VALUING THE ENVIRONMENT: PAST PRACTICE, FUTURE PROSPECT

by

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Abstract

Economists seek to measure the preferences of individuals for environmental improvement or conservation. Valuation is undertaken to allow the trade-offs involved in economic development decisions, to be explicit, and thereby take the environment better into account. Examples are given of environmental valuation in developed and developing country settings, and of local and global environmental problems. It is concluded that valuation assists in protecting the environmental, and the prospects for its use are ever increasing, both for decision making and for the estimation of indicators of well being.

1. What Does it Mean to 'Value the Environment' ?

Strictly speaking, there is no activity that can rightly be called 'valuing the environment'. What economists do is to seek measures of individuals' prefer-ences for environmental improvement or conservation, or individuals' loss of wellbeing because of environmental degradation or from losing an environ-mental asset. They find those measures in the concepts of expressed or revealed 'willingness to pay' (WTP) and 'willingness to accept compensation' (WTAC). They then make certain assumptions about our ability to aggregate these individual valuations. The shorthand for this activity - 'valuing the environment' is convenient, but misleading to many. It implies that there is only one source of value - human preferences. Utilitarianism is only one of a number of value systems and we all know that its practical counterpart - benefit cost analysis as practised in modern project appraisal - suffers from various ethical drawbacks (for a recent statement, see Hausman, 1992). The aggregation assumption also has its own problems, notably that of 'interpersonal comparisons of utility' (Elster and Roemer, 1992).

But while benefit-cost analysis has problems, so do alternative paradigms for making social choice. Indeed, some of them appear fundamentally unsuited to the practical, real world choices that have to be made. In the context of this Conference, those choices relate to the conflict between the conservation of environmental assets and traditional patterns of economic development: clearance of tropical forest for agriculture, for example, versus forest conservation. If environmental assets have inviolable 'intrinsic rights', then much economic development is morally unsound. If the rights of the people whose livelihoods are subsequently put at stake are allowed, then we have a conflict of rights and no clear decision rule that enables us to choose the 'right' course of action. Both of those positions would be applauded by some philosophers and many environmentalists, but they do not add up, I suggest, to a constructive view of social choice in the context of economic development, however suited they are to armchair philosophising.

2. Why 'Value the Environment' ? The Consequences of Asymmetry

The previous brief discussion establishes the main reason for 'valuing the environment': choices have to be made and hence there is a need to compare the net social gains of one policy option with that of another. If we accept the WTP/WTAC indicators as our measuring rods, money becomes the convenient unit of account[1].If there were markets in all gains and losses, the economist's task would be relatively simple. The value of marketed outputs and inputs could be compared for each option, and that with the highest net gain would be 'socially preferred'[2]. But the pervasive problem with environment is that so many environ-mental assets are not marketed - there are no values to compare with those from economic development. Pursuing the tropical forest example, what *actually* gets compared is the net return from agriculture, livestock or timber and the market value of a conserved forest, which is zero or close to zero. Not surprisingly, clearance and logging win the day. There is an asymmetry of valuation. The 'economic playing field' is biased against the conservation option because, if there are economic values in conservation, they have no market, or only an incomplete market.

And this is the link between economic valuation and sustainable development. *However* sustainable development is defined (Pezzey, 1992; Pearce, 1994), the 'bottom line' is not debateable: the environment needs to be higher on the development agenda if there is to be sustainable development (WCED, 1987). That much follows from the simple observation that environmental services invariably do go unvalued, so that paths of development based on the asymmetry of values noted above must, of necessity, be economically inefficient. We need only the observation of missing or incomplete markets to reach this conclusion.

The inefficiency arising from asymmetric valuation occurs at all levels. At the project level, the computation of net social benefits is distorted unless environ-mental impacts are properly valued. At the sectoral level, we have no mechanism for comparing sectoral priorities unless we have some idea of relative net social gains from sectoral investment and change. And at the national level, we will continue to be tempted to use GNP as an indicator of national wellbeing until we have an acceptable measure of GNP modified for the depreciation of environmental assets - some sort of 'green national income'. The valuation issue is therefore pervasive to the *way* we encourage economic development, and this justifies the attention being paid

[1] This is quite different to saying that compensation, for example, should always be thought of in terms of cash. Other goods, replacement assets etc. may be more appropriate. But they can be related back to money in the resulting calculus.

[2] The aggregation problem arises again. There will be gainers and losers under each option. Benefit-cost analysis proceeds on the assumption that gainers do not *actually* have to compensate losers - so called 'hypothetical compensation'. But if losers are not compensated they are actually worse off and this has obvious implications for distributive justice.

to it.

