MARKET-BASED VALUATION APPROACH

Prepared by

Awang Noor Abd. Ghani
Department of Forest Management
Faculty of Forestry
Universiti Putra Malaysia
43400 UPM Serdang, Selangor

1. Introduction

The use of environmental goods and services may alter economic activities for development purposes and this will change the monetary revenues and costs of the economic activities. Thus, the change in revenues and costs can be used to value the change in the environment. In this case, we can easily measure the value of a benefit as an increase in revenue or as a decrease in monetary outlay, and cost is an increase in monetary outlay or as a reduction in revenue.

The primary characteristic of this approach is to use of actual market prices whenever available. This makes possible because many environmental goods and services are traded in the market, either locally or internationally. For instance, timber harvest from the forest is traded at the local market as well as for export. The price of timber and associated cost of timber harvesting can be used to value its stumpage (i.e. standing tree in the forest, either dead or alive). Proper prices for environmental goods and services must be determined in order to impute the benefits and costs for planning, benefit cost analysis, resource accounting, and other purposes.

In a competitive market, where the price of goods and services are at their equilibrium, every economic commodity would be priced at its marginal value product (MVP). That is, the price of every good and service would exactly equal that the last unit utilised contributes to production, or the value in use of the item for consumption would exactly balance the value it could contribute to additional production.

The market price is used in both financial and economic analyses. But to be used in economic analysis, the market price need to be adjusted for any market distortions. In financial analysis, we use market price to indicate the willingness to pay for the exchange of right. This is usually taken from perpective of the individual, private frim, or company concerned out of pocket cash flow. Whatever benefits and costs incurred by the society is not taken into account. The benefits and costs are evaluated in monetary terms using market prices and taking into account subsidies, taxes, and other transfer payments.

However, in economic analysis, we normally use shadow price or accounting price because this involves the real exchange of resource utilisation to the economy. Economic analysis is carried out from the community, society or public point of view. Thus, the financial price should be be corrected for market failures (distortions, imperfections) and policy failures if the values are to be in economic terms. The financial value of goods and services need not be corrected for market distortions or policy failures.

Box 1. Principle

Market-based approach use the market price of goods and services to value environmental goods and services. The price should be be corrected for market failures (distortions, imperfections) and policy failures if the values are to be in economic terms. The financial value of goods and services need not be corrected for market distortions or policy failures.

2. Categories of Valuation Techniques Based on Market Approach

Economic value of environmental goods and services using market-based approach, can be estimated either from the benefit or cost point of view (Hufschmidt, et al. 1983). This classification is depicted in Figure 1. From the benefit side, the available techniques are:

2.1 The change-in Poductivity Technique (Market value or productivity approach)
2.2 The change-in income technique (Human capital, Forgone earnings approach)

These techniqes assess the production of a particular environmental good or service and the value is imputed in accordance to the benefits derived from economic activities.

While from the cost side, the techniques comprise three groups (IIED, 1997):

Group 1:

2.4 Opportunity cost approach

Group 2:

2.5 Replacement cost approach
2.6 Restoration cost technique
2.7 Damage cost avoided

Group 3:

2.8 Preventive expenditure method (Defensive expenditures or Exclusion facilities)

These techniques assess the costs of different measures that would ensure the maintenance of the benefits provided the environmental good and service that is being valued. These cost estimates are then used to impute enviornmnetal benefits.

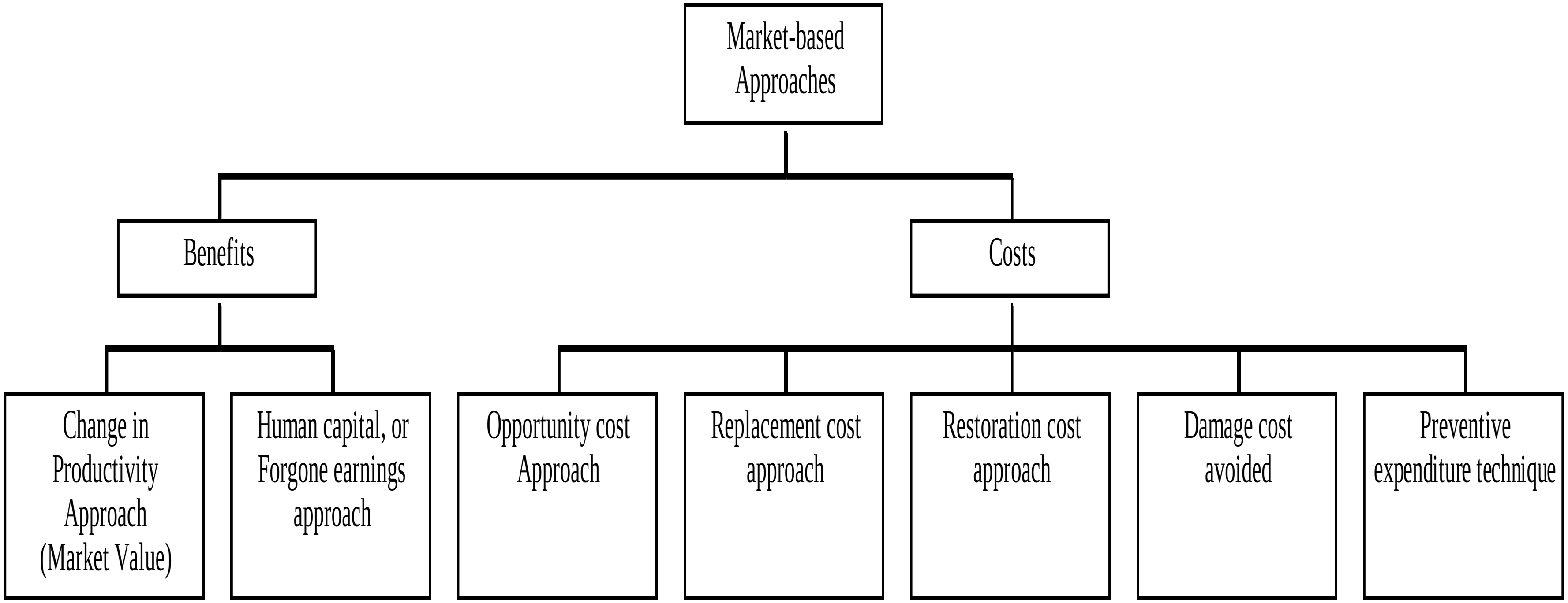
It should be note that the cost based techniques should be used with caution because of the following problems:

