Policy Sciences (2006) 38: 205–224
DOI: 10.1007/s11077-005-9003-2

Ecological inequality in assessing well-being: Some applications

MARIANO TORRAS
Adelphi University

Abstract. Claims to the inadequacy of GDP growth as an indicator of well-being improvement are widespread. Yet the notion of well-being is very broad, hence difficult to quantify, so alternative indexes (e.g., ISEW, GPI) may also be deficient. This article approaches well-being from a multi-dimensional perspective which, unlike earlier attempts to incorporate inequality and environmental variables, focuses especially on "ecological inequality," or inequality in the distribution of the social cost associated with resource depletion. A methodology for assessing well-being improvements is developed, one which includes an accounting for ecological inequality, and is applied to four countries: Brazil, Costa Rica, Indonesia, and the Philippines. The variability in the results strongly suggests that in addition to depending on the subjective perspective of the policymaker regarding the relative importance of the income growth realized by different population groups, well-being assessments depend critically on the existing ecological distribution. More research into quantifying ecological distribution is therefore warranted. Absent significant progress in this area, sensitivity analysis such as that conducted here may inform policy better than GDP or alternative well-being indexes or aggregates.

Introduction

National income accounting has enjoyed preeminence in guiding policy since its inception, as noted by Repetto et al.:

> "Whatever their shortcomings, and however little their construction is understood by the general public, the national income accounts are undoubtedly one of the most significant social inventions of the twentieth century. *Their political and social impact can scarcely be overestimated*." (1989: 1, my emphasis)

Perhaps it is growing awareness of the "political and social impact" of GDP that has shifted attention in recent years to the limitations of per capita GDP growth[1] as an indicator of national well-being improvement. At least as important, however, is the increasingly widespread interest in sustainable development (e.g., Bartelmus, 1997; Common and Perrings, 1992; Perrings, 1995; Pezzoli, 1997).

Concerns about whether GDP growth implies or is even consistent with sustainable development center around two main issues: whether perpetual growth is physically *possible*, and, if so, the extent to which it is *desirable*. The latter question, which is the main focus in the article, is an inescapably normative matter. The "desirability" of GDP growth depends entirely on one's subjective definition of development (see, e.g., Dasgupta and Mäler, 2000; Lélé, 1991; Levett, 1998).

We have seen a few alternative well-being indexes such as the index of sustainable economic welfare (ISEW) and the genuine progress indicator (GPI) which seek to correct for some of the most salient weaknesses of GDP. Yet since the notion of well-being is so broad and encompassing, it is possible that merely devising another means of arriving at a quantitative standard (however significant an improvement over GDP) may not best inform policy. The approach followed here produces an array of possible outcomes, each depending on certain assumptions as well as different subjective perspectives.

Unlike earlier studies that develop measures of well-being incorporating inequality and environmental variables (Daly and Cobb, 1989; Prescott-Allen, 2001) the present study additionally employs the notion of "ecological inequality," meaning inequality in the distribution of the social cost associated with resource depletion. All three criteria, in addition to income per capita, figure in the well-being assessment methodology developed here. The method is applied to data from four developing countries: Brazil, Costa Rica, Indonesia, and the Philippines.

Significant variability in the results strongly suggests that well-being assessments are sensitive to the existing ecological distribution, as well as to the subjective perspective of the policymaker regarding the relative importance of the income growth realized by different population groups. The results imply, therefore, that the notion of ecological inequality (and especially its measurement) deserves much more attention given its importance to well-being. Until such data become readily available, however, sensitivity analysis may be superior to indexes or simple aggregates in informing policymakers, in that it may reveal how measured well-being is often itself sensitive to one's assumptions and perspectives.

Literature review

GDP growth as an index of well-being improvement has come under increased criticism in recent years. We can identify at least five major problems with GDP. First, income, while undoubtedly important, is only one dimension of well-being. Since it is all that it measures, GDP growth is too narrow as a proxy for well-being improvement. Here is a shortcoming that other indicators such as the Morris's (1980) physical quality of life index (PQLI), Prescott-Allen's (2001) real well-being indicator (RWI), and (perhaps most well known) the UNDP's perennial human development index (HDI) seek to address. Measures such as these account for such social variables as literacy, health, environmental quality, and "freedom," among many others. Yet precisely because they are all multi-dimensional expressions of well-being, they are to be seen as substitutes for – rather than revisions or refinements to – GDP.

Second, there are important benefits rendered outside the market that GDP ignores, and third, it is questionable whether some forms of income should be included in the measure. Family-provided child rearing, housework, and volunteer work are examples of services that provide a social benefit but do not figure in the income accounts. So-called defensive expenditures (see, e.g., Leipert, 1987; Røpke, 1997) that count but arguably should not refer to expenses that society undertakes in order to remedy negative environmental or social externalities (e.g., oil spill cleanups, high crime rates).

Such concerns possibly date back to the work of Nordhaus and Tobin (1972), and more recent studies on the ISEW and GPI (Daly and Cobb, 1989; Cobb et al., 1995) seek to correct for such problems by adding estimated benefits and subtracting estimated defensive expenditures from GDP. Unlike the social indicators mentioned earlier, the ISEW and GPI represent refinements to the GDP accounts. In other words, they are denominated in currency units and are thus directly comparable to GDP. Country case studies using such indicators (e.g., Castañeda, 1997; Stockhammer et al., 1997) consistently support the so-called "threshold hypothesis" (Max-Neef, 1995), or the idea that beyond a certain economic scale the additional cost of continued GDP growth exceeds the marginal benefits. I will have more to say about this shortly.

A distinct branch of the literature emphasizes a fourth problem with GDP, the fact that it includes the value of natural resource inputs used in production without a commensurate accounting for the reduction in the value of the overall stock of natural resources (e.g., Asheim, 2002; Bartelmus and Seifert, 2003; Harrison, 1989; Lutz, 1993). Economists, in other words, reduce GDP for depreciation – the decline in value of existing man-made capital – but make no adjustment in the case of "natural capital." The inconsistency means that the GDP approach calls income what is really consumption of wealth or capital. We have seen an abundance of competing perspectives that seek to address the problem.

Even the premise of environmental adjustments to GDP is not without controversy, as the United Nations' system of national accounts (SNA) has moved slowly even toward adoption of so-called "satellite accounts," in other words, natural resource accounts *not* to be combined with the income accounts. Many, on the other hand, have seen fit to integrate the two into a "green GDP," yet making notably different assumptions in measuring it. In their case studies, researchers at the World Resources Institute (WRI), such as Repetto et al. (1989), opt for the so-called "net price" approach to valuing natural resources, essentially treating a country's entire stock of a given resource as a fixed asset. The consequence is that the entire value of the depleted resource is subtracted from GDP in the same way that depreciation is subtracted from GDP to yield NDP. In contrast, the so-called "user cost" approach favored by researchers at the World Bank and others treats natural resource depletion as a reduction in inventories, with very different implications for the income accounts.[2]

Other approaches depart more from the mainstream, but are nonetheless worthy of consideration. The ecological economics literature has long distinguished between "weak" and "strong" sustainability, dating at least back to Daly (1991). Weak sustainability refers to a non-decreasing stock of total assets – that is, man-made plus natural assets – while strong sustainability additionally requires non-decreasing natural assets. The rationale here is that since there is limited substitutability between the two types of assets, no amount of man-made capital would be adequate if we depleted our natural resources beyond some critical point. Such concepts appear to have intensified interest in the valuation of ecosystems, with probably the best known effort here being the article by Costanza et al. (1997). While no doubt important, much more research is required in this area prior to any integration of more "holistic" ecological values into the income accounts.

