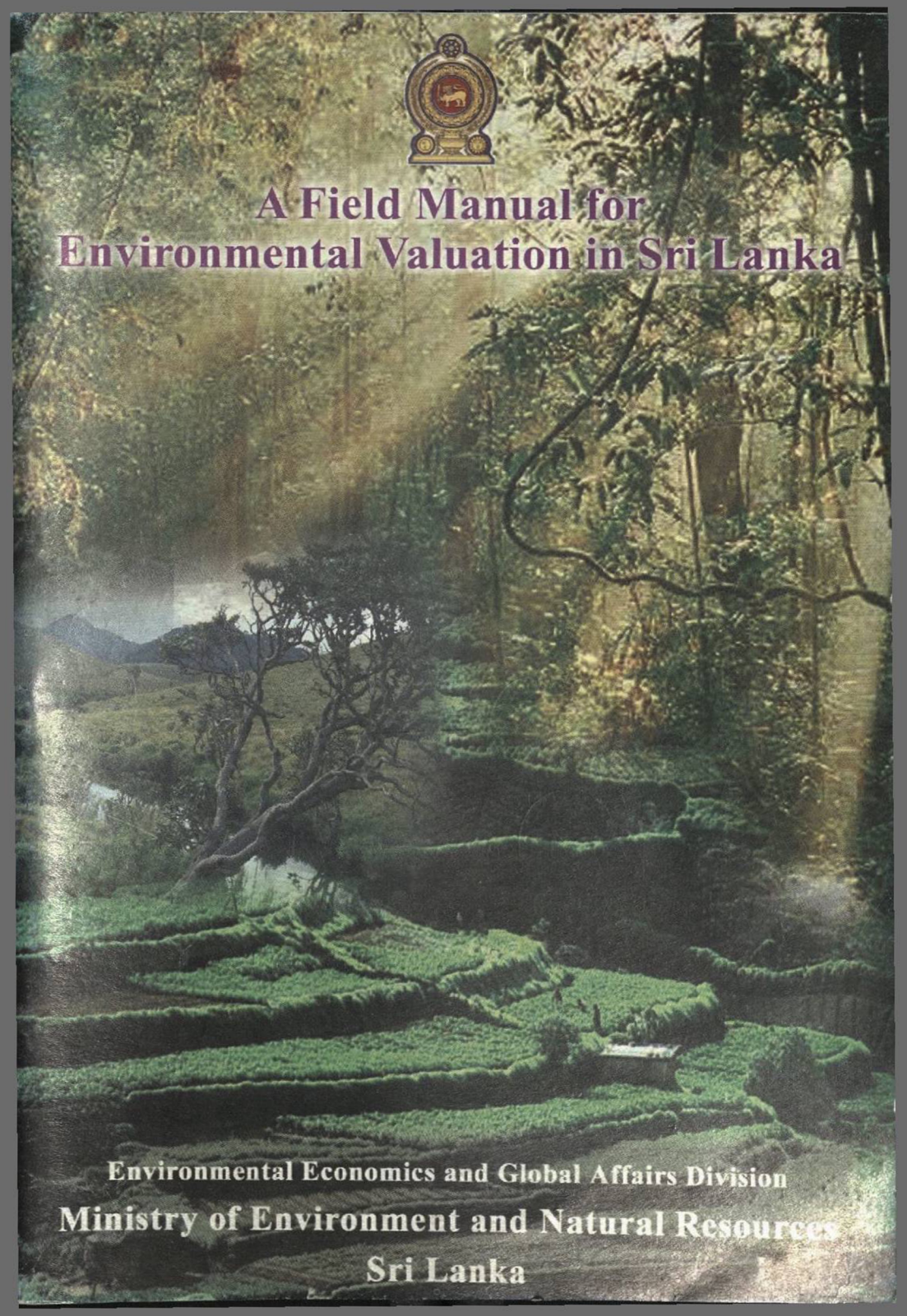

A Field Manual for Environmental Valuation in Sri Lanka

Environmental Economics and Global Affairs Division
Ministry of Environment and Natural Resources
Sri Lanka

A FIELD MANUAL FOR ENVIRONMENTAL VALUATION IN SRI LANKA

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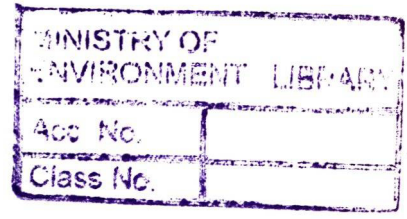

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Ministry of Environment and Natural Resources

Sri Lanka

First Edition - 2005

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Published by : Environmental Economics and Global Affairs
Division,
Ministry of Environment and Natural Resources,
Sri Lanka.

ISBN : 955-9120-16-6

Cover page design by : R.S.A. Ranasinghe

Available at : Environmental Economics and Global Affairs
Division
Ministry of Environment and Natural Resources
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ACKNOWLEDGEMENT

This manual was produced under constant encouragement of Dr. Suren Batagoda, Director Environmental Economics and Global Affairs, Ministry of Environment and Forestry and his team of professionals at the same Ministry.

The financial sponsorship was provided by the World Bank Environmental Action 1 Project of the Ministry of Environmental and Forestry.

This manual could have been presented in better language and style of presentation. The desire to achieve such was a reason for the delay in the publication of the manual. Though perhaps not perfect this manual presents the essential technical content to conduct a Benefit Cost Analysis of a project, incorporating values of environmental impacts.

Hemesiri Kotagama

Shamen Vidanage

Upali Dahanayaka

SCOPE OF THE MANNUAL

Although it is best that economic growth and environmental conservation are achieved concomitantly, a trade-off between economic growth and environment conservation may sometimes be required to achieve sustainable development. Conventionally the analytical methods that facilitated decision-making on worthiness of development projects viz.: economic Benefit Cost Analysis (BCA) that assesses economic impact and Environmental Impact Analysis (EIA) that assesses environmental impacts of projects were done separately. Integration of BCA and EIA referred to as Extended Benefit Cost Analysis (EBCA) allows explicit consideration of trade-off between economic and environmental impacts of projects in decision-making on worthiness of projects. EBCA monetarily values significant environmental impacts (benefits and costs) identified by the EIA and sums such with monetarily valued economic impacts enabling explicit comparison of the overall benefits and costs of the project to society.

The National Environmental Act (No. 47 of 1980) of Sri Lanka states that the EIA report of a project to contain an EBCA " ... if such an analysis has been prepared". Some international banks and donor agencies prefer an EBCA to be contained in project proposals. EBCA is useful in environmental policy analysis in deciding incentives to be provided to the private sector to undertake investments in environmental conservation.

Measures to promote the application of EBCA through; institutional reforms, implementing formal and informal education programs etc, have been undertaken by the Sri Lankan government. Yet, due to many reasons the application of EBCA in Sri Lanka has been low. It may be that a complete EBCA does not provid useful cost-effective incremental information over separate BCA and EIA. Conducting studies to monetarily value the environmental impacts may be expensive and even if done to scientific perfection decision-makers may not be convinced of its reliability and usefulness. It may be presumed that over the time the cost of conducting environmental valuation studies would reduce and with improvements in scientific methodology of environmental valuation its reliability would improve. It is reasonable to consider that, decision makers and project analysts, some of whom are not economists, are not convinced on the usefulness of EBCA.. Although

comprehensive text books/ manuals on EBCA of projects are available, these are often non-comprehensible to professionals and decision-makers, some of who are non-economist. Hence this book provides a simplified explanation of 'why and how' to conduct an EBCA. This book expects that sceptics, particularly non-economists, who doubt the usefulness of EBCA are convinced of its usefulness. Given the simplified explanations of economic concepts, this book may also be useful to particularly undergraduate students to understand the intuition behind the applied implications of some complex economic concepts.

The involvement of multidisciplinary professionals in project analysis has increased with the need to consider environmental impacts in project analysis. Economic analysis is the hub of project analysis. General awareness on economic analysis by non-economist would enable effective co-operation among team members. This would lead to design and analysis of better projects. Well-designed and analysed projects could attract funding both locally and internationally. Sri Lanka depends heavily on foreign funding to finance large projects. This manual could contribute to improving human resources in project analysis directly among practising professionals.

It is reasonable to assume that that the ideal practices of EBCA given in textbooks are not practicable due to institutional, legal and economic factors specific to countries. Some existing and emerging situations in Sri Lanka that limit the ideal use of EBCA are as follows.

- *BCA and EIA are conducted by separate organisations, preventing effective integration of the analysis to an EBCA.*
- *Most environmental impacts are mitigated to meet legally defined national environmental standards (where by the project would not have unmitigated adverse environmental impacts that need to be monetarily valued) and environmental mitigation costs are financially internalised to the BCA. Hence the EBCA would be limited to a Least Cost Analysis (LCA) of environmental mitigation alternatives.*
- *With increased private sector investments in the economy, the BCA data that is required for an EBCA may not be provided by the private sector.*
- *Socio-political factors often out-weight the technical-environmental and economic factors in project decision making.*

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CHAPTER 1

USEFULNESS OF EXTENDED BENEFIT COST ANALYSIS OF PROJECT

Benefit Cost Analysis (BCA) is a method of comparing benefit and cost of investment projects. It enables the summarising of benefits and costs of investment projects through a methodical process to a single quantitative (monetary) numerari. It values benefits and costs of investment projects based on preferences of individuals in society. Hence BCA allows decisions on investments be made based on societies preferences in a democratic and transparent manner.

Conventionally only economic aspects of projects have been considered in BCA ignoring environmental impacts. Thus decisions have not been guided towards sustainable development. Extended Benefit Cost Analysis (EBCA) enables the consideration of environmental impacts too in decision making on worthiness of projects through inclusion of values of environmental impacts to BCA.

This chapter explains the usefulness of EBCA as a social decision-making methodology. First, the usefulness of EBCA is explained from a pragmatic point of view and next from a theoretical point of view. Finally the procedure of EBCA is briefly explained to provide a foundation for detailed explanation in subsequent chapters.

1.1. Pragmatic Issues

1.1.1. Methodological

Investment projects generate both environmental and economic impacts (costs and benefits). Environmental Impact Assessment (EIA) and Benefit Cost Analysis (BCA) are analytical methods that generate information to

compare, environmental and economic costs and benefits, respectively, to facilitate decisions on worthiness of projects.

What are EIA, BCA and EBCA?

EIA is a process of predicting and appraising environmental impacts of projects, mostly using tools of technical sciences. Conventionally the appraising has been based on technical criteria and not explicitly on social criteria. BCA assesses the efficiency with which resources (including the environment) are used in projects to meet society's needs, based on society's preferences. Whilst both EIA and BCA are analytical tools of collection, analysis and interpretation of information of project costs and benefits, BCA explicitly recognize society's preferences as the decision making criteria. EBCA offers a means of integrating EIA and BCA, such that decisions on project worthiness are based on society's preference and a trade-off between environmental and economic cost benefits are allowed.

The EIA generates information only on the environmental impacts, whilst BCA generates information only on economic impacts. The separation of EIA and BCA does not allow the consideration of trade-off between environmental and economic impacts of projects, hence does not contribute to decision making to achieve sustainable development (see box 1).

Box 1. Sustainable Development and Decision Making

Sustainable development is a development process that best satisfies the present generation whilst leaving option for the future generations too to best satisfy themselves with respect to economic, social and environmental needs. Given the irreversibility of use of some environmental uses and the non-substitutability of some environmental functions, environmental conservation is necessary to achieve sustainable development. Thus ssustainable development recognizes the existence of trade-off in development between economic growth in the short-term and environmental conservation, which has a longer-term implication on social welfare. Judicious decisions therefore need to be made to achieve a socially desirable balance between economic growth and environmental conservation.

Projects are referred to as "building-blocks" in development as projects are the smallest units of organized investments. A project is an investment with organized set of activities that uses resources to produce socially desired commodities. Since resources are scarce and have alternative uses, decisions need to be taken to allocate resources on a priority basis to the socially most desired projects. Decision making on selection of projects is based on a comparison of the benefits and costs. If the benefits of a project exceed the costs, the projects should be undertaken. Benefit-Cost Analysis (BCA) is an economic method that facilitates the selection of projects. Conventionally, BCA did not consider environmental cost and benefits in the analysis of projects.

Conventional BCA identifies, quantifies and monetarily values only economic impacts of projects. The monetary valuation of economic impacts using market prices, in BCA, allows unambiguous comparison of benefits and costs enabling easy decision making. As market prices are used in BCA, it enables decisions to be made on a societal perspective (see section 1.2 on an explanation on how market prices reflect social values. EIA, only identifies and quantifies the environmental impacts of projects, but does not explicitly value impacts from a societal perspective. The EIA is assessed by a panel of technical experts, who may or may not represent the preferences of the society. Therefore, decision making of projects based only on EIA is deficient from a societal decision making perspective.

The integration of EIA and BCA offers the possibility of rectifying above identified weaknesses of decision making on worthiness of projects. The only major additional requirement is to value the environmental impacts monetarily based on social preferences and integrate such to the BCA. Thus referred to as Extended Benefit Cost Analysis (BCA extended to

include society's values on environmental impacts). Hence EBCA strengthens both the EIA and BCA as an analytical method facilitating decision making on choice of investments projects with respect to sustainable development. The advances in environmental economic theory and research enables valuation (though not perfectly) of environmental impacts (though not all impacts) to reasonable accuracy to guide social decisions. This does not mean that all environmental impacts could be and should be valued. In certain cases informed subjective decisions may have to be taken where environmental impacts are not valued due to ethical reasons.

1.1.2. National policy

The National Environmental Act (No. 47 of 1980) of Sri Lanka requires that an EIA should be conducted on prescribed projects. The act specifies that an EIA report could contain an EBCA "if such has been prepared". EBCA was not made obligatory, perhaps because the EBCA method was not well developed and/or Sri Lanka did not have the institutional and human resource capacity to undertake EBCA in the 1980s. Since then, the government has taken measures to promote the application of EBCA through; institutional reforms, implementing formal and informal education programs etc. Yet the application of EBCA has been low. A primary reason may be that, decision makers and project analysts, some of whom are not economists, are not convinced on the usefulness of and/ or the methodological procedure of EBCA.

