Application of Environmental Economic Evaluation to Forest Policies in Sabah, Malaysia

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Introduction

Figure 1 shows relationship between forest conservation policies and their evaluation systems. Among them, the current research takes up the Forest Certification project and the Clean Development Mechanism (CDM) project for afforestation and reforestation, to apply the environmental economic evaluation system. In particular, we have studied what kind of roles the environmental economic evaluation performs for internalization of environmental benefits and costs through cost-benefit analysis of these projects, as trying evaluations of natural ecosystem in Sabah including the Kinabalu Park as well as the Deramakot Forest Reserve Area.

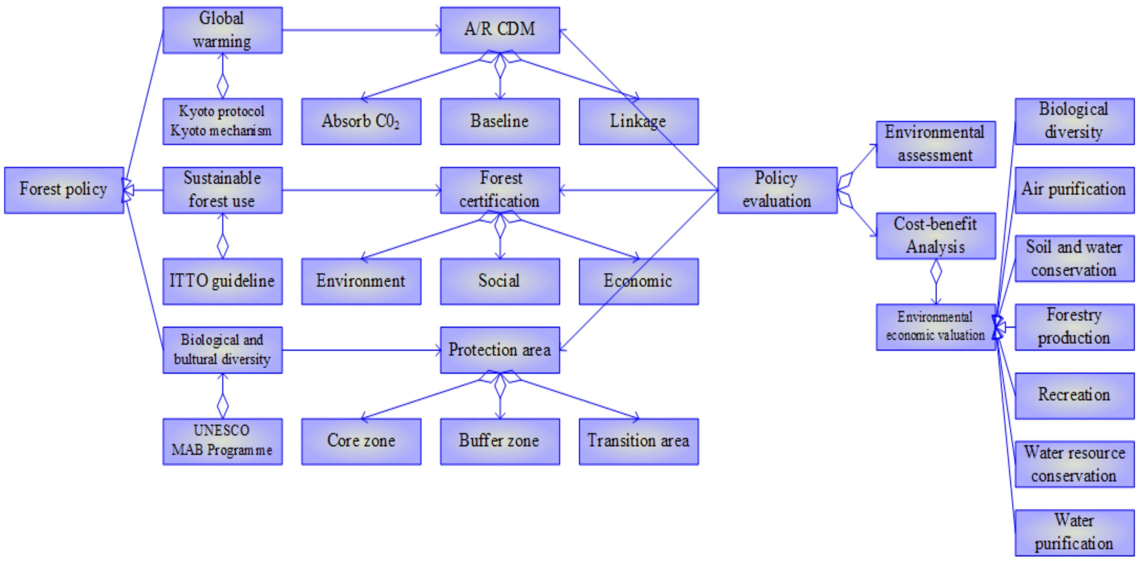

Figure 1 Relationship between Forest Conservation Policies and Evaluation Systems

Necessity of Environmental Economic Evaluation for Forest Policies

In carrying out the project as forest policy, calculating environmental values provides objective evaluation standards. It will support in preserving good forest ecosystem, formulating regulations/laws for forest preservation, zoning nature preservation areas and controlling land use for amenity preservation. Further, it can provide basic data to carry out public or private projects, which have a high economic efficiency from the environmental standpoints. The social loss occurs as precious forest resources decrease. Environmental economic evaluation can make contributions to the policies as follows ;

1) Switch from policies only for economic growth by plantation or clear-cutting toward policies with environmental preservation functions such as water resources conservation and flood control,
2) Promotion of policies which increase environmental values at the expense of efficient and fair

operation/maintenance costs,

3) Development of policies which improve overall social welfare considering public services such as amenity, biodiversity and local culture, not only for national economic growth or private sector's profits, and

4) Formulation of policies actively aiming at environment-oriented land use and social structure for urban area with little natural resources and degraded.

