

**Paper Presented at Conference on Developments in Forestry and Environment
Management in Sri Lanka
Beyond Environmental Economics: New Directions for Policy Making**

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Introduction

In the 1950s and 1960s economics had its focus on economic growth ignoring the fact that some of the inputs essential to the production process were limited in supply. In other words, the sustainability of the growth process was not addressed properly. Since 1970, a number of world views appeared ranging from a support for a market technology driven growth process which is environmentally damaging, through a position advocating prudent resource management to an 'eco-preservationist' positions which explicitly reject economic growth. Against this background environmental economics became established as a sub discipline (Pearce and Turner, 1990). Environmental economics (EE) was considered as an opportunity to accommodate the environmental implications of the growth economy and society within a modified (though not radically different) set of economic models.

The subject has developed immensely during the last three decades both in theoretical and empirical grounds. Micro level applications of EE include estimating demands for various environmental goods and services and damage estimations (through various environmental valuation methods), designing of economic instruments, project level cost benefit analyses, aiding renewable and non renewable resource harvesting decisions. Macro level applications include green accounting (integrating environmental additions and depletions into system of national accounts), development of macro level indicators etc. Such applications seem to cover a wide variety of real world issues ranging from biodiversity, energy, agricultural and local pollution issues to global issues such as climate change, ozone depletion and ultimately towards the long term survival of mankind. Although Environmental economics seem to address these issues quite comprehensively than conventional economics and pure scientific approaches, the outcomes of such applications are often subject to debate. Doubts are being raised mainly from different disciplines indicating non recognition of their concerns, particularly from ethical, ecological and philosophical grounds.

Most natural resource policy decisions in many countries have made sure that environmental economic values are being incorporated. There are however policy gaps, partly due to the yet unresolved theoretical issues of the subject and partly due to the single disciplinary roots of economics. The subject of ecological economics arose partly in response to such concerns and enriched the analysis with the incorporation of ecological inter linkages to the economics (Costanza, 1991).

The objective of the paper is therefore to first elaborate on the various aspects of the subject that are being used in the various natural resource management issues. For example, EE provides explanations for resource degradation basically the economic failure arguments and proposes corrections accordingly. The paper elaborates on the usefulness of such arguments and the critique, the need for alternative explanations.

The second section discusses more practical issues, how the decision making has been aided by the discipline through standard micro level and macro level analysis with special emphasis on Sri Lanka. It also discusses the drawbacks of the analytical tools especially in relation to the instances where the multidisciplinary integration could enhance the outcome. Some of these integrations are however, only theoretical conceptualizations while others have been actually tested in different contexts. The subject of environmental economics has benefited immensely from various other disciplines. The third section of

this paper is devoted to discuss on such disciplines that could be further integrated in order to widen the scope of the subject.

Explanations of Resource Degradation - Market Failure vs. Cultural Failure

Environmental economics has proved to provide an excellent explanation of environmental degradation rooted in the concepts of economic failures. Economic failures could be of three types; market failure, intervention or policy failure (both at local and international levels) and global appropriation failure. Market failure refers to the failure to reflect natural resource functional and other values achieving a socially efficient level of resource conservation due mainly to externalities and public goods (Pearce and Brown, 1994; Barbier *et al.*, 1994). Local policy failures refers to the situation where policy interventions necessary to correct market failures are not taken, or over-correct or under-correct the problem. Policy failures also occur when government decisions or policies are themselves responsible for excessive environmental degradation. International policy failure includes misdirected policies of bilateral and multilateral aid agencies and international donors¹. The reasons behind the policy failure are mainly explained by undervaluing of ecosystems (Panayotou and Ashton, 1992; Shane, 1980).