Although comprehensive text books/ manuals on EBCA are available, these may be non-comprehensible to professionals and decision-makers, who are often non-economist. Hence this book provides a simplified explanation of 'why and how' to conduct an EBCA.

With increased private sector investments in economic activity and the simultaneous decrease in public investment the role of economic analysis of projects have diminished. However, given that environmental conservation often is not privately profitable although could be

economically profitable EBCA could be used to decide on appropriate incentives that need to be provided to the private sector to undertake investments that geared to sustainable development.

1.1.3. Global perspective

International banks and donor agencies prefer to use EBCA in deciding on worthiness of projects (see box 2). In the case of decision making on worthiness of national projects by a national government, where the projects are few and economic, social and environmental circumstances are closely known to the decision-makers, EBCA may not be useful. However, in the case of international agencies, given the large number of projects from varied countries, the decision makers would not have close and reliable information, therefore would prefer EBCA as it provides summarised, objective information on worthiness of projects.

Box 2. Use of EBCA by International Banks

"The Initial Environmental Examination (IEE) and Environmental Impact assessment (EIA) are two of the primary mechanisms through which the Asian Development bank considers environmental impacts during a project cycle. ... The IEE and EIA have been effective tools for assessing the potential environmental impacts associated with Bank-financed projects and, until recently, described most impacts in qualitative terms. However, to help establish a project's true costs and benefits, the Bank recommends that economic values be assigned to these impacts determined from IEE/EIA and engineering design studies so that all factors affecting a project can be evaluated at the same time by the project manager and/or consultant. ... The Asian Development Bank, The World Bank, and others have initiated work on internalizing the environmental impacts of projects in economic evaluation."

Sri Lanka would have to depend on external finances for its development for a reasonable period in future. This would be particularly so for investments in large public sector projects such as in the environmental sector given the limitation of financing such through national public finances. Well-designed and analysed projects, meeting the requirements of international banks and donors would have a better chance of attracting funding for development. Hence it is prudent that project proposals submitted to international banks and donors contain an EBCA.

1.2. Theoretical Issues

1.2.1. Role of economics in social decision making

Economics offers a theoretical framework to guide societal decision making on use of resources (including environment). Economic analysis enables the assessment of worthiness of using resources to meet social needs based on social preferences. Economic analysis of projects enables to take decisions on use of resources from a society's perspective. A brief explanation of how economic analysis relates to social decision making is given below.

Human beings attempt to satisfy oneself throughout life. Thus have to make decisions, as there are numerous alternatives through which satisfaction can be derived. Satisfaction is derived from sources that are spiritual (own intellect), social (human inter-relationships) and economic (consumption of commodities). Whilst individuals attempt to satisfy oneself individually, human beings having being organised as a society, satisfy them selves through sharing of sources of satisfaction, among the present and future generations.

The resources that are required to produce commodities that satiate human desires are scarce, given the insatiable desires of human beings for consumption. Hence decisions need to be made, on how resources could be allocated, among production of alternative commodities to best satisfy society. The study of society's decision-making process, on allocation of scarce resources to produce commodities, that best satisfy society, is economics. The most known economic processes/systems are the market economic system and the centrally planned economic system.

In a centrally planned economic system a central authority takes decisions on production and consumption. In a market economic system individuals, as producers and consumers, take independent decisions to best satisfy themselves, given the technology to produce and access to resources and the preferences on consumption and available income. The market co-

ordinates these independent decisions by individuals, as supply of producers and demand by consumers on commodities resulting to prices (or social values) being determined. The prices in turn guide consumption and production decisions leading to allocation of resources that best satisfy both consumers and producers simultaneously. The merit of the market economic system is that the abilities of producers and the wishes of the consumers are co-ordinated and harmonised (i.e. brought to an equilibrium) at a low cost.

Which economic system is superior, is yet unresolved. The choice of an economic system itself is a social choice. During different periods of history and in different countries, the two economic systems have gained operational prominence. Further, in reality, neither pure market nor centrally planned economic systems prevail. What prevails is a mixed economic system that has the character of both market and centrally planned economic systems.

Currently, mixed economies are inclined more to the market economic system with limited government intervention in the market. In a mixed economic system, the government assures conditions for the market to allocate resources and allocates some resources (such as environmental) that the market fails to allocate (see box 3 pm market failure). Further the government would attempt to satisfy society with respect some aspirations that the market may fail to provide (such as fairness in the distribution of income). Government rectifies the market failures though enacting policies that guide producers as well as consumers and through government investments in sectors where the market fails. Projects are considered as the smallest units of investment. BCA was first proposed as a tool to be used by government to decide on the worthiness of projects in relation to satisfying economic needs of society.

Box 3. Market Failure

The market would allocate resources efficiently (satisfy society), under prevailing distribution of income, if property ownership is defined and enforced, if perfect competition prevails in the market (i.e. large number of buyers and sellers, homogenous products, free mobility of resources, technology and information, entry and exit to the industry free). Despite the strength of the market system it has weakness internal to the system that leads to the failure of the market in allocating resources efficiently. These failures arise in following situations.

- Where barriers to perfectly competitive markets exists (such as in the case of economies of scale allowing for monopolies, government intervention in the market through price regulation, taxes, subsidy etc.).
- Where deficiencies in property rights, either in defining of rights, or in the enforcement of rights exists (such as the case for environmental resource as air and other natural resources).
- Prevalence of public goods; i.e. commodities of which consumption by one individual does not reduce the amount of commodity available to another individual, (such as the enjoyment of scenic beauty).
- Prevalence of externalities; i.e., when production or consumption of one person effects another and is not compensated for the benefit or the cost, (such as the upstream pollution of water bodies effecting downstream uses).
- Where market fails to elicit the preference of some sectors of the society present and future leading to inequity/unfairness in the sharing of benefits derived from the economy. Market does not represent the wishes of the poor of the present generation. The market demand for commodities becomes effective not only on the wishes of people but also on their purchasing power (income) of the existing distribution of income.
- Further markets are unable elicit the preference of future generations. Hence the market may not allocate/conserve sufficient resources to meet needs of future generations creating inter-generational inequities.

Market failures will preclude sustainable development through inefficient and inequitable resource allocation in the present and future generations.

1.3. Ideal and Practice of Project Analysis.

Project analysis is undertaken to take decisions on resource allocation where market fails to decide on the best allocation of some resources (such as environment) to some social needs (such as public goods). It is ideally expected that project analysis would enable to take decisions on allocation of resources to best satisfy society (maximise welfare), where decisions on resource use are taken independently by individuals. Social

welfare comprises of many attributes, such as maximising consumption (economic), achieving equity in consumption among present (social) and future (environmental) generations. There could be complimentarities as well as conflicts among the different attributes in maximising welfare. Ideally project analysis need to recognise such for which an essential requirement is measurement of social welfare that integrates all attributes of social welfare. Project analysis should provide numerical indicators of social benefits and costs of projects. Such a measurement has not been yet found.

Hence the approach practised in project analysis has been partial. Projects have been analysed with respect to only the economic attribute of potential to maximise consumption (measured monetarily as income). There have been approaches to integrate social attribute of equity of consumption within the present generation to project analysis by considering impacts of projects on income distribution. These approaches suggest that income received by poor should be given a higher weight than income received by rich. Hence attempts to derive such weights have been undertaken. Yet these approaches have not been practically applied. In practice Social Impact Assessment (SIA) qualitatively examines the impact on income distribution and other social impacts of projects. This practice does not enable considering society's values on social impacts and also does not allow for trade-off between economic (present consumption) and social aspirations of society.

The approach to integrate equity of consumption between generations to project analysis has been two fold. First, savings as opposed to immediate consumption derived from increased income from projects have been given higher weights. This approach too has not become popular in use. Next, as environment conservation has been recognised as essential to assure equal or better consumption opportunities to future society, the environmental impacts of projects have been considered in decision making. The practice has been to conduct EIAs of physically identifying and where possible quantifying environmental impacts of projects. The information of the EIA has been considered along side the BCA analysis

in decision making. This practice does not enable considering social values on environmental preferences and also does not allow for trade-off between economic (present consumption) and environmental (future consumption) aspirations of society. The ideal as proposed by EBCA is to value environmental impacts of projects from a societal perspective, using the same unit of measurement (money) used to measure economic impacts and sum up economic and environmental impacts, to obtain a net measurement of economic welfare.

Ideally project analysis should consider a composite measure of social welfare comprising of economic, social and environmental aspects. Due to practical difficulties of such measurement in practice economic, social and environmental analysis has been undertaken separately and integrated where possible by quantifying and valuing the impacts by use of a commensurable unit. This unit has been monetary and the basis for valuation has been societal preferences derived from individual preferences.

1.4. The Basic Procedure of EBCA

BCA is an analytical method that uses market economic theory and concepts in the analysis of projects to facilitate the decision making on the choice socially worthy projects. BCA provides numerical indicators of social benefits and costs of projects. As BCA emulates markets in decision making on resource use in which the criteria of decision making is primarily efficiency of resource use. Although other social aspirations, such as equity could be addressed through modifications of BCA, it is rarely done in practice. Impact of projects on equity and other social issues are assessed through Social Impact Assessment (SIA). Decision making on choice of projects is based on a comparison of the benefits and costs. If the benefits of a project exceed the costs, the project is worthy of implementation. The main role of BCA is in facilitation of the collection and synthesis of information on economic benefits and costs of projects such that they could be easily compared.

Benefits and costs of a project vary physically and are spread over time. Costs and benefits therefore cannot be directly compared. In BCA of a project the incremental benefits and costs of the project are identified, quantified and valued using a common measure (such as monetary prices); also benefits and costs incurred in the future are discounted to present values to enable comparison at a common point in time. Thus BCA requires estimates of unit monetary values (prices) to value different benefits and costs and appropriate discount factors to discount benefits and costs realised over time. If the market functions perfectly, the market price indicates the unit monetary value society places on resources and commodities, while the market discount factor gives the opportunity cost of capital and time preferences of the society. If the market does not function perfectly, the market prices and discount factor should be adjusted (shadow priced) to reflect social values. Market imperfection could arise due to market failures or policy interventions.

BCA could be carried out either to guide private decision making (Financial Analysis) or social decision making (Economic Analysis). In financial analysis, benefits and costs are valued in terms of market prices and the decision is made with respect to the objective of profit maximisation. In economic analysis benefits are defined as improvements in human/social welfare (i.e. an increase in national income). Costs are defined as opportunity costs, which is the value of benefits forgone by not using the resources in the economically most profitable alternative investment. The decision is made with respect to objective of economic efficiency (maximisation of national income).

Conventionally BCA considered only benefits and costs that occurred within the project boundary and could be identified, quantified and valued. Environmental impacts that could neither be easily identified and quantified nor had market prices (because they are not traded in the market) were ignored. Thus decision made on development projects based on conventional BCA did not recognise the trade-off between economic growth and environmental conservation.

The main role of EBCA is to integrate BCA with EIA of a project. Valuing the environmental impacts identified and quantified by the EIA and integrating these values to the BCA analysis does this. If it can be shown that the sum of economic and environmental benefits exceeds the sum of economic and environmental costs then the development project would be selected for implementation.

The market fails in valuing the environment (see Appendix l) Often the values of environmental resources are underestimated by the market economic system leading to overuse of environmental resource. Environmental economics offers a host of techniques to value environmental resources, where the market fails to value. Proper choice of valuation techniques and use of such, enables estimation of environmental values that are reasonable and acceptable for the purpose of EBCA.

CHAPTER 2

DEFINITION OF A PROJECT, PROJECT CYCLE AND ANALYTICAL MODULES

Projects are analysed by a team of multidisciplinary professionals. Basic knowledge on other disciplines would help in effective teamwork as it helps to understand the usefulness and method of project analysis. As much as an economist should be able to understand issues related to environmental impacts of projects, an environmental specialist needs to understand the basic economic principles, to successfully analyse projects.

In this chapter the definition of a project is reviewed to identify the different aspects of a project that need to be recognised in integrating BCA and EIA of a project. The project cycle that has been conventionally associated with BCA is juxtaposed with the EIA procedure to indicate how economic and environmental considerations could be integrated in the overall project planning and analysis. The analysis undertaken by different analytical modules of project analysis are briefly presented to indicate the multidisciplinary professionalism required to conduct an EBCA.

2.1. Definition of a Project

A project, in the public sector, is the smallest investment unit of a national plan, program and policy. Hence a project is referred to as a 'building block' of development.

A project is a set of activities that are implemented, with use of resources (including the environment and natural resources) to gain benefits (including environmental benefits), over-time in a specific geographical area. Project activities may be organised as project components for analytical and implementation convenience, based on technical criteria and organisational structure that exists in a country. For example, a coast conservation project in Sri Lanka may have components such as:

- coast conservation,
- fisheries development,
- coastal biodiversity protection and
- coastal social development

Such breakdown of components may facilitate analysis as specialised professionals could undertake the analysis of each component. However to be considered as a project the components together should make-up a system that consists of interactive components together producing overall/ unifying benefits. The components of a project may be linked through environmental impacts and interactions. For example coastal erosion would be linked to the protection of coral reefs and mangroves and protection of coral reefs and mangroves would be linked to fisheries development. Reduced income from coastal fisheries would lead to increased dependence on harvesting coral reefs and mangrove products. Hence the linkages between overall benefits and costs must be considered as far as possible and practicable (in terms of manageability) in defining a project.

Projects use environmental resources either as a direct input or indirectly through use of the assimilative capacity to assimilate wastes. Conventionally, use of environmental resources were ignored in project analysis, due to the methodological inability to quantify and monetarily value those. Other reasons were that some benefits and costs of environmental resource use were realised over long period of time during which its economic value was considered marginal and environmental impacts were realised out of the geographical project boundary. It is important that projects are defined to incorporate environmental resource use considering a time period and geographical boundary to accommodate environmental impacts.

Conventionally only benefits and costs realised within the national boundary were considered in the analysis of projects. However some of the environmental impacts (such as cost impact on global climate and benefit impact of biodiversity conservation) are realised beyond national boundaries i.e. internationally. Where projects are financed on international

finances, such organisations may require the consideration and inclusion of international impacts of projects in the analysis of such. Conceptually and ethically too consideration of international impacts is justifiable as it has a clear influence on global sustainable development and international social harmony.