3. Valuation in Practice

3.1 The LDC Experience

Most, but not all, of our experience in economic valuation is in the rich world of the OECD countries. To some extent this is not surprising. Not only did the idea of 'efficiency in government' arise first in the developed world (eg. McKean, 1958), giving rise to a whole set of procedures for dealing with non-market products such as defence, health, education and environment, but the conflict between environment and economic development was more likely to arise in high income contexts. This historical experience has tended to reinforce the assumption that environment is an 'income elastic' commodity, something we worry about only when basic needs have been met and we move into a high consumption phase of development. To some extent, therefore, the asymmetry of valuation reflects human preferences - there are no markets in environmental commodities because there is no demand for those commodities. Once the demand emerges, the markets get created. And the demand is more likely to arise when things get bad than when they appear to be satisfactory. The Climate Change and Biodiversity Conventions, The Montreal Protocol, the Global Environment Facility, the various attempts to get our oceans cleaned up - can all be seen as examples of markets emerging in response to crisis.

One of the features of the sustainable development debate has been a questioning of this income elasticity assumption. For the poor, the environment is an integral part of development until such times as technological substitutes can be provided. This is true of fuelwood and fodder, other forest products, water supply, water quality, soil and soil nutrients. There is a direct dependence of livelihoods on natural resources in their unprocessed state. Clean air may be something you can wait for until it can be afforded. Clean water and biomass energy are not.

There is a second dimension of the sustainable development debate which is highly relevant to the valuation issue, namely North-South transfers. The Brundtland Commission (WCED 1987), the Rio Conventions and Agenda 21 have focused a lot of attention on the issue of both the scale and nature of the transfers between rich and poor countries. Leaving aside some of the rather silly estimates of required transfers that circulated at the Rio Earth Summit, there is an important issue of how these transfers can be determined. They can be thought of as comprising two components: an equity component based on what the North ought to transfer to the South for developmental reasons, and a self-interested component based on the transfers necessary to secure the North's own collective benefit from conservation and environmental improve-ment in the South. In the former case we need to uncover the South's own 'local' WTP for environmental improvement. In the latter case we need to elicit the North's WTP for the South's environment. We provide examples of each of these.

To date, the most successful applications of economic valuation techniques in the developing world have been in the context of water supply, sanitation and forest functions. The available case studies are summarised in Pearce and Whittington (1993). A few examples are given here. Extensive further detail is available in Pearce (1993a) and for natural habitats and biodiversity in Pearce and Moran (1994) and Pearce *et al.*(1993).

3.2 Local Values : Water and Sanitation

The first cases concern the value of water supply and sanitation. Traditionally, water supply investments have been evaluated by rules of thumb related to assumed willingness - to - pay for basic services. Since the service is usually supplied to the poor, the assumption has been that only the most basic provision - public taps and hand pumps - is warranted. No-one is willing to pay for better, more elaborate services. This 'basic needs' philosophy would be satisfactory if the resulting public supplies were reliable. But perhaps one in four public supply systems are not working at any one point of time, while use rates of those that do work are low - only one-third of people connected to public supply systems in Cote d'Ivoire and Kenya actually use them. Yet the benefits of such systems in terms of public health and time saving are clearly substantial. Households' true willingness to pay is therefore worth estimating.

The World Bank's programme of work on economic valuation of water supply has basically adopted two approaches to deriving economic values: *dichotomous choice* and *contingent valuation.*

With dichotomous choice one can observe how people choose between alternative means of water supply involving different allocations of time. In Ukundu, Kenya villagers could choose between water from vendors who visit the house, water sold at 'kiosks' in the village, and water from the well (Mu et al., 1989). In terms of *collection time*, relative to use of the well, house delivery saves the most collection time and collecting from kiosks the least amount of time. In terms of *expenditure*, household vending costs the most, then kiosk water, with well water being the cheapest. By looking at actual choices, the trade-off between money and time can be determined. Time saving is one of the benefits of water supply improvement. In this case, if water quality is invariant between sources, time savings will generally define total benefits. The Ukundu study found that users of vendors and kiosks were revealing high WTP for time savings, of the order of 8% of incomes.