Cost-benefit Analysis

The cost-benefit analysis is a technique to prioritize policies or projects by evaluating social costs and benefits in monetary terms, and comparing the cost with validity. Public infrastructure or private-sector projects have been usually evaluated only with the direct benefits and costs that are so-called "internal economic effects". However, when the target policies/projects are more concerned with environmental impacts or services, it is also needed to internalize the "external effects" of environment and natural resources. If such environmental damages and contribution are estimated as social costs and benefits, it would be possible to duly evaluate the policies/projects not only from the viewpoints of economic efficiency but also from social and environmental ones through the analysis. Table 1 shows a cost-benefit analysis model to calculate a typical evaluation parameter "Net Present Value" for forest policies. Calculating value of the external benefit (*Be*) and the external cost (*Ce*) can realize economic internalization of environmental aspects, leading to fair and social evaluation of the forest policies.

Table 1 Cost-benefit Analysis Model for Forest Policy

$$NPV = B_d + B_e - C_d - C_p - C_e$$

NPV = net present value
Bd = direct benefit from the forest policy
Be = external benefit (including environmental services)
Cd = direct cost to implement the forest policy
Cp = cost for counter-measures to prevent environmental loss
Ce = external cost (including unavoidable environmental damage)

Application of Environmental Economic Evaluation to Forest Certification Project

(1) Background of Forest Certification Project

The competition with non-certified cheap woods hinders the spread of forest certification system. Under the system, marketable woods and their commercial usage have been limited due to their youngness. Therefore, it is a task to manufacture various marketable products using the certified woods. Prices of the certified products are 10 – 20% higher than non-certified ones, although quality is not different between them. So the problem is how to appeal to consumers for environmental significance attributed to the certified products.

At the Deramakot Forest Reserve Area managed by Sabah Forestry Department, tree-cutting have been controlled with the RIL (Reduced Impact Logging) method which is a model for sustainable forest management. It minimizes the environmental damage relying on natural regeneration function and duly considering biodiversity in the forest. Because of such background, the RIL area was first in Sabah certified as sustainable management forest by FSC (Forest Stewardship Council) in 1997.

However, the forest certification system has not been commonly applied in Sabah, because the system necessitates extra techniques and additional cost for preliminary survey and forest management. Economic benefit covering such additional cost is uncertain and environmental contribution is not recognized in wood market. Commercial forests in Sabah have been mostly logged in a short period with a cost-saving productive method. In addition, impacts on society and culture have to be evaluated as management change of commercial forests and setting-up of reserve area affect employment opportunity and life resources for local people.

(2) Cost-benefit Analysis of Forest Certification Project

Table 2 presents typical elements to be included into the cost-benefit analysis model. Improvement of public service functions as well as reduction of environmental and social impacts are required to obtain the forest certificate. Compared with non-certified forests, the certified forests therefore need additional cost to monitor environmental and social impacts on logging area. The model has to cover such additional costs and benefits, reflecting local people's values for project impacts on social and cultural aspects.

Table 2 Typical Costs and Benefits of Forest Certification Project

Bd = value of certificated woods
Be = social and environmental benefit (improvement of biodiversity, flood control, water resources conservation, creation of local employment, etc.)
Cd = direct cost for certification procedure, forest management, logging, etc.
Cp = cost for environmental and social conservation (monitoring, counter-measures, etc.)
Ce = unavoidable social and environmental damage (degraded biodiversity, income reduction, etc.)

(3) Cost for Certification

Cd varies depending on the size of forests. For example, the cost to obtain the certificate is US$0.01-1.3/ha/year under the FSC system while that for Swiss imported woods under the CoC (Chain-of-Custody) system is estimated from US$500 to 1% of the wood price. In case of the SGS which is a FSC certification organization, the cost of certification is US$4,000-100,000/case depending on forest area. Because the direct cost for certification is thus a financially large burden to private foresters, external social and environmental benefits from the certification system should be clarified to wood products consumers so that the higher prices of the certified woods could be well acceptable in market.

(4) Price of Certified Woods

Be is reflected to the price of certified woods and processed products, so that the certified products are sold with 10-20% higher market prices than non-certification products. These prices will further increase for profitability with a small demand because marketable species, diameter and age are limited. If the consumers purchase more Malaysian certified woods, it will help to reduce illegal logging and excessive deforestation in Malaysia. In addition, the wood-mileage evaluation should be reflected on the international and domestic market prices to promote environment-oriented forestry all over the world.