Projects have been considered in the past as mostly producing direct economic benefits and indirectly environmental costs (such as air and water pollution from industrial projects) and benefits (such as a highway project reducing air pollution). However, projects could also directly generate environmental benefits (such as watershed, wildlife, forest, solid waste, and air and water management projects). These projects are generally referred to as environmental projects. The public sector is now largely responsible in undertaking investments in environmental projects as the investments by the private sector is limited due to the difficulty to appropriate benefits of such investments commercially. The share of lending on environmental projects has increased among international lending agencies too. Hence the application of EBC would be most dominant in analysing environmental projects.

2.2. Public Sector Projects and Potential Use of EBCA

Projects could be undertaken by either the public or private sector. BCA and EBCA have been mostly applied to public sector projects as BCA and EBCA are concerned of the overall impact of investments on society whilst the private sector would be concerned on impacts of investments only if such effects financial profits.

The policy of Sri Lanka is to encourage more private investments whilst limiting public investments to produce pure public goods and commodities that the private sector fails to invest to produce. It could be envisaged that it would be the public sector of Sri Lanka that would be investing mostly on projects to produce environmental benefits i.e., improve or sustain environmental benefits or reduce and manage environmental damages. There are few projects that could produce environmental benefits that the

private sector could undertake such as eco-tourism, organic farming, waste treatment.

The public sector would undertake infrastructure development projects that could have major environmental impacts (such as highways, power generation, irrigation etc). As mentioned earlier EBCA of monetarily valuing environmental impacts would be clearly useful in analysing projects producing environmental benefits. With regard to public sector infrastructure projects, where national environmental standards are legally defined it could be expected that most of the adverse environmental impacts would be mitigated and internalised to the project costs. This is true for private sector projects too. Hence only a least cost analysis of alternatives to achieve national environmental standards should be undertaken in such projects. However, some infrastructure projects may indirectly generate significant environmental benefits (such as a highway project reducing air pollution, an irrigation project raising the water table supporting adjacent wild fauna and flora),in which case an EBCA could be done.

EBCA will be particularly useful in analysing public sector projects if financing is sought from international lending agencies. In such case environmental impacts may have to be valued irrespective of the existence of environmental standards. This would clearly allow a trade-off between environmental impacts and economic impacts, if necessary beyond the national legal standards. The applicability of such analysis is controversial and yet unresolved. Such projects that are analysed contravening national environmental standards would invariably pose problems of implementation unless national environmental standards are changed.

EBCA could help the private sector in canvassing for government support to meet environmental standards or to request change environmental standards. If EBCA could show that a project whilst being economically worthy though financially not worthy due to environmental standards, the private investors could request government support or relaxation of environmental standards. The use of EBCA is emerging as a strong tool

of policy analysis to identify the need of government to support the private sector investment in environmental conservation. A clear example is the use of EBCA to justify subsidies to promote the adoption of soil conservation investments in Sri Lanka (Weeraperuma et.al. 2002).

2.3. Project Cycle and the EIA Procedure

The project cycle explains the sequence of analytical and administrative activities undertaken in planning, analysing and implementing projects. The EIA too has an analytical and administrative sequence of activities. It is necessary that the EIA is built in to the project cycle (or vice-versa) at all stages and also as early as possible. Integration of environmental aspects to the project cycle as early as possible would lead to better design of projects and thereby would reduce environmental costs of projects and also delays in approval of projects.

First methods such as EBCA could support the integration of economic and environmental aspects in the project cycle. Second the integration requires reforms in the organisational structures of project planning and approval to share information on economic and environmental impacts of projects. Ideally the EBCA should be undertaken in one institution. In practice this is rarely the case as in Sri Lanka, where the BCA is undertaken and assessed by the NPD and the project proponent (Ministry or Department) undertakes and asses the EIA under guidance of CEA. Though a representative of the NPD is in the Technical Evaluation Committee evaluating the EIA, it is not clear whether the financial and economic viability is criteria to be discussed in evaluating the EIA. Institutional reforms to integrate the BCA and EIA in Sri Lanka have been proposed but have not been implemented (Jayawickrema, 1997).

In Sri Lanka the EIA of public sector projects up to recent time was undertaken only after the National Planning Department (NPD) approved the project as economically viable. This has lead to undue delay on approving projects and also the risk of projects being not approved due to adverse environmental impacts, after time and money spent to design projects (Jayawickrema, 1997). This has now been rectified by including

a checklist of environmental impacts, to the format for submission of project proposals for preliminary screening by the NPD.

i. Identification of projects

Identification implies outline of an investment concepts in a crude but reasonable comprehensive manner (ODA, 1988). Identification of potential public sector projects could be based on national policies, plans and programmes. Currently line ministries identify projects and submit to the NPD with information required for in the Format for Submission of Project Proposals for Preliminary Screening (NPD, 1996) for initial approval to be included in the project pipeline. Currently an environmental checklist is contained in the format for submission of project proposals for preliminary screening. The sectoral environmental guidelines provided by the Central Environmental Authority (CEA) could be extremely useful in identifying potential environmental impacts of projects even at the early stages of identification of a project in a given sector. Ideally Strategic Environmental Assessments should be undertaken for policies, programs and plans to guide the choice of project concepts that are environmentally benign.

ii. Prefeasibility assessment

At the Prefeasibility assessment of a project, alternatives that could achieve the major objective of the project would be examined. In doing so the alternatives must be assessed in terms of the potential to reduce environmental costs and enhance environmental benefits. The alternatives refer to project site, size and design etc. For example consider the objective of increasing power generation, the alternatives could be reduction of waste of power through demand management as opposed to increased supply, the technical alternatives to increase supply could renewable (hydro, dendro, wind, solar) or non-renewable sources (coal, oil). A coal power plant could have different environmental impacts with different magnitude depending on alternative sites (consider the example of siting

a coal based electricity generating plant being located in Trincomalle, Hamabantota or Kalpitiya). A hydro power project may have different implications on loss of biodiversity due to submergence of fauna and flora depending on the height of the dam (consider the example of the Kukuleganga hydro electricity project, where dam height was reduced to reduce submergence to save biodiversity).

The technical, commercial, institutional, organisational, financial, economic, environmental feasibility of the alternatives should be considered in a preliminary manner. These aspects are considered by the National Planning Department (NPD) based on the information submitted by line ministries proposing projects (see #). It is prudent to conduct preliminary financial and economic analysis of the project based on secondary information. This could prevent the undertaking of EIA of projects that are not financially and economically viable.

iii. Design and Analysis

Once the NPD approves the project concept the line ministry proposing the project would undertake the detailed design and analyses of the project on technical, financial, economic, market, social, institutional, environmental aspects.

A bottom up approach of consulting grass root society is preferred over top down approach of bureaucrats identifying and designing projects. Log Frame Analysis (LFA) is a useful effective and widely used tool in identification and design of projects. It enables participatory identification of projects and systematic design of projects and subsequently monitoring of projects. Environmental impact of projects could be identified in the LFA.

iv. Evaluation

At evaluation, guided by the analysis of the project, an informed judgement is made, by decision-makers whether the project is worthy of

implementation. Though financial and economic criteria would be considered in the decision making those would not be the only criteria considered in evaluating public sector projects.

As mentioned earlier in Sri Lanka currently the BCA and the EIA are evaluated separately. This does not allow decisions to objectively consider possible trade-offs between economic and environmental impacts. A Technical Evaluation Committee (TEC) comprising of independent specialists (including an economist) and representatives from government institutions (including the NPD) evaluates the EIA . It is not clear whether this TEC has a mandate to discuss financial and economic viability as decision-making criteria. Though it is conceptually clear that projects that are not financially viable when undertaken by the private sector may cause irreversible losses to the environment when projects are terminated due to financial non-worthiness.

Ideally the TEC decision making should be guided by considering whether:

- project alternatives (design, site, technology) have been considered, to minimise adverse environmental impacts and maximise beneficial environmental impacts
- environmental impacts have been mitigated as required by law
- whether the least cost environmental mitigation has been undertaken
- whether a least cost environmental impact monitoring plan has been proposed
- Whether the economic rate of return (including values of environmental impacts) is acceptable.

The aspects that should be considered by an environmental economist in evaluating the EIA at the TEC are as follows.

- Whether environmental impacts that are significant and quantifiable and monetarily valued have been included in the analysis using appropriate methods of environmental valuation.
- Special attention should be given to non-quantified environmental impacts.
- Consider whether the environmental mitigation alternatives have been selected on least cost analysis and included in the EBCA.

- Check whether environmental monitoring cost has been included in the EBCA.
- Check whether the cost of non-renewable resources has been included.
- Consider whether environmental cost recovery potentials have been explored.

Often the TEC tends to discuss the social impacts much more than the biophysical environmental impacts of projects. This happens given the direct impacts of social changes on human beings and due to the political nature of impacts. Whilst considering social impacts of projects is necessary to assure that projects contribute to sustainable development it need to be recognised by the TEC that considering the environmental impacts as equally important. Importance of an organised discussion with all views taken account of without submission to authority of person or an individual discipline is required for a good decision.

v. Implementation

Project implementation could be examined as occurring in three phases viz. investment phase, development phase and full productive phase. The management requirements are different at different phases of implementation. The environmental impacts are most visible during the investment phase. However, continuous monitoring of environmental impacts must be done during the full production phase as well.

vi. Monitoring and evaluation

Monitoring is measurement of progress and performance of the project. Evaluation is judgement on whether the project has performed well or not. The objective of monitoring and evaluation (as with environmental impacts) is to correct mistakes and improve project implementation. To monitor project, standards against with which success/failure could be compared must be defined. This is done in the project LFA. It is preferred that these standards are measurable. Standards could be quality, quantity and time based. Monitoring of environmental impact could be done based

on the environmental monitoring plan provided in the EIA report. The support of civil society too, can be utilised in Monitoring environmental impacts.

vii. Project identification

The lessons learnt from evaluated projects in the past would enable to identify and design better projects for the future. Hence special attention should be paid in evaluating environmental impacts in past project evaluations.

2.4. Network of activities in relation to the project cycle

In Figure I, the generic sequence of activities of the conventional project cycle is matched with the EIA procedures recommended by the Central environmental Authority (CEA) of Sri Lanka (CEA, 1995). The activities of the BCA and EIA should occur concurrently. The EIA procedure is legal whilst the BCA is not. EIA has legally defined time periods for activities to occur whilst the BCA does not.

Table 1. Overlapping project cycle activities of BCA and EIA

BCA	EIA
1.Identification of projects PP identifies project concept and submit to NPD	Project Proponent (PP) gathers information on the existing environment at stakeholder consultations LFA. Check whether the project is a prescribed project. PP submits the preliminary information to CEA, Coast Conservation Department (CCD) or depending on the jurisdiction of the North Western Province Environment Agency (NWP-EA) If the agency is CEA then a Project Approving Agency (PAA) will be identified to implement the IEE/EIA process depending on the type of the project

2. Pre-feasibility evaluation Objectives of the project clarified and alternative projects that could achieve the same objective examined. The technical, commercial, institutional & organisational, economic, environmental, financial and environmental feasibility of alternative projects considered in a preliminary manner. This will be done by the line agency under a ministry (ex. Coast Conservation Department) Project identification form submitted to NPD for preliminary approval (Public sector) and to PAA/CEA. Private sector projects submit to PAA/CEA, projects which envisage BOI status will be submitted to BOI.	PAA, CCD or NWP-EA will decide on co-operating agencies to be involved in the process. PAA, CCD or NWP-EA will decide whether an IEE or EIA is required. PAA will appoint technical sub committee. Scope and draft the TOR for IEE or EIA. Submission of the ToR to the Project proponent.
3. Analysis Detailed technical design, financial and economic and other analysis conducted	PP with the assistance of consultants conducts the EIA, and submits IEER/ EIAR to the PAA, CCD or NWP-EA. PAA checks for adequacy and opens the EIAR for public commenting.

23. Appraisal Undertaken by NPD for public sector projects. Similar process is taken place for BOI projects. Non BOI private sector project appraisal will be done by the Board of Directors of the company	IEER will not be open for public commenting, a decision will be given to PP on acceptance/rejectionTechnical evaluation committee (TEC) evaluates EIAR and the public comments and seeks additional clarifications if necessary. TEC submits the TEC report to PAA with their recommendations on acceptance /rejectionChief executive of the PAA will decide on the project based on TECR recommendations. If the PAA is not CEA, then they will obtain CEA concurrence and issue approval with conditions or reject.
4. Evaluation Appraised public sector projects are sent to project pipeline for donor funding or allocation of public sector finances	
5. Implementation. On cabinet clearance, treasury will allocate finances to the project-implementing agency (often the PP) for implementation of activities.	
6. Monitoring and evaluation	PAA with other relevant agencies will implement compliance monitoring of the conditions laid down in the clearance letter according to the monitoring plan. CEA will monitor emissions and effluents for EPL purposes NGOs too could monitor and notify relevant authorities if environmental conditions are violated by the PP

2.5. Multidisciplinary Nature of Project Analysis

Analysis of projects requires a multidisciplinary approach and professionals of different disciplines have to work as a team. The team should consist of technical specialists (such as engineers, agronomists etc, depending on the nature of the project), sociologist, institutional specialist, financial/ market analyst and economist, environmental impact assessment specialist etc. The involvement of the number of professionals of different disciplines has increased with the need of an EIA of projects and also as the discipline of the environment cuts across many disciplines.

Knowing the role and responsibility of each other of the team facilitates effective teamwork. The analysis undertaken by different professionals is described briefly below. Each professional team member should be able to explain to other team members the nature of the analysis that would be undertaken and how it contributes to the design and analysis of the project. In doing so each professional team member should be able to explain information expected from others too. Terms of reference (with expected activities and time frame) should be provided to each expert involved in the analysis, considering the overall information requirement on the design and analysis of the project. Generally the work of technical specialist and sociologists would begin early and that of environmental impact specialists, economists later when the project concept is consolidated. However, the whole team should be convened early too to conceptualise the project and to build-up the team. Each disciplinary (module) analysis could be undertaken simultaneously, although some analysis such as technical analysis must be known for other analysis such environmental impact assessment to begin. A team leader with the assistance of an economist should do the integration of the different modules to the final analysis to be presented as a report.

i. Technical analysis

Technical analysis is the process of designing and assessing the technical feasibility of the project, undertaken by professionals such as engineers

and agronomists etc. It would consider alternative technology/design, site, scale etc that could be used to achieve project objectives. It is essential that all possible alternatives are considered in terms of achieving the project objective to minimize adverse social and environmental impacts.

