and sustainable community development projects. Economic success in the tourism sector will depend heavily on the maintenance of environmental quality. To sustain projected increases in tourism, any development must be compatible with the environmental surroundings.

While the collaborative management agreement provides the governance structure for the management of the Park, the Tourism Concession will be responsible for financial management, investments in Park infrastructure and marketing. A Joint Venture company (JV) "Putri Naga Komodo" has been established to run the concession. The charter of the JV directs that any profits and revenues earned will be invested back into conservation. The rationale behind the agreement was based on a proven track record of each partner in investing in KNP, as well as complementary between the conservation NGO and the tourism-oriented private sector company.

4 Brief Analysis

Our study found 10 cases study of on going ES market. Based on these study, we classified the efforts of the sellers of environmental services into three categories (van Noordwijk et al, 2003): (1) Natural capital, generally properties that 'come with the territory; (2) guardianship of natural capital, absence of threats or more active 'avoiding negative effects', and (3). Mitigation of threats or 'effecting positive effects' through 'stewardship'.

Stewardship service is important for biodiversity, carbon sequestration and watershed functions, while natural capital and guardianship are more applicable for landscape beauty functions. Land lease, carbon credit and water fees are rewards types for stewardship functions. The rewards are most likely given to individual, although on the practical the individual should be grouped as a farmers group. On the other hand rewards for natural capital and guardianship are entrance permit and ecotourism services. The reward is given to the owner of the natural capital (National Park) and communities who provide a service as a guardian. To guard the natural resources, it will be effective if there is an agreement among the member of the community (See Table 3).

It is interesting that the type of seller or provider is related to the type of effort or services. For example, the natural capital services are rewarded to the owner of the capital (Government and National Park for the landscape beauty case). Guardianship service is rewarded to community, while stewardship service is more rewarded to individual/farmers group.

Table 3 Type of Services, Seller and Reward of the on Going ES Market

Case Study	Type of effort	Type of seller	Type of reward
A. Biodiversity: 1. Community based-medicine plantation conservation at Meru Betiri National Park	Stewardship	Farmers group	Land lease
B. Carbon 1. Climate change, forest and peatland in Indonesia	Stewardship	Farmers group	Carbon credit not Kyoto
C. Watershed Toba Lake site	Natural Capital	Government	Water use fee
Negotiation Support System (NSS) and Social Forestry (Hutan Kemasyarakatan)	Stewardship	Farmers group	Land lease
D. Landscape beauty 1. Community based ecotourism Package in Gunung Halimun National Park	Natural Capital Guardian	National Park Community	Eco-tourism services
2.Komodo National Park Collaborative Management Initiative	Natural Capital Guardian	National Park	Eco-tourism concession
3.Community based Ecotourism Development and Conservation in Togean Island	Natural capital and guardian	National Park, community	Entrance permit and ecotourism services
4.Sustainable Community Based Ecotourism in Tiga Gili	Natural capital and guardian	National park, community	Entrance permit and ecotourism services

The development of markets for biodiversity in Indonesia is increasingly driven by both local and international research centers and NGOs. Private demand for conservation is not readily available as access to genetic material is still considered free. A case study from community based - medicine plantation conservation at Meru Betiri National Park, East Java shows that there is a huge potential opportunity to develop payment by bioprospectors[1]. The other case study describes efforts to develop market for biodiversity-friendly products at jungle rubber in Jambi.

For carbon market, the awareness to establish incentive-disincentive systems has been raised. It targeted the communities and institutions directly involved in land rehabilitation or re-greening

[1] Bioprospecting is the search for commercially valuable biochemical compounds or genetic material in the wild for seed, pharmaceutical and crop industries.

activities. Watershed protection markets are beginning to evolve in Indonesia. In many cases, strong intermediaries and willingness to pay often stimulate the emergence of the markets. In other words, the markets are established in a perception that forests are 'good' and people are willing to pay for the services they believe are provided. Only limited supporting scientific evidence – especially on the cause and effect of land use-water linkages – has been undertaken. In fact, it is essential to clarify the problem, which service from certain watershed is being demanded and its drivers depending on people's need and values.

Particularly forest land uses, its expected environmental services drive related users to different interests and practices to manage. In this situation, conflict management becomes urgently considered to shorten the gap between expected results and real world. The Negotiation Support System (NSS) is one of approaches in managing the conflict over natural resource uses (see Box and Section 3.2 for the case study).

In relevance with Landell-Mills and Porras (2002), the payment for landscape beauty is related to the establishment of a mechanism for protecting the biodiversity. On the other hand, as landscape beauty is the commodity purchased by the tourists, it should be noted that increasing the supply of biodiversity protection does not always raise scenic beauty and equally, the sale of the scenic beauty may not encourage an increased supply of biodiversity.

Some case studies reveal that the communities living in and adjacent to the tourism area serve as the local land steward to provide the scenic beauty. Efforts to compensate them have been made by setting up consortiums that act as intermediaries for the payment of the landscape beauty. These consortiums usually consist of government, local and international NGOs and private sectors.

5 Concluding Remark

Based on the review of 84 studies relate to environmental services, this study reveals that the development of environmental services in Indonesia is still in its early stage. However, there are many initiative/ emerging projects and researches related to the development of market of environmental services. Meanwhile, each ES (watershed function, carbon, biodiversity and landscape beauty) shows different level of its market development stage. We found that environmental services market for landscape beauty is relatively more progressive.

Although the existing ES market is limited in our study, but it is clear that the reward is given to the effort to produce the ES function, such as stewardship, guardian and natural capital. Among few cases on the existing of ES market, stewardship service is important for biodiversity, carbon sequestration and watershed functions; while natural capital and guardianship is more applicable for landscape beauty functions. Land lease and carbon credit are used as a rewards for rewarding stewardship services. In the setting, where dependency of community's livelihood on land or forest is high, rewarding land lease with require sustainable land management could be effective to provide environmental services and enhance livelihoods. On the others hand, entrance fee and eco-tourism services are used a reward for natural and guardian services on landscape beauty functions.

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The Real Costs of Carbon Sink Projects in Tropical Ecosystems of India: an Analysis of Their Profitability

Promode Kant

1 Introduction

The Kyoto Protocol requires the industrialized countries to reduce their combined greenhouse gas emissions by at least 5.2 % compared to 1990 levels by the period 2008~2012. A number of flexibility mechanisms, including the clean development mechanism (CDM), have been incorporated in the Protocol in order to facilitate compliance. The twin objectives of CDM are to assist industrialized countries achieve compliance with their emission limitation and reduction commitments and help the non-industrialized countries move towards achieving sustainable development.

Land use, land-use change and forestry offers low cost climate change mitigation options through protection of existing carbon stocks, sequestration of more carbon, and substitution of fossil fuel use by bio-fuels. Globally, these terrestrial sinks are estimated to have the capacity to help reduce atmospheric carbon by about 83 to 131 giga tons of carbon (GtC) by the year 2050 out of which forests may account for as much as 60 to 87 GtC and agriculture soils for the remaining 23 to 44 GtC (IPCC, 2001a; IPCC, 2001b).

Afforestation and reforestation are permitted activities for earning carbon credits under CDM. In a normal afforestation project the total cost of the project would include the regeneration and maintenance costs and the opportunity cost of the land. But a CDM carbon sequestration project must fulfill the Protocol requirements of additionality, leakage accounting, sustainability, biodiversity conservation and a measurement and verification system based on consistent, transparent and accurate methodologies leading to a credible certification of the carbon credits. These requirements make significant contribution to the cost of production of carbon credits.

This paper examines the underlying issues in details, reviews literature for the current and expected prices of carbon, makes an assessment of real costs and presents an analysis of the profitability of CDM afforestation projects in the different agro-climatic conditions obtaining in India.

2 Carbon Price Trends

The markets evolve and true prices emerge out of interactions between a large number of buyers and the sellers. Speculations also have a role to play in the development of such markets provided the speculators are both buyers and sellers, which balances the excesses from both sides. But carbon is a new commodity on sale and there are few sellers and fewer buyers. The carbon market today is a miniscule, purely experimental and, sometimes, speculative market with speculations being influenced by the buyers (and not sellers), which explains both the cautious negotiated project prices of US$ 10-14 per ton of carbon (/tC) under the Prototype Carbon Fund of the World bank (PCF, 2002) and the weighted average prices of a mere US$3.6/tC in the fledgling trading in carbon credits in the Chicago Climate Exchange in the auctions held in October 2003. Since these were some of the first such transactions and were carried out in times of great uncertainty about the rules governing CDM these have to be seen essentially as venture capital investments with high risk adjustment in the prices paid. As the first commitment period of 2008-12 approaches resulting in enhanced demands and the rules governing the trade become clearer, it is expected that the venture nature of the transactions would give way to a price trend that would not discount risks so heavily and the market should then show the volume and price predictability necessary in an industry with such long term investments.

Currently there are not many buyers in the market. There are several reasons that limit the demand for CDM forest carbon sinks. The foremost is that the Kyoto Protocol has not yet become operational. Then the cap on carbon credits earned through CDM, the maximum amount allowed to be credited, equals only 1% of the base year greenhouse gas emissions of the investing country (Pohjola et al, 2003) thus limiting the demand for CDM sinks. The withdrawal of the USA from the Protocol, responsible for a quarter of the global emissions and thus the biggest market for carbon credits for abatement and the feeble chances that it would return to the Protocol in its present shape, has further severely restricted the demand for carbon credits. The action of Australia in following suit has worsened the demand scene still more while the Bonn Agreement allowing Canada and Japan take advantage of sequestration through forest management (as distinct from forest plantations for which additional lands are required for sequestration) to earn carbon credits and the possibility that trade in "hot air" would not be prevented does not give much hope for increase in demand for carbon credits and, therefore, the possibilities of a demand led market helping raise carbon prices to levels above the production costs are minimal.

3 The Upper Price Limit

The carbon sequestration offers a limited alternative to the abatement of carbon emission and it can be expected that the emitter, required to reduce emissions or abate equivalent amount of carbon in an approved sink, would opt for the cheapest option available at that time. The sequestered carbon prices are, therefore, limited by the marginal cost of abating carbon emission that ranges from US$15/t$CO_2$ (or US$55/tC) in most industrialized countries to substantially higher in more energy efficient economies (PCF, 2002). This is then the maximum price range possible for the carbon sequestered. For cheaper options the buyer would go for other products or sources whose marginal costs of abating carbon emissions or sequestering carbon is lower.

4 Reviews of Carbon Sequestration Costs in Some CDM Hosts

Benitez et al (2003) have reviewed the literature on costs of carbon sequestration in some of the major potential CDM host countries. Their review findings are given in the table below:

Country	Practise	Cost US$	C-pool[1]	Remarks[2]	Reference
China	Reforestation	10	n/a	Ex OC&T	Winjum et al (1993)
China	Plantations	0-2	n/a	n/a	Xu (1995)
India	Reforestation	15	n/a	Ex OC&T	Winjum et al (1993)
India	Plantations	0-1.1	n/a	n/a	Kolshus (2001)
Malaysia	Reforestation	5	n/a	Ex OC&T	Winjum et al (1993)
Indonesia	Plantations	0-1	n/a	n/a	Sathaye et al (2001)
Tanzania	Plantations	0-3	n/a	n/a	Sathaye et al (2001)
South Africa	Reforestation	9	n/a	Ex OC&T	Winjum et al (1993)
Mexico	n/a	10	B, S, P	n/a	IPCC (2000)
Mexico	n/a	10-35	B, S, P	In OC, Ex T	Masera et al (2001)
Venezuela	n/a	17	n/a	n/a	Kauppi et al (2001)
Brazil	n/a	10	B	Ex OC&T	Winjum et al (1993)
Brazil	n/a	0	B, S, P	In OC&T	Sathaye et al (2001)
Costa Rica	n/a	5	B	n/a	Maura-costa et al (1998)

Benitez et al (2003) have cautioned against comparing the costs as the basic assumptions as well as carbon pools included in these assessments by different researchers vary widely. Most studies include only the initial cost of planting and exclude the land opportunity costs and the timber and other environmental benefits that may accrue. The costs of monitoring, verification and certification have been kept out of these estimates. Zero costs are the no-regret options under which converting an agricultural lands into forestry is profitable even without carbon payments (Benitez et al, 2003). This is indicative of the large availability of degraded (possibly due to excessive harvesting) but potentially productive lands in thinly populated countries with low demand for agricultural products.

It would also be noticeable from the above data that the reforestation costs are several times (5 to 12 times) higher than the plantation costs. This is not unexpected since the reforestation involves multi-species planting in gaps and aided natural regeneration that is costlier compared to the raising of mono-specific tree plantations in open lands as the 'Kyoto forest' must fulfill the condition of biodiversity conservation in that it should not only not destroy or weaken the existing biodiversity but should actively strengthen it. So in the context of carbon sequestration for the purpose of long storage the reforestation costs are more relevant but, for fuel wood production on agricultural or fallow lands for displacement of fossil fuels, the plantation costs would provide a truer basis for comparisons of profitability.

5 Cost of Reforestation in India

The cost of raising a plantation for reforestation over 1 ha of public land in India under the reforestation schemes of the National Afforestation & Eco-restoration Board of the Indian Ministry of Environment & Forests is as follows:

[1] B = biomass, S = soils, P = products, n/a = not available
[2] Ex = excluding, In = including , OC = opportunity cost, T = timber benefits, n/a = not available

Planting and 3 years maintenance costs (for raising 1100 mixed trees, bushes and herbs per ha) = Rs 17100

Soil & moisture conservation activity around plants per ha (15% of planting cost) = Rs 2565

The total cost of planting and maintenance and taking up the requisite soil and moisture conservation measures would thus be Rs 19665 (US$ 425) per ha. This excludes the land cost or the opportunity costs for using lands for tree growing and the plantation maintenance costs are only for the first three years. The requirement of raising a mix plantation of both timber trees and non-timber bushes and herbs fulfils a key requirement of bio-diversity conservation under the CDM.

6 Land Productivity in India

India has 10 different bio-geographic zones and 26 biotic provinces (WII, 2000). There is a huge variation in land productivity and many attempts have been made to categorize these lands in terms of their potential forest productivity. One of these is the Paterson's productivity Index, also called the CVP (Climate, Vegetation, Productivity) Index. Paterson argued that the optimal productivity is a function of light, temperature and moisture conditions. His formula estimates forest productivity in ideal sites under ideal conditions of management (Lal, 1992)

$$\text{CVP Index} = (T_v/T_a) \times P \times (E/100) \times (G/12), \text{ where}$$

T_v is the mean temperature of the hottest month in Celsius
T_a is the difference between the mean temperatures of the hottest and the coldest months
P is annual precipitation in millimeters
E is the evapo-transpiration intensity, and
G is the growing season in months

Trans-Himalayan bio-geographic zone covers the biotic provinces of Ladakh and high altitude regions abutting the Tibetan Autonomous Region of China. The area is very cold and arid and the only vegetation is sparse alpine steppe. Extensive areas consist of bare rocks and glaciers. It falls below 25 in the CVP index and is considered non-productive and is thus unsuitable for carbon sequestration purposes.

The Indian Desert covers the Thar and Kutch desert regions in western India characterized by sandy deserts, seasonal salt marshes and sparse thorn forests. The CVP index is well below 100 and the potential productivity lies between 1~3 m^3/ha/year. The forest lands of Bikaner (CVP index 31) on the margins of this desert have been estimated at 2.05 m^3/ha/year (Lal, 1992). These lands are largely unsuitable for raising forests for the purpose of carbon sequestration.

The Semi-arid zone is spread over the plains of Punjab, Haryana, Gujarat and Rajasthan and parts of Uttar Pradesh and Madhya Pradesh. The CVP index lies between 100~300 with a potential productivity of 3-6 m^3/ha/year (Lal, 1992). Most lands here are under agriculture, with well-developed irrigation facilities and have been the traditional area for agro forestry in India. The extent of forests is limited and carbon sequestration in this zone over large areas would be possible only under agro forestry conditions though small opportunities for reforestation for carbon sequestration may also present themselves.

The Himalayan bio-geographic zone extends over four prominent biotic provinces of Northwest, West, Central and East Himalayas and has sharp altitudinal variation. The region is covered with forests and lies in the CVP index range of about 300 with a productivity potential of about 6 m^3/ha/year except on higher elevations. Some plantation species have done exceedingly well here like the Cryptomaria japonica in the Darjeeling hills in the East Himalayan biotic province where productivity as high as 39m^3/ha/yr has been reported (Lal, 1992). The region requires extensive re-clothing of lands with forests in view of severe degradation which has taken place in many hilly areas in the past few decades leading to loss of biodiversity, soil losses and erosion and provides good opportunities for reforestation. However, these are not the best-suited lands for those seeking to earn carbon credits alone, as the requirement of protecting the rich biodiversity of the region would limit the amount of carbon that can be sequestered.

The Deccan Peninsula is a large area of raised land covering about 40% of India's land surface. It is bound by Satpura mountain range in the north, Western Ghats on the west and the Eastern Ghats on the east. The elevation of the plateau varies from 300 meters to 900 meters. The tropical moist and dry deciduous forests cover large parts of this tract. The CVP index ranges from 300 to 1000 with the potential forest productivity range of 6-9 m^3/ha/year. This zone provides opportunities for carbon sequestration in both agro-forestry and in reforestation.

The Gangetic plains are India's most fertile lands with alluvial soils most suited for agriculture. Most of these lands are under agriculture. The CVP index ranges from 300 to 1000 with the potential forest productivity range of 6-9 m^3/ha/year. This zone provides large opportunities for carbon sequestration in agro-forestry but very little in reforestation since the extent of forest cover is very limited and the little that is available is fairly well protected and is unlikely to qualify for reforestation under the CDM. The species that has done exceptionally well under agro forestry in this region is the poplar, which grows well here and a network of processing industry and market has developed around this agro forestry tree species.

The North East bio-geographic region covers the Brahmputra and Barak river valleys and the northeastern hills. The forest types are mostly evergreens and moist deciduous. The CVP index ranges from 1000 to 5000 and productivity potential lies between 9 and 12 m^3/ha/year. Dhubri in the western Assam has CVP index of 1520 and productivity potential of 9.12 m^3/ha/year and in the extreme east the forests of Sibsagar have a CVP index of 1730 and potential productivity of 9.29 m^3/ha/year. This zone has been subject to shifting cultivation and thus presents huge opportunities for reforestation and afforestation as well as agro forestry. Gmelina arborea does well here and may produce up to 35 m^3/ha/year under short rotation plantation (NAS, 1980).

The Coastal Region extends over the coastal belts on the west and east cost of peninsular India.

The west coast with its high rainfall falls in the CVP index range of 5000 plus with potential productivity on excess of 12 m^3/ha/year. The east coast is relatively drier and CVP index here range from 1000 to 5000 and potential productivity from 9 to 12 m^3/ha/year. The east coast has been the home to some of the most extensive Casuarina plantation ever tried anywhere for fuel wood purposes. This species has the potential of yielding about 20 tons of firewood annually. Sesbania grandiflora is another promising species that can yield 20~25 m^3/ha/year and has been planted in the Eastern Godavari district along the east coast (NAS, 1980).

Western Ghats covers only 5% of India's land surface but is one of the two biggest reservoir of India's biodiversity. Eastern face of the western ghats is drier compared to the western face. CVP index on the eastern face ranges from 1000 to 5000 with productivity potential of 9 to 12 m^3/ha/year while the wetter western face has CVP above 5000 and potential productivity in excess of 12 m^3/ha/year. Forests cover a significant part of the western ghats but opportunities for reforestation are not many as few areas would qualify for CDM reforestation projects. However, afforestation and agro forestry models particularly in plantation crops like tea, coffee, tapioca, cardamom etc would provide good opportunities for taking up carbon sequestration projects. Eucalyptus globulas in the Nilgiri hills has been reported to have productivity of 40 m^3/ha/year (Lal, 1992). Silver oak also does very well in tea plantation lands.

The Indian Islands are a group of 325 islands of which the Andaman and Nicobar islands are two of the largest and most well known. The rainfall is very heavy and climate warm and humid. Though no definitive results of CVP index studies are available but drawing comparison with other areas it must fall in the range of highest CVP index (5000 plus) and productivity potential beyond 12 m^3/ha/year. But these islands are already heavily forested and there are few opportunities for reforestation or afforestation here and is thus of little interest for carbon sequestration projects.

7 Opportunity Costs

Placing lands under tree cover has the opportunity cost of the benefits foregone from other uses of land. The owners of lands do not act for a single objective; they have multiple objectives and the relative priority changes with changing macro-economic environment. If there is a contract with punitive provisions to enforce it, the landowner loses his freedom to change course and use his land assets in some other more productive venture even when his losses only increase with every passing year in the changed environment reflected in the lowered market prices. The monetary liquidity of these land assets also gets affected adversely because these can then be sold only to buyers interested in honoring the CDM agreement conditions. This restricted access to the market would result in lowering land prices. This can have serious implication in countries like India where land possession provides easy asset liquidity and is often seen as an excellent market tool of investment providing both good returns and an easy liquidity.

7.1 Land Rental for Agricultural Lands Taken Up for Carbon Sequestration

The market would respond to these risks and restrictions by increasing rentals of the lands put under carbon sequestration. In India two methods of assessing market rentals for lands are in vogue. One very commonly used for fixing lands rented out for agriculture is seeking one half share of the crops produced by the tenant. This has the advantage of linking the land rent to its quality but has an accompanying disadvantage of inability to separate the incompetence of the tenant from the rent since the returns from the land reflect not only the land quality but also the inputs and the competence or otherwise of the cultivator. The average annual revenue from one hectare of poorer quality rain-fed agriculture lands, in India being in the range of Rs 6,000 (US$ 130) the annual rental would amount to US$ 65. But this has only limited parallel with renting land for carbon sequestration as the period of renting is only 4 months to 3 years at a time as against practically giving up the ownership for one to two generations in the case of carbon sequestration.

The other method for fixing land rentals is by ensuring that the net present value of the land assets at the time of entering into contract is recovered in 25 years (one generation) time. The rental in the first year would thus be one twenty-fifth of the land value and in subsequent years it would be increased by the monetary discount rate. In India the average costs of agricultural lands, away from urban areas and not legally available for other commercial purposes, ranges from Rs 100000 to Rs 600000 per ha depending on the land quality, access to markets, labor availability and irrigation facilities. Assuming that only the poorer quality of agricultural lands would find preference in the CDM carbon market the land rental in the first year of planting would be about Rs 4000 (US$ 87) /ha and Rs 100000 (US$ 2174) over a rotation of 25 years.

7.2 Opportunity Costs for Government Forests Lands Taken up for C Sequestration

The government forests lands in India have an actual average productivity of 0.7 m^3/ha/year (Lal, 1992) with a very wide variation ranging from near zero in Trans-Himalayan and Desert zones to the high of 3 m^3/ha/year in the Andaman Nicobar islands. It has to be noted that this productivity is on sustainable forestry basis under the current systems of management and has the attendant non-monitory, but very significant, benefits of biodiversity conservation, protection of soil and moisture regimes and wild life conservation. Reforestation under CDM would ensure the continuation of these non-monitory benefits and, therefore, the opportunity cost would be the direct earnings from the sustainable utilization of forest biomass before the sequestration projects was taken up.

7.3 Opportunity Costs for Encroached Government Forests Lands Taken up for C Sequestration

There are an estimated 0.75 million ha of government forests lands under encroachment in India. Since eviction has not been possible in spite of several efforts a realistic view of the situation would be that these lands have provided a temporary opportunity to the government for settlement of people and the opportunity cost would be measured by the costs incurred in settling these people elsewhere which would involve purchase of land, construction of houses and infrastructural facilities and transportation of people and their assets to the new sites. These are prohibitive costs, and going by current Indian norms it costs upwards of Rs 300000 per ha. Such high costs would make even the most attractive C-credit project economically unviable. An alternate way could be to involve these people in the management of reforested lands raised over part of the encroached area through the mechanism of joint forest management in which case the opportunity cost would be value of benefits from cultivation foregone and this category could then be clubbed with the non-forest lands under agriculture taken up for sequestration project discussed below for the purpose of assessing the opportunity costs.

7.4 Opportunity Costs for Non-Government Forests Lands Taken Up for C Sequestration

On these lands, usually under excessive harvesting, the opportunity costs to the owner(s) are the real outgo of earnings even when these arise from unsustainable harvesting. Further even though there are non-monitory benefits from reforestation these are often not valued by the owner(s) and, therefore, increase in non-monitory benefits as would accrue from CDM reforestation activities is unlikely to enthuse them. Their expectation would clearly be that their monitory earnings go up significantly under the CDM project compared to their current levels of earning. The opportunity costs, from the point of view of the owner(s), would be the monitory equivalent of the benefits irrespective of the sustainability of the process.

7.5 Is It Possible to Lower Land Rentals by Planting on Saline/Alkaline Soils or in Very Remote Localities?

The land rentals are decided on the basis of other uses of the land in the prevailing macro-economic environment. The opportunity costs can be brought down by (i) choosing lands unfit for agriculture like saline and alkaline soils or (ii) by choosing extremely remote lands. In the first, while the rentals could be very low, the trade-off would be with both the production costs and productivity and the costs per unit carbon may actually go up. In the second case of extremely remote lands the opportunity costs could be a fraction of that in more accessible area but here the compromise would be on the returns from associate products like timber and the minor forest produce which would not fetch the same rates as in more accessible areas. Also the production costs and the transaction costs would rise sharply due to increased costs of accessing labor and human expertise in remote localities. The drop in costs due to remoteness of land chosen would, therefore, be significant but a point would soon be reached where the remoteness would not reduce costs further. Further, it would not be easy to find many remote lands which are not already forests as defined (0.05 – 1 ha lands with tree cover of 10-30% crown density) since remoteness, and consequent absence of biotic interference, would itself encourage forestry growth and Kyoto forests can not be raised on lands which are already forested. Also, most remote areas are catchments of important rivers and government policies often do not encourage enhancing accessibility to these areas that would accompany large scale planting efforts.