A study in Brazil used the contingent valuation approach which essentially involves asking people either directly what they are willing to pay, or less directly what their choice would be if they were faced with certain prices for the service in question (see Briscoe *et al.*, 1990). The question took the form 'If you are required to pay X, would you connect to the new supply or use an alternative supply?'. Three different areas were surveyed, some with improved services available, to which households might or might not be connected, and some without. In the 'without' cases some had services planned with an announced tariff, others expected a service but did not know of what kind or what the tariff would be. From the survey the probabilities of being connected were estimated, and these were found to behave as predicted. The higher the price and the greater the distance to the source, the less likely was connection. WTP estimates were also obtained from the questionnaires. The results provide not just an estimate of the average WTP, but also indicate how households would respond to higher prices, an important consideration if revenue-raising is a concern. Maximum WTP for a yard tap was around 2.5 times the prevailing tariff and some 2.3% of family income. Some 'strategic bias' - deliberate under-reporting of WTP - was probably present so that true WTP was probably higher than this. Equity considerations could be taken care of by providing relatively highly priced services to the better off and using revenues to cross subsidise the needs of the poor for free public taps.

Less than 300 million people lived in developing country urban areas in 1950. Today the figure is over 1,300 million. By 2000 it will be 1.9 billion. By the year 2000 there will be 200 cities with populations over 1 million people, of which 150 will be in developing countries. The cost of the necessary infra-structure for this urban development is enormous. As with water supply generally, sanitation systems tend to be primitive for the poor and subsidised systems of the less primitive schemes tend to benefit the middle and upper income classes. And as with water, willingness-to-pay is generally *assumed* rather than estimated. Charges above 3 per cent of household incomes are thought not to be affordable.

In Kumasi, Ghana, WTP was estimated through a contingent valuation approach. The options were water closets with a piped sewerage system and ventilated pit latrines ('KVIPs'). The latter represent a far cheaper option for sanitation than connecting sewers and installing water closets. Households varied according to the systems already in place. Some had water connections and could therefore be asked their WTP for a water closet and a KVIP. Households with water closets could be asked how much they would be WTP for a connection to the sewer, and so on. KVIPs can operate without water connections. The results showed that households without water closets were WTP roughly the same sum for a WC or a KVIP. In terms of WTP for KVIPs, households with bucket latrines bid the lowest price; those using public latrines bid significantly higher prices (around 30-35% more), reflecting the inconvenience and lack of privacy of the public systems. Overall mean bids of around $1.5 per month compare to average existing expenditures of about $0.5 per month. Comparing WTP with the costs of provision of KVIPs and WCs, WTP was found to be *less* than costs of supply. Given that sanitation systems yield extensive external benefits in the form of public health, a subsidy would probably be justified (the benefits of improved health were not estimated). The study showed that the required subsidy for a WC system for Kumasi would amount to some $60 million. The required overall subsidy for the KVIP system would amount to some $4 million (see Whittington *et al.,* 1991).

3.3 Local and Global Values: Forest Conservation

Korup National Park lies in Southwest Province, Cameroon. It contains Africa's oldest rainforest, over 60 million years old, with high species endemism. There are over 1000 species of plant, and 1300 animal species including 119 mammals and 15 primates. Out of the total listed species, 60 occur nowhere else and 170 are currently listed as endangered. Continued land-use changes are putting substantial pressure on the rainforest. The Worldwide Fund for Nature (WWF) initiated a programme of conservation, centred on a management area of 126,000 hectares plus a surrounding buffer sound of 300,000 hectares. A similar pro-gramme was initiated for Oban national Park just across the border in Nigeria.

Economic valuation of the rainforest's benefits was carried out in order to assist with the process of raising development aid funds to conserve the area (Ruitenbeek 1990a, 1990b, 1992). Benefits of conservation were then compared to the costs of the conservation project plus the forgone timber revenues. While the framework for analysis was the total economic value concept, existence and option values were not directly estimated. The procedure involved estimating direct and indirect use values *to the Cameroon* and then seeing what the existence and option value *would have to be* in order to justify the project. Since it was thought that the non-use values would mainly reside with people outside the Cameroun, the focus of attention for non-use values was on seeing what international transfers might be needed. The results are shown in Box 1.