- The estimates do not actually measure the demand or willingness to pay (WTP) for environmental goods and services.

- Investment in maintenance is not a profitable use of economic resources, thus the cost of maintenance may be larger than the WTP for the original environmental benefits.

- Supply of capital and labour for maintenance activities is perfectly inelastic, and additional demand generated by these activities might raise the market prices of these inputs. Thus, it might overestimate the cost of maintenance.

Figure 1. Taxonomy of Market-based Valuation Technique



3. Change-in Productivity Approach (Market value)

The Concept

This is an application of straightforward benefit cost analysis, in which market price is used to value the output from a production process. Values from a change in the enviornment can be derived from associated change in productivity. An increase in output due to change is a measure of an increase in benefit, and a decrease in output is a measure of an increase in cost. Values for a change in the environment can be derived from the associated change in productivity. Thus,

- An increase in output due to the change is a measure of an increase in benefit

- A decrease in output is a measure of an increase in cost

The emphasis is on economic valuation of environmental quality effects on natural or human built system. The effects on these systems are reflected in the productivity of the systems and in the products that derive from them and enter in the market transactions. Changes in environmenatl quality lead to changes in productivity and production costs which change the prices and the levels of outputs, which can be observed and measured in the marketplace.

Examples:

- Does the minimum benefit of noise control cover the cost
- What are the economic effects or reducing emissions of green house gases
- What are the economic effects of soil conservation program
- What are the economic effects of reduced impact of logging
- Reduction in soil erosion may stabilize or increase rice paddy yields

The assumptions of this technique including the followings:

(1) No change in factor prices

If the output increase is small relative to the total market for output, and if the increase in inputs is small relative to market for input, it can be assumed that output and inputs will remain constant after a change in output. In this case, the projected output change can be multiplied by market prices to obtain the economic value of the change. This is done through:

- Calculate gross margin for each unit of output
- Use aggregate farm or project level budgets (total revenue minus total cost) for the with and without project sitaution
- Estimate changes in land values per hectare as a result of changes in productivity

Calculate gross margin for each unit of output

The gross margin is given by:

GM = (q x P) - (q x variable cost)s)

where q is the one unit of q, Q is total output, P is market price

The estimated gross margin for the whole output Q is given by:

Net change = Q x GM

The net benefit of the program or project is given by:

NB = Q x GM - cost of the project (fixed + operation + maintenance and replacement)

Use total farm budgets for with and without situations

This is usually done by identfying abd valuing the costs and benefits that will arie with the proposed project and to compare them with the situation as it would be without the project. The difference is called the incremental net benefit arising from the project investment. The conceptual framework for this analysis is given in table below:

Item	Year					
	1	2	3	..	..	t
With project: (Environmental Conservation)						
Benefits (B^W)	(B_1^W)					(Bt^W)
Costs (C^W)	(C_1^W)					(Ct^W)
NB^W (1)	NB_1^W					NBt^W
Without project:						
Benefits (B^{WO})	(B_1^{WO})					(Bt^{WO})
Costs (C^{WO})	(C_1^{WO})					(Ct^{WO})
NB^{WO} (2)						
Incremental Net Benefit (INB) (1-2)	**INB_1**	**INB_2**				**INB_t**
Discount factor	**$1/(1+r)^1$**	**$1/(1+r)^2$**				**$1/(1+r)^t$**
Present Value of Increme Incremental Net Benefits	**$INB_1*1/(1+r)^1$**	**$INB_{12}*1/(1+r)^2$**				**$INB_t*1/(1+r)^t$**