7.6 Higher Volumes of Carbon Sequestration Will Not Reduce Costs

Land is the unavoidable and the most important factor of production in carbon sequestration and is a limited resource. It cannot be reproduced and, therefore, its supply curve is inelastic from the society's point of view. A particular type of venture, though, may find the land supply curve somewhat elastic because greater rent given by it may attract lands currently under other uses. When an input is limited the entry of new investors seeking more of the same resource will drive the resource towards becoming even more limited in availability and ultimately scarce. Thus the entry of a large number of investors in carbon sequestration projects will make land scarcer and new investors would find it costlier. Since land is the costliest factor of production contributing to more than half the cost of production in carbon sequestration ventures attempts to reduce costs through increased cost efficiency measures related to other factors of production would have only marginal effect. Carbon sequestration is, therefore, an industry that cannot be expected to have a reducing, or even constant, cost of production but will have to bear greater costs of production with increasing demands.

8 Costs caused by leakage

The CDM rules make the accounting of all negative leakages mandatory for earning carbon credits. Leakages can take place in the shape of activity displacement, demand displacement, supply displacement or investment crowding (IPCC, 2000). *Activity displacement* would occur when an activity (say, use as a grazing or play ground) on a land taken up for carbon sequestration shifts to another land in the neighborhood and causes a certain loss of carbon on the new land. Usually, the land taken up for raising a Kyoto forest would either be a forest land, grazing land or farm land and, except when the activity is grazing or farming, the activity being displaced to an alternative land would not require extensive lands and bringing it within the project by sparing a small extent of land for the purpose would not pose too serious a problem. In the case of agro-forestry the impetus to shift to tree growing from farming usually arises from lowered economic returns from agriculture crops due to oversupply and, therefore, it would be rare for new areas being brought under cultivation because of loss of cropland to agro forestry elsewhere. Displacement of grazing, however, by a large number of cattle to an alternate site would constitute a major leakage and may even render the project unviable on this count.

Demand displacement occurs when carbon removal through, say, fuel-wood collection going on over a land taken up for carbon sequestration shifts to another accessible land. In developing countries like India it could pose a serious problem because both agriculture and forest lands provide the fuel, small timber and livelihood needs of many people who may not figure as owners of the lands. From author's own experience across the vast landscape of India the average yield of fuel from one hectare of agriculture land in India is about half a ton and twice this value in the case of forest lands and in most cases it would be prudent to consider this as the default value of leakage due to demand displacement.

Supply displacement is when cheaper forest products from a plantation supported by, say, CDM makes costlier forest products from existing forests unviable and lead to conversion of the existing forests in to agricultural lands due to economic pressures. In India the gap between the supply and demand of forest product is enormous. For the year 1994 the total demand of wood was estimated to lie between 324 to 434 Mm^3 and the total production (from all sources, licit or otherwise) was estimated at 294 Mm^3 whereas the total sustainable cut from all sources in India is estimated at 127 Mm^3 (MoEF, 1999). The gap between sustainable removals and demand is therefore as large as 197 to 307 Mm^3, which is so large that for quite sometime to come we cannot produce enough in India for supply displacement to cause any serious leakage.

Investment crowding could occur when the incentives to invest in plantations for carbon sequestration are so high that the funds meant for other economic activities, like solar power generation for replacement of fossil fuel, are also diverted for the former. Certainly there is no danger of it happening in India because of land for afforestation would limit the investment even if funds were available without any constraints.

Leakage avoidance and leakage limiting involve costs and it is not sufficient to only prevent leakage treating it as a case of theft. Alternatives will have to be provided within the physical and economic reach of the erstwhile users of the lands put under plantations. These entail costs on the proponent and the state that have to be added to the cost of carbon sequestration and storage. Murray et al (2002) estimated that leakage in afforestation projects for the US show leakages ranging from about 20% in the Lake states to over 40% in the southern states and that smaller project sizes did not necessarily have smaller leakages. The study also concluded that at higher carbon prices the leakage declines since there is wider participation under the promise of higher returns.

Since leakage is often considered synonymous with licit or illicit removal of biomass for fuel wood and timber or for earning livelihood it is easy to identify it with poverty. It then becomes logical to adopt the higher range of 40% leakage in the US for a developing country like India. But this need not be the case since the nature of leakage in these two societies is essentially different. In a poorer country like India leakage would be driven by the scarcity of biomass whereas in a rich country like the US the driving force would be the investments that would have been made in enterprises increasing biomass under the BAU scenario going to activities that either do not result in carbon sequestration or do it in smaller measure. In other words, leakage in poorer countries is generally the loss of biomass whereas it is mostly the reduction in the production of biomass in the developed countries. The underlying factor not being poverty in all the cases it would be wrong to conclude that the leakages in developing countries would be higher compared to the developed countries. Since no figures are available for India we would adopt the lower range of leakage of 20% and treat the leakage costs at 20% of the total production costs.

9 Transaction costs

The transaction costs can be broadly defined as the costs incurred in linking goods and services produced with their prospective consumers. These have also been defined as all costs incurred in reaching a product to the consumer except the production and transportation costs. Cacho et al (2002) have adopted a modified version of classification of transaction costs by Dudek and Wienar (1996) that includes the search costs, negotiation costs, verification and certification costs, monitoring costs, enforcement costs and the insurance costs under the overall transaction costs. *Search costs* are incurred as the investors and hosts seek partners for mutual benefits and *negotiation costs* are incurred, after the search is over, in reaching an agreement over the terms of partnership. *Verification and certification costs* are incurred when the negotiated contract parameters require the approval of an accredited agency. For example, GHG abatement contract between an investor and a host under the CDM would require verification of the claims of carbon sequestration and fulfillment of the conditions of cut-off date of 31.12.1989, biodiversity conservation etc by an independent body following which the authorized agency in the host country would issue the carbon certificates.

The *implementation costs* refers to the costs incurred in implementing the provisions of the negotiated contract like keeping records, making payments and dealing with discords. Large projects often require establishment of an office for this purpose. *Monitoring costs* are the amounts expended to observe and measure the intermediate milestones, progress indicators and achievements made in real time as the project takes off and test them against the forecasts. Projects that fix less than 2~3 tC/ha/year cannot be monitored in a cost effective manner because the cost of measuring these quantities is similar to the cost of measuring 10~15 tC/ha/year (Macdicken (1997) quoted in Cacho et al (2002).

Enforcement costs are incurred when monitoring reveals deviation from the agreed terms of the contract. In complex multi-layered agreements among partners belonging to different political, legal and administrative environments, as would be the case under CDM, disputes arise frequently because same words often carry different meanings to different partners. Also the very nature of the long term contract between the host/seller and the investor/purchaser is prone to be more adversarial than co-operative as both try to maximize their benefits, the host by relaxing standards in order to spend less and the investor insisting on even harder standards as markets start discounting severely even minor flaws in the carbon credits earned. The litigation costs incurred in enforcing such contracts can be very high.

Insurance costs arise from the risks that the ventures face. Tree growing locks up the land resource used for a long time and in the case of planting for carbon sequestration it would be even longer. Long-term investments face high risks of drop in prices far below expectations on account of changed market preferences, policies and the technological development. Forestry also faces the risk of fire and damage by insects and pathogens and the risks factor varies from activity to activity and the environment under which the activities take place. A pine plantation has higher risks of fire compared to an oak plantation in the Himalayas. In long gestation forestry crops market uncertainties raise risks of lowered prices at the time of harvesting and policy uncertainties of a government given to experimentation can lead to serious risks of miscalculation of both the cost of inputs and expected prices of the output. Over and above this, the stringent CDM requirements for the award of carbon credits and uncertainties arising out of the enormous complexities of the rules laid down for this purpose, enhance the chances of failing to satisfy the accredited agency authorized to issue carbon credit certificates.

9.1 Estimates of Transaction Costs in Afforestation Projects

In her detailed work on transaction costs involved in obtaining carbon credits through carbon sequestration, Milne (2002) has examined six large afforestation and reforestation projects in Latin America and Russia and reported it to be in the range of US$ 0.57 to 2.96 per ton of projected sequestration of carbon in these projects and estimated the transaction costs to range from 6% to 45% of the total project costs. The small data does not give any correlation between the project size and the transaction costs.

Detailed examination of some of these transaction cost estimates reveals them to be underestimates. For example, Milne (2002) had estimated the transaction costs for the Russian afforestation project RUSAFOR to be US$ 0.84/tC but this did not include enforcement and insurance costs. Enforcement costs, incurred mostly on litigation, was a non-issue because this was essentially an agreement between five Russian government organizations including the Russian Federal Forest Service on one side and the US Environmental Protection Agency and the Oregon State University on the other, all more eager than the other to ensure the success of the project to assess the possibilities of the vast Siberian land mass to sequester carbon. Insurance was not considered necessary for the project, as it was essentially a non-commercial venture. Further, since the Russian Federal Forest Service was the primary participant with in-house availability of high grade technical skills in all aspects of the project these were not costed lowering the transaction costs significantly.

The situation in most other projects examined by Milne appears similar underestimates when viewed in the context of the transaction costs that the host/seller and the investor/purchaser are likely to face in the CDM forestry carbon sequestration projects. The best scenario for comparison with the CDM projects is presented by the Chilean afforestation project with transaction cost estimates of US$ 2.96 /tC is which thousand of farmers are co-participants and almost all the categories of transaction costs are covered including the insurance costs lacking in all the other five projects studied by Milne. It would thus be reasonable to adopt this transaction cost of about US$ 3/tC for the purpose of our cost estimates.

9.2 Production of Associate and Rival Products

A complex production system like the forests is capable of producing several *associate products* and a few *rival products* that would influence the costs significantly. Some of the *associate products* of carbon sequestration in forests would be water conservation, soil conservation, bio-diversity conservation, non-timber forest produce, firewood and small timber from thinning etc. Timber on harvest becomes a *rival product* because increase in its production reduces the output of the main product carbon. However, even timber production can also become an associate product, or at least exhibit a reduced rivalry, by its end use since timber meant for furniture and building material would continue to store carbon for a long time. The venture would be successful if the net present worth of the returns is higher than the costs. But the market trends today are far lower and the demand scenario does not give much hope for increase in demand for carbon credits and, therefore, market by itself is unlikely to help raise carbon prices to levels above the production costs.

10 Analyses of the Real Costs of Carbon Sequestration

There would be sustained interest in taking up CDM forestry projects only if benefits exceed costs (B > C) by a significant margin

$$C = R + O + P + L, \text{ where}$$

C=Total production costs

R=Total land rental discounted to the base year

O=Total opportunity costs (except those accounted for in land rental) including non-monetory benefits to the extent felt by the project proponent

P=Total planting and maintenance costs discounted to the base year

L=Total leakage costs to the project proponent discounted to the base year

$$\text{And } B = (Bcc - T) + Bap + Bnm$$

B=Total monitory value of benefits

Bcc=Total carbon credit values discounted to the base year

T=Total transaction costs discounted to the base year

Bap=Total value of the associate products discounted to the base year

Bnm=Total value of the non-monitory benefits accruing and appreciated by the project participants

10.1 Profitability of an Agro-forestry Sequestration Project

For an understanding of the above let us take an agro-forestry project in Darjeeling hills in Eastern Himalayan biotic province of the Himalayan bio-geographic zone in which Cryptomaria japonica, which has a productivity potential of 39 m^3/ha/year (Lal, 1992), is planted on a 25 year rotation basis. With a wood density of 0.6 and biomass - carbon conversion factor of 0.5 the productivity in terms of carbon amounts to 13 tC/ha/year. Assuming a carbon value of US$ 15 per tC and assuming further that over the next 25 years the increase in carbon prices would keep pace with the current monitory discount rate of 5% the total benefits that accrue to the project participants would be

$$B = \text{US\$ } (15 \times 13 \times 25 - 3 \times 13 \times 25) + 0 + 0 = \text{US\$ } 3900$$

In arriving at this we first assume that there are no associated products (Bap = 0) either during the 25 years or at the culmination of the project. Also, that the non-monitory benefits hold no attraction for the project participants (Bnm = 0).

The production costs would be

$$C = 2174 + 0 + 425 + 0.2 \text{ x } (2174 + 425) = \text{US\$ } 3119$$

Here we assume opportunity costs O = 0 as all such costs to the project participants have been accounted for in the land rental itself. Also the leakage costs, L, is assumed to be 20% of the remaining production costs.

Thus at the carbon prices of US$ 15 per tC the perceived benefits are larger than the production costs and the venture would be economically viable. But if the prices fall below USD 13/tC the venture would no longer be profitable unless the project participants earn from associated products also. These leads us to the possibility of using the resource produced as a fuel resource to displace fossil fuel or as a replacement for cement or steel in construction and thus displace fossil fuel that would have been used in producing that quantity of cement or steel. Alternately the harvested wood could be utilized in a manner that stores carbon over a long period. It may be noted that the accounting methodology for carbon stored in harvested wood products has not yet been agreed upon and is likely to be taken up in the forthcoming Conference of Parties (COP 10).

10.2 Profitability of a Typical Reforestation Project

Let us now take an example of reforestation by government forest department in eligible degraded government forests lands in the North Eastern bio-geographic region (where the potential productivity lies between 9 to 12 m3/ha/year) at a site with potential productivity of, say, 10 m3/ha/year. Here there would be no land rental (R = 0). Also, since the land has become degraded there is no harvesting except what is removed by people of the neighborhood by way of fuel wood and grasses which would constitute leakage which, as in the previous case, is assumed to be 20% of the production cost. The opportunity cost would be the non-monitory benefits foregone by the society but since the reforestation for sequestration would ensure at least the same measure of non-monitory benefits we would assume O = Bnm. The total production cost per ha over a period of 25 years would thus be

C = 0 + Bnm + 425 + 0.2 x 425 = $ 510 + Bnm and, assuming no associated products (Bap = 0) the benefit values would be

$$B = 15 \text{ x } 3.5 \text{ x } 25 - 3 \text{ x } 3.5 \text{ x } 25 + \text{Bnm} + 0 = \$ \ 1050 + \text{Bnm}$$

Thus B > C even without any associated products at this carbon productivity and price. But if the productivity falls to half of the projected value or the carbon prices drop below $ 8 /tC the benefit value would no longer be above the costs unless associated products add value.

11 Conclusions

The true cost of sequestering and storing carbon in trees is the total of the land rental, planting and maintenance costs, transaction costs and the cost of accounting leakage. In India the land rental or the land use opportunity costs are the biggest constituent of these costs and, land being a limited resource, greater requirement for land for carbon sequestration would drive its prices up. At present the negotiated price range of carbon for projects supported by responsible multilateral bodies is US $ 15/tC and while at this price range the carbon sequestration projects are marginally economical in lands of high potential productivity even a slight reduction in real prices (when adjusted against inflation) would render these projects unviable.

The very low prevailing prices of $ 3-4/tC in the Chicago Climate Exchange points towards such a possibility. A demand induced price rise for carbon credits is unlikely because the withdrawal of the USA and Australia from the Kyoto Protocol and reduction in the need for emission abatement by Canada and Japan by allowing them large carbon sinks through forest *management* has reduced the demand drastically. Since individual project developers may have no influence on the prices a useful strategy would be to rely on high productivity to reduce the cost of producing carbon credits even though it would limit the choices to only the warmer and more humid lands of higher productivity and to a few species in agro-forestry.

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Payments for Environmental Services (PES): Issues and Applications in Asia

Rina Maria P. Rosales

1 Introduction[1]

The concept of payments for environmental services or PES, also known as markets for environmental services or MES, may sound new to most people. Yet the concept is not entirely alien, particularly to stakeholders directly affected by environmental and natural resource management. The literature defines market development for environmental services as the creation of incentive systems, mainly through imposing correct prices, which provide the link between providers of the environmental service and beneficiaries of the service.[2] Correct prices would encourage land managers to behave in ways that increase, or at least maintain, certain intangible environmental functions, such as:

- Carbon sequestration, or the storage of carbon in biomass or soils
- Watershed protection, including maintenance of water quality, quantity and water flows
- Biodiversity conservation, or provision of habitat for endangered species
- Landscape and seascape beauty, or maintenance of landscapes and seascapes that people find attractive

The role of the government is further distinguished in the PES arena. Because of the public nature of most of these services, the government plays a big role in market development. In the case of national parks, for instance, government becomes the seller of such services by ensuring that such services are provided through their protection and conservation efforts. Payments come in the form of economic instruments instituted in these protected areas, e.g. entrance and user fees, with the assumption that revenues from these instruments will sustain protection activities, and consequently environmental services. In some cases, politicians reduce subsidies that encourage wasteful use of natural resources and the loss of environmental functions.

China is no exception to the increasing number of countries whose governments recognize the importance of protecting their natural resources through PES schemes. During the World Parks Congress in Durban, South Africa last September 2003, Mrs. Lu Zhi of CI China stated: "*The government recognizes the interest of the local people to protect some of their resources. These can be a single tree, a pond or a piece of forest. They are now actively looking how to regulate these interests.*" Recent changes in Chinese law have incorporated approaches such as PES, and the government is heavily investing in nature conservation. Mr. Zhu Guangqing of the State

[1] Rosales, RMP. (2003). *Developing Pro-Poor Markets for Environmental Services in the Philippines.*
[2] Landell-Mills, N. and Porras, I. (2002). *Silver Bullet or Fool's Gold?*

Environmental Protection Agency further explained: *"Local government and local communities increasingly understand environmental issues and engage on nature conservation. New laws and frameworks as well as increased funding for conservation stimulate their participation."*

Non-government organizations have likewise been active players in promoting payment schemes for conservation. Sometimes, direct payments are made to farmers and other private landowners, to promote environment-friendly land use practices. Still, in some cases, land is directly purchased or leased for conservation or sustainable use activities. There are some NGOs that have purchased development rights from private landowners, or have directly competed with timber companies to acquire long-term concessions on public forests. [1]

The creation of new rights and responsibilities by the government is also another type of incentive scheme. For instance, countries signatory to the Kyoto Protocol to the United Nations Framework Convention on Climate Change are now obligated to reduce or mitigate emissions of greenhouse gases. Polluters coming from these countries purchase carbon credits from forestry operators to allow them to continue their commercial operations. Trade is thus made possible, wherein the rights and responsibilities are bought and sold in the market.[2]

2 Economic Rationales

The impetus to create MES or PES schemes stems from the recognition that benefits and costs of conservation or environmental management are unevenly distributed. Many of these benefits are being enjoyed almost for free, or at least at undervalued prices, by the beneficiaries. This in turn is due to the failure of the market to account for the true value of these goods and services because of a number of reasons. One, the public nature of these services means that there are no private property rights established over them, thus they are not readily traded in the market. Second, it would be difficult to exclude other users from enjoying these services even if they don't pay for them, such as clean air, for instance. This is what is known as the non-exclusive nature of some environmental services. Finally, even with the presence of some users benefiting from the service, it does not lessen the amount of the service available for others to use. For instance, when carbon is sequestered, the whole world benefits from it, wherever the sequestration occurs. All these reasons contribute to the under-valued nature of environmental services.

Corollary to this, those who are providing these goods and services are undertaking conservation at a cost, which is not being paid for. Upland communities that practice sustainable land use activities do not get paid by those who benefit from clean water downstream. Forest dwellers that protect the trees do not get paid by the global community for ensuring carbon is stored and locked up.

Payments for environmental services, as environmental economists in the development sector are espousing it, attempts to target both environmental conservation and poverty alleviation. This is what makes the concept exciting and attractive. Environmental awareness has grown to the point

[1] Bishop, J. (2003) *Payments for Ecosystem Services: A Case for Sustainable Globalisation?*
[2] Ibid

of creating a consumer market that is conscious of environment-friendly technologies and products, wanting to purchase environment-friendly goods and services. But even bigger than that is the fact that there is a natural demand for environmental goods and services. There is no question about the human population wanting sufficient water supply and improved water quality, or clean air. Hence, in economic parlance, demand exists yet supply is threatened, giving rise to a positive price. This forms the basis for market creation, and consequently payment schemes.

3 Issues Related with PES

There is, however, the danger that payments may not accrue to those that are really in need, or the poorest of the poor. Most of the demand is coming from urban or nearby urban areas, while the providers of the environmental services usually come from the rural sector, sometimes even from remote coastal communities. Theoretically, it would be logical to assume that such payment transfers would then be progressive, since the payments will be coming from the urban populace (who are assumed to be richer), given to the rural populace (who are presumably poorer in general). However, this does not happen automatically. In some cases, where subsidies or payments are indeed provided, these payments are not being earned by the poor simply because of the lack of legal titles or clearly defined ownership of land or rights. Furthermore, the poor are usually excluded from such market schemes simply because the necessary information and expertise for involvement is inaccessible to them. Finally, some operations require capital and technology due to scale, and will require long-term investments, all of which are not possible when dealing with poor communities. Long-term benefits cannot replace day-to-day subsistence needs, and the poor will not opt for conservation activities if they will be required to wait too long.

Still, there are some cases when there is no critical mass of environmental service being provided, such that a market cannot be created. Beneficiaries may be too few in number, or may even involve poor people who do not have the capacity to pay for such additional expenses. In developing countries, the problem is compounded by the presence of weak institutions which cannot implement such payment schemes efficiently, such that the process becomes more costly to enforce rather than not having any payment scheme in place.

Then there is the question of measuring the service being provided, and accounting for its true value, which will translate into the payment mechanism, since many of these benefits do not possess any market price. It may be the case that the provision of the service is being done at a great opportunity cost. If so, then the net benefit to society may be very small, marginal in fact, or worse it may be negative. Such situations are not conducive to being subjected to PES schemes, because in the end, overall welfare becomes lower despite being able to provide for increased or improved environmental services in a specific area. This should be taken into account when determining whether or not to implement a PES scheme.

Related to this is the issue of the service itself, whether encouraging it will actually displace other environmental services. For instance, newly planted trees may indeed increase carbon sequestration functions, but in turn may reduce water flow downstream, or displace endemic biodiversity. Such trade-offs need to be recognized at the very least, and affected stakeholders should be made aware that such trade-offs are possible.[1]

Noteworthy in some instances is the replacement of labor-intensive operations, e.g. logging and mining, by more environment-friendly activities, e.g. eco-tourism. There is the danger that the PES scheme needed would be so large so as to compensate for the labor displaced. Furthermore, some PES schemes would require non-use or restricted access to NTFPs, for instance. Many of these subsistence economies have relied on such products for their livelihood for generations, and taking such access away from them may not be that simply replaced by actual payment schemes, particularly if there are cultural implications involved.[2]

4 Elements of PES Schemes

The main hypothesis for PES is that it intends to promote environmental conservation, while simultaneously reducing poverty. Poor communities, or even governments of developing countries, are encouraged to practice sustainable land use activities, and in the process get paid for their efforts. Note that these are not subsidies that are being provided, rather are payments for actual services rendered. The assumption is that those that demand such services are willing and able to pay therefore, and the suppliers are physically living in or nearby areas where these environmental services are found, therefore are able to ensure their continued supply. Through sustainable land use practices, either through environment-friendly practices or rehabilitation of degraded areas, the provision of the environmental service is ensured.

The payments may come in various forms, not necessarily direct monetary payments, although that would be the ideal scheme if it can be easily implemented. Sometimes, securing tenurial or property rights is enough incentive for poor communities. What is more crucial is the enabling environment that would allow for a PES scheme to be implemented.

First, there should be no legal impediments, or contradicting incentive schemes embodied in other laws or ordinances, that may cancel the economic incentive of the PES scheme. Ideally, a law should be instituted that would allow for PES schemes. This addresses problems of property rights, which is usually the main hindrance governments or NGOs face in coming up with PES programs.

China has had a wealth of experience in twenty years of forestland tenure and contracting-out systems, as well as forestry taxation schemes. For instance, in the late 1970s, the "Household Responsibility System" was extended from agriculture to forestry. This allowed rural households that had not previously been permitted to generate private returns from forestry investment to lease forestland and own-planted trees. IIED has done a comprehensive study on emerging policy opportunities that are being tentatively explored by local and national authorities, which include payments for forest environmental services.

Second, there should be appropriate studies that would attempt to measure ecological effects and

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[1] Ibid.
[2] Ibid.

economic values of the environmental service being provided or encouraged. Ecological studies are important to determine the overall effect of encouraging the particular environmental service and subjecting it to a payment system. More importantly, the environmental service itself should be traceable and distinct, and the beneficiaries and providers can be clearly identified. Likewise, economic values are crucial in determining just how much payment should be made, and whether there are opportunity costs involved in providing the service. The transactions and/or administrative costs of setting up the system should be computed, to find out if there are net benefits in setting up the PES scheme.

Third, there should be a capable institution, whether government or non-government, that can ably provide the necessary interventions in setting the system up. Because of the failure of the current market system to account for proper values of environmental services and for poor communities to exercise property rights over them, there is a need for brokering to correct for such failures. Awareness and political will are important elements of capacity. Furthermore, there should be the long-term prospect of institutionalizing whatever mechanisms the brokering institutions set up to sustain the mechanism.