Box 1: The Korup Project

<u>Benefits and Costs to the Cameroon</u>
(Present values, Million CFA, 1989 prices)
(Discount Rate = 8%)

Costs of Conservation Project:	
Resource costs:	- 4475
Forgone forest benefits	
timber:	- 353
forest products	- 223

	- 5051

Benefits of Conservation Project:	
Direct Use Benefits	
Use of forest products	+ 354
Tourism	+ 680
Indirect Use Benefits	
Protection of Fisheries	+ 1770
Flood control	+ 265
Soil productivity	+ 130

	+ 3199

Net Benefits to Cameroun	- 1852

Economic Rate of Return	6.2%
Net Benefits to Cameroun if the discount rate is 6%	+ 319

From the standpoint of the Cameroon, the project appears not be worthwhile because there is a negative net present value of some 1852 million CFA at 8% discount rate, although there is a modest positive net present value if the discount rate is lowered to 6%. But the analysis covers only some of the components of total economic value. What of existence and option values? These were not estimated directly. Instead, the issue therefore becomes one of asking whether the rest of the world would be willing to pay 1852 million CFA (in present value terms) to the Cameroon to reflect these option and existence values. One way of testing this is to look at existing conservation transfers through debt-for-nature swaps. Translated into a per hectare basis, the required transfer for the Cameroon is just over 1000 ecus per km^2. Debt-for-nature swaps have implied various valuations ranging from as low as 15 ecu per km^2 (Bolivia) to around 1600 ECUs per km^2 (Costa Rica). Given the high species endemism and diversity of Korup, values of 1000 ecus or more would seem justified. The conservation of Korup forest becomes justified in economic terms provided this transfer actually takes place.

The resource costs are based on budgets and plans in the Korup National Park Master Plan, net of compensation payments (which are internal transfers) and other costs regarded as being not attributable to the conservation project. The forgone forest benefits includes timber from potential commercial logging (the 353 million CFA) and some forgone traditional uses of the forest, mainly hunting, that would be forbidden within a designated national park, and which cannot be offset by diverting activity elsewhere (the 223 million CFA). This proscription of traditional uses affects some 800 villagers within the national park boundaries. In the long run, however, other residents, mainly some 12,000 people on the periphery will be able to continue their traditional use of the forest, which they would not be able to do if deforestation continued. Thus, while one group loses benefits another, larger, group gains (the 354 million CFA). The tourism figure is conjectural and is based on an eventual 1000 visitors per year by the year 2000 and their expected expenditure adjusted for the shadow wage rate. The fisheries item is important. Rainfall in the forest feeds several rivers which feed into large mangrove areas rich in fish. The mangroves prosper on the basis of freshwater inundation in high water periods and saltwater in low water periods. If the forest was to disappear, peak flows from the forest would increase and there would be added sediment and less salinity. Basically, the mangrove swamps would no longer function as the habitat for the rich fish species that make up both the on and offshore fisheries. Since the link between the rainforest and the offshore fishery is less established than the link to the inshore fishery, only damage to the onshore fishery was estimated. This was valued at the market value of fish and, as a check, at the income derived from the fishery.

The flood alleviation benefits were calculated by looking at the expected value of the income losses that would accrue if there was a flood. The soil fertility benefits were based on a broad brush assessment that, if the forest disappeared, cash crop yields would decline by 10%.

The implicit minimum requirement for an international transfer (the so-called 'rainforest supply price') was estimated by taking the present value of net costs (the 1852 million CFA) and dividing by the present value of the hectarage that could be identified as being protected by the conservation project - some 500,000 'hectare years'. This produces the value of 3600 CFA per hectare per year, or some 1060 ecus/km^2.

Notable omissions from the study are twofold: no attempt was made to assess the value of the forest to local people over and above its use value; and no attempt was made to estimate the net contribution to CO_2 emissions from deforestation. Both omissions are likely to reduce the net present value deficit shown in the table. But only the former will lower the rainforest supply price because CO_2 benefits are likely to attract a negligible if not zero willingness to pay on the part of Cameroon citizens. The CO_2 benefits will, however, make it *more* likely that the rest of the world will pay for rainforest conservation (i.e. it affects the rain-forest demand price). We illustrate below how relevant the CO_2 benefits can be.

3.4 Global Missing Markets

The final example of valuation raises an interesting issue relating to the North's willingness to pay for environmental improvement in the South. Economists are used to speaking of 'market failure' as a major factor in explaining environmental degradation, along with misdirected interventions by governments themselves (Pearce and Warford 1993, Repetto 1986). Market failure relates to the inability of markets to account for the social costs of economic activity: the upstream polluter, for example, does not pay for downstream pollution unless forced to do so by regulation or some for of pollution taxation. But market failure is not just a local phenomenon. Many environmental assets have global economic value. This is most pronounced and least understood for biological diversity, but extends to global climatic change. Pursuing our tropical forest example once more, all forests store carbon so that, if cleared for agriculture there will be a release of carbon dioxide which will contribute to the accelerated greenhouse effect and hence global warming. In order to derive a value for the 'carbon credit' that should be ascribed to a tropical forest, we need to know (a) the net carbon released when forests are converted to other uses, and (b) the economic value of one tonne of carbon released to the atmosphere.