Calculate the NPV of Incremental Net Benefits:

$$\mathbf{NPV = INB_1*1/(1+r)^1 + INB_2*1/(1+r)^2 + INB_3*1/(1+r)^3 + ... + INB_t*1/(1+r)^t}$$

NPV = net present value
INB = incremental net benefit
r = interest rate
t = year, t=1,......,n

(2) Changed factor prices

Increase output Q affects the output and factor prices. This requires demand and supply curves whereby these curves need to be estimated so that price elasticity of demand can be determined. Assuming a linear demand curve, then the price effect, P, as a result of changes in the production of the good, Q, can be calculated. Thus the gross benefit of the extra output can be calculated as follows:

$$GB = Q \times \left(\frac{P\ before + P\ after}{2}\right)$$

The problem with this approach is market distortion (taxes, subsidies, etc.), which requires adjustment to correct this distortion. In this case, we need to calculate import or export parity prices if the good is internationally traded.

Finding market price

In order to obtain market price, we can gather the information from many sources. We normally obtain actual prices in recent transactions and consult many sources. For example, we can obtain information from published reports, statistical bulletins, and other secondary sources published by the government or private agencies. Information can also be obtained through primary sources such as personal interviews, mail questionnaires, telephones interviews, etc. with relevant agencies, social groups, individuals and so forth.

Market price

- Find prices that reflect the prevailing market value

- Rule: determining the price at "point of first sale". Example, in agriculture, "the boundary of the farm". This is known as "farm gate price". In forestry, "the boundary of the logging compartment. This is known as "stumpage price" or 'ex-metau price".

- Sources of market clearing or efficient price:

To calculate farm gate price, we need to whether the good or service is locally traded, internationally traded, or a combination of locally made good and imported item.

Farm gate (locally traded)
Import parity price (internationally traded good)
Export parity price (internationally traded good)

- For locally traded good or service, use market price to calculate financial value
- For internationally traded good, calculate the import or export parity price

Box 2

Step In Calculation: Financial Export Parity Price

C.i.f. at point of import (foreign)

Deduct: unloading at point of export
Deduct: freight to point of import
Deduct:insurance
***Equals*:f.o.b. at point of export (domestic)**
Convert: foreign currency to domestic currency at official exchange rate
Deduct:tariffs, or *add* subsidy
Deduct:local port charges
Deduct:local transport and marketing costs from project to point of export
(if not part of project cost)
***Equals*:export parity price at project boundary or central market**
Conversion allowance if necessary (e.g. log to sawntimber)
Deduct: local storage, transport and marketing costs
(if not part of project cost)
***Equals*:export parity price at farm gate**

Box 3

Step In Calculation: Financial Import Parity Price

C.i.f. at point of import (foreign)

Add: freight to point of import
*Add:*unloading at point of import
*Add:*insurance

***Equals*:c.i.f. at point of import (domestic)**
Convert: foreign currency to domestic currency at official exchange rate
Add:tariffs, or deduct subsidy
Add:local port charges
Add:local transport and marketing costs from project to point of export
(if not part of project cost)

***Equals*:import parity price at project boundary or central market**
Conversion allowance if necessary (e.g. log to sawntimber)
Deduct: local storage, transport, and marketing costs
(if not part of project cost)

***Equals*:import parity price at farm gate**

Shadow price or accounting price

In financial analysis, there is no need to calculate shadow price because market distortions do not affect the real resource flow in the economy.

However, in economic analysis, shadow price must be determined since ‘proper’ price should reflect the true economic value. The true economic value should account for market distortions which results in either market or policy failures.

Market failures are due to:
- public good/open access good
- externality
- monopoly
- incomplete information
- property rights are not well defined

Policy failures are due to:
- intervention/regulation
- high exclusion cost
- exchange rate control
- subsidies/taxation
- price ceilings
- quota/non-tariff barriers

Once the financial value of the costs and benefits have been determined, it must be valued in terms of economic value in order to reflect the value to society as a whole

In some cases the market price may be used as a rough approximation of the economic value of the good or service, in particular when changes to the market price are trivial and involve complex mathematical calculations or constraints by data availability. However, in other cases it may be possible and appropriate to adjust the market price to correct for major market and policy failures

In calculating economic value, some adjustments are needed:

- adjust for direct transfer payment
- adjust for price distortions in traded items
- adjust for price distortions in non-traded items
- adjust for foreign exchange premium

- Adjust for direct transfer payment

Direct transfer payments include direct taxes, direct subsidies and credit transactions (loans, receipts, repayment of principal, and interest payments)

- Adjust for price distortions in traded items

There are also many instances in estimating the economic value of a traded commodity that involve deriving a shadow price based on international prices. In such instances it is necessary to calculate export or import parity prices. These are the estimated prices at the farm gate or project boundary, which are derived by adjusting the c.i.f. (cost, insurance, and freight) or f.o.b. prices (free on board) by all the relevant charges between the farm gate and the border price and the point where the c.i.f. or f.o.b. price is quoted.