Fourth, the payment scheme should be mapped out. The choice of the appropriate economic instrument would depend on the legal, economic and institutional implications of such. There are numerous instruments to choose from, all of which have been tested in the market, and each of them having pros and cons with respect to implementation. What is appropriate will depend on particular conditions of the market under study.

Finally, monitoring, evaluation and institutionalization of the scheme should be implemented, to ensure the sustainability and long-term viability of the scheme. Monitoring and evaluation are especially important given the nascent character of PES. Experimentation is still pretty much the name of the game. Although it offers much promise in theory, evidence of its effectiveness in promoting both conservation and poverty alleviation is still evolving. Hence, there are still lessons to be learned before we embrace PES as a powerful tool in pursuing economic and environmental objectives.

5 RUPES Program in Asia[1]

Many upland and mountain communities in Asia manage landscapes that provide environmental services to outside beneficiaries, but without sharing in the benefits of those services. The services can include clean and abundant water supplies from watersheds, biodiversity protection, stocks of carbon that alleviate global warming and landscape beauty and amenity. Rewarding the poor upland communities for providing these services would enhance their livelihoods and reduce poverty. Clear opportunities are now emerging in this respect. Through partnership with the International Fund for Agriculture and Development (IFAD), ICRAF has taken on the role of coordinating a consortium of partners, including IUCN, interested in contributing to, and being a part of, a program for developing mechanisms for rewarding upland poor in Asia for the

[1] ICRAF (2002). *Rewarding the Upland Poor for Environmental Services They Provide (RUPES).*

environmental services they provide (RUPES).

RUPES intends to match the beneficiaries with the corresponding providers of environmental services in the uplands, and test an array of mechanisms within poor communities living within or nearby the study areas. It will implement studies on identifying and monitoring the environmental service being subjected to PES, the corresponding land use options, and their associated benefits and costs. As far as establishing an enabling environment is concerned, it aims to institutionalize PES schemes, and in the process, create awareness among government officials, producers and consumers of these services. To ensure coordination and efficiency, it tries to establish partnerships among local, national and international stakeholders in implementing the Program.

The international consortium of partners is made up of organizations active in environmental research, namely:

- Center for Int'l Forestry Research (CIFOR)
- World Resources Institute (WRI)
- The World Conservation Union (IUCN)
- The World Agro forestry Center (ICRAF)
- Winrock International
- World Wide Fund for Nature (WWF)
- Conservation International (CI)
- International Institute for Environment & Development (IIED)
- Economy and Environment Program for Southeast Asia (EEPSEA)
- International Development Research Centre (IDRC)

The consortium is encouraged to advocate for RUPES principles at national and international levels, raise awareness and draw new budgets for the Program's implementation and expansion, and document lessons learned, particularly on which mechanisms fit for which group of rural poor, how to implement such mechanisms, and how to build capacity at the national and local levels.

A number of initiatives have been approved for implementation, three of which are located in Indonesia, one in the Philippines and one in Nepal. Proposals are currently being developed in Sri Lanka and Lao PDR. Meanwhile, negotiations are being conducted in Vietnam and China for introducing RUPES and testing PES mechanisms therein.

Indonesia[1]

Batang Hari Catchment, Jambi

Jambi is the third largest rubber-producing province in Indonesia. Around 97% natural rubber comes from smallholder farmers tapping rubber gardens. Jungle rubber agro-forests act as a reservoir of forest diversity. However, the productivity of jungle rubber remains very low, and intensive monoculture plantations of both oil palm and clonal rubber have higher profitability.

[1] ICRAF (2003).

Small farmers are thus prepared to sell their agroforests that will then be converted to a more intensive system, leading to a decline in traditional jungle rubber areas. Without rewards for the environmental services provided by rubber agro-forests, these systems are bound to be replaced by oil palm monocultures or any other more profitable land-use.

The RUPES project thus aims to reward these rubber tappers for the environmental services provided by these agro-forests in the Batang Hari catchment. It aims to test a number of institutional mechanisms for obtaining a win-win on environmental protection and poverty reduction. A consortium of national research agencies, universities and NGOs has evaluated the main land use options that exist in the area and confirmed the special claim that these rubber agro-forests can make on harbouring a major part of forest biodiversity, along with benefits in carbon stocks and watershed functions. In the short-term, rewards will come in the form of secure certification, access to markets, and direct financial rewards to the land owners. On the other hand, long-term rewards will come in the form of market-based rewards for multiple products of jungle rubber agro-forests.

Project activities include the following:

- Characterizing sites for testing the RUPES mechanism
- Poverty mapping
- Developing a stakeholder communication strategy.
- Reviewing potential payment mechanisms and feasibility studies of certification schemes
- Following up with potential buyers of biodiversity conservation.

Singkarak Watershed

Singkarak Lake is located in the central part of West Sumatra. There is an artificial water tunnel developed by the Hydropower Electricity Company (PTLA) in the western part of the lake, and it produces electricity of about 966 GWH per year. The water of the Lake's outlet also serves as a source of irrigation water for rice paddies in four districts downstream. Fishing for a highly valued local fish species is also popular among people living near the Lake. Due to increasing forest degradation, functions of the Singkarak watershed are deteriorating. The watershed function problems that arise in this area are regularity of water flow and water quality. Drought is affecting electricity production as well as rice growing in the downstream areas. Meanwhile, during the wet season, water levels increase and cause floods that often occur in the downstream areas.

Strong local institutions and their coherence are added values of this area as an action research site. The local government along with other community leaders took the initiative to establish a management body for Singkarak Lake called *Badan Pengelola Danau Singkarak.* They are now trying to accelerate the rehabilitation of the degraded areas surrounding the Lake. However, due to lack of financial and incentives systems, the progress of rehabilitation is slow. RUPES intends to correct this through developing local capacity to identify activities that generate environmental services. In particular, the site has potential for quantifying watershed protection and carbon sequestration functions, with potential buyers including the PTLA. An assessment will be made of these buyers' willingness to pay, including the conduct of roundtable discussions regarding the ideal type of payments, system of payments and the institutional system necessary for the payment transfer to the local communities. Rehabilitation efforts using community funds will continue, while the RUPES project will attempt to influence local government regulations to facilitate the proposed mechanisms. In addition to the economic valuation studies, a rapid hydrological assessment will be conducted to include the concerns of farmers and stakeholders downstream.

Sumberjaya

Sumberjaya (which means 'source of wealth') - a sub district in the mountain range of Bukit Barisan is a benchmark for conflicts of forest watershed functions in Indonesia, particularly water flow, water quality and sediment control. It has witnessed one of the most intensive 'eviction' episodes, increasing poverty of squatter families in the area. The supply of clean water, problems with domestic debris and soil sedimentation of the river have become the main issues in this watershed. Land use conflicts between the communities and Forestry Department also arise because most of the watershed is classified as protection forest and national park.

Under the RUPES Project, the action research will focus on three sub watersheds of 200-1500 ha: Way Petai, Way Ringkih and the Gunung Abung-Simpangsari. Economic valuation studies will be conducted to estimate the economic value of water, based on the willingness of farmer groups to deliver the environmental services and the willingness of service buyers to pay for improved water quality and supply. Using a participatory map of ownership and/or tenure of riparian areas as baseline, the proposed reward mechanisms are temporary land tenure with better criteria, clearer guidelines of the 'reward scheme' from the local government (Forestry Department), and direct financial payment and/or in-kind payment from the Hydropower Electricity Company and domestic water users. A participatory monitoring program for water flow and quality (sediment, E. coli, nutrient and chemical contents) at the sub-catchment level will be set-up. Other outputs include a study determining the water supply-demand chain, establishment of "river care", policy briefs, and documentation of the process to distill lessons learned.

Philippines

Ikalahan Ancestral Domain[1]

The Ikalahan Ancestral Domain is located in Luzon, one of the three major island groups in the Philippines. It includes the Kalahan Reserve and totals approximately 58,000 hectares of mountain lands between 550 and 1717 meters above sea level. It is considered to be a rich source of biodiversity and has a great potential for eco-tourism in that part of the country. The area further provides both water for drinking and irrigation systems and has a proportion of the land in production forests as well as agriculture.

The Reserve has been under the legal control of the Ikalahan community, represented by its

[1] ICRAF (2003).

People's Organization, the Kalahan Educational Foundation, Inc., since 1974. In 1999, the Philippine government approved the Ancestral Domain Claim of the Foundation, thus formalizing the legal rights of the PO over developing and managing their land. About 20,000 persons live within the Ancestral Domain of whom at least 90% belong to the Ikalahan and another 5% belong to other tribes of Indigenous People, primarily the Ifugao, Ibaloy and Kankanaey. About 2,500 persons live within the Kalahan Reserve. The Kalahan Foundation will be working with RUPES in testing payments for carbon sequestration, watershed protection and biodiversity conservation.

Prior to 1990, serious logging and deforestation occurred in Kalahan. Since the PO took over its management, tree cover has partially recovered, and environment-friendly practices have been put in place. However, the area is still not self-sustaining, as most of the current environmental services provided by sustainable land use practices are not being paid for.

The RUPES project with the Kalahan Foundation will confirm the existence and quantitative measurements of carbon sequestration and watershed protection functions of the Reserve and test payments for these services. The buyer of the carbon is still to be determined although there are on-going negotiations with the managers of the irrigation systems to provide the payment for the Ikalahan community's efforts in protecting the watershed. In addition, there is the possibility of using payments from ecotourism efforts to bolster the biodiversity conservation in the Reserve, partly through the establishment of an educational center. All these are coupled with extensive reforestation efforts to approximate the original forest cover prior to the logging period.

Other PES Efforts in the Philippines

Outside of the RUPES Programme, there are other case studies in the Philippines for developing markets for environmental services. The National Integrated Protected Areas System (NIPAS) Act of 1992 creates a system of protected areas all over the country, each of which is managed by a Protected Area Management Board (PAMB). The composition of the PAMB is such that 25% of its members should be represented by non-government organizations and people's organizations. PAMBs are allowed by the law to raise their own funds, through the imposition of various types of user fees or through donations. These user fees then go to an earmarked central fund called the Integrated Protected Areas Fund (IPAF), 75% of which goes back to the site upon approval, by the PAMB, of a workplan detailing the disbursements of their revenues. In other words, the system works itself out so that local communities are represented in the decision-making process, they are part of the planning process for the protected area and thus will presumably include their own development plans (provided of course it does not run into conflict with sustainable management of the area), and the management board is allowed to raise its own revenues and get back most of it for site management. In a way, rewards are awarded to the communities living inside or nearby the protected areas, in payment for their efforts in managing the area. Again, there is the implicit granting of some form of property rights to these communities, by virtue of their recognition as part of the management board. Meantime, the user fees provide the mechanism by which the actual users or beneficiaries of the environmental services pay for the benefits (i.e. the environmental services) they derive from the protected area.

For some of these protected areas under the NIPAS, economic valuation studies have been conducted to estimate the value of its natural resources. These studies were then used as basis for setting the appropriate user fees, many of which were Park entrance fees and resource user fees for sustainable extraction activities.

A similar reward scheme exists in the energy sector. Upon commencement of operations of a power generating plant, the power generating company is mandated to pay 25% of one centavo for every kwh generated by its plant. These funds go to an earmarked central fund managed by the Department of Energy, and will be disbursed to projects implemented by local communities onsite. Projects should specifically cater to reforestation, watershed management, or health and/or environment enhancement. Only local groups, including local governments, can avail of this Fund. On the other hand, another 25% of one centavo for every kwh generated goes to a similar fund, this time for development and livelihood projects. Again, only local groups living in the area where the power plant is situated can avail of such funds. As of 2002, total money generated for both types of funds amounted to PhP 1,563,614,326 or approximately US$ 28,429,351.

Nepal[1]

The Kulekhani watershed is located in the Makwanpur district, approximately 50 km southwest of Kathmandu in Nepal. At an altitude of between 1400 and 2300 m., this watershed has a total area of 12,496 ha. It has a total population of 43,003 with the majority of the inhabitants being disadvantaged ethnic groups and low caste people (Dalits), 50% of who live below the poverty line. Water from the Kulekhani River and its tributaries are the source of power for two hydropower plants located downstream, with one more proposed hydropower plant to be built by the Nepal Electricity Authority.

In their work with RUPES, Winrock International will work with local communities to identify the range of environmental services being provided, quantify and value such services. Major issues to be dealt with involve the lack of tenure of these migrants, as well as the lack of political will, financial resources and community interest in commitment in watershed protection activities. In addition, the project will identify transfer payment mechanisms, including new methods and approaches, and determine what preconditions are necessary and constraints to consider in implementing these services. The project will work towards strengthening the capacity of local institutions to implement transfer payments through appropriate institutional arrangements, agreements, and monitoring and enforcement mechanisms. At present, there are conflicting and competing government agencies in the course of managing the watershed. Best practices and lessons learned will then be compiled and disseminated to raise awareness at all levels on how the transfer of payments in delivering environmental services can benefit upland communities in Nepal and other Asian countries.

Sri Lanka[2]

[1] ICRAF (2003).
[2] IUCN (2004). Project proposals submitted to the Technical Evaluation Committee for RUPES in Sri Lanka.

There are four potential sites in Sri Lanka that are being considered for PES mechanisms, two of which are presented here for illustration purposes.

Marymount Sub-Catchment

The Marymount sub-catchment area is located in the hill country of Sri Lanka. It provides water for hydropower generation. Land tenure is a major problem, which hinders long-term investments in soil and water conservation. Lack of social harmony and unsound marketing systems are other issues faced by the local communities living in the uplands. There are a number of environmental issues which have to be addressed by the proposed project:

- Catchment soil erosion
- Improper land use management systems
- Catchment reservation encroachment
- Deforestation
- Forest fires in dry periods
- Siltation and water pollution of the reservoir

Upland farmers have been identified as the providers of the environmental services from the watershed. Reward mechanisms can be set-up to encourage them to engage in proper soil and water conservation practices. The electricity board is targeted to be the main buyer of the service, and the Mahawelli (River Basin) Authority can be the main institutional partner for the project.

Knuckles Conservation Area

The Knuckles Conservation Area (KCA) is an isolated rugged hilly region designated under the Conservation Forest category, with 400m-1900m altitudes, 18c-30c temperatures, covering wet and intermediate climatic zones in the Matale and Kandy districts of the central province of Sri Lanka. The forest region covers an area of approximately 21,000 has, spanning the upland and highland peneplains. It is separated from the main central highlands by a deeply incised valley of the Mahaweli River, commonly referred to as the 'Dumbara Valley'. The Knuckles catchment area contributes to about 30% of the water in Victoria, Randenigala and Rantambe reservoirs of the river Mahaweli. Out of 3,650 species of known flowering plants in the country, a total of 1033 flowering plants, belonging to 141 families, have been recorded from the above vegetation types in Knuckles.

IUCN just concluded a project entitled "Innovations and Application of Participatory Economic Planning for Conservation of Bio-diversity and Water Resources in the Knuckles Range of forests" which was implemented during the period January 2002 to June 2003. The main activities included social mobilization and strengthening of village level CBOs for participatory conservation, livelihood improvements through promoting sustainable agricultural practices, community management of irrigation water through participatory rehabilitation of minor irrigation structures and promotion of alternative livelihoods through vocational training and Eco-tourism.

The Knuckles area is ripe for a PES mechanism. It has a high level of biodiversity significance as well as strong community-based organizations with a high level of environmental awareness, mainly established through the IUCN project. Payment schemes may be developed through the promotion of eco-tourism in the area, and benefit-sharing schemes from its proceeds to be set-up.

The proposal's objectives include strengthening of the existing community-based environmental organizations, with a view to ensuring a sustainable grass root institutional mechanism through which proposed rewards could be channeled to the upland farmers. Linkages will be developed between the participating stakeholders and the grass roots societies, which will be represented by upland farmers, marginalized communities and women. Upland farmers, the marginalized communities in the plantation sector, and women in general will be the immediate beneficiaries from the reward system.

Lao PDR[1]

There are no proposals developed yet for Lao PDR. However, during the RUPES stakeholders' consultation workshop held last November 2003, one of the possibilities that arose was to focus on developing a specific project idea for ecotourism in Mun La District, Oudomxai Province. The area in question contains 65 villages, 21 of which were selected as targets for ecotourism. The villages were identified because of the Ikor ethnic make up of the population and the extent to which they are disadvantaged. The villages are all remote, and rely on slash and burn agriculture for crops of rice and opium to earn their livelihoods. Many of the villages are over a four-hour walk from the nearest road. Rewards would then be determined for the local people for protecting their environment, particularly through veering away from slash and burn agriculture. Weaving was suggested as a possible alternative livelihood. Overall, ecotourism was proposed as a form of income for the district.

The long-term objective would be to establish sustainable practices for the villages, while the short-term objectives would be to improve food security and options for income generation. Some ideas for the project proposal include:

- community development activities, using a participatory approach
- agriculture alternatives such as livestock and agroforestry
- credit services to improve livelihoods and allow access to micro-credit as well as infrastructure development
- capacity building for government officials at provincial, district and village levels.

China

In China, there have been efforts in many of the PES elements mentioned above, in one way or another. As far as laws are concerned, there have been a number of significant legal pronouncements that are either supporting or even advocating PES in the pursuit of environmental conservation. In August 2002, for instance, the Law of Rural Land Contracts was approved, which endows farmers with long-term and guaranteed right of using rural lands. The contractor has legal

[1] IUCN (2003). Final Report: Workshop on Rewarding the Upland Poor for Environmental Services They Provide.

rights of using the land, benefiting from the returns, and transferring rights.[1]

Economic incentives have further been implemented in the country. Public investment in biodiversity conservation and sustainable use has increased over the years. Furthermore, preferential taxation has been granted to income from biodiversity conservation and sustainable use. In August 2001, the State Council released "Implementation Suggestions on Several Policies and Measures of Western Development Programme" which provides "exemption from agricultural special local product taxation for 10 years to gain income resulting from protecting ecosystems and returning farmlands to forests".[2]

So far, one of the most exciting developments in China in the PES arena is the establishment of the Forest Ecological Compensation Scheme. It started in Sichuan province, where the local government decided to that 30% of income from entrance fees would be used for forest protection. This inspired the Ministry of Finance to come up with a national approach in forest ecological compensation, which was later on incorporated into the Forest Law in 1998, to support the provision of public benefits by protection forests and special-use forests. These included payments for afforestation, protection, tending and management.

Finally, the Cropland Conversion Program is a positive development due to its focus on communities and is the first policy on a large-scale that provides compensation to individuals. The objectives of the Program include improvement of the ecological environment, achievement of solutions to flooding problems in the Yangtze and Yellow Rivers, and prevention of desertification. Under this program, grain, cash and seedling subsidies are provided to farmers. The duration of the subsidies depends on specific situations, such as the type of forest to be developed. It has already resulted in ecological, economic and social benefits since its establishment in 1999, and is currently being implemented in 24 provinces and in a total of 1,500 counties.

6 Latin America: Some Examples

Outside of Asia, there are other countries in the developing world that have established PES schemes in efforts to simultaneously target environmental conservation and poverty alleviation. Latin America is replete with these examples, particularly the countries of Ecuador, Costa Rica, Brazil, El Salvador and Colombia. Two illustrations are provided below.

Watershed Protection Services in Pimampiro, Ecuador[3]

San Pedro de Pimampiro is a municipality located in the northeast corner of the Imbabura Province in the Andean region of Ecuador. The Province of Imbabura has an extension of 4,560 km^2 and is located in the valley of the Chota River. The leading economic sectors in the province

[1] Tu Ruihe (2002). Memo to Dr. H. Zedan, Executive Secretary, re: Information on Incentive Measures in China. State Environmental Protection Administration, Beijing.
[2] Ibid.
[3] Echavarria, Marta et. al. (2002). *Impact Assessment of Watershed Environmental Services: Emerging Lessons from Pimampiro and Cuenca in Ecuador.*

are agricultural with milk and livestock production, as well as bean, banana, corn and coffee crops. The municipality suffers from water shortages. Until 2001, domestic water users received the service two days a week, for a period of two hours per day. A quarter of the population had limited access to drinking water services. In addition, water quality is also a problem considering that the town depended on a resource that was affected by agriculture upstream. However, considering the serious limitations of the service, the leading concern is still access. For these reasons, developing the appropriate infrastructure for increasing water flow has been a priority.

The *Asociación Autónoma de Agricultura y Ganandería Nueva América* (Nueva América Agriculture and Livestock Autonomous Association) is located thirty-two kilometers south of the city of Pimampiro upstream, in the Mariano Acosta parish and within the Palauco River watershed. It was created in 1985 to formalise the group's tenure over 502 hectares of land. Between 1989 and 1997, the Association finished paying for the land for a total of 638 hectares. Of the 638 hectares the Nueva América Association owns, 390 hectares are forest, 163.3 hectares *páramo*, 74.9 hectares are dedicated to agriculture and livestock, and the remaining 9.8 hectares are degraded land. This area has faced strong deforestation pressures for wood extraction, agriculture and cattle raising. The construction of a highway 10 years ago also increased the deforestation rate by facilitating wood transport. In 1985, Pimampiro used to have 19,000 hectares of primary forest. Today there are less than 7,000 hectares.

The two main water users in the area are domestic households and farmers who rely on irrigation. CEDERENA received US$ 326,200 from AIF for three years to implement a project to counteract environmental degradation and to help 450 small farmers in the application of soil conservation, organic farming, watershed recovery and sustainable forest management techniques. As part of the implementation of this project, the UMAT implemented an environmental payment system in order to create incentives for the people who conserve the forest, as well as penalize those who do not. With the participation of the Municipality and CEDERENA, the Nueva América Association reorganized their management plan into 5 programs, including an Environmental Service Program with four projects: 1) The maintenance of forest capacity to regulate quantity and quality of water; 2) Carbon sequestration; 3) Ecotourism; and 4) Biodiversity Protection.

This payment system is considered a pilot experience and thus was only implemented for Nueva America. Yet, DFC and in turn CEDERENA has worked in other areas that could be potential applicants to the payment mechanism.

The Municipality of San Pedro de Pimampiro considered the forest and páramo ecosystems of Nueva América important for the maintenance of quality and quantity of water, and decided to begin with that pilot experience. Hence, the Municipality approved a new ordinance[1] that established a Water Regulation for the Payment of Environmental Services for Forest and Páramo Conservation, which became part of the UMAT's responsibilities.

[1] The ordinance that creates the fund has 13 articles and covers the following issues: an introduction to the fund, the activities and bases for the creation the fund, fund financing and management, ecosystem categories, payment candidates, sanctions.

The fund was created with an initial investment of US$15,000, of which US$10,000 came from the IAF (via CEDERENA) and the remaining US$5,000 came from the DFC Project. Additionally, the fund receives the 20% increase that was placed on the drinking water price, which was calculated to amount to US$ 500 a month. The resources are managed in an account with the national development bank, Banco Nacional de Fomento. However, since only 60% of the water sold is paid for, the municipality does not provide the agreed upon amount to the fund.

A committee manages the fund, which is composed of the following representatives: the Mayor of Pimampiro, the Financial Director of the Municipality, the Director of the UMAT, the President of the Municipality's Environmental Commission and a representative of CEDERENA.

Paying for Watershed Protection Services in Costa Rica[1]

In the early 1990's, as part of a central government initiative to make the environment an integral part of Costa Rica's development policy, the Ministry of Energy and Natural Resources decided to value the country's natural patrimony, with special emphasis on biodiversity, water and climate change mitigation. The Center for Tropical Science conducted studies to establish economic and ecological values of water resources as a first attempt to value the environmental services provided by the national environment. Through contingent valuation, the study attempted to quantify the water resource in physical and monetary terms, considering its costs, uses and threats.

The study made a physical quantification of the resource based on a characterization of Costa Rica's ecosystems. It analyzed the current water prices, estimated its depreciation costs and calculated a cost for protecting the water sources. Finally, the study surveyed three rural communities in order to determine the willingness to pay if quality and quantity is assured in the long term. The results of the study concluded that prices could be increased up to 121% in order to reflect the economic and ecological value of water.

At the same time that these studies were underway, the Ministry was reviewing the forest law, which gave foresters a series of legal and economic incentives to plant trees or manages forests sustainably. The payment system needed to be modified, in order to reduce the fiscal drain and ensure its long-term financial sustainability. Therefore, the government decided to establish a system of payment for environmental services, using economic tools to guide policy.

The National Forest Office and National Fund for Forest Financing (FONAFIFO) were created to develop modalities for the payment of environmental services at the local level. The Fund collects resources through a tax on gasoline use, as well as carbon offsets, fines and other procedures under the Ministry. Every year, the FONAFIFO determines how much to pay per hectare planted or managed and what total area will be included in the program annually.

Using the results of the water valuation studies, the FONAFIFO determined a fee to pay foresters depending on the plantation or system established. Due to financial difficulties, the system is

[1] Echavarria, M. (2003). *Valuation of Water-Related Services to Downstream Users in Rural Watersheds: Determining Values for the Use and Protection of Water Resources.*

funded in the most part by the gas tax and the sale of climate mitigation services rather than by water charges. Yet, the government of Costa Rica continues to study alternatives in order to effectively determine the real "cost" of water and design a tariff structure that includes the fair distribution, clean up and conservation of the water resource.

7 Conclusions

The novelty of the PES concept in the field of environmental economics has sparked the interest of many national, local and international players in the development sector. This is not surprising. For the past decades, environmental conservation and poverty alleviation strategies seemed to be at loggerheads with each other, maybe not conceptually, but at least in the implementation schemes being pursued. PES now offers a possibility for the two development objectives to be achieved simultaneously.