Technical analysis is a prerequisite to identify the input/ costs and output/ benefit of each alternative (design, technology, site etc). Technical analysis is a prerequisite for most other analyses such as financial, economic, social, environmental impact analysis as benefits and costs (including environmental) depend on the technical design of the project. Technical specialists in collaboration with the economist, must quantify the incremental benefits and costs comparing the "with and without" the project scenarios. The identified cost and benefits must be spread over the project period. Inputs and outputs of the projects must be distinguished between domestic and internationally traded inputs and outputs. The financial analyst and the economist should closely assist technical specialists in deciding on major project components and identifying an estimating cost and benefits for each component. This could be done by the economist and technical specialist collaboratively developing a format to identify input and outputs of the project in a manner that facilitates BCA, EIA and finally EBCA.

The technical specialist should collaborate with the environmental (and social) specialist to identify possible environmental (social) impacts and mitigation technology of project alternatives.

ii. Institutional analysis

Institutional analysis is an analysis of whether the project matches with socio-cultural behaviour of concerned society or does the project give sufficient incentives and time to change institutions with minimum conflict. It would also examine the possibility of getting local institution, participation of local people in the project. Environmental resources are often public, common or open access property resources hence examining

property right issues with respect to project would be important. This will be done by the SIA specialist.

iii. Organisational analysis

Organisational analysis examines whether the relationship between organisations related to the project and other organisations of the economy is compatible and also analysis on internal organisation of the project management on its suitability. The aim would be to minimise conflicts and maximise complementarily between organisations. It would attempt to define authority and responsibilities of the organisation clearly. Environmental management may require the co-operation of many organisations.

iv. Managerial analysis

Managerial analysis examines the act of co-ordinating resources both physical and human activities of the project. It is an analysis of whether project is manageable at different levels of the project, i.e. from top level management to the grassroots. The availability of physical, financial and human resources for effective management must be considered. Environmental management may require specific knowledge and skill among professionals. At the grass root if environmental resources have common property characteristics, collective management institution would be required.

v. Social analysis

The SIA would examine the following aspects of the project.

- Impact on income distribution in terms of who benefits and who pays the cost of the project activities. Income distribution could be considered in the analysis through weighing procedures, if not, the distribution of project costs and benefits among social groups should be clearly explained. The impact of environmental costs and benefits among different social groups should be considered too.

- ❖ Impact on employment generation: Some projects could give high returns with low employment and some could give high employment with low returns. Nationally achieving both objectives increased income and employment is important.

- ❖ Impact of projects on different regions. With the politicisation of Sri Lanka into provinces it would become important to examine the impacts of the project benefits and costs on different provinces.

- ❖ Impact on gender and other socially marginalized (ethnic, indigenous) groups in society.

vi. Commercial/ market analysis

The following issues would be examined by the commercial analysis.

- Would there be an effective demand and a remunerative price for the project output?
- Will the project output effect the prevailing price? If so, how much and how should the prevailing price be adjusted for analysis should be considered by the economist.
- Where (domestic or export) will the product be sold?
- Would the output meet the market requirements of quality and reliability of supply, particularly if exported?
- Is there sufficient infrastructure for project linked activities such as processing transport etc?
- What are the arrangements to procure equipment and supplies for the project?
- How could delays in supplies of inputs be minimised, whilst getting such for minimum prices and allowing for transparency and accountability in procurement procedures?
- Does the project ensure inputs to operation and maintenance of the project?

vii. Financial analysis

The financial analysis will examine the financial profitability of project components identified in terms of project participants, and of the whole project. Thus financial analysis considers a private accounting stand. It assumes that each participant of the project must be financially benefited for the success of the whole project. If a project participant is not financially benefited the government may have to support the project participant to make the whole project feasible. This may often be the case with environmental activities of projects such as soil conservation.

Financial analysis provides information on the projects financial efficiency; financial incentives required (subsidy), credit worthiness, liquidity (whether the project could manage itself with the financial flow). Financial analysis also assesses the fiscal impact, if the project is large and would need treasury funds. Financial analysis is done by valuing inputs and outputs of the projects using market prices and the market interest rate.

viii. Economic analysis.

Economic analysis is an analysis of net benefit of the project to the society as a whole. Thus a social accounting stand is considered. Financial analysis is used with modifications, to conduct the economic analysis. The modifications are:

- Taxes, subsidies and loans are treated as transfer payments thus excluded from analysis.
- Efficiency (shadow) prices are used and not market prices if market prices are distorted/imperfect.
- Economic interest is used instead of the financial interest rate.

ix. Environment impact analysis

EIA is legally mandatory for prescribed projects in Sri Lanka. EIA ideally would:

- identify, and quantify environmental incremental changes (benefits and costs) overtime caused by the project.
- Conduct cost effective analysis on alternatives (site, location, design, and technology) on environmental management costs based on achieving national environmental standards.
- Conduct environmental valuation if necessary.

x. Impact on government budget

Particularly if projects are large and do not have internalized cost recovery, such may have substantial demands on government budget. Hence it is necessary to analyse such to enable the availability of public finances. Often Environmental projects are financed by public. Environmental costs such as monitoring may have to be borne by the government unless project proponents are charged for.

2.6. Procedure and Guiding Concepts in Economic Analysis of Projects.

The manual here on explains only the economic analysis of projects. The procedure of economic analysis of project consists of four activities. These are:

- Quantifying the physical items of the project's costs and benefits,
- Monetary valuation of project's cost and benefits,
- Discounting the monetary costs and benefit flows,
- Estimating decision-making criteria.

From an analytical point of view to conduct an EBCA of a project, both economic and environmental, cost and benefits should be identifiable, quantifiable over time and amenable to monetary valuation. Conventional BCA identified only economic costs and benefits within a narrowly defined project area and time, ignoring environmental impacts that are realised in a wider geographic area and over longer period of time. Hence the EIA needs to identify and quantify over time, the incremental environmental impacts of projects. If environmental costs and/or benefits can not be

identified, quantified and monetarily valued an EBCA can not be conducted. To conduct an effective EIA the project activities and project area must be clearly defined.

CHAPTER 3

PROCEDURE AND BASIC CONCEPTS USED IN BCA AND EBCA OF PROJECTS

The procedure and the basic concepts used in BCA are explained as the procedure and concepts in conducting EBCA are similar. The procedure of BCA consists of following steps.

- Identifying project cost and benefit (including environmental) impacts
- Quantifying incremental impacts over time
- Monetary valuation of impacts
- Financial
- Economic
- Environmental
- Social
- Discounting the monetary cost and benefit flows
- Estimating decision-making criteria
- Examining the impact of risk and uncertainty on decision-making criteria.

The economist will have to interact with the other professionals such as engineers and other technical specialists in identifying and quantifying economic impacts of the projects. Informing other professional on the type of information that is required for the analysis should be done as early as possible.

3.1. Identifying Project Cost and Benefit Impacts

Project Impacts: Project impacts are two fold, viz.; benefits and costs. Beneficial impacts are results of the project that contribute to the achievement of the objective of the project and cost impacts are opportunities foregone in terms of resources use (including environmental and natural resources) to achieve the objectives of the project.

Economic, Environmental and Social Impacts: Projects have impacts that could be economic (including environment) or social; all of which should be considered in deciding on the worthiness of a project. Economic impacts relate to resource (land, labour and capital) use changes producing human needs. Environment is an economic resource as it produces human needs and is relatively scarce. The environment provides natural resources (such as water, minerals etc), which are used in producing commodities or environment can be directly but non-destructively consumed as an amenity (scenery, wild life) or of providing other life and ecological supporting services (green house protection, ecological stability). Environment provides option values particularly biodiversity may contain genetic options to improve food and health security in the future. Environment may satisfy the human needs of satisfying themselves with the knowledge of existence of undisturbed environment or existence of some animal and plant species. Although the environment is a resource, environmental impacts of projects were not included in conventional BCA, due to the inability to quantify and value environmental impacts.

Social impacts relate to changes in human relations, which may be organised as family, village, township, nation etc. As is the case with environmental impacts due to methodological limitations of the inability to quantify social impacts, conventional BCA does not quantitatively compare the social benefits and costs. The social impacts were only descriptively presented in BCA based on a Social Impact Assessment (SIA). There have been attempts to develop analytical methodology to quantify the social impact of income distribution and included in the BCA. This approach provides higher weights to income received by the poor. Despite theoretical and research developments such approaches are not used yet in practice. With the recent renewed interest of poverty alleviation through the development process it is necessary that attention is renewed to consider impacts of projects on income distribution and poverty alleviation.

In order to identify impacts of a project the following should be clearly defined.

- Objective/s of the project
- Accounting stand of the analysis
- Spatial and temporal boundary of the project.

Objectives of the Project: Projects are designed to achieve objectives of achieving human needs (beneficial economic impact) through use of resources (economic cost impact). Projects may have such objectives as increasing or sustaining agricultural, industrial or service (including environmental) production. BCA could be carried out on only projects that produce quantifiable and monetarily valuable objectives. If the objective of a project is non-quantifiable and/or is non-amenable to monetary valuation such projects should be analysed using cost-effective analysis.

Accounting Stand of Projects: Projects could be analysed to support different decision-makers such as private entrepreneurs, public institutions or government, international financial organisations. Depending on who is to be advised (private entrepreneur or government) through BCA the inclusion of some costs and benefits and their valuations differ. Private entrepreneur's objective being maximising profits would exclude environmental damage costs as such cost is impacted on others and if not compensated does not influence the profits. However if legal environmental standards require to mitigate environmental damages or taxes are levied on environmental damages (or subsidies provided for environmental benefits) then environmental impacts are relevant in a private accounting stand.

On the other hand government with the objective of maximising the welfare of the society of the nation would always include environmental damages (or benefits) as such effects the welfare of the present and future society. However national governments may not include global environmental costs, such as carbon emission, unless compelled to by financial lending organisations. Financial lending organisations would

want all environmental costs and benefits (including global) considered in the BCA as such organisations are accountable to the global community that supports the lending.

Spatial and Temporal Boundary of Projects: Environmental impacts are known to influence a wide geographical area and over a longer period of time. Irrigation projects may change the direction and quantity of flow of water having downstream impacts. For example the Kirindioya irrigation project is known to have changed the water quality in the lagoons having potential impacts on fisheries productivity and biodiversity. The change of the habitat may influence in the long term the arrival/existence of migratory birds. Thus the project boundary conceptually could extend to overseas and to very long time periods, which may not be pragmatic in analysis. Although the project boundary has been conventionally limited to the nation international impacts may have to be considered as retaliatory action is possible due to negative impacts on other countries and also if international finances are to be borrowed. Hence the project boundary (spatial and temporal) should be carefully and pragmatically identified to include all major environmental impacts. This should be done early and agreed with the participation of the team of professional involved in the analysis of the project.

Primary vs. Secondary Impacts: The project impacts that are directly related to the identified objective of the project, arise within the identified project boundary and within the identified accounting stand are referred to as primary impacts and those that are not are referred as secondary impacts. Only primary impacts are directly considered in the BCA.

If the project boundary is defined to recognise environmental impacts and an economic accounting stand is considered environmental impacts would be a primary economic impact. Environmental impacts would not be considered as a primary impact from a financial accounting stand if such an impact is not directly related to financial profits.

The secondary economic impacts are any benefits or resource costs that arise linked to the achievement of the objective of the project. These are:

- Forward and backward linkage impacts
- Investment and consumption multiplier impacts.

Forward and backward linkage impacts are resource use changes caused by reduced product prices and increased input prices caused by the project. Investment and consumption multiplier impacts are changes in consumption and investment, due to surplus income generated by the project. Investment multipliers are considered as a beneficial impact over consumption where investment funds are scarce in a country. There have been attempts to quantitatively recognise the impact of investment multipliers in BCA but is not used in practice.

Tangible vs. intangible impacts: Economic impacts (including environment) of projects could be either tangible or non-tangible. Some economic impacts that are not tangible are improved health, education, improved amenity etc. Those impacts that are not tangible and can not be quantified, should be identified and the impact should only be descriptively presented in the BCA or cost effective analysis could be undertaken.

Use of Checklists: Use of standard check lists/spread sheets would facilitate the identification of project impacts. The CEA of Sri Lanka has published manuals which provides guidelines and checklists that enables identification of environmental impacts of projects in different economic sectors (such as agriculture, irrigation, transport etc,).

3.2. Quantifying Impacts

In quantifying the primary and tangible impacts (cost and benefits) the following two principles should be followed.

- Quantify only the incremental impact
- Quantify the impact over the time

Quantifying the incremental impact: In order to quantify the incremental impact the "with and without" project scenarios should be compared. If impacts are quantified by comparing the "before and after" scenarios of the project the estimates of impacts would be an over or under estimation. The direct benefits of coast and coastal biodiversity conservation would arise from savings of property and infrastructure and increased contribution to rural livelihood and ecotourism etc from conserved biodiversity. Without the project benefits would be decreasing over time. With the project benefits are increase over time. If the before and after the project scenarios are compared the benefit estimates would be erroneous and smaller. Another example is of irrigation projects, where increased agricultural productivity with irrigation may lead to less forest dependence and save forest biodiversity, whereas without the project forest dependence would have increased and lead to loss of forest biodiversity.

Another example is without the implementation of the Upper Kothamale HydroPower Project the alternative would be producing electricity using thermal power (auto-diesel). The pollution emission of auto-diesel to the equivalent of power that could have been produced by the Upper Kothmale Hydro Power Project is particulate 56 ton/yr., carbon dioxide 3269888 ton/yr., sulphur dioxide 7400 ton/yr., Nox 5197 ton/yr. Thus it is argued that the hydro electricity project would have environmental benefits, too.

In the jargon used in EIA the without project scenario is referred to as the existing environment. Most EIA describe the static situation of the existing environment and do not provide details on changes of the existing environment without project. For example even without the project coasts would get eroded due to other natural and socio-economic factors.