Carbon will be released at different rates according to the method of clearance and subsequent land use. With burning there will be an immediate release of CO_2 into the atmosphere, and some of the remaining carbon will be locked in ash and charcoal which is resistant to decay. The slash not converted by fire into CO_2 or charcoal and ash decays over time, releasing most of its carbon to the atmosphere within 10-20 years. Studies of tropical forests indicate that significant amounts of cleared vegetation become lumber, slash, charcoal and ash; the proportion differs for closed and open forests; the smaller stature and drier climate of open forests result in the combustion of higher proportion of the vegetation.

If tropical forested land is converted to pasture or permanent agriculture, then the amount of carbon stored in secondary vegetation is equivalent to the carbon content of the biomass of crops planted, or the grass grown on the pasture. If a secondary forest is allowed to grow, then carbon will accumulate, and maximum biomass density is attained after a relatively short time.

Box 2 illustrates the net carbon storage effects of land use conversion from tropical forests; closed primary, closed secondary, or open forests; to shifting cultivation, permanent agriculture, or pasture. The negative figures represent emissions of carbon; for example, conversion from closed primary forest to shifting agriculture results in a net loss of 194 tC/ha. The greatest loss of carbon involves change of land use from primary closed forest to permanent agriculture. These figures represent the once and for all change that will occur in carbon storage as a result of the various land use conversions.

Box 2: Changes in Forest Land Use and Carbon Release

(tC/ha)

	Original C	Shifting Agriculture	Permanent Agriculture	Pasture
Original C		79	63	63
Closed primary	283	-204	-220	-220
Closed second	194	-106	-152	-122
Open forest	115	- 36	- 52	- 52

Shifting agriculture represents carbon in biomass and soils in second year of shifting cultivation cycle.

Source: Brown and Pearce (1994)

The data suggest that, allowing for the carbon fixed by subsequent land uses, carbon released from deforestation of secondary and primary tropical forest is of the order of 100-200 tonnes of carbon per hectare.

The carbon released from burning tropical forests contributes to global warming, and we now have several estimates of the minimum economic damage done by global warming, leaving aside catastrophic events. Recent work by Fankhauser (1994) suggests a 'central' value of $20 of damage for every tonne of carbon released. Applying this figure to the data in the Table, we can conclude that converting an open forest to agriculture or pasture would result in global warming damage of, say,

$600-1000 per hectare; conversion of closed secondary forest would cause damage of $2000-3000 per hectare; and conversion of primary forest to agriculture would give rise to damage of about $4000 - 4400 per hectare. Note that these estimates allow for carbon fixation in the subsequent land use.

How do these estimates relate to the development benefits of land use conversion? We can illustrate with respect to the Amazon region of Brazil. Schneider (1993) reports upper bound values of $300 per hectare for land in the Paragominas area of Para, a range of only $15 to $150 for land in Rondonia. If we take a 'carbon credit' value of $2000 the figures suggest carbon credit values at least 7 times and could be over 100 times the price of land in Rondonia. These 'carbon credits' also compare favourably with the value of forest land for timber in, say Indonesia, where estimates are of the order of $2000-2500 per hectare. All this suggest the scope for a global bargain. The land is worth $300 per hectare to the forest colonist but several times this to the world at large. If the North can transfer a sum of money greater than $300 but less than the damage cost from global warming, there are mutual gains to be obtained.

Note that if the transfers did take place at, say, $500 per hectare, then the cost per tonne carbon reduced is of the order of $5 tC ($500/100 tC/ha). These unit costs compare favourably with those to be achieved by carbon emission reduction policies through fossil fuel conversion. Avoiding deforestation becomes a legitimate and potentially important means of reducing global warming rates.

4. Valuation and the National Accounts

Significant effort has gone into both the theoretical and practical problems of adjusting measures of gross national product (GNP) to reflect environmental concerns (Ahmad *et al.* 1989; Lutz 1993). The basic idea is that 'true' or 'sustainable' income is that flow of income that which leaves the capital stock of the economy intact. Intuitively, we can more sustain an economy by mining its capital stock than a businessman can survive by depleting his own capital. The link to the concept of sustainable development is obvious: no development path can be sustained beyond the short run if it involves running down national assets. But assets in this context have to be construed far more broadly: they include the conventional man-made (or 'reproducible') capital assets such as roads and schools; human capital in the form of the stock of knowledge, skills and capabilities; *and* environmental assets. Just as we measure *net* national income (NNP or NDP) as GNP less depreciation on the man-made capital stock, so we need to make adjustments for any depreciation (or enhancement) of environmental capital. At its very simplest, then, we would expect to see a modified GNP figure obeying a formula such as:

gNNP = GNP - äKm - äKn

where 'g' dignifies 'green' or 'adjusted' net national product; äKm is depreci-ation on man-made capital assets; and ä is depreciation on natural capital.