There are still a lot of lessons to be learned before we can claim this with conviction. The issues associated with PES, many of which were enumerated in this paper, can attest to this. Notwithstanding, there is a whole range of opportunities in Asian countries such as China for testing PES mechanisms. There are no hard and fast rules that have been developed, which makes the task more challenging and stimulating. The key now is to take calculated risks and learn from previous experiences in development and conservation work, particularly in involving local governments and local communities in decision-making. After all, they are the ones who will benefit most from our efforts in the long-term.

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The Costs and Benefits of the Potential Climate Change Mitigation Options in the Philippine Forestry Sector

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1 Introduction

Our immediate environment is changing through the years. With a concentration of high temperatures in the 1990s, an increase of about .05 degrees was experienced (Killman 2000). It was reported that the earth's temperature increases partly due to the emissions of greenhouse gases (GHGs) associated with human activities such as burning fossil fuels, biomass burning, cement manufacture, cow and sheep rearing, deforestation and other land use changes. These GHGs trap heat that would have otherwise radiated into space. The GHGs include carbon dioxide, nitrous oxide, methane, ozone and CFCs. Carbon is the most abundant of the GHGs and the primary gas responsible for the green house effect (Tietenberg 1996). Reducing a considerable amount of carbon in the atmosphere or at least preventing its emission is a big contribution to the benefit of future generations that are to be affected by the present carbon emission trends. Thus, the greenhouse impacts will have to be addressed with increases in energy conservation and efficiency, a switch to low carbon fuels and reduction in the use of chemicals with high greenhouse effects.

The forests can be a temporary solution to the climate change problem. If managed properly, they act as carbon sinks and keep large amounts of CO2 from the atmosphere. Although forests are never a complete solution to address the greenhouse gas emissions, these are temporary reservoirs that can buy valuable time while waiting for the development of better and cost effective emission reduction technologies (Pearce 1999). The IPCC Third Assessment Report in 2001 has also recognized that although not necessarily permanent, conservation and sequestration of carbon through forests may allow time for further options to be further developed and implemented.

To be able to draw policy directions towards mitigating climate change, it is vital that established cost and benefit trends be in place to guide policy makers to make rational decisions. Thus, indications must be provided as to how much is incurred and what are the benefits derived by the forestry sector and society as a whole in the pursuit of these climates change mitigation strategies.

2 Potential Climate Change Mitigation Options in the Forestry Sector

There are various potential forestry mitigation measures, which had been forwarded in the study by Lasco and Pulhin in 2001. These include reforestation, forest protection, agroforestry, bioenergy and sustainable forest management. These options however, although presently being pursued by the government, may not necessarily be for climate change mitigation but rather to comply with the country's multiple objectives of forest rehabilitation, energy generation and provision of nutritional needs. However, this research focused on short and long rotation tree plantations, regeneration, forest protection and agroforestry as the potential mitigation options to be studied.

3 Carbon Storage and Carbon Potential

The results of the study showed that at the end of the study period which is 75 years, short and long rotation plantations have the capability to sequester relatively high amounts of carbon, that is, 405 and 336 tC per ha, respectively but these are eventually emitted during harvest. Thus, at the end of the study period, carbon stored for this option was computed at zero. On the other hand, tree plantations without harvest but with introduced forest-based livelihood options, sequestered a total of 154.4 tC per ha. This option minimizes the pressure on the utilization of forest resources by the communities. Furthermore, tree plantations with no harvesting activities are able to attain its maximum aboveground carbon content of 154.4tC per a (IPCC, 1996) on its 33rd year of existence. In addition, regeneration projects emit approximately 17.54 tC per ha and sequester and store 119.71 tC per ha over 75 years.

As far as forest protection is concerned, the baseline carbon content of the area was estimated and reported at 202.5 tC per ha with a yearly increment of 0.945 tC per ha per year. This forestry option has the capability to sequester 31.18 tC per ha up to its 33rd year. This amount when added to the beginning carbon balance totaled to 233.68 tC which is the estimated maximum carbon ceiling for old growth forests where forest protection projects are undertaken (IPCC, 1996). The carbon ceiling is experienced because the trees once mature and are said to be in a state of carbon equilibrium. This is the time when no sequestration takes place. Thus, the amount of carbon stored on the 33rd year will be the prevailing volume on site until the 75th year, assuming no emissions/harvests take place.

The beginning carbon balance for the agroforestry project was estimated at 13.05 tC per ha assuming the land originated from grassland areas. The total amount of carbon sequestered was 101.25 tC per ha but due to the fuelwood harvests amounting to 28.2 tC per ha, the resulting total carbon sequestered was 73.05 tC per ha over 75 years.

4 Cost Estimation Approaches

Because of the inter-temporal nature of net carbon sequestration, two cost estimation approaches were used (IPCC 1995). The first was the flow summation approach. It simply sums the total tons of carbon captured regardless of when capture takes place. This approach treats equally the early and late capture or release of carbon the second was the levelization/discounting method, which differentiates the costs and accomplishments according to when carbon was captured. The treatment of the time value of carbon is considered as important (Newell and Stavins, 2000) because it can radically alter the choices in the mitigation options to adopt. And because carbon sink-enhancing activities result to uneven flows, distortions become greater if no discounting is applied (Fearnside, Lashof and Muora-Costa, 1999).

5 Present and Annualized Values of Carbon Sequestered

The present values of carbon (in tC per ha) for each climate change mitigation option are presented in Table 1. This represents the difference between the discounted values of carbon sequestration and emission in each of the forestry mitigation options.

Table 1 Present and Annualized Values of Carbon Stored and Sequestered per Potential Forestry Mitigation Option

Mitigation Option	Present Value of Carbon Stored/Sequestered (tC/ha)	Annualized Carbon Stored/Sequestered (tC/ha)
Short Rotation	248.62	4.73
Long Rotation	211.22	4.02
Tree Plantation without harvest, with butterfly farming	5,908.01	112.35
Tree Plantation without harvest, with seed extraction and processing	5,908.01	112.35
Regeneration	2,680.25	50.97
Forest Protection	11,843.27	50.97
Agroforestry	2,350.53	44.70

The same table shows that when a 1 percent discount rate was applied to get the present value of carbon sequestered per potential mitigation option, forest protection had the highest value at 11,843.27 tC per ha while tree plantations without harvest provided the second highest present value of 5,908.01 tC per ha. The present values for the tree plantations with the two livelihood options gave the same values of carbon sequestered/stored because they differed only in the kind of livelihood alternative which did not require any harvest or planting. Thus, no changes in sequestration nor emission were observed. Although short and long rotation plantations produced biomass, which locked the carbon from the atmosphere, these trees were harvested and in the process emitted the carbon, previously sequestered. Therefore, these two options have the lowest present values of carbon at 211.22 tC per ha for long rotation and 248.62 tC per ha for short rotation plantations.

The annualized carbon stored/sequestered for forest protection was 225.22 tC per ha while 112.35 tC per ha was estimated for tree plantation without harvest. On the other hand, 50.97 tC per ha and 44.70 tC per ha were estimated as the annualized carbon stored/sequestered for regeneration and agroforestry, respectively. Only 4.73 and 4.02 tC per ha were estimated for short and long rotation plantations, respectively.

6 Costs Incurred in the Pursuit of Each Mitigation Option

The undiscounted costs incurred in the establishment and maintenance of tree plantations with harvest for the first year was P14, 977 per ha while a higher establishment cost of P35, 718 per ha for tree plantations without harvest was noted due to the additional cost for the livelihood development fund.

The first year expenses needed to establish regeneration projects was P12, 650 per ha while only P3, 028 per ha was needed for forest protection. Because of the intensive site development for agricultural and forestry crops, P34, 560 per ha was incurred for agroforestry.

The present value of costs was highest for agroforestry due to the high investment and labor costs while the lowest was for forest protection (Table 2).

Table 2 Present and Annualized Values of Costs per Potential Forestry Mitigation Option

Mitigation Option	Present Value of Costs		Annualized Value	
	1%	15%	1%	15%
	(P/ha)		(P/ha)	
Short Rotation	249,266	42,179	4,740	6,327
Short Rotation Harvest	214,133	38,123	4,072	11,804
Tree Plantation without harvest, with livelihood(Butterfly farming)	270,732	78,690	5,148	11,804
Tree Plantation without harvest, with livelihood (Seed extraction and processing)	270,732	78,690	5,148	
Regeneration	270,085	44,526	5,136	6,679
Forest Protection	84,726	13,391	1,611	2,009
Agroforestry	1,550,589	180,049	29,486	27,008

7 Cost Requirements to Sequester 1 tC with and without Carbon Discounting

There seems to be a considerable difference in the fund requirements to sequester 1 tC from the atmosphere among the different mitigation options as shown in Table 3. With the flow summation approach, that is, without carbon discounting, forest protection required the least cost to absorb carbon (P363 per tC) while agroforestry entailed the highest cost (P21, 226 per tC). Short and long rotation with harvest had almost the same cost requirements of P616 and P610 per tC, respectively. A relatively high budget is needed for tree plantations without harvest at P1, 753 per tC while P1, 968 is required to sequester 1 tC for regeneration projects.

Table 3 Cost Requirements to Sequester 1tC per Potential Forestry Mitigation Option with and without Carbon Discounting.

Mitigation Option	Cost Requirement	
	Flow summation (without discounting) (P/tC)	Levelization (with discounting) (P/tC)
Short Rotation	616	1,002
Long Rotation	610	1,014
Tree Plantation without harvest, With livelihood (Butterfly Farming)	1,753	46
Tree Plantation without harvest, With livelihood (Seed extraction and processing)	1,753	46
Regeneration	1,968	101

Forest Protection	363	7
Agroforestry	21,226	660

On the other hand, when sequestration and emission of carbon was properly discounted and accounted for, a change in the previous trend was observed. Forest protection, however, still required the least amount to sequester carbon at P7 per tC. Although a notable amount of carbon has been sequestered for the short and long rotation plantations, these options entailed the highest costs because the amount of carbon had been subjected to discounting. Tree plantations without harvest when subjected to the flow summation approach required very high carbon sequestration costs because of the high investment and fixed carbon uptake. When compared with the results of the levelization approach, the sequestration costs decreased from P1, 753 to P46 per tC due to the accounting of the value of carbon locked in the standing trees.

8 Benefits Derived in the Pursuit of the Potential Climate Change Mitigation Options

Aside from carbon, there are other marketed and non-marketed products from each mitigation option. These products come in the form of timber, pulpwood, fuelwood, honey, agricultural crops and other products from the livelihood alternatives. These are exchanged and traded in existing and functional markets. Among the products derived from all options, mango fruits from the agroforestry project provided the highest benefit of P130, 000 per ha per year. Revenue from timber at P409, 340 per ha per rotation was also a considerable benefit contributed by the long rotation plantation as well as the revenue of P 65, 625 per ha per rotation from short rotation plantation. Carbon has been in the past, considered a non-marketed good for it has no established market. However, as a result of the proposed implementation of the Clean Development Mechanism (CDM), the World Bank has provided for a prototype carbon fund of which 2 forestry projects in Brazil and Romania have already benefited. A price of $12.8 per tC is paid (Brown, 2003).

On the other hand, water, although traded in the market has not been properly attributed with its true value. The price attached to it most often is the cost of its distribution and improvement of its quality and not its scarcity value. Thus, the water contribution of each mitigation option was also considered as a benefit.

Therefore, while there are no readily marketed goods harvested from forest protection areas, a considerable amount of carbon is stored over a 75-year period with an annualized value of 225.22 tC per ha and an estimated value of P144, 141 per ha per year.

The said areas are likewise reservoir of approximately 10, 290 cu m of water per ha per year, which roughly translates to a peso value of P78, 718. Considering the best alternative use for water, the computed economic rent (Rivera, et. al. 2000) of P7.65 per cu m of raw water exclusive of processing and distribution cost was used.

Figure 1 shows the benefit trends for all the potential forestry mitigation options. The benefit derived from agroforestry was highest while long rotation with harvest was fluctuating. Benefits from long rotation plantations may be high during rotation but tremendously decreases after harvest. This is when carbon emission is experienced. Forest protection exhibited a constant trend while tree plantations without harvest showed an increasing trend, which began to stabilize on the 33rd year when the area reached its aboveground maximum biomass.

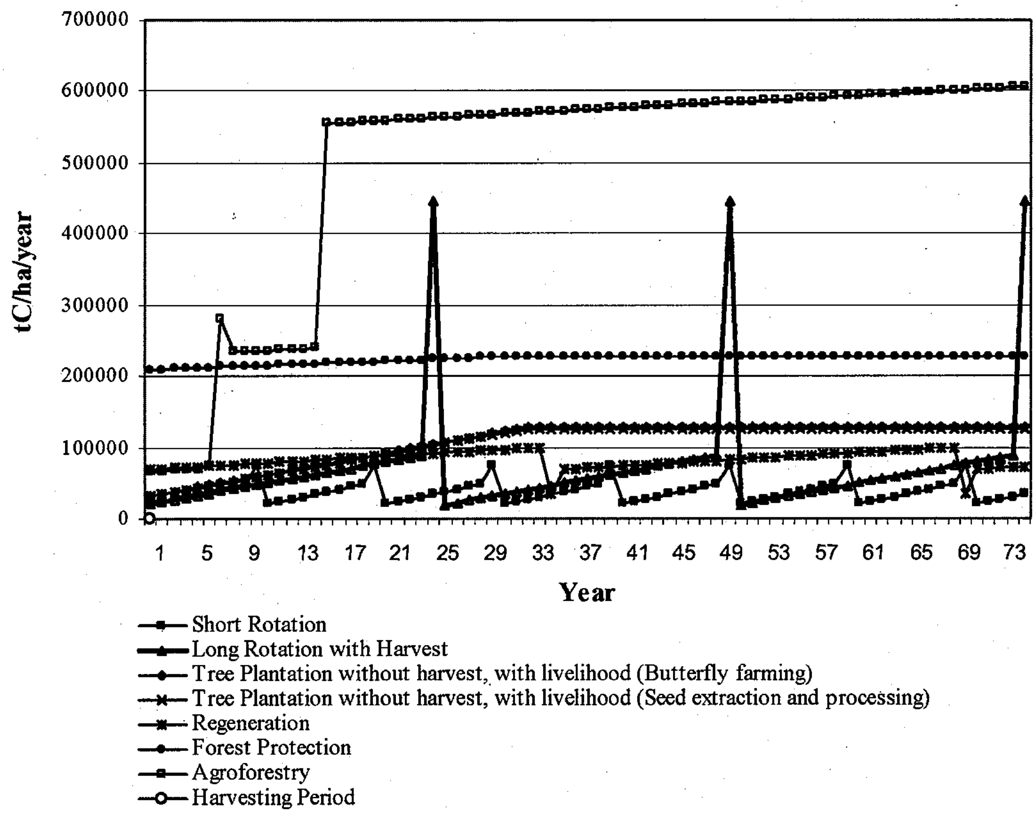

Figure 1 Benefits derived from the potential forestry climate change mitigation options

9 Financial and Economic Feasibilities of the Potential Climate Change Mitigation Options

The financial feasibility of the various options had been estimated adopting two profitability indicators – the Net Present Value (NPV) and Benefit Cost Ratio (BCR). Using the National Economic Development Authority (NEDA) official hurdle rate of 15 percent, these profitability indicators showed that forest protection had the highest NPV of P1,405,882 per ha followed by agroforestry at P1,045,858 per ha (Table 4). While forest protection has only carbon and water as its products, it was shown that the NPV is still relatively high. This is due to the high stocks of carbon and water in the given option. Multiplying these amounts with the market prices of the said resources resulted to a high NPV. It must be noted that the other products and services provided by this option such as biodiversity values, aesthetics, recreational and erosion control functions have not been considered in the valuation of benefits.

Table 4 Financial Net Present Value and Benefit Cost Ratio of Each Potential Forestry Mitigation Option

Mitigation Option	Profitability Indicators	
	Net Present Value (P/ha)	Benefit Cost Ratio (%)
Short Rotation	183,779	5
Long Rotation with Harvest	227,665	7
Tree Plantation without harvest, with livelihood (Butterfly Farming)	267,558	4
Tree Plantation without harvest, with livelihood (Seed extraction and processing)	258,671	4
Regeneration	207,152	6
Forest Protection	1,405,882	106
Agroforestry	1,045,858	7

While the NPV derived for agroforestry was lower than the NPV of forest protection by hundreds of thousands of pesos, the value of the marketed and readily consumable benefits from agroforestry in terms of agriculture and forest – based products are considerable compared to forest protection, which for this study, has only carbon and water. However, if carbon credits are aimed for in the future together with the conservation/preservation of the other non-marketed benefits and services, then protection forest is the best option in terms of its high NPV and BCR. Plantation forests with no harvesting are also good candidates for carbon sequestration projects since results have shown that this option has the capacity to store high amounts of carbon not to mention the high NPV estimates. The BCRs for all options indicated financial feasibility.

The value of the mitigation options to society as a whole may be determined through its economic feasibility, which takes into consideration the scarcity value of the resources according to society's perspective. With this, shadow pricing was done particularly for labor and for the foreign (dollar) exchange rate. Compared to the financial NPV and BCR as shown in Table 4, the economic NPV and BCR of the potential mitigation options were higher (Table 5). With shadow pricing, adjustments were made to bring about changes in the cost and benefit streams of the financial analysis. The cost side has decreased due to the adoption of a 0.6 shadow rate for labor while the benefits side has increased due to the adjustments in the dollar exchange rate used in pricing carbon. Furthermore, the forest charges, which were previously part of the cost stream in the financial analysis, were transferred to the benefit stream in the economic analysis since these are considered as revenues used in the implementation of government projects for society's welfare.

Table 5 Economic Net Present Value and Benefit Cost Ratio of Each Mitigation Option

Mitigation Option	Profitability Indicators	
	Net Present Value (P/ha)	Benefit Cost Ratio (%)
Short Rotation	1,961,357	9
Long Rotation with Harvest	4,804,446	23
Tree Plantation without harvest, with livelihood (Butterfly Farming)	5,802,865	22

Tree Plantation without harvest, with livelihood (Seed extraction and processing)	5,732,754	22
Regeneration	4,382,554	17
Forest Protection	13,151,228	156
Agroforestry	23,473,653	16

10 Carbon Contributions to the Present Value of Benefits of the Potential Climate Change Mitigation Option

Table 6 shows that forest protection has a potential to contribute 97 percent in carbon value to the total present value of benefits over a 75-year period. A considerable carbon contribution of 75 percent can also be observed for tree plantations without harvest. Regeneration as an option likewise contributes to the present value of benefits, 44 percent in terms of carbon. The other options such as short and long rotation plantations and agroforestry, although financially feasible, account for only 8.7, 3.2 and 7.2 percent carbon contributions, respectively. These findings imply that although the total benefits derived from these options are high, the carbon contribution may not be high enough to merit their prioritization as climate change mitigation options in the forestry sector but rather as projects for timber and food production.

Table 6 Percent Carbon Contribution to the Present Value Benefits of Potential Mitigation Options

Mitigation Option	Percent Contribution to Present Value of Benefits
Short Rotation	8.7
Long Rotation with Harvest	3.2
Tree Plantation without harvest, with livelihood (Butterfly Farming)	75.0
Tree Plantation without harvest, with livelihood (Seed extraction and processing)	75.0
Regeneration	44.0
Forest Protection	97.0
Agroforestry	7.2

11 Ranking of Potential Mitigation Options

Among the potential forestry mitigation options, forest protection ranks first in its capacity to sequester/store the highest amount of carbon over a 75-year period while tree plantations without harvest ranked second. The other options where harvesting was done ranked the lowest since carbon previously sequestered was emitted during harvest.

As far as the financial and economic feasibilities are concerned, forest protection still ranked the highest, which means that the benefits derived from this option far outweigh the costs incurred. Furthermore, agroforestry ranked second and short rotation the last. Although agroforestry exhibited high financial and economic Net Present Values, the amount of carbon contribution to the total benefits is minimal resulting to a rank of second to the last. This implies that the high NPV for agroforestry is attributable not to its carbon sequestration potentials but rather to the revenues derived from the agricultural crops produced in the said option.

12 Conclusions, Recommendations and Policy Implications

The huge amount of carbon locked in the tree biomass, government policy of no harvest and non-implementation of other forms of activities in protected areas qualify forest protection as the best potential option for climate change mitigation in the forestry sector. Furthermore, it provides the highest NPV among the other options. However, forest protection areas are under the jurisdiction and maintenance of the government. This implies that only the government or other non-profit oriented organizations, which are for the conservation and protection of the environment, can pursue this strategy. In addition, limitation in land area is seen as a constraint for its expanded implementation. Furthermore, additional protection costs on the part of the government are expected. At present, while the costs incurred to pursue forest protection is low, it is inevitable that higher expenses for protection and maintenance will be spent to ensure the security of keeping the carbon intact in these projects sites.

Strengthening the capability of the Protected Areas Management Board (PAMB) to manage and protect the areas under its jurisdiction must likewise be addressed. Appropriate selection criteria must be developed in choosing the people who will constitute the PAMB. Sufficient funds through policy directives must also be generated for the efficient and effective management by PAMB of the environmental resources.

In the pursuit of the forestry mitigation options, it must be considered that the country, due to tight financial conditions must implement projects with maximum benefits and minimal costs. Nevertheless, the primary objectives and desired outputs must also be taken into consideration. While carbon sequestration of forest protection areas is high together with its NPV, the other needs of the country such as wood for construction materials and paper production, food and fuel must also be appropriately considered. Even the provision of employment or livelihood alternatives to the communities must be appropriately thought of.

Since one of the strategies adopted by the government is the community-based forest management where the upland dwellers are tapped to become partners for the sustainable management of forest resources, this approach may also be harnessed in the mitigation of climate change. Existing tenurial agreements with individuals, communities and corporations may be revised to include additional responsibilities of all parties. Even incentive and sanction mechanisms must be provided in this partnership for climate change mitigation.

Incentives may come in the form of monetary benefits at the end of an agreed period when no harvests or poaching have been done. Sanctions or punishments may be in the form of cancellation of privileges such as access to resources and to some extent he cancellation of the tenurial agreement.

Constraints on the availability of resources such as funds, manpower, raw materials, etc. are always encountered in project implementation. The study has provided estimates on the costs and benefits of the potential climate change mitigation options in the forestry sector. These alternatives can then be prioritized by considering the individual's and society's points of view.

It must always be considered that any resource not priced properly tends to be used wastefully. Thus, the importance of attaching an appropriate value specifically to our natural resources must be fully emphasized for the benefit not only of today's but tomorrow's generation as well.

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Land Use & Land Allocation Decision in Philippine Forestlands: Application of Total Economic Valuation & Benefits Transfer

Herminia A. Francisco

1 Introduction[1]

A critical component of any management scheme in the forestlands has to do with land tenure security or use-rights recognition. This emphasis recognizes that there exists a positive relationship between land tenure and natural resource management. Specifically, it posits that resource users will most likely invest in managing the resources if they are convinced that they will be able to reap the benefits from such an investment. This is because the lack of well-defined user rights is recognized as an important constraint to adoption of conservation practices and technologies that can alleviate poverty and reduce environmental degradation. It is also a known fact that many natural resource management practices require long-term investments. Hence, farmers or communities will only make these investments if they are assured to reap the benefits of their investment.

In contrast to privatization wherein complete control is transferred to the party to whom the property right is bestowed, however, the government can only assign user rights over the resource to certain interest groups; with the State still retaining ownership over them. The interest groups could either be the local government units (LGU) under whose jurisdiction the natural resource belongs, the non-government organizations (NGOs), who have taken upon themselves to champion the protection and management of the natural resources in behalf of society, the Indigenous Community (IC), whose special rights over many of these natural resources is recognized and protected by law under the Indigenous People's Right Act (IPRA), the community themselves, who are directly benefiting from the natural resources and in like manner, who stand to lose with their depletion, or the private sector, who have their own business interest to protect, within the limits set by law on the manner of natural resource use.

The assignment of user rights over a specified enclosed natural resource area such as a forest is thus viewed as one strategy to encourage investment in natural resource conservation. This strategy is attractive because the State still retains 'ownership' over said resources. Ultimately, society benefits from such a strategy as it is expected to result in the rehabilitation of degraded

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forestlands and the sustainable utilization of the forest resources derived there from.

Furthermore, there is also a renewed clamor now to increased public (local communities and the local government units) sector participation in natural resources management decisions, in addition to the legal recognition of their land and resource rights. There are many natural resource management practices where groups of farmers working together are needed. The absence of ineffective collective action at the local level is thus one other constraint to adoption of some necessary natural resource management practices. Increased public participation in policy decisions and development plans is expected to broaden the local support base for any efforts to manage the country's forest resources.

User right security and public participation are key pillars to the USAID-DENR EcoGovernance project. One of the key questions that this project hopes to address is: how much benefit does society realizes from forestlands under various types of resource allocation instruments (property rights)? This study was conducted to provide answer to this question as guide to resource managers in their land allocation decisions. In addition, it is of interest to find out the total economic value of a given forest area and how such value is broken down into use values and non-use values. Full cost accounting requires that total economic value of proposed activities be considered in decisions involving use of the country's limited resources.