The prediction of with and without project trends should be based on use of technical methods. It may be based on modelling/simulation or any other empirical method of predicting trends. However, in practice often these predictions are based on expert judgement and team consensus.

Quantifying Impacts Over-time: Project costs and benefits must be identified in terms of incremental physical quantities over time. Where data is not available or predictions are complicated predicting incremental environmental impacts may be difficult. Nevertheless, an attempt to do so however crude it may be, is necessary. For example the benefits of soil conservation in terms of improved crop productivity may begin to accrue from the second year of the project and improve by 10% every year until the 10^{th} year and stabilise there onwards.

3.3. Monetary Valuation of Economic Impacts

Rationale for Valuation: The objective of BCA is to facilitate decision making on worthiness of projects by quantifying and comparing the benefits with costs. The fact that the impacts (benefits or costs) are quantified in different physical units prevents the summing of the impacts to a single denominator. Further the physical quantification of impacts does not reveal the human preference based valuation of the impacts, that is required in decision-making. Hence the impacts should be valued due to the following reasons.

- To enable the summing of impacts quantified in different physical units
- To enable easy comparison of benefits and costs
- To enable the incorporation of preferences of the decision-maker (private or public).

Opportunity Cost Principle of Valuation: The project inputs are valued based on the value of net output produced by the input in present use that would be lost due to withdrawal of resources to the project. The project outputs are valued based on the following alternative possibilities because project output could either be traded or non-traded. Traded output could either reduce purchases of the product from alternative sources at higher cost or enable sales or both and valuation will be based on the following.

- Value of cost saved from buying it from alternative sources
- Value of net revenue from selling internationally.

If non-traded valuation will be based on value consumer's place on increased domestic supply.

International vs Local Currency: The denominator in valuation is currency. Either international or local currency can be used as the denominator. Generally local currency is more used. Projects with a large component of traded impacts could use foreign currency as the denominator. Since environmental impacts (particularly benefits) are mostly non-traded use of local currency for valuation is preferred. However environmental mitigation costs that involve capital technology may be largely traded favouring use of international currency.

Financial vs Economic Analysis: Values will differ depending on the decision-makers accounting stands viz., financial and economic. Market prices (the price that the investor pays or receives) are used for valuation in financial analysis to reflect the objective of private investors (maximising financial profit) and economic prices are used in economic analysis to reflect the objective of society (maximising social welfare). Economic prices differ from market prices if the market is distorted (government intervention or market failure). In practice market prices used for financial analysis, if are distorted, adjustments are done (shadow pricing) to value impacts in economic analysis. The economic value is the value of a resource in its best (to society) alternative use.

Shadow Pricing: Distortion in price (market price not equal to economic price) could arise due to:

- Inflation
- Inherent imperfections in the market
- Monopoly and the lack other conditions for perfect market (market failure.
- Government intervention in the market
- Intervention in foreign exchange rate (government fixing the foreign exchange rate)
- Intervention in trade (import and export taxes and subsidies or quantity restriction as quotas and licensing)
- Intervention in local market (price fixing, taxes and subsidies).

Those could be corrected by:

- Excluding transfer payments (i.e. taxes, subsidies, and interest payments on loans).
- Using economic (shadow /accounting) price.

The economic prices could be estimated by using the conversion factors that are published by the National Planning Department of Sri Lanka. The conversion factor is defined as follows.

Conversion factor = Economic price/ market price.

Conversion factors are available for single items, sectors or a standard conversion factor (for distortions between international and domestic prices due to distorted trade). The Standard Conversion Factor (SCF) is defined as follows.

SCF = CIF value of all imports/ CIF value of all imports + import taxes – import subsidies.

The equation may also consider exports. This SCF however does not consider trade distortions due to quantity restrictions. Considering those are difficult as we need price elasticities of demand etc. Hence it would be best to adjust it based on "informed guess". Conversion factor is calculated for foreign exchange, too. The level of price distortion is now diminishing with economic reforms of liberalised trade, privatisation of state ventures and minimising of government interventions in the market.

Valuing Labour: Where market wages are institutionally determined these wages have to be converted to economic values i.e. the marginal value product from where the labour is drawn to the project. Logically if there was unemployment then the Shadow Wage Rate is 0. However in informal sectors the market prices would be approximately equal to the economic prices.

Valuing Land: The value of land is the foregone net value of production. If there is irreversible change to land value such as of biodiversity or natural non-renewable resources, then capitalised value should be included.

Transfer payments: These are payments (expenses or income) that do not represent use of resources. But represent a shift on the right to use resources from one entity to another's (doesn't contribute to national income i.e. the marginal value use of resources). Therefore considered only in financial analysis and not in economic analysis. There are 4 kinds of transfer payments viz.

- Taxes (which could be direct such as income tax and indirect such as sales, excise, import, export taxes)
- Subsidies (which could be lower input price and higher output prices)
- Loans
- Debt service (interest and principal repayments)

Even if the project is foreign financed and debt service will be paid abroad, debt servicing is considered as a transfer payment and omitted from economic analysis. This is to separate the decisions of:

- How good a project is (the purpose of project analysis)from
- How to finance the project.

Depreciation is excluded in economic analysis but included in financial analysis.

Environmental impact valuation too, can be considered as a form of shadow pricing. In the case of environmental impacts the market fails to provide the economic values of the impacts. Economic valuation of the environmental impacts and integration of these values to BCA enable to correct this price distortion. Environmental taxes and or subsidies are part of the economic price where such represent the economic values of the environmental impacts. These although referred to as taxes represent changes in real resource use and not transfer of right of use of resources.

Sunk costs: Costs that have been incurred in the past although may be related to the project are not considered in the analysis. These costs are not incremental due to the project.

Tradable vs. nontradeables: Project inputs and outputs can be either traded or non-traded. Non-trading could occur because it is not profitable to trade (i.e. CIF price > domestic cost of production > FOB price) or because government intervention preventing trade (thus non-traded of tradable). Most project inputs on environmental mitigation may be traded (as imported capital technology) whilst most environmental benefits would be non-traded (as watershed, forest, soil conservation; air, water, noise pollution mitigation). The trading of environmental benefits is yet limited (such as eco-tourism). Most environmental benefits that can be traded are yet not traded either because it is yet not profitable to do so or because governments have not accepted to trade (biodiversity, carbon emissions etc). Some commodities may be prevented from trade due to environmental precautions (such products that have genetically modified organisms . Some trade can be prevented due to environmental regulations.

Traded inputs and outputs are valued at CIF price for imports and FOB price for exports. CIF and FOB prices should be adjusted to the project boundary cost by considering transport, handling and other costs. CIF and FOB prices should be converted to local currency using the market exchange rate and the foreign exchange premium.

Commodities that are tradable but not traded should be valued using CIF or FOB prices if it is expected that it would be traded in the future. Such an approach to valuation is in congruence with the basis of BCA that trade is beneficial to any country. However if it is envisaged that trade will not occur due to government prevention such commodities should not be valued using CIF or FOB prices.

The valuation of non-tradables is complicated. The values of non-tradables are hence estimated by a central agency such as the NPD in Sri Lanka. In principle non-traded inputs are valued by step-wise breaking down of the

traded and non-traded inputs that are used in the production of the non-traded input, whilst summing the value of the traded components at each step. Non-traded outputs are valued by estimating the consumer surplus.

Predicting future prices: The future prices used for project analysis needs to be predicted. Whilst price predicting models of econometric sophistication can be used often in practice informed professional judgements are made to predict prices.

Changes of relative prices and inflation: BCA is to guide the decision making on the allocation of resources to best satisfy society. Hence the impacts (benefits and costs) are valued using economic prices that best reflect societies relative valuation of impacts. Relative valuation implies that value is based on human preferences that relate to values of alternatives. Inflation is the increase in the average price level relating all commodities in general. Inflation will effect cost and benefit in the same magnitude and does not effect relative values. Therefore will not effect decision on worthiness of investment projects. Hence in economic analysis of projects a constant price using the prices of base year is used in valuing impacts over the years. The same principle applies in the valuation of environmental impacts. On the same reasoning the interest rate used in economic analysis is the inflation free interest rate. However in the case of financial analysis and government budgetary implications analysis market prices or prices with inflationary effect is considered.

In the case of possibility of relative changes in the prices such should be considered in the analysis. However, prediction on relative changes on prices is difficult and is practised only if such relative changes in prices are significantly possible.

Contingency cost: The project is designed with the assumptions of certainty of design, input requirement, geological formations, weather and prices etc. But uncertainty/risk is a fact of life. To account to such probable cost escalation due to natural reasons contingency allowance/

cost is included. This may be considered as a percentage of the total costs. Contingencies are two types:

- Physical
- Price.

Only physical contingencies are considered in economic analysis.

Residual Value: The residual value of resources and assets beyond the project period is included in the analysis.

Decommissioning costs: Projects may have decommissioning costs such as to restore the project site to environmentally accepted standards. Such costs need to be included in the analysis.

Depletion premium: Projects could be using renewable or non-renewable resources. The use of non-renewable resource depletes the resource and would not be available for the future generations. The non-renewable resources could be those for which substitutes are available (by technology or site) and those for which substitutes are not available at all (endangered and endemic species).

In case of non-renewable resources a depletion premium need to be added to the market price to account for the depletion. However the value of non-renewable resources for which there is no potential substitute non-quantitative decision criteria need to be considered.

The cost of exploiting a non-renewable resource now is that it would not be available in the future and more expensive substitute will have to be used. Therefore the cost of exploiting now is the discounted cost of the higher value substitute to be used as an input or the higher value that is forgone of an output. According to ODA (1988) this premium can be calculated as follows.

$DJt = PA\ t+n - CJ\ t+n / (1+r)\ n$

DJt = Value of unit of resource J of the premium DJ in any particular year t
n = number of remaining years over which the resource will be exploited
PA t+n = the price of the equivalent amount of the substitute resource which will be available in period n
CJ t+n = the long run cost of extracting a unit of the resource would be in the future period n, if any of it remained to be extracted.
r = interest rate.

3.4. Discounting Costs and Benefits

Rationale for discounting: The cost and benefit cash flows provide the monetary flow of cost and benefits (financial and economic) of the project over time. These flows over time should be converted to a value at a common point of time to be comparable as benefits and costs at different points of time are different. A given benefit now is preferred than in the future. This preference for the present over the future is partly due to:

- Opportunity cost of using resources at present vs. in future. (i.e. interest earning, reinvestment possibility) (interest is the reward for foregoing present consumption)
- Risk.

If the markets are perfect, the market interest rate will reflect the social time preference valuation.

Where markets are distorted and also because markets being myopic do not adequately represent time preferences of present and future generations, financial interest rates are modified to economic interest rates. This too is a form of shadow pricing of the interest rate. On the premise that society time preference extends more to prefer future than of individuals, interests rates lower than market interest rates are used in economic analysis. The same argument is more strongly extended towards environmental and natural resource use over time. The need to use a lower interest rate is argued by some in the case of projects that have significant environmental

impacts. For practical purposes the economic interest rate proposed by the National Planning Department of Sri Lanka should be used.

3.5. Estimating Indicators for Decision Making

There are alternative indicators that can be used to guide decisions on choice of projects. No single indicator could be considered as the best indicator over others. No indicator is able to provide all the information required for decision-making. Hence indicators must be considered as only an objective, guide to decision-making that summarises, important but not all, relevant information. Indicators must be used along with other relevant information in decision-making. These indicators can be estimated using spreadsheet computer software. Some of the indicators that are widely used are as follows.

- Net Present Value (NPV)
- Benefit Cost Ratio (BCR)
- Internal Rate of Return (IRR)

These indicators can be used for financial or economic analysis.

Net Present Value: It is the difference between the discounted benefits and costs of the project. If the NPV is 0 or + of independent projects, such projects are worthy.

Benefit cost ratio: It is the ratio between discounted benefits and costs of the project. If the BCR is higher than 1, such projects are worthy of implementation.

Internal rate of return: It is the discount rate that makes the present value of the benefits equals to present value of costs of the project. Independent projects that have IRR > 1% (could be the financial or economic interest rate) are considered worthy for implementation.

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3.6. Sensitivity Analysis

Projects could face uncertainties that are physical or market/price related. In order to recognise the influence of uncertainties of projects in decision making the decision-makers should be provided with additional information. Sensitivity analysis enables to identify risk variables in the project circle and addresses those in the design of the project. Such information could be generated by re-estimating the choice criteria under predicted conditions of uncertainties. Such analysis is referred to as sensitivity analysis. Sensitivity analysis of projects could be done on the following.

- Price sensitivity analysis could be done on changes in input/output prices, shadow prices.
- Delay in implementation
- Cost over-runs, particularly of projects having a heavy investment in early period with no or little returns in the early periods.
- Yield (benefit) changes
- Sensitivity to interest rate
- Sensitivity of the project to environmental mitigation costs.
- Sensitivity to estimated environmental values

The values for sensitivity analysis must be reasonable and based on past experiences if available and not hypothetical. Sensitivity analysis could be done for a combination of above (cross sensitivity analysis). If variables are interdependent, those variables must be considered together in the sensitivity analysis. Insurance payments must be included as a direct cost. Insurance could be an environmental mitigation cost for probable environmental damages.

3.7. Impact on Budget and Foreign Exchange Earnings

If the benefits are estimated as consumer surpluses (often environmental benefits) and there is no cost recovery, this may lead to projects having problems of liquidity in meeting recurrent costs if national budget is constrained. Hence the impact of particularly environmental projects on

national budget must be carefully considered. Special concern must be taken in assuring the availability of recurrent costs for such projects. Environmental monitoring adds up to the government/provincial budget. Hence least cost monitoring should be looked for such as community participation for monitoring. The need of foreign exchange costs of projects must be examined carefully, where foreign exchange earnings are scarce.

3.8. Cost Effectiveness Analysis:

BCA could be done only if both costs and benefits could be identified and valued. However benefits of some projects (social infrastructure) can not be adequately valued (health, education, drinking water). In such cases the alternative that has the least economic cost is considered as the best. Hence the economic prices and economic interest rates are used. It is assumed that all alternatives achieve the same level of benefits. Cost effective analysis can be used in finding the least cost alternative (technology, site, scale etc) to meet environmental standards too.