Annex 1 shows how such a formula might be expanded to cover non-renewable resources, renewable resources and pollution damage.

Unfortunately, the experts are not in agreement as to how a gGNP measure should be estimated. The competing methodologies are summarised in the identities below. The names of prominent authors are linked to the different approaches, but it should be stressed that there is a wide spectrum of opinion among these authors. Note that the last one relates to *wealth* rather than income and at least one country (Canada) is pursuing the idea of modified wealth accounting. Wealth accounting has obvious links to a measure of sustainable development if a condition for sustainable development is taken to be *at least* a constant stock of all assets (Solow 1986).

(1) $gGDP = GDP + ES +/- ED_1 - IR$

(2) $gNDP = NDP + RDIS - RDEP - ED_2$

(3) $NW = NFA + TAm + TAn$

where:

gGDP	=	'green' gross domestic product;
ES	=	the value of environmental services (Peskin)
ED_1	=	environmental damages which are deducted according to one school of thought (Peskin) and added (Harrison) according to another, depending on how GDP is measured
IR	=	invested resource rents in the sense of El Serafy
GNDP	=	'green' net domestic product
RDIS	=	the value of resource discoveries (Repetto, Hartwick, Hamilton)
RDEP	=	the value of resource depreciation (Repetto, Hartwick)
ED_2	=	environmental damage which in this case is deducted from net product (Bartelmus, Hueting and Bosch)
DE	=	defensive expenditures
NW	=	national wealth (Hamilton)
NFA	=	net financial assets
TAm	=	man-made tangible assets
TAn	=	'natural' tangible assets

Further detail is given in Hamilton *et al.* (1993).

The underlying policy perspective is that because decision-makers are influenced by measures of GNP, it is essential to have a modified measure of GNP - green GNP (gGNP) so that those decision-makers receive the right signals about the 'true' progress of the economy. However, those countries that have experimented with adjusted income measures, including those that eschew adjusted *monetary* measures in favour of conventional GNP allied to sets of *physical* resource accounts ('satellite accounting') reveal very different motives for wanting a modified set of accounts. A survey by Hamilton *et al*. (1993) shows that a few seek to develop 'sustainability indicators' (Canada); several seek to improve their macro-economic planning capabilities to trace out the implications of economic decisions, and not surprisingly this is the focus in those countries with a strong macro-planning background (Norway, Sweden, Finland); and some have clearly followed a trend without any particular 'philosophy' in mind. The other, perhaps more controversial, observation is that the extent to which modified income accounting alters *behaviour* has yet to be tested. Unquestionably, it has led to a number of insights, especially in underlining the extent to which countries, both developing (e.g. Philippines - see Cruz and Repetto 1992) and developed (eg the United Kingdom - see Pearce 1993b) have failed to re-invest rents from the exploitation of resources. Given the Hartwick-Solow rule on re-investing rents for sustainable consumption, we can truly say that certain countries have been, and are, living off capital assets of a relatively short-lived nature. There is also the whole 'consciousness raising' aspect of modified income accounting. But how far it will feed into changes in political behaviour is very likely to depend on (a) further resolving the disputes between the experts as to the 'right' way to modify the accounts and (b) finding short-cut measures which avoid the often high cost of detailed exercises.

5. Valuation: Where Next ?

What then can we learn from this quick *tour d'horizon* of the valuation issue ? There are several propositions we can make:

The moral debate about the underlying ethics of economic valuation will continue. This reflects the wider debate about neoclassical welfare economics generally, of which environmental valuation is one part.

The number of valuation exercises has increased rapidly and shows no sign of abating.

Valuation is essential if we are even to approach the correction of distorted development paths based on the asymmetry of values for the environment and for 'development'. Valuation is not inimical to development. It is a corrective against wrong and unsustainable development.

The experience to date with valuation in the developing world shows us that it can be very successful in eliciting the social value of basic needs such as water and sanitation. This enables such values to enter into project appraisal in place of 'rules of thumb' that have been used hitherto.