2 Objectives of the Study

This paper was written to look at the economics of selected Philippine forestry projects under alternative user right arrangements. A sample of forestry projects under the following allocation instruments were analyzed: 7 projects under Community-based Forest Management Agreement (CBFMA), 3 projects under Industrial Forest Management Agreement (IFMA), 2 sites with certificate of ancestral domain claim (CADC); and, 2 projects under the Co-management arrangement between DENR, LGU, and Community' and 1 site under Protected Area (PA) status. Together, the 15 forestry projects were analyzed in terms of their economic viability, using total economic valuation principle.

Specifically, the tasks undertaken in this study are as follows:

- Compilation and recalculation of economic analyses results of 15 forestry projects, under different allocation instruments (using 2002 prices);
- Literature search on indirect use and non-use values of forest resources and services to be used for "benefits transfer" to Philippine conditions; and
- Calculation of the total economic value of forest resources in all study sites to capture both the use and non-use values of the forests.

3 Analytical Framework

3.1 Total Economic Value and Property Rights

The principle of total economic valuation recognizes that a given natural resource, say a forest or a coastal ecosystem has economic values that go beyond use values (Fig 1). Use values could either be direct or indirect. The former entails actual interaction with the resource, mostly in terms of consumptive goods and services like for food, wood, fodder, industrial products, genetic resources, medicinal plants, and recreation among others. Indirect uses pertain mostly to ecological services provided by natural resource ecosystems such as watershed protection, flood control, erosion control, windbreak, carbon sequestration, and as gene pool. These are life-support services of nature that are often recognized only when the flow of these services become impaired. Because these services partake the characteristic of public goods (i.e. non-rivalry and non-excludability), pricing them remains a major challenge. Over the last decade, the efforts to quantify and monetize said environmental services are on the rise.

In addition to these use values, natural resources are important for reasons not necessarily connected with use of the resource or the commodities derived there from. These reasons would include concern for one-self (wanting to keep the resource protected to keep one's ***option to use*** the resource open in the future); concern for family members yet to come (wanting to ***bequest*** future generation with the chance to avail of the services offered by the natural resource); and concern for humanity as a whole (wanting to protect the natural resource so that humanity will benefit from its ***existence*** now and in the future). Option value, bequest value and existence value are the so-called ***non-use values*** of most natural ecosystems. Several studies have already been conducted to assess how much people are actually willing to pay for these non-use values, using contingent valuation methodology or choice modeling studies. Still, more studies on this topic are needed, particularly in natural resource-endowed developing countries, like the Philippines.

As depicted in figure 1, the different types of economic values vary in prominence under the various land use rights. Direct use values for instance are the main (if not, the sole) focus in the case of the IFMA and SIFMA. To CBFMA holders, direct use values take central focus as well but concern for indirect uses of the resource, such as watershed function, erosion control, and biodiversity are likewise recognized and appropriately considered in the land use plan. To CADC holders, direct and indirect uses are also important. To this group, however, non-use values, particularly, bequest value to members of their tribe is quite important, along with the religious/spiritual values of the resource. In the case of critical watersheds and other protected areas---which are often subjected to co-management by LGU, DENR and the PO, the indirect uses and non-use values could take more prominence than direct use values. A complete economic analysis (taken from society's perspective) takes these non-use economic values as equally important. Admittedly, however, what matters most to local people are the direct use values and to some extent, the indirect use values. This paper attempted to present how the economic analysis results of forestry projects will change if the total economic valuation principle is adopted.

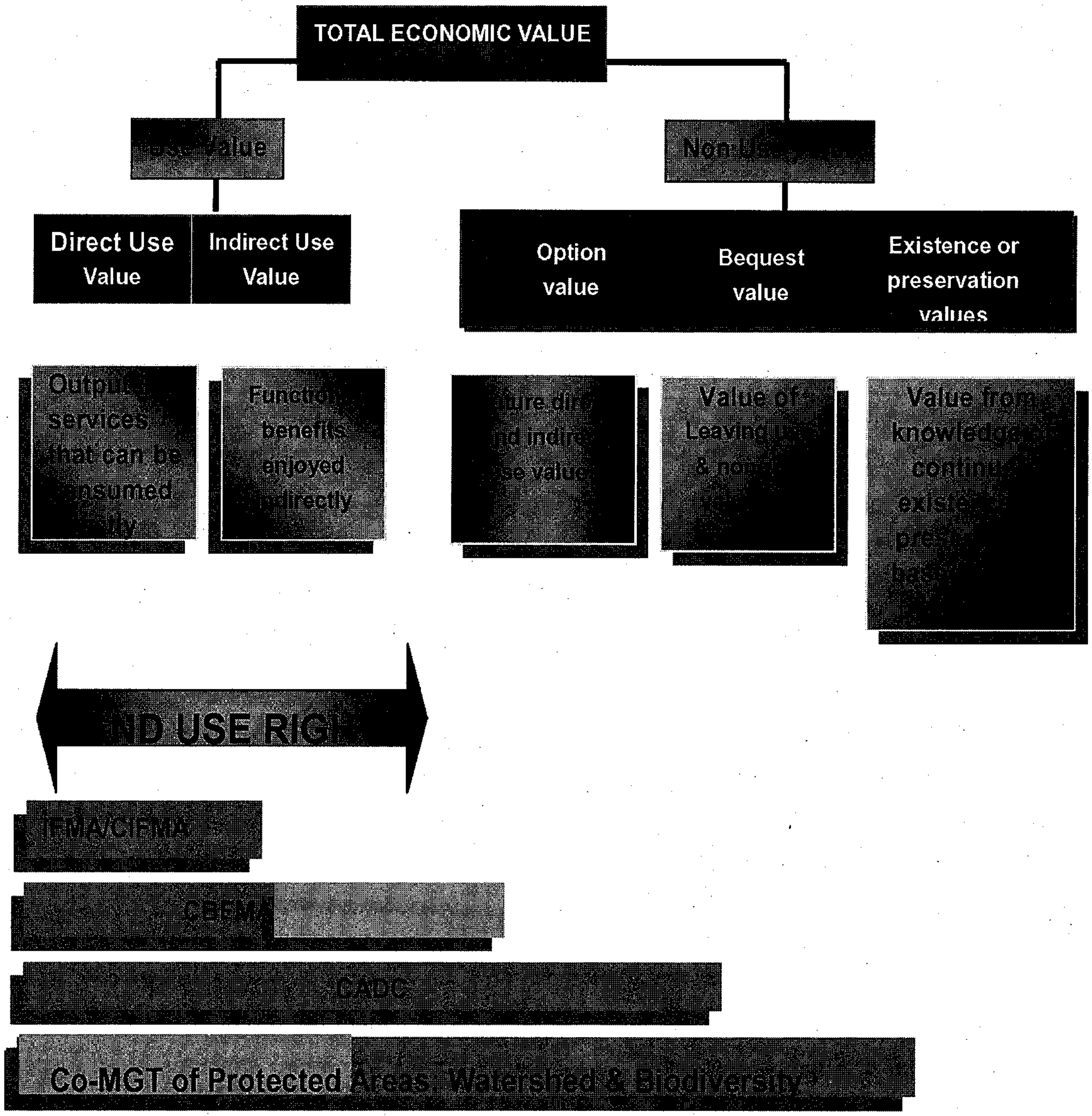

Figure 1 Total Economic Value and Land Use Rights

3.2 Economic Analysis Analytics

The basic analytical tool to use in analyzing the economics of alternative land uses and those of alternative allocation instruments is that of Benefit Cost Analysis (BCA). This tool computes the present value of stream of benefits and costs of a project and then compares them to arrive at the Net Present Value (NPV). The NPV is the difference between the present (discounted) value of benefits and the present (discounted) value of costs. A positive NPV indicates that the project is beneficial since gains exceed the costs. The calculation uses a discount factor to bring the stream of benefits and costs to their value at the present. Discounting recognizes that there is 'time value of money'; as such, it would be incorrect to simply add benefits and costs occurring at different years. One needs to make these figures comparable and this is done through discounting. Once discounted, the numbers could now be compared.

$$NPV = \sum_{t=0}^{n} \frac{B_t}{(1+r)^t} - \sum_{t=0}^{n} \frac{C_t}{(1+r)^t}$$

Where: B_t = benefit at time t

C_t = cost at time t

NPV= net present value

n = life span of the project

$1/(1+r)^t$= discount factor

Economic analysis could be undertaken at different levels as shown in Figure 2. Level 1 analysis pertains to benefit cost analysis of the various land uses under a given land allocation/user rights scheme. The computational analysis will yield an answer to the economic question: *What is the economic return of allocating XX hectares to the various land uses, so indicated in the resource management plan?* This question boils down to ascertaining the profitability of a given land area to be subjected to varying land uses. It is needed to assess the efficiency in the use of the resources employed in the production activities. Level 2 analysis asks: *What is the economic return from a given land area that is allocated to various user rights' groups?* This is the question posed by resource managers, faced with the task of allocating a given land to various user groups, employing different allocation instruments. Level 3 is simply an extension of Level 2 analysis. It asks: *If the current allocation of land to the various user groups could be feasibly (legally) changed, what will be the economic returns in the alternative allocation arrangements?*

These various levels of analysis are guides to resource managers in deciding what is the economically best use of the limited forestlands under consideration. Note, however, that not everything can be decided on economic basis alone. Equally important concerns are the social acceptability of a given allocation decision, as well as the legality of such a decision. These other concerns though are something that resource managers should incorporate in the decision-making analysis—most probably in the context of multi-criteria analysis (MCA). Specifically, MCA treats economics as just one of the objectives that are important to the different interest groups who have a stake on how resources are allocated. Other concerns such as social concerns, environmental impacts, distributional/equity effects, and others do come into the decision framework as well. Oftentimes, though, the importance of each of these objectives would vary depending on who the stakeholders are. Hence, some kind of consensus building process and ranking of objectives may be needed to decide on the most acceptable allocation decision.

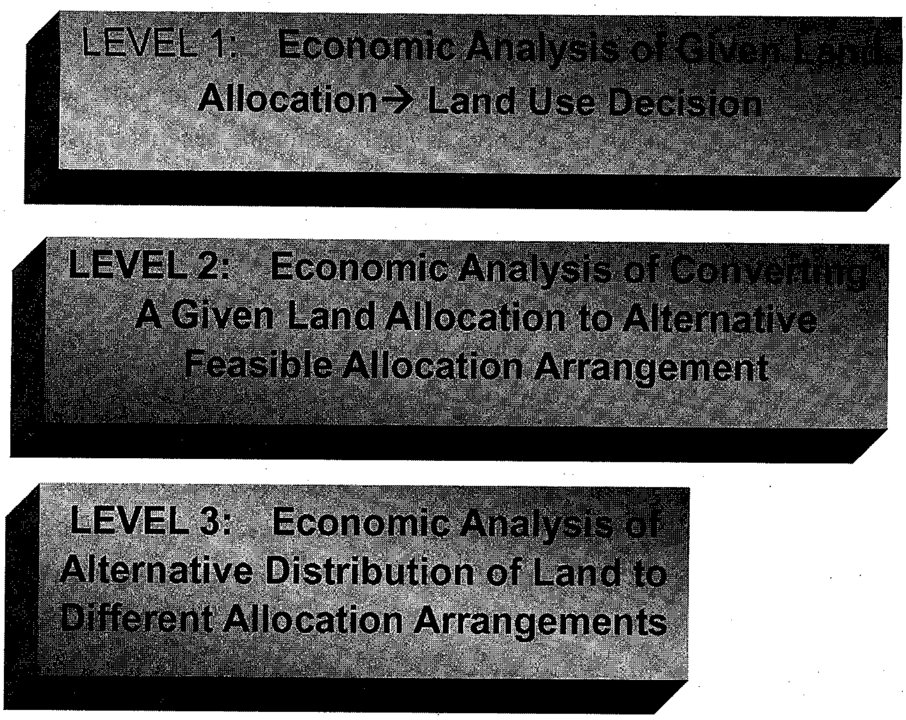

Figure 2 Level of Analysis: Land Allocation Decisions

3.3 Benefits Transfer and Economic Analysis

The total economic valuation principle discussed in section 3.1 calls for the inclusion of relevant economic values, beyond direct use values, in economic analysis, Specifically, a more comprehensive BCA should incorporates the indirect use values or functions of the forest ecosystem, as well as other non-use values. The indirect use functions mostly refer to ecological services such as watershed function, biodiversity value, and carbon sequestration. The non-use values, as explained earlier, include option, bequest, and existence values. For IFMA and SIFMA areas, where the dominant uses are indeed use values, the limited focus of past economic analysis may have been justified, but still incomplete. For other user groups, however, where a significant proportion of the land areas are set aside for protection purposes—to preserve indirect use values and those of non-use values, the non-inclusion of these values in economic analysis would seriously underestimate the net benefits (social welfare impacts) of the land allocation option being analyzed.

The decision not to incorporate the non-traditional economic values in economic analysis, as mentioned, was largely due to the absence of such information. Most of these values are neither tangible nor observed in the markets. Nor are these values readily observable in terms of behavior of beneficiaries; hence, their measurement is not indeed easy. Furthermore, methodological progress in the measurement and monetization of said values have only developed in the last decade. As such, the inclusions of said values in economic analysis have been limited to their being listed under the general category of 'non-quantifiable benefits'.

As was also indicated earlier, however, some progresses have been made in the last decade to generate information on indirect use and non-use values of forest and coastal ecosystems. Research studies on tropical forest ecosystems, however, were limited in few countries as shown in Table 1. These few studies, nonetheless, could serve as our basis for the benefits transfer (BT) procedure mentioned earlier.

Specifically, BT entails adopting the environmental values generated in a foreign country, after certain adjustments, to the study sites. These adjustments may entail the use of local socio-economic and biophysical information, where values transferred are in the form of functional relationships (e.g. willingness to pay function, dose-response function, travel cost function, production function, etc). Where unit values (e.g., value per hectare of forestland) are used, adjustments often include: foreign exchange adjustment, adjustment for purchasing power parity to reflect differences in economic position of the two countries, and price adjustments (using consumer price index) to account the differences in prices over time as shown in Appendix A.

Tables 1a to 1c shows the unit values of indirect use and non-use values of tropical forest ecosystem in some parts of the world. The literature search did not yield much information. Nonetheless, one could start with these numbers. Following the procedures given in Appendix A, the values generated from the literature search were subjected to adjustments for income differences across countries (using ratio of Gross Domestic Products), price variations over time (using consumer price index as deflator) and for domestic exchange rate (using USD1=P53). The values obtained from the literature are mostly in terms of per hectare per year. Since most of the forestry projects analyzed in the paper have a life span of 25 years and used discount rates of 12% and 15% to arrive at the Net Present Value (NPV), the per hectare values were converted to NPV also with the same life span and discount rates. The results of the three adjustments and the NPV calculations are shown in the last two columns—as adjusted BT figures to Philippine condition using 2002 prices on per year and discounted over 25 years, respectively.

Table 1a Indirect Use Values based on Literature Search & BT values to Philippine Condition.

Uses	Country	Amount (USD)	BT Values (P-2002 prices)	BT Values (NPV/ha for 25 years) 12%	15%
Indirect Uses					
Watershed protection					
▪ protection to onshore and offshore fisheries (Ruiteenbeek 1989)	Korup & Cameroon Park	54/ha/yr with benefits to accrue in 2010 &beyond	P13,901/ha/yr	P109,02 7	P89,858
▪ flood control (Ruiteenbeek 1989)	Korup & Cameroon Park	2.3/ha/yr	P592/ha/ yr	P4,643	P3,827
▪ Soil fertility maintenance (Ruiteenbeek 1989)	Korup & Cameroon Park	8/ha/yr	P2,059/ha/yr	P16,149	P13,310
watershed protection over 90 years at 6% discount rate (NPV and 90 years) (Bann 1997)	Tapean Forest, Cambodia	USD75.59/ ha	P20,359/ha @6%	P9,631	P7,938
▪ Watershed protection for hydroelectricity generation (average net benefit of forest protection) (Jesdapipat & Kiratikarnkul 1998)	Thailand	THB 66.62 per year per rai	P53.4/rai/yr or P333.75/ha/yr	P2,618	P2,157
Biodiversity Value					
Medicinal Plants ((Ruiteenbeek 1989)	Cameroon	0.2-0.70 /ha/yr	P51.5-180.2/ha/yr	P404-1, 413	P333-1, 165
Biodiversity (NPV @6% & 90 years) (Bann 1997)	Tapean Forest, Cambodia	USD511/ha	P137,270/ha at 6%	P68,470	P56,431
Value of carbon sequestration (Lasco 1997)					
▪ protection forest (PhP)	Phil	398-1,590/ha/yr	P545-2,178/ha/yr	P4,275-17,082	P3,523-14,079
▪ tree plantations (PhP)	Phil	1,140-4,558/ha/yr	P1562-6,244/ha/yr	P12,25 1-48,97 3	P10,097 -40,362
▪ agroforestry farms (PhP)	Phil	610-2,438/ha/yr	P836-3,340/ha/yr	P6,557-12,196	P5,404-21,590
Carbon storage (NPV @6% discount rate over 90 years) (Bann 1997)	Tapean Forest, Cambodia	USD6.86/ha	P1,843/ha@6%	P872	P719
Direct Use Values (often not included as well)					
Tourism and recreation (Ruiteenbeek 1989)	Korup National Part, Cameroon	19/ha	P489/ha	P3,835	P3,161
Recreational Benefits (Rosales 2000)	Sohoton, Samar Island, Phil	PhP2,041/ha in NPV	P2,243/ha	P17,59 2	P14,499

Table 1b Non-use Values for Tropical Forest Ecosystem, selected Countries and Year & BT values to Philippine Condition.

Non-use Values	Country	USD	BT Values (2002 prices)	BT Values (NPV over 25 years)	
				12%	15%
Existence value (Rosales & Francisco 2000)	Samar Island, Philippines	P8000/ha in NPV	P8,791/ha	P8791	P7245

Table 1c Estimates of Non-timber Forest Products, Selected Countries and Year & BT values to Philippine condition.

Non-timber Products	Country	Amount (USD)	BT Values	BT Values NPV for 25 years	
				12%	15%
-nuts and rubber (Schwartzman, 1989)	Brazil	5/ha/year	PhP189/ha/yr	P1,482	P1,222
-latex and fruit (Pinedo-Vasquez et al 1992)	Peru	20/ha/year	PhP968/ha/yr	P7,592	P6,257
-medicinal plants (Balick and Mendelsohn 1992)	Belize	36 – 162/ha/year	PhP1659-7,466/ha/yr	P13,012-58,557	P10,724-48,261
-rattan and bamboo (Kumari 1994)	Malaysia Kalimantan	48/ha/year	PhP1,131/ha/yr	P8,871	P7,311
-fruit and medicine (Grimes et al 1993)	Ecuador	63-147/3-ha primary forest	PhP4,583-10,694/3-ha primary forest	P35,945-83,874	P29,625-69,128
Wildlife in one km2 (Kumari 1994)	Malaysia	8	PhP188/km2	P147.45	P121.53
Non-timber forest products (aggregate)NPV—over 90 years (Bann 1997)	Tapean Forest, Cambodia	USD748/ha @6% discount rate	PhP200,935/ha@6%,	P95,059	P78,346

These BT values could be used in adjusting economic analysis results that consider only direct use values. Note that one could decide which of the values to use, based on the perceived close resemblance of the site to the country. For this paper, the values generated in the Philippines are the first choice, followed by those derived in other Southeast Asian countries. In particular, the specific BT values that were used in the paper are as given in Table 2.

Table 2 Benefits Transfer Values used in Economic Analysis Re-estimation for Selected Forestry Projects in the Philippines, 2002.

Economic Value	Source (country)	NPV (12%)	NPV (15%)
Watershed Protection	Bann (1997)-Cambodia	P9,631	P7,939
Biodiversity Value	Bann (1997)-Cambodia	P68,470	P56,431
Carbon Sequestration:			
▪ forest Protection	Lasco (1997)-Philippines	P10,679	P8,801
▪ tree plantation		P30,612	P25,230
▪ agroforestry		P9,377	P13,497
Existence Value	Rosales & Francisco (2000)	P8,791	P7,245
Recreational Benefits	Rosales (2000)	P17,592	P14,499
Wildlife	Kumari (1994)-Malaysia	P147	P122
Rattan and bamboo	Kumari (1994)-Malaysia	P8,871	P7,311

4 Economic Analysis Results

This section discusses the results of the three-level economic analyses depicted in Figure 2. It also presents results of efforts to incorporate indirect use values and non-use values in economic analysis of the various allocation rights—a principle referred to as total economic valuation—in this report.

4.1 Economic Analysis of Selected Forestry Projects (Focus on Use Value only)

Level 1 analysis was based on data generated from selected forestry projects in the Philippines, representing the various allocation right instruments. As indicated earlier, most economic analysis of forestry projects in the country have focused only on the USE value of the forest resources. Given our total economic valuation framework, this use-value focus, is thus considered a partial analysis since INDIRECT and NON-USE VALUES are not considered in the calculations. It should be noted that not all the forestry projects visited have economic analysis reports. Where these are available, adjustments for price differences using consumer price index to express them in 2002 prices were carried out. Where no economic analysis results were found, NPVs were estimated anew based on proposed land uses with DENR costing as the basis (Table 3). The details in terms of area allocation to the various land uses for each site arecontained in the developmental plan for each project site. The NPV given are before tax and before payments of government share. The paper made no assumption on these values as these would depend on the final negotiations among the various parties involved in resource management and hence could only be determined at a latter date.

Table 3 Net Present Value (NPV) of Selected Forestry Projects by Tenurial Arrangement: *(Direct Use Value Only)*

Tenurial Instrument	Net Present Value (2002 prices)		
	Discount Rate	***For Total Area***	***Per Hectare***
Community Based Forest Mgt (CBFM)			**58,556**
Sapang Bato Watershed, Clark	12%	181,401,254	84,216
Field Reservation 1997 (2,154 ha)	15%	110,609,183	51,351
Mananga-Kotkot-Lusaran	12%	177,377,411	31,184
Watershed, Cebu 1996 (5,688 ha)	15%	189,429,925	30,943
Logum Baobo Watershed,	12%	96,349,833	34,608
Campostela Valley 2003 (2,784)	15%	61,736,184	22,175
Saug Watershed, Davao	12%	53,875,456	13,716
Del Norte 1996 (3,928 ha)	15%	10,865,962	2,766
Ubay, Mabini & Alicia	12%	310,810,003	236,898
Watershed Subproject, Bohol,1997	15%	210,516,497	160,455
(1,312 ha)			
Itogon Watershed, Benguet, 1996	12%	356,493,469	84,517
(4,218 ha)	15%	222,390,408	52,724
CAMAR Multipurpose Cooperative	12%	58,287,884	58,288
(1,000 hectares)	15%	39,648,046	39,648
Industrial Forest Mgt Agreement (IFMA)			**59,229**
Luzon Mahogany Timber	12%	336,627,075	31,303
Industries, Isabela (10,754 ha)	15%	242,204,152	22,522
Toplite Lumber, Dipaculao Aurora	12%	185,166,188	30,247
(6,121.81 ha)	15%	132,600,947	21,660
Sirawai Plywood and	12%	1,318,915,036	92,868
Lumber Corp., Zamboanga	15%	815,187,325	57,399
Del Norte, 2001 (14,202 ha)			
Certificate of Ancestral Domain Claim (CADC)			**65,273**
Ilongot Livelihood Assn.*, 2002	12%	1,098,643	43,946
(25-ha utilization of natural forest)	15%	865,528	34,621
Lake Sebu	12%	2,391,827,233	65,288
	15%	1,547,581,430	42,243
CO-MANAGEMENT			**86,934**
Maasin Watershed, Iloilo, 1995	12%	183,116,908	68.200
(2,685 ha)	15%	110,951,930	41,322
Lower Magat Forest Reserve	12%	2,158,525,126	89,008
(24,251 ha)	15%	1,452,556,284	59,897
PROTECTED AREAS			**29,715**
Mt. Kanlaon Natural Park	12%	789,151,308	29,715
	15%	517,493,619	19,486

**activities based on annual workplan only Exchange rate: USD1: PhP50*

There are 15 forestry projects included in the analysis. Attempts were made to include more but the absence of economic analysis data in many project documents precludes increasing the number of sample cases.

As one can see, NPV of CBFM site on a per hectare basis varies substantially with values ranging from P13,716 in the Saug watershed in Davao del Norte to as high as P236,898 in Ubay, Mabini and Alicia Watershed in Bohol per hectare over a 25-year project duration, using a 12% discount rate. The high value in the latter was due to inclusion of large area of fruit plantation in this site. The mid point value to this big range is P125,307 while the weighted average NPV per hectare is only P58,556 per hectare for a 25 year rotation.

In the case of the IFMA site, the weighted average NPV per hectare was estimated at P59,229. For the three sample IFMA sites, the NPV per hectare ranges from P30,247 to P92,868/ha with the mid-point value of P61,558/ha. One would expect that IFMA sites would yield the highest direct use values in all forestry projects. It is of course possible that the higher cost of operation of these industrial firms may dampen profit. But it is also reasonable to assume that the IFMA applicants who prepared the economic analysis as part of their application had presented a very conservative results to minimize taxation payments and other forest charges. In the case of the CBFM sites, the economic analysis was prepared for the community, by DENR staff with assistance from local consultants.