The fifth and final GDP growth shortcoming is its silence on the question of inequality. GDP growth by itself tells us little about whether the entire, or even the majority of, the population is experiencing well-being improvements. Ahluwalia and

Chenery (1974) were among the first to note that GDP growth disproportionately counts the income growth of the wealthier segments of society, often masking more modest gains or even declines experienced by poorer groups.

Of the GDP weaknesses noted, the present study focuses on the last two: resource depletion and inequality. It is not the first such study. Indeed, one aspect that sets the ISEW and GPI apart from other alternatives to GDP is that they also make separate adjustments for (some types of) resource depletion and environmental damage as well as for distributional inequality. Yet the methodological approach employed in the present study is a departure from the ISEW and GPI, for several reasons.

First, the focus is on well-being improvements in developing countries. Contrary to the threshold hypothesis, most developing country case studies heretofore have not questioned whether GDP growth was desirable, only whether it was sustainable. In contrast, this study explores the extent to which growth in LDCs is conducive to well-being improvements. Second, published information for developing countries in the numerous ISEW and GPI categories (e.g., commuting costs, advertising expenses) is exceedingly difficult to come by (even for the industrialized countries that have been studied the estimates are often very rough). The scope is therefore limited to only a few variables.

Third, recent studies have called into question the reliability of the conclusions of recent ISEW and GPI studies. Neumayer (2000) offers several recommendations for improving methods for assessing resource depletion and environmental damage, finding that if one follows his recommendations the threshold hypothesis no longer holds in most country cases. He therefore concludes that support for the hypothesis is mostly an artifact of the methodological assumptions underlying the ISEW and GPI. Lawn (2003) arrives at a similar conclusion, although his demonstration that both indicators possess theoretically sound foundations is an important contribution to the literature. Finally, and perhaps most important, however significant an improvement over GDP the ISEW and GPI might represent, they nevertheless are uni-dimensional alternatives. Neither is at all sensitive to the vast uncertainty in many of the measurements undertaken, nor to the subjective valuations often involved. The methodology that developed here considers several possible well-being outcomes that reflect such sensitivity.

Inequality-resource depletion synthesis approach

My approach draws upon two distinct bodies of work. The first is the "green GDP" approach adopted by the WRI and seen in studies by Repetto et al. (1989), Solórzano et al. (1991), and Cruz and Repetto (1992) on Indonesia, Costa Rica, and the Philippines, as well as in a study by Torras (2000) on Brazil. Each study compares the estimated aggregate value of resource depletion in the respective country to GDP and gross domestic investment in the interest of assessing the extent to which the path followed in each country is welfare-enhancing and sustainable.[3]

Elkins (2000) and Pearce et al. (1996), among others, have argued that focusing only on the growth rates of green GDP says little or nothing about the sustainability or long-run viability of the growth path. Figure 1 illustrates. In three of the four cases, green GDP follows basically the same growth path as conventional GDP. The only way in which this would not hold is if the value of resource depletion relative to GDP varied significantly from one year to the next. This occurred only in the case of Indonesia. The green GDP growth patterns by themselves fail to reveal, for instance, that the trajectory followed by Brazil was much more intensive in the use of its natural resources than, say, Costa Rica, hence arguably less sustainable.

The relative magnitude of resource depletion not only plays an important role in determining sustainability but also in the well-being improvement outcomes. For this reason the ratios of overall resource depletion relative to GDP are provided in Figure 2. As can be seen, Indonesia and Brazil experienced substantial changes relative to the

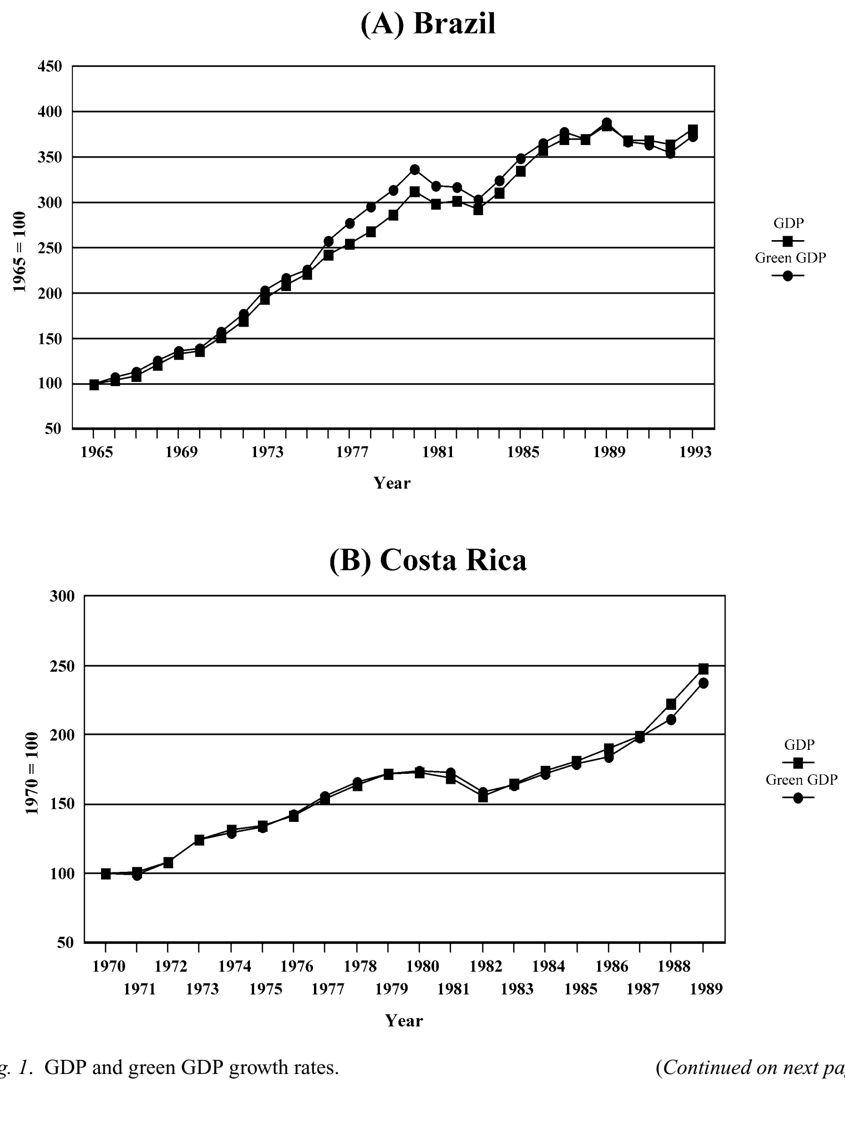
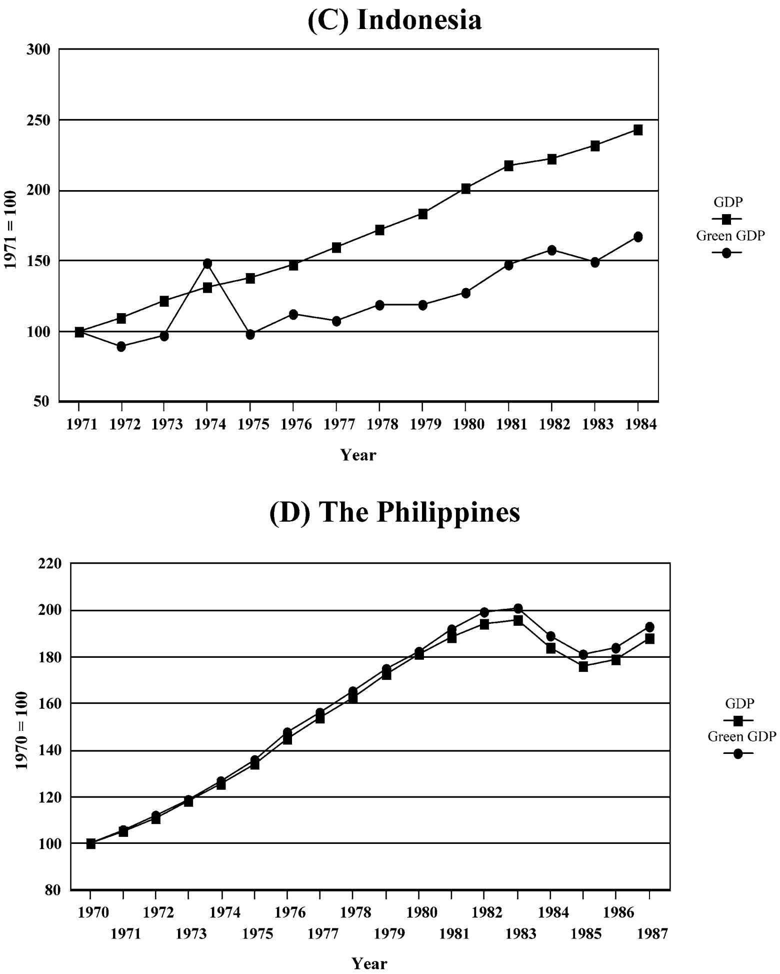