Application of Environmental Economic Evaluation to CDM Project

(1) Background of CDM Project

The CDM projects have positive effects not only on air quality by absorbing CO_2 and producing O_2 but also on total ecosystem. They also contribute in improving flood control function and water resource conservation as usual afforestation projects. But, at the same time, afforestation/reforestation activities will have negative impacts on natural ecosystem and local community when mono-species plantation of fast-growing or exotic trees is introduced.

A difference to the CDM projects from the usual afforestation activities is additional cost for acquisition of the credit. Its example is the cost to monitor and prevent the "linkage", which means incremental CO_2 emission at the tree-cutted agricultural area newly cultivated by farmers who are forced to move from the CDM project sites. As such, social environmental consideration is strictly required under the CDM projects. When the CDM system is introduced in Sabah with a large population and natural environment, impacts of the projects should be fully assessed.

(2) Cost-benefit Analysis of CDM Project

In addition to benefit from air purification function of CO_2 absorption, other *Be* and *Ce* should also be internalized for evaluation of the CDM project. And monitoring and preventive costs for the linkage are to be included as *Cp*. Values of forestry resources are usually estimated through market prices. When these values are increased or reduced, they are regarded as *Bd* or *Cd* respectively. But, if local people consume forest resources for fuel materials, building materials and food not through the market, they should be evaluated as *Be* or *Ce* to be internalized into the cost-benefit analysis model. In addition, social benefit or cost accrues from the CDM project's impact on local people , such as employment opportunity and community disturbance by the forest management. Typical costs and benefits of the CDM project is shown in Table 3.

Table 3 Typical Costs and Benefits of CDM Project

Bd = increased wood products
Be = absorbed CO_2, flood control, water resources conservation, local employment, etc.
Cd = cost of afforestation management (investigation, monitoring, afforestation, logging, road maintenance, etc.)
Cp = cost of social and environmental preservation measures
Ce = unavoidable social environmental damage (degraded biodiversity mono-plantation of fast-growing or exotic species such as eucalyptus, influence to traditional culture, etc.)

(3) Credit Period

Because the credit period affects the credit price, the credit period is the important matter for the entrepreneurs. In COP9, the credit period was set to 60 years at the longest (renewable 20 years twice) or 30 years (no renewable). This relatively longer period has been determined, considering difference of growth period by species and area. However, unlike power station construction or energy-saving projects, afforestation does not have permanence to absorb CO_2 in the future. It is a problem that CO_2 will be emitted again when trees are cut or caught in fires.

Monetary Evaluation Methods for Environmental Values

In actually applying the cost-benefit analysis models presented in the previous chapters, elements more unfamiliar and difficult to evaluate in monetary terms are *Ce* and *Be*. So, in this and following chapters, methodological framework to evaluate typical environmental values ("cost" when it is lost, and "benefit" when it is conserved or improved) is studies, and actual measurement is tried for natural forest, commercial forest and agricultural land in Sabah. Environmental functions are major targets under the current study. The main purpose to apply the monetary evaluation methods is to quantitatively measure the benefits. Envisaged benefits could be largely classified into 9 categories as follows :

1) Fostered water resources,
2) Conserved water quality,
3) Erosion and flood control capacity,
4) Air purification,
5) Aesthetic and recreational amenity,
6) Biodiversity services
7) Forestry resources,
8) Fishery resources, and
9) Agricultural resources

Potential methods for estimating the monetary value of natural resources and environmental benefits are examined. The next table presents a menu of valuation techniques which have been developed so far in environmental/resource economics, as well as typical examples of the evaluated effects. These are largely divided into two categories (OVA and SVA), based on their extent of objectivity or subjectivity.