For the two co-management sites, represented by Mainit Watershed and the Lower Magat Forest Reserve—the NPV per hectare averaged P86, 934 per hectare. In the case of the two CADC site, the weighted average NPV is P65, 273 per hectare. This relatively higher value was based on resource utilization permits from natural forests—which does not require much investment on the part of the farmers. For the Mt. Kanlaon protected area, the NPV was estimated at P29,715 per hectare. This low use value per hectare is not surprising since Mt. Kanlaon puts priority on indirect and non-use values like biodiversity conservation.

4.2 Total Economic Valuation in Selected Forestry Projects

Using the BT values that were estimated for the Philippine conditions (Tables 1 & 2), total economic valuation (TEV) was carried out for the selected forestry projects listed in Table 3. Specifically, the value of indirect uses (ecological function) such as watershed function, biodiversity value, and carbon sequestration value were estimated. Finally, the non-use value, represented mostly by existence value, was also calculated for the sample forestry projects. In the application of these values, watershed function values were assumed to be 30-100% of the BT value, depending on the land use (e.g. natural forest got a value of 100% while for plantation forest, a value of 30% was assigned). In the case of biodiversity value, the values range from 10% to 70% of the given BT value, with Mt. Kanlaon getting the highest value due to the nature of this project. The carbon sequestration values given in Lasco (1997) for the Philippines were taken as is. Non-use value on the other hand was applied only for natural forest. The results are shown in Table 4, with the total economic value in NPV terms, estimated for 25 years and using a discount rate of 12%. The more detailed estimation of TEV was shown in Appendix Table 1—if one is interested in the site-specific forestry project valuation.

In the CBFM project sites, the direct use value accounts for 65% of the total economic value (TEV), with proportion ranging from 30.67% in Saug watershed to 89.64% for the Ubay, Mabini, Alicia watershed. Of the indirect use values, carbon sequestration function is the biggest at 19% of TEV, followed by watershed function (7%), biodiversity value (6%) and the least is existence value of 3%. All together, the indirect use and non-use value for CBFM sites averaged P28, 552/ha in NPV terms. This value should be added to the mid-point value of P P125, 307/ha that is believed to be a more realistic value of returns from CBFM forestry projects with a 25-year project duration.

In the IFMA sites, the inclusion of indirect use and non-use values increased TEV by 44% from the weighted average NPV of 59,229/ha to P85, 392/ha. The use value accounts for 69% of TEV, watershed function is 4%, biodiversity value is 8%, and carbon sequestration is 18%. For the CADC site, the TEV was computed to be P95, 448 weighted average per hectare. Of this amount, direct use values still dominate at P65, 273 (68%). Most of these values were obtained from the natural forest through resource utilization permits

In the case of the Protected Area, the inclusion of the indirect use and non-use values increases the NPV per hectare from P29, 715 per hectare to P64, 842. For this particular land allocation instrument, the indirect and non-use values dominate at 54% of the TEV. This amounts to P35,127 per hectare. Of the indirect use values- biodiversity value takes the highest share of 36% of the TEV. Watershed function and carbon sequestration values account to 7-8% each. The high value appropriated by biodiversity is but expected since the area is protected for biodiversity conservation indeed. In the co-managed forestry projects, the TEV is the highest, with a weighted average of P104, 368/ha. Of this amount, the direct use value dominates at 83%.

In all forestry project sites, one could see the dominance of use values in TEV with indirect use and non-use values representing 17% to 54% of direct use value. This information provides an insight on the relative magnitude of the components of TEV.

Table 5 presents a summary of the weighted average TEV, direct use values and indirect and non-use values for the 15 forestry projects analyzed in the paper. The detailed accounts of the sources of these different value items are shown in Appendix Table 1. As one can see, the highest TEV is realizable from co-management scheme, followed by CADC and CBFM. The higher return from the CADC areas was due to the resource utilization activities in natural forests that enable the communities to realize more returns with low cost. The protected area has the least TEV of P64, 842/ha. The breakdown of the various components of the total economic value is best presented graphically (Figure 3). As shown in the graph, across all allocation instruments, the direct use value dominates. The share differs ranging from 46% in protected area to 83% in the Co-management arrangement. Is it interesting to note that the IFMA site obtained a direct use value share (69%) that is close to the shares obtained from CBFM and CADC sites. One normally would expect that the more business/commercial IFMA sites would have higher share for direct use values. However, the analysis shows that plantation forest can potentially sequester more carbon—albeit temporary in nature.

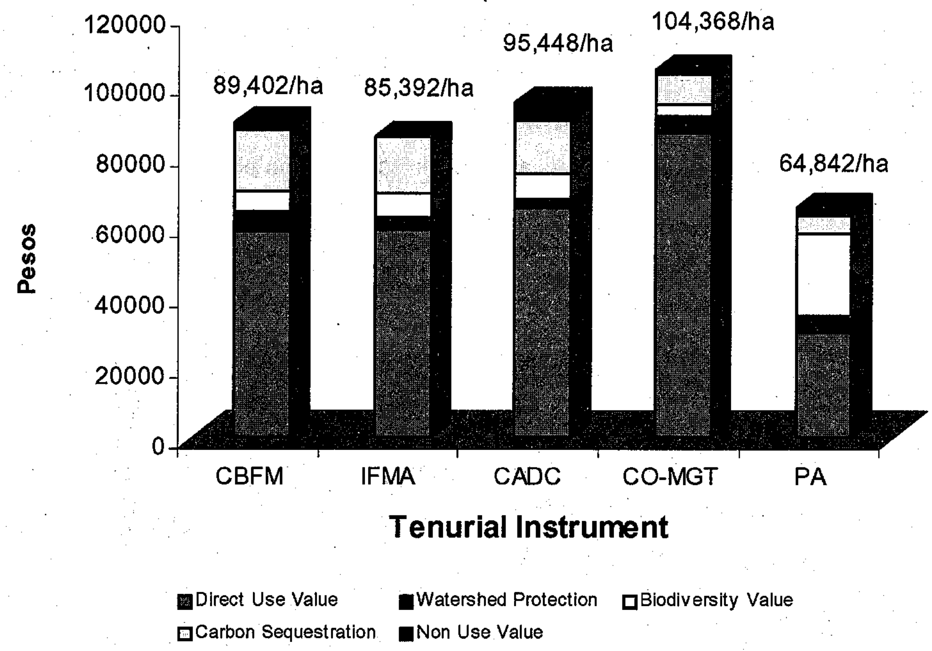

Figure 3 Breakdown of Total Economic Value to its Various Components

The more meaningful interpretation of the TEV components shown in Table 4 and Appendix Table 1, however, is not to look at them on a per hectare basis. Rather—one should view a forest area as having multiple uses, with some uses simultaneously produced (i.e. joint products) while others are competitive in nature. Timber and non-timber extraction for instance may compete with biodiversity conservation, particularly in protected areas. Hence, decisions are made upfront to exclude realization of use values for some portion of the forest designated as protection forests. A typical scenario therefore is to have a forest area, delineated into different zones, such as multiple use zone, protection zone, and others. These various allocation decisions do reflect the preference of the community and do affect the TEV of given forestry areas. Hence, as our analysis had shown, Protected areas will be dominated by Indirect and Non-use values when compared to other forestry projects. As such, while it is technically possible to devote the whole forest areas to use values, by allowing all-out extraction activities---there is a conscious decision being made to ensure that the other values could be realized through some conservation or protection initiatives.

Figure 4 reflects TEV for the forestry projects analyzed, evaluated in terms of share of the various TEV components to the aggregate TEV for the forestry projects. The results are not significantly different from the per hectare analysis since the per hectare values were derived from the aggregate values in the first place. The presentation is made nonetheless to make it clear that one does not necessarily assume that a hectare of forest land will have all the TEV components. Rather—it is the case that portions of the forestland will be devoted to use values and some parts to non-use values.

As shown in Figure 4, use value eats up the biggest share of TEV (65%-83%), except in the case of the protected areas wherein the use value is 46% of TEV. In the protected forestry area—biodiversity value accounted for 36% of TEV—this area being designated as such because of rich biodiversity resource. The carbon sequestration value of CBFM, IFMA and CADC sites are close to a fifth of TEV—and hence, is also substantial. Non-use value, specifically, existence value is quite low. This may be more of a reflection of the inadequate basis for benefits transfer since only study in the country was found on this aspect. These valuation needs t o be revisited as more data become available.

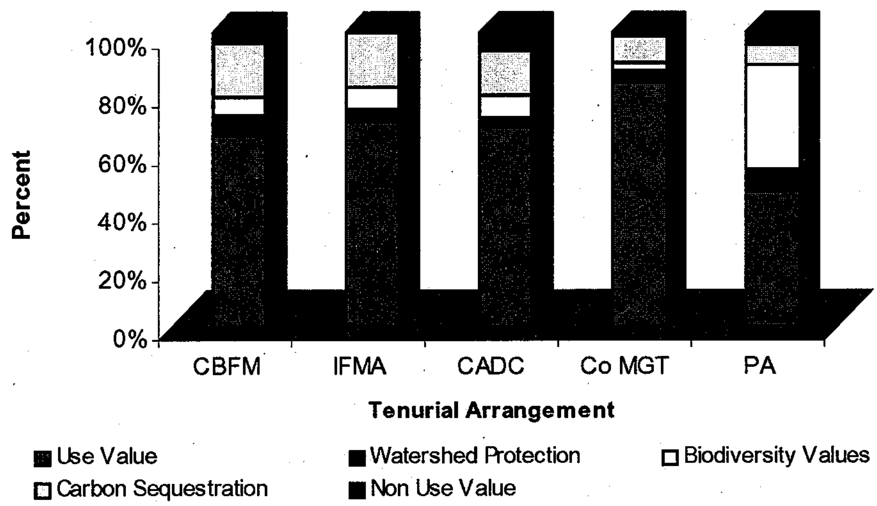

Figure 4 Percent distribution of TEV into its various components

Table 4 Adjusted NPVs (with incorporation of other economic values), Selected Forestry Projects, Philippines.

Project Area	Total Area (ha)	Direct Use Values	Indirect Use Values			Non-Use Values	Total Economic Value
			Watershed Protection Value	Biodiversity Value	Carbon Sequestration		
CBFM							
Mananga-Kotkot-Lusaran Watershed	5,688	177,377,411 **(44.18)**	64,500,733.20 (16.06)	60,739,737 (15.13)	58,247,551 (14.55)	40,461,600 (10.08)	401,507,032.20 P70, 588/ha
Saug Watershed	3,928	53,875,456 **(30.67)**	12,637,798.20 (7.19)	4,868,217 (2.77)	104,288,715 (59.37)	0	175,670,186.20 P44, 723/ha
Logum-Baobo Watershed	2,784	96,349,833 **(63.63)**	12,630,093.40 (8.34)	16,816,232 (11.10)	25,636,718 (16.93)	0	151,432,876.40 P54, 394/ha
Itogon Watershed	4,218	356,493,469 **(74.34)**	15,624,371.30 (3.26)	18,918,261 (3.94)	88,524,925 (18.46)	0	479,561,026.30 P113, 694/ha
Ubay-Mabini, Alicia Watershed	1,312	310,810,003 **(89.64)**	4,985,005.60 (1.44)	4,245,140 (1.22)	26,691,124 (7.70)	0	346,731,272.60 P264, 277/ha
Sapang-Bato Watershed	2,154	181,401,254 **(75.48)**	7,879,121.10 (3.28)	6,039,054 (2.51)	45,004,914 (18.73)	0	240,324,343.10 P111, 571/ha
CAMAR Multipurpose Coop	1,000	58,287,884 (64.96)	6,803,338.40 (7.58)	5,265,343 (5.87)	11,456,231 (12.77)	7,916,400 (8.82)	89,729,196.40 **P89,729.20**
AVERAGE (% share)	**3,012**	58,556 **65%**	**5,932 7%**	**5,544 6%**	**17,076 19%**	**2,295 3%**	89,402 100%
IFMA							
Luzon Mahogany Timber Industries	10,754	336,627,075 **(52.37)**	43,233,559 (6.73)	115,056,988 (17.90)	147,807,885.50 (23.00)	0	642,725,507.50 P59, 766/ha
Toplite Lumber	6,121.81	185,166,188 **(56.16)**	6,994,995.30 (2.20)	0	126,216,125.22 (39.64)	0	318,377,308.52 P52,007/ha
Sirawai Plywood Lumber Corp.	14202	1,318,915,036 **(77.92)**	58,498,694 (3.46)	101,773,808 (6.01)	213,509,179 (12.61)	0	1,692,696,717 P119, 187/ha
AVERAGE (% share)	**10,359**	**59,229** 69%	**3,499 4%**	**6,977 8%**	**15,688 18%**	**0**	85,392 100%

Table 4 (continued…)

Project Area	Total Area (ha)	Direct Use Values	Indirect Use Values			Non-Use Values	Total Economic Value
			Watershed Protection Value	Biodiversity Value	Carbon Sequestration		
CADC							
Ilongot Livelihood Association	25-ha utilization Natural Forest	1,098,643 (76.63)	28,893 (2.02)	0	306,120 (21.35)	0	1,433,656 P57, 346
Lake Sebu	36,635	2,391,827,233 (68.38)	102,425,685 (2.93)	273,229,535 (7.81)	534,327,165 (15.28)	195,881,920 (5.60)	3,497,728,173 **P95,475/ha**
AVERAGE (in % share)	**18,330**	**65,274 68%**	**2,795 3%**	**7,453 8%**	**14,584 15%**	**5,343 6%**	**95,448 100.00**
CO-MGT							
Maasin Watershed	2,685	183,116,908 (74.12)	12,903,614 (5.22)	7,969,908 (3.23)	43,057,428 (17.43)	0	247,047,858 P92, 010/ha
Lower Magat Forest Reserve	24,251	2,158,525,126 (84.18)	112,022,977 (4.37)	74,050,305 (2.89)	197,756,364 (7.71)	21,845,635 (0.85)	2,564,200,407 P105, 736/ha
AVERAGE (in % share)	**13,468**	**86,934 83%**	**4,638 4%**	**3,045 3%**	**8,940 9%**	**811 1%**	**104,368 100.00**
PROTECTED AREAS: Mt. Kanlaon	**26,558**	789,151,308 (46%)	132,925,959 (8%)	621,165,318 (36%)	114,159,950 (7%)	64,646,465 (4%)	1,722,048,999 P64, 842/ha 100%

Table 5 Summary of Economic Values per hectare for the 15 Forestry Projects by Tenurial Arrangements (weighted average).

Tenurial Arrangement	Total Economic Value	Direct Use Value		Indirect & Non-Use Value
		Mean	Mid-pt	
IFMA	85,392	59,229	61,558	26,163
CBFM	89,402	58,556	125,307	28,552
CO-MANAGEMENT	104,368	86,934	78,604	17,434
CADC	95,448	65,273	54,617	30,175
PROTECTED AREA	64,842	29,715	29,715	35,127

5 Summary and Conclusions

There are two main tasks carried out in this paper. One is to obtain the net present value (NPV) estimates for selected forestry projects under different allocation instruments. There were 15 forestry projects evaluated for the purpose, with 7 under CBFM, 3 under IFMA, 2 under Co-management, 2 under CADC and 1 Protected area. The limited number of samples was largely a result of the limited cases with economic analysis information. In some of these cases, the economic analysis was constructed based only on land use information and had to rely on cost estimates of DENR. Since the various economic analyses were undertaken at different time period, adjustments were made to bring them all to 2002 price levels.

The economic analysis undertaken in the various forestry projects analyzed have focused on the direct use values of the forest resources in the given forestlands. As pointed in the paper, in addition to direct use values (consisting largely of consumptive goods and services derived from the forest), the forest also provides indirect use values (mostly in terms of ecological services like watershed function, carbon sequestration and biodiversity value) and non-use values (option, bequest and existence) to society. Data constraints on these other values have led to the general practice of including only the direct use values in economic analysis.

The second task is an attempt to extend the economic analysis to incorporate other economic values in the forests—particularly, indirect use values and non-use values. For this purpose, the study relied on Benefits Transfer (BT) approach. This refers to the practice of using values generated in other study areas (mostly, other countries) to one's study site. The procedure requires three types of adjustments before one can use the transfer values: a) adjustment for differences in income, b) adjustment for differences in foreign currency, and c) adjustment for price differences. In addition, adjustments were made to reflect varying bio-physical conditions in the area.

The task of undertaking BT starts with an extensive literature search on the different studies that may have included valuation of environmental services. This process took time but the Internet search was rewarding. Once the values were obtained—the per unit values were subjected to the three adjustments mentioned earlier. Finally, the NPV per hectare for these environmental services were estimated, over the same life span as the forestry projects using the same discount rate. The study then estimated the total economic value (TEV) for the 15 forestry projects that were evaluated. The results showed that direct use value still dominates the TEV of forestlands, with values ranging from 46% for Protected areas to 83% in Co-management sites and the average, being 60%. Consistent with expectations, the indirect and non-use values are relatively bigger in terms of proportion in the Protected Area sites. These values need to be revisited once more studies become available that be 'borrowed' or applied to Philippine conditions.

Information on the indirect use value and non-use value can be useful in determining the benefits to society of forest protection efforts. They could also come handy in the future, when a mechanism for charging off-site beneficiaries to share in forest protection efforts—through environmental service payments—as a means to encourage further investment in resource conservation.

The study generates Net Present Value estimates per hectare of land under various land allocation instruments. Resource managers hope to use these numbers to come up with quick estimates on how much benefit the community will get (considering use value alone or use and non-use values together) from the forestlands under their control. Future efforts along this line should consider more project sites to come up with range of values per province or even on a per region basis. These more site-specific values will be most useful or suited for benefits transfer application.

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Annex Table 1 Detailed Total Economic Value Calculations, 15 Forestry Projects, 2002

Project Area	Area (ha)	Direct UseValues	Indirect Use Values: Watershed Protection	Indirect Use Values: Biodiversity Value	Indirect Use Values: Carbon Sequestration	Non Use Value Existence Value	Total Value
CBFM							
		44.18	16.06	15.13	14.55	10.08	100.00
Mananga-Kotkot-Lusaran Watershed	5688	177,377,411.00	64,500,733.20	60,739,737.00	58,427,551.00	40,461,600.00	401,507,032.20
Protection Forest:	3506						70,588.44
Strict protection	2300		54,781,128.00	47,244,300.00	24,561,700.00	40,461,600.00	
Riparian	1206						
Production Forest	607		1,753,805.10		18,581,484.00		
Agroforestry	1179		5,677,474.50	8,072,613.00	11,055,483.00		
Enrichment Planting	396		2,288,325.60	5,422,824.00	4,228,884.00		
		30.67	7.19	2.77	59.37	0.00	100.00
Saug Watershed Subproject	3928	53,875,456.00	12,637,798.20	4,868,217.00	$ 104,288,715.00	0.00	175,670,186.20
Reforestation	3189		9,213,977.70		97,621,668.00		44,722.55
Agroforestry	711		3,423,820.50	4,868,217.00	6,667,047.00		
Bamboo	28						
		63.63	8.34	11.10	16.93	0.00	100.00
Logum-Baobo Watershed	2784	96,349,833.00	12,630,093.40	16,816,232.00	25,636,718.00	0.00	151,432,876.40
Agroforestry	2456		11,826,868.00	16,816,232.00	23,029,912.00	0.00	54,393.99
Bamboo	50						
Falcata-Durian Plantation	278		803,225.40		2,606,806.00		
		74.34	3.26	3.94	18.46	0.00	100.00
Itogon Watershed	4218	356,493,469.00	15,624,371.30	18,918,261.00	88,524,925.00		479,561,026.30
Reforestation	2352		6,795,633.60		71,999,424.00		113,693.94
Agroforestry	439		2,114,004.50	3,005,833.00	4,116,503.00		
ANR (Enrichment Planting)	1162		6,714,733.20	15,912,428.00	12,408,998.00		
Streambank Rehabilitation	178		514,295.40				
Erosion Control	87		251,369.10				

Annex Table 1 (cont…)

Project Area	Area (ha)	Direct UseValues	Indirect Use Values			Non Use Value Existence Value	Total Value
			Watershed Protection	Biodiversity Value	Carbon Sequestration		
		89.64	1.44	1.22	7.70	0.00	100.00
Ubay, Mabini, Alicia Watershed subproject	1312	310,810,003.00	4,985,005.60	4,245,140.00	26,691,124.00	0.00	346,731,272.60
Reforestation	682		1,970,502.60		20,877,384.00		264,276.88
Agroforestry	620		2,985,610.00	4,245,140.00	5,813,740.00		
Riverbank Protection	10		28,893.00				
		75.48	3.28	2.51	18.73	0.00	100.00
Sapang Bato Watershed	2154	181,401,254.00	7,879,121.10	6,039,054.00	45,004,914.00	0.00	240,324,343.10
Reforestation	1200		3,467,160.00		36,734,400.00		111,571.19
Agroforestry	882		4,247,271.00	6,039,054.00	8,270,514.00		
Bamboo (buho)	15						
Greenbelt (Banana)	24		69,343.20				
Roadside Planting	33		95,346.90				
		64.96	7.58	5.87	12.77	8.82	100.00
CFP CAMAR Multipurpose Coop	1000	58,287,884.00	6,803,338.40	5,265,343.00	11,456,231.00	7,916,400.00	89,729,196.40
Plantation Forest	64		184,915.20		1,959,168.00		89,729.20
Natural Production Forest	312		1,502,436.00	4,272,528.00	3,331,848.00		
Agroforestry	145		698,247.50	992,815.00	1,359,665.00		
Brushland areas (ANR)	29		83,789.70				
Protection Forest:	450		4,333,950.00		4,805,550.00	7,916,400.00	
AVERAGE		**58,556**	**5,932**	**5,544**	**17,076**	**2,295**	**89,402**
(% share)		**65%**	**7%**	**6%**	**19%**	**3%**	**100%**

Annex Table 1 (cont…)

Project Area	Area (ha)	Direct Use Values	Indirect Use Values			Non Use Value Existence Value	Total Value
			Watershed Protection	Biodiversity Value	Carbon Sequestration		
IFMA		52.37	6.73	17.90	23.00	0.00	100.00
Luzon Mahogany Timber Industries, Inc.	10754	336,627,075.00	43,233,559.00	115,056,988.00	147,807,885.50	0.00	642,725,507.50
Plantation Development	2352		6,795,633.60		71,999,424.00		59,766.18
Timber production (ASLO)	5297		25,507,703.50	72,537,118.00	28,283,331.50		
Enrichment Planting	225		1,083,487.50	3,081,150.00	3,443,850.00		
Timber Stand Improvement	2880		16,642,368.00	39,438,720.00	44,081,280.00		
		58.16	2.20	0.00	39.64	0.00	100.00
Toplite Lumber	6121.81	185,166,188.00	6,994,995.30	0.00	126,216,125.22	0.00	318,377,308.52
Plantation Establishment	3700.81		10,692,750.33		113,289,195.72		52,007.05
Timber Production	2421		6,994,995.30		12,926,929.50		
		77.92	3.46	6.01	12.61	0.00	100.00
Sirawai Plywood and Lumber Corporation	14202	1,318,915,036.00	58,498,694.00	101,773,808.00	213,509,179.00	0.00	1,692,696,717.00
Timber Production (ASLO)	7432		35,788,796.00	101,773,808.00	39,683,164.00		119,187.21
Tree Plantation	5135		14,836,555.50		157,192,620.00		
Mix Fruit Plantation	635		3,057,842.50		5,954,395.00		
Rubber	1000		4,815,500.00		10,679,000.00		
AVERAGE		**59,229**	**3,499**	**6,977**	**15,688**	**0**	
(% share)		**69%**	**4%**	**8%**	**18%**	**0%**	**100%**
CADC		76.63	2.02		21.35		100.00
Ilongot	25	1,098,643.00	28,893.00		306,120.00		1,433,656.00
Plantation Establishment	10		28,893.00		306,120.00		57,346.24
Timber Utilization	15						

Annex Table 1 (cont...)