Fig. 1. GDP and green GDP growth rates. (*Continued on next page*)



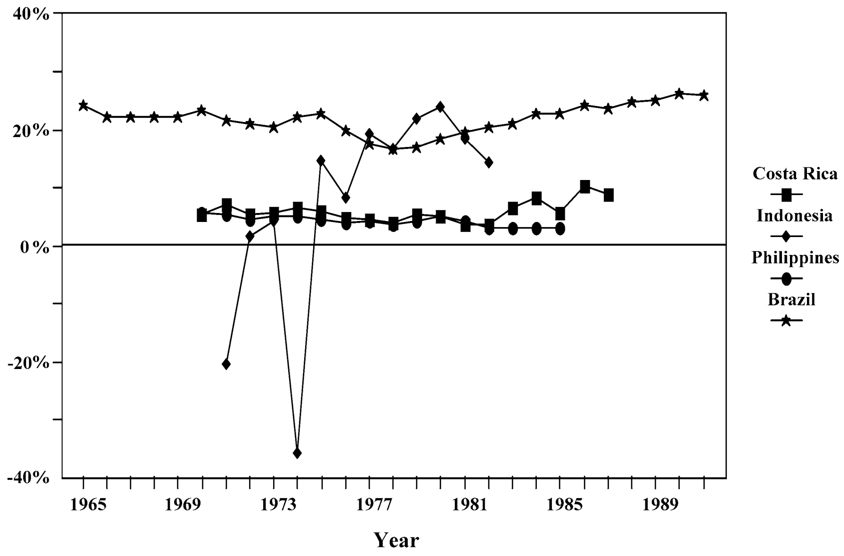
Sources: Cruz and Repetto (1992); Repetto *et al.* (1989); Solórzano *et al.* (1991); Torras (2000)

Fig. 1. (*Continued*)

other two countries, and the changes were far more volatile in the case of Indonesia, mostly because of discoveries of large petroleum deposits in 1971 and again in 1974.

It should be emphasized that selection of these case studies does not imply a preference for the WRI approach over any of the others discussed; indeed, resolving the debate is far beyond the scope of the article. Rather, these are chosen because to the author's knowledge they remain the most comprehensive green GDP studies conducted on developing countries, and are therefore most suitable for the decomposition technique adopted in what follows.

The second GDP alternative on which the study is based, that of Ahluwalia and Chenery (1974, hereafter A&C), adjusts "green GDP" for distributional inequality.



Sources: Cruz and Repetto (1992); Repetto *et al*. (1989); Solórzano *et al*. (1991); Torras (2000)

Fig. 2. Resource depletion as a percentage of GDP.

The authors were among the first to make explicit that the income growth of the wealthiest members of society carries greater weight than that of society's poorest in determination of GDP growth. Consider, for example, a case in which the wealthiest twenty per cent of the population garners two-thirds of all national income, while the poorest twenty per cent receives just two percent. In this situation the income growth rate of the richest quintile takes on about thirty-three times more weight, in the determination of GDP growth, than does the income growth rate of the poorest quintile.[4]

A&C recommend either "equal" or "poverty" weights as alternative schema for assessing national well-being improvement.[5] Supposing that we divided a population into quintiles, the equal weights scheme implies multiplying the income growth of each quintile by 20 percent and summing the products to obtain an alternative measure of "well-being growth." The poverty weights variant, in contrast, places greater weight on the income growth of the poorer groups, on grounds that the ability to meet society's basic needs carries greater social value than amenities or superfluous wants (see, e.g., Barrera, 1997). In their empirical study, A&C assigned the poorest 40 percent of the population in each country a weight of 0.6 and the wealthiest 20 percent only 0.1, with the remainder, 0.3, to the second and third quintiles combined. Here, the inverse of the weights implied by the conventional GDP growth measure were chosen, for purposes of symmetry. Either of these, however, or any one among many other possible schemes may be employed.

Table 1 displays the outcomes of applying the A&C methodology to our four countries of interest, for the corresponding periods covered in each of the earlier studies.[6] The first column of numbers (denoted "GDP weights") is really nothing more

Table 1. Alternative assessments of welfare change, Ahluwalia & Chenery method.