This involves removing any indirect transfer payments that operate through changing market prices of traded goods and services. The basic approach is to adjust the border price of the good or service for domestic transport, marketing costs, and profit margin incurred between the boundary (or farmgate) and the border.

Box 4

Elements of C.i.f. and f.o.b.

C.i.f.*Includes:*

F.o.b. cost at point of export
Freight charges to point of import
Insurance charges
Unloading from ship to pier at port

Excludes:

Import duties and subsidies (exclude in economic analysis)
Port charges at port of entry for taxes, handling, storage agents fees, and the like

F.o.b.*Includes:*

All costs to get goods on board--but still in harbour of exporting country
Local marketing and transport costs
Local port charges including taxes, storage, loading, fumigation, agents' fees, and the like
Exclude: Export taxes and subsidies
Project boundary price
Farm-gate price

Box 5

Step In Calculation: Economic Export Parity Price

C.i.f. at point of import (foreign)

Deduct: unloading at point of export
Deduct: freight to point of import
Deduct:insurance

***Equals*:f.o.b. at point of export (domestic)**

Convert: foreign currency to domestic currency at official exchange rate (OER) if using SCF approach, or at SER if using SER approach

Exclude:tariffs, or subsidy
(For the following items, care must be taken when using SCF approach, in that all values must be multiplied by SCF to calculate the economic value. If the SER is used the market value is used, i.e. there is no need to multiply by the SCF)

Deduct:local port charges
Deduct:local transport and marketing costs from project to point of export (if not part of project cost)

***Equals*:export parity price at project boundary or central market**

Conversion allowance if necessary (e.g. log to sawntimber)
Deduct: local storage, transport and marketing costs (if not part of project cost)

***Equals*:export parity price at farm gate**

Box 6

Step In Calculation: Economic Import Parity Price

C.i.f. at point of import (foreign)

Add: freight to point of import
*Add:*unloading at point of import
*Add:*insurance

***Equals*:c.i.f. at point of import (domestic)**

Convert: foreign currency to domestic currency at official exchange rate
Exclude:tariffs, or deduct subsidy
(For the following items, care must be taken when using SCF approach, in that all values must be multiplied by SCF to calculate the economic value. If the SER is used the market value is used, i.e. there is no need to multiply by the SCF)
Add:local port charges
Add:local transport and marketing costs from project to point of export (if not part of project cost)

***Equals*:import parity price at project boundary or central market**

Conversion allowance if necessary (e.g. log to sawntimber)
Deduct: local storage, transport, and marketing costs (if not part of project cost)

***Equals*:import parity price at farm gate**

- Adjust for price distortions in non-traded items

Remove any price distortions in non-traded items. If the domestic price is a good estimate of the opportunity cost, then this can be used as the economic value. However, if the market price for non-traded good or service is distorted due to market or policy failures then the shadow price needs to be determined. Example: using rural wage rates to value agriculture or agriculture-based activities may be misleading when there is surplus labour in the low seasons and the marginal value product of the additional worker is much lower than the going wage rate.

- Adjust for foreign exchange premiums

National trade policies that restrict free flow of internationally traded commodities (e.g. bans on log exports, quotas on timber imports, tariffs on imported goods and subsidies on exported goods) and over (or under) valued exchange rates may lead to individuals paying a "premium" on traded goods over (or below) what they pay for non-traded goods which is generally referred to as foreign exchange premium (FXP).

There are two approaches to incorporate the foreign exchange premium in calculating shadow price:

(i) Shadow exchange rate (SER) approach
(ii) Standard conversion factor (SCF) approach

The relationship between the shadow exchange rate (SER) approach, standard conversion factor approach (SCF), and foresign exchange premium (FXP) is illustrated in Box 7. Box 8 shows examples of calculation of foreign exchange premium, shadow exchange rate and standard conversion factor. Box 9 shows the framework for calculating inrenatinally traded goods using the shadow exchange rate or stabdard conversion factor approaches.

Box 7

Formula

SER = OER x (1+FXP)

SCF = 1 / (1+FXP)

SER = OER / SCF

SCF = OER / SER

Box 8

Examples of calculation of Foreign Exchange Premium, Shadow Exchange Rate and Standard Conversion Factor

Foreign Exchange Premium: percentage overvaluation of the domestic currency
(1+FXP) estimated as; $[M(1+t_m) + X(1-t_x)] / [M+X]$
where:

M= CIF value of imports (in domestic currency)
t_m= average *ad valorem* import tariff rate
X= FOB value of exports (in domestic currency)
t_x= average *ad valorem* export tax rate

Example:

CIF value of imports in foreign currency = US$100
Official exchange rate (OER)= RM3.8 per US$1.00
Ad valorem import tariff= 30%
FOB value of exports in foreign currency= US$50
Ad valorem export subsidy = 20% (-20% export tax)
Hence:
M = US$100x3.8 = RM380
X = US$50 x 3.8 = RM190

(1+FXP) = [380*(1.3) + 190*(1.2)] / [380 + 190] = 722/570 = 1.267

NB: Commodity-specific tariff and subsidy rates can be incorporated:

Example:

Two items imported, US$100 (tariff=30%) and US$200 (tariff=25%). Exchange rate, exports and export subsidy rate as above.