Project Area	Area (ha)	Direct UseValues	Indirect Use Values			Non Use Value Existence Value	Total Value
			Watershed Protection	Biodiversity Value	Carbon Sequestration		
		68.38	2.93	7.81	15.28	5.60	100.00
Lake Sebu	36635	2,391,827,233.00	102,425,685.00	273,229,535.00	534,327,165.00	195,881,920.00	3,497,728,173.00
Agriculture (rice & corn)	4000						95,475.04
Agroforestry	6000		28,893,000.00	41,082,000.00	56,262,000.00		
Natural forest Management	1,000		4,815,500.00	13,694,000.00	10,679,000.00	8,791,000.00	
Existing plantation	1000		2,889,300.00		10,679,000.00		
Reforestation	14,000		40,450,200.00		428,568,000.00		
Community forest reserves	2635		25,377,685.00	54,125,535.00	28,139,165.00	46,354,920.00	
Traditional hunting grounds	8000			164,328,000.00		140,736,000.00	
AVERAGE		**65,273**	**2,795**	**7,453**	**14,584**	**5,343**	**95,448**
(% share)		**68%**	**3%**	**8%**	**15%**	**6%**	**100%**
Co Managed		74.12	5.22	3.23	17.43	0.00	100.00
Maasin Watershed	2685	183,116,908.00	12,903,613.80	7,969,908.00	43,057,428.00	0.00	247,047,857.80
Reforestation	1050		5,056,275.00		32,142,600.00		92,010.38
Agroforestry	1164		7,847,338.80	7,969,908.00	10,914,828.00		
Bamboo Plantation	300						
Rattan	111						
Riverbank Protection	60		173,358.00				
		89,007.67					

Annex Table 1 (cont…)

Project Area	Area (ha)	Direct Use Values	Indirect Use Values			Non Use Value Existence Value	Total Value
			Watershed Protection	Biodiversity Value	Carbon Sequestration		
		84.18	4.37	2.89	7.71	0.85	100.00
Lower Magat Forest Reserve	24251	2,158,525,126.00	112,022,976.50	74,050,305.00	197,756,364.00	21,845,635.00	2,564,200,406.50
Protection Forest							105,735.86
Rehab of degraded areas	6235		30,024,642.50		33,291,782.50		
Managed Natural Forest	2,485		16,753,124.50	51,044,385.00	26,537,315.00	21,845,635.00	
Production Forest		2,138,822,086.00					
Plantation/orchard	7,273		35,023,131.50		111,320,538.00		
CBFM	4,983		23,995,636.50		26,606,728.50		
Silvi-pasture	2,155		6,226,441.50				
Nature-based Tourism	1,120	19,703,040.00		23,005,920.00			
AVERAGE		**86,934**	**4,638**	**3,045**	**8,940**	**811**	**104,368**
(% share)		**83%**	**4%**	**3%**	**9%**	**1%**	**100%**
Protected Area		789,151,307.71	132,925,959.25	621,165,317.60	114,159,950.21	64,646,464.61	1,722,048,999.38
Mt. Kanlaon	26557.6	758,921,742.67					64,842.04
Strict Protection Zone	7353.71	29,714.71	70,823,581.01	503,508,523.70	23,559,080.73	64,646,464.61	118.22
Restoration Zone	7168.51		20,711,975.94		21,944,242.81		
Multiple Use Zone	10317		24,840,780.83		50,306,153.44		
Recreational Zone	1718.37	30,229,565.04	16,549,621.47	117,656,793.90	18,350,473.23		

Annex A

Adjustments of Benefit Transfer Estimates *

To facilitate the unit transfer of benefit estimates, adjustments should be done to account for the differences in income, price level, preferences, culture, substitution, and social characteristics between the original and the project site. This is also undertaken to offset their influences. However, external factors such as climate, lifestyle, and resource base may also affect the results of the valuation exercise and could cause uncertainties. Thus, the adjustments can only make the transferred values more realistic. It is not possible to remove entirely the biases or errors associated with the benefits transfer analysis.

The original context underwent three stages of adjustments. The first one involves adjustments in GDP (PPP) for transnational transfer. This entails multiplying the original context values with the GDP (PPP) of the transfer/context country for the current year. The result is then divided with the GDP (PPP) of the original context/country for the current year. This is shown below:

$$A_i = \frac{X^0_{i,oc}\left(\mathrm{GDP}^t_{\mathrm{TC}}\right)}{\mathrm{GDP}^t_{\mathrm{OC}}},$$

Where $A_{1i}n$=i^{th} original context value after the first adjustment
$X^0_{i,OC}$= i^{th} initial original context value
GDP^t_{TC}= GDP (PPP) of the transfer/context country for the current year; and
GDP^t_{OC}= GDP (PPP) of the original/context country for the current year.

This approach is taken from the 1996 ADB Workbook for environmental valuation. It implies that people always spend the same proportion of their disposable income on environmental impacts. This assumption states that environmental services are neither a necessity nor a luxury good since poor and rich people tend to spend their disposable income on both of these goods, respectively.

The second approach is the price Index Adjustment for time factor. This is computed by multiplying the GDP (PPP) adjusted value by the ratio of the current price index of the transfer/context country using the study date as the base year. This is expressed in the following equation:

$$A_{2i} = A_i\left(\frac{\mathrm{CPI}^t_{TCp}}{\mathrm{CPI}^0_{TCp}}\right),$$

Where A_{21} = i^{th} original context value after second adjustment;
A_{1i}= i^{th} original context value after first adjustment;

* Taken from Saplaco (2000), "Valuasia: Benefits Transfer for Southeast Asia"

$CPI'_{TC,0}$= CPI of the transfer/context country for the current year, using the study date as base year, and

GDP'_{OC}= CPI of the transfer/context country for the initial year/study date, using the study date as base year.

This adjustment was used to remove the impact of time differences, which normally occurs between the primary study and the transfer exercise. Time differences affect development level, income levels, consumption preferences and environmental quality, although price indicator is the only measurable index. The adjustment was carried out with reference to the study/survey time rather than the time of publication due to the time lag of these activities.

The third adjustment done is on the standard currency, which necessitates multiplying the transferred values with the exchange rate of the transfer context to the original context at the current year. This adjustment is necessary to express the transferred values to the original context using the currency of the transfer context. This is shown below:

$$A_{3i} = A_{2i} e^{t}_{TC,OC} ,$$

Where A31= ith original context value after third adjustment

A_{21}= i^{th} original context value after second adjustment; and

$e^{t}_{TC,OC}$=currency ratio of the transfer context to the original context at the current year.

In summary, the original context underwent the following adjustments:

$$X^{t}_{i,TC} = X^{0}_{i,OC} \left(\frac{GDP^{t}_{TC}}{GDP^{t}_{OC}} \right) \left(\frac{CPI^{t}_{TC,0}}{CPI^{0}_{TC,0}} \right) e^{t}_{TC,OC} ,$$

Where Xt i,OC= ith transferred value;

$X^{0}_{i,OC}$= i^{th} original context value;

GDP^{t}_{TC}= GDP (PPP) of the transfer/context country for the current year; and

GDP^{t}_{OC}= GDP (PPP) of the original/context country for the current year.

$CPI^{tt}_{TC,0}$ = CPI of the transfer/context country for the current year, using the study date as base year, and

GDP^{t}_{OC}= CPI of the transfer/context country for the initial year/study date, using the study date as base year.

The above adjustments required the GDP (PPP), Price Index, and exchange rates across the Southeast Asian region and other countries of original potential contexts. The data were obtained from year-end issues of Asia week, Far Eastern Economic Review, Asian Development Bank Publication, and other sources.

Progress in the Environmental Accounting in the Republic of Korea with Special Reference to Forest Resources

Yeo-Chang Youn and DongKyun PARK

1 Current Status of Environmental Accounts

Gross National Product (GNP) has played a key role in economic development and provided a target and measure of success, as well as a framework for tracing monetary flows, which has been at the core of economic policymaking. However, since 1960s, GNP has been criticized as a target for the development, since while it grew many aspects of welfare stagnated or declined. So, much emphasis has been placed on the need for the integration of data on environmental and natural resources into economic accounting such as System of National Accounts (SNA). SNA, which is one of the most significant social inventions of the twentieth century, is the standard framework for measuring a country's macroeconomic performance and it has provided the most widely used indicators for the assessment of trends of economic growth and of the economic counterpart of social welfare. But, a number of economists and conservationists have argued that the United Nations SNA systematically understate the contribution of natural resources. The SNA includes stock accounts that identify assets and liabilities at particular points in time, and flow accounts that keep track of transactions during intervals of time.

Certain drawbacks of SNA have raised some doubts about their usefulness for the measurement of long-term environmentally sound and sustainable economic development, such as regarding environmental protection expenditures as increases in GNP that may instead be considered as social costs of the maintenance of environmental quality. In this context that environmental accounting has been proposed as a supplement or replacement for SNA. To respond this, the feasibility of physical and monetary accounting in the areas of natural resources and the environment was first explored in the workshops jointly organized by UNEP and the World Bank. Later, United Nations Statistical Office also developed a framework for integrated environmental economic accounting that included certain aspects of environmental accounting in the SNA.

Bank of Korea has publishes National Accounts based on the UN's SNA since 1957. Korea National Statistical Agency reports the National Wealth every 10 years since 1968 and forest growing stock is accounted there. Nowadays, we all agree that National Accounts include only the expenditure for environmental protection but not imputed costs such as depreciation and degradation of environmental assets. Ministry of Environment is developing SEEA for calculating "Green GDP" since mid 1990s. The Korea Environment Research Institute under MOE has been conducting a research project that started in 2001 for developing Korean SEEA. Elements included in SEEA are considered for accounting environmental assets. The lack of statistical information available for use limits the implementation of SEEA in Korea. The availability of environmental statistics ranges from only 27% to 36%.

The Ministry of Environment (MOE), in association with National Statistics Agency and Bank of Korea, is currently preparing full accounts that will include agriculture, mineral resources, forestry and water resources, and pollution (such as air, water, solid wastes). The initial impetus to begin compiling natural resource and environmental accounts came about as a result of decisions stemming from the MOE to produce Green GDP in 2010, where it was decided that more information was required on the complex relationship between the economy, environment and society.

2 Forest Resources Account

Forests provide valuable services apart from wood products. Among other things, forests are home for many wildlife animals and plant species. Moreover, they are also a place for recreation, provide scenic view and recreation sites, and they protect the soil and ground water as well as absorb carbon dioxide. Most of these services have not been marketed, so their real values are difficult to assess in monetary terms. It is important to examine forest values in a broad way so that national income accounts and related satellite accounts may be more clearly understood. However, in recent years, many studies provide true value of forest, which was recognized among the policy decision-makers and ordinary people.

Forest Resource Account (FRA) is a management tool that integrates forest information from many sources and makes it possible for decision-makers to evaluate and carry out forest policies and planning. In this study, physical and monetary FRA is to monitor stocks and flows of timber production, the amount of carbon absorption, and forest recreation use in physical and monetary terms. In order to make sure that multiple resources of forests are valued consistently and comparably some of the broad non-timber values are naturally excluded from FRA. There is a strong link between the forestry stock accounts and the flow accounts. The recoverable volumes harvested, as found in the physical stock account, are the basis for the flows. Having taken the amount harvested, the physical flow account then shows how the variety of different forestry products originating at logs, moves throughout the economy. The monetary flow account shows the dollar values associated with the physical flows. The monetary flow account has been produced under the same SEEA asset classification as the physical accounts.

The total land area is 9.94 million ha of which forests account for 6.42 million ha. Forests covering 65% of the Korean landscape have been the dominant feature shaping our long traditions and unique culture. Except for forests, about 19% of land area is classified into agricultural lands and the rest 16% is for other purposes including housing development, industrial sites, and other public uses. In comparison with other countries, land area for other purposes is relatively low.

To meet the future land demand for human settlement, industrial sites, and public facilities, major supply source would be the conversion from agricultural land, forestland, and land reclamation. The additional land area for human settlement, industrial site, and public facility were estimated to be 40,000 ha, 12,000 ha, and 78,000 ha, respectively, thus totaling up to 130,000 ha during the year of 1992 through 2001. According to the Third Comprehensive Planning of National Land Use (1992 - 2001), about 65,800 ha of agricultural land and 39,900 ha of forestland should be converted into other uses. If socioeconomic and other conditions in Korea kept the same pace, it is estimated that about 140,000 ha would have converted into other uses by the year 2020.

Korea is a typical mountainous country where it is difficult to reserve plain forests, and it is also a populous country characterized by the ever-increased demand for land available for various purposes including industrial and recreational uses. Therefore, the success of sustainable forest and mountain development depends greatly on how we deal with the mountainous forests and the people living in and around rural forest communities that are primarily relying upon forest resources.

Forest types in Korea have been classified into five categories that are conifers, broad-leaved, and mixed forests, bamboo stand, and non-stocked areas, totaling up to 6.42 million ha. Of total forestland, conifers forest occupied the largest portion of about 42.2% and broad-leaved and mixed forests accounted for about 25.9%, respectively. There are still non-stocked areas included in forests because of topographical features across the country. About 22.3% of total forest land in Korea was under governmental authority including Korea Forest Service and other governmental bodies. A large portion of forestland, over 70%, was under the private ownership. The rest 7.7% of forestland belonged to public organizations and institutions. As of 2002, total timber stock was 448.5 million • ; which increased from 407.6 million in 2000, in spite of a slight decrease of forest land. Of total timber stock volume, about over 60% was from private forests and about 30.9% from national forests. The public forests accounted for the rest of total volume.

In Korea, one of the most difficult problems hindering the effective and intensive forest management practices could be singled out as the excessive number of private owners that consequently resulted into too small size of forest owned by each owner to be managed in efficient way. In many cases, the motives for owning forests privately were not for managing forests, rather for other purpose such as real estate investment for future value increase, family graveyard, and inheritance property. Also spatial dispersion of small-size private forests caused difficulties in managing forests intensively because of intermixed between national and private forests spatially. The private forest owners usually have not shown any interest and voluntarily participated in forest planning and management practices. The large portion of private forest owners, 61%, owned forests less than 1 ha. Over 99% of private owners kept forests less than 30 ha but their total ownership accounted for 76% of total private forests and for 53% of total forests in Korea.

Though reforestation has been successfully accomplished, harvestable forest resources are extremely limited because about 70% of forests are under 30 years old with little economic value. But demand for timber has sharply increased due to national economic development and now about 90% of timber demand is dependent on foreign sources. This trend would last for other 30 to 40 years, since by then forests in Korea would reach the harvestable stage. In general, medium- and large-size quality timber could be produced from forests only over 40 years old that account for about 10% of all forests. Since any income could hardly come from these young forests in addition to the low timber price, intensive tending works including thinning have not actively pursued in Korea.

Korea Forest Services reported annually the estimated total national monetary value of various forest non-market services, such as forest recreation, improvement of air quality, water storage and conservation, soil conservation, and protection of wildlife. It was estimated up to 49,951 billion Won in 1995 using cost-based and contingent valuation methods. In other words, Korea Forest Services citied the report from Korea Forest Research Institute (KFRI) which is announced spontaneously the non-market "public benefits" of forests as an effort to seek more support for forestry sector from the public and government such as recreation, soil and water conservation, and biological diversity. However, it is no doubt that the resulted monetary amount would be underestimated because functions studied were only a few considered among many forest welfare functions. The intangible benefits of forests are 29 times of tangible forest products value. The public value of forests in Korea is equal to 9.7% of gross national product as of the year 2000. The intangible public value of forest is about USD 650/year/ha. Table 1 shows the time trend of non-marketed services value of forest in Korea.

Table 1 Value of Non-marketed Services of Forest by Year

Unit: 1 billion Won

Function	1987	1992	1995	2000
Total	17,656	27,610	34,611	49,951
CO_2 Absorption & O_2 Production	4,579	8,380	7,228	13,535
Water Storage & Conservation	3,040	7,932	14,053	18,126
Forest Soil Conservation	3,781	7,229	8,063	12,692
Recreational Benefits	5,997	3,548	4,488	4,830
Wildlife Protection & Others	259	521	779	768

To estimate Green GDP, Korea Environment Institute (KEI) completed a pilot compilation of the SEEA in 1997. Asset accounts for land, forest, fish and mineral resources as well as environmental protection expenditures and emissions into land, air and water were estimated. Due to the government forest protection policy, deforestation and forest depletion in Korea do not constitute an environmental concern and forest stocks have been increasing steadily as a result of the extensive reforestation. Park and Youn (1997) also constructed physical and monetary accounts for timber, carbon absorption, and forest recreation in Korea. Recently, Travel Cost Method, Contingent Valuation and Replacement cost Method in combination with production function approach have been applied to the valuation of forest resources in Korea. Youn (2003) developed a forest accounting system for a watershed area with a special reference to timber, water conservation, forest carbon and recreation in a certain mountain area. The forest resource accounting system for South Korea can be applied to policy analysis. A policy analysis based on forest resource accounting system was conducted by Park (1996).

FRA has been developed in Nordic countries like Finland and Norway as well as France. Norway and Finland developed forest products accounts including use account and mass balance, whereas based on forest resource inventory France developed forest account and forest land account. For this study, forest resource physical stocks and any changes in those stocks during an accounting period can be recorded in physical units appropriate to the particular resource. More technically, forest resources or services can be expressed in physical and monetary terms for changes in water storage, forest recreation, amount of carbon fixation, and growing stock of timber within a year.

FRA describes changes in the state of forests by breaking them down into those in different categorized components of forests. This method makes it possible to keep track of decrease or increase in forest biomass. The basic accounting identity is that opening stocks plus all growth, increase or addition less all destruction or diminution equals closing stocks. Net changes in the value of stocks are attributed to current year additions, such as growth, less deductions like deforestation plus any price changes of the resource during the year. Estimates of changes in forest area, agricultural land, and other land uses were based on annual surveys. Data on forest area, type, volume, growth, and composition were based on detailed field studies done by Korea Forest Service.

For timber resources, capital accounts can be expressed in physical and economic terms. The volume at the end of a period equals the initial volume plus the increases due to annual growth and new forests (reforestation and secondary forests) minus the changes due to deforestation, exploitation, and damage and fires. Physical depreciation of forest resources can also be expressed as the difference between the final area and the initial area of forests. Differences in surface area are resulted from the changes in agricultural land, golf course, and newly reforested areas. Nevertheless, depreciation expressed in purely physical terms tends to hide important differences in composition, quality, age, and value among timber stands.

The accounting framework for timber resources in physical units could be expressed in hectares, in tons of biomass, or in cubic meters of available timber. The last measure (timber resources in cubic meters of available timber) is probably the most important economic measure, so total growing stock of productive forest should be used for this study. To construct asset accounts for forestry, one can get opening and closing stocks of forest by using growing stocks of conifers, non-conifers, and mixed forests in this study. For, monetary account, one should calculate the average prices of wood products per cubic meter for conifers, non-conifers, and mixed forests with reasonable assumptions. Then the total monetary value of forests in Korea can be estimated by multiplying the average price per cubic meter by the total growing stock of each forest.

Data on the growing stock of forests, disaggregated by species are obtained from the Korea Forest Service. But no data are available on the different categories of stock changes, and all changes, consisting of exploitation of timber for direct use in production, reforestation, natural growth, reductions due to fires, diseases and other natural causes, so these items are not included in the account. It can be safely concluded that there is no depletion of forests in Korea, since additions to the stock, through natural growth and reforestation exceeded, in all years, reductions due to direct exploitation and natural causes.

In a highly populated and land-limited country such as Korea, the forest serves many functions. It supplies forestry products, provides public recreational areas, stores precipitation, maintains ground water, and prevents soil erosion. Forests have played great in water storage and conservation acting like a fully environmentally sound dam and will be more important in the future. The total benefit of water conservation forests could be estimated on the basis of less constructing multipurpose dams as much as like water storage capacity of forests. Forest soil conservation benefit was usually estimated as damage prevention device or recovery cost. However, these functions including biodiversity are not included in this study due to information and data limitation. CO_2 fixation and forest recreation were also included in physical and monetary account.

The threat associated with global climate change due to an increase of greenhouse gas emissions could severely damage international economic development and ecological balance. The ability to "fix CO_2" in the form of carbon through plant growth, particularly in forest ecosystems, is an important tool to combat the increase of atmospheric CO_2. Reduction in CO_2 level is an obligation for most of the countries to implement the Kyoto protocol. This means that CO_2 reduction by forest has a value, which can be estimated by taking account alternative methods of fixing CO_2. The amount of CO_2 fixed by forest is measured by using IPCC approach. The economic value of CO_2 fixation by the whole forest was estimated by multiplying carbon tax. Estimated total number of visitors to forest related National Parks was used for physical account for the year of 1998 to 1994. By asking willingness-to-pay to forest recreation participants, consumer's surplus was estimated and used for monetary account.

3 Forest Account in National Level

3.1 Timber Account

Due to the extensive reforestation and protection policies adopted by the government, growing stock in Korea has been increasing steadily in the last three decades. For timber account, forests can be classified as productive and non-productive one. The former consists of forests designated for economic uses like logging, silviculture and road building. A necessary condition for an activity to be treated as productive is that it must be carried out under the instigation, control and responsibility of some institutional unit that exercises ownership rights over whatever is produced. These products and activities may be harmonized but are also reported in physical terms such as the number of hectares of forests or volume of standing timber.

Physical timber accounts are generally drawn in terms of physical volume of growing stock in terms of as cubic meters. They describe all timber in the productive forest, whatever the economic classification. Each volume measurement has naturally some assumptions and they are not explained in detail. Physical account includes opening and closing stocks, at the beginning and end of the year, and changes in quantity are expressed in logging and net increment.

We used estimates of stumpage price and production costs. Standing timber prices were estimated using observable stumpage prices of each species rather than residual value method of timber appraisal. Stumpage values are net of average extraction costs and discount values are average prime interest rate. Small trees are worth less per unit of volume than large trees. A variety of approaches were employed in the valuation of standing timber. For example, Sweden and Finland use stumpage prices while Germany uses a hedonic pricing model.

To calculate the monetary value of forest, the average prices of softwood and hardwood log were estimated. Average price for softwood and hardwood log was obtained by dividing total amount of each species by the total production. Since the ratio of growing stocks of conifers and non-conifers is 6:4, average log price of mixed forests was obtained by adding 60 percent of conifers price and 40 percent of non-conifers price. In the calculation of the monetary value, since the value of standing timber in the mountain was only 30 percent of market value, final value of the monetary values were multiplied by 0.3, respectively. The current market price is the average price for the trees of age class Ⅲ(age of 21 to 30) and Ⅳ(age of 31 to 40). For the value of standing timber age class Ⅰ and Ⅱ, current market price was discounted. On the other hand, market price was multiplied for age class Ⅴ and Ⅵ.

Value of Standing Timber(Ⅰ - Ⅱ) = Value of Standing Timber(Ⅲ-Ⅳ) / (1 + 0.038)20

Value of Standing Timber(Ⅴ- Ⅵ) = Value of Standing Timber(Ⅲ-Ⅳ) × (1 + 0.038)20

Since no general accurate information is available on the cost of harvesting, transportation and a normal return to capital, estimates of the stumpage value are based on field survey and expert's opinions. Table 8 shows the monetary asset account for the commercial (productive) forest calculated using average unit net prices. These prices are used as an approximation to the stumpage value and reflect the net rent corresponds to 30% of the market prices for timber. Opening and closing stocks in monetary terms are obtained by multiplying timber stocks by their net prices at the beginning and end of the accounting period. A prime-lending rate of 3.8 percent was used for interest rate during the period of 1985 to 1994. Monetary account is derived from the physical account by multiplying monetary unit values to the growing stocks and changes therein. Below table shows monetary timber for productive forest in 1994.

Table 2 Physical Timber Account for Productive Forest by Species & Year

Unit : 1,000 • •

Year	Total	Net Annual Increment	Coniferous Forest	Deciduous Forest	Mixed Forest
85	138,516	5,506	5,506	5,506	5,506
90	185,730	10,684	10,684	10,684	10,684
94	228,811	9,102	9,102	9,102	9,102

Table 3 Monetary Timber Account for Productive Forest by Species & Year

Unit: 100 million Won

Year	Total	Net Annual Increment	Coniferous Forest	Deciduous Forest	Mixed Forest
85	15,604	2,506	5,506	5,506	5,506
90	26,817	3,090	10,684	10,684	10,684
94	49,493	4,681	9,102	9,102	9,102

However, for the timber account in 2002, National Statistical Agency developed new market prices, which were calculated according to region, species type, and age class. Volume of growing stock for productive forest was 77.6% of total growing stock in Korea. Softwood price is estimated from three species according to their ratio of growing stock.

Table 4 Growing Stock and Forestland Area

Unit : 1000 • ; 1000 ㎡, %

Category	2002	2001	2000	Change Rate	
				2002	2001
Growing Stock	448,456	428,347	407,576	4.7	5.1
Forestland Area	62,623	62,598	62,622	0.04	△0.04

Table 5 Average Market Price and Price of Standing Timber

Unit : won/• ; %

Category	Market Price		Change	Standing Timber Price		Change
	2002	2001	2002	2002	2001	2002
Softwood	121,225	111,979	8.3	55,357	51,266	8.0
Pinus densiflora	124,226	113,150	9.8	54,668	49,793	9.8
Pinus koraiensis	108,000	107,000	0.9	65,810	65,219	0.9
Larch	108,360	106,886	1.4	55,313	54,558	1.4
Hardwood	84,953	95,000	△10.6	47,616	51,300	△7.2

Table 6 Price of Standing Timber by Age Class and Type

Unit: won/• ; %

Category	Year	Age Ⅰ	Age Ⅱ	Age Ⅲ	Age Ⅳ	Age Ⅴ	Age Ⅵ
Hardwood	2002	–	28,228	40,750	46,483	55,338	60,072
	2001	–	27,354	38,737	43,820	52,461	55,210
	Change	–	3.2	5.2	6.1	5.5	8.8
Softwood	2002	–	30,868	34,646	38,371	43,096	45,144
	2001	–	28,349	33,584	39,786	47,133	51,300
	Change	–	8.9	3.2	-3.6	-8.6	△12.0

So, total value of timber for productive forest was 14.2 billion won. Depending on the assumption, this value can be entered in Green GNP or EDP.

Table 7 Value, Growing Stock, Average Price by Forest Use Type

Category	Value of Standing Timber		Growing Stock		Average
	(10billion won)	Ratio (%)	(10billion won)	Ratio (%)	Price(won/•)
Total	18,282	100.0	448,456	100.0	40,767
Productive Forest	14,189	77.6	347,423	77.5	40,841
Non-Productive Forest	4,093	22.4	101,033	22.5	40,541

Table 8 Value, Growing Stock, Average Price by Forest Species Type

Category	Value of Standing Timber		Growing Stock		Average
	(10billion won)	Ratio (%)	(10billion won)	Ratio (%)	Price(won/•)
Total	18,282	100.0	448,456	100.0	40,767
Softwood Forest	7,999	43.8	189,431	42.2	42,226
Hardwood Forest	4,669	25.5	121,542	27.1	38,419
Mixed Forest	5,614	30.7	137,482	30.7	40,831

3.2 Carbon Account

A preventive effective of global warming due to carbon dioxide sequestration by forest as a reservoir of carbon will be greatly increased unless any other efficient measures for carbon dioxide reduction would be available. Timber absorbs and stores carbon annually and this form of annual services would take place on non-economic forestland as well as productive lands.