3.9. Considering Savings vs. Consumption:

If the country does not have sufficient savings and is unable to use policies to generate savings it may want to select projects that favour savings than consumption. This also relates to inter-generational equity as increasing current savings reduces consumption from the present and distributes it to the future generation. Environmental conservation too is a savings for sake of improved welfare of the future generations. Hence environmental projects may be favoured over others in project selections.

3.10. Considering Rich vs. Poor:

If the government is unable to achieve equity objectives through policy then the government may want to select projects that influence equity. That is a situation where the government is unable to generate sufficient revenue to address issues of equity.

Only the distribution implication of the net income of the project is considered. The recipients of the net income flow should be identified. The categories of recipients considered could be

- Income/consumption level (rich and poor)
- Propensity to save/consume
- Public vs. private sector
- National vs. foreign
- Gender

Next weights should be given differentially to income received by different recipients. Weights could be derived empirically based on revealed preferences (past government decisions).

Segregating net income among recipients and also deriving weights are both practically difficult. Favouring the poor would also be contradictory to wanting savings as the poor consume more at present. Hence application of income weights in project analysis has been limited to academic literature. However recognising savings and distributional issues in project selection are important.

3.11. Cost Recovery:

The government could re-invest on other projects if it could recover costs on implemented projects. Hence possibilities to recover costs must be examined in the analysis of projects. Cost recovery from environmental projects may be difficult but not impossible.

CHAPTER 4

INTEGRATING EIA WITH BCA

The procedure of integrating of EIA with BCA (i.e. EBCA) is straightforward. The environmental impacts that have been identified in the EIA should be screened, by the team of experts analysing the project, based on the following criteria.

- The environmental significance of the impact
- Social sensitivity of the impact
- Availability of data to estimate incremental impacts over time

Environmental impacts that are environmentally significant (degree of damage or benefit, geographical spread, irreversibility of damage etc), and not highly socially sensitive and the incremental change which could be quantified overtime can be considered for valuation through an appropriate method. Once valued, the environmental cost and benefit streams could be discounted along with the economic costs and benefit steams to estimate decision-making criteria.

If the environmental impacts are subject to environmental standards, such would be mitigated and the mitigation cost should be included in the analysis. Only any remaining residual impact would have to be valued. This chapter first explains the concept of value of the environment and then explains some of the environmental valuation methods, the advantages and disadvantages of those methods along with a Sri Lankan example of application.

4.1. Concept of Economic Value of the Environment

The value of an environmental resource is not intrinsic to the resource. Values that the market derives for resources arise due to initially, human desire to consume commodities produced by the resource. Hence economic value of the environment is essentially anthropocentric. The concept of economic value of the environment is summarised in Table 2.

Economic value is derived from human utility (satisfaction) generated in the use of commodities produced from scarce commodities. Environment is a scarce resource. Human satisfaction can be generated through either personal or non-personal use of environment. In personal use of environment individuals gain satisfaction by meeting individualistic/ selfish desires. In non-personal use of the environment individuals derive satisfaction on the feeling that the environmental resources will be available for use by other individuals, particularly of the next generation.

Personal use of environment could take three forms, direct use, indirect use, and option use. Direct and indirect uses occur at present and option use may occur in future. Direct use refers to the direct consumption of commodities of environment either destructively or non-destructively. Examples of destructive use of environment are harvest of timber and some non-timber forest products such as food, fibre and medicines etc from forests[1]. The value of timber harvested in Sri Lanka in 1995 has been estimated at RS. 521 million from natural forests and forest plantations (De Silva and Kotagama, 1996). Around 500 plant species are believed to be used medicinally in Sri Lanka (MTHEWA, 1993). Villagers in the periphery of the Knuckles forest use 48 forest plant types for food, medicines and roping material etc, deriving a value of RS. 4095.00 per ha per year. (Gunatillake et.al., 1993). Similarly, villagers in the periphery of the Sinharaja forest derive a value of RS. 575.00 per ha per year by harvesting non-timber forest products (Gunatilake et.al, 1993).

Non-destructive use of environment is exemplified by enjoying the scenery of nature, use of environment for education, photography and eco-tourism etc. In 1993, 13,273 Sri Lankans and 963 foreigners have visited Sinharaja forest, for above purposes. On entrance fees this would have earned approximately Rs. 200,000. Hence if entrance fee was used to show the use-value of the Sinharaja forest, the value could be imputed as RS. 18/ ha/year (Steel, 1996). Similarly, the value derived from the Horton Plains and Yala wild life sanctuaries are; RS. 1150/ha/year and RS. 250/ha/year, respectively (Steel, 1996). Kariyawasam (1992) has estimated the recreational value of Sinharaja forest to Sri Lankans as RS. 394,000.00

1 Not all non-timber forest harvests are destructive. Non-timber forest products may be non-destructively and also sustainable harvested.

and the value per visit as RS. 1.50 based on a travel cost study. A study done by (Gunawardene, Edirisinghe and Kotagama, 1995) has estimated the willingness to pay for recreational benefits of Hikkaduwa marine sanctuary of Sri Lankans and foreigners as RS. 222/year and 358/ year, respectively.

Table 2 Components of Total Economic Value of the Environment

Use Values (personal consumption of commodities)			Non-Use Values (non-personal consumption of commodities)	
Present use values		Future use values		
Direct use values	Indirect use values	Optional use values	Bequest values	Existence values
Value generated from direct consumption of commodities	Value generated from indirect consumption of commodities	Value generated from maintaining options for eitherdirect or indirect consumption of commodities in future	Value generated from conserving of consumption opportunities for future generations	Value generated from preserving existence of biological resources for their own sake.
Examples:				
Food, Fiber, Timber, Fuel-wood. Medicines. Recreation etc.	Maintenance of ecological systems. Nutrient recycling, Carbon sequestration. Watershed protection etc.	Use of chemical as future pharmaceutical, Use of genes in increasing future agricultural productivity	Preserving unique habitats. species etc.	Preserving endangered habitats, species etc.

Modified and adopted from: Barbier, et al. 1991

Indirect uses of environment can be seen through the maintenance of ecological functions. Examples include maintenance of food chains, regulation of pests in cultivated crops through natural predators, maintenance of nature as a primary resilient life support system, and habitat conservation indirectly contributing to preservation of watershed functions (water and soil conservation). Very few economic studies have been done to estimate these values, mainly because of the inadequacy of bio-scientific information. De Silva and Kotagama (1995) have estimated the Sri Lankan watershed values at RS 1510/ha/yr for agro - hydrological benefits and RS 224/ha/yr for domestic water purification benefits.

An important indirect use of environment is its influence on moral and cultural values of society. Traditional Sri Lankan has held reverence to nature. Many customs, norms and institutions that guide human behaviour were linked to nature, and cultural sustenance is considered a necessity for sustainable development. Whether the study of the influence of environment on human culture is within the domain of economics is arguable. Nevertheless culture is a strong factor that influences human preferences, thus economic values.

Option use of the environment refers to the satisfaction gained through conserving the environment, with hope that in future, it could be used directly or indirectly. For example conserved biodiversity could probably be used as a source of genetic material in crop or livestock improvement or in extracting chemicals for pharmaceutical purposes. Contingent valuation studies have estimated the option value of Sinharaja (Abeygunawardene, 1992) as RS. 54.70/year and RS. 204.50/year ($/ha/year) for peripheral communities in Sinharaja and Urban communities in Sri Lanka, respectively. Gunawardene, Edirisinghe and Kotagama (1995) also using contingent valuation have estimated the option value of Hikkaduwa Marine sanctuary as RS. 106.62/ year for Sri Lankans and RS. 145.00/ year for foreigners. Kotagama and Thushantha (1996) have estimated the pharmaceutical prospecting value of Sinharaja at RS. 5900/ha/year.

Non-personal use of environment could take two forms: bequest use and existence use. Bequest use stems from satisfaction of knowing that the environment would exist for use by future generations. Existence use is from the knowledge that environment exists for its own right for the ecosystem. Sri Lanka has had a culture that has greatly appreciated existence values. Around 300 BC, in the sermon by Arahat Mahinda to the king Devanampiyatissa there is mention that:

"*the birds and beasts have equal right to this land and the king is only their custodian " (Mahavamsa, 6th century A.D.)*

Using contingent valuation, Abeygunawardene (1992) and Gunawardena et, al. (1995) have estimated bequest and existence values of Sinharaja forest and Hikkaduwa marine sanctuary respectively. The bequest value of Sinharaja has been estimated at RS. 72.30/ year for peripheral communities and RS. 271.20 /year for urban communities; the existence value, RS. 41.30/ year for peripheral communities and RS. 171.60/ year for urban communities in Sri Lanka. The bequest value of Hikkaduwa marine sanctuary has been estimated at RS. 270.93/ year for Sri Lankans and RS. 496.50/ year for foreigners; the existence value. RS. 83.56/ year for Sri Lankans and RS. 133.00/ year for foreigners.

The relative importance of the above environmental values would depend on its stage of development and the cultural association with the environment. Generally developing countries like Sri Lanka, under the present economic context, would give more attention to direct uses that give immediate benefits, while affluent developed countries would give more higher valuation to the existence of environment.

4.2. Environmental Valuation Techniques

Several environmental valuation techniques (EVT) are discussed in this section. Though not claiming to list all techniques, the selected EVTs show the range of tools available for valuation. Selected EVTs are followed by a brief summary of a Sri Lankan study where available, which illustrates

the use of the principle, method, advantages and disadvantages of the EVTs discussed.

4.2.1. Productivity Change

Principle: when a change in the environment affects a marketable commodity, the value of the environmental change can be represented by the change in the commodity's market value due to the environmental impact.

Method: The method consists of two steps:

(1) Estimating the physical relationship between the cause (environmental change) and the effect on the commodity. This relationship is referred to as the damage function.

(2) Estimating monetary value. The change in the physical quantity of the commodity affected by environmental change is multiplied by the market price of the commodity.

Advantages: This method is easily understood because of its simplicity, apparent pure scientific base and close relation to the market. It appeals to technical scientists and even to those who do not have knowledge of economics.

Disadvantages: Damage function is not readily available. Even if available, damage functions may be site specific. Estimation of damage functions could be expensive in terms of time and other resources required. Estimating damage function could have technical problems of isolating the cause and effect from other extraneous factors and of accounting for natural change that would occur irrespective of the environmental change. Only use value of the environmental change can be estimated by this technique.

Study Illustrating Productivity Change:

Sumanaratne, N. and P. Abeygunawardena. An Economic Evaluation of Salinity Problem in Inginimitiya Irrigation Project. Unpublished manuscript.

The study conducted an economic feasibility of correcting salinity in an irrigation project. Using ten blocks, the effect on productivity was quantified and the impacts were monetarily valued.

The damage function was assessed through the observation of yield reduction in fields with different levels of salinity. Using various assumptions, it was estimated that the reduction in paddy yield was about 400 metric tons per season. The present value of crop loss at a discount rate of 20 percent would be equal to Rs. 21 million over a period of 20 years.

The advantages of this methodology are quite apparent in this example because of the scientific nature of the data gathering process and the use of market prices. However, the disadvantages can also be seen regarding the simplicity of the damage function used. It is assumed that a good study will minimise the possibility of a deviation in crop yield due to reasons other than salinity. However, totally ruling out this possibility is only possible through setting-up experimental plots, which are obviously costly.

The study also used the preventive expenditure approach that assesses the value people place on preventing salinity. This is another EVT that enhances the value of the study because it provides an alternative estimates of the environmental impact of salinity.

4.2.2. Preventive and Replacement Cost

Principle: The value of the environmental change is estimated by valuing the cost people incur to prevent damage caused by the environmental

change or the expenditure people would incur to replace the damaged environment (replacement cost) to its initial state.

Method: Two methods could be used:

(1) Collecting data on actual cost people incur to prevent an environmental damage or restore an environmental damage.

(2) Estimating the preventive or restoration costs based on opinion of technical experts.

Advantages: The preventive or restoration cost estimates may readily be acceptable because of the clear intuitive principles they are based on.

Disadvantages: The preventive expenditure method assumes that people are aware of the environmental problems and would take preventive action, which may not be the case. The technique is biased towards valuation of higher income groups who could afford preventive expenditure. It assumes that the benefit from preventive expenditure is solely for the prevention of the environmental damage, whereas it could have other benefits, hence undertaken. Replacement cost assumes that the original environment could be fully restored. This may not be technically possible. Even if possible it may not have the same value as the original (e.g. archaeological sites).

Study Illustrating Replacement Cost:

Samarakoon, S.M.M. and P. Abeygunawardena. 1995. An Economic Assessment of On-Site Effect of Soil Erosion in Potato Lands in Nuwara Eliya District of Sri Lanka. J.of Sus. Agri. 6(2/3):81-92.

The study valued on-site effects of soil erosion using secondary data verified by interviews from potato cultivators.

The first step was to quantify the amount of soil eroded through the universal soil loss equation, which predicts the amount of soil erosion

through its relationship with factors such as rainfall, erodability, slope and farming practices. It was estimated that 9-15 tons per hectare was lost depending on the season. Based on these figures, the NPK and organic matter lost from the volume of eroded soil were estimated. Using the market value of lost NPK, organic matter and the associated labour and maintenance cost, it was estimated that the replacement cost ranged from Rs 2,305-3,443/ha.

The values are readily acceptable because of the methodology adopted. However, the clear caveat is identified by the author, citing that addressing the spatial and inter-temporal aspects of soil erosion requires the understanding if the private cultivator is willing to account soil erosion in his profit calculations.

Other studies using the replacement cost technique include:

Sumanaratne, N. and P. Abeygunawardena. An Economic Evaluation of Salinity Problem in Inginimitiya Irrigation Project. Unpublished manuscript.

Clark, R., H. Manthrithilake, R. White, and M. Stocking. 1996. Economic Valuation of Soil Erosion and Conservation. Paper Presented at the 9th Conference of the International Soil Conservation Organisation, Bonn 26-30 August.

4.2.3. Human Capital

Principl: When a change in the environment affects human health, the value of lost productivity (wages), medical treatment costs, and in the case of death — the present value of potential productivity, is seen to be the value of the environmental change.