(1+FXP) = [380*(1.3) + 760*(1.25) + 100*(1.2)] / [380 + 760 + 190] = 1564 / 1330 = 1.176

Calculation of SER (using (1+FXP) = 1.267)

SER = OER x (1+FXP) = 3.8 x 1.267 = 4.815

Calculation of SCF

SCF = 1 / (1+FXP) = 1 / 1.267 = 0.789
or SCF = OER/SER = 3.8 / 4.185 = 0.789

Box 9

Economic Valuation of Traded Goods

A. When starting from the border price (defined as the CIF or FOB price multiplied by the official exchange rate (OER)).

Two things can be done:

1. Shadow exchange rate (SER) approach: adjust for the foreign exchange (FX) premium.

= border price x (1+FX premium)
= border price x (1+% overvaluation of domestic currency)
= CIF or FOB x SER (since SER = OER x (1+FX premium)

2. Standard conversion factor (SCF) approach: border price needs no adjustment, since SCF applied only to non-traded goods. So,

--use CIF or FOB x OER

B. When starting from the domestic market price

1. SER approach:

- adjust for transfers (remove taxes, tariffs, subsidies)
- this gives the border price (assuming no transport costs)[1]
- multiply border price x (1+FX premium)

2. SCF approach

- adjust for transfers
- this gives the border price (assuming no transport costs), which needs no further adjustment

---

[1] If the domestic market price pertains to a location in the interior of the country, it would probably include costs of transport and handling associated with moving the product from the border to that location. In calculating the project-level economic price, these transport and handling costs might have to be adjusted up or down.

Example of Calculating Import Parity Price for A Good (e.g. Rice, Log)
(Financial and Economic Value)

Assumptions:
1. Use real price
2. Overvaluation of FXP 10%
3. OER = RM3.8=US$1.00
4. Tariff rate: 30%
Therefore:SER = OER x (1+FXP) = 3.8 x 1.1 = 4.18
SCF = 1/(1+FXP) = 1/(1.1) = 0.909 or SCF = OER/SER = 3.8/4.18 = 0.909

Item	**Financial Value**	**Economic value**	
		Using SER	Using SCF
Take: FOB at port of export (Thunder Bay)	US$201.40	US$201.40	US$201.40
Add: Freight to port of import	US$20.53	US$20.53	US$20.53
Add: Insurance			
Add: Unloading at port of import			
Equals: CIF at point of import	US$221.93 (x OER)	US$221.93 (x SER)	US$221.93 (x OER)
Convert foreign currency to domestic	RM843.33	RM927.67	RM843.33
Add: Tariffs (0.3x843.33)	253.00		
Deduct: Subsidies			
Add: Local port charges	20.00	20.00	18.18
Add: Local transport and marketing cost to relevant market (KL)			
bagging	2.00	2.00	1.82
bags	10.00	10.00	9.09
transport	40.00	40.00	36.36
importers' overhead	45.00	45.00	40.91
Equals: Market price (KL)	1213.33	1044.67	949.69
Deduct: transport and marketing costs from project			
Wholesales' margin	-40.00	-40.00	-36.36
transport	-25.00	-25.00	-22.73
bagging	-2.00	-2.00	-1.82
bags	-10.00	-10.00	-9.09
Deduct: Loading, handling and storage costs at project			
transport	-2.00	-2.00	-1.82
storage	-10.00	-10.00	-9.09
Equals: Import parity price (value)	**1124.33**	**955.67**	**868.78**

Using Imported Sabah Log To Calculate Financial and Economic Value of Log Price For Semenanjung Malaysia (Log Banned From Semenanjung)

Assumptions:
1. 10% import duty of log
2. Species: Keruing
3. OER = RM3.8 = US$1.00
4. Overvaluation of FXP = 10%

SER = OER x (1+FXP) = 3.8 x 1.1 =4.18

SCF = 1/(1+FXP) = 1/(1.1) = 0.909 or SCF = OER/SER = 3.8/4.18 = 0.909

Item	Financial value	Economic value	
		Using SER	Using SCF
FOB at KK (domestic currency, RM)	180	180	180
Add: transport (US$17)	64.60 (17 x 3.8)	71.60 (17x4.18)	64.60 (17x3.8)
Add: Port charges	16	16	14.54
Add: tax (.10 x 180)	18		
Equals: CIF at Port Klang	278.60	267.60	259.14
Add: Local transport and marketing to KL	16.00	16.00	14.54
Equals: market price (KL)	294.6	283.60	273.68
Deduct: Transport from mill, including profit margin (project boundary or betau)	33.00	33.00	30.00
Equals: Import Parity Price	261.60	250.6	243.68

4. The change-in Income Technique

Income can be lost due to loss of work from ill health, premature illness or death. Public implicitly places values of human life and illness in day-to-day safety health, and environmental quality decisions.