Country	GDP weights*	Equal weights	Poverty weights
Brazil (1965–1993)	2.6%	2.2%	1.8%
Costa Rica (1970–1989)	2.1%	2.3%	1.6%
Indonesia (1971–1984)	4.8%	4.9%	6.5%
Philippines (1970–1987)	1.2%	1.7%	2.5%

Sources: UNDP (1999); Author's calculations.
*Same as per capita GDP growth by definition.

than the average annual growth rate in income per capita for the relevant period in each country. It is labeled GDP weights to remind the reader that GDP growth implicitly places greater weight on the income growth of wealthier members of society.

The fact that the growth rate for Brazil is greatest (2.6 percent per annum) under GDP weights signifies that inequality generally worsened over the period studied. Placing greater weight on the income growth of the poor lowers the overall rate, signifying that poorer groups on the whole experienced less rapid (if not negative) income growth rates than the richer groups. It follows from this that inequality worsened.

The story is somewhat ambiguous for Costa Rica. The largest number comes from assuming equal weights, because the second and third richest quintiles experienced by far the most rapid income growth rates. Still, only the poorest quintile experienced negative growth, and this explains why the number drops so sharply (from 2.3% to 1.6%) when we place disproportionate weight on the income growth of the poor. Finally, judging from the numbers for Indonesia and the Philippines, inequality should have decreased over the respective time periods, as indeed was the case.

Its accounting for inequality in calculations of well-being change sets the A&C approach apart from many other well-being indicators. Certainly the WRI approach is among the latter, since it does not address the question of income distribution. Yet if the main weakness of the WRI approach is its silence on the question of inequality, the problem with the A&C method is its disregard for resource depletion and the more general question of sustainability.[7] Applying A&C's alternative weights scheme to the WRI's green GDP instead of to conventional GDP would therefore yield a more inclusive indicator of social progress than would either approach taken separately. Yet as discussed in what follows, merely combining the two methodologies gives rise to another problem.

Methodology: A note on ecological inequality

Applying A&C's weights to green rather than conventionally-measured GDP growth is a promising undertaking if for no other reason than that the product is a broader indicator of social progress or national well-being improvement. Yet such a hybrid indicator fails to address the separate question of how the depletion-related externalities or costs are distributed across the population – what Martinez-Alier (1995, 1997) has referred to as "ecological distribution" – and the bearing this may have on national well-being assessment.[8] Merely combining the WRI and A&C methodologies in fact implies that the total resource depletion externality is allocated disproportionately to the wealthy, since conventional GDP and aggregate natural capital depletion are combined (to form green GDP) prior to the disaggregating by population quintile. In other words, ecological distribution is assumed to immensely favor the poor.

Is this reasonable? If natural resources contribute significantly to wealth generation, it is fair to assume that the consequences of resource depletion are disproportionately felt by those who most benefit from their use (i.e., the wealthy). But is their relative suffering necessarily proportionate to the income shares? Here the case is more dubious, for the user cost associated with the depleted resource is in many cases but a fraction of the overall externality.

For example, unsustainable cutting of forest no doubt deprives (mostly wealthy) individuals of future income, but it also leads to river siltation and soil erosion. It is not at all clear that these effects favor the wealthy, and many would argue that the opposite is the case (see, e.g., Boyce, 1994; Dasgupta, 1995; Khan, 1997; Martinez-Alier, 1993). Likewise, rapid exhaustion of minerals is at the expense of future income streams, but also produces adverse safety or health effects (e.g., mercury poisoning). It would not be unreasonable to assign greater shares of such damage to the poorer groups, at least according to the environmental justice literature (e.g., Bullard, 2000; Davidson and Anderton, 2000; Ringquist, 1998) which consistently finds that pollution is often concentrated in areas mostly populated by poor or minority groups.

The field of political ecology – essentially a synthesis of political economy and human ecology – is the only area that has thus far attempted to deal directly with the question of ecological distribution. Political ecology is, in general, a body of scholarship that focuses on how existing social, political, and ideological institutions govern property rights, and how these in turn determine land-use patterns (Millikan, 1992; Schmink and Wood, 1987). But the mechanism through which different land use types generate different environmental outcomes – i.e., “winners” and “losers” – is also of fundamental importance (Bryant, 1992). A large hacienda owner in Brazil, for example, is likely to be less affected by the soil erosion resulting from the deforestation that his ranching activities require than the subsistence farmers trying to eke out a living.

Unfortunately, research on political ecology has thus far failed to produce a unique, coherent theory (Moore, 1993; Peet and Watts, 1993; Peluso, 1992). Thus not only are the ecological distribution figures that might be utilized for the proposed analysis unavailable, but also a sound theoretical framework on which to base any reasonable ecological distribution estimates. Any attempt to quantify ecological distribution is necessarily highly complex, as there no doubt are additional as yet not fully comprehended ecological effects that defy reliable monetary estimation (even in aggregate – never mind their distribution across the population). Yet we would be unable to continue with the analysis if we merely ignored the matter of ecological distribution.

I therefore adopt two alternative ecological distribution assumptions, in addition to the default assumption that ecological distribution favors the poor in proportion to their income share. The first, termed “equal weights,” involves dividing the total resource depletion externality into five equal parts that are then subtracted from the aggregate income of each quintile. The resulting growth rates for each quintile are then based on the change in income net of the value of the externality for each. For the second alternative, labeled "poverty weights," it is assumed that the poor suffer the greatest share of the total ecological externality, which is distributed according to the inverse of the GDP weights. In other words, the actual income shares displayed in Appendix Table 1 are again being used, but in this case to divide the resource depletion social cost.

One might object that the latter alternative is unrealistic; it would indeed be difficult to imagine a country with a severely unequal income distribution in which the ecological inequality favored the rich to the same degree. Yet, for reasons stated earlier, it is also unlikely that it would favor the poor to such a degree. The "true" ecological distribution will almost certainly be somewhere between these extremes in most countries, possibly close to the "equal weights." More important, however, in the presence of enormous uncertainty on the question it is useful to study a range of possibilities in order to gain insight into the sensitivity of overall well-being to the ecological distribution. The weights to be assigned are necessarily arbitrary; again, using the inverse of the income shares for the poverty weighting scheme at least provides some symmetry to the analysis.

In order to avoid confusion, it is important to distinguish in what follows between income weights – the same originally used by A&C – and ecological weights, or the alternative assumptions discussed above. "Green income" growth rates are calculated for the individual quintiles under each of these three sets of ecological weights, and weighted sums are taken based on GDP, equal, and poverty income weights. The result is a three-by-three matrix of nine alternative well-being measures.

The nine distinct outcomes reflect the inherent complexity in quantifying the notion of development or national well-being improvement. It should be stressed that because of the conceptual differences among them, there is no inconsistency in combining different weighting schemes. Poverty ecological weights can, for example, reasonably be combined with equal or GDP income weights, as can GDP ecological weights be coupled with equal or poverty income weights. The two weighting schemes apply to different aspects of the problem. Income weights define the relative importance to national well-being of the differential quintile growth rates. This is a normative issue, and all three scenarios are presented to demonstrate the effects of different normative stances. The ecological weights, in contrast, are used in quantifying the (proxy for) well-being for each quintile. While this is an objective matter in principle, the three alternative scenarios must be presented in the absence of adequate evidence to resolve it.