Global appropriation failure refers to the missing markets for global benefits. If biodiversity is conserved in a tropical forest, for example, it yields a benefit to people in other countries, but if the country in question receives no financial or other resources to pay for these global external benefits, it will have little incentive to look after the biological resources. This global appropriation failure arises not from the malfunctioning of markets, but from the fact that the markets are not there at all (missing markets) (Pearce and Moran, 1994). Correction of such failures requires demonstration of the values of the forest and inclusion of them in decision making framework and creation of the missing markets (Perrings *et al.*, 1994; Swanson, 1994; Barbier *et al.*, 1994; Pearce and Moran, 1994).

It is argued however in economic psychology literature that unrealistic assumptions of neoclassical utility theory had led to unfortunate consequences of environmental and social policy (Stratford and Davidson, 2002). In addition, predictions based on theory of consumer choice seem to be less accurate than those based on more realistic assumptions on human behaviour. Inclusion of other values in addition to the economic values has often been recognised as a necessary condition for sustainability (Gowdy and Mayumi (2001).

This discussion of root cases of environmental degradation can be extended to other failures perhaps that are more fundamental and whose correction often requires lesser effort. For example, there are cultural mechanisms that encourage conservation activities and cultural failures that lead to degradation of environment. Non recognition of such cultural values and encouragement of cultural changes that are non conducive for holistic conservation are defined here as cultural failures (Gunawardena and Edwards-Jones, 2008). Culture can influence people's attitudes and preferences, and thus economic activity. Culture and cultural diversity shapes the way in which society interacts with its environment (environmental behaviour), and resource use (Cochrane, 2006; Matutinovic, 2001; Norgaard, 1994; Berkes and Folke 1992 and 1994; Leboyer *et al.* 1996). Cultural influences may occur in various levels of the society such as local, national and global as well as individual and institutional levels. New cultural traits could emerge within a culture through acquired knowledge, implying its Lamarkian nature (Matutinovic, 2001).

¹ Establishment of a wood working complex close to the Sinharaja forest with external aid which provided a rationale for the logging project in 1970s is an example for both local and global policy failures.

Main mechanisms of conservation in Sri Lanka for example, conservation of the forests and other natural and semi natural areas, are taking place largely through institutional and voluntary processes. The former refers to the protected areas being managed by the State Forest and Wildlife departments (which have conservation as a tradition), and the latter refers to the voluntary conservation efforts by individuals in maintaining biodiversity rich home gardens. Economic justifications are rarely sought for such conservation efforts of institutions and individuals. However, policy changes and rapid urbanisation are posing threats slowly into these mechanisms.

The above discussion suggests that correction of cultural failures to be more fundamental than correction of economic failures at least in the developing country context. This involves firstly the explicit recognition of the role played by culture in natural area conservation by individuals as well as communities. The recognition and correction or re-evaluation of cultural changes that are non conducive for conservation would be the second step towards the correction of cultural failures.

Gunawardena and Edwards-Jones (2008) concludes that search for alternative models to describe resource degradation in developing countries is needed therefore due to two reasons. Firstly, the fundamental flaws associated with the economic failure argument (failure of the economic failure) and secondly, difficulties encountered in correcting such failures (demonstration and appropriation failures) within developing country context. Failure to support the optimal level of conservation by the developed countries or in other words why appropriation is not voluntary and the cultural roots of such inaction need to be explicitly recognised in order to suggest the solutions (in the form of cultural reforms) that ensure long lasting conservation.

Decision Making with Environmental Values

Environmental values have practical applications at various levels of policy making. At the micro level, projects, programmes and policies usually require an economic assessment before implementation. As mentioned earlier, negligence of values of natural environments in decision making has been the main underlying cause of environmental degradation. In order to incorporate environmental values into decision making, decision tools such as cost benefit analysis and cost-effective analysis are used to decide whether a project or policy is viable from both economic and environment point of view. At the macro level, environmental value incorporation into national accounting could provide green accounts, which provides a true reflection of the natural resource damages and resource growth and pollution damages of a country which is a more accurate figure than the traditional GDP figures.