Monetary damages associated with health effects comprise three components:

- forgone earnings through premature death, sickness or absenteeism
- increased medical expenditures
- physic costs

This problem could be due environmental effects (e.g. pollution)

Income can be gained due to improvement in health, postponed illness and fewer deaths

Changes in health are due to changes in the effect:

- the loss in health is an environmental cost
- the gain is environmental benefit6

Thus, effect can be valued as a change in income

Theoretically, premature illness or death, social costs are incurred by the partial or total loss of the individuals services to society. The value of life or working lost is usually equated with the value of individual's labour, assuming the validity of the theory of marginal productivity of labour. The value of an individual's labour is the individual projected future earnings, discounted to the present with age, sex and education

The loss earning function can be written as:

$L_I = \Sigma Y_t * P^t_T * 1/\{(1+r)^{-(t-T)}\}$

where:

Y_t = expected gross earnings (value added by the person during the t-th year, exclusive of any yields from his ownership of non-human capital)
P^t_T = probability of the person being alive during the year
r = social discount rate

In this case, human is viewed as a unit of capital. However, there are problems to value the followings:

- children
- home makers
- retired workers
- handicapped people

The value is zero for unemployed or not paid direct wage. For homemakers can use average wage rate. For non-productive workers of the population the value is zero.

Applications:

- Do pollution control regulation increase incomes
- Do the benefits of pollution control regulations exceed the costs
- Do the benefits of more stringent regulations exceeded the costs

What need to be done:

Monetary values would need to be estimated for the benefits of improvement in health from sulphur oxide control. Effect of sulphur oxide concentration of several strategies for pollution management was predicted and a linear relationship was assumed between reductions of sulphur oxide and increase in the number of working days. The increase in wages due increased pollution control was calculated for each area from the predicted decrease in working days. The benefits of pollution control were identified as the increase in wages.

As an example, to calculate the value of human life in terms of forgone earnings for premature death, the following steps are followed:

a. Calculate total-output approach to Calcutta forgone earnings using the following formula:

$$V_x = \sum_{n=x}^{\infty} \frac{(P^n{}_x)_1 * (Pnx)_2 * (P^n{}_x)_3 * Y_n}{(1+r)^{n-x}}$$

where:

V_x = present value of the future earnings of an individual at age x,
$(P^n{}_x)_1$ = probability that an individual of age x will be alive at age n,
$(P^n{}_x)_2$ = probability that an individual of age x will be alive at age n will be in the labour force,
$(P^n{}_x)_2$ = probability that an individual of age x will be alive at age n in the labour force will be employed at age n,
Y_n = earnings at age n, and
r = discount rate.

b. Calculate the cost of different diseases related to air pollution by age group and sex.

c. Calculate the loss earnings using the expected gross earnings

Age	Number of deaths	Present value of earnings per individual using discount rates of		Total loss from premature death using discount rates of	
		0.05	0.10	0.05	0.10
10-14	7	47,624	17,826	333,368	124,782
15-19	4	49,800	28,635	199,200	112,140
20-24	3	69,676	37,690	209,028	113,070
25-29	6	73,143	43,098	438,858	258,588
30-34	7	70,523	43,982	493,661	307,873
35-39	11	64,038	41,834	704,418	460,174
40-44	23	55,638	38,129	1,279,674	876,967
45-49	30	45,836	33,077	1,375,080	992,310
50-54	84	35,001	26,690	2,940,084	2,241,960
55-59	150	23,419	18,920	3,512,850	2,838,000
60-64	269	11,685	9,917	3,143,265	2,667,673
65-69	314	4,056	3,559	1,273,584	1,117,526
70-74	268	692	951	185,456	174,468
Total losses	1,176			16,126,000	12,285,532
Average loses per individual				13,713	10,447

Source: Hufschmidt et al. (1983)

5. The Opportunity Cost Approach

The underlying concept of opportunity cost approach is that the opportunity cost of unpriced uses (e.g. conservation of forest for national park instead of timber production) can be estimated from the forgone income from other uses, such as agriculture or forestry.
This approach measures what have to be given up for the sake of conservation; it does not measure the benefits of land conserved for unpriced uses. The valuation of unpriced benefits can be estimated using other non-market techniques. For instance, the recreational benefits can be estimated using the travel cost method.

For the individual goods, the opportunity cost approach can be estimated when individual labour is involved in harvesting and collection. The implicit assumption is that the decision to spend time in the collection and harvesting of a good is weighted against alternative productive uses of labour. Thus, the opportunity cost of time spent in these activities can be used to impute the value for the benefits brought by consumption of good collection of harvesting. In this case, data required include the time and efficiency of collection activity, and the wage rate (rural).