Despite the uncertainty, the sensitivity analysis described is at least a step in the direction of accounting for ecological distribution in well-being assessment. As we will see, combining the WRI and A&C methodologies produces a wider range of quantitative figures for well-being change than the A&C analysis on its own. The following section presents the results of the analysis.

Results

As discussed, the "green income" for each of the individual quintiles is computed by subtracting the quintile share of the social cost associated with the resource depletion (for which there are three scenarios) from the quintile income share. For these

Table 2. Green income growth rates, by quintile, under competing ecological distribution assumptions.

	Richest quintile	Second quintile	Third quintile	Fourth quintile	Poorest quintile
Brazil, 1965–1993					
GDP	2.8%	2.2%	2.3%	1.9%	1.5%
Equal	2.9%	2.1%	1.8%	−4.4%	−4.6%
Poverty	2.9%	2.3%	2.3%	−0.1%	−3.5%
Costa Rica, 1970–1989					
GDP	1.0%	3.6%	3.1%	2.5%	0.4%
Equal	1.1%	3.8%	3.1%	2.2%	−1.3%
Poverty	1.2%	3.8%	3.1%	1.9%	−1.6%
Indonesia, 1971–1984					
GDP	0.5%	1.3%	3.3%	5.6%	3.6%
Equal	2.2%	1.6%	2.0%	2.6%	−1.5%
Poverty	3.0%	2.9%	3.3%	1.8%	−15.6%
Philippines, 1970–1987					
GDP	1.0%	1.3%	1.9%	1.6%	3.6%
Equal	0.9%	1.3%	2.0%	1.9%	5.0%
Poverty	0.9%	1.2%	1.9%	1.9%	13.7%

Sources. Cruz and Repetto (1992), Repetto et al. (1989), Solórzano et al. (1991), Torras (2000) and UNDP (1999); Author's calculations.

numbers, the reader may consult Appendix Table A2. The resulting green income growth rates for each quintile for the each of the countries and the respective time periods are shown in Table 2.

The poorest 40 percent of the Brazilian population, already gaining far more slowly than the wealthier groups even in the absence of any adjustment, actually loses ground if we assume either equal or poverty ecological weights. The changes to the growth rates for the three richest quintiles are, by comparison, rather small. Accounting for the resource depletion cost has less of an impact on these groups because of their significantly higher income levels.

Only the poorest 20 percent of the Costa Rican population, in contrast, saw green income shrink from 1970 to 1989, and at a significantly slower annual rate than the same group in Brazil (−1.3% under equal weights and −1.6% under poverty weights). Also, unlike the case in Brazil where the richest 20 percent are gaining at the most rapid rate – and where inequality is unambiguously worsening population wide – in Costa Rica the middle three quintiles are gaining far more rapidly than the richest. The direction of the overall change in inequality is thus somewhat ambiguous.

In Indonesia the poorest 20 percent also suffer shrinking green income if we adopt either equal or poverty weights, albeit with a sizable difference between the two cases (−1.5% vs. −15.6%). The latter figure in the poverty weights case is really somewhat of an artifact of the period chosen to study. Indonesia actually had a sizable net *gain* in overall natural resource value in 1971 according to the WRI (Repetto et al., 1989) due in large part to discovery of sizable petroleum reserves.[9] Assuming poverty ecological weights, the effect is to make green income more than double conventional income for the poorest 20 percent. Since in 1984 there was a sizable loss, of which the majority was again allocated to the poorest quintile, this group's green income was barely ten percent of what it was in 1971.

As for the other quintiles, the second-poorest actually experienced the most rapid green income growth assuming GDP weights. This group is made unambiguously worse off relative to the richer ones, however, as we move from the GDP to the poverty ecological weights. While for the middle quintile there was little or no change (ignoring the equal weights scenario), the richest 40 percent of the population experienced more rapid green income growth under the equal and especially the poverty weights assumptions. The apparent greater sensitivity to the assumed ecological distribution, particularly for the wealthier quintiles, is not a surprise given that resource depletion accounted for a relatively large share of GDP over many of the years studied. This was also true for Brazil, but whereas the depletion-GDP ratio was reasonably consistent over time for the latter, Indonesia experienced significant volatility in this regard.

Finally, the Philippines exhibits remarkable consistency across the three ecological distribution assumptions, except, again, in the case of the poorest quintile. Annual income growth for this bottom 20 percent is much more rapid when the majority share of the social cost is allocated to it. This result, also a bit anomalous, is a consequence of the depletion deduction in 1970 (assuming poverty ecological weights) being nearly as large as gross income, creating an artificially low starting point for this quintile. Seventeen years later gross income for the group was much higher and their share of the social cost was actually lower.

The results of applying the A&C weights to the quintile growth rates are presented in Table 3. For three of the four countries (Costa Rica the exception), annual per capita "well-being improvement" appears to vary significantly across different assumptions. In the case of Brazil, if we limit ourselves to the two-by-two sub-matrix on the lower right (i.e., if we consider only equal or poverty weights in both dimensions), the well-being improvement rate is either negative or only marginally positive.

It is not surprising that the outcomes in the Costa Rican case vary little between equal and poverty ecological weights, since the individual quintile growth rates on which they are based are also very similar. The rate of well-being improvement assuming poverty income weights is in both cases, of course, much lower, since the poorest quintile was the only one to experience a negative growth rate under either assumption. Finally, in the GDP income weights column rates are either as high as or higher than in the other two columns because, again, the growth rates for the wealthier (though not the wealthiest) quintiles are higher.

The fact that the poverty income weights produces the most rapid well-being improvement rate for Indonesia (3.5% per annum compared with 1.8% assuming GDP income weights) indicates a reduction in inequality from 1971 to 1984. As noted earlier when A&C's weighting scheme is applied to conventional (i.e., non-adjusted) income, the more rapid income growth rates of the poorer quintiles are receiving a greater weight. Well-being improvement rates are lower in the sub-matrix on the lower right – negative assuming poverty ecological weights – and this is evidence that the increase in the resource depletion externality allocated to these poorer quintiles overwhelms their gains in gross income.

Table 3. Welfare improvement rates under alternative assumptions.

	Income weights		
	GDP	Equal	Poverty
(A) Brazil, 1965–1993			
GDP Ecological Weights	2.6%	2.1%	1.7%
Equal Ecological Weights	2.0%	−0.4%	−3.3%
Poverty Ecological Weights	2.4%	0.8%	−1.8%
(B) Costa Rica, 1970–1989			
GDP Ecological Weights	1.8%	2.1%	1.4%
Equal Ecological Weights	1.8%	1.8%	0.5%
Poverty Ecological Weights	1.8%	1.7%	0.2%
(C) Indonesia, 1971–1984			
GDP Ecological Weights	1.8%	2.8%	3.5%
Equal Ecological Weights	1.8%	1.4%	0.5%
Poverty Ecological Weights	1.5%	−0.9%	−5.7%
(D) The Philippines, 1970–1987			
GDP Ecological Weights	1.4%	1.9%	2.6%
Equal Ecological Weights	1.4%	2.2%	3.4%
Poverty Ecological Weights	1.7%	3.9%	8.0%

Sources. UNDP (1999), Author's calculations.