In addition, economic values are being used for designing of economic instruments –either to encourage the environmental friendly behaviour through for example, subsidies or to discourage the damaging behaviours through taxing. Natural resource damage assessment and compensation for such damages is another application of economic values.

Cost Benefit Analysis in Sri Lanka: Applications, Drawbacks and Corrections

CBA is the most common method of project analysis (Winpenny, 1991). The main rationale for conducting cost-benefit analysis is to subject project choice to a consistent set of general objectives of national policy (UNIDO, 1972). CBA can be utilised as a method for identifying a decision rule for choosing a preferred alternative.

Although Cost benefit analysis has a long history in the world, it has become a part of the environmental policy of Sri Lanka only recently. According to the National Environmental Act of Sri Lanka (NEA), Environmental Impact Assessments (EIA) is a mandatory requirement for new projects and carrying out

an extended cost benefit analysis (ECBA) is a part of it. However, EIAs of many projects in Sri Lanka have not been subjected to proper ECBA due to various reasons including lack of expertise.

The basic methodology ECBA involves identification and measurement of environmental effects and translating them into monetary terms for inclusion in the formal project analysis. According to economic welfare theory, individual preferences should form the basis for evaluating the costs and benefits of public policy designed to provide non-market goods and individual preferences are stated in terms of the willingness-to-pay for the provision of a good.

Extended Cost Benefit Analysis for EIAs - Sri Lankan Examples

The following section illustrates few Sri Lankan examples of ECBA carried out as requirement for EIAs of the projects. Table 1 illustrates the different valuation methods used and the specific issues related to each project that has not been accommodated by the ECBA.

Table 1: Incorporation of environmental values into development projects

Project	Environmental damages/ benefits and Valuation methods	Comments – issues not accommodated in the CBA
Baseline road extension Phase III (Gunawardena, 2003)	Costs Construction costs (CVM) Loss of home gardens (BTM) Loss of wetland (BTM) Lost social interactions (RCM) Benefits from reduced emissions (GDC)	Incorporation of environmental values did not affect outcome of the project. The project however widened existing inequalities of by enhancing access mainly to the private vehicle owners. There is no single public transport mode operating along the entire length of the project.
Broadland minihydro project (Gunawardena, 2004)	Costs Lost monuments (CVM) Lost water sports (MPM) Lost scrubland/ forest (RCM/GDC) Lost homegarden (BTM) Water pollution (RCM) Loss of forest product collection (MPM) Loss of scenic view of the river (CVM) Benefits of avoided coal power generation (GDC)	The project resulted in several inequality issues as discussed in the section ‘application of distributional weight to a power project’
Common Waste treatment plant for Moratuwa/ Rathmalana area (Gunawardena, 2005)	Benefits Increased fish production (MP) Avoided cost of future rehabilitation of the Lunawa lagoon Avoided cost of lost preservation value (BTM) Increased recreational potential of the Bolgoda lagoon (BTM)	Without environmental values, the project would not be justifiable There were however, many environmental values which were not estimated due to various reasons.
Export	Cost	The land use of the project site is a

processing zone at Henegama (Gunawardena, 2006)	Last Coconut and Paddy Yield (MPM) Loss of income due to loss animal rearing grounds (MPM) Contribution to Global Warming (GDC) Lost Water Shed benefits	coconut plantation with many intercrops and livestock which uses very little external inputs hence functioning in very close accordance to the sustainability rules which also provided ecosystem services to the surrounding community. The converted system is highly fuelled by external energy and other inputs and intended to bring lot of pollution in the area. The money metric of the CBA has not been capable of capturing the sustainability difference in the two systems and favoured the unsustainable system.
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CVM – contingent valuation method; BTM – Benefit Transfer Method; RCM – Replacement Cost Method; GDC – Global Damage Cost Method; MPM – Market Price Method

Uses of Environmental Values in Project Decision Making - Financial vs. Economic Analysis

This section provides details on how environmental values have been used in few case studies in several sectors (Table 2). The analyses have captured both positive and negative externalities of individual projects. The comparison between financial and the economic analysis emphasizes the usefulness of the environmental values in justifying the project without which the project would result in negative values. Although these studies have been carried out outside the policy realm, the implications of results are important in justifying the proposed actions.