Some development projects are incompatible with sustainability of natural ecosystem and have negative externalities. The project may change the original ecosystem and it may be destroyed and difficult to re-establish. In such cases, the opportunity cost of the project is the present value of the net benefits accruing from natural ecosystem as a conservation for indefinite time spent in the future. It should be noted that these benefits might be difficult to measure. Conversely, the opportunity cost of conservation is the present value of development benefits forgone. If conservation and development is considered as mutually exclusive, the economically efficient use of the resource is the one that maximizes the present value of net benefits. The rate of discount is important in this analysis. Using a low discount rate on future conservation benefits may not be sufficient

6. Replacement Cost Technique

The technique identifies the expenditure necessary to replace an environmental resource or a human made good, service or asset. Expenditure actually incurred on replacement is a measure of the minimum willingness to pay to continue to receive a particular benefit. It gives only a minimum estimate because more may have been spent had it been seen to be necessary to do so.

The main assumption of this technique is that replacement is worth doing. That is, the individuals who undertake replacement have revealed a WTP for the improvement that is as high as the replacement cost. However, if they do not undertake the replacement activities, their WTP is below this cost. This is based on the assumption that the individuals have correct information about environmental damage. It is a proxy method in the absence of a more direct measure of the welfare loss incurred.

To demonstrate the application of Replacement Cost Approach, the case study as reported by Kim and Dixon (1986) is used.

In the case study, the productive asset that has been damaged is the soil in the upland areas. leaching of nutrients and soil erosion have both occurred and have reduced the value of the land by reducing its productivity. The cost of soil physical replacing lost soil, restoring lost nutrients, and compensating for downstream losses is measured. this is the replacement cost that will maintain the productivity of the system and compensate for off-site damages.

There are several steps to conduct the replacement cost approach.

Stage 1. estimate the physical soil loss

The soil loss was estimated through actual survey or estimated using the Universal Soil Loss Equation (USLE). The average soil loss estimated using actual survey was 40.35 tons per hectare, while the theoretical loss was 39.9 tons per hectare.

The USLE is given by:

$A = R \times K \times LS \times C \times P$

where:

A = annual soil loss in tons per hectare,
R = rainfall factor,

LS = length and slope factor,
C = cropping factor,
P = erosion control practice factor.

The values of the variables are:

R = 500
K = 0.25 for the sandy loam incheon
LS = 1.2 (average slope of 15%)
C = 0.35 for soybean-barely mix
P = 0.76 for contoured terraces

Therefore, A = 500 x 0.25 x 1.2 x 0.35 x 0.76 = 39.9 tons/ha/year

Stage 2. estimate Nutrient Loss

It was estimated that the annual nutrient loss per hectare was estimated as follows:

Nutrient	Kg lost per ha
N	15.7
P	3.6
K	14.6
Ca	10.6
Mg	1.6
Organic matter	75.4

Stage 3. Estimate cost associated with replacing lost nutrients and soil, cleaning up silted paddy fields downstream, maintaining crop productivity. Assumptions of the data are that crop production, labour inputs, and crop yields are constant over the years.

It is assumed that soil loss from the upland fields will be deposited in streams, rivers, and fields in lower areas. This soil can be dug up and returned. The cost to recover and replace eroded soil in the upland fields is composed of truck rental and spreading costs.

The components of replacement cost are:

(1) Field maintenance and repair

W35,000 per year over 15 year period

(2) Compensation payment due to loss of rice production and valued at local market price (W500 per litre)

Amount loss = 60 litres

Total compensation = W500 x 60 = W30,000 per year

(3) Irrigation costs

Supplemental irrigation is required to replace water lost by runoff. The runoff is estimated at 1,379 tons per hectare. One third of this amount is to be replaced at an average cost of W200 per ton:

1,379 x 0.333 x W200 = W91,841, or rounding to W92,000 per hectare

(4) Soil replacement cost

The cost of dug up and replaced in the fields (truck rental cost and labour for soil recovery and spreading):

W2,000 x 40 = W80,000 per ton per year

(5) Nutrient replacement cost

Nutrient	Kg lost per ha	Cost per kg (won)	Cost per ha (won)
N	15.7	480	7,536
P	3.6	345	1,242
K	14.6	105	1,533
Ca	10.6	60	636
Mg	1.6	1,400	2,240
Organic matter	75.4	175	13,195
Total	121.5		26,382

Spreading or application cost is W40 per kg. Total application cost is W40 x 121.5 = W4,860.

Total nutrient replacement cost W26,382 + W4,860 = W31,200 per year

Summary of annual cost per hectare

Field maintenance and repair	W35,000
Compensation	W30,000
Irrigation	W92,000
Soil replacement	W80,000
Nutrient replacement	W31,200

Stage 4. Determine the interest rate to be used and time frame of the analysis

Interest rate	10%
Time period	15 years

Stage 5. Calculate the net present value of the annual replacement cost of soil and nutrients over the years under consideration using the following formula:

$$\text{Total PV(T)} = \sum_{t=1}^{15} RC_t \times 1/\{(1+r)^t\}$$

where:

PV(T) = present value
RC_t = replacement cost at time t
r = interest rate
t = year

or, we can use the annual equal payment formula:

$$PV(T) = \text{annual RC} \times [\{(1+r)^t - 1\} / \{i(1+r)\}^t]$$

Year (t) Col.1	Replacement cost *Col. 2*	10% discount factor (r) *Col. 3*	Present value (Pv_t) *Col 2 x Col 3*
1	268,200	0.909	243,794
2	268,200	0.826	221,533
3	268,200	0.751	201,418
4	268,200	0.683	183,181
5	268,200	0.621	166,552
6	268,200	0.564	151,265
7	268,200	0.513	137,587
8	268,200	0.467	125,249
9	268,200	0.424	113,717
10	268,200	0.386	103,525
11	268,200	0.350	93,870
12	268,200	0.319	85,556
13	268,200	0.290	77,778
14	268,200	0.263	70,537
15	268,200	0.239	64,100
Total			2,039,661

the present value of replacement costs over 15 year period with a 10 percent discount rate is W2,039,661.

Using the annuity formula we have the same result as follows:

$$PV = 268{,}200 \times [\{(1+0.10)^{15} - 1\} / \{0.10 \times (1+0.10)\}^{15}] = W2{,}039{,}661$$

7. The Relocation Cost Technique

This technique is similar to the preventive-expenditure technique. This means that the cost of activities involved to maintain a level of enjoyment or output are estimated and calculated. In this case, the costs incurred include relocation of individual activities or entire firms or households, communities to a new location rather than adjustments to defend an existing activity at an existing location.

To estimate the cost using this technique, there is a need to know the characteristics of users under current condition.

For example, the benefits of maintaining a habitat for conservation can be estimated from the cost of relocating the users to other alternative sites.

The step invloved include:

1. Estimate the current cost to visit to the site (RM X).
2. Estimate the cost incurred to visit to other areas (RM Y)
3. Calculate the difference net cost of replacement (Net cost RM = RM Y - RM X)

The net cost of replacement is a measure of the individual benefit of maintaining a particular habitat or environment.

4. Calculate the total cost of replacement

Total Cost = Net cost x Total number of people affected

8. Damage Cost Avoided

This is a general approach, not strictly the cost based valuation technique. The assumption of the method is that the costs of environmental degradation provides a measure of environmental benefits (IIED, 1997). This technique can be combined with other techniques (actual market-based, revealed preference, and stated preference technique) to impute the environmental damage by altering or damaging the ecosystem. The net benefits of environmental conservation is measured through estimating the cost incurred to avoid the damage.

9. Preventive Expenditure Method

This method is also known as “exclusion facilities”, “defensive expenditures” (Hufshcmidt et al., 1983) or “mitigation expenditure” (IIED, 1997).

Households are sometimes willing to pay to prevent damage to their environment and so defend their existing level of enjoyment from it. They will spend when they believe that that the benefits from the damage that is avoided exceed the payments to prevent it. The willingness to incur these expenses indicates the benefit from protection.

This is estimated from the costs of preventing a reduction in the level of environmental goods and services from a particular area.

There are two variations of this approach:

- Elicitation of what people are willing to pay to prevent damage to the environment or themselves. This can be done through constructed or stated preference approach (using contingent valuation method) or by examining of past events in similar circumstances through the use of revealed preference technique (or surrogate market approach).

- Obtain a figure for what it would cost to maintain environmental benefits by investing in the prevention of their degradation. Projected estimates of expenditures on soil and water conservation aimed at halting or reversing degradation could provide an estimate of the benefits derived by nutrient cycling and watershed protection.

One example is to value watershed protection regime through the loss of building logging roads for extraction of timber from the forest could be valued in terms of what it would cost to move timber to less damaging extraction techniques such as reduced impact logging or non-mechanised extraction, extraction by cable yarding, or helicopter logging.

References

ADB. 1996. Economic evaluation of environmental impacts: A workbook. Asian Development Bank, Manila.

Anon. 1995. Techniques to value environmental resources: An introductory handbook. Australian Government Publishing Services, Canberra.

Barbier, E.B., M.C. Acerman, and D. Knowler. 1997. Economic valuation of wetlands; A guide for policy makers and planners. Ramsar Convention Bureau, Gland, Switzerland.

Bishop, J. J.T. (ed.) 1999. Valuing forests: A review of Methods and applications in developing countries. International Institute for Environment and Development, London.

Dixon, J.A. and M.M. Hufschmidt (eds.) 1986. Economic valuation techniques for the environment: A case study workbook. The John Hopkins University Press, Baltimore.

Hufschmidt, M.M., D.E. James, A.D. Meister, B. T. Bower, and J.A. Dixon. 1983. Environment, natural systems, and development: an economic valuation guide.The John Hopkins University Press, Baltimore.

IIED. 1994. Economic evaluation of tropical forest land use options: A review of methodology and applications. Environmental Economics Programme, International Institute for Environment and Development, London.

Kim, S.H., and J.A. Dixon. 1986. Economic valuation of environmental quality aspects of upland agrocultural projects in Korea. In Pp. 63-82 J.A. Dixon and M.M. Hufschmidt (eds.) 1986. Economic valuation techniques for the environment: A case study workbook. The John Hopkins University Press, Baltimore.