Finally, the Philippines is a highly unusual case in that the numbers increase for the most part moving from left to right as well as from top to bottom. This means that not only did inequality unambiguously diminish from 1970 to 1987 as indicated from Table 1, but that the overall resource depletion externality declined over time as well, relative to GDP. Placing greater weight on the anomalously high growth rate of the bottom 20 percent results in four of the five highest growth rates residing in the sub-matrix of equal and poverty weights assumptions. Consequently, we might conclude that GDP growth *under* stated progress in well-being improvement in the Philippines from 1970 to 1987, at least insofar as we limit ourselves to the inequality and ecological dimensions of the well-being problem.

Conclusion

Many consider GDP growth to be an inadequate proxy for well-being improvement. The preceding analysis attempted to show that not only can inequality and resource depletion independently impact on well-being, but that ecological distribution (i.e., both concerns simultaneously) can as well. There is an especially notable divergence between GDP growth and quantitative well-being improvement – except perhaps in the case of Costa Rica – when we consider only the equal and poverty weights possibilities for both the income and ecological dimensions of the problem.

In only three of four cases, however, do the results suggest that GDP growth overstates well-being improvement. In the case of the Philippines, measured well-being improved at a more rapid rate than GDP under *any* of the nine combinations of assumptions because both inequality and the average natural resource intensity of economic activity declined over the studied period. The opposite was true in the other countries, with especially stark outcomes for Brazil and Indonesia.

The disparity often found between GDP growth and well-being improvement implies a need to move away from GDP, or at least to diminish its policy relevance. Continued use of sensitivity analysis around different educated assumptions appears preferable to single indicators – GDP or variants thereof. Any significant variability in the multiple outcomes would appropriately signal a need for caution in the face of uncertainty, while relative consistency across different continua would provide more robust evidence than could any one-dimensional indicator.

None of this is to claim that the approach followed here is definitive – hardly, in fact, since it considers but a few possible dimensions of well-being. Yet the results of the analysis do suggest that ecological distribution is likely to bear significantly on overall national well-being. The greatest challenge in making the concept more operational will be to find methods that properly measure or otherwise quantify ecological distribution.

Martinez-Alier (1993) makes a convincing case that even estimating the dollar value of the social cost associated with resource depletion – to say nothing of the ecological distribution – is an inescapably subjective exercise since different population groups value the environment differently. Such an observation bodes ill for any hope of quantifying well-being along the lines suggested in this paper, though fortunately we need not adopt this extreme relativist view. Nor, however, should we embrace the opposite extreme – that is, a narrow indicator like GDP growth that ignores any normative or subjective considerations.

By accounting for the inherent subjectivity of the relative importance of the income growth of different population groups, the methodology presented in this paper represents a compromise between the extreme positions. And the fairly wide range in some of the outcomes appear to support the view that national well-being depends crucially not only on the degree of inequality and resource depletion, but as well on the ecological distribution. It therefore seems that, whatever the challenges and caveats, this under-researched area deserves greater attention.

Appendix

Table A1. Quintile income shares.

	Year	Poorest quintile	2nd quintile	3rd quintile	4th quintile	Richest quintile
Brazil	1965	0.032	0.066	0.103	0.19	0.608
	1993	0.024	0.054	0.096	0.174	0.653
Costa Rica	1970	0.053	0.081	0.114	0.157	0.595
	1989	0.04	0.091	0.143	0.219	0.507
Indonesia	1971	0.066	0.078	0.126	0.236	0.494
	1984	0.0825	0.125	0.1528	0.22	0.4197
Philippines	1970	0.036	0.087	0.122	0.208	0.547
	1987	0.052	0.091	0.133	0.206	0.518

Table A2. Decomposition of green GDP by quintile*

		Externality Per Capita			Green GDP Per Capita		
	(A) GDP per capita	(B) GDP ecological weights	(C) Equal ecological weights	(D) Poverty ecological weights	(E) GDP ecological weights [A–B]	(F) Equal ecological weights [A–C]	(G) Poverty ecological weights [A–D]
			(A) Brazil, 1965–1993				
1965							
Poorest Quintile	296.14	72.07	450.46	1,369.89	224.07	−154.32	−1,073.75
2nd Quintile	610.17	148.50	450.46	429.06	461.67	159.7	181.1
3rd Quintile	956.49	232.79	450.46	232.79	723.7	506.03	723.7
4th Quintile	1,762.98	429.06	450.46	148.50	1,333.92	1,312.52	1,614.48
Richest Quintile	5,628.74	1,369.89	450.46	72.07	4,258.85	5,178.28	5,556.67
1993							
Poorest Quintile	453.21	117.48	996.09	3,250.82	335.73	−542.87	−2,797.61
2nd Quintile	1,041.32	269.93	996.09	866.34	771.39	45.24	174.99
3rd Quintile	1,835.79	475.87	996.09	475.87	1,359.92	839.71	1,359.92
4th Quintile	3,342.12	866.34	996.09	269.93	2,475.79	2,346.04	3,072.19
Richest Quintile	12,540.93	3,250.82	996.09	117.48	9,290.10	11,544.84	12,423.45
			(B) Costa Rica, 1970–1989				
1970							
Poorest Quintile	14,177.71	755.87	2,868.16	8,527.81	13,421.84	11,309.55	5,649.91
2nd Quintile	21,854.06	1,165.13	2,868.16	2,254.72	20,688.93	18,985.90	19,599.34
3rd Quintile	30,710.18	1,637.29	2,868.16	1,637.29	29,072.89	27,842.02	29,072.89
4th Quintile	42,291.08	2,254.72	2,868.16	1,165.13	40,036.36	39,422.92	41,125.95
Richest Quintile	159,953.73	8,527.81	2,868.16	755.87	151,425.92	157,085.57	159,197.86

(*Continued on next page*)

Table A2. (*Continued*)