Table 2: Use of environmental values in projects of different sectors

Project	Remarks
Energy sector	
Dendro power plant under community ownership ¹	The project is only justifiable with environmental values. This is one of the few sources of energy available for off grid community. Environmental values therefore supports intragenerational equity.
Biogas power plant which uses solid waste ²	Provides a case for government subsidies for solid waste transport for the project site without which the project would not be viable. Project benefits included, reduction of solid waste and methane emissions.
Samanalawewa Hydropower plant ³	Cost of inundation of vegetation, agricultural benefits etc, have been valued
Forestry sector	
Sinharaja conservation project ⁴	Global and local non use values were estimated; in order to address intragenerational equity issues, global resource transfers are suggested
Plantation sector	
Intercropping options for Rubber plantation ⁵	Economic viability of the plantation increased significantly
Carbon offset benefits for rubber plantations ⁷	Economic viability of the plantation increased significantly

Irrigation sector

Small tanks rehabilitation project⁸

Project is justifiable only with non agricultural uses such as recreation and other functions of tank systems.

Tourism/ coastal sector

Project for visitor management centers for coastal resources⁹

Project is viable only along with environmental values for Muthurajawela, Madu Ganga coastal visitor centres

1 – Chaturika and Gunawardena, 2005; 2 - Karunaratne and Gunawardena, 2004 ; 3 Udayakumara and Gunawardena, 2003- ;4 –Gunawardena, 1997, 2006; 5 - Wijemanne and Gunawardena, 2008; 7 – Muunasinghe et al, 2005 ; 8 – Dayananda and Gunawardena, 2006c; 9 – Gunawardena, 2002

Drawbacks and Corrections for CBA

There are two types of objections for the use of CBA in natural resource issues. One is dealing with measurement and methodological problems. The other objects that even if measurement and methodological problems could be resolved, the method is fundamentally flawed on philosophical grounds (Norton, 1987; Sagoff, 1988). One of the most serious shortcomings of CBA is its measurement of efficiency without regard to whom the benefits and costs accrue. This is due to the inherent weaknesses of the hypothetical nature of compensation of the CBA. If a project yields benefits mainly to well-off groups of society, at the expense of the less well-off, it may be unsuitable on distributional grounds, although it shows high present values.

CBA deals with expressions of money values, which are dependent upon individual's ability to pay that depends upon incomes and wealth. The application of the value judgment that individual preferences should count and the following proposition that a decision which reflects individual's preferences is a good decision is not always legitimate. The failure to consider the effect of the distribution of income may result in decisions which favour the rich. Use of positive discount rates is another issue of CBA which affects intergenerational equity and sustainability.

Corrections are discussed firstly in relation to intragenerational issues – negligence of the losers and winners of a project and suggests two corrective mechanisms; use of distribution weights and making the hypothetical transfer real. Secondly it discusses corrections for sustainability issues, how to made CBA comply with at least weak sustainability. Intergenerational equity which is denied due to use of positive discount rate is discussed next. How to account for aggregation and threshold effects are also dealt with.

Corrections to Intragenerational Equity Issues - Application of Distributional Weights

Since a given policy or a project could affect the distribution of benefits and costs, it is important to distinguish the parties who loses and wins. It is possible that the major beneficiaries are at a global level, whereas the costs are borne by the local population or the vice-versa. Such distributional differences in cost and benefits could be corrected through application of distributional weights.