Table 4 Menu of Valuation Methods for Environmental Effects

Valuation Method	Typical Effects Valued
Objective Valuation Approaches (OVA)	
1) Change in Productivity	Productivity
2) Cost of Illness	Health (morbidity)
3) Human Capital	Health (mortality)
4) Replacement (Restoration) Cost	Capital assets, and natural resource assets
Subjective Valuation Approaches (SVA)	
1) Preventive (Mitigative) Expenditure	Health, productivity, capital assets, and natural resource assets
2) Hedonic Approaches	
- Property (Land) Value	Environmental quality, and productivity
- Wage Differential	Health
3) Travel Cost Method (TCM)	Natural resource assets, and touristic assets
4) Contingent Valuation Method (CVM)	Any effects including biological and aesthetic values
5) Conjoint Analysis	

Source: Economic Analysis of Environmental Effects

Objective Valuation Approaches

The first set if methods in the table are the Objective Valuation Approaches (OVA) that are based on physical relationships that formally describe cause and effect relationships and provide objective measures of effects resulting from various causes. OVA use "damage functions" which relate the level of offending activity to the degree of physical damage to a natural or man-made asset, or to the degree of health impact. OVA in general provide measures of the gross benefits, in the sense of losses avoided, of preventive or remedial actions. The important assumptions for OVA are :

- The net value of averting damage is at least equal to the cost which would be incurred if the damage actually occurred ; and
- Rational individuals, in order to prevent some damage from occurring, would be willing to pay an amount less than or equal to the costs arising from the predicted level of environmental effects.

Subjective Valuation Approaches

In contrast to OVA, the second set of approaches in the table, the Subjective Valuation Approaches (SVA), are based on more subjective assessments of possible damage expressed in real or hypothetical market behavior. Using revealed behavior involves examination of real markets for goods or services which are affected by environmental impacts, such as air or water pollution, in which people actually make trade offs between the environmental impact and other goods or income. In other cases environmental impacts cannot be valued, even indirectly, through market behavior. The alternative is to construct hypothetical markets for various options to reduce environmental damages, and to ask directly a sample of people to express how much they would be willing to pay for various reductions in environmental impacts. These are the so-called "Contingent Valuation Methods" (CDM) and "Conjoint Analysis".

Applicable Evaluation Framework

The selection of a particular method of measurement obviously depends on what is being measured. Selection procedure starts with any environmental impact and determines whether or not there is measurable change in production, or if the primary effect of the impact is change in environmental quality. According to availability of necessary data for monetary calculation, the more applicable evaluation methods for the above-mentioned 9 kinds of benefits brought from the forest ecosystem could be selected as below :

(1) Fostered Water Resources

It is assumed that development water discharge (incremental water discharge usable during the dry season) is equal to an average outflow of groundwater fostered by incremental vegetation. Therefore, benefit of the water fostering function of the incremental vegetation is evaluated with costs necessary to obtain the same development discharge from irrigation dams (construction and O&M costs of irrigation dams).

Natural vegetation in the watershed fosters groundwater for use in the watershed area and the downstream. And the fostered water flows into rivers and lakes, contributing to stabilization of discharged water amount there. So, loss of the vegetation affects the groundwater utilization and river discharge, decreasing products of agricultural and fishery sectors using water as key input. These industrial production losses can be taken as value of the water fostering function of the vegetation.

Increased water resources → Change in environmental quality → Human habitat
→ **Replacement Cost Method**
[Benefit] = [Incremental vegetation] x [Average unit groundwater outflow of vegetation]
x [(Annual construction cost of irrigation dam per unit development discharge)
+ (Annual O&M cost of irrigation dam per unit development discharge)]

Increased water resources → Measurable change in production → Non-distorted market prices
→ **Change in Productivity Method**
[Benefit] = [Incremental vegetation area] x [Fostered groundwater per unit vegetation]
x [Contribution rate of unit groundwater to each sectoral production]

(2) Conserved Water Quality

The value of water quality is assumed to be equivalent to the incremental cost of treating the water so that it is suitable for downstream uses. The level of treatment depends on the downstream use. For example, irrigation water does not require the same level of purity as drinking water, so the cost of treating water for use in agriculture would be less than drinking water supply. The incremental cost could be calculated as the extra alum or lime, filter capacity, treatment plant operation costs, etc. needed to treat the excess water pollutants.