		Externality Per Capita			Green GDP Per Capita		
	(A) GDP per capita	(B) GDP ecological weights	(C) Equal ecological weights	(D) Poverty ecological weights	(E) GDP ecological weights [A–B]	(F) Equal ecological weights [A–C]	(G) Poverty ecological weights [A–D]
1989							
Poorest Quintile	15,814.63	1,408.82	7,044.10	17,856.80	14,405.81	8,770.53	−2,042.17
2nd Quintile	35,978.29	3,205.07	7,044.10	7,713.29	32,773.22	28,934.19	28,265.00
3rd Quintile	56,537.31	5,036.53	7,044.10	5,036.53	51,500.78	49,493.21	51,500.78
4th Quintile	86,585.11	7,713.29	7,044.10	3,205.07	78,871.82	79,541.01	83,380.05
Richest Quintile	200,450.47	17,856.80	7,044.10	1,408.82	182,593.67	193,406.36	199,041.65
(C) Indonesia, 1971–1984							
1971							
Poorest Quintile	15,199.35	−3,086.47	−9,352.94	−23,101.75	18,285.82	24,552.29	38,301.10
2nd Quintile	17,962.87	−3,647.65	−9,352.94	−11,036.46	21,610.52	27,315.81	28,999.34
3rd Quintile	29,016.94	−5,892.35	−9,352.94	−5,892.35	34,909.29	38,369.88	34,909.29
4th Quintile	54,349.20	−11,036.46	−9,352.94	−3,647.65	65,385.66	63,702.13	57,996.84
Richest Quintile	113,764.85	−23,101.75	−9,352.94	−3,086.47	136,866.60	123,117.78	116,851.32
1984							
Poorest Quintile	34,838.83	6,014.34	14,580.21	30,596.57	28,824.49	20,258.62	4,242.26
2nd Quintile	52,786.11	9,112.63	14,580.21	16,038.23	43,673.48	38,205.90	36,747.88
3rd Quintile	64,525.74	11,139.28	14,580.21	11,139.28	53,386.46	49,945.53	53,386.46
4th Quintile	92,903.55	16,038.23	14,580.21	9,112.63	76,865.32	78,323.34	83,790.92
Richest Quintile	177,234.63	30,596.57	14,580.21	6,014.34	146,638.06	162,654.42	171,220.30

(*Continued on next page*)

Table A2. (*Continued*)

		Externality Per Capita			Green GDP Per Capita		
	(A) GDP per capita	(B) GDP ecological weights	(C) Equal ecological weights	(D) Poverty ecological weights	(E) GDP ecological weights [A–B]	(F) Equal ecological weights [A–C]	(G) Poverty ecological weights [A–D]
			(D) The Philippines, 1970–1987				
1970							
Poorest Quintile	243.46	13.75	76.74	209.74	229.71	166.72	33.72
2nd Quintile	591.64	33.41	76.74	79.93	558.22	514.89	511.71
3rd Quintile	830.28	46.89	76.74	46.89	783.39	753.53	783.39
4th Quintile	1,415.31	79.93	76.74	33.41	1,335.38	1,338.57	1,381.90
Richest Quintile	3,713.93	209.74	76.74	13.75	3,504.19	3,637.19	3,700.18
1987							
Poorest Quintile	432.06	13.49	51.87	134.44	418.57	380.18	297.62
2nd Quintile	756.1	23.60	51.87	53.34	732.50	704.23	702.76
3rd Quintile	1,105.07	34.49	51.87	34.49	1,070.57	1,053.19	1,070.57
4th Quintile	1,708.76	53.34	51.87	23.60	1,655.43	1,656.89	1,685.16
Richest Quintile	4,306.78	134.44	51.87	13.49	4,172.35	4,254.91	4,293.30

*Units represent the local currency in constant prices, with the respective base year being the terminal year in the corresponding period studied.

Notes

1. For simplicity, "GDP growth" hereafter signifies per capita GDP growth.
2. Only a fraction of the value of the resource is taken to be true income, so the reduction to the income accounts is far more modest. For a detailed and illuminating comparison of the two approaches, see Young and Serôa da Motta (1995).
3. Actually, each considers only a subset, consisting in each case of the three most economically important natural resources. In Indonesia these are petroleum, timber, and soil, while in Costa Rica and the Philippines they are timber, soil, and fisheries.
4. This is *not* to say that GDP growth weights individual dollars differently across income groups – it does not. While many may feel that a dollar is worth more to a poor than to a rich person, it is a separate matter, since GDP growth obviously weights all dollars equally. However, since wealthier groups have many more dollars, the growth rate that *their income class* experiences carries much greater weight in determining the overall GDP growth rate than does the growth rate of poorer groups.
5. The objection might be raised that doing so requires interpersonal utility comparisons, a practice considered unacceptable in neoclassical welfare economics (see, e.g., Harberger, 1984). Yet the same objection applies to the conventional or "GDP" weights, or indeed to any quantitative indicator of social welfare that aggregates individual characteristics. Developing national-level well-being indicators is inescapably a normative exercise because some value judgment regarding the relative importance of each social group cannot be avoided.
6. The GDP and poverty weights are based on the quintile income shares for each country, which are found in Appendix Table A1. Since the income growth rates are the annual average for the respective periods covered – that is, they are not for any one particular year – I used the average of the income shares at the beginning and the end of the period for each case. Where income distribution data were not available for a specific year, the numbers for the year which was closest to it were used.
7. Although, to be fair, sustainable development was not nearly as visible an issue at the time of their writing as at present.
8. Martinez-Alier (1995: 520) distinguishes among three types of ecological distribution: social, spatial, and temporal. Social ecological distribution, the only one of the three considered in this paper, refers to *within-country* inequality in resource depletion or pollution burden. Spatial ecological distribution implies *cross-country* inequality in exposure to natural resource depletion or environmental degradation, and temporal ecological distribution signifies *cross-generational* inequality in the distribution of these costs.
9. As noted by an anonymous reviewer, the practice of counting natural capital appreciation resulting from discoveries as income is questionable to say the least. While doing so may be valid in an accounting sense, there is nothing "economic" about merely discovering that one is richer. The problem points to a flaw in the original WRI studies upon which the present work is based, but attending to it is beyond my present scope.

References

Ahluwalia, M. and H. Chenery (1974). 'The economic framework,' in H. Chenery, M. Ahluwalia, C. L. G. Bell, J. H. Dully, and R. Jolly, eds., *Redistribution with Growth*, London: Oxford University Press, pp. 38–51.

Asheim, G. (2002). 'Green national accounting for welfare and sustainability: A taxonomy of assumptions and results', Center for Economic Studies, Working Paper Series No. 827.

Barrera, A. (1997). 'Degrees of unmet needs in the *Superfluous Income* Criterion,' *Review of Social Economy* 55: 460–486.

Bartelmus, P. (1997). 'Whither economics? From optimality to sustainability?,' *Environment and Development Economics* 2: 323–345.

Bartelmus, P. and E. Seifert (2003). *Green Accounting*, The International Library of Environmental Economics and Policy Series, Aldershot: Ashgate Press.