Use of distributional weights is one of the most controversial aspects in the CBA. The traditional argument for not using distribution weights is the ability of the tax transfer system to bring about the necessary changes. Distributional weights are important in achieving intragenerational equity. Distribution weights can be estimated by two methods. The first method involves specifying a parameter that applies to the whole income distribution that reflects society's aversion to inequality. The second method uses revealed preference method to estimate the distribution weights.

The first method determines distribution weights specifying reasonable assumptions. These include, firstly, assumption on similar utility functions of individuals and secondly, diminishing marginal utility of

individual with respect to income. The social marginal utility of any group i is given by $ai = Y_i^{-\eta}$ where the η is a positive constant signifying the elasticity of the social marginal utility function. The final assumption is to specify a value for η . When $\eta = 0$, it means every group's weight must be equal to 1 which is assumed by the traditional CBA. When $\eta = \infty$, η will be equal to infinity which implies only the effect on the worst off individuals in society matters. When η is set between 0 and ∞ , distribution weights are determined by the inverse of the groups' income.

Case Study: Application of Distributional Weights for a Power Project

The following section provides an example of such application for a power project in Sri Lanka (Gunawardena, 2008). Table 3 shows the percentage of costs and benefits after applying the distribution weights for a minihydro project. The difficult issues in this exercise are to recognize different groups who are affected by the project and to determine their income.

Table 3: Distribution of costs and benefits with and without distribution weights for a minihydro power project

Income group	Percentage of cost/ benefit without distribution weights (when $\eta = 0$)	Percentage of cost/ benefit with distribution weights $1 < \eta < \infty$	Percentage of cost/ benefit when $\eta = \infty$
Cost bearers			
Remote high income (visitors)	30.9	1.4	0
Remote high income (non visitors)	10.9	0.97	0
Local high income (visitors)	3.2	0.66	0
Local low income (living closed to project site)	55.8	96.96	100
Total	100	100	100
Beneficiaries			
Remote high income (non visitors)	13.2	2.2	0
Local average income	86.8	97.8	100

(Source: Gunawardena, 2008)

CBA of the project implies that the project is worthwhile undertaking. However, if the local poor groups are the main cost bearers while local as well as remote affluent groups are the main beneficiaries, the traditional approach seems to be unfair (column 1, Table 3). When the distribution weights are applied, percentage of cost incurred by different groups differs significantly. Cost of local low income people is 97% while that of remote high income groups become insignificant. With the distribution weights, project implies that at least a 9% of its electricity generated need to be provided for the poorer groups for the project to pass the efficiency test.

The main implications for the government is that while implementing redistributive programs in general, it is essential to adjust the individual programs to better reflect the concerns of the poor. If the incomes of

the very poor households who are presently without electricity is considered in the analysis, it may recommend even a higher percentage of electricity benefits to be allocated for such groups.

Corrections to Intragenerational Equity Issues – Making Kaldor Hicks Compensation Real - Justification for Global Resource Transfer

This section explores another approach to correct the intragenerational equity in relation to a rain forest conservation project (Gunawardena, 1997; 2006). There is a wide disparity of sharing the conservation costs and benefits by different segments of the society. In order to investigate this in more detail, the benefits and costs of a conservation project for the Sinharaja Rain Forest Reserve have been estimated with the use of a contingent valuation (CV) method for both local foreign respondents and household survey of forest dwellers.

The results showed that the designation of the forest as a Forest Reserve has resulted in costs to local people in terms of lost forest products and forgone timber and it is 30 times the local benefits. The Reserve establishment however secured recreational and non use values of the urban affluent and the global citizens. CBA of the Sinharaja Conservation project resulted in positive NPV (net present value) and the project is economically justifiable when both local and global benefits are taken into account. The project does not pass the CBA rule without global values. Total local benefits are only US\$ 0.4 million while total global benefits (mainly non-use values) are US \$ 77 million (Gunawardena, 1997).