Conserved or improved water quality → Change in environmental quality → Water quality
→ **Replacement Cost Method** or **Preventive Expenditure Method**
[Benefit by preventive expenditure method]
= [Reduced water pollutants]
x [Unit cost for construction and O&M of water filter plant to remove the pollutants]

(3) Erosion and Flood Control Capacity

In case there is stripped area without vegetation in the watershed, severe erosion would occur under heavy rainfall and its downstream water quality is degraded. So value of the vegetation's erosion control function is evaluated using construction costs of check dams to control and mitigate the washed-away soil.

Strengthened erosion control capacity → Change in environmental quality → Water quality
→ **Replacement Cost Method** or **Preventive Expenditure Method**
[Benefit by preventive expenditure method]
= [Amount of soil erosion without vegetation]
x [Unit cost for check dam construction to control or mitigate the washed-away soil]

Watershed degradation contributes to increased flooding in two ways. First, tree cutting and other land disturbance reduce the water holding capacity of the soil, causing larger peak flows of drainage after rain storms. Second, the sediment that erodes from the stripped or disturbed land fills the beds of rivers and lakes, allowing flood water to rise above the river and lake banks. The value of flood damage resulting from watershed degradation could be estimated as the value of the incremental amount of increased flooding or decreased flood control capacity.

Strengthened flood control capacity → Change in environmental quality → Human habitat
→ **Replacement Cost Method**
[Benefit] = [Reduced cost to rehabilitate damages due to mud-slide and flooding]
= [Cost to restore damaged land and building] + [Cost to remove mud and water]
+ [Repair cost of paddy dikes] + [Cost to rebuild or relocate damaged infrastructure]
+ [Other expenditure in rehabilitation]

When land and buildings are damaged, the measure of damage should be calculated as the cost to restore them to their original condition. The restoration activities might include removal of mud and dust, repairing of buildings and paddy dikes, and finding temporary accommodation while the buildings are being repaired. Roads, bridges, pipelines, electrical power lines and other public infrastructure could be damaged by mud slides and flooding associated with land disturbance activities in the watershed. The value of the damage in these cases could be calculated as cost to rebuild or relocate the damaged infrastructure.

The next equation reflects that the loss of revenue from lost farm production is a value of the strengthened erosion- and flood-control capacity when agricultural land is covered by mud slides.

Strengthened erosion and flood control capacity → Measurable change in agricultural production
→ Non-distorted market prices → **Change-in-Productivity Method**
[Benefit] = [Agricultural area protected from erosion]
x [Incremental products] x [Unit market price of product]

(4) Air Purification

Oxygen supply function of the incremental vegetation is evaluated by calculating the oxygen weight discharged from the vegetation based on the existing research data, which is multiplied by unit market price of the industrial oxygen. And amount of CO_2 absorbed by the incremental vegetation is estimated for calculation of a total cost to remove them alternatively. This total cost is regarded as an economic value of the air purification function of the incremental vegetation.

Improved air quality → Change in environmental quality → Air quality
→ **Replacement Cost Method**
[Benefit] = [Amount of incremental vegetation]
x {[(Annual net O_2 discharge per vegetation) x (Unit market price of O_2)]
+ [(Annual net CO_2 absorption net vegetation) x (Unit removal cost of CO_2)]}

(5) Aesthetic and Recreational Amenity, and

(6) Biodiversity Services

The value of the aesthetic quality of the natural environment is difficult to calculate in monetary terms, because it depends on the subjective preference of each individual person. One approach to assigning a monetary value to aesthetic qualities is to estimate how much the people living in and around the area would pay to preserve them (willingness to pay, WTP). The cumulative regional WTP could be interpreted to be equal to the overall value of restoring the aesthetic quality of the environment. In addition, It is likely that Malaysian and international tourists who visit the National Park would also be willing to pay some small amount of money such as a surcharge on hotel room rates for preserving the aesthetic quantities of the Park.