Often ignored, but one very important service provided by forests is their capacity to absorb carbon dioxide from the air. Trees can grow through the absorption of carbon dioxide from the air and 50 percent of their weight consists of carbon. In this way, they can reduce air pollution. Since the emission of carbon dioxide is viewed as a major cause of global warming, it is very logical to regard the absorption of CO_2 as a positive external effect of forest growth. This potential value of this external value is enormous, given the valuations of carbon dioxide emissions that are implicit in some public policies.

The volume of standing timber will be a reasonable indicator of carbon storage. However, considerable effort must go into examining total carbon storage and uptake throughout the life of both economic and non-economic forests in order to gain better knowledge about the relationship between the commercial measures of stem biomass and total forest carbon uptake and storage. In this study, IPCC method of calculating carbon absorption for hardwood and softwood were employed to measure net carbon absorption by whole forests in Korea. To figure out carbon emission, we used domestic wood supply and fuelwood consumption by adopting IPCC approach. Using this method, Table 11 reported the physical carbon account for the whole forest from 1985 to 1994.

Net Carbon Absorption by HW = 0.5 × (Net Increment of Stem Biomass × 0.47 × 1.29 × 1.28)

Net Carbon Absorption by SW = 0.5 × (Net Increment of Stem Biomass × 0.80 × 1.22 × 1.41)

Total Carbon Emission = 0.5×((Domestic Wood Supply×0.95) + Consumption of Firewood)×1.35

Total Carbon Absorption = Net Carbon Absorption + Total Carbon Emission

Table 9 Physical Carbon Account for the Whole Forest by Year

Unit: 1,000tC

Year	Net Carbon Absorption	Total Carbon Emission	Total Carbon Absorption
1985	5,059	962	6,020
1990	7,400	947	8,347
1994	7,007	862	7,868

The last decade witnessed a large increase in the use of economic instruments to protect the environment in OECD countries, with a growing emphasis on tax instruments, in particular in the context of "green" tax reforms. Environmental taxes on fossil fuel inputs may be more appropriate to deal with carbon dioxide emissions. A number of countries, including Sweden and Finland, have already introduced carbon taxes on fossil fuels, with the aim of reducing carbon dioxide emissions. Carbon tax is a kind of environmental tax to mitigate greenhouse gases (GHG) emissions, by imposing tax on the emission of them. Carbon tax is technically to impose tax on energy consumption, since most of GHG emissions come from fuel combustion.

Finland was the first country to introduce a carbon tax in 1990. While the carbon tax started in 1990 at a fairly modest level of FIM 24.5 per ton of carbon, the rate has been steadily increased since, to reach FIM 374 in 1998. Norway implemented a CO_2 tax on mineral oil of NOK 0.46 per liter in 1991. The CO_2 taxes over about 60% of total Norwegian CO_2 emissions. In Sweden, a major tax reform was introduced in 1991 and the rates of the CO_2 tax vary according to the type of fuel.

Value of Carbon Absorption = Total Amount Carbon Absorption × Carbon Tax

If the absorption of CO_2 by forests were to be subsidized at the same rate which emissions are going to be taxed like carbon tax, Korean forest management practices would change radically. Jung (2000) examined the effect of carbon tax on the Korean economy, employing the Second General Model (SGM) developed by Pacific Northwest National Laboratory of USA. He uses various carbon tax rates from 50,000 to 200,000 Won/tC and reported that it is very difficult to stabilize the CO_2 emissions of 2030 at the level of 200 with a carbon tax of 200,000Won/tC. In this study, we selected USD 50/tC for 50-year rotation period.

Table 10 Monetary Carbon Account for the Whole Forest by Year

Unit: US$ 1 million

Year	Coniferous Forest	Deciduous Forest	Total
1985	94.277	82.287	176.565
1990	66.637	119.225	185.862
1994	115.919	108.416	224.335

3.3 Forest Recreation Account

The Contingent Valuation Method (CVM) for the evaluation of forest recreational benefit was used to evaluate the total recreational benefits of forests at the country level. According to the nation-wide population survey, the average willingness to pay by the people who visited the forest in 1990 was 41,640 won. Using 1992 income level, Kim (1994) converted this value to 44,259 won per person in 1992. Without accounting the benefits enjoyed by people younger than 18 years old, the total benefits accrued to the Korean adults from recreation participation were estimated 2,423.6 billion won in 1992. If it is assumed that there is no difference in the preference among generations, the total value of forest recreation enjoyed by the whole population is estimated as 3,548 billion won.

Often non-market values are estimates of consumer's surplus for non-market goods and services. A study of people's willingness to pay (WTP) for forest recreation in Korean forests was made by Forest Research Institute (1993). Those were interviewed were asked about how much they spent and how much they are willing to pay more to visit nation parks. One should be very cautious about WTP measures of this type. The data should be interpreted as a very rough estimate of the value that the present generation places on these forests, and under the assumption that the present generation has not considered the welfare of future generations. Visitors were asked about their willingness to pay for visiting national parks. Valuation is a crucial but still controversial aspect of environmental accounting, requiring further exploration with a view to developing widely acceptable standard methodologies.

First, to calculate total number of participants in forest recreation, we used the total number of 15 national forest-type park employing log-log model, assuming that number of visits will depend on the income and other factors. It is assumed that the demand function for forest recreation can be estimated by simple regression of income.

$$\ln VISIT = -6.73 + 0.8678 \ln NIP - 0.3612\, D9194$$

$$\quad (-5.89) \qquad (11.35) \qquad\qquad (-8.41)$$

ln: natural log, ( ): t-value, Adjusted R2: 0.9206

VISIT: No. of 15 National Park Visitors/1000 person

NIP: National Income per capita

D9194: Dummy Variable (1983-90 = 0, 1991-94 = 1)

After figuring out coefficient of NIP, Increasing rate of forest recreation participants(F.R. PP) by year was calculated by multiplying increasing rate of national income per person. Then, we estimate number of participant per person per year and total number of forest recreation participation was calculated by multiplying number of population over 18 years old.

$$\textit{Rate of no. F.R. PP} = b_1 \times \textit{Rate of Income per capita}$$

$$\textit{Total No. of F. R. PP} = \textit{No. of PP per capita} \times \textit{No. of Pop. Over age 18}$$

Table 11 Physical Forest Recreation Account by Year

Unit: 1,000 person

Year	No. Participation of F. R. over age 18	No. Participation of F. R. for total pop.
1985	31,014	49,010
1990	52,308	76,306
1994	69,037	97,149

The value of forest recreation in terms of tourism should be the people's willingness to pay for the services they provide. Consumer's surplus was measured by asking willingness to pay for participating forest recreation.

$$Pr\,(yes) = 1 / (1 + exp^{-(1.1827 + (-0.000045 * Offer) + (0.00000156 * Income))})$$

$$E\,(WTP) = \ln (1 + exp^{a}) / (-b) = \ln (1 + exp^{1.1827 + 0.00000156 * Income}) / (0.000045)$$

$$\textit{Total Value of F. R. (over age 18)} = \textit{Consumer Surplus} \times \textit{Total No. F. R. Participation}$$

For monetary account, we measured consumer's surplus by employing the willingness to pay method. In this study, consumer's surplus was 39,228 won in 1990 and total value of forest recreation participation for whole population

Table 12 Monetary Forest Recreation Account by Year

Unit: Billion Won

Year	Consumer Surplus(Won)	Value of F. R. over age 18	Value of F. R.for total pop.
1985	35,196	10,915.6	13,936.6
1990	39,229	20,519.8	25,223.4
1994	46,149	31,860.2	38,340.0

4 Forest Resource Account in Regional Level

The project site is the Baek-Eun Mountain of Southern Experimental Forest of Seoul National University, where is located in the southwestern part of Korea, covering an area of 4,900ha. The area of forestland is 4,055ha and 2,135ha belongs to University, whereas non-forest area is 845ha, such as residential and agriculture land and watershed management area for Su-a Dam. This is a first regional research that studied the specific mountain in Korea, developing a forest accounting system for a watershed area with a special reference to timber, water conservation, forest carbon and recreation from 1992 to 2002.

The characteristic of forest is deciduous forest (or hardwood forest) and hardwood growing stock 94% of total stock of standing timber. Physical timber accounts are generally drawn in terms of physical volume of growing stock in terms of as cubic meters like previous studies. The data on the growing stock of forests comes from the annual forest management plan and disaggregated only by coniferous and deciduous. The age of most trees is age class 3 and 4 (from 31 years old to 49years old) and there were no logging activity and damages were not reported. So the average price of hardwood and softwood in the market was used for the monetary account. The same approach was used to calculate average prices. Below table shows timber account in physical and monetary terms for university forest.

Table 13 Timber Account from 1992 to 2002

Unit : • /million won

Category	Total	Coniferous Forest	Deciduous Forest
Opening Stocks (1992)	153313.7	9044.3	144269.4
Closing Stock (2002)	219008.0	19967.7	199040.3
Net Increment(volume)	199040.3	10923.4	54770.8
Net Increment(monetary)	1523.2	283.7	1239.5

For carbon account, IPCC method of calculating carbon absorption for hardwood and softwood were employed to measure net carbon absorption by whole forest and ignored emission since there were no harvesting between 1992 and 2002. Carbon tax of USD 50 was used for calculation of monetary account. However, considering that carbon trading is possible in near future, the carbon account of this forest was reevaluated using USD 15 per ton Carbon.

Table 14 Carbon Account from 1992 to 2002

Unit: tC

Category	Total	Coniferous Forest	Deciduous Forest
Opening Stocks (1992)	108537.3	3509.2	105028.1
Closing Stock (2002)	152648.8	7747.5	144901.3
Net Increment(volume)	44111.5	4238.3	39873.2

Table 15 Carbon Monetary Account

1$=1,300won

Category	Amount of Absorption(tC)	Value of Absorption (1000won)	
		Case 1: 50$/tC	Case 2: 15$/tC
Opening Stocks (1992)	108537.3	7,054,925	2,116,477
Closing Stock (2002)	152,648.8	9,922,172	2,976,652
Net Increment	44,111.5	2,867,247	860,175
Average per year	4,411.0	286,724	86,017

TCM was used for recreation account of forest unlike previous national level study and surveyed was done among the citizens who lived and often have used the recreation forest in Baek-Eun mountain. The demand curve for the recreational forest was not derived from the national level, since this forest recreational value is limited to regional level. So only three cities were chosen and questionnaires were distributed to households. The visiting rates of three cities are 0.66, 0.76 and 0.58 and the numbers of annual average visit to recreation forest were 2.4, 4.1, and 2.2, respectively. Average total travel cost was calculated based on the distance, actual spending, and opportunity cost. The forest recreational value of three cities were estimated and added up three figures for the total annual value of study site. In 2002, recreational value was 30,211million to nearby citizens.

One important consideration for coming up with water stocks is that water is a renewable resource. Therefore, the main issues to consider when preparing a water stock account are volume, accessibility, time, uses and storage. Analysis of water stock entails studying the water cycle. Analyzing the spatial component requires study of water regions where do not necessarily tie in with administrative boundaries. Therefore, this makes it difficult to compare water data with other data that is usually compiled based on administrative boundaries in regional accounts. In this paper, we only narrow our research scope into the value or function of preventing/control of flood. The scarcity of water is a seasonal issue hence constructing accounts on an annual basis to fit within ordinary accounts is not as useful as quarterly data which can be used to take account of the times when water is scarce and valuable. The economic uses of water vary. Other considerations that are crucial for water accounts are the accurately measured flows and stock of water. The type of water source is also of critical importance and these include lakes, reservoirs, springs, rivers, and ground water in Korea. Issues related to quality of water have not yet been brought into the accounts because of various complications such as BOD has a short lived impact while heavy metals in water have a long impact hence making an aggregate yearly quality assessment is difficult. It was noted that construction of water accounts was not an easy task and no standard yet existed.

Table 16 Water Account for Su-Euo Dam

Unit: ton

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Accounting of Protection Value of Forests in Hainan Province

Zhang Tao

1 Defining the content and range for protection value accounting

In principle, all types of forests have protection values on the environment in the area where they grow. This study focuses on forests that have been classified as protection forests in Hainan province. In addition, the protection value referred in this study is the monitory expression of protection functions of forest in the following two aspects: 1) the value of improving microclimate for agriculture, mainly reflected in crop production increase; 2) the economic value from preventing damage of winds and disasters.

Approach used for accounting: First the total area of protection forests in Hainan Province and specific areas being protected by these forests should be determined, then different methods were used to account the annual monitory cost for each type of protection forests, and the accounting results were modified according to Hainan provincial and national social and economic situation. Finally, the sum of the three types of protection values is calculated, and discounted with an appropriate rate. The results are taken as the protection value of forests in Hainan.

According to remote sensing and the statistics of the fourth forest inventory, the area of forested land in Hainan province was 1.49507333 million ha with a forest coverage of 51.3%, of which 0.977 million ha are tropical forests. The total area of protection forests in Hainan was 643 960ha. The protection forests can be divided into three types: coastal shelterbelt forests, farmland shelterbelt forest networks and soil and water conservation forests. However the three types of forests cannot be completely separated, for example, the coastal shelterbelt forests protect the entire agriculture and pasture in Hainan as protection screens.

2 Accounting of protection value of forests in Hainan

2.1 Method for accounting

2.1.1 Production function method

According to the accessibility and availability of data, the production function method was used for accounting of the value of protection forests in improving microclimate for agriculture. According to the basic model of the production function method, the function of protecting farmland is taken as an important factor affecting agriculture production. The consequence of this protection function is the change of cost or efficiency for agriculture production, further leading to the change of input and output proportion Which could be tested with market prices, ultimately the value of improving microclimate for agriculture of the protection forests can be calculated indirectly through the production change resulted from the change of production efficiency of farmland protected by forests.

For accounting of protection value of farmland protection forests, the foundation is to use the extra profit resulted from the protection for agriculture production as a substitute. Farmland shelterbelt forests mainly prevent wind. The consequence of improving microclimate is, at a certain extent, the improvement of the dynamic, thermal and hydrologic effects on the entire region under protection, forming a unique area for ecological benefits, hence increasing the crop production in the protected area, reflecting a regional crop production increase. Therefore, when constructing the protection benefit in practicality, the value of increased crop production in the protected area (compared with areas with no protection forests) is used to substitute the protection value (VP_1) of the protection forests, i.e.

$$V_{P1} = S * M_{vi} (Q_{i1} - Q_{io}) - CT$$

Where: $Qi1$ is the crop production in the ith unit with protection forest; Qio is the crop production of the ith unit with no protection forest; MVi is the unit price of agricultural products; S is the protection index; CT is the modification value.

This model is the basic theoretical model. However, when accounting protection value for a certain area of farmland forests, we will find that calculation of impacts of protection forests on crop production increase is complicated, there are areas of pure production increase, neighboring areas affected by forests and the forests occupied areas, and these should be calculated separately. Meanwhile, the calculation is also affected by year, species, age, structure of the forest network and various natural disasters and other factors. These require modification through the protection index that considers all these factors. However, generally it is difficult to calculate for single factor. Therefore, different areas were set for comparisons under the same condition. Calculation was conducted from points to area on a yearly basis. This is a common method under current scientific and technological conditions.

2.1.2 Hedonic Pricing method

The fundamental idea of Hedonic Pricing method is to use the price that people paid for environment services to determine the preference of the people, and use this to estimate the economic value of environment service. It is different from the production function method that uses the difference of market prices reflected by production difference, to calculate the protection value of forests; the hedonic pricing method uses the difference of market prices between with and without farmland shelterbelt forests to indirectly calculate the value of forest protecting the farmland. Due to the protection benefit provided by forest, the production per unit area of farmland within the range of forest protection is higher than that without forest protection. This difference in production can be reflected by the unit area price or the leasing price in the land market. On accounting protection value of forests, we suppose, in general at the same radial distance to central city and commercial district, when all other conditions are the same, the difference of market land prices between under protection and no protection is caused by the protection of forest. Therefore, we first calculate the total area of farmland under protection of forests in Hainan province, then measure the average difference of market prices per unit land area between protected and un-protected farmland, the approximate protection value of forest can be obtained by multiplying the two figures.

2.2 Accounting of protection value of forests in Hainan

2.2.1 Accounting of the value of improving microclimate for agriculture

Hainan experiences a tropical monsoon climate, with evident dry and wet seasons. It is known as "typhoon corridor" and has frequent natural disasters, leading to the disadvantage of fragile ecological environment and imposing serious threat to agricultural production. Therefore tropical forests, particularly the farmland and coastal protection forests in Hainan play an important role as protective screens in agriculture development, bringing evident production increase.

Results from observations for many years and at various locations indicate that the effects of farmland protection forests on agriculture production differ among types of the protection forests, climate and soil in the protection areas and types of crops under protection. The existing experimental data in Hainan shows that an investigation in 1981 indicated that the rice production was increased by 60% in normal years with normal management of the farmland protection forest network in Hongqi township of Qiongshan city; in Wenchang city, the rice production was increased by 60 kg, peanut production i by 75 kg and tomato production by 500 kg per mu (15mu=1ha) respectively after planting of protection forests.

Currently Hainan has 643 960 ha of protection forests, of which farmland protection forests are mainly "Eucalyptus-Casuarina" or "Eucalyptus-Taiwan Acacia", coastal shelterbelt forests are mainly Casuarinas or Mangroves. The total area of farmland in Hainan province is 400 000 ha, but not all farmland are protected. According to Song et al. (1994), in Huang-Huai-Hai plain the area of increased crop production accounts for 71.7% of the area under protection by the forest networks, the area of decreased crop production due to side effects of the protection forests accounts for 8.6% and area of plain production for 19.7%. The average decrease of crop production in the areas with side effects of the forests was about 13%. All these factors should be considered in evaluation of protection values. Lang et al. developed the "effective area index" for ecological value accounting; it considers that only part of the forest can produce a certain ecological value, the proportion of this part of forest to the total forest area was known as the effective area index of that ecological value. He calculated the effective area index for 10 types of forest ecological in more than 20 provinces, among which the effective area index of improving microclimate of Hainan's forests was 0.4. This study uses the area of protected farmland with increased crop production to calculate the value of improving microclimate.

When accounting is based on production increase of farmland under protection, suppose all of the 400 000 ha farmland of Hainan are protected, and 71.7% of the farmland have increased crop production, and 8.6% of the total farmland have decreased crop production and were excluded from the total farmland area to eliminate the side effects of forests, then the area of crop production increase due to protection was 252 400 ha (63.1%×1,016,896 ha). If rice and peanut were used to estimate the value of improving microclimate, and the national protection prices were taken as the prices of the crops, 1.2 RMB/kg for rice and 2 RMB/kg for peanut, the annual value of Hainan's forests of improving microclimate was between 272.59 million RMB and 567.90 million RMB. This study takes the lower value of 272.59 million RMB.

Table 1 Value increase from protection forest in Hainan province

Production increase area (ha)	Rice			Peanut		
	yield (kg/ha)	production (10^4 kg)	value (10^4 RMB)	yield (kg/ha)	production (10^4 kg)	value (10^4 RMB)
252400	900	22716	27259.2	1125	28395	56790

This result has certain appropriateness. However, for very strict accounting, other two factors need to be considered. Firstly, the cost of harvesting and transportation should be subtracted from the value of crop production increase to obtain the net monetary value of the forest protection function. Secondly, careful analysis needs to be conducted on market responses to production changes due to forest protection benefit. In general, if effects of an environment factor on market output were too small to cause large change in demand and supply of a given product, the current market price can then be directly used for calculation. If the change of output was large enough to affect the price of the product, a new price should be predicted.

2.2.2 Accounting of value of resisting sandy wind, preventing and reducing disasters

Hainan is surrounded by sea and typhoon indulges in willful persecution, the coastal shelterbelt forests have played great role as protective screens for the agriculture production and the people's properties. For example, in Wulonggang area in the northern Wenchang County, there were 1,266 ha of moving sand dunes and semi-fixed sandy land, before afforestation, sand moved towards to inland and covered farmland and villages, 5 natural villages and more than 150 households had to move locations for three times. After afforestation, the moving sand dunes were stopped. Several villages at the bottom margins got rid of the threatening conditions. The farmland covered by moving sand has been restored for cultivation. Another example is Qiongshan city, where an investigation conducted in 1981 indicated that under the protection of shelterbelt forest networks, the loss of rice production during attack by typhoon was 50% less than under no protection forests, and damaging to rubber forest was 40-60% less. According to the accessibility of data, this study uses relative ratio method to calculate the ecological value of resisting sandy wind, preventing and reducing disasters of the coastal shelterbelt forests in Hainan. According to existing studies, China's 10,000 km coastal protection forests can reduce the yearly loss due to typhoon by 0.9-1.2 billion RMB for the economic development in the coastal regions. According to this rate, it is predicted that Hainan's 1,500 km coastal shelterbelt forests can reduce yearly loss due to typhoon by 0.135~0.18 billion RMB for the economic development in Hainan. This study takes the lower estimation of 0.135 billion RMB.

Based on the above figures, the total value from protection forests in Haina is 407.59 million RMB.

3 Conclusions

Using production function method and Hedonic pricing method the values of both production increase from farmland protraction forest and resisting sandy wind, preventing and reducing disasters from coastal protection forests were accounted, they are as much as 272.59 million RMB and 135.00 RMB respectively, i.e., the annual value from protection forests so Hainan is 407.59 million RMB in total.

The results are available, but due to the limit of method and the data used, the accuracy of the results should be improved further.

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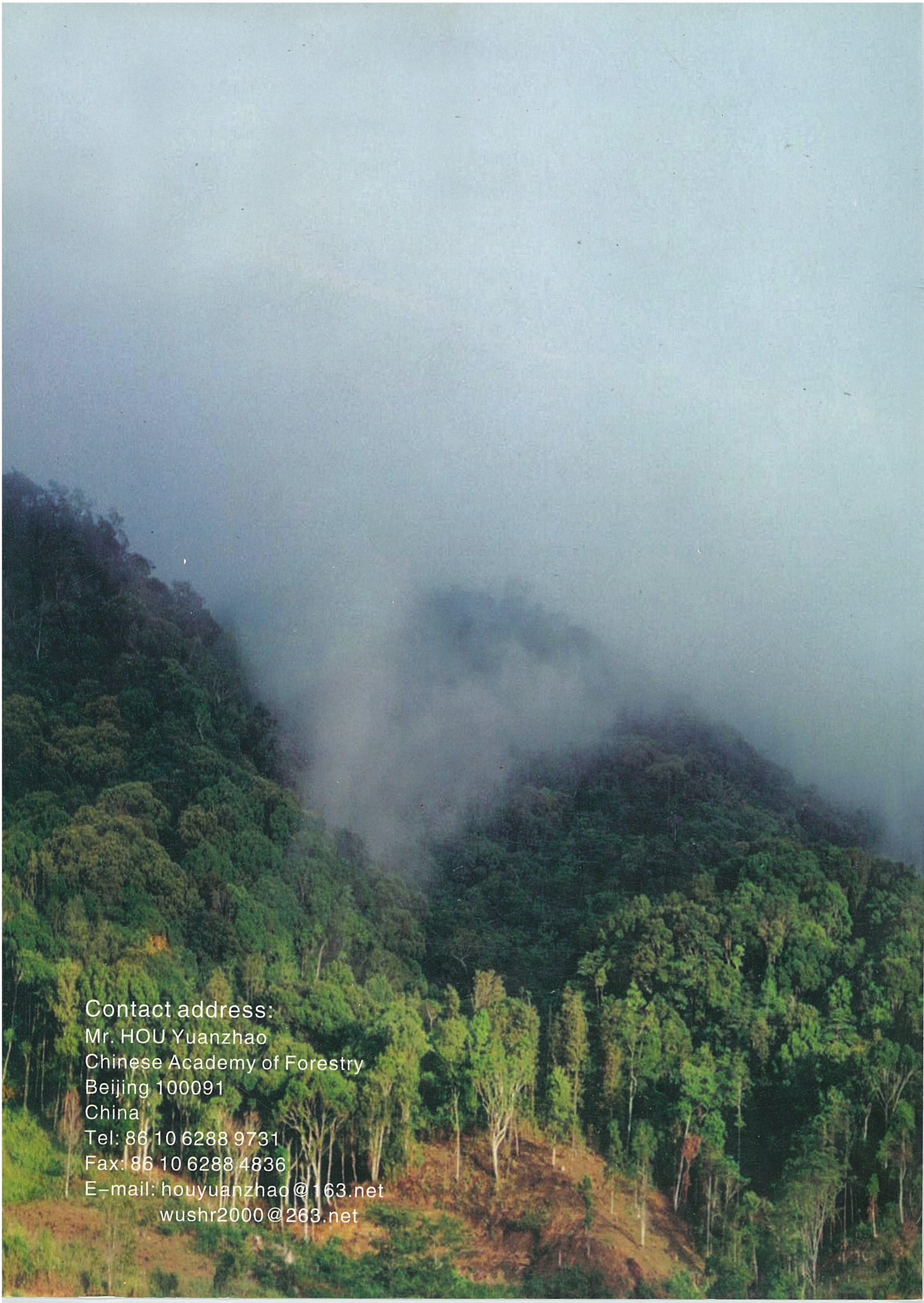
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