Method: The application of the human capital approach is similar to that of the productivity loss approach. It is necessary to identify the cause of the environmental change and its effect on human health. The number of

of persons affected is quantified (typically via dose response functions), and the loss of working days and the wages earned are then used to estimate the value of the environmental change

Advantages: The analytical method is simple and is intelligible to policy makers.

Disadvantages: The cause and effect of environmental change and human health is not well known. Epidemiological research is expensive. To consider the value of unemployed and poor as zero could be an inequitable proposition. Psychological costs of suffering and long-term chronic conditions of illness will not be valued. Valuing human life monetarily may be ethically objected.

4.2.4. Hedonic Value

Principle: There are two hedonic methods in environmental valuation: Property value and wage differential methods. In the absence of a market for environmental quality, its value is obtained from prices of surrogates such as property and wages. It is presumed that the property value and wages encompass a value to environmental quality. Furthermore, the value of the environment could be decomposed if all other factors determining property value and wage are known.

Method: Data is collected on the value of property or wages in varying environmental quality conditions, including factors affecting property value and wage level. By regressing the property value or wage level with determining factors including environmental quality variables, the value of the environmental quality is estimated.

Advantages: The technique can estimate the total value of the environment.

Disadvantages: Hedonic methods require a large database and a 'sophisticated' analytical technique, i.e., regression. Problems connected

with the use of the regression technique are therefore associated with this method. Environmental variables may not be as accurately quantifiable as is required for regression. People may not be aware of the environmental quality difference in the case of some pollutants until the change is drastic.

4.2.5. Travel Cost

Principle: The value people place on environmental quality is estimated based on the cost of travelling to the site, and the value of productive time lost in visiting the site.

Method: The area surrounding the concerned site is divided into equi-distant concentric zones. Visitation rates for each of the zones are calculated. The visitation rates are regressed on travel costs and other socio-economic variables for each zone, to derive demand curves for each zone. Consumer surplus is estimated from the demand curves.

Advantages: The technique can be used to estimate total value of the environment.

Disadvantages: The application of the technique requires the collection of large amounts of data, and involves regression analysis. Therefore problems associated with regression analysis are inherent in the technique. Considering the value of productive time may be erroneous if travel is undertaken during leisure time, or by the unemployed. A trip may be to multiple sites. In such situations, decomposing the cost to a single site may be difficult. The value of the environment estimated by travel cost does not consider the total value of the environment. It ignores option and existence values. It also ignores the benefits derived from the site for those who do not visit the site, such as those living closes by.

Study Illustrating Travel Cost:

Kariyawasam, D. 1992. Using the Travel Cost Method for Assessing Recreational Benefits in a Biosphere Reserve. The Sri Lanka Forester. 20 (3&4):11-18.

The study applied the travel cost method to value a lowland rainforest. The study adequately documents the rigor required in data collection using this EVT. Primary data was collected through a field survey, and visiting rates were applied to the sample using secondary data. The regression analysis showed that the total annual consumer surplus for recreational use of the rainforest amounted to Rs 15,770 or Rs 1.50 per domestic visit.

It is apparent that the values derived are low. The author identifies certain explanations, which are inevitably linked to difficulties in data collection. The author also acknowledges that the travel cost method values only one of the many potential environmental benefits brought by a rainforest.

Another study, which used the EVT, is:

Silva, K.A.D.I., and H.B. Kotagama. 1997. An Optimal Fee for Entrance to Udawalawe National Park: An Assessment. Tropical Agri.Res. 9:317-329.

4.2.6. Contingent Valuation

Principle: People are directly asked their willingness to pay for an environmental benefit, or the willingness to accept compensation for its loss, assuming they are aware of the change in the environment and its implication to human welfare.

Method: Sample surveys are conducted to elicit peoples valuation of willingness to pay or accept. Different techniques are used (open-ended questioning, bidding games, etc.) to elicit responses.

Advantages: Theoretically the method is able to value all benefits (use and nonuse) of the environment. It is the only applicable technique for valuing environmental changes that do not have any relation to the market.

Disadvantages: The method is of a hypothetical nature. Its results may not be readily acceptable to technical scientists and policy makers. The method holds the possibility of estimating biased values (which could be corrected). It requires that people be aware of the environmental change and its likely impact. The method does not constrain the demand for environment on actual income (which could be corrected). Hence values may be unrealistic.

Study Illustrating Contingent Valuation:

Ekanayake, E.R.M. and P. Abeygunawardena. 1994. Valuation of Conservation Commodity of the Sinharaja Forest: Towards Total Economic Value.

The study aimed to capture monetary value for the flow of environmental and natural resources using contingent valuation to show both use and non-use values. Primary data was collected in three different areas representing urban residents and residents on the periphery of the forest. The survey asked 240 respondents questions regarding willingness-to-pay, in order to create a hypothetical market for the various benefits derived from forests. The study resulted in estimating an average willingness-to-pay of Rs 663.64 for forest conservation with the highest amount cited for bequest values.

The study having been carefully conducted, technical experts knowledgeable of the process can easily accept the results. However, it is clear that these values are largely dependent on the conditions in the project area. The author identifies that improved educational campaign for forest conservation would be a worthwhile endeavour. This can be seen as a factor, which would increase the respondent's valuation of the forest.

Another related study is:

Senaratne, D.M.A.H., P.Abeygunawardane, and K.A.S.S. Kodithuwakku. 1993. Factors Influencing the Appreciation of Benefits Provided by

Peradeniya Botanical Garden: Willingness to Pay Approach. Tropical Agri. Res. Vol. 5:160-167.

4.2.7. Benefits-Transfer Method

Principle: The value of the environmental impacts that have been already estimated (within the country or outside it) is used with appropriate modification.

Method: Estimates of the value of environmental impacts, which are closely similar to the impacts of the concern project, are selected. These values are adjusted to account for differences in income, property rights, land prices, institutions and culture etc. (See Box 4).

Advantages: The method is rapid and convenient.

Disadvantages: The acceptability of the values could be questioned if the conditions, particularly income and culture, differ widely.

Study Illustrating Benefits-Transfer:

De Silva, S. and H.B. Kotagama. 1997 . Values of Carbon Sequestration and Sink Service of Forests in Sri Lanka: Justification for International Resource Transfer for Forest Conservation. Paper presented at the National Symposium on Climate Change (March).
Benefits-transfer in this study involved several steps, two of which are discussed in this summary. The first instance involves the carbon uptake rate (CUR). CUR values have not been computed in Sri Lanka. Thus, the value estimated by the US Environmental Protection Agency (1989) which is 6.78 tons of carbon per hectare per year was used. Another transfer was performed to obtain a monetary value for global warming damages. The avoided damages were obtained using the study by Brown, et al. (1993) which valued damages at $10 per ton of carbon based on one percent of Global World Product.

Derivation of estimate did not require extensive resources. But the study presents the range of available literature from which estimates could be transferred. From these, the authors use judgement on the most appropriate values. Because of the research performed to survey available literature and the estimates derived become more defensible. Furthermore, since values used were global in nature and adjustments were not required.

It is, however, important to note that because of the nature of the study, the literature is not location specific. More care would be necessary if the transfer performed was location specific and adjustments with respect to income and socio-economic characteristics, etc. would be required.

4.3. Choice of valuation technique

The choice of the appropriate EVT would have to be done by an interdisciplinary EIA team. Some criteria that could be considered in the choice of EVT are as follows.

Data requirement: Two types of data that can be used, are primary and secondary data. Collection of primary data is generally expensive and requires more trained personnel and time. Certain EVTs such as CVM require more primary data whilst methods like Change in Productivity can be applied with secondary data. Care must be taken in the use of secondary data and reliable data are required for damage functions. If unavailable considerable technical expertise, experimentation and epidemiological studies would be required to generate damage function. Such requirements would require considerable resources. However since damage functions are technical, it is believed that once estimated they can be used in different socio-economic circumstances.

Importance of free market: The major assumption on which EVT's are based is that the social value of the environment has been derived from aggregation of individual values/preferences. A perfectly competitive market reflects through prices, social values of resources based on individual preferences. Most EVT's (except contingent valuation

technique) depend indirectly on a market price of the commodity affected by environmental change. Hence the "degree of market perfectness" of the considered commodity determines the degree of accuracy of the valuation.

Ability to estimate the total value of the environment can be used as one criterion. The value of the environment is composed broadly of use values and non-use values. Use values generally are more tangible (e.g. fisheries production) and measurable, whilst non-use values are not (e.g. preserving the environment for the future generation).

Analytical requirement: The sophistication of statistical/econometric techniques required for the application of EVT's vary.

Ethical/cultural acceptability: Techniques such as the human capital approach may not be ethically acceptable because the value of human life is estimated based on potential cost earnings. Those techniques that indirectly depend on market prices derive values based on the existing property rights and income distribution, which may not be socially equitable.

With these considerations, particularly when the study has resource constraints, the EVT known as benefits-transfer method is likely to be a feasible approach for many applications. The reason for using such rapid analytic valuation methods is to quickly gain information on the significance of environmental impacts and whether they should be considered in decision-making. The results can be used in deciding whether to proceed with a given activity, modify the activity to mitigate damages, or enhance environmentally beneficial outcomes. Table 3 briefly outlines the steps in performing benefits-transfer:

Selection of literature is clearly important in the application of BTM whether it is to be used as the primary EVT or used to act as a counter check for the main technique used.

Table 3 Steps in Benefits-Transfer Method		
Select Literature		*Choose similar environmental impacts and socio-economic characteristics; verify technical quality of the study*
⇓		
Adjust Values		*use most appropriate/ applicable values;adjust based on income, socio-economic factors, etc.*
⇓		*use a range of reported values;*
Calculate Unit Values Per Unit of Time		*Perform required adjustments;*
⇓		
Calculate Total Discounted Values		*Identify period of time impacts will occuruse appropriate discount rate*
Adopted from: Asian Development Bank. 1996.		

APPENDIX 1

MARKET FAILURES IN ALLOCATING ENVIRONMENTAL RESOURCES

The use of BCA is required because the market fails to allocate some resources efficiently. In a market economic system, individuals as producers and consumers, take independent decisions to best satisfy themselves, given the technology to produce and access to resources and the preferences on consumption and available income. The market co-ordinates these independent decisions of individuals, as supply of producers and demand of consumers on commodities resulting to determining of prices (or social values). It is intuitively clear that consumers would demand less and producers would wish to supply more at high prices of a commodity. The market assures the attainment of the equilibrium (satisfying consumers and producers simultaneously) price through adjustments in the supply and demand. Where the supply is realised to be in excess of the demand the producers would reduce supplies. The equilibrium prices in turn guide consumption and production decisions leading to allocation of resources that best satisfy both consumers and producers simultaneously. From an overall society's perspective resource allocation is optimal if the resource allocation (therefore price) can not be changed without, at least making one individual worse off. For example a price higher than the equilibrium price would make the producers worse off as there would unsold commodities. A price below the equilibrium price would make the consumers worse off as the supply would not meet the demand by the consumers. Any movement to the equilibrium price makes both consumers and producers better off. Hence the market allocates resources according to wishes of the society satisfying both consumers and producers simultaneously. This is the strength of the market. However, the market could function only if certain conditions prevail.

The market would allocate resources efficiently (satisfy society), under prevailing distribution of income, if property ownership is defined and enforced, if perfect competition prevails in the market (i.e. large number

of buyers and sellers, homogenous products, free mobility of resources, technology and information, free entry and exit to the industry). Despite the strength of the market system it has weakness internal to the system that leads to the failure of the market in allocating resources efficiently. These failures arise in the following situations.

- Where barriers to perfectly competitive markets exist (such as in the case of economies of scale allowing for monopolies, government intervention in the market through price regulation, taxes and subsidies etc.).

- Where deficiencies in property rights, either in defining of rights, or in the enforcement of rights exist (such as the case for environmental resource as air and other natural resources). Resources owned by nobody or every body (or if ownership can not be enforced) can not be neither be sold or bought. Hence such resources would not have price or the price would be zero. Resources with a zero price are perceived to be free and would be overused leading to degradation and destruction.

- Commodities of which consumption by one individual does not reduce the amount of it available to another individual, (such as the enjoyment of scenic beauty) can neither be sold nor bought. Non would buy such commodities as those are available uncompetitively and free. These commodities are referred to as public commodities.

- Prevalence of externalities; i.e., when production or consumption of one person effects another and is not compensated for the benefit or the cost, (such as the upstream pollution of water bodies effecting downstream uses). Such situations arise mainly because property rights can not be defined and enforced on such effects, due to technical inability or high cost to define, measure and enforce.

- Where market fails to elicit the preference of some sectors of the society present and future leading to inequity/unfairness in the sharing of benefits derived from the economy. Market does not

represent the wishes of the poor of the present generation. The market demand for commodities becomes effective not only on the wishes of people but also on their purchasing power (income) of the existing distribution of income. Hence the market prices reflect the preferences of only the rich who could afford to purchase.

- Further the market is obviously unable to elicit the preference of future generations, as they are unborn (unless the preferences of future generations are assumed to be reflected by the present generation). Hence the market may not allocate/conserve sufficient resources to meet needs of future generations creating inter-generational inequities.

Market failures preclude sustainable development through inefficient and inequitable resource allocation in the present and future generations.

APPENDIX 2

AN APPLIED EXAMPLE OF ENVIROMENTAL BENFIT COST ANALYSIS OF A COASTAL RESOURCE MANAGEMENT (CRM) PROJECT

This appendix describes the EBCA of a CRM project in Sri Lanka, which was financed for implementation by the Asian Development Bank. The CRM project was designed to address the unsustainable and conflicting uses of coastal and marine resources in 8 selected sites in Sri Lanka. The investment activities are mainly on planning and implementation of strategies to maintain the coastal and marine resource use at present level of use and thereby avert further degradation and unsustainable use of the resource. Some investments on improving livelihood of coastal resource dependent communities have been also proposed with the expectation of de-linking the dependence on overuse of coastal and marine resources.

Description of Project Sites: Resource uses Trends

Negambo Lagoon

Negambo lagoon located in north of Colombo, is in the close vicinity of the expanding Colombo municipal area. Despite the pressure on land and resource use exerted by the rapidly increasing urban population, the Negambo lagoon still provides livelihood to a large community whilst maintaining the biodiversity of the lagoon and wetland marsh land. This large lagoon supports a rich fishery, and a growing foreign and local tourism industry. As mentioned above the threats to the lagoon arise due to expanding population exerting demand on the habitat for land and extraction of resources, user conflicts, pollution due to industries prawn farming etc, and siltation. There has been extensive research done quantifying the economic importance of the lagoon (Samarakoon, 1995)[1].