Since developing country valuation exercises have so far been confined mainly to water and sanitation, we have little idea as yet about the sectoral priorities that would emerge if we compared such investments with other investments. Hazarding a guess, it seems likely that *local* valuation exercises will:

(a) reinforce the view that what we might term '*environmental basic needs investments*' - water, biomass, sanitation - have very high social rates of return;

(b) raise the profile of water pollution control investments due to the strong link between water pollution and human health;

(c) reveal high rates of return to soil erosion control and nutrient investment.

As far as the *global* values of tropical forests and other 'biodiversity havens' are concerned, those who pin their hopes on the global value of genetic materials through biotechnology, pharmaceuticals etc. are very probably backing low value opportunities (Pearce and Moran 1994). Far greater potential exists in terms of the values of carbon storage and use and non-use values for diverse systems. We know a good deal about carbon values, but next to nothing about global biodiversity values. The latter are the greatest challenge to the 'economic valuers'. Global 'missing markets' do a lot to explain the skewed development paths of resource rich countries, and hence the loss of so much of the world's environmental assets.

Perversely, while we are making efforts to value environmental benefits and damages, we very often have little idea about the opportunity costs of conserving environmental assets. That is, we know very little about the so-called development 'benefits' that accrue from land conversion, the main source of environmental loss. There is a high likelihood that a very high percentage of land conversions are carried out for zero or negative net gains: the resulting incomes barely compensate labour, leaving nothing as the gain in rent. If the development gain is zero, or near zero, then it requires little by way of positive economic value for environmental services to justify conservation.

Finally, valuation is an integral part of most modified national accounting systems. Getting the analytical exercises into the *real* political arena, where we can observe behavioural change, will require some resolution of the existing methodological debate and the development of rapid appraisal techniques.

Annex 1: An Approach to Modified Income Accounting

This annex is based mainly on Hartwick (1990).

Conventional GNP is defined as

GNP = NNP + äKm ...[1]

where äKm is depreciation on man-made capital. We need to extend this to allow for natural capital Kn and for pollution damage. Take natural capital first. Above is extended to

GNP = NNP + äKm + äKn ...[2]

Hence

NNP = GNP - äKm - äKn ...[3]

How is äKn measured ?

For **non-renewable resources** Hartwick shows that for each kind of natural capital (Kn_i) it is given by:

$\text{äKn}_i = [P_i - MC_i][Q_i - N_i]$ ...[4]

where P_i is the shadow price of the resource (= market price in a competitive economy)

MC_i is the marginal cost of extraction

P_i-MC_i is then the user cost or royalty on the resource.

Q_i is output of the resource (its 'draw down')

N_i is new discoveries.

So, the first extension gives:

NNP = GNP - äKm - $\text{Ó}_i[P_i - MC_i][Q_i - N_i]$ ...[5]

where subscript i refers to non-renewable resources.

If $N_i > Q_i$, NNP grows relative to the conventional definition. Otherwise it is less. (Note: the way in which new discoveries are treated here is open to dispute).

For **renewable resources** (subscript j) the principle is the same but we now have to allow for the natural growth rate of the resource $g(X_j)$ and its harvest rate H_j. The net growth $[g(X_j) - H_j]$ is then valued at the royalty $P_j - MC_j$.

This second extension now produces

$$\begin{aligned} \mathbf{NNP = GNP - \text{ä}Km -} \quad & \mathbf{\text{Ó}_i[P_i - MC_i][Q_i - N_i]} \\ \mathbf{+} \quad & \mathbf{\text{Ó}_j[P_j - MC_j][g(X_j) - H_j]} \quad \mathbf{...[6]} \end{aligned}$$

Note that if the harvest rate exceeds the growth rate, the last bracketed expression is negative and NNP falls.

For **pollution damage** we proceed as follows. Let D_k be the **flow** of pollution of type k in physical units; P_k is the shadow price of pollution damage (estimated, e.g. by contingent valuation etc.), and MC_k is the marginal cost of pollution abatement. There are **two** effects of pollution: one on households - the disutility of pollution - and this will equal the flow of pollution multiplied by the shadow price of pollution, i.e. $P_k.D_k$; and the other on production and this will equal $MC_k.D_k$. The **sum** of these two impacts is then:

$(P_k + MC_k).D_k$

and this needs to be **deducted** from GNP to get to NNP. Thus, if $D_k > 0$ there is more pollution and a positive value of damage $P_k.D_k$ to householders and this should be deducted from GNP. Hence NNP < GNP. If pollution damage **falls**, i.e. $D_k < 0$. Both P and MC are positive, so the expression $(P_k + MC_k).D_k$ is *negative* and since it is being deducted from GNP the effect is to *add* to NNP. NNP > GNP.