If the decision has to be based on the national level benefits and costs only, the conservation project would not be justifiable on economic grounds which might lead to justification of alternative land uses for the reserve. If the decision however to be made on inclusive of global values, the project will pass the cost benefit rule. However, the hypothetical compensation needs to be made real through some type of transfer mechanism. The study suggests that the minimum baseline for such transfer should cover the local cost component which amounts to US \$ 891 per ha per year or a total of \$8,957,742 per year. It is also worth mentioning that so far, Sri Lanka has only been compensated with only a very small fraction of the global values through the implicit mechanisms of global conservation movements (DCS, 1998).

Corrections to Sustainability² Issues of CBA

Since CBA converts all capital into money metric, it only complies with weak sustainability. Neumayer (1999) however argues that CBA would only be consistent with weak sustainability if the (hypothetical) compensation in which the analysis is based was effective and not just hypothetical, at least in the case of projects with costs accruing in the future. Weak sustainability also reflects a failure of intergenerational ethics.

Pearce *et al.*, (1989) suggested that sustainability to be integrated to CBA by incorporating sustainability constraint. That is, for a group of projects undertaken by a decision maker, environmental damage should be zero or negative. However, Ciriacy-Wantrup (1968) and Bishop (1978; 1979) argue that sustainability requires the application of a safe minimum standard for conservation of natural resources. Multi criteria analysis also provides an opportunity to incorporate strong sustainability. There is however, little practical evidence on demonstration of such issues.

² The sustainability is defined in EE in relation to capital and sustainability rules for resource use. There are two sustainability positions: weak sustainability assumes that a constant economic production can be maintained forever through a high degree of substitutability between manmade and natural capital. The strong sustainability arguments emphasize the complementarity between these two capital types and (Ekins et al., 2003) identifies economic production as a process that uses energy to transform materials into goods and services; producing a manufactured-capital substitute requires input of natural capital (Costanza and Daly, 1992) and that the multi-functional nature of ecosystems cannot be substituted with manufactured- capital.

Corrections to Intergenerational Equity - Discounting Issue of CBA

CBA fails to incorporate intergenerational equity objective in evaluation of projects whose impacts extend throughout a long period of time. The use of a positive discount rate is incompatible with the intergenerational equity objective (Pearce and Turner, 1990). Discounting is also inconsistent with the philosophy of sustainability. In other words, discounting has inherent bias against the future, which means that future generations' preferences count less than our own present ones.

There are several ways to address this issue. For a project that carries an intergenerational impact could use either zero or Social discount rate, could use the approaches suggested by Krutilla and Fisher (1975) which suggests to retain the conventional discount rate but increasing the value of the environmental good with time, or could design different mechanisms to take future generations into account in the analysis (Intergenerational CBA Approach).

Sáeza and Requena (2007) introduce intergenerational equity in a Cost–Benefit Analysis, through two indicators of environmental profitability, Intergenerational Transfer Amount (ITA), which quantifies in monetary units what the current generation is willing to pass on future generations when an environmental restoration project is carried out, and the Critical Environmental Rate (CER), measures the implicit environmental profitability. The information provided by the environmental profitability indicators proposed renders more transparency to the quantification of the levels of intergenerational equity applied, thereby facilitating the difficult reconciliation of the CBA technique with the objective of sustainability.

Corrections to Aggregation Issues and Threshold Effects of CBA

The individual ecosystem goods/service valuations used in CBA can, however, mislead policymakers. The total system value is always greater than the sum of its parts and threshold effects may lead to non-linear damage impacts. The hierarchical and multifunctional characteristics of ecosystems could lead to double counting of benefits from individual services (some of which are intermediate and others final) which need to be handled carefully in any valuation aggregation procedure (Barbier, 1994; Fisher *et al.*, 2007; Turner *et al.*, 2003).

Macro Level Applications of Environmental Values

At the macro level, environmental values have two main functions, first, towards developing better indicators of development, and secondly to produce green GDP figures. These two topics are discussed in turn.