[1] Samarakoon, Jayampathy (1995) "Participatory Planning and Integrated Coastal Management for an Estuarine Peat Marsh Ecosystem in Sri Lanka". Coastal and Marine Environmental Management: Proceedings of a Workshop. Asian Development Bank.

Lunawa Lagoon

Lunawa lagoon is a small 'lagoon' in close proximity to Colombo city and the Moratuwa- Ratmalana industrial area. The discharge of industrial and domestic wastes to the lagoon for several years has lead to heavy pollution of the lagoon. This has been further aggravated due to the disconnection of the lagoon with the sea due to formation of sandbars at the opening to the sea. The lagoon is nearly devoid of natural fauna and flora. It has posed a health threat with alleged increases in mosquito related diseases. As with the case of closely located Bologoda lake Lunawa lagoon has the potential to be used for recreational purposes.

Madu Ganga Estuary and Lagoon

Being located quite a distance away from the Colombo City the Madu Ganga estuary and lagoon has at present a pristine natural environment with dense mangroves and wetlands. It has been traditionally used for fishing, including prawn fishery. Madu ganga has recently been attracted for eco-tourism and also conventional recreation based tourism such as speed boating and surfing etc. The recent tourist resource use activities have developed conflicts with conventional fisheries resource use, posing a potential threat to both resource use activities and the pristine nature of the habitat.

Unawatuna Bay

Unawatuna bay close to Galle town has been a popular tourist site due to attraction of scenery, beach and coral reefs. The area has been traditionally used for fishing too. The tourism in the area is adversely effected due to unplanned construction in the beach and the surroundings. Fishing is under threat due to overfishing of ornamental fish in the reefs and due to use of dynamite for offshore fishing. Located close by is a unique biodiversity rich habitat, i.e. Rummassala.

Kalametiya (Tangalla – Hambantota)

In close proximity to Tangalle town are Kalametiya and Mawella lagoon (another selected project site). The lagoon is associated with wetlands rich of biodiversity, which also provides habitat for migratory bird species. The area is unique in being nesting area for migratory turtles. The habitats are threatened due altered water flows (change of salinity levels) to the lagoons due to upstream irrigation water use, overfishing, shell and coral mining, mangrove cutting and poaching of turtle eggs. The Rekewa lagoon, which is immediately adjacent to Kelametiya, has been well researched and has undergone past attempts of Special Area Management (SAM).

Bar Reef

Bar reef is one of the few remaining a coral reef in Sri Lanka that is still relatively in pristine condition. Although the area has been declared as a sanctuary, due to inadequate management the reef biodiversity is threatened due fishing, particularly for ornamental fish for exports.

Hikkaduwa

Hikkaduwa is a very popular tourist resort area due to sandy beaches, shallow sea and coral reefs. Although the Hikkaduwa coral reef area has been declared as a marine sanctuary and attempts to manage it as a SAM site has been undertaken there is still a threat to this critical natural habitat. The envisaged damaged to the habitat will lead to the loss of biodiversity and further to the loss of the revenue form tourism too.

Mawella Lagoon.

Mawella lagoon is in close proximity to Kalemetiya. The habitat conditions, economic use and potential threats are very similar to those experienced at Kalemetiya.

Identification of Incremental Economic Benefits Arising from Project Investments.

It is expected that without the project investments the present resource use trends will continue in all sites leading to degradation of the resource and loss of livelihood to communities. It is expected that with the project the degradation of the resource would be averted and the present level of resource use where sustainable would be continued, with least restrictions on such resource use. Unsustainable resource use would be curtailed through provision of alternative livelihood opportunities. Hence the incremental benefit of the CRM project investment arises from the difference of the present resource use (assumed sustainable) and the predicted non-sustainable resource use. It was assumed that the non-sustainable use without the project would lead to a loss of 1% of the habitat/resource value. This assumed value is less than the rate of de-forestation in Sri Lanka which is about 2.5 to 3%. Further White and Barker (1995)[1] has reported that the coral cover in Hikkaduwa has decreased from 21.7% in 1985 to 13.2% in 1994, which is about a loss of 1% per year.

Given below (Table 1) is a brief description of the expected incremental benefits that would accrue due to project investments in each site, based on the classification of benefits as given in ADB (1996). The identification of the benefits was based on site visits, consultation of scientific experts and focus group discussions with communities at site. A checklist of probable use and nonuse benefits were considered based on Carpenter and Margosa (1989)[2], Hoagland et.al., (1995)[3] and ADB (1996).

Screening of Incremental Benefits for Quantification and Valuation.

The Procedure proposed in ADB (1996) was used to screen and select benefits that could be quantified and valued. The benefits of CRM investments are both marketable (easy to quantify and value) and non-

marketable (difficult to quantify and value). In the analysis only the marketable benefits were quantified and valued except in sites where the expected benefit is predominately the conservation of biodiversity. Table 2 gives the benefits that were selected for quantification and valuation.

Quantification and Valuation of Screened Incremental Benefits.

The principle of with and without project was considered as to quantify the incremental benefits. The information on without project use of resources and their values were obtained mostly from published sources and through site visits.

Table 3 given the qualification and valuation of incremental environmental cost and benefits

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[1] White, Alan. T. Virginia Barker and Gunatilake Thanthirigama (1995) Joining Economics and Integrated Coastal Management to Conserve Tourism and Biodiversity Resources in Sri Lanka, Coastal Resource Management Project, Sri Lanka.

[2] Carpenter, Richard. A., and James E. Maragos (1989) How to Assess Environmental Impacts on Tropical Islands and Coastal Areas, Environment and Policy Institute, East West Center, Honolulu, Hawai.

[3] Hoagland, Porter. Yoshiaki Kaoru and James M. Broadus (1995) A Methodological Review of Net Benefit Evaluation for Marine resources, Pollution and Environmental Economics Division, World bank.

Table 1. The benefits from CRM investments at project sites.

Project site	Identified Benefits Environmental Resource	Human Welfare	Human Health
1.Negambo lagoon	1.Preservation of mangrove and wetland biodiversity. 2. Protection of coastal erosion	Sustainable utilisation of mangrove vegetation based products and fisheries products.Sustained recreation uses	
2. Lunawa Lagoon		Increased recreation usesImproved scenery and residential environment	
3. Maduganga	1.Preservation of pristine mangrove and wetland biodiversity	Sustainable utilisation of mangrove vegetation based products and fisheries products. 2. Sustained recreation uses	2. Reduced health damages
4. Unawatuna Bay	Preservation of coral reef biodiversityPrevention of coastal erosion	1. Sustained recreational use	
5. Kalemetiya Lagoon	Preservation of mangrove and wetland biodiversity (specially turtle nesting habitats and migratory bird habitats. 2. Protection of coastal erosion	Sustainable utilisation of mangrove vegetation based products and fisheries products.Increased recreational uses	
6. Bar reef	Preservation of reef biodiversityPrevention of coastal erosion		
7. Hikkaduwa	Preservation of coral reef biodiversity 2. Prevention of coastal erosion	1. Sustained recreational use	
8. Mawela lagoon	Preservation of mangrove and wetland biodiversity. 2. Protection of coastal erosion	Sustainable utilisation of mangrove vegetation based products and fisheries products.	

Table 2. Benefits that were selected for quantification and valuation.

Project Site	Selected Benefits	
	Environmental Resource	Human Welfare
1. Negambo lagoon		Sustainable utilisation of mangrove vegetation based products and fisheries products.Sustained recreation uses
2. Lunawa Lagoon		Increased recreation uses
3. Maduganga	1. Preservation of pristine mangrove and wetland biodiversity	Sustainable utilisation of mangrove vegetation based products and fisheries products.
4. Unawatuna Bay		1. Sustained recreational use
5. Kalemetiya Lagoon		Sustainable utilisation of mangrove vegetation based products and fisheries products.
6. Bar reef	Preservation of reef biodiversity	
		1. Sustained recreational use
7. Hikkaduwa 8. Mawela lagoon		Sustainable utilisation of mangrove vegetation based products and fisheries products.

Table 3. Sources of information supporting quantification and valuation of incremental benefits.

Project Site	Expected Benefits	Quantification of incremental benefit
1. Negambo lagoon	Sustainable utilisation of mangrove vegetation based products and fisheries products.Sustained recreation uses	Samarakoon (1995) has reported the following economic values per annum obtained from the Negambo lagoon: Lagoon fishery US $ 3.0 million, coastal shrimp fishery US $ 0.5 million, coastal small pelagic fishery US $ 1.5 million and recreational tourist value US $ 0.1 million. The incremental benefit occurs through prevention of a 1-% loss of above values.
2. Lunawa Lagoon	Increased recreational uses	Bhuwendralingam et.al. (1994) has estimated the potential net income from tourism in the Bolgoda lake which is in close proximity to Lunawa lagoon as Rs. 46 million. Considering the Lunawa lagoon to be one third of Bolgoda lagoon the recreational value at Lunawa in 1998 would be approximately US $ 0.3 million per year. The same study has considered the growth of tourism, based on National Accounts as 3% per annum. The incremental benefit occurs through the growth of the recreation value at the rate of 3% starting from the 6th year of the project.
3. Maduganga	Sustainable utilisation of mangrove vegetation based products and fisheries products.	As reported by Samarakoon (1995) the annual value of fishery from the Negamboo lagoon is US $ 5 million. The Negamboo lagoon is 3,164 ha. Therefore the per hectare fisheries value is US $ 1580 per ha per year. Using benefit transfer, given the extent of Maduganga lagoon as 770 ha the fisheries value is US$ 1.2 million per year. The incremental benefit occurs through prevention of a 1% loss of above values

Project Site	Expected Benefits	Quantification of incremental benefit
4. Unawatuna Bay	1. Sustained recreational use	Unawatuna bay is similar to Hikkaduwa in terms of resource use as a tourist resort. White and Barker (1995) has estimated the Willingness to Pay (WTP) of a tourist as US $ 8 per person per year. The Number of persons visiting the site has been estimated as 14169. Hence the WTP of foreign tourists only is US $ 113352 per year. Gunawardene (1995) has estimated the WTP of foreign tourist at Hikkaduwa for non-use values US $ 11. Considering the number of foreign tourists visiting the site only as 14169 the WTP is US $ 156571 per year. These estimates have been used for the Unawatuna site. However the tourist growth rate has been considered as 3%, which is less than for Hikkaduwa (White and Barker 1995). The incremental benefit is from avoiding the potential loss of tourism.
5. Kalemetiya Lagoon	Sustainable utilisation of mangrove vegetation based products and fisheries products.Maintaining option value of biodiversity	The lagoon fishery value estimated by Samarakoon (1995) as US $ 1580 per ha for the Negambo lagoon transferred to Kalemetiya. The approximate effective (with partly lunama lagoon) lagoon extent of Kalemetiya is 400 ha. The per hectare option value of biodiversity was considered as US $ 15 based on study by Ruitenbeek (1991) in Indonesia quoted by ADB (1996). No adjustments were done. The incremental benefit is from avoiding a 1% loss of fisheries income and 1% loss of option value of biodiversity.
6. Bar reef	Preservation of reef biodiversity	Non use values on biodiversity estimated for Hikkaduwa coral reef was considered. Gunawardene (1995) has estimated the WTP of foreign tourist at Hikkaduwa for non-use values US $ 11. Considering the number of foreign tourists visiting the site only as 14169 the WTP is US $ 156571 per year. Incremental benefit is from avoiding a 1% loss of biodiversity.

Project Site	Expected Benefits	Quantification of incremental benefit
7. Hikkaduwa	1. Sustained recreational use	White and Barker (1995) has estimated the Willingness to Pay (WTP) of a tourist visiting Hikkaduwa resort as US $ 8 per person per year. The Number of persons visiting the site has been estimated as 14169. Hence the WTP of foreign tourists only is US $ 113352 per year. Gunawardene (1995) has estimated the WTP of foreign tourist at Hikkaduwa for non-use values US $ 11. Considering the number of foreign tourists visiting the site only as 14169 the WTP is US $ 156571 per year. The tourist growth rate has been considered as 10% Hikkaduwa. White and Barker (1995) mentions 3.5% (actual) to 17.5% (predicted) range of tourist growth to Hikkaduwa. The incremental benefit is from avoiding the loss of potential earnings from tourism.
8. Mawela lagoon	Sustainable utilisation of mangrove vegetation based products and fisheries products.	The lagoon fishery value estimated by Samarakoon (1995) as US $ 1580 per ha for the Negambo lagoon transferred to Mawela lagoon. The approximate lagoon extent of Mawela is 250 ha. The per hectare option value of biodiversity was considered as US $ 15 based on study by Ruitenbeek (1991) in Indonesia quoted by ADB (1996). The value was transferred without adjustment. The incremental benefits arise from avoiding a 1% loss of above values.

Table 4. Results of the Economic Analysis.

Site	EIRR %	Remarks
1. Negambo lagoon	27	Data on benefits for the analysis is based on studies done at the site.
2. Lunawa	29	Benefits of avoided health damages and increased amenity/property values have not been considered.
3. Madu ganga	30	Benefits of eco-tourism, non-use values of biodiversity have not been considered.
4. Unawatuna	14	Benefit estimates are based on only the WTP of foreign tourists.
5. Kalemetiya	1	Eco-tourism benefits have not been included. The site is a unique habitat of turtle nesting.
6. Bar reef	10	Only non-use value of biodiversity based on WTP of foreign tourists have been considered.
7. Hikkaduwa	22	Only use and non-use values of foreign tourists have been considered.
8. Mawella lagoon	12	
9. Overall CRM investment	24	

The results indicate that except the Kalemetiya site in all other sites CRM investments are economically justifiable with having EIRR above 10%. In the case of Kalemetiya the most important benefit arising of managing the natural resources, which is the uniqueness of the area for turtle nesting has not been valued. The Kalametiya lagoon area is at present used for bird watching and has potential for development of eco-tourism too. The EIRR for the overall CRM project investment is 24% suggesting economic viability of CRM project investments.

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