So the final expression for NNP is:

$$\begin{aligned} \mathbf{NNP = GNP - \text{ä}Km -} \quad & \mathbf{\text{Ó}_i[P_i - MC_i][Q_i - N_i]} \\ \mathbf{+} \quad & \mathbf{\text{Ó}_j[P_j - MC_j][g(X_j) - H_j]} \\ \mathbf{-} \quad & \mathbf{\text{Ó}_k[P_k + MC_k]D_k} \quad \mathbf{...[7]} \end{aligned}$$

References

Y. Ahmad, S. El Serafy, and E. Lutz 1989
Environmental Accounting for Sustainable Development, World Bank, Washington DC.

J. Briscoe, P. de Castro, C. Griffin, J. North and O. Olsen 1990
Toward Equitable and Sustainable Rural Water Supplies: a Contingent valuation Study in Brazil, *World Bank Economic Review*, Vol.4, No.2.

K. Brown and D.W. Pearce 1994
The Economic Value of Carbon Storage in Tropical Forests, in J. Weiss (ed), *The Economics of Project Appraisal and the Environment*, Edward Elgar, London.

W. Cruz and R. Repetto 1992
The Environmental Effects of Stabilization and Structural Adjustment Programs, World Resources Institute, Washington DC.

J. Elster and J. Roemer 1991
Interpersonal Comparisons of Well-Being, Cambridge University Press, Cambridge

S. Fankhauser 1994
Evaluating the Social Costs of Greenhouse Gas Emissions, CSERGE Working Paper GEC 94-01, Centre for Social and Economic Research on the Global Environment, University College London and University of East Anglia.

K. Hamilton, D.W. Pearce, G. Atkinson, A. Gomez-Lobo and C. Young 1993
The Policy Implications of Natural Resource and Environmental Accounting, CSERGE, University College London. Report to the Environment Department, World Bank.

J. Hartwick 1990
Natural Resources, National Accounting and Economic Depreciation, *Journal of Public Economics*, 43.

D. Hausman 1992
The Inexact and Separate Science of Economics, Cambridge University Press, Cambridge.

E. Lutz (ed) 1993
Toward Improved Accounting for the Environment, World Bank, Washington DC.

R. McKean 1958
Efficiency in Government Through Systems Analysis, Wiley, New York

X. Mu, D. Whittington and J. Briscoe 1989
Modeling Village Water Demand Behavior: a Discrete Choice Approach, *Water Resources Research*, 26, No.4.

D.W. Pearce 1994
Sustainable Development, in D.W.Pearce, *Ecological Economics: Essays in the*

Theory and Practice of Environmental Economics, Edward Elgar, London.

D.W. Pearce 1993a
Economic Values and the Natural World, Earthscan, London.

D.W. Pearce (ed) 1993b
Blueprint 3: Measuring Sustainable Development, Earthscan, London.

D.W. Pearce, T. Swanson, K. Brown and C. Perrings 1993
Economics and the Conservation of Global Biological Diversity, Global Environment Facility, World Bank, Washington DC

D.W. Pearce and D. Moran 1994
The Economic Value of Cultural and Biological Diversity, Earthscan, London, forthcoming.

D.W. Pearce and J. Warford 1993
World Without End: Economics, Environment and Sustainable Development, Oxford University Press, New York and Oxford.

J. Pezzey 1992
Sustainable Development Concepts: an Economic Analysis, Environment Department, World Bank, Washington DC.

R. Repetto 1986
World Enough and Time: Successful Strategies for Resource Management, Yale University Press, New Haven.

J. Ruitenbeek 1990a
Evaluating Economic Policies for Promoting Rainforest Conservation in Developing Countries, Ph.D thesis, London School of Economics, London.

J. Ruitenbeek 1990b
Economic Analysis of Tropical Forest Conservation Initiatives: Examples from West Africa, World Wide Fund for Nature, Godalming, UK, 1990.

J. Ruitenbeek 1992
The Rainforest Supply Price: a Tool for Evaluating Rainforest Conservation Expenditures, *Ecological Economics*, Vol.6, No.1, July.

R. Schneider 1993
The Potential for Trade with the Amazon in Greenhouse Gas Reduction, LATEN Dissemination Note No.2, Latin America Technical Department, Environment Division, World Bank, Washington DC.

R.Solow 1986
On the Intergenerational Allocation of Natural Resources, *Scandinavian Journal of*

Economics, 88(1).

WCED (World Commission on Environment and Development)
Our Common Future, Oxford University Press, Oxford.