Indicators of Sustainability/ Development

Due to failure of the GDP as a true measure of welfare, the need for sustainability indicators has arisen which reflect various facets of resource use and human progress within an economy. Economic values of environmental resources and damage assessments have been incorporated into various sustainability indicators developed during past two decades. For example, Moran et al (2008) presents the UN Human Development Index (HDI) as an indicator of development and the Ecological Footprint as an indicator of human demand on the biosphere. They argue that HDI of no less than 0.8 and a per capita Ecological Footprint less than the globally available biocapacity per person represents minimum requirements for sustainable development that is globally replicable.

Attempts to integrate sustainability aspects into macro level are evident in certain indices. For example, Siche et al (2007) introduces Emergy³ performance indices (EMPIs) with reference to emergy accounting indices for example, renewability (REN) and emergy sustainability index (EmSI).

Wen and Chen (2007) illustrates how CBA frameworks could incorporate economic–ecological–social interaction, which finally integrated into an index as Net Progress Proceeds (NPP). The results illustrate that NPR of China's economic growth had been negative for a long time and has just become positive since year 2000 but was quite low. Similar results have been obtained for USA by Daly and Cobb (1990) using an Indicator of Sustainable Economic Welfare (ISEW). Sri Lanka also attempted developing a composite indicator incorporating GDP, foot print, forest cover and HDI (MENR, 2008).

Use of Economic Values Towards Green GDP

Natural resource accounting has been accepted as an essential pre-requisite for sustainable economic development. Changes in resource stocks provide an indication of the status of resource which provides guidelines for appropriate inter-temporal resource allocation for sustainable development. The System of national Accounts (SNA) is the widely practiced national accounting system but it provides only inadequate treatment in resource accounting especially additions and depletion. Green accounts have been proposed as a solution for this. However, the main problem related to the estimation of green GDP is the inadequacy of the environmental values estimates available. Table 4 illustrates the available estimates for Sri Lanka and the uses of such values within the national accounting framework.

Table 4: Integrating environmental values in national accounts

Environmental value estimates	Towards green GDP
Consumer surplus for parks ^{1,2} , protected areas and Botanical gardens ³	CS could be added to forest sector revenues
Ecosystem service values ^{4,5} and other use ⁶ and non use values ⁷ of natural environments	Could be added to Forest sector revenues
Ecosystem service values and other use and non use values of man made ecosystems such as coconut ⁸ and rubber plantations ⁹ , tank systems ¹⁰ and home gardens ¹¹	Could be added to plantation and agricultural sector revenues
Value of environmentally friendly behaviours for eg. Rain water harvesting ¹²	Could be added to services sector revenues
Pollution costs ¹³ and environmental management costs of industries ¹⁴	Could be deducted from industrial sector revenues
Ecosystem degradation due to pollution ¹⁵	Could be deducted from Forest sector revenues
Environmental rehabilitation costs due to man made and natural disasters ¹⁶	Could be deducted from relevant sector revenues

1 – Rathnayaka and Gunawardena (2002); 2 – Sooriyabandara; 3 - Jayaratne and Gunawardena (2008); 4 - Gunawardena (2008); 5 – Mendis and Gunawardena (2008); 6 – Jaltota & Gunawardena (2003); 7 - Gunawardena et al(1996); 8 - Gunawardena (2005); 9 – Munasinghe et al (2007), Wijemanne and Gunawardena (2008); 10 – Dayananada & Gunawardena (2006a,b); 11 – Priyadharshika, 2007; 12 – Dissanayake etal (2008); 13 – Chandrasiri

³ Emergy analysis was developed as a method of ecosystem valuation from the point of view of the biophysical economy. Odum (1986) used for the first time the term “emergy” (written with “m”) with the meaning of “EMbodied enERGY”. In practice, emergy analysis includes geophysics to value the amount of energy connected to the production and use of natural and anthropic resources.