Boyce, J. K. (1994). 'Inequality as a cause of environmental degradation,' *Ecological Economics* 11: 169–178.
Bullard, R. (2000). *Dumping in Dixie: Race, Class, and Environmental Quality*, 3rd ed., Boulder: Westview Press.
Bryant, R. L. (1992). 'Political ecology: An emerging research agenda in third-world studies', *Political Geography* 11: 12–36.
Castañeda, B. (1997). 'An index of sustainable economic welfare (ISEW) for Chile,' Institute of Ecological Economics, Solomons, MD, pp. 34.
Cobb, C., T. Halstead and J. Rowe (1995). 'If GDP is up, why is America down?,' *Atlantic Monthly* 276: 59–78.
Common, M. and C. Perrings (1992). 'Towards an ecological economics of sustainability,' *Ecological Economics* 6: 7–34.
Costanza, R., R. d'Arge, R. de Groot, S. Farber, M. Grasso, B. Hannon, K. Limburg, S. Naeem, R. V. O'Neill, H. Paruelo, R. G. Raskin, P. Sutton and M. van den Belt (1997). 'The value of the world's ecosystem services and natural capital', *Nature* 15: 253–260.
Cruz, W. and R. Repetto (1992). *The Environmental Effects of Stabilization and Structural Adjustment Programs: The Philippines Case*, Washington, DC: World Resources Institute.
Daly, H. (1991). *Steady-State Economics*, 2nd ed., Washington D.C. and Covelo: Island Press.
Daly, H. and J. Cobb (1989). *For the Common Good: Redirecting the Economy towards Community, the Environment, and a Sustainable Future*, Boston: Beacon Press.
Dasgupta, P. (1995). 'Economic development and the environment: Issues, policies, and the political economy', in M.G. Quibria, ed., *Critical Issues in Asian Development*, Oxford: Oxford University Press, pp. 160–185.
Dasgupta, P. and K. Mäler (2000). 'Net national product, wealth, and social well-being', *Environment and Development Economics* 5: 69–93.
Davidson, P. and D. Anderton (2000). 'Demographics of dumping II: A national environmental equity survey and the distribution of hazardous materials handlers', *Demography* 37: 461–466.
Ekins, P. (2000). *Economic Growth and Environmental Sustainability: The Prospects for Green Growth*, New York: Routledge.
Harberger, A. C. (1984). 'Basic needs versus distribution weights in social cost-benefit analysis', *Economic Development and Cultural Change* 32: 455–474.
Harrison, A. (1989). 'Introducing natural capital into the SNA', in Y. J. Ahmad, S. El Serafy and E. Lutz, eds., *Environmental Accounting for Sustainable Development*, Washington, DC: World Bank, pp. 19–25.
Khan, H. A. (1997). 'Ecology, inequality, and poverty: The case of Bangladesh', *Asian Development Review* 15: 164–179.
Lawn, P. (2003). 'A theoretical foundation to support the index of sustainable economic welfare (ISEW), Genuine progress indicator (GPI), and other related indexes,' *Ecological Economics* 44: 105–118.
Leipert, C. (1987). 'A critical appraisal of gross national product: The measurement of net national welfare and environmental accounting', *Journal of Economic Issues* 21: 357–373.
Lélé, S. (1991). 'Sustainable development: A critical review', *World Development* 19: 607–621.
Levett, R. (1998). 'Sustainability indicators – integrating quality of life and environmental protection,' *Journal of the Royal Statistical Society* 161: 291–302.
Lutz, E., ed. (1993). *Towards Improved Accounting for the Environment*, Washington, DC: World Bank.
Martinez-Alier, J. (1993). 'Distributional obstacles to international environmental policy: The failures at rio and prospects after rio,' *Environmental Values* 2: 97–124.
Martinez-Alier, J. (1995). 'Distributional issues in ecological economics,' *Review of Social Economy* 53: 511–528.
Martinez-Alier, J. (1997). 'Some issues in agrarian and ecological economics, in memory of georgescu-roegen,' *Ecological Economics* 22: 225–238.
Max-Neef, M. (1995). 'Economic growth and quality of life: A threshold hypothesis,' *Ecological Economics* 15: 115–118.
Millikan, B. H. (1992). 'Tropical deforestation, land degradation, and society: Lessons from Rondônia, Brazil,' *Latin American Perspectives* 19: 45–72.
Moore, D. S. (1993). 'Contesting Terrain in Zimbabwe's Eastern Highlands: Political Ecology, Ethnography, and Peasant Resource Struggles,' *Economic Geography* 69: 380–401.

Morris, D. (1980). *Measuring the Condition of the World's Poor: The Physical Quality of Life Index*, New York: Pergamon Press for the Overseas Development Council.

Neumayer, E. (2000). 'On the Methodology of ISEW, GPI, and Related Measures: Some Constructive Comments and Some Doubt on the Threshold Hypothesis,' *Ecological Economics* 34: 347–361.

Nordhaus, W. and J. Tobin (1972). 'Is Growth Obsolete?' in M. Moss (ed.), *The Measurement of Economic and Social Performance, Studies in Income and Wealth*, Vol. 38, National Bureau of Economic Research.

Pearce, D., K. Hamilton, and G. Atkinson (1996). 'Measuring Sustainable Development: Progress on Indicators,' *Environment and Development Economics* 1: 85–101.

Peet, R. and M. Watts (1993). 'Introduction: Development Theory and Environment in an Age of Market Triumphalism,' *Economic Geography* 69: 227–253.

Peluso, N. L. (1992). 'The Political Ecology of Extraction and Extractive Reserves in East Kalimantan, Indonesia,' *Development and Change* 23: 49–74.

Perrings, C. (1995). 'Ecology, economics, and ecological economics,' *Ambio* 24: 60–64.

Prescott-Allen, R. (2001). *The Well-Being of Nations*, Washington DC: Island Press.

Pezzoli, K. (1997). 'Sustainable development: A transdisciplinary overview of the literature,' *Journal of Environmental Planning and Management* 40: 549–74.

Repetto, R., W. Magrath, M. Wells, C. Beer and F. Rossini (1989). *Wasting Assets: Natural Resources in the National Income Accounts*. Washington DC: World Resources Institute.

Ringquist, E. (1998). 'A question of justice: Equity in environmental litigation, 1974–1991,' *Journal of Politics* 60: 1148–1165.

Røpke, I. (1997). 'Economic growth and the environment – or the extinction of the GDP Dinosaur,' in A. Tylecote and J. van der Straaten (eds.), *Environment, Technology, and Economic Growth: The Challenge to Sustainable Development*, Cheltenham: Edward Elgar, pp. 55–72.

Schmink, M. and C. H. Wood (1987). 'The "Political Ecology" of Amazonia,' in P. D. Little, M. M. Horowitz and A. E. Nyerges, eds., *Lands at Risk in the Third World: Local-Level Perspectives*, Boulder: Westview Press, pp. 38–57.

Solórzano, R., R. De Camino, R. Woodward, J. Tosi, V. Watson, A. Vásquez, C. Villalobos and J. Jiménez (1991). *Accounts Overdue: Natural Resource Depreciation in Costa Rica*, Washington DC: World Resources Institute.

Stockhammer, E., H. Hochreiter, B. Obermayr and K. Steiner (1997). 'The index of sustainable economic welfare (ISEW) as an alternative to GDP in measuring economic welfare. The results of the Austrian (revised) ISEW calculation 1955–1992,' *Ecological Economics* 21: 19–34.

Torras, M. (2000). 'Sustainability or natural capital "Disinvestment?' A retrospective on brazilian development, 1965–1993,' *Estudos Econômicos* 30: 351–375.

UNDP (1999). *Human Development Report*, United Nations Development Programme Reports.

Young, C. E. F. and R. Serôa da Motta (1995). 'Measuring sustainable income from mineral extraction in Brazil,' *Resources Policy* 21: 113–125.