Aesthetic and biodiversity quality → Change in environmental quality → Aesthetics, biodiversity
→ **Contingent Valuation Method**
[Non-use benefit including existence value]
= [Average WTP of non-use value of local households] x [Number of local households]
+ [Average WTP of non-use value of tourists] x [Number of tourists]

Conserved or improved aesthetic quality → Change in environmental quality → Recreation
→ **Travel-Cost Method** or **Contingent Valuation Method**
[Use-benefit by travel cost method]
= [Average travel cost of tourists] x [Incremental number of tourists]
+ [Average travel cost of local visitors] x [Incremental number of local visitors]
Where [Travel cost] = [Transportation fee] + [Time cost] + [Opportunity cost of stay]
[Use-benefit by contingent-valuation method]
= [Average WTP of use value of local households] x [Number of local households]
+ [Average WTP of use value of tourists] x [Number of tourists]

Tourism accounts for a part of the trade of goods and services in and around the National Park. A majority of tourists visiting the Park could be classified as “Adventure and Eco-tourists” enjoying the natural landscape of the area.

Conserved or improved aesthetic quality → Measurable change in tourism production
Non-distorted market prices → **Change in Productivity Method**
[Benefit] = [Incremental tourists due to environmental improvement or conservation]
x [Incremental net profit of tourism sector per tourist]

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(7) Improved Forestry Resources

Forests provide several valuable goods and services, including wood products, flood control by stabilizing soil, aesthetic quality and habitat for wildlife. Potential methods for calculating the value of the loss of flood control and aesthetic quality are mentioned in the above sections, respectively. The value of loss of timber and other wood products could be estimated as the overall income that would be derived from harvesting, processing, and selling the products on a sustainable logging on land of similar area, tree types, proximity to roads and factories, etc. where watershed management has been well done.

Improved forestry resources → Measurable change in forestry production
→ Non-distorted market prices → **Change in Productivity Method**
[Benefit] = [Incremental forest land] x [Amount of incremental forest goods]
x [Unit market price of forest goods]

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(8) Conserved or Improved Fishery Resources

Siltation of river/lake beds and other fish habitat is the main source of environmental damage that poor watershed management causes to fishery resources. Top soil is eroded during heavy rain, and the sediment drains into these sensitive aquatic areas decreasing their ability to support fish life. The value of the damage to fishery resources might be estimated as the loss of fishing income caused by the siltation of fish habitat.The loss of fishing income might be estimated directly or indirectly. If historical records were available, it might be possible to directly estimate the reduction in fishing income. But these results might be unreliable because such factors as improved fishing techniques and boats, increase in the sale price of fish, and increases in the number of people who work in the fishing industry must all be considered. In addition, this direct estimate might unfairly bias against the watershed management, because the other factors such as over-harvesting and pollution from the inland fishery itself might have contributed to the decline in fishing. Consequently, an indirect method of comparison would probably give better results.

Conserved or improved fishery resources → Measurable change in fishery production
→ Non-distorted market prices → **Change in Productivity Method**
[Benefit] = [Improved or conserved water area]
x [Amount of incrementally caught fish and other fishery products]
x [Unit market price of such fishery products]

(9) Improved or Conserved Agricultural Resources

The extension program of agroforestry technology would increase productivity of the existing agricultural land. This could be a major benefit, so that the incremental agricultural products between with-project and without-project are evaluated with non-distorted market prices.

Improved agricultural resources → Measurable change in agricultural production
→ Non-distorted market prices → **Change in Productivity Method**
[Benefit] = [Amount of incremental agricultural products]
x [Unit market price of the agricultural products]

8. Results of Economic Evaluation for Natural Ecosystem in Sabah

In accordance with the existing data and information available, the most appropriate evaluation methods were selected and economic values for various environmental functions have been measured for such typical ecosystems in Sabah as natural forest, commercial forest and agricultural land. As shown in Table 5, annual overall value of the natural forest seems much higher than the other two ecosystems, although their non-use value of biodiversity services could not be calculated due to lack of data.

“6. Biodiversity services” for the natural forest has been calculated with statistical data (Table 6) collected through questionnaire survey to tourists and local residents around the Kinabalu Park. In order to measure the value for the commercial forest and agricultural land, another questionnaire survey should be carried out to apply the contingent valuation method, furthermore “conjoint analysis” which had been also tried under the current study but resulting in statistically insignificant outputs unfortunately.

Table 5 Economic Values of Environmental Functions

Environmental Functions	Evaluation Methods	Economic Value (RM/ha/year in 2003 price)		
		Natural Forest	Commercial Forest	Agricultural Land
1. Fostered water resources	Replacement cost	91	102	21
2. Conserved water quality	Preventive-expenditure	29,693	7,423	Not related
3. Erosion & flood control	Replacement cost, Change-in-productivity	21,391	5,348	Not related
4.Air purification (including CO_2 absorption)	Replacement cost	24,006	27,828	Little data
5. Aesthetic & recreational amenity	Travel cost	8,735	Not related	Not related
6. Biodiversity services (non-use)	Contingent valuation	112,024,000	Little data	Little data
7. Forestry resources	Change-in-productivity	Not related	51～89	Not related
8. Agricultural resources	Change-in-productivity	Not related	Not related	1,917～19,940
9. Improved fishery resources	Change-in-productivity	1.45	0.36	Not related

Table 6 Average Value for Biodiversity Services

Subject	Unit	Foreign Tourists	Malaysian Tourists	Local Residents
Number of Samples	person	97	76	24
1. Biodiversity of natural forest	\$/ha/year	58	10	5
2. Biodiversity of commercial forest	\$/ha/year	37	9	6
3. Average value for flora	\$/species/year	0.9	0.2	0.1

Note） US\$ 1＝RM 3.8

9. Contribution to Forest Policy/Project by Environmental Economic Evaluation

CO_2-absorption function of forest resources is expected as incentive to prevent decrease of a tropical forest. Actually, the forest certification, CDM and ISO14001 has become powerful systems to implement so-called "corporative social responsibility"(CSR). However, the CDM project and the forest certification project should not be managed only as CO_2 absorption source, but also for sustainable forest management. For example, further environmental consideration should be taken such as targeting secondary forests rather than natural forests when a plantation expands.

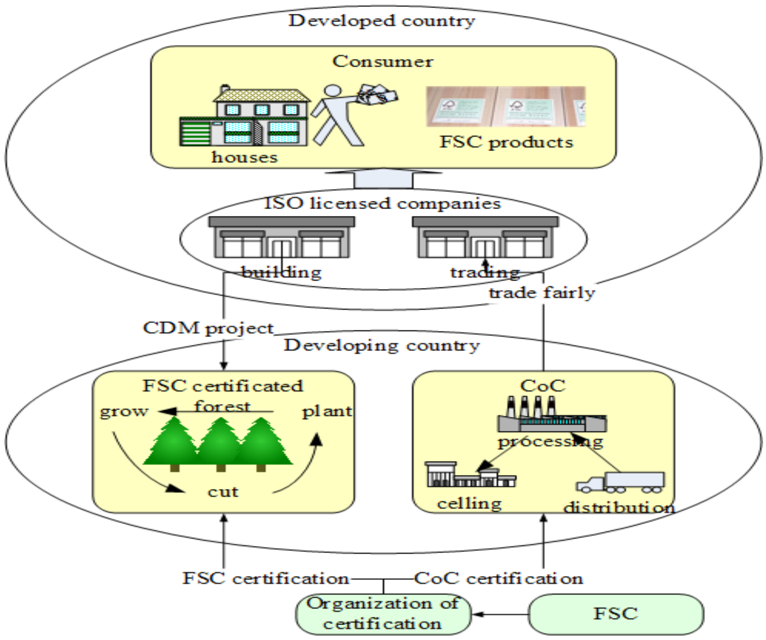

Figure 2 Structural Example of Sustainable Forest Management

As Figure 2 shows, additional value can be added to the certified woods by means of putting the certification labels because of the recent activation of green consumerism. Private foresters can improve their social images through selling eco-friendly certified products. The certified forests help prevent environmental destruction by afforestation managed with technical standards regulating logging methods, tree species and maintenance of logging roads for biodiversity and security of the employment. Environmental value of the certified woods has already been internalized, for example setting the price of certified woods at 20% higher than the non-certified woods.

In activating more and more such environment-oriented forestry systems, the environmental economic evaluation approach focused in this study is quite useful clarifying the objective environmental values of the systems and persuading both foresters and consumers to be actively involved into the sustainable forestry and environmental conservation.