& Gunawardena (2000); 14 – Abhayaratne and Gunawardena (2008); 15 - Herath and Gunawardena (2002); 16 – Dehiwala and Gunawardena (2007)

How the Interdisciplinary Studies Could Improve the Scope of the Subject

This section intends to discuss the integrations from other disciplines which are capable of providing new directions for comprehensive environmental policy making. Table 5 summarises the issues that are discussed in the paper and the contributions from other disciplines for solving yet unresolved issues of decision making.

Table 5: Contributions from other disciplines towards comprehensive policy making

Issue	Beyond EE: Contributions from other disciplines
Incomplete understanding of underlying causes of resource degradation and economic failure argument being incomplete	Religious explanations (Gunawardena and Edwards-Jones, 2002); Norton <i>et al</i> , 1998); Conservation psychology (Beringer, 2003); Neuro economics; Institutional economics (Costanza and Daly, 1992)
Incorporation of sustainability into decision making since CBA often fails even weak sustainability and Green accounting only offers weak sustainability	Incorporation of non monetized impacts into multicriteria framework Ethical approaches (SMS)
Lack of intragenerational equity due to non application of distributional weights within CBA	Religions/ ethics approaches Traditional approaches to decision making
Lack of inter generational equity due to use of positive discount rates in CBA	Krutilla-Fisher Algorithm (Krutilla and Fisher, 1975)
Relying on individual willingness to pay values as the basis of all value and WTP being dependant on income	Safe Minimum Standard approach to decision making (Ciriacy-Wantrup, 1968)
Non incorporation of sustainability rules at micro level	Assessment of individual activities or set of activities for sustainability (Life cycle Assessment) (Weerakkody and Gunawardena, 2006)
Non incorporation of limits set by environment / entropy on individual activities	Ecological foot print analysis at households/ community level
Non incorporation of sustainability rules at macro level	Steady state economics (Daly and Cobb, 1990)
Non recognition of the intrinsic value of resources	Environmental ethics (Callicott, 1989)
Undue emphasis of neo classical economics on satisfaction of non satiable human wants	Marxist economics – for setting priorities; Religious approaches that encourage simple life (Daniels, 2005)
Use of money metric as the only numeriae in decision making	Multidimensional analysis (Elin Palm and Hansson, 2006; Tesfamichael and Pitcher, 2006)
Lack of regard on complex systems when there are irreversibilities and threshold effects	Incorporation of ecology, systems ecology and biocomplexity (Colwell, 1998; Carpenter and Folke (in press)
Emphasis on instrumental value rather than intrinsic value	Deep ecology (Naess, 1973), environmental ethics

It is necessary that we accept the limitations of environmental economics as a mono-criterion decision approach. Tools and techniques of EE are useful, but they should be applied in a broader context jointly with other criteria.

The formulation of new world view that could derive a more environmentally benign world has been discussed widely (Soderbaum, 1994; Daniels, 2005; Taylor, 2004 and Hall, 1989) and similarly the role of Eastern religions and cultures forming the basis of such world view has been subject of much discussion (Daniels, 2005; Hargrove, 1989 and Hall, 1989; Goonatilake, 1993). However, the development of a global ethic motivating people's behaviour on a widespread basis is a complex issue which has been less well explored. The activation of such ethic has to be operated in the institutions in global, regional and national level (Rapoport, 1993).

A fundamental question is whether environmental economics is capable of incorporating all these, or are we looking for new economics? Or have we to totally give up basing our decisions on a discipline that is so flawed?

Discussion

Environmental economics as a sub discipline of economics provides explanations and solutions for environmental degradation issues. Economic failures are identified as root causes of resource degradation and it offers a wide range of methods, analytical and decision making tools to address such issues. While the applicability of such tools is remarkable in the wide ranging of natural resource issues faced by the world today, it still leaves some unresolved issues at various levels of decision making. The paper presents the idea that the desired most comprehensive decision making tool however, may not be purely economics, ecology or ethics but a combination of the